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INTERNATIONAL METEOROLOGICAL TABLES

Edited by S. LETESTU

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NOTE

FORM FOR NOTING NEW SETS OF TABLES RECEIVED

Set No.	Dated	Inserted in the publication	
		by	date
Amend N°1	March 1968	F. G.	13.6.73
Second set	April 1968	F. G.	13.6.73
Amend N°2	July 1973	F. G.	4.6.74
Third set	July 1973	F. G.	4.6.74

PREFACE

The first edition of the International Meteorological Tables was published in 1890 in response to a wish expressed by the International Meteorological Congress which met in Rome in 1879. These tables have not been reprinted and more recent requirements have had to be met by the various tables produced by national Meteorological Services and institutes. The question of a new edition of the International Meteorological Tables was first raised at the first session of the Commission for Aerology (Toronto, 1953) when it was suggested that the Executive Committee might establish a panel of experts to consider the matter in detail. This was done, and subsequently various working groups and panels of experts helped in the preparatory work on the tables. Dr. S. Letestu of the Swiss Meteorological Service was appointed full-time editor in 1965.

The need for the new International Meteorological Tables was twofold. In the first place it was felt that there should be a set of tables established in conformity with the various definitions and physical values adopted by WMO ; such a publication would, it was thought, complement other WMO publications, in particular the Technical Regulations. The second reason was to provide tables suitable for use by both meteorologists and scientists of other disciplines for documentation and routine meteorological work. In order to make sure that the tables were a practical working instrument, therefore, it was necessary to take into account not only the standard WMO practices but also the current usages of meteorologists and other scientists.

Thus particular care had to be taken in the choice of units listed in Table I — "Units, Dimensions and Conversion Factors". Only metric units were chosen, with a few rare exceptions (such as the knot) which had been accepted by WMO ; units of the International System were given preference whenever possible. Where no physical value had been adopted officially by WMO, those adopted by the competent international organization were used ; where there were no internationally adopted values, the most recent and reliable ones were chosen. The sources of all values used are given in the references.

Use has been made of existing tables wherever possible ; in particular some of the Smithsonian Meteorological Tables have been either directly reproduced or recalculated with the necessary unit conversions. The other tables have been computed by various national Meteorological Services. The source of each table is indicated and information is also given about the method of computation for each new table.

The loose-leaf form of presentation has been chosen to facilitate the insertion of further tables as they appear and the replacement of those which become out-of-date.

Grateful acknowledgements are offered to the members of the panel of experts and of the various working groups on the International Meteorological Tables. The first working group, which was composed of Mr. L. P. Harrison (U.S.A.), Mr. H. C. S. Thom (U.S.A.) and Mr. G. A. Bull (United Kingdom), with Dr. L. Dufour (Belgium) as chairman, conducted a survey among the various

national Meteorological Services and drew up the first list of tables, with orders of priority. A panel of experts, composed of Dr. L. Dufour, Mr. L. P. Harrison and Mr. Khrgian (U.S.S.R.) then continued the work of the previous group. Three members of a new working group, Dr. D. J. Bouman (Netherlands) (chairman), Dr. L. Dufour and Mr. R. J. List (U.S.A.), met in Geneva in 1963 and prepared detailed directives for each of the first set of tables. They also laid down some general principles valid for all the tables. At its fourth session (Brussels, 1965), the Commission for Aerology continued the mandate of the group to serve as an advisory body for further work on the tables.

WMO is grateful to all the persons and institutions already mentioned and to the many others, too numerous to list here, whose co-operation has made possible the publication of the first set of tables. The experts consulted about each table and the Services or bodies which computed it or authorized its reproduction are, however, mentioned in the introduction to it.

This publication was prepared in the Research Section of the Technical Division of the WMO Secretariat.

Geneva, May 1966

D. A. Davies
Secretary-General

GENERAL REMARKS

Presentation of numerical tables

The numerical tables are photographic reproductions of the original documents, mainly automatic print-out from computers. This process was chosen to avoid misprints, but it causes some lack of uniformity in the presentation of the tables and also in the typography of figures.

Conventions for the writing of numbers

In tables common to both the English and the French versions, the decimal sign between the integer part and the decimal part of numbers is a point.

To facilitate the reading of large numbers the figures are grouped in threes, the groups being separated by a space without comma or point.

Symbols

The mathematical symbols are those in general use (see Introduction 1.1, section 11). It should be remembered in particular that :

log means the logarithm to the base 10 (decadic logarithm) ;

ln means the logarithm to the base e (natural logarithm).

Although the international symbol for the second is s, the abbreviation sec, widely used in English, has been retained in the English version of the IMT for consistency with other WMO publications.

Interpolation

Linear interpolation can be used with a sufficient accuracy when the second differences between successive tabular values do not exceed 4 units of the last significant figure. The introductions mention the tables, or parts of tables, in which linear interpolation is practicable.

Abbreviations

The following abbreviations are used for works to which frequent reference is made :

WMO TR : 'WMO TR: WMO Technical Regulations (WMO – No. 49), Volume I, 1971 edition; Volume II, 3rd edition, 1970; Volume III, first edition, 1971."

IMT : International Meteorological Tables.

SMT : Smithsonian Meteorological Tables, 6th edition. Smithsonian Institution, Washington, 1951.
(The number following the abbreviation SMT indicates the number of the table.)

> Throughout, replace:
> "degree Kelvin" by "kelvin"
> the symbol "°K" by the symbol "K"
> the symbol "sec" by the symbol "s"

NOTE ON GEOPOTENTIAL UNITS

Tables on atmospheric dynamics and atmospheric statics related to geopotential (Tables 2.3.1, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7 and 3.12) have been prepared using the geopotential metre (gpm) as the unit of geopotential. In consequence of the adoption of the standard geopotential metre (m′), the definition of which appears in Table 1.1, section 19 (Amend. (VII, 1973)), a conversion of units should be made in the above-mentioned tables when greater precision is required.

The relationship between the standard geopotential metre (m′) and the geopotential metre (gpm) is:

$$1\ \mathrm{m}' = \frac{9.806\,65}{9.8}\ \mathrm{gpm},$$

which implies that if $H_{m'}$ is a geopotential expressed in standard geopotential metres and H_{gpm} the same geopotential expressed in geopotential metres, then

$$H_{m'} = \frac{9.8}{9.806\,65} H_{gpm}$$

or

$$H_{gpm} - H_{m'} = \Delta$$

with

$$\Delta = \left(1 - \frac{9.8}{9.806\,65}\right) H_{gpm} = 0.000\,678\,11\ H_{gpm}$$

$$= \left(\frac{9.806\,65}{9.8} - 1\right) H_{m'} = 0.000\,678\,57\ H_{m'}.$$

Note that the difference Δ is small, less than one per thousand, and can be ignored in most applications.

The following table gives the value of Δ as a function of geopotential H_{gpm}; $H_{m'}$ can also be taken as argument, the resulting error being negligible.

H_{gpm} or $H_{m'}$	Δ	H_{gpm} or $H_{m'}$	Δ	H_{gpm} or $H_{m'}$	Δ
100	0.1	1 000	0.7	10 000	6.8
200	0.1	2 000	1.4	20 000	13.6
300	0.2	3 000	2.0	30 000	20.3
400	0.3	4 000	2.7	40 000	27.1
500	0.3	5 000	3.4	50 000	33.9
600	0.4	6 000	4.1	60 000	40.7
700	0.5	7 000	4.7	70 000	47.5
800	0.5	8 000	5.4	80 000	54.2
900	0.6	9 000	6.1	90 000	61.0

CONTENTS OF THE FIRST, SECOND AND THIRD SET

Introduction to Table 1.1

UNITS, DIMENSIONS AND CONVERSION FACTORS

1 *Coherent systems of units*

Units might be chosen arbitrarily, but this would tend to lead to the appearance of several additional numerical factors in the equations between the numerical values of physical quantities. A more convenient method is to define a system of units in such a way that the equations between the numerical values have exactly the same form as the corresponding equations between quantities. A unit system defined in this way is called *coherent* in relation to the system of quantities and equations in question.

2 *The International System of Units*

The "International System of Units", name adopted by the Conférence générale des Poids et Mesures [1] (CGPM-11, 1960), is a coherent system of units founded on the seven basic units:

the metre,
the kilogramme,
the second,
the ampere,
the kelvin,
the candela,
the mole,

for the basic quantities of length, mass, time, electric current, temperature, luminous intensity and amount of substance. By abbreviation this system is referred to as the system of *SI units* (*unités SI* in French).

3 *Basic units*

Definitions of the seven basic units are given below: [2]

3.1 *Unit of length*

The metre is the length equal to 1 650 763.73 wavelengths in a vacuum of the radiation corresponding to the transition between the level $2p_{10}$ and $5d_5$ of the atom of krypton 86 (CGPM-11, 1960).

3.2 *Unit of mass*

The kilogramme is the unit of mass; it is represented by the mass of the International Kilogramme Prototype (CGPM-3, 1901).

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[1] Henceforth referred to as CGPM.
[2] The original French text is reproduced exactly in the French version of the IMT.

3.3 *Unit of time*

The second is the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium-133 atom (CGPM-13, 1967/1968).

3.4 *Unit of electric current*

The ampere is the strength of a constant current which, flowing through two linear parallel conductors of infinite length, of negligible cross-section, placed in a vacuum at a distance of 1 m from each other, would cause between these conductors a force equal to 2×10^{-7} MKS units of force for every metre of length (CGPM-9, 1948).

NOTE: The MKS unit of force is the newton.

3.5 *Unit of temperature*

The kelvin, unit of thermodynamic temperature, is the fraction 1/273.16 of the thermodynamic temperature of the triple point of water (CGPM-13, 1967/1968).

NOTE: The name "kelvin" and the symbol "K" replaced the name "degree Kelvin" and the symbol "°K" in 1967.

3.6 *Unit of luminous intensity*

The candela is the luminous intensity, in the perpendicular direction, of a surface of 1/600 000 square metre of a black body at the temperature of freezing platinum under a pressure of 101 325 newtons per square metre (CGPM-13, 1967/1968).

3.7 *Unit of amount of substance*

The mole is the amount of substance of a system which contains as many elementary entities as there are atoms in 0.012 kilogrammes of carbon 12; its symbol is "mol".

When the mole is used, the elementary entities must be specified and may be atoms, molecules, ions, electrons, other particles, or specified groups of such particles (CGPM-14, 1971).

NOTE: The mole was introduced as a basic unit in 1971.

4 *Temperature scales*

The basic temperature is the *thermodynamic temperature*, symbol T, the unit of which is the kelvin, symbol K. Its definition is given in section 3.5.

The *Celsius temperature*, symbol t, is defined by:

$$t = T - 273.15 \text{ K}$$

The unit employed to express a Celsius temperature is the degree Celsius, symbol °C, which is equal to the kelvin.

International Practical Temperature Scale of 1968 (IPTS-68) [1], [2]

For the purpose of practical measurements, the Comité international des Poids et Mesures adopted, in 1968, a scale of temperatures based on: (1) a number of defining fixed points that can be reproduced with high accuracy (in particular the triple point of water and the normal boiling point of water which are assigned the temperatures of 0.01 °C and 100 °C respectively); (2) standard instruments calibrated at those temperatures; and (3) certain procedures for interpolation. This scale is chosen in such a way that the temperature measured on it closely approximates the thermodynamic temperature.

The International Practical Temperature Scale of 1968 distinguishes between the International Practical Kelvin Temperature with the symbol T_{68} and the International Practical Celsius Temperature with the symbol t_{68}, the relation between T_{68} and t_{68} is

$$t_{68} = T_{68} - 273.15 \text{ K}$$

NOTE 1: The official French text of the IPTS-68 is published in *Comptes rendus des séances de la treizième Conférence générale des Poids et Mesures*, Annexe 2; the English text can be found in *Metrologia*, Vol. 5, No. 2.

NOTE 2: This scale replaces the International Practical Temperature Scale of 1948 (amended edition of 1960).

5 *The fundamental unit of energy and its relation to other units of energy*

The fundamental unit of energy is the *joule* (CGPM-9, 1948). If for one reason or another the use of the abandoned unit *calorie* cannot be avoided, the author himself is obliged to denote which conversion factor to joules should be applied (see Table 1.1, section 17).

6 *Relative atomic or molecular mass*

6.1 Until recently two definitions of relative atomic mass were used :

(*a*) *The physical definition* based on the convention that the exact value of 16 should be given to the relative atomic mass of the nuclide ^{16}O.

(*b*) *The chemical definition* based on the convention that the exact value of 16 should be given to the relative atomic mass of the natural mixture of isotopes O.

6.2 The values of the relative atomic mass A of any element (and thus of the relative molecular mass of a substance) under physical and chemical definition are related by the formula:

$$A \text{ (phys.)} = 1.000\,275\, A \text{ (chem.)}$$

6.3 The General Assemblies of the International Union of Pure and Applied Physics and of the International Union of Pure and Applied Chemistry came to a compromise in their sessions of 1960 and 1961, and a new definition, called the *unified definition*, has been given.

In the unified definition the exact value of 12 is adopted for the relative atomic mass of the nuclide ^{12}C.

The conversion factors to be used are:

$$A\ (\text{unif.}) = A\ (\text{phys.}):\ (1.000\,317\,917 \pm 0.000\,000\,017)$$

$$A\ (\text{unif.}) = A\ (\text{chem.}):\ (1.000\,043 \pm 0.000\,005)$$

(see E. R. Cohen and C. W. M. Dumond, *Rev. Mod. Phys.*, *37*, 537–594. October 1965).

6.4 The fourteenth Conférence générale des Poids et Mesures decided (Resolution 3) in 1971 to introduce the mole as a basic unit in the International System of Units with the definition appearing in section 3.7.

6.5 Also in consequence of the unified definition, the definition has been given of a new concept called the *(unified) atomic mass constant.* The atomic mass constant equals 1/12 of the rest mass of an atom of nuclide ^{12}C. This constant is taken to be the (unified) atomic mass unit, symbol u:

$$1\ \text{u} = \text{atomic mass constant} = 1.660\,44 \times 10^{-27}\ \text{kg}\ ^{(1)}$$

Thus the rest mass of an atom (or a molecule) can be expressed in kilogrammes or in atomic mass units, u; the numerical value of this mass expressed in u equals the relative atomic (or molecular) mass of the element (or substance) under consideration.

NOTE 1: This is the 1963 value as quoted in the ISO International Standard 31/IX-1973; see also Table 1.1, section 29.2, note 1.

7 *Use of prefixes*

Instead of exponentials on base 10, it is customary to use prefixes.

Prefixes indicating decimal multiples or submultiples of Units

Multiple	*Prefix*	*Symbol*
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10	deca	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

8 *Dimensions*

The dimensions of the basic units for length, mass, time, temperature, electric current and luminous intensity are respectively denoted in this table by

$$L, M, T, \Theta, I, J$$

9 *Units used in the IMT*

In general only metric units are used in IMT, except for other units recognized by WMO. In Table 1.1, however, conversion factors for conversion of non-metric units to metric units are also given, restricted to those which are or have been of some importance in meteorology. For units which have become obsolete the Table météorologique internationale (Comité météorologique internationale, Paris, 1890) may be consulted.

10 *Contents of tables*

For each quantity, Table 1.1 generally first gives the SI unit with its definition and an indication of dimension in the basic units, then the other metric units, and finally the conversion factors for the non-metric units.

11 *References*

ISO * International Standards:

31/I–1965	*Basic quantities and units of the SI and quantities and units of space and time.* 2nd Edition, replacing R 31/I–1956.
Erratum	Erratum of first printing December 1965.
31/II–1958	*Quantities and units of periodic and related phenomena.*
31/III–1960	*Quantities and units of mechanics.*
31/IV–1960	*Quantities and units of heat.*
31/V–1965	*Quantities and units of electricity and magnetism.*
31/VI–1973	*Quantities and units of light and related electromagnetic radiations.*
31/VII–1965	*Quantities and units of acoustics.*
31/VIII–1973	*Quantities and units of physical chemistry and molecular physics.*
31/IX–1973	*Quantities and units of atomic and nuclear physics.*
31/X–1973	*Quantities and units of nuclear reactions and ionizing radiations.*
31/XI–1961	*Mathematical signs and symbols for use in the physical sciences and technology.*
1000–1973	*Rules for the use of units of the international system of units and a selection of the decimal multiples and sub-multiples of the SI units.*

* ISO = International Organisation for Standardization (Organisation internationale de normalisation).

International Union of Pure and Applied Physics. Commission for Symbols, Units and Nomenclature. Document UIP 11 (SUN 65-3 (1965)), *Symbols, units and nomenclature in physics.*

* * *

Table 1.1 and its introduction were drawn up by the Working Group on International Meteorological Tables established by Resolution 9 (CAe-III).

Introduction to Table 2.2

THE BEAUFORT WIND SCALE

Whereas wind speed is generally measured by the speed of the horizontal motion of the air, the Beaufort scale provides a measure of the force of the wind with reference to its effects on the surface. For this purpose classes are defined according to certain specifications such as waves, spray, etc., and numbered (Beaufort number or force). The force of the wind is described by the number of the class, the specifications for which correspond to the effects observed. The Beaufort scale is therefore a discrete scale.

The wind force scale was introduced in about 1806 by Admiral Sir Francis Beaufort, who used specifications relating to the rigging of a man-of-war. This method of assessing wind force became generally accepted among sailors, who used more or less subjective specifications. In 1927 Captain Petersen gave a description of the objective specifications for the assessment of wind force at sea according to the Beaufort scale, and this description served as a basis for the international specifications which are given in Table 10.1 of the Guide to Instrument and Observing Practices (WMO – No. 8. TP. 3). Table 6.2 of the same publication gives the parallel specifications for observation on land. These specifications are reproduced below.

The Beaufort scale is still in general use among sailors both as a matter of tradition and because it is representative of the state of the sea and conditions of navigation, but for such a scale to be of use in meteorology the equivalents of Beaufort numbers must be established in terms of wind speeds measured by instruments according to the standard practices (Guide to Instrument and Observing Practices, Chapters 6 and 10, section 10.2). This equivalence has been studied statistically by comparing Beaufort forces observed on the basis of the above-mentioned specifications with wind speeds measured by instruments. Complicated by the fact that instrument measurements are not made at ground- or sea-level but at a given height, the question has given rise to much discussion, especially in the case of high Beaufort numbers (9 to 12), where statistical data are few. Several tables of equivalents have been put forward but have not met with general approval.

Table 2.2 gives the speed equivalent ~~speeds~~ ~~for~~ to Beaufort numbers — in m sec^{-1} and knots — * ~~recommended by a small majority at the fourth session of the Commission for Maritime Meteorology in 1964 (Recommendation 5). This recommendation will not come into force until it has been adopted by the Executive Committee.~~

Note : The Beaufort forces 13 to 17 introduced by the "International Meteorological Committee" in 1946, were not retained by CMM II.

* as they appear in WMO Pub N° 9 TP 4, Volume B
– Weather Reports – Codes.

Table 2.2 Beaufort wind scale
Echelle anémométrique Beaufort

Beaufort number *Chiffre Beaufort*	Mean speed equivalent at a standard height of 10 m above sea-level or above open flat ground *Equivalence de vitesse moyenne à une hauteur standard de* 10 m *au-dessus du niveau de la mer ou au-dessus d'un terrain plat découvert*	
	m s^{-1}	knots *nœuds*
0	0 – 0.2	< 1
1	0.3 – 1.5	1 – 3
2	1.6 – 3.3	4 – 6
3	3.4 – 5.4	7 – 10
4	5.5 – 7.9	11 – 16
5	8.0 – 10.7	17 – 21
6	10.8 – 13.8	22 – 27
7	13.9 – 17.1	28 – 33
8	17.2 – 20.7	34 – 40
9	20.8 – 24.4	41 – 47
10	24.5 – 28.4	48 – 55
11	28.5 – 32.6	56 – 63
12	≧ 32.7	≧ 64

Introduction to Table 2.3

GEOSTROPHIC WIND

Geostrophic wind is the wind, in horizontal frictionless motion, calculated when the Coriolis horizontal force is assumed equal and opposite to the ~~pressure horizontal force.~~ force of the horizontal pressure gradient.

Table 2.3.1 — Geostrophic wind for constant pressure surfaces

The geostrophic wind equation on a constant pressure surface, using hydrostatic approximation, is :

$$V_g = \frac{G}{f}\frac{\partial \Phi}{\partial n}$$

where Φ is the geopotential on the surface, n any direction on this surface, V_g the geostrophic wind component perpendicular to n, f the Coriolis parameter and G a coefficient depending on the units of geopotential used ($G = 9.8$ if Φ is expressed in geopotential metres).

If the contours are drawn for intervals of geopotential $\Delta\Phi$ expressed in geopotential metres, the above equation becomes :

$$V_g \text{ (m sec}^{-1}) = 8.817\,95 \times 10^{-5} \frac{1}{f}\frac{\Delta\Phi}{\Delta n}, \qquad V_g \text{ (knots)} = 1.714\,07 \times 10^{-4} \frac{1}{f}\frac{\Delta\Phi}{\Delta n}$$

where Δn is the distance, measured in mean degrees of latitude (1), between the intersections of n with two consecutive contours.

If the direction n is chosen perpendicular to the contours, Δn becomes the contour spacing and V_g the speed of the geostrophic wind.

The four tables 2.3.1 give the values of V_g in m sec^{-1} and in knots for 40 and 60 gpm contour intervals. V_g is expressed as a function of the latitude and of the distance Δn between the contours, Δn being measured both in mean degrees of latitude and in kilometres.

These tables can be used for other intervals since V_g is proportional to the contour intervals ($\Delta\Phi$ in geopotential metres) and inversely proportional to the contour spacing (Δn). For example, if the contours are drawn for intervals $\Delta\Phi = 50$ gpm, V_g may be found by multiplying the tabular values of V_g for $\Delta\Phi = 40$ gpm by $\frac{50}{40}$. If the intervals between the contours are 40 gpm but values of V_g are required over greater contour spacing Δn, 15 mean degrees of latitude for instance, merely multiply the tabular values of V_g for 10 mean degrees of latitude by $\frac{10}{15}$:

$$V_g \text{ (knots)} = 6.1 \times \frac{10}{15} = 4.1 \text{ knots for latitude 50 degrees.}$$

Table 2.3.2 — Geostrophic wind for constant level surfaces

The geostrophic wind equation on a surface of constant geopotential is :

$$V_g = \frac{1}{f\rho}\frac{\partial p}{\partial n}$$

where p is the pressure on the surface, n any direction on this surface, V_g the geostrophic wind component perpendicular to n, f the Coriolis parameter and ρ the density of the air.

On a constant level surface where the isobars are drawn for pressure intervals Δp and where the density of air is 1 kg m^{-3}, the above equation becomes :

$$V_g \text{ (m sec}^{-1}) = 8.997\,9 \times 10^{-4} \frac{1}{f}\frac{\Delta p}{\Delta n}, \qquad V_g \text{ (knots)} = 1.749\,05 \times 10^{-3} \frac{1}{f}\frac{\Delta p}{\Delta n}$$

where Δn is the distance, measured in mean degrees of latitude (1), between the intersections of n with two consecutive isobars.

If the direction n is chosen perpendicular to the isobars, Δn becomes the isobar spacing and V_g the speed of the geostrophic wind.

The four tables 2.3.2 give the values of V_g both in m sec^{-1} and in knots for 4 and 5 mb isobar intervals ; V_g is expressed as a function of the latitude and of the distance Δn between the isobars, Δn being measured both in mean degrees of latitude and in kilometres.

These tables can be used for other intervals since V_g is proportional to the isobar intervals (Δp in mb) and inversely proportional to the isobar spacing (Δn). For example, if the isobars are drawn for intervals of 3 mb, V_g may be found by multiplying the tabular values of V_g for $\Delta p = 4$ mb by $\frac{3}{4}$. If the intervals between isobars are 4 mb but values of V_g are required over greater isobar spacing, 15 mean degrees of latitude for instance, merely multiply the tabular values of V_g for 10 mean degrees of latitude by $\frac{10}{15}$:

$$V_g \text{ (knots)} = 6.3 \times \frac{10}{15} = 4.2 \text{ knots for latitude 50 degrees.}$$

As the geostrophic wind is inversely proportional to the density of the air and the tables are computed for a density of 1 kg m^{-3} (corresponding to the average density at about 2 km above sea-level) the geostrophic wind for any density can be found by dividing the geostrophic wind values in the tables by the density expressed in kg m^{-3}. Thus for a density of 0.85 kg m^{-3} when $\Delta p =$ 4 mb and $\Delta n = 2$ mean degrees of latitude, at 50 degrees of latitude :

$$V_g \text{ (knots)} = \frac{31.3}{0.85} = 36.8 \text{ knots}$$

Table 2.3 has been computed by the U.S. Weather Bureau on an IBM 7094 computer ; the programme, established in Fortran code, is kept at the WMO Secretariat.

NOTE 1 : The length of the mean degree of latitude is taken in this computation as 1/90 of one quarter of the terrestrial meridian, i.e. 1/90 of 10 002 288 m = 111 137 m according to the international ellipsoid of reference (more recent measurements of the Earth show differences, but too small to affect tabulated values of V_g).

Though the true length of a degree of latitude varies slightly with latitude, it can be used instead of the mean degree of latitude for the measurement of Δn at a given place, the maximum error resulting for V_g being of the order of 0.5 %.

These considerations are not applicable when Δn is measured in km.

Introduction to Table 2.4

GRADIENT WIND

The gradient wind is the wind, in horizontal frictionless motion, calculated when assuming no tangential acceleration.

The gradient wind V is related to the geostrophic wind by the following equation :

$$V = \frac{rf}{2}\left(-1 + \sqrt{1 + \frac{4V_g}{rf}}\right) \tag{1}$$

where V_g is the geostrophic wind (see Table 2.3), f the Coriolis parameter, and r the radius of curvature of the trajectory, using the convention that r is positive for cyclonic curvature and negative for anticyclonic curvature.

Note that the rf parameter has the dimension of speed ($L \times T^{-1} = LT^{-1}$) and that the relation (1) is independent of the units employed provided that rf, V_g and V are expressed in the same units.

Tables 2.4.1.1 and 2.4.1.2 show the values of the rf parameter as a function of the latitude and of the radius of curvature r expressed both in mean degrees of latitude and in kilometres (Table 2.4.1.1 for rf expressed in m sec^{-1} and Table 2.4.1.2 for rf in knots). As the rf parameter is linear in r, it is easy to find rf for values of r not quoted in the table, by simple addition (e.g. for $r = 23$ degrees, add the values of rf for 20 degrees to those for 3 degrees).

Table 2.4.2 shows values of the gradient wind V as a function of the geostrophic wind V_g and of the rf parameter according to equation (1). Though the table is dimensionless, care must be taken to maintain consistant units for V_g, rf and V. It is in two parts.

Table 2.4.2.1 is for use when the curvature is cyclonic.

Table 2.4.2.2 is for use when the curvature is anticyclonic.

In the latter case only real values of V must be considered, so

$$1 + \frac{4V_g}{rf} \geqq 0$$

If this condition is not fulfilled the values of V are complex numbers and the gradient wind cannot be defined : the wind would not flow along the isobars or contours. At the limit, $1 + \frac{4V_g}{rf} = 0$, V becomes critical :

$$V_{\text{critical}} = 2V_g$$

and $$|rf|_{\text{critical}} = 4V_g.$$

Directions for use of the Tables

(1) Determine the geostrophic wind from Table 2.3 (30 m sec^{-1} for instance).

(2) Determine the radius of curvature r of the trajectory (12 mean degrees of latitude for instance). Then, in Table 2.4.1, find the value of rf (in the same units as V_g) for the radius of curvature r and the latitude of the given point (such as $rf = 159$ m sec^{-1} for a latitude of 55°).

(3) Find the value of V for V_g and rf in Table 2.4.2 (cyclonic or anticyclonic curvature as the case may be). V is expressed in the same units (in this example $V = 26$ m sec^{-1} for cyclonic curvature and $V = 40$ m sec^{-1} for anticyclonic curvature).

Table 2.4 has been computed by the U.S. Weather Bureau on an IBM 7094 computer ; the programme, established in Fortran code, is kept at the WMO Secretariat.

Introduction to Table 2.5

THE CORIOLIS PARAMETER AND THE ROSSBY PARAMETER

The Coriolis parameter f appears in the equations of motion on the Earth on account of the Coriolis acceleration due to the rotation of the Earth (see Introductions to Tables 2.3 and 2.4); f is dependent only on the latitude φ and its value is given by

$$f = 2\omega \sin \varphi$$

where ω is the angular velocity of the Earth.

The Rossby parameter β is the rate at which the Coriolis parameter increases for a northward displacement l on the Earth, $\beta = \frac{\mathrm{d}f}{\mathrm{d}l}$, i.e.

$$\beta = \frac{2\omega \cos \varphi}{R}$$

where R is the radius of the Earth.

The β parameter takes its importance from Rossby's long-wave formula for a sinusoidal perturbation on a zonal current:

$$U - c = \frac{\beta L^2}{4\pi^2}$$

where U is the velocity of an undisturbed zonal current,
c is the phase velocity of the sinusoidal perturbation,
L is the wavelength of the perturbation,
β is assumed to be constant with latitude for a given current.

This formula is valid on the assumption of a frictionless, homogeneous and incompressible atmosphere in horizontal motion.

Table 2.5 gives values of f and β for each degree of latitude. Linear interpolation is practicable throughout the table.

The following constants have been used in the computation:

$$\omega = \frac{2\pi}{1 \text{ sideral day}} = \frac{2\pi}{86\,164.1} = 7.292\,116 \times 10^{-5} \text{ rad sec}^{-1}$$ (see Table 1.1, section 4)

$$R = 6\,371\,229 \text{ m}$$

R is the mean radius of the international ellipsoid of reference. Most recent values of R differ from the above value by about 4 parts in 10^5; such differences are too small to affect the tabulated values of β.

Table 2.5 has been computed by the U.S. Weather Bureau on an IBM 7094 computer; the programme, established in Fortran code, is kept at the WMO Secretariat.

Introduction to Table 3.1

THE RELATION BETWEEN GEOPOTENTIAL AND GEOMETRIC HEIGHT

Geopotential Φ, expressed in geopotential metres (see the definition of the geopotential metre, Table 1.1, section 19), is found by means of the equation :

$$\Phi = \frac{1}{9.8} \int_0^z g \mathrm{d}Z \tag{1}$$

where g is the acceleration of gravity and Z the geometric height.

To integrate equation (1), let us assume, as a first approximation, that g is given by Newton's inverse square law :

$$g = g_\varphi \frac{R^2}{(R+Z)^2} \tag{2}$$

where g (in m sec^{-2}) is the acceleration of gravity for the height Z and the latitude φ, g_φ (in m sec^{-2}) is the acceleration of gravity at mean sea-level for the same latitude φ, and R (in metres) is the length of the Earth's radius at the given latitude.

Incorporating this value of g into equation (1) and integrating, we get :

$$\Phi = \frac{g_\varphi . R}{9.8} \left(\frac{Z}{R+Z}\right) \tag{3}$$

or

$$Z = \frac{R.\Phi}{\left(\frac{g_\varphi R}{9.8}\right) - \Phi} \; . \tag{4}$$

The first approximation is rather crude because the expression chosen for g would be valid only if the Earth were a non-rotating sphere composed of shells of equal density.

In the equations (2) and (3), g and Φ are given as a function of the actual acceleration of gravity at mean sea-level, g_φ. An improvement can be made by introducing the condition that the vertical gradient of g must be equal to the actual vertical gradient at mean sea-level.

To fulfil this condition, let us replace R by a fictitious value R' and differentiate equation (2) with respect to Z :

$$\frac{\partial g}{\partial Z} = -2 g_\varphi \frac{R'^2}{(R'+Z)^3}$$

whence, for $Z = 0$,

$$R' = \frac{2 g_\varphi}{-\left(\frac{\partial g}{\partial Z}\right)_{Z=0}} \; .$$

The approximation taken for g, equation (2), is sufficiently accurate when R is replaced by R', because the values of g and its vertical gradient at mean sea-level are made to correspond with the values calculated on the ellipsoid with allowance for the distribution of densities and for centrifugal acceleration. Now the equations (3) and (4) between the geopotential Φ and the geometric height Z fulfil two boundary conditions, i.e. for the first and the second partial derivative of Φ with respect to Z when $\Phi = Z = 0$; this gives a satisfactory approximation for the relationship between geometric height and the geopotential up to about 600 km. For great heights, the more advanced theory of Helmert[1] is more reliable.

The notion of geopotential loses its meaning for altitudes where g becomes zero and changes sign, i.e. where centrifugal force equals and then exceeds the force of attraction. In the plane of the Equator this occurs at a distance from the centre of the Earth of 6.6 times the Earth's radius. For high levels the notions of geographical latitude and altitude must be treated with circumspection, as geometric height is no longer measured along a line perpendicular to the terrestrial surface but along a line of force of g.

Calculation of the vertical gradient of gravity at mean sea-level

Let V be the gravitational potential of the Earth and ω its angular velocity; in the x, y, z co-ordinate system where the z axis is taken as the axis of rotation, the full expression of the gravity potential W is:

$$W = V + \frac{\omega^2}{2}(x^2 + y^2) \tag{5}$$

If we take the laplacian of W, knowing that the laplacian of the gravitational potential is nil for every external point ($\nabla^2 V = 0$), we obtain:

$$\nabla^2 W = 2\omega^2.$$

On the other hand, geometrical considerations (see for instance R. Wavre: *Figures planétaires et géodésie*, Gauthier-Villars, Paris, 1932, pp. 49–52) lead to the following equation:

$$\nabla^2 W = -\left(\frac{\partial g}{\partial Z}\right)_{Z=0} - g_\varphi C \tag{6}$$

where C is twice the mean curvature of the Earth's surface, i.e.

$$C = \frac{1}{M} + \frac{1}{N},$$

M and N respectively being the radii of curvature of the ellipsoid in the meridian plane and in a vertical plane perpendicular to it.

Now we get $\frac{\partial g}{\partial Z}$ from equations (5) and (6):

$$-\left(\frac{\partial g}{\partial Z}\right)_{Z=0} = g_\varphi \left(\frac{1}{M} + \frac{1}{N}\right) + 2\omega^2 . \tag{7}$$

[1] Helmert, F. R., *Die mathematischen und physikalischen Theorien der höheren Geodäsie*, Vol. 2, 1886.

ω is a constant and $\frac{1}{M}$ and $\frac{1}{N}$ depend only on the form of the ellipsoid and the latitude, viz. :

$$\frac{1}{M} = \frac{(1 - e^2 \sin^2 \varphi)^{3/2}}{a(1 - e^2)}, \qquad \frac{1}{N} = \frac{(1 - e^2 \sin^2 \varphi)^{1/2}}{a}$$

where a is the semi-major axis of the Earth and e the eccentricity.

Developing in series and keeping only the terms containing powers of e less than or equal to 4, we obtain :

$$\frac{1}{M} + \frac{1}{N} = \frac{2}{a}(c_0 + c_1 \cos 2\varphi + c_2 \cos 4\varphi)$$

where $c_0 = 1 + 5/32\, e^4$,
$c_1 = 1/2\, e^2 + 5/16\, e^4$,
$c_2 = 1/32\, e^4$.

On the other hand, the expression of g_φ (see Table 3.8.2) is :

$$g_\varphi = 9.806\,16\,(1 - 0.002\,637\,3 \cos 2\varphi + 0.000\,005\,9 \cos^2 2\varphi) \text{ m s}^{-1}.$$

Thus calculating $\frac{1}{M} + \frac{1}{N}$ for the international ellipsoid of reference ($a =$ 6 378 388 m and $e^2 = 0.006\,722\,670\,02$), taking $\omega = 7.292\,116 \times 10^{-5}$ sec^{-1}, and entering these values in equation (7) we obtain :

$$-\left(\frac{\partial g}{\partial Z}\right)_{Z=0} = 3.085\,462 \times 10^{-6} + 2.27 \times 10^{-9} \cos 2\varphi - 2 \times 10^{-12} \cos 4\varphi. \quad (8)$$

NOTE : This method was worked out by L. P. Harrison from a suggestion by W. D. Lambert. The calculation of $\frac{\partial g}{\partial Z}$ at mean sea-level (equation 8) is given in an unpublished manuscript by W. D. Lambert of which a copy is kept at the WMO Secretariat.

Description and use of the Tables

Table 3.1.1 provides values of the quantities R' and $\frac{g_\varphi R'}{9.8}$ as a function of latitude φ. The last figure in the tabular values is not significant but makes it possible to obtain a smoother interpolation, mainly for high altitudes. Linear interpolation may only affect the accuracy of the last figure, except for the values of $\frac{g_\varphi R'}{9.8}$ when $\varphi < 25^\circ$ and $55^\circ < \varphi < 70^\circ$ where the figure for the tens may be in error by one unit.

To calculate Φ as a function of Z, or conversely Z as a function of Φ, merely replace R and $\frac{g_\varphi R}{9.8}$ in equations (3) and (4) by the values given in the table for R' and $\frac{g_\varphi R'}{9.8}$.

Examples :

(1) Given a station at latitude $\varphi = 51^o10'$ and height $Z = 1\,384.4$ metres, by interpolating the tabular values we obtain $R' = 6\,360\,942$ m and $\frac{g\varphi R'}{9.8} =$ 6 368 529 gpm ; entering these values in equation (3) we get $\Phi = 1\,385.7$ gpm.

(2) Given a point at latitude $\varphi = 20^o30'$ with a geopotential of $\Phi = 6\,400.0$ gpm, by interpolating the tabular values we obtain $R' = 6\,340\,216$ m and $\frac{g\varphi R'}{9.8}$ = 6 331 593 gpm ; entering these values in equation (4) we get $Z = 6\,415.2$ m.

Table 3.1.2 gives the value of the geopotential Φ directly as a function of latitude φ and geometric height Z.

Table 3.1.3 gives the value of geometric height Z directly as a function of latitude φ and geopotential Φ.

In both of these tables, tabular values with arguments exceeding 200 000 gpm or 200 000 m are uncertain by approximately one unit in the last figure.

Linear interpolation according to altitude or geopotential is practicable without restriction for arguments of less than 30 000 ; between 30 000 and 130 000, errors of one unit in the last figure may result ; above 130 000 only the last figure may be affected.

Tables 3.1.1, 3.1.2 and 3.1.3 are reproductions of the SMT 49, 50 and 51.

Introduction to Tables 3.2, 3.3 and 3.4

GEOPOTENTIAL DIFFERENCES BETWEEN ISOBARIC SURFACES AS A FUNCTION OF PRESSURE AND OF MEAN VIRTUAL TEMPERATURE

The difference of geopotential $\Delta\Phi$, expressed in geopotential metres, between two surfaces of constant pressure p_1 and p_2 is given by the relation (derived from the hydrostatic equation) :

$$\Delta\Phi = \frac{R}{9.8} T_{mv} \ln \frac{p_1}{p_2} \qquad (1)$$

where R is the gas constant for dry air, expressed in J kg^{-1} ^{o}K^{-1}, and T_{mv} is the mean virtual temperature, expressed in ^{o}K, between the given isobaric surfaces. The mean virtual temperature is defined as the mean of the virtual temperature T_v according to the logarithm of pressure :

$$T_{mv} = \int_{p_2}^{p_1} T_v \, d \ln p \Big/ \int_{p_2}^{p_1} d \ln p.$$

Equation (1) can also be written :

$$\Delta\Phi = \frac{R}{9.8} \frac{1}{\log e} (273.15 + t_{mv}) \log \frac{p_1}{p_2} \qquad (2)$$

where t_{mv} is the mean virtual temperature expressed in ^{o}C.

As the following value has been adopted for R (Resolution 17(Cg–III), see WMO TR, Appendix C, section 9) :

$$R = 287.05 \text{ J kg}^{-1} \, {}^{o}\text{K}^{-1},$$

equation (2) is reduced to :

$$\Delta\Phi = 67.445 \, (273.15 + t_{mv}) \log \frac{p_1}{p_2} \text{ gpm.} \qquad (3)$$

Geopotential differences between selected isobaric surfaces as a function of mean virtual temperature (Tables 3.2 and 3.3)

Tables 3.2 and 3.3 give the difference of geopotential (in geopotential metres) between two selected isobaric surfaces as a function of the mean virtual temperature of the layer between these surfaces. The two tables differ only in the choice of isobaric surfaces.

To obtain the difference of geopotential between two given pressure surfaces, the first step is to determine the mean virtual temperature of the layer, then to look up in the table the value of $\Delta\Phi$ corresponding to the given layer (pressure on its boundary surfaces) and to the mean virtual temperature (for layer 850–700 mb and $t_{mv} = -8^{o}$C, for example, Table 3.3 gives $\Delta\Phi = 1\,508$ gpm).

Table 3.2 — Geopotential differences between consecutive isobaric surfaces as a function of mean virtual temperature

This table gives the thicknesses (differences of geopotential) between consecutive isobaric surfaces. Increments are 50 mb between 1 050 and 200 mb, 25 mb between 200 and 100 mb, 10 mb between 100 and 10 mb and 5 mb between 10 and 5 mb. The difference of geopotential between two non-consecutive isobaric surfaces not appearing in Table 3.3 is obtained by breaking this layer into layers bounded by consecutive isobaric surfaces and by finding the difference of geopotential for each of these layers as a function of the mean virtual temperature, then merely adding the thickness of these layers — for example $\Delta\Phi(700/550) = \Delta\Phi(700/650) + \Delta\Phi(650/600) + \Delta\Phi(600/550)$.

Table 3.3 — Geopotential differences between pairs of standard isobaric surfaces as a function of mean virtual temperature

This table gives the differences of geopotential:

(*a*) between consecutive standard isobaric surfaces, and

(*b*) between selected pairs of non-consecutive standard isobaric surfaces.

Since pressure in equation (3) appears only as a ratio, it is not necessary to repeat tabular values for all combinations of pressures (for example 500/400 = 250/200). When a pressure ratio appears for the second time, therefore, the reader is referred to the corresponding layer already given.

Table 3.3 is used to establish directly the relative topography of layers between two standard isobaric surfaces as a function of mean virtual temperature; conversely, it can serve in the determination of the mean virtual temperature of a layer between two standard isobaric surfaces as a function of thicknesses (for example, in the 700/500 mb layer, for a thickness of 2 568 gpm, the mean virtual temperature will be 12.6°C).

A table showing mean virtual temperature as a function of the differences of geopotential between standard isobaric surfaces is planned for the second set of the IMT.

Geopotential differences between standard isobaric surfaces and surfaces of given pressure (Table 3.4)

Table 3.4 is intended for use in the calculation of the geopotential difference between any constant pressure surface and the standard isobaric surface immediately above or below. This geopotential difference is a function of the pressure of the isobaric surface in question and the mean virtual temperature of the layer.

Equation (3) can be written:

$$\Delta\Phi = \Delta\Phi_0 + \Delta\Phi_t \qquad (4)$$

where $\Delta\Phi_0$ is the geopotential difference between the isobaric surfaces having a pressure of p_1 and p_2 for a mean virtual temperature of 0°C,

$$\Delta\Phi_0 = 67.445 \times 273.15 \log \frac{p_1}{p_2} = 18\,422.6 \log \frac{p_1}{p_2} \text{ gpm}$$

and where $\Delta\Phi_t$ is a correction depending on $\Delta\Phi_0$ and on the mean virtual temperature of the p_1p_2 layer,

$$\Delta\Phi_t = \Delta\Phi_0 \frac{t_{mv}}{273.15} \text{ gpm.}$$

Table 3.4.1 gives the geopotential difference $\Delta\Phi_0$, expressed in gpm, for a mean virtual temperature of 0°C, between a surface of constant pressure p_1 and the standard isobaric surface p_2 = 1 000 and 850 mb immediately above, as a function of p_1. Table 3.4.1′ is the same as the one before as regards the 1 000 mb isobaric surface but with smaller intervals between pressure arguments (0.1 mb).

Table 3.4.2 gives geopotential differences, expressed in gpm, for a mean virtual temperature of 0°C between a constant pressure surface p_2 and the standard isobaric surface p_1 immediately below, as a function of the pressure p_2.

Table 3.4.3 gives the correction $\Delta\Phi_t$, expressed in gpm, as a function of the mean virtual temperature t_{mv} and the geopotential difference $\Delta\Phi_0$; the intervals of $\Delta\Phi_0$ are 10 gpm between 0 and 1 000 gpm and 1 000 gpm between 1 000 and 5 000 gpm. We should note that $\Delta\Phi_t$ is proportional to $\Delta\Phi_0$ so that the values of $\Delta\Phi_t$ corresponding to values of $\Delta\Phi_0$ over 1 000 gpm are found by simple addition ; for example, if $\Delta\Phi_0$ = 2 340 gpm, find in the table the values of $\Delta\Phi_t$ for $\Delta\Phi_0$ = 2 000 gpm and $\Delta\Phi_0$ = 340 gpm, and add these two values together. The correction $\Delta\Phi_t$ takes the same sign as the mean virtual temperature t_{mv}.

To find the geopotential difference between a surface of constant pressure p_1 (for instance p_1 = 1 028 mb and the standard isobaric surface immediately above (in this example p_2 = 1 000 mb) :

(1) Find in Table 3.4.1 or 3.4.1′ the value of $\Delta\Phi_0$ corresponding to the given pressure p_1 = 1 028 mb for the isobaric surface p_2 = 1 000 mb, or $\Delta\Phi_0$ = 221 gpm.

(2) Find the mean virtual temperature of the layer between the surfaces p_1 = 1 028 mb and p_2 = 1 000 mb, for example t_{mv} = 17°C. Then, in Table 3.4.3, read off the value of $\Delta\Phi_t$ corresponding to $\Delta\Phi_0$ = 221 gpm and t_{mv} = 17°C, i.e. $\Delta\Phi_t$ = 14 gpm.

(3) The geopotential difference is then obtained by adding $\Delta\Phi_t$ to $\Delta\Phi_0$, or $\Delta\Phi = 221 + 14 = 235$ gpm.

To calculate the geopotential difference between a surface of constant pressure p_2 and the standard isobaric surface immediately below (p_1), the same procedure is followed with Table 3.4.2 instead of Table 3.4.1. For instance, if p_2 = 207 mb and p_1 = 300 mb, Table 3.4.2 reads $\Delta\Phi_0$ = 2 969 gpm ; for a mean virtual temperature t_{mv} = —43°C, Table 3.4.3 gives for $\Delta\Phi_t$ the value of $\Delta\Phi_t$ = — (153 + 315) = — 468 gpm. The geopotential difference will thus be : $\Delta\Phi$ = 2 969 — 468 = 2 501 gpm.

Computation of the geopotential of any isobaric surface

To calculate the geopotential of any isobaric surface when the virtual temperatures below this surface are known, Tables 3.3 and 3.4 are used together as follows :

(1) Find the geopotential difference between the isobaric surface in question and the standard isobaric surface immediately below by means of Tables 3.4.2 and 3.4.3.

(2) Find the geopotential difference between the reference surface (for example ground level) and the standard isobaric surface immediately above by means of Tables 3.4.1 and 3.4.3.

(3) Divide the layer bounded by the standard isobaric surfaces mentioned under (1) and (2) into layers between consecutive standard isobaric surfaces and find the geopotential difference for each by means of Table 3.3.

(4) Add the geopotential differences found under (1), (2) and (3) to the geopotential level of the reference surface, found as a function of altitude by means of Table 3.1.2.

Example : For a constant pressure surface of 165 mb and a reference surface (for example ground level) 153 m above sea-level with a pressure of 1 008 mb, the calculation works out as follows after the mean virtual temperatures (t_{mv}) of the various layers have been found :

Tables	*Isobaric surfaces* mb	t_{mv} °C		*Geopotential difference* gpm
3.4.2	165 – 200	— 53.0	$\Delta\Phi_0 =$ 1 539	1 240
3.4.3			$\Delta\Phi_t =$ — 299	
3.3	200 – 300	— 54.6		2 596
	300 – 400	— 46.3		1 912
	400 – 500	— 34.7		1 559
	500 – 700	— 20.2		2 493
	700 – 850	— 7.5		1 511
	850 – 1 000	+ 3.4		1 317
3.4.1	1 000 – 1 008	+ 7.4	$\Delta\Phi_0 =$ 64	66
3.4.3			$\Delta\Phi_t =$ 2	
3.1.2	Geopotential of the reference surface		($\varphi = 47°$)	153
	Geopotential of the surface in question :			12 847

NOTE : If greater accuracy of computation is required, the layer bounded by the extreme standard isobaric surfaces, in this example 200 and 1 000 mb, can be divided into thinner layers bounded by the isobaric surfaces given in Table 3.2, i.e. 200 – 250 – 300 – . . . 950 – 1 000 mb. The calculation is analogous to the preceding one, except that Table 3.2 is used instead of Table 3.3.

Linear interpolation is practicable in all the tables except Table 3.4.2 for standard isobaric surfaces of 50 mb pressure or less.

Tables 3.2 and 3.3 were computed by the U.S. Weather Bureau on an IBM 7094 computer ; the programme, established in Fortran code, is kept at the WMO Secretariat.

Tables 3.4.1 and 3.4.2 have been specially recomputed by the Japan Meteorological Agency after the pattern of Tables 1 and 2 of the *Rawinsonde Observation Computation Tables and Diagrams* (Japan Meteorological Agency 1957) taking into account the new values of the physical constants and the standard isobaric levels adopted by WMO.

Table 3.4.3 is a partial reproduction of Table 4 of the above-mentioned work. The values of $\Delta\Phi_t$ for $\Delta\Phi_0$ arguments between 1 000 and 5 000 gpm are taken from SMT 52 D.

Introduction to Tables 3.5, 3.6 and 3.7

MEAN VIRTUAL TEMPERATURE OF LAYERS BETWEEN PAIRS OF STANDARD ISOBARIC SURFACES AS A FUNCTION OF GEOPOTENTIAL DIFFERENCE

RELATIONS BETWEEN INCREASES IN PRESSURE AND INCREASES IN GEOPOTENTIAL

Mean virtual temperature of layers between pairs of standard isobaric surfaces as a function of geopotential difference (Table 3.5)

The mean virtual temperature t_{mv} of a layer between two surfaces of constant pressure p_1 and p_2 is obtained from equation (3) of the Introduction 3.2/3/4, viz :

$$t_{mv} = \frac{\Delta\Phi}{67.445 \log \frac{p_1}{p_2}} - 273.15 \ ^\circ\mathrm{C}$$

where $\Delta\Phi$ is the geopotential difference, expressed in gpm, between the boundary surfaces.

Table 3.5 gives the mean virtual temperature values as a function of the differences of geopotential for the layers between two consecutive standard isobaric surfaces and for certain selected layers between two non-consecutive standard isobaric surfaces.

Linear interpolation is practicable throughout the table.

Table 3.5 was computed by the Environmental Science Services Administration (U.S. Department of Commerce) on a CDC 6600 computer ; the programme, established in Fortran language, is kept at the WMO Secretariat.

Relations between increases in pressure and increases in geopotential (Tables 3.6 and 3.7)

The increase in geopotential $d\Phi$, expressed in gpm, corresponding to a pressure, dp increase is given by the relation :

$$d\Phi = -\frac{R}{9.8} T_v \frac{dp}{p} \qquad (1)$$

where $R = 287.05$ J kg^{-1} $^\circ$K^{-1} is the gas constant for dry air, T_v is virtual temperature in $^\circ$K, and p is pressure.

This equation is the differential form of equation (1) of the Introduction 3.2/3/4.

If pressure is expressed in mb and virtual temperature in °C, $t_v = T_v - 273.15$, the increase in geopotential corresponding to an increase in pressure of 1 millibar is :

$$(d\Phi)_{1\,\text{mb}} = -\frac{287.05}{9.8} \cdot \frac{(273.15 + t_v)}{p} \text{ gpm} \qquad (2)$$

and the increase in pressure corresponding to an increase in geopotential of 10 geopotential metres is :

$$(dp)_{10\,\text{gpm}} = -\frac{9.8 \times 10}{287.05} \cdot \frac{p}{273.15 + t_v} \text{ mb.} \qquad (3)$$

Table 3.6 gives the increment in geopotential corresponding to a 1 mb pressure decrease, as a function of pressure and virtual temperature. Linear interpolation is practicable with respect to virtual temperature but not with respect to pressure.

Table 3.7 gives the pressure increment corresponding to a 10 gpm geopotential decrease, as a function of pressure and virtual temperature. Linear interpolation is practicable with respect to pressure but not with respect to virtual temperature.

Tables 3.6 and 3.7 are reproduced from SMT 57 and 60, which were computed using the following values of physical constants : $R = 287.04$ J kg^{-1} °K^{-1} and T_0 (temperature of the normal ice point) = 273.16°K. These values show slight differences from corresponding IMT values mentioned in this Introduction, but these differences lead to deviations of no more than unity in the last significant figure given in SMT 57 and 60.

Introduction to Table 3.8

INTERNATIONAL BAROMETER CONVENTIONS AND THE PROCEDURE FOR CALCULATING THEORETICAL VALUES OF LOCAL ACCELERATION OF GRAVITY

Table 3.8 is divided into two parts :

Table 3.8.1 – International barometer conventions ;
Table 3.8.2 – Procedure for calculating theoretical values of local acceleration of gravity.

Table 3.8.1 calls for no comment. In Table 3.8.2, however, the procedure outlined for the calculation of acceleration of gravity contains some peculiarities. Thus this introduction is mainly to the latter table.

The procedure for calculating the acceleration of gravity for meteorological purposes

The potential of gravity for any point external to a fluid celestial body is determined entirely by (*a*) the free surface of the body, (*b*) its angular velocity, and (*c*) its total mass (Stokes's theorem).

Consequently, the theoretical value of the acceleration of gravity at the Earth's surface or above it depends upon (*a*) the form of the Earth, (*b*) its angular velocity, and (*c*) the potential of gravity at the Earth's surface, or the acceleration of gravity at a point on it.

Theoretical value of the acceleration of gravity at sea-level

The variation of the acceleration of gravity at sea-level as a function of latitude is given by Clairaut's formula rectified, or, in the case of an ellipsoid of revolution :

$$g_{\varphi,0} = g_E\,(1 + \beta \sin^2 \varphi + \varepsilon \sin^2 2\varphi)$$

$$\text{with} \quad \beta = \frac{5m}{2} - f - \frac{17}{14} fm$$

$$\varepsilon = \frac{f}{8}\,(5m - f)$$

where $g_{\varphi,0}$ is the acceleration of gravity at sea-level at latitude φ ;
g_E the acceleration of gravity at sea-level on the Equator ;
f the flattening of the Earth ;
m the ratio of centrifugal to gravity acceleration at the Equator.

The numerical values of the coefficients β and ε, as also of g_E, depend on the hypotheses made about the form of the Earth and on the value taken for the acceleration of gravity at a point on the surface.

(1) The International Association of Geodesy (Stockholm, 1930) has adopted the following *International Gravity Formula* :

$$g_{\varphi,0} = 978.049\,0\,(1 + 0.005\,288\,4 \sin^2 \varphi - 0.000\,005\,9 \sin^2 2\varphi) \text{ cm sec}^{-2} \qquad \text{(i 1)}$$

This formula is based on the following hypotheses :

(*a*) The form of the Earth is that of the *International Ellipsoid of Reference*, which is an ellipsoid of revolution with a semi-major axis $a = 6\,378\,388$ m and flattening $f = 1/297$.

(*b*) The value of the acceleration of gravity at sea-level is 978.049 0 cm sec^{-2} on the Equator (or 980.629 cm sec^{-2} at latitude 45°). These values are established in the Potsdam system, i.e. the reference value taken is the acceleration of gravity 981.274 cm sec^{-2} measured at Potsdam in 1906, generally used as reference value in geophysics.

(2) Meteorologists use another formula to calculate the theoretical value of the acceleration of gravity at sea-level which serves as basis for the *Meteorological Gravity System* :

$$g_{\varphi,0} = 980.616\,(1 - 0.002\,637\,3 \cos 2\varphi + 0.000\,005\,9 \cos^2 2\varphi) \text{ cm sec}^{-2} \qquad \text{(i 2)}$$

or expressed in sin φ,

$$g_{\varphi,0} = 978.035\,6\,(1 + 0.005\,288\,5 \sin^2 \varphi - 0.000\,005\,9 \sin^2 2\varphi) \text{ cm sec}^{-2}.$$

The basis for this formula is as follows :

(*a*) The form of the Earth is that of the *International Ellipsoid of Reference.*

(*b*) The value 980.616 cm sec^{-2} has been chosen as the most representative of the acceleration of gravity at sea-level at latitude 45° in accordance with the opinion of the International Association of Geodesy (1950). This is the value generally used by physicists.

The values for the acceleration of gravity found in the meteorological system are 0.013 cm sec^{-2} lower than those of the Potsdam system.

It should be noted that the Potsdam system is widely used in geodesy, where absolute values of the acceleration of gravity are much less important than relative ones. Meteorology, by contrast, is concerned with absolute values.

Variation of the acceleration of gravity with altitude [1]

Lambert [2] gives the following equation for the calculation of the theoretical value of the acceleration of gravity $g_{\varphi,z}$ (in cm sec^{-2}) at a point situated in "free air" at an altitude Z (in m) and latitude φ :

$$\begin{aligned} g_{\varphi,z} = g_{\varphi,0} &- (3.085\,462 \times 10^{-4} + 2.27 \times 10^{-7} \cos 2\varphi)Z \\ &+ (7.254 \times 10^{-11} + 1.0 \times 10^{-13} \cos 2\varphi)Z^2 \\ &- (1.517 \times 10^{-17} + 6 \times 10^{-20} \cos 2\varphi)Z^3 \text{ cm sec}^{-2}. \qquad \text{(i 3)} \end{aligned}$$

[1] See also the Introduction to Table 3.1 on the problems of the variation of acceleration of gravity with altitude.

[2] Lambert, W. D., *Formula for the geopotential including the effects of elevation and of the flattening of the Earth.* Unpublished MS, 15 October 1946 (copy at WMO Secretariat).

This equation is derived from Helmert's [1] expression of the potential U with the term in D/r^4 disregarded, thus :

$$U = \frac{MK^2}{r} + \frac{K^2 (C - A)}{2r^3} (1 - 3s^2) + \frac{\omega^2}{2} r^2 (1 - s^2)$$

where M is the Earth's mass,
K^2 the Newtonian gravitation constant,
r the radius vector of the point in question,
$s = \sin \theta$, the sine of the geocentric latitude,
ω the angular velocity of the Earth's rotation,
C and A the moments of inertia of the Earth about the polar axis and an equatorial axis.

If we take $r = r_0 + Z$, where r_0 is the length of the radius vector between the centre and the surface, the expression for U is developed in series according to Z and equation (i 3) is obtained by approximations. The numerical values used are those of the Meteorological Gravity System.

Calculated local value of the acceleration of gravity at a point on the Earth's surface

Equation (2), Table 3.8.2, gives the calculated local value of the acceleration of gravity g as a function of station latitude and elevation taking the configuration of the ground into account.

The first two terms on the right give the theoretical value of the acceleration of gravity as a function of latitude and elevation ; this is a simplified form of the expression given by formula (i 3) above.

The third term is a correction for relief, incorporating the gravitational forces exerted by the surrounding terrain.

Equation (3), Table 3.8.2, is the equivalent of formula (2) for marine stations.

Calculated local value of the acceleration of gravity in free air

The *free-air term* given by equation (4), Table 3.8.2, is made up of the terms in Z and Z^2 given in equation (i 3). When the free-air term is introduced into equation (2), the symbol H in the last term then represents the elevation of the point on the Earth's surface in the vertical from the point in question.

Observed values of the acceleration of gravity

Direct gravimetric measurements are not as a rule made in absolute values but in relation to the values of the acceleration of gravity already determined at neighbouring stations. It is important to know what gravity system was used for this (generally the Potsdam system) and to convert the values if necessary (subtract 0.013 cm sec^{-2} from the values of the Potsdam system to obtain the equivalents in the Meteorological Gravity System).

The value of the acceleration of gravity measured at a given point generally differs from the value calculated by the methods outlined in Table 3.8.2. In fact

---

[1] Helmert, F. R., *Die mathematischen und physikalischen Theorien der höheren Geodäsie*, Vol. II, p. 77 equ. (1), 1886.

the Earth's surface is only imperfectly represented by an ellipsoid of revolution, and the distribution of mass is not regular either on the surface or in the interior of the Earth.

The *gravity anomaly* is the difference between the observed value of the acceleration of gravity reduced to sea-level, and its theoretical value obtained by equation (i 1) or (i 2). Various gravity anomalies are defined according to the method of reduction used.

The Bouguer anomaly A_B is defined by the equation :

$$g = g_{\varphi,0} - CH + A_B \qquad \text{(i 4)}$$

where g is the observed acceleration of gravity in cm sec^{-2} ;

$g_{\varphi,0}$ the theoretical acceleration, in cm sec^{-2}, of gravity at sea-level for the latitude φ of the given point ;

H the elevation, in metres, of the point in question ;

C an elevation-correction factor used in the calculation of the Bouguer anomaly (0.000 196 8 cm sec^{-2} if the density of the Earth's crust is taken as 2.67 g cm^{-3}) ;

A_B the Bouguer anomaly, in cm sec^{-2}.

The Bouguer anomaly is a difference of acceleration of gravity and so is independent of considerations of system provided the same system is used to express g and $g_{\varphi,0}$. Geodetic associations have drawn up contour maps of Bouguer anomalies for certain regions.

COMMENT : Comparison of equation (i 3) above with equation (2), Table 3.8.2, shows that the acceleration of gravity is the same for a point at a given height, whether it be in the free air or on the Earth's surface, provided that the elevation of the surrounding terrain be constant ($H = H'$). Yet the elevation-correction factor for the calculation of the Bouguer anomaly (equation i 4) is different from the one for equation (2). In fact, the elevation-correction term CH for equation (i 4) is the sum :

(*a*) of the variation in the acceleration of gravity in the free air (—0.000 308 6 H cm sec^{-2}) and

(*b*) of the acceleration provided by the gravitational forces exerted at the given point by the layer of the Earth's surface of thickness H : +0.000 111 8 H cm sec^{-2}, i.e. —0.000 196 8 H cm sec^{-2}.

However, experience shows that the value of the acceleration of gravity calculated with the elevation-correction for equation (2) is more representative of observed values. This is because the layers of the Earth's crust between the given point and sea-level are to a large extent compensated by lower-density layers at greater depth (isostatic compensation).

The factor 0.000 111 8, representing the acceleration of gravity due to the gravitational force of a homogeneous layer 1 m thick, enters into the terrain-correction term in equation (2).

Standard (normal) gravity

It is sometimes necessary to adopt an arbitrary reference value for the acceleration of gravity, as, for instance, in graduating the scales of mercury barometers or fixing the conversion factors for millibars and normal millimetres of mercury. A value of this kind cannot be related to the measured or theoretical value of the acceleration of gravity in specified conditions, for example sea-level at latitude 45°, because such values are likely to change as new experimental data become available. Accordingly a conventional numerical value g_n, known as the standard acceleration of gravity, has to be fixed which will remain, by definition, the reference value.

WMO has adopted the following value for the normal acceleration of gravity :

$$g_n = 980.665 \text{ cm sec}^{-2}$$

This value agrees with that recommended by the International Committee of Weights and Measures (1901, 1948).

Tables 3.8.1 and 3.8.2 are reproduced from Appendices A and B of WMO TR.
A conversion table of normal millimetres of mercury in millibars and tables of the theoretical acceleration of gravity as a function of latitude and geometric height are planned for the second set of IMT.

Introduction to Table 3.9

ICAO STANDARD ATMOSPHERE

A standard atmosphere is a hypothetical atmosphere in which the relations between the geopotential, temperature and pressure are defined according to basic assumptions, independently of the actual values observed. In 1952, in order to achieve uniformity between the various atmospheres of this kind already introduced, ICAO defined a standard atmosphere to an altitude of 20 km for civil aviation purposes (Annex 8 to the International Civil Aviation Convention). A new definition extending to 32 km was adopted by the ICAO Council on 12 November 1963, to take effect on 1 April 1964. Amendment 87 defines standard atmosphere in these terms :

"*Standard atmosphere.* When the term 'standard atmosphere' is used in any standards of the airworthiness of aircraft that are applicable to aircraft the prototype of which is submitted to the appropriate national authorities for certification on and after 12 November 1966 it means an atmosphere defined as follows :

"(*a*) The air is a perfect dry gas ;

"(*b*) The physical constants are :

Sea-level mean molecular weight :

$M_0 = 28.964\,4 \times 10^{-3}$ kg/mole

Sea-level atmospheric pressure :

$P_0 = 1\,013.250$ millibars

$= 1.013\,250 \times 10^5$ newtons m^{-2}

Sea-level temperature :

$t_0 = 15°C$ (59°F)

$T_0 = 288.15°K$ (518.67°R)

Sea-level atmospheric density :

$\rho_0 = 1.225\,0$ kg m^{-3}

Temperature of the ice point :

$T_i = 273.15°K$ (491.67°R)

Universal gas constant :

$R^* = 8.314\,32$ joules $(°K)^{-1}$ $mole^{-1}$

"(*c*) The temperature gradient from 5 000 standard geopotential metres below sea-level to an altitude at which the air temperature becomes —56.5°C is —0.006 5°C per standard geopotential metre; from that level (11 000 standard geopotential metres) to an altitude of 20 000 standard geopotential metres the temperature gradient is zero (0) ; and from 20 000 to 32 000 standard geopotential metres the temperature gradient is + 0.001 0°C per standard geopotential metre.

. . .

"NOTE 2 : The standard geopotential metre has the value 9.806 65 m^2 sec^{-2} (the standard geopotential foot has the value 32.174 05 ft^2 sec^{-2})."

The values of the thermodynamic constants used in the definition of standard atmosphere agree well with the values adopted by WMO ($R^* = 8.314\ 32$ joule mol^{-1} $^oK^{-1}$, $M = 28.964\ 4 \times 10^{-3}$ kg mol^{-1}) and with the definition of the Celsius scale of temperatures ($t^oC = T^oK - 273.15$). ~~But the definition of the standard geopotential metre differs from that adopted by WMO (see Table 1.1, section 49, note 1).~~

The other physical values introduced in the definition of standard atmosphere (pressure and temperature at sea-level, temperature gradient) were chosen arbitrarily in order to give a very stylized model of the atmosphere which would agree most nearly with the average values observed in the middle latitudes. However the standard atmosphere was introduced essentially for aviation (in particular for the calibration of altimeters, calculation of D values, etc.) and can in no case be regarded as representative of climatological averages.

The relations between pressure, temperature, density and geopotential are shown by the following equations :

(*a*) Layers of the atmosphere where the temperature gradient is constant : $L' = \text{const.}$

$$T = T_b + L'h$$

$$\frac{P}{P_b} = \left(\frac{T_b}{T_b + L'h}\right)^{\frac{G}{RL'}};$$

(*b*) Isothermal layers of the atmosphere : $L' = 0$

$$\frac{P}{P_b} = e^{-\frac{Gh}{RT_b}};$$

and in both cases (*a*) and (*b*)

$$\rho = \frac{1}{R}\frac{P}{T}$$

where

P is the pressure and P_b the pressure at the base of the layer;

T the absolute temperature and T_b the absolute temperature at the base of the layer ;

h the difference of geopotential between the given point and the base of the layer, $h = H - H_b$, H being the geopotential of the given point and H_b the geopotential at the base of the layer ;

L' the temperature gradient in relation to the geopotential

$$L' = \frac{\partial T}{\partial H};$$

ρ the density of the air ;

R the gas constant for dry air ;

G a coefficient depending on the unit of geopotential chosen (G = 9.806 65 if the geopotential is expressed in standard geopotential metres).

The ICAO standard atmosphere is divided into three layers for this calculation :

	H standard gpm	T °K	P mb	L' °C/standard gpm
Layer with constant temperature gradient	0	288.15	1 013.25	
				— 0.006 5
	11 000	216.65	226.32	
Isothermal layer				0
	20 000	216.65	54.748 7	
Layer with constant temperature gradient				+ 0.001
	32 000	228.65	8.680 14	

Standard atmosphere and altimetry

In meteorology the standard atmosphere concept is mainly connected with altimetry. Pressure-sensitive altimeters are really aneroid barometers with an altitude scale (geopotential level, see note 2) which has the same relation to the pressure scale as in the standard atmosphere ; also the altimeter mechanism is designed so that the altitude scale is linear.

As pressure is constant at any given level in the standard atmosphere, the pressure observed at sea-level or at a given station generally differs from the pressure postulated for that level in the standard atmosphere. In order to overcome this difficulty, the standard atmosphere is fictitiously translated upward or downward until the standard atmosphere pressure coincides with the observed pressure at the reference station. In practice this is achieved by rotating the altimeter dial or mechanism until the altitude scale corresponds to the actual altitude for the reference level : hence the expression "altimeter setting".

The following values are used in aeronautical meteorology :

(*a*) Pressure-altitude is the altitude corresponding to a given pressure in standard atmosphere.

(*b*) The altimeter setting, or QNH, is the pressure corresponding to sea-level when the standard atmosphere is offset vertically until the pressure observed at a given station (QFE) coincides with the same pressure in the standard atmosphere. An altimeter set to QNH indicates the true altitude at the station in question.

If H^* is the pressure-altitude of the QFE and H' the elevation of the station (in standard gpm), the QNH is the pressure corresponding to the altitude H_0^* in the standard atmosphere where :

$$H_0^* = H^* - H'$$

(*c*) The QNE is the pressure-altitude of the QFE. An altimeter set to 1 013.25 mb shows the QNE at the station in question.

Example : Take a station at a level of 423 standard gpm where the pressure observed (QFE) is 943.5 mb. We find :

QNE = H^* = 597 standard gpm, H_0^* = 597 — 423 = 174 standard gpm and QNH = 992.5 mb.

(*d*) The *D*-value is the amount (positive or negative) by which the altitude H of a point on an isobaric surface differs from the altitude (H_p) of the same isobaric surface in the ICAO standard atmosphere (i.e. *D*-value $= H - H_p$).

An altimeter set to the QNH would thus show the true geopotential altitude (geopotential level) if the distribution of the temperature observed in the layer between the point in question and the reference station were the same as in the standard atmosphere. As this is not generally the case, the following correction ΔH must be added to the altitude H shown by the altimeter:

$$\Delta H = \frac{T_{mv} - T_{ms}}{T_{ms}} (H - H_0)$$

where H_0 is the height of the reference station,

T_{mv} the mean virtual temperature of the $H - H_0$ layer, and

T_{ms} the mean temperature of the $H - H_0$ layer in the standard atmosphere.

* * *

Table 3.9.1 gives the values of temperature (in °C), pressure (in mb) and density (in kg m^{-3}) as a function of the geopotential or geopotential altitude (see note 2). Table 3.9.2 gives the geopotential as a function of pressure. The data in these two tables are taken from the *U.S. Standard atmosphere, 1962*, prepared by the Committee on Extension to the Standard Atmosphere (COESA) on the basis of definitions which have been adopted by ICAO.

Linear interpolation is not practicable in Table 3.9.1 (except of course for temperature) but is practicable in Table 3.9.2 for pressure values greater than 350 mb.

NOTE 1 : ICAO Document 7488/2, published in 1965, gives the relation between the variables and contains tables showing the corresponding values of the temperature, pressure, density and geopotential; it also gives the specific weights, viscosity, kinematic viscosity and speed of sound at the various altitudes.

NOTE 2: In the ICAO standard atmosphere, a distinction is introduced between geopotential (measured in standard gpm), which is a specific energy (see Table 1.1, section 19), and geopotential altitude (measured in m) which is a length. For this latter, the factor 9.806 65 has, by definition, the dimension of an acceleration. Therefore geopotential altitude H is the altitude (expressed in m) which would correspond to a given pressure level if the acceleration of gravity were constant and equal to 9.806 65 m s^{-2}. The numerical value of geopotential measured in standard gpm, and of geopotential altitude measured in metres, is the same for a given level.

For relatively low altitudes, geometric altitudes and geopotential altitude are often used interchangeably as the error involved is less than the instrument error.

NOTE 3: The International Standard Atmosphere (ISA) includes the ICAO Standard atmosphere to 32 000 m′ and a further extension to 50 000 m′; this extension is made by introducing the following assumptions for the temperature gradient L':

$L' = +0.0028$°C m'^{-1} from 32 000 m′ to 47 000 m′

$= 0$ from 47 000 m′ to 50 000 m′

(Reference: ISO/TC 20, Drafts International Standard ISO/DIS 2533)

Introduction to table 3.10

ALTIMETER SETTING (QNH) COMPUTATION FACTORS

Calculation of the Altimeter Setting (QNH) is based on the following relationship (see Introduction 3.9, page 3, Standard atmosphere and altimetry):

$$H_0^\star = H^\star - H' \qquad (1)$$

where

$H^\star$ is the pressure-altitude corresponding to pressure measured at the station in question,

H' is the geopotential of the station expressed in standard geopotential metres (m') (geopotential altitude),

$H_0^\star$ is the pressure-altitude corresponding to the altimeter setting.

The relationship between the pressure-altitude and the pressure in the ICAO Standard Atmosphere is given in Table 3.9.

Although this method of calculation is relatively straightforward, in practice it is more convenient to use a linear relationship between QFE and QNH where the coefficients depend only on the geopotential of the station; by this method tables for any station can be drawn up rapidly, and if desired conversion from QFE to QNH can be made by using revolution counters linked by a simple gear system.

The following approximation can be used with negligible error for stations below about 3 000 to 4 000 m:

$$\text{QNH} = A + B \times \text{QFE} \qquad (2)$$

with

$$A = -P_b \frac{L'}{T_b} H' \quad \text{and} \quad B = \frac{P_b}{p\,(H')} \left(1 + \frac{L'}{T_b} H'\right)$$

where $P_b = 1\,013.25$ mb;

$L' = -0.006\,5$ K m'$^{-1}$;

$T_b = 288.15$ K.

H' is the geopotential of the station in m' and $p\,(H')$ the pressure corresponding to H' in the standard atmosphere; QFE and QNH are expressed in millibars.

The above relationship is derived as follows.

For conditions of constant lapse rate, but not isothermal (case (*a*) of Introduction 3.9, page 2), the geopotential H' is given by the following equation as a function of the pressure p:

$$H' = -\frac{T_b}{L'} \left[1 - \left(\frac{p}{P_b}\right)^{-\frac{RL'}{G}}\right] \qquad (3)$$

where R is the gas constant for dry air and G, a dimensionless coefficient having a value of 9.806 65.

Replace H_0^* and H^* in equation (1) by their expressions in p_0 (QNH) and p (QFE) from equation (3) ; it is possible by setting $y = \frac{p}{P_b}$ and $x = \frac{P_b - p_0}{P_b}$ to develope the series

$$y = \frac{p\,(H')}{P_b} - x\,\frac{p\,(H')}{P_b}\,\frac{1}{1 + \frac{L'}{T_b}H'} + R_1$$

where R_1 is the remainder of the series.

Replacing x and y by their actual values gives the following expression for p_0 :

$$p_0 = -P_b\,\frac{L'}{T_b}\,H' + p\,\frac{P_b}{p\,(H')}\left(1 + \frac{L'}{T_b}\,H'\right) - \frac{P_b^2}{p\,(H')}\left(1 + \frac{L'}{T_b}\,H'\right)R_1. \quad (4)$$

The first two terms on the right hand side correspond to the value of p_0 given in equation (2), whereas the last term represents the error due to using only the first two terms of the series.

The maximum error is given in the following table as a function of the geopotential of the station, H', when the difference between the QNH and the standard pressure P_b is $\pm$ 30 mb and $\pm$ 40 mb :

H' m'	Maximum error for $p_0 = 1\,013.25 \pm 30$ mb mb	Maximum error for $p_0 = 1\,013.25 \pm 40$ mb mb
1 000	±0.009	±0.015
2 000	±0.019	±0.033
3 000	±0.03	±0.052
4 000	±0.04	±0.07
5 000	±0.05	±0.08

Table 3.10 gives the coefficients A and B as a function of the geopotential level H' of the station in question. Linear interpolation is practicable throughout the table.

Use of the table

Calculate first the geopotential, in m', of the station as a function of its geometric altitude by means of Table 3.1 taking into account the Note on geopotential units, page IX ; for low altitudes (below 1 000 metres) and where great precision is not required both can be considered identical. Then select the values of coefficients A and B in Table 3.10 and enter them in equation (2).

For example if the elevation of the station is 2 583 m and its latitude 20°, Table 3.1.2 gives by interpolation a geopotential of 2 578 gpm, which, converted to m', gives $2\,578 \times \frac{9.8}{9.806\,65} = 2\,576$ m'.

Table 3.10 gives for $H = 2\,576$ m' :

$$A = 58.88 \qquad B = 1.290\,18.$$

Equation (2) then becomes

$$QNH = 58.88 + 1.290\,18 \times QFE$$

which for QFE of 721.4 mb gives QNH = 989.6 mb.

Table 3.10 was prepared in the WMO Secretariat.

NOTE : This method is taken from an unpublished manuscript by S. Letestu, *Pression barométrique et altimétrie*, a copy of which in kept is the WMO Secretariat.

Introduction to Table 3.11

CORRECTION TO ALTIMETER READING AS A FUNCTION OF THE MEAN VIRTUAL TEMPERATURE OF THE LAYER OF AIR

The principle of operation of the altimeter and of the system by which it can be adjusted to correspond to a reference station (altimeter setting) is described in Introduction 3.9, pages 3 and 4. However the geopotential altitude indicated by an altimeter after setting must be corrected to account for the difference between the actual observed temperatures and those stated for the standard atmosphere. These corrections may be determined from Table 3.11.

Letting p_0 represent the pressure reduced to mean sea level (altimeter setting or QNH), p the pressure observed at the station (QFE) and p_1 the pressure at the level of the altimeter ; then $H_0^\star$, $H^\star$ and $H_1^\star$ are the corresponding pressure-altitudes. If I is the geopotential altitude indicated by the altimeter set to QNH and H' the geopotential altitude of the reference station, then the following relationship can be stated :

$$I - H' = H_1^\star - H^\star = \frac{R}{G}\, T_{\mathrm{ms}}\,(H^\star,\, H_1^\star)\, \ln \frac{p}{p_1}$$

where R is the gas constant for dry air, $G = 9.806\,65$ and $T_{\mathrm{ms}}\,(H^\star,\, H^\star)$, the mean temperature of the layer between $H^\star$ and $H^\star$ in the stand d atmosphere.

The true geopotential altitude I' of the pressure level p_1 corresponding to level of the altimeter is given by the expression :

$$I' - H' = \frac{R}{G}\, T_{\mathrm{mv}}\, \ln \frac{p}{p_1}$$

where T_{mv} is the observed mean virtual temperature of the layer between the levels H' and I' (or pressure levels p and p_1).

The correction $\varDelta$ to add to the altimeter reading I is :

$$\varDelta = I' - I = (I - H')\, \frac{T_{\mathrm{mv}} - T_{\mathrm{ms}}\,(H^\star,\, H_1^\star)}{T_{\mathrm{ms}}\,(H^\star,\, H_1^\star)}\ .$$

This equation is given in Introduction 3.9, page 4, with a slightly different notation.

By defining $T_{\mathrm{ms}}\,(H^\star)$ as the mean temperature of the layer between 0 and $H^\star$ in the standard atmosphere, the following equations can be written :

$$T_{\mathrm{ms}}\,(H^\star,\, H_1^\star) = \frac{H_1^\star - H^\star}{\dfrac{H_1^\star}{T_{\mathrm{ms}}\,(H_1^\star)} - \dfrac{H^\star}{T_{\mathrm{ms}}\,(H^\star)}} \qquad (1)$$

and

$$\Delta = \left(\frac{H_1^*}{T_{ms}(H_1^*)} - \frac{H^*}{T_{ms}(H^*)} \right) \Delta T \qquad (2)$$

where $\Delta T = T_{mv} - T_{ms}(H^*, H_1^*)$.

Equations (1) and (2) are valid for all levels because only equations derived from the hydrostatic equation (see Introduction 3.2/3/4, p. 1) have been used and not those particular hypotheses on the temperature distribution in the standard atmosphere.

If only those layers having a constant, but not zero, lapse rate are considered, equation (1) can be written as :

$$T_{ms}(H^*, H_1^*) = \frac{T(H^*) - T(H_1^*)}{\ln \dfrac{T(H^*)}{T(H_1^*)}} \qquad (1')$$

where $T(H^*)$ and $T(H_1^*)$ are the temperatures at the levels H^* and H_1^*, respectively.

The mean temperature in this case depends only on the temperatures at the bottom and top of the layer.

NOTE : Although T_{mv} represents the mean virtual temperature of the layer between the level of the reference station and that of the altimeter, T_{ms} represents the mean temperature, in the standard atmosphere, between the levels H^* and H_1^* corresponding to pressures p and p_1. It is possible in practice to confuse I and H_1^* as well as H' and H^* in calculating Δ, this leading to an error in T_{ms} usually not greater than one degree.

Table 3.11.1 gives the mean temperature $T_{ms}(H^*, H_1^*)$, in K, of different layers of air in the standard atmosphere as a function of H^* and H_1^* expressed in m′, and also as a function of the temperature in °C of the bottom and top of the layer. Linear interpolation is practicable.

Table 3.11.2 gives the magnitude of $\dfrac{H^*}{T_{ms}(H^*)} \times \Delta T$ as a function of H^* expressed in m′ and ΔT in °C. Linear interpolation is practicable.

Use of the tables

When an approximation will suffice for practical purposes it is possible to use the geopotential altitude indicated by the altimeter and the geopotential altitude of the reference station. When greater precision is required however it is necessary to determine the pressure heights H_1^* and H^* corresponding to the observed pressures at the levels of the altimeter and the reference station. These may be obtained respectively by subtracting from the altimeter reading and the level of the reference station the pressure-altitude corresponding to the QNH (see Table 3.9.2). The mean virtual temperature T_{mv} of the layer being considered must then be determined using, for example, data from upper air soundings.

The correction Δ is calculated in the following manner :

1. In Table 3.11.1 find the mean temperature T_{ms} corresponding to the geopotential altitude H' of the reference station and the geopotential altitude I indicated by the altimeter, or the pressure-altitudes H^* and H^*.

2. Calculate the difference $\Delta T = T_{mv} - T_{ms}$.

3. In Table 3.11.2 find the value of $\frac{H^*}{T_{ms}(H^*)} \times \Delta T$ corresponding to the appropriate values of H^* (or H') and ΔT ; and the value of $\frac{H_1^*}{T_{ms}(H_1^*)} \times \Delta T$ for the appropriate values of H_1^* (or I) and ΔT.

The correction Δ is obtained by substracting the first quantity from the second. Note that the correction Δ has the same sign as ΔT.

Example : Let 8 475 m′ be the geopotential altitude I read on the altimeter, 1 534 m′ the geopotential altitude H' of the reference station, 1 024 mb the QNH and —14.4°C the mean virtual temperature of the layer ($T_{mv} = 258.8$ K). The pressure-altitude corresponding to 1 024 mb is —89 m′, therefore the pressure-altitudes are $H^* = 1\,534 + 89 = 1\,623$ m′ and $H_1^* = 8\,475 + 89 = 8\,564$ m′.

Using these values of H^* and H_1^* in Table 3.11.1 yields $T_{ms} = 254.4$ K (—18.8°C) then $\Delta T = 4.4$°C ; Table 3.11.2 gives a value of 25 m′ for $H^* = 1\,623$ m′ and a value of 146 m′ for $H_1^* = 8\,564$ m′.

The correction to be applied to the altimeter reading then is $\Delta = 146 - 25 = 121$ m′.

If I and H' are used directly instead of H^* and H_1^* then Table 3.11.1 gives $T_{ms} = 255.0$ K (—18.2°C) from which can be determined $\Delta T = 3.8$°C. Then, using Table 3.11.2, $\Delta = 124 - 20 = 104$ m′.

Note : It frequently happens that the mean virtual temperature of the layer is not known but only the temperature (virtual) at the reference station and at the level of the altimeter. If the latter is below 11 000 m′ and if it is assumed that the vertical temperature gradient is constant (but not zero) in the layer being considered, then Table 3.11.1 can be used to calculate the mean temperature using the values of temperature at the bottom and top of the layer. In effect, if only these values of temperature are used, this table applies to all of the atmosphere in which the lapse rate is constant but not zero according to equation (1′).

For example, if the temperature at the reference station is 12°C and at the level of the altimeter —18°C, the mean (virtual) temperature is 2.5°C.

Tables 3.11.1 and 3.11.2 have been prepared according to the ICAO standard atmosphere which is described in the Introduction to 3.9. They have been calculated by la Météorologie Nationale de France on a computer CDC 6400 ; the programme written in Fortran language is kept by la Météorologie Nationale.

Introduction to Table 3.12

REDUCTION OF PRESSURE TO A SELECTED LEVEL*

The reduction of pressure to a selected geopotential level consists of calculating the pressure at that level, knowing the pressure and the geopotential at another level as well as the mean virtual temperature of the layer of air between the two levels.

Let p_1 be the pressure measured at geopotential level Φ_1, p_2 the pressure to be determined at geopotential level Φ_2 and t_{mv} the mean virtual temperature, in °C, of the layer between these two levels.

The geopotential difference between the two levels, $\Delta\Phi = \Phi_2 - \Phi_1$, is given by equation (3) in Introduction 3.2/3/4 :

$$\Delta \Phi = 67.445\ (273.15 + t_{mv}) \log \frac{p_1}{p_2} \text{ gpm.} \qquad (1)$$

When $t_{mv} = 0°C$, equation (1) reduces to :

$$\Delta \Phi_0 = 67.445 \times 273.15 \log \frac{p_1}{p_2}, \qquad (2)$$

Thus, if P designates an arbitrary pressure, then

$$67.445 \times 273.15 \log \frac{P}{p_2} = 674.45 \times 273.15 \log \frac{P}{p_1} + \Delta \Phi_0. \qquad (3)$$

and finally, from equations (1) and (2) :

$$\Delta \Phi_0 = \Delta \Phi \frac{273.15}{273.15 + t_{mv}}\ . \qquad (4)$$

Table 3.12.1 gives the values of the expression $67.445 \times 273.15 \log \dfrac{1\,100}{p}$ as a function of the pressure p, in mb, the pressure P being fixed arbitrarily at 1 100 mb. Linear interpolation is practicable where pressure p is greater than 140 mb.

Table 3.12.2 gives $\Delta\Phi_0$, in gpm, as a function of $\Delta\Phi$, in gpm, and t_{mv}, in °C. Linear interpolation is practicable throughout the table.

Use of the tables

Knowing the pressure p_1 at the geopotential level Φ_1, determine the pressure p_2 at geopotential level Φ_2 when the mean virtual temperature of the layer is t_{mv}.

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* NOTE : The geopotential metre (gpm) has been used in this Table for the sake of consistency with Tables 2.3.1, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6 and 3.7 of the former sets. For conversion to standard geopotential metres (m'), see Note on geopotential units, page IX.

First determine from Table 3.12.2 the value of $\Delta\Phi_0$ corresponding to $\Delta\Phi = \Phi_2 - \Phi_1$ and t_{mv} ($\Delta\Phi_0$ and $\Delta\Phi$ have the same sign) and, from Table 3.12.1, the value of the expression $67.445 \times 273.15 \log \frac{1\,100}{p_1}$. Then use these two values in equation (3) which gives the value of the expression $67.445 \times 273.15 \log \frac{1\,100}{p_2}$; p_2 is the argument corresponding to the value $67.445 \times 273.15 \log \frac{1\,100}{p_2}$ in Table 3.12.1.

For example if $\Phi_1 = 1\,345$ gpm, $\Phi_2 = 1\,800$ gpm, $p_1 = 873.2$ mb and $t_{mv} = 7.3°C$, Table 3.12.2 gives, by interpolation, $\Delta\Phi_0 = 443.2$ for $\Delta\Phi = 455$ gpm and $t_{mv} = 7.3°C$; Table 3.12.1 gives, by interpolation, $67.445 \times 273.15 \log \frac{1\,100}{p} = 1\,847.4$ for $p = 873.2$ mb. Then equation (3) gives $67.445 \times 273.15 \log \frac{1\,100}{p_2} = 1\,847.4 + 443.2 = 2\,290.6$ and Table 3.12.1 is used to get $p_2 = 826.1$ mb by inverse interpolation.

Special case — Reduction of pressure to mean sea level

In this case $\Phi_2 = 0$, and $\Phi_1 = -\Delta\Phi$ is the geopotential of the station being considered (obtained by converting the geometric elevation of the station using Table 3.1). The mean virtual temperature t_{mv} is that of the imaginary layer of air extending from the level of the station down to the mean sea level ; it can only be determined by reference to the hypothetical distribution of temperature and humidity in this layer. The methods presently used are described in Technical Note No. 91, *Methods in use for the reduction of atmospheric pressure* (WMO – No. 226. TP. 120).

Determination of height by means of pressure

Table 3.12.1 can be used together with Table 3.4.3 to determine the geopotential difference between two levels of known pressure, p_1 and p_2. For this, find in Table 3.12.1 the values of the expression $67.445 \times 273.15 \log \frac{1\,100}{p}$ for pressures p_1 and p_2, then calculate $\Delta\Phi_0$ referring to equation (3) and finally Table 3.4.3 gives the correction $\Delta\Phi_t$ to apply to $\Delta\Phi_0$, as a function of $\Delta\Phi_0$ and the mean virtual temperature t_{mv}, in °C, of the layer between the two levels being considered.

For example, if $p_1 = 953.6$ mb, $p_2 = 815.3$ mb and $t_{mv} = 14.6°C$, Table 3.12.1 gives the expression $67.445 \times 273.15 \log \frac{1\,100}{p} = 1\,142.7$ for $p_1 = 953.6$ mb and $2\,396.3$ for $p_2 = 815.3$ mb. Equation (3) gives $2\,396.3 = 1\,142.7 + \Delta\Phi_0$ from which $\Delta\Phi_0 = 1\,253.6$ gpm. Finally Table 3.4.3 gives $\Delta\Phi_t = 66$ gpm for $\Delta\Phi_0 = 1\,253.6$ gpm and $t_{mv} = 14.6°C$, from which $\Delta\Phi = 1\,254 + 66 = 1\,320$ gpm. The geopotential levels thus determined can be converted into altitudes using Table 3.1.3.

This method of determination of heights can be utilized in place of the method described in Introduction 3.2/3/4 when the mean virtual temperature is given for the whole layer.

NOTE : When the mean virtual temperature of the layer is not known, but only the virtual temperature at the base and top of the layer, the mean virtual temperature can be estimated by assuming a uniform gradient and applying the method described in the Introduction to Table 3.11, page 3.

Tables 3.12.1 and 3.12.2 are reproductions of SMT 48 B and 48 D. SMT 48 B gives the values of the expression $67.442 \times 273.16 \log \frac{1\,100}{p}$ which is slightly different from that described above, however the differences between the values of these expressions is less than 0.1 gpm when p is greater than 100 mb.

SMT 48 D gives $\Delta \Phi_0 = \Delta \Phi \frac{273.16}{273.16 + t_{mv}}$ in place of the value of $\Delta \Phi_0$ given in equation (4) ; the resulting difference in $\Delta \Phi_0$ is not more than 0.1 gpm for the values given in the table.

Introduction to Table 3.13

CORRECTION AND REDUCTION OF MERCURY BAROMETER READING

In order to conform to the International Barometer Conventions (Table 3.8.1, section 4) the scales of mercury barometers must be graduated in a manner to give exact readings, in units of pressure (mb or $(\text{mm Hg})_n$), under normal instrument conditions ; that is at a temperature of 0°C and normal acceleration of gravity $g_n = 980.665$ cm s^{-2}. It should be noted that scales graduated in $(\text{mm Hg})_n$ have an exact graduation in mm on adjustable cistern barometers whereas scales on fixed cistern barometers are reduced linearly.

The exact reading means that the instrument is designed so that the value of the element being measured is read directly in the case of an ideal instrument. In practice measurements are affected by instrumental errors and corrections appropriate to each instrument must be applied to the readings.

Since readings are usually made under conditions which differ from normal temperature and normal acceleration of gravity, it is necessary to reduce the barometer reading p^*, corrected for instrument error, to normal temperature 0°C and normal acceleration of gravity to obtain the correct value p of the pressure. One of the two following formulae apply according to the type of barometer :

A. *Adjustable cistern barometers (Fortin barometer, movable scale barometers) and siphon barometers:*

$$p = (1 + c)\,(1 - f)\,p^* \tag{1}$$

where $c = \dfrac{g - g_n}{g_n}$,

$$f = \frac{(\alpha - \beta)\,t}{1 + \alpha\,t},$$

g is local acceleration of gravity, in cm s^{-2},

g_n = 980.665 cm s^{-2}, normal acceleration of gravity,

α = 0.000 181 8°C^{-1}, coefficient of volumetric expansion of Hg,

β = 0.000 018 4°C^{-1}, coefficient of linear expansion of the scale (brass scale),

t, the temperature of the instrument as read from the attached thermometer, in °C.

B. *Fixed cistern barometer*

$$p = (1 + c)\,[p^* - f\,(p^* + Q)]\,. \tag{2}$$

Q is a factor dependant on the design of the instrument and its value is generally indicated by the manufacturer for each type of barometer, ordinarily comprised between 30 and 50 mb (generally 47 mb for modern, Kew pattern station barometers). Q can also be calculated using one of the two following equations :

$$Q = 10^{-4} \rho_0 \, g_n \frac{V_0}{A} \frac{\alpha - 3\eta}{\alpha - \beta} = 1.24 \frac{V_0}{A} \text{ if pressure is expressed in mb,}$$

$$Q = \frac{V_0}{A} \frac{\alpha - 3\eta}{\alpha - \beta} \text{ if pressure is expressed in (mm Hg)}_n,$$

where ρ_0 = 13.595 1 g cm^{-3} is the standard density of mercury at 0°C,

η = 0.000 010°C^{-1}, a coefficient of linear expansion representing the expansion of the cistern and tube,

V_0, the total volume, in mm^3, of mercury in the instrument at a temperature of 0°C, and

A, the effective surface of the cistern, in mm^2.

Note that the product $-fQ$ represents the displacement of the zero of the scale as a consequence of the variation of the total volume of mercury with temperature.

Corretions for reduction of barometer readings to normal conditions

Two corrections are necessary to reduce barometer readings to normal conditions : one for temperature and one for gravity. For adjustable cistern barometers it does not matter which is applied first, however, for fixed cistern barometers the correction for temperature must always be made first. Only corrections for the fixed cistern barometer will be considered in the remainder of this section since corrections for the adjustable cistern barometer is a special case of the foregoing where $Q = 0$.

Equation (2) can be written

$$p = p^\star + C_t + C_g$$

where $C_t = -f\,(p^\star + Q)$ is the correction for temperature ; and

$C_g = c\,(p^\star + C_t)$ is the correction for gravity.

1. Correction for temperature

Table 3.13.1 gives the value of C_t as a function of the temperature of the instrument, in °C, and the term $(p^\star + Q)$, C_t being expressed in the same units of pressure as the term $(p^\star + Q)$, mb or (mm Hg)$_n$. The table can be used with negative as well as positive values of temperature, however care should be taken to ensure that the sign of the correction C_t is opposite to that of the temperature. Linear interpolation is practicable.

NOTE : Table 3.13.1 has been prepared for positive values of t using the equation :

$$C_t = \frac{(\alpha - \beta)\, t}{1 + \alpha\, t} (p^\star + Q) .$$

Here the term in the denominator is very close to unity so that this expression can be used for negative values of t by changing the sign of C_t. More precisely, however, the value of C_t for a negative value of temperature (designated by $-t$) is described by the following expression:

$$C_t = -f(-t) \times (p^\star + Q) = +f(t) \times (p^\star + Q)\frac{1+\alpha t}{1-\alpha t} \approx f(t) \times (p^\star + Q) \times (1 + 2\alpha t).$$

Thus the correction for a negative value of temperature, $-t$, is equal to the correction (positive) given in the table plus the term $2\alpha t C_t$ which, for $p^\star + Q = 1\,000$, has the following values :

0.01 at $t = -10$°C ;
0.02 at $t = -20$°C ;
0.05 at $t = -30$°C.

2. *Correction for gravity*

The correction C_g varies relatively little with pressure when the value of g is close to g_n ; the term $p^\star + C_t$ can thus be replaced by the mean climatological value of pressure p_n so that

$$C_g = c\,p_n\,;$$

thus, if the range of pressure with respect to the mean value is not greater than ± 30 mb, the error introduced by this approximation is not larger than ± 0.05 mb when g lies between 979.035 and 982.295 cm s^{-2}.

The value of the local acceleration of gravity shall be on the meteorological gravity system following the provisions of Table 3.8.1, section 5. If necessary the methods outlined in Table 3.8.2 may be used as well as Table 6.3.

Reduction of pressure to the official station elevation

It is necessary, in certain cases, to reduce the pressure to the official station elevation before reducing it to the conventional level (generally mean sea level). Thus, if H_z represents the elevation, in m, of the barometer and H_s, the official elevation, in m, of the station, the pressure p_s, in mb, at the official elevation of the station is given by the following equation :

$$p_s = p + \frac{H_z - H_s}{10}(\Delta p)_{10\,\text{gpm}},$$

where p is the observed pressure in mb, and $(\Delta p)_{10\,\text{gpm}}$ is the increase of pressure (in mb) corresponding to a decrease of geopotential of 10 gpm. $(\Delta p)_{10\,\text{gpm}}$ can be found in Table 3.7 by taking respectively as values of pressure and temperature the mean pressure and the mean temperature of the layer $H_z - H_s$. In this case the difference between values expressed in gpm and those expressed in m is negligible and can be disregarded.

When the difference $H_z - H_s$ is small, as is generally the case (from 10 to 15 m), the mean pressure of the layer can be replaced by mean pressure of the station and the mean temperature of the layer by the temperature observed at the station (screen temperature). This latter should be replaced by the climatological temperature only after careful consideration as for instance in cases where the difference in levels is only a few metres or where the temperature variation is small.

When the difference in levels is large, it is necessary to use the method outlined in Introduction 3.12.

Capillary depression of a mercury column

The free surface of a column of mercury in a tube is a convex surface, termed the meniscus, the top of which is lower than the plane surface which would limit the column in the absence of capillarity or in a tube of infinitely large diameter ; the difference in height is termed the capillary depression.

The angle of contact δ of the free surface of mercury with the wall of the tube is determined by the surface tension σ of the mercury in the presence of a gas, the interfacial tension σ_1 of the mercury with the surface of the tube and the interfacial tension σ_2 of the gas with the surface of the tube so that

$$\sigma_1 - \sigma_2 = \sigma \cos \delta .$$

If p_c is the supplementary pressure introduced by the capillary effect,

$$p_c = \frac{4}{D} \sigma \cos \delta$$

where D is the inner diameter of the tube.

However, the angle δ is difficult to estimate and it is preferable to calculate the capillary depression as a function of the height of the meniscus, which is defined as the vertical distance between the uppermost part of the meniscus and the plane containing the circle of contact of the free surface of mercury with the tube. This is determined by integration of the following equation over the surface of the meniscus :

$$\frac{1}{R_1} + \frac{1}{R_2} = \frac{p'}{\sigma}$$

where R_1 and R_2 are the principal radii of curvature of the surface and p' the difference in pressure between the two sides of the surface of the meniscus.

Table 3.13.2 gives the capillary depression, in mm, as a function of the inner diameter of the tube, in mm, and of the height of the meniscus, in mm, for three values of the surface tension of mercury, 400, 450 and 500 dyn cm^{-1}. The table has been calculated for a temperature of 20°C, for normal acceleration of gravity and assuming that the surface of the mercury is exposed to a vacuum. Linear interpolation is practicable.

The value of the surface tension of mercury exposed to a vacuum depends, to a large extent, on the purity of the mercury ; that is at 20°C, 500 dyn cm^{-1} for very pure mercury, and 400 dyn cm^{-1} for that which is slightly contaminated. A value of 450–475 dyn cm^{-1} is general for a barometer at room temperature. The surface tension of mercury in the presence of air is of the order of 430 dyn cm^{-1} at 18°C.

The capillary effect is found also in the barometer cistern. In this case it is necessary to consider not only the inner wall of the cistern but also the outer surface of the lower end of the tube which projects into the cistern. The pressure of capillarity p_c will then be, assuming that δ has the same value on both surfaces,

$$p_c = \frac{4\,\sigma\cos\delta}{D_1 - d},$$

where D_1 is the inner diameter of the cistern and d is the outer diameter of the tube.

It can be seen that the effect of capillarity is much weaker in the cistern than in the tube, the inner diameter of the cistern being some six times larger than the inner diameter of the tube.

It should be noted that Table 3.13.2 applies strictly only to the column of mercury in a barometer but it can also be used for the column of mercury in a manometer or in the open part of a siphon barometer. It cannot however be applied to the mercury surface in a barometer cistern.

Correction for capillarity

The capillary effect is normally considered in the calibration of most barometers. If such has not been done, an appropriate correction can be determined from the table using values of the measured height of the meniscus and the known inner diameter of the tube. The capillary depression so determined is expressed in mm and can be added directly to the pressure if it is expressed in $(\text{mm Hg})_n$; if the pressure is expressed in mb it is necessary to convert the capillary depression before adding it to the pressure.

In cases where the capillary effect was considered in the original calibration of the barometer but the height of the meniscus has altered in the course of time (through the inevitable contamination of the mercury surface) it is possible instead of making a new calibration, to calculate the correction for capillarity corresponding to the height of the meniscus at the time of calibration and that corresponding to the present height of the meniscus and apply the difference between the two as a new correction.

Table 3.13.1 is a reproduction of Table 5.2.2 published in the *Manual of Barometry*, WBAN, Vol. I, Washington D.C., 1963.

Table 3.13.2 is a reproduction of the table established by F.A. Gould, M.A. and T. Vickers, M.A.*.

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* F.A. Gould, M.A. and T. Vickers, M.A., *Capillary depression in mercury barometers and manometers*. Journal of Scientific Instruments, **29**, pp. 85-87, 1952.

Introduction to Table 4.4

PROPERTIES OF WATER VAPOUR

Table 4.4 describes the behaviour of water vapour in general. For this purpose it gives the values of the compressibility factor and expressions for use in the calculation of specific heat at constant pressure, specific enthalpy and specific entropy.

The expression of density ρ_v of water vapour can be written in general as follows :

$$\rho_v = \frac{e}{C_v R_w T} \tag{1}$$

where e is the water vapour pressure ;

T the absolute temperature in °K ;

R_w the gas constant for 1 kg of water vapour = 461.51 J kg^{-1} °K^{-1} (if ρ_v is to be expressed in kg m^{-3}, e in mb, T in °K, the value 4.615 1 must be taken for R_w) ;

C_v the compressibility factor, a function of the pressure e and the temperature T.

The specific heat at constant pressure c_{pv}, the specific enthalpy h_v and the specific entropy s_v are found by the following equations, when enthalpy and entropy are assigned the value zero for saturated liquid at a temperature of 0°C :

$$c_{pv} = 4R_w + \Delta c_{pv} \tag{2}$$

$$h_v = 4R_w \left[t + \frac{L_v(0)}{4R_w} \right] + \Delta h_v \tag{3}$$

$$s_v = 4R_w \left\{ \ln T - \frac{1}{4} \ln e - \left[\ln T_0 - \frac{1}{4} \ln e_w(0) \right] + \frac{L_v(0)}{4R_w T_0} \right\} + \Delta s_v \tag{4}$$

where t is the temperature in °C and T_0 the normal ice point ;

$e_w(0)$ the saturation vapour pressure over water at 0°C ;

$L_v(0)$ the latent heat of vaporization of water at 0°C, and

Δc_{pv}, Δh_v and Δs_v are smaller terms, functions of temperature and pressure, respectively called specific heat at constant pressure residual, specific enthalpy residual and specific entropy residual.

As $R_w = 461.51$ J kg^{-1} °K^{-1}, $e_w(0) = 6.1070$ mb and $L_v(0) = 2.50084 \times 10^6$ J kg^{-1}, equations (2), (3) and (4) become, if e is expressed in mb and t in °C :

$$c_{pv} = 1\,846.0 + \Delta c_{pv} \qquad \text{J kg}^{-1}\,°\text{K}^{-1} \tag{2'}$$

$$h_v = 1\,846.0\,(t + 1354.71) + \Delta h_v \qquad \text{J kg}^{-1} \tag{3'}$$

$$s_v = 1\,846.0\,\left(\ln T - \frac{1}{4} \ln e - 0.1981\right) + \Delta s_v \qquad \text{J kg}^{-1}\,°\text{K}^{-1} \tag{4'}$$

Table 4.4 gives the values of C_v, Δc_{pv}, Δh_v and Δs_v as a function of temperature, for selected values of pressure, in particular saturation vapour pressure over ice e_i and saturation vapour pressure over water e_w, both calculated by means of the Goff-Gratch formulae. Linear interpolation is practicable over the whole of the table except for Δc_{pv} at temperatures over 20°C.

The table shows that C_v remains very near to unity and that Δc_{pv}, Δh_v and Δs_v are small in relation to the first term on the right-hand side of equations (2'), (3') and (4'), so that it is generally possible for practical purposes to take C_v as unity and to ignore Δc_{pv}, Δh_v, Δs_v.

The values of the compressibility factor and the above expressions of specific heat at constant pressure, specific enthalpy and specific entropy are derived as follows from the Goff-Gratch formulation of the thermodynamic properties of water vapour :

Let g be the specific free enthalpy (or Gibbs' thermodynamic potential) $g = h - sT$. The above-mentioned functions can then be deduced from g :

$$h_v = \frac{\partial(\tau g)}{\partial \tau} \quad \text{where} \quad \tau = 1/T, \tag{5}$$

$$s_v = -\frac{\partial g}{\partial T}, \tag{6}$$

$$\nu = \frac{\partial g}{\partial e} \quad \text{where } \nu \text{ is the specific volume} = \frac{1}{\rho}. \tag{7}$$

And also :

$$c_{pv} = \frac{\partial h_v}{\partial T}, \tag{8}$$

$$C_v = \frac{e\,\nu}{R_w T}. \tag{9}$$

The free enthalpy of water vapour at sufficiently low pressure and not too low temperature can be expressed by :

$$g = g^0(T) + R_w T \ln e - eA_{vv}(T) - \frac{1}{2} e^2 A_{vvv}(T) - \dots \tag{10}$$

$g^0(T)$ is a function of temperature only, called "zero-pressure" reduced free enthalpy (reduced free enthalpy is defined as $g - R_w T \ln e$). $g^0(T)$ is directly calculable from the spectroscopic constants of the molecular species and can be written :

$$g^0/R_w T = 4 \ln \frac{1}{T} + \varphi(T) \tag{11}$$

where $\varphi(T)$ is small by comparison with $4 \ln \frac{1}{T}$.

A_{vv} and A_{vvv} are functions of temperature only, known as second and third virial coefficients.

By transferring the value of g^0 from equation (11) to equation (10) and differentiating according to equations (5) and (6), we obtain the values of h_v and s_v given in equations (3) and (4), always provided we take into account that the expressions for h_v and s_v contain an arbitrary constant and that their zero values are arbitrarily assigned at 0°C for saturated liquid. Another differentiation, according to equation (8), gives the value of c_{pv} in equation (2). The residuals Δh_v, Δs_v, Δc_{pv} contain the functions $\varphi(T)$, $A_{vv}(T)$ as well as their derivatives.

Differentiation of (10) with respect to e and multiplication by e gives the well-known expression of the virial :

$$e\nu = R_W T - eA_{VV}(T) - e^2 A_{VVV}(T) - \ldots,$$

from which, by equation (9), we can deduce :

$$C_V = 1 - e\,\frac{A_{VV}}{R_W T} - e^2\,\frac{A_{VVV}}{R_W T} - \ldots .$$

The ideal gas hypothesis

According to the equation of state for ideal gas, density is given by :

$$\rho_V\,(\text{ideal}) = \frac{e}{R_W T}.$$

The compressibility factor may be interpreted as the factor by which the density, calculated for an ideal gas, must be divided to obtain the density in general :

$$\rho_V = \frac{1}{C_V}\,\rho_V\,(\text{ideal}).$$

On the other hand, if it is assumed that water vapour is an ideal gas of which the specific heat at constant pressure is equal to $4R_W$, it will be seen that the first term of the right-hand side of equations (2), (3) and (4) is respectively the specific heat at constant pressure, the specific enthalpy, and the specific entropy. Thus the specific heat at constant pressure residual Δc_{pV}, the specific enthalpy residual Δh_V and the specific entropy residual Δs_V, may be regarded as the correction which must be added, respectively, to the specific heat at constant pressure, specific enthalpy, and specific entropy calculated for water vapour as an ideal gas, to take into account the deviation from the perfect gas laws.

$$c_{pV} = c_{pV}\,(\text{ideal}) + \Delta c_{pV}$$
$$h_V = h_V\,(\text{ideal}) + \Delta h_V$$
$$s_V = s_V\,(\text{ideal}) + \Delta s_V.$$

SMT 91 was drawn up from data prepared by J. A. Goff and S. Gratch. As no further experimental data are available, values from SMT 91 have been used in Table 4.4, the only change being in the system of units for Δc_{pV}, Δh_V and Δs_V. It should be borne in mind that as a result of the adoption of (1) a new value for R_W and a new temperature scale °C, and (2) new Goff-Gratch formulae for e_i and e_W (Resolution 19 (Cg-IV)), the values of C_V, Δc_{pV}, Δh_V, Δs_V have been slightly modified. However, computation shows that errors due to these changes fall within experimental tolerances and are too small to affect the values in the table.

NOTE 1 : The factor 4.186 84 was chosen for the conversion of IT calories into joules because it was the conversion factor in use when the tables were drawn up, according to SMT 1-K (see also the Introduction to Table 1.1, section 5). Table 4.4 gives the converted values of the IT calories in joules to the same number of decimal places as the original table ; there is therefore an uncertainty of ± 2 in the last decimal place.

NOTE 2 : The e_W values for supercooled water (from —50°C to 0°C) given in the table have been calculated by extrapolation of the Goff-Gratch formula (see the note to Introduction 4.6/7).

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GOFF, J. A., *Final Report of the Working Subcommittee of the International Joint Committee on Psychrometric Data.* ASME Trans., *71*, 1949.

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GOFF, J. A., and GRATCH, S., *Low-pressure properties of water from —160 to 212°F.* ASHVE Trans., *52*, pp. 95–129, 1946.

Introduction to Table 4.5

PROPERTIES OF CONDENSED WATER

The first part of the table sets out values of the specific heat at constant pressure c_i and c_w of solid (ice) and liquid water respectively. In order to obtain the values of c_w below 0°C it was necessary to extrapolate the Goff-Gratch formula for $e_w(T)$ and the Smith-Keyes liquid volume data [1]. Only the former extrapolation contributes appreciable uncertainty to the results, but the justification for relying upon it pending further research has been discussed elsewhere [2].

The first part of the table also lists values of the latent heat of vaporization. fusion and sublimation as calculated from the Goff-Gratch formulation. Values for super-cooled liquid are consistent with, and therefore subject to, the same extrapolation uncertainties as the values of c_w.

The second part of the table gives values of the density of pure water under a pressure of one atmosphere (1 013.25 mb) which have been taken from Dorsey's compilation [3] based on the results of various investigations. As the presence of dissolved air decreases the density of water, the table also lists the differences in density reported by Marek [4] between water which has been freed of air by exhaustion just prior to the measurement and water at the same temperature which has been exposed to air for intervals of one to three days.

The first Table 4.5 is taken from SMT 92 with the values in IT calories converted into joules [5]. The second Table is from SMT 118. Both SMT 92 and SMT 118 are still valid because, so far as can be ascertained, no more recent experimental data are available.

Linear interpolation is practicable :

for c_i and L_s throughout the table ;

for c_w except for temperatures between 0 and 20°C ;

for L_v except for temperatures below —20°C ; and

for density throughout the table.

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1 SMITH, L. B., and KEYES, F. G., Proc. Amer. Acad. Arts and Sci., *69*, pp. 285–314, 1934.

2 GOFF, J. A., *Final Report of the Working Subcommittee of the International Joint Committee on Psychrometric Data.* ASME Trans., *71*, 1949.

3 DORSEY, N. E., *Properties of ordinary water substance*, pp. 199–201, Reinhold Publ. Corp., New York, 1940.

4 MAREK, W. J., Ann. d. Physik (Wied.), *44*, pp. 171–172, 1891.

5 See Introduction 4.4, note 1.

Introduction to Tables 4.6 and 4.7

SATURATION VAPOUR PRESSURE OVER A PLANE SURFACE OF PURE WATER (Table 4.6)

SATURATION VAPOUR PRESSURE OVER A PLANE SURFACE OF ICE (Table 4.7)

Both these tables of saturation vapour pressure of water vapour in the pure phase have been computed using the new Goff-Gratch formulae adopted by Resolution 19(Cg-IV) (see WMO TR, Appendix C, section 13).

Saturation vapour pressure

(*a*) Over water (e_w), 0°C to 100°C

$$\begin{aligned}\log e_w = &+ 10.795\,74\,(1 - T_1/T) - 5.028\,00 \log (T/T_1) \\ &+ 1.504\,75 \times 10^{-4}\,[1 - 10^{-8.296\,9\,(T/T_1 - 1)}] \\ &+ 0.428\,73 \times 10^{-3}\,[10^{4.769\,55(1 - T_1/T)} - 1] \\ &+ 0.786\,14\end{aligned}$$

where

$T_1 = 273.16$ °K (the triple point of water) ;
e_w is expressed in millibars and T in °K.

NOTE : The above formula is based on data which have been experimentally confirmed only in the range 0° to 100°C, but the same formula can be used for saturation vapour pressure over super-cooled water in the range —50° to 0°C with, so far as is known, insignificant error.

(*b*) Over ice (e_i), 0°C to —100°C

$$\log e_i = -9.096\,85\left(\frac{T_1}{T} - 1\right) - 3.566\,54 \log\left(\frac{T_1}{T}\right) + 0.876\,82\left(1 - \frac{T}{T_1}\right) + 0.786\,14$$

where

$T_1 = 273.16$°K (the triple point of water);
e_i is expressed in millibars and T in °K.

The Goff-Gratch formulae are based on integration of the Clausius-Clapeyron equation considering the deviation from an ideal gas, and on modern experimental data. The following will give a rough idea of the methods used for the establishment of these formulae.

On the one hand, precise calorimetric measurements have been made at the U.S. National Bureau of Standards, particularly of the amount of heat γ to be added to an adiabatic calorimeter, containing water in both liquid and vapour phases, in order to keep the temperature constant during adiabatic withdrawal of a volume ν of saturated vapour, γ and ν being expressed per unit mass of vapour withdrawn. These quantities are linked by the Clausius-Clapeyron equation :

$$\gamma = T\nu \frac{de_w}{dT}. \tag{1}$$

On the other hand the virial equation states :

$$v\, e_W = R_W T - A_{vv}\, e_W - A_{vvv}\, e^2{}_W - \ldots \quad (2)$$

The combination of equations (1) and (2) gives the differential equation :

$$\frac{d \ln e_W}{dT} = \frac{\gamma / R_W T^2}{1 - A_{vv}\, e_W / R_W T - A_{vvv}\, e^2{}_W / R_W T - \ldots} \quad (3)$$

As the negative terms of the denominator are small compared with unity, it is enough to have a first approximation of e_W. The right-hand side of equation (3) is then reduced to a semi-empirical equation of suitable form for integration, and this leads to the formula for saturation vapour pressure over water. The integration of equation (3) is also carried out numerically, after which the constants in the saturation pressure formula are adjusted by least squares.

The formula for saturated vapour pressure over ice is obtained similarly.

Linear interpolation is practicable throughout Table 4.6 and in Table 4.7 for temperatures above —42°C.

Tables 4.6 and 4.7 have been reproduced from tables computed by the Centre de calcul de l'Institut royal météorologique de Belgique. The programme, written in Fortran IV code, is kept at the Institut royal météorologique de Belgique.

Reference

Goff, J. A., and Gratch, S., *Low-pressure properties of water from —160 to 212°F.* ASHVE Trans., *52*, pp. 95–129, 1946.

Introduction to Tables 4.8 and 4.9

DENSITY OF PURE WATER VAPOUR AT SATURATION WITH RESPECT TO A PLANE SURFACE OF PURE WATER (Table 4.8)

DENSITY OF PURE WATER VAPOUR AT SATURATION WITH RESPECT TO A PLANE SURFACE OF ICE (Table 4.9)

The density ρ_v of water vapour at saturation with respect to a plane surface of pure water and with respect to a plane surface of ice is obtained by means of the following equations when water vapour is considered as a real gas :

$$(\rho_v)_{\text{water}} = \frac{e_w}{C_v R_w T} \quad \text{and} \quad (\rho_v)_{\text{ice}} = \frac{e_i}{C_v R_w T} \qquad (1)$$

where R_w is the gas constant for water vapour ;
T the absolute temperature of water vapour ;
e_w the saturation vapour pressure over water at temperature T ;
e_i the saturation vapour pressure over ice at temperature T, and
C_v the compressibility factor for water vapour (see Table 4.4).

It should be noted that the use of density values calculated for water vapour as a real gas (equation 1) will often lead to incompatibilities, especially if these values have to be introduced into equations formulated for an ideal gas. Depending on the problem to be solved, density values are required for water vapour as an ideal gas or for water vapour as a real gas. It is therefore simplest to provide a table for water vapour as an ideal gas, accompanied by a table of the corrections to be applied in order to obtain real gas densities. Let us therefore introduce a correction factor τ defined by the equation :

$$\frac{1}{C_v} = 1 + \tau. \qquad (2)$$

If $\rho_v^{(i)}$ is the density of saturated water vapour regarded as an ideal gas,

$$(\rho_v^{(i)})_{\text{water}} = \frac{e_w}{R_w T} \quad \text{and} \quad (\rho_v^{(i)})_{\text{ice}} = \frac{e_i}{R_w T}, \qquad (3)$$

equation (1) becomes, over water or ice,

$$\rho_v = (1 + \tau)\, \rho_v^{(i)} = \rho_v^{(i)} + \tau \rho_v^{(i)}. \qquad (4)$$

Thus the density of water vapour, as a real gas, is equal to the density $\rho_v^{(i)}$ for the ideal gas hypothesis, plus a correction term $\tau\rho_v^{(i)}$.

Tables 4.8 and 4.9 each consist of two tables :

(*a*) A table giving the density, $\rho_v^{(i)}$, of saturated water vapour over water and over ice respectively as a function of temperature, for water vapour as an ideal gas (Tables 4.8.1 and 4.9.1) ;

(*b*) A table giving the correction $\tau\rho_v^{(i)}$ as a function of temperature (Tables 4.8.2 and 4.9.2). To obtain the density of saturated water vapour as a real gas, merely add this correction to the value given in Tables 4.8.1 or 4.9.1 for the same temperature.

For instance, at the temperature of 15.3°C, the density of saturated water vapour (ideal gas) over water $\rho_v^{(i)}$ is 13.05 g m^{-3} (Table 4.8.1), the correction $\tau\rho_v^{(i)}$ is 0.01 g m^{-3} (Table 4.8.2) ; and the density of the water vapour as a real gas is $\rho_v = 13.05 + 0.01 = 13.06$ g m^{-3}.

Tables 4.8 and 4.9 have been drawn up with the following basic values : e_w and e_i according to the Goff-Gratch formula adopted by Resolution 19 (Cg-IV) (Tables 4.6 and 4.7) ; $R_w = 461.51$ J kg^{-1} °K^{-1} ; and the C_v values of Table 4.4.

Linear interpolation is practicable in all the tables, except Table 4.9.1, for temperatures less than —41°C.

Tables 4.8 and 4.9 have been drawn up by the Institut royal météorologique de Belgique. The programme of the computations, written in Fortran IV code, is kept at the Institut royal météorologique de Belgique.

Introduction to Table 4.10

RELATIONS BETWEEN SATURATION VAPOUR PRESSURE OF WATER VAPOUR IN THE PURE PHASE AND OF MOIST AIR (COEFFICIENTS f_w AND f)

The saturation vapour pressure of moist air, defined in Table 4.3, section 10, must not be confused with the saturation vapour pressure in the pure phase for the same temperature, whether with respect to water or to ice. The differences between these quantities, though often negligible in practice, are caused by the following :

(*a*) The pressure of the liquid or solid phase associated with moist air at saturation is not the same as the saturation vapour pressure of water vapour ;

(*b*) The liquid or solid phase associated with moist air does not consist of pure water or pure ice, but of water or ice containing dissolved air ;

(*c*) If moist air is regarded as a real gas, its pressure cannot be regarded as the sum of the pressure which dry air and water vapour would have if they were isolated at the same temperature and in the same volume.

Consequently, two coefficients should be introduced, f_w and f_i, functions of the temperature and pressure of moist air at saturation and defined by :

$$f_w = \frac{e'_w}{e_w} \quad \text{and} \quad f_i = \frac{e'_i}{e_i}$$

where e'_w and e'_i are, respectively, the saturation vapour pressures of moist air with respect to water and with respect to ice, and

where e_w and e_i are the saturation vapour pressures in the pure phase with respect to water and to ice.

Expressions for f_w and f_i were drawn up by J. A. Goff and S. Gratch in their formulation of the thermodynamic properties of moist air and water vapour (see reference, equation (8)) ; these expressions are compatible with the formulae for saturation vapour pressure in the pure phase, given in the Introduction to Table 4.6/7.

Table 4.10 gives values of f_w and f_i as functions of temperature and pressure of moist air at saturation. Linear interpolation is practicable throughout the table.

To calculate the saturation vapour pressure of moist air with respect to water, find in Table 4.10 the f_w value corresponding to the pressure and temperature of the moist air and, in Table 4.6, the e_w value for the same temperature.

In the case of saturation with respect to ice, find f_i similarly, in Table 4.10, and e_i in Table 4.7. These values are then substituted in one of the relations :

$$e'_w = f_w e_w \quad \text{or} \quad e'_i = f_i e_i .$$

For instance, if the pressure of moist air saturated with respect to water is $p = 960$ mb and its temperature is $t = 12.3$°C, Table 4.6 gives $e_w = 14.295$ mb for $t = 12.3$°C and Table 4.10, by interpolation, $f_w = 1.004\,2$ for $p = 960$ mb and $t = 12.3$°C. Thus the saturation vapour pressure of moist air with respect to water is :

$$e'_w = 1.004\,2 \times 14.295 = 14.355 \text{ mb}.$$

Note 1 : In the table, the values of f_w range from 1 to 1.006 5 and those of f_i from 1 to 1.008 9, as these values remain between 1 and 1.005 in the meteorological range of temperature and pressure. The approximation $e'_w \approx e_w$ and $e'_i \approx e_i$, often used in practical calculations, introduces an error not exceeding 0.5%. This error generally exceeds the tolerance for values of e_w and e_i which are, as given in reference (Table 7), for e_w, ± 0.1% (0°C) and ± 0.05% (+50°C) and, for e_i, ± 0.1% (0°C) and ± 0.6% (—50°C).

Note 2 : It is often assumed in practice (*a*) that moist air is a mixture of ideal gases obeying Dalton's law and (*b*) that the associated phases are pure water and pure ice. These assumptions do not imply that the f_w and f_i coefficients are equal to unity because the first of the causes set out at the beginning of this Introduction must always be considered ; in such a case, the f_w and f_i values are nearer to unity than in the general case (for instance $f_w \approx 1.001$ instead of 1.004 for 1 000 mb and 0°C).

Table 4.10 is a reproduction of SMT 89 and 90 which were based on data by J. A. Goff and S. Gratch.

Reference

Goff, J. A., *Final Report of the Working Subcommittee of the International Joint Committee on Psychrometric Data*, ASME Trans. *71*, pp. 903–913, 1949.

Introduction to Table 4.11

VIRTUAL TEMPERATURE INCREMENT

The virtual temperature T_v of moist air as defined in Table 4.3, section 20, is given by the expression :

$$T_v = T \frac{1 + \frac{r}{\varepsilon}}{1 + r} \tag{1}$$

where T is the temperature of the moist air, r the mixing ratio and ε the ratio of the molecular weight of water vapour to that of dry air, $\varepsilon = M_v/M_a = 0.621\,98$.

It is practical to introduce into the calculations the difference D between the virtual temperature and the temperature, expressed in °K or in °C, $D = T_v - T$.

When the humidity parameter is the mixing ratio, the difference D is obtained directly from equation (1) :

$$D = T_v - T = \left(\frac{1}{\varepsilon} - 1\right) \frac{r}{1 + r} T \tag{2}$$

with $$\frac{1}{\varepsilon} - 1 = 0.607\,77.$$

When the humidity parameter is the relative humidity or the thermodynamic dew-point temperature, the difference D is easily calculated by means of the difference D_w between the virtual temperature and the temperature of moist air saturated with respect to water at the same pressure p and at the same temperature T as the moist air concerned ; the expression for D_w is given by equation (2) substituting for r the saturation mixing ratio r_w at pressure p and temperature T :

$$D_w = \left(\frac{1}{\varepsilon} - 1\right) \frac{r_w}{1 + r_w} T \cdot \tag{3}$$

A. *The humidity parameter is the relative humidity with respect to water.*

It is more convenient to express the relative humidity with respect to water U_w decimally instead of in per cent. So the formula given in Table 4.3, section 15, is written :

$$U_w = \frac{r}{r_w} \cdot \frac{\varepsilon + r_w}{\varepsilon + r} \cdot \tag{4}$$

Finding r and r_w by means of equations (2) and (3) and introducing these expressions into equation (4), we obtain :

$$D = U_w D_w \frac{1}{1 + (1 - U_w)\dfrac{D_w}{T}};$$

or, by expanding the expression $1 \Big/ \left[1 + (1 - U_w)\dfrac{D_w}{T}\right]$ in series and retaining the first two terms only :

$$D = U_w D_w - U_w (1 - U_w) \frac{{D_w}^2}{T}. \qquad (5)$$

The term originating from the remainder R_2 of the expansion in series, namely $U_w D_w R_2$, is less than 0.005°C for D_w up to 15°C, so it can be ignored in the meteorological range of pressure and temperature.

For practical calculations the first term of the second member of equation (5) will generally suffice, the contribution of the second term being always less than 0.1°C when D_w does not exceed 10°C.

B. ***The humidity parameter is the thermodynamic dew-point temperature.***

The difference $D_w(p,T_d)$ at pressure p and at a temperature equal to the thermodynamic dew-point temperature T_d of the moist air concerned is given by equation (3) :

$$D_w (p,T_d) = \left(\frac{1}{\varepsilon} - 1\right) \frac{r_w (p,T_d)}{1 + r_w (p,T_d)} T_d \qquad (6)$$

where $r_w(p,T_d)$ is the saturation mixing ratio at pressure p and temperature T_d.

Now, according to the definition of the thermodynamic dew-point temperature (Table 4.3, section 12), $r_w(p,T_d) = r$, so that equation (2) has only to be divided, member by member, by equation (6) to give :

$$D = D_w (p,T_d) \frac{T}{T_d}. \qquad (7)$$

Table 4.11 gives values of D_w as a function of temperature and pressure. Linear interpolation is practicable with respect to temperature for D_w values less than 15°C and with respect to pressure for temperatures not exceeding 43°C at 1 050 mb, 25°C at 700 mb, 5°C at 500 mb and —20°C at 200 mb.

Directions for the use of the table

(*a*) When the humidity parameter is relative humidity :

Find in the table the D_w value for the temperature t (°C) and pressure p (mb) of the air mass concerned ; the difference between the virtual temperature and temperature is given by equation (5), the second term of the right-hand member being ignored, if appropriate.

For example, for $t = 25.30$°C and $p = 963$ mb, the table gives by interpolation $D_w = 3.84$°C ; thus we calculate for $U_w = 58\% = 0.58$:

$$U_w D_w = 0.58 \times 3.84 = 2.227 \approx 2.23^\circ\mathrm{C} \ ;$$

$$- U_w (1 - U_w) \frac{D_w^2}{T} = -0.58 \times 0.42 \frac{(3.84)^2}{273.15 + 25.30} = -0.012^\circ\mathrm{C}$$

The difference $D = T_v - T$ is equal to 2.23°C or 2.22°C depending on whether one or two terms of equation (5) are used, which gives $t_v = 27.53$°C or 27.52°C.

(*b*) When the humidity indicator is the thermodynamic dew-point temperature :

Find in the table the D_w value for the thermodynamic dew-point temperature t_d (°C) and pressure p (mb) then multiply this value by the ratio of the temperature (°K) to the thermodynamic dew-point temperature (°K) to obtain the difference between the virtual temperature and temperature (equation (7)).

For example, $t = 15.2$°C ($T = 288.35$°K), $t_d = 12.4$°C ($T_d = 285.55$°K) and $p = 983$ mb ; for 12.4°C and 983 mb, the table gives by interpolation $D_w = 1.59$°C ; thus we obtain $D = 1.59 \dfrac{288.35}{285.55} = 1.61$°C and $t_v = (15.2 +$ $+ 1.6)$°C $= 16.8$°C.

Table 4.11 is reproduced from SMT 72 which was computed by means of equation (3) using values of saturation mixing ratio from SMT 73, $\varepsilon = 0.621\,97$ and $T_0 = 273.16$°K. These values show slight differences from corresponding IMT values ; these differences lead to deviations of less than unity in the last significant digit given in SMT 72.

NOTE : For the calculation of adjusted virtual temperature, see Introduction 4.12.

Introduction to Table 4.12

DENSITY OF AIR

Density of air regarded as an ideal gas (Table 4.12.1)

The density ρ of dry air regarded as an ideal gas is deduced from the equation of state for ideal gas, i.e. :

$$\rho = \frac{p \times 10^2}{R\,T} \text{ kg m}^{-3} \qquad (1)$$

where p is pressure in mb, T temperature in °K, and $R = 287.05$ J kg^{-1} °K^{-1}, the ideal gas constant for dry air.

The density of moist air regarded as an ideal gas is given by the same equation, temperature then being replaced by virtual temperature T_v, also in °K :

$$\rho = \frac{p \times 10^2}{R\,T_v} \text{ kg m}^{-3} \,. \qquad (2)$$

Virtual temperature is defined in Table 4.3, section 20, and the method of calculation is given in Introduction 4.11.

Table 4.12.1 gives the density, in kg m^{-3}, of moist air regarded as an ideal gas, as a function of pressure, in mb, and virtual temperature, in °C. Linear interpolation is practicable throughout the table.

Deviation from the ideal gas laws : the compressibility factor (Table 4.12.2)

The density of moist air is given by the following expression when moist air is regarded as a real gas, i.e. taking into account deviations from the ideal gas laws in the behaviour of moist air :

$$\rho_{\text{real}} = \frac{p \times 10^2}{C\,R\,T_v} \text{ kg m}^{-3} \qquad (3)$$

where C is the compressibility factor of moist air, a function of pressure, temperature and humidity.

The density of moist air regarded as a real gas can therefore be deduced from the equation of state for moist air regarded as an ideal gas (equation (2)), by substituting the adjusted virtual temperature, $T'_v = C\,T_v$, defined in Table 4.3, section 21, for the virtual temperature :

$$\rho_{\text{real}} = \frac{p \times 10^2}{R\,T'_v} \text{ kg m}^{-3} \,.$$

Table 4.12.2 gives the compressibility factor for moist air (dimensionless) as a function of pressure, in mb, temperature, in °C, and relative humidity, U_w; below 0°C the values given are for dry air as the effects of water vapour are negligible for these temperatures. Linear interpolation is practicable throughout the table.

The values in the table are those computed by J. A. Goff and S. Gratch on the basis of their formulation of the thermodynamic properties of air and water vapour (see reference in Introduction 4.10). This computation takes into account not only interaction between molecules of the same gas, as in the case of water vapour (see Introduction 4.4), but also interaction between dissimilar molecules.

It will be seen from Table 4.12.2 that the compressibility factor deviates very little from unity (by 0.001 7, at most, for temperatures between +50°C and —50°C) so that values of T'_v remain very near to T_v (maximum deviation 0.4°C).

Directions for the use of the Tables

To obtain the density of moist air regarded as an ideal gas at pressure p, in mb, and temperature t, in °C, and with a relative humidity U_w, calculate virtual temperature t_v, in °C, by means of Table 4.11, then find the density corresponding to pressure p and virtual temperature t_v in Table 4.12.1.

For the density of moist air regarded as a real gas, use adjusted virtual temperature t'_v instead of virtual temperature t_v and read from Table 4.12.1 in the same way.

Calculation of the adjusted virtual temperature t'_v

Find in Table 4.12.2 the value of the compressibility factor C for pressure p, temperature t and relative humidity U_w. The adjusted virtual temperature t'_v, in °C, is worked out from virtual temperature t_v, in °C, by means of the equation:

$$t'_v = t_v - (1 - C)\,(273 + t_v)\,;$$

t_v can be rounded off to the nearest degree in the second term of the right-hand member of the equation.

For example, if $p = 963$ mb, $t = 25.30$°C and $U_w = 58\%$, the virtual temperature is $t_v = 27.52$°C and the density of moist air regarded as an ideal gas, for 963 mb and 27.52°C, is given in Table 4.12.1 as ρ (ideal)= 1.115 8 kg m^{-3}. The compressibility factor for $p = 963$ mb, $t = 25.30$°C and $U_w = 58\%$, according to Table 4.12.2, is $C = 0.999\,6$; the adjusted virtual temperature is therefore $t'_v = 27.52 - (1 - 0.999\,6)\,(273 + 28) = 27.40$°C; the density of moist air regarded as a real gas, for 963 mb and 27.40°C, is given in Table 4.12.1 as ρ (real)= 1.116 2 kg m^{-3}.

COMMENT : Adjusted virtual temperature is used instead of virtual temperature when deviations from the equation of state for ideal gas in the behaviour of moist air are to be taken into account. It may therefore be introduced as a device to avoid explicit use of the compressibility factor in equations where temperature appears only in the expression of density ; this is so in the hydrostatic equation. This comment relates to Tables 3.2, 3.3, 3.4, 3.5, 3.6 and 3.7.

Table 4.12.1 is reproduced from SMT 71 which was computed using the following values for physical constants : $R = 287.04$ J kg^{-1} $^{o}K^{-1}$ and T_0 (temperature of the normal ice point) = 273.16°K. These values show slight differences from corresponding IMT values mentioned in this Introduction ; these differences lead to deviations of less than unity in the last significant digit given in SMT 71.

Table 4.12.2 is a reproduction of SMT 84 based on data prepared by J. A. Goff and S. Gratch. These values have been retained because no more recent data are available and they are affected neither by the changes in the values of the physical functions and constants nor by the change in the definition of relative humidity.

Introduction to Table 4.13

RELATIONS BETWEEN MIXING RATIO, THERMODYNAMIC DEW-POINT TEMPERATURE AND THERMODYNAMIC FROST-POINT TEMPERATURE

(Saturation mixing ratio tables)

The saturation vapour pressure e'_{w} of moist air saturated with respect to water at pressure p and temperature T with a mixing ratio r_{w} is given by the equation (Table 4.3, section 10) :

$$e'_{\mathrm{w}}(p,T) = \frac{r_{\mathrm{w}}}{\varepsilon + r_{\mathrm{w}}}\, p \tag{1}$$

where ε is the ratio of the molecular weight of water vapour to that of dry air, $\varepsilon = M_{\mathrm{v}}/M_{\mathrm{a}} = 0.621\,98$.

The definition of the thermodynamic dew-point temperature T_{d} (Table 4.3, section 12) of moist air at pressure p, temperature T and with mixing ratio r involves the relation :

$$r_{\mathrm{w}}\,(p,T_{\mathrm{d}}) = r$$

or, taking (1) into account,

$$e'_{\mathrm{w}}\,(p,T_{\mathrm{d}}) = \frac{r}{\varepsilon + r}\, p\,. \tag{2}$$

Lastly, the saturation vapour pressure of moist air e'_{w} is related to that of the pure phase e_{w} by the equation :

$$e'_{\mathrm{w}}\,(p,T) = f_{\mathrm{w}}\,(p,T)\, e_{\mathrm{w}}\,(T) \tag{3}$$

where $f_{\mathrm{w}}\,(p,T)$ is a coefficient depending on the pressure and temperature of the moist air (see Table 4.10).

For saturation with respect to ice, the equations are analogous to equations (1), (2) and (3), the subscript i denoting saturation with respect to ice and T_{f} the thermodynamic frost-point temperature (Table 4.3, section 13) :

$$e'_{\mathrm{i}}\,(p,T) = \frac{r_{\mathrm{i}}}{\varepsilon + r_{\mathrm{i}}}\, p\;, \tag{1'}$$

$$e'_{\mathrm{i}}\,(p,T_{\mathrm{f}}) = \frac{r}{\varepsilon + r}\, p\;, \tag{2'}$$

$$e'_{\mathrm{i}}\,(p,T) = f_{\mathrm{i}}\,(p,T)\, e_{\mathrm{i}}\,(T)\,. \tag{3'}$$

The relations between the humidity parameters r (in g kg^{-1}), t_d and t_f are given in the following five tables (t_d and t_f denote the values of T_d and T_f expressed in °C) :

Table 4.13.1 — Thermodynamic dew-point temperature as a function of mixing ratio and pressure

This table was drawn up by computing e_w for each value of p and of r by means of equations (2) and (3), using f_w values drawn from Table 4.10 after making a first approximation of t_d. The final value of t_d was obtained from e_w by inversion of Table 4.6.

Table 4.13.2 — Mixing ratio as a function of thermodynamic dew-point temperature and pressure

This table was drawn up by obtaining e_w from Table 4.6 for each value of t_d, then r was calculated by means of equations (2) and (3).

Table 4.13.3 — Thermodynamic frost-point temperature as a function of mixing ratio and pressure

This table was drawn up by a procedure analogous to that of Table 4.13.1 but with use of equations (2′) and (3′) and Table 4.7.

Table 4.13.4 — Mixing ratio as a function of thermodynamic frost-point temperature and pressure

This table was drawn up by a procedure analogous to that of Table 4.13.2 but with use of Table 4.7 and equations (2′) and (3′).

Table 4.13.5 — Thermodynamic frost-point temperature as a function of thermodynamic dew-point temperature

The relation between thermodynamic dew-point and frost-point temperatures is obtained from equations (2) and (2′),

$$e'_w\,(p,T_d) = e'_i\,(p,T_f)\,,$$

or, taking equations (3) and (3′) into account :

$$e_i\,(T_f) = e_w\,(T_d)\,\frac{f_w\,(p,T_d)}{f_i\,(p,T_f)}\,.$$

Comparison of the value of f_w and that of f_i for the same pressure but different temperatures, by means of Table 4.10, shows that the difference does not exceed 0.000 2 when the difference of temperature is of the same order as the difference between T_d and T_f (maximum 4°C) ; thus the ratio $f_w(p,T_d)/f_i(p,T_f)$ can be taken as unity, the resulting error not exceeding 0.000 2. The relation between T_d and T_f is therefore in practice independent of pressure and Table 4.13.5 was established by using Tables 4.6 and 4.7 together.

Linear interpolation

Table 4.13.1 : practicable with respect to p arguments when p is higher than 800 mb ; generally not practicable with respect to r arguments (practicable if tabular values are rounded off to 0.1°C).

Table 4.13.2 : not practicable (maximum relative error introduced by linear interpolation with respect to t_d arguments : 0.2 per cent — with respect to p arguments : 0.1 per cent at 1 000 mb and 0.3 per cent at 500 mb).

Table 4.13.3 : practicable with respect to p arguments when p is higher than 700 mb ; not practicable with respect to r arguments.

Table 4.13.4 : not practicable (maximum relative error introduced by linear interpolation with respect to t_f arguments : 0.3 per cent — with respect to p arguments : 0.3 per cent when p is higher than 500 mb).

Table 4.13.5 : practicable throughout the table.

Tables 4.13.1, 4.13.2 and 4.13.5 were not drawn up for values of thermodynamic dew-point temperature below —50°C because the formula for e_w is used, for saturation over supercooled water, only between —50°C and 0°C (see Introduction 4.6/7, page 1, note).

Accuracy of the tables

It is difficult to assess the accuracy of the values in the tables. It depends on that of the e_w, e_i, f_w and f_i values. J. A. Goff and S. Gratch [1] gave the tolerances on r_w and r_i which correspond to r in Tables 4.13.2 and 4.13.4, in connexion with an earlier computation. These tolerances, equal to at least twice the estimated probable error, are as follows for a pressure of one normal atmosphere :

on r_w : $\pm 0.2\%$ for temperature above 0°C (not mentioned for temperature below 0°C) ;

on r_i : $\pm 0.2\%$ at 0°C increasing to $\pm 1\%$ at —80°C.

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[1] GOFF, J. A., *Final Report of the Working Subcommittee of the International Joint Committee on Psychrometric Data*, ASME Trans. *71*, pp. 903–913 (Table 10), 1949.

The corresponding tolerances on t_d are of the order of $\pm 0.04^{\circ}C$ for temperatures over $0^{\circ}C$ and on t_f, from $\pm 0.04^{\circ}C$ (at $0^{\circ}C$) to $\pm 0.06^{\circ}C$ (at $-80^{\circ}C$).

It should be borne in mind, however, that these tolerances were determined from tolerances previously established which, in the opinion of the above-mentioned authors, could be greatly reduced.

COMMENT : In practical calculations, the following approximations are often used : $e'_w = e_w$ and $e'_i = e_i$.

The values of r found by using this approximation are slightly lower than those in Tables 4.13.1 and 4.13.3 though the relative difference is not more than 0.5%. The values of t_d and t_f are slightly higher than those in Tables 4.13.2 and 4.13.4 respectively, though the difference is not more than $0.1^{\circ}C$.

Relations between temperature and mixing ratio of moist air saturated with respect to water and with respect to ice

When moist air is saturated with respect to water, the thermodynamic dew-point temperature is the same as the temperature, $T_d = T$, and the mixing ratio is the saturation mixing ratio $r = r_w$; similarly, for saturation with respect to ice, $T_f = T$ and $r = r_i$. Tables 4.13.1, 4.13.2, 4.13.3 and 4.13.4 give the following relations for moist air at saturation :

Table 4.13.1 : Temperature of moist air saturated with respect to water as a function of mixing ratio and pressure.

Table 4.13.2 : Mixing ratio of moist air saturated with respect to water as a function of temperature and pressure.

Table 4.13.3 : Temperature of moist air saturated with respect to ice as a function of mixing ratio and pressure.

Table 4.13.4 : Mixing ratio of moist air saturated with respect to ice as a function of temperature and pressure.

Conversion between the various humidity parameters

The series of Tables 4.13 provides for conversion, by direct reading, between mixing ratio and thermodynamic dew-point temperature and thermodynamic frost-point temperature ; it also permits conversion between these humidity parameters and relative humidity by a simple calculation.

Relative humidity with respect to water, U_w, expressed in per cent, of moist air at pressure p and temperature t, is related to the mixing ratio by the equation (Table 4.3, section 15) :

$$U_w = 100 \frac{r}{r_w} \cdot \frac{\varepsilon + r_w}{\varepsilon + r} \tag{4}$$

where r_w is the saturation mixing ratio at pressure p and temperature t ; r and r_w are expressed in kg kg^{-1} (1 kg kg^{-1} = 10^3 g kg^{-1}).

If the humidity parameter is r, merely read r_w in Table 4.13.2 with pressure p and temperature t as arguments.

If the humidity parameter is t_d : Table 4.13.2 gives r with p and t_d as pressure and temperature arguments ; the same table gives r_w taking p and t as pressure and temperature arguments.

If the humidity parameter is t_f, Table 4.13.4 gives r with p and t_f as pressure and temperature arguments, and Table 4.13.2 gives r_w with p and t as pressure and temperature arguments.

All that remains is to introduce the values of r and r_w thus obtained, in equation (4).

Example : If $p = 1\,010$ mb and $t = 16.0$°C. Table 4.13.2 gives $r_w =$ $= 11.445$ g kg^{-1}

(*a*) if $r = 8.311$ g kg^{-1},

$$U_w = 100\,\frac{0.008\,311}{0.011\,445} \times \frac{0.621\,98 + 0.011\,445}{0.621\,98 + 0.008\,311} = 72.98\,\% \approx 73.0\,\%\,;$$

(*b*) if $t_d = 11.3$°C, Table 4.13.2 gives $r = 8.389$ g kg^{-1} for 1 010 mb and 11.3°C whence $U_w = 73.65\% \approx 73.7\%$;

(*c*) if $t_f = -4.0$°C, Table 4.13.4 gives $r = 2.716$ g kg^{-1} for 1 010 mb and —4.0°C
whence $U_w = 24.06\% \approx 24.1\%$.

Conversely, if the humidity parameter is U_w, find first of all the value of r_w corresponding to pressure p and temperature t in Table 4.13.2, then work out the value of r from equation (4) written :

$$r = \frac{\varepsilon\, r_w\; U_w/100}{\varepsilon + r_w\,(1 - U_w/100)}\,;$$

t_d and t_f are given by Tables 4.13.1 and 4.13.3 respectively, for pressure p and mixing ratio r.

Example : Let $p = 850$ mb, $t = -5.6$°C and $U_w = 63\%$; Table 4.13.2 gives $r_w = 2.972$ g kg^{-1} for 850 mb and —5.6°C, giving :

$$r = \frac{0.621\,98 \times 0.002\,972 \times 0.63}{0.621\,98 + 0.002\,972 \times 0.37} = 0.001\,869 \text{ kg kg}^{-1} = 1.869 \text{ g kg}^{-1}$$

whence $t_d = -11.53$°C and $t_f = -10.27$°C.

The series of Tables 4.13 was drawn up by the Centre de calcul de l'Institut royal météorologique de Belgique using an IBM 7040 computer. The programme, in Fortran IV language, is kept at the Institut royal météorologique de Belgique.

Introduction to Table 4.14

POTENTIAL TEMPERATURE COMPUTATION

Potential temperature of dry air

The potential temperature of dry air at pressure p and temperature T is the temperature Θ that a parcel of air would attain if transferred adiabatically to standard pressure, $p_0 = 1\,000$ mb.

As entropy remains constant in the reversible adiabatic transformations of closed systems, potential temperature is given by the equation :

$$s_a\,(p,T) = s_a\,(p_0,\Theta) \tag{1}$$

where s_a is the specific entropy of dry air.

When dry air is regarded as an ideal gas with constant specific heat capacity, equation (1) has the solution :

$$\Theta = T\left(\frac{1\,000}{p}\right)^{\frac{R}{c_p}} \tag{2}$$

where p is expressed in mb, T and Θ in °K, and where c_p is the specific heat capacity at constant pressure and R the ideal gas constant for dry air ; Table 4.1 gives $R/c_p = 2/7$ exactly.

Potential temperature of unsaturated moist air

The potential temperature of unsaturated moist air, Θ_m, is defined as for dry air, though it will be noted that the composition of the moist air remains unchanged, i.e. the mixing ratio r remains constant.

In the case of moist air, equation (1) becomes :

$$s_m\,(p,T,r) = s_m\,(p_0,\Theta_m,r) \tag{3}$$

where s_m is the entropy of moist air per unit mass of dry air.

When dry air and water vapour are regarded as ideal gases having constant specific heat capacities, equation (3) has the solution :

$$\Theta_m = T\left(\frac{1\,000}{p}\right)^{\frac{R + rR_w}{c_p + r\,c_{pv}}} \tag{4}$$

where c_{pv} is the specific heat capacity at constant pressure and R_w the ideal gas constant for water vapour.

If c_p, c_{pv}, R and R_w are replaced by their values according to Table 4.1, and if it is noted that r is small by comparison with unity (r generally remains below 10^{-2} in meteorological ranges of temperature and pressure), equation (4) can be written :

$$\Theta_m \approx T \left(\frac{1\,000}{p}\right)^{\frac{R}{c_p}(1-0.23\,r)}$$

or again, Θ being the potential temperature of dry air at the same pressure p and the same temperature T as the moist air :

$$\frac{\Theta_m - \Theta}{\Theta} \approx -0.067\ r\ \ln\left(\frac{1\,000}{p}\right).$$

Calculation shows that the difference $\Theta_m - \Theta$ rarely attains 0.15°C for moist air near to saturation, and generally remains at less than 0.1°C so that, where potential temperature is concerned, no distinction need be made between moist and dry air for most practical purposes.

COMMENT : Potential temperature of dry air regarded as a real gas.

The entropy of a "real gas" can be expressed in the following form, denoting as $s^\star$ specific entropy calculated in the hypothesis of an ideal gas the specific heat capacity of which is constant and as Δs a correction term known as the specific entropy residual :

$$s(p,T) = s^\star(p,T) + \Delta s(p,T).$$

Introducing this expression in equation (1), we obtain, for dry air :

$$s_a^\star\,(p,T) - s_a^\star\,(p_0,\Theta) + \Delta s_a\,(p,T) - \Delta s_a\,(p_0,\Theta) = 0.$$

By means of this equation, it is possible to calculate the difference between the potential temperature of dry air regarded as a real gas and that of dry air regarded as an ideal gas with constant specific heat capcity. Using the values of the specific entropy residual established by J. A. Goff and S. Gratch and published in SMT 86, we find that this difference may be of the order of 0.1 degree.

Table 4.14.1, "Ratio of absolute potential temperature to absolute temperature for dry air as a function of pressure", gives the quantity $\frac{\Theta}{T} = \left(\frac{1\,000}{p}\right)^{2/7}$ as a function of pressure in mb. Linear interpolation is practicable when pressure is equal to or greater than 45 mb.

Table 4.14.2 gives the potential temperature of dry air expressed in °K as a function of pressure in mb and temperature in °C calculated by means of formula (2).

Linear interpolation is of course practicable with respect to temperature; it is practicable with respect to pressure in the following ranges: (*a*) for pressures in excess of 850 mb at all temperatures, (*b*) for pressures between 850 and 700 mb with temperature below 0°C.

Direction for the use of the Tables

Table 4.14.1 is used for the calculation of potential temperature with greater accuracy than is possible with Table 4.14.2. It may also be used to determine the temperature of a parcel of air subject to an adiabatic transformation. If p_1, T_1 relate to the initial state and p_2, T_2 to a new state reached adiabatically, we shall have:

$$\frac{T_2}{T_1} = \left(\frac{1\,000}{p_1}\right)^{2/7} \Big/ \left(\frac{1\,000}{p_2}\right)^{2/7} .$$

For instance, for $T_1 = 261°K$, $p_1 = 623$ mb and $p_2 = 935$ mb, T_2 is found by reading in the table the values of $\left(\frac{1\,000}{p}\right)^{2/7}$ for 623 and 935 mb, i.e.:

$$T_2 = 261\,\frac{1.144\,8}{1.019\,4} = 293.1°K \cdot$$

Tables 4.14.1 and 4.14.2 are reproductions of SMT 77 and 75 respectively. SMT 75 was computed on the basis of the old temperature scale ($T_0 = 273.16$). Differences arising from the adoption of the new temperature scale lead to deviations of less than unity in the last significant digit given in the table; the values for the 70 mb and 10 mb pressure arguments which do not appear in SMT 75 have been computed specially for Table 4.14.2.

Introduction to Table 4.15

RELATIONS BETWEEN PRESSURE, TEMPERATURE AND MIXING RATIO ALONG SATURATION PSEUDO-ADIABATS

The pseudo-adiabatic transformations of saturated moist air as regarded in meteorology are pseudo-adiabatic transformations during which it is assumed that condensed water leaves the system and that no exchange of dry air and of water vapour takes place with the environment.

This type of adiabatic transformation was introduced in meteorology by von Bezold.[1] The following equation was proposed by the IMO Commission for Aerology (Toronto, 1947) to describe these transformations and was used for the construction of aerological diagrams :[2]

$$(c_p + r_\mathrm{w} c_\mathrm{w})\,\mathrm{d}\ln T - R\,\mathrm{d}\ln(p - e_\mathrm{w}) + \mathrm{d}\,(L_\mathrm{v} r_\mathrm{w}/T) = 0 \qquad (1)$$

with $r_\mathrm{w} = \dfrac{\varepsilon\, e_\mathrm{w}}{p - e_\mathrm{w}}$

where c_p is the specific heat capacity at constant pressure of dry air,
c_w the specific heat capacity of water,
p the total pressure of moist air,
e_w the saturation vapour pressure with respect to water,
R the gas constant for dry air,
L_v the latent heat of vaporization of water, and
ε the ratio of the molecular weight of water vapour to that of dry air.

A discussion of pseudo-adiabatic transformations and the means of establishing equation (1) are found in reference [3].

The saturation pseudo-adiabats are the lines on the aerological diagram representing the relation between pressure and temperature when pseudo-adiabatic transformations are in progress. These lines are identified by the temperature corresponding to 1 000 mb pressure ; this temperature is the pseudo wet-bulb potential temperature.

In the technique used by W. L. Godson,[4] equation (1) was formulated differently, taking into account the relations

$$\frac{\mathrm{d}L_\mathrm{v}}{\mathrm{d}T} = c_{p\mathrm{v}} - c_\mathrm{w}\,, \qquad \frac{\mathrm{d}\ln e_\mathrm{w}}{\mathrm{d}T} = \frac{\varepsilon L_\mathrm{v}}{RT^2}$$

and

$$c_p = \frac{7}{2}\,R\,, \qquad c_{p\mathrm{v}} = 4\,\frac{R}{\varepsilon}\,,$$

thus

$$\frac{\mathrm{d}p}{\mathrm{d}T} = \frac{7p}{2T}\left[1 + \frac{r_{\mathrm{w}}L_{\mathrm{v}}}{RT}\cdot\frac{\varepsilon L_{\mathrm{v}}}{c_pT} + \frac{r_{\mathrm{w}}}{7\varepsilon}\right] \Big/ \left[1 + \frac{r_{\mathrm{w}}L_{\mathrm{v}}}{RT}\right].$$

The equation was then integrated numerically step by step for each pseudo-adiabat, at 2°C intervals. The technique of computation is described on page 31 of reference [4].

The values of the physical constants and functions used in this computation are those given in Publication No. 79 (IMO).[5] There are differences between these and the values now adopted by WMO and published in the IMT, mainly with regard to the temperature of the normal ice point, the ideal gas constant for dry air and the saturation vapour pressure in the pure phase. However, these differences arise for the most part from the readjustment imposed by the new definition of the temperature scales ; so the values of temperature computed in the same conditions, using in one case old values and in the other case new values of physical constants and functions, show deviations of less than 1/100 of a degree, which corresponds here to a deviation of less than 0.3 mb in pressure values computed in the same conditions. These are of the same order as the uncertainty introduced by numerical integration, the probable error in pressure then being 0.2 mb according to reference [4].

Table 4.15.1 gives pressure in mb as a function of temperature in °C along the pseudo-adiabats for 2°C intervals of pseudo wet-bulb potential temperature. Linear interpolation is generally not practicable ; however, the errors involved would be smaller than 0.6 mb.

Table 4.15.2 gives the saturation mixing ratio in g kg^{-1} as a function of temperature in °C along the pseudo-adiabats shown in Table 4.15.1. The values of the saturation mixing ratio show slight deviations from those given by Table 4.13.2 for the same pressure and the same temperature. These deviations are due to the approximation in Table 4.15.2 consisting in equating the value of saturation vapour pressure of moist air to that of the pure phase ; the use of different sets of values for physical constants and functions (e_{w} and ε) in the computation of Tables 4.13.2 and 4.15.2 leads by itself to negligible deviations in the corresponding values of saturation mixing ratio. Linear interpolation is only practicable in some parts of the table.

Table 4.15.1 reproduces the values given in Tables E I to E VII of reference [4].

Table 4.15.2 has been computed from the previous table ; the value of r_{w} was computed for every temperature and pressure value, using $\varepsilon = 0.621\ 97$ and the values of e_{w} in Publication No. 79.

Note : The tables are not computed for temperatures values below —50°C because the formula for saturation vapour pressure e_{w} is used, in the case of supercooled water, only between —50 and 0°C (see Introduction 4.6/7, page 1, note).

References

1. Bezold, W. von, *Zur Thermodynamik der Atmosphäre.* Sitzungsber. Berlin. Akad., 1888.

2. World meteorological organization, *Les diagrammes aérologiques.* WMO - No. 66. TP. 25, section 2.2.3, 1957.

3. DUFOUR, L., *Les transformations sans échange thermique et sans échange énergétique dans l'atmosphère.* IRM de Belgique, Publications série B, N° 44, 1964.

4. GODSON, W. L., *New Canadian Tephigram.* Meteorological Division, Department of Tranports, Canada, CIR — 2237, TEC 140, 26 January 1953.

5. INTERNATIONAL METEOROLOGICAL ORGANIZATION, *Values of some physical functions and constants used in meteorology. Definitions and specifications of water vapour in the atmosphere.* IMO Publication No. 79, 1951.

Introduction to Table 4.16

TERMINAL VELOCITY OF FALL OF WATER DROPLETS, ICE CRYSTALS AND SOLID PRECIPITATION IN STILL AIR

Water droplets (Table 4.16.1)

The force F_D exerted by air on a sphere of diameter d moving at a constant velocity v is given by the equation:

$$F_D = \pi \frac{d^2}{4} \cdot \frac{1}{2} C_D \rho' v^2 \qquad (1)$$

where ρ' is the density of the air and C_D a coefficient known as the drag coefficient, a function of the Reynolds number Re; in the case of the sphere, the expression for Re is:

$$Re = \frac{d v \rho'}{\eta} \qquad (2)$$

where η is the (dynamic) viscosity of the air.

The terminal velocity of fall is reached when the force F_D is equal to the weight of the sphere, less its buoyancy, i.e.:

$$F_D = g(m - m') = \frac{1}{6} \pi g d^3 (\rho - \rho') \qquad (3)$$

where g is the acceleration of gravity, m the mass of the sphere, m' the mass of air contained in the same volume and ρ the density of the sphere, i.e. of water in this case.

(*a*) *Small droplets*

In the case of droplets of less than 80 μ in diameter, it can be assumed that the droplets retain a spherical form and that the force can be calculated by means of Stokes's law:

$$F_D = 3 \pi \eta d v,$$

whence we obtain, taking equation (3) into account:

$$v = \frac{1}{18} g \frac{(\rho - \rho')d^2}{\eta}.$$

Table 4.16.1 A gives the terminal velocities of fall of droplets of pure water in still air as a function of their diameter for the pressure of 1 013.25 mb and temperature 20°C, the air being regarded as dry ; the following values were used for the physical constants :

$$g = 980.665 \text{ cm sec}^{-2},$$
$$\rho = 0.998\,21 \text{ g cm}^{-3} \text{ (Table 4.5 B)},$$
$$\rho' = 1.204\,1 \times 10^{-3} \text{ g cm}^{-3} \text{ (Table 4.12.1), and}$$
$$\eta = 1\,815 \times 10^{-7} \text{ g cm}^{-1} \text{ sec}^{-1} \text{ (Table 4.17).}$$

It will be noted that the density of air ρ' is small compared with the density of water ρ and can thus be ignored, so that the terminal velocity of fall is practically independent of pressure ; it does depend however on temperature through the intermediary of η and a little on ρ. The terminal velocity of fall $v(t)$ at temperature t can be deduced easily from the value v given in the table by the relation :

$$v\,(t) = v\,\frac{\eta\,(20)}{\eta\,(t)}$$

where η (20) and η (t) are the values of η at 20°C and at temperature t respectively (Table 4.17).

(*b*) *Medium and large droplets*

When the diameter of the droplet is more than 80 μ the equations given above cannot be used since the airflow becomes turbulent, and large drops (diameter over 500 μ approximately) change shape in falling. Thus their terminal velocity has to be measured directly.

Table 4.16.1 B gives the results obtained in the laboratory by R. Gunn and G. D. Kinzer [1] for droplets of distilled water falling in still air at pressure 1 013.25 mb, temperature 20°C and relative humidity 50%. The table gives the terminal velocity of falling drops as a function of their equivalent diameter, i.e. of the diameter of a sphere of distilled water having the same mass as the droplet concerned. The table also gives the Reynolds number and drag coefficient calculated for a sphere of water having the same mass as the droplet ; the Reynolds number was calculated by means of equation (2) and the drag coefficient by means of equations (1) and (3), m' being negligible in regard to m :

$$C_{\text{D}} = \frac{8\,g\,\rho' m}{\pi\,\eta^{\,2} Re^2}\,.$$

Droplets with a mass of 158 000 μg were found to be unstable.

[1] Gunn, R. and Kinzer, G. D., Journ. Meteorol., *6*, p. 243, 1949 (also SMT 114).

Ice crystals and solid precipitation (Table 4.16.2)

Ice crystals and solid precipitation appear in many shapes and structures and their behaviour depends on the conditions under which they are observed. Table 4.16.2 gives in graph form the results obtained by various workers and is necessarily limited to typical cases.

(*a*) *Ice crystals*

Figure (*a*) shows the terminal velocity of fall of various types of snow crystals as a function of their linear dimensions, observed at ground-level by Nakaya and Terada.[2]

(*b*) *Snowflakes*

The terminal velocity of a falling snowflake depends largely upon its dimensions and density. As the mean diameter and density of flakes are quite closely related, the density decreasing with increasing size of flake, the terminal velocity of fall can be represented as a function of a single variable.

Magono and Nakamura [3] observed snow flakes by allowing them to come through a hole in the roof of a hut where the temperature was nearly 0°C. Figure (*b*.1) shows the relation between the mean diameter and the density of snowflakes ; Figure (*b*.2) indicates the terminal velocity of fall of observed snowflakes as a function of the difference between density of flake and density of air. The authors propose the semi-empirical formula as representing the terminal velocity of fall v, expressed in cm sec^{-1} :

$$v = 330\ (\sigma - \rho)^{1/4}$$

where σ and ρ are density in g cm^{-3} of flake and of air respectively.

Comment : The value 330 of the coefficient is derived from theoretical considerations whereas a value 377 would be given by the observation data reported in Figure (*b*.2).

Figures (*b*.1) and (*b*.2) are reproduced from Figures 3 and 9 of the paper.[3]

(*c*) *Hailstones*

If it is assumed that hailstones are smooth spheres, the theoretical terminal velocity of fall is calculated by means of equations (1) and (3) using experimental relations between the drag coefficient and the Reynolds number. Figures (*c*.1) and (*c*.2) are reproductions of the results obtained by Bilham and Relf.[4] The curves in Figure (*c*.1) show the terminal velocity of fall as a function of diameter d for various densities of sphere, i.e. 0.915 g cm^{-3} (pure ice), 0.8, 0.6 and 0.4 g cm^{-3}, these curves being calculated for average surface conditions. The two curves in Figure (*c*.2) were calculated for average conditions

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[2] Nakaya, U. and Terada, T. Jr., J. Fac. Sci., Hokkaido Univ., Ser. II, *1*, 1935.
[3] Magono, C. and Nakamura, T., Journ. Met. Soc. Japan, Ser. II, *43*, pp. 139–147, 1965.
[4] Bilham, E. G. and Relf, E. F., J. Roy. Met. Soc., *63*, pp. 149–162, 1937.

on the surface and at altitude 3 048 m (10 000 ft) for sphere density of 0.6 g cm^{-3}. The values of the physical constants used for the average surface conditions are :

$\rho' = 0.075\,8$ lb ft^{-3} (= 1.214 kg m^{-3}) and $\frac{\eta}{\rho'} = 0.000\,159$ ft^2 sec^{-1} (= 0.000 014 8 m^2 sec^{-1}).

It will be noted that within a certain range of values of *d*, three terminal velocities are possible ; the central branch of the curve shows an unstable régime and can be interpreted as the border line between two stable régimes represented by the upper and lower branches of the curve, the latter showing the terminal velocity attained in free fall. The presence of three terminal velocities is due to the sharp variation of C_D for *Re* values between 3×10^5 and 4×10^5. For spheres of between 6 and 40 mm in diameter, C_D can be regarded as contant and equal to about 0.5 ; the sections of the curves for this value of C_D are shown as dotted lines in the lower left-hand part of Figure (*c*.1).

The terminal velocity of fall observed for hailstones is different from the theoretical value obtained for smooth spheres and shows a considerable dispersion for the same mass and the same density. These variations are due to the fact that hailstones take forms other than the sphere and that their surface varies in roughness. Wind-tunnel measurements of air resistance have been undertaken at the Institut fédéral pour l'étude de la neige et des avalanches (Weissfluhjoch/Davos, elevation 2 664 m) on hailstones up to 5 cm in diameter. Figure (*d*), borrowed from Roland List,[5] shows the terminal velocities of fall deduced from these measurements as a function of the mean radius *r* of the projection of the hailstone on a plane perpendicular to the velocity ; the lines numbered 1 to 9 relate to various forms of hailstone, drag coefficient and density ; the hatched zones show the areas of probable values for hailstones and snow pellets.

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[5] List, R., Z. angew. Math. Phys., *X*, pp. 143–159, 1959.

Introduction to Table 4.17

VISCOSITY AND THERMAL CONDUCTIVITY OF DRY AIR DIFFUSION OF WATER VAPOUR IN AIR

Viscosity

Viscosity (dynamic viscosity) η can be defined as the ratio of the shearing stress to velocity shear, or, in a parallel flow :

$$\tau = \eta \frac{\partial u}{\partial z}$$

where u is the velocity of the fluid, z a direction perpendicular to it and τ the tangential force exerted in a direction parallel to the velocity on a unit area perpendicular to z.

Table 4.17 gives the viscosity η of dry air as a function of temperature for the pressure of one normal atmosphere (1 013.25 mb). Viscosity increases slightly with pressure, rising about 1×10^{-8} N sec m^{-2}, as pressure increases from 0 to 1 000 mb. The presence of water vapour in air decreases viscosity ; this decrease is of the order of 1 to 2 per cent for an increase of 0.1 in the mole fraction of water vapour.

Kinematic viscosity ν is the ratio of dynamic viscosity to density ρ, $\nu = \eta/\rho$. The kinematic viscosity of air is computed by using viscosity values from Table 4.17 and density values from Table 4.12.

Units of viscosity and kinematic viscosity are given in Table 1.1, sections 15 and 16.

Thermal conductivity

Thermal conductivity λ is defined by the equation :

$$\frac{dQ}{dt} = -\lambda \frac{\partial T}{\partial x}$$

where dQ is the quantity of heat flowing in a time dt across a unit area perpendicular to the direction x and T is temperature. The SI unit of thermal conductivity is the joule per metre per second per degree (J m^{-1} sec^{-1} $^{\circ}$K^{-1}).

The thermal conductivity of air is practically independent of pressure within the pressure and temperature ranges observed in meteorology. Table 4.17 gives values of the thermal conductivity of dry air as a function of temperature.

Thermal conductivity increases slightly when the air contains a small proportion of vapour and decreases for larger proportions. These thermal conductivity variations remain small, however, for the water vapour concentrations encountered in meteorology; the relative increase of thermal conductivity is less than 1 per cent for a mole fraction of water vapour varying between 0 and 0.1.

The thermal diffusivity or thermometric conductivity, a, is equal to thermal conductivity divided by specific heat capacity at constant pressure c_p and by density ρ : $a = \lambda / c_p \rho$. The SI unit of thermal diffusivity is the square metre per second. The thermal diffusivity of air is computed using the values of λ from Table 4.17, the values of ρ from Table 4.12 and $c_p = 1\,005$ J kg^{-1} °K^{-1} (Table 4.1).

Molecular diffusion

The coefficient of diffusion D of a substance is defined by the equation :

$$\frac{\mathrm{d}m}{\mathrm{d}t} = -D \frac{\partial d}{\partial x}$$

where dm is the mass of the substance considered flowing in the direction x across a unit area perpendicular to this direction in a time dt and where d is the concentration (mass per unit volumes) of the substance. The diffusion coefficient is expressed in square metres per second in the SI system.

The above relation can also be written :

$$\frac{\partial d}{\partial t} = \mathrm{div}\,(D\,\nabla\,d)\,.$$

In the case of the diffusion of water vapour in air, d is the concentration of water vapour d_v (Table 4.3, section 3).

The diffusion coefficient is inversely proportional to pressure; the diffusion coefficient for a pressure p and a temperature T, i.e. $D\,(p,T)$, is worked out from the value of the coefficient of diffusion for a pressure p_0 and the temperature T by the relation :

$$D\,(p,T) = \frac{p_0}{p}\,D\,(p_0,T)\,.$$

Table 4.17 gives the diffusion coefficient of water vapour in air as a function of temperature for the pressure of one normal atmosphere, $p_0 = 1\,013.25$ mb. The values of the diffusion coefficient have been established for air containing only traces of water vapour.

Linear interpolation is practicable throughout Table 4.17.

The values in Table 4.17 have been taken from the tables drawn up by E. A. Mason and L. Monchick [1] and converted into SI units.

[1] MASON, E. A. and MONCHICK, L., *Survey of the equation of state and transport properties of moist gases*, in *Humidity and moisture*, Vol. III, pp. 257–272, Reinhold Publishing Corp. New York (Tables 7, 9 and 10), 1965.

Introduction to Table 4.20

RELATION BETWEEN RELATIVE HUMIDITY AND MIXING RATIO

The relative humidity U_w of moist air with respect to water, defined in Table 4.3, section 15, is related to the mixing ratio by the following :

$$U_w = 100 \frac{r}{r_w} \cdot \frac{\varepsilon + r_w}{\varepsilon + r} \% \qquad (1)$$

where r is the mixing ratio of moist air,

r_w is the saturation mixing ratio at the temperature and pressure of the moist air being considered,

ε is the ratio of the molecular weight of water vapour to that of dry air = 0.621 98.

It would be possible to prepare a table of U_w with respect to r and r_w by means of equation (1), however such a table would be cumbersome if constructed in a manner which would permit linear interpolation. It is therefore simpler to express the relationship in the following form :

$$U_w = 100 \frac{r}{r_w} + \Delta U \qquad (2a)$$

or

$$\frac{r}{r_w} = \frac{1}{100} (U_w - \Delta U) \qquad (2b)$$

with $$\Delta U = 100 \frac{r}{r_w} \left(1 - \frac{r}{r_w}\right) \frac{\frac{r_w}{\varepsilon}}{1 + \frac{r_w}{\varepsilon} \cdot \frac{r}{r_w}}$$

or $$\Delta U = U_w \left(1 - \frac{U_w}{100}\right) \frac{\frac{r_w}{\varepsilon}}{1 + \frac{r_w}{\varepsilon}\left(1 - \frac{U_w}{100}\right)} .$$

ΔU can then be expressed either as a function of r_w and the ratio $\frac{r}{r_w}$ or as a function of r_w and U_w; it should be noted that only one table is required since, for each value of r_w, ΔU takes the same value for $\frac{r}{r_w}$ as for $U_w = 100\left(1 - \frac{r}{r_w}\right)$.

Table 4.20 gives the value of ΔU corresponding to two parameters : r_w, expressed in g kg^{-1} and $\frac{r}{r_w}$ or U_w in per cent. Linear interpolation is practicable throughout.

Use of the table

(1) To calculate the relative humidity U_w of moist air at pressure p temperature t and having a mixing ratio r :

Find from Table 4.13.2 the saturation mixing ratio r_w corresponding to pressure p and temperature t, then calculate the ratio $\frac{r}{r_w}$ (a slide rule calculation is generally sufficiently accurate). Then find from Table 4.20 the value of ΔU corresponding to r_w and $\frac{r}{r_w}$, and calculate U_w using equation (2*a*). For example, consider $p = 1\,000$ mb, $t = 12°C$ and $r = 5.64$ g kg^{-1} ; Table 4.13.2 gives $r_w = 8.880$ g kg^{-1} for 1 000 mb and 12°C ; the ratio $\frac{r}{r_w}$ is $\frac{5.64}{8.88} = 0.635$; then by interpolation in Table 4.20, $\Delta U = 0.33$ for $r_w = 8.880$ g kg^{-1} and $r/r_w = 0.635$, thus :

$$U_w = 100 \times 0.635 + 0.33 = 63.8\,\%\,.$$

(2) To calculate the mixing ratio of moist air at pressure p, temperature t and having a relative humidity U_w :

Find from Table 4.13.2 the saturation mixing ratio r_w corresponding to pressure p and temperature t ; then from Table 4.20 the value ΔU corresponding to r_w and U_w ; equation (2*b*) gives the ratio $\frac{r}{r_w}$ from which r can be calculated (slide rule accuracy will suffice). Consider for example $p = 950$ mb, $t = 25°C$ and $U_w = 73\%$. Table 4.13.2 gives $r_w = 21.546$ g kg^{-1} for 950 mb and 25°C ; Table 4.20 gives, by interpolation, $\Delta U = 0.6$ for $r_w = 21.546$ g kg^{-1} and $U_w = 73\%$; from these can be calculated

$$\frac{r}{r_w} = \frac{1}{100}\,(73 - 0.6) = 0.724$$

and $r = 21.546 \times 0.724 = 15.6$ g kg^{-1}.

Comments on the definition of relative humidity

The definition of relative humidity has been modified several times over the years ; the old definition, analogous to the one now in use, was replaced in 1947 (Resolution 166 of the Directors' Conference of the International Meteorological Organization — Washington 1947) by the following definition which can be found in Publication 79 of the IMO :

$$U_{1947} = 100\,\frac{r}{r_w}\,\%\,.$$

The definition presently in force, as it appears in Table 4.3, section 15 was introduced by WMO in 1953 (Recommendation 3 (CAe-I) adopted by Resolution 40 (EC-IV)).

The conversion between the values of relative humidity determined in conformance with one or the other of these definitions is carried out by means of equation (2*a*) in the form

$$U_w = U_{1947} + \Delta U.$$

Table 4.20 was prepared in the Secretariat.

Introduction to Table 4.21

RELATIONSHIP BETWEEN RELATIVE HUMIDITY AND THERMODYNAMIC DEW-POINT TEMPERATURE

The relative humidity with respect to water, U_w, is related to the vapour pressure of water in moist air by the relation (Table 4.3, section 15) :

$$U_w = 100 \frac{e'}{e'_w (p, T)}$$

where e' is the water vapour pressure in moist air,

$e'_w (p, T)$ is the saturation vapour pressure with respect to water in moist air at the same pressure p and the same temperature T as the moist air under consideration.

The definition of the thermodynamic dew-point temperature T_d (Table 4.3, section 12) implies that :

$$e' = e'_w (p, T_d)$$

where $e'_w (p, T_d)$ is the saturation vapour pressure of moist air at pressure p and temperature T_d.

Finally, the saturation vapour pressure of moist air, e'_w is related to that of the pure phase, e_w by the relationship :

$$e'_w (p, T) = f_w (p, T) \cdot e_w (T)$$

where $f_w (p, T)$ is a coefficient dependant on the pressure and temperature of moist air (see Table 4.10).

The relative humidity U_w can thus be expressed as :

$$U_w = 100 \frac{e_w (T_d)}{e_w (T)} \cdot \frac{f_w (p, T_d)}{f_w (p, T)} .$$

It can be seen from Table 4.10 that the range of variation of f_w is small when the pressure remains constant, not greater than 0.002 for a temperature change from $-$ 50 to + 50°C ; if then the ratio $\frac{f_w (p, T_d)}{f_w (p, T)}$ is considered equal to unity the resulting error in U_w will be less than 0.1%.

The relationship between relative humidity, temperature and thermodynamic dew-point temperature is therefore practically independant of pressure and can be calculated by means of the preceeding equation which becomes :

$$U_w \approx 100 \frac{e_w (T_d)}{e_w (T)};$$

e_w is given as a function of temperature in Table 4.6.

Table 4.21.1 gives the relative humidity, expressed in %, as a function of temperature, in °C, and the difference between the thermodynamic dew-point temperature and the temperature (dew-point depression) in °C. Linear interpolation is practicable.

Table 4.21.2 gives the thermodynamic dew-point temperature, in °C, as a function of temperature and relative humidity, in %. Linear interpolation is practicable.

Table 4.21 was calculated by la Météorologie Nationale de France by means of a CDC 6400 computer. The programme, written in Fortran language, is kept by la Météorologie Nationale.

Introduction to Tables 4.22 and 4.23

RELATIONS BETWEEN THERMODYNAMIC WET-BULB TEMPERATURE, MIXING RATIO AND THERMODYNAMIC DEW-POINT TEMPERATURE

RELATIONS BETWEEN THERMODYNAMIC ICE-BULB TEMPERATURE AND MIXING RATIO

Tables relative to thermodynamic wet-bulb temperature

The definition of the thermodynamic wet-bulb temperature T_w is given in Table 4.3, section 18, together with the equations which show the relation between it and the mixing ratio.

The first of these equations is expressed as a function of enthalpies (the notation is the same as in Table 4.3) :

$$h\,(p, T, r) + [r_w\,(p, T_w) - r]\, h_w\,(p, T_w) = h\,(p, T_w, r_w\,(p, T_w))\,; \qquad (1)$$

this equation is rigorous and is not based on any simplifying hypotheses.

The second equation is derived from the first by replacing the enthalpies by their values after the introduction of the following simplifying hypotheses : that air and water vapour are ideal gases with constant specific heat capacity and that the enthalpy of moist air is equal to the sum of the enthalpies of dry air and water vapour. Hence

$$T - T_w = \frac{[r_w\,(p, T_w) - r]\, L_v\,(T_w)}{c_p + r\, c_{pv}} \qquad (2)$$

where :

p	is the pressure,
T	the thermodynamic temperature,
T_w	the thermodynamic wet-bulb temperature,
$r_w\,(p, T_w)$	the saturation mixing ratio at pressure p and temperature T_w,
r	the mixing ratio of the moist air under consideration,
$L_v\,(T_w)$	the specific latent heat of vaporization at temperature T_w,
c_p	the specific heat capacity at constant pressure of dry air,
c_{pv}	the specific heat capacity at constant pressure of water vapour.

This relation can also be written with t and t_w designating the Celsius temperatures corresponding to thermodynamic temperatures T and T_w respectively and with r and $r_w\,(p, T_w)$ expressed in g kg^{-1},

$$t - t_w = \frac{[r_w\,(p, t_w) - r]\, L_v\,(t_w)}{10^3\, c_p + r\, c_{pv}}\,. \qquad (2')$$

Each of the equations (1) and (2) contains four variables : p, T, T_w and r, and each table would therefore have to contain three arguments. This would make the tables very cumbersome and impractical. It is therefore preferable to establish tables of factors for computing the required quantity in a simple way. Other tables give the quantity in question for a selected value of one of the variables.

Equation (2) has been selected for the establishment of these tables rather than equation (1) because, apart from the simplification it affords in calculation, it can more easily be broken down into simple factors containing only two variables. Otherwise, the differences between the calculated values using equation (1) and equation (2) are slight and comparable to the uncertainty in data relating to real gases (see Note 1).

The physical constants and functions used in the calculations are the following : values of r_w, in g kg^{-1}, from Table 4.13.2 ; values of L_v, in J kg^{-1}, from Table 4.5 A ; $c_p = 1\,005$ J kg^{-1} K^{-1} and $c_{pv} = 1.85 \times 10^3$ J kg^{-1} K^{-1} (Table 4.1).

Mixing ratio as a function of thermodynamic wet-bulb temperature, temperature and pressure (Tables 4.22.1.1 and 4.22.1.2)

The expression for r is deduced directly from equation (2') :

$$r = r_w(p, t_w) - r_w(p, t_w) \times A(t, t_w) - B(t, t_w) \qquad (3)$$

with $A(t, t_w) = \dfrac{c_{pv}(t - t_w)}{L_v(t_w) + c_{pv}(t - t_w)}$

$$B(t, t_w) = \frac{c_p(t - t_w)}{L_v(t_w) + c_{pv}(t - t_w)} \times 10^3.$$

Table 4.22.1.1 gives the factors A and B as a function of t_w and of the difference $t - t_w$ expressed in °C. Linear interpolation is practicable.

Use of the table

Consider moist air at pressure p, temperature t and thermodynamic wet-bulb temperature t_w. To get the mixing ratio, first obtain from Table 4.13.2 the saturation mixing ratio $r_w(p, t_w)$, in g kg^{-1}, corresponding to pressure p and temperature t_w, then from Table 4.22.1.1 the factors $A(t, t_w)$ and $B(t, t_w)$; these quantities may then be introduced into equation (3) to obtain r in g kg^{-1}. Note that the second term on the right-hand side of equation (3) is small with respect to the other terms and can be neglected when great precision is not required. The calculation reduces then to a matter of simple subtraction.

Example : if $p = 965$ mb, $t = 16.2$°C and $t_w = 11.3$°C ; Table 4.13.2 gives $r_w = 8.793$ g kg^{-1} by interpolation for 965 mb and 11.3°C ; Table 4.22.1.1

gives $A = 0.003\,65$ and $B = 1.982\,9$ for $t_w = 11.3°C$ and $t - t_w = 4.9°C$; equation (3) thus gives :

$$r = 8.793 - 8.793 \times 0.003\,65 - 1.982\,9 = 6.778 \text{ g kg}^{-1},$$

or, neglecting the second term on the right hand side :

$$r = 6.810 \text{ g kg}^{-1}.$$

Table 4.22.1.2 gives the mixing ratio, in g kg^{-1}, directly, as a function of t and of the difference $t - t_w$ for a pressure of 1000 mb. Linear interpolation is practicable throughout the table.

This table has been calculated with the aid of equation (3) using the values of A and B given in Table 4.22.1.1 and the values of r_w from Table 4.13.2.

Thermodynamic wet-bulb temperature as a function of mixing ratio, temperature and pressure (Tables 4.22.2.1 and 4.22.2.2)

By regrouping the terms, equation (2′) can be written :

$$r + \frac{c_{pv}}{L_v(t_w)} r(t - t_w) + \frac{10^3 c_p}{L_v(t_w)} t = r_w(p, t_w) + \frac{10^3 c_p}{L_v(t_w)} t_w. \tag{4}$$

Let

$$r_w(p, t_w) + \frac{10^3 c_p}{L_v(t_w)} t_w = F(p, t_w); \tag{5}$$

having calculated F as a function of p and t_w, it is possible to prepare a table of t_w as a function of F and p. Such a table permits the determination of t_w for moist air at pressure p, temperature t and having a mixing ratio r, by means of the following approximations :

1. Considering that the second term of the left-hand side of equation (4) is small with respect to the other terms and that L_v varies comparatively little with temperature, equation (4) can be written :

$$r + \frac{10^3 c_p}{L_v(t)} t = F'. \tag{6}$$

This equation gives values of F' approaching the value F, which permits the determination of a value of t'_w approximating to that of t_w.

2. Then, replacing t_w by t'_w, equation (4) gives :

$$r + \frac{c_{pv}}{L_v(t'_w)} r(t - t'_w) + \frac{10^3 c_p}{L_v(t'_w)} t = F''; \tag{6′}$$

The value F'' thus obtained permits the calculation of a new approximation, t''_w.

The approximation $t_w \approx t''_w$ is generally sufficient; the difference between t_w and t'_w is less than 1°C and that between t_w and t''_w does not exceed 0.03°C. Nevertheless a new approximation can be made where greater precision is required.

Table 4.22.2.1 gives t_w, in °C, as a function of F and of pressure p in mb; it also gives the factors $\frac{c_{pv}}{L_v(t_w)}$ and $\frac{10^3 c_p}{L_v(t_w)}$ as functions of t_w, in °C. Linear interpolation is practicable.

The table was prepared by calculating $F(p, t_w)$ as a function of t_w and p by means of equation (5), then by tabulating the values of t_w as a function of F.

Use of the table

The table is used in accordance with the above method, i.e.: first calculate F' from equation (6) using the value of the factor $\frac{10^3 c_p}{L_v(t_w)}$ corresponding to t; then take from the table the value of t'_w corresponding to F' and p, and insert this value in equation (6′) as well as the values of the factors $\frac{c_{pv}}{L_v(t'_w)}$ and $\frac{10^3 c_p}{L_v(t'_w)}$ corresponding to t'_w. After calculating F'', use the table to determine t''_w corresponding to F'' and p.

This approximation is generally sufficient, but if greater precision is required, a new approximation can be obtained by putting t''_w in equation (6′) and proceeding in the same manner as described above.

Thus, for example, if $p = 950.0$ mb, $t = 15.0$°C, $r = 5.5$ g kg^{-1}, Table 4.22.2.1 — part II — gives $\frac{10^3 c_p}{L_v(t_w)} = 0.407\,61$ for $t = 15.0$; from equation (6)

$$F' = 5.5 + 0.407\,61 \times 15.0 = 11.61$$

and part I of the table gives $t'_w = 9.34$°C for $F' = 11.61$ and $p = 950.0$ mb. As $\frac{10^3 c_p}{L_v(t_w)} = 0.405\,41$ and $\frac{c_{pv}}{L_v(t_w)} = 0.000\,746$ for $t'_w = 9.34$°C, equation (6′) then becomes:

$$F'' = 5.5 + 0.000\,746 \times 5.5\,(15.0 - 9.34) + 0.405\,41 \times 15.0 = 11.60.$$

A value of $t''_w = 9.33$°C can then be taken from the table knowing $F'' = 11.60$ and $p = 950.0$ mb. A new approximation gives $F''' = 11.60$ from which $t'''_w = 9.33$°C.

Table 4.22.2.2 gives the thermodynamic wet-bulb temperature t_w in °C as a function of the mixing ratio r and the temperature t at a pressure of 1 000 mb. Linear interpolation is practicable.

Table 4.22.2.2 has been computed by inversing Table 4.22.1.2.

Thermodynamic dew-point temperature t_d as a function of thermodynamic wet-bulb temperature, temperature and pressure (Table 4.22.3)

A table of thermodynamic dew-point temperature as a function of thermodynamic wet-bulb temperature and temperature, established for an arbitrary pressure, say 1 000 mb, can be used with sufficient accuracy for moist air at any pressure p by means of the following method :

In equation (3) replace r and r_w by their respective values $\frac{\varepsilon e}{p - e}$ and $\frac{\varepsilon e_w (t_w)}{p - e_w (t_w)}$, e being the vapour pressure and e_w the saturation vapour pressure with respect to water in its pure phase ; this requires that the factor f_w be considered equal to 1. Solving with respect to e :

$$e = \frac{1}{\varepsilon L_v (t_w) + (\varepsilon c_{pv} - c_p)(t - t_w)} [\varepsilon e_w (t_w) \alpha L_v (t_w) - p c_p (t - t_w)] \quad (7)$$

where $\alpha = \frac{p - e}{p - e_w (t_w)}$.

Noting that $(\varepsilon c_{pv} - c_p)/\varepsilon = R_w/2$, R_w being the ideal gas constant for water vapour, and making the following approximations :

$$\alpha \approx 1 \text{ and } \frac{1}{\varepsilon L_v (t_w) + \frac{1}{2} \varepsilon R_w (t - t_w)} \approx \frac{1}{\varepsilon L_v (t_w)},$$

equation (7) becomes

$$e \approx e_w (t_w) - p \frac{c_p}{\varepsilon L_v (t_w)} (t - t_w) ; \quad (8)$$

t_d is then determined from e by the relation $e = e_w (t_d)$ assuming factor f_w equivalent to 1.

Consider now moist air at a pressure of 1 000 mb, at temperature t_1, in which t_w and t_d have, respectively, the same values as in moist air at pressure p and temperature t, which implies that e and $e_w (t_w)$ have the same values in both cases ; equation (8) can be written :

$$e \approx e_w (t_w) - 1\,000 \frac{c_p}{\varepsilon L_v (t_w)} (t_1 - t_w). \quad (9)$$

Equating the values of e given by equations (8) and (9) gives :

$$p (t - t_w) \approx 1\,000 (t_1 - t_w). \quad (10)$$

It is sufficient, therefore, in the case of moist air at any pressure, to calculate by means of equation (10) the temperature t_1 of moist air at a pressure of 1 000 mb having the same t_w and t_d as the moist air being considered. Then to look in the table established for 1 000 mb for the value of t_d corresponding to t_1 and t_w.

The error in t_d calculated in this manner is less than 0.05°C in the range of conditions of temperature and pressure normally encountered in meteorology and when the relative humidity is above 40 per cent ; it can be as high as 0.2°C in cases where the relative humidity is very low (5 to 10 per cent) (see note 2).

Table 4.22.3 gives the thermodynamic dew-point temperature t_d, expressed in °C, as a function of the temperature t, in °C, and the difference $t - t_w$, in °C, at a pressure of 1 000 mb. Linear interpolation is practicable.

The table was produced by calculating r at a pressure of 1 000 mb by means of equation (3), as in Table 4.22.1.2, then taking the corresponding value of t_d from Table 4.13.1.

Use of the table

Consider moist air at pressure p, in mb, at temperature t, in °C, and having a thermodynamic wet-bulb temperature t_w, in °C. In the general case where the pressure is other than 1 000 mb, the temperature t_1 of moist air at 1 000 mb and having the same t_w (and t_d) as the moist air being considered can be calculated by means of equation (10) :

$$t_1 = t_w + \frac{p}{1\,000}\,(t - t_w).$$

The value of t_d corresponding to t_1 and $(t_1 - t_w)$ can then be found in Table 4.22.3.

Thus, for $p = 912$ mb, $t = 23.6$°C and $t_w = 17.4$°C :

$$t_1 = 17.4 + \frac{912}{1\,000} \times 6.2 = 23.05^{\circ}\mathrm{C}.$$

Then using Table 4.22.3 with $t_1 = 23.05$°C and $t_1 - t_w = 5.65$°C, gives, by interpolation, $t_d = 14.2$°C.

Tables relative to thermodynamic ice-bulb temperature

The same reasoning and calculations as described above apply to the thermodynamic ice-bulb temperature replacing, as appropriate, the thermodynamic wet-bulb temperature t_w by the thermodynamic ice-bulb temperature t_i, the saturation mixing ratio with respect to water r_w by the saturation mixing ratio with respect to ice r_i and the specific latent heat of vaporization L_v by the specific latent heat of sublimation L_s.

Equation (2′) then becomes :

$$t - t_i = \frac{[r_i\,(p, t_i) - r]\,L_s\,(t_i)}{10^3\,c_p + r\,c_{pv}}. \qquad (2'')$$

The physical quantities introduced in the calculations are : for r_i the values found in Table 4.13.4 and for L_s the values in Table 4.5–A.

Mixing ratio as a function of the thermodynamic ice-bulb temperature, temperature and pressure (Tables 4.23.1.1 and 4.23.1.2)

Equation (3) can be written in this case :

$$r = r_i(p, t_i) - r_i(p, t_i) \times A'(t, t_i) - B'(t, t_i) \qquad (3')$$

with $A'(t, t_i) = \dfrac{c_{pv}(t - t_i)}{L_s(t_i) + c_{pv}(t - t_i)}$

$$B'(t, t_i) = \frac{c_p(t - t_i)}{L_s(t_i) + c_{pv}(t - t_i)} \times 10^3.$$

Table 4.23.1.1 gives the factors A' and B' as functions of t_i and the difference $t - t_i$ expressed in °C. Linear interpolation is practicable.

Table 4.23.1.1 is used in the same manner as Table 4.22.1.1, transferring to equation (3′) the values of A' and B' from the table and the values of $r_i(p, t_i)$ from Table 4.13.4.

Table 4.23.1.2 gives the mixing ratio directly as a function of t and the difference $t - t_i$ for a pressure of 1 000 mb. Linear interpolation is practicable.

This table has been calculated in a manner similar to that used for Table 4.22.1.2 using values of r_i from Table 4.13.4.

Thermodynamic ice-bulb temperature as a function of mixing ratio, temperature and pressure (Tables 4.23.2.1 and 4.23.2.2)

Table 4.23.2.1 gives the value of t_i as a function of F_i and p as well as the factors $\dfrac{c_{pv}}{L_s(t_i)}$ and $\dfrac{10^3 c_p}{L_s(t_i)}$ as a function of t_i.

The function F_i is defined in this case by the equation :

$$r_i(p, t_i) + \frac{10^3 c_p}{L_s(t_i)} t_i = F_i.$$

Linear interpolation is practicable.

Table 4.23.2.1 has been calculated in a manner similar to 4.22.2.1 and can be used in the same manner. A first approximation is obtained by the equation :

$$r + 10^3 \frac{c_p}{L_s(t)} t = F'_i ;$$

the value of t_i' corresponding to F_i' and p can be taken from the table and from this a second approximation can be made :

$$r + \frac{c_{pv}}{L_s(t_i')} r(t - t_i') + \frac{10^3 c_p}{L_s(t_i')} t = F_i'' ;$$

and t_i'' is given by the table as a function of F_i'' and p.

Table 4.23.2.2 gives the thermodynamic ice-bulb temperature t_i in °C as a function of the mixing ratio r and the temperature for a pressure of 1 000 mb. Linear interpolation is practicable.

Table 4.23.2.2 was computed by inverting Table 4.23.1.2.

The series of Tables 4.22 and 4.23 were calculated by la Météorologie Nationale de France on a CDC 6400 computer. The programme written in FORTRAN language is kept by la Météorologie Nationale.

NOTE 1 : Difference between the values of T_W calculated on the one hand by the general formula (equation (1)) and on the other by the formula based on the ideal gas hypothesis (equation (2)).

Let us consider equation (1) and make the following transformations on its various terms :

$$h_W(p, T_W) = h_W(e_W, T_W) + v_W(p - e_W)$$

where v_W is the specific volume of water ; further :

$$h_W(p, T_W) = h_v(e_W, T_W) - L_v(T_W) + v_W(p - e_W)$$

where h_v is the specific enthalpy of water vapour.

If h^* is the specific enthalpy of moist air when dry air and water vapour are regarded as ideal gases with constant specific heat capacities and Δh is the specific enthalpy residual of moist air (see Introduction 4.24), then

$$h(p, T, r) = h^*(p, T, r) + \Delta h(p, T, r) = (c_p + r\,c_{pv})\,T + C_2 + rC_1 + \Delta h(p, T, r)$$

and, if Δh_v is the specific enthalpy residual of water vapour (see Introduction 4.4)

$$h_v(e_W, T_W) = c_{pv} T_W + C_1 + \Delta h_v(e_W, T_W)$$

where, C_1 and C_2 are arbitrary constants.

Equation (1) can then be written as :

$$(T - T_W) - \frac{[r_W(p, T_W) - r]\,L_v(T_W)}{c_p + r\,c_{pv}} = - \frac{\Delta}{c_p + r\,c_{pv}} .$$

The second term of the left hand side of the equation can be seen to be equal to the difference $T - T_W$ calculated in the ideal gas hypothesis (equation (2)) ; the equation can therefore be written :

$$(T - T_W) - (T - T_W)_{\text{ideal}} = - \frac{\Delta}{c_p + r\,c_{pv}}$$

where

$$\begin{aligned} \Delta = {} & \Delta h(p, T, r) - \Delta h(p, T_W, r_W) \\ & + [r_W(p, T_W) - r]\,\Delta h_v(e_W, T_W) \\ & + [r_W(p, T_W) - r]\,v_W(p - e_W). \end{aligned}$$

The calculation and examination of Table 4.4 shows that the value of the expressions given in the second and third lines is small with respect to that of the expression in the first line ; examination of Table 4.24 shows that for the same pressure, the value of the expression $\Delta h\ (p,\ t,\ r) - \Delta h\ (p,\ T_w,\ r_w)$ does not exceed 40-80 J kg^{-1} and only reaches these levels for extreme values of the difference $T - T_w$; this value is of the same order as the tolerances given for Δh (see Table 12 of reference 1 quoted in Introduction 4.4).

Thus the difference in the values of T_w calculated by means of equation (1) or by means of equation (2) is $\frac{\Delta}{c_p - r\ c_{pv}}$ or about 0.04 to 0.08°C at a maximum ; this value is comparable to the tolerance in the value of T_w calculated by means of equation (1).

NOTE 2 : Error introduced by using Table 4.22.3 when the pressure is other than 1 000 mb.

Let e be the value of the vapour pressure calculated for a pressure p and temperature t and $e^\star$ the value calculated for a pressure of 1 000 mb and temperature t_1, using in both cases equation (7). Replacing t_1 by its value obtained by means of equation (10), the difference $e^\star - e$ can be expressed as follows :

$$e^\star - e \approx \frac{R_w}{2L_v\ (t_w)}\ e\ (t - t_w) \left(1 - \frac{p}{1\ 000}\right) + e_w\ (t_w)\ (\alpha_1 - \alpha) \left[1 - \frac{R_w}{2L_v\ (t_w)} \frac{p}{p_1}\ (t - t_w)\right] \quad (11)$$

where $\alpha_1 = \frac{1\ 000 - e}{1\ 000 - e_w}$, then $\alpha_1 - \alpha \approx - \frac{1\ 000 - p}{1\ 000\ p}\ [e_w\ (t_w) - e]$;

considering the expression in brackets of the second term on the right-hand side of equation (11) as equal to 1, and making the rough approximation (but sufficient for present purposes)

$$\frac{t - t_w}{L_v\ (t_w)} \approx \varepsilon \left[\frac{e_w\ (t_w) - e}{p\ c_p}\right],$$

equation (11) becomes :

$$e^\star - e \approx [e_w\ (t_w) - e]\ \frac{1\ 000 - p}{1\ 000\ p} \left[\frac{\varepsilon\ R_w}{2\ c_p}\ e - e_w\ (t_w)\right],$$

where $\varepsilon\ R_w/2\ c_p \approx 0.14$,

from which $|e^\star - e| < e_w\ (t_w)\ [e_w\ (t_w) - e]\ \frac{1\ 000 - p}{1\ 000\ p}.$

Calculations show that this difference is small and that the resulting differences in values of t_d are also small. The examples shown below are representative of these differences :

p mb	t °C	t_w °C	U_w %	$\lvert e^\star - e \rvert$ less than mb	difference in t_d less than °C
800	30	25	75	0.02	0.01
	30	20	43	0.029	0.025
	30	10	5	0.03	0.2
500	0	—5	43	0.006 8	0.05
	0	—8	10	0.008 7	0.12
200	—30	—31	63	0.000 26	0.008
	—30	—32	28	0.000 47	0.03

The error introduced by assuming $f_w\ (p,\ t_w) = 1$ has not been considered here : it is generally smaller than the one described in this note.

Introduction to Table 4.24

THERMODYNAMIC PROPERTIES OF MOIST AIR

Table 4.24 describes the behaviour of moist air and gives the expressions for the calculation of heat capacity at constant pressure, enthalpy and entropy in the most general case possible, that is, without the introduction of simplifying hypotheses such as the equation of state of an ideal gas. The data in this table are derived from the Goff and Gratch formulation of the thermodynamic properties of air and water vapour and are therefore compatible with those of Tables 4.4, 4.5, 4.8, 4.10, 4.12.2, 4.13 and 4.6 ; this latter was calculated using the formula adopted by Fourth Congress (Resolution 19 (Cg-IV)).

In moist air at pressure p, thermodynamic temperature T and having a mixing ratio r, heat capacity at constant pressure C_p, enthalpy H and entropy S per $(1 + r)$ units of mass of moist air (or per unit of mass of dry air) are expressed by the following equations :

$$C_p = \frac{7}{2} R \left(1 + \frac{8}{7} \frac{r}{\varepsilon}\right) + \Delta C_p \qquad (1)$$

$$H = \frac{7}{2} R \left[t + \frac{8}{7} \frac{r}{\varepsilon} \left(t + \frac{\varepsilon L_v (0)}{4 R}\right)\right] + \Delta H \qquad (2)$$

$$\begin{aligned} S = {} & \frac{7}{2} R \left(\ln T - \frac{2}{7} \ln p - \ln T_0\right) + \\ & + 4 R \frac{r}{\varepsilon} \left[\ln T - \frac{1}{4} \ln p + \frac{\varepsilon L_v (0)}{4 R T_0} - \ln T_0 + \frac{1}{4} \ln e_w (0)\right] - \\ & - R \left[\frac{r}{\varepsilon} \ln \frac{r}{\varepsilon} - \left(1 + \frac{r}{\varepsilon}\right) \ln \left(1 + \frac{r}{\varepsilon}\right)\right] + \Delta S \end{aligned} \qquad (3)$$

where

R	is the ideal gas constant for dry air,
ε	the ratio of the molecular weight of water vapour to that of dry air,
t	the Celsius temperature $t = T - T_0$
T_0	the thermodynamic temperature of the normal ice point,
$L_v (0)$	the specific latent heat of vapourization of water at 0°C,
$e_w (0)$	the saturation vapour pressure of water in the pure phase at 0°C.

ΔC_p, ΔH and ΔS are small terms with respect to the others ; they are functions of pressure, temperature and mixing ratio and are called, respectively, heat capacity at constant pressure residual, enthalpy residual and entropy residual.

Enthalpy and entropy of moist air are relative quantities, each comprising two arbitrary constants grouped in an expression having the form $C_1 + r\,C_2$. These constants have been defined in equations (2) and (3) in the following manner:

In dry air ($r = 0$), the value 0 was assigned to enthalpy and to the quantity $S + R \ln p$ (p being expressed in millibars), called the reduced entropy, for pressure equal to zero and temperature equal to 0°C; this implies $\Delta H = 0$ and $\Delta S = 0$ for $r = 0$, $p = 0$ and $t = 0$°C.

In pure water vapour ($r = \infty$), the value 0 was assigned to the specific enthalpy $\frac{H}{r}$ and to the specific entropy $\frac{S}{r}$ for the liquid phase at a temperature of 0°C and saturation vapour pressure $e_w(0)$; this implies that $\frac{\Delta H}{r} = 0$ and $\frac{\Delta S}{r} = 0$ for $r = \infty$, $p = e_w(0)$ and $t = 0$°C.

Taking numerical values $R = 287.05$ J kg^{-1} K^{-1}, $\varepsilon = 0.621\,98$, $T_0 = 273.15$ K, $L_v(0) = 2.500\,84 \times 10^6$ J kg^{-1}, $e_w(0) = 6.107\,0$ mb and expressing p in mb, T in K, t in °C, and r in kg kg^{-1}, equations (1), (2) and (3) take the following forms which permit the calculation of C_p, H and S for $(1 + r)$ kg of moist air (or for 1 kg of dry air):

$$C_p = 1\,004.68\,(1 + 1.837\,45\,r) + \Delta C_p \quad \text{J K}^{-1} \qquad (1')$$

$$H = 1\,004.68\,[t + 1.837\,45\,r\,(t + 1\,354.70)] + \Delta H \quad \text{J} \qquad (2')$$

$$S = 1\,004.68\left(\ln T - \frac{2}{7}\ln p - 5.610\,02\right) + $$

$$+\,1\,846.04\,r\left(\ln T - \frac{1}{4}\ln p - 0.198\,10\right) + S_m + \Delta S \quad \text{J K}^{-1} \qquad (3')$$

where $S_m = -R\left[\frac{r}{\varepsilon}\ln\frac{r}{\varepsilon} - \left(1 + \frac{r}{\varepsilon}\right)\ln\left(1 + \frac{r}{\varepsilon}\right)\right]$

is a positive term, function of the mixing ratio only, called the mixing entropy.

NOTE: The specific heat capacity at constant pressure, the specific enthalpy and the specific entropy of moist air are obtained by dividing C_p, H and S respectively by $(1 + r)$.

Let C_p^*, H^* and S^* be the heat capacity at constant pressure, enthalpy and entropy respectively of $(1 + r)$ units of mass of moist air calculated according to the following hypotheses: (*a*) dry air and water vapour are ideal gases with constant specific heat capacity and (*b*) enthalpy and entropy of moist air are respectively the sum of enthalpies and the sum of entropies of dry air and of water vapour; the value zero of enthalpy and entropy for dry air as well as for water vapour is assigned in the same manner as previously. The equations (1), (2) and (3) can therefore be written as :

$$C_p = C_p^\star + \Delta C_p, \tag{1''}$$

$$H = H^\star + \Delta H, \tag{2''}$$

$$S = S^\star + \Delta S. \tag{3''}$$

Description and use of the tables

Tables 4.24.1, 4.24.2 and 4.24.3 give respectively the residual quantities ΔC_p in J K^{-1}, ΔH in J and ΔS in J K^{-1} for $(1 + r)$ kg of moist air as a function of pressure (mb), temperature (°C) and of the ratio $r/r_w\,(p, t)$ where $r_w\,(p, t)$ is the saturation mixing ratio at pressure p and temperature t (Table 4.13.2). For temperatures below 0°C, these quantities are practically independent of the ratio $r/r_w\,(p, t)$ and therefore are indicated as functions of pressure and temperature only. For temperatures equal to and above 0°C, the tabular values are given as functions of pressure, temperature and the ratio $r/r_w\,(p, t)$; they are also mentioned for zero pressure in column $r/r_w\,(p, t) = 0$ to facilitate the interpolation although the ratio $r/r_w\,(p, t)$ is not defined in this case. Linear interpolation is sufficient within the limits of precision of the tables.

Table 4.24.4 gives the mixing entropy S_m, in J K^{-1}, for $(1 + r)$ kg of moist air as a function of the mixing ratio r expressed in kg kg^{-1}. Linear interpolation is practicable.

The heat capacity at constant pressure and enthalpy of moist air at pressure p, temperature t and with mixing ratio r can be obtained by looking for the value of $r_w\,(p, t)$ corresponding to p and to t in Table 4.13.2 and then calculating the ratio $r/r_w\,(p, t)$; the values of ΔC_p and ΔH corresponding to p, t and $r/r_w\,(p, t)$ can be taken from Tables 4.24.1 and 4.24.2 and used in equations (1′) and (2′). Entropy is obtained by taking S_m from Table 4.24.4 and ΔS from Table 4.24.3 after having calculated $r/r_w\,(t, p)$; these values are then used in equation (3′).

For example, consider moist air with $p = 900$ mb, $t = 15$°C ($T = 288.15$ K) and $r = 8.53$ g kg^{-1} (0.008 53 kg kg^{-1}). Table 4.13.2 gives $r = 12.054$ g kg^{-1} for $p = 900$ mb and $t = 15$°C, this gives $\dfrac{r}{r_w} = \dfrac{8.53}{12.054} = 0.71$. Tables 4.24.1, 4.24.2 and 4.24.3 give respectively for $p = 900$ mb, $t = 15$°C and $r/r_w = 0.71$ by interpolation,

$$\Delta C_p = 1.6 \text{ J K}^{-1}, \quad \Delta H = -0.24 \times 10^3 \text{ J}, \quad \Delta S = -0.71 \text{ J K}^{-1};$$

and Table 4.24.4 gives $S_m = 20.85$ J K^{-1} for $r = 0.008\,53$ kg kg^{-1}. Equations (1′), (2′) and (3′) permit the calculation of C_p, H and S for 1.008 5 kg of moist air :

$$C_p = 1\,004.68\,(1 + 1.837\,45 \times 0.008\,53) + 1.6 = 1\,022.0 \text{ J K}^{-1}$$

$$H = 1\,004.68\,[15 + 1.837\,45 \times 0.008\,53\,(15 + 1\,354.70)] - 0.24 \times 10^3$$
$$= 36.40 \times 10^3 \text{ J}$$

$$S = 1\,004.68\left(\ln 288.15 - \frac{2}{7}\ln 900 - 5.610\,02\right) +$$

$$+ 1\,846.04 \times 0.008\,53\left(\ln 288.15 - \frac{1}{4}\ln 900 - 0.198\,10\right) + 20.85 - 0.71$$

$$= -1\,839.66 + 20.85 - 0.71 = -1\,819.52 \text{ J K}^{-1}.$$

It will be noted that the values of ΔC_p, ΔH and ΔS are small with respect to the other terms in equations (1′), (2′) and (3′) and can generally be neglected in calculations.

The values in Table 4.24.1, 4.24.2, 4.24.3 and 4.24.4 have been taken, respectively from SMT 88, 85, 86 and 87, then converted to SI units using the factor 4.186 84 for the conversion of IT calories into joules (see Note 1, Introduction 4.4, p. 4). SMT 88, 85, 86, 87 have been established according to the information prepared by J. A. Goff and S. Gratch ; since the appearance of these tables the values of the physical constants used in the calculations have undergone some changes as a result of the adoption (*a*) of new temperature scales and a new value of R and (*b*) a new definition of atomic mass. However, the resulting differences in the values of ΔC_p, ΔH and ΔS are negligible since these quantities have been calculated directly on the basis of reduced free enthalpies at zero pressure, the second virial coefficients and the coefficient of interaction (see note). The values of S_m given in Table 4.24.4 are not affected by the change in value of ε (0.621 98 instead of 0.621 97 in the SMT) nor of R.

Note : Establishment of formulae (1), (2) and (3) and calculation of the residual quantities ΔC_p, ΔH and ΔS.

A brief outline of Goff-Gratch formulation of thermodynamic properties of water vapour can be found in Introduction 4.4. In the case of moist air the approach is similar, the difference being that moist air is a mixture of two gases in variable proportions, dry air being considered here as a unique gas, so that it is necessary to take into account the interaction between dry air and water vapour.

The free enthalpy (or the Gibbs thermodynamic potential) g of a mixture of n_a moles of dry air and n_v moles of water vapour is

$$g = x_a\,\mu_a + x_v\,\mu_v\,;$$

x_a and x_v are respectively the mole fraction of dry air and that of water vapour ;
μ_a and μ_v are respectively the molar chemical potential of dry air and that of water vapour, given by equations :

$$\mu_a = g_a^0\,(T) + R^\star\,T \ln x_a\,p - p\,[x_a\,(2 - x_a)\,A_{aa} + x_v\,(2 - x_a)\,A_{av}] - \ldots$$
$$\mu_v = g_v^0\,(T) + R^\star\,T \ln x_v\,p - p\,[x_v\,(2 - x_v)\,A_{vv} + x_a\,(2 - x_v)\,A_{av}] - \ldots$$

where

$R^\star$ is the gas constant for one mole of ideal gas ;

A_{aa}, the second virial coefficient for dry air ;

A_{vv}, the second virial coefficient for water vapour ;

A_{av}, the coefficient of interaction between dry air and water vapour.

$g_a^0\ (T)$ and $g_v^0\ (T)$ are functions which depend only on temperature, called reduced free enthalpies at zero pressure, which are expressed in the case of dry air and of water vapour by

$$g_a^0\ (T)/R^*\ T = \frac{7}{2} \ln \frac{1}{T} + \varphi_a\ (T)\ ;$$

$$g_v^0\ (T)/R^*\ T = 4 \ln \frac{1}{T} + \varphi_v\ (T)\ ;$$

$\varphi_a\ (T)$ and $\varphi_v\ (T)$ being small terms with respect to the others.

Noting that the free enthalpy of $(1 + r)$ units of mass of moist air is equal to $\frac{1}{M_a}\left(1 + \frac{r}{\varepsilon}\right) g$ (M_a being the apparent molecular mass of dry air), equations (1), (2) and (3) are deduced from the free enthalpy following the same procedures as for water vapour (Introduction 4.4). The residual values ΔC_p, ΔH and ΔS come from the terms in $\varphi_a\ (T)$, $\varphi_v\ (T)$, A_{aa}, A_{vv} and A_{av} which are determined by the molecular properties of the gases under consideration.

References : see Introduction 4.4.

Introduction to Table 6.1

SCALE VARIATIONS OF RECOMMENDED MAP PROJECTIONS

Three types of projections are recommended for weather charts (WMO TR, paragraph 7.2.1) : the polar stereographic projection, Lambert's conformal conic projection and the Mercator projection ; all three are conformal (except at the poles in Lambert's conformal conic projection and the Mercator projection), i.e. all angles are preserved ; at any one point the scale is the same in all directions for infinitesimal distances and is a function of latitude and of the scale chosen for the standard parallel(s). The relation between a short distance on the ground ΔL and the corresponding distance Δl measured on the chart is :

$$\Delta l = S\ k\ \Delta L \qquad (1)$$

where S is the scale of the chart for the standard parallel(s), and
k a scale factor depending on latitude only, for each type of projection.

The distances Δl and ΔL must be expressed in the same unit ; the factors S and k are dimensionless.

The factor k is given by the following formulae if the Earth is assumed to be spherical and latitude is designated by φ, colatitude $(90^\circ - \varphi)$ by χ and the latitude of the standard parallels by φ_1 and φ_2 (colatitude χ_1 and χ_2) :

For the Mercator projection :

$$k = \frac{\cos \varphi_1}{\cos \varphi} ;$$

For the polar stereographic projection :

$$k = \frac{\cos^2 \dfrac{\chi_1}{2}}{\cos^2 \dfrac{\chi}{2}} ;$$

For Lambert's conformal conic projection :

$$k = nm \frac{\left(\operatorname{tg} \dfrac{\chi}{2}\right)^n}{\sin \chi}$$

where $$n = \frac{\log \sin \chi_1 - \log \sin \chi_2}{\log \operatorname{tg} \dfrac{\chi_1}{2} - \log \operatorname{tg} \dfrac{\chi_2}{2}} \quad \text{and} \quad m = \frac{\sin \chi_1}{n \left(\operatorname{tg} \dfrac{\chi_1}{2}\right)^n} .$$

Table 6.1 gives the scale factor k as a function of latitude for the projections recommended for weather charts, on the assumption that the Earth is spherical. Linear interpolation is not practicable.

To find a distance ΔL on the Earth corresponding to a relatively short length Δl measured on the chart (e.g. $\Delta l = 2.5$ cm, or 0.000 025 km) :

(1) Ascertain the projection of the chart and the standard parallels (shown in an inset on the chart itself) and in the table find the value of k corresponding to the mean latitude of the length in question (for example, in the case of Lambert's conformal conic projection, standard parallels 30° and 60°, the mean latitude of the length in question is $\varphi = 50°$, $k = 0.968$).

(2) Introduce into formula (1) the value S of the scale at the standard latitude (for example S = 1 : 15 000 000), the value of k already found, and the length Δl. In the example, this gives :

$$0.000\,025 = \frac{1}{15\,000\,000} \times 0.968\,\Delta L$$

or $\Delta L = 387$ km.

In order to find long distances covering several degrees of latitude the coefficient k or $\frac{1}{k}$ must be found by one of the following equations (obtained by representing k, or $\frac{1}{k}$, by a second degree polynomial) :

$$k = \frac{1}{6}\,(k_A + 4\,k_{1/2} + k_B)$$

$$\frac{1}{k} = \frac{1}{6}\left(\frac{1}{k_A} + \frac{4}{k_{1/2}} + \frac{1}{k_B}\right).$$

where k_A and k_B are the values of the scale factor k for the latitudes of the two extremities of the segment measured, and $k_{1/2}$ the value of k for the latitude of the middle of this segment.

The values of the scale coefficient of Table 6.1 are those of W. R. Gregg and I. R. Tannehill [1] for the Mercator projection and Lambert's conformal conic projection (standard parallels 30° and 60°). The Institut géographique national de France has undertaken the computation for the polar stereographic projection and Lambert's conformal conic projection (standard parallels 10° and 40°) giving information on the method of computation for long distances.

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[1] Month. Weath. Rev., *65*, p. 415, 1937 (reprinted also in SMT 165).

Introduction to Table 6.2

LENGTH OF ONE DEGREE ON A PARALLEL AND ON A MERIDIAN

Let a be the semi-major axis (equatorial radius) and b the semi-minor axis (polar radius) of the ellipsoid of revolution representing the Earth's surface : the flattening f is the ratio $\frac{a-b}{a}$ and the latitude φ the angle between the normal of the generating ellipse and its major axis.

The radius r of a parallel is :

$$r = \frac{a^2}{b} \frac{1}{\sqrt{\frac{a^2}{b^2} + \mathrm{tg}^2\varphi}} = \frac{a}{\sqrt{1 + (1-f)^2 \mathrm{tg}^2\varphi}}$$

whence we derive the length l of one degree on the parallel : $l = \frac{2\pi r}{360}$.

The radius of curvature R of a meridian, i.e. of the generating ellipse, is given by the relation :

$$R = \frac{b^2}{a}\left[1 - \left(\frac{a^2 - b^2}{a^2}\right)\sin^2\varphi\right]^{-\frac{3}{2}} = a\,(1-f)^2\left[1 - f\,(2-f)\sin^2\varphi\right]^{-\frac{3}{2}}$$

and the length L of the arc between latitude φ_1 and latitude φ_2 is thus :

$$L = \int_{\varphi_1}^{\varphi_2} R\,(\varphi)\mathrm{d}\varphi \cdot$$

The length of one degree on the meridian is obtained by taking the difference $\varphi_2 - \varphi_1$ as one degree.

Table 6.2 gives the length of arc corresponding to one degree on the parallel as a function of latitude and the length of arc of the meridian between two consecutive values of latitude expressed in whole degrees. The table was calculated for the International Ellipsoid of Reference ($a = 6\,378\,388$ m and $f = 1/297$) adopted by the International Congress on Geodesy (Madrid 1924).

The length of the mean degree of latitude is 1/90 of one quarter of the terrestrial meridian, viz. : 111 137 m in the International Ellipsoid of Reference.

The values in Table 6.2 are taken from SMT 162 and 163.

NOTE : New measurements, obtained by means of satellites in particular, have given the following generally recognized values of $a = 6\,378\,150$ m and $f = 1/298.3$. Their use introduces differences of a few metres in the length of the degree.

TABLES

Table 1.1

UNITS, DIMENSIONS AND CONVERSION FACTORS

1 *Length*

SI unit: metre (m)

Definition: see Introduction 1.1, section 3.1
Dimension: L

Metric units:

ångström (Å)		$1\ \text{Å} = 10^{-10}$ m $= 10^{-8}$ cm
micron	(μ) [1]	$1\ \mu = 10^{-6}$ m $= 10^{-4}$ cm

Non-metric units:

(international) yard [2] (yd)	1 yd = 0.914 4 m
(international) foot [2] (ft)	1 ft = 0.304 8 m
(international) inch [2] (in)	1 in = 2.54 cm = 0.025 4 m
(international) mile [2] (mile)	1 mile = 1 609.344 m
international nautical mile [3]	1 international nautical mile = 1 852 m
light year (l.y.)	1 l.y. = $9.460\,5 \times 10^{15}$ m
astronomical unit (AU)	1 AU = 1.495×10^{11} m
parsec (pc)	1 pc = 3.084×10^{16} m

NOTE 1: The name "micron" and the symbol "μ" should no longer be used (CGPM-13), but replaced by "micrometre" and the symbol "μm".

NOTE 2: These relations were adopted (1 July, 1959) by the six national laboratories of the United States of America, the United Kingdom, Canada, Australia, South Africa and New Zealand. They are official units in the United States for all purposes, whether scientific or industrial. However for geodetic measurements the U.S. Survey foot = 1 200/3 937 m, defined in 1893, continues to be used. The Weights and Measures Act, 1963, legalized those units in the United Kingdom.

NOTE 3: The Secretary of Commerce and the Secretary of Defense of the U.S.A. officially adopted the international nautical mile of 1852 m with effect from 1 July 1954. The U.K., however, still uses a nautical mile of 6 080 feet corresponding to 1 853.184 m.

2 *Area*

SI unit: square metre (m^2)

Definition: area of a square with sides of 1 m
Dimension: L^2

Non-metric units:

square yard (yd^2)	1 yd^2 = 0.836 127 m^2
square foot (ft^2)	1 ft^2 = 0.092 903 m^2
square inch (in^2)	1 in^2 = 6.451 6 cm^2 = 0.000 645 16 m^2

3 *Volume*

SI unit: cubic metre (m^3)

Definition: volume of a cube with sides of 1 m
Dimension: L^3

Metric unit :

litre (1) (l) $1\ l = 1\ dm^3 = 10^{-3}\ m^3$

Non-metric units :

cubic yard (yd^3)	$1\ yd^3 = 0.764\ 555\ m^3$
cubic foot (ft^3)	$1\ ft^3 = 0.028\ 316\ 8\ m^3$
cubic inch (in^3)	$1\ in^3 = 16.387\ 1\ cm^3 = 16.387\ 1 \times 10^{-6}\ m^3$
bushel (UK)	1 bushel = 36.368 7 dm^3
gallon (UK)	1 gallon = 4.546 09 dm^3
gallon (US)	1 gallon = 3.785 41 dm^3
pint (UK)	1 pint = 0.568 261 dm^3
liquid pint (US)	1 liquid pint = 0.473 176 dm^3
fluid ounce (UK) (fl. oz)	1 fl. oz = 28.413 0 cm^3
fluid ounce (US) (fl. oz)	1 fl. oz = 29.573 5 cm^3

NOTE 1 : The word "litre" may be used as a special name for the cubic decimetre, but is not to be used to express high-precision measurements of volume (CGPM-12, 1964).

4 *Time*

SI unit : second (s)

Definition : see Introduction 1.1, section 3.3

Dimension : T

Derived units and other units

minute (min)	1 min = 60 s (exact)
hour (h)	1 h = 3 600 s (exact)
day (d)	1 d = 86 400 s (exact)

tropical year (mean solar, ordinary) (1) (a)

$1\ a = 31.556\ 926 \times 10^6\ s = 365.242\ 198\ 78\ d$

1 sidereal second = 0.997 270 s (2)

1 sidereal day = 86 164.1 s (2) = 23 h 56 min 4.091 s (2)

NOTE 1 : On 1900.0, decreasing by 6.14×10^{-8} days per year.

NOTE 2 : The exact conversion factors are not constant but varying in time. However in the 20th century this secular variation does not affect the values given for the conversion factors if restricted to the number of decimals given.

5 *Speed*

SI unit : metre per second ($m\ s^{-1}$)

Dimension : LT^{-1}

Metric unit :

kilometre per hour ($km\ h^{-1}$) $1\ km\ h^{-1} = 1/3.6\ m\ s^{-1}$

Non-metric unit :

knot 1 knot = 1 international nautical mile per hour = $1\ 852\ m\ h^{-1}$

$= 1\ 852/3\ 600\ m\ s^{-1} \approx 0.514\ m\ s^{-1}$

6 *Acceleration*

SI unit : metre per second squared ($m\ s^{-2}$)

Dimension : LT^{-2}

Metric unit :

gal   1 gal = 1 cm s^{-2} = 0.01 m s^{-2}

7 *Mass*

SI unit : kilogramme (kg)

Definition : see Introduction 1.1, section 3.2

Dimension : M

Metric unit :

tonne (t)   1 t = 1 000 kg

Non-metric units :

(unified) atomic mass unit (u)	1 u = $1.660\ 44 \times 10^{-27}$ kg [1]
international pound (avoirdupois) (lb)	1 lb = 0.453 592 37 kg [2]
slug [3]	1 slug = 980.665/30.48 lb (exactly) = 32.174 0 lb = 14.593 9 kg
grain	1 grain = $\frac{1}{7\ 000}$ lb = 64.798 91 mg (exactly)
ounce (oz)	1 oz = $\frac{1}{16}$ lb = 28.349 5 g

NOTE 1 : See Introduction 1.1, section 6.5.

NOTE 2 : Here the definition given by the ISO is followed. There exist two other definitions :

(*a*) 1 lb (UK) = 0.453 592 338 kg (determined experimentally in 1933).

(*b*) 1 lb avdp (US) = 0.453 592 427 7 kg (exactly). (The relation given in the definition was officially adopted on or before 21 March 1894. The factor therein is the result of an experimental determination in 1883 of the mass at that time of the United Kingdom standard).

The following remark is pertinent to the ISO definition. Consideration has been given to the possibility of redefining the U.K. and U.S. pounds (avoirdupois) on a common legal basis by reference to the kilogramme, and the following values have been proposed

1 pound = 0.453 592 3 kg
or = 0.453 592 37 kg

Both these values are such that the ratio of the grain (1/7 000 lb) to the kilogramme would be exactly expressible as a terminating decimal. No decision, however, has so far been reached. The adoption of a lb equivalent to 0.453 592 37 kg should not be regarded as giving it any special status. This value however coincides with that adopted in 1959 for precise measurements for science and technology by the following national laboratories : The Applied Physics Division, National Research Council, Ottawa, Canada ; The Dominion Physical Laboratory, Lower Hutt, New Zealand ; The National Bureau of Standards, Washington, D.C., United States ; The National Laboratory, Teddington, United Kingdom ; The National Physical Research Laboratory, Pretoria, South Africa ; The National Standards Laboratory, Sydney, Australia (see Note 1 to section 1).

NOTE 3 : This unit is the British technical unit of mass.

8 *Density*

SI unit : kilogramme per cubic metre (kg m^{-3})

Dimension : ML^{-3}

9 *Specific volume*

SI unit : cubic metre per kilogramme (m^3 kg^{-1})

Dimension : L^3M^{-1}

10 *Momentum*

SI unit : kilogramme metre per second (kg m s^{-1})

Dimension : LMT^{-1}

11 *Moment of momentum ; angular momentum*

SI unit : kilogramme metre squared per second (kg m^2 s^{-1})

Dimension : L^2MT^{-1}

12 *Moment of inertia*

SI unit : kilogramme metre squared (kg m^2)

Dimension : L^2M

13 *Force*

SI unit : newton (N)

Definition : 1 N is that force which, when applied to a body having a mass of 1 kg, gives it an acceleration of 1 m s^{-2}

Dimension : LMT^{-2}

Metric units :

dyne (dyn)	1 dyn = 10^{-5} N
sthène (sn)	1 sn = 10^3 N = 1 kN
kilogramme-force (kgf)	1 kgf = 9.806 65 N (exactly) (1)

Non-metric units :

poundal (pdl)	1 pdl = 0.138 255 N
pound-force (lbf)	1 lbf = 4.448 22 N = 32.174 0 pdl (2)

NOTE 1 : This is the metric technical unit of force. The unit is also given the abbreviation kp instead of kgf. It should be distinguished from the (inconstant) local weight of a body having a mass of 1 kg.

NOTE 2 : This is the British technical unit of force. It should be distinguished from the (inconstant) local weight of a body having a mass of 1 lb. This would be called "pound-weight".

14 *Pressure*

SI unit: pascal (Pa)

Definition: 1 pascal = 1 newton per square metre (1N m^{-2})

Dimension: $L^{-1}MT^{-2}$

Metric units :

pièze (pz)	1 pz = 1 sn m^{-2} = 10^3 Pa (exactly)
bar (bar)(1)	1 bar = 10^5 Pa = 10^6 dyn cm^{-2} = 1 hpz (exactly)
millibar (mbar or mb)(2)	1 mb = 10^2 Pa = 10^3 dyn cm^{-2}

Non-metric units :

normal atmosphere (atm)	1 atm = 101 325 N m^{-2} (exactly) (3) = 1 013.25 mb
torr	1 torr = $\frac{1}{760}$ atm = 133.322 N m^{-2} = 1.333 22 mb
technical atmosphere (at)	1 at = 98 066.5 N m^{-2} (exactly) = 980.665 mb
poundal per square foot (pdl ft^{-2})	1 pdl ft^{-2} = 1.488 16 N m^{-2} = 0.014 881 mb
conventional millimetre of mercury (mm Hg)	1 mm Hg = 133.322 N m^{-2} = 1.333 22 mb (4)
standard millimetre of mercury $(\text{mm Hg})_n$	1 $(\text{mm Hg})_n$ = 133.322 4 N m^{-2} = 1.333 224 mb (5)

NOTE 1 : The microbar (1 μbar = 1 dyn cm^{-2}) is also called the barye.

NOTE 2 : The international symbol is mbar, the abbreviation mb is used in meteorology.

NOTE 3 : Definition adopted by CGPM-10 (1954) for all types of usages.

NOTE 4 : It follows from this definition that a pressure of 760 mm Hg exceeds 1 atm by less than 2×10^{-7} atm.

NOTE 5 : International Barometer Conventions (see Table 3.8.1).

15 *Viscosity (dynamic viscosity)*

SI unit : newton second per square metre (N s m^{-2})

Definition : 1 N s m^{-2} is the viscosity of a fluid in which the velocity under a shear stress of 1 N m^{-2} has a gradient of 1 m s^{-1} per metre perpendicular to the plane of the shear

Dimension : $L^{-1}MT^{-1}$

Metric unit :

poise (P) 1 P = 0.1 N s m^{-2} = 1 dyn s cm^{-2} = 1 g cm^{-1} s^{-1} (exactly)

16 *Viscosity (kinematic viscosity)*

SI unit : square metre per second (m^2 s^{-1})

Definition : 1 m^2 s^{-1} is the kinematic viscosity of a fluid with dynamic viscosity 1 N s m^{-2} and density 1 kg m^{-3}

Dimension : L^2T^{-1}

Metric unit :

stokes (St) 1 St = 0.000 1 m^2 s^{-1} = 1 cm^2 s^{-1}

17 *Energy*

SI unit : joule (J) (1)

Definition : 1 J is the work done when the point of application of a force of 1 N is displaced through a distance of 1 m in the direction of the force.

Dimension : L^2MT^{-2}

Metric unit :

erg (erg) 1 erg = 1 dyn cm = 10^{-7} J (exactly)

Non-metric units :

kilogram-force metre (kgf m)	1 kgf m = 9.806 65 J (exactly)
kilowatt hour (kWh)	1 kWh = 3.6×10^6 J (exactly)
15° calorie (cal_{15})	1 cal_{15} = 4.185 5 J (2)
IT calorie (cal_{IT})	1 cal_{IT} = 4.186 8 J (exactly) (3)
thermochemical calorie	1 cal (thermochem) = 4.184 0 J (4)
foot poundal (ft pdl)	1 ft pdl = 0.042 140 1 J
British thermal unit (Btu)	1 Btu = 1 055.06 J

NOTE 1 : The CGPM (1948) adopted this unit for electric work and for heat as well as for mechanical work and for energy. This unit was sometimes called ***absolute joule.*** Until 1948 the *international joule* was also used for electrical work and sometimes for heat. The "international" units were abandoned by the CGPM-9 (1948). The conversion factors given by the Comité international des poids et mesures (1946) lead to the approximate relation

$$1 \textit{ mean international joule} = \frac{(1.000\,34)^2}{1.000\,49}\ \mathrm{J} = 1.000\,19\ \mathrm{J}$$

NOTE 2 : The conversion factor shown was proposed by the Comité consultatif de thermométrie et calorimétrie and adopted by the Comité international des poids et mesures (1950) as being the most accurate value which could then be deduced from experiment. This factor is uncertain by 0.0005 J.

NOTE 3 : This conversion factor has been adopted as defining the IT calorie by the Fifth International Conference on Properties of Steam (London, 1956). However, the WMO TR, Appendix C (6), gives 4.186 84 J.

NOTE 4 : This conversion factor has been adopted by the U.S. National Bureau of Standards as giving the definitive relation between the thermochemical calorie and the joule.

18 *Power*

SI unit : watt (W) (1)

Definition : 1 W = 1 J s^{-1}

Dimension : L^2MT^{-3}

Metric unit :

erg per second (erg s^{-1}) 1 erg s^{-1} = 10^{-7} W (exactly)

Non-metric unit :

IT kilocalorie per hour ($kcal_{IT}\ h^{-1}$) 1 $kcal_{IT}\ h^{-1}$ = 1.163 W

NOTE 1 : Until 1948 the *international watt,* defined as the product of 1 international volt and 1 international ampere, was used in electrical measurements. This unit was abandoned by the CGPM-9 (1948). The conversion factors given by the Comité international des poids et mesures (1946) lead to the approximative relation

$$1 \textit{ mean international watt} = \frac{(1.000\,34)^2}{1.000\,49}\ \mathrm{W} = 1.000\,19\ \mathrm{W}$$

19 *Specific energy*

SI unit : joule per kilogramme ($J\ kg^{-1}$)

Dimension : L^2T^{-2}

Non-metric unit :

Standard geopotential metre (m′)

$$1\ m' = 9.806\ 65\ J\ kg^{-1} = 9.806\ 65\ m^2\ s^{-2}$$

NOTE 1 : The standard geopotential metre has been adopted by WMO (see WMO TR, Volume I, edition 1971, Appendix C, section 7) as the unit of geopotential and from 1 July 1972 replaces the geopotential metre (gpm) defined by

$1\ gpm = 9.8\ J\ kg^{-1} = 9.8\ m^2\ s^{-2}$

For conversions between standard geopotential metres and geopotential metres, see Note on page IX.

20 *Temperature* (1)

SI unit : kelvin (2)

Definition : see Introduction 1.1, section 3.5

Dimension : Θ

Metric unit :

Degree Celsius (°C) (2) : the Celsius temperature t of a system is given by $t = (T–273.15)$ °C in which T is the temperature in kelvins

Non-metric units :

degree Rankine (°R) (3) : $1°R = \frac{5}{9}\ K$

degree Fahrenheit (°F) : the Fahrenheit temperature of a system is given by $t = (T–459.67)$ °F in which T is the absolute temperature in degrees Rankine (4)

NOTE 1 : For this section see also Introduction 1.1, section 4.

NOTE 2 : A difference of temperature is expressed in kelvins (K), it may also be expressed in degrees Celsius (°C) (CGPM-13).

NOTE 3 : °R should not be mistaken for an abbreviation for the abandoned degree Réaumur.

NOTE 4 : If t_C °C, t_F °F, T_K K and T_R °R relate to one and the same physical state, then the numerical values t_C, t_F, T_K and T_R are connected by

$$t_C = \frac{5}{9}(t_F - 32) = T_K - 273.15 = \frac{5}{9}T_R - 273.15$$

and also by

$$t_C + 40 = \frac{5}{9}(t_F + 40)$$

21 *Quantity of heat*

See *Energy*, section 17 of this Table

22 *Amount of substance*

SI unit: mole (mol)

Definition: see Introduction 1.1, section 3.7.

NOTE 1 : See also Introduction 1.1, section 6.4.

NOTE 2 : The numerical value of the quantity of matter expressed in moles is also called the number of moles.

23 *Molar quantities*

Expressions such as molar mass, molar volume, molar entropy, etc., are used to express the quotient of mass, volume, entropy, etc., by the quantity of matter.

24 *Luminous intensity*

SI unit : candela (cd)

Definition : see Introduction 1.1, section 3.6
Dimension : J

25 *Luminance*

SI unit : nit (nit)

Definition : 1 nit = 1 candela per square metre (1 cd m^{-2})
Dimension : JL^{-2}

Metric unit :

stilb (sb) (1) 1 sb = 1 cd cm^{-2} = 10^4 cd m^{-2}

Non-metric unit :
apostilb (asb) (1) 1 asb = $(10^{-4}\pi^{-1})$ sb = π^{-1} cd m^{-2}

NOTE 1 : The use of these units is not recommended.

26 *Luminous flux*

Unit : lumen (lm)

Definition : the total luminous flux from a point source of 1 candela equals 4π lumens so that 1 lm = 1 cd steradian.
Dimension : J

27 *Illumination*

Units : lux (lx) 1 lx = 1 lm m^{-2}
phot (1) (ph) 1 ph = 1 lm cm^{-2} = 10^4 lx

Dimension : JL^{-2}

NOTE 1 : The use of this unit is not recommended.

28 *Energy per unit area*

SI unit : joule per square metre ($J\ m^{-2}$)

Dimension : MT^{-2}

Non-metric unit :

langley [1] (Ly) $1\ Ly = 1\ cal_{15}\ cm^{-2} = 4.185\ 5 \times 10^4\ J\ m^{-2}$

NOTE (1) : The unit langley is still used in meteorology (radiation) although CGPM (1948) decided to abandon it. See also Introduction 1.1, section 5.

29 *List of selected physical constants*

29.1 In the following list, the best values currently available are given according to E. R. Cohen and C. W. M. Dumond, Rev. Mod. Phys., *37*, 537–594, October 1965. The digits in parentheses following some values represent the standard deviation error in the final digits of the quoted value. The unified scale of atomic weight is used throughout.

29.2 *Physical constants : least-squares adjusted output values of 1963* [1]

Velocity of light	c	$= 2.997\ 925\ (1) \times 10^8\ m\ s^{-1}$
Avogadro's constant	N_A	$= 6.022\ 52\ (9) \times 10^{23}\ mol^{-1}$
Boltzmann's constant	k	$= 1.380\ 54\ (6) \times 10^{-23}\ J\ K^{-1}$
Electron rest mass	m	$= 9.109\ 08\ (13) \times 10^{-31}\ kg$
Planck's constant	h	$= 6.625\ 59\ (16) \times 10^{-34}\ J\ s$
First radiation constant	c_1	$= 2\pi hc^2 = 3.741\ 50\ (9) \times 10^{-16}\ J\ m^2\ s^{-1}$
Second radiation constant	c_2	$= hc/k = 1.438\ 79\ (6) \times 10^{-2}\ m\ K$
Wien displacement law constant	$\lambda_{max}T$	$= (0.289\ 782 \pm 0.000\ 013) \times 10^{-2}\ m\ K$ *
Stephan-Boltzmann constant	σ	$= 5.669\ 7\ (10) \times 10^{-8}\ J\ m^{-2}\ K^{-4}\ s^{-1}$
Standard molar volume of ideal gas	V_m	$= (22\ 413.6 \pm 0.6) \times 10^{-6}\ m^3\ mol^{-1}$
Molar constant of ideal gas	R	$= 8.314\ 34\ (35)\ J\ mol^{-1}\ K^{-1}$ [2]

Relative atomic masses :

Oxygen nuclide ^{16}O	15.994 915
Carbon nuclide ^{12}C	12 (exactly)
Hydrogen nuclide [1]	1.007 825
Deuterium	2.014 102
Neutron	1.008 665 4 (4)

NOTE 1 : The values of physical constants given in this list are retained in the present amendment because they are still largely used on an international basis, in particular in the ISO International Standard 31. New values, given by B. N. Taylor, W. H. Parker

* Cohen, Dumond, Layton and Rollet, *Rev. Mod. Phys. 27*, 377, 1955.

and D. N. Langenberg, Rev. Mod. Phys. *41*, 375 (1969), which differ significantly from former values, are given below:

Avogadro's constant	N_A	$= 6.022\,169\ (40) \times 10^{23}\ \mathrm{mol}^{-1}$
Boltzmann's constant	k	$= 1.380\,622\ (59) \times 10^{-23}\ \mathrm{J\ K}^{-1}$
Electron rest mass	m	$= 9.109\,558\ (54) \times 10^{-31}\ \mathrm{kg}$
Planck's constant	h	$= 6.626\,196\ (50) \times 10^{-34}\ \mathrm{J\ s}$
(united) atomic mass unit	u	$= 1.660\,531\ (11) \times 10^{-27}\ \mathrm{kg}$

30 *Index of units*

Table 1.2 Conversion of standard millimetres of mercury to millibars *

Conversion des millimètres de mercure normaux en millibars *

$(mm\ Hg)_n$	0	1	2	3	4	5	6	7	8	9
	mb	mb	mb	mb	mb	mb	mb	mb	mb	mb.
0	0.00	1.33	2.67	4.00	5.33	6.67	8.00	9.33	10.67	12.00
10	13.33	14.67	16.00	17.33	18.67	20.00	21.33	22.66	24.00	25.33
20	26.66	28.00	29.33	30.66	32.00	33.33	34.66	36.00	37.33	38.66
30	40.00	41.33	42.66	44.00	45.33	46.66	48.00	49.33	50.66	52.00
40	53.33	54.66	56.00	57.33	58.66	60.00	61.33	62.66	63.99	65.33
50	66.66	67.99	69.33	70.66	71.99	73.33	74.66	75.99	77.33	78.66
60	79.99	81.33	82.66	83.99	85.33	86.66	87.99	89.33	90.66	91.99
70	93.33	94.66	95.99	97.33	98.66	99.99	101.33	102.66	103.99	105.32
80	106.66	107.99	109.32	110.66	111.99	113.32	114.66	115.99	117.32	118.66
90	119.99	121.32	122.66	123.99	125.32	126.66	127.99	129.32	130.66	131.99
100	133.32	134.66	135.99	137.32	138.66	139.99	141.32	142.65	143.99	145.32
110	146.65	147.99	149.32	150.65	151.99	153.32	154.65	155.99	157.32	158.65
120	159.99	161.32	162.65	163.99	165.32	166.65	167.99	169.32	170.65	171.99
130	173.32	174.65	175.99	177.32	178.65	179.99	181.32	182.65	183.98	185.32
140	186.65	187.98	189.32	190.65	191.98	193.32	194.65	195.98	197.32	198.65
150	199.98	201.32	202.65	203.98	205.32	206.65	207.98	209.32	210.65	211.98
160	213.32	214.65	215.98	217.32	218.65	219.98	221.32	222.65	223.98	225.31
170	226.65	227.98	229.31	230.65	231.98	233.31	234.65	235.98	237.31	238.65
180	239.98	241.31	242.65	243.98	245.31	246.65	247.98	249.31	250.65	251.98
190	253.31	254.65	255.98	257.31	258.65	259.98	261.31	262.65	263.98	265.31
200	266.64	267.98	269.31	270.64	271.98	273.31	274.64	275.98	277.31	278.64
210	279.98	281.31	282.64	283.98	285.31	286.64	287.98	289.31	290.64	291.98
220	293.31	294.64	295.98	297.31	298.64	299.98	301.31	302.64	303.98	305.31
230	306.64	307.97	309.31	310.64	311.97	313.31	314.64	315.97	317.31	318.64
240	319.97	321.31	322.64	323.97	325.31	326.64	327.97	329.31	330.64	331.97
250	333.31	334.64	335.97	337.31	338.64	339.97	341.31	342.64	343.97	345.31
260	346.64	347.97	349.30	350.64	351.97	353.30	354.64	355.97	357.30	358.64
270	359.97	361.30	362.64	363.97	365.30	366.64	367.97	369.30	370.64	371.97
280	373.30	374.64	375.97	377.30	378.64	379.97	381.30	382.64	383.97	385.30
290	386.63	387.97	389.30	390.63	391.97	393.30	394.63	395.97	397.30	398.63
300	399.97	401.30	402.63	403.97	405.30	406.63	407.97	409.30	410.63	411.97
310	413.30	414.63	415.97	417.30	418.63	419.97	421.30	422.63	423.97	425.30
320	426.63	427.96	429.30	430.63	431.96	433.30	434.63	435.96	437.30	438.63
330	439.96	441.30	442.63	443.96	445.30	446.63	447.96	449.30	450.63	451.96
340	453.30	454.63	455.96	457.30	458.63	459.96	461.30	462.63	463.96	465.30
350	466.63	467.96	469.29	470.63	471.96	473.29	474.63	475.96	477.29	478.63
360	479.96	481.29	482.63	483.96	485.29	486.63	487.96	489.29	490.63	491.96
370	493.29	494.63	495.96	497.29	498.63	499.96	501.29	502.63	503.96	505.29
380	506.63	507.96	509.29	510.62	511.96	513.29	514.62	515.96	517.29	518.62
390	519.96	521.29	522.62	523.96	525.29	526.62	527.96	529.29	530.62	531.96
400	533.29	534.62	535.96	537.29	538.62	539.96	541.29	542.62	543.96	545.29
410	546.62	547.96	549.29	550.62	551.95	553.29	554.62	555.95	557.29	558.62
420	559.95	561.29	562.62	563.95	565.29	566.62	567.95	569.29	570.62	571.95
430	573.29	574.62	575.95	577.29	578.62	579.95	581.29	582.62	583.95	585.29
440	586.62	587.95	589.29	590.62	591.95	593.28	594.62	595.95	597.28	598.62
450	599.95	601.28	602.62	603.95	605.28	606.62	607.95	609.28	610.62	611.95
460	613.28	614.62	615.95	617.28	618.62	619.95	621.28	622.62	623.95	625.28
470	626.62	627.95	629.28	630.61	631.95	633.28	634.61	635.95	637.28	638.61
480	639.95	641.28	642.61	643.95	645.28	646.61	647.95	649.28	650.61	651.95
490	653.28	654.61	655.95	657.28	658.61	659.95	661.28	662.61	663.95	665.28
500	666.61	667.95	669.28	670.61	671.94	673.28	674.61	675.94	677.28	678.61

$(mm\ Hg)_n$	.1	.2	.3	.4	.5	.6	.7	.8	.9
mb	.13	.27	.40	.53	.67	.80	.93	1.07	1.20

* Reproduced from — *reproduit de* — SMT 11
1 $(mm\ Hg)_n$ = 1.333224 mb (Table 3.8.1 — section (3) b).

TABLE 1.2 — 2

	.0 mb	.1 mb	.2 mb	.3 mb	.4 mb	.5 mb	.6 mb	.7 mb	.8 mb	.9 mb
500	666.61	666.75	666.88	667.01	667.15	667.28	667.41	667.55	667.68	667.81
501	667.95	668.08	668.21	668.35	668.48	668.61	668.75	668.88	669.01	669.15
502	669.28	669.41	669.55	669.68	669.81	669.95	670.08	670.21	670.35	670.48
503	670.61	670.74	670.88	671.01	671.14	671.28	671.41	671.54	671.68	671.81
504	671.94	672.08	672.21	672.34	672.48	672.61	672.74	672.88	673.01	673.14
505	673.28	673.41	673.54	673.68	673.81	673.94	674.08	674.21	674.34	674.48
506	674.61	674.74	674.88	675.01	675.14	675.28	675.41	675.54	675.68	675.81
507	675.94	676.08	676.21	676.34	676.48	676.61	676.74	676.88	677.01	677.14
508	677.28	677.41	677.54	677.68	677.81	677.94	678.08	678.21	678.34	678.48
509	678.61	678.74	678.88	679.01	679.14	679.28	679.41	679.54	679.68	679.81
510	679.94	680.08	680.21	680.34	680.48	680.61	680.74	680.88	681.01	681.14
511	681.28	681.41	681.54	681.68	681.81	681.94	682.08	682.21	682.34	682.48
512	682.61	682.74	682.88	683.01	683.14	683.28	683.41	683.54	683.68	683.81
513	683.94	684.08	684.21	684.34	684.48	684.61	684.74	684.88	685.01	685.14
514	685.28	685.41	685.54	685.68	685.81	685.94	686.08	686.21	686.34	686.48
515	686.61	686.74	686.88	687.01	687.14	687.28	687.41	687.54	687.68	687.81
516	687.94	688.08	688.21	688.34	688.48	688.61	688.74	688.88	689.01	689.14
517	689.28	689.41	689.54	689.68	689.81	689.94	690.08	690.21	690.34	690.48
518	690.61	690.74	690.88	691.01	691.14	691.28	691.41	691.54	691.68	691.81
519	691.94	692.08	692.21	692.34	692.48	692.61	692.74	692.88	693.01	693.14
520	693.28	693.41	693.54	693.68	693.81	693.94	694.08	694.21	694.34	694.48
521	694.61	694.74	694.88	695.01	695.14	695.28	695.41	695.54	695.68	695.81
522	695.94	696.08	696.21	696.34	696.48	696.61	696.74	696.88	697.01	697.14
523	697.28	697.41	697.54	697.68	697.81	697.94	698.08	698.21	698.34	698.48
524	698.61	698.74	698.88	699.01	699.14	699.28	699.41	699.54	699.68	699.81
525	699.94	700.08	700.21	700.34	700.48	700.61	700.74	700.88	701.01	701.14
526	701.28	701.41	701.54	701.68	701.81	701.94	702.08	702.21	702.34	702.48
527	702.61	702.74	702.88	703.01	703.14	703.28	703.41	703.54	703.68	703.81
528	703.94	704.08	704.21	704.34	704.48	704.61	704.74	704.88	705.01	705.14
529	705.28	705.41	705.54	705.68	705.81	705.94	706.08	706.21	706.34	706.48
530	706.61	706.74	706.88	707.01	707.14	707.28	707.41	707.54	707.68	707.81
531	707.94	708.08	708.21	708.34	708.48	708.61	708.74	708.88	709.01	709.14
532	709.28	709.41	709.54	709.68	709.81	709.94	710.08	710.21	710.34	710.48
533	710.61	710.74	710.88	711.01	711.14	711.28	711.41	711.54	711.67	711.81
534	711.94	712.07	712.21	712.34	712.47	712.61	712.74	712.87	713.01	713.14
535	713.27	713.41	713.54	713.67	713.81	713.94	714.07	714.21	714.34	714.47
536	714.61	714.74	714.87	715.01	715.14	715.27	715.41	715.54	715.67	715.81
537	715.94	716.07	716.21	716.34	716.47	716.61	716.74	716.87	717.01	717.14
538	717.27	717.41	717.54	717.67	717.81	717.94	718.07	718.21	718.34	718.47
539	718.61	718.74	718.87	719.01	719.14	719.27	719.41	719.54	719.67	719.81
540	719.94	720.07	720.21	720.34	720.47	720.61	720.74	720.87	721.01	721.14
541	721.27	721.41	721.54	721.67	721.81	721.94	722.07	722.21	722.34	722.47
542	722.61	722.74	722.87	723.01	723.14	723.27	723.41	723.54	723.67	723.81
543	723.94	724.07	724.21	724.34	724.47	724.61	724.74	724.87	725.01	725.14
544	725.27	725.41	725.54	725.67	725.81	725.94	726.07	726.21	726.34	726.47
545	726.61	726.74	726.87	727.01	727.14	727.27	727.41	727.54	727.67	727.81
546	727.94	728.07	728.21	728.34	728.47	728.61	728.74	728.87	729.01	729.14
547	729.27	729.41	729.54	729.67	729.81	729.94	730.07	730.21	730.34	730.47
548	730.61	730.74	730.87	731.01	731.14	731.27	731.41	731.54	731.67	731.81
549	731.94	732.07	732.21	732.34	732.47	732.61	732.74	732.87	733.01	733.14
550	733.27	733.41	733.54	733.67	733.81	733.94	734.07	734.21	734.34	734.47

$(mm\ Hg)_n$	.01	.02	.03	.04	.05	.06	.07	.08	.09
mb	.01	.03	.04	.05	.07	.08	.09	.11	.12

$(mm\ Hg)_n$	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
	mb	mb	mb	mb	mb	mb	mb	mb	mb	mb
550	733.27	733.41	733.54	733.67	733.81	733.94	734.07	734.21	734.34	734.47
551	734.61	734.74	734.87	735.01	735.14	735.27	735.41	735.54	735.67	735.81
552	735.94	736.07	736.21	736.34	736.47	736.61	736.74	736.87	737.01	737.14
553	737.27	737.41	737.54	737.67	737.81	737.94	738.07	738.21	738.34	738.47
554	738.61	738.74	738.87	739.01	739.14	739.27	739.41	739.54	739.67	739.81
555	739.94	740.07	740.21	740.34	740.47	740.61	740.74	740.87	741.01	741.14
556	741.27	741.41	741.54	741.67	741.81	741.94	742.07	742.21	742.34	742.47
557	742.61	742.74	742.87	743.01	743.14	743.27	743.41	743.54	743.67	743.81
558	743.94	744.07	744.21	744.34	744.47	744.61	744.74	744.87	745.01	745.14
559	745.27	745.41	745.54	745.67	745.81	745.94	746.07	746.21	746.34	746.47
560	746.61	746.74	746.87	747.01	747.14	747.27	747.41	747.54	747.67	747.81
561	747.94	748.07	748.21	748.34	748.47	748.61	748.74	748.87	749.01	749.14
562	749.27	749.41	749.54	749.67	749.81	749.94	750.07	750.21	750.34	750.47
563	750.61	750.74	750.87	751.01	751.14	751.27	751.41	751.54	751.67	751.81
564	751.94	752.07	752.20	752.34	752.47	752.60	752.74	752.87	753.00	753.14
565	753.27	753.40	753.54	753.67	753.80	753.94	754.07	754.20	754.34	754.47
566	754.60	754.74	754.87	755.00	755.14	755.27	755.40	755.54	755.67	755.80
567	755.94	756.07	756.20	756.34	756.47	756.60	756.74	756.87	757.00	757.14
568	757.27	757.40	757.54	757.67	757.80	757.94	758.07	758.20	758.34	758.47
569	758.60	758.74	758.87	759.00	759.14	759.27	759.40	759.54	759.67	759.80
570	759.94	760.07	760.20	760.34	760.47	760.60	760.74	760.87	761.00	761.14
571	761.27	761.40	761.54	761.67	761.80	761.94	762.07	762.20	762.34	762.47
572	762.60	762.74	762.87	763.00	763.14	763.27	763.40	763.54	763.67	763.80
573	763.94	764.07	764.20	764.34	764.47	764.60	764.74	764.87	765.00	765.14
574	765.27	765.40	765.54	765.67	765.80	765.94	766.07	766.20	766.34	766.47
575	766.60	766.74	766.87	767.00	767.14	767.27	767.40	767.54	767.67	767.80
576	767.94	768.07	768.20	768.34	768.47	768.60	768.74	768.87	769.00	769.14
577	769.27	769.40	769.54	769.67	769.80	769.94	770.07	770.20	770.34	770.47
578	770.60	770.74	770.87	771.00	771.14	771.27	771.40	771.54	771.67	771.80
579	771.94	772.07	772.20	772.34	772.47	772.60	772.74	772.87	773.00	773.14
580	773.27	773.40	773.54	773.67	773.80	773.94	774.07	774.20	774.34	774.47
581	774.60	774.74	774.87	775.00	775.14	775.27	775.40	775.54	775.67	775.80
582	775.94	776.07	776.20	776.34	776.47	776.60	776.74	776.87	777.00	777.14
583	777.27	777.40	777.54	777.67	777.80	777.94	778.07	778.20	778.34	778.47
584	778.60	778.74	778.87	779.00	779.14	779.27	779.40	779.54	779.67	779.80
585	779.94	780.07	780.20	780.34	780.47	780.60	780.74	780.87	781.00	781.14
586	781.27	781.40	781.54	781.67	781.80	781.94	782.07	782.20	782.34	782.47
587	782.60	782.74	782.87	783.00	783.14	783.27	783.40	783.54	783.67	783.80
588	783.94	784.07	784.20	784.34	784.47	784.60	784.74	784.87	785.00	785.14
589	785.27	785.40	785.54	785.67	785.80	785.94	786.07	786.20	786.34	786.47
590	786.60	786.74	786.87	787.00	787.14	787.27	787.40	787.54	787.67	787.80
591	787.94	788.07	788.20	788.34	788.47	788.60	788.74	788.87	789.00	789.14
592	789.27	789.40	789.54	789.67	789.80	789.94	790.07	790.20	790.34	790.47
593	790.60	790.74	790.87	791.00	791.14	791.27	791.40	791.54	791.67	791.80
594	791.94	792.07	792.20	792.34	792.47	792.60	792.73	792.87	793.00	793.13
595	793.27	793.40	793.53	793.67	793.80	793.93	794.07	794.20	794.33	794.47
596	794.60	794.73	794.87	795.00	795.13	795.27	795.40	795.53	795.67	795.80
597	795.93	796.07	796.20	796.33	796.47	796.60	796.73	796.87	797.00	797.13
598	797.27	797.40	797.53	797.67	797.80	797.93	798.07	798.20	798.33	798.47
599	798.60	798.73	798.87	799.00	799.13	799.27	799.40	799.53	799.67	799.80
600	799.93	800.07	800.20	800.33	800.47	800.60	800.73	800.87	801.00	801.13

$(mm\ Hg)_n$	.01	.02	.03	.04	.05	.06	.07	.08	.09
mb	.01	.03	.04	.05	.07	.08	.09	.11	.12

TABLE 1.2 — 4

$(\text{mm Hg})_n$	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
	mb	mb	mb	mb	mb	mb	mb	mb	mb	mb
600	799.93	800.07	800.20	800.33	800.47	800.60	800.73	800.87	801.00	801.13
601	801.27	801.40	801.53	801.67	801.80	801.93	802.07	802.20	802.33	802.47
602	802.60	802.73	802.87	803.00	803.13	803.27	803.40	803.53	803.67	803.80
603	803.93	804.07	804.20	804.33	804.47	804.60	804.73	804.87	805.00	805.13
604	805.27	805.40	805.53	805.67	805.80	805.93	806.07	806.20	806.33	806.47
605	806.60	806.73	806.87	807.00	807.13	807.27	807.40	807.53	807.67	807.80
606	807.93	808.07	808.20	808.33	808.47	808.60	808.73	808.87	809.00	809.13
607	809.27	809.40	809.53	809.67	809.80	809.93	810.07	810.20	810.33	810.47
608	810.60	810.73	810.87	811.00	811.13	811.27	811.40	811.53	811.67	811.80
609	811.93	812.07	812.20	812.33	812.47	812.60	812.73	812.87	813.00	813.13
610	813.27	813.40	813.53	813.67	813.80	813.93	814.07	814.20	814.33	814.47
611	814.60	814.73	814.87	815.00	815.13	815.27	815.40	815.53	815.67	815.80
612	815.93	816.07	816.20	816.33	816.47	816.60	816.73	816.87	817.00	817.13
613	817.27	817.40	817.53	817.67	817.80	817.93	818.07	818.20	818.33	818.47
614	818.60	818.73	818.87	819.00	819.13	819.27	819.40	819.53	819.67	819.80
615	819.93	820.07	820.20	820.33	820.47	820.60	820.73	820.87	821.00	821.13
616	821.27	821.40	821.53	821.67	821.80	821.93	822.07	822.20	822.33	822.47
617	822.60	822.73	822.87	823.00	823.13	823.27	823.40	823.53	823.67	823.80
618	823.93	824.07	824.20	824.33	824.47	824.60	824.73	824.87	825.00	825.13
619	825.27	825.40	825.53	825.67	825.80	825.93	826.07	826.20	826.33	826.47
620	826.60	826.73	826.87	827.00	827.13	827.27	827.40	827.53	827.67	827.80
621	827.93	828.07	828.20	828.33	828.47	828.60	828.73	828.87	829.00	829.13
622	829.27	829.40	829.53	829.67	829.80	829.93	830.07	830.20	830.33	830.47
623	830.60	830.73	830.87	831.00	831.13	831.27	831.40	831.53	831.67	831.80
624	831.93	832.07	832.20	832.33	832.47	832.60	832.73	832.87	833.00	833.13
625	833.27	833.40	833.53	833.66	833.80	833.93	834.06	834.20	834.33	834.46
626	834.60	834.73	834.86	835.00	835.13	835.26	835.40	835.53	835.66	835.80
627	835.93	836.06	836.20	836.33	836.46	836.60	836.73	836.86	837.00	837.13
628	837.26	837.40	837.53	837.66	837.80	837.93	838.06	838.20	838.33	838.46
629	838.60	838.73	838.86	839.00	839.13	839.26	839.40	839.53	839.66	839.80
630	839.93	840.06	840.20	840.33	840.46	840.60	840.73	840.86	841.00	841.13
631	841.26	841.40	841.53	841.66	841.80	841.93	842.06	842.20	842.33	842.46
632	842.60	842.73	842.86	843.00	843.13	843.26	843.40	843.53	843.66	843.80
633	843.93	844.06	844.20	844.33	844.46	844.60	844.73	844.86	845.00	845.13
634	845.26	845.40	845.53	845.66	845.80	845.93	846.06	846.20	846.33	846.46
635	846.60	846.73	846.86	847.00	847.13	847.26	847.40	847.53	847.66	847.80
636	847.93	848.06	848.20	848.33	848.46	848.60	848.73	848.86	849.00	849.13
637	849.26	849.40	849.53	849.66	849.80	849.93	850.06	850.20	850.33	850.46
638	850.60	850.73	850.86	851.00	851.13	851.26	851.40	851.53	851.66	851.80
639	851.93	852.06	852.20	852.33	852.46	852.60	852.73	852.86	853.00	853.13
640	853.26	853.40	853.53	853.66	853.80	853.93	854.06	854.20	854.33	854.46
641	854.60	854.73	854.86	855.00	855.13	855.26	855.40	855.53	855.66	855.80
642	855.93	856.06	856.20	856.33	856.46	856.60	856.73	856.86	857.00	857.13
643	857.26	857.40	857.53	857.66	857.80	857.93	858.06	858.20	858.33	858.46
644	858.60	858.73	858.86	859.00	859.13	859.26	859.40	859.53	859.66	859.80
645	859.93	860.06	860.20	860.33	860.46	860.60	860.73	860.86	861.00	861.13
646	861.26	861.40	861.53	861.66	861.80	861.93	862.06	862.20	862.33	862.46
647	862.60	862.73	862.86	863.00	863.13	863.26	863.40	863.53	863.66	863.80
648	863.93	864.06	864.20	864.33	864.46	864.60	864.73	864.86	865.00	865.13
649	865.26	865.40	865.53	865.66	865.80	865.93	866.06	866.20	866.33	866.46
650	866.60	866.73	866.86	867.00	867.13	867.26	867.40	867.53	867.66	867.80

$(\text{mm Hg})_n$	.01	.02	.03	.04	.05	.06	.07	.08	.09
mb	.01	.03	.04	.05	.07	.08	.09	.11	.12

TABLE 1.2 — 5

$(mm\ Hg)_n$	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
	mb	mb	mb	mb	mb	mb	mb	mb	mb	mb
650	866.60	866.73	866.86	867.00	867.13	867.26	867.40	867.53	867.66	867.80
651	867.93	868.06	868.20	868.33	868.46	868.60	868.73	868.86	869.00	869.13
652	869.26	869.40	869.53	869.66	869.80	869.93	870.06	870.20	870.33	870.46
653	870.60	870.73	870.86	871.00	871.13	871.26	871.40	871.53	871.66	871.80
654	871.93	872.06	872.20	872.33	872.46	872.60	872.73	872.86	873.00	873.13
655	873.26	873.40	873.53	873.66	873.80	873.93	874.06	874.19	874.33	874.46
656	874.59	874.73	874.86	874.99	875.13	875.26	875.39	875.53	875.66	875.79
657	875.93	876.06	876.19	876.33	876.46	876.59	876.73	876.86	876.99	877.13
658	877.26	877.39	877.53	877.66	877.79	877.93	878.06	878.19	878.33	878.46
659	878.59	878.73	878.86	878.99	879.13	879.26	879.39	879.53	879.66	879.79
660	879.93	880.06	880.19	880.33	880.46	880.59	880.73	880.86	880.99	881.13
661	881.26	881.39	881.53	881.66	881.79	881.93	882.06	882.19	882.33	882.46
662	882.59	882.73	882.86	882.99	883.13	883.26	883.39	883.53	883.66	883.79
663	883.93	884.06	884.19	884.33	884.46	884.59	884.73	884.86	884.99	885.13
664	885.26	885.39	885.53	885.66	885.79	885.93	886.06	886.19	886.33	886.46
665	886.59	886.73	886.86	886.99	887.13	887.26	887.39	887.53	887.66	887.79
666	887.93	888.06	888.19	888.33	888.46	888.59	888.73	888.86	888.99	889.13
667	889.26	889.39	889.53	889.66	889.79	889.93	890.06	890.19	890.33	890.46
668	890.59	890.73	890.86	890.99	891.13	891.26	891.39	891.53	891.66	891.79
669	891.93	892.06	892.19	892.33	892.46	892.59	892.73	892.86	892.99	893.13
670	893.26	893.39	893.53	893.66	893.79	893.93	894.06	894.19	894.33	894.46
671	894.59	894.73	894.86	894.99	895.13	895.26	895.39	895.53	895.66	895.79
672	895.93	896.06	896.19	896.33	896.46	896.59	896.73	896.86	896.99	897.13
673	897.26	897.39	897.53	897.66	897.79	897.93	898.06	898.19	898.33	898.46
674	898.59	898.73	898.86	898.99	899.13	899.26	899.39	899.53	899.66	899.79
675	899.93	900.06	900.19	900.33	900.46	900.59	900.73	900.86	900.99	901.13
676	901.26	901.39	901.53	901.66	901.79	901.93	902.06	902.19	902.33	902.46
677	902.59	902.73	902.86	902.99	903.13	903.26	903.39	903.53	903.66	903.79
678	903.93	904.06	904.19	904.33	904.46	904.59	904.73	904.86	904.99	905.13
679	905.26	905.39	905.53	905.66	905.79	905.93	906.06	906.19	906.33	906.46
680	906.59	906.73	906.86	906.99	907.13	907.26	907.39	907.53	907.66	907.79
681	907.93	908.06	908.19	908.33	908.46	908.59	908.73	908.86	908.99	909.13
682	909.26	909.39	909.53	909.66	909.79	909.93	910.06	910.19	910.33	910.46
683	910.59	910.73	910.86	910.99	911.13	911.26	911.39	911.53	911.66	911.79
684	911.93	912.06	912.19	912.33	912.46	912.59	912.73	912.86	912.99	913.13
685	913.26	913.39	913.53	913.66	913.79	913.93	914.06	914.19	914.33	914.46
686	914.59	914.72	914.86	914.99	915.12	915.26	915.39	915.52	915.66	915.79
687	915.92	916.06	916.19	916.32	916.46	916.59	916.72	916.86	916.99	917.12
688	917.26	917.39	917.52	917.66	917.79	917.92	918.06	918.19	918.32	918.46
689	918.59	918.72	918.86	918.99	919.12	919.26	919.39	919.52	919.66	919.79
690	919.92	920.06	920.19	920.32	920.46	920.59	920.72	920.86	920.99	921.12
691	921.26	921.39	921.52	921.66	921.79	921.92	922.06	922.19	922.32	922.46
692	922.59	922.72	922.86	922.99	923.12	923.26	923.39	923.52	923.66	923.79
693	923.92	924.06	924.19	924.32	924.46	924.59	924.72	924.86	924.99	925.12
694	925.26	925.39	925.52	925.66	925.79	925.92	926.06	926.19	926.32	926.46
695	926.59	926.72	926.86	926.99	927.12	927.26	927.39	927.52	927.66	927.79
696	927.92	928.06	928.19	928.32	928.46	928.59	928.72	928.86	928.99	929.12
697	929.26	929.39	929.52	929.66	929.79	929.92	930.06	930.19	930.32	930.46
698	930.59	930.72	930.86	930.99	931.12	931.26	931.39	931.52	931.66	931.79
699	931.92	932.06	932.19	932.32	932.46	932.59	932.72	932.86	932.99	933.12
700	933.26	933.39	933.52	933.66	933.79	933.92	934.06	934.19	934.32	934.46

$(mm\ Hg)_n$	.01	.02	.03	.04	.05	.06	.07	.08	.09
mb	.01	.03	.04	.05	.07	.08	.09	.11	.12

TABLE 1.2 — 6

$(mm\ Hg)_n$	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
	mb	mb	mb	mb	mb	mb	mb	mb	mb	mb
700	933.26	933.39	933.52	933.66	933.79	933.92	934.06	934.19	934.32	934.46
701	934.59	934.72	934.86	934.99	935.12	935.26	935.39	935.52	935.66	935.79
702	935.92	936.06	936.19	936.32	936.46	936.59	936.72	936.86	936.99	937.12
703	937.26	937.39	937.52	937.66	937.79	937.92	938.06	938.19	938.32	938.46
704	938.59	938.72	938.86	938.99	939.12	939.26	939.39	939.52	939.66	939.79
705	939.92	940.06	940.19	940.32	940.46	940.59	940.72	940.86	940.99	941.12
706	941.26	941.39	941.52	941.66	941.79	941.92	942.06	942.19	942.32	942.46
707	942.59	942.72	942.86	942.99	943.12	943.26	943.39	943.52	943.66	943.79
708	943.92	944.06	944.19	944.32	944.46	944.59	944.72	944.86	944.99	945.12
709	945.26	945.39	945.52	945.66	945.79	945.92	946.06	946.19	946.32	946.46
710	946.59	946.72	946.86	946.99	947.12	947.26	947.39	947.52	947.66	947.79
711	947.92	948.06	948.19	948.32	948.46	948.59	948.72	948.86	948.99	949.12
712	949.26	949.39	949.52	949.66	949.79	949.92	950.06	950.19	950.32	950.46
713	950.59	950.72	950.86	950.99	951.12	951.26	951.39	951.52	951.66	951.79
714	951.92	952.06	952.19	952.32	952.46	952.59	952.72	952.86	952.99	953.12
715	953.26	953.39	953.52	953.66	953.79	953.92	954.06	954.19	954.32	954.46
716	954.59	954.72	954.86	954.99	955.12	955.25	955.39	955.52	955.65	955.79
717	955.92	956.05	956.19	956.32	956.45	956.59	956.72	956.85	956.99	957.12
718	957.25	957.39	957.52	957.65	957.79	957.92	958.05	958.19	958.32	958.45
719	958.59	958.72	958.85	958.99	959.12	959.25	959.39	959.52	959.65	959.79
720	959.92	960.05	960.19	960.32	960.45	960.59	960.72	960.85	960.99	961.12
721	961.25	961.39	961.52	961.65	961.79	961.92	962.05	962.19	962.32	962.45
722	962.59	962.72	962.85	962.99	963.12	963.25	963.39	963.52	963.65	963.79
723	963.92	964.05	964.19	964.32	964.45	964.59	964.72	964.85	964.99	965.12
724	965.25	965.39	965.52	965.65	965.79	965.92	966.05	966.19	966.32	966.45
725	966.59	966.72	966.85	966.99	967.12	967.25	967.39	967.52	967.65	967.79
726	967.92	968.05	968.19	968.32	968.45	968.59	968.72	968.85	968.99	969.12
727	969.25	969.39	969.52	969.65	969.79	969.92	970.05	970.19	970.32	970.45
728	970.59	970.72	970.85	970.99	971.12	971.25	971.39	971.52	971.65	971.79
729	971.92	972.05	972.19	972.32	972.45	972.59	972.72	972.85	972.99	973.12
730	973.25	973.39	973.52	973.65	973.79	973.92	974.05	974.19	974.32	974.45
731	974.59	974.72	974.85	974.99	975.12	975.25	975.39	975.52	975.65	975.79
732	975.92	976.05	976.19	976.32	976.45	976.59	976.72	976.85	976.99	977.12
733	977.25	977.39	977.52	977.65	977.79	977.92	978.05	978.19	978.32	978.45
734	978.59	978.72	978.85	978.99	979.12	979.25	979.39	979.52	979.65	979.79
735	979.92	980.05	980.19	980.32	980.45	980.59	980.72	980.85	980.99	981.12
736	981.25	981.39	981.52	981.65	981.79	981.92	982.05	982.19	982.32	982.45
737	982.59	982.72	982.85	982.99	983.12	983.25	983.39	983.52	983.65	983.79
738	983.92	984.05	984.19	984.32	984.45	984.59	984.72	984.85	984.99	985.12
739	985.25	985.39	985.52	985.65	985.79	985.92	986.05	986.19	986.32	986.45
740	986.59	986.72	986.85	986.99	987.12	987.25	987.39	987.52	987.65	987.79
741	987.92	988.05	988.19	988.32	988.45	988.59	988.72	988.85	988.99	989.12
742	989.25	989.39	989.52	989.65	989.79	989.92	990.05	990.19	990.32	990.45
743	990.59	990.72	990.85	990.99	991.12	991.25	991.39	991.52	991.65	991.79
744	991.92	992.05	992.19	992.32	992.45	992.59	992.72	992.85	992.99	993.12
745	993.25	993.39	993.52	993.65	993.79	993.92	994.05	994.19	994.32	994.45
746	994.59	994.72	994.85	994.99	995.12	995.25	995.39	995.52	995.65	995.79
747	995.92	996.05	996.18	996.32	996.45	996.58	996.72	996.85	996.98	997.12
748	997.25	997.38	997.52	997.65	997.78	997.92	998.05	998.18	998.32	998.45
749	998.58	998.72	998.85	998.98	999.12	999.25	999.38	999.52	999.65	999.78
750	999.92	1000.05	1000.18	1000.32	1000.45	1000.58	1000.72	1000.85	1000.98	1001.12

$(mm\ Hg)_n$	.01	.02	.03	.04	.05	.06	.07	.08	.09
mb	.01	.03	.04	.05	.07	.08	.09	.11	.12

TABLE 1.2 — 7

$(mm\ Hg)_n$	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
	mb	mb	mb	mb	mb	mb	mb	mb	mb	mb
750	999.92	1000.05	1000.18	1000.32	1000.45	1000.58	1000.72	1000.85	1000.98	1001.12
751	1001.25	1001.38	1001.52	1001.65	1001.78	1001.92	1002.05	1002.18	1002.32	1002.45
752	1002.58	1002.72	1002.85	1002.98	1003.12	1003.25	1003.38	1003.52	1003.65	1003.78
753	1003.92	1004.05	1004.18	1004.32	1004.45	1004.58	1004.72	1004.85	1004.98	1005.12
754	1005.25	1005.38	1005.52	1005.65	1005.78	1005.92	1006.05	1006.18	1006.32	1006.45
755	1006.58	1006.72	1006.85	1006.98	1007.12	1007.25	1007.38	1007.52	1007.65	1007.78
756	1007.92	1008.05	1008.18	1008.32	1008.45	1008.58	1008.72	1008.85	1008.98	1009.12
757	1009.25	1009.38	1009.52	1009.65	1009.78	1009.92	1010.05	1010.18	1010.32	1010.45
758	1010.58	1010.72	1010.85	1010.98	1011.12	1011.25	1011.38	1011.52	1011.65	1011.78
759	1011.92	1012.05	1012.18	1012.32	1012.45	1012.58	1012.72	1012.85	1012.98	1013.12
760	1013.25	1013.38	1013.52	1013.65	1013.78	1013.92	1014.05	1014.18	1014.32	1014.45
761	1014.58	1014.72	1014.85	1014.98	1015.12	1015.25	1015.38	1015.52	1015.65	1015.78
762	1015.92	1016.05	1016.18	1016.32	1016.45	1016.58	1016.72	1016.85	1016.98	1017.12
763	1017.25	1017.38	1017.52	1017.65	1017.78	1017.92	1018.05	1018.18	1018.32	1018.45
764	1018.58	1018.72	1018.85	1018.98	1019.12	1019.25	1019.38	1019.52	1019.65	1019.78
765	1019.92	1020.05	1020.18	1020.32	1020.45	1020.58	1020.72	1020.85	1020.98	1021.12
766	1021.25	1021.38	1021.52	1021.65	1021.78	1021.92	1022.05	1022.18	1022.32	1022.45
767	1022.58	1022.72	1022.85	1022.98	1023.12	1023.25	1023.38	1023.52	1023.65	1023.78
768	1023.92	1024.05	1024.18	1024.32	1024.45	1024.58	1024.72	1024.85	1024.98	1025.12
769	1025.25	1025.38	1025.52	1025.65	1025.78	1025.92	1026.05	1026.18	1026.32	1026.45
770	1026.58	1026.72	1026.85	1026.98	1027.12	1027.25	1027.38	1027.52	1027.65	1027.78
771	1027.92	1028.05	1028.18	1028.32	1028.45	1028.58	1028.72	1028.85	1028.98	1029.12
772	1029.25	1029.38	1029.52	1029.65	1029.78	1029.92	1030.05	1030.18	1030.32	1030.45
773	1030.58	1030.72	1030.85	1030.98	1031.12	1031.25	1031.38	1031.52	1031.65	1031.78
774	1031.92	1032.05	1032.18	1032.32	1032.45	1032.58	1032.72	1032.85	1032.98	1033.12
775	1033.25	1033.38	1033.52	1033.65	1033.78	1033.92	1034.05	1034.18	1034.32	1034.45
776	1034.58	1034.72	1034.85	1034.98	1035.12	1035.25	1035.38	1035.52	1035.65	1035.78
777	1035.92	1036.05	1036.18	1036.32	1036.45	1036.58	1036.71	1036.85	1036.98	1037.11
778	1037.25	1037.38	1037.51	1037.65	1037.78	1037.91	1038.05	1038.18	1038.31	1038.45
779	1038.58	1038.71	1038.85	1038.98	1039.11	1039.25	1039.38	1039.51	1039.65	1039.78
780	1039.91	1040.05	1040.18	1040.31	1040.45	1040.58	1040.71	1040.85	1040.98	1041.11
781	1041.25	1041.38	1041.51	1041.65	1041.78	1041.91	1042.05	1042.18	1042.31	1042.45
782	1042.58	1042.71	1042.85	1042.98	1043.11	1043.25	1043.38	1043.51	1043.65	1043.78
783	1043.91	1044.05	1044.18	1044.31	1044.45	1044.58	1044.71	1044.85	1044.98	1045.11
784	1045.25	1045.38	1045.51	1045.65	1045.78	1045.91	1046.05	1046.18	1046.31	1046.45
785	1046.58	1046.71	1046.85	1046.98	1047.11	1047.25	1047.38	1047.51	1047.65	1047.78
786	1047.91	1048.05	1048.18	1048.31	1048.45	1048.58	1048.71	1048.85	1048.98	1049.11
787	1049.25	1049.38	1049.51	1049.65	1049.78	1049.91	1050.05	1050.18	1050.31	1050.45
788	1050.58	1050.71	1050.85	1050.98	1051.11	1051.25	1051.38	1051.51	1051.65	1051.78
789	1051.91	1052.05	1052.18	1052.31	1052.45	1052.58	1052.71	1052.85	1052.98	1053.11
790	1053.25	1053.38	1053.51	1053.65	1053.78	1053.91	1054.05	1054.18	1054.31	1054.45
791	1054.58	1054.71	1054.85	1054.98	1055.11	1055.25	1055.38	1055.51	1055.65	1055.78
792	1055.91	1056.05	1056.18	1056.31	1056.45	1056.58	1056.71	1056.85	1056.98	1057.11
793	1057.25	1057.38	1057.51	1057.65	1057.78	1057.91	1058.05	1058.18	1058.31	1058.45
794	1058.58	1058.71	1058.85	1058.98	1059.11	1059.25	1059.38	1059.51	1059.65	1059.78
795	1059.91	1060.05	1060.18	1060.31	1060.45	1060.58	1060.71	1060.85	1060.98	1061.11
796	1061.25	1061.38	1061.51	1061.65	1061.78	1061.91	1062.05	1062.18	1062.31	1062.45
797	1062.58	1062.71	1062.85	1062.98	1063.11	1063.25	1063.38	1063.51	1063.65	1063.78
798	1063.91	1064.05	1064.18	1064.31	1064.45	1064.58	1064.71	1064.85	1064.98	1065.11
799	1065.25	1065.38	1065.51	1065.65	1065.78	1065.91	1066.05	1066.18	1066.31	1066.45
800	1066.58	1066.71	1066.85	1066.98	1067.11	1067.25	1067.38	1067.51	1067.65	1067.78

$(mm\ Hg)_n$	.01	.02	.03	.04	.05	.06	.07	.08	.09
mb	.01	.03	.04	.05	.07	.08	.09	.11	.12

$(mm\ Hg)_n$	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
	mb	mb	mb	mb	mb	mb	mb	mb	mb	mb
800	1066.58	1066.71	1066.85	1066.98	1067.11	1067.25	1067.38	1067.51	1067.65	1067.78
801	1067.91	1068.05	1068.18	1068.31	1068.45	1068.58	1068.71	1068.85	1068.98	1069.11
802	1069.25	1069.38	1069.51	1069.65	1069.78	1069.91	1070.05	1070.18	1070.31	1070.45
803	1070.58	1070.71	1070.85	1070.98	1071.11	1071.25	1071.38	1071.51	1071.65	1071.78
804	1071.91	1072.05	1072.18	1072.31	1072.45	1072.58	1072.71	1072.85	1072.98	1073.11
805	1073.25	1073.38	1073.51	1073.65	1073.78	1073.91	1074.05	1074.18	1074.31	1074.45
806	1074.58	1074.71	1074.85	1074.98	1075.11	1075.25	1075.38	1075.51	1075.65	1075.78
807	1075.91	1076.05	1076.18	1076.31	1076.45	1076.58	1076.71	1076.85	1076.98	1077.11
808	1077.24	1077.38	1077.51	1077.64	1077.78	1077.91	1078.04	1078.18	1078.31	1078.44
809	1078.58	1078.71	1078.84	1078.98	1079.11	1079.24	1079.38	1079.51	1079.64	1079.78
810	1079.91	1080.04	1080.18	1080.31	1080.44	1080.58	1080.71	1080.84	1080.98	1081.11
811	1081.24	1081.38	1081.51	1081.64	1081.78	1081.91	1082.04	1082.18	1082.31	1082.44
812	1082.58	1082.71	1082.84	1082.98	1083.11	1083.24	1083.38	1083.51	1083.64	1083.78
813	1083.91	1084.04	1084.18	1084.31	1084.44	1084.58	1084.71	1084.84	1084.98	1085.11
814	1085.24	1085.38	1085.51	1085.64	1085.78	1085.91	1086.04	1086.18	1086.31	1086.44
815	1086.58	1086.71	1086.84	1086.98	1087.11	1087.24	1087.38	1087.51	1087.64	1087.78
816	1087.91	1088.04	1088.18	1088.31	1088.44	1088.58	1088.71	1088.84	1088.98	1089.11
817	1089.24	1089.38	1089.51	1089.64	1089.78	1089.91	1090.04	1090.18	1090.31	1090.44
818	1090.58	1090.71	1090.84	1090.98	1091.11	1091.24	1091.38	1091.51	1091.64	1091.78
819	1091.91	1092.04	1092.18	1092.31	1092.44	1092.58	1092.71	1092.84	1092.98	1093.11
820	1093.24	1093.38	1093.51	1093.64	1093.78	1093.91	1094.04	1094.18	1094.31	1094.44
821	1094.58	1094.71	1094.84	1094.98	1095.11	1095.24	1095.38	1095.51	1095.64	1095.78
822	1095.91	1096.04	1096.18	1096.31	1096.44	1096.58	1096.71	1096.84	1096.98	1097.11
823	1097.24	1097.38	1097.51	1097.64	1097.78	1097.91	1098.04	1098.18	1098.31	1098.44
824	1098.58	1098.71	1098.84	1098.98	1099.11	1099.24	1099.38	1099.51	1099.64	1099.78
825	1099.91	1100.04	1100.18	1100.31	1100.44	1100.58	1100.71	1100.84	1100.98	1101.11
826	1101.24	1101.38	1101.51	1101.64	1101.78	1101.91	1102.04	1102.18	1102.31	1102.44
827	1102.58	1102.71	1102.84	1102.98	1103.11	1103.24	1103.38	1103.51	1103.64	1103.78
828	1103.91	1104.04	1104.18	1104.31	1104.44	1104.58	1104.71	1104.84	1104.98	1105.11
829	1105.24	1105.38	1105.51	1105.64	1105.78	1105.91	1106.04	1106.18	1106.31	1106.44
830	1106.58	1106.71	1106.84	1106.98	1107.11	1107.24	1107.38	1107.51	1107.64	1107.78
831	1107.91	1108.04	1108.18	1108.31	1108.44	1108.58	1108.71	1108.84	1108.98	1109.11
832	1109.24	1109.38	1109.51	1109.64	1109.78	1109.91	1110.04	1110.18	1110.31	1110.44
833	1110.58	1110.71	1110.84	1110.98	1111.11	1111.24	1111.38	1111.51	1111.64	1111.78
834	1111.91	1112.04	1112.18	1112.31	1112.44	1112.58	1112.71	1112.84	1112.98	1113.11
835	1113.24	1113.38	1113.51	1113.64	1113.78	1113.91	1114.04	1114.18	1114.31	1114.44
836	1114.58	1114.71	1114.84	1114.98	1115.11	1115.24	1115.38	1115.51	1115.64	1115.78
837	1115.91	1116.04	1116.18	1116.31	1116.44	1116.58	1116.71	1116.84	1116.98	1117.11
838	1117.24	1117.38	1117.51	1117.64	1117.78	1117.91	1118.04	1118.17	1118.31	1118.44
839	1118.57	1118.71	1118.84	1118.97	1119.11	1119.24	1119.37	1119.51	1119.64	1119.77
840	1119.91	1120.04	1120.17	1120.31	1120.44	1120.57	1120.71	1120.84	1120.97	1121.11
841	1121.24	1121.37	1121.51	1121.64	1121.77	1121.91	1122.04	1122.17	1122.31	1122.44
842	1122.57	1122.71	1122.84	1122.97	1123.11	1123.24	1123.37	1123.51	1123.64	1123.77
843	1123.91	1124.04	1124.17	1124.31	1124.44	1124.57	1124.71	1124.84	1124.97	1125.11
844	1125.24	1125.37	1125.51	1125.64	1125.77	1125.91	1126.04	1126.17	1126.31	1126.44
845	1126.57	1126.71	1126.84	1126.97	1127.11	1127.24	1127.37	1127.51	1127.64	1127.77
846	1127.91	1128.04	1128.17	1128.31	1128.44	1128.57	1128.71	1128.84	1128.97	1129.11
847	1129.24	1129.37	1129.51	1129.64	1129.77	1129.91	1130.04	1130.17	1130.31	1130.44
848	1130.57	1130.71	1130.84	1130.97	1131.11	1131.24	1131.37	1131.51	1131.64	1131.77
849	1131.91	1132.04	1132.17	1132.31	1132.44	1132.57	1132.71	1132.84	1132.97	1133.11
850	1133.24	1133.37	1133.51	1133.64	1133.77	1133.91	1134.04	1134.17	1134.31	1134.44

$(mm\ Hg)_n$	.01	.02	.03	.04	.05	.06	.07	.08	.09
mb	.01	.03	.04	.05	.07	.08	.09	.11	.12

Table 1.3.1 **Conversion of knots into m s^{-1} and km h^{-1}**
Conversion des nœuds en m s^{-1} *et* km h^{-1}

Knots *nœuds*	m s^{-1}	km h^{-1}	Knots *nœuds*	m s^{-1}	km h^{-1}	Knots *nœuds*	m s^{-1}	km h^{-1}
1	.51	1.85	41	21.09	75.93	81	41.67	150.01
2	1.03	3.70	42	21.61	77.78	82	42.19	151.86
3	1.54	5.56	43	22.12	79.64	83	42.70	153.72
4	2.06	7.41	44	22.64	81.49	84	43.22	155.57
5	2.57	9.26	45	23.15	83.34	85	43.73	157.42
6	3.09	11.11	46	23.67	85.19	86	44.25	159.27
7	3.60	12.96	47	24.18	87.04	87	44.76	161.12
8	4.12	14.82	48	24.70	88.90	88	45.28	162.98
9	4.63	16.67	49	25.21	90.75	89	45.79	164.83
10	5.14	18.52	50	25.72	92.60	90	46.30	166.68
11	5.65	20.37	51	26.23	94.45	91	46.81	168.53
12	6.17	22.22	52	26.75	96.30	92	47.33	170.38
13	6.68	24.08	53	27.26	98.16	93	47.84	172.24
14	7.20	25.93	54	27.78	100.01	94	48.36	174.09
15	7.71	27.78	55	28.29	101.86	95	48.87	175.94
16	8.23	29.63	56	28.81	103.71	96	49.39	177.79
17	8.74	31.48	57	29.32	105.56	97	49.90	179.64
18	9.26	33.34	58	29.84	107.42	98	50.42	181.50
19	9.77	35.19	59	30.35	109.27	99	50.93	183.35
20	10.29	37.04	60	30.87	111.12	100	51.44	185.20
21	10.80	38.89	61	31.38	112.97	200	102.89	370.40
22	11.32	40.74	62	31.90	114.82			
23	11.83	42.60	63	32.41	116.68	300	154.33	555.60
24	12.35	44.45	64	32.93	118.53			
25	12.86	46.30	65	33.44	120.38	400	205.78	740.80
26	13.38	48.15	66	33.96	122.23	500	257.22	926.00
27	13.89	50.00	67	34.47	124.08			
28	14.41	51.86	68	34.99	125.94			
29	14.92	53.71	69	35.50	127.79			
30	15.43	55.56	70	36.01	129.64			
31	15.94	57.41	71	36.52	131.49			
32	16.46	59.26	72	37.04	133.34			
33	16.97	61.12	73	37.55	135.20			
34	17.49	62.97	74	38.17	137.05			
35	18.00	64.82	75	38.58	138.90			
36	18.52	66.67	76	39.10	140.75			
37	19.03	68.52	77	39.61	142.60			
38	19.55	70.38	78	40.13	144.46			
39	20.06	72.23	79	40.64	146.31			
40	20.58	74.08	80	41.16	148.16			

Table 1.3.2 **Conversion of m s^{-1} into knots and km h^{-1}**
Conversion des m s^{-1} *en nœuds et* km h^{-1}

m s^{-1}	Knots *nœuds*	km h^{-1}	m s^{-1}	Knots *nœuds*	km h^{-1}	m s^{-1}	Knots *nœuds*	km h^{-1}
1	1.94	3.6	41	79.69	147.6	81	157.45	291.6
2	3.89	7.2	42	81.64	151.2	82	159.40	295.2
3	5.83	10.8	43	83.58	154.8	83	161.34	298.8
4	7.78	14.4	44	85.53	158.4	84	163.29	302.4
5	9.72	18.0	45	87.47	162.0	85	165.23	306.0
6	11.66	21.6	46	89.41	165.6	86	167.17	309.6
7	13.61	25.2	47	91.36	169.2	87	169.12	313.2
8	15.55	28.8	48	93.30	172.8	88	171.06	316.8
9	17.49	32.4	49	95.24	176.4	89	173.00	320.4
10	19.44	36.0	50	97.19	180.0	90	174.95	324.0
11	21.38	39.6	51	99.13	183.6	91	176.89	327.6
12	23.33	43.2	52	101.08	187.2	92	178.84	331.2
13	25.27	46.8	53	103.02	190.8	93	180.78	334.8
14	27.22	50.4	54	104.97	194.4	94	182.73	338.4
15	29.16	54.0	55	106.91	198.0	95	184.67	342.0
16	31.10	57.6	56	108.85	201.6	96	186.61	345.6
17	33.05	61.2	57	110.80	205.2	97	188.56	349.2
18	34.99	64.8	58	112.74	208.8	98	190.50	352.8
19	36.93	68.4	59	114.68	212.4	99	192.44	356.4
20	38.88	72.0	60	116.63	216.0	100	194.38	360.0
21	40.82	75.6	61	118.57	219.6	200	388.77	720.0
22	42.77	79.2	62	120.52	223.2			
23	44.71	82.8	63	122.46	226.8	300	583.15	1 080.0
24	46.66	86.4	64	124.41	230.4			
25	48.60	90.0	65	126.35	234.0	400	777.54	1 440.0
26	50.54	93.6	66	128.29	237.6	500	971.92	1 800.0
27	52.49	97.2	67	130.24	241.2			
28	54.43	100.8	68	132.18	244.8			
29	56.37	104.4	69	134.12	248.4			
30	58.32	108.0	70	136.07	252.0			
31	60.26	111.6	71	138.01	255.6			
32	62.21	115.2	72	139.96	259.2			
33	64.15	118.8	73	141.90	262.8			
34	66.10	122.4	74	143.85	266.4			
35	68.04	126.0	75	145.79	270.0			
36	69.98	129.6	76	147.73	273.6			
37	71.92	133.2	77	149.68	277.2			
38	73.87	136.8	78	151.62	280.8			
39	75.81	140.4	79	153.56	284.4			
40	77.75	144.0	80	155.51	288.0			

Table 2.2 **Beaufort wind scale**
Echelle anémométrique Beaufort

Beaufort scale *Echelle Beaufort*	Equivalent speeds *Equivalence de vitesse*						
	m s^{-1}					knots *nœuds*	
number *chiffre*	mean *moyenne*	limits *limites*	interval *intervalle*			mean *moyenne*	limits *limites*
			between limits *entre les limites*	lower half *moitié inférieure*	upper half *moitié supérieure*		
0	0.8	0 – 1.3	—	—	0.5	1	0 – 2
1	2.0	1.4 – 2.7	1.3	0.6	0.7	4	3 – 5
2	3.6	2.8 – 4.5	1.7	0.8	0.9	7	6 – 8
3	5.6	4.6 – 6.6	2.0	1.0	1.0	11	9 – 12
4	7.9	6.7 – 8.9	2.2	1.1	1.1	15	13 – 16
5	10.2	9.0 – 11.3	2.3	1.2	1.1	19	17 – 21
6	12.6	11.4 – 13.8	2.4	1.2	1.2	24	22 – 26
7	15.1	13.9 – 16.4	2.5	1.2	1.3	29	27 – 31
8	17.8	16.5 – 19.2	2.7	1.3	1.4	35	32 – 37
9	20.8	19.3 – 22.4	3.1	1.5	1.6	41	38 – 43
10	24.2	22.5 – 26.0	3.5	1.7	1.8	47	44 – 50
11	28.0	26.1 – 30.0	3.9	1.9	2.0	54	51 – 57
12	—	$\geqq$ 30.1	—	2.1	—	—	$\geqq$ 58

Table 2.3.1.1 Geostrophic wind: constant pressure surfaces — Contour interval of 40 gpm — Wind in m sec^{-1}

Vent géostrophique : surfaces à pression constante — Intervalle de géopotentiel de 40 gpm — Vent en m s^{-1}

Contour spacing *Ecartement des isohypses*		Latitude (degrees — *degrés*)															
Degrees of latitude *Degrés de latitude*	km	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
0.6	67	232.1	155.7	117.9	95.4	80.6	70.3	62.7	57.0	52.6	49.2	46.5	44.5	42.9	41.7	40.9	40.5
0.7	78	199.0	133.5	101.0	81.8	69.1	60.2	53.7	48.9	45.1	42.2	39.9	38.1	36.8	35.8	35.1	34.7
0.8	89	174.1	116.8	88.4	71.5	60.5	52.7	47.0	42.8	39.5	36.9	34.9	33.4	32.2	31.3	30.7	30.3
0.9	100	154.8	103.8	78.6	63.6	53.7	46.9	41.8	38.0	35.1	32.8	31.0	29.7	28.6	27.8	27.3	27.0
1.0	111	139.3	93.4	70.7	57.2	48.4	42.2	37.6	34.2	31.6	29.5	27.9	26.7	25.7	25.0	24.6	24.3
1.1	122	126.6	84.9	64.3	52.0	44.0	38.3	34.2	31.1	28.7	26.8	25.4	24.3	23.4	22.8	22.3	22.1
1.2	133	116.1	77.9	58.9	47.7	40.3	35.1	31.4	28.5	26.3	24.6	23.3	22.2	21.4	20.9	20.5	20.2
1.3	144	107.1	71.9	54.4	44.0	37.2	32.4	28.9	26.3	24.3	22.7	21.5	20.5	19.8	19.3	18.9	18.7
1.4	156	99.5	66.7	50.5	40.9	34.5	30.1	26.9	24.4	22.6	21.1	19.9	19.1	18.4	17.9	17.5	17.3
1.5	167	92.9	62.3	47.1	38.2	32.2	28.1	25.1	22.8	21.0	19.7	18.6	17.8	17.2	16.7	16.4	16.2
1.6	178	87.0	58.4	44.2	35.8	30.2	26.4	23.5	21.4	19.7	18.5	17.5	16.7	16.1	15.6	15.3	15.2
1.7	189	81.9	55.0	41.6	33.7	28.5	24.8	22.1	20.1	18.6	17.4	16.4	15.7	15.1	14.7	14.4	14.3
1.8	200	77.4	51.9	39.3	31.8	26.9	23.4	20.9	19.0	17.5	16.4	15.5	14.8	14.3	13.9	13.6	13.5
1.9	211	73.3	49.2	37.2	30.1	25.5	22.2	19.8	18.0	16.6	15.5	14.7	14.0	13.5	13.2	12.9	12.8
2.0	222	69.6	46.7	35.4	28.6	24.2	21.1	18.8	17.1	15.8	14.8	14.0	13.3	12.9	12.5	12.3	12.1
2.1	233	66.3	44.5	33.7	27.3	23.0	20.1	17.9	16.3	15.0	14.1	13.3	12.7	12.3	11.9	11.7	11.6
2.2	245	63.3	42.5	32.1	26.0	22.0	19.2	17.1	15.5	14.4	13.4	12.7	12.1	11.7	11.4	11.2	11.0
2.3	256	60.6	40.6	30.7	24.9	21.0	18.3	16.4	14.9	13.7	12.8	12.1	11.6	11.2	10.9	10.7	10.6
2.4	267	58.0	38.9	29.5	23.8	20.2	17.6	15.7	14.3	13.2	12.3	11.6	11.1	10.7	10.4	10.2	10.1
2.5	278	55.7	37.4	28.3	22.9	19.3	16.9	15.0	13.7	12.6	11.8	11.2	10.7	10.3	10.0	9.8	9.7
2.6	289	53.6	35.9	27.2	22.0	18.6	16.2	14.5	13.2	12.1	11.4	10.7	10.3	9.9	9.6	9.4	9.3
2.7	300	51.6	34.6	26.2	21.2	17.9	15.6	13.9	12.7	11.7	10.9	10.3	9.9	9.5	9.3	9.1	9.0
2.8	311	49.7	33.4	25.3	20.4	17.3	15.1	13.4	12.2	11.3	10.5	10.0	9.5	9.2	8.9	8.8	8.7
2.9	322	48.0	32.2	24.4	19.7	16.7	14.5	13.0	11.8	10.9	10.2	9.6	9.2	8.9	8.6	8.5	8.4
3.0	333	46.4	31.1	23.6	19.1	16.1	14.1	12.5	11.4	10.5	9.8	9.3	8.9	8.6	8.3	8.2	8.1
3.5	389	39.8	26.7	20.2	16.4	13.8	12.0	10.7	9.8	9.0	8.4	8.0	7.6	7.4	7.2	7.0	6.9
4.0	445	34.8	23.4	17.7	14.3	12.1	10.5	9.4	8.6	7.9	7.4	7.0	6.7	6.4	6.3	6.1	6.1
4.5	500	31.0	20.8	15.7	12.7	10.7	9.4	8.4	7.6	7.0	6.6	6.2	5.9	5.7	5.6	5.5	5.4
5.0	556	27.9	18.7	14.1	11.4	9.7	8.4	7.5	6.8	6.3	5.9	5.6	5.3	5.1	5.0	4.9	4.9
6.0	667	23.2	15.6	11.8	9.5	8.1	7.0	6.3	5.7	5.3	4.9	4.7	4.4	4.3	4.2	4.1	4.0
7.0	778	19.9	13.3	10.1	8.2	6.9	6.0	5.4	4.9	4.5	4.2	4.0	3.8	3.7	3.6	3.5	3.5
8.0	889	17.4	11.7	8.8	7.2	6.0	5.3	4.7	4.3	3.9	3.7	3.5	3.3	3.2	3.1	3.1	3.0
9.0	1000	15.5	10.4	7.9	6.4	5.4	4.7	4.2	3.8	3.5	3.3	3.1	3.0	2.9	2.8	2.7	2.7
10.0	1111	13.9	9.3	7.1	5.7	4.8	4.2	3.8	3.4	3.2	3.0	2.8	2.7	2.6	2.5	2.5	2.4

Table 2.3.1.2 **Geostrophic wind : constant pressure surfaces — Contour interval of 40 gpm — Wind in knots**

Vent géostrophique : surfaces à pression constante — Intervalle de géopotentiel de 40 gpm — Vent en nœuds

Contour spacing *Ecartement des isohypses*		Latitude (degrees — *degrés*)															
Degrees of latitude *Degrés de latitude*	km	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
0.6	67	451.2	302.7	229.1	185.4	156.7	136.6	121.9	110.8	102.3	95.7	90.5	86.5	83.4	81.1	79.6	78.7
0.7	78	386.8	259.5	196.4	158.9	134.3	117.1	104.5	95.0	87.7	82.0	77.5	74.1	71.5	69.5	68.2	67.4
0.8	89	338.4	227.0	171.8	139.0	117.5	102.5	91.4	83.1	76.7	71.7	67.9	64.8	62.5	60.8	59.7	59.0
0.9	100	300.8	201.8	152.7	123.6	104.5	91.1	81.3	73.9	68.2	63.8	60.3	57.6	55.6	54.1	53.0	52.4
1.0	111	270.7	181.6	137.5	111.2	94.0	82.0	73.1	66.5	61.4	57.4	54.3	51.9	50.0	48.7	47.7	47.2
1.1	122	246.1	165.1	125.0	101.1	85.5	74.5	66.5	60.4	55.8	52.2	49.3	47.2	45.5	44.2	43.4	42.9
1.2	133	225.6	151.4	114.5	92.7	78.4	68.3	60.9	55.4	51.1	47.8	45.2	43.2	41.7	40.6	39.8	39.3
1.3	144	208.3	139.7	105.7	85.6	72.3	63.0	56.3	51.1	47.2	44.1	41.8	39.9	38.5	37.4	36.7	36.3
1.4	156	193.4	129.7	98.2	79.5	67.2	58.5	52.2	47.5	43.8	41.0	38.8	37.1	35.7	34.8	34.1	33.7
1.5	167	180.5	121.1	91.6	74.2	62.7	54.6	48.8	44.3	40.9	38.3	36.2	34.6	33.4	32.4	31.8	31.5
1.6	178	169.2	113.5	85.9	69.5	58.8	51.2	45.7	41.6	38.4	35.9	33.9	32.4	31.3	30.4	29.8	29.5
1.7	189	159.3	106.8	80.9	65.4	55.3	48.2	43.0	39.1	36.1	33.8	31.9	30.5	29.4	28.6	28.1	27.8
1.8	200	150.4	100.9	76.4	61.8	52.2	45.5	40.6	36.9	34.1	31.9	30.2	28.8	27.8	27.0	26.5	26.2
1.9	211	142.5	95.6	72.3	58.5	49.5	43.1	38.5	35.0	32.3	30.2	28.6	27.3	26.3	25.6	25.1	24.8
2.0	222	135.4	90.8	68.7	55.6	47.0	41.0	36.6	33.2	30.7	28.7	27.1	25.9	25.0	24.3	23.9	23.6
2.1	233	128.9	86.5	65.5	53.0	44.8	39.0	34.8	31.7	29.2	27.3	25.8	24.7	23.8	23.2	22.7	22.5
2.2	245	123.1	82.6	62.5	50.6	42.7	37.3	33.2	30.2	27.9	26.1	24.7	23.6	22.7	22.1	21.7	21.5
2.3	256	117.7	79.0	59.8	48.4	40.9	35.6	31.8	28.9	26.7	25.0	23.6	22.6	21.8	21.2	20.8	20.5
2.4	267	112.8	75.7	57.3	46.3	39.2	34.2	30.5	27.7	25.6	23.9	22.6	21.6	20.8	20.3	19.9	19.7
2.5	278	108.3	72.7	55.0	44.5	37.6	32.8	29.3	26.6	24.5	23.0	21.7	20.7	20.0	19.5	19.1	18.9
2.6	289	104.1	69.9	52.9	42.8	36.2	31.5	28.1	25.6	23.6	22.1	20.9	20.0	19.2	18.7	18.4	18.2
2.7	300	100.3	67.3	50.9	41.2	34.8	30.4	27.1	24.6	22.7	21.3	20.1	19.2	18.5	18.0	17.7	17.5
2.8	311	96.7	64.9	49.1	39.7	33.6	29.3	26.1	23.7	21.9	20.5	19.4	18.5	17.9	17.4	17.0	16.9
2.9	322	93.4	62.6	47.4	38.4	32.4	28.3	25.2	22.9	21.2	19.8	18.7	17.9	17.3	16.8	16.5	16.3
3.0	333	90.2	60.5	45.8	37.1	31.3	27.3	24.4	22.2	20.5	19.1	18.1	17.3	16.7	16.2	15.9	15.7
3.5	389	77.4	51.9	39.3	31.8	26.9	23.4	20.9	19.0	17.5	16.4	15.5	14.8	14.3	13.9	13.6	13.5
4.0	445	67.7	45.4	34.4	27.8	23.5	20.5	18.3	16.6	15.3	14.3	13.6	13.0	12.5	12.2	11.9	11.8
4.5	500	60.2	40.4	30.5	24.7	20.9	18.2	16.3	14.8	13.6	12.8	12.1	11.5	11.1	10.8	10.6	10.5
5.0	556	54.1	36.3	27.5	22.2	18.8	16.4	14.6	13.3	12.3	11.5	10.9	10.4	10.0	9.7	9.5	9.4
6.0	667	45.1	30.3	22.9	18.5	15.7	13.7	12.2	11.1	10.2	9.6	9.0	8.6	8.3	8.1	8.0	7.9
7.0	778	38.7	25.9	19.6	15.9	13.4	11.7	10.4	9.5	8.8	8.2	7.8	7.4	7.1	7.0	6.8	6.7
8.0	889	33.8	22.7	17.2	13.9	11.8	10.2	9.1	8.3	7.7	7.2	6.8	6.5	6.3	6.1	6.0	5.9
9.0	1000	30.1	20.2	15.3	12.4	10.4	9.1	8.1	7.4	6.8	6.4	6.0	5.8	5.6	5.4	5.3	5.2
10.0	1111	27.1	18.2	13.7	11.1	9.4	8.2	7.3	6.6	6.1	5.7	5.4	5.2	5.0	4.9	4.8	4.7

Table 2.3.1.3 **Geostrophic wind : constant pressure surfaces — Contour interval of 60 gpm — Wind in m sec^{-1}**

Vent géostrophique : surfaces à pression constante — Intervalle de géopotentiel de 60 gpm — Vent en m s^{-1}

Contour spacing / *Ecartement des isohypses*		Latitude (degrees — *degrés*)															
Degrees of latitude / *Degrés de latitude*	km	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
0.6	67	348.2	233.6	176.8	143.1	120.9	105.4	94.1	85.5	78.9	73.8	69.8	66.7	64.3	62.6	61.4	60.7
0.7	78	298.4	200.2	151.5	122.6	103.6	90.4	80.6	73.3	67.7	63.3	59.8	57.2	55.2	53.7	52.6	52.0
0.8	89	261.1	175.2	132.6	107.3	90.7	79.1	70.5	64.1	59.2	55.4	52.4	50.0	48.3	46.9	46.0	45.5
0.9	100	232.1	155.7	117.9	95.4	80.6	70.3	62.7	57.0	52.6	49.2	46.5	44.5	42.9	41.7	40.9	40.5
1.0	111	208.9	140.2	106.1	85.8	72.6	63.2	56.4	51.3	47.4	44.3	41.9	40.0	38.6	37.6	36.8	36.4
1.1	122	189.9	127.4	96.4	78.0	66.0	57.5	51.3	46.6	43.1	40.3	38.1	36.4	35.1	34.1	33.5	33.1
1.2	133	174.1	116.8	88.4	71.5	60.5	52.7	47.0	42.8	39.5	36.9	34.9	33.4	32.2	31.3	30.7	30.3
1.3	144	160.7	107.8	81.6	66.0	55.8	48.7	43.4	39.5	36.4	34.1	32.2	30.8	29.7	28.9	28.3	28.0
1.4	156	149.2	100.1	75.8	61.3	51.8	45.2	40.3	36.6	33.8	31.6	29.9	28.6	27.6	26.8	26.3	26.0
1.5	167	139.3	93.4	70.7	57.2	48.4	42.2	37.6	34.2	31.6	29.5	27.9	26.7	25.7	25.0	24.6	24.3
1.6	178	130.6	87.6	66.3	53.6	45.3	39.5	35.3	32.1	29.6	27.7	26.2	25.0	24.1	23.5	23.0	22.8
1.7	189	122.9	82.4	62.4	50.5	42.7	37.2	33.2	30.2	27.9	26.1	24.6	23.5	22.7	22.1	21.7	21.4
1.8	200	116.1	77.9	58.9	47.7	40.3	35.1	31.4	28.5	26.3	24.6	23.3	22.2	21.4	20.9	20.5	20.2
1.9	211	110.0	73.8	55.8	45.2	38.2	33.3	29.7	27.0	24.9	23.3	22.0	21.1	20.3	19.8	19.4	19.2
2.0	222	104.5	70.1	53.0	42.9	36.3	31.6	28.2	25.7	23.7	22.1	20.9	20.0	19.3	18.8	18.4	18.2
2.1	233	99.5	66.7	50.5	40.9	34.5	30.1	26.9	24.4	22.6	21.1	19.9	19.1	18.4	17.9	17.5	17.3
2.2	245	95.0	63.7	48.2	39.0	33.0	28.7	25.7	23.3	21.5	20.1	19.0	18.2	17.5	17.1	16.7	16.6
2.3	256	90.8	60.9	46.1	37.3	31.5	27.5	24.5	22.3	20.6	19.3	18.2	17.4	16.8	16.3	16.0	15.8
2.4	267	87.0	58.4	44.2	35.8	30.2	26.4	23.5	21.4	19.7	18.5	17.5	16.7	16.1	15.6	15.3	15.2
2.5	278	83.6	56.1	42.4	34.3	29.0	25.3	22.6	20.5	18.9	17.7	16.8	16.0	15.4	15.0	14.7	14.6
2.6	289	80.4	53.9	40.8	33.0	27.9	24.3	21.7	19.7	18.2	17.0	16.1	15.4	14.8	14.4	14.2	14.0
2.7	300	77.4	51.9	39.3	31.8	26.9	23.4	20.9	19.0	17.5	16.4	15.5	14.8	14.3	13.9	13.6	13.5
2.8	311	74.6	50.1	37.9	30.7	25.9	22.6	20.2	18.3	16.9	15.8	15.0	14.3	13.8	13.4	13.2	13.0
2.9	322	72.0	48.3	36.6	29.6	25.0	21.8	19.5	17.7	16.3	15.3	14.4	13.8	13.3	13.0	12.7	12.6
3.0	333	69.6	46.7	35.4	28.6	24.2	21.1	18.8	17.1	15.8	14.8	14.0	13.3	12.9	12.5	12.3	12.1
3.5	389	59.7	40.0	30.3	24.5	20.7	18.1	16.1	14.7	13.5	12.7	12.0	11.4	11.0	10.7	10.5	10.4
4.0	445	52.2	35.0	26.5	21.5	18.1	15.8	14.1	12.8	11.8	11.1	10.5	10.0	9.7	9.4	9.2	9.1
4.5	500	46.4	31.1	23.6	19.1	16.1	14.1	12.5	11.4	10.5	9.8	9.3	8.9	8.6	8.3	8.2	8.1
5.0	556	41.8	28.0	21.2	17.2	14.5	12.6	11.3	10.3	9.5	8.9	8.4	8.0	7.7	7.5	7.4	7.3
6.0	667	34.8	23.4	17.7	14.3	12.1	10.5	9.4	8.6	7.9	7.4	7.0	6.7	6.4	6.3	6.1	6.1
7.0	778	29.8	20.0	15.2	12.3	10.4	9.0	8.1	7.3	6.8	6.3	6.0	5.7	5.5	5.4	5.3	5.2
8.0	889	26.1	17.5	13.3	10.7	9.1	7.9	7.1	6.4	5.9	5.5	5.2	5.0	4.8	4.7	4.6	4.6
9.0	1000	23.2	15.6	11.8	9.5	8.1	7.0	6.3	5.7	5.3	4.9	4.7	4.4	4.3	4.2	4.1	4.0
10.0	1111	20.9	14.0	10.6	8.6	7.3	6.3	5.6	5.1	4.7	4.4	4.2	4.0	3.9	3.8	3.7	3.6

Table 2.3.1.4 **Geostrophic wind : constant pressure surfaces — Contour interval of 60 gpm — Wind in knots**
Vent géostrophique : surfaces à pression constante — Intervalle de géopotentiel de 60 gpm — Vent en nœuds

Contour spacing *Ecartement des isohypses*		Latitude (degrees — *degrés*)															
Degrees of latitude *Degrés de latitude*	km	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
0.6	67	676.8	454.1	343.6	278.1	235.1	204.9	182.8	166.2	153.4	143.5	135.7	129.7	125.1	121.7	119.3	118.0
0.7	78	580.1	389.2	294.5	238.4	201.5	175.6	156.7	142.5	131.5	123.0	116.3	111.2	107.2	104.3	102.3	101.1
0.8	89	507.6	340.6	257.7	208.6	176.3	153.7	137.1	124.7	115.1	107.6	101.8	97.3	93.8	91.3	89.5	88.5
0.9	100	451.2	302.7	229.1	185.4	156.7	136.6	121.9	110.8	102.3	95.7	90.5	86.5	83.4	81.1	79.6	78.7
1.0	111	406.1	272.5	206.2	166.9	141.0	122.9	109.7	99.7	92.1	86.1	81.4	77.8	75.0	73.0	71.6	70.8
1.1	122	369.2	247.7	187.4	151.7	128.2	111.8	99.7	90.7	83.7	78.3	74.0	70.7	68.2	66.4	65.1	64.4
1.2	133	338.4	227.0	171.8	139.0	117.5	102.5	91.4	83.1	76.7	71.7	67.9	64.8	62.5	60.8	59.7	59.0
1.3	144	312.4	209.6	158.6	128.4	108.5	94.6	84.4	76.7	70.8	66.2	62.6	59.9	57.7	56.2	55.1	54.5
1.4	156	290.1	194.6	147.3	119.2	100.7	87.8	78.4	71.2	65.8	61.5	58.2	55.6	53.6	52.1	51.1	50.6
1.5	167	270.7	181.6	137.5	111.2	94.0	82.0	73.1	66.5	61.4	57.4	54.3	51.9	50.0	48.7	47.7	47.2
1.6	178	253.8	170.3	128.9	104.3	88.1	76.8	68.6	62.3	57.5	53.8	50.9	48.6	46.9	45.6	44.8	44.2
1.7	189	238.9	160.3	121.3	98.2	83.0	72.3	64.5	58.7	54.1	50.6	47.9	45.8	44.1	42.9	42.1	41.6
1.8	200	225.6	151.4	114.5	92.7	78.4	68.3	60.9	55.4	51.1	47.8	45.2	43.2	41.7	40.6	39.8	39.3
1.9	211	213.7	143.4	108.5	87.8	74.2	64.7	57.7	52.5	48.4	45.3	42.9	41.0	39.5	38.4	37.7	37.3
2.0	222	203.0	136.2	103.1	83.4	70.5	61.5	54.9	49.9	46.0	43.0	40.7	38.9	37.5	36.5	35.8	35.4
2.1	233	193.4	129.7	98.2	79.5	67.2	58.5	52.2	47.5	43.8	41.0	38.8	37.1	35.7	34.8	34.1	33.7
2.2	245	184.6	123.8	93.7	75.8	64.1	55.9	49.9	45.3	41.8	39.1	37.0	35.4	34.1	33.2	32.5	32.2
2.3	256	176.6	118.5	89.6	72.5	61.3	53.5	47.7	43.4	40.0	37.4	35.4	33.8	32.6	31.7	31.1	30.8
2.4	267	169.2	113.5	85.9	69.5	58.8	51.2	45.7	41.6	38.4	35.9	33.9	32.4	31.3	30.4	29.8	29.5
2.5	278	162.4	109.0	82.5	66.7	56.4	49.2	43.9	39.9	36.8	34.4	32.6	31.1	30.0	29.2	28.6	28.3
2.6	289	156.2	104.8	79.3	64.2	54.2	47.3	42.2	38.4	35.4	33.1	31.3	29.9	28.9	28.1	27.5	27.2
2.7	300	150.4	100.9	76.4	61.8	52.2	45.5	40.6	36.9	34.1	31.9	30.2	28.8	27.8	27.0	26.5	26.2
2.8	311	145.0	97.3	73.6	59.6	50.4	43.9	39.2	35.6	32.9	30.7	29.1	27.8	26.8	26.1	25.6	25.3
2.9	322	140.0	94.0	71.1	57.5	48.6	42.4	37.8	34.4	31.7	29.7	28.1	26.8	25.9	25.2	24.7	24.4
3.0	333	135.4	90.8	68.7	55.6	47.0	41.0	36.6	33.2	30.7	28.7	27.1	25.9	25.0	24.3	23.9	23.6
3.5	389	116.0	77.8	58.9	47.7	40.3	35.1	31.3	28.5	26.3	24.6	23.3	22.2	21.4	20.9	20.5	20.2
4.0	445	101.5	68.1	51.5	41.7	35.3	30.7	27.4	24.9	23.0	21.5	20.4	19.5	18.8	18.3	17.9	17.7
4.5	500	90.2	60.5	45.8	37.1	31.3	27.3	24.4	22.2	20.5	19.1	18.1	17.3	16.7	16.2	15.9	15.7
5.0	556	81.2	54.5	41.2	33.4	28.2	24.6	21.9	19.9	18.4	17.2	16.3	15.6	15.0	14.6	14.3	14.2
6.0	667	67.7	45.4	34.4	27.8	23.5	20.5	18.3	16.6	15.3	14.3	13.6	13.0	12.5	12.2	11.9	11.8
7.0	778	58.0	38.9	29.5	23.8	20.1	17.6	15.7	14.2	13.2	12.3	11.6	11.1	10.7	10.4	10.2	10.1
8.0	889	50.8	34.1	25.8	20.9	17.6	15.4	13.7	12.5	11.5	10.8	10.2	9.7	9.4	9.1	9.0	8.8
9.0	1000	45.1	30.3	22.9	18.5	15.7	13.7	12.2	11.1	10.2	9.6	9.0	8.6	8.3	8.1	8.0	7.9
10.0	1111	40.6	27.2	20.6	16.7	14.1	12.3	11.0	10.0	9.2	8.6	8.1	7.8	7.5	7.3	7.2	7.1

Table 2.3.2.1 **Geostrophic wind : constant level surfaces — Isobar interval of 4 mb — Wind in m sec^{-1}**

Vent géostrophique : surfaces à niveau constant — Intervalle de pression de 4 mb — Vent en m s^{-1}

(Air density — *Masse volumique de l'air :* 1 kg m^{-3})

Isobar spacing / *Ecartement des isobares*		Latitude (degrees — *degrés*)															
Degrees of latitude / *Degrés de latitude*	km	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
0.6	67	236.9	158.9	120.3	97.3	82.3	71.7	64.0	58.2	53.7	50.2	47.5	45.4	43.8	42.6	41.8	41.3
0.7	78	203.0	136.2	103.1	83.4	70.5	61.5	54.8	49.9	46.0	43.0	40.7	38.9	37.5	36.5	35.8	35.4
0.8	89	177.6	119.2	90.2	73.0	61.7	53.8	48.0	43.6	40.3	37.7	35.6	34.0	32.8	31.9	31.3	31.0
0.9	100	157.9	105.9	80.2	64.9	54.8	47.8	42.7	38.8	35.8	33.5	31.7	30.3	29.2	28.4	27.8	27.5
1.0	111	142.1	95.4	72.2	58.4	49.4	43.0	38.4	34.9	32.2	30.1	28.5	27.2	26.3	25.5	25.1	24.8
1.1	122	129.2	86.7	65.6	53.1	44.9	39.1	34.9	31.7	29.3	27.4	25.9	24.8	23.9	23.2	22.8	22.5
1.2	133	118.4	79.5	60.1	48.7	41.1	35.9	32.0	29.1	26.8	25.1	23.7	22.7	21.9	21.3	20.9	20.6
1.3	144	109.3	73.3	55.5	44.9	38.0	33.1	29.5	26.8	24.8	23.2	21.9	20.9	20.2	19.7	19.3	19.1
1.4	156	101.5	68.1	51.5	41.7	35.3	30.7	27.4	24.9	23.0	21.5	20.4	19.4	18.8	18.2	17.9	17.7
1.5	167	94.7	63.6	48.1	38.9	32.9	28.7	25.6	23.3	21.5	20.1	19.0	18.2	17.5	17.0	16.7	16.5
1.6	178	88.8	59.6	45.1	36.5	30.8	26.9	24.0	21.8	20.1	18.8	17.8	17.0	16.4	16.0	15.7	15.5
1.7	189	83.6	56.1	42.4	34.3	29.0	25.3	22.6	20.5	19.0	17.7	16.8	16.0	15.4	15.0	14.7	14.6
1.8	200	79.0	53.0	40.1	32.4	27.4	23.9	21.3	19.4	17.9	16.7	15.8	15.1	14.6	14.2	13.9	13.8
1.9	211	74.8	50.2	38.0	30.7	26.0	22.6	20.2	18.4	17.0	15.9	15.0	14.3	13.8	13.4	13.2	13.0
2.0	222	71.1	47.7	36.1	29.2	24.7	21.5	19.2	17.5	16.1	15.1	14.2	13.6	13.1	12.8	12.5	12.4
2.1	233	67.7	45.4	34.4	27.8	23.5	20.5	18.3	16.6	15.3	14.3	13.6	13.0	12.5	12.2	11.9	11.8
2.2	245	64.6	43.3	32.8	26.5	22.4	19.6	17.5	15.9	14.6	13.7	13.0	12.4	11.9	11.6	11.4	11.3
2.3	256	61.8	41.5	31.4	25.4	21.5	18.7	16.7	15.2	14.0	13.1	12.4	11.8	11.4	11.1	10.9	10.8
2.4	267	59.2	39.7	30.1	24.3	20.6	17.9	16.0	14.5	13.4	12.6	11.9	11.3	10.9	10.6	10.4	10.3
2.5	278	56.8	38.1	28.9	23.4	19.7	17.2	15.4	14.0	12.9	12.1	11.4	10.9	10.5	10.2	10.0	9.9
2.6	289	54.7	36.7	27.8	22.5	19.0	16.5	14.8	13.4	12.4	11.6	11.0	10.5	10.1	9.8	9.6	9.5
2.7	300	52.6	35.3	26.7	21.6	18.3	15.9	14.2	12.9	11.9	11.2	10.6	10.1	9.7	9.5	9.3	9.2
2.8	311	50.8	34.1	25.8	20.9	17.6	15.4	13.7	12.5	11.5	10.8	10.2	9.7	9.4	9.1	8.9	8.8
2.9	322	49.0	32.9	24.9	20.1	17.0	14.8	13.2	12.0	11.1	10.4	9.8	9.4	9.1	8.8	8.6	8.5
3.0	333	47.4	31.8	24.1	19.5	16.5	14.3	12.8	11.6	10.7	10.0	9.5	9.1	8.8	8.5	8.4	8.3
3.5	389	40.6	27.2	20.6	16.7	14.1	12.3	11.0	10.0	9.2	8.6	8.1	7.8	7.5	7.3	7.2	7.1
4.0	445	35.5	23.8	18.0	14.6	12.3	10.8	9.6	8.7	8.1	7.5	7.1	6.8	6.6	6.4	6.3	6.2
4.5	500	31.6	21.2	16.0	13.0	11.0	9.6	8.5	7.8	7.2	6.7	6.3	6.1	5.8	5.7	5.6	5.5
5.0	556	28.4	19.1	14.4	11.7	9.9	8.6	7.7	7.0	6.4	6.0	5.7	5.4	5.3	5.1	5.0	5.0
6.0	667	23.7	15.9	12.0	9.7	8.2	7.2	6.4	5.8	5.4	5.0	4.7	4.5	4.4	4.3	4.2	4.1
7.0	778	20.3	13.6	10.3	8.3	7.1	6.1	5.5	5.0	4.6	4.3	4.1	3.9	3.8	3.6	3.6	3.5
8.0	889	17.8	11.9	9.0	7.3	6.2	5.4	4.8	4.4	4.0	3.8	3.6	3.4	3.3	3.2	3.1	3.1
9.0	1000	15.8	10.6	8.0	6.5	5.5	4.8	4.3	3.9	3.6	3.3	3.2	3.0	2.9	2.8	2.8	2.8
10.0	1111	14.2	9.5	7.2	5.8	4.9	4.3	3.8	3.5	3.2	3.0	2.8	2.7	2.6	2.6	2.5	2.5

Table 2.3.2.2 **Geostrophic wind : constant level surfaces — Isobar interval of 4 mb — Wind in knots**

Vent géostrophique : surfaces à niveau constant — Intervalle de pression de 4 mb — Vent en nœuds

(Air density — *Masse volumique de l'air :* 1 kg m^{-3})

Isobar spacing *Ecartement des isobares*		Latitude (degrees — *degrés*)															
Degrees of latitude *Degrés de latitude*	km	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
0.6	67	460.4	308.9	233.8	189.2	159.9	139.4	124.4	113.1	104.4	97.6	92.3	88.2	85.1	82.8	81.2	80.3
0.7	78	394.6	264.8	200.4	162.2	137.1	119.5	106.6	96.9	89.5	83.7	79.1	75.6	72.9	70.9	69.6	68.8
0.8	89	345.3	231.7	175.3	141.9	119.9	104.5	93.3	84.8	78.3	73.2	69.2	66.2	63.8	62.1	60.9	60.2
0.9	100	306.9	205.9	155.8	126.1	106.6	92.9	82.9	75.4	69.6	65.1	61.5	58.8	56.7	55.2	54.1	53.5
1.0	111	276.3	185.3	140.3	113.5	95.9	83.6	74.6	67.8	62.6	58.6	55.4	52.9	51.0	49.7	48.7	48.2
1.1	122	251.1	168.5	127.5	103.2	87.2	76.0	67.8	61.7	56.9	53.2	50.4	48.1	46.4	45.1	44.3	43.8
1.2	133	230.2	154.5	116.9	94.6	80.0	69.7	62.2	56.5	52.2	48.8	46.2	44.1	42.5	41.4	40.6	40.1
1.3	144	212.5	142.6	107.9	87.3	73.8	64.3	57.4	52.2	48.2	45.0	42.6	40.7	39.3	38.2	37.5	37.0
1.4	156	197.3	132.4	100.2	81.1	68.5	59.7	53.3	48.5	44.7	41.8	39.6	37.8	36.5	35.5	34.8	34.4
1.5	167	184.2	123.6	93.5	75.7	64.0	55.8	49.8	45.2	41.7	39.0	36.9	35.3	34.0	33.1	32.5	32.1
1.6	178	172.7	115.8	87.7	70.9	60.0	52.3	46.6	42.4	39.1	36.6	34.6	33.1	31.9	31.0	30.4	30.1
1.7	189	162.5	109.0	82.5	66.8	56.4	49.2	43.9	39.9	36.8	34.4	32.6	31.1	30.0	29.2	28.7	28.3
1.8	200	153.5	103.0	77.9	63.1	53.3	46.5	41.5	37.7	34.8	32.5	30.8	29.4	28.4	27.6	27.1	26.8
1.9	211	145.4	97.6	73.8	59.7	50.5	44.0	39.3	35.7	33.0	30.8	29.2	27.9	26.9	26.1	25.6	25.3
2.0	222	138.1	92.7	70.1	56.8	48.0	41.8	37.3	33.9	31.3	29.3	27.7	26.5	25.5	24.8	24.4	24.1
2.1	233	131.5	88.3	66.8	54.1	45.7	39.8	35.5	32.3	29.8	27.9	26.4	25.2	24.3	23.6	23.2	22.9
2.2	245	125.6	84.2	63.8	51.6	43.6	38.0	33.9	30.8	28.5	26.6	25.2	24.1	23.2	22.6	22.1	21.9
2.3	256	120.1	80.6	61.0	49.4	41.7	36.4	32.4	29.5	27.2	25.5	24.1	23.0	22.2	21.6	21.2	20.9
2.4	267	115.1	77.2	58.4	47.3	40.0	34.8	31.1	28.3	26.1	24.4	23.1	22.1	21.3	20.7	20.3	20.1
2.5	278	110.5	74.1	56.1	45.4	38.4	33.5	29.9	27.1	25.0	23.4	22.2	21.2	20.4	19.9	19.5	19.3
2.6	289	106.3	71.3	53.9	43.7	36.9	32.2	28.7	26.1	24.1	22.5	21.3	20.4	19.6	19.1	18.7	18.5
2.7	300	102.3	68.6	51.9	42.0	35.5	31.0	27.6	25.1	23.2	21.7	20.5	19.6	18.9	18.4	18.0	17.8
2.8	311	98.7	66.2	50.1	40.5	34.3	29.9	26.7	24.2	22.4	20.9	19.8	18.9	18.2	17.7	17.4	17.2
2.9	322	95.3	63.9	48.4	39.1	33.1	28.8	25.7	23.4	21.6	20.2	19.1	18.3	17.6	17.1	16.8	16.6
3.0	333	92.1	61.8	46.8	37.8	32.0	27.9	24.9	22.6	20.9	19.5	18.5	17.6	17.0	16.6	16.2	16.1
3.5	389	78.9	53.0	40.1	32.4	27.4	23.9	21.3	19.4	17.9	16.7	15.8	15.1	14.6	14.2	13.9	13.8
4.0	445	69.1	46.3	35.1	28.4	24.0	20.9	18.7	17.0	15.7	14.6	13.8	13.2	12.8	12.4	12.2	12.0
4.5	500	61.4	41.2	31.2	25.2	21.3	18.6	16.6	15.1	13.9	13.0	12.3	11.8	11.3	11.0	10.8	10.7
5.0	556	55.3	37.1	28.1	22.7	19.2	16.7	14.9	13.6	12.5	11.7	11.1	10.6	10.2	9.9	9.7	9.6
6.0	667	46.0	30.9	23.4	18.9	16.0	13.9	12.4	11.3	10.4	9.8	9.2	8.8	8.5	8.3	8.1	8.0
7.0	778	39.5	26.5	20.0	16.2	13.7	11.9	10.7	9.7	8.9	8.4	7.9	7.6	7.3	7.1	7.0	6.9
8.0	889	34.5	23.2	17.5	14.2	12.0	10.5	9.3	8.5	7.8	7.3	6.9	6.6	6.4	6.2	6.1	6.0
9.0	1000	30.7	20.6	15.6	12.6	10.7	9.3	8.3	7.5	7.0	6.5	6.2	5.9	5.7	5.5	5.4	5.4
10.0	1111	27.6	18.5	14.0	11.4	9.6	8.4	7.5	6.8	6.3	5.9	5.5	5.3	5.1	5.0	4.9	4.8

Table 2.3.2.3 **Geostrophic wind : constant level surfaces — Isobar interval of 5 mb — Wind in** m sec^{-1}

Vent géostrophique : surfaces à niveau constant — Intervalle de pression de 5 mb — *Vent en* m s^{-1}

(Air density — *Masse volumique de l'air :* 1 kg m^{-3})

Isobar spacing / *Ecartement des isobares*: Degrees of latitude / *Degrés de latitude*	km	Latitude (degrees — *degrés*) 10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
0.6	67	296.1	198.6	150.3	121.7	102.8	89.6	80.0	72.7	67.1	62.8	59.4	56.7	54.7	53.2	52.2	51.6
0.7	78	253.8	170.3	128.8	104.3	88.1	76.8	68.6	62.3	57.5	53.8	50.9	48.6	46.9	45.6	44.7	44.2
0.8	89	222.1	149.0	112.7	91.2	77.1	67.2	60.0	54.5	50.3	47.1	44.5	42.5	41.0	39.9	39.2	38.7
0.9	100	197.4	132.4	100.2	81.1	68.6	59.8	53.3	48.5	44.7	41.8	39.6	37.8	36.5	35.5	34.8	34.4
1.0	111	177.6	119.2	90.2	73.0	61.7	53.8	48.0	43.6	40.3	37.7	35.6	34.0	32.8	31.9	31.3	31.0
1.1	122	161.5	108.4	82.0	66.4	56.1	48.9	43.6	39.7	36.6	34.2	32.4	30.9	29.8	29.0	28.5	28.2
1.2	133	148.0	99.3	75.2	60.8	51.4	44.8	40.0	36.4	33.6	31.4	29.7	28.4	27.4	26.6	26.1	25.8
1.3	144	136.7	91.7	69.4	56.1	47.5	41.4	36.9	33.6	31.0	29.0	27.4	26.2	25.3	24.6	24.1	23.8
1.4	156	126.9	85.1	64.4	52.1	44.1	38.4	34.3	31.2	28.8	26.9	25.4	24.3	23.4	22.8	22.4	22.1
1.5	167	118.4	79.5	60.1	48.7	41.1	35.9	32.0	29.1	26.8	25.1	23.7	22.7	21.9	21.3	20.9	20.6
1.6	178	111.0	74.5	56.4	45.6	38.6	33.6	30.0	27.3	25.2	23.5	22.3	21.3	20.5	20.0	19.6	19.4
1.7	189	104.5	70.1	53.1	42.9	36.3	31.6	28.2	25.7	23.7	22.2	21.0	20.0	19.3	18.8	18.4	18.2
1.8	200	98.7	66.2	50.1	40.6	34.3	29.9	26.7	24.2	22.4	20.9	19.8	18.9	18.2	17.7	17.4	17.2
1.9	211	93.5	62.7	47.5	38.4	32.5	28.3	25.3	23.0	21.2	19.8	18.7	17.9	17.3	16.8	16.5	16.3
2.0	222	88.8	59.6	45.1	36.5	30.8	26.9	24.0	21.8	20.1	18.8	17.8	17.0	16.4	16.0	15.7	15.5
2.1	233	84.6	56.8	42.9	34.8	29.4	25.6	22.9	20.8	19.2	17.9	17.0	16.2	15.6	15.2	14.9	14.7
2.2	245	80.7	54.2	41.0	33.2	28.0	24.4	21.8	19.8	18.3	17.1	16.2	15.5	14.9	14.5	14.2	14.1
2.3	256	77.2	51.8	39.2	31.7	26.8	23.4	20.9	19.0	17.5	16.4	15.5	14.8	14.3	13.9	13.6	13.5
2.4	267	74.0	49.7	37.6	30.4	25.7	22.4	20.0	18.2	16.8	15.7	14.8	14.2	13.7	13.3	13.1	12.9
2.5	278	71.1	47.7	36.1	29.2	24.7	21.5	19.2	17.5	16.1	15.1	14.2	13.6	13.1	12.8	12.5	12.4
2.6	289	68.3	45.8	34.7	28.1	23.7	20.7	18.5	16.8	15.5	14.5	13.7	13.1	12.6	12.3	12.0	11.9
2.7	300	65.8	44.1	33.4	27.0	22.9	19.9	17.8	16.2	14.9	13.9	13.2	12.6	12.2	11.8	11.6	11.5
2.8	311	63.4	42.6	32.2	26.1	22.0	19.2	17.1	15.6	14.4	13.4	12.7	12.2	11.7	11.4	11.2	11.1
2.9	322	61.3	41.1	31.1	25.2	21.3	18.5	16.5	15.0	13.9	13.0	12.3	11.7	11.3	11.0	10.8	10.7
3.0	333	59.2	39.7	30.1	24.3	20.6	17.9	16.0	14.5	13.4	12.6	11.9	11.3	10.9	10.6	10.4	10.3
3.5	389	50.8	34.1	25.8	20.9	17.6	15.4	13.7	12.5	11.5	10.8	10.2	9.7	9.4	9.1	8.9	8.8
4.0	445	44.4	29.8	22.5	18.2	15.4	13.4	12.0	10.9	10.1	9.4	8.9	8.5	8.2	8.0	7.8	7.7
4.5	500	39.5	26.5	20.0	16.2	13.7	12.0	10.7	9.7	8.9	8.4	7.9	7.6	7.3	7.1	7.0	6.9
5.0	556	35.5	23.8	18.0	14.6	12.3	10.8	9.6	8.7	8.1	7.5	7.1	6.8	6.6	6.4	6.3	6.2
6.0	667	29.6	19.9	15.0	12.2	10.3	9.0	8.0	7.3	6.7	6.3	5.9	5.7	5.5	5.3	5.2	5.2
7.0	778	25.4	17.0	12.9	10.4	8.8	7.7	6.9	6.2	5.8	5.4	5.1	4.9	4.7	4.6	4.5	4.4
8.0	889	22.2	14.9	11.3	9.1	7.7	6.7	6.0	5.5	5.0	4.7	4.5	4.3	4.1	4.0	3.9	3.9
9.0	1000	19.7	13.2	10.0	8.1	6.9	6.0	5.3	4.8	4.5	4.2	4.0	3.8	3.6	3.5	3.5	3.4
10.0	1111	17.8	11.9	9.0	7.3	6.2	5.4	4.8	4.4	4.0	3.8	3.6	3.4	3.3	3.2	3.1	3.1

Table 2.3.2.4 **Geostrophic wind : constant level surfaces — Isobar interval of 5 mb — Wind in knots**

Vent géostrophique : surfaces à niveau constant — Intervalle de pression de 5 mb — *Vent en nœuds*

(Air density — *Masse volumique de l'air :* 1 kg m^{-3})

Isobar spacing *Ecartement des isobares*		Latitude (degrees — *degrés*)															
Degrees of latitude *Degrés de latitude*	km	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
0.6	67	575.5	386.1	292.2	236.5	199.9	174.2	155.5	141.3	130.5	122.0	115.4	110.3	106.4	103.5	101.5	100.3
0.7	78	493.3	331.0	250.5	202.7	171.3	149.3	133.3	121.1	111.8	104.6	98.9	94.5	91.2	88.7	87.0	86.0
0.8	89	431.6	289.6	219.2	177.4	149.9	130.7	116.6	106.0	97.8	91.5	86.6	82.7	79.8	77.6	76.1	75.2
0.9	100	383.7	257.4	194.8	157.7	133.3	116.2	103.7	94.2	87.0	81.3	76.9	73.5	70.9	69.0	67.7	66.9
1.0	111	345.3	231.7	175.3	141.9	119.9	104.5	93.3	84.8	78.3	73.2	69.2	66.2	63.8	62.1	60.9	60.2
1.1	122	313.9	210.6	159.4	129.0	109.0	95.0	84.8	77.1	71.2	66.5	62.9	60.1	58.0	56.4	55.4	54.7
1.2	133	287.8	193.1	146.1	118.2	99.9	87.1	77.7	70.7	65.2	61.0	57.7	55.1	53.2	51.7	50.7	50.2
1.3	144	265.6	178.2	134.9	109.1	92.3	80.4	71.8	65.2	60.2	56.3	53.3	50.9	49.1	47.8	46.8	46.3
1.4	156	246.7	165.5	125.2	101.3	85.7	74.7	66.6	60.6	55.9	52.3	49.5	47.3	45.6	44.3	43.5	43.0
1.5	167	230.2	154.5	116.9	94.6	80.0	69.7	62.2	56.5	52.2	48.8	46.2	44.1	42.5	41.4	40.6	40.1
1.6	178	215.8	144.8	109.6	88.7	75.0	65.3	58.3	53.0	48.9	45.8	43.3	41.4	39.9	38.8	38.1	37.6
1.7	189	203.1	136.3	103.1	83.5	70.5	61.5	54.9	49.9	46.0	43.1	40.7	38.9	37.5	36.5	35.8	35.4
1.8	200	191.8	128.7	97.4	78.8	66.6	58.1	51.8	47.1	43.5	40.7	38.5	36.8	35.5	34.5	33.8	33.4
1.9	211	181.7	121.9	92.3	74.7	63.1	55.0	49.1	44.6	41.2	38.5	36.4	34.8	33.6	32.7	32.0	31.7
2.0	222	172.7	115.8	87.7	70.9	60.0	52.3	46.6	42.4	39.1	36.6	34.6	33.1	31.9	31.0	30.4	30.1
2.1	233	164.4	110.3	83.5	67.6	57.1	49.8	44.4	40.4	37.3	34.9	33.0	31.5	30.4	29.6	29.0	28.7
2.2	245	157.0	105.3	79.7	64.5	54.5	47.5	42.4	38.5	35.6	33.3	31.5	30.1	29.0	28.2	27.7	27.4
2.3	256	150.1	100.7	76.2	61.7	52.1	45.5	40.6	36.9	34.0	31.8	30.1	28.8	27.7	27.0	26.5	26.2
2.4	267	143.9	96.5	73.1	59.1	50.0	43.6	38.9	35.3	32.6	30.5	28.9	27.6	26.6	25.9	25.4	25.1
2.5	278	138.1	92.7	70.1	56.8	48.0	41.8	37.3	33.9	31.3	29.3	27.7	26.5	25.5	24.8	24.4	24.1
2.6	289	132.8	89.1	67.4	54.6	46.1	40.2	35.9	32.6	30.1	28.2	26.6	25.4	24.5	23.9	23.4	23.2
2.7	300	127.9	85.8	64.9	52.6	44.4	38.7	34.6	31.4	29.0	27.1	25.6	24.5	23.6	23.0	22.6	22.3
2.8	311	123.3	82.7	62.6	50.7	42.8	37.3	33.3	30.3	28.0	26.1	24.7	23.6	22.8	22.2	21.7	21.5
2.9	322	119.1	79.9	60.5	48.9	41.4	36.0	32.2	29.2	27.0	25.2	23.9	22.8	22.0	21.4	21.0	20.8
3.0	333	115.1	77.2	58.4	47.3	40.0	34.8	31.1	28.3	26.1	24.4	23.1	22.1	21.3	20.7	20.3	20.1
3.5	389	98.7	66.2	50.1	40.5	34.3	29.9	26.7	24.2	22.4	20.9	19.8	18.9	18.2	17.7	17.4	17.2
4.0	445	86.3	57.9	43.8	35.5	30.0	26.1	23.3	21.2	19.6	18.3	17.3	16.5	16.0	15.5	15.2	15.0
4.5	500	76.7	51.5	39.0	31.5	26.7	23.2	20.7	18.8	17.4	16.3	15.4	14.7	14.2	13.8	13.5	13.4
5.0	556	69.1	46.3	35.1	28.4	24.0	20.9	18.7	17.0	15.7	14.6	13.8	13.2	12.8	12.4	12.2	12.0
6.0	667	57.6	38.6	29.2	23.6	20.0	17.4	15.5	14.1	13.0	12.2	11.5	11.0	10.6	10.3	10.1	10.0
7.0	778	49.3	33.1	25.0	20.3	17.1	14.9	13.3	12.1	11.2	10.5	9.9	9.5	9.1	8.9	8.7	8.6
8.0	889	43.2	29.0	21.9	17.7	15.0	13.1	11.7	10.6	9.8	9.2	8.7	8.3	8.0	7.8	7.6	7.5
9.0	1000	38.4	25.7	19.5	15.8	13.3	11.6	10.4	9.4	8.7	8.1	7.7	7.4	7.1	6.9	6.8	6.7
10.0	1111	34.5	23.2	17.5	14.2	12.0	10.5	9.3	8.5	7.8	7.3	6.9	6.6	6.4	6.2	6.1	6.0

Table 2.4.1.1 **Gradient wind — *rf* parameter in** m sec^{-1}
Vent du gradient — Paramètre rf en m s^{-1}

Radius of curvature *r* / *Rayon de courbure r*		Latitude (degrees — *degrés*)															
Degrees of latitude / *Degrés de latitude*	km	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
1	111	3	4	6	7	8	9	10	11	12	13	14	15	15	16	16	16
2	222	6	8	11	14	16	19	21	23	25	27	28	29	30	31	32	32
3	333	8	13	17	21	24	28	31	34	37	40	42	44	46	47	48	48
4	445	11	17	22	27	32	37	42	46	50	53	56	59	61	63	64	65
5	556	14	21	28	34	41	46	52	57	62	66	70	73	76	78	80	81
6	667	17	25	33	41	49	56	63	69	74	80	84	88	91	94	96	97
7	778	20	29	39	48	57	65	73	80	87	93	98	103	107	110	112	113
8	889	23	34	44	55	65	74	83	92	99	106	112	118	122	125	128	129
9	1000	25	38	50	62	73	84	94	103	112	119	126	132	137	141	144	145
10	1111	28	42	55	68	81	93	104	115	124	133	140	147	152	157	160	161
11	1223	31	46	61	75	89	102	115	126	137	146	154	162	168	172	176	178
12	1334	34	50	67	82	97	112	125	138	149	159	168	176	183	188	192	194
13	1445	37	55	72	89	105	121	135	149	161	173	182	191	198	204	208	210
14	1556	39	59	78	96	113	130	146	160	174	186	197	206	213	219	223	226
15	1667	42	63	83	103	122	139	156	172	186	199	211	220	228	235	239	242
16	1778	45	67	89	110	130	149	167	183	199	212	225	235	244	250	255	258
17	1889	48	71	94	116	138	158	177	195	211	226	239	250	259	266	271	274
18	2000	51	76	100	123	146	167	188	206	223	239	253	264	274	282	287	291
19	2112	53	80	105	130	154	177	198	218	236	252	267	279	289	297	303	307
20	2223	56	84	111	137	162	186	208	229	248	266	281	294	305	313	319	323
25	2778	70	105	139	171	203	232	260	287	310	332	351	367	381	391	399	404
30	3334	84	126	166	205	243	279	313	344	372	398	421	441	457	470	479	484

Table 2.4.1.2 **Gradient wind — rf parameter in knots**
Vent du gradient — Paramètre rf en nœuds

Radius of curvature r / *Rayon de courbure r*		Latitude (degrees — *degrés*)															
Degrees of latitude / *Degrés de latitude*	km	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
1	111	5	8	11	13	16	18	20	22	24	26	27	29	30	30	31	31
2	222	11	16	22	27	32	36	41	45	48	52	55	57	59	61	62	63
3	333	16	24	32	40	47	54	61	67	72	77	82	86	89	91	93	94
4	445	22	33	43	53	63	72	81	89	97	103	109	114	118	122	124	126
5	556	27	41	54	67	79	90	101	111	121	129	136	143	148	152	155	157
6	667	33	49	65	80	95	108	122	134	145	155	164	171	178	183	186	188
7	778	38	57	75	93	110	127	142	156	169	181	191	200	207	213	217	220
8	889	44	65	86	107	126	145	162	178	193	206	218	228	237	243	248	251
9	1000	49	73	97	120	142	163	182	201	217	232	246	257	266	274	279	282
10	1111	55	82	108	133	158	181	203	223	241	258	273	286	296	304	310	314
11	1223	60	90	119	146	173	199	223	245	265	284	300	314	326	335	341	345
12	1334	66	98	129	160	189	217	243	267	290	310	327	343	355	365	372	377
13	1445	71	106	140	173	205	235	263	290	314	336	355	371	385	396	403	408
14	1556	77	114	151	186	221	253	284	312	338	361	382	400	414	426	434	439
15	1667	82	122	162	200	236	271	304	334	362	387	409	428	444	456	465	471
16	1778	88	130	172	213	252	289	324	356	386	413	437	457	474	487	496	502
17	1889	93	139	183	226	268	307	344	379	410	439	464	485	503	517	527	534
18	2000	98	147	194	240	284	325	365	401	434	465	491	514	533	548	559	565
19	2112	104	155	205	253	299	343	385	423	459	490	518	543	563	578	590	596
20	2223	109	163	216	266	315	361	405	446	483	516	546	571	592	609	621	628
25	2778	137	204	269	333	394	452	506	557	603	645	682	714	740	761	776	785
30	3334	164	245	323	399	473	542	608	668	724	774	819	857	888	913	931	942

Table 2.4.2.1 **Gradient wind (dimensionless) — Cyclonic curvature**
Vent du gradient (sans dimension) — Courbure cyclonique

Geostrophic wind / *Vent géostrophique* V_g	*rf* parameter / *Paramètre rf*																								
	4	6	8	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	200	300	400	500	600	700	800
5	3	3	3	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
10	5	5	6	6	7	8	8	9	9	9	9	9	9	9	9	9	9	9	10	10	10	10	10	10	10
15	6	7	8	8	10	11	12	12	12	13	13	13	13	13	13	14	14	14	14	14	14	15	15	15	15
20	7	8	9	10	12	14	15	15	16	16	17	17	17	17	17	18	18	18	18	19	19	19	19	19	20
25	8	10	11	12	14	16	17	18	19	20	20	20	21	21	21	21	22	22	22	23	24	24	24	24	24
30	9	11	12	13	16	19	20	21	22	23	23	24	24	25	25	25	25	26	26	27	28	28	29	29	29
35	10	12	13	14	18	21	22	24	25	26	26	27	27	28	28	29	29	29	30	32	32	33	33	33	34
40	11	13	14	16	20	23	25	26	27	28	29	30	31	31	32	32	32	33	34	36	37	37	38	38	38
45	12	14	15	17	22	25	27	29	30	31	32	33	34	34	35	35	36	36	38	40	41	42	42	42	43
50	12	15	16	18	23	27	29	31	32	34	35	36	37	37	38	39	39	40	41	44	45	46	46	47	47
55	13	15	17	19	25	28	31	33	35	36	37	39	39	40	41	42	42	43	45	47	49	50	51	51	52
60	14	16	18	20	26	30	33	35	37	39	40	41	42	43	44	45	45	46	48	51	53	54	55	56	56
65	14	17	19	21	27	32	35	37	39	41	42	44	45	46	47	48	48	49	52	55	57	58	59	60	60
70	15	18	20	22	29	33	37	39	41	43	45	46	47	49	50	50	51	52	55	59	61	62	63	64	65
75	15	18	21	23	30	35	38	41	43	45	47	49	50	51	52	53	54	55	58	62	65	66	67	68	69
80	16	19	22	24	31	36	40	43	45	48	49	51	52	54	55	56	57	58	61	66	68	70	71	72	73
85	17	20	22	25	32	38	42	45	47	50	52	53	55	56	57	59	60	61	64	69	72	74	75	77	77
90	17	20	23	25	34	39	43	47	49	52	54	56	57	59	60	61	62	63	67	72	76	78	79	81	82
95	18	21	24	26	35	40	45	48	51	54	56	58	60	61	62	64	65	66	70	76	79	82	83	85	86
100	18	22	25	27	36	42	46	50	53	56	58	60	62	63	65	66	67	69	73	79	83	85	87	89	90
110	19	23	26	29	38	44	49	53	57	59	62	64	66	68	70	71	72	74	79	86	90	93	95	97	98
120	20	24	27	30	40	47	52	56	60	63	66	68	70	72	74	76	77	79	84	92	97	100	102	104	106
130	21	25	28	31	42	49	55	59	63	67	70	72	74	77	79	80	82	84	90	98	103	107	110	112	114
140	22	26	30	33	44	52	57	62	66	70	73	76	78	81	83	85	87	88	95	104	110	114	117	120	122
150	23	27	31	34	46	54	60	65	69	73	77	80	82	85	87	89	91	93	100	110	116	121	124	127	129
160	23	28	32	35	47	56	62	68	72	76	80	83	86	89	91	93	95	97	105	116	122	127	131	134	137
170	24	29	33	37	49	58	65	71	75	80	83	87	90	92	95	97	99	101	110	121	129	134	138	141	144
180	25	30	34	38	51	60	67	73	78	83	86	90	93	96	99	101	103	106	114	127	135	141	145	148	151
190	26	31	35	39	52	62	69	76	81	86	90	93	97	100	102	105	107	110	119	132	141	147	152	155	159
200	26	32	36	40	54	64	72	78	84	88	93	97	100	103	106	109	111	114	124	137	146	153	158	162	166
250	30	36	41	45	61	73	82	90	96	102	107	112	116	120	123	127	130	133	145	162	174	183	190	195	200
300	33	40	45	50	68	81	91	100	107	114	120	125	130	135	139	143	147	150	165	185	200	211	220	227	232

Table 2.4.2.2 **Gradient wind (dimensionless) — Anticyclonic curvature**

Vent du gradient (sans dimension) — Courbure anticyclonique

Geostrophic wind / *Vent géostrophique* / V_g	rf parameter / *Paramètre rf*																								
	4	6	8	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	200	300	400	500	600	700	800
5					10	6	6	6	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
10							20	14	13	12	12	11	11	11	11	11	11	11	11	10	10	10	10	10	10
15									30	22	20	19	18	18	18	17	17	17	16	16	16	15	15	15	15
20											40	30	28	26	25	25	24	24	23	22	21	21	21	21	21
25													50	38	36	34	33	32	29	28	27	26	26	26	26
30															60	47	44	41	37	34	33	32	32	31	31
35																	70	56	45	40	39	38	37	37	37
40																			55	48	45	44	43	43	42
45																			68	55	52	50	49	48	48
50																			100	63	59	56	55	54	54
55																				73	66	63	61	60	59
60																				83	74	70	68	66	65
65																				95	82	77	74	73	71
70																				111	90	84	81	79	78
75																				150	100	92	88	85	84
80																					111	100	95	92	90
85																					123	109	103	99	97
90																					137	118	110	106	103
95																					155	128	118	113	110
100																					200	138	127	121	117
110																						163	145	137	132
120																						200	166	154	147
130																							190	173	163
140																							223	193	181
150																							300	218	200
160																								248	221
170																								291	245
180																									274
190																									311
200																									400

Table 2.5 **Coriolis parameter and Rossby parameter**
Paramètre de Coriolis et paramètre de Rossby

φ: latitude in degrees — *latitude en degrés*
f: Coriolis parameter in rad sec^{-1} — *paramètre de Coriolis en* rad s^{-1}
β: Rossby parameter in rad m^{-1} sec^{-1} — *paramètre de Rossby en* rad m^{-1} s^{-1}

φ	f	β	φ	f	β	φ	f	β
	$\times 10^{-4}$	$\times 10^{-11}$		$\times 10^{-4}$	$\times 10^{-11}$		$\times 10^{-4}$	$\times 10^{-11}$
0	0.	2.289	30	0.7292	1.982	60	1.2630	1.145
1	0.0255	2.289	31	0.7511	1.962	61	1.2756	1.110
2	0.0509	2.288	32	0.7728	1.941	62	1.2877	1.075
3	0.0763	2.286	33	0.7943	1.920	63	1.2995	1.039
4	0.1017	2.284	34	0.8155	1.898	64	1.3108	1.003
5	0.1271	2.280	35	0.8365	1.875	65	1.3218	0.967
6	0.1524	2.277	36	0.8572	1.852	66	1.3323	0.931
7	0.1777	2.272	37	0.8777	1.828	67	1.3425	0.894
8	0.2030	2.267	38	0.8979	1.804	68	1.3522	0.858
9	0.2281	2.261	39	0.9178	1.779	69	1.3616	0.820
10	0.2533	2.254	40	0.9375	1.754	70	1.3705	0.783
11	0.2783	2.247	41	0.9568	1.728	71	1.3790	0.745
12	0.3032	2.239	42	0.9759	1.701	72	1.3870	0.707
13	0.3281	2.230	43	0.9946	1.674	73	1.3947	0.669
14	0.3528	2.221	44	1.0131	1.647	74	1.4019	0.631
15	0.3775	2.211	45	1.0313	1.619	75	1.4087	0.592
16	0.4020	2.200	46	1.0491	1.590	76	1.4151	0.554
17	0.4264	2.189	47	1.0666	1.561	77	1.4210	0.515
18	0.4507	2.177	48	1.0838	1.532	78	1.4266	0.476
19	0.4748	2.164	49	1.1007	1.502	79	1.4316	0.437
20	0.4988	2.151	50	1.1172	1.471	80	1.4363	0.397
21	0.5227	2.137	51	1.1334	1.441	81	1.4405	0.358
22	0.5463	2.122	52	1.1493	1.409	82	1.4442	0.319
23	0.5699	2.107	53	1.1647	1.378	83	1.4476	0.279
24	0.5932	2.091	54	1.1799	1.345	84	1.4504	0.239
25	0.6164	2.075	55	1.1947	1.313	85	1.4529	0.200
26	0.6393	2.057	56	1.2091	1.280	86	1.4549	0.160
27	0.6621	2.040	57	1.2231	1.247	87	1.4564	0.120
28	0.6847	2.021	58	1.2368	1.213	88	1.4575	0.080
29	0.7071	2.002	59	1.2501	1.179	89	1.4582	0.040
						90	1.4584	0.000

Table 2.6 Difference between the velocity of a zonal current and the phase velocity of a sinusoidal perturbation (Rossby's formula)

Différence entre la vitesse d'un courant zonal et la vitesse de phase d'une perturbation sinusoïdale (formule de Rossby)

l : length of a degree of longitude on the parallel in question (see Table 6.2) — *longueur d'un degré de longitude sur le parallèle considéré (voir table 6.2)*

Wave length expressed in l — *longueur d'onde exprimée en l*

Latitude	10		15		20		25		30		35	
	l/24 h	m s^{-1}	l/24 h	m s^{-1}	l/24 h	m s^{-1}	l/24 h	m s^{-1}	l/24 h	m s^{-1}	l/24 h	m s^{-1}
10°	0.5	0.7	1.2	1.5	2.2	2.7	3.4	4.3	4.9	6.2	6.6	8.4
20	0.5	0.6	1.1	1.3	2.0	2.4	3.1	3.7	4.4	5.4	6.0	7.3
30	0.4	0.5	0.9	1.1	1.7	1.9	2.6	2.9	3.8	4.2	5.1	5.7
40	0.3	0.3	0.7	0.7	1.3	1.3	2.0	2.0	3.0	2.9	4.0	4.0
50	0.2	0.2	0.5	0.4	0.9	0.8	1.4	1.2	2.1	1.7	2.8	2.3
60	0.1	0.1	0.3	0.2	0.6	0.4	0.9	0.6	1.3	0.8	1.7	1.1
70	0.1	0.0	0.1	0.1	0.3	0.1	0.4	0.2	0.6	0.3	0.8	0.4
80	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.2	0.0	0.2	0.0

Wave length expressed in l — *longueur d'onde exprimée en l*

Latitude	40		45		50		55		60		65	
	l/24 h	m s^{-1}	l/24 h	m s^{-1}	l/24 h	m s^{-1}	l/24 h	m s^{-1}	l/24 h	m s^{-1}	l/24 h	m s^{-1}
10°	8.7	11.0	11.0	13.9	13.5	17.2	16.4	20.8	19.5	24.7	22.9	29.0
20	7.9	9.5	10.0	12.1	12.3	14.9	14.9	18.0	17.7	21.5	20.8	25.2
30	6.7	7.5	8.5	9.5	10.5	11.7	12.7	14.1	15.1	16.8	17.7	19.7
40	5.2	5.2	6.6	6.6	8.2	8.1	9.9	9.8	11.8	11.7	13.8	13.7
50	3.7	3.1	4.7	3.9	5.8	4.8	7.0	5.8	8.3	6.9	9.8	8.1
60	2.2	1.4	2.8	1.8	3.5	2.3	4.2	2.7	5.0	3.3	5.9	3.8
70	1.0	0.5	1.3	0.6	1.6	0.7	2.0	0.9	2.4	1.0	2.8	1.2
80	0.3	0.1	0.3	0.1	0.4	0.1	0.5	0.1	0.6	0.1	0.7	0.2

Wave length expressed in l — *longueur d'onde exprimée en l*

Latitude	70		75		80		85		90		100	
	l/24 h	m s^{-1}	l/24 h	m s^{-1}	l/24 h	m s^{-1}	l/24 h	m s^{-1}	l/24 h	m s^{-1}	l/24 h	m s^{-1}
10°	26.5	33.6	30.4	38.6	34.6	43.9	39.1	49.6	43.8	55.6	54.1	68.6
20	24.1	29.2	27.7	33.6	31.5	38.2	35.6	43.1	39.9	48.3	49.3	59.7
30	20.5	22.9	23.5	26.3	26.8	29.9	30.2	33.8	33.9	37.9	41.9	46.7
40	16.1	15.9	18.4	18.2	21.0	20.7	23.7	23.4	26.6	26.2	32.8	32.4
50	11.3	9.4	13.0	10.8	14.8	12.3	16.7	13.8	18.7	15.5	23.1	19.2
60	6.9	4.4	7.9	5.1	8.9	5.8	10.1	6.5	11.3	7.3	14.0	9.0
70	3.2	1.4	3.7	1.6	4.2	1.9	4.7	2.1	5.3	2.3	6.6	2.9
80	0.8	0.2	1.0	0.2	1.1	0.2	1.2	0.3	1.4	0.3	1.7	0.4

Wave length expressed in l — *longueur d'onde exprimée en l*

Latitude	110		120		130		140		160		180	
	l/24 h	m s^{-1}	l/24 h	m s^{-1}	l/24 h	m s^{-1}	l/24 h	m s^{-1}	l/24 h	m s^{-1}	l/24 h	m s^{-1}
10°	65.4	83.0	77.9	98.8	91.4	116.0	106.0	134.5	138.5	175.7	175.3	222.4
20	59.6	72.2	70.9	85.9	83.2	100.8	96.5	116.9	126.1	152.7	159.6	193.3
30	50.7	56.6	60.3	67.3	70.7	79.0	82.0	91.6	107.2	119.6	135.6	151.4
40	39.7	39.2	47.2	46.7	55.4	54.8	64.2	63.5	83.9	83.0	106.2	105.0
50	27.9	23.2	33.2	27.6	39.0	32.4	45.2	37.5	59.1	49.0	74.8	62.1
60	16.9	10.9	20.1	13.0	23.6	15.3	27.4	17.7	35.8	23.1	45.3	29.3
70	7.9	3.5	9.4	4.2	11.1	4.9	12.8	5.7	16.8	7.4	21.2	9.4
80	2.0	0.5	2.4	0.5	2.9	0.6	3.3	0.7	4.3	1.0	5.5	1.2

NOTE : The table gives the difference $U - c$ as it appears in the Rossby's formula quoted in Introduction 2.5. Table 2.6 is a reproduction of SMT 43.

NOTE : La table donne la différence $U - c$ telle qu'elle apparaît dans la formule de Rossby citée dans l'introduction 2.5. La table 2.6 est une reproduction de la SMT 43.

Table 3.1.1 **Factors for computing the relation between geopotential and geometric height**
Facteurs pour le calcul de la relation entre le géopotentiel et l'altitude géométrique

Latitude	R'	$\frac{g_\phi R'}{9.8}$	Latitude	R'	$\frac{g_\phi R'}{9.8}$	Latitude	R'	$\frac{g_\phi R'}{9.8}$
	m	gpm		m	gpm		m	gpm
0°	6334984	6322289	30°	6345653	6341274	60°	6367103	6379519
1	6334995	6322306	31	6346305	6342440	61	6367738	6380658
2	6335035	6322378	32	6346967	6343616	62	6368371	6381783
3	6335099	6322492	33	6347647	6344829	63	6368983	6382880
4	6335191	6322654	34	6348337	6346058	64	6369582	6383945
5	6335306	6322863	35	6349033	6347300	65	6370171	6385001
6	6335449	6323114	36	6349736	6348549	66	6370732	6386003
7	6335616	6323407	37	6350456	6349834	67	6371280	6386979
8	6335806	6323745	38	6351177	6351120	68	6371810	6387931
9	6336030	6324144	39	6351907	6352422	69	6372324	6388847
10	6336267	6324570	40	6352638	6353718	70	6372821	6389734
11	6336536	6325048	41	6353376	6355034	71	6373294	6390578
12	6336824	6325557	42	6354120	6356363	72	6373743	6391379
13	6337140	6326120	43	6354868	6357696	73	6374175	6392150
14	6337480	6326725	44	6355612	6359025	74	6374584	6392879
15	6337838	6327368	45	6356360	6360358	75	6374972	6393574
16	6338219	6328046	46	6357108	6361685	76	6375340	6394230
17	6338626	6328769	47	6357852	6363015	77	6375680	6394839
18	6339058	6329537	48	6358601	6364349	78	6375997	6395406
19	6339506	6330333	49	6359345	6365679	79	6376293	6395938
20	6339971	6331158	50	6360083	6366996	80	6376562	6396412
21	6340461	6332028	51	6360820	6368313	81	6376806	6396855
22	6340973	6332945	52	6361552	6369612	82	6377025	6397240
23	6341496	6333874	53	6362273	6370900	83	6377222	6397597
24	6342043	6334845	54	6362993	6372188	84	6377389	6397892
25	6342603	6335848	55	6363697	6373446	85	6377532	6398151
26	6343184	6336879	56	6364401	6374699	86	6377654	6398369
27	6343782	6337946	57	6365092	6375932	87	6377746	6398531
28	6344393	6339032	58	6365772	6377148	88	6377811	6398647
29	6345018	6340145	59	6366435	6378328	89	6377845	6398707
						90	6377862	6398737

Table 3.1.2 **Geometric metres to geopotential metres**
Conversion des mètres en mètres géopotentiels

	Latitude										
	0°	10°	20°	30°	40°	45°	50°	60°	70°	80°	90°
m	gpm	gpm	gpm	gpm	gpm	gpm.	gpm	gpm	gpm	gpm	gpm
1000	998	998	998	999	1000	1000	1001	1002	1002	1003	1003
2000	1995	1996	1997	1998	2000	2001	2002	2003	2005	2006	2006
3000	2993	2993	2994	2997	2999	3000	3002	3004	3007	3008	3008
4000	3989	3990	3992	3995	3998	4000	4002	4005	4008	4010	4011
5000	4986	4987	4989	4993	4997	4999	5002	5006	5009	5012	5012
6000	5982	5983	5986	5990	5995	5998	6001	6006	6010	6013	6014
7000	6978	6979	6983	6987	6993	6997	7000	7006	7011	7014	7015
8000	7974	7975	7979	7984	7991	7995	7999	8006	8011	8015	8016
9000	8969	8971	8975	8981	8989	8993	8997	9005	9011	9015	9017
10000	9964	9966	9970	9977	9986	9991	9995	10004	10011	10015	10017
11000	10959	10961	10966	10973	10983	10988	10993	11002	11010	11015	11017
12000	11953	11955	11961	11969	11979	11985	11990	12001	12009	12015	12017
13000	12947	12949	12955	12964	12976	12982	12988	12999	13008	13014	13016
14000	13941	13943	13950	13960	13972	13978	13984	13997	14006	14013	14015
15000	14935	14937	14944	14954	14967	14974	14981	14994	15004	15011	15014
16000	15928	15930	15938	15949	15963	15970	15977	15991	16002	16010	16012
17000	16921	16923	16931	16943	16958	16965	16973	16988	17000	17008	17010
18000	17913	17916	17924	17937	17952	17960	17969	17984	17997	18005	18008
19000	18905	18908	18917	18930	18947	18955	18964	18980	18994	19003	19006
20000	19897	19900	19909	19923	19941	19950	19959	19976	19990	20000	20003
21000	20889	20892	20902	20916	20934	20944	20954	20972	20987	20996	21000
22000	21880	21883	21893	21909	21928	21938	21948	21967	21982	21993	21996
23000	22871	22875	22885	22901	22921	22931	22942	22962	22978	22989	22992
24000	23862	23865	23876	23893	23914	23925	23936	23956	23973	23984	23988
25000	24852	24856	24867	24885	24906	24918	24929	24951	24968	24980	24984
26000	25842	25846	25858	25876	25898	25910	25922	25945	25963	25975	25979
27000	26832	26836	26848	26867	26890	26903	26915	26938	26957	26970	26974
28000	27821	27825	27838	27858	27882	27895	27908	27932	27952	27964	27969
29000	28810	28815	28828	28848	28873	28886	28900	28925	28945	28959	28963
30000	29799	29804	29817	29838	29864	29878	29892	29918	29939	29952	29957
35000	34738	34743	34759	34784	34814	34830	34846	34877	34901	34917	34923
40000	39669	39676	39694	39722	39756	39775	39793	39828	39856	39874	39881
45000	44593	44600	44621	44652	44691	44712	44732	44771	44803	44824	44831
50000	49509	49517	49540	49575	49618	49641	49664	49707	49742	49765	49773
55000	54417	54426	54451	54490	54537	54562	54588	54635	54674	54699	54708
60000	59318	59327	59355	59397	59449	59476	59504	59556	59598	59626	59635
65000	64211	64221	64251	64297	64353	64383	64412	64469	64514	64544	64555
70000	69096	69107	69139	69188	69249	69281	69313	69374	69423	69455	69467
75000	73974	73986	74020	74073	74137	74172	74206	74271	74324	74359	74371
80000	78844	78857	78893	78949	79018	79055	79092	79161	79218	79255	79268
85000	83707	83720	83759	83819	83892	83931	83970	84044	84104	84143	84157
90000	88561	88576	88617	88680	88758	88799	88841	88919	88982	89024	89038
95000	93409	93424	93467	93534	93616	93660	93704	93786	93853	93897	93912
100000	98249	98265	98310	98381	98467	98513	98559	98646	98716	98762	98779
105000	103081	103098	103146	103220	103310	103359	103407	103498	103572	103621	103637
110000	107906	107923	107974	108051	108146	108197	108247	108343	108421	108471	108489
115000	112723	112741	112794	112875	112974	113027	113080	113180	113261	113314	113333
120000	117533	117552	117607	117692	117795	117851	117906	118010	118095	118150	118169
125000	122336	122355	122413	122501	122609	122666	122724	122832	122921	122978	122998
130000	127131	127151	127211	127302	127415	127475	127534	127647	127739	127799	127820

	Latitude										
	0°	10°	20°	30°	40°	45°	50°	60°	70°	80°	90°
m	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm
130000	127131	127151	127211	127302	127415	127475	127534	127647	127739	127799	127820
140000	136698	136721	136785	136883	137004	137069	137134	137255	137354	137419	137441
150000	146237	146261	146329	146435	146565	146634	146703	146833	146940	147009	147033
160000	155746	155771	155845	155957	156096	156170	156243	156382	156496	156569	156595
170000	165225	165252	165330	165450	165597	165676	165754	165902	166022	166101	166128
180000	174676	174705	174787	174914	175070	175153	175236	175393	175520	175603	175632
190000	184098	184128	184215	184349	184514	184601	184689	184854	184989	185077	185107
200000	193490	193522	193614	193755	193928	194021	194113	194287	194429	194521	194554
210000	202855	202888	202985	203133	203315	203412	203509	203691	203840	203937	203971
220000	212190	212225	212326	212482	212672	212774	212876	213067	213223	213325	213360
230000	221497	221534	221640	221802	222001	222108	222214	222414	222577	222684	222721
240000	230776	230814	230925	231094	231302	231413	231524	231733	231903	232015	232053
250000	240027	240066	240181	240358	240575	240691	240806	241024	241201	241317	241358
260000	249249	249291	249410	249594	249820	249940	250060	250287	250471	250592	250634
270000	258444	258487	258611	258802	259036	259161	259286	259521	259713	259838	259882
280000	267611	267655	267784	267982	268225	268355	268484	268728	268927	269057	269102
290000	276750	276796	276930	277135	277386	277521	277655	277908	278114	278248	278295
300000	285861	285909	286047	286260	286520	286659	286798	287060	287273	287412	287460
310000	294946	294995	295138	295357	295627	295770	295914	296184	296404	296548	296598
320000	304003	304054	304201	304427	304706	304854	305002	305281	305509	305657	305709
330000	313032	313085	313237	313471	313757	313910	314063	314351	314586	314739	314792
340000	322035	322089	322246	322487	322782	322940	323097	323394	323636	323794	323849
350000	331011	331067	331228	331476	331780	331942	332104	332410	332659	332821	332878
360000	339960	340017	340183	340438	340751	340918	341085	341399	341655	341822	341881
370000	348882	348941	349112	349374	349695	349867	350039	350362	350625	350797	350857
380000	357777	357838	358013	358283	358613	358790	358966	359297	359568	359745	359806
390000	366647	366709	366889	367165	367505	367686	367866	368207	368485	368666	368729
400000	375489	375553	375738	376021	376370	376555	376741	377090	377375	377561	377626
410000	384306	384372	384561	384851	385208	385399	385589	385947	386239	386430	386496
420000	393097	393164	393358	393655	394021	394216	394411	394778	395077	395272	395340
430000	401861	401930	402128	402433	402808	403007	403207	403583	403889	404089	404159
440000	410600	410670	410873	411185	411569	411773	411977	412362	412675	412880	412951
450000	419313	419385	419593	419912	420304	420513	420721	421115	421436	421645	421718
460000	428000	428074	428286	428612	429013	429227	429440	429842	430170	430384	430459
470000	436662	436737	436954	437287	437697	437915	438133	438545	438880	439098	439175
480000	445298	445375	445597	445937	446355	446579	446801	447221	447563	447787	447865
490000	453909	453987	454214	454561	454989	455216	455444	455872	456222	456450	456529
500000	462495	462575	462806	463161	463597	463829	464061	464499	464855	465088	465169
510000	471056	471137	471373	471735	472179	472417	472653	473100	473463	473701	473784
520000	479591	479674	479915	480284	480737	480979	481221	481676	482047	482289	482373
530000	488102	488187	488432	488808	489270	489517	489763	490227	490605	490852	490938
540000	496588	496675	496924	497308	497779	498030	498281	498753	499139	499390	499478
550000	505050	505138	505392	505783	506262	506518	506774	507255	507648	507904	507993
560000	513487	513576	513835	514233	514721	514982	515242	515732	516132	516393	516484
570000	521899	521990	522254	522659	523156	523421	523686	524185	524592	524857	524950
580000	530287	530380	530648	531060	531566	531836	532106	532614	533028	533298	533392
590000	538651	538746	539019	539438	539952	540227	540501	541018	541439	541714	541810
600000	546991	547087	547365	547791	548314	548594	548872	549398	549826	550106	550203
610000	555307	555404	555687	556120	556652	556936	557220	557754	558190	558474	558573
620000	563599	563698	563985	564425	564966	565255	565543	566086	566529	566818	566918
630000	571867	571968	572259	572707	573256	573550	573843	574394	574844	575138	575240

Table 3.1.3 Geopotential metres to geometric metres
Conversion des mètres géopotentiels en mètres

	Latitude										
	0°	10°	20°	30°	40°	45°	50°	60°	70°	80°	90°
gpm	m	m	m	m	m	m	m	m	m	m	m
1000	1002	1002	1002	1001	1000	1000	999	998	998	997	997
2000	2005	2004	2003	2002	2000	1999	1998	1997	1995	1994	1994
3000	3007	3007	3006	3003	3001	3000	2998	2996	2993	2992	2992
4000	4011	4010	4008	4005	4002	4000	3998	3995	3992	3990	3989
5000	5014	5013	5011	5007	5003	5001	4998	4994	4991	4988	4988
6000	6018	6017	6014	6010	6005	6002	5999	5994	5990	5987	5986
7000	7022	7021	7018	7013	7007	7003	7000	6994	6989	6986	6985
8000	8026	8025	8021	8016	8009	8005	8001	7994	7989	7985	7984
9000	9031	9029	9025	9019	9011	9007	9003	8995	8989	8985	8983
10000	10036	10034	10030	10023	10014	10009	10005	9996	9989	9985	9983
11000	11041	11040	11034	11027	11017	11012	11007	10998	10990	10985	10983
12000	12047	12045	12040	12031	12021	12015	12010	11999	11991	11985	11983
13000	13053	13051	13045	13036	13024	13018	13012	13001	12992	12986	12984
14000	14059	14057	14051	14041	14029	14022	14016	14003	13994	13987	13985
15000	15066	15063	15057	15046	15033	15026	15019	15006	14995	14989	14986
16000	16073	16070	16063	16052	16038	16030	16023	16009	15998	15990	15988
17000	17080	17077	17069	17057	17043	17035	17027	17012	17000	16992	16990
18000	18088	18085	18076	18064	18048	18040	18031	18016	18003	17995	17992
19000	19096	19092	19084	19070	19054	19045	19036	19020	19006	18997	18994
20000	20104	20101	20091	20077	20060	20050	20041	20024	20010	20000	19997
21000	21112	21109	21099	21084	21066	21056	21047	21028	21013	21004	21000
22000	22121	22118	22107	22092	22073	22062	22052	22033	22018	22007	22004
23000	23130	23127	23116	23100	23080	23069	23058	23038	23022	23011	23008
24000	24140	24136	24125	24108	24087	24076	24065	24044	24027	24016	24012
25000	25150	25146	25134	25116	25094	25083	25071	25050	25032	25020	25016
26000	26160	26156	26144	26125	26102	26090	26078	26056	26037	26025	26021
27000	27170	27166	27153	27134	27111	27098	27086	27062	27043	27030	27026
28000	28181	28177	28164	28144	28119	28106	28093	28069	28049	28036	28031
29000	29192	29187	29174	29153	29128	29115	29101	29076	29055	29042	29037
30000	30204	30199	30185	30163	30137	30123	30109	30083	30062	30048	30043
35000	35266	35260	35244	35219	35188	35172	35155	35125	35100	35083	35078
40000	40336	40329	40310	40282	40247	40228	40209	40174	40145	40127	40120
45000	45414	45406	45385	45353	45313	45292	45271	45231	45199	45178	45171
50000	50500	50492	50468	50432	50388	50365	50341	50297	50261	50238	50229
55000	55594	55585	55559	55520	55471	55445	55419	55370	55331	55305	55296
60000	60697	60687	60658	60615	60562	60533	60505	60452	60408	60380	60370
65000	65807	65796	65766	65719	65661	65630	65599	65541	65494	65464	65453
70000	70926	70914	70881	70830	70768	70734	70701	70639	70588	70555	70543
75000	76053	76040	76005	75950	75883	75847	75812	75745	75690	75654	75642
80000	81188	81175	81137	81078	81006	80968	80930	80858	80800	80762	80749
85000	86331	86317	86277	86214	86138	86097	86057	85980	85918	85877	85863
90000	91483	91468	91425	91359	91278	91234	91191	91110	91044	91001	90986
95000	96643	96627	96581	96511	96426	96380	96334	96248	96178	96133	96117
100000	101811	101794	101746	101672	101582	101534	101485	101395	101321	101273	101256
105000	106988	106970	106919	106842	106746	106695	106645	106549	106472	106421	106403
110000	112173	112154	112101	112019	111919	111866	111812	111712	111631	111577	111559
115000	117366	117346	117291	117205	117100	117044	116988	116883	116798	116742	116723
120000	122567	122547	122489	122399	122289	122231	122172	122062	121973	121915	121894
125000	127777	127756	127695	127602	127487	127426	127365	127250	127157	127096	127075
130000	132996	132974	132910	132813	132693	132629	132566	132446	132349	132285	132263

	Latitude										
	0°	10°	20°	30°	40°	45°	50°	60°	70°	80°	90°
gpm	m	m	m	m	m	m	m	m	m	m	m
130000	132996	132974	132910	132813	132693	132629	132566	132446	132349	132285	132263
140000	143458	143434	143365	143260	143130	143061	142992	142863	142757	142689	142665
150000	153954	153928	153854	153740	153601	153526	153452	153313	153199	153125	153100
160000	164484	164456	164377	164255	164105	164026	163946	163797	163675	163596	163568
170000	175048	175019	174934	174804	174644	174559	174474	174314	174184	174100	174070
180000	185647	185616	185525	185387	185217	185126	185036	184866	184727	184637	184606
190000	196280	196247	196151	196004	195824	195728	195632	195451	195305	195209	195176
200000	206948	206913	206812	206656	206465	206363	206262	206071	205916	205815	205779
210000	217651	217614	217507	217343	217141	217034	216927	216725	216561	216455	216418
220000	228389	228350	228237	228064	227852	227739	227626	227414	227242	227129	227090
230000	239163	239121	239003	238821	238598	238479	238361	238138	237957	237838	237797
240000	249971	249928	249804	249613	249379	249255	249130	248896	248706	248582	248539
250000	260815	260770	260640	260440	260196	260065	259935	259690	259491	259361	259316
260000	271696	271648	271512	271303	271047	270911	270775	270519	270311	270175	270128
270000	282612	282562	282420	282202	281935	281793	281651	281383	281166	281024	280975
280000	293564	293512	293364	293137	292858	292710	292562	292284	292057	291909	291858
290000	304552	304499	304344	304108	303818	303663	303509	303219	302983	302830	302776
300000	315577	315522	315361	315115	314814	314653	314493	314191	313946	313786	313730
310000	326638	326581	326414	326159	325845	325679	325512	325199	324944	324778	324720
320000	337737	337677	337504	337239	336914	336741	336568	336243	335979	335807	335747
330000	348872	348810	348631	348356	348019	347840	347661	347324	347050	346872	346809
340000	360045	359981	359795	359511	359162	358976	358790	358442	358158	357973	357908
350000	371255	371189	370997	370702	370341	370149	369957	369596	369302	369111	369044
360000	382503	382434	382236	381931	381558	381359	381161	380787	380484	380286	380217
370000	393789	393718	393512	393198	392812	392606	392402	392016	391702	391498	391427
380000	405112	405039	404827	404502	404104	403892	403680	403282	402958	402747	402674
390000	416474	416398	416180	415845	415434	415215	414996	414586	414252	414034	413958
400000	427874	427796	427571	427225	426801	426576	426351	425927	425583	425358	425280
410000	439313	439232	439000	438644	438207	437975	437743	437307	436952	436721	436640
420000	450790	450707	450468	450101	449652	449413	449174	448725	448359	448121	448038
430000	462306	462221	461975	461598	461135	460889	460643	460181	459805	459560	459474
440000	473862	473774	473521	473133	472657	472404	472151	471675	471289	471036	470949
450000	485457	485367	485106	484707	484218	483957	483698	483209	482811	482552	482462
460000	497091	496999	496731	496321	495818	495551	495284	494781	494373	494106	494014
470000	508765	508670	508396	507974	507458	507183	506909	506393	505973	505700	505604
480000	520480	520382	520100	519667	519137	518855	518573	518044	517613	517332	517234
490000	532234	532134	531844	531401	530856	530567	530278	529734	529292	529004	528904
500000	544029	543926	543629	543174	542616	542318	542022	541465	541011	540715	540613
510000	555864	555758	555454	554987	554415	554110	553806	553235	552770	552467	552361
520000	567740	567632	567320	566841	566255	565943	565631	565045	564569	564258	564150
530000	579657	579546	579227	578736	578136	577815	577496	576896	576408	576089	575979
540000	591615	591502	591174	590672	590057	589729	589402	588787	588287	587961	587848
550000	603615	603499	603164	602650	602019	601684	601349	600720	600207	599874	599758
560000	615657	615538	615194	614668	614023	613680	613337	612693	612169	611827	611708
570000	627740	627618	627267	626729	626069	625717	625367	624707	624171	623821	623700
580000	639865	639741	639381	638831	638156	637796	637437	636763	636214	635857	635732
590000	652033	651905	651538	650975	650284	649917	649550	648861	648299	647934	647807
600000	664243	664113	663737	663161	662456	662080	661705	661000	660426	660053	659923
610000	676496	676363	675979	675391	674669	674285	673902	673181	672595	672213	672080
620000	688792	688656	688264	687662	686925	686533	686141	685405	684806	684416	684280
630000	701131	700992	700591	699977	699224	698823	698423	697671	697059	696661	696522

Table 3.2 Geopotential differences between consecutive isobaric surfaces as a function of mean virtual temperature

Différences de géopotentiel entre surfaces isobares consécutives en fonction de la température virtuelle moyenne

p : isobaric surface pressure — *pression dans la surface isobare*

t_{mv} : mean virtual temperature — *température virtuelle moyenne*

p	t_{mv}	0	1	2	3	4	5	6	7	8	9
mb	°C	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm
900											
	-70	322	320	319	317	315	314	312	311	309	307
	-60	338	336	334	333	331	330	328	326	325	323
	-50	353	352	350	349	347	345	344	342	341	339
	-40	369	368	366	364	363	361	360	358	357	355
	-30	385	383	382	380	379	377	376	374	372	371
	-20	401	399	398	396	395	393	391	390	388	387
	-10	417	415	414	412	410	409	407	406	404	402
	-0	433	431	429	428	426	425	423	421	420	418
	0	433	434	436	437	439	441	442	444	445	447
	10	448	450	452	453	455	456	458	460	461	463
	20	464	466	467	469	471	472	474	475	477	479
	30	480	482	483	485	486	488	490	491	493	494
	40	496	498	499	501	502	504	505	507	509	510
	50	512	513	515	517	518	520	521	523	524	526
950											
	-70	305	304	302	301	299	298	296	295	293	292
	-60	320	319	317	316	314	313	311	310	308	307
	-50	335	334	332	331	329	328	326	325	323	322
	-40	350	349	347	346	344	343	341	340	338	337
	-30	365	364	362	361	359	358	356	355	353	352
	-20	380	379	377	376	374	373	371	370	368	367
	-10	395	394	392	391	389	388	386	385	383	382
	-0	410	409	407	406	404	403	401	400	398	397
	0	410	412	413	415	416	418	419	421	422	424
	10	425	427	428	430	431	433	434	436	437	439
	20	440	442	443	445	446	448	449	451	452	454
	30	455	457	458	460	461	463	464	466	467	469
	40	470	472	473	475	476	478	480	481	483	484
	50	486	487	489	490	492	493	495	496	498	499
1000											
	-70	290	289	287	286	285	283	282	280	279	277
	-60	305	303	302	300	299	297	296	295	293	292
	-50	319	317	316	315	313	312	310	309	307	306
	-40	333	332	330	329	327	326	325	323	322	320
	-30	347	346	345	343	342	340	339	337	336	335
	-20	362	360	359	357	356	355	353	352	350	349
	-10	376	375	373	372	370	369	367	366	365	363
	-0	390	389	388	386	385	383	382	380	379	377
	0	390	392	393	395	396	398	399	400	402	403
	10	405	406	408	409	410	412	413	415	416	418
	20	419	420	422	423	425	426	428	429	430	432
	30	433	435	436	438	439	440	442	443	445	446
	40	448	449	450	452	453	455	456	458	459	460
	50	462	463	465	466	468	469	470	472	473	475
1050											

p	t_{mv}	0	1	2	3	4	5	6	7	8	9
mb	°C	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm
700											
	-70	411	409	406	404	402	400	398	396	394	392
	-60	431	429	427	425	423	421	419	417	415	413
	-50	451	449	447	445	443	441	439	437	435	433
	-40	471	469	467	465	463	461	459	457	455	453
	-30	491	489	487	485	483	481	479	477	475	473
	-20	512	510	508	506	503	501	499	497	495	493
	-10	532	530	528	526	524	522	520	518	516	514
	-0	552	550	548	546	544	542	540	538	536	534
	0	552	554	556	558	560	562	564	566	568	570
	10	572	574	576	578	580	582	584	586	588	590
	20	592	594	596	598	601	603	605	607	609	611
	30	613	615	617	619	621	623	625	627	629	631
	40	633	635	637	639	641	643	645	647	649	651
750											
	-70	384	382	380	378	376	375	373	371	369	367
	-60	403	401	399	397	395	393	392	390	388	386
	-50	422	420	418	416	414	412	410	409	407	405
	-40	441	439	437	435	433	431	429	428	426	424
	-30	460	458	456	454	452	450	448	446	445	443
	-20	479	477	475	473	471	469	467	465	463	462
	-10	497	496	494	492	490	488	486	484	482	480
	-0	516	514	513	511	509	507	505	503	501	499
	0	516	518	520	522	524	526	528	530	531	533
	10	535	537	539	541	543	545	547	548	550	552
	20	554	556	558	560	562	564	566	567	569	571
	30	573	575	577	579	581	583	584	586	588	590
	40	592	594	596	598	600	601	603	605	607	609
800											
	-70	361	359	357	355	354	352	350	348	347	345
	-60	379	377	375	373	371	370	368	366	364	363
	-50	396	394	393	391	389	387	386	384	382	380
	-40	414	412	410	409	407	405	403	402	400	398
	-30	432	430	428	426	425	423	421	419	418	416
	-20	450	448	446	444	442	441	439	437	435	434
	-10	467	466	464	462	460	458	457	455	453	451
	-0	485	483	481	480	478	476	474	473	471	469
	0	485	487	489	490	492	494	496	497	499	501
	10	503	505	506	508	510	512	513	515	517	519
	20	521	522	524	526	528	529	531	533	535	537
	30	538	540	542	544	545	547	549	551	553	554
	40	556	558	560	561	563	565	567	569	570	572
850											
	-70	340	338	337	335	333	332	330	328	327	325
	-60	357	355	354	352	350	348	347	345	343	342
	-50	374	372	370	369	367	365	364	362	360	359
	-40	390	389	387	385	384	382	380	379	377	375
	-30	407	405	404	402	400	399	397	395	394	392
	-20	424	422	420	419	417	415	414	412	410	409
	-10	441	439	437	436	434	432	431	429	427	426
	-0	457	456	454	452	451	449	447	446	444	442
	0	457	459	461	462	464	466	467	469	471	472
	10	474	476	477	479	481	482	484	486	487	489
	20	491	492	494	496	497	499	501	503	504	506
	30	508	509	511	513	514	516	518	519	521	523
	40	524	526	528	529	531	533	534	536	538	539
	50	541	543	544	546	548	549	551	553	554	556
900											

p	t_{mv}	0	1	2	3	4	5	6	7	8	9
mb	°C	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm
500											
	-70	567	564	562	559	556	553	550	548	545	542
	-60	595	592	589	587	584	581	578	576	573	570
	-50	623	620	617	615	612	609	606	603	601	598
	-40	651	648	645	643	640	637	634	631	629	626
	-30	679	676	673	670	668	665	662	659	656	654
	-20	707	704	701	698	696	693	690	687	684	682
	-10	735	732	729	726	723	721	718	715	712	710
	-0	763	760	757	754	751	749	746	743	740	737
	0	763	765	768	771	774	777	779	782	785	788
	10	790	793	796	799	802	804	807	810	813	816
	20	818	821	824	827	830	832	835	838	841	844
	30	846	849	852	855	857	860	863	866	869	871
550											
	-70	518	515	513	510	508	505	502	500	497	495
	-60	543	541	538	536	533	531	528	525	523	520
	-50	569	566	564	561	559	556	553	551	548	546
	-40	594	592	589	587	584	581	579	576	574	571
	-30	620	617	615	612	610	607	604	602	599	597
	-20	645	643	640	638	635	632	630	627	625	622
	-10	671	668	666	663	660	658	655	653	650	648
	-0	696	694	691	689	686	683	681	678	676	673
	0	696	699	701	704	706	709	711	714	717	719
	10	722	724	727	729	732	734	737	739	742	745
	20	747	750	752	755	757	760	762	765	768	770
	30	773	775	778	780	783	785	788	790	793	796
600											
	-70	476	474	472	469	467	465	462	460	458	455
	-60	500	497	495	493	490	488	486	483	481	479
	-50	523	521	518	516	514	511	509	507	504	502
	-40	547	544	542	540	537	535	533	530	528	526
	-30	570	568	565	563	561	558	556	554	551	549
	-20	594	591	589	586	584	582	579	577	575	572
	-10	617	615	612	610	608	605	603	601	598	596
	-0	640	638	636	633	631	629	626	624	622	619
	0	640	643	645	647	650	652	654	657	659	662
	10	664	666	669	671	673	676	678	680	683	685
	20	687	690	692	694	697	699	701	704	706	708
	30	711	713	715	718	720	722	725	727	730	732
	40	734	737	739	741	744	746	748	751	753	755
650											
	-70	441	439	437	434	432	430	428	426	424	421
	-60	463	461	458	456	454	452	450	447	445	443
	-50	484	482	480	478	476	474	471	469	467	465
	-40	506	504	502	500	497	495	493	491	489	487
	-30	528	526	523	521	519	517	515	513	510	508
	-20	550	547	545	543	541	539	536	534	532	530
	-10	571	569	567	565	563	560	558	556	554	552
	-0	593	591	589	586	584	582	580	578	576	573
	0	593	595	597	599	602	604	606	608	610	612
	10	615	617	619	621	623	625	628	630	632	634
	20	636	639	641	643	645	647	649	652	654	656
	30	658	660	662	665	667	669	671	673	675	678
	40	680	682	684	686	688	691	693	695	697	699
700											

TABLE 3.2 — 4

p mb	t_{mv} °C	0 gpm	1 gpm	2 gpm	3 gpm	4 gpm	5 gpm	6 gpm	7 gpm	8 gpm	9 gpm
300											
	-70	917	913	908	904	899	895	890	886	881	877
	-60	962	958	953	949	944	940	935	931	926	922
	-50	1008	1003	999	994	990	985	980	976	971	967
	-40	1053	1048	1044	1039	1035	1030	1026	1021	1017	1012
	-30	1098	1093	1089	1084	1080	1075	1071	1066	1062	1057
	-20	1143	1139	1134	1129	1125	1120	1116	1111	1107	1102
	-10	1188	1184	1179	1175	1170	1166	1161	1157	1152	1148
	-0	1233	1229	1224	1220	1215	1211	1206	1202	1197	1193
	0	1233	1238	1242	1247	1251	1256	1260	1265	1269	1274
	10	1278	1283	1288	1292	1297	1301	1306	1310	1315	1319
	20	1324	1328	1333	1337	1342	1346	1351	1355	1360	1364
350											
	-70	795	791	787	783	779	775	771	767	763	759
	-60	834	830	826	822	818	814	810	806	802	798
	-50	873	869	865	861	857	853	849	845	842	838
	-40	912	908	904	900	896	892	888	885	881	877
	-30	951	947	943	939	935	931	928	924	920	916
	-20	990	986	982	978	974	971	967	963	959	955
	-10	1029	1025	1021	1018	1014	1010	1006	1002	998	994
	-0	1068	1064	1061	1057	1053	1049	1045	1041	1037	1033
	0	1068	1072	1076	1080	1084	1088	1092	1096	1100	1104
	10	1107	1111	1115	1119	1123	1127	1131	1135	1139	1143
	20	1147	1150	1154	1158	1162	1166	1170	1174	1178	1182
400											
	-70	701	697	694	691	687	684	680	677	673	670
	-60	735	732	728	725	722	718	715	711	708	704
	-50	770	766	763	760	756	753	749	746	742	739
	-40	804	801	797	794	791	787	784	780	777	773
	-30	839	835	832	829	825	822	818	815	811	808
	-20	873	870	866	863	860	856	853	849	846	842
	-10	908	904	901	898	894	891	887	884	880	877
	-0	942	939	935	932	929	925	922	918	915	911
	0	942	946	949	953	956	960	963	967	970	973
	10	977	980	984	987	991	994	998	1001	1004	1008
	20	1011	1015	1018	1022	1025	1029	1032	1036	1039	1042
	30	1046	1049	1053	1056	1060	1063	1067	1070	1073	1077
450											
	-70	627	624	621	618	615	612	608	605	602	599
	-60	658	655	652	649	645	642	639	636	633	630
	-50	689	686	682	679	676	673	670	667	664	661
	-40	720	716	713	710	707	704	701	698	695	692
	-30	750	747	744	741	738	735	732	729	726	723
	-20	781	778	775	772	769	766	763	760	757	753
	-10	812	809	806	803	800	797	794	791	787	784
	-0	843	840	837	834	831	828	824	821	818	815
	0	843	846	849	852	855	858	861	865	868	871
	10	874	877	880	883	886	889	892	895	899	902
	20	905	908	911	914	917	920	923	926	929	932
	30	936	939	942	945	948	951	954	957	960	963
500											

p	t_{mv}	0	1	2	3	4	5	6	7	8	9
mb	°C	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm
150											
	-90	827	822	818	813	809	804	800	795	791	786
	-80	872	868	863	859	854	850	845	841	836	831
	-70	917	913	908	904	899	895	890	886	881	877
	-60	962	958	953	949	944	940	935	931	926	922
	-50	1008	1003	999	994	990	985	980	976	971	967
	-40	1053	1048	1044	1039	1035	1030	1026	1021	1017	1012
	-30	1098	1093	1089	1084	1080	1075	1071	1066	1062	1057
	-20	1143	1139	1134	1129	1125	1120	1116	1111	1107	1102
	-10	1188	1184	1179	1175	1170	1166	1161	1157	1152	1148
	-0	1233	1229	1224	1220	1215	1211	1206	1202	1197	1193
	0	1233	1238	1242	1247	1251	1256	1260	1265	1269	1274
175											
	-90	716	712	709	705	701	697	693	689	685	681
	-80	755	752	748	744	740	736	732	728	724	720
	-70	795	791	787	783	779	775	771	767	763	759
	-60	834	830	826	822	818	814	810	806	802	798
	-50	873	869	865	861	857	853	849	845	842	838
	-40	912	908	904	900	896	892	888	885	881	877
	-30	951	947	943	939	935	931	928	924	920	916
	-20	990	986	982	978	974	971	967	963	959	955
	-10	1029	1025	1021	1018	1014	1010	1006	1002	998	994
	-0	1068	1064	1061	1057	1053	1049	1045	1041	1037	1033
	0	1068	1072	1076	1080	1084	1088	1092	1096	1100	1104
	10	1107	1111	1115	1119	1123	1127	1131	1135	1139	1143
200											
	-80	1262	1256	1249	1243	1236	1230	1223	1217	1210	1204
	-70	1328	1321	1315	1308	1302	1295	1289	1282	1276	1269
	-60	1393	1387	1380	1374	1367	1360	1354	1347	1341	1334
	-50	1459	1452	1445	1439	1432	1426	1419	1413	1406	1400
	-40	1524	1517	1511	1504	1498	1491	1485	1478	1472	1465
	-30	1589	1583	1576	1570	1563	1557	1550	1543	1537	1530
	-20	1655	1648	1642	1635	1628	1622	1615	1609	1602	1596
	-10	1720	1713	1707	1700	1694	1687	1681	1674	1668	1661
	-0	1785	1779	1772	1766	1759	1753	1746	1740	1733	1727
	0	1785	1792	1798	1805	1811	1818	1825	1831	1838	1844
	10	1851	1857	1864	1870	1877	1883	1890	1896	1903	1910
	20	1916	1923	1929	1936	1942	1949	1955	1962	1968	1975
	30	1981	1988	1994	2001	2008	2014	2021	2027	2034	2040
250											
	-80	1031	1026	1021	1015	1010	1005	999	994	989	983
	-70	1085	1080	1074	1069	1064	1058	1053	1048	1042	1037
	-60	1138	1133	1128	1122	1117	1112	1106	1101	1096	1090
	-50	1192	1186	1181	1176	1170	1165	1160	1154	1149	1144
	-40	1245	1240	1234	1229	1224	1218	1213	1208	1202	1197
	-30	1299	1293	1288	1282	1277	1272	1266	1261	1256	1250
	-20	1352	1347	1341	1336	1331	1325	1320	1315	1309	1304
	-10	1405	1400	1395	1389	1384	1379	1373	1368	1363	1357
	-0	1459	1453	1448	1443	1437	1432	1427	1421	1416	1411
	0	1459	1464	1469	1475	1480	1485	1491	1496	1501	1507
	10	1512	1517	1523	1528	1533	1539	1544	1550	1555	1560
300											

TABLE 3.2 — 6

p	t_{mv}	0	1	2	3	4	5	6	7	8	9
mb	°C	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm
70											
	−100	677	673	669	666	662	658	654	650	646	642
	−90	716	712	709	705	701	697	693	689	685	681
	−80	755	752	748	744	740	736	732	728	724	720
	−70	795	791	787	783	779	775	771	767	763	759
	−60	834	830	826	822	818	814	810	806	802	798
	−50	873	869	865	861	857	853	849	845	842	838
	−40	912	908	904	900	896	892	888	885	881	877
	−30	951	947	943	939	935	931	928	924	920	916
	−20	990	986	982	978	974	971	967	963	959	955
	−10	1029	1025	1021	1018	1014	1010	1006	1002	998	994
	−0	1068	1064	1061	1057	1053	1049	1045	1041	1037	1033
80											
	−100	597	594	590	587	584	580	577	573	570	566
	−90	632	628	625	622	618	615	611	608	604	601
	−80	666	663	659	656	653	649	646	642	639	635
	−70	701	697	694	691	687	684	680	677	673	670
	−60	735	732	728	725	722	718	715	711	708	704
	−50	770	766	763	760	756	753	749	746	742	739
	−40	804	801	797	794	791	787	784	780	777	773
	−30	839	835	832	829	825	822	818	815	811	808
	−20	873	870	866	863	860	856	853	849	846	842
	−10	908	904	901	898	894	891	887	884	880	877
	−0	942	939	935	932	929	925	922	918	915	911
90											
	−100	534	531	528	525	522	519	516	513	510	507
	−90	565	562	559	556	553	550	547	544	541	537
	−80	596	593	590	587	584	581	578	574	571	568
	−70	627	624	621	618	615	612	608	605	602	599
	−60	658	655	652	649	645	642	639	636	633	630
	−50	689	686	682	679	676	673	670	667	664	661
	−40	720	716	713	710	707	704	701	698	695	692
	−30	750	747	744	741	738	735	732	729	726	723
	−20	781	778	775	772	769	766	763	760	757	753
	−10	812	809	806	803	800	797	794	791	787	784
	−0	843	840	837	834	831	828	824	821	818	815
100											
	−90	1197	1191	1184	1177	1171	1164	1158	1151	1145	1138
	−80	1262	1256	1249	1243	1236	1230	1223	1217	1210	1204
	−70	1328	1321	1315	1308	1302	1295	1289	1282	1276	1269
	−60	1393	1387	1380	1374	1367	1360	1354	1347	1341	1334
	−50	1459	1452	1445	1439	1432	1426	1419	1413	1406	1400
	−40	1524	1517	1511	1504	1498	1491	1485	1478	1472	1465
	−30	1589	1583	1576	1570	1563	1557	1550	1543	1537	1530
	−20	1655	1648	1642	1635	1628	1622	1615	1609	1602	1596
	−10	1720	1713	1707	1700	1694	1687	1681	1674	1668	1661
	−0	1785	1779	1772	1766	1759	1753	1746	1740	1733	1727
125											
	−90	978	973	967	962	957	951	946	941	935	930
	−80	1031	1026	1021	1015	1010	1005	999	994	989	983
	−70	1085	1080	1074	1069	1064	1058	1053	1048	1042	1037
	−60	1138	1133	1128	1122	1117	1112	1106	1101	1096	1090
	−50	1192	1186	1181	1176	1170	1165	1160	1154	1149	1144
	−40	1245	1240	1234	1229	1224	1218	1213	1208	1202	1197
	−30	1299	1293	1288	1282	1277	1272	1266	1261	1256	1250
	−20	1352	1347	1341	1336	1331	1325	1320	1315	1309	1304
	−10	1405	1400	1395	1389	1384	1379	1373	1368	1363	1357
	−0	1459	1453	1448	1443	1437	1432	1427	1421	1416	1411
	0	1459	1464	1469	1475	1480	1485	1491	1496	1501	1507

p mb	t_{mv} °C	0 gpm	1 gpm	2 gpm	3 gpm	4 gpm	5 gpm	6 gpm	7 gpm	8 gpm	9 gpm
30											
	-100	1459	1451	1442	1434	1425	1417	1408	1400	1392	1383
	-90	1543	1535	1526	1518	1510	1501	1493	1484	1476	1467
	-80	1628	1619	1611	1602	1594	1585	1577	1569	1560	1552
	-70	1712	1703	1695	1687	1678	1670	1661	1653	1644	1636
	-60	1796	1788	1779	1771	1762	1754	1746	1737	1729	1720
	-50	1880	1872	1864	1855	1847	1838	1830	1821	1813	1805
	-40	1965	1956	1948	1939	1931	1923	1914	1906	1897	1889
	-30	2049	2040	2032	2024	2015	2007	1998	1990	1981	1973
	-20	2133	2125	2116	2108	2099	2091	2083	2074	2066	2057
	-10	2217	2209	2201	2192	2184	2175	2167	2158	2150	2142
	-0	2302	2293	2285	2276	2268	2260	2251	2243	2234	2226
	0	2302	2310	2319	2327	2335	2344	2352	2361	2369	2378
	10	2386	2394	2403	2411	2420	2428	2437	2445	2453	2462
	20	2470	2479	2487	2496	2504	2512	2521	2529	2538	2546
40											
	-100	1132	1125	1119	1112	1106	1099	1093	1086	1079	1073
	-90	1197	1191	1184	1177	1171	1164	1158	1151	1145	1138
	-80	1262	1256	1249	1243	1236	1230	1223	1217	1210	1204
	-70	1328	1321	1315	1308	1302	1295	1289	1282	1276	1269
	-60	1393	1387	1380	1374	1367	1360	1354	1347	1341	1334
	-50	1459	1452	1445	1439	1432	1426	1419	1413	1406	1400
	-40	1524	1517	1511	1504	1498	1491	1485	1478	1472	1465
	-30	1589	1583	1576	1570	1563	1557	1550	1543	1537	1530
	-20	1655	1648	1642	1635	1628	1622	1615	1609	1602	1596
	-10	1720	1713	1707	1700	1694	1687	1681	1674	1668	1661
	-0	1785	1779	1772	1766	1759	1753	1746	1740	1733	1727
50											
	-100	925	919	914	909	903	898	893	887	882	877
	-90	978	973	967	962	957	951	946	941	935	930
	-80	1031	1026	1021	1015	1010	1005	999	994	989	983
	-70	1085	1080	1074	1069	1064	1058	1053	1048	1042	1037
	-60	1138	1133	1128	1122	1117	1112	1106	1101	1096	1090
	-50	1192	1186	1181	1176	1170	1165	1160	1154	1149	1144
	-40	1245	1240	1234	1229	1224	1218	1213	1208	1202	1197
	-30	1299	1293	1288	1282	1277	1272	1266	1261	1256	1250
	-20	1352	1347	1341	1336	1331	1325	1320	1315	1309	1304
	-10	1405	1400	1395	1389	1384	1379	1373	1368	1363	1357
	-0	1459	1453	1448	1443	1437	1432	1427	1421	1416	1411
60											
	-100	782	777	773	768	764	759	755	750	746	741
	-90	827	822	818	813	809	804	800	795	791	786
	-80	872	868	863	859	854	850	845	841	836	831
	-70	917	913	908	904	899	895	890	886	881	877
	-60	962	958	953	949	944	940	935	931	926	922
	-50	1008	1003	999	994	990	985	980	976	971	967
	-40	1053	1048	1044	1039	1035	1030	1026	1021	1017	1012
	-30	1098	1093	1089	1084	1080	1075	1071	1066	1062	1057
	-20	1143	1139	1134	1129	1125	1120	1116	1111	1107	1102
	-10	1188	1184	1179	1175	1170	1166	1161	1157	1152	1148
	-0	1233	1229	1224	1220	1215	1211	1206	1202	1197	1193
70											

p mb	t_{mv} °C	0 gpm	1 gpm	2 gpm	3 gpm	4 gpm	5 gpm	6 gpm	7 gpm	8 gpm	9 gpm
5											
	-100	3515	3495	3475	3455	3434	3414	3394	3373	3353	3333
	-90	3718	3698	3678	3658	3637	3617	3597	3576	3556	3536
	-80	3922	3901	3881	3861	3840	3820	3800	3779	3759	3739
	-70	4125	4104	4084	4064	4043	4023	4003	3982	3962	3942
	-60	4328	4307	4287	4267	4246	4226	4206	4185	4165	4145
	-50	4531	4510	4490	4470	4449	4429	4409	4388	4368	4348
	-40	4734	4713	4693	4673	4652	4632	4612	4592	4571	4551
	-30	4937	4916	4896	4876	4855	4835	4815	4795	4774	4754
	-20	5140	5119	5099	5079	5058	5038	5018	4998	4977	4957
	-10	5343	5322	5302	5282	5262	5241	5221	5201	5180	5160
	-0	5546	5525	5505	5485	5465	5444	5424	5404	5383	5363
10											
	-100	3515	3495	3475	3455	3434	3414	3394	3373	3353	3333
	-90	3718	3698	3678	3658	3637	3617	3597	3576	3556	3536
	-80	3922	3901	3881	3861	3840	3820	3800	3779	3759	3739
	-70	4125	4104	4084	4064	4043	4023	4003	3982	3962	3942
	-60	4328	4307	4287	4267	4246	4226	4206	4185	4165	4145
	-50	4531	4510	4490	4470	4449	4429	4409	4388	4368	4348
	-40	4734	4713	4693	4673	4652	4632	4612	4592	4571	4551
	-30	4937	4916	4896	4876	4855	4835	4815	4795	4774	4754
	-20	5140	5119	5099	5079	5058	5038	5018	4998	4977	4957
	-10	5343	5322	5302	5282	5262	5241	5221	5201	5180	5160
	-0	5546	5525	5505	5485	5465	5444	5424	5404	5383	5363
	0	5546	5566	5586	5607	5627	5647	5668	5688	5708	5728
	10	5749	5769	5789	5810	5830	5850	5871	5891	5911	5932
	20	5952	5972	5992	6013	6033	6053	6074	6094	6114	6135
	30	6155	6175	6195	6216	6236	6256	6277	6297	6317	6338
	40	6358	6378	6398	6419	6439	6459	6480	6500	6520	6541
20											
	-100	2056	2045	2033	2021	2009	1997	1985	1973	1961	1950
	-90	2175	2163	2151	2140	2128	2116	2104	2092	2080	2068
	-80	2294	2282	2270	2258	2246	2235	2223	2211	2199	2187
	-70	2413	2401	2389	2377	2365	2353	2341	2330	2318	2306
	-60	2531	2520	2508	2496	2484	2472	2460	2448	2436	2425
	-50	2650	2638	2626	2615	2603	2591	2579	2567	2555	2543
	-40	2769	2757	2745	2733	2721	2710	2698	2686	2674	2662
	-30	2888	2876	2864	2852	2840	2828	2817	2805	2793	2781
	-20	3007	2995	2983	2971	2959	2947	2935	2923	2912	2900
	-10	3125	3113	3102	3090	3078	3066	3054	3042	3030	3018
	-0	3244	3232	3220	3208	3197	3185	3173	3161	3149	3137
	0	3244	3256	3268	3280	3292	3303	3315	3327	3339	3351
	10	3363	3375	3387	3398	3410	3422	3434	3446	3458	3470
30											

Table 3.3 Geopotential differences between pairs of standard isobaric surfaces as a function of mean virtual temperature

Différences de géopotentiel entre les surfaces isobares standard prises deux à deux en fonction de la température virtuelle moyenne

p : pressure on standard isobaric surface — *pression dans la surface isobare standard*
t_{mv} : mean virtual temperature — *température virtuelle moyenne*

A Consecutive standard isobaric surfaces
Surfaces isobares standard consécutives

p	t_{mv}	0	1	2	3	4	5	6	7	8	9
mb	°C	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm
500											
	-100	1706	1697	1687	1677	1667	1657	1647	1638	1628	1618
	-90	1805	1795	1785	1775	1766	1756	1746	1736	1726	1716
	-80	1904	1894	1884	1874	1864	1854	1844	1835	1825	1815
	-70	2002	1992	1982	1973	1963	1953	1943	1933	1923	1913
	-60	2101	2091	2081	2071	2061	2051	2042	2032	2022	2012
	-50	2199	2189	2180	2170	2160	2150	2140	2130	2120	2111
	-40	2298	2288	2278	2268	2258	2249	2239	2229	2219	2209
	-30	2396	2387	2377	2367	2357	2347	2337	2327	2318	2308
	-20	2495	2485	2475	2465	2456	2446	2436	2426	2416	2406
	-10	2594	2584	2574	2564	2554	2544	2534	2525	2515	2505
	-0	2692	2682	2672	2662	2653	2643	2633	2623	2613	2603
	0	2692	2702	2712	2722	2731	2741	2751	2761	2771	2781
	10	2791	2800	2810	2820	2830	2840	2850	2860	2869	2879
	20	2889	2899	2909	2919	2929	2938	2948	2958	2968	2978
	30	2988	2998	3007	3017	3027	3037	3047	3057	3067	3076
	40	3086	3096	3106	3116	3126	3136	3145	3155	3165	3175
700											
	-70	1155	1150	1144	1138	1133	1127	1121	1116	1110	1104
	-60	1212	1207	1201	1195	1189	1184	1178	1172	1167	1161
	-50	1269	1263	1258	1252	1246	1241	1235	1229	1224	1218
	-40	1326	1320	1315	1309	1303	1297	1292	1286	1280	1275
	-30	1383	1377	1371	1366	1360	1354	1349	1343	1337	1332
	-20	1440	1434	1428	1423	1417	1411	1406	1400	1394	1388
	-10	1497	1491	1485	1479	1474	1468	1462	1457	1451	1445
	-0	1553	1548	1542	1536	1531	1525	1519	1514	1508	1502
	0	1553	1559	1565	1570	1576	1582	1588	1593	1599	1605
	10	1610	1616	1622	1627	1633	1639	1644	1650	1656	1661
	20	1667	1673	1679	1684	1690	1696	1701	1707	1713	1718
	30	1724	1730	1735	1741	1747	1752	1758	1764	1770	1775
	40	1781	1787	1792	1798	1804	1809	1815	1821	1826	1832
850											
	-70	967	962	958	953	948	943	939	934	929	924
	-60	1015	1010	1005	1000	996	991	986	981	977	972
	-50	1062	1058	1053	1048	1043	1038	1034	1029	1024	1019
	-40	1110	1105	1100	1096	1091	1086	1081	1077	1072	1067
	-30	1157	1153	1148	1143	1138	1134	1129	1124	1119	1115
	-20	1205	1200	1196	1191	1186	1181	1177	1172	1167	1162
	-10	1253	1248	1243	1238	1234	1229	1224	1219	1215	1210
	-0	1300	1296	1291	1286	1281	1276	1272	1267	1262	1257
	0	1300	1305	1310	1315	1319	1324	1329	1334	1338	1343
	10	1348	1353	1357	1362	1367	1372	1376	1381	1386	1391
	20	1395	1400	1405	1410	1415	1419	1424	1429	1434	1438
	30	1443	1448	1453	1457	1462	1467	1472	1476	1481	1486
	40	1491	1495	1500	1505	1510	1515	1519	1524	1529	1534
	50	1538	1543	1548	1553	1557	1562	1567	1572	1576	1581

p mb	t_{mv} °C	0 gpm	1 gpm	2 gpm	3 gpm	4 gpm	5 gpm	6 gpm	7 gpm	8 gpm	9 gpm
10											
	table 3.2										
20											
	table 3.2										
30											
	-100	2591	2576	2561	2546	2531	2516	2501	2486	2471	2456
	-90	2740	2725	2710	2696	2681	2666	2651	2636	2621	2606
	-80	2890	2875	2860	2845	2830	2815	2800	2785	2770	2755
	-70	3040	3025	3010	2995	2980	2965	2950	2935	2920	2905
	-60	3189	3174	3159	3144	3129	3114	3100	3085	3070	3055
	-50	3339	3324	3309	3294	3279	3264	3249	3234	3219	3204
	-40	3489	3474	3459	3444	3429	3414	3399	3384	3369	3354
	-30	3638	3623	3608	3593	3578	3563	3548	3533	3518	3503
	-20	3788	3773	3758	3743	3728	3713	3698	3683	3668	3653
	-10	3937	3922	3907	3893	3878	3863	3848	3833	3818	3803
	-0	4087	4072	4057	4042	4027	4012	3997	3982	3967	3952
	0	4087	4102	4117	4132	4147	4162	4177	4192	4207	4222
	10	4237	4252	4267	4282	4297	4311	4326	4341	4356	4371
	20	4386	4401	4416	4431	4446	4461	4476	4491	4506	4521
	30	4536	4551	4566	4581	4596	4611	4626	4641	4656	4671
50											
	= 500/700										
70											
	-100	1809	1799	1788	1778	1767	1757	1746	1736	1725	1715
	-90	1913	1903	1893	1882	1872	1861	1851	1840	1830	1819
	-80	2018	2007	1997	1987	1976	1966	1955	1945	1934	1924
	-70	2122	2112	2101	2091	2081	2070	2060	2049	2039	2028
	-60	2227	2216	2206	2196	2185	2175	2164	2154	2143	2133
	-50	2331	2321	2310	2300	2290	2279	2269	2258	2248	2237
	-40	2436	2425	2415	2404	2394	2384	2373	2363	2352	2342
	-30	2540	2530	2519	2509	2498	2488	2478	2467	2457	2446
	-20	2645	2634	2624	2613	2603	2593	2582	2572	2561	2551
	-10	2749	2739	2728	2718	2707	2697	2687	2676	2666	2655
	-0	2854	2843	2833	2822	2812	2801	2791	2781	2770	2760
	0	2854	2864	2875	2885	2895	2906	2916	2927	2937	2948
	10	2958	2969	2979	2990	3000	3010	3021	3031	3042	3052
	20	3063	3073	3084	3094	3104	3115	3125	3136	3146	3157
	30	3167	3178	3188	3198	3209	3219	3230	3240	3251	3261
	40	3272	3282	3292	3303	3313	3324	3334	3345	3355	3366
	50	3376	3387	3397	3407	3418	3428	3439	3449	3460	3470
100											
	= 20/30 — table 3.2										
150											
	= 30/40 — table 3.2										
200											
	= 20/30 — table 3.2										
300											
	= 30/40 — table 3.2										
400											
	= 200/250 — table 3.2										
500											

B Selected pairs of non-consecutive standard isobaric surfaces

Surfaces isobares standard non consécutives, choisies par groupes de deux

p mb	t_{mv} °C	0 gpm	1 gpm	2 gpm	3 gpm	4 gpm	5 gpm	6 gpm	7 gpm	8 gpm	9 gpm
100 / 200	= 10/20 table 3.2										
150 / 300	= 10/20 table 3.2										
200 / 400	= 10/20 table 3.2										
300 / 500	= 30/50 table 3.3 — A										
400											
	-70	3330	3314	3297	3281	3264	3248	3232	3215	3199	3182
	-60	3494	3477	3461	3445	3428	3412	3396	3379	3363	3346
	-50	3658	3641	3625	3609	3592	3576	3559	3543	3527	3510
	-40	3822	3805	3789	3773	3756	3740	3723	3707	3691	3674
	-30	3986	3969	3953	3936	3920	3904	3887	3871	3855	3838
	-20	4150	4133	4117	4100	4084	4068	4051	4035	4018	4002
	-10	4313	4297	4281	4264	4248	4232	4215	4199	4182	4166
	-0	4477	4461	4445	4428	4412	4395	4379	4363	4346	4330
	0	4477	4494	4510	4527	4543	4559	4576	4592	4609	4625
	10	4641	4658	4674	4690	4707	4723	4740	4756	4772	4789
	20	4805	4822	4838	4854	4871	4887	4904	4920	4936	4953
	30	4969	4986	5002	5018	5035	5051	5067	5084	5100	5117
	40	5133	5149	5166	5182	5199	5215	5231	5248	5264	5281
700											
500											
	-70	3157	3142	3126	3111	3095	3080	3064	3049	3033	3018
	-60	3313	3297	3282	3266	3251	3235	3220	3204	3189	3173
	-50	3468	3453	3437	3422	3406	3391	3375	3360	3344	3328
	-40	3624	3608	3593	3577	3562	3546	3531	3515	3499	3484
	-30	3779	3764	3748	3733	3717	3701	3686	3670	3655	3639
	-20	3935	3919	3904	3888	3872	3857	3841	3826	3810	3795
	-10	4090	4074	4059	4043	4028	4012	3997	3981	3966	3950
	-0	4245	4230	4214	4199	4183	4168	4152	4137	4121	4106
	0	4245	4261	4277	4292	4308	4323	4339	4354	4370	4385
	10	4401	4416	4432	4448	4463	4479	4494	4510	4525	4541
	20	4556	4572	4587	4603	4618	4634	4650	4665	4681	4696
	30	4712	4727	4743	4758	4774	4789	4805	4821	4836	4852
	40	4867	4883	4898	4914	4929	4945	4960	4976	4992	5007
850											
500 / 1000	= 10/20 table 3.2										
700 / 1000	= 70/100 table 3.3 — A										

TABLE **3.3** — 4

p	t_{mv}	0	1	2	3	4	5	6	7	8	9
mb	°C	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm
10											
	-100	5572	5540	5508	5475	5443	5411	5379	5347	5314	5282
	-90	5894	5861	5829	5797	5765	5733	5701	5668	5636	5604
	-80	6215	6183	6151	6119	6087	6055	6022	5990	5958	5926
	-70	6537	6505	6473	6441	6409	6376	6344	6312	6280	6248
	-60	6859	6827	6795	6763	6730	6698	6666	6634	6602	6569
	-50	7181	7149	7116	7084	7052	7020	6988	6956	6923	6891
	-40	7503	7470	7438	7406	7374	7342	7310	7277	7245	7213
	-30	7824	7792	7760	7728	7696	7664	7631	7599	7567	7535
	-20	8146	8114	8082	8050	8018	7985	7953	7921	7889	7857
	-10	8468	8436	8404	8371	8339	8307	8275	8243	8211	8178
	-0	8790	8758	8725	8693	8661	8629	8597	8565	8532	8500
30											
20											
	-100	4647	4620	4594	4567	4540	4513	4486	4459	4432	4406
	-90	4916	4889	4862	4835	4808	4781	4755	4728	4701	4674
	-80	5184	5157	5130	5103	5077	5050	5023	4996	4969	4942
	-70	5452	5426	5399	5372	5345	5318	5291	5264	5238	5211
	-60	5721	5694	5667	5640	5613	5587	5560	5533	5506	5479
	-50	5989	5962	5935	5909	5882	5855	5828	5801	5774	5748
	-40	6258	6231	6204	6177	6150	6123	6096	6070	6043	6016
	-30	6526	6499	6472	6445	6419	6392	6365	6338	6311	6284
	-20	6794	6767	6741	6714	6687	6660	6633	6606	6580	6553
	-10	7063	7036	7009	6982	6955	6929	6902	6875	6848	6821
	-0	7331	7304	7277	7251	7224	7197	7170	7143	7116	7090
50											
30											
	-100	4297	4272	4248	4223	4198	4173	4148	4124	4099	4074
	-90	4545	4521	4496	4471	4446	4421	4397	4372	4347	4322
	-80	4794	4769	4744	4719	4694	4670	4645	4620	4595	4570
	-70	5042	5017	4992	4967	4943	4918	4893	4868	4843	4818
	-60	5290	5265	5240	5216	5191	5166	5141	5116	5091	5067
	-50	5538	5513	5489	5464	5439	5414	5389	5364	5340	5315
	-40	5786	5762	5737	5712	5687	5662	5637	5613	5588	5563
	-30	6035	6010	5985	5960	5935	5910	5886	5861	5836	5811
	-20	6283	6258	6233	6208	6183	6159	6134	6109	6084	6059
	-10	6531	6506	6481	6456	6432	6407	6382	6357	6332	6308
	-0	6779	6754	6729	6705	6680	6655	6630	6605	6581	6556
70											
50 100	= 10/20 table 3.2										
70											
	-100	3865	3843	3821	3798	3776	3754	3731	3709	3687	3664
	-90	4089	4066	4044	4022	3999	3977	3955	3932	3910	3888
	-80	4312	4290	4267	4245	4223	4200	4178	4156	4133	4111
	-70	4535	4513	4490	4468	4446	4423	4401	4379	4356	4334
	-60	4758	4736	4714	4691	4669	4647	4624	4602	4580	4557
	-50	4982	4959	4937	4915	4892	4870	4848	4825	4803	4781
	-40	5205	5182	5160	5138	5116	5093	5071	5049	5026	5004
	-30	5428	5406	5383	5361	5339	5316	5294	5272	5249	5227
	-20	5651	5629	5607	5584	5562	5540	5517	5495	5473	5450
	-10	5875	5852	5830	5808	5785	5763	5741	5718	5696	5674
	-0	6098	6075	6053	6031	6008	5986	5964	5941	5919	5897
	0	6098	6120	6142	6165	6187	6209	6232	6254	6276	6299
150											

Table 3.4.1 Geopotential differences between standard isobaric surfaces and surfaces of given pressure below them, with mean virtual temperature 0° C

Différences de géopotentiel entre les surfaces isobares standard et les surfaces de pression donnée situées au-dessous d'elles, pour une température virtuelle moyenne de 0° C

p_2 : pressure of standard isobaric surfaces — *pression des surfaces isobares standard*
p_1 : pressure of given isobaric surfaces — *pression des surfaces isobares données*

p_2	p_1	0	1	2	3	4	5	6	7	8	9
mb	mb	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm
	850	0	9	19	28	38	47	56	66	75	84
	860	94	103	112	121	131	140	149	158	168	177
	870	186	195	204	214	223	232	241	250	259	268
	880	278	287	296	305	314	323	332	341	350	359
	890	368	377	386	395	404	413	422	431	440	448
	900	457	466	475	484	493	502	510	519	528	537
	910	546	555	563	572	581	590	598	607	616	624
850	920	633	642	651	659	668	677	685	694	702	711
	930	720	728	737	745	754	763	771	780	788	797
	940	805	814	822	831	839	848	856	865	873	881
	950	890	898	907	915	924	932	940	949	957	965
	960	974	982	990	999	1007	1015	1024	1032	1040	1048
	970	1057	1065	1073	1081	1090	1098	1106	1114	1122	1130
	980	1139	1147	1155	1163	1171	1179	1187	1196	1204	1212
	990	1220	1228	1236	1244	1252	1260	1268	1276	1284	1292
	1000	0	8	16	24	32	40	48	56	64	72
	1010	80	88	95	103	111	119	127	135	143	151
	1020	158	166	174	182	190	198	205	213	221	229
	1030	236	244	252	260	268	275	283	291	298	306
	1040	314	321	329	337	345	352	360	367	375	383
1000	1050	390	398	406	413	421	428	436	444	451	459
	1060	466	474	481	489	496	504	511	519	526	534
	1070	541	549	556	564	571	579	586	593	601	608
	1080	616	623	631	638	645	653	660	667	675	682
	1090	689	697	704	711	719	726	733	741	748	755

Table 3.4.1′

p_2	p_1	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
mb	mb	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm
	1000	0	1	2	2	3	4	5	6	6	7
	1001	8	9	10	10	11	12	13	14	14	15
	1002	16	17	18	18	19	20	21	22	22	23
	1003	24	25	26	26	27	28	29	30	30	31
	1004	32	33	34	34	35	36	37	38	38	39
	1005	40	41	41	42	43	44	45	45	46	47
	1006	48	49	49	50	51	52	53	53	54	55
	1007	56	57	57	58	59	60	61	61	62	63
	1008	64	65	65	66	67	68	69	69	70	71
	1009	72	72	73	74	75	76	76	77	78	79
	1010	80	80	81	82	83	84	84	85	86	87
	1011	88	88	89	90	91	91	92	93	94	95
	1012	95	96	97	98	99	99	100	101	102	103
	1013	103	104	105	106	106	107	108	109	110	110
	1014	111	112	113	114	114	115	116	117	118	118
1000	1015	119	120	121	121	122	123	124	125	125	126
	1016	127	128	129	129	130	131	132	133	133	134
	1017	135	136	136	137	138	139	140	140	141	142
	1018	143	144	144	145	146	147	147	148	149	150
	1019	151	151	152	153	154	155	155	156	157	158
	1020	158	159	160	161	162	162	163	164	165	165
	1021	166	167	168	169	169	170	171	172	173	173
	1022	174	175	176	176	177	178	179	180	180	181
	1023	182	183	183	184	185	186	187	187	188	189
	1024	190	191	191	192	193	194	194	195	196	197
	1025	198	198	199	200	201	201	202	203	204	205
	1026	205	206	207	208	208	209	210	211	212	212
	1027	213	214	215	215	216	217	218	219	219	220
	1028	221	222	223	223	224	225	226	226	227	228
	1029	229	230	230	231	232	233	233	234	235	236

Table 3.4.2 Geopotential differences between standard isobaric surfaces and surfaces of given pressure above them, with mean virtual temperature 0° C

Différences de géopotentiel entre les surfaces isobares standard et les surfaces de pression donnée situées au-dessus d'elles, pour une température virtuelle moyenne de 0° C

p_1 : pressure of standard isobaric surfaces — *pression des surfaces isobares standard*
p_2 : pressure of given isobaric surfaces — *pression des surfaces isobares données*

p_1	p_2	0	1	2	3	4	5	6	7	8	9
mb	mb	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm
	500	2692	2676	2660	2644	2628	2612	2597	2581	2565	2550
	510	2534	2518	2502	2487	2471	2456	2440	2425	2409	2394
	520	2378	2363	2348	2332	2317	2302	2286	2271	2256	2241
	530	2226	2211	2196	2181	2166	2151	2136	2121	2106	2091
	540	2076	2062	2047	2032	2017	2003	1988	1973	1959	1944
	550	1929	1915	1900	1886	1872	1857	1843	1828	1814	1800
	560	1785	1771	1757	1743	1728	1714	1700	1686	1672	1658
	570	1644	1630	1616	1602	1588	1574	1560	1546	1532	1518
	580	1505	1491	1477	1463	1450	1436	1422	1409	1395	1381
	590	1368	1354	1341	1327	1314	1300	1287	1273	1260	1247
700											
	600	1233	1220	1207	1193	1180	1167	1154	1141	1127	1114
	610	1101	1088	1075	1062	1049	1036	1023	1010	997	984
	620	971	958	945	932	920	907	894	881	868	856
	630	843	830	818	805	792	780	767	755	742	729
	640	717	704	692	680	667	655	642	630	618	605
	650	693	581	568	556	544	532	519	507	495	483
	660	471	459	447	434	422	410	398	386	374	362
	670	350	339	327	315	303	291	279	267	255	244
	680	232	220	208	197	185	173	162	150	138	127
	690	115	104	92	80	69	57	46	34	23	11
	700	1553	1542	1531	1519	1508	1496	1485	1474	1462	1451
	710	1440	1429	1417	1406	1395	1384	1373	1361	1350	1339
	720	1328	1317	1306	1295	1284	1273	1262	1251	1240	1229
	730	1218	1207	1196	1185	1174	1163	1152	1141	1130	1120
	740	1109	1098	1087	1076	1066	1055	1044	1033	1023	1012
	750	1001	991	980	969	959	948	938	927	917	906
	760	895	885	874	864	853	843	833	822	812	801
	770	791	780	770	760	749	739	729	718	708	698
850	780	688	677	667	657	647	636	626	616	606	596
	790	586	576	565	555	545	535	525	515	505	495
	800	485	475	465	455	445	435	425	415	405	396
	810	386	376	366	356	346	336	327	317	307	297
	820	287	278	268	258	249	239	229	219	210	200
	830	191	181	171	162	152	142	133	123	114	104
	840	95	85	76	66	57	47	38	28	19	9
	850	1300	1291	1281	1272	1263	1253	1244	1235	1225	1216
	860	1207	1197	1188	1179	1170	1160	1151	1142	1133	1123
	870	1114	1105	1096	1087	1078	1068	1059	1050	1041	1032
	880	1023	1014	1005	996	986	977	968	959	950	941
	890	932	923	914	905	896	888	879	870	861	852
	900	843	834	825	816	807	799	790	781	772	763
	910	755	746	737	728	719	711	702	693	685	676
1000	920	667	658	650	641	632	624	615	606	598	589
	930	581	572	563	555	546	538	529	521	512	504
	940	495	487	478	470	461	453	444	436	427	419
	950	410	402	394	385	377	368	360	352	343	335
	960	327	318	310	302	293	285	277	268	260	252
	970	244	235	227	219	211	203	194	186	178	170
	980	162	153	145	137	129	121	113	105	97	88
	990	80	72	64	56	48	40	32	24	16	8

TABLE 3.4 — 3

p_1	p_2	0	1	2	3	4	5	6	7	8	9
mb	mb	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm
10		....	....	....	....	....	5546	4087	2854	1785	843
20	10	5546	4783	4087	3447	2854	2302	1785	1300	843	410
30	20	3244	2854	2481	2126	1785	1459	1145	843	552	271
50	30	4087	3825	3571	3324	3086	2854	2628	2409	2196	1988
	40	1785	1588	1395	1207	1023	843	667	495	327	162
70	50	2692	2534	2378	2226	2076	1929	1785	1644	1505	1368
	60	1233	1101	971	843	717	593	471	350	232	115
	70	2854	2740	2628	2518	2409	2302	2196	2091	1988	1886
100	80	1785	1686	1588	1491	1395	1300	1207	1114	1023	932
	90	843	755	667	581	495	410	327	244	162	80
	100	3244	3164	3086	3008	2930	2854	2778	2703	2628	2555
	110	2481	2409	2337	2266	2196	2126	2057	1988	1920	1852
150	120	1785	1719	1653	1588	1523	1459	1395	1332	1269	1207
	130	1145	1084	1023	962	902	843	784	725	667	609
	140	552	495	439	382	327	271	216	162	107	54
	150	2302	2249	2196	2143	2091	2039	1988	1937	1886	1835
	160	1785	1735	1686	1637	1588	1539	1491	1443	1395	1347
200	170	1300	1253	1207	1160	1114	1068	1023	977	932	888
	180	843	799	755	711	667	624	581	538	495	453
	190	410	368	327	285	244	203	162	121	80	40
	200	3244	3204	3164	3125	3086	3046	3008	2969	2930	2892
	210	2854	2816	2778	2740	2703	2665	2628	2591	2555	2518
	220	2481	2445	2409	2373	2337	2302	2266	2231	2196	2161
	230	2126	2091	2057	2022	1988	1954	1920	1886	1852	1819
	240	1785	1752	1719	1686	1653	1620	1588	1555	1523	1491
300	250	1459	1427	1395	1363	1332	1300	1269	1238	1207	1176
	260	1145	1114	1084	1053	1023	993	962	932	902	873
	270	843	813	784	755	725	696	667	638	609	581
	280	552	523	495	467	439	410	382	354	327	299
	290	271	244	216	189	162	134	107	80	54	27
	300	2302	2275	2249	2222	2196	2169	2143	2117	2091	2065
	310	2039	2014	1988	1962	1937	1911	1886	1861	1835	1810
	320	1785	1760	1735	1711	1686	1661	1637	1612	1588	1563
	330	1539	1515	1491	1467	1443	1419	1395	1371	1347	1324
	340	1300	1277	1253	1230	1207	1183	1160	1137	1114	1091
400	350	1068	1046	1023	1000	977	955	932	910	888	865
	360	843	821	799	777	755	733	711	689	667	645
	370	624	602	581	559	538	516	495	474	453	431
	380	410	389	368	347	327	306	285	264	244	223
	390	203	182	162	141	121	101	80	60	40	20
	400	1785	1765	1745	1726	1706	1686	1666	1647	1627	1607
	410	1588	1568	1549	1529	1510	1491	1472	1452	1433	1414
	420	1395	1376	1357	1338	1319	1300	1281	1263	1244	1225
	430	1207	1188	1170	1151	1133	1114	1096	1078	1059	1041
	440	1023	1005	986	968	950	932	914	896	879	861
500	450	843	825	807	790	772	755	737	719	702	685
	460	667	650	632	615	598	581	563	546	529	512
	470	495	478	461	444	427	410	394	377	360	343
	480	327	310	293	277	260	244	227	211	194	178
	490	162	145	129	113	97	80	64	48	32	16

Table 3.4.3 **Correction to geopotential differences as a function of departure of mean virtual temperature from 0° C**

Correction à appliquer aux différences de géopotentiel en fonction de l'écart entre la température virtuelle moyenne et 0° C

$\Delta\Phi_0$: geopotential difference in gpm with mean virtual temperature 0° C
différence de géopotentiel, en gpm, pour une température virtuelle moyenne de 0° C

t_{mv} : mean virtual temperature in ° C — *température virtuelle moyenne en ° C*

$\Delta\Phi_t$ (tabulated values in gpm — *valeurs tabulaires en* gpm) :

correction to be added to / subtracted from $\Delta\Phi_0$ for t_{mv} positive / negative

correction à ajouter à / soustraire de $\Delta\Phi_0$ *lorsque* t_{mv} *est positif / négatif*

TABLE 3.4 — 5

$\Delta\Phi_0$ / t_{mv}	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210
1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
2	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
3	0	0	0	0	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
4	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3
5	0	0	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	3	4	4
6	0	0	1	1	1	1	2	2	2	2	2	3	3	3	3	4	4	4	4	4	5
7	0	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5
8	0	1	1	1	1	2	2	2	3	3	3	4	4	4	4	5	5	5	6	6	6
9	0	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	7	7
10	0	1	1	1	2	2	3	3	3	4	4	4	5	5	5	6	6	7	7	7	8
11	0	1	1	2	2	2	3	3	4	4	4	5	5	6	6	6	7	7	8	8	8
12	0	1	1	2	2	3	3	4	4	4	5	5	6	6	7	7	7	8	8	9	9
13	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10
14	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11
15	1	1	2	2	3	3	4	4	5	5	6	7	7	8	8	9	9	10	10	11	12
16	1	1	2	2	3	4	4	5	5	6	6	7	8	8	9	9	10	11	11	12	12
17	1	1	2	2	3	4	4	5	6	6	7	7	8	9	9	10	11	11	12	12	13
18	1	1	2	3	3	4	5	5	6	7	7	8	9	9	10	11	11	12	13	13	14
19	1	1	2	3	3	4	5	6	6	7	8	8	9	10	10	11	12	13	13	14	15
20	1	1	2	3	4	4	5	6	7	7	8	9	10	10	11	12	12	13	14	15	15
21	1	2	2	3	4	5	5	6	7	8	8	9	10	11	12	12	13	14	15	15	16
22	1	2	2	3	4	5	6	6	7	8	9	10	10	11	12	13	14	14	15	16	17
23	1	2	3	3	4	5	6	7	8	8	9	10	11	12	13	13	14	15	16	17	18
24	1	2	3	4	4	5	6	7	8	9	10	11	11	12	13	14	15	16	17	18	18
25	1	2	3	4	5	5	6	7	8	9	10	11	12	13	14	15	16	16	17	18	19
26	1	2	3	4	5	6	7	8	9	10	10	11	12	13	14	15	16	17	18	19	20
27	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
28	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	21	22
29	1	2	3	4	5	6	7	8	10	11	12	13	14	15	16	17	18	19	20	21	22
30	1	2	3	4	5	7	8	9	10	11	12	13	14	15	16	18	19	20	21	22	23
31	1	2	3	5	6	7	8	9	10	11	12	14	15	16	17	18	19	20	22	23	24
32	1	2	4	5	6	7	8	9	11	12	13	14	15	16	18	19	20	21	22	23	25
33	1	2	4	5	6	7	8	10	11	12	13	14	16	17	18	19	21	22	23	24	25
34	1	2	4	5	6	7	9	10	11	12	14	15	16	17	19	20	21	22	24	25	26
35	1	3	4	5	6	8	9	10	12	13	14	15	17	18	19	21	22	23	24	26	27
36	1	3	4	5	7	8	9	11	12	13	14	16	17	18	20	21	22	24	25	26	28
37	1	3	4	5	7	8	9	11	12	14	15	16	18	19	20	22	23	24	26	27	28
38	1	3	4	6	7	8	10	11	13	14	15	17	18	19	21	22	24	25	26	28	29
39	1	3	4	6	7	9	10	11	13	14	16	17	19	20	21	23	24	26	27	29	30
40	1	3	4	6	7	9	10	12	13	15	16	18	19	21	22	23	25	26	28	29	31
41	2	3	5	6	8	9	11	12	14	15	17	18	20	21	23	24	26	27	29	30	32
42	2	3	5	6	8	9	11	12	14	15	17	18	20	22	23	25	26	28	29	31	32
43	2	3	5	6	8	9	11	13	14	16	17	19	20	22	24	25	27	28	30	31	33
44	2	3	5	6	8	10	11	13	14	16	18	19	21	23	24	26	27	29	31	32	34
45	2	3	5	7	8	10	12	13	15	16	18	20	21	23	25	26	28	30	31	33	35
46	2	3	5	7	8	10	12	13	15	17	19	20	22	24	25	27	29	30	32	34	35
47	2	3	5	7	9	10	12	14	15	17	19	21	22	24	26	28	29	31	33	34	36
48	2	4	5	7	9	11	12	14	16	18	19	21	23	25	26	28	30	32	33	35	37
49	2	4	5	7	9	11	13	14	16	18	20	22	23	25	27	29	30	32	34	36	38
50	2	4	5	7	9	11	13	15	16	18	20	22	24	26	27	29	31	33	35	37	38
51	2	4	6	7	9	11	13	15	17	19	21	22	24	26	28	30	32	34	35	37	39
52	2	4	6	8	10	11	13	15	17	19	21	23	25	27	29	30	32	34	36	38	40
53	2	4	6	8	10	12	14	16	17	19	21	23	25	27	29	31	33	35	37	39	41
54	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
55	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
56	2	4	6	8	10	12	14	16	18	21	23	25	27	29	31	33	35	37	39	41	43
57	2	4	6	8	10	13	15	17	19	21	23	25	27	29	31	33	35	38	40	42	44
58	2	4	6	8	11	13	15	17	19	21	23	25	28	30	32	34	36	38	40	42	45
59	2	4	6	9	11	13	15	17	19	22	24	26	28	30	32	35	37	39	41	43	45
60	2	4	7	9	11	13	15	18	20	22	24	26	29	31	33	35	37	40	42	44	46
61	2	4	7	9	11	13	16	18	20	22	25	27	29	31	33	36	38	40	42	45	47
62	2	5	7	9	11	14	16	18	20	23	25	27	30	32	34	36	39	41	43	45	48
63	2	5	7	9	12	14	16	18	21	23	25	28	30	32	35	37	39	42	44	46	48
64	2	5	7	9	12	14	16	19	21	23	26	28	30	33	35	37	40	42	45	47	49
65	2	5	7	10	12	14	17	19	21	24	26	29	31	33	36	38	40	43	45	48	50
66	2	5	7	10	12	14	17	19	22	24	27	29	31	34	36	39	41	43	46	48	51
67	2	5	7	10	12	15	17	20	22	25	27	29	32	34	37	39	42	44	47	49	52
68	2	5	7	10	12	15	17	20	22	25	27	30	32	35	37	40	42	45	47	50	52
69	3	5	8	10	13	15	18	20	23	25	28	30	33	35	38	40	43	45	48	51	53
70	3	5	8	10	13	15	18	21	23	26	28	31	33	36	38	41	44	46	49	51	54

TABLE 3.4 — 6

t_{mv} \ $\Delta\Phi_0$	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350	360	370	380	390	400	410
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3
3	2	2	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	5
4	3	3	3	4	4	4	4	4	4	4	5	5	5	5	5	5	5	6	6	6	6
5	4	4	4	4	5	5	5	5	5	5	6	6	6	6	6	7	7	7	7	7	8
6	5	5	5	5	5	6	6	6	6	7	7	7	7	7	8	8	8	8	9	9	9
7	5	6	6	6	6	7	7	7	7	8	8	8	8	9	9	9	9	10	10	10	11
8	6	6	7	7	7	8	8	8	8	9	9	9	10	10	10	11	11	11	11	12	12
9	7	7	8	8	8	9	9	9	10	10	10	11	11	11	12	12	12	13	13	13	14
10	8	8	8	9	9	10	10	10	11	11	11	12	12	12	13	13	14	14	14	15	15
11	8	9	9	10	10	10	11	11	12	12	12	13	13	14	14	14	15	15	16	16	17
12	9	10	10	11	11	11	12	12	13	13	14	14	14	15	15	16	16	17	17	18	18
13	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20
14	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	21	21
15	12	12	13	13	14	14	15	15	16	16	17	18	18	19	19	20	20	21	21	22	23
16	12	13	13	14	15	15	16	16	17	18	18	19	19	20	21	21	22	22	23	23	24
17	13	14	14	15	16	16	17	17	18	19	19	20	21	21	22	22	23	24	24	25	26
18	14	14	15	16	16	17	18	18	19	20	20	21	22	22	23	24	24	25	26	26	27
19	15	15	16	17	17	18	19	19	20	21	22	22	23	24	24	25	26	26	27	28	29
20	15	16	17	18	18	19	20	21	21	22	23	23	24	25	26	26	27	28	29	29	30
21	16	17	18	18	19	20	21	22	22	23	24	25	25	26	27	28	28	29	30	31	32
22	17	18	19	19	20	21	22	23	23	24	25	26	27	27	28	29	30	31	31	32	33
23	18	19	19	20	21	22	23	24	24	25	26	27	28	29	29	30	31	32	33	34	35
24	18	19	20	21	22	23	24	25	25	26	27	28	29	30	31	32	33	33	34	35	36
25	19	20	21	22	23	24	25	26	27	27	28	29	30	31	32	33	34	35	36	37	38
26	20	21	22	23	24	25	26	27	28	29	30	30	31	32	33	34	35	36	37	38	39
27	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
28	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
29	22	23	24	25	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	44
30	23	24	25	26	27	29	30	31	32	33	34	35	36	37	38	40	41	42	43	44	45
31	24	25	26	27	28	30	31	32	33	34	35	36	37	39	40	41	42	43	44	45	47
32	25	26	27	28	29	30	32	33	34	35	36	37	39	40	41	42	43	45	46	47	48
33	25	27	28	29	30	31	33	34	35	36	37	39	40	41	42	43	45	46	47	48	50
34	26	27	29	30	31	32	34	35	36	37	39	40	41	42	44	45	46	47	49	50	51
35	27	28	29	31	32	33	35	36	37	38	40	41	42	44	45	46	47	49	50	51	53
36	28	29	30	32	33	34	36	37	38	40	41	42	43	45	46	47	49	50	51	53	54
37	28	30	31	33	34	35	37	38	39	41	42	43	45	46	47	49	50	51	53	54	56
38	29	31	32	33	35	36	38	39	40	42	43	45	46	47	49	50	51	53	54	56	57
39	30	31	33	34	36	37	39	40	41	43	44	46	47	49	50	51	53	54	56	57	59
40	31	32	34	35	37	38	40	41	42	44	45	47	48	50	51	53	54	56	57	59	60
41	32	33	35	36	38	39	41	42	44	45	47	48	50	51	53	54	56	57	59	60	62
42	32	34	35	37	38	40	42	43	45	46	48	49	51	52	54	55	57	58	60	62	63
43	33	35	36	38	39	41	43	44	46	47	49	50	52	54	55	57	58	60	61	63	65
44	34	35	37	39	40	42	43	45	47	48	50	52	53	55	56	58	60	61	63	64	66
45	35	36	38	40	41	43	44	46	48	49	51	53	54	56	58	59	61	63	64	66	68
46	35	37	39	40	42	44	45	47	49	51	52	54	56	57	59	61	62	64	66	67	69
47	36	38	40	41	43	45	46	48	50	52	53	55	57	59	60	62	64	65	67	69	71
48	37	39	40	42	44	46	47	49	51	53	54	56	58	60	62	63	65	67	69	70	72
49	38	39	41	43	45	47	48	50	52	54	56	57	59	61	63	65	66	68	70	72	74
50	38	40	42	44	46	48	49	51	53	55	57	59	60	62	64	66	68	70	71	73	75
51	39	41	43	45	47	49	50	52	54	56	58	60	62	63	65	67	69	71	73	75	77
52	40	42	44	46	48	49	51	53	55	57	59	61	63	65	67	69	70	72	74	76	78
53	41	43	45	47	49	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80
54	42	43	45	47	49	51	53	55	57	59	61	63	65	67	69	71	73	75	77	79	81
55	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	77	79	81	83
56	43	45	47	49	51	53	55	57	59	62	64	66	68	70	72	74	76	78	80	82	84
57	44	46	48	50	52	54	56	58	61	63	65	67	69	71	73	75	77	79	81	83	86
58	45	47	49	51	53	55	57	59	62	64	66	68	70	72	74	76	79	81	83	85	87
59	45	48	50	52	54	56	58	60	63	65	67	69	71	73	76	78	80	82	84	86	89
60	46	48	51	53	55	57	59	62	64	66	68	70	72	75	77	79	81	83	86	88	90
61	47	49	51	54	56	58	60	63	65	67	69	71	74	76	78	80	83	85	87	89	92
62	48	50	52	54	57	59	61	64	66	68	70	73	75	77	79	82	84	86	89	91	93
63	48	51	53	55	58	60	62	65	67	69	71	74	76	78	81	83	85	88	90	92	95
64	49	52	54	56	59	61	63	66	68	70	73	75	77	80	82	84	87	89	91	94	96
65	50	52	55	57	59	62	64	67	69	71	74	76	79	81	83	86	88	90	93	95	98
66	51	53	56	58	60	63	65	68	70	72	75	77	80	82	85	87	89	92	94	97	99
67	52	54	56	59	61	64	66	69	71	74	76	78	81	83	86	88	91	93	96	98	101
68	52	55	57	60	62	65	67	70	72	75	77	80	82	85	87	90	92	95	97	100	102
69	53	56	58	61	63	66	68	71	73	76	78	81	83	86	88	91	93	96	99	101	104
70	54	56	59	62	64	67	69	72	74	77	79	82	85	87	90	92	95	97	100	103	105

t_{mv} \ $\Delta\Phi_0$	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590	600	610
1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
2	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4
3	5	5	5	5	5	5	5	5	5	5	6	6	6	6	6	6	6	6	6	7	7
4	6	6	6	6	7	7	7	7	7	7	7	8	8	8	8	8	8	8	9	9	9
5	8	8	8	8	8	8	9	9	9	9	9	10	10	10	10	10	10	11	11	11	11
6	9	9	9	10	10	10	10	11	11	11	11	11	12	12	12	12	13	13	13	13	13
7	11	11	11	11	12	12	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16
8	12	12	13	13	13	13	14	14	14	15	15	15	16	16	16	16	17	17	17	18	18
9	14	14	14	14	15	15	15	16	16	16	17	17	17	18	18	18	19	19	19	20	20
10	15	15	16	16	16	17	17	18	18	18	19	19	19	20	20	21	21	21	22	22	22
11	17	17	17	18	18	19	19	19	20	20	21	21	21	22	22	23	23	23	24	24	25
12	18	18	19	19	20	20	21	21	22	22	22	23	23	24	24	25	25	25	26	26	27
13	20	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29
14	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31
15	23	23	24	24	25	25	26	26	27	27	28	29	29	30	30	31	31	32	32	33	33
16	24	25	25	26	26	27	28	28	29	29	30	30	31	32	32	33	33	34	35	35	36
17	26	26	27	27	28	29	29	30	30	31	32	32	33	34	34	35	35	36	37	37	38
18	27	28	28	29	30	30	31	32	32	33	34	34	35	36	36	37	38	38	39	40	40
19	29	29	30	31	31	32	33	33	34	35	35	36	37	38	38	39	40	40	41	42	42
20	30	31	31	32	33	34	34	35	36	37	37	38	39	40	40	41	42	42	43	44	45
21	32	32	33	34	35	35	36	37	38	38	39	40	41	42	42	43	44	45	45	46	47
22	33	34	35	35	36	37	38	39	39	40	41	42	43	43	44	45	46	47	48	48	49
23	35	35	36	37	38	39	40	40	41	42	43	44	45	45	46	47	48	49	50	51	51
24	36	37	38	39	40	40	41	42	43	44	45	46	47	47	48	49	50	51	52	53	54
25	38	38	39	40	41	42	43	44	45	46	47	48	49	49	50	51	52	53	54	55	56
26	39	40	41	42	43	44	45	46	47	48	49	49	50	51	52	53	54	55	56	57	58
27	41	42	43	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
28	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	62	63
29	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	61	62	63	64	65
30	45	46	47	48	49	51	52	53	54	55	56	57	58	59	60	62	63	64	65	66	67
31	47	48	49	50	51	52	53	54	56	57	58	59	60	61	62	64	65	66	67	68	69
32	48	49	50	52	53	54	55	56	57	59	60	61	62	63	64	66	67	68	69	70	71
33	50	51	52	53	54	56	57	58	59	60	62	63	64	65	66	68	69	70	71	72	74
34	51	52	54	55	56	57	59	60	61	62	63	65	66	67	68	70	71	72	73	75	76
35	53	54	55	56	58	59	60	62	63	64	65	67	68	69	70	72	73	74	76	77	78
36	54	55	57	58	59	61	62	63	65	66	67	69	70	71	72	74	75	76	78	79	80
37	56	57	58	60	61	62	64	65	66	68	69	70	72	73	74	76	77	79	80	81	83
38	57	58	60	61	63	64	65	67	68	70	71	72	74	75	77	78	79	81	82	83	85
39	59	60	61	63	64	66	67	69	70	71	73	74	76	77	79	80	81	83	84	86	87
40	60	62	63	64	66	67	69	70	72	73	75	76	78	79	81	82	83	85	86	88	89
41	62	63	65	66	68	69	71	72	74	75	77	78	80	81	83	84	86	87	89	90	92
42	63	65	66	68	69	71	72	74	75	77	78	80	81	83	85	86	88	89	91	92	94
43	65	66	68	69	71	72	74	76	77	79	80	82	83	85	87	88	90	91	93	94	96
44	66	68	69	71	72	74	76	77	79	81	82	84	85	87	89	90	92	93	95	97	98
45	68	69	71	72	74	76	77	79	81	82	84	86	87	89	91	92	94	96	97	99	100
46	69	71	72	74	76	77	79	81	83	84	86	88	89	91	93	94	96	98	99	101	103
47	71	72	74	76	77	79	81	83	84	86	88	89	91	93	95	96	98	100	102	103	105
48	72	74	76	77	79	81	83	84	86	88	90	91	93	95	97	98	100	102	104	105	107
49	74	75	77	79	81	83	84	86	88	90	91	93	95	97	99	100	102	104	106	108	109
50	75	77	79	81	82	84	86	88	90	92	93	95	97	99	101	103	104	106	108	110	112
51	77	78	80	82	84	86	88	90	91	93	95	97	99	101	103	105	106	108	110	112	114
52	78	80	82	84	86	88	89	91	93	95	97	99	101	103	105	107	109	110	112	114	116
53	80	81	83	85	87	89	91	93	95	97	99	101	103	105	107	109	111	113	114	116	118
54	81	83	85	87	89	91	93	95	97	99	101	103	105	107	109	111	113	115	117	119	121
55	83	85	87	89	91	93	95	97	99	101	103	105	107	109	111	113	115	117	119	121	123
56	84	86	88	90	92	94	96	98	100	103	105	107	109	111	113	115	117	119	121	123	125
57	86	88	90	92	94	96	98	100	102	104	106	109	111	113	115	117	119	121	123	125	127
58	87	89	91	93	96	98	100	102	104	106	108	110	113	115	117	119	121	123	125	127	130
59	89	91	93	95	97	99	102	104	106	108	110	112	114	117	119	121	123	125	127	130	132
60	90	92	94	97	99	101	103	105	108	110	112	114	116	119	121	123	125	127	130	132	134
61	92	94	96	98	100	103	105	107	109	112	114	116	118	121	123	125	127	130	132	134	136
62	93	95	98	100	102	104	107	109	111	113	116	118	120	123	125	127	129	132	134	136	138
63	95	97	99	101	104	106	108	111	113	115	118	120	122	125	127	129	131	134	136	138	141
64	96	98	101	103	105	108	110	112	115	117	119	122	124	127	129	131	134	136	138	141	143
65	98	100	102	105	107	109	112	114	117	119	121	124	126	128	131	133	136	138	140	143	145
66	99	101	104	106	109	111	114	116	118	121	123	126	128	130	133	135	138	140	143	145	147
67	101	103	105	108	110	113	115	118	120	123	125	128	130	132	135	137	140	142	145	147	150
68	102	105	107	110	112	115	117	119	122	124	127	129	132	134	137	139	142	144	147	149	152
69	104	106	109	111	114	116	119	121	124	126	129	131	134	136	139	141	144	147	149	152	154
70	105	108	110	113	115	118	120	123	126	128	131	133	136	138	141	144	146	149	151	154	156

TABLE 3.4 — 8

t_{mv} \ $\Delta\Phi_0$	610	620	630	640	650	660	670	680	690	700	710	720	730	740	750	760	770	780	790	800	810
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2	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	6	6	6	6	6	6
3	7	7	7	7	7	7	7	7	8	8	8	8	8	8	8	8	8	9	9	9	9
4	9	9	9	9	10	10	10	10	10	10	10	11	11	11	11	11	11	11	12	12	12
5	11	11	12	12	12	12	12	12	13	13	13	13	13	14	14	14	14	14	14	15	15
6	13	14	14	14	14	14	15	15	15	15	16	16	16	16	16	17	17	17	17	18	18
7	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	21	21
8	18	18	18	19	19	19	20	20	20	21	21	21	21	22	22	22	23	23	23	23	24
9	20	20	21	21	21	22	22	22	23	23	23	24	24	24	25	25	25	26	26	26	27
10	22	23	23	23	24	24	25	25	25	26	26	26	27	27	27	28	28	29	29	29	30
11	25	25	25	26	26	27	27	27	28	28	29	29	29	30	30	31	31	31	32	32	33
12	27	27	28	28	29	29	29	30	30	31	31	32	32	33	33	33	34	34	35	35	36
13	29	30	30	30	31	31	32	32	33	33	34	34	35	35	36	36	37	37	38	38	39
14	31	32	32	33	33	34	34	35	35	36	36	37	37	38	38	39	39	40	40	41	42
15	33	34	34	35	36	36	37	37	38	38	39	40	40	41	41	42	42	43	43	44	44
16	36	36	37	37	38	39	39	40	40	41	42	42	43	43	44	45	45	46	46	47	47
17	38	39	39	40	40	41	42	42	43	44	44	45	45	46	47	47	48	49	49	50	50
18	40	41	42	42	43	43	44	45	45	46	47	47	48	49	49	50	51	51	52	53	53
19	42	43	44	45	45	46	47	47	48	49	49	50	51	51	52	53	54	54	55	56	56
20	45	45	46	47	48	48	49	50	51	51	52	53	53	54	55	56	56	57	58	59	59
21	47	48	48	49	50	51	52	52	53	54	55	55	56	57	58	58	59	60	61	62	62
22	49	50	51	52	52	53	54	55	56	56	57	58	59	60	60	61	62	63	64	64	65
23	51	52	53	54	55	56	56	57	58	59	60	61	61	62	63	64	65	66	67	67	68
24	54	54	55	56	57	58	59	60	61	62	62	63	64	65	66	67	68	69	69	70	71
25	56	57	58	59	59	60	61	62	63	64	65	66	67	63	69	70	70	71	72	73	74
26	58	59	60	61	62	63	64	65	66	67	68	69	69	70	71	72	73	74	75	76	77
27	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
28	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
29	65	66	67	68	69	70	71	72	73	74	75	76	78	79	80	81	82	83	84	85	86
30	67	68	69	70	71	72	74	75	76	77	78	79	80	81	82	83	85	86	87	88	89
31	69	70	71	73	74	75	76	77	78	79	81	82	83	84	85	86	87	89	90	91	92
32	71	73	74	75	76	77	78	80	81	82	83	84	86	87	88	89	90	91	93	94	95
33	74	75	76	77	79	80	81	82	83	85	86	87	88	89	91	92	93	94	95	97	98
34	76	77	78	80	81	82	83	85	86	87	88	90	91	92	93	95	96	97	98	100	101
35	78	79	81	82	83	85	86	87	88	90	91	92	94	95	96	97	99	100	101	103	104
36	80	82	83	84	86	87	88	90	91	92	94	95	96	98	99	100	101	103	104	105	107
37	83	84	85	87	88	89	91	92	93	95	96	98	99	100	102	103	104	106	107	108	110
38	85	86	88	89	90	92	93	95	96	97	99	100	102	103	104	106	107	109	110	111	113
39	87	89	90	91	93	94	96	97	99	100	101	103	104	106	107	109	110	111	113	114	116
40	89	91	92	94	95	97	98	100	101	103	104	105	107	108	110	111	113	114	116	117	119
41	92	93	95	96	98	99	101	102	104	105	107	108	110	111	113	114	116	117	119	120	122
42	94	95	97	98	100	101	103	105	106	108	109	111	112	114	115	117	118	120	121	123	125
43	96	98	99	101	102	104	105	107	109	110	112	113	115	116	118	120	121	123	124	126	128
44	98	100	101	103	105	106	108	110	111	113	114	116	118	119	121	122	124	126	127	129	130
45	100	102	104	105	107	109	110	112	114	115	117	119	120	122	124	125	127	128	130	132	133
46	103	104	106	108	109	111	113	115	116	118	120	121	123	125	126	128	130	131	133	135	136
47	105	107	108	110	112	114	115	117	119	120	122	124	126	127	129	131	132	134	136	138	139
48	107	109	111	112	114	116	118	119	121	123	125	127	128	130	132	134	135	137	139	141	142
49	109	111	113	115	117	118	120	122	124	126	127	129	131	133	135	136	138	140	142	144	145
50	112	113	115	117	119	121	123	124	126	128	130	132	134	135	137	139	141	143	145	146	148
51	114	116	118	119	121	123	125	127	129	131	133	134	136	138	140	142	144	146	147	149	151
52	116	118	120	122	124	126	128	129	131	133	135	137	139	141	143	145	147	148	150	152	154
53	118	120	122	124	126	128	130	132	134	136	138	140	142	144	146	147	149	151	153	155	157
54	121	123	125	127	128	130	132	134	136	138	140	142	144	146	148	150	152	154	156	158	160
55	123	125	127	129	131	133	135	137	139	141	143	145	147	149	151	153	155	157	159	161	163
56	125	127	129	131	133	135	137	139	141	144	146	148	150	152	154	156	158	160	162	164	166
57	127	129	131	134	136	138	140	142	144	146	148	150	152	154	157	159	161	163	165	167	169
58	130	132	134	136	138	140	142	144	147	149	151	153	155	157	159	161	163	166	168	170	172
59	132	134	136	138	140	143	145	147	149	151	153	156	158	160	162	164	166	168	171	173	175
60	134	136	138	141	143	145	147	149	152	154	156	158	160	163	165	167	169	171	174	176	178
61	136	138	141	143	145	147	150	152	154	156	159	161	163	165	167	170	172	174	176	179	181
62	138	141	143	145	148	150	152	154	157	159	161	163	166	168	170	172	175	177	179	182	184
63	141	143	145	148	150	152	155	157	159	161	164	166	168	171	173	175	178	180	182	185	187
64	143	145	148	150	152	155	157	159	162	164	166	169	171	173	176	178	180	183	185	187	190
65	145	148	150	152	155	157	159	162	164	167	169	171	174	176	178	181	183	186	188	190	193
66	147	150	152	155	157	159	162	164	167	169	172	174	176	179	181	184	186	188	191	193	196
67	150	152	155	157	159	162	164	167	169	172	174	177	179	182	184	186	189	191	194	196	199
68	152	154	157	159	162	164	167	169	172	174	177	179	182	184	187	189	192	194	197	199	202
69	154	157	159	162	164	167	169	172	174	177	179	182	184	187	189	192	195	197	200	202	205
70	156	159	161	164	167	169	172	174	177	179	182	185	187	190	192	195	197	200	202	205	208

t_{mv} \ $\Delta\Phi_0$	810	820	830	840	850	860	870	880	890	900	910	920	930	940	950	960	970	980	990	1000	1010
1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4
2	6	6	6	6	6	6	6	6	7	7	7	7	7	7	7	7	7	7	7	7	7
3	9	9	9	9	9	9	10	10	10	10	10	10	10	10	10	11	11	11	11	11	11
4	12	12	12	12	12	13	13	13	13	13	13	13	14	14	14	14	14	14	14	15	15
5	15	15	15	15	16	16	16	16	16	16	17	17	17	17	17	18	18	18	18	18	18
6	18	18	18	18	19	19	19	19	20	20	20	20	20	21	21	21	21	22	22	22	22
7	21	21	21	22	22	22	22	23	23	23	23	24	24	24	24	25	25	25	25	26	26
8	24	24	24	25	25	25	25	26	26	26	27	27	27	28	28	28	28	29	29	29	30
9	27	27	27	28	28	28	29	29	29	30	30	30	31	31	31	32	32	32	33	33	33
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12	36	36	36	37	37	38	38	39	39	40	40	40	41	41	42	42	43	43	43	44	44
13	39	39	40	40	40	41	41	42	42	43	43	44	44	45	45	46	46	47	47	48	48
14	42	42	43	43	44	44	45	45	46	46	47	47	48	48	49	49	50	50	51	51	52
15	44	45	46	46	47	47	48	48	49	49	50	51	51	52	52	53	53	54	54	55	55
16	47	48	49	49	50	50	51	52	52	53	53	54	54	55	56	56	57	57	58	59	59
17	50	51	52	52	53	54	54	55	55	56	57	57	58	59	59	60	60	61	62	62	63
18	53	54	55	55	56	57	57	58	59	59	60	61	61	62	63	63	64	65	65	66	67
19	56	57	58	58	59	60	61	61	62	63	63	64	65	65	66	67	67	68	69	70	70
20	59	60	61	62	62	63	64	64	65	66	67	67	68	69	70	70	71	72	72	73	74
21	62	63	64	65	65	66	67	68	68	69	70	71	71	72	73	74	75	75	76	77	78
22	65	66	67	68	68	69	70	71	72	72	73	74	75	76	77	77	78	79	80	81	81
23	68	69	70	71	72	72	73	74	75	76	77	77	78	79	80	81	82	83	83	84	85
24	71	72	73	74	75	76	76	77	78	79	80	81	82	83	83	84	85	86	87	88	89
25	74	75	76	77	78	79	80	81	81	82	83	84	85	86	87	88	89	90	91	92	92
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27	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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31	92	93	94	95	96	98	99	100	101	102	103	104	106	107	108	109	110	111	112	113	115
32	95	96	97	98	100	101	102	103	104	105	107	108	109	110	111	112	114	115	116	117	118
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36	107	108	109	111	112	113	115	116	117	119	120	121	123	124	125	127	128	129	130	132	133
37	110	111	112	114	115	116	118	119	121	122	123	125	126	127	129	130	131	133	134	135	137
38	113	114	115	117	118	120	121	122	124	125	127	128	129	131	132	134	135	136	138	139	141
39	116	117	119	120	121	123	124	126	127	128	130	131	133	134	136	137	138	140	141	143	144
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43	128	129	131	132	134	135	137	139	140	142	143	145	146	148	150	151	153	154	156	157	159
44	130	132	134	135	137	139	140	142	143	145	147	148	150	151	153	155	156	158	159	161	163
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48	142	144	146	148	149	151	153	155	156	158	160	162	163	165	167	169	170	172	174	176	177
49	145	147	149	151	152	154	156	158	160	161	163	165	167	169	170	172	174	176	178	179	181
50	148	150	152	154	156	157	159	161	163	165	167	168	170	172	174	176	178	179	181	183	185
51	151	153	155	157	159	161	162	164	166	168	170	172	174	176	177	179	181	183	185	187	189
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56	166	168	170	172	174	176	178	180	182	185	187	189	191	193	195	197	199	201	203	205	207
57	169	171	173	175	177	179	182	184	186	188	190	192	194	196	198	200	802	204	207	209	211
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59	175	177	179	181	184	186	188	190	192	194	197	199	201	203	205	207	210	212	214	216	218
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61	181	183	185	188	190	192	194	197	199	201	203	205	208	210	212	214	217	219	221	223	226
62	184	186	188	191	193	195	197	200	202	204	207	209	211	213	216	218	220	222	225	227	229
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67	199	201	204	206	208	211	213	216	218	221	223	226	228	231	233	235	238	240	243	245	248
68	202	204	207	209	212	214	217	219	222	224	227	229	232	234	236	239	241	244	246	249	251
69	205	207	210	212	215	217	220	222	225	227	230	232	235	237	240	242	245	248	250	253	255
70	208	210	213	215	218	220	223	226	228	231	233	236	238	241	243	246	249	251	254	256	259

ΔΦ₀ / imv	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210
70	3	5	8	10	13	15	18	21	23	26	28	31	33	36	38	41	44	46	49	51	54
71	3	5	8	10	13	16	18	21	23	26	29	31	34	36	39	42	44	47	49	52	55
72	3	5	8	11	13	16	18	21	24	26	29	32	34	37	40	42	45	47	50	53	55
73	3	5	8	11	13	16	19	21	24	27	29	32	35	37	40	43	45	48	51	53	56
74	3	5	8	11	14	16	19	22	24	27	30	33	35	38	41	43	46	49	51	54	57
75	3	5	8	11	14	16	19	22	25	27	30	33	36	38	41	44	47	49	52	55	58
76	3	6	8	11	14	17	19	22	25	28	31	33	36	39	42	45	47	50	53	56	58
77	3	6	8	11	14	17	20	23	25	28	31	34	37	39	42	45	48	51	54	56	59
78	3	6	9	11	14	17	20	23	26	29	31	34	37	40	43	46	49	51	54	57	60
79	3	6	9	12	14	17	20	23	26	29	32	35	38	40	43	46	49	52	55	58	61
80	3	6	9	12	15	18	21	23	26	29	32	35	38	41	44	47	50	53	56	59	62
81	3	6	9	12	15	18	21	24	27	30	33	36	39	42	44	47	50	53	56	59	62
82	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
83	3	6	9	12	15	18	21	24	27	30	33	36	40	43	46	49	52	55	58	61	64
84	3	6	9	12	15	18	22	25	28	31	34	37	40	43	46	49	52	55	58	62	65
85	3	6	9	12	16	19	22	25	28	31	34	37	40	44	47	50	53	56	59	62	65
86	3	6	9	13	16	19	22	25	28	31	35	38	41	44	47	50	54	57	60	63	66
87	3	6	10	13	16	19	22	25	29	32	35	38	41	45	48	51	54	57	61	64	67
88	3	6	10	13	16	19	23	26	29	32	35	39	42	45	48	52	55	58	61	64	68
89	3	7	10	13	16	20	23	26	29	33	36	39	42	46	49	52	55	59	62	65	68
90	3	7	10	13	16	20	23	26	30	33	36	40	43	46	49	53	56	59	63	66	69

ΔΦ₀ / imv	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350	360	370	380	390	400	410
70	54	56	59	62	64	67	69	72	74	77	79	82	85	87	90	92	95	97	100	103	105
71	55	57	60	62	65	68	70	73	75	78	81	83	86	88	91	94	96	99	101	104	107
72	55	58	61	63	66	69	71	74	76	79	82	84	87	90	92	95	98	100	103	105	108
73	56	59	61	64	67	69	72	75	78	80	83	86	88	91	94	96	99	102	104	107	110
74	57	60	62	65	68	70	73	76	79	81	84	87	89	92	95	98	100	103	106	108	111
75	58	60	63	66	69	71	74	77	80	82	85	88	91	93	96	99	102	104	107	110	113
76	58	61	64	67	70	72	75	78	81	83	86	89	92	95	97	100	103	106	109	111	114
77	59	62	65	68	70	73	76	79	82	85	87	90	93	96	99	101	104	107	110	113	116
78	60	63	66	69	71	74	77	80	83	86	89	91	94	97	100	103	106	109	111	114	117
79	61	64	67	69	72	75	78	81	84	87	90	93	95	98	101	104	107	110	113	116	119
80	62	64	67	70	73	76	79	82	85	88	91	94	97	100	103	105	108	111	114	117	120
81	62	65	68	71	74	77	80	83	86	89	92	95	98	101	104	107	110	113	116	119	122
82	63	66	69	72	75	78	81	84	87	90	93	96	99	102	105	108	111	114	117	120	123
83	64	67	70	73	76	79	82	85	88	91	94	97	100	103	106	109	112	115	119	122	125
84	65	68	71	74	77	80	83	86	89	92	95	98	101	105	108	111	114	117	120	123	126
85	65	68	72	75	78	81	84	87	90	93	96	100	103	106	109	112	115	118	121	124	128
86	66	69	72	76	79	82	85	88	91	94	98	101	104	107	110	113	116	120	123	126	129
87	67	70	73	76	80	83	86	89	92	96	99	102	105	108	111	115	118	121	124	127	131
88	68	71	74	77	81	84	87	90	93	97	100	103	106	110	113	116	119	122	126	129	132
89	68	72	75	78	81	85	88	91	94	98	101	104	108	111	114	117	121	124	127	130	134
90	69	72	76	79	82	86	89	92	96	99	102	105	109	112	115	119	122	125	128	132	135

ΔΦ₀ / imv	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590	600	610
70	105	108	110	113	115	118	120	123	126	128	131	133	136	138	141	144	146	149	151	154	156
71	107	109	112	114	117	120	122	125	127	130	133	135	138	140	143	146	148	151	153	156	159
72	108	111	113	116	119	121	124	127	129	132	134	137	140	142	145	148	150	153	156	158	161
73	110	112	115	118	120	123	126	128	131	134	136	139	142	144	147	150	152	155	158	160	163
74	111	114	116	119	122	125	127	130	133	135	138	141	144	146	149	152	154	157	160	163	165
75	113	115	118	121	124	126	129	132	135	137	140	143	146	148	151	154	157	159	162	165	167
76	114	117	120	122	125	128	131	134	136	139	142	145	147	150	153	156	159	161	164	167	170
77	116	118	121	124	127	130	132	135	138	141	144	147	149	152	155	158	161	163	166	169	172
78	117	120	123	126	128	131	134	137	140	143	146	148	151	154	157	160	163	166	168	171	174
79	119	121	124	127	130	133	136	139	142	145	147	150	153	156	159	162	165	168	171	174	176
80	120	123	126	129	132	135	138	141	144	146	149	152	155	158	161	164	167	170	173	176	179
81	122	125	128	130	133	136	139	142	145	148	151	154	157	160	163	166	169	172	175	178	181
82	123	126	129	132	135	138	141	144	147	150	153	156	159	162	165	168	171	174	177	180	183
83	125	128	131	134	137	140	143	146	149	152	155	158	161	164	167	170	173	176	179	182	185
84	126	129	132	135	138	141	145	148	151	154	157	160	163	166	169	172	175	178	181	185	188
85	128	131	134	137	140	143	146	149	152	156	159	162	165	168	171	174	177	180	184	187	190
86	129	132	135	139	142	145	148	151	154	157	161	164	167	170	173	176	179	183	186	189	192
87	131	134	137	140	143	147	150	153	156	159	162	166	169	172	175	178	182	185	188	191	194
88	132	135	139	142	145	148	151	155	158	161	164	168	171	174	177	180	184	187	190	193	197
89	134	137	140	143	147	150	153	156	160	163	166	169	173	176	179	182	186	189	192	195	199
90	135	138	142	145	148	152	155	158	161	165	168	171	175	178	181	185	188	191	194	198	201

ΔΦ₀ / tmv	610	620	630	640	650	660	670	680	690	700	710	720	730	740	750	760	770	780	790	800	810
70	156	159	161	164	167	169	172	174	177	179	182	185	187	190	192	195	197	200	202	205	208
71	159	161	164	166	169	172	174	177	179	182	185	187	190	192	195	198	200	203	205	208	211
72	161	163	166	169	171	174	177	179	182	185	187	190	192	195	198	200	203	206	208	211	214
73	163	166	168	171	174	176	179	182	184	187	190	192	195	198	200	203	206	208	211	214	216
74	165	168	171	173	176	179	182	184	187	190	192	195	198	200	203	206	209	211	214	217	219
75	167	170	173	176	178	181	184	187	189	192	195	198	200	203	206	209	211	214	217	220	222
76	170	172	175	178	181	184	186	189	192	195	198	200	203	206	209	211	214	217	220	223	225
77	172	175	178	180	183	186	189	192	195	197	200	203	206	209	211	214	217	220	223	226	228
78	174	177	180	183	186	188	191	194	197	200	203	206	208	211	214	217	220	223	226	228	231
79	176	179	182	185	188	191	194	197	200	202	205	208	211	214	217	220	223	226	228	231	234
80	179	182	185	187	190	193	196	199	202	205	208	211	214	217	220	223	226	228	231	234	237
81	181	184	187	190	193	196	199	202	205	208	211	214	216	219	222	225	228	231	234	237	240
82	183	186	189	192	195	198	201	204	207	210	213	216	219	222	225	228	231	234	237	240	243
83	185	188	191	194	198	201	204	207	210	213	216	219	222	225	228	231	234	237	240	243	246
84	188	191	194	197	200	203	206	209	212	215	218	221	224	228	231	234	237	240	243	246	249
85	190	193	196	199	202	205	208	212	215	218	221	224	227	230	233	236	240	243	246	249	252
86	192	195	198	201	205	208	211	214	217	220	224	227	230	233	236	239	242	246	249	252	255
87	194	197	201	204	207	210	213	217	220	223	226	229	233	236	239	242	245	248	252	255	258
88	197	200	203	206	209	213	216	219	222	226	229	232	235	238	242	245	248	251	255	258	261
89	199	202	205	209	212	215	218	222	225	228	231	235	238	241	244	248	251	254	257	261	264
90	201	204	208	211	214	217	221	224	227	231	234	237	241	244	247	250	254	257	260	264	267

ΔΦ₀ / tmv	810	820	830	840	850	860	870	880	890	900	910	920	930	940	950	960	970	980	990	1000	1010
70	208	210	213	215	218	220	223	226	228	231	233	236	238	241	243	246	249	251	254	256	259
71	211	213	216	218	221	224	226	229	231	234	237	239	242	244	247	250	252	255	257	260	263
72	214	216	219	221	224	227	229	232	235	237	240	242	245	248	250	253	256	258	261	264	266
73	216	219	222	224	227	230	233	235	238	241	243	246	249	251	254	257	259	262	265	267	270
74	219	222	225	228	230	233	236	238	241	244	247	249	252	255	257	260	263	265	268	271	274
75	222	225	228	231	233	236	239	242	244	247	250	253	255	258	261	264	266	269	272	275	277
76	225	228	231	234	236	239	242	245	248	250	253	256	259	262	264	267	270	273	275	278	281
77	228	231	234	237	240	242	245	248	251	254	257	259	262	265	268	271	273	276	279	282	285
78	231	234	237	240	243	246	248	251	254	257	260	263	266	268	271	274	277	280	283	286	288
79	234	237	240	243	246	249	252	255	257	260	263	266	269	272	275	278	281	283	286	289	292
80	237	240	243	246	249	252	255	258	261	264	267	269	272	275	278	281	284	287	290	293	296
81	240	243	246	249	252	255	258	261	264	267	270	273	276	279	282	285	288	291	294	297	299
82	243	246	249	252	255	258	261	264	267	270	273	276	279	282	285	288	291	294	297	300	303
83	246	249	252	255	258	261	264	267	270	273	277	280	283	286	289	292	295	298	301	304	307
84	249	252	255	258	261	264	268	271	274	277	280	283	286	289	292	295	298	301	304	308	311
85	252	255	258	261	264	268	271	274	277	280	283	286	289	293	296	299	302	305	308	311	314
86	255	258	261	264	268	271	274	277	280	283	286	290	293	296	299	302	305	309	312	315	318
87	258	261	264	268	271	274	277	280	283	287	290	293	296	299	303	306	309	312	315	318	322
88	261	264	267	871	274	277	280	283	287	290	293	296	300	303	306	309	312	316	319	322	325
89	264	267	270	274	277	280	283	287	290	293	296	300	303	306	310	313	316	319	323	326	329
90	267	270	273	277	280	283	287	290	293	297	300	303	306	310	313	316	320	323	326	329	333

t_{mv} \ $\Delta\Phi_0$	1000	2000	3000	4000	5000
1	4	7	11	15	18
2	7	15	22	29	37
3	11	22	33	44	55
4	15	29	44	59	73
5	18	37	55	73	92
6	22	44	66	88	110
7	26	51	77	103	128
8	29	59	88	117	146
9	33	66	99	132	165
10	37	73	110	146	183
11	40	81	121	161	201
12	44	88	132	176	220
13	48	95	143	190	238
14	51	103	154	205	256
15	55	110	165	220	275
16	59	117	176	234	293
17	62	124	187	249	311
18	66	132	198	264	329
19	70	139	209	278	348
20	73	146	220	293	366
21	77	154	231	308	384
22	81	161	242	322	403
23	84	168	253	337	421
24	88	176	264	351	439
25	92	183	275	366	458
26	95	190	286	381	476
27	99	198	297	395	494
28	103	205	308	410	513
29	106	212	318	425	531
30	110	220	329	439	549
31	113	227	340	454	567
32	117	234	351	469	586
33	121	242	362	483	604
34	124	249	373	498	622
35	128	256	384	513	641
36	132	264	395	527	659
37	135	271	406	542	677
38	139	278	417	556	696
39	143	286	428	571	714
40	146	293	439	586	732
41	150	300	450	600	750
42	154	308	461	615	769
43	157	315	472	630	787
44	161	322	483	644	805
45	165	329	494	659	824
46	168	337	505	674	842
47	172	344	516	688	860
48	176	351	527	703	879
49	179	359	538	718	897

t_{mv} \ $\Delta\Phi_0$	1000	2000	3000	4000	5000
50	183	366	549	732	915
51	187	373	560	747	934
52	190	381	571	761	952
53	194	388	582	776	970
54	198	395	593	791	988
55	201	403	604	805	1007
56	205	410	615	820	1025
57	209	417	626	835	1043
58	212	425	637	849	1062
59	216	432	648	864	1080
60	220	439	659	879	1098
61	223	447	670	893	1117
62	227	454	681	908	1135
63	231	461	692	923	1153
64	234	469	703	937	1171
65	238	476	714	952	1190
66	242	483	725	966	1208
67	245	491	736	981	1226
68	249	498	747	996	1245
69	253	505	758	1010	1263
70	256	513	769	1025	1281
71	260	520	780	1040	1300
72	264	527	791	1054	1318
73	267	534	802	1069	1336
74	271	542	813	1084	1355
75	275	549	824	1098	1373
76	278	556	835	1113	1391
77	282	564	846	1128	1409
78	286	571	857	1142	1428
79	289	578	868	1157	1446
80	293	586	879	1171	1464
81	297	593	890	1186	1483
82	300	600	901	1201	1501
83	304	608	912	1215	1519
84	308	615	923	1230	1538
85	311	622	934	1245	1556
86	315	630	945	1259	1574
87	318	637	955	1274	1592
88	322	644	966	1289	1611
89	326	652	977	1303	1629
90	329	659	988	1318	1647

Table 3.5 Mean virtual temperature of layers between pairs of standard isobaric surfaces as a function of geopotential difference

Température virtuelle moyenne des couches limitées par deux surfaces isobares standard en fonction de la différence de géopotentiel

ΔΦ : geopotential difference — *différence de géopotentiel*

ΔΦ gpm	0	20	40	60	80	100	120	140	160	180
gpm	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
Layer — *couche* : 1000–850 mb										
1000	-63.1	-58.9	-54.7	-50.5	-46.3	-42.1	-37.9	-33.7	-29.5	-25.3
1200	-21.1	-16.9	-12.7	-8.5	-4.3	-0.1	4.1	8.3	12.5	16.7
1400	20.9	25.1	29.3	33.6	37.8	42.0	46.2	50.4	54.6	58.8
Layer — *couche* : 850–700 mb										
1200	-62.1	-58.6	-55.1	-51.6	-48.1	-44.6	-41.0	-37.5	-34.0	-30.5
1400	-27.0	-23.5	-19.9	-16.4	-12.9	-9.4	-5.9	-2.4	1.2	4.7
1600	8.2	11.7	15.2	18.7	22.3	25.8	29.3	32.8	36.3	39.8
Layers — *couches* : 700–500 ; 70–50 mb										
1600	-110.8	-108.8	-106.7	-104.7	-102.7	-100.7	-98.6	-96.6	-94.6	-92.5
1800	-90.5	-88.5	-86.5	-84.4	-82.4	-80.4	-78.3	-76.3	-74.3	-72.2
2000	-70.2	-68.2	-66.2	-64.1	-62.1	-60.1	-58.0	-56.0	-54.0	-52.0
2200	-49.9	-47.9	-45.9	-43.8	-41.8	-39.8	-37.8	-35.7	-33.7	-31.7
2400	-29.6	-27.6	-25.6	-23.5	-21.5	-19.5	-17.5	-15.4	-13.4	-11.4
2600	-9.3	-7.3	-5.3	-3.3	-1.2	-0.8	2.8	4.9	6.9	8.9
2800	11.0	13.0	15.0	17.0	19.1	21.1	23.1	25.2	27.2	29.2
3000	31.2	33.3	35.3	37.3	39.4	41.4	43.4	45.5	47.5	49.5
Layer — *couche* : 500–400 mb										
1200	-89.6	-86.5	-83.4	-80.4	-77.3	-74.3	-71.2	-68.1	-65.1	-62.0
1400	-59.0	-55.9	-52.8	-49.8	-46.7	-43.7	-40.6	-37.5	-34.5	-31.4
1600	-28.4	-25.3	-22.2	-19.2	-16.1	-13.1	-10.0	-6.9	-3.9	-0.8
1800	2.2	5.3	8.4	11.4	14.5	17.5	20.6	23.7	26.7	29.8
Layers — *couches* : 400–300 ; 200–150 mb										
1400	-107.0	-104.6	-102.3	-99.9	-97.5	-95.1	-92.8	-90.4	-88.0	-85.6
1600	-83.3	-80.9	-78.5	-76.2	-73.8	-71.4	-69.0	-66.7	-64.3	-61.9
1800	-59.5	-57.2	-54.8	-52.4	-50.0	-47.7	-45.3	-42.9	-40.6	-38.2
2000	-35.8	-33.4	-31.1	-28.7	-26.3	-23.9	-21.6	-19.2	-16.8	-14.4
2200	-12.1	-9.7	-7.3	-4.9	-2.6	-0.2	2.2	4.5	6.9	9.3
2400	11.7	14.0	16.4	18.8	21.2	23.5	25.9	28.3	30.7	33.0
Layers — *couches* : 300–200 ; 150–100 ; 30–20 mb										
2000	-104.7	-103.1	-101.4	-99.7	-98.0	-96.3	-94.6	-93.0	-91.3	-89.6
2200	-87.9	-86.2	-84.5	-82.9	-81.2	-79.5	-77.8	-76.1	-74.4	-72.8
2400	-71.1	-69.4	-67.7	-66.0	-64.3	-62.6	-61.0	-59.3	-57.6	-55.9
2600	-54.2	-52.5	-50.9	-49.2	-47.5	-45.8	-44.1	-42.4	-40.8	-39.1
2800	-37.4	-35.7	-34.0	-32.3	-30.7	-29.0	-27.3	-25.6	-23.9	-22.2
3000	-20.5	-18.9	-17.2	-15.5	-13.8	-12.1	-10.4	-8.8	-7.1	-5.4
3200	-3.7	-2.0	-0.3	1.3	3.0	4.7	6.4	8.1	9.8	11.4
Layers — *couches* : 100–70 ; 1000–700 mb										
1800	-100.9	-98.9	-97.0	-95.1	-93.2	-91.3	-89.4	-87.5	-85.5	-83.6
2000	-81.7	-79.8	-77.9	-76.0	-74.1	-72.1	-70.2	-68.3	-66.4	-64.5
2200	-62.6	-60.7	-58.7	-56.8	-54.9	-53.0	-51.1	-49.2	-47.3	-45.3
2400	-43.4	-41.5	-39.6	-37.7	-35.8	-33.9	-31.9	-30.0	-28.1	-26.2
2600	-24.3	-22.4	-20.5	-18.5	-16.6	-14.7	-12.8	-10.9	-9.0	-7.1
2800	-5.1	-3.2	-1.3	0.6	2.5	4.4	6.3	8.3	10.2	12.1
3000	14.0	15.9	17.8	19.7	21.7	23.6	25.5	27.4	29.3	31.2
3200	33.1	35.1	37.0	38.9	40.8	42.7	44.6	46.5	48.5	50.4

TABLE 3.5 — 2

ΔΦ gpm	0	20	40	60	80	100	120	140	160	180
gpm	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
Layers — *couches*: 50–30 ; 500–300 mb										
2600	-99.4	-98.0	-96.7	-95.4	-94.0	-92.7	-91.4	-90.0	-88.7	-87.4
2800	-86.0	-84.7	-83.3	-82.0	-80.7	-79.3	-78.0	-76.7	-75.3	-74.0
3000	-72.6	-71.3	-70.0	-68.6	-67.3	-66.0	-64.6	-63.3	-62.0	-60.6
3200	-59.3	-57.9	-56.6	-55.3	-53.9	-52.6	-51.3	-49.9	-48.6	-47.3
3400	-45.9	-44.6	-43.2	-41.9	-40.6	-39.2	-37.9	-36.6	-35.2	-33.9
3600	-32.5	-31.2	-29.9	-28.5	-27.2	-25.9	-24.5	-23.2	-21.9	-20.5
3800	-19.2	-17.8	-16.5	-15.2	-13.8	-12.5	-11.2	-9.8	-8.5	-7.2
4000	-5.8	-4.5	-3.1	-1.8	-0.5	0.9	2.2	3.5	4.9	6.2
4200	7.6	8.9	10.2	11.6	12.9	14.2	15.6	16.9	18.2	19.6
4400	20.9	22.3	23.6	24.9	26.3	27.6	28.9	30.3	31.6	32.9
Layers — *couches*: 20–10 ; 1000–500 ; 400–200 ; 300–150 ; 200–100 ; 100–50 mb										
3400	-105.7	-104.7	-103.7	-102.7	-101.7	-100.8	-99.8	-98.8	-97.8	-96.8
3600	-95.8	-94.9	-93.9	-92.9	-91.9	-90.9	-89.9	-88.9	-88.0	-87.0
3800	-86.0	-85.0	-84.0	-83.0	-82.0	-81.1	-80.1	-79.1	-78.1	-77.1
4000	-76.1	-75.1	-74.2	-73.2	-72.2	-71.2	-70.2	-69.2	-68.3	-67.3
4200	-66.3	-65.3	-64.3	-63.3	-62.3	-61.4	-60.4	-59.4	-58.4	-57.4
4400	-56.4	-55.4	-54.5	-53.5	-52.5	-51.5	-50.5	-49.5	-48.6	-47.6
4600	-46.6	-45.6	-44.6	-43.6	-42.6	-41.7	-40.7	-39.7	-38.7	-37.7
4800	-36.7	-35.7	-34.8	-33.8	-32.8	-31.8	-30.8	-29.8	-28.9	-27.9
5000	-26.9	-25.9	-24.9	-23.9	-22.9	-22.0	-21.0	-20.0	-19.0	-18.0
5200	-17.0	-16.0	-15.1	-14.1	-13.1	-12.1	-11.1	-10.1	-9.1	-8.2
5400	-7.2	-6.2	-5.2	-4.2	-3.2	-2.3	-1.3	-0.3	0.7	1.7
5600	2.7	3.7	4.6	5.6	6.6	7.6	8.6	9.6	10.6	11.5
5800	12.5	13.5	14.5	15.5	16.5	17.4	18.4	19.4	20.4	21.4
6000	22.4	23.4	24.3	25.3	26.3	27.3	28.3	29.3	30.3	31.2
6200	32.2	33.2	34.2	35.2	36.2	37.1	38.1	39.1	40.1	41.1
6400	42.1	43.1	44.0	45.0	46.0	47.0	48.0	49.0	50.0	50.9
Layer — *couche*: 850–500 mb										
3000	-80.1	-78.8	-77.6	-76.3	-75.0	-73.7	-72.4	-71.1	-69.8	-68.6
3200	-67.3	-66.0	-64.7	-63.4	-62.1	-60.8	-59.5	-58.3	-57.0	-55.7
3400	-54.4	-53.1	-51.8	-50.5	-49.2	-48.0	-46.7	-45.4	-44.1	-42.8
3600	-41.5	-40.2	-39.0	-37.7	-36.4	-35.1	-33.8	-32.5	-31.2	-29.9
3800	-28.7	-27.4	-26.1	-24.8	-23.5	-22.2	-20.9	-19.7	-18.4	-17.1
4000	-15.8	-14.5	-13.2	-11.9	-10.6	-9.4	-8.1	-6.8	-5.5	-4.2
4200	-2.9	-1.6	-0.4	0.9	2.2	3.5	4.8	6.1	7.4	8.7
4400	9.9	11.2	12.5	13.8	15.1	16.4	17.7	18.9	20.2	21.5
4600	22.8	24.1	25.4	26.7	28.0	29.2	30.5	31.8	33.1	34.4
4800	35.7	37.0	38.3	39.5	40.8	42.1	43.4	44.7	46.0	47.3
Layer — *couche*: 700–400 mb										
3200	-77.9	-76.7	-75.5	-74.3	-73.0	-71.8	-70.6	-69.4	-68.2	-66.9
3400	-65.7	-64.5	-63.3	-62.1	-60.8	-59.6	-58.4	-57.2	-56.0	-54.7
3600	-53.5	-52.3	-51.1	-49.9	-48.6	-47.4	-46.2	-45.0	-43.8	-42.5
3800	-41.3	-40.1	-38.9	-37.7	-36.4	-35.2	-34.0	-32.8	-31.6	-30.3
4000	-29.1	-27.9	-26.7	-25.5	-24.2	-23.0	-21.8	-20.6	-19.4	-18.1
4200	-16.9	-15.7	-14.5	-13.3	-12.0	-10.8	-9.6	-8.4	-7.2	-5.9
4400	-4.7	-3.5	-2.3	-1.1	0.2	1.4	2.6	3.8	5.0	6.3
4600	7.5	8.7	9.9	11.1	12.4	13.6	14.8	16.0	17.2	18.5
4800	19.7	20.9	22.1	23.3	24.6	25.8	27.0	28.2	29.4	30.7
5000	31.9	33.1	34.3	35.5	36.8	38.0	39.2	40.4	41.6	42.9
Layer — *couche*: 150–70 mb										
3800	-102.9	-102.0	-101.1	-100.2	-99.3	-98.4	-97.6	-96.7	-95.8	-94.9
4000	-94.0	-93.1	-92.2	-91.3	-90.4	-89.5	-88.6	-87.7	-86.8	-85.9
4200	-85.0	-84.1	-83.2	-82.3	-81.4	-80.5	-79.6	-78.7	-77.8	-76.9
4400	-76.1	-75.2	-74.3	-73.4	-72.5	-71.6	-70.7	-69.8	-68.9	-68.0
4600	-67.1	-66.2	-65.3	-64.4	-63.5	-62.6	-61.7	-60.8	-59.9	-59.0
4800	-58.1	-57.2	-56.3	-55.4	-54.5	-53.7	-52.8	-51.9	-51.0	-50.1
5000	-49.2	-48.3	-47.4	-46.5	-45.6	-44.7	-43.8	-42.9	-42.0	-41.1
5200	-40.2	-39.3	-38.4	-37.5	-36.6	-35.7	-34.8	-33.9	-33.0	-32.2
5400	-31.3	-30.4	-29.5	-28.6	-27.7	-26.8	-25.9	-25.0	-24.1	-23.2
5600	-22.3	-21.4	-20.5	-19.6	-18.7	-17.8	-16.9	-16.0	-15.1	-14.2
5800	-13.3	-12.4	-11.5	-10.7	-9.8	-8.9	-8.0	-7.1	-6.2	-5.3
6000	-4.4	-3.5	-2.6	-1.7	-0.8	0.1	1.0	1.9	2.8	3.7

TABLE 3.5 — 3

ΔΦ gpm	0	20	40	60	80	100	120	140	160	180
gpm	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
Layer — *couche*: 70–30 mb										
4200	-103.9	-103.1	-102.3	-101.5	-100.7	-99.9	-99.1	-98.3	-97.5	-96.7
4400	-95.9	-95.1	-94.2	-93.4	-92.6	-91.8	-91.0	-90.2	-89.4	-88.6
4600	-87.8	-87.0	-86.2	-85.4	-84.6	-83.8	-83.0	-82.2	-81.4	-80.5
4800	-79.7	-78.9	-78.1	-77.3	-76.5	-75.7	-74.9	-74.1	-73.3	-72.5
5000	-71.7	-70.9	-70.1	-69.3	-68.5	-67.7	-66.8	-66.0	-65.2	-64.4
5200	-63.6	-62.8	-62.0	-61.2	-60.4	-59.6	-58.8	-58.0	-57.2	-56.4
5400	-55.6	-54.8	-54.0	-53.2	-52.3	-51.5	-50.7	-49.9	-49.1	-48.3
5600	-47.5	-46.7	-45.9	-45.1	-44.3	-43.5	-42.7	-41.9	-41.1	-40.3
5800	-39.5	-38.6	-37.8	-37.0	-36.2	-35.4	-34.6	-33.8	-33.0	-32.2
6000	-31.4	-30.6	-29.8	-29.0	-28.2	-27.4	-26.6	-25.8	-24.9	-24.1
6200	-23.3	-22.5	-21.7	-20.9	-20.1	-19.3	-18.5	-17.7	-16.9	-16.1
6400	-15.3	-14.5	-13.7	-12.9	-12.1	-11.2	-10.4	-9.6	-8.8	-8.0
6600	-7.2	-6.4	-5.6	-4.8	-4.0	-3.2	-2.4	-1.6	-0.8	0.0
Layer — *couche*: 50–20 mb										
4400	-109.2	-108.5	-107.7	-107.0	-106.2	-105.5	-104.7	-104.0	-103.2	-102.5
4600	-101.8	-101.0	-100.3	-99.5	-98.8	-98.0	-97.3	-96.5	-95.8	-95.1
4800	-94.3	-93.6	-92.8	-92.1	-91.3	-90.6	-89.8	-89.1	-88.3	-87.6
5000	-86.9	-86.1	-85.4	-84.6	-83.9	-83.1	-82.4	-81.6	-80.9	-80.1
5200	-79.4	-78.7	-77.9	-77.2	-76.4	-75.7	-74.9	-74.2	-73.4	-72.7
5400	-72.0	-71.2	-70.5	-69.7	-69.0	-68.2	-67.5	-66.7	-66.0	-65.2
5600	-64.5	-63.8	-63.0	-62.3	-61.5	-60.8	-60.0	-59.3	-58.5	-57.8
5800	-57.0	-56.3	-55.6	-54.8	-54.1	-53.3	-52.6	-51.8	-51.1	-50.3
6000	-49.6	-48.9	-48.1	-47.4	-46.6	-45.9	-45.1	-44.4	-43.6	-42.9
6200	-42.1	-41.4	-40.7	-39.9	-39.2	-38.4	-37.7	-36.9	-36.2	-35.4
6400	-34.7	-33.9	-33.2	-32.5	-31.7	-31.0	-30.2	-29.5	-28.7	-28.0
6600	-27.2	-26.5	-25.7	-25.0	-24.3	-23.5	-22.8	-22.0	-21.3	-20.5
6800	-19.8	-19.0	-18.3	-17.6	-16.8	-16.1	-15.3	-14.6	-13.8	-13.1
7000	-12.3	-11.6	-10.8	-10.1	-9.4	-8.6	-7.9	-7.1	-6.4	-5.6
Layer — *couche*: 30–10 mb										
5400	-105.3	-104.7	-104.1	-103.5	-102.9	-102.2	-101.6	-101.0	-100.4	-99.7
5600	-99.1	-98.5	-97.9	-97.3	-96.6	-96.0	-95.4	-94.8	-94.2	-93.5
5800	-92.9	-92.3	-91.7	-91.0	-90.4	-89.8	-89.2	-88.6	-87.9	-87.3
6000	-86.7	-86.1	-85.5	-84.8	-84.2	-83.6	-83.0	-82.3	-81.7	-81.1
6200	-80.5	-79.9	-79.2	-78.6	-78.0	-77.4	-76.8	-76.1	-75.5	-74.9
6400	-74.3	-73.6	-73.0	-72.4	-71.8	-71.2	-70.5	-69.9	-69.3	-68.7
6600	-68.1	-67.4	-66.8	-66.2	-65.6	-64.9	-64.3	-63.7	-63.1	-62.5
6800	-61.8	-61.2	-60.6	-60.0	-59.3	-58.7	-58.1	-57.5	-56.9	-56.2
7000	-55.6	-55.0	-54.4	-53.8	-53.1	-52.5	-51.9	-51.3	-50.6	-50.0
7200	-49.4	-48.8	-48.2	-47.5	-46.9	-46.3	-45.7	-45.1	-44.4	-43.8
7400	-43.2	-42.6	-41.9	-41.3	-40.7	-40.1	-39.5	-38.8	-38.2	-37.6
7600	-37.0	-36.4	-35.7	-35.1	-34.5	-33.9	-33.2	-32.6	-32.0	-31.4
7800	-30.8	-30.1	-29.5	-28.9	-28.3	-27.7	-27.0	-26.4	-25.8	-25.2
8000	-24.5	-23.9	-23.3	-22.7	-22.1	-21.4	-20.8	-20.2	-19.6	-19.0
8200	-18.3	-17.7	-17.1	-16.5	-15.8	-15.2	-14.6	-14.0	-13.4	-12.7
8400	-12.1	-11.5	-10.9	-10.2	-9.6	-9.0	-8.4	-7.8	-7.1	-6.5

Table 3.6 Geopotential increment corresponding to a pressure decrease of 1 mb

Accroissement de géopotentiel correspondant à une diminution de pression de 1 mb

Virtual temperature *Température virtuelle* °C	Pressure — *pression*, mb 1050 gpm	1000 gpm	950 gpm	900 gpm	850 gpm	800 gpm	750 gpm	700 gpm	600 gpm
— 80	5.3882	5.6576	5.9554	6.2862	6.6560	7.0720	7.5435	8.0823	9.4294
— 70	5.6671	5.9505	6.2637	6.6117	7.0006	7.4381	7.9340	8.5007	9.9175
— 60	5.9461	6.2434	6.5720	6.9371	7.3452	7.8043	8.3246	8.9192	10.406
— 50	6.2250	6.5363	6.8803	7.2626	7.6898	8.1704	8.7151	9.3376	10.894
— 40	6.5040	6.8292	7.1886	7.5880	8.0344	8.5365	9.1056	9.7560	11.382
— 30	6.7829	7.1221	7.4970	7.9134	8.3790	8.9026	9.4962	10.174	11.870
— 20	7.0619	7.4150	7.8053	8.2389	8.7235	9.2687	9.8867	10.593	12.358
— 10	7.3408	7.7079	8.1136	8.5643	9.0681	9.6349	10.277	11.011	12.846
0	7.6198	8.0008	8.4219	8.8898	9.4127	10.001	10.668	11.430	13.335
10	7.8987	8.2937	8.7302	9.2152	9.7573	10.367	11.058	11.848	13.823
20	8.1777	8.5866	9.0385	9.5407	10.102	10.733	11.449	12.267	14.311
30	8.4566	8.8795	9.3468	9.8661	10.446	11.099	11.839	12.685	14.799
40	8.7356	9.1724	9.6552	10.192	10.791	11.465	12.230	13.103	15.287
50	9.0145	9.4653	9.9635	10.517	11.136	11.832	12.620	13.522	
60	9.2935	9.7582	10.272	10.842					

Virtual temperature *Température virtuelle* °C	Pressure — *pression*, mb 500 gpm	400 gpm	350 gpm	300 gpm	250 gpm	200 gpm	175 gpm	150 gpm	125 gpm
—100						25.359	28.982	33.812	40.575
— 90				17.882	21.459	26.824	30.655	35.765	42.918
— 80	11.315	14.144	16.165	18.859	22.630	28.288	32.329	37.717	45.261
— 70	11.901	14.876	17.001	19.835	23.802	29.753	34.003	39.670	47.604
— 60	12.487	15.609	17.838	20.811	24.974	31.217	35.677	41.623	49.947
— 50	13.073	16.341	18.675	21.788	26.145	32.682	37.350	43.575	52.290
— 40	13.658	17.073	19.512	22.764	27.317	34.146	39.024	45.528	54.634
— 30	14.244	17.805	20.349	23.740	28.488	35.611	40.698	47.481	56.977
— 20	14.830	18.538	21.186	24.717	29.660	37.075	42.371	49.433	59.320
— 10	15.416	19.270	22.023	25.693	30.832	38.540	44.045	51.386	61.663
0	16.002	20.002	22.859	26.669	32.003	40.004	45.719	53.339	64.006
10	16.587	20.734	23.696	27.646	33.175	41.468	47.392	55.291	
20	17.173	21.466	24.533	28.622	34.346	42.933			
30	17.759	22.199	25.370						
40	18.345								

Virtual temperature *Température virtuelle* °C	Pressure — *pression*, mb 100 gpm	80 gpm	60 gpm	50 gpm	40 gpm	30 gpm	20 gpm	15 gpm	10 gpm	5 gpm
—110	47.789	59.736	79.649	95.578	119.47	159.30	238.95	318.59	477.89	955.78
—100	50.718	63.398	84.530	101.44	126.80	169.06	253.59	338.12	507.18	1014.4
— 90	53.647	67.059	89.412	107.29	134.12	178.82	268.24	357.65	536.47	1072.9
— 80	56.576	70.720	94.294	113.15	141.44	188.59	282.88	377.17	565.76	1131.5
— 70	59.505	74.381	99.175	119.01	148.76	198.35	297.53	396.70	595.05	1190.1
— 60	62.434	78.043	104.06	124.87	156.09	208.11	312.17	416.23	624.34	1248.7
— 50	65.363	81.704	108.94	130.73	163.41	217.88	326.82	435.75	653.63	1307.3
— 40	68.292	85.365	113.82	136.58	170.73	227.64	341.46	455.28	682.92	1365.8
— 30	71.221	89.026	118.70	142.44	178.05	237.40	356.11	474.81	712.21	1424.4
— 20	74.150	92.687	123.58	148.30	185.38	247.17	370.75	494.33	741.50	1483.0
— 10	77.079	96.349	128.46	154.16	192.70	256.93	385.40	513.86	770.79	1541.6
0	80.008	100.01	133.35	160.02	200.02	266.69	400.04	533.39	800.08	1600.2

Table 3.7 Pressure increment corresponding to a geopotential decrease of 10 gpm

Accroissement de pression correspondant à une diminution de géopotentiel de 10 gpm

Virtual temperature *Température virtuelle* °C	Pressure — *pression*, mb								
	1050 mb	1000 mb	950 mb	900 mb	850 mb	800 mb	750 mb	700 mb	600 mb
— 80	1.8559	1.7675	1.6792	1.5908	1.5024	1.4140	1.3256	1.2373	1.0605
— 70	1.7646	1.6805	1.5965	1.5125	1.4284	1.3444	1.2604	1.1764	1.0083
— 60	1.6818	1.6017	1.5216	1.4415	1.3614	1.2814	1.2013	1.1212	.96101
— 50	1.6064	1.5299	1.4534	1.3769	1.3004	1.2239	1.1474	1.0709	.91795
— 40	1.5375	1.4643	1.3911	1.3179	1.2447	1.1714	1.0982	1.0250	.87858
— 30	1.4743	1.4041	1.3339	1.2637	1.1935	1.1233	1.0531	.98285	.84245
— 20	1.4160	1.3486	1.2812	1.2138	1.1463	1.0789	1.0115	.94403	.80917
— 10	1.3622	1.2974	1.2325	1.1676	1.1028	1.0379	.97303	.90816	.77842
0	1.3124	1.2499	1.1874	1.1249	1.0624	.99990	.93741	.87491	.74992
10	1.2660	1.2057	1.1454	1.0852	1.0249	.96459	.90430	.84401	.72344
20	1.2228	1.1646	1.1064	1.0481	.98991	.93169	.87345	.81522	.69876
30	1.1825	1.1262	1.0699	1.0136	.95726	.90095	.84464	.78833	.67571
40	1.1447	1.0902	1.0357	.98120	.92669	.87218	.81767	.76316	.65414
50	1.1093	1.0565	1.0037	.95084	.89802	.84519	.79237	.73954	
60	1.0760	1.0248	.97354	.92230					

Virtual temperature *Température virtuelle* °C	Pressure — *pression*, mb								
	500 mb	400 mb	350 mb	300 mb	250 mb	200 mb	175 mb	150 mb	125 mb
—100						.39434	.34504	.29575	.24646
— 90				.55921	.46601	.37281	.32621	.27960	.23300
— 80	.88376	.70701	.61864	.53026	.44188	.35351	.30932	.26513	.22094
— 70	.84026	.67221	.58819	.50416	.42013	.33611	.29409	.25208	.21007
— 60	.80084	.64067	.56059	.48051	.40042	.32034	.28030	.24025	.20021
— 50	.76496	.61196	.53547	.45898	.38248	.30598	.26774	.22949	.19124
— 40	.73215	.58572	.51251	.43929	.36607	.29286	.25625	.21964	.18304
— 30	.70204	.56163	.49143	.42122	.35102	.28082	.24571	.21061	.17551
— 20	.67431	.53945	.47202	.40459	.33715	.26972	.23601	.20229	.16858
— 10	.64869	.51895	.45408	.38921	.32434	.25947	.22704	.19461	.16217
0	.62494	.49995	.43746	.37496	.31247	.24998	.21873	.18748	.15623
10	.60287	.48229	.42201	.36172	.30143	.24115	.21100	.18086	
20	.58230	.46584	.40761	.34938	.29115	.23292			
30	.56310	.45047	.39417						
40	.54511								

Virtual temperature *Température virtuelle* °C	Pressure — *pression*, mb									
	100 mb	80 mb	60 mb	50 mb	40 mb	30 mb	20 mb	15 mb	10 mb	5 mb
—110	.20925	.16740	.12555	.10463	.08370	.06278	.04185	.03139	.02093	.01046
—100	.19717	.15773	.11830	.09858	.07887	.05915	.03943	.02958	.01972	.00986
— 90	.18640	.14912	.11184	.09320	.07456	.05592	.03728	.02796	.01864	.00932
— 80	.17675	.14140	.10605	.08838	.07070	.05303	.03535	.02651	.01768	.00884
— 70	.16805	.13444	.10083	.08403	.06722	.05042	.03361	.02521	.01681	.00840
— 60	.16017	.12814	.09610	.08008	.06407	.04805	.03203	.02403	.01602	.00801
— 50	.15299	.12239	.09179	.07650	.06120	.04590	.03060	.02295	.01530	.00765
— 40	.14643	.11714	.08786	.07321	.05857	.04393	.02929	.02196	.01464	.00732
— 30	.14041	.11233	.08424	.07020	.05616	.04212	.02808	.02106	.01404	.00702
— 20	.13486	.10789	.08092	.06743	.05394	.04046	.02697	.02023	.01349	.00674
— 10	.12974	.10379	.07784	.06487	.05189	.03892	.02595	.01946	.01297	.00649
0	.12499	.09999	.07499	.06249	.04999	.03750	.02500	.01875	.01250	.00625

Table 3.8.1

INTERNATIONAL BAROMETER CONVENTIONS*

(1) *Standard temperature and density of mercury*

The value of 0°C shall be the standard temperature to which mercury barometer readings are reduced for the purpose of relating actual density of mercury at its observed temperature to the standard density of mercury at 0°C.

The standard density of mercury at 0°C (symbol $\rho_{Hg,0}$) shall be considered to be 13.5951 grammes per cubic centimetre ; and, for the purposes of calculating absolute pressures by means of the hydrostatic equation, the mercury in the column of a mercury barometer shall be regarded conventionally as an incompressible fluid.

(2) *Standard (normal) gravity*

Barometric readings shall be reduced from local acceleration of gravity to standard (normal) gravity. The value of standard (normal) gravity (symbol g_n) shall be regarded as a conventional constant :

$$g_n = 980.665 \text{ cm sec}^{-2}$$

NOTE : This is recognized by scientists as a gravity datum to which reported barometric data in mm or inches of mercury shall refer but it does *not* represent the value of gravity at latitude 45°, at sea-level.

(3) *Pressure units*

(*a*) The *millibar*, defined as a unit of pressure equal to 1 000 dynes cm^{-2}, shall be the unit in which pressures are reported for meteorological purposes.

(*b*) In accordance with the provisions of paragraphs (1) and (2), a column of mercury at a standard temperature of 0°C when subjected to an acceleration of gravity equal to standard (normal) gravity, $g_n = 980.665$ cm sec^{-2}, may be regarded as representing pressure due to the weight of mercury on a unit cross-section area (one square centimetre). When the mercury column under these standard conditions of temperature and gravity has a *true* scale height of one millimetre, it shall be considered to represent a unit of pressure called "one millimetre of mercury under standard conditions", symbol "$(mm\ Hg)_n$". When it is clear from the context that standard conditions are implied, the briefer term "millimetre of mercury" may be used in reference to this unit. In view of the provisions of paragraphs (1), (2) and (3 *a*), a column of mercury having a true scale height of 760 millimetres when subjected to standard conditions of temperature and gravity yields a pressure of 1 013 250 dynes cm^{-2} = 1 013.250 mb.

Consistent with the foregoing the following conversion factors obtain :

$$1 \text{ millibar} = 0.750\,062\ (\text{mm Hg})_n$$
$$1\ (\text{mm Hg})_n = 1.333\,224 \text{ mb}$$

* This table is reproduced from Appendix A to WMO TR.

(*c*) Analogous to the case outlined above under (*b*), "one inch of mercury under standard conditions", symbol "$(\text{in Hg})_n$", shall refer to the pressure due to the weight of mercury per unit cross-section area when the column has a true scale height of one inch, *provided* the mercury is at the standard temperature of 0°C (32°F) and it is subjected to an acceleration of gravity equal to the standard (normal) value, $g_n = 980.665$ cm sec^{-2}.
When it is clear from the context that standard conditions are implied, the briefer term "inch of mercury" may be used in reference to this unit.
In cases where the conventional engineering relationship between the inch and millimetre is assumed, namely 1 inch = 25.4 millimetres, the following conversion factors obtain :

$$1 \text{ mb} = 0.029\,530\,0 \ (\text{in Hg})_n$$
$$1 \ (\text{in Hg})_n = 33.863\,9 \text{ mb}$$
$$1 \ (\text{mm Hg})_n = 0.039\,370\,08 \ (\text{in Hg})_n$$

(*d*) When pressure data are issued, preference shall be given to expressing them in millibars ; but if they are required in other units they should be given preferably in standard units as outlined under (*b*) and (*c*) above ; that is, either in $(\text{mm Hg})_n$ or in $(\text{in Hg})_n$, as the case may be.

(4) *Mercury barometer scales and standard instrumental conditions*

Except for mercury barometers, still serviceable and graduated with scales on a different basis than that outlined below, scales on mercury barometers shall be graduated so that they yield true pressure readings directly in standard units as defined under paragraph (3) when the entire instrument is maintained at the standard temperature of 0°C and at the standard (normal) value of gravity, $g_n = 980.665$ cm sec^{-2}.

It will be understood that the foregoing recommendation implies that the scales of Fortin barometers graduated in millimetres or inches shall yield true linear readings when the scale is maintained at a temperature of 0°C, except possibly for the case of barometers referred to in the first clause of the preceding paragraph.

Mercury barometers having scales engraved so as to yield standard units of pressure as prescribed in paragraph (3) when the instrument is maintained at the standard conditions of temperature and gravity specified under paragraphs (1) and (2) should have inscribed on the barometer scale(s) whichever of the following legends are appropriate :

"True mb at 0°C and 980.665 cm sec^{-2}" (1)

"True $(\text{mm Hg})_n$ at 0°C and 980.665 cm sec^{-2}" (2)

"True $(\text{in Hg})_n$ at 0°C and 980.665 cm sec^{-2}" (3)

Barometers may have more than one scale engraved on them ; for example, mb and $(\text{mm Hg})_n$, or mb and $(\text{in Hg})_n$, provided the conditions specified above are fulfilled.

(5) ***Determination of local acceleration of gravity***

The value of $g_{\varphi,H}$ required for reducing barometer readings to standard gravity shall be based on the most accurate determination of the acceleration of gravity, g, available. In the event that the local value of the acceleration of gravity has not been determined on the basis of some method considered to be more accurate in the absolute sense than the methods outlined in Table 3.8.2, it shall be ascertained in accordance with the provisions reproduced in Table 3.8.2.

(6) *Standard instrumental conditions for mercury barometers bearing altitude scales*

Except for mercury barometers still serviceable and graduated with scales on a different basis from that outlined below, mercury barometers that bear a scale representing altitudes corresponding to pressures in accordance with some specified standard atmosphere shall have the scale graduated so that it will indicate the assumed pressure-altitude relationship when the entire instrument is maintained at the standard temperature of 0°C and at the standard (normal) value of gravity, $g_n = 980.665$ cm sec^{-2}.

Barometers bearing scales satisfying these standard conditions should have inscribed on the scales an inscription of the following character:

"True ---- pressure-altitude
at 0°C, 980.665 cm sec^{-2}"

where there is inserted in the blank space the standard on which the pressure-altitude relationship is based, for example, ICAO.

Table 3.8.2

PROCEDURE FOR CALCULATING THEORETICAL VALUES OF LOCAL ACCELERATION OF GRAVITY *

(1) The theoretical value ($g_{\varphi,0}$) of the acceleration of gravity at mean sea-level at geographic latitude φ is computed by means of the equation:

$$g_{\varphi,0} = 980.616\ (1 - 0.002\ 637\ 3 \cos 2\varphi + 0.000\ 005\ 9 \cos^2 2\varphi), \text{ in cm sec}^{-2} \quad (1)$$

(2) The local value of the acceleration of gravity at a given point on the surface of the ground at a land station is computed by means of the equation :

$$g = g_{\varphi,0} - 0.000\ 308\ 6\ H + 0.000\ 111\ 8\ (H - H') \quad (2)$$

where

g = local calculated value of the acceleration of gravity, in cm sec^{-2}, at the given point ;

$g_{\varphi,0}$ = theoretical value of the acceleration of gravity in cm sec^{-2} at mean sea-level at geographic latitude φ ,computed in accord with equation (1) above ;

H = actual elevation of the given point, in metres above mean sea-level ; and

H' = mean elevation in metres above mean sea-level, of the actual surface of the terrain included within a circle whose radius is about 150 kilometres, centred at the given point.

(3) The local value of the acceleration of gravity at a given point within a distance (H) above mean sea-level of not more than about 10 kilometres where the point lies over the sea-water surface is computed by means of the equation :

$$g = g_{\varphi,0} - 0.000\ 308\ 6\ H - 0.000\ 068\ 8\ (D - D') \quad (3)$$

where

g = local calculated value of the acceleration of gravity, in cm sec^{-2}, at the given point ;

$g_{\varphi,0}$ = theoretical value of the acceleration of gravity, in cm sec^{-2}, at mean sea-level at geographic latitude φ, computed in accord with equation (1);

H = actual elevation of the given point, in metres above mean sea-level ;

D = depth of water, in metres, below the given point ;

D' = mean depth of water, in metres, included within a circle whose radius is about 150 kilometres centred at the given point.

(4) At stations or points on or near a sea coast, the local value of the acceleration of gravity is calculated, so far as practicable, through the use of equations (2) and (3) on a *pro rata* basis, weighting the last term of equation (2) according to the relative area of land included within the specified circle and weighting the

* This table is reproduced from Appendix B to WMO TR.

last term of equation (3) according to the relative area of the sea included within the circle, then combining algebraically the values thus secured to obtain a correction which is applied to the first two terms in the right-hand members of either of those equations.

(5) In order to compute the value of the acceleration of gravity at a given point in the free air at an altitude Z in metres, above mean sea-level, equations (2) and (3), for land and sea surfaces respectively, may be adapted for the purpose by substituting for the term

$$-\,0.000\,308\,6\;H$$

in equations (2) and (3) the following free-air term :

Free-air term =

$$\left\{-\,[0.000\,308\,55 + 0.000\,000\,227 \cos 2\varphi]Z + [0.000\,072\,54 + 0.000\,000\,10 \cos\,2\varphi]\left(\frac{Z}{1000}\right)^2\right\} \qquad (4)$$

(6) Any value of the acceleration of gravity derived in the manner described in paragraphs (1)–(5), inclusive, shall be referred to as being on the *meteorological gravity system*, to distinguish the data from those on the so-called *Potsdam system* which is widely used by geodetic organizations and which is on a basis that yields values 0.013 cm sec^{-2} greater than those on the meteorological gravity system.

NOTE : Further procedures for determining local acceleration of gravity are given in WMO Publication No. 8. TP. 3.

Table 3.9.1 ICAO standard atmosphere : temperature, pressure and density as function of geopotential altitude

Atmosphère type OACI : température, pression et masse volumique en fonction de l'altitude géopotentielle

H : geopotential altitude in m or geopotential in standard gpm — *altitude géopotentielle en* m *ou géopotentiel en* gpm standard

t : temperature, ° C

p : pressure in mb — *pression en* mb

ρ : density in kg m^{-3} — *masse volumique en* kg m^{-3}

H	*t*	*p*	*ρ*	*H*	*t*	*p*	*ρ*
- 1000	21.500	1139.29	1.3470	16000	-56.500	102.874	0.16542
- 500	18.250	1074.77	1.2849	16500	-56.500	95.0748	0.15288
0	15.000	1013.25	1.2250	17000	-56.500	87.8666	0.14129
500	11.750	954.608	1.1673	17500	-56.500	81.2049	0.13058
1000	8.500	898.745	1.1116	18000	-56.500	75.0482	0.12068
1500	5.250	845.560	1.0581	18500	-56.500	69.3583	0.11153
2000	2.000	794.952	1.0065	19000	-56.500	64.0999	0.10307
2500	-1.250	746.825	0.95686	19500	-56.500	59.2401	0.095257
3000	-4.500	701.085	0.90912	20000	-56.500	54.7487	0.088035
3500	-7.750	657.640	0.86323	20500	-56.000	50.6025	0.081180
4000	-11.000	616.402	0.81913	21000	-55.500	46.7787	0.074873
4500	-14.250	577.283	0.77677	21500	-55.000	43.2517	0.069069
5000	-17.500	540.199	0.73612	22000	-54.500	39.9978	0.063727
5500	-20.750	505.068	0.69711	22500	-54.000	36.9953	0.058809
6000	-24.000	471.810	0.65970	23000	-53.500	34.2242	0.054280
6500	-27.250	440.348	0.62384	23500	-53.000	31.6663	0.050109
7000	-30.500	410.607	0.58950	24000	-52.500	29.3048	0.046267
7500	-33.750	382.514	0.55662	24500	-52.000	27.1241	0.042727
8000	-37.000	355.998	0.52517	25000	-51.500	25.1101	0.039466
8500	-40.250	330.990	0.49509	25500	-51.000	23.2497	0.036459
9000	-43.500	307.424	0.46635	26000	-50.500	21.5308	0.033688
9500	-46.750	285.236	0.43890	26500	-50.000	19.9425	0.031133
10000	-50.000	264.362	0.41271	27000	-49.500	18.4745	0.028777
10500	-53.250	244.743	0.38772	27500	-49.000	17.1175	0.026604
11000	-56.500	226.320	0.36392	28000	-48.500	15.8628	0.024599
11500	-56.500	209.161	0.33633	28500	-48.000	14.7026	0.022749
12000	-56.500	193.304	0.31083	29000	-47.500	13.6296	0.021042
12500	-56.500	178.648	0.28726	29500	-47.000	12.6370	0.019466
13000	-56.500	165.104	0.26548	30000	-46.500	11.7186	0.018012
13500	-56.500	152.586	0.24535	30500	-46.000	10.8688	0.016669
14000	-56.500	141.018	0.22675	31000	-45.500	10.0823	0.015429
14500	-56.500	130.326	0.20956	31500	-45.000	9.35421	0.014283
15000	-56.500	120.445	0.19367	32000	-44.500	8.68014	0.013225
15500	-56.500	111.314	0.17899				

Table 3.9.2 ICAO standard atmosphere : geopotential altitude as a function of pressure

Atmosphère type OACI : altitude géopotentielle en fonction de la pression

p : pressure in mb — *pression en* mb

H : geopotential altitude in m or geopotential in standard gpm
altitude géopotentielle en m *ou géopotentiel en* gpm standard

p	H
10.00	31055
10.50	30730
11.00	30420
11.50	30125
12.00	29843
12.50	29572
13.00	29313
13.50	29063
14.00	28823
14.50	28591
15.00	28368
15.50	28152
16.00	27943
16.50	27741
17.00	27545
17.50	27355
18.00	27170
18.50	26991
19.00	26816
19.50	26647
20.0	26481
21.0	26163
22.0	25860
23.0	25570
24.0	25294
25.0	25029
26.0	24774
27.0	24530
28.0	24294
29.0	24068
30.0	23849
31.0	23637
32.0	23432
33.0	23234
34.0	23042
35.0	22856
36.0	22675
37.0	22499
38.0	22328
39.0	22162

p	H
40.0	22000
41.0	21842
42.0	21688
43.0	21537
44.0	21390
45.0	21247
46.0	21107
47.0	20970
48.0	20836
49.0	20705
50.0	20576
51.0	20450
52.0	20327
53.0	20206
54.0	20087
55.0	19971
56.0	19857
57.0	19744
58.0	19634
59.0	19526
60.0	19419
61.0	19314
62.0	19211
63.0	19110
64.0	19010
65.0	18912
66.0	18815
67.0	18719
68.0	18625
69.0	18533
70.0	18442
71.0	18352
72.0	18263
73.0	18175
74.0	18089
75.0	18004
76.0	17920
77.0	17837
78.0	17755
79.0	17675

p	H
80.0	17595
81.0	17516
82.0	17438
83.0	17361
84.0	17285
85.0	17210
86.0	17136
87.0	17063
88.0	16990
89.0	16919
90.0	16848
91.0	16778
92.0	16708
93.0	16640
94.0	16572
95.0	16505
96.0	16439
97.0	16373
98.0	16308
99.0	16243
100.0	16180
105.0	15870
110.0	15575
115.0	15293
120.0	15023
125.0	14765
130.0	14516
135.0	14277
140.0	14046
145.0	13823
150.0	13608
155.0	13400
160.0	13199
165.0	13004
170.0	12815
175.0	12631
180.0	12452
185.0	12278
190.0	12109
195.0	11945

p	H
200.0	11784
210.0	11475
220.0	11180
230.0	10898
240.0	10626
250.0	10363
260.0	10109
270.0	9862
280.0	9623
290.0	9390
300.0	9164
310.0	8944
320.0	8729
330.0	8520
340.0	8316
350.0	8117
360.0	7923
370.0	7732
380.0	7546
390.0	7364
400.0	7185
410.0	7011
420.0	6839
430.0	6671
440.0	6506
450.0	6344
460.0	6184
470.0	6028
480.0	5874
490.0	5723
500.0	5574
510.0	5428
520.0	5284
530.0	5142
540.0	5003
550.0	4865
560.0	4730
570.0	4596
580.0	4464
590.0	4335
600.0	4206
610.0	4080
620.0	3955
630.0	3832
640.0	3711

p	H
650.0	3591
660.0	3472
670.0	3355
680.0	3239
690.0	3125
700.0	3012
710.0	2901
720.0	2790
730.0	2681
740.0	2573
750.0	2466
760.0	2361
770.0	2256
780.0	2153
790.0	2050
800.0	1949
810.0	1849
820.0	1749
830.0	1651
840.0	1554
850.0	1457
860.0	1362
870.0	1267
880.0	1173
890.0	1081
900.0	988
910.0	897
920.0	807
930.0	717
940.0	628
950.0	540
960.0	453
970.0	366
980.0	281
990.0	195
1000.0	111
1010.0	27
1020.0	-56
1030.0	-139
1040.0	-220
1050.0	-302
1060.0	-382
1070.0	-462
1080.0	-541
1090.0	-620
1100.0	-698

Table 3.10 **Altimeter setting (QNH) computation factors**

Facteurs pour le calcul du calage de l'altimètre (QNH)

Geopotential *géopotentiel* m'	*A*	*B*	Geopotential *géopotentiel* m'	*A*	*B*
0	0	1.000 00	2 000	45.71	1.217 12
50	1.14	1.004 81	2 050	46.86	1.223 23
100	2.29	1.009 66	2 100	48.00	1.229 41
150	3.43	1.014 53	2 150	49.14	1.235 63
200	4.57	1.019 43	2 200	50.28	1.241 88
250	5.71	1.024 37	2 250	51.43	1.248 18
300	6.86	1.029 32	2 300	52.57	1.254 51
350	8.00	1.034 31	2 350	53.71	1.260 88
400	9.14	1.039 33	2 400	54.86	1.267 28
450	10.29	1.044 38	2 450	56.00	1.273 73
500	11.43	1.049 45	2 500	57.14	1.280 24
550	12.57	1.054 57	2 550	58.28	1.286 78
600	13.71	1.059 71	2 600	59.43	1.293 33
650	14.86	1.064 89	2 650	60.57	1.299 95
700	16.00	1.070 09	2 700	61.71	1.306 61
750	17.14	1.075 32	2 750	62.86	1.313 31
800	18.29	1.080 58	2 800	64.00	1.320 05
850	19.43	1.085 88	2 850	65.14	1.326 84
900	20.57	1.091 22	2 900	66.28	1.333 67
950	21.71	1.096 58	2 950	67.43	1.340 56
1 000	22.86	1.101 98	3 000	68.57	1.347 46
1 050	24.00	1.107 40	3 050	69.71	1.354 41
1 100	25.14	1.112 86	3 100	70.86	1.361 42
1 150	26.28	1.118 37	3 150	72.00	1.368 47
1 200	27.43	1.123 89	3 200	73.14	1.375 56
1 250	28.57	1.129 45	3 250	74.28	1.382 71
1 300	29.71	1.135 04	3 300	75.43	1.389 88
1 350	30.86	1.140 67	3 350	76.57	1.397 11
1 400	32.00	1.146 33	3 400	77.71	1.404 40
1 450	33.14	1.152 04	3 450	78.85	1.411 74
1 500	34.28	1.157 78	3 500	80.00	1.419 09
1 550	35.43	1.163 54	3 550	81.14	1.426 51
1 600	36.57	1.169 35	3 600	82.28	1.433 98
1 650	37.71	1.175 19	3 650	83.43	1.441 51
1 700	38.86	1.181 06	3 700	84.57	1.449 07
1 750	40.00	1.186 98	3 750	85.71	1.456 68
1 800	41.14	1.192 93	3 800	86.85	1.464 34
1 850	42.28	1.198 92	3 850	88.00	1.472 04
1 900	43.43	1.204 94	3 900	89.14	1.479 81
1 950	44.57	1.211 00	3 950	90.28	1.487 63
			4 000	91.43	1.495 49

Table 3.11.1 **Mean temperature of various layers in ICAO standard atmosphere**
Température moyenne de différentes couches dans l'atmosphère type OACI

*H** : pressure–altitude — *altitude–pression*, m′
t : temperature, °C (base or top of the layer — *base ou sommet de la couche*)

Top of the layer *sommet de la couche*		Base of the layer — *base de la couche*										
	H* :	0	500	1000	1500	2000	2500	3000	3500	4000	4500	5000
	t :	15.00	11.75	8.50	5.25	2.00	—1.25	—4.50	—7.75	—11.00	—14.25	—17.50
H*	t	K	K	K	K	K	K	K	K	K	K	K
500	11.75	286.5										
1000	8.50	284.9	283.3									
1500	5.25	283.2	281.6	280.0								
2000	2.00	281.6	280.0	278.4	276.8							
2500	-1.25	279.9	278.3	276.7	275.1	273.5						
3000	-4.50	278.3	276.7	275.1	273.5	271.9	270.3					
3500	-7.75	276.6	275.0	273.4	271.8	270.2	268.6	267.0				
4000	-11.00	274.9	273.4	271.8	270.2	268.6	267.0	265.4	263.8			
4500	-14.25	273.3	271.7	270.1	268.5	266.9	265.3	263.7	262.1	260.5		
5000	-17.50	271.6	270.0	268.4	266.9	265.3	263.7	262.1	260.5	258.9	257.3	
5500	-20.75	269.9	268.3	266.8	265.2	263.6	262.0	260.4	258.8	257.2	255.6	254.0
6000	-24.00	268.2	266.6	265.1	263.5	261.9	260.4	258.8	257.2	255.6	254.0	252.4
6500	-27.25	266.5	264.9	263.4	261.8	260.3	258.7	257.1	255.5	253.9	252.3	250.7
7000	-30.50	264.7	263.2	261.7	260.1	258.6	257.0	255.4	253.9	252.3	250.7	249.1
7500	-33.75	263.0	261.5	260.0	258.4	256.9	255.3	253.7	252.2	250.6	249.0	247.4
8000	-37.00	261.3	259.8	258.2	256.7	255.2	253.6	252.1	250.5	248.9	247.4	245.8
8500	-40.25	259.5	258.0	256.5	255.0	253.4	251.9	250.3	248.8	247.2	245.7	244.1
9000	-43.50	257.8	256.3	254.8	253.2	251.7	250.2	248.6	247.1	245.5	244.0	242.4
9500	-46.75	256.0	254.5	253.0	251.5	250.0	248.5	246.9	245.4	243.8	242.3	240.7
10000	-50.00	254.3	252.8	251.3	249.8	248.2	246.7	245.2	243.7	242.1	240.6	239.0
10500	-53.25	252.5	251.0	249.5	248.0	246.5	245.0	243.5	241.9	240.4	238.9	237.3
11000	-56.50	250.7	249.2	247.7	246.2	244.7	243.2	241.7	240.2	238.7	237.1	235.6

TABLE 3.11 — 2

Top of the layer *sommet de la couche*		Base of the layer — *base de la couche*										
	*H** :	0	500	1000	1500	2000	2500	3000	3500	4000	4500	5000
	t :	15.00	11.75	8.50	5.25	2.00	—1.25	—4.50	—7.75	—11.00	—14.25	—17.50
*H**	*t*	K	K	K	K	K	K	K	K	K	K	K
12000	-56.50	247.5	246.0	244.5	243.1	241.6	240.1	238.7	237.2	235.7	234.2	232.7
13000	-56.50	244.8	243.4	241.9	240.5	239.1	237.7	236.3	234.8	233.4	232.0	230.6
14000	-56.50	242.5	241.2	239.8	238.4	237.1	235.7	234.3	233.0	231.6	230.3	228.9
15000	-56.50	240.6	239.3	238.0	236.7	235.3	234.0	232.7	231.5	230.2	228.9	227.6
16000	-56.50	239.0	237.7	236.4	235.2	233.9	232.7	231.4	230.2	229.0	227.8	226.6
17000	-56.50	237.5	236.3	235.1	233.9	232.7	231.5	230.3	229.1	228.0	226.8	225.7
18000	-56.50	236.3	235.1	233.9	232.8	231.6	230.5	229.3	228.2	227.1	226.1	225.0
19000	-56.50	235.1	234.0	232.9	231.8	230.7	229.6	228.5	227.4	226.4	225.4	224.4
20000	-56.50	234.1	233.1	232.0	230.9	229.8	228.8	227.8	226.8	225.8	224.8	223.9
21000	-55.50	233.3	232.2	231.2	230.2	229.1	228.1	227.2	226.2	225.2	224.3	223.4
22000	-54.50	232.5	231.5	230.5	229.5	228.6	227.6	226.7	225.7	224.8	224.0	223.1
23000	-53.50	231.9	230.9	230.0	229.0	228.1	227.2	226.3	225.4	224.5	223.7	222.9
24000	-52.50	231.4	230.5	229.5	228.6	227.7	226.8	226.0	225.1	224.3	223.5	222.7
25000	-51.50	231.0	230.1	229.2	228.3	227.4	226.6	225.7	224.9	224.2	223.4	222.7
26000	-50.50	230.6	229.7	228.9	228.0	227.2	226.4	225.6	224.8	224.1	223.3	222.6
27000	-49.50	230.3	229.5	228.7	227.8	227.0	226.3	225.5	224.7	224.0	223.3	222.7
28000	-48.50	230.1	229.3	228.5	227.7	226.9	226.2	225.4	224.7	224.0	223.4	222.7
29000	-47.50	229.9	229.1	228.4	227.6	226.9	226.1	225.4	224.7	224.1	223.4	222.8
30000	-46.50	229.8	229.0	228.3	227.6	226.8	226.1	225.4	224.8	224.2	223.5	223.0
31000	-45.50	229.7	229.0	228.3	227.5	226.8	226.2	225.5	224.9	224.3	223.7	223.1
32000	-44.50	229.7	229.0	228.2	227.6	226.9	226.2	225.6	225.0	224.4	223.8	223.3

Table 3.11.2 **Correction of altimeter reading as a function of pressure-altitude and deviation of observed temperature from standard temperature**

Correction des lectures de l'altimètre en fonction de l'altitude-pression et de l'écart entre la température observée et la température standard

Pressure-altitude *altitude-pression* m'	$\Delta T = T_{mv} - T_{ms}$, °C 1 m'	2 m'	3 m'	4 m'	5 m'	6 m'	7 m'	8 m'	9 m'	10 m'
500	2	3	5	7	9	10	12	14	16	17
1000	4	7	11	14	18	21	25	28	32	35
1500	5	11	16	21	26	32	37	42	48	53
2000	7	14	21	28	36	43	50	57	64	71
2500	9	18	27	36	45	54	63	71	80	89
3000	11	22	32	43	54	65	75	86	97	108
3500	13	25	38	51	63	76	89	101	114	127
4000	15	29	44	58	73	87	102	116	131	145
4500	16	33	49	66	82	99	115	132	148	165
5000	18	37	55	74	92	110	129	147	166	184
5500	20	41	61	82	102	122	143	163	183	204
6000	22	45	67	89	112	134	157	179	201	224
6500	24	49	73	98	122	146	171	195	220	244
7000	26	53	79	106	132	159	185	212	238	264
7500	29	57	86	114	143	171	200	228	257	285
8000	31	61	92	122	153	184	214	245	276	306
8500	33	65	98	131	164	196	229	262	295	327
9000	35	70	105	140	175	209	244	279	314	349
9500	37	74	111	148	186	223	260	297	334	371
10000	39	79	118	157	197	236	275	315	354	393
10500	42	83	125	166	208	250	291	333	374	416
11000	44	88	132	176	219	263	307	351	395	439
12000	48	97	145	194	242	291	339	388	436	485
13000	53	106	159	212	266	319	372	425	478	531
14000	58	115	173	231	289	346	404	462	520	577
15000	62	125	187	249	312	374	436	499	561	623
16000	67	134	201	268	335	402	469	536	603	670
17000	72	143	215	286	358	429	501	573	644	716
18000	76	152	229	305	381	457	533	609	686	762
19000	81	162	242	323	404	485	566	646	727	808
20000	85	171	256	342	427	513	598	683	769	854
21000	90	180	270	360	450	540	630	720	810	900
22000	95	189	284	378	473	568	662	757	851	946
23000	99	198	298	397	496	595	694	793	893	992
24000	104	207	311	415	519	622	726	830	933	1037
25000	108	216	325	433	541	649	758	866	974	1082
26000	113	225	338	451	564	676	789	902	1015	1127
27000	117	234	352	469	586	703	821	938	1055	1172
28000	122	243	365	487	608	730	852	973	1095	1217
29000	126	252	378	504	631	757	883	1009	1135	1261
30000	131	261	392	522	653	783	914	1044	1175	1305
31000	135	270	405	540	675	810	945	1080	1214	1349
32000	139	279	418	557	697	836	975	1115	1254	1393

Table 3.12.1 **Values of the term** 67.445 × 273.15 log $\frac{1\,100}{p}$ **as a function of pressure** p**, in** mb

Valeurs de l'expression 67,445 × 273,15 log $\frac{1\,100}{p}$ *en fonction de la pression* p*, en* mb

p mb	0	1	2	3	4	5	6	7	8	9
0		56030.1	50484.3	47240.3	44938.6	43153.3	41694.6	40461.2	39392.9	38450.5
10	37607.6	36845.0	36148.8	35508.4	34915.5	34363.5	33847.2	33362.1	32904.8	32472.2
20	32061.8	31671.5	31299.3	30943.6	30603.1	30276.5	29962.7	29660.8	29369.8	29089.0
30	28817.8	28555.4	28301.4	28055.2	27816.4	27584.5	27359.1	27139.9	26926.5	26718.7
40	26516.1	26318.5	26125.7	25937.5	25753.5	25573.7	25397.9	25225.8	25057.4	24892.4
50	24730.8	24572.3	24417.0	24264.6	24115.0	23968.2	23824.1	23682.5	23543.3	23406.5
60	23272.1	23139.8	23009.7	22881.7	22755.7	22631.7	22509.5	22389.2	22270.7	22153.9
70	22038.7	21925.3	21813.3	21703.0	21594.1	21486.7	21380.8	21276.2	21172.9	21071.0
80	20970.4	20871.0	20772.8	20675.8	20580.0	20485.3	20391.8	20299.3	20207.8	20117.4
90	20028.0	19939.6	19852.2	19765.7	19680.1	19595.4	19511.7	19428.8	19346.7	19265.5
100	19185.1	19105.4	19026.6	18948.6	18871.3	18794.7	18718.9	18643.7	18569.3	18495.6
110	18422.5	18350.1	18278.3	18207.2	18136.7	18066.9	17997.6	17928.9	17860.8	17793.3
120	17726.3	17659.9	17594.1	17528.8	17464.0	17399.7	17336.0	17272.7	17210.0	17147.7
130	17085.9	17024.6	16963.8	16903.4	16843.5	16784.0	16724.9	16666.3	16608.1	16550.4
140	16493.0	16436.1	16379.5	16323.4	16267.6	16212.3	16157.3	16102.7	16048.4	15994.5
150	15941.0	15887.9	15835.0	15782.6	15730.5	15678.7	15627.2	15576.1	15525.3	15474.8
160	15424.7	15374.8	15325.3	15276.0	15227.1	15178.5	15130.1	15082.1	15034.3	14986.8
170	14939.6	14892.7	14846.0	14799.7	14753.5	14707.7	14662.1	14616.8	14571.7	14526.9
180	14482.3	14438.0	14393.9	14350.1	14306.5	14263.1	14220.0	14177.1	14134.4	14091.9
190	14049.7	14007.7	13965.9	13924.4	13883.0	13841.9	13801.0	13760.3	13719.7	13679.4
200	13639.3	13599.4	13559.7	13520.2	13480.9	13441.8	13402.8	13364.1	13325.5	13287.2
210	13249.0	13211.0	13173.1	13135.5	13098.0	13060.7	13023.6	12986.6	12949.8	12913.2
220	12876.8	12840.5	12804.4	12768.4	12732.6	12697.0	12661.5	12626.2	12591.0	12556.0
230	12521.1	12486.4	12451.9	12417.4	12383.2	12349.1	12315.1	12281.3	12247.6	12214.0
240	12180.6	12147.3	12114.2	12081.2	12048.4	12015.6	11983.1	11950.6	11918.3	11886.1
250	11854.0	11822.1	11790.3	11758.6	11727.0	11695.6	11664.3	11633.1	11602.0	11571.0
260	11540.2	11509.5	11478.9	11448.4	11418.1	11387.8	11357.7	11327.7	11297.7	11267.9
270	11238.3	11208.7	11179.2	11149.9	11120.6	11091.5	11062.4	11033.5	11004.6	10975.9
280	10947.3	10918.8	10890.3	10862.0	10833.8	10805.7	10777.7	10749.7	10721.9	10694.2
290	10666.5	10639.0	10611.5	10584.2	10556.9	10529.8	10502.7	10475.7	10448.8	10422.0
300	10395.3	10368.7	10342.1	10315.7	10289.3	10263.0	10236.9	10210.7	10184.7	10158.8
310	10132.9	10107.2	10081.5	10055.9	10030.4	10004.9	9979.6	9954.3	9929.1	9904.0
320	9878.9	9854.0	9829.1	9804.3	9779.5	9754.9	9730.3	9705.8	9681.4	9657.0
330	9632.7	9608.5	9584.4	9560.3	9536.3	9512.4	9488.6	9464.8	9441.1	9417.5
340	9393.9	9370.4	9347.0	9323.6	9300.3	9277.1	9253.9	9230.8	9207.8	9184.9
350	9162.0	9139.1	9116.4	9093.7	9071.0	9048.5	9026.0	9003.5	8981.1	8958.8
360	8936.6	8914.4	8892.2	8870.2	8848.2	8826.2	8804.3	8782.5	8760.7	8739.0
370	8717.4	8695.8	8674.2	8652.8	8631.3	8610.0	8588.7	8567.4	8546.2	8525.1
380	8504.0	8483.0	8462.0	8441.1	8420.2	8399.4	8378.7	8358.0	8337.3	8316.7
390	8296.2	8275.7	8255.2	8234.9	8214.5	8194.2	8174.0	8153.8	8133.7	8113.6
400	8093.6	8073.6	8053.7	8033.8	8014.0	7994.2	7974.5	7954.8	7935.2	7915.6
410	7896.0	7876.6	7857.1	7837.7	7818.4	7799.1	7779.8	7760.6	7741.4	7722.3
420	7703.2	7684.2	7665.2	7646.3	7627.4	7608.6	7589.8	7571.0	7552.3	7533.6
430	7515.0	7496.4	7477.9	7459.4	7440.9	7422.5	7404.1	7385.8	7367.5	7349.3
440	7331.0	7312.9	7294.8	7276.7	7258.6	7240.6	7222.7	7204.8	7186.9	7169.0
450	7151.2	7133.5	7115.8	7098.1	7080.4	7062.8	7045.3	7027.8	7010.3	6992.8
460	6975.4	6958.0	6940.7	6923.4	6906.1	6888.9	6871.7	6854.6	6837.5	6820.4
470	6803.3	6786.3	6769.4	6752.4	6735.5	6718.7	6701.8	6685.1	6668.3	6651.6
480	6634.9	6618.2	6601.6	6585.0	6568.5	6552.0	6535.5	6519.1	6502.6	6486.3
490	6469.9	6453.6	6437.3	6421.1	6404.9	6388.7	6372.5	6356.4	6340.4	6324.3
500	6308.3	6292.3	6276.3	6260.4	6244.5	6228.7	6212.8	6197.0	6181.3	6165.5
510	6149.8	6134.2	6118.5	6102.9	6087.3	6071.8	6056.3	6040.8	6025.3	6009.9
520	5994.5	5979.1	5963.8	5948.5	5933.2	5917.9	5902.7	5887.5	5872.3	5857.2
530	5842.1	5827.0	5812.0	5796.9	5781.9	5767.0	5752.0	5737.1	5722.2	5707.4
540	5692.5	5677.7	5663.0	5648.2	5633.5	5618.8	5604.1	5589.5	5574.9	5560.3

p mb	0	1	2	3	4	5	6	7	8	9
550	5545.7	5531.2	5516.7	5502.2	5487.7	5473.3	5458.9	5444.5	5430.2	5415.9
560	5401.6	5387.3	5373.0	5358.8	5344.6	5330.4	5316.3	5302.2	5288.1	5274.0
570	5260.0	5245.9	5231.9	5218.0	5204.0	5190.1	5176.2	5162.3	5148.4	5134.6
580	5120.8	5107.0	5093.3	5079.5	5065.8	5052.1	5038.5	5024.8	5011.2	4997.6
590	4984.0	4970.5	4957.0	4943.5	4930.0	4916.5	4903.1	4889.7	4876.3	4862.9
600	4849.6	4836.2	4822.9	4809.7	4796.4	4783.2	4770.0	4756.8	4743.6	4730.4
610	4717.3	4704.2	4691.1	4678.1	4665.0	4652.0	4639.0	4626.0	4613.1	4600.1
620	4587.2	4574.3	4561.5	4586.6	4535.8	4523.0	4510.2	4497.4	4484.6	4471.9
630	4459.2	4446.5	4433.8	4421.2	4408.6	4396.0	4383.4	4370.8	4358.2	4345.7
640	4333.2	4320.7	4308.2	4295.8	4283.4	4270.9	4258.5	4246.2	4233.8	4221.5
650	4209.2	4196.9	4184.6	4172.3	4160.1	4147.9	4135.6	4123.5	4111.3	4099.1
660	4087.0	4074.9	4062.8	4050.7	4038.7	4026.6	4014.6	4002.6	3990.6	3978.6
670	3966.7	3954.8	3942.8	3930.9	3919.1	3907.2	3895.4	3883.5	3871.7	3859.9
680	3848.2	3836.4	3824.7	3812.9	3801.2	3789.5	3777.9	3766.2	3754.6	3743.0
690	3731.4	3719.8	3708.2	3696.6	3685.1	3673.6	3662.1	3650.6	3639.1	3627.7
700	3616.2	3604.8	3593.4	3582.0	3570.6	3559.3	3548.0	3536.6	3525.3	3514.0
710	3502.8	3491.5	3480.2	3469.0	3457.8	3446.6	3435.4	3424.3	3413.1	3402.0
720	3390.8	3379.7	3368.7	3357.6	3346.5	3335.5	3324.5	3313.4	3302.4	3291.5
730	3280.5	3269.5	3258.6	3247.7	3236.8	3225.9	3215.0	3204.1	3193.3	3182.5
740	3171.6	3160.8	3150.0	3139.3	3128.5	3117.8	3107.0	3096.3	3085.6	3074.9
750	3064.2	3053.6	3042.9	3032.3	3021.7	3011.1	3000.5	2989.9	2979.4	2968.8
760	2958.3	2947.7	2937.2	2926.7	2916.3	2905.8	2895.4	2884.9	2874.5	2864.1
770	2853.7	2843.3	2832.9	2822.6	2812.2	2801.9	2791.6	2781.3	2771.0	2760.7
780	2750.4	2740.2	2730.0	2719.7	2709.5	2699.3	2689.1	2679.0	2668.8	2658.7
790	2648.5	2638.4	2628.3	2618.2	2608.1	2598.0	2588.0	2577.9	2567.9	2557.9
800	2547.9	2537.9	2527.9	2517.9	2508.0	2498.0	2488.1	2478.2	2468.3	2458.4
810	2448.5	2438.6	2428.8	2418.9	2409.1	2399.3	2389.4	2379.6	2369.9	2360.1
820	2350.3	2340.6	2330.8	2321.1	2311.4	2301.7	2292.0	2282.3	2272.6	2263.0
830	2253.3	2243.7	2234.1	2224.5	2214.9	2205.3	2195.7	2186.1	2176.6	2167.1
840	2157.5	2148.0	2138.5	2129.0	2119.5	2110.0	2100.6	2091.1	2081.7	2072.3
850	2062.8	2053.4	2044.0	2034.6	2025.3	2015.9	2006.6	1997.2	1987.9	1978.6
860	1969.3	1960.0	1950.7	1941.4	1932.1	1922.9	1913.6	1904.4	1895.2	1886.0
870	1876.8	1867.6	1858.4	1849.2	1840.1	1830.9	1821.8	1812.6	1803.5	1794.4
880	1785.3	1776.2	1767.2	1758.1	1749.0	1740.0	1731.0	1721.9	1712.9	1703.9
890	1694.9	1685.9	1677.0	1668.0	1659.0	1650.1	1641.2	1632.2	1623.3	1614.4
900	1605.5	1596.6	1587.8	1578.9	1570.0	1561.2	1552.4	1543.5	1534.7	1525.9
910	1517.1	1508.3	1499.6	1490.8	1482.0	1473.3	1464.5	1455.8	1447.1	1438.4
920	1429.7	1421.0	1412.3	1403.6	1395.0	1386.3	1377.7	1369.0	1360.4	1351.8
930	1343.2	1334.6	1326.0	1317.4	1308.8	1300.3	1291.7	1283.2	1274.7	1266.1
940	1257.6	1249.1	1240.6	1232.1	1223.6	1215.2	1206.7	1198.2	1189.8	1181.4
950	1172.9	1164.5	1156.1	1147.7	1139.3	1130.9	1122.6	1114.2	1105.9	1097.5
960	1089.2	1080.8	1072.5	1064.2	1055.9	1047.6	1039.3	1031.0	1022.8	1014.5
970	1006.3	998.0	989.8	981.5	973.3	965.1	956.9	948.7	940.5	932.4
980	924.2	916.0	907.9	899.7	891.6	883.5	875.4	867.2	859.1	851.1
990	843.0	834.9	826.8	818.8	810.7	802.7	794.6	786.6	778.6	770.6
1000	762.6	754.6	746.6	738.6	730.6	722.7	714.7	706.7	698.8	690.9
1010	682.9	675.0	667.1	659.2	651.3	643.4	635.6	627.7	619.8	612.0
1020	604.1	596.3	588.4	580.6	572.8	565.0	557.2	549.4	541.6	533.8
1030	526.1	518.3	510.5	502.8	495.1	487.3	479.6	471.9	464.2	456.5
1040	448.8	441.1	433.4	425.7	418.0	410.4	402.7	395.1	387.5	379.8
1050	372.2	364.6	357.0	349.4	341.8	334.2	326.6	319.0	311.5	303.9
1060	296.4	288.8	281.3	273.7	266.2	258.7	251.2	243.7	236.2	228.7
1070	221.2	213.8	206.3	198.8	191.4	183.9	176.5	169.1	161.6	154.2

Table 3.12.2 **Reduction of geopotential differences to 0°C temperature ($\Delta\Phi_0$)**

Réduction des différences de géopotentiel à la température de 0°C ($\Delta\Phi_0$)

t_{mv} : mean virtual temperature of the layer — *température virtuelle moyenne de la couche*

t_{mv} °C	$\Delta\Phi$: Geopotential difference — *différence de géopotentiel*, gpm											
	100	200	300	400	500	600	700	800	900	1000	2000	3000
−100	157.8	315.5	473.2	631.0	788.8	946.5	1104.2	1262.0	1419.8	1577.5	3155.0	4732.5
− 99	156.8	313.7	470.5	627.4	784.2	941.1	1097.9	1254.8	1411.6	1568.4	3136.9	4705.3
− 98	155.9	311.9	467.8	623.8	779.7	935.7	1091.6	1247.6	1403.5	1559.5	3119.0	4678.5
− 97	155.1	310.1	465.2	620.3	775.3	930.4	1085.4	1240.5	1395.6	1550.6	3101.3	4651.9
− 96	154.2	308.4	462.6	616.8	770.9	925.1	1079.3	1233.5	1387.7	1541.9	3083.8	4625.6
− 95	153.3	306.6	460.0	613.3	766.6	919.9	1073.3	1226.6	1379.9	1533.2	3066.5	4599.7
− 94	152.5	304.9	457.4	609.9	762.3	914.8	1067.3	1219.7	1372.2	1524.7	3049.3	4574.0
− 93	151.6	303.2	454.9	606.5	758.1	909.7	1061.3	1213.0	1364.6	1516.2	3032.4	4548.6
− 92	150.8	301.6	452.4	603.1	753.9	904.7	1055.5	1206.3	1357.1	1507.8	3015.7	4523.5
− 91	150.0	299.9	449.9	599.8	749.8	899.7	1049.7	1199.6	1349.6	1499.6	2999.1	4498.7
− 90	149.1	298.3	447.4	596.5	745.7	894.8	1044.0	1193.1	1342.2	1491.4	2982.7	4474.1
− 89	148.3	296.7	445.0	593.3	741.6	890.0	1038.3	1186.6	1335.0	1483.3	2966.6	4449.8
− 88	147.5	295.1	442.6	590.1	737.6	885.2	1032.7	1180.2	1327.7	1475.3	2950.5	4425.8
− 87	146.7	293.5	440.2	586.9	733.7	880.4	1027.1	1173.9	1320.6	1467.3	2934.7	4402.0
− 86	146.0	291.9	437.8	583.8	729.8	875.7	1021.6	1167.6	1313.6	1459.5	2919.0	4378.5
− 85	145.2	290.3	435.5	580.7	725.9	871.0	1016.2	1161.4	1306.6	1451.7	2903.5	4355.2
− 84	144.4	288.8	433.2	577.6	722.0	866.4	1010.8	1155.3	1299.7	1444.1	2888.1	4332.2
− 83	143.6	287.3	430.9	574.6	718.2	861.9	1005.5	1149.2	1292.8	1436.5	2872.9	4309.4
− 82	142.9	285.8	428.7	571.6	714.5	857.4	1000.3	1143.2	1286.1	1429.0	2857.9	4286.9
− 81	142.2	284.3	426.5	568.6	710.8	852.9	995.1	1137.2	1279.4	1421.5	2843.0	4264.6
− 80	141.4	282.8	424.2	565.7	707.1	848.5	989.9	1131.3	1272.7	1414.2	2828.3	4242.5
− 79	140.7	281.4	422.1	562.8	703.4	844.1	984.8	1125.5	1266.2	1406.9	2813.8	4220.6
− 78	140.0	279.9	419.9	559.9	699.8	839.8	979.8	1119.7	1259.7	1399.7	2799.3	4199.0
− 77	139.3	278.5	417.8	557.0	696.3	835.5	974.8	1114.0	1253.3	1392.5	2785.1	4177.6
− 76	138.5	277.1	415.6	554.2	692.7	831.3	969.8	1108.4	1246.9	1385.5	2770.9	4156.4
− 75	137.8	275.7	413.5	551.4	689.2	827.1	964.9	1102.8	1240.6	1378.5	2757.0	4135.4
− 74	137.2	274.3	411.5	548.6	685.8	822.9	960.1	1097.2	1234.4	1371.6	2743.1	4114.7
− 73	136.5	272.9	409.4	545.9	682.4	818.8	955.3	1091.8	1228.2	1364.7	2729.4	4094.1
− 72	135.8	271.6	407.4	543.2	679.0	814.8	950.5	1086.3	1222.1	1357.9	2715.8	4073.8
− 71	135.1	270.2	405.4	540.5	675.6	810.7	945.8	1081.0	1216.1	1351.2	2702.4	4053.6
− 70	134.5	268.9	403.4	537.8	672.3	806.7	941.2	1075.6	1210.1	1344.6	2689.1	4033.7
− 69	133.8	267.6	401.4	535.2	669.0	802.8	936.6	1070.4	1204.2	1338.0	2675.9	4013.9
− 68	133.1	266.3	399.4	532.6	665.7	798.9	932.0	1065.2	1198.3	1331.4	2662.9	3994.4
− 67	132.5	265.0	397.5	530.0	662.5	795.0	927.5	1060.0	1192.5	1325.0	2650.0	3975.0
− 66	131.9	263.7	395.6	527.4	659.3	791.2	923.0	1054.9	1186.7	1318.6	2637.2	3955.8
− 65	131.2	262.5	393.7	524.9	656.1	787.4	918.6	1049.8	1181.0	1312.3	2624.5	3936.8
− 64	130.6	261.2	391.8	522.4	653.0	783.6	914.2	1044.8	1175.4	1306.0	2612.0	3918.0
− 63	130.0	260.0	389.9	519.9	649.9	779.9	909.8	1039.8	1169.8	1299.8	2599.5	3899.3
− 62	129.4	258.7	388.1	517.4	646.8	776.2	905.5	1034.9	1164.3	1293.6	2587.2	3880.9
− 61	128.8	257.5	386.3	515.0	643.8	772.5	901.3	1030.0	1158.8	1287.5	2575.0	3862.6
− 60	128.1	256.3	384.4	512.6	640.7	768.9	897.0	1025.2	1153.3	1281.5	2563.0	3844.4
− 59	127.5	255.1	382.6	510.2	637.7	765.3	892.8	1020.4	1147.9	1275.5	2551.0	3826.5
− 58	127.0	253.9	380.9	507.8	634.8	761.7	888.7	1015.7	1142.6	1269.6	2539.1	3808.7
− 57	126.4	252.7	379.1	505.5	631.8	758.2	884.6	1011.0	1137.3	1263.7	2527.4	3791.1
− 56	125.8	251.6	377.4	503.1	628.9	754.7	880.5	1006.3	1132.1	1257.9	2515.7	3773.6
− 55	125.2	250.4	375.6	500.8	626.1	751.3	876.5	1001.7	1126.9	1252.1	2504.2	3756.3
− 54	124.6	249.3	373.9	498.6	623.2	747.8	872.5	997.1	1121.8	1246.4	2492.8	3739.2
− 53	124.1	248.1	372.2	496.3	620.4	744.4	868.5	992.6	1116.7	1240.7	2481.5	3722.2
− 52	123.5	247.0	370.5	494.0	617.6	741.1	864.6	988.1	1111.6	1235.1	2470.2	3705.4
− 51	123.0	245.9	368.9	491.8	614.8	737.7	860.7	983.6	1106.6	1229.6	2459.1	3688.7
− 50	122.4	244.8	367.2	489.6	612.0	734.4	856.8	979.2	1101.6	1224.0	2448.1	3672.2

t_{mv} °C	ΔΦ : Geopotential difference — *différence de géopotentiel*, gpm											
	100	200	300	400	500	600	700	800	900	1000	2000	3000
—50	122.4	244.8	367.2	489.6	612.0	734.4	856.8	979.2	1101.6	1224.0	2448.1	3672.2
—49	121.9	243.7	365.6	487.4	609.3	731.2	853.0	974.9	1096.7	1218.6	2437.2	3655.8
—48	121.3	242.6	364.0	485.3	606.6	727.9	849.2	970.5	1091.9	1213.2	2426.4	3639.5
—47	120.8	241.6	362.3	483.1	603.9	724.7	845.5	966.3	1087.0	1207.8	2415.6	3623.5
—46	120.2	240.5	360.8	481.0	601.2	721.5	841.8	962.0	1082.2	1202.5	2405.0	3607.5
—45	119.7	239.4	359.2	478.9	598.6	718.3	838.1	957.8	1077.5	1197.2	2394.5	3591.7
—44	119.2	238.4	357.6	476.8	596.0	715.2	834.4	953.6	1072.8	1192.0	2384.0	3576.0
—43	118.7	237.4	356.0	474.7	593.4	712.1	830.8	949.5	1068.1	1186.8	2373.7	3560.5
—42	118.2	236.3	354.5	472.7	590.8	709.0	827.2	945.4	1063.5	1181.7	2363.4	3545.1
—41	117.7	235.3	353.0	470.6	588.3	706.0	823.6	941.3	1058.9	1176.6	2353.2	3529.8
—40	117.2	234.3	351.5	468.6	585.8	702.9	820.1	937.2	1054.4	1171.6	2343.1	3514.7
—39	116.7	233.3	350.0	466.6	583.3	699.9	816.6	933.2	1049.9	1166.6	2333.1	3499.6
—38	116.2	232.3	348.5	464.6	580.8	697.0	813.1	929.3	1045.4	1161.6	2323.2	3484.8
—37	115.7	231.3	347.0	462.7	578.3	694.0	809.7	925.3	1041.0	1156.7	2313.3	3470.0
—36	115.2	230.4	345.5	460.7	575.9	691.1	806.3	921.4	1036.6	1151.8	2303.6	3455.4
—35	114.7	229.4	344.1	458.8	573.5	688.2	802.9	917.6	1032.3	1147.0	2293.9	3440.9
—34	114.2	228.4	342.6	456.9	571.1	685.3	799.5	913.7	1027.9	1142.2	2284.3	3426.5
—33	113.7	227.5	341.2	455.0	568.7	682.4	796.2	909.9	1023.7	1137.4	2274.8	3412.2
—32	113.3	226.5	339.8	453.1	566.3	679.6	792.9	906.2	1019.4	1132.7	2265.4	3398.1
—31	112.8	225.6	338.4	451.2	564.0	676.8	789.6	902.4	1015.2	1128.0	2256.0	3384.0
—30	112.3	224.7	337.0	449.4	561.7	674.0	786.4	898.7	1011.0	1123.4	2246.8	3370.1
—29	111.9	223.8	335.6	447.5	559.4	671.3	783.1	895.0	1006.9	1118.8	2237.5	3356.3
—28	111.4	222.8	334.3	445.7	557.1	668.5	779.9	891.4	1002.8	1114.2	2228.4	3342.6
—27	111.0	221.9	332.9	443.9	554.8	665.8	776.8	887.7	998.7	1109.7	2219.4	3329.0
—26	110.5	221.0	331.6	442.1	552.6	663.1	773.6	884.2	994.7	1105.2	2210.4	3315.6
—25	110.1	220.1	330.2	440.3	550.4	660.4	770.5	880.6	990.7	1100.7	2201.5	3302.2
—24	109.6	219.3	328.9	438.5	548.2	657.8	767.4	877.1	986.7	1096.3	2192.6	3289.0
—23	109.2	218.4	327.6	436.8	546.0	655.2	764.4	873.6	982.7	1091.9	2183.9	3275.8
—22	108.8	217.5	326.3	435.0	543.8	652.6	761.3	870.1	978.8	1087.6	2175.2	3262.8
—21	108.3	216.7	325.0	433.3	541.6	650.0	758.3	866.6	975.0	1083.3	2166.6	3249.8
—20	107.9	215.8	323.7	431.6	539.5	647.4	755.3	863.2	971.1	1079.0	2158.0	3237.0
—19	107.5	215.0	322.4	429.9	537.4	644.9	752.3	859.8	967.3	1074.8	2149.5	3224.3
—18	107.1	214.1	321.2	428.2	535.3	642.3	749.4	856.4	963.5	1070.5	2141.1	3211.6
—17	106.6	213.3	319.9	426.5	533.2	639.8	746.5	853.1	959.7	1066.4	2132.7	3199.1
—16	106.2	212.4	318.7	424.9	531.1	637.3	743.6	849.8	956.0	1062.2	2124.4	3186.7
—15	105.8	211.6	317.4	423.2	529.0	634.9	740.7	846.5	952.3	1058.1	2116.2	3174.3
—14	105.4	210.8	316.2	421.6	527.0	632.4	737.8	843.2	948.6	1054.0	2108.0	3162.1
—13	105.0	210.0	315.0	420.0	525.0	630.0	735.0	840.0	945.0	1050.0	2099.9	3149.9
—12	104.6	209.2	313.8	418.4	523.0	627.6	732.2	836.8	941.4	1046.0	2091.9	3137.8
—11	104.2	208.4	312.6	416.8	521.0	625.2	729.4	833.6	937.8	1042.0	2083.9	3125.9
—10	103.8	207.6	311.4	415.2	519.0	622.8	726.6	830.4	934.2	1038.0	2076.0	3114.0
— 9	103.4	206.8	310.2	413.6	517.0	620.4	723.8	827.3	930.7	1034.1	2068.1	3102.2
— 8	103.0	206.0	309.1	412.1	515.1	618.1	721.1	824.1	927.2	1030.2	2060.3	3090.5
— 7	102.6	205.3	307.9	410.5	513.2	615.8	718.4	821.0	923.7	1026.3	2052.6	3078.9
— 6	102.2	204.5	306.7	409.0	511.2	613.5	715.7	818.0	920.2	1022.5	2044.9	3067.4
— 5	101.9	203.7	305.6	407.5	509.3	611.2	713.1	814.9	916.8	1018.6	2037.3	3056.0
— 4	101.5	203.0	304.5	405.9	507.4	608.9	710.4	811.9	913.4	1014.9	2029.7	3044.6
— 3	101.1	202.2	303.3	404.4	505.6	606.7	707.8	808.9	910.0	1011.1	2022.2	3033.3
— 2	100.7	201.5	302.2	403.0	503.7	604.4	705.2	805.9	906.6	1007.4	2014.8	3022.1
— 1	100.4	200.7	301.1	401.5	501.8	602.2	702.6	802.9	903.3	1003.7	2007.3	3011.0
0	100.0	200.0	300.0	400.0	500.0	600.0	700.0	800.0	900.0	1000.0	2000.0	3000.0

t_{mv} °C	ΔΦ : Geopotential difference — *différence de géopotentiel*, gpm											
	100	200	300	400	500	600	700	800	900	1000	2000	3000
0	100.0	200.0	300.0	400.0	500.0	600.0	700.0	800.0	900.0	1000.0	2000.0	3000.0
1	99.6	199.3	298.9	398.5	498.2	597.8	697.4	797.1	896.7	996.4	1992.7	2989.0
2	99.3	198.5	297.8	397.1	496.4	595.6	694.9	794.2	893.5	992.7	1985.5	2978.2
3	98.9	197.8	296.7	395.7	494.6	593.5	692.4	791.3	890.2	989.1	1978.3	2967.4
4	98.6	197.1	295.7	394.2	492.8	591.3	689.9	788.5	887.0	985.6	1971.1	2956.7
5	98.2	196.4	294.6	392.8	491.0	589.2	687.4	785.6	883.8	982.0	1964.0	2946.1
6	97.9	195.7	293.6	391.4	489.3	587.1	685.0	782.8	880.7	978.5	1957.0	2935.5
7	97.5	195.0	292.5	390.0	487.5	585.0	682.5	780.0	877.5	975.0	1950.0	2925.0
8	97.2	194.3	291.5	388.6	485.8	582.9	680.1	777.2	874.4	971.6	1943.1	2914.6
9	96.8	193.6	290.4	387.2	484.0	580.9	677.7	774.5	871.3	968.1	1936.2	2904.3
10	96.5	192.9	289.4	385.9	482.3	578.8	675.3	771.7	868.2	964.7	1929.4	2894.0
11	96.1	192.3	288.4	384.5	480.6	576.8	672.9	769.0	865.2	961.3	1922.6	2883.9
12	95.8	191.6	287.4	383.2	479.0	574.8	670.5	766.3	862.1	957.9	1915.8	2873.8
13	95.5	190.9	286.4	381.8	477.3	572.7	668.2	763.7	859.1	954.6	1909.1	2863.7
14	95.1	190.2	285.4	380.5	475.6	570.8	665.9	761.0	856.1	951.2	1902.5	2853.8
15	94.8	189.6	284.4	379.2	474.0	568.8	663.6	758.4	853.2	948.0	1895.9	2843.8
16	94.5	188.9	283.4	377.9	472.3	566.8	661.3	755.7	850.2	944.7	1889.3	2834.0
17	94.1	188.3	282.4	376.6	470.7	564.8	659.0	753.1	847.3	941.4	1882.8	2824.2
18	93.8	187.6	281.5	375.3	469.1	562.9	656.7	750.5	844.4	938.2	1876.4	2814.5
19	93.5	187.0	280.5	374.0	467.5	561.0	654.5	748.0	841.5	935.0	1869.9	2804.9
20	93.2	186.4	279.5	372.7	465.9	559.1	652.2	745.4	838.6	931.8	1863.6	2795.3
21	92.9	185.7	278.6	371.4	464.3	557.2	650.0	742.9	835.7	928.6	1857.2	2785.8
22	92.5	185.1	277.6	370.2	462.7	555.3	647.8	740.4	832.9	925.5	1850.9	2776.4
23	92.2	184.5	276.7	368.9	461.2	553.4	645.6	737.9	830.1	922.3	1844.7	2767.0
24	91.9	183.8	275.8	367.7	459.6	551.5	643.5	735.4	827.3	919.2	1838.5	2757.7
25	91.6	183.2	274.8	366.5	458.1	549.7	641.3	732.9	824.5	916.2	1832.3	2748.4
26	91.3	182.6	273.9	365.2	456.5	547.9	639.2	730.5	821.8	913.1	1826.2	2739.3
27	91.0	182.0	273.0	364.0	455.0	546.0	637.0	728.0	819.0	910.0	1820.1	2730.2
28	90.7	181.4	272.1	362.8	453.5	544.2	634.9	725.6	816.3	907.0	1814.1	2721.1
29	90.4	180.8	271.2	361.6	452.0	542.4	632.8	723.2	813.6	904.0	1808.0	2712.1
30	90.1	180.2	270.3	360.4	450.5	540.6	630.7	720.8	810.9	901.0	1802.1	2703.1
31	89.8	179.6	269.4	359.2	449.0	538.8	628.7	718.5	808.3	898.1	1796.2	2694.2
32	89.5	179.0	268.5	358.1	447.6	537.1	626.6	716.1	805.6	895.1	1790.3	2685.4
33	89.2	178.4	267.7	356.9	446.1	535.3	624.5	713.8	803.0	892.2	1784.4	2676.6
34	88.9	177.9	266.8	355.7	444.7	533.6	622.5	711.4	800.4	889.3	1778.6	2667.9
35	88.6	177.3	265.9	354.6	443.2	531.9	620.5	709.1	797.8	886.4	1772.8	2659.3
36	88.4	176.7	265.1	353.4	441.8	530.1	618.5	706.8	795.2	883.6	1767.1	2650.7
37	88.1	176.1	264.2	352.3	440.4	528.4	616.5	704.6	792.6	880.7	1761.4	2642.1
38	87.8	175.6	263.4	351.2	438.9	526.7	614.5	702.3	790.1	877.9	1755.8	2633.6
39	87.5	175.0	262.5	350.0	437.5	525.0	612.5	700.0	787.6	875.1	1750.1	2625.2
40	87.2	174.5	261.7	348.9	436.1	523.4	610.6	697.8	785.0	872.3	1744.5	2616.8
41	86.9	173.9	260.8	347.8	434.7	521.7	608.6	695.6	782.5	869.5	1739.0	2608.5
42	86.7	173.3	260.0	346.7	433.4	520.0	606.7	693.4	780.1	866.7	1733.5	2600.2
43	86.4	172.8	259.2	345.6	432.0	518.4	604.8	691.2	777.6	864.0	1728.0	2592.0
44	86.1	172.3	258.4	344.5	430.6	516.8	602.9	689.0	775.1	861.3	1722.5	2583.8
45	85.9	171.7	257.6	343.4	429.3	515.1	601.0	686.8	772.7	858.6	1717.1	2575.7
46	85.6	171.2	256.8	342.3	427.9	513.5	599.1	684.7	770.3	855.9	1711.7	2567.6
47	85.3	170.6	256.0	341.3	426.6	511.9	597.2	682.6	767.9	853.2	1706.4	2559.6
48	85.1	170.1	255.2	340.2	425.3	510.3	595.4	680.4	765.5	850.5	1701.1	2551.6
49	84.8	169.6	254.4	339.2	424.0	508.7	593.5	678.3	763.1	847.9	1695.8	2543.7
50	84.5	169.1	253.6	338.1	422.6	507.2	591.7	676.2	760.8	845.3	1690.6	2535.8

Table 3.13.1 **Correction of mercury barometer for temperature**
Correction de température du baromètre à mercure

For temperatures { above / below } 0°C, the correction is to be { subtracted / added }

Pour les températures { au-dessus / au-dessous } de 0°C, la correction doit être { soustraite / ajoutée }

Attached thermometer *thermomètre attaché* °C	$p^* + Q$ { barometer reading + Q term for fixed cistern barometers / *lecture du baromètre + terme Q pour les baromètres à cuvette fixe* } 400	500	600	700	720	740	760	780
0	0	0	0	0	0	0	0	0
.5	.03	.04	.05	.06	.06	.06	.06	.06
1.0	.07	.08	.10	.11	.12	.12	.12	.13
1.5	.10	.12	.15	.17	.18	.18	.19	.19
2.0	.13	.16	.20	.23	.24	.24	.25	.25
2.5	0.16	0.20	0.24	0.29	0.29	0.30	0.31	0.32
3.0	.20	.24	.29	.34	.35	.36	.37	.38
3.5	.23	.29	.34	.40	.41	.42	.43	.45
4.0	.26	.33	.39	.46	.47	.48	.50	.51
4.5	.29	.37	.44	.51	.53	.54	.56	.57
5.0	0.33	0.41	0.49	0.57	0.59	0.60	0.62	0.64
5.5	.36	.45	.54	.63	.65	.66	.68	.70
6.0	.39	.49	.59	.69	.71	.72	.74	.76
6.5	.42	.53	.64	.74	.76	.79	.81	.83
7.0	.46	.57	.69	.80	.82	.85	.87	.89
7.5	0.49	0.61	0.73	0.86	0.88	0.91	0.93	0.95
8.0	.52	.65	.78	.91	.94	.97	.99	1.02
8.5	.55	.69	.83	.97	1.00	1.03	1.05	1.08
9.0	.59	.73	.88	1.03	1.06	1.09	1.12	1.15
9.5	.62	.77	.93	1.08	1.12	1.15	1.18	1.21
10.0	0.65	0.82	0.98	1.14	1.17	1.21	1.24	1.27
10.5	.68	.86	1.03	1.20	1.23	1.27	1.30	1.34
11.0	.72	.90	1.08	1.26	1.29	1.33	1.36	1.40
11.5	.75	.94	1.13	1.31	1.35	1.39	1.43	1.46
12.0	.78	.98	1.17	1.37	1.41	1.45	1.49	1.53
12.5	0.82	1.02	1.22	1.43	1.47	1.51	1.55	1.59
13.0	.85	1.06	1.27	1.49	1.53	1.57	1.61	1.66
13.5	.88	1.10	1.32	1.54	1.58	1.63	1.67	1.72
14.0	.91	1.14	1.37	1.60	1.64	1.69	1.73	1.78
14.5	.95	1.18	1.42	1.65	1.70	1.75	1.80	1.84
15.0	0.98	1.22	1.47	1.71	1.76	1.81	1.86	1.91
15.5	1.01	1.26	1.52	1.77	1.82	1.87	1.92	1.97
16.0	1.04	1.30	1.56	1.82	1.88	1.93	1.98	2.03
16.5	1.08	1.34	1.61	1.88	1.94	1.99	2.04	2.10
17.0	1.11	1.38	1.66	1.94	1.99	2.05	2.10	2.16
17.5	1.14	1.43	1.71	2.00	2.05	2.11	2.17	2.22
18.0	1.17	1.47	1.76	2.05	2.11	2.17	2.23	2.29
18.5	1.21	1.51	1.81	2.11	2.17	2.23	2.29	2.35
19.0	1.24	1.55	1.86	2.17	2.23	2.29	2.35	2.41
19.5	1.27	1.59	1.91	2.22	2.29	2.35	2.41	2.48
20.0	1.30	1.63	1.95	2.28	2.34	2.41	2.47	2.54
20.5	1.33	1.67	2.00	2.34	2.40	2.47	2.54	2.60
21.0	1.37	1.71	2.05	2.39	2.46	2.53	2.60	2.67
21.5	1.40	1.75	2.10	2.45	2.52	2.59	2.66	2.73
22.0	1.43	1.79	2.15	2.51	2.58	2.65	2.72	2.79

TABLE 3.13 — 2

Attached thermometer *thermomètre. attaché* °C	$p^* + Q$ { barometer reading + Q term for fixed cistern barometers / *lecture du baromètre + terme Q pour les baromètres à cuvette fixe* 400	500	600	700	720	740	760	780
22.5	1.46	1.83	2.20	2.56	2.64	2.71	2.78	2.86
23.0	1.50	1.87	2.25	2.62	2.69	2.77	2.84	2.92
23.5	1.53	1.91	2.29	2.68	2.75	2.83	2.91	2.98
24.0	1.56	1.95	2.34	2.73	2.81	2.89	2.97	3.05
24.5	1.59	1.99	2.39	2.79	2.87	2.95	3.03	3.11
25.0	1.63	2.03	2.44	2.85	2.93	3.01	3.09	3.17
25.5	1.66	2.07	2.49	2.90	2.99	3.07	3.15	3.24
26.0	1.69	2.11	2.54	2.96	3.04	3.13	3.21	3.30
26.5	1.72	2.15	2.59	3.02	3.10	3.19	3.28	3.36
27.0	1.76	2.20	2.63	3.07	3.16	3.25	3.34	3.42
27.5	1.79	2.24	2.68	3.13	3.22	3.31	3.40	3.49
28.0	1.82	2.28	2.73	3.19	3.28	3.37	3.46	3.55
28.5	1.85	2.32	2.78	3.24	3.34	3.43	3.52	3.61
29.0	1.89	2.36	2.83	3.30	3.39	3.49	3.58	3.68
29.5	1.92	2.40	2.88	3.36	3.45	3.55	3.64	3.74
30.0	1.95	2.44	2.93	3.41	3.51	3.61	3.71	3.80
30.5	1.98	2.48	2.97	3.47	3.57	3.67	3.77	3.87
31.0	2.01	2.52	3.02	3.53	3.63	3.73	3.83	3.93
31.5	2.05	2.56	3.07	3.58	3.68	3.79	3.89	3.99
32.0	2.08	2.60	3.12	3.64	3.74	3.85	3.95	4.05
32.5	2.11	2.64	3.17	3.70	3.80	3.91	4.01	4.12
33.0	2.14	2.68	3.22	3.75	3.86	3.97	4.07	4.18
33.5	2.18	2.72	3.26	3.81	3.92	4.03	4.13	4.24
34.0	2.21	2.76	3.31	3.87	3.98	4.09	4.20	4.31
34.5	2.24	2.80	3.36	3.92	4.03	4.15	4.26	4.37
35.0	2.27	2.84	3.41	3.98	4.09	4.21	4.32	4.43
35.5	2.31	2.88	3.46	4.03	4.15	4.26	4.38	4.50
36.0	2.34	2.92	3.51	4.09	4.21	4.32	4.44	4.56
36.5	2.37	2.96	3.55	4.15	4.27	4.38	4.50	4.62
37.0	2.40	3.00	3.60	4.20	4.32	4.44	4.56	4.68
37.5	2.43	3.04	3.65	4.26	4.38	4.50	4.63	4.75
38.0	2.47	3.08	3.70	4.32	4.44	4.56	4.69	4.81
38.5	2.50	3.12	3.75	4.37	4.50	4.62	4.75	4.87
39.0	2.53	3.16	3.80	4.43	4.56	4.68	4.81	4.94
39.5	2.56	3.20	3.84	4.49	4.61	4.74	4.87	5.00
40.0	2.60	3.24	3.89	4.54	4.67	4.80	4.93	5.06
40.5	2.63	3.28	3.94	4.60	4.73	4.86	4.99	5.12
41.0	2.66	3.32	3.99	4.65	4.79	4.92	5.05	5.19
41.5	2.69	3.37	4.04	4.71	4.84	4.98	5.12	5.25
42.0	2.72	3.41	4.09	4.77	4.90	5.04	5.18	5.31
42.5	2.76	3.45	4.13	4.82	4.96	5.10	5.24	5.38
43.0	2.79	3.49	4.18	4.88	5.02	5.16	5.30	5.44
43.5	2.82	3.53	4.23	4.94	5.08	5.22	5.36	5.50
44.0	2.85	3.57	4.28	4.99	5.14	5.28	5.42	5.56
44.5	2.89	3.61	4.33	5.05	5.19	5.34	5.48	5.63
45.0	2.92	3.65	4.38	5.11	5.25	5.40	5.54	5.69

Attached thermometer *thermomètre attaché* °C	$p^* + Q$ { barometer reading + Q term for fixed cistern barometers / *lecture du baromètre + terme Q pour les baromètres à cuvette fixe* 780	800	820	840	860	880	900	920
0	0	0	0	0	0	0	0	0
.5	.06	.07	.07	.07	.07	.07	.07	.08
1.0	.13	.13	.13	.14	.14	.14	.15	.15
1.5	.19	.20	.20	.21	.21	.22	.22	.23
2.0	.25	.26	.27	.27	.28	.29	.29	.30
2.5	0.32	0.33	0.33	0.34	0.35	0.36	0.37	0.38
3.0	.38	.39	.40	.41	.42	.43	.44	.45
3.5	.45	.46	.47	.48	.49	.50	.51	.53
4.0	.51	.52	.54	.55	.56	.57	.59	.60
4.5	.57	.59	.60	.62	.63	.65	.66	.68
5.0	0.64	0.65	0.67	0.69	0.70	0.72	0.73	0.75
5.5	.70	.72	.74	.75	.77	.79	.81	.83
6.0	.76	.78	.80	.82	.84	.86	.88	.90
6.5	.83	.85	.87	.89	.91	.93	.95	.98
7.0	.89	.91	.94	.96	.98	1.01	1.03	1.05
7.5	0.95	0.98	1.00	1.03	1.05	1.08	1.10	1.13
8.0	1.02	1.04	1.07	1.10	1.12	1.15	1.17	1.20
8.5	1.08	1.11	1.14	1.16	1.19	1.22	1.25	1.28
9.0	1.15	1.17	1.20	1.23	1.26	1.29	1.32	1.35
9.5	1.21	1.24	1.27	1.30	1.33	1.36	1.39	1.43
10.0	1.27	1.30	1.34	1.37	1.40	1.44	1.47	1.50
10.5	1.34	1.37	1.40	1.44	1.47	1.51	1.54	1.58
11.0	1.40	1.44	1.47	1.51	1.54	1.58	1.61	1.65
11.5	1.46	1.50	1.54	1.58	1.61	1.65	1.69	1.73
12.0	1.53	1.57	1.60	1.64	1.68	1.72	1.76	1.80
12.5	1.59	1.63	1.67	1.71	1.75	1.79	1.83	1.87
13.0	1.66	1.70	1.74	1.78	1.83	1.87	1.91	1.95
13.5	1.72	1.76	1.80	1.85	1.89	1.94	1.98	2.02
14.0	1.78	1.83	1.87	1.92	1.96	2.01	2.05	2.10
14.5	1.84	1.89	1.94	1.98	2.03	2.08	2.13	2.17
15.0	1.91	1.96	2.00	2.05	2.10	2.15	2.20	2.25
15.5	1.97	2.02	2.07	2.12	2.17	2.22	2.27	2.32
16.0	2.03	2.09	2.14	2.19	2.24	2.29	2.35	2.40
16.5	2.10	2.15	2.20	2.26	2.31	2.37	2.42	2.47
17.0	2.16	2.22	2.27	2.33	2.38	2.44	2.49	2.55
17.5	2.22	2.28	2.34	2.39	2.45	2.51	2.57	2.62
18.0	2.29	2.35	2.40	2.46	2.52	2.58	2.64	2.70
18.5	2.35	2.41	2.47	2.53	2.59	2.65	2.71	2.77
19.0	2.41	2.48	2.54	2.60	2.66	2.72	2.78	2.85
19.5	2.48	2.54	2.60	2.67	2.73	2.79	2.86	2.92
20.0	2.54	2.60	2.67	2.74	2.80	2.87	2.93	3.00
20.5	2.60	2.67	2.74	2.80	2.87	2.94	3.00	3.07
21.0	2.67	2.73	2.80	2.87	2.94	3.01	3.08	3.14
21.5	2.73	2.80	2.87	2.94	3.01	3.08	3.15	3.22
22.0	2.79	2.86	2.94	3.01	3.08	3.15	3.22	3.29

Attached thermometer *thermomètre attaché* °C	$p^* + Q$ { barometer reading + Q term for fixed cistern barometers *lecture du baromètre + terme Q pour les baromètres à cuvette fixe* 780	800	820	840	860	880	900	920
22.5	2.86	2.93	3.00	3.08	3.15	3.22	3.30	3.37
23.0	2.92	2.99	3.07	3.14	3.22	3.29	3.37	3.44
23.5	2.98	3.06	3.14	3.21	3.29	3.36	3.44	3.52
24.0	3.05	3.12	3.20	3.28	3.36	3.44	3.51	3.59
24.5	3.11	3.19	3.27	3.35	3.43	3.51	3.59	3.67
25.0	3.17	3.25	3.33	3.42	3.50	3.58	3.66	3.74
25.5	3.24	3.32	3.40	3.48	3.57	3.65	3.73	3.82
26.0	3.30	3.38	3.47	3.55	3.64	3.72	3.81	3.89
26.5	3.36	3.45	3.53	3.62	3.71	3.79	3.88	3.96
27.0	3.42	3.51	3.60	3.69	3.78	3.86	3.95	4.04
27.5	3.49	3.58	3.67	3.76	3.85	3.93	4.02	4.11
28.0	3.55	3.64	3.73	3.82	3.91	4.01	4.10	4.19
28.5	3.61	3.71	3.80	3.89	3.98	4.08	4.17	4.26
29.0	3.68	3.77	3.87	3.96	4.05	4.15	4.24	4.34
29.5	3.74	3.84	3.93	4.03	4.12	4.22	4.32	4.41
30.0	3.80	3.90	4.00	4.10	4.19	4.29	4.39	4.49
30.5	3.87	3.96	4.06	4.16	4.26	4.36	4.46	4.56
31.0	3.93	4.03	4.13	4.23	4.33	4.43	4.53	4.63
31.5	3.99	4.09	4.20	4.30	4.40	4.50	4.61	4.71
32.0	4.05	4.16	4.26	4.36	4.47	4.57	4.68	4.78
32.5	4.12	4.22	4.33	4.43	4.54	4.65	4.75	4.86
33.0	4.18	4.29	4.40	4.50	4.61	4.72	4.82	4.93
33.5	4.24	4.35	4.46	4.57	4.68	4.79	4.90	5.01
34.0	4.31	4.42	4.53	4.64	4.75	4.86	4.97	5.08
34.5	4.37	4.48	4.59	4.71	4.82	4.93	5.04	5.15
35.0	4.43	4.55	4.65	4.77	4.89	5.00	5.11	5.23
35.5	4.50	4.61	4.73	4.82	4.96	5.07	5.19	5.30
36.0	4.56	4.68	4.79	4.91	5.03	5.14	5.26	5.38
36.5	4.62	4.74	4.86	4.98	5.10	5.21	5.33	5.45
37.0	4.68	4.80	4.92	5.04	5.16	5.28	5.40	5.52
37.5	4.75	4.87	4.99	5.11	5.23	5.36	5.48	5.60
38.0	4.81	4.93	5.06	5.18	5.30	5.43	5.55	5.67
38.5	4.87	5.00	5.12	5.25	5.37	5.50	5.62	5.75
39.0	4.94	5.06	5.19	5.32	5.44	5.57	5.69	5.82
39.5	5.00	5.13	5.25	5.38	5.51	5.64	5.77	5.90
40.0	5.06	5.19	5.32	5.45	5.58	5.71	5.84	5.97
40.5	5.12	5.26	5.39	5.52	5.65	5.78	5.91	6.04
41.0	5.19	5.32	5.45	5.59	5.72	5.85	5.98	6.12
41.5	5.25	5.38	5.52	5.65	5.78	5.92	6.06	6.19
42.0	5.31	5.45	5.58	5.72	5.86	5.99	6.13	6.27
42.5	5.38	5.51	5.65	5.78	5.93	6.06	6.20	6.34
43.0	5.44	5.58	5.72	5.86	6.00	6.14	6.27	6.41
43.5	5.50	5.64	5.78	5.92	6.06	6.21	6.35	6.49
44.0	5.56	5.71	5.85	5.99	6.13	6.28	6.42	6.56
44.5	5.63	5.77	5.91	6.06	6.20	6.35	6.49	6.65
45.0	5.69	5.83	5.98	6.13	6.27	6.42	6.56	6.71

Attached thermometer *thermomètre attaché* °C	$p^* + Q$ { barometer reading + Q term for fixed cistern barometers / *lecture du baromètre + terme Q pour les baromètres à cuvette fixe* } 920	940	960	980	1000	1020	1040	1060	1080
0	0	0	0	0	0	0	0	0	0
.5	.08	.08	.08	.08	.08	.08	.08	.09	.09
1.0	.15	.15	.16	.16	.16	.17	.17	.17	.18
1.5	.23	.23	.24	.24	.25	.25	.25	.26	.26
2.0	.30	.31	.31	.32	.33	.33	.34	.35	.35
2.5	0.38	0.38	0.39	0.40	0.41	0.42	0.42	0.43	0.44
3.0	.45	.46	.47	.48	.49	.50	.51	.52	.53
3.5	.53	.54	.55	.56	.57	.58	.59	.61	.62
4.0	.60	.61	.63	.64	.65	.67	.68	.69	.71
4.5	.68	.69	.71	.72	.73	.75	.76	.78	.79
5.0	0.75	0.77	0.78	0.80	0.82	0.83	0.85	0.87	0.88
5.5	.83	.84	.86	.88	.90	.92	.93	.95	.97
6.0	.90	.92	.94	.96	.98	1.00	1.02	1.04	1.06
6.5	.98	1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.15
7.0	1.05	1.07	1.10	1.12	1.14	1.17	1.19	1.21	1.23
7.5	1.13	1.15	1.17	1.20	1.22	1.25	1.27	1.30	1.32
8.0	1.20	1.23	1.25	1.28	1.31	1.33	1.36	1.38	1.41
8.5	1.28	1.30	1.33	1.36	1.39	1.41	1.44	1.47	1.50
9.0	1.35	1.38	1.41	1.44	1.47	1.50	1.53	1.56	1.59
9.5	1.43	1.46	1.49	1.52	1.55	1.58	1.61	1.64	1.67
10.0	1.50	1.53	1.57	1.60	1.63	1.66	1.70	1.73	1.76
10.5	1.58	1.61	1.64	1.68	1.71	1.75	1.78	1.82	1.85
11.0	1.65	1.69	1.72	1.76	1.79	1.83	1.87	1.90	1.94
11.5	1.73	1.76	1.80	1.84	1.88	1.91	1.95	1.99	2.03
12.0	1.80	1.84	1.88	1.92	1.96	2.00	2.04	2.07	2.11
12.5	1.87	1.92	1.96	2.00	2.04	2.08	2.12	2.16	2.20
13.0	1.95	2.00	2.04	2.08	2.12	2.17	2.21	2.25	2.29
13.5	2.02	2.07	2.11	2.16	2.20	2.24	2.29	2.33	2.38
14.0	2.10	2.14	2.19	2.24	2.28	2.33	2.37	2.42	2.46
14.5	2.17	2.22	2.27	2.32	2.36	2.41	2.46	2.50	2.55
15.0	2.25	2.30	2.35	2.40	2.44	2.49	2.54	2.59	2.64
15.5	2.32	2.37	2.42	2.48	2.53	2.58	2.63	2.68	2.73
16.0	2.40	2.45	2.50	2.55	2.61	2.66	2.71	2.76	2.82
16.5	2.47	2.53	2.58	2.63	2.69	2.74	2.80	2.85	2.90
17.0	2.55	2.60	2.66	2.71	2.77	2.82	2.88	2.94	2.99
17.5	2.62	2.68	2.74	2.79	2.85	2.91	2.96	3.02	3.08
18.0	2.70	2.76	2.81	2.87	2.93	2.99	3.05	3.11	3.17
18.5	2.77	2.83	2.89	2.95	3.01	3.07	3.13	3.19	3.25
19.0	2.85	2.91	2.97	3.03	3.09	3.16	3.22	3.28	3.34
19.5	2.92	2.98	3.05	3.11	3.18	3.24	3.30	3.37	3.43
20.0	3.00	3.06	3.13	3.19	3.26	3.32	3.39	3.45	3.52
20.5	3.07	3.14	3.20	3.27	3.34	3.40	3.47	3.54	3.60
21.0	3.14	3.21	3.28	3.35	3.42	3.49	3.56	3.62	3.69
21.5	3.22	3.29	3.36	3.43	3.50	3.57	3.64	3.71	3.78
22.0	3.29	3.37	3.44	3.51	3.58	3.65	3.72	3.80	3.87

TABLE 3.13 — 6

Attached thermometer / *thermomètre attaché* °C	$p^* + Q$ { barometer reading + Q term for fixed cistern barometers / *lecture du baromètre + terme Q pour les baromètres à cuvette fixe*								
	920	940	960	980	1000	1020	1040	1060	1080
22.5	3.37	3.44	3.52	3.59	3.66	3.73	3.81	3.88	3.95
23.0	3.44	3.52	3.59	3.67	3.74	3.82	3.89	3.97	4.04
23.5	3.52	3.59	3.67	3.75	3.82	3.90	3.98	4.05	4.13
24.0	3.59	3.67	3.75	3.83	3.90	3.98	4.06	4.14	4.22
24.5	3.67	3.75	3.83	3.91	3.99	4.07	4.14	4.22	4.30
25.0	3.74	3.82	3.90	3.99	4.07	4.15	4.23	4.31	4.39
25.5	3.82	3.90	3.98	4.06	4.15	4.23	4.31	4.40	4.48
26.0	3.89	3.97	4.06	4.14	4.23	4.31	4.40	4.48	4.57
26.5	3.96	4.05	4.14	4.22	4.31	4.40	4.48	4.57	4.65
27.0	4.04	4.13	4.21	4.30	4.39	4.48	4.57	4.65	4.74
27.5	4.11	4.20	4.29	4.38	4.47	4.56	4.65	4.74	4.83
28.0	4.19	4.28	4.37	4.46	4.55	4.64	4.73	4.83	4.92
28.5	4.26	4.35	4.45	4.54	4.63	4.73	4.82	4.91	5.00
29.0	4.34	4.43	4.53	4.62	4.71	4.81	4.90	5.00	5.09
29.5	4.41	4.51	4.60	4.70	4.79	4.89	4.99	5.08	5.18
30.0	4.49	4.58	4.68	4.78	4.88	4.97	5.07	5.17	5.27
30.5	4.56	4.66	4.76	4.86	4.96	5.06	5.15	5.25	5.35
31.0	4.63	4.73	4.84	4.94	5.04	5.14	5.24	5.34	5.44
31.5	4.71	4.81	4.91	5.02	5.12	5.22	5.32	5.42	5.53
32.0	4.78	4.89	4.99	5.09	5.20	5.30	5.41	5.51	5.61
32.5	4.86	4.96	5.07	5.17	5.28	5.38	5.49	5.60	5.70
33.0	4.93	5.04	5.15	5.25	5.36	5.47	5.57	5.68	5.79
33.5	5.01	5.11	5.22	5.33	5.44	5.55	5.66	5.77	5.88
34.0	5.08	5.19	5.30	5.41	5.52	5.63	5.74	5.85	5.96
34.5	5.15	5.27	5.38	5.49	5.60	5.71	5.83	5.94	6.05
35.0	5.23	5.34	5.46	5.57	5.68	5.80	5.91	6.02	6.14
35.5	5.30	5.42	5.53	5.65	5.76	5.88	5.99	6.11	6.22
36.0	5.38	5.49	5.61	5.73	5.84	5.96	6.08	6.19	6.31
36.5	5.45	5.57	5.69	5.81	5.92	6.04	6.16	6.28	6.40
37.0	5.52	5.65	5.77	5.89	6.01	6.13	6.25	6.37	6.49
37.5	5.60	5.72	5.84	5.96	6.09	6.21	6.33	6.45	6.57
38.0	5.67	5.80	5.92	6.04	6.17	6.29	6.41	6.54	6.66
38.5	5.75	5.87	6.00	6.12	6.25	6.37	6.50	6.62	6.75
39.0	5.82	5.95	6.07	6.20	6.33	6.45	6.58	6.71	6.83
39.5	5.90	6.02	6.15	6.28	6.41	6.54	6.66	6.79	6.92
40.0	5.97	6.10	6.23	6.36	6.49	6.62	6.75	6.88	7.01
40.5	6.04	6.18	6.31	6.44	6.57	6.70	6.83	6.96	7.09
41.0	6.12	6.25	6.38	6.52	6.65	6.78	6.92	7.05	7.18
41.5	6.19	6.33	6.46	6.60	6.73	6.86	7.00	7.13	7.27
42.0	6.27	6.40	6.54	6.67	6.81	6.95	7.08	7.22	7.36
42.5	6.34	6.48	6.62	6.75	6.89	7.03	7.17	7.30	7.44
43.0	6.41	6.55	6.69	6.83	6.97	7.11	7.25	7.39	7.53
43.5	6.49	6.63	6.77	6.91	7.05	7.19	7.33	7.48	7.62
44.0	6.56	6.70	6.84	6.99	7.13	7.28	7.42	7.56	7.70
44.5	6.65	6.78	6.92	7.07	7.21	7.36	7.50	7.65	7.79
45.0	6.71	6.86	7.00	7.15	7.29	7.44	7.59	7.73	7.88

Table 3.13.2 **Capillarity depression of a mercury column**
Dépression capillaire d'une colonne de mercure

Unit : 1 mm mercury at 20°C under normal gravity
Unité : 1 mm *de mercure à* 20°C *sous gravité normale*

Bore of tube *lumière du tube* mm	Meniscus height — *hauteur du ménisque*, mm										
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1
	(Surface tension — *tension superficielle*, 400 dyn cm^{-1})										
8	0.054	0.108	0.162	0.214	0.265	0.315	0.363	0.409	0.453	0.494	0.533
10	.029	.058	.087	.115	.143	.170	.196	.222	.247	.270	.292
16	.006	.011	.016	.022	.027	.032	.037	.042	.047	.052	.056
22	.001	.002	.003	.004	.005	.006	.008	.009	.010	.010	.011
	(Surface tension — *tension superficielle*, 450 dyn cm^{-1})										
1	5.2	9.3	12.6								
2	1.32	2.56	3.65	4.54							
3	0.573	1.134	1.662	2.149	2.582	2.958	3.263	3.517			
4	.314	0.623	0.921	1.205	1.471	1.715	1.936	2.131	2.302	2.444	2.563
5	0.193	0.384	0.570	0.750	0.923	1.086	1.238	1.378	1.505	1.619	1.720
6	.128	.254	.379	.500	.617	0.729	0.836	0.937	1.030	1.117	1.196
7	.088	.176	.263	.348	.430	.510	.587	.661	0.730	0.794	0.855
8	.063	.126	.189	.250	.310	.368	.424	.478	.530	.579	.625
9	.046	.093	.138	.183	.228	.271	.313	.353	.392	.429	.464
10	0.035	0.069	0.103	0.137	0.170	0.202	0.234	0.264	0.294	0.322	0.349
11	.026	.052	.078	.104	.128	.153	.177	.200	.223	.245	.265
12	.020	.040	.059	.079	.098	.117	.135	.153	.170	.187	.203
13	.015	.030	.045	.060	.075	.089	.104	.117	.131	.144	.156
14	.012	.023	.035	.046	.058	.069	.080	.090	.101	.111	.120
15	0.009	0.018	0.027	0.036	0.045	0.053	0.062	0.070	0.078	0.086	0.093
16	.007	.014	.021	.028	.035	.041	.048	.054	.060	.067	.072
17	.006	.011	.016	.022	.027	.032	.037	.042	.047	.052	.056
18	.004	.008	.013	.017	.021	.025	.029	.033	.036	.040	.044
19	.003	.006	.010	.013	.016	.019	.022	.026	.028	.031	.034
20	0.003	0.005	0.008	0.010	0.013	0.015	0.017	0.020	0.022	0.024	0.026
21	.002	.004	.006	.008	.010	.012	.014	.015	.017	.019	.020
22	.002	.003	.005	.006	.008	.009	.011	.012	.013	.015	.016
	(Surface tension — *tension superficielle*, 500 dyn cm^{-1})										
8	0.072	0.143	0.215	0.286	0.354	0.421	0.485	0.547	0.607	0.663	0.716
10	.040	.080	.120	.159	.197	.235	.272	.308	.342	.375	.407
16	.009	.017	.026	.034	.043	.051	.059	.067	.075	.082	.090
22	.002	.004	.006	.008	.010	.012	.014	.016	.018	.020	.021

Bore of tube *lumière du tube* mm	Meniscus height — *hauteur du ménisque*, mm 1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
	(Surface tension — *tension superficielle*, 400 dyn cm^{-1})									
8	0.533	0.569	0.603	0.633	0.660	0.684	0.705	0.723	0.737	0.749
10	.292	.314	.333	.352	.369	.384	.398	.410	.421	.430
16	.056	.060	.065	.068	.072	.076	.079	.082	.084	.086
22	.011	.012	.013	.014	.014	.015	.016	.016	.017	.018
	(Surface tension — *tension superficielle*, 450 dyn cm^{-1})									
1										
2										
3										
4	2.563									
5	1.720	1.807	1.881	1.942						
6	1.196	1.266	1.329	1.384	1.431	1.470	1.503			
7	0.855	0.910	0.961	1.006	1.047	1.082	1.112	1.137	1.157	
8	.625	.668	.708	0.744	0.777	0.807	0.833	0.855	0.874	0.890
9	.464	.498	.529	.557	.584	.608	.630	.649	.665	.679
10	0.349	0.375	0.399	0.422	0.443	0.462	0.480	0.495	0.509	0.522
11	.265	.285	.304	.322	.338	.354	.368	.380	.392	.402
12	.203	.218	.233	.247	.260	.272	.283	.293	.303	.311
13	.156	.168	.180	.190	.200	.210	.219	.227	.234	.241
14	.120	.130	.139	.147	.155	.163	.170	.176	.182	.187
15	0.093	0.101	0.108	0.114	0.120	0.126	0.132	0.137	0.141	0.146
16	.072	.078	.083	.089	.093	.098	.102	.106	.110	.113
17	.056	.061	.065	.069	.073	.076	.080	.083	.086	.088
18	.044	.047	.050	.054	.057	.059	.062	.064	.067	.069
19	.034	.037	.039	.042	.044	.046	.048	.050	.052	.054
20	0.026	0.029	0.030	0.032	0.034	0.036	0.037	0.039	0.040	0.042
21	.020	.022	.024	.025	.027	.028	.029	.030	.031	.032
22	.016	.017	.018	.020	.021	.022	.023	.024	.024	.025
	(Surface tension — *tension superficielle*, 500 dyn cm^{-1})									
8	0.716	0.766	0.813	0.855	0.894	0.929	0.961	0.989	1.013	1.031
10	.407	.436	.464	.491	.517	.542	.563	.582	0.600	0.615
16	.090	.097	.104	.110	.116	.122	.128	.133	.138	.142
22	.021	.023	.025	.026	.028	.029	.031	.032	.033	.034

Table 4.1

THERMODYNAMIC CONSTANTS AND FUNCTIONS [1]

1. Basic constants

Apparent molecular weight of dry air[2] (M)
$M = 28.964\,4$

Absolute temperature of the normal ice point (T_0)
$T_0 = 273.15°K$

Absolute temperature of the triple point (T_1)
$T_1 = 273.16°K$

Gas constant for 1 mole of ideal gas (R^*)
$R^* = 8.314\,32$ J mol^{-1} °K^{-1} $= 8.314\,32 \times 10^7$ erg mol^{-1} °K^{-1}

Gas constant for 1 kilogramme of dry air (R)
$R = 287.05$ J kg^{-1} °K^{-1} $= 2.870\,5 \times 10^6$ erg g^{-1} °K^{-1}

Molecular weight of water vapour (M_w)
$M_w = 18.015\,3$

Gas constant for 1 kilogramme of water vapour[2] (R_w)
$R_w = 461.51$ J kg^{-1} °K^{-1} $= 4.615\,1 \times 10^6$ erg g^{-1} °K^{-1}

2. Specific heats capacity

	Recommended values	*Range of actual values*
Dry air:		
constant pressure c_p	1 005 J kg^{-1} °K^{-1}	1 003 – 1 011 J kg^{-1} °K^{-1}
constant volume c_v	718 J kg^{-1} °K^{-1}	718 – 720 J kg^{-1} °K^{-1}
ratio $X = c_p/c_v$	$7/5 = 1.4$ (exact)	1.40 – 1.41
difference $R = c_p - c_v$	287.05 J kg^{-1} °K^{-1}	
Water:		
liquid c_w	4.19×10^3 J kg^{-1} °K^{-1}	4.18×10^3 J kg^{-1} °K^{-1} (40°C) 4.22×10^3 J kg^{-1} °K^{-1} (0°C) 4.77×10^3 J kg^{-1} °K^{-1} (—40°C)
ice c_i	2.09×10^3 J kg^{-1} °K^{-1}	2.11×10^3 J kg^{-1} °K^{-1} (0°C) 1.38×10^3 J kg^{-1} °K^{-1} (—100°C)

[1] Table 4.1 was drawn up by the Working Group on IMT established by Res. 9 (CAe-III).

[2] See note to Introduction 1.1, section 6.3.

	Recommended values	*Range of actual values*
Water vapour :		
constant pressure c_{pv}	1.85×10^3 J kg^{-1} °K^{-1}	$1.84 \times 10^3 - 1.93 \times 10^3$ J kg^{-1} °K^{-1}
constant volume c_{vv}	1.39×10^3 J kg^{-1} °K^{-1}	$1.38 \times 10^3 - 1.42 \times 10^3$ J kg^{-1} °K^{-1}
ratio $X_v = c_{pv}/c_{vv}$	4/3 (exact) = 1.333	1.32 – 1.33
difference $R_w = c_{pv} — c_{vv}$	461.51 J kg^{-1} °K^{-1}	

3. Heats of transformation of phase of water

	Recommended values	*Range of actual values*	
Heat of fusion L_f		0.334×10^6 J kg^{-1}	(0°C)
		0.203×10^6 J kg^{-1}	(—50°C)
Heat of sublimation L_s	2.835×10^6 J kg^{-1}	2.834×10^6 J kg^{-1}	(0°C)
		2.839×10^6 J kg^{-1}	(—30°C)
		2.824×10^6 J kg^{-1}	(—100°C)
Heat of vaporization L_v		2.406×10^6 J kg^{-1}	(40°C)
		2.501×10^6 J kg^{-1}	(0°C)
		2.635×10^6 J kg^{-1}	(—50°C)

4. Density

The density of air (ρ) in SI units is given by

$$\rho = \frac{p}{RT'_v} \text{ kg m}^{-3} \tag{1}$$

where p is the atmospheric pressure in N m^{-2} (pascal) ;
R the gas constant for dry air : 287.05 J kg^{-1} °K^{-1}, and
T'_v the adjusted virtual temperature of the air in °K.

For pressure p measured in millibars, the density ρ in kg m^{-3} (1 kg m^{-3} = 10^{-3} g cm^{-3}) is

$$\rho = 0.348\,371 \frac{p}{T'_v} \tag{2}$$

For p = 1 013.25 mb and T'_v = 273.15 °K (0°C) this gives

$$\rho = 1.292\,3 \text{ kg m}^{-3} = 1.292\,3\ 10^{-3} \text{ g cm}^{-3}.$$

Table 4.2

COMPOSITION OF DRY AIR UP TO ABOUT 25 KM

(1) *Composition of dry air up to about 25 km* [1]

Constituent gas	*Mole fraction* [2] *(per cent)*
Nitrogen	78.09
Oxygen	20.95
Argon	0.93
Carbon dioxide	0.03
Neon	1.8×10^{-3}
Helium	5.24×10^{-4}
Krypton	1.0×10^{-4}
Hydrogen	5.0×10^{-5}
Xenon	8.0×10^{-6}
Ozone	1.0×10^{-6}
Radon	6.0×10^{-18}

(2) *Molecular weights of gases constituting dry air*

Constituent gas	*Molecular weight* [3] ($^{12}C = 12.000\,0$)
Nitrogen (N_2)	28.013
Oxygen (O_2)	31.999
Argon (A)	39.948
Carbon dioxide (CO_2)	44.010
Neon (Ne)	20.183
Helium (He)	4.003
Krypton (Kr)	83.80
Hydrogen (H_2)	2.016
Xenon (Xe)	131.30
Ozone (O_3)	47.998
Radon (Rn)	222

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[1] Reproduced from WMO TR, Appendix C.

[2] The mole fraction x_i of the i^{th} component of a mixture of gases is defined by

$$x_i = \frac{m_i / M_i}{\Sigma (m_i / M_i)}$$

where m_i is the mass of the i^{th} component in a given volume or mass of the mixture and M_i is its molecular weight, the summation indicated being made over all components.

[3] See Introduction 1.1, section 6.3.

Table 4.3

DEFINITIONS AND SPECIFICATIONS OF WATER VAPOUR IN THE ATMOSPHERE *

(1) The ***mixing ratio*** r of moist air is the ratio of the mass m_v of water vapour to the mass m_a of dry air with which the water vapour is associated :

$$r = \frac{m_v}{m_a}$$

(2) The ***specific humidity***, ***mass concentration*** or ***moisture content*** q of moist air is the ratio of the mass m_v of water vapour to the mass $m_v + m_a$ of moist air in which the mass of water vapour m_v is contained :

$$q = \frac{m_v}{m_v + m_a}$$

(3) ***Vapour concentration (density of water vapour in a mixture) or absolute humidity :*** For a mixture of water vapour and dry air the vapour concentration ρ_v is defined as the ratio of the mass of vapour m_v to the volume V occupied by the mixture :

$$\rho_v = \frac{m_v}{V}$$

(4) *Mole fraction of the water vapour of a sample of moist air :* The mole fraction x_v of the water vapour of a sample of moist air, composed of a mass m_a of dry air and a mass m_v of water vapour is defined by the ratio of the number of moles of water vapour ($n_v = m_v/M_v$) to the total number of moles of the sample $n_v + n_a$, where n_a indicates the number of moles of dry air ($n_a = m_a/M_a$) of the sample concerned. This gives us :

$$x_v = \frac{n_v}{n_a + n_v}$$

or

$$x_v = \frac{r}{0.621\,98 + r}$$

where

r is merely the mixing ratio ($r = m_v/m_a$) of the water vapour of the sample of moist air.

(5) The ***vapour pressure*** e' of water vapour in moist air at total pressure p and with mixing ratio r is defined by :

$$e' = \frac{r}{0.621\,98 + r}\, p = x_v\, p$$

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* Except for sections 20 and 21 this table is a reproduction of Appendix D to the WMO TR, Vol. I (ed. 1971).

(6) *Saturation :* Moist air at a given temperature and pressure is said to be saturated if its mixing ratio is such that the moist air can co-exist in neutral equilibrium with an associated condensed phase (liquid or solid) at the same temperature and pressure, the surface of separation being plane.

(7) *Saturation mixing ratio :* The symbol r_w denotes the saturation mixing ratio of moist air with respect to a plane surface of the associated liquid phase. The symbol r_i denotes the saturation mixing ratio of moist air with respect to a plane surface of the associated solid phase. The associated liquid and solid phases referred to consist of almost pure water and almost pure ice respectively, there being some dissolved air in each.

(8) *Saturation vapour pressure in the pure phase :* The saturation vapour pressure e_w of pure aqueous vapour with respect to water is the pressure of the vapour when in a state of neutral equilibrium with a plane surface of pure water at the same temperature and pressure ; similarly for e_i in respect to ice. e_w and e_i are temperature-dependent functions only, i.e. :

$$e_w = e_w\ (T)$$
$$e_i = e_i\ (T)$$

(9) *Mole fraction of water vapour in moist air saturated with respect to water :* The mole fraction of water vapour in moist air saturated with respect to water, at pressure p and temperature T, is the mole fraction x_{vw} of the water vapour of a sample of moist air, at the same pressure p and the same temperature T, that is in stable equilibrium in the presence of a plane surface of water containing the amount of dissolved air corresponding to equilibrium. Similarly, x_{vi} will be used to indicate the saturation mole fraction with respect to a plane surface of ice containing the amount of dissolved air corresponding to equilibrium.

(10) *Saturation vapour pressure of moist air :* The saturation vapour pressure with respect to water e'_w of moist air at pressure p and temperature T is defined by :

$$e'_w = \frac{r_w}{0.621\,98 + r_w}\, p = x_{vw}\, p$$

Similarly, the saturation vapour pressure with respect to ice e'_i of moist air at pressure p and temperature T is defined by:

$$e'_i = \frac{r_i}{0.621\,98 + r_i}\, p = x_{vi}\, p$$

(11) *Relations between saturation vapour pressures of the pure phase and of moist air :* In the meteorological range of pressure and temperature the following relations hold with an error of 0.5 per cent or less :

$$e'_w = e_w$$
$$e'_i = e_i$$

(12) The *thermodynamic dew-point temperature* T_d of moist air at pressure p and with mixing ratio r is the temperature at which moist air, saturated with respect to water at the given pressure, has a saturation mixing ratio r_w equal to the given mixing ratio r.

(13) The *thermodynamic frost-point temperature* T_f of moist air at pressure p and mixing ratio r is the temperature at which moist air, saturated with respect to ice at the given pressure, has a saturation mixing ratio r_i equal to the given mixing ratio r.

(14) The *dew- and frost-point temperatures* so defined are related to the mixing ratio r and pressure p by the respective equations :

$$e'_w (T_d) = \frac{r}{0.621\,98 + r}\, p = x_v\, p$$

$$e'_i (T_f) = \frac{r}{0.621\,98 + r}\, p = x_v\, p$$

(15) * The *relative humidity U_w with respect to water of moist air* at pressure p and temperature T is the ratio in per cent of the vapour mole fraction x_v to the vapour mole fraction x_{vw} which the air would have if it were saturated with respect to water at the same pressure p and temperature T. Accordingly :

$$U_w = 100 \left(\frac{x_v}{x_{vw}}\right)_{p,T} = 100 \left(\frac{p x_v}{p x_{vw}}\right)_{p,T} = 100 \left(\frac{e'}{e'_w}\right)_{p,T}$$

where subscripts p, T indicate that each term is subject to identical conditions of pressure and temperature. The last expression is formally similar to the classical definition based on the assumption of Dalton's law of partial pressures.

U_w is also related to the mixing ratio r by :

$$U_w = 100\, \frac{r}{r_w} \cdot \frac{0.621\,98 + r_w}{0.621\,98 + r}$$

where

r_w is the saturation mixing ratio at the pressure and temperature of the moist air.

(16) * The *relative humidity U_i with respect to ice of moist air* at pressure p and temperature T is the ratio in per cent of the vapour mole fraction x_v to the vapour mole fraction x_{vi} which the air would have if it were saturated with respect to ice at the same pressure p and temperature T.

Corresponding to the defining equation in (15) :

$$U_i = 100 \left(\frac{x_v}{x_{vi}}\right)_{p,T} = 100 \left(\frac{p x_v}{p x_{vi}}\right)_{p,T} = 100 \left(\frac{e'}{e'_i}\right)_{p,T}$$

(17) *Relative humidity at temperatures less than 0*°C is to be evaluated with respect to water. The advantages of this procedure are as follows :

(*a*) Most hygrometers which are essentially responsive to the relative humidity indicate relative humidity with respect to water at all temperatures.

* Definitions (15) and (16) do not apply to moist air when the pressure p is less than the saturation vapour pressure of pure water and ice respectively at the temperature T.

(*b*) The majority of clouds at temperatures below 0°C consist of water, or mainly of water.

(*c*) Relative humidities greater than 100 per cent would in general not be observed. This is of particular importance in synoptic weather messages, since the atmosphere is often supersaturated with respect to ice at temperatures below 0°C.

(*d*) The majority of existing records of relative humidity at temperatures below 0°C are expressed on a basis of saturation with respect to water.

(18) The ***thermodynamic wet-bulb temperature*** of moist air at pressure p, temperature T and mixing ratio r is the temperature T_w attained by the moist air when brought adiabatically to saturation at pressure p by the evaporation into the moist air of liquid water at pressure p and temperature T_w and containing the amount of dissolved air corresponding to equilibrium with saturated air of the same pressure and temperature.

T_w is defined by the equation :

$$h\,(p, T, r) + [r_w\,(p, T_w) - r]\; h_w\,(p, T_w) = h\,(p, T_w, r_w\,(p, T_w))$$

where

$r_w\,(p, T_w)$	is the mixing ratio of saturated moist air at pressure p and temperature T_w ;
$h_w\,(p, T_w)$	is the enthalpy * of 1 gramme of pure water at pressure p and temperature T_w ;
$h\,(p, T, r)$	is the enthalpy of $1 + r$ grammes of moist air, composed of 1 gramme of dry air and r grammes of water vapour, at pressure p and temperature T ;
$h\,(p, T_w, r_w\,(p, T_w))$	is the enthalpy of $1 + r_w$ grammes of saturated air, composed of 1 gramme of dry air and r_w grammes of water vapour, at pressure p and temperature T_w. (This is a function of p and T_w only, and may appropriately be denoted by $h_{sw}\,(p, T_w)$.)

If air and water vapour are regarded as ideal gases with constant specific heat capacities, the above equation becomes :

$$T - T_w = \frac{[r_w\,(p, T_w) - r]\; L_v\,(T_w)}{c_p + r c_{pv}}$$

where

$L_v\,(T_w)$	is the heat of vaporization of water at temperature T_w ;
c_p	is the specific heat capacity of dry air at constant pressure ;
c_{pv}	is the specific heat capacity of water vapour at constant pressure.

NOTE : Thermodynamic wet-bulb temperature as here defined has for some time been called "temperature of adiabatic saturation" by the air-conditioning engineers.

* The enthalpy of a system in equilibrium at pressure p and temperature T is defined as $E + pV$, where E is the internal energy of the system and V is its volume. The sum of the enthalpies of the phases of a closed system is conserved in adiabatic isobaric processes.

(19) The ***thermodynamic ice-bulb temperature*** of moist air at pressure p, temperature T and mixing ratio r is the temperature T_i at which pure ice at pressure p must be evaporated into the moist air in order to saturate it adiabatically at pressure p and temperature T_i. The saturation is with respect to ice.

T_i is defined by the equation :

$$h\,(p,\,T,\,r) + [r_i\,(p,\,T_i) - r]\,h_i\,(p,\,T_i) = h\,(p,\,T_i,\,r_i\,(p,\,T_i))$$

where

$r_i\,(p,\,T_i)$	is the mixing ratio of saturated moist air at pressure p and temperature T_i ;
$h_i\,(p,\,T_i)$	is the enthalpy of 1 gramme of pure ice at pressure p and temperature T_i ;
$h\,(p,\,T,\,r)$	is the enthalpy of $1 + r$ grammes of moist air, composed of 1 gramme of dry air and r grammes of water vapour, at pressure p and temperature T ;
$h\,(p,\,T_i,\,r_i\,(p,\,T_i))$	is the enthalpy of $1 + r_i$ grammes of saturated air, composed of 1 gramme of dry air and r_i grammes of water vapour, at pressure p and temperature T_i. (This is a function of p and T_i only, and may appropriately be denoted by $h_{si}\,(p,\,T_i)$.)

If air and water vapour are regarded as ideal gases with constant specific heat capacities this equation becomes :

$$T - T_i = \frac{[r_i\,(p,\,T_i) - r]\,L_s\,(T_i)}{c_p + rc_{pv}}$$

where

$L_s\,(T_i)$	is the heat of sublimation of ice at temperature T_i.

The relationship between T_w and T_i as defined and the wet-bulb or ice-bulb temperature as indicated by a particular psychrometer is a matter to be determined by carefully controlled experiment, taking into account the various parameters concerned, for example, ventilation, size of thermometer bulb and radiation.

(20) The ***virtual temperature*** of moist air at pressure p, temperature T and mixing ratio r, is the temperature T_v which dry air must have at the given pressure p in order to have the same density as moist air when the densities of both dry air and moist air are deduced from the equation of state for ideal gas.

The virtual temperature T_v is given by the expression :

$$T_v = T\,\frac{1 + \dfrac{r}{0.621\,98}}{1 + r}$$

(21) The ***adjusted virtual temperature*** of moist air at pressure p, temperature T and mixing ratio r, is the temperature T'_v which dry air must have at

the given pressure p in order to have the same density as moist air when the density of dry air is deduced from the equation of state for ideal gas while moist air is regarded as a real gas.

The adjusted virtual temperature T'_v is linked to the virtual temperature T_v by the equation :

$$T'_v = CT_v$$

where C is the compressibility factor, a function of pressure, temperature and humidity. In the meteorological range of pressure and temperature the value of C lies between 0.995 6 and 1.

Table 4.4 **Properties of water vapour** – *Propriétés de la vapeur d'eau*

Temperature °C	C_v (Dimensionless *sans dimensions*) Pressure — *pression* 0	e_i	e_w	Δh_v, J kg^{-1} Pressure — *pression* 0	e_i	e_w	Δs_v, J kg^{-1} °K^{-1} Pressure — *pression* 0	e_i	e_w	Δc_{pv}, J kg^{-1} °K^{-1} Pressure — *pression* 0	e_i	e_w
-100	1.0000	1.0000		-0.4 x10^3	-0.4 x10^3		-1.7	-1.7		3.8	3.8	
- 90	1.0000	1.0000		-0.4	-0.4		-1.7	-1.7		4.2	4.2	
- 80	1.0000	1.0000		0.0	-0.4		-1.3	-1.3		4.6	4.6	
- 70	1.0000	1.0000		0.0	0.0		-1.3	-1.3		5.0	5.0	
- 60	1.0000	1.0000		0.0	0.0		-0.8	-0.8		5.9	5.9	
- 50	1.0000	1.0000	1.0000	0.0	0.0	0.0 x10^3	-0.4	-0.8	-0.8	6.3	7.1	7.1
- 40	1.0000	1.0000	1.0000	0.0	0.0	0.0	-0.4	-0.4	-0.4	7.1	8.4	8.8
- 30	1.0000	0.9999	0.9999	0.0	0.0	0.0	0.0	0.0	-0.4	8.4	10.5	11.3
- 20	1.0000	0.9999	0.9998	0.0	0.0	0.0	0.4	0.0	0.0	9.6	13.4	14.2
- 10	1.0000	0.9997	0.9997	0.4	0.0	0.0	0.8	0.0	0.0	11.3	17.6	18.0
0	1.0000	0.9995	0.9995	0.4	0.0	0.0	1.3	0.0	0.0	13.0	23.4	23.4
+ 10	1.0000		0.9992	0.4		0.0	1.7		0.0	15.1		30.6
+ 20	1.0000		0.9988	0.8		-0.4	2.1		-0.4	17.2		39.4
+ 30	1.0000		0.9982	0.8		-0.4	2.9		-1.3	19.7		50.7

Temperature °C	Pressure *Pression* mb	C_v	Δh_v J kg^{-1}	Δs_v J kg^{-1} °K^{-1}	Δc_{pv} J kg^{-1} °K^{-1}
40	0	1.0000	1.3 x10^3	3.8	22.6
	50	0.9982	-0.4	0.0	49.8
	e_w	0.9973	-0.8	-2.1	64.1
50	0	1.0000	1.3	4.6	25.5
	50	0.9985	0.0	1.3	46.5
	100	0.9969	-1.3	-1.7	69.5
	e_w	0.9962	-1.7	-3.3	80.8
60	0	1.0000	1.7	5.4	28.9
	50	0.9987	0.4	2.9	45.2
	100	0.9974	-0.4	-0.4	62.8
	150	0.9961	-1.7	-2.5	81.6
	e_w	0.9948	-2.5	-5.0	100.9

C_v : compressibility factor
facteur de compressibilité

Δh_v : specific enthalpy residual
enthalpie spécifique résiduelle

Δs_v : specific entropy residual
entropie spécifique résiduelle

Δc_{pv} : specific heat at constant pressure residual
chaleur spécifique à pression constante résiduelle

e_i : saturation vapour pressure over ice
pression de vapeur saturante au-dessus de la glace

e_w : saturation vapour pressure over water
pression de vapeur saturante au-dessus de l'eau

Table 4.5 **Properties of condensed water**
Propriétés de l'eau à l'état liquide et solide

A **Latent and specific heats**
Chaleur latente et chaleur spécifique

c_i : specific heat at constant pressure of ice — *chaleur spécifique à pression constante de la glace*

c_w : specific heat at constant pressure of water — *chaleur spécifique à pression constante de l'eau*

L_v : latent heat of vaporisation — *chaleur latente de vaporisation*

L_f : latent heat of fusion — *chaleur latente de fusion*

L_s : latent heat of sublimation — *chaleur latente de sublimation*

Temperature °C	c_i J kg^{-1} °K^{-1}	c_w J kg^{-1} °K^{-1}	L_v J kg^{-1}	L_f J kg^{-1}	L_s J kg^{-1}
			x10^6	x10^6	x10^6
-100	1382				2.8236
- 90	1449				2.8278
- 80	1520				2.8316
- 70	1591				2.8345
- 60	1662				2.8366
- 50	1738	5.4 x10^3	2.6348	0.2035	2.8383
- 40	1813	4.77	2.6030	0.2357	2.8387
- 30	1884	4.52	2.5749	0.2638	2.8387
- 20	1959	4.35	2.5494	0.2889	2.8383
- 10	2031	4.27	2.5247	0.3119	2.8366
0	2106	4217.8	2.50084	0.3337	2.8345
5		4202.3	2.4891		
10		4192.3	2.4774		
15		4186.0	2.4656		
20		4181.8	2.4535		
25		4179.7	2.4418		
30		4178.5	2.4300		
35		4178.0	2.4183		
40		4178.5	2.4062		
45		4179.3	2.3945		
50		4180.6	2.3823		
55		4182.2	2.3702		

B Density of water
Masse volumique de l'eau

t : Temperature
ρ : Density — *Masse volumique*

t °C	ρ g cm^{-3}	t °C	ρ g cm^{-3}	t °C	ρ g cm^{-3}	t °C	ρ g cm^{-3}
−13	0.99690	1	0.99990	15	0.99910	29	0.99595
−12	.99727	2	.99994	16	.99895	30	.99565
−11	.99761	3	.99997	17	.99878	31	.99535
−10	.99791	4	.99997	18	.99860	32	.99503
− 9	.99822	5	.99996	19	.99841	33	.99471
− 8	0.99847	6	0.99994	20	0.99821	34	0.99438
− 7	.99869	7	.99990	21	.99800	35	.99404
− 6	.99892	8	.99985	22	.99777	36	.99369
− 5	.99915	9	.99978	23	.99754	37	.99333
− 4	.99935	10	.99970	24	.99730	38	.99297
− 3	0.99953	11	0.99961	25	0.99705	39	0.99260
− 2	.99965	12	.99950	26	.99679	40	.99222
− 1	.99975	13	.99938	27	.99652	41	.99183
0	.99984	14	.99925	28	.99624	42	.99144

Decrease of density due to the presence of dissolved air
Diminution de la masse volumique due à la présence d'air en dissolution

Temperature °C	Difference g cm^{-3}
0	0.0000025
5	0.0000033
10	0.0000032
15	0.0000022
20	0.0000004

Table 4.6 Saturation vapour pressure over a plane surface of pure water

Pression de vapeur saturante au-dessus d'une surface plane d'eau pure

Triple-point — *Point triple :* 273.16 °K ; 6.1114 mb

Temperature °C	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
	Unity — *Unité* 0.1 mb									
- 50	0.6354									
- 49	0.7122	0.7041	0.6962	0.6883	0.6805	0.6728	0.6652	0.6576	0.6501	0.6427
- 48	0.7973	0.7884	0.7796	0.7708	0.7622	0.7536	0.7452	0.7368	0.7285	0.7203
- 47	0.8916	0.8817	0.8719	0.8623	0.8527	0.8432	0.8339	0.8246	0.8154	0.8063
- 46	0.9959	0.9850	0.9742	0.9635	0.9529	0.9424	0.9320	0.9218	0.9116	0.9015
	Unity — *Unité* mb									
- 45	0.1111	0.1099	0.1087	0.1075	0.1064	0.1052	0.1041	0.1029	0.1018	0.1007
- 44	0.1238	0.1225	0.1212	0.1199	0.1186	0.1173	0.1161	0.1148	0.1136	0.1123
- 43	0.1379	0.1364	0.1350	0.1335	0.1321	0.1307	0.1293	0.1279	0.1265	0.1252
- 42	0.1533	0.1517	0.1501	0.1485	0.1470	0.1454	0.1439	0.1424	0.1409	0.1394
- 41	0.1704	0.1686	0.1668	0.1651	0.1634	0.1617	0.1600	0.1583	0.1566	0.1550
- 40	0.1891	0.1871	0.1852	0.1833	0.1814	0.1795	0.1776	0.1758	0.1740	0.1722
- 39	0.2097	0.2075	0.2054	0.2033	0.2012	0.1991	0.1971	0.1951	0.1931	0.1911
- 38	0.2322	0.2299	0.2276	0.2252	0.2230	0.2207	0.2184	0.2162	0.2140	0.2118
- 37	0.2570	0.2544	0.2519	0.2493	0.2468	0.2443	0.2419	0.2394	0.2370	0.2346
- 36	0.2841	0.2813	0.2785	0.2757	0.2730	0.2702	0.2675	0.2649	0.2622	0.2596
- 35	0.3138	0.3107	0.3076	0.3046	0.3016	0.2986	0.2957	0.2927	0.2898	0.2870
- 34	0.3463	0.3429	0.3395	0.3362	0.3329	0.3297	0.3264	0.3232	0.3201	0.3169
- 33	0.3817	0.3780	0.3744	0.3708	0.3672	0.3636	0.3601	0.3566	0.3531	0.3497
- 32	0.4204	0.4164	0.4124	0.4085	0.4045	0.4007	0.3968	0.3930	0.3892	0.3854
- 31	0.4627	0.4583	0.4539	0.4496	0.4453	0.4411	0.4369	0.4327	0.4286	0.4245
- 30	0.5087	0.5039	0.4992	0.4945	0.4898	0.4852	0.4806	0.4761	0.4716	0.4671
- 29	0.5588	0.5536	0.5484	0.5433	0.5382	0.5332	0.5282	0.5233	0.5184	0.5135
- 28	0.6133	0.6076	0.6020	0.5965	0.5909	0.5855	0.5800	0.5747	0.5693	0.5640
- 27	0.6726	0.6664	0.6603	0.6543	0.6483	0.6423	0.6364	0.6306	0.6248	0.6190
- 26	0.7369	0.7303	0.7236	0.7171	0.7105	0.7041	0.6977	0.6913	0.6850	0.6788
- 25	0.8068	0.7995	0.7924	0.7852	0.7782	0.7712	0.7642	0.7573	0.7505	0.7437
- 24	0.8826	0.8747	0.8669	0.8592	0.8515	0.8439	0.8364	0.8289	0.8215	0.8141
- 23	0.9647	0.9562	0.9477	0.9393	0.9310	0.9228	0.9146	0.9065	0.8985	0.8905
- 22	1.0536	1.0444	1.0352	1.0261	1.0172	1.0082	0.9994	0.9906	0.9819	0.9732
- 21	1.1498	1.1398	1.1299	1.1201	1.1104	1.1007	1.0911	1.0816	1.0722	1.0628
- 20	1.2538	1.2430	1.2323	1.2217	1.2112	1.2007	1.1904	1.1801	1.1699	1.1598
- 19	1.3661	1.3545	1.3430	1.3315	1.3201	1.3089	1.2977	1.2866	1.2755	1.2646
- 18	1.4874	1.4749	1.4624	1.4501	1.4378	1.4256	1.4135	1.4016	1.3897	1.3778
- 17	1.6183	1.6048	1.5913	1.5780	1.5648	1.5516	1.5386	1.5257	1.5128	1.5001
- 16	1.7594	1.7448	1.7303	1.7160	1.7017	1.6875	1.6735	1.6595	1.6457	1.6320
- 15	1.9114	1.8957	1.8801	1.8646	1.8493	1.8340	1.8189	1.8038	1.7889	1.7741
- 14	2.0751	2.0582	2.0414	2.0247	2.0082	1.9917	1.9754	1.9593	1.9432	1.9273
- 13	2.2512	2.2330	2.2149	2.1970	2.1792	2.1615	2.1440	2.1266	2.1093	2.0921
- 12	2.4405	2.4209	2.4015	2.3822	2.3631	2.3441	2.3252	2.3065	2.2879	2.2695
- 11	2.6438	2.6228	2.6020	2.5813	2.5607	2.5403	2.5201	2.4999	2.4800	2.4601
- 10	2.8622	2.8397	2.8173	2.7951	2.7730	2.7511	2.7293	2.7077	2.6863	2.6650
- 9	3.0965	3.0724	3.0484	3.0245	3.0008	2.9773	2.9540	2.9308	2.9078	2.8849
- 8	3.3478	3.3219	3.2962	3.2706	3.2452	3.2200	3.1950	3.1701	3.1454	3.1209
- 7	3.6171	3.5893	3.5618	3.5344	3.5072	3.4802	3.4533	3.4267	3.4002	3.3739
- 6	3.9055	3.8758	3.8463	3.8169	3.7878	3.7589	3.7301	3.7016	3.6732	3.6451
- 5	4.2142	4.1824	4.1508	4.1194	4.0882	4.0573	4.0265	3.9959	3.9656	3.9355
- 4	4.5444	4.5104	4.4766	4.4430	4.4097	4.3765	4.3436	4.3109	4.2785	4.2462
- 3	4.8974	4.8610	4.8249	4.7890	4.7534	4.7180	4.6828	4.6478	4.6131	4.5786
- 2	5.2745	5.2357	5.1971	5.1588	5.1207	5.0829	5.0453	5.0079	4.9708	4.9340
- 1	5.6772	5.6358	5.5946	5.5536	5.5130	5.4726	5.4325	5.3926	5.3530	5.3136
0	6.1070	6.0627	6.0188	5.9751	5.9317	5.8886	5.8458	5.8032	5.7609	5.7189

TABLE 4.6 — 2

Temperature °C	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
0	6.1070	6.1515	6.1963	6.2414	6.2868	6.3324	6.3784	6.4247	6.4712	6.5181
1	6.5653	6.6127	6.6605	6.7086	6.7570	6.8057	6.8547	6.9040	6.9536	7.0035
2	7.0538	7.1044	7.1553	7.2065	7.2581	7.3099	7.3621	7.4147	7.4675	7.5207
3	7.5743	7.6281	7.6823	7.7369	7.7918	7.8470	7.9026	7.9585	8.0148	8.0714
4	8.1284	8.1858	8.2435	8.3015	8.3599	8.4187	8.4778	8.5374	8.5972	8.6575
5	8.7181	8.7791	8.8405	8.9023	8.9644	9.0269	9.0898	9.1531	9.2168	9.2808
6	9.3453	9.4102	9.4754	9.5411	9.6071	9.6736	9.7405	9.8077	9.8754	9.9435
7	10.012	10.081	10.150	10.220	10.290	10.361	10.432	10.503	10.575	10.648
8	10.720	10.794	10.867	10.941	11.016	11.091	11.166	11.242	11.319	11.395
9	11.473	11.550	11.628	11.707	11.786	11.866	11.946	12.026	12.107	12.189
10	12.271	12.353	12.436	12.520	12.604	12.688	12.773	12.858	12.944	13.031
11	13.118	13.205	13.293	13.382	13.471	13.560	13.650	13.741	13.832	13.923
12	14.016	14.108	14.202	14.295	14.390	14.485	14.580	14.676	14.772	14.870
13	14.967	15.065	15.164	15.263	15.363	15.464	15.565	15.667	15.769	15.872
14	15.975	16.079	16.184	16.289	16.395	16.501	16.608	16.716	16.824	16.933
15	17.042	17.152	17.263	17.374	17.486	17.599	17.712	17.826	17.940	18.055
16	18.171	18.288	18.405	18.522	18.641	18.760	18.880	19.000	19.121	19.243
17	19.365	19.488	19.612	19.737	19.862	19.988	20.114	20.242	20.370	20.498
18	20.628	20.758	20.889	21.020	21.153	21.286	21.419	21.554	21.689	21.825
19	21.962	22.099	22.238	22.376	22.516	22.657	22.798	22.940	23.083	23.226
20	23.371	23.516	23.662	23.809	23.956	24.104	24.254	24.404	24.554	24.706
21	24.858	25.011	25.165	25.320	25.476	25.633	25.790	25.948	26.107	26.267
22	26.428	26.590	26.752	26.915	27.080	27.245	27.411	27.577	27.745	27.914
23	28.083	28.254	28.425	28.597	28.771	28.945	29.120	29.296	29.472	29.650
24	29.829	30.009	30.189	30.371	30.553	30.737	30.921	31.106	31.293	31.480
25	31.668	31.858	32.048	32.239	32.431	32.624	32.819	33.014	33.210	33.407
26	33.606	33.805	34.005	34.207	34.409	34.613	34.817	35.023	35.229	35.437
27	35.646	35.856	36.067	36.279	36.492	36.706	36.921	37.137	37.355	37.573
28	37.793	38.014	38.236	38.459	38.683	38.908	39.135	39.362	39.591	39.821
29	40.052	40.284	40.517	40.752	40.988	41.225	41.463	41.702	41.943	42.184
30	42.427	42.671	42.917	43.163	43.411	43.660	43.910	44.162	44.415	44.669
31	44.924	45.181	45.439	45.698	45.958	46.220	46.483	46.747	47.013	47.280
32	47.548	47.817	48.088	48.360	48.634	48.909	49.185	49.463	49.741	50.022
33	50.303	50.587	50.871	51.157	51.444	51.732	52.022	52.314	52.607	52.901
34	53.197	53.494	53.792	54.092	54.394	54.697	55.001	55.307	55.614	55.923
35	56.233	56.545	56.858	57.173	57.489	57.807	58.126	58.447	58.769	59.093
36	59.418	59.745	60.074	60.404	60.735	61.069	61.404	61.740	62.078	62.417
37	62.759	63.101	63.446	63.792	64.140	64.489	64.840	65.193	65.547	65.903
38	66.260	66.620	66.981	67.343	67.708	68.074	68.441	68.811	69.182	69.555
39	69.930	70.306	70.684	71.064	71.446	71.829	72.214	72.601	72.990	73.381
40	73.773	74.168	74.564	74.961	75.361	75.763	76.166	76.571	76.978	77.387
41	77.798	78.211	78.625	79.042	79.460	79.880	80.303	80.727	81.153	81.581
42	82.011	82.443	82.876	83.312	83.750	84.190	84.632	85.075	85.521	85.969
43	86.419	86.870	87.324	87.780	88.238	88.698	89.160	89.624	90.091	90.559
44	91.029	91.502	91.976	92.453	92.932	93.413	93.896	94.381	94.869	95.358
45	95.850	96.344	96.840	97.339	97.839	98.342	98.847	99.354	99.863	100.38
46	100.89	101.41	101.92	102.44	102.97	103.49	104.02	104.55	105.08	105.62
47	106.15	106.69	107.24	107.78	108.33	108.87	109.43	109.98	110.53	111.09
48	111.65	112.22	112.78	113.35	113.92	114.49	115.07	115.65	116.23	116.81
49	117.40	117.98	118.57	119.17	119.76	120.36	120.96	121.56	122.17	122.78
50	123.39	124.00	124.62	125.24	125.86	126.48	127.11	127.74	128.37	129.01

Table 4.7 **Saturation vapour pressure over a plane surface of ice**
Pression de vapeur saturante au-dessus d'une surface plane de glace

Triple-point — *Point triple :* 273.16 °K; 6.1114 mb

Unity — *Unité :* 0.00001 mb

Temperature °C	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
-100	1.4020									
- 99	1.7174	1.6830	1.6494	1.6163	1.5839	1.5521	1.5209	1.4903	1.4603	1.4309
- 98	2.0989	2.0574	2.0167	1.9767	1.9375	1.8991	1.8613	1.8243	1.7880	1.7523
- 97	2.5594	2.5094	2.4603	2.4121	2.3648	2.3184	2.2728	2.2281	2.1842	2.1411
- 96	3.1140	3.0538	2.9948	2.9367	2.8798	2.8239	2.7690	2.7151	2.6622	2.6103
- 95	3.7807	3.7084	3.6374	3.5677	3.4993	3.4321	3.3662	3.3014	3.2378	3.1753
- 94	4.5802	4.4936	4.4086	4.3250	4.2430	4.1624	4.0833	4.0055	3.9292	3.8543
- 93	5.5373	5.4337	5.3319	5.2320	5.1338	5.0374	4.9426	4.8496	4.7582	4.6684
- 92	6.6804	6.5568	6.4353	6.3160	6.1988	6.0836	5.9704	5.8592	5.7500	5.6427
- 91	8.0432	7.8960	7.7513	7.6091	7.4693	7.3320	7.1971	7.0645	6.9342	6.8062
- 90	9.6646	9.4896	9.3175	9.1484	8.9822	8.8189	8.6583	8.5005	8.3454	8.1930
- 89	11.590	11.382	11.178	10.977	10.780	10.586	10.396	10.208	10.024	9.8426
- 88	13.872	13.626	13.384	13.147	12.913	12.683	12.457	12.235	12.016	11.801
- 87	16.572	16.281	15.995	15.714	15.438	15.166	14.898	14.635	14.377	14.122
- 86	19.760	19.417	19.080	18.748	18.421	18.100	17.784	17.474	17.168	16.868
- 85	23.518	23.114	22.717	22.326	21.941	21.562	21.190	20.824	20.463	20.109
- 84	27.940	27.465	26.998	26.538	26.085	25.640	25.202	24.770	24.346	23.929
- 83	33.134	32.576	32.028	31.488	30.956	30.433	29.918	29.412	28.913	28.423
- 82	39.224	38.571	37.928	37.295	36.672	36.059	35.455	34.861	34.276	33.700
- 81	46.353	45.589	44.837	44.096	43.367	42.649	41.942	41.247	40.562	39.888
- 80	54.684	53.792	52.913	52.048	51.196	50.357	49.532	48.718	47.918	47.129
- 79	64.404	63.364	62.340	61.330	60.337	59.358	58.394	57.445	56.511	55.591
- 78	75.727	74.516	73.323	72.148	70.991	69.851	68.728	67.622	66.533	65.461
- 77	88.894	87.486	86.100	84.734	83.389	82.063	80.757	79.471	78.204	76.956
- 76	104.18	102.55	100.94	99.355	97.793	96.254	94.738	93.244	91.772	90.322

Unity — *Unité :* 0.001 mb

Temperature °C	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
- 75	1.2191	1.2002	1.1815	1.1631	1.1450	1.1272	1.1096	1.0923	1.0752	1.0584
- 74	1.4243	1.4024	1.3808	1.3595	1.3386	1.3179	1.2976	1.2775	1.2578	1.2383
- 73	1.6614	1.6361	1.6112	1.5866	1.5624	1.5386	1.5150	1.4918	1.4690	1.4465
- 72	1.9351	1.9060	1.8772	1.8489	1.8209	1.7934	1.7662	1.7395	1.7131	1.6871
- 71	2.2506	2.2170	2.1839	2.1512	2.1190	2.0873	2.0560	2.0251	1.9947	1.9647
- 70	2.6136	2.5749	2.5368	2.4993	2.4622	2.4257	2.3897	2.3542	2.3191	2.2846
- 69	3.0307	2.9863	2.9426	2.8995	2.8569	2.8149	2.7735	2.7327	2.6924	2.6527
- 68	3.5094	3.4585	3.4084	3.3589	3.3100	3.2619	3.2144	3.1675	3.1213	3.0757
- 67	4.0580	3.9997	3.9423	3.8856	3.8296	3.7744	3.7200	3.6662	3.6133	3.5610
- 66	4.6858	4.6192	4.5534	4.4886	4.4245	4.3614	4.2991	4.2376	4.1769	4.1171
- 65	5.4034	5.3273	5.2521	5.1780	5.1049	5.0327	4.9615	4.8912	4.8218	4.7534
- 64	6.2224	6.1356	6.0499	5.9653	5.8818	5.7994	5.7181	5.6379	5.5587	5.4805
- 63	7.1560	7.0571	6.9595	6.8631	6.7679	6.6740	6.5813	6.4898	6.3995	6.3104
- 62	8.2189	8.1064	7.9952	7.8855	7.7772	7.6703	7.5648	7.4606	7.3578	7.2562
- 61	9.4275	9.2996	9.1733	9.0486	8.9255	8.8039	8.6839	8.5654	8.4484	8.3329
- 60	10.800	10.655	10.511	10.370	10.230	10.092	9.9557	9.8211	9.6882	9.5570
- 59	12.357	12.192	12.029	11.869	11.710	11.554	11.399	11.247	11.096	10.947
- 58	14.120	13.934	13.750	13.568	13.388	13.211	13.036	12.863	12.692	12.523
- 57	16.115	15.905	15.697	15.491	15.288	15.087	14.889	14.693	14.500	14.309
- 56	18.371	18.133	17.897	17.665	17.436	17.209	16.985	16.763	16.545	16.329
- 55	20.916	20.648	20.382	20.120	19.861	19.605	19.352	19.102	18.855	18.612
- 54	23.787	23.484	23.185	22.889	22.597	22.309	22.024	21.742	21.463	21.188
- 53	27.020	26.679	26.342	26.010	25.681	25.356	25.034	24.717	24.403	24.093
- 52	30.657	30.274	29.895	29.521	29.151	28.785	28.424	28.067	27.714	27.365
- 51	34.745	34.314	33.889	33.468	33.053	32.642	32.236	31.834	31.437	31.045

TABLE 4.7 — 2

Temperature °C	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
- 50	39.334	38.851	38.373	37.901	37.435	36.973	36.517	36.066	35.621	35.180
- 49	44.479	43.938	43.403	42.874	42.350	41.833	41.322	40.816	40.316	39.822
- 48	50.244	49.638	49.038	48.446	47.860	47.280	46.707	46.141	45.581	45.027
- 47	56.694	56.016	55.346	54.683	54.027	53.379	52.738	52.104	51.477	50.857
- 46	63.905	63.147	62.398	61.657	60.924	60.200	59.483	58.774	58.073	57.380
- 45	71.958	71.112	70.276	69.448	68.630	67.821	67.020	66.229	65.445	64.671
- 44	80.942	79.999	79.066	78.143	77.230	76.327	75.434	74.551	73.677	72.813
- 43	90.954	89.904	88.865	87.836	86.819	85.813	84.818	83.833	82.859	81.895
	Unity — *Unité :* mb									
- 42	0.1021	0.1009	0.0998	0.0986	0.0975	0.0964	0.0953	0.0942	0.0931	0.0920
- 41	0.1145	0.1132	0.1119	0.1106	0.1094	0.1081	0.1069	0.1057	0.1045	0.1033
- 40	0.1283	0.1268	0.1254	0.1240	0.1226	0.1212	0.1198	0.1185	0.1171	0.1158
- 39	0.1436	0.1420	0.1404	0.1388	0.1373	0.1357	0.1342	0.1327	0.1312	0.1297
- 38	0.1606	0.1588	0.1570	0.1553	0.1536	0.1519	0.1502	0.1485	0.1468	0.1452
- 37	0.1794	0.1774	0.1755	0.1735	0.1716	0.1697	0.1679	0.1660	0.1642	0.1624
- 36	0.2002	0.1980	0.1959	0.1937	0.1916	0.1895	0.1874	0.1854	0.1834	0.1814
- 35	0.2232	0.2208	0.2184	0.2161	0.2137	0.2114	0.2091	0.2069	0.2046	0.2024
- 34	0.2487	0.2460	0.2434	0.2408	0.2382	0.2356	0.2331	0.2306	0.2281	0.2257
- 33	0.2768	0.2739	0.2710	0.2681	0.2652	0.2624	0.2596	0.2568	0.2541	0.2514
- 32	0.3078	0.3046	0.3014	0.2982	0.2951	0.2919	0.2889	0.2858	0.2828	0.2798
- 31	0.3420	0.3385	0.3349	0.3314	0.3280	0.3245	0.3211	0.3178	0.3144	0.3111
- 30	0.3797	0.3758	0.3719	0.3680	0.3642	0.3604	0.3567	0.3530	0.3493	0.3456
- 29	0.4212	0.4168	0.4126	0.4083	0.4041	0.4000	0.3958	0.3917	0.3877	0.3837
- 28	0.4668	0.4620	0.4573	0.4526	0.4480	0.4434	0.4389	0.4344	0.4300	0.4255
- 27	0.5169	0.5116	0.5065	0.5013	0.4963	0.4912	0.4862	0.4813	0.4764	0.4716
- 26	0.5719	0.5661	0.5604	0.5548	0.5492	0.5437	0.5382	0.5328	0.5275	0.5221
- 25	0.6322	0.6259	0.6197	0.6135	0.6074	0.6013	0.5953	0.5894	0.5835	0.5776
- 24	0.6983	0.6914	0.6846	0.6779	0.6712	0.6645	0.6579	0.6514	0.6449	0.6385
- 23	0.7708	0.7632	0.7558	0.7483	0.7410	0.7337	0.7265	0.7194	0.7123	0.7053
- 22	0.8501	0.8418	0.8336	0.8255	0.8175	0.8095	0.8016	0.7938	0.7861	0.7784
- 21	0.9368	0.9277	0.9188	0.9099	0.9012	0.8924	0.8838	0.8753	0.8668	0.8584
- 20	1.0315	1.0217	1.0119	1.0022	0.9926	0.9831	0.9737	0.9643	0.9551	0.9459
- 19	1.1350	1.1243	1.1136	1.1030	1.0925	1.0821	1.0718	1.0616	1.0515	1.0415
- 18	1.2479	1.2362	1.2246	1.2130	1.2016	1.1903	1.1790	1.1679	1.1568	1.1459
- 17	1.3711	1.3583	1.3456	1.3330	1.3205	1.3082	1.2959	1.2838	1.2717	1.2598
- 16	1.5053	1.4913	1.4775	1.4638	1.4502	1.4367	1.4234	1.4101	1.3970	1.3840
- 15	1.6514	1.6362	1.6212	1.6062	1.5914	1.5768	1.5622	1.5478	1.5335	1.5193
- 14	1.8104	1.7939	1.7775	1.7613	1.7452	1.7292	1.7134	1.6977	1.6821	1.6667
- 13	1.9833	1.9653	1.9475	1.9299	1.9124	1.8950	1.8778	1.8607	1.8438	1.8270
- 12	2.1712	2.1517	2.1323	2.1132	2.0941	2.0753	2.0566	2.0380	2.0196	2.0014
- 11	2.3752	2.3540	2.3330	2.3122	2.2916	2.2711	2.2508	2.2306	2.2106	2.1908
- 10	2.5966	2.5737	2.5509	2.5283	2.5059	2.4837	2.4616	2.4397	2.4180	2.3965
- 9	2.8368	2.8119	2.7872	2.7627	2.7384	2.7143	2.6903	2.6666	2.6431	2.6198
- 8	3.0970	3.0700	3.0433	3.0167	2.9904	2.9643	2.9384	2.9126	2.8871	2.8618
- 7	3.3789	3.3497	3.3207	3.2920	3.2634	3.2352	3.2071	3.1792	3.1516	3.1242
- 6	3.6840	3.6524	3.6211	3.5899	3.5591	3.5285	3.4981	3.4679	3.4380	3.4083
- 5	4.0141	3.9799	3.9460	3.9123	3.8790	3.8458	3.8130	3.7803	3.7480	3.7159
- 4	4.3709	4.3340	4.2973	4.2610	4.2249	4.1890	4.1535	4.1182	4.0833	4.0485
- 3	4.7564	4.7165	4.6769	4.6377	4.5987	4.5600	4.5216	4.4835	4.4457	4.4081
- 2	5.1727	5.1296	5.0869	5.0445	5.0024	4.9606	4.9191	4.8780	4.8372	4.7966
- 1	5.6219	5.5754	5.5293	5.4836	5.4381	5.3931	5.3483	5.3039	5.2598	5.2161
0	6.1064	6.0563	6.0065	5.9572	5.9082	5.8596	5.8113	5.7634	5.7159	5.6687

Table 4.8.1 **Density of pure water vapour at saturation with respect to a plane surface of pure water**

Density of water vapour behaving as an ideal gas

Masse volumique de la vapeur d'eau pure à la saturation par rapport à une surface plane d'eau pure

Masse volumique de la vapeur d'eau considérée comme un gaz parfait

Unity — *Unité :* g m^{-3}

Temperature °C	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
-50	0.06170									
-49	0.06885	0.06810	0.06736	0.06663	0.06590	0.06518	0.06447	0.06377	0.06307	0.06238
-48	0.07673	0.07591	0.07509	0.07428	0.07348	0.07269	0.07191	0.07113	0.07036	0.06960
-47	0.08542	0.08452	0.08362	0.08273	0.08184	0.08097	0.08011	0.07925	0.07840	0.07756
-46	0.09500	0.09400	0.09301	0.09203	0.09106	0.09010	0.08914	0.08820	0.08727	0.08634
-45	0.1055	0.1044	0.1033	0.1023	0.1012	0.1001	0.09909	0.09805	0.09702	0.09601
-44	0.1171	0.1159	0.1147	0.1135	0.1123	0.1112	0.1100	0.1089	0.1078	0.1066
-43	0.1298	0.1285	0.1272	0.1259	0.1246	0.1233	0.1220	0.1208	0.1195	0.1183
-42	0.1437	0.1423	0.1409	0.1394	0.1380	0.1366	0.1352	0.1339	0.1325	0.1311
-41	0.1590	0.1574	0.1559	0.1543	0.1527	0.1512	0.1497	0.1482	0.1467	0.1452
-40	0.1757	0.1740	0.1723	0.1706	0.1689	0.1672	0.1655	0.1639	0.1622	0.1606
-39	0.1940	0.1921	0.1902	0.1884	0.1865	0.1847	0.1829	0.1810	0.1793	0.1775
-38	0.2140	0.2119	0.2099	0.2078	0.2058	0.2038	0.2018	0.1998	0.1979	0.1959
-37	0.2358	0.2335	C.2313	0.2291	0.2269	0.2247	0.2225	0.2203	0.2182	0.2161
-36	0.2596	0.2571	0.2547	0.2522	0.2498	0.2474	0.2451	0.2427	0.2404	0.2381
-35	0.2855	0.2828	0.2801	0.2775	0.2749	0.2723	0.2697	0.2671	0.2646	0.2621
-34	0.3137	0.3108	0.3079	0.3050	0.3021	0.2993	0.2965	0.2937	0.2910	0.2882
-33	0.3444	0.3412	0.3381	0.3349	0.3318	0.3287	0.3257	0.3227	0.3197	0.3167
-32	0.3778	0.3743	0.3709	0.3675	0.3641	0.3607	0.3574	0.3541	0.3509	0.3476
-31	0.4140	0.4102	0.4065	0.4028	0.3992	0.3955	0.3919	0.3883	0.3848	0.3813
-30	0.4533	0.4492	0.4452	0.4412	0.4372	0.4333	0.4293	0.4255	0.4216	0.4178
-29	0.4959	0.4915	0.4871	0.4828	0.4785	0.4742	0.4699	0.4657	0.4616	0.4574
-28	0.5421	0.5373	0.5325	0.5278	0.5232	0.5185	0.5139	0.5094	0.5049	0.5004
-27	0.5920	0.5869	0.5817	0.5766	0.5716	0.5666	0.5616	0.5567	0.5518	0.5469
-26	0.6461	0.6405	0.6349	0.6294	0.6240	0.6185	0.6132	0.6078	0.6025	0.5973
-25	0.7045	0.6984	0.6924	0.6865	0.6806	0.6747	0.6689	0.6631	0.6574	0.6517
-24	0.7675	0.7610	0.7545	0.7481	0.7417	0.7354	0.7291	0.7229	0.7167	0.7106
-23	0.8356	0.8286	0.8216	0.8146	0.8078	0.8009	0.7941	0.7874	0.7807	0.7741
-22	0.9090	0.9014	0.8938	0.8864	0.8790	0.8716	0.8643	0.8570	0.8498	0.8427
-21	0.9880	0.9798	0.9717	0.9637	0.9557	0.9478	0.9399	0.9321	0.9243	0.9166
-20	1.073	1.064	1.056	1.047	1.038	1.030	1.021	1.013	1.005	0.9963
-19	1.165	1.155	1.146	1.137	1.127	1.118	1.109	1.100	1.091	1.082
-18	1.263	1.253	1.243	1.233	1.223	1.213	1.203	1.194	1.184	1.174
-17	1.369	1.358	1.347	1.336	1.326	1.315	1.305	1.294	1.284	1.273
-16	1.483	1.471	1.459	1.448	1.436	1.425	1.413	1.402	1.391	1.380
-15	1.604	1.592	1.579	1.567	1.555	1.542	1.530	1.518	1.506	1.494
-14	1.735	1.722	1.708	1.695	1.682	1.669	1.656	1.643	1.630	1.617
-13	1.875	1.861	1.846	1.832	1.818	1.804	1.790	1.776	1.762	1.749
-12	2.025	2.009	1.994	1.979	1.964	1.949	1.934	1.919	1.904	1.890
-11	2.185	2.169	2.152	2.136	2.120	2.104	2.088	2.072	2.056	2.040
-10	2.357	2.339	2.322	2.304	2.287	2.270	2.252	2.236	2.219	2.202
- 9	2.540	2.521	2.502	2.484	2.465	2.447	2.429	2.410	2.392	2.375
- 8	2.736	2.716	2.696	2.676	2.656	2.636	2.617	2.597	2.578	2.559
- 7	2.945	2.923	2.902	2.881	2.860	2.839	2.818	2.797	2.777	2.756
- 6	3.168	3.145	3.122	3.099	3.077	3.054	3.032	3.010	2.988	2.966
- 5	3.405	3.381	3.357	3.332	3.308	3.285	3.261	3.237	3.214	3.191
- 4	3.658	3.632	3.607	3.581	3.555	3.530	3.505	3.480	3.455	3.430
- 3	3.928	3.900	3.873	3.845	3.818	3.791	3.764	3.738	3.711	3.685
- 2	4.215	4.185	4.156	4.127	4.098	4.069	4.041	4.012	3.984	3.956
- 1	4.520	4.489	4.458	4.427	4.396	4.365	4.335	4.305	4.274	4.245
- 0	4.844	4.811	4.778	4.745	4.712	4.680	4.647	4.615	4.583	4.552

TABLE 4.8 — 2

Temperature °C	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
	Unity — *Unité :* g m^{-3}									
0	4.844	4.878	4.912	4.946	4.980	5.014	5.049	5.083	5.118	5.154
1	5.189	5.225	5.260	5.296	5.333	5.369	5.406	5.443	5.480	5.517
2	5.555	5.593	5.631	5.669	5.707	5.746	5.785	5.824	5.864	5.903
3	5.943	5.983	6.024	6.064	6.105	6.146	6.187	6.229	6.271	6.313
4	6.355	6.397	6.440	6.483	6.526	6.570	6.614	6.658	6.702	6.747
5	6.791	6.837	6.882	6.927	6.973	7.019	7.066	7.112	7.159	7.206
6	7.254	7.302	7.350	7.398	7.447	7.495	7.544	7.594	7.644	7.693
7	7.744	7.794	7.845	7.896	7.948	7.999	8.051	8.104	8.156	8.209
8	8.262	8.316	8.369	8.423	8.478	8.532	8.587	8.643	8.698	8.754
9	8.810	8.867	8.924	8.981	9.039	9.096	9.154	9.213	9.272	9.331
10	9.390	9.450	9.510	9.571	9.631	9.692	9.754	9.816	9.878	9.940
11	10.00	10.07	10.13	10.19	10.26	10.32	10.39	10.45	10.52	10.58
12	10.65	10.72	10.78	10.85	10.92	10.99	11.06	11.12	11.19	11.26
13	11.33	11.40	11.47	11.55	11.62	11.69	11.76	11.83	11.91	11.98
14	12.05	12.13	12.20	12.28	12.35	12.43	12.51	12.58	12.66	12.74
15	12.82	12.89	12.97	13.05	13.13	13.21	13.29	13.37	13.45	13.53
16	13.62	13.70	13.78	13.87	13.95	14.03	14.12	14.20	14.29	14.38
17	14.46	14.55	14.64	14.72	14.81	14.90	14.99	15.08	15.17	15.26
18	15.35	15.44	15.54	15.63	15.72	15.81	15.91	16.00	16.10	16.19
19	16.29	16.38	16.48	16.58	16.68	16.78	16.87	16.97	17.07	17.17
20	17.27	17.38	17.48	17.58	17.68	17.79	17.89	17.99	18.10	18.21
21	18.31	18.42	18.53	18.63	18.74	18.85	18.96	19.07	19.18	19.29
22	19.40	19.51	19.63	19.74	19.85	19.97	20.08	20.20	20.31	20.43
23	20.55	20.67	20.78	20.90	21.02	21.14	21.26	21.38	21.51	21.63
24	21.75	21.87	22.00	22.12	22.25	22.38	22.50	22.63	22.76	22.89
25	23.01	23.14	23.28	23.41	23.54	23.67	23.80	23.94	24.07	24.21
26	24.34	24.48	24.61	24.75	24.89	25.03	25.17	25.31	25.45	25.59
27	25.73	25.88	26.02	26.16	26.31	26.45	26.60	26.75	26.89	27.04
28	27.19	27.34	27.49	27.64	27.80	27.95	28.10	28.26	28.41	28.57
29	28.72	28.88	29.04	29.20	29.35	29.51	29.68	29.84	30.00	30.16
30	30.33	30.49	30.66	30.82	30.99	31.16	31.32	31.49	31.66	31.83
31	32.00	32.18	32.35	32.52	32.70	32.87	33.05	33.23	33.40	33.58
32	33.76	33.94	34.12	34.31	34.49	34.67	34.86	35.04	35.23	35.41
33	35.60	35.79	35.98	36.17	36.36	36.55	36.75	36.94	37.14	37.33
34	37.53	37.73	37.92	38.12	38.32	38.52	38.72	38.93	39.13	39.34
35	39.54	39.75	39.95	40.16	40.37	40.58	40.79	41.00	41.22	41.43
36	41.65	41.86	42.08	42.30	42.51	42.73	42.95	43.18	43.40	43.62
37	43.85	44.07	44.30	44.52	44.75	44.98	45.21	45.44	45.68	45.91
38	46.14	46.38	46.61	46.85	47.09	47.33	47.57	47.81	48.05	48.30
39	48.54	48.79	49.03	49.28	49.53	49.78	50.03	50.28	50.54	50.79
40	51.05	51.30	51.56	51.82	52.08	52.34	52.60	52.86	53.13	53.39
41	53.66	53.93	54.20	54.47	54.74	55.01	55.28	55.56	55.83	56.11
42	56.39	56.67	56.95	57.23	57.51	57.79	58.08	58.36	58.65	58.94
43	59.23	59.52	59.81	60.10	60.40	60.70	60.99	61.29	61.59	61.89
44	62.19	62.50	62.80	63.11	63.41	63.72	64.03	64.34	64.65	64.97
45	65.28	65.60	65.91	66.23	66.55	66.87	67.19	67.52	67.84	68.17
46	68.50	68.83	69.16	69.49	69.82	70.15	70.49	70.83	71.17	71.50
47	71.85	72.19	72.53	72.88	73.22	73.57	73.92	74.27	74.62	74.98
48	75.33	75.69	76.05	76.41	76.77	77.13	77.49	77.86	78.22	78.59
49	78.96	79.33	79.70	80.08	80.45	80.83	81.21	81.59	81.97	82.35
50	82.74	83.12	83.51	83.90	84.29	84.68	85.07	85.47	85.86	86.26
51	86.66	87.06	87.47	87.87	88.28	88.68	89.09	89.50	89.91	90.33
52	90.74	91.16	91.58	92.00	92.42	92.84	93.27	93.69	94.12	94.55
53	94.98	95.42	95.85	96.29	96.73	97.17	97.61	98.05	98.50	98.94
54	99.39	99.84	100.3	100.7	101.2	101.7	102.1	102.6	103.0	103.5
55	104.0	104.4	104.9	105.4	105.8	106.3	106.8	107.3	107.8	108.2
56	108.7	109.2	109.7	110.2	110.7	111.2	111.7	112.2	112.7	113.2
57	113.7	114.2	114.7	115.2	115.7	116.2	116.7	117.2	117.7	118.3
58	118.8	119.3	119.8	120.3	120.9	121.4	121.9	122.5	123.0	123.5
59	124.1	124.6	125.2	125.7	126.3	126.8	127.4	127.9	128.5	129.0
60	129.6									

Table 4.8.2 **Density of pure water vapour at saturation with respect to a plane surface of pure water**
Correction for deviation from ideal gas law
Masse volumique de la vapeur d'eau pure à la saturation par rapport à une surface plane d'eau pure
Correction pour les déviations à la loi des gaz parfaits

Correction is to be added to density
La correction est à ajouter à la masse volumique

Temperature °C	Correction g m^{-3}	Temperature °C	Correction g m^{-3}	Temperature °C	Correction g m^{-3}
-50	0.	0	0.002	30	0.1
-49	0.0000	1	0.003	31	0.1
-48	0.0000	2	0.003	32	0.1
-47	0.0000	3	0.003	33	0.1
-46	0.0000	4	0.004	34	0.1
-45	0.0000	5	0.004	35	0.1
-44	0.0000	6	0.005	36	0.1
-43	0.0000	7	0.01	37	0.1
-42	0.0000	8	0.01	38	0.1
-41	0.0000	9	0.01	39	0.1
-40	0.0000	10	0.01	40	0.1
-39	0.0000	11	0.01	41	0.1
-38	0.0000	12	0.01	42	0.2
-37	0.0000	13	0.01	43	0.2
-36	0.0000	14	0.01	44	0.2
-35	0.0000	15	0.01	45	0.2
-34	0.0000	16	0.01	46	0.2
-33	0.0000	17	0.02	47	0.2
-32	0.0000	18	0.02	48	0.3
-31	0.0000	19	0.02	49	0.3
-30	0.0000	20	0.02	50	0.3
-29	0.0000	21	0.02	51	0.3
-28	0.0001	22	0.02	52	0.4
-27	0.0001	23	0.03	53	0.4
-26	0.0001	24	0.03	54	0.4
-25	0.0001	25	0.03	55	0.5
-24	0.0001	26	0.04	56	0.5
-23	0.0001	27	0.04	57	0.5
-22	0.0001	28	0.04	58	0.6
-21	0.0002	29	0.05	59	0.6
-20	0.0002			60	0.7
-19	0.0002				
-18	0.0002				
-17	0.0003				
-16	0.0003				
-15	0.0003				
-14	0.0004				
-13	0.0005				
-12	0.001				
-11	0.001				
-10	0.001				
- 9	0.001				
- 8	0.001				
- 7	0.001				
- 6	0.001				
- 5	0.001				
- 4	0.001				
- 3	0.002				
- 2	0.002				
- 1	0.002				

Table 4.9.1 **Density of pure water vapour at saturation with respect to a plane surface of ice**

Density of water vapour behaving as an ideal gas

Masse volumique de la vapeur d'eau pure à la saturation par rapport à une surface plane de glace

Masse volumique de la vapeur d'eau considérée comme un gaz parfait

Unity — *Unité :* 0.0001 g m^{-3}

Temperature °C	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
-100	0.1754									
- 99	0.2137	0.2095	0.2055	0.2015	0.1975	0.1937	0.1899	0.1862	0.1825	0.1790
- 98	0.2597	0.2547	0.2498	0.2450	0.2402	0.2356	0.2311	0.2266	0.2222	0.2179
- 97	0.3148	0.3088	0.3030	0.2972	0.2916	0.2860	0.2805	0.2752	0.2699	0.2647
- 96	0.3809	0.3737	0.3667	0.3598	0.3530	0.3464	0.3398	0.3334	0.3271	0.3209
- 95	0.4598	0.4513	0.4429	0.4347	0.4266	0.4186	0.4108	0.4031	0.3956	0.3882
- 94	0.5540	0.5438	0.5338	0.5240	0.5143	0.5048	0.4955	0.4864	0.4774	0.4685
- 93	0.6660	0.6539	0.6420	0.6303	0.6189	0.6076	0.5965	0.5856	0.5749	0.5643
- 92	0.7991	0.7847	0.7706	0.7567	0.7431	0.7297	0.7165	0.7036	0.6908	0.6783
- 91	0.9568	0.9398	0.9231	0.9066	0.8905	0.8746	0.8590	0.8436	0.8285	0.8137
- 90	1.1434	1.1233	1.1035	1.0841	1.0650	1.0462	1.0277	1.0095	0.9917	0.9741
- 89	1.3637	1.3400	1.3167	1.2938	1.2712	1.2490	1.2272	1.2057	1.1846	1.1638
- 88	1.6235	1.5955	1.5681	1.5410	1.5144	1.4883	1.4626	1.4372	1.4123	1.3878
- 87	1.9290	1.8962	1.8639	1.8321	1.8008	1.7701	1.7398	1.7100	1.6807	1.6518
- 86	2.2878	2.2493	2.2114	2.1741	2.1374	2.1012	2.0657	2.0307	1.9962	1.9623
- 85	2.7084	2.6633	2.6189	2.5752	2.5322	2.4898	2.4481	2.4071	2.3667	2.3269
- 84	3.2007	3.1479	3.0960	3.0448	2.9945	2.9449	2.8961	2.8481	2.8008	2.7543
- 83	3.7757	3.7141	3.6535	3.5938	3.5350	3.4771	3.4201	3.3639	3.3087	3.2542
- 82	4.4463	4.3745	4.3039	4.2342	4.1657	4.0982	4.0317	3.9662	3.9017	3.8382
- 81	5.2271	5.1436	5.0613	4.9803	4.9005	4.8219	4.7445	4.6682	4.5931	4.5192
- 80	6.1346	6.0376	5.9421	5.8480	5.7552	5.6639	5.5739	5.4852	5.3979	5.3118
- 79	7.1878	7.0754	6.9645	6.8553	6.7478	6.6417	6.5373	6.4344	6.3330	6.2331
- 78	8.4081	8.2779	8.1496	8.0231	7.8985	7.7756	7.6546	7.5353	7.4178	7.3020
- 77	9.8198	9.6692	9.5209	9.3746	9.2305	9.0884	8.9484	8.8103	8.6743	8.5402

Unity — *Unité :* 0.001 g m^{-3}

Temperature °C	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
- 76	1.1450	1.1277	1.1105	1.0936	1.0770	1.0606	1.0444	1.0285	1.0127	0.9973
- 75	1.3331	1.3131	1.2933	1.2738	1.2546	1.2357	1.2171	1.1987	1.1805	1.1627
- 74	1.5496	1.5266	1.5039	1.4814	1.4593	1.4376	1.4161	1.3949	1.3740	1.3534
- 73	1.7986	1.7721	1.7460	1.7203	1.6949	1.6698	1.6451	1.6207	1.5967	1.5730
- 72	2.0845	2.0541	2.0242	1.9946	1.9654	1.9367	1.9083	1.8803	1.8527	1.8255
- 71	2.4123	2.3775	2.3431	2.3093	2.2758	2.2428	2.2103	2.1782	2.1466	2.1153
- 70	2.7876	2.7478	2.7085	2.6697	2.6314	2.5937	2.5564	2.5197	2.4834	2.4476
- 69	3.2167	3.1712	3.1263	3.0819	3.0382	2.9950	2.9524	2.9104	2.8689	2.8280
- 68	3.7066	3.6547	3.6034	3.5528	3.5029	3.4536	3.4050	3.3570	3.3096	3.2629
- 67	4.2653	4.2061	4.1477	4.0900	4.0330	3.9769	3.9214	3.8666	3.8126	3.7593
- 66	4.9014	4.8340	4.7675	4.7019	4.6371	4.5731	4.5099	4.4476	4.3860	4.3253
- 65	5.6248	5.5482	5.4726	5.3980	5.3243	5.2515	5.1797	5.1088	5.0388	4.9696
- 64	6.4464	6.3595	6.2737	6.1889	6.1053	6.0226	5.9410	5.8605	5.7809	5.7024
- 63	7.3784	7.2798	7.1823	7.0864	6.9915	6.8978	6.8052	6.7138	6.6236	6.5344
- 62	8.4342	8.3226	8.2124	8.1036	7.9961	7.8899	7.7850	7.6815	7.5792	7.4782
- 61	9.6288	9.5026	9.3780	9.2549	9.1333	9.0131	8.8945	8.7773	8.6615	8.5471

Unity — *Unité :* 0.01 g m^{-3}

Temperature °C	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
- 60	1.0979	1.0836	1.0696	1.0556	1.0419	1.0283	1.0149	1.0017	0.9886	0.9756
- 59	1.2503	1.2342	1.2183	1.2026	1.1871	1.1718	1.1566	1.1417	1.1269	1.1123
- 58	1.4221	1.4039	1.3860	1.3683	1.3509	1.3336	1.3165	1.2997	1.2830	1.2665
- 57	1.6155	1.5951	1.5750	1.5550	1.5354	1.5159	1.4967	1.4777	1.4589	1.4404
- 56	1.8331	1.8102	1.7875	1.7651	1.7430	1.7211	1.6995	1.6781	1.6570	1.6361
- 55	2.0775	2.0518	2.0264	2.0012	1.9764	1.9518	1.9275	1.9035	1.8797	1.8563
- 54	2.3519	2.3230	2.2945	2.2663	2.2384	2.2108	2.1835	2.1566	2.1299	2.1036
- 53	2.6594	2.6271	2.5951	2.5635	2.5322	2.5013	2.4707	2.4405	2.4106	2.3811
- 52	3.0038	2.9676	2.9318	2.8964	2.8614	2.8267	2.7925	2.7587	2.7252	2.6921
- 51	3.3889	3.3485	3.3084	3.2688	3.2297	3.1910	3.1527	3.1148	3.0774	3.0404

Temperature °C	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
- 50	3.8193	3.7741	3.7294	3.6852	3.6414	3.5982	3.5554	3.5131	3.4713	3.4299
- 49	4.2997	4.2493	4.1994	4.1500	4.1012	4.0530	4.0052	3.9580	3.9112	3.8650
- 48	4.8354	4.7791	4.7233	4.6685	4.6141	4.5603	4.5070	4.4544	4.4022	4.3507
- 47	5.4320	5.3694	5.3075	5.2462	5.1856	5.1257	5.0664	5.0077	4.9496	4.8922
- 46	6.0959	6.0263	5.9575	5.8893	5.8219	5.7552	5.6891	5.6238	5.5592	5.4953
- 45	6.8340	6.7567	6.6801	6.6044	6.5294	6.4553	6.3819	6.3093	6.2374	6.1663
- 44	7.6537	7.5678	7.4828	7.3988	7.3155	7.2332	7.1517	7.0710	6.9912	6.9122
- 43	8.5631	8.4679	8.3736	8.2804	8.1880	8.0966	8.0062	7.9167	7.8281	7.7405
- 42	9.5711	9.4656	9.3612	9.2578	9.1555	9.0542	8.9540	8.8547	8.7565	8.6593

Unity — *Unité :* g m^{-3}

Temperature °C	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
- 41	0.1069	0.1057	0.1046	0.1034	0.1023	0.1012	0.1000	0.09894	0.09785	0.09678
- 40	0.1192	0.1179	0.1167	0.1154	0.1141	0.1129	0.1117	0.1104	0.1092	0.1081
- 39	0.1329	0.1314	0.1300	0.1286	0.1273	0.1259	0.1245	0.1232	0.1218	0.1205
- 38	0.1479	0.1464	0.1448	0.1433	0.1417	0.1402	0.1387	0.1372	0.1358	0.1343
- 37	0.1646	0.1628	0.1611	0.1594	0.1577	0.1561	0.1544	0.1528	0.1511	0.1495
- 36	0.1829	0.1810	0.1791	0.1772	0.1754	0.1735	0.1717	0.1699	0.1681	0.1663
- 35	0.2031	0.2010	0.1989	0.1968	0.1948	0.1928	0.1908	0.1888	0.1868	0.1848
- 34	0.2253	0.2230	0.2207	0.2184	0.2162	0.2140	0.2117	0.2096	0.2074	0.2052
- 33	0.2498	0.2472	0.2447	0.2422	0.2397	0.2373	0.2348	0.2324	0.2300	0.2277
- 32	0.2766	0.2738	0.2710	0.2683	0.2656	0.2629	0.2602	0.2576	0.2549	0.2523
- 31	0.3061	0.3030	0.3000	0.2969	0.2940	0.2910	0.2881	0.2852	0.2823	0.2794
- 30	0.3384	0.3350	0.3317	0.3284	0.3251	0.3219	0.3186	0.3154	0.3123	0.3092
- 29	0.3738	0.3701	0.3664	0.3628	0.3592	0.3557	0.3522	0.3487	0.3452	0.3418
- 28	0.4126	0.4085	0.4045	0.4006	0.3966	0.3927	0.3889	0.3851	0.3813	0.3775
- 27	0.4550	0.4506	0.4462	0.4419	0.4376	0.4333	0.4291	0.4249	0.4207	0.4166
- 26	0.5014	0.4965	0.4918	0.4870	0.4823	0.4777	0.4730	0.4685	0.4639	0.4594
- 25	0.5520	0.5468	0.5415	0.5364	0.5312	0.5261	0.5211	0.5161	0.5111	0.5062
- 24	0.6073	0.6016	0.5959	0.5902	0.5846	0.5791	0.5736	0.5681	0.5627	0.5573
- 23	0.6676	0.6614	0.6552	0.6490	0.6429	0.6368	0.6308	0.6249	0.6190	0.6131
- 22	0.7334	0.7266	0.7198	0.7131	0.7064	0.6998	0.6933	0.6868	0.6803	0.6740
- 21	0.8050	0.7976	0.7902	0.7829	0.7756	0.7684	0.7613	0.7542	0.7472	0.7403
- 20	0.8829	0.8748	0.8668	0.8589	0.8510	0.8431	0.8354	0.8277	0.8201	0.8125
- 19	0.9677	0.9589	0.9502	0.9415	0.9329	0.9244	0.9160	0.9076	0.8993	0.8911
- 18	1.060	1.050	1.041	1.031	1.022	1.013	1.004	0.9945	0.9855	0.9765
- 17	1.160	1.149	1.139	1.129	1.119	1.109	1.099	1.089	1.079	1.069
- 16	1.268	1.257	1.246	1.235	1.224	1.213	1.202	1.191	1.181	1.170
- 15	1.386	1.374	1.362	1.350	1.338	1.326	1.314	1.303	1.291	1.280
- 14	1.514	1.500	1.487	1.474	1.461	1.449	1.436	1.423	1.411	1.398
- 13	1.652	1.638	1.623	1.609	1.595	1.581	1.568	1.554	1.540	1.527
- 12	1.801	1.786	1.771	1.755	1.740	1.725	1.710	1.696	1.681	1.666
- 11	1.963	1.946	1.930	1.913	1.897	1.881	1.865	1.849	1.833	1.817
- 10	2.138	2.120	2.102	2.084	2.067	2.049	2.032	2.014	1.997	1.980
- 9	2.327	2.307	2.288	2.269	2.250	2.231	2.212	2.193	2.175	2.156
- 8	2.531	2.510	2.489	2.468	2.447	2.427	2.407	2.387	2.367	2.347
- 7	2.751	2.728	2.706	2.683	2.661	2.639	2.617	2.595	2.574	2.552
- 6	2.988	2.964	2.939	2.915	2.891	2.867	2.844	2.820	2.797	2.774
- 5	3.244	3.217	3.191	3.165	3.139	3.113	3.088	3.063	3.038	3.013
- 4	3.519	3.490	3.462	3.434	3.406	3.379	3.351	3.324	3.297	3.270
- 3	3.815	3.784	3.754	3.724	3.694	3.664	3.635	3.605	3.576	3.547
- 2	4.134	4.101	4.068	4.036	4.003	3.971	3.940	3.908	3.877	3.846
- 1	4.476	4.441	4.406	4.371	4.336	4.302	4.268	4.234	4.200	4.167
- 0	4.844	4.806	4.768	4.731	4.694	4.657	4.620	4.584	4.548	4.512

Table 4.9.2 Density of pure water vapour at saturation with respect to a plane surface of ice
Correction for deviation from ideal gas law

Masse volumique de la vapeur d'eau pure à la saturation par rapport à une surface plane de glace
Correction pour les déviations à la loi des gaz parfaits

Correction is to be added to density
La correction est à ajouter à la masse volumique

Temperature °C	Correction $g\ m^{-3}$	Temperature °C	Correction $g\ m^{-3}$
-100	0.00000000	- 50	0.0000006
- 99	0.00000000	- 49	0.0000007
- 98	0.00000000	- 48	0.0000008
- 97	0.00000000	- 47	0.0000010
- 96	0.00000000	- 46	0.0000012
- 95	0.00000000	- 45	0.000002
- 94	0.00000000	- 44	0.000002
- 93	0.00000000	- 43	0.000002
- 92	0.00000000	- 42	0.000003
- 91	0.00000000	- 41	0.000003
- 90	0.00000000	- 40	0.000004
- 89	0.00000000	- 39	0.000005
- 88	0.00000000	- 38	0.000006
- 87	0.00000000	- 37	0.000007
- 86	0.00000000	- 36	0.000008
- 85	0.00000000	- 35	0.000010
- 84	0.00000000	- 34	0.000012
- 83	0.00000000	- 33	0.000014
- 82	0.00000000	- 32	0.00002
- 81	0.00000000	- 31	0.00002
- 80	0.00000000	- 30	0.00002
- 79	0.00000000	- 29	0.00003
- 78	0.00000000	- 28	0.00003
- 77	0.00000000	- 27	0.00004
- 76	0.00000000	- 26	0.00005
- 75	0.00000000	- 25	0.00006
- 74	0.00000000	- 24	0.00007
- 73	0.00000000	- 23	0.00008
- 72	0.00000000	- 22	0.00009
- 71	0.00000001	- 21	0.00011
- 70	0.00000001	- 20	0.00012
- 69	0.00000001	- 19	0.00015
- 68	0.00000001	- 18	0.0002
- 67	0.00000001	- 17	0.0002
- 66	0.00000002	- 16	0.0002
- 65	0.00000002	- 15	0.0003
- 64	0.00000003	- 14	0.0003
- 63	0.00000003	- 13	0.0004
- 62	0.00000004	- 12	0.0004
- 61	0.00000005	- 11	0.0005
- 60	0.00000007	- 10	0.0006
- 59	0.00000008	- 9	0.0007
- 58	0.00000010	- 8	0.0008
- 57	0.00000013	- 7	0.0009
- 56	0.0000002	- 6	0.0010
- 55	0.0000002	- 5	0.0012
- 54	0.0000002	- 4	0.0014
- 53	0.0000003	- 3	0.002
- 52	0.0000004	- 2	0.002
- 51	0.0000005	- 1	0.002

Table 4.10 **Relations between saturation vapour pressure of water vapour in the pure phase and of moist air (coefficients f_w and f_i)**

Relations entre la pression de vapeur saturante de la vapeur d'eau dans la phase pure et celle de l'air humide (coefficients f_w et f_i)

Coefficient f_w

Temperature °C	Pressure — *pression*, mb										
	5	10	30	50	100	200	300	500	700	900	1100
—50	1.0000	1.0001	1.0002	1.0003	1.0006	1.0012	1.0018	1.0030	1.0042	1.0053	1.0065
—40	1.0001	1.0001	1.0002	1.0003	1.0006	1.0011	1.0017	1.0027	1.0038	1.0049	1.0060
—30	1.0001	1.0001	1.0002	1.0003	1.0006	1.0011	1.0016	1.0026	1.0036	1.0046	1.0055
—20	1.0001	1.0002	1.0003	1.0004	1.0006	1.0011	1.0015	1.0024	1.0034	1.0043	1.0052
—10	1.0001	1.0002	1.0004	1.0005	1.0007	1.0011	1.0015	1.0024	1.0032	1.0041	1.0049
0		1.0002	1.0005	1.0006	1.0008	1.0012	1.0016	1.0024	1.0032	1.0040	1.0047
10					1.0010	1.0014	1.0018	1.0025	1.0032	1.0040	1.0047
20					1.0012	1.0016	1.0020	1.0027	1.0034	1.0041	1.0048
30							1.0023	1.0030	1.0037	1.0044	1.0050
40							1.0026	1.0034	1.0041	1.0048	1.0054
50								1.0037	1.0045	1.0052	1.0059
60									1.0048	1.0056	1.0064

Coefficient f_i

Temperature °C	Pressure — *pression*, mb										
	5	10	30	50	100	200	300	500	700	900	1100
—100	1.0001	1.0001	1.0003	1.0005	1.0010	1.0020	1.0030				
— 90	1.0000	1.0001	1.0003	1.0004	1.0009	1.0018	1.0027	1.0045			
— 80	1.0000	1.0001	1.0002	1.0004	1.0008	1.0016	1.0024	1.0040	1.0057	1.0073	1.0089
— 70	1.0000	1.0001	1.0002	1.0004	1.0007	1.0015	1.0022	1.0036	1.0051	1.0066	1.0080
— 60	1.0000	1.0001	1.0002	1.0003	1.0007	1.0013	1.0020	1.0033	1.0046	1.0059	1.0073
— 50	1.0000	1.0001	1.0002	1.0003	1.0006	1.0012	1.0018	1.0030	1.0042	1.0054	1.0066
— 40	1.0001	1.0001	1.0002	1.0003	1.0006	1.0011	1.0017	1.0028	1.0039	1.0050	1.0061
— 30	1.0001	1.0001	1.0002	1.0003	1.0006	1.0011	1.0016	1.0026	1.0036	1.0046	1.0056
— 20	1.0001	1.0002	1.0003	1.0004	1.0006	1.0011	1.0015	1.0024	1.0034	1.0043	1.0052
— 10	1.0001	1.0002	1.0004	1.0005	1.0007	1.0011	1.0015	1.0024	1.0033	1.0041	1.0050
0		1.0002	1.0005	1.0006	1.0008	1.0012	1.0016	1.0024	1.0032	1.0040	1.0048

Table 4.11 Virtual temperature increment of saturated moist air
Correction de température virtuelle de l'air humide saturé

Temperature	Pressure — *pression*, mb 1100	1050	1000	950	900	850	800	750	700	650
°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
—40	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03
—39	.02	.02	.02	.02	.02	.02	.02	.02	.03	.03
—38	.02	.02	.02	.02	.02	.03	.03	.03	.03	.03
—37	.02	.02	.02	.03	.03	.03	.03	.03	.03	.04
—36	.02	.03	.03	.03	.03	.03	.03	.04	.04	.04
—35	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.05
—34	.03	.03	.03	.03	.04	.04	.04	.04	.05	.05
—33	.03	.03	.04	.04	.04	.04	.05	.05	.05	.06
—32	.04	.04	.04	.04	.04	.05	.05	.05	.06	.06
—31	.04	.04	.04	.05	.05	.05	.05	.06	.06	.07
—30	0.04	0.04	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07
—29	.05	.05	.05	.05	.06	.06	.07	.07	.07	.08
—28	.05	.06	.06	.06	.06	.07	.07	.08	.08	.09
—27	.06	.06	.06	.07	.07	.08	.08	.09	.09	.10
—26	.07	.07	.07	.07	.08	.08	.09	.09	.10	.11
—25	0.07	0.07	0.08	0.08	0.09	0.09	0.10	0.10	0.11	0.12
—24	.08	.08	.09	.09	.10	.10	.11	.11	.12	.13
—23	.09	.09	.09	.10	.10	.11	.12	.13	.13	.14
—22	.09	.10	.10	.11	.11	.12	.13	.14	.15	.16
—21	.10	.11	.11	.12	.12	.13	.14	.15	.16	.17
—20	0.11	0.12	0.12	0.13	0.13	0.14	0.15	0.16	0.17	0.18
—19	.12	.13	.13	.14	.15	.16	.17	.18	.19	.20
—18	.13	.14	.15	.15	.16	.17	.18	.20	.21	.22
—17	.15	.15	.16	.17	.18	.19	.20	.21	.23	.24
—16	.16	.17	.18	.19	.20	.21	.22	.23	.25	.26
—15	0.17	0.18	0.19	0.20	0.21	0.23	0.24	0.26	0.27	0.29
—14	.19	.20	.21	.22	.23	.25	.26	.28	.30	.31
—13	.21	.22	.23	.24	.25	.27	.28	.30	.32	.34
—12	.22	.23	.25	.26	.27	.29	.31	.33	.35	.37
—11	.24	.25	.27	.28	.30	.31	.33	.35	.38	.41
—10	0.26	0.27	0.29	0.30	0.32	0.34	0.36	0.38	0.41	0.44
— 9	.28	.30	.31	.33	.34	.37	.39	.41	.44	.48
— 8	.31	.32	.34	.35	.37	.40	.42	.45	.48	.52
— 7	.33	.35	.37	.38	.40	.43	.46	.49	.52	.56
— 6	.36	.38	.40	.42	.44	.46	.49	.53	.56	.61
— 5	0.39	0.41	0.43	0.45	0.48	0.50	0.53	0.57	0.61	0.66
— 4	.42	.44	.46	.49	.51	.55	.58	.62	.66	.71
— 3	.46	.48	.50	.53	.56	.59	.63	.67	.72	.77
— 2	.49	.52	.54	.57	.60	.64	.68	.72	.78	.84
— 1	.53	.56	.59	.62	.65	.69	.73	.78	.84	.90
0	0.58	0.60	0.64	0.67	0.70	0.75	0.79	0.85	0.91	0.98
1	.62	.65	.68	.72	.76	.80	.86	.91	.98	1.05
2	.67	.70	.74	.78	.82	.87	.92	.98	1.05	1.13
3	.72	.76	.79	.84	.88	.93	.99	1.06	1.13	1.22
4	.78	.81	.85	.90	.95	1.01	1.07	1.14	1.22	1.32
5	0.84	0.88	0.92	0.97	1.02	1.08	1.15	1.23	1.32	1.42
6	.90	.94	.99	1.04	1.10	1.17	1.24	1.32	1.42	1.53
7	.97	1.02	1.07	1.12	1.18	1.25	1.33	1.42	1.52	1.64
8	1.04	1.09	1.15	1.21	1.27	1.35	1.43	1.53	1.64	1.77
9	1.12	1.17	1.23	1.30	1.37	1.45	1.54	1.65	1.76	1.90
10	1.20	1.26	1.32	1.40	1.47	1.56	1.66	1.77	1.90	2.04

TABLE 4.11 — 2

Temperature	Pressure — *pression*, mb									
	1100	1050	1000	950	900	850	800	750	700	650
°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
10	1.20	1.26	1.32	1.40	1.47	1.56	1.66	1.77	1.90	2.04
11	1.29	1.35	1.42	1.50	1.58	1.67	1.78	1.90	2.03	2.19
12	1.38	1.45	1.52	1.60	1.69	1.79	1.90	2.03	2.18	2.35
13	1.48	1.55	1.63	1.72	1.81	1.92	2.04	2.18	2.33	2.51
14	1.59	1.66	1.75	1.84	1.94	2.06	2.19	2.33	2.50	2.69
15	1.70	1.78	1.87	1.97	2.08	2.20	2.34	2.50	2.68	2.89
16	1.82	1.91	2.00	2.11	2.23	2.36	2.51	2.68	2.87	3.09
17	1.95	2.04	2.15	2.26	2.39	2.53	2.68	2.87	3.07	3.31
18	2.09	2.19	2.30	2.42	2.55	2.70	2.87	3.07	3.29	3.54
19	2.23	2.34	2.46	2.59	2.73	2.89	3.07	3.28	3.52	3.79
20	2.38	2.50	2.62	2.76	2.92	3.09	3.29	3.51	3.76	4.05
21	2.54	2.67	2.80	2.95	3.11	3.30	3.51	3.74	4.02	4.33
22	2.71	2.84	2.99	3.15	3.32	3.52	3.74	3.99	4.29	4.62
23	2.90	3.03	3.19	3.36	3.54	3.75	3.99	4.26	4.58	4.93
24	3.09	3.23	3.40	3.58	3.78	4.00	4.26	4.54	4.88	5.26
25	3.29	3.45	3.62	3.82	4.03	4.27	4.54	4.85	5.21	5.61
26	3.51	3.67	3.86	4.07	4.29	4.55	4.84	5.17	5.55	5.98
27	3.74	3.92	4.11	4.33	4.58	4.85	5.16	5.50	5.91	6.37
28	3.98	4.17	4.38	4.62	4.87	5.17	5.49	5.87	6.30	6.79
29	4.24	4.44	4.67	4.91	5.19	5.50	5.85	6.25	6.71	7.23
30	4.51	4.73	4.97	5.23	5.53	5.86	6.23	6.65	7.14	7.70
31	4.79	5.02	5.28	5.56	5.88	6.23	6.62	7.08	7.59	8.19
32	5.09	5.34	5.61	5.91	6.25	6.62	7.04	7.52	8.07	8.71
33	5.41	5.67	5.96	6.28	6.64	7.04	7.48	8.00	8.58	9.26
34	5.74	6.02	6.33	6.67	7.05	7.47	7.95	8.50	9.12	9.84
35	6.10	6.39	6.73	7.09	7.49	7.94	8.45	9.02	9.69	10.45
36	6.47	6.78	7.14	7.52	7.95	8.43	8.97	9.58	10.29	11.10
37	6.87	7.20	7.57	7.98	8.44	8.94	9.52	10.17	10.92	11.79
38	7.28	7.64	8.03	8.47	8.95	9.49	10.10	10.80	11.59	12.52
39	7.73	8.10	8.52	8.98	9.49	10.07	10.72	11.45	12.30	13.29
40	8.19	8.59	9.03	9.52	10.06	10.68	11.36	12.15	13.05	14.10
41	8.68	9.10	9.57	10.09	10.66	11.31	12.04	12.88	13.84	14.95
42	9.19	9.64	10.14	10.69	11.30	11.99	12.76	13.66	14.67	15.86
43	9.73	10.21	10.73	11.32	11.97	12.70	13.52	14.47	15.54	16.81
44	10.30	10.80	11.36	11.98	12.67	13.44	14.32	15.33	16.46	17.82
45	10.90	11.43	12.02	12.68	13.41	14.23	15.16	16.24	17.44	18.89
46	11.53	12.10	12.72	13.42	14.19	15.07	16.05	17.19	18.47	20.00
47	12.19	12.79	13.46	14.19	15.02	15.94	16.99	18.20	19.55	21.18
48	12.89	13.53	14.23	15.01	15.88	16.87	17.98	19.26	20.70	22.42
49	13.63	14.30	15.05	15.87	16.80	17.84	19.02	20.37	21.91	23.73
50	14.40	15.11	15.90	16.78	17.76	18.86	20.11	21.54	23.18	25.10
51	15.21	15.97	16.81	17.74	18.77	19.95				
52	16.07	16.87	17.76	18.74	19.83	21.08				
53	16.97	17.82	18.76	19.80	20.95	22.28				
54	17.91	18.81	19.81	20.91	22.13	23.54				
55	18.90	19.86	20.91	22.08	23.37	24.87				
56	19.95	20.95	22.07	23.31	24.67	26.26				
57	21.04	22.11	23.29	24.60	26.04	27.73				
58	22.19	23.32	24.57	25.96	27.49	29.27				
59	23.40	24.59	25.91	27.38	29.01	30.89				
60	24.66	25.92	27.32	28.87	30.62	32.59				

Temperature	Pressure — *pression*, mb 650	600	550	500	450	400	350	300	250	200
°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
−40	0.03	0.03	0.03	0.03	0.04	0.04	0.05	0.06	0.07	0.08
−39	.03	.03	.03	.04	.04	.05	.05	.06	.07	.09
−38	.03	.04	.04	.04	.05	.05	.06	.07	.08	.10
−37	.04	.04	.04	.05	.05	.06	.06	.08	.09	.11
−36	.04	.04	.05	.05	.06	.07	.07	.08	.10	.13
−35	0.05	0.05	0.05	0.06	0.07	0.07	0.08	0.09	0.11	0.14
−34	.05	.05	.06	.06	.07	.08	.09	.10	.12	.15
−33	.06	.06	.06	.07	.08	.09	.10	.11	.14	.17
−32	.06	.07	.07	.08	.09	.10	.11	.13	.15	.19
−31	.07	.07	.08	.09	.10	.11	.12	.14	.17	.21
−30	0.07	0.08	0.08	0.09	0.10	0.12	0.13	0.16	0.19	0.23
−29	.08	.09	.09	.10	.12	.13	.15	.17	.21	.26
−28	.09	.10	.11	.12	.13	.15	.16	.19	.23	.28
−27	.10	.11	.12	.13	.14	.16	.18	.21	.25	.31
−26	.11	.12	.13	.14	.16	.18	.20	.23	.27	.34
−25	0.12	0.13	0.14	0.16	0.17	0.20	0.21	0.25	0.30	0.38
−24	.13	.14	.16	.17	.19	.21	.24	.28	.33	.41
−23	.14	.16	.17	.19	.21	.23	.26	.30	.36	.45
−22	.16	.17	.19	.20	.23	.26	.29	.33	.40	.50
−21	.17	.19	.20	.22	.25	.28	.31	.37	.44	.55
−20	0.18	0.20	0.22	0.24	0.27	0.30	0.34	0.40	0.48	0.60
−19	.20	.22	.24	.27	.29	.33	.38	.44	.53	.66
−18	.22	.24	.26	.29	.32	.36	.41	.48	.57	.72
−17	.24	.26	.28	.32	.35	.39	.45	.52	.63	.78
−16	.26	.28	.31	.35	.38	.43	.49	.57	.68	.85
−15	0.29	0.31	0.34	0.38	0.41	0.47	0.53	0.62	0.74	0.93
−14	.31	.34	.37	.42	.45	.51	.58	.68	.81	1.02
−13	.34	.37	.40	.45	.49	.55	.63	.74	.89	1.11
−12	.37	.40	.44	.49	.54	.60	.69	.80	.97	1.21
−11	.41	.44	.48	.53	.59	.66	.75	.88	1.05	1.32
−10	0.44	0.48	0.52	0.57	0.64	0.72	0.82	0.95	1.15	1.43
− 9	.48	.52	.56	.62	.69	.78	.89	1.04	1.24	1.56
− 8	.52	.56	.61	.67	.75	.84	.96	1.12	1.35	1.69
− 7	.56	.61	.66	.73	.81	.91	1.04	1.22	1.46	1.83
− 6	.61	.66	.72	.79	.88	.99	1.13	1.32	1.59	1.99
− 5	0.66	0.71	0.78	0.85	0.95	1.07	1.22	1.43	1.72	2.15
− 4	.71	.77	.84	.93	1.03	1.16	1.33	1.55	1.86	2.33
− 3	.77	.84	.91	1.00	1.12	1.26	1.44	1.68	2.02	2.52
− 2	.84	.90	.99	1.09	1.21	1.36	1.55	1.82	2.18	2.73
− 1	.90	.98	1.07	1.17	1.31	1.47	1.68	1.96	2.36	2.95
0	.98	1.06	1.15	1.27	1.41	1.59	1.82	2.12	2.55	3.19
1	1.05	1.14	1.24	1.37	1.52	1.72	1.96	2.29	2.75	3.45
2	1.13	1.23	1.34	1.47	1.64	1.85	2.12	2.47	2.97	3.72
3	1.22	1.32	1.44	1.59	1.77	2.00	2.28	2.67	3.20	4.01
4	1.32	1.43	1.56	1.71	1.90	2.15	2.46	2.88	3.45	4.33
5	1.42	1.53	1.67	1.84	2.05	2.32	2.65	3.10	3.72	4.66
6	1.53	1.65	1.80	1.99	2.21	2.49	2.85	3.34	4.00	5.02
7	1.64	1.78	1.94	2.14	2.38	2.68	3.07	3.59	4.31	5.41
8	1.77	1.91	2.09	2.30	2.56	2.88	3.30	3.86	4.64	5.82
9	1.90	2.06	2.25	2.47	2.75	3.10	3.55	4.15	4.99	6.26
10	2.04	2.21	2.42	2.66	2.96	3.33	3.81	4.46	5.36	6.73

Temperature	Pressure — *pression*, mb 650	600	550	500	450	400	350	300	250	200
°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
10	2.04	2.21	2.42	2.66	2.96	3.33	3.81	4.46	5.36	6.73
11	2.19	2.37	2.59	2.85	3.18	3.58	4.10	4.78	5.76	7.24
12	2.35	2.54	2.78	3.06	3.41	3.84	4.40	5.14	6.19	7.77
13	2.51	2.72	2.98	3.28	3.66	4.11	4.71	5.51	6.64	8.34
14	2.69	2.92	3.19	3.52	3.92	4.41	5.05	5.91	7.12	8.95
15	2.89	3.13	3.42	3.77	4.20	4.73	5.42	6.34	7.64	9.61
16	3.09	3.35	3.66	4.04	4.50	5.06	5.80	6.79	8.18	10.30
17	3.31	3.59	3.92	4.32	4.82	5.42	6.21	7.27	8.77	11.04
18	3.54	3.84	4.19	4.62	5.15	5.80	6.65	7.79	9.39	11.83
19	3.79	4.11	4.48	4.95	5.51	6.21	7.11	8.33	10.05	12.67
20	4.05	4.40	4.80	5.29	5.89	6.64	7.61	8.92	10.76	13.57
21	4.33	4.69	5.13	5.65	6.29	7.09	8.13			
22	4.62	5.01	5.48	6.03	6.72	7.58	8.69			
23	4.93	5.35	5.85	6.44	7.17	8.09	9.29			
24	5.26	5.71	6.24	6.87	7.66	8.64	9.92			
25	5.61	6.09	6.65	7.33	8.17	9.22	10.59			
26	5.98	6.49	7.09	7.82	8.72	9.84	11.29			
27	6.37	6.92	7.56	8.34	9.29	10.49	12.05			
28	6.79	7.37	8.06	8.88	9.90	11.18	12.85			
29	7.23	7.85	8.58	9.46	10.55	11.92	13.70			
30	7.70	8.36	9.14	10.08	11.24	12.70	14.60			
31	8.19	8.89	9.72	10.73	11.96					
32	8.71	9.46	10.34	11.41	12.73					
33	9.26	10.05	11.00	12.14	13.55					
34	9.84	10.68	11.69	12.91	14.41					
35	10.45	11.35	12.43	13.73	15.33					
36	11.10	12.06	13.20	14.59	16.29					
37	11.79	12.81	14.03	15.50	17.32					
38	12.52	13.61	14.90	16.47	18.40					
39	13.29	14.44	15.82	17.49	19.55					
40	14.10	15.33	16.79	18.57	20.76					
41	14.95									
42	15.86									
43	16.81									
44	17.82									
45	18.89									
46	20.00									
47	21.18									
48	22.42									
49	23.73									
50	25.10									

Table 4.12.1 Density of air regarded as an ideal gas

Masse volumique de l'air considéré comme un gaz parfait

Virtual temperature *Température virtuelle* t_v	Pressure — *pression*, mb										
	1100	1000	900	800	700	600	500	400	300	200	100
°C	kg m⁻³	kg m⁻³	kg m⁻³	kg m⁻³	kg m⁻³	kg m⁻³	kg m⁻³	kg m⁻³	kg m⁻³	kg m⁻³	kg m⁻³
−110	2.3488	2.1352	1.9217	1.7082	1.4947	1.2811	1.0676	0.8541	0.6406	0.4270	0.2135
−109	2.3344	2.1222	1.9100	1.6978	1.4856	1.2733	1.0611	0.8489	0.6367	0.4244	0.2122
−108	2.3203	2.1094	1.8984	1.6875	1.4766	1.2656	1.0547	0.8437	0.6328	0.4219	0.2109
−107	2.3063	2.0967	1.8870	1.6773	1.4677	1.2580	1.0483	0.8387	0.6290	0.4193	0.2097
−106	2.2925	2.0841	1.8757	1.6673	1.4589	1.2505	1.0421	0.8337	0.6252	0.4168	0.2084
−105	2.2789	2.0717	1.8646	1.6574	1.4502	1.2430	1.0359	0.8287	0.6215	0.4143	0.2072
−104	2.2654	2.0595	1.8535	1.6476	1.4416	1.2357	1.0297	0.8238	0.6178	0.4119	0.2059
−103	2.2521	2.0474	1.8427	1.6379	1.4332	1.2284	1.0237	0.8190	0.6142	0.4095	0.2047
−102	2.2390	2.0354	1.8319	1.6283	1.4248	1.2213	1.0177	0.8142	0.6106	0.4071	0.2035
−101	2.2260	2.0236	1.8212	1.6189	1.4165	1.2142	1.0118	0.8094	0.6071	0.4047	0.2024
−100	2.2131	2.0119	1.8107	1.6095	1.4083	1.2072	1.0060	0.8048	0.6036	0.4024	0.2012
− 99	2.2004	2.0004	1.8003	1.6003	1.4003	1.2002	1.0002	0.8001	0.6001	0.4001	0.2000
− 98	2.1878	1.9890	1.7901	1.5912	1.3923	1.1934	0.9945	0.7956	0.5967	0.3978	0.1989
− 97	2.1754	1.9776	1.7799	1.5821	1.3844	1.1866	0.9888	0.7911	0.5933	0.3955	0.1978
− 96	2.1631	1.9665	1.7698	1.5732	1.3765	1.1799	0.9832	0.7866	0.5899	0.3933	0.1966
− 95	2.1510	1.9554	1.7599	1.5644	1.3688	1.1733	0.9777	0.7822	0.5866	0.3911	0.1955
− 94	2.1390	1.9445	1.7501	1.5556	1.3612	1.1667	0.9723	0.7778	0.5834	0.3889	0.1945
− 93	2.1271	1.9338	1.7404	1.5470	1.3536	1.1602	0.9669	0.7735	0.5801	0.3868	0.1934
− 92	2.1154	1.9231	1.7308	1.5385	1.3461	1.1538	0.9615	0.7692	0.5769	0.3846	0.1923
− 91	2.1038	1.9125	1.7213	1.5300	1.3388	1.1475	0.9563	0.7650	0.5738	0.3825	0.1913
− 90	2.0923	1.9021	1.7119	1.5217	1.3314	1.1412	0.9510	0.7608	0.5706	0.3804	0.1902
− 89	2.0809	1.8917	1.7026	1.5134	1.3242	1.1350	0.9459	0.7567	0.5675	0.3783	0.1892
− 88	2.0697	1.8815	1.6934	1.5052	1.3171	1.1289	0.9408	0.7526	0.5645	0.3763	0.1882
− 87	2.0586	1.8714	1.6843	1.4971	1.3100	1.1229	0.9357	0.7486	0.5614	0.3743	0.1871
− 86	2.0476	1.8614	1.6753	1.4891	1.3030	1.1169	0.9307	0.7446	0.5584	0.3723	0.1861
− 85	2.0367	1.8515	1.6664	1.4812	1.2961	1.1109	0.9258	0.7406	0.5555	0.3703	0.1852
− 84	2.0259	1.8417	1.6576	1.4734	1.2892	1.1050	0.9209	0.7367	0.5525	0.3683	0.1842
− 83	2.0153	1.8321	1.6489	1.4656	1.2824	1.0992	0.9160	0.7328	0.5496	0.3664	0.1832
− 82	2.0047	1.8225	1.6402	1.4580	1.2757	1.0935	0.9112	0.7290	0.5467	0.3645	0.1822
− 81	1.9943	1.8130	1.6317	1.4504	1.2691	1.0878	0.9065	0.7252	0.5439	0.3626	0.1813
− 80	1.9840	1.8036	1.6232	1.4429	1.2625	1.0822	0.9018	0.7214	0.5411	0.3607	0.1804
− 79	1.9737	1.7943	1.6149	1.4354	1.2560	1.0766	0.8972	0.7177	0.5383	0.3589	0.1794
− 78	1.9636	1.7851	1.6066	1.4281	1.2496	1.0711	0.8926	0.7140	0.5355	0.3570	0.1785
− 77	1.9536	1.7760	1.5984	1.4208	1.2432	1.0656	0.8880	0.7104	0.5328	0.3552	0.1776
− 76	1.9437	1.7670	1.5903	1.4136	1.2369	1.0602	0.8835	0.7068	0.5301	0.3534	0.1767
− 75	1.9339	1.7581	1.5823	1.4065	1.2307	1.0549	0.8790	0.7032	0.5274	0.3516	0.1758
− 74	1.9242	1.7493	1.5743	1.3994	1.2245	1.0496	0.8746	0.6997	0.5248	0.3499	0.1749
− 73	1.9146	1.7405	1.5665	1.3924	1.2184	1.0443	0.8703	0.6962	0.5222	0.3481	0.1741
− 72	1.9051	1.7319	1.5587	1.3855	1.2123	1.0391	0.8659	0.6927	0.5196	0.3464	0.1732
− 71	1.8956	1.7233	1.5510	1.3786	1.2063	1.0340	0.8617	0.6893	0.5170	0.3447	0.1723
− 70	1.8863	1.7148	1.5433	1.3719	1.2004	1.0289	0.8574	0.6859	0.5144	0.3430	0.1715
− 69	1.8771	1.7064	1.5358	1.3651	1.1945	1.0239	0.8532	0.6826	0.5119	0.3413	0.1706
− 68	1.8679	1.6981	1.5283	1.3585	1.1887	1.0189	0.8491	0.6792	0.5094	0.3396	0.1698
− 67	1.8589	1.6899	1.5209	1.3519	1.1829	1.0139	0.8449	0.6759	0.5070	0.3380	0.1690
− 66	1.8499	1.6817	1.5135	1.3454	1.1772	1.0090	0.8409	0.6727	0.5045	0.3363	0.1682
− 65	1.8410	1.6736	1.5063	1.3389	1.1715	1.0042	0.8368	0.6695	0.5021	0.3347	0.1674
− 64	1.8322	1.6656	1.4991	1.3325	1.1659	0.9994	0.8328	0.6663	0.4997	0.3331	0.1666
− 63	1.8235	1.6577	1.4919	1.3262	1.1604	0.9946	0.8289	0.6631	0.4973	0.3315	0.1658
− 62	1.8148	1.6498	1.4849	1.3199	1.1549	0.9899	0.8249	0.6599	0.4950	0.3300	0.1650
− 61	1.8063	1.6421	1.4779	1.3137	1.1495	0.9852	0.8210	0.6568	0.4926	0.3284	0.1642
− 60	1.7978	1.6344	1.4709	1.3075	1.1441	0.9806	0.8172	0.6538	0.4903	0.3269	0.1634
− 59	1.7894	1.6267	1.4641	1.3014	1.1387	0.9760	0.8134	0.6507	0.4880	0.3253	0.1627
− 58	1.7811	1.6192	1.4573	1.2953	1.1334	0.9715	0.8096	0.6477	0.4858	0.3238	0.1619
− 57	1.7729	1.6117	1.4505	1.2894	1.1282	0.9670	0.8058	0.6447	0.4835	0.3223	0.1612
− 56	1.7647	1.6043	1.4438	1.2834	1.1230	0.9626	0.8021	0.6417	0.4813	0.3209	0.1604
− 55	1.7566	1.5969	1.4372	1.2775	1.1178	0.9582	0.7985	0.6388	0.4791	0.3194	0.1597

TABLE 4.12 — 2

Virtual temperature *Température virtuelle* t_v	Pressure — *pression*, mb										
	1100	1000	900	800	700	600	500	400	300	200	100
°C	kg m^{-3}	kg m^{-3}	kg.m^{-3}	kg m^{-3}	kg m^{-3}	kg m^{-3}	kg m^{-3}	kg m^{-3}	kg.m.$^{-3}$	kg m^{-3}	kg.m.$^{-3}$
−55	1.7566	1.5969	1.4372	1.2775	1.1178	0.9582	0.7985	0.6388	0.4791	0.3194	0.1597
−54	1.7486	1.5896	1.4307	1.2717	1.1127	0.9538	0.7948	0.6359	0.4769	0.3179	0.1590
−53	1.7407	1.5824	1.4242	1.2659	1.1077	0.9494	0.7912	0.6330	0.4747	0.3165	0.1582
−52	1.7328	1.5752	1.4177	1.2602	1.1027	0.9452	0.7876	0.6301	0.4726	0.3150	0.1575
−51	1.7250	1.5682	1.4113	1.2545	1.0977	0.9409	0.7841	0.6273	0.4704	0.3136	0.1568
−50	1.7173	1.5611	1.4050	1.2489	1.0928	0.9367	0.7806	0.6245	0.4683	0.3122	0.1561
−49	1.7096	1.5542	1.3988	1.2433	1.0879	0.9325	0.7771	0.6217	0.4663	0.3108	0.1554
−48	1.7020	1.5473	1.3925	1.2378	1.0831	0.9284	0.7736	0.6189	0.4642	0.3095	0.1547
−47	1.6945	1.5404	1.3864	1.2323	1.0783	0.9243	0.7702	0.6162	0.4621	0.3081	0.1540
−46	1.6870	1.5336	1.3803	1.2269	1.0736	0.9202	0.7668	0.6135	0.4601	0.3067	0.1534
−45	1.6796	1.5269	1.3742	1.2215	1.0689	0.9162	0.7635	0.6108	0.4581	0.3054	0.1527
−44	1.6723	1.5203	1.3682	1.2162	1.0642	0.9122	0.7601	0.6081	0.4561	0.3041	0.1520
−43	1.6650	1.5137	1.3623	1.2109	1.0596	0.9082	0.7568	0.6055	0.4541	0.3027	0.1514
−42	1.6578	1.5071	1.3564	1.2057	1.0550	0.9043	0.7536	0.6028	0.4521	0.3014	0.1507
−41	1.6507	1.5006	1.3506	1.2005	1.0504	0.9004	0.7503	0.6002	0.4502	0.3001	0.1501
−40	1.6436	1.4942	1.3448	1.1953	1.0459	0.8965	0.7471	0.5977	0.4483	0.2988	0.1494
−39	1.6366	1.4878	1.3390	1.1902	1.0415	0.8927	0.7439	0.5951	0.4463	0.2976	0.1488
−38	1.6296	1.4815	1.3333	1.1852	1.0370	0.8889	0.7407	0.5926	0.4444	0.2963	0.1481
−37	1.6227	1.4752	1.3277	1.1802	1.0326	0.8851	0.7376	0.5901	0.4426	0.2950	0.1475
−36	1.6159	1.4690	1.3221	1.1752	1.0283	0.8814	0.7345	0.5876	0.4407	0.2938	0.1469
−35	1.6091	1.4628	1.3165	1.1702	1.0240	0.8777	0.7314	0.5851	0.4388	0.2926	0.1463
−34	1.6024	1.4567	1.3110	1.1654	1.0197	0.8740	0.7284	0.5827	0.4370	0.2913	0.1457
−33	1.5957	1.4506	1.3056	1.1605	1.0154	0.8704	0.7253	0.5803	0.4352	0.2901	0.1451
−32	1.5891	1.4446	1.3001	1.1557	1.0112	0.8668	0.7223	0.5778	0.4334	0.2889	0.1445
−31	1.5825	1.4386	1.2948	1.1509	1.0071	0.8632	0.7193	0.5755	0.4316	0.2877	0.1439
−30	1.5760	1.4327	1.2895	1.1462	1.0029	0.8596	0.7164	0.5731	0.4298	0.2865	0.1433
−29	1.5696	1.4269	1.2842	1.1415	0.9988	0.8561	0.7134	0.5707	0.4281	0.2854	0.1427
−28	1.5632	1.4210	1.2789	1.1368	0.9947	0.8526	0.7105	0.5684	0.4263	0.2842	0.1421
−27	1.5568	1.4153	1.2737	1.1322	0.9907	0.8492	0.7076	0.5661	0.4246	0.2831	0.1415
−26	1.5505	1.4096	1.2686	1.1276	0.9867	0.8457	0.7048	0.5638	0.4229	0.2819	0.1410
−25	1.5443	1.4039	1.2635	1.1231	0.9827	0.8423	0.7019	0.5615	0.4212	0.2808	0.1404
−24	1.5381	1.3982	1.2584	1.1186	0.9788	0.8389	0.6991	0.5593	0.4195	0.2796	0.1398
−23	1.5319	1.3926	1.2534	1.1141	0.9748	0.8356	0.6963	0.5571	0.4178	0.2785	0.1393
−22	1.5258	1.3871	1.2484	1.1097	0.9710	0.8323	0.6936	0.5548	0.4161	0.2774	0.1387
−21	1.5198	1.3816	1.2434	1.1053	0.9671	0.8290	0.6908	0.5526	0.4145	0.2763	0.1382
−20	1.5138	1.3761	1.2385	1.1009	0.9633	0.8257	0.6881	0.5505	0.4128	0.2752	0.1376
−19	1.5078	1.3707	1.2336	1.0966	0.9595	0.8224	0.6854	0.5483	0.4112	0.2741	0.1371
−18	1.5019	1.3654	1.2288	1.0923	0.9557	0.8192	0.6827	0.5461	0.4096	0.2731	0.1365
−17	1.4960	1.3600	1.2240	1.0880	0.9520	0.8160	0.6800	0.5440	0.4080	0.2720	0.1360
−16	1.4902	1.3547	1.2193	1.0838	0.9483	0.8128	0.6774	0.5419	0.4064	0.2709	0.1355
−15	1.4844	1.3495	1.2145	1.0796	0.9446	0.8097	0.6747	0.5398	0.4048	0.2699	0.1349
−14	1.4787	1.3443	1.2099	1.0754	0.9410	0.8066	0.6721	0.5377	0.4033	0.2689	0.1344
−13	1.4730	1.3391	1.2052	1.0713	0.9374	0.8035	0.6696	0.5356	0.4017	0.2678	0.1339
−12	1.4674	1.3340	1.2006	1.0672	0.9338	0.8004	0.6670	0.5336	0.4002	0.2668	0.1334
−11	1.4618	1.3289	1.1960	1.0631	0.9302	0.7973	0.6644	0.5316	0.3987	0.2658	0.1329
−10	1.4562	1.3238	1.1915	1.0591	0.9267	0.7943	0.6619	0.5295	0.3972	0.2648	0.1324
− 9	1.4507	1.3188	1.1869	1.0551	0.9232	0.7913	0.6594	0.5275	0.3956	0.2638	0.1319
− 8	1.4452	1.3139	1.1825	1.0511	0.9197	0.7883	0.6569	0.5255	0.3942	0.2628	0.1314
− 7	1.4398	1.3089	1.1780	1.0471	0.9162	0.7854	0.6545	0.5236	0.3927	0.2618	0.1309
− 6	1.4344	1.3040	1.1736	1.0432	0.9128	0.7824	0.6520	0.5216	0.3912	0.2608	0.1304
− 5	1.4291	1.2992	1.1692	1.0393	0.9094	0.7795	0.6496	0.5197	0.3897	0.2598	0.1299
− 4	1.4238	1.2943	1.1649	1.0355	0.9060	0.7766	0.6472	0.5177	0.3883	0.2589	0.1294
− 3	1.4185	1.2896	1.1606	1.0316	0.9027	0.7737	0.6448	0.5158	0.3869	0.2579	0.1290
− 2	1.4133	1.2848	1.1563	1.0278	0.8994	0.7709	0.6424	0.5139	0.3854	0.2570	0.1285
− 1	1.4081	1.2801	1.1521	1.0241	0.8960	0.7680	0.6400	0.5120	0.3840	0.2560	0.1280
0	1.4029	1.2754	1.1478	1.0203	0.8928	0.7652	0.6377	0.5102	0.3826	0.2551	0.1275

Virtual temperature *Température virtuelle* t_v	Pressure — *pression*, mb										
	1100	1000	900	800	700	600	500	400	300	200	100
°C	kg m⁻³	kg m⁻³	kg m⁻³	kg m⁻³	kg m⁻³	kg m⁻³	kg m⁻³	kg m⁻³	kg m⁻³	kg m⁻³	kg m⁻³
0	1.4029	1.2754	1.1478	1.0203	0.8928	0.7652	0.6377	0.5102	0.3826	0.2551	0.1275
1	1.3978	1.2707	1.1437	1.0166	0.8895	0.7624	0.6354	0.5083	0.3812	0.2541	0.1271
2	1.3927	1.2661	1.1395	1.0129	0.8863	0.7597	0.6331	0.5064	0.3798	0.2532	0.1266
3	1.3877	1.2615	1.1354	1.0092	0.8831	0.7569	0.6308	0.5046	0.3785	0.2523	0.1262
4	1.3827	1.2570	1.1313	1.0056	0.8799	0.7542	0.6285	0.5028	0.3771	0.2514	0.1257
5	1.3777	1.2525	1.1272	1.0020	0.8767	0.7515	0.6262	0.5010	0.3757	0.2505	0.1252
6	1.3728	1.2480	1.1232	0.9984	0.8736	0.7488	0.6240	0.4992	0.3744	0.2496	0.1248
7	1.3679	1.2435	1.1192	0.9948	0.8705	0.7461	0.6218	0.4974	0.3731	0.2487	0.1244
8	1.3630	1.2391	1.1152	0.9913	0.8674	0.7435	0.6195	0.4956	0.3717	0.2478	0.1239
9	1.3582	1.2347	1.1112	0.9878	0.8643	0.7408	0.6174	0.4939	0.3704	0.2469	0.1235
10	1.3534	1.2303	1.1073	0.9843	0.8612	0.7382	0.6152	0.4921	0.3691	0.2461	0.1230
11	1.3486	1.2260	1.1034	0.9808	0.8582	0.7356	0.6130	0.4904	0.3678	0.2452	0.1226
12	1.3439	1.2217	1.0995	0.9774	0.8552	0.7330	0.6109	0.4887	0.3665	0.2443	0.1222
13	1.3392	1.2174	1.0957	0.9740	0.8522	0.7305	0.6087	0.4870	0.3652	0.2435	0.1217
14	1.3345	1.2132	1.0919	0.9706	0.8492	0.7279	0.6066	0.4853	0.3640	0.2426	0.1213
15	1.3299	1.2090	1.0881	0.9672	0.8463	0.7254	0.6045	0.4836	0.3627	0.2418	0.1209
16	1.3253	1.2048	1.0843	0.9638	0.8434	0.7229	0.6024	0.4819	0.3614	0.2410	0.1205
17	1.3207	1.2007	1.0806	0.9605	0.8405	0.7204	0.6003	0.4803	0.3602	0.2401	0.1201
18	1.3162	1.1965	1.0769	0.9572	0.8376	0.7179	0.5983	0.4786	0.3590	0.2393	0.1197
19	1.3117	1.1924	1.0732	0.9540	0.8347	0.7155	0.5962	0.4770	0.3577	0.2385	0.1192
20	1.3072	1.1884	1.0695	0.9507	0.8319	0.7130	0.5942	0.4753	0.3565	0.2377	0.1188
21	1.3028	1.1843	1.0659	0.9475	0.8290	0.7106	0.5922	0.4737	0.3553	0.2369	0.1184
22	1.2984	1.1803	1.0623	0.9443	0.8262	0.7082	0.5902	0.4721	0.3541	0.2361	0.1180
23	1.2940	1.1763	1.0587	0.9411	0.8234	0.7058	0.5882	0.4705	0.3529	0.2353	0.1176
24	1.2896	1.1724	1.0551	0.9379	0.8207	0.7034	0.5862	0.4690	0.3517	0.2345	0.1172
25	1.2853	1.1684	1.0516	0.9348	0.8179	0.7011	0.5842	0.4674	0.3505	0.2337	0.1168
26	1.2810	1.1645	1.0481	0.9316	0.8152	0.6987	0.5823	0.4658	0.3494	0.2329	0.1165
27	1.2767	1.1607	1.0446	0.9285	0.8125	0.6964	0.5803	0.4643	0.3482	0.2321	0.1161
28	1.2725	1.1568	1.0411	0.9254	0.8098	0.6941	0.5784	0.4627	0.3470	0.2314	0.1157
29	1.2683	1.1530	1.0377	0.9224	0.8071	0.6918	0.5765	0.4612	0.3459	0.2306	0.1153
30	1.2641	1.1492	1.0343	0.9193	0.8044	0.6895	0.5746	0.4597	0.3448	0.2298	0.1149
31	1.2599	1.1454	1.0309	0.9163	0.8018	0.6872	0.5727	0.4582	0.3436	0.2291	0.1145
32	1.2558	1.1416	1.0275	0.9133	0.7991	0.6850	0.5708	0.4567	0.3425	0.2283	0.1142
33	1.2517	1.1379	1.0241	0.9103	0.7965	0.6827	0.5690	0.4552	0.3414	0.2276	0.1138
34	1.2476	1.1342	1.0208	0.9074	0.7939	0.6805	0.5671	0.4537	0.3403	0.2268	0.1134
35	1.2436	1.1305	1.0175	0.9044	0.7914	0.6783	0.5653	0.4522	0.3392	0.2261	0.1131
36	1.2396	1.1269	1.0142	0.9015	0.7888	0.6761	0.5634	0.4507	0.3381	0.2254	0.1127
37	1.2356	1.1232	1.0109	0.8986	0.7863	0.6739	0.5616	0.4493	0.3370	0.2246	0.1123
38	1.2316	1.1196	1.0077	0.8957	0.7837	0.6718	0.5598	0.4479	0.3359	0.2239	0.1120
39	1.2276	1.1160	1.0044	0.8928	0.7812	0.6696	0.5580	0.4464	0.3348	0.2232	0.1116
40	1.2237	1.1125	1.0012	0.8900	0.7787	0.6675	0.5562	0.4450	0.3337	0.2225	0.1112
41	1.2198	1.1089	0.9980	0.8872	0.7763	0.6654	0.5545	0.4436	0.3327	0.2218	0.1109
42	1.2160	1.1054	0.9949	0.8843	0.7738	0.6633	0.5527	0.4422	0.3316	0.2211	0.1105
43	1.2121	1.1019	0.9917	0.8815	0.7713	0.6612	0.5510	0.4408	0.3306	0.2204	0.1102
44	1.2083	1.0984	0.9886	0.8788	0.7689	0.6591	0.5492	0.4394	0.3295	0.2197	0.1098
45	1.2045	1.0950	0.9855	0.8760	0.7665	0.6570	0.5475	0.4380	0.3285	0.2190	0.1095
46	1.2007	1.0916	0.9824	0.8732	0.7641	0.6549	0.5458	0.4366	0.3275	0.2183	0.1092
47	1.1970	1.0882	0.9793	0.8705	0.7617	0.6529	0.5441	0.4353	0.3264	0.2176	0.1088
48	1.1932	1.0848	0.9763	0.8678	0.7593	0.6509	0.5424	0.4339	0.3254	0.2170	0.1085
49	1.1895	1.0814	0.9733	0.8651	0.7570	0.6488	0.5407	0.4326	0.3244	0.2163	0.1081
50	1.1859	1.0780	0.9702	0.8624	0.7546	0.6468	0.5390	0.4312	0.3234	0.2156	0.1078

Virtual temperature *Température virtuelle* t_v	Pressure — *pression*, mb										
	1100	1000	900	800	700	600	500	400	300	200	100
°C	kg m⁻³	kg m⁻³	kg m⁻³	kg m⁻³	kg m⁻³	kg m⁻³	kg m⁻³	kg.m⁻³	kg m⁻³	kg.m⁻³	kg m⁻³
50	1.1859	1.0780	0.9702	0.8624	0.7546	0.6468	0.5390	0.4312	0.3234	0.2156	0.1078
51	1.1822	0.0747	0.9673	0.8598	0.7523	0.6448	0.5374	0.4299	0.3224	0.2149	0.1075
52	1.1786	1.0714	0.9643	0.8571	0.7500	0.6429	0.5357	0.4286	0.3214	0.2143	0.1071
53	1.1750	1.0681	0.9613	0.8545	0.7477	0.6409	0.5341	0.4273	0.3204	0.2136	0.1068
54	1.1714	1.0649	0.9584	0.8519	0.7454	0.6389	0.5324	0.4259	0.3195	0.2130	0.1065
55	1.1678	1.0616	0.9555	0.8493	0.7431	0.6370	0.5308	0.4247	0.3185	0.2123	0.1062
56	1.1642	1.0584	0.9526	0.8467	0.7409	0.6350	0.5292	0.4234	0.3175	0.2117	0.1058
57	1.1607	1.0552	0.9497	0.8442	0.7386	0.6331	0.5276	0.4221	0.3166	0.2110	0.1055
58	1.1572	1.0520	0.9468	0.8416	0.7364	0.6312	0.5260	0.4208	0.3156	0.2104	0.1052
59	1.1537	1.0488	0.9440	0.8391	0.7342	0.6293	0.5244	0.4195	0.3147	0.2098	0.1049
60	1.1503	1.0457	0.9411	0.8366	0.7320	0.6274	0.5228	0.4183	0.3137	0.2091	0.1046
61	1.1468	1.0426	0.9383	0.8340	0.7298	0.6255	0.5213	0.4170	0.3128	0.2085	0.1043
62	1.1434	1.0394	0.9355	0.8316	0.7276	0.6237	0.5197	0.4158	0.3118	0.2079	0.1039
63	1.1400	1.0364	0.9327	0.8291	0.7255	0.6218	0.5182	0.4145	0.3109	0.2073	0.1036
64	1.1366	1.0333	0.9300	0.8266	0.7233	0.6200	0.5166	0.4133	0.3100	0.2067	0.1033
65	1.1333	1.0302	0.9272	0.8242	0.7212	0.6181	0.5151	0.4121	0.3091	0.2060	0.1030
66	1.1299	1.0272	0.9245	0.8218	0.7190	0.6163	0.5136	0.4109	0.3082	0.2054	0.1027
67	1.1266	1.0242	0.9218	0.8193	0.7169	0.6145	0.5121	0.4097	0.3073	0.2048	0.1024
68	1.1233	1.0212	0.9191	0.8169	0.7148	0.6127	0.5106	0.4085	0.3064	0.2042	0.1021
69	1.1200	1.0182	0.9164	0.8146	0.7127	0.6109	0.5091	0.4073	0.3055	0.2036	0.1018
70	1.1167	1.0152	0.9137	0.8122	0.7107	0.6091	0.5076	0.4061	0.3046	0.2030	0.1015
71	1.1135	1.0123	0.9110	0.8098	0.7086	0.6074	0.5061	0.4049	0.3037	0.2025	0.1012
72	1.1103	1.0093	0.9084	0.8075	0.7065	0.6056	0.5047	0.4037	0.3028	0.2019	0.1009
73	1.1071	1.0064	0.9058	0.8051	0.7045	0.6039	0.5032	0.4026	0.3019	0.2013	0.1006
74	1.1039	1.0035	0.9032	0.8028	0.7025	0.6021	0.5018	0.4014	0.3011	0.2007	0.1004
75	1.1007	1.0006	0.9006	0.8005	0.7004	0.6004	0.5003	0.4003	0.3002	0.2001	0.1001
76	1.0976	0.9978	0.8980	0.7982	0.6984	0.5987	0.4989	0.3991	0.2993	0.1996	0.0998
77	1.0944	0.9949	0.8954	0.7959	0.6965	0.5970	0.4975	0.3980	0.2985	0.1990	0.0995
78	1.0913	0.9921	0.8929	0.7937	0.6945	0.5953	0.4960	0.3968	0.2976	0.1984	0.0992
79	1.0882	0.9893	0.8904	0.7914	0.6925	0.5936	0.4946	0.3957	0.2968	0.1979	0.0989
80	1.0851	0.9865	0.8878	0.7892	0.6905	0.5919	0.4932	0.3946	0.2959	0.1973	0.0986
81	1.0821	0.9837	0.8853	0.7870	0.6886	0.5902	0.4918	0.3935	0.2951	0.1967	0.0984
82	1.0790	0.9809	0.8828	0.7847	0.6866	0.5886	0.4905	0.3924	0.2943	0.1962	0.0981
83	1.0760	0.9782	0.8804	0.7825	0.6847	0.5869	0.4891	0.3913	0.2935	0.1956	0.0978
84	1.0730	0.9754	0.8779	0.7803	0.6828	0.5853	0.4877	0.3902	0.2926	0.1951	0.0975
85	1.0700	0.9727	0.8754	0.7782	0.6809	0.5836	0.4864	0.3891	0.2918	0.1945	0.0973
86	1.0670	0.9700	0.8730	0.7760	0.6790	0.5820	0.4850	0.3880	0.2910	0.1940	0.0970
87	1.0640	0.9673	0.8706	0.7738	0.6771	0.5804	0.4836	0.3869	0.2902	0.1935	0.0967
88	1.0611	0.9646	0.8682	0.7717	0.6752	0.5788	0.4823	0.3858	0.2894	0.1929	0.0965
89	1.0582	0.9620	0.8658	0.7696	0.6734	0.5772	0.4810	0.3848	0.2886	0.1924	0.0962
90	1.0552	0.9593	0.8634	0.7674	0.6715	0.5756	0.4797	0.3837	0.2878	0.1919	0.0959
91	1.0523	0.9567	0.8610	0.7653	0.6697	0.5740	0.4783	0.3827	0.2870	0.1913	0.0957
92	1.0495	0.9541	0.8587	0.7632	0.6678	0.5724	0.4770	0.3816	0.2862	0.1908	0.0954
93	1.0466	0.9514	0.8563	0.7612	0.6660	0.5709	0.4757	0.3806	0.2854	0.1903	0.0951
94	1.0437	0.9489	0.8540	0.7591	0.6642	0.5693	0.4744	0.3795	0.2847	0.1898	0.0949
95	1.0409	0.9463	0.8517	0.7570	0.6624	0.5678	0.4731	0.3785	0.2839	0.1893	0.0946
96	1.0381	0.9437	0.8493	0.7550	0.6606	0.5662	0.4719	0.3775	0.2831	0.1887	0.0944
97	1.0353	0.9412	0.8471	0.7529	0.6588	0.5647	0.4706	0.3765	0.2824	0.1882	0.0941
98	1.0325	0.9386	0.8448	0.7509	0.6570	0.5632	0.4693	0.3755	0.2816	0.1877	0.0939
99	1.0297	0.9361	0.8425	0.7489	0.6553	0.5617	0.4681	0.3744	0.2808	0.1872	0.0936
100	1.0270	0.9336	0.8402	0.7469	0.6535	0.5602	0.4668	0.3734	0.2801	0.1867	0.0934

Table 4.12.2 Compressibility factor of moist air
Facteur de compressibilité de l'air humide

Dry air / *Air sec*

Pressure / *Pression* mb	Temperature °C	
0	−100	1.0000
300		0.9988
700		0.9972
1100		0.9956
0	− 90	1.0000
300		0.9990
700		0.9977
1100		0.9964
0	− 80	1.0000
300		0.9992
700		0.9981
1100		0.9970
0	− 70	1.0000
300		0.9993
700		0.9984
1100		0.9975
0	− 60	1.0000
300		0.9994
700		0.9987
1100		0.9979
0	− 50	1.0000
300		0.9995
700		0.9989
1100		0.9983
0	− 40	1.0000
300		0.9996
700		0.9991
1100		0.9986
0	− 30	1.0000
300		0.9997
700		0.9993
1100		0.9988
0	− 20	1.0000
300		0.9997
700		0.9994
1100		0.9990
0	− 10	1.0000
300		0.9998
700		0.9995
1100		0.9992

Moist air / *Air humide*

Pressure / *Pression* mb	Temperature / Température °C	Relative humidity / *Humidité relative* % 0	25	50	75	100
0	0	1.0000				
300		0.9998	0.9998	0.9998	0.9998	0.9998
700		0.9996	0.9996	0.9996	0.9996	0.9996
1100		0.9994	0.9994	0.9994	0.9993	0.9993
0	10	1.0000				
300		0.9999	0.9999	0.9998	0.9998	0.9998
700		0.9997	0.9997	0.9997	0.9997	0.9996
1100		0.9995	0.9995	0.9995	0.9995	0.9994
0	20	1.0000				
300		0.9999	0.9999	0.9998	0.9998	0.9997
700		0.9997	0.9997	0.9997	0.9997	0.9996
1100		0.9996	0.9996	0.9996	0.9995	0.9995
0	30	1.0000				
300		0.9999	0.9999	0.9998	0.9997	0.9996
700		0.9998	0.9998	0.9997	0.9997	0.9996
1100		0.9997	0.9997	0.9996	0.9996	0.9995
0	40	1.0000				
300		0.9999	0.9998	0.9996	0.9994	0.9992
700		0.9999	0.9998	0.9997	0.9996	0.9994
1100		0.9998	0.9997	0.9997	0.9996	0.9995
0	50	1.0000				
300		0.9999				
700		0.9999	0.9998	0.9996	0.9993	0.9990
1100		0.9999	0.9998	0.9996	0.9994	0.9992
0	60	1.0000				
300		1.0000				
700		0.9999	0.9997	0.9996	0.9988	0.9982
1100		0.9999	0.9997	0.9996	0.9991	0.9987

Table 4.13 **Relations between mixing ratio, thermodynamic dew-point temperature and thermodynamic frost-point temperature**

Relations entre le rapport de mélange, la température thermodynamique du point de rosée et la température thermodynamique du point de gelée

t_d : **thermodynamic dew-point temperature** — ***température thermodynamique du point de rosée,*** **°C**

t_f : **thermodynamic frost-point temperature** — ***température thermodynamique du point de gelée,*** **°C**

r : **mixing ratio** — ***rapport de mélange,*** **g kg^{-1}**

p : **pressure** — ***pression,*** **mb**

Saturation mixing ratio tables are obtained by using Table 4.13 as follows :

Table 4.13.1 Temperature of moist air saturated with respect to water as a function of mixing ratio and pressure

Table 4.13.2 Mixing ratio of moist air saturated with respect to water as a function of temperature and pressure

Table 4.13.3 Temperature of moist air saturated with respect to ice as a function of mixing ratio and pressure

Table 4.13.4 Mixing ratio of moist air saturated with respect to ice as a function of temperature and pressure

Les tables du rapport de mélange de saturation s'obtiennent en utilisant la table 4.13 comme suit :

Table 4.13.1 *Température de l'air humide saturé par rapport à l'eau en fonction du rapport de mélange et de la pression*

Table 4.13.2 *Rapport de mélange de l'air humide saturé par rapport à l'eau en fonction de la température et de la pression*

Table 4.13.3 *Température de l'air humide saturé par rapport à la glace en fonction du rapport de mélange et de la pression*

Table 4.13.4 *Rapport de mélange de l'air humide saturé par rapport à la glace en fonction de la température et de la pression*

Table 4.13.1 **Thermodynamic dew-point temperature as a function of mixing ratio and pressure**

Température thermodynamique du point de rosée en fonction du rapport de mélange et de la pression

r	p, mb 1050	1000	950	900	850	800	750	700	650	600
g kg^{-1}	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C
0.04	-49.54	-49.95								
0.05	-47.56	-47.98	-48.44	-48.91	-49.42	-49.94				
0.06	-45.91	-46.35	-46.81	-47.30	-47.80	-48.34	-48.91	-49.52		
0.07	-44.50	-44.94	-45.41	-45.90	-46.42	-46.96	-47.54	-48.15	-48.81	-49.51
0.08	-43.26	-43.71	-44.18	-44.66	-45.20	-45.75	-46.34	-46.95	-47.62	-48.33
0.09	-42.15	-42.61	-43.08	-43.59	-44.11	-44.68	-45.27	-45.89	-46.57	-47.28
0.10	-41.15	-41.62	-42.09	-42.61	-43.13	-43.70	-44.30	-44.92	-45.61	-46.33
0.11	-40.24	-40.71	-41.19	-41.71	-42.24	-42.81	-43.41	-44.04	-44.73	-45.47
0.12	-39.40	-39.87	-40.36	-40.87	-41.42	-41.98	-42.60	-43.24	-43.92	-44.67
0.13	-38.62	-39.09	-39.59	-40.10	-40.66	-41.23	-41.84	-42.49	-43.18	-43.92
0.14	-37.89	-38.37	-38.87	-39.39	-39.94	-40.53	-41.13	-41.79	-42.49	-43.24
0.15	-37.21	-37.69	-38.19	-38.72	-39.27	-39.86	-40.48	-41.13	-41.83	-42.59
0.16	-36.57	-37.05	-37.56	-38.08	-38.65	-39.23	-39.85	-40.52	-41.22	-41.97
0.17	-35.96	-36.45	-36.95	-37.49	-38.05	-38.65	-39.27	-39.93	-40.65	-41.41
0.18	-35.39	-35.88	-36.39	-36.92	-37.49	-38.08	-38.71	-39.38	-40.09	-40.86
0.19	-34.84	-35.34	-35.85	-36.39	-36.95	-37.55	-38.18	-38.85	-39.58	-40.35
0.20	-34.33	-34.82	-35.33	-35.87	-36.45	-37.04	-37.68	-38.36	-39.07	-39.85
0.21	-33.82	-34.32	-34.84	-35.39	-35.95	-36.56	-37.20	-37.87	-38.60	-39.38
0.22	-33.35	-33.85	-34.37	-34.91	-35.49	-36.09	-36.74	-37.42	-38.14	-38.92
0.23	-32.89	-33.39	-33.91	-34.47	-35.03	-35.65	-36.29	-36.97	-37.71	-38.49
0.24	-32.45	-32.95	-33.48	-34.02	-34.61	-35.22	-35.86	-36.56	-37.29	-38.07
0.25	-32.02	-32.54	-33.05	-33.62	-34.19	-34.81	-35.46	-36.14	-36.88	-37.67
0.26	-31.62	-32.12	-32.66	-33.21	-33.79	-34.41	-35.06	-35.75	-36.50	-37.29
0.27	-31.22	-31.73	-32.26	-32.82	-33.41	-34.02	-34.68	-35.38	-36.11	-36.91
0.28	-30.84	-31.35	-31.88	-32.45	-33.03	-33.66	-34.31	-35.00	-35.75	-36.55
0.29	-30.48	-30.98	-31.52	-32.08	-32.67	-33.29	-33.95	-34.65	-35.40	-36.20
0.30	-30.11	-30.63	-31.16	-31.73	-32.32	-32.94	-33.61	-34.31	-35.05	-35.86
0.31	-29.77	-30.28	-30.82	-31.39	-31.97	-32.61	-33.27	-33.97	-34.73	-35.53
0.32	-29.43	-29.94	-30.49	-31.05	-31.65	-32.28	-32.94	-33.65	-34.40	-35.21
0.33	-29.10	-29.62	-30.16	-30.73	-31.33	-31.95	-32.63	-33.33	-34.08	-34.90
0.34	-28.78	-29.30	-29.84	-30.42	-31.01	-31.65	-32.32	-33.02	-33.78	-34.60
0.35	-28.47	-28.99	-29.54	-30.11	-30.71	-31.35	-32.01	-32.73	-33.49	-34.30
0.36	-28.17	-28.69	-29.24	-29.81	-30.41	-31.04	-31.72	-32.44	-33.20	-34.01
0.37	-27.87	-28.40	-28.94	-29.52	-30.12	-30.76	-31.44	-32.15	-32.91	-33.74
0.38	-27.59	-28.11	-28.66	-29.23	-29.84	-30.48	-31.15	-31.87	-32.64	-33.47
0.39	-27.30	-27.83	-28.38	-28.95	-29.57	-30.20	-30.88	-31.61	-32.37	-33.20
0.40	-27.02	-27.56	-28.10	-28.69	-29.30	-29.93	-30.62	-31.34	-32.11	-32.93
0.41	-26.76	-27.29	-27.84	-28.42	-29.02	-29.68	-30.36	-31.08	-31.85	-32.68
0.42	-26.50	-27.02	-27.58	-28.16	-28.77	-29.42	-30.10	-30.83	-31.60	-32.43
0.43	-26.24	-26.77	-27.33	-27.90	-28.52	-29.17	-29.85	-30.58	-31.36	-32.19
0.44	-25.98	-26.52	-27.07	-27.66	-28.27	-28.92	-29.61	-30.34	-31.11	-31.94
0.45	-25.74	-26.27	-26.83	-27.42	-28.03	-28.68	-29.37	-30.10	-30.88	-31.72
0.46	-25.50	-26.02	-26.59	-27.18	-27.79	-28.45	-29.13	-29.86	-30.65	-31.49
0.47	-25.26	-25.79	-26.36	-26.94	-27.56	-28.21	-28.90	-29.64	-30.42	-31.26
0.48	-25.02	-25.56	-26.12	-26.72	-27.34	-27.98	-28.68	-29.42	-30.20	-31.03
0.49	-24.80	-25.34	-25.89	-26.49	-27.11	-27.77	-28.46	-29.19	-29.97	-30.82
0.5	-24.57	-25.11	-25.68	-26.27	-26.89	-27.55	-28.24	-28.97	-29.77	-30.61
0.6	-22.53	-23.07	-23.65	-24.25	-24.88	-25.56	-26.26	-27.01	-27.81	-28.68
0.7	-20.76	-21.32	-21.90	-22.52	-23.16	-23.84	-24.56	-25.32	-26.13	-27.00
0.8	-19.21	-19.78	-20.37	-20.99	-21.65	-22.34	-23.06	-23.84	-24.66	-25.55
0.9	-17.83	-18.41	-19.00	-19.63	-20.29	-20.98	-21.73	-22.51	-23.35	-24.24

r	p, mb									
	1050	1000	950	900	850	800	750	700	650	500
g kg^{-1}	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C
1.0	-16.58	-17.16	-17.77	-18.40	-19.06	-19.77	-20.52	-21.31	-22.15	-23.05
1.1	-15.44	-16.01	-16.64	-17.28	-17.95	-18.66	-19.42	-20.21	-21.06	-21.97
1.2	-14.38	-14.97	-15.59	-16.24	-16.92	-17.64	-18.40	-19.20	-20.06	-20.98
1.3	-13.41	-13.99	-14.63	-15.28	-15.96	-16.69	-17.45	-18.27	-19.13	-20.06
1.4	-12.49	-13.09	-13.72	-14.38	-15.07	-15.80	-16.57	-17.39	-18.26	-19.20
1.5	-11.64	-12.24	-12.87	-13.54	-14.23	-14.96	-15.75	-16.57	-17.45	-18.40
1.6	-10.83	-11.44	-12.07	-12.74	-13.45	-14.18	-14.96	-15.80	-16.69	-17.64
1.7	-10.06	-10.68	-11.32	-11.99	-12.70	-13.45	-14.23	-15.06	-15.95	-16.91
1.8	-9.34	-9.96	-10.61	-11.28	-11.99	-12.74	-13.54	-14.38	-15.27	-16.23
1.9	-8.66	-9.28	-9.92	-10.61	-11.32	-12.07	-12.87	-13.72	-14.62	-15.59
2.0	-7.99	-8.62	-9.28	-9.95	-10.68	-11.44	-12.24	-13.08	-13.99	-14.96
2.1	-7.37	-7.99	-8.66	-9.34	-10.06	-10.82	-11.63	-12.49	-13.40	-14.38
2.2	-6.77	-7.40	-8.05	-8.75	-9.48	-10.24	-11.05	-11.91	-12.83	-13.81
2.3	-6.19	-6.82	-7.49	-8.18	-8.91	-9.68	-10.50	-11.36	-12.28	-13.27
2.4	-5.64	-6.27	-6.93	-7.64	-8.37	-9.14	-9.95	-10.83	-11.75	-12.74
2.5	-5.10	-5.74	-6.41	-7.11	-7.84	-8.62	-9.44	-10.32	-11.24	-12.24
2.6	-4.59	-5.23	-5.90	-6.60	-7.34	-8.12	-8.94	-9.82	-10.75	-11.75
2.7	-4.08	-4.73	-5.41	-6.11	-6.85	-7.64	-8.47	-9.34	-10.28	-11.28
2.8	-3.60	-4.25	-4.92	-5.64	-6.38	-7.17	-7.99	-8.88	-9.82	-10.83
2.9	-3.13	-3.78	-4.47	-5.18	-5.92	-6.71	-7.55	-8.44	-9.38	-10.39
3.0	-2.68	-3.33	-4.01	-4.73	-5.49	-6.27	-7.11	-7.99	-8.94	-9.96
3.1	-2.24	-2.89	-3.58	-4.30	-5.05	-5.85	-6.69	-7.58	-8.53	-9.55
3.2	-1.81	-2.47	-3.16	-3.88	-4.64	-5.43	-6.28	-7.17	-8.12	-9.15
3.3	-1.40	-2.05	-2.75	-3.47	-4.23	-5.02	-5.87	-6.77	-7.73	-8.76
3.4	-0.99	-1.66	-2.35	-3.07	-3.83	-4.64	-5.49	-6.39	-7.35	-8.38
3.5	-0.60	-1.26	-1.95	-2.69	-3.45	-4.25	-5.10	-6.00	-6.97	-8.00
3.6	-0.21	-0.88	-1.58	-2.31	-3.07	-3.88	-4.74	-5.64	-6.61	-7.65
3.7	0.16	-0.51	-1.21	-1.93	-2.71	-3.52	-4.38	-5.28	-6.25	-7.29
3.8	0.52	-0.14	-0.84	-1.58	-2.35	-3.16	-4.02	-4.93	-5.90	-6.94
3.9	0.89	0.21	-0.49	-1.23	-2.00	-2.82	-3.68	-4.59	-5.57	-6.61
4.0	1.23	0.56	-0.14	-0.88	-1.66	-2.48	-3.34	-4.26	-5.24	-6.29
4.1	1.57	0.90	0.19	-0.55	-1.33	-2.14	-3.01	-3.93	-4.91	-5.96
4.2	1.91	1.23	0.52	-0.22	-0.99	-1.82	-2.69	-3.62	-4.60	-5.65
4.3	2.24	1.56	0.85	0.10	-0.68	-1.51	-2.38	-3.30	-4.29	-5.34
4.4	2.56	1.88	1.16	0.41	-0.37	-1.19	-2.06	-2.99	-3.98	-5.04
4.5	2.87	2.19	1.47	0.72	-0.06	-0.89	-1.77	-2.70	-3.69	-4.75
4.6	3.18	2.49	1.78	1.03	0.24	-0.59	-1.47	-2.40	-3.40	-4.46
4.7	3.48	2.80	2.08	1.32	0.53	-0.30	-1.18	-2.11	-3.11	-4.17
4.8	3.78	3.09	2.37	1.61	0.82	-0.01	-0.89	-1.83	-2.83	-3.89
4.9	4.07	3.38	2.65	1.90	1.11	0.27	-0.62	-1.55	-2.55	-3.62
5.	4.35	3.66	2.94	2.18	1.38	0.55	-0.34	-1.28	-2.28	-3.36
6.	6.96	6.25	5.51	4.74	3.93	3.08	2.17	1.21	0.19	-0.91
7.	9.20	8.48	7.73	6.95	6.12	5.24	4.32	3.35	2.30	1.19
8.	11.17	10.44	9.68	8.88	8.04	7.16	6.22	5.23	4.17	3.04
9.	12.94	12.20	11.42	10.61	9.76	8.86	7.92	6.91	5.84	4.69
10.	14.53	13.78	13.00	12.18	11.31	10.40	9.44	8.43	7.34	6.18
11.	15.99	15.23	14.44	13.61	12.74	11.82	10.85	9.82	8.72	7.54
12.	17.33	16.56	15.76	14.93	14.05	13.12	12.14	11.10	9.99	8.80
13.	18.58	17.81	17.00	16.15	15.26	14.32	13.33	12.28	11.17	9.97
14.	19.74	18.97	18.15	17.29	16.39	15.45	14.45	13.39	12.26	11.06
15.	20.83	20.05	19.22	18.36	17.45	16.50	15.49	14.43	13.29	12.08
16.	21.86	21.07	20.24	19.37	18.45	17.49	16.48	15.40	14.26	13.04
17.	22.83	22.04	21.20	20.32	19.40	18.43	17.41	16.33	15.18	13.94
18.	23.75	22.95	22.11	21.22	20.30	19.32	18.29	17.20	16.05	14.80
19.	24.63	23.82	22.97	22.08	21.15	20.17	19.14	18.04	16.87	15.61
20.	25.46	24.64	23.79	22.90	21.97	20.98	19.94	18.83	17.65	16.39

TABLE 4.13 — 4

r	p, mb									
	1050	1000	950	900	850	800	750	700	650	500
g kg^{-1}	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C
21.	26.26	25.44	24.58	23.68	22.74	21.75	20.70	19.58	18.40	17.14
22.	27.03	26.20	25.33	24.43	23.48	22.48	21.43	20.31	19.12	17.85
23.	27.75	26.93	26.06	25.15	24.20	23.19	22.13	21.01	19.81	18.53
24.	28.46	27.62	26.75	25.84	24.88	23.87	22.81	21.67	20.47	19.19
25.	29.14	28.30	27.42	26.50	25.54	24.52	23.45	22.32	21.11	19.82
26.	29.79	28.95	28.07	27.15	26.18	25.16	24.08	22.94	21.73	20.42
27.	30.42	29.57	28.69	27.76	26.79	25.77	24.68	23.54	22.32	21.02
28.	31.03	30.18	29.29	28.36	27.38	26.35	25.27	24.12	22.89	21.58
29.	31.62	30.77	29.88	28.94	27.96	26.93	25.83	24.68	23.45	22.13
30.	32.19	31.33	30.44	29.50	28.51	27.47	26.38	25.22	23.99	22.66
31.	32.75	31.89	30.99	30.05	29.06	28.02	26.91	25.75	24.50	23.18
32.	33.28	32.42	31.51	30.57	29.57	28.53	27.43	26.26	25.02	23.68
33.	33.81	32.94	32.04	31.08	30.09	29.04	27.93	26.75	25.50	24.17
34.	34.32	33.44	32.53	31.58	30.58	29.52	28.41	27.24	25.98	24.64
35.	34.81	33.94	33.03	32.07	31.06	30.01	28.89	27.70	26.44	25.10
36.	35.29	34.41	33.49	32.53	31.53	30.47	29.35	28.16	26.90	25.54
37.	35.76	34.88	33.96	33.00	31.99	30.92	29.80	28.60	27.34	25.99
38.	36.22	35.33	34.41	33.44	32.43	31.36	30.24	29.04	27.77	26.41
39.	36.67	35.78	34.85	33.88	32.87	31.79	30.66	29.46	28.19	26.82
40.	37.10	36.21	35.28	34.31	33.29	32.21	31.08	29.88	28.60	27.23
41.	37.53	36.63	35.70	34.73	33.70	32.62	31.49	30.28	29.00	27.62
42.	37.95	37.05	36.12	35.14	34.11	33.03	31.89	30.68	29.39	28.02
43.	38.35	37.45	36.51	35.53	34.50	33.42	32.27	31.07	29.77	28.39
44.	38.75	37.85	36.91	35.93	34.89	33.80	32.65	31.44	30.15	28.76
45.	39.14	38.24	37.29	36.31	35.27	34.18	33.03	31.81	30.51	29.12
46.	39.52	38.62	37.67	36.68	35.64	34.55	33.39	32.17	30.87	29.47
47.	39.90	38.99	38.04	37.05	36.01	34.91	33.75	32.52	31.22	29.82
48.	40.26	39.35	38.40	37.41	36.36	35.26	34.11	32.88	31.56	30.17
49.	40.62	39.71	38.76	37.76	36.71	35.61	34.44	33.21	31.90	30.50
50.	40.98	40.06	39.11	38.11	37.06	35.95	34.78	33.55	32.23	30.83
60.	44.18	43.24	42.26	41.24	40.17	39.04	37.84	36.58	35.23	33.79
70.	46.90	45.95	44.95	43.91	42.81	41.66	40.44	39.15	37.78	36.32
80.	49.27	48.30	47.28	46.22	45.11	43.94	42.70	41.39	40.00	38.51
90.	51.36	50.37	49.34	48.27	47.14	45.95	44.70	43.37	41.96	40.44
100.	53.23	52.23	51.19	50.10	48.96	47.75	46.48	45.14	43.70	42.18

r	p, mb									
	550	500	450	400	350	300	250	200	150	100
g kg^{-1}	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C
0.04										
0.05										
0.06										
0.07										
0.08	-49.09	-49.93								
0.09	-48.05	-48.89	-49.82							
0.10	-47.11	-47.96	-48.89	-49.92						
0.11	-46.25	-47.11	-48.04	-49.09						
0.12	-45.46	-46.33	-47.27	-48.32	-49.50					
0.13	-44.73	-45.60	-46.56	-47.61	-48.79					
0.14	-44.04	-44.91	-45.88	-46.94	-48.13	-49.50				
0.15	-43.40	-44.28	-45.25	-46.32	-47.52	-48.88				
0.16	-42.80	-43.69	-44.66	-45.74	-46.94	-48.32	-49.91			
0.17	-42.23	-43.12	-44.09	-45.18	-46.40	-47.78	-49.39			
0.18	-41.69	-42.59	-43.57	-44.66	-45.87	-47.27	-48.88			
0.19	-41.17	-42.07	-43.06	-44.15	-45.39	-46.78	-48.41			
0.20	-40.69	-41.59	-42.59	-43.68	-44.91	-46.32	-47.95	-49.91		
0.21	-40.21	-41.12	-42.12	-43.23	-44.47	-45.87	-47.52	-49.49		
0.22	-39.77	-40.68	-41.68	-42.79	-44.03	-45.45	-47.09	-49.08		
0.23	-39.34	-40.25	-41.26	-42.38	-43.62	-45.04	-46.70	-48.69		
0.24	-38.92	-39.84	-40.85	-41.96	-43.22	-44.65	-46.32	-48.31		
0.25	-38.53	-39.45	-40.47	-41.59	-42.84	-44.28	-45.94	-47.94		
0.26	-38.14	-39.06	-40.08	-41.21	-42.48	-43.91	-45.59	-47.60		
0.27	-37.77	-38.70	-39.72	-40.85	-42.11	-43.57	-45.24	-47.26	-49.81	
0.28	-37.41	-38.35	-39.37	-40.51	-41.77	-43.22	-44.90	-46.93	-49.49	
0.29	-37.06	-37.99	-39.02	-40.16	-41.44	-42.89	-44.59	-46.62	-49.18	
0.30	-36.73	-37.67	-38.70	-39.84	-41.12	-42.58	-44.27	-46.31	-48.88	
0.31	-36.40	-37.35	-38.38	-39.53	-40.80	-42.27	-43.96	-46.01	-48.60	
0.32	-36.08	-37.02	-38.06	-39.21	-40.51	-41.96	-43.68	-45.73	-48.31	
0.33	-35.77	-36.73	-37.76	-38.91	-40.21	-41.68	-43.39	-45.45	-48.03	
0.34	-35.48	-36.43	-37.47	-38.63	-39.91	-41.40	-43.11	-45.17	-47.77	
0.35	-35.18	-36.13	-37.18	-38.34	-39.64	-41.11	-42.84	-44.90	-47.52	
0.36	-34.89	-35.85	-36.90	-38.06	-39.37	-40.85	-42.58	-44.65	-47.26	
0.37	-34.62	-35.58	-36.63	-37.80	-39.10	-40.59	-42.32	-44.40	-47.01	
0.38	-34.35	-35.31	-36.37	-37.54	-38.84	-40.33	-42.06	-44.15	-46.77	
0.39	-34.08	-35.04	-36.10	-37.28	-38.59	-40.08	-41.82	-43.90	-46.54	
0.40	-33.82	-34.79	-35.85	-37.02	-38.34	-39.84	-41.58	-43.68	-46.31	-49.91
0.41	-33.58	-34.55	-35.61	-36.78	-38.09	-39.60	-41.35	-43.45	-46.08	-49.70
0.42	-33.33	-34.30	-35.37	-36.54	-37.86	-39.37	-41.11	-43.22	-45.87	-49.49
0.43	-33.08	-34.05	-35.12	-36.31	-37.63	-39.13	-40.89	-42.99	-45.66	-49.28
0.44	-32.85	-33.82	-34.89	-36.07	-37.41	-38.91	-40.67	-42.78	-45.45	-49.07
0.45	-32.62	-33.60	-34.67	-35.85	-37.18	-38.70	-40.46	-42.58	-45.24	-48.88
0.46	-32.39	-33.37	-34.45	-35.63	-36.96	-38.48	-40.25	-42.37	-45.03	-48.69
0.47	-32.16	-33.15	-34.22	-35.42	-36.75	-38.27	-40.03	-42.16	-44.84	-48.50
0.48	-31.94	-32.93	-34.00	-35.20	-36.54	-38.06	-39.83	-41.96	-44.65	-48.31
0.49	-31.73	-32.72	-33.80	-34.99	-36.34	-37.86	-39.64	-41.77	-44.46	-48.12
0.5	-31.52	-32.51	-33.60	-34.79	-36.13	-37.66	-39.44	-41.58	-44.27	-47.94
0.6	-29.60	-30.61	-31.71	-32.92	-34.29	-35.85	-37.66	-39.83	-42.58	-46.31
0.7	-27.94	-28.97	-30.09	-31.33	-32.72	-34.29	-36.13	-38.34	-41.11	-44.90
0.8	-26.50	-27.54	-28.67	-29.92	-31.33	-32.92	-34.79	-37.01	-39.83	-43.68
0.9	-25.20	-26.25	-27.40	-28.67	-30.08	-31.71	-33.59	-35.85	-38.69	-42.58

r	p, mb									
	550	500	450	400	350	300	250	200	150	100
g kg^{-1}	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C
1.0	-24.03	-25.09	-26.25	-27.54	-28.96	-30.61	-32.51	-34.79	-37.66	-41.58
1.1	-22.96	-24.03	-25.20	-26.50	-27.94	-29.60	-31.52	-33.82	-36.72	-40.68
1.2	-21.97	-23.05	-24.24	-25.55	-27.00	-28.67	-30.61	-32.92	-35.85	-39.84
1.3	-21.06	-22.15	-23.34	-24.66	-26.13	-27.81	-29.76	-32.10	-35.04	-39.06
1.4	-20.21	-21.31	-22.51	-23.83	-25.32	-27.00	-28.97	-31.33	-34.30	-38.35
1.5	-19.41	-20.52	-21.72	-23.05	-24.55	-26.25	-28.23	-30.61	-33.60	-37.67
1.6	-18.66	-19.77	-20.98	-22.33	-23.83	-25.55	-27.54	-29.92	-32.93	-37.02
1.7	-17.94	-19.06	-20.29	-21.64	-23.15	-24.87	-26.88	-29.28	-32.31	-36.43
1.8	-17.27	-18.40	-19.63	-20.98	-22.51	-24.24	-26.26	-28.68	-31.71	-35.86
1.9	-16.63	-17.76	-18.99	-20.36	-21.89	-23.64	-25.67	-28.09	-31.15	-35.32
2.0	-16.01	-17.15	-18.40	-19.77	-21.31	-23.06	-25.09	-27.54	-30.61	-34.80
2.1	-15.43	-16.57	-17.82	-19.20	-20.75	-22.51	-24.56	-27.01	-30.09	-34.31
2.2	-14.87	-16.01	-17.27	-18.66	-20.21	-21.98	-24.03	-26.51	-29.61	-33.83
2.3	-14.33	-15.48	-16.75	-18.14	-19.70	-21.48	-23.55	-26.01	-29.13	-33.38
2.4	-13.81	-14.96	-16.24	-17.64	-19.21	-20.98	-23.06	-25.56	-28.68	-32.94
2.5	-13.31	-14.48	-15.75	-17.15	-18.73	-20.52	-22.61	-25.10	-28.24	-32.53
2.6	-12.83	-13.99	-15.28	-16.69	-18.27	-20.07	-22.16	-24.67	-27.82	-32.11
2.7	-12.37	-13.54	-14.82	-16.24	-17.83	-19.64	-21.73	-24.25	-27.42	-31.73
2.8	-11.91	-13.09	-14.38	-15.80	-17.40	-19.21	-21.32	-23.84	-27.01	-31.35
2.9	-11.48	-12.66	-13.95	-15.39	-16.98	-18.80	-20.91	-23.46	-26.64	-30.98
3.0	-11.05	-12.24	-13.54	-14.97	-16.58	-18.41	-20.53	-23.07	-26.27	-30.63
3.1	-10.65	-11.84	-13.14	-14.58	-16.19	-18.02	-20.15	-22.71	-25.91	-30.28
3.2	-10.25	-11.45	-12.75	-14.19	-15.81	-17.65	-19.78	-22.35	-25.57	-29.94
3.3	-9.86	-11.06	-12.37	-13.82	-15.44	-17.29	-19.43	-21.99	-25.23	-29.63
3.4	-9.49	-10.69	-12.00	-13.46	-15.08	-16.93	-19.08	-21.66	-24.89	-29.31
3.5	-9.11	-10.33	-11.65	-13.10	-14.73	-16.59	-18.74	-21.33	-24.58	-28.99
3.6	-8.76	-9.96	-11.29	-12.76	-14.39	-16.25	-18.42	-21.00	-24.26	-28.70
3.7	-8.41	-9.63	-10.95	-12.42	-14.05	-15.92	-18.09	-20.70	-23.95	-28.41
3.8	-8.07	-9.29	-10.62	-12.08	-13.73	-15.61	-17.78	-20.39	-23.66	-28.12
3.9	-7.74	-8.95	-10.29	-11.77	-13.42	-15.30	-17.48	-20.09	-23.37	-27.84
4.0	-7.41	-8.64	-9.97	-11.46	-13.10	-14.98	-17.17	-19.80	-23.08	-27.57
4.1	-7.09	-8.32	-9.67	-11.14	-12.80	-14.69	-16.88	-19.51	-22.81	-27.31
4.2	-6.78	-8.01	-9.36	-10.84	-12.51	-14.40	-16.60	-19.23	-22.54	-27.04
4.3	-6.48	-7.71	-9.06	-10.55	-12.22	-14.11	-16.32	-18.95	-22.28	-26.79
4.4	-6.18	-7.42	-8.77	-10.26	-11.93	-13.83	-16.04	-18.69	-22.01	-26.54
4.5	-5.89	-7.13	-8.49	-9.98	-11.66	-13.57	-15.78	-18.43	-21.76	-26.30
4.6	-5.61	-6.84	-8.20	-9.71	-11.39	-13.30	-15.52	-18.17	-21.51	-26.05
4.7	-5.32	-6.57	-7.93	-9.44	-11.11	-13.03	-15.26	-17.92	-21.27	-25.82
4.8	-5.04	-6.30	-7.66	-9.17	-10.85	-12.77	-15.00	-17.68	-21.02	-25.59
4.9	-4.78	-6.02	-7.40	-8.90	-10.60	-12.52	-14.75	-17.43	-20.79	-25.37
5.	-4.51	-5.77	-7.14	-8.65	-10.35	-12.27	-14.51	-17.19	-20.56	-25.14
6.	-2.09	-3.37	-4.77	-6.32	-8.04	-10.00	-12.29	-15.02	-18.46	-23.12
7.	-0.00	-1.31	-2.74	-4.31	-6.06	-8.06	-10.38	-13.16	-16.65	-21.39
8.	1.82	0.50	-0.94	-2.54	-4.33	-6.35	-8.71	-11.53	-15.05	-19.86
9.	3.45	2.12	0.65	-0.96	-2.77	-4.82	-7.21	-10.06	-13.64	-18.51
10.	4.94	3.57	2.10	0.46	-1.37	-3.45	-5.85	-8.74	-12.36	-17.28
11.	6.28	4.91	3.41	1.76	-0.08	-2.18	-4.62	-7.54	-11.19	-16.16
12.	7.52	6.14	4.63	2.96	1.10	-1.02	-3.49	-6.43	-10.12	-15.13
13.	8.68	7.28	5.76	4.07	2.19	0.05	-2.43	-5.40	-9.12	-14.18
14.	9.75	8.34	6.81	5.11	3.21	1.06	-1.45	-4.44	-8.19	-13.29
15.	10.76	9.34	7.79	6.08	4.17	2.00	-0.53	-3.55	-7.33	-12.46
16.	11.71	10.28	8.72	7.00	5.07	2.88	0.34	-2.70	-6.51	-11.68
17.	12.61	11.17	9.59	7.86	5.92	3.71	1.16	-1.90	-5.74	-10.93
18.	13.46	12.01	10.42	8.67	6.72	4.50	1.93	-1.15	-5.00	-10.24
19.	14.27	12.81	11.21	9.45	7.48	5.25	2.66	-0.43	-4.31	-9.57
20.	15.04	13.57	11.97	10.19	8.22	5.98	3.37	0.25	-3.65	-8.93

r	p, mb									
	550	500	450	400	350	300	250	200	150	100
g kg^{-1}	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C	t_d, °C
21.	15.77	14.29	12.68	10.90	8.91	6.65	4.04	0.91	-3.01	-8.33
22.	16.47	15.00	13.37	11.58	9.58	7.31	4.68	1.53	-2.41	-7.76
23.	17.15	15.66	14.03	12.23	10.22	7.94	5.29	2.13	-1.83	-7.20
24.	17.80	16.30	14.66	12.85	10.83	8.54	5.89	2.71	-1.27	-6.67
25.	18.42	16.92	15.27	13.45	11.42	9.12	6.45	3.26	-0.74	-6.15
26.	19.03	17.51	15.86	14.04	12.00	9.68	7.01	3.79	-0.22	-5.66
27.	19.61	18.09	16.42	14.59	12.54	10.22	7.53	4.31	0.28	-5.18
28.	20.17	18.64	16.98	15.13	13.08	10.74	8.04	4.81	0.76	-4.73
29.	20.71	19.18	17.50	15.65	13.59	11.25	8.53	5.29	1.23	-4.28
30.	21.24	19.70	18.02	16.16	14.09	11.74	9.02	5.75	1.67	-3.85
31.	21.75	20.20	18.51	16.65	14.57	12.21	9.47	6.21	2.12	-3.44
32.	22.24	20.69	19.00	17.13	15.04	12.67	9.93	6.64	2.53	-3.02
33.	22.73	21.17	19.46	17.59	15.49	13.12	10.36	7.07	2.95	-2.64
34.	23.19	21.63	19.93	18.04	15.94	13.55	10.79	7.48	3.35	-2.25
35.	23.65	22.08	20.36	18.47	16.36	13.98	11.20	7.89	3.74	-1.88
36.	24.09	22.51	20.80	18.90	16.79	14.38	11.60	8.28	4.12	-1.52
37.	24.52	22.95	21.22	19.32	17.19	14.78	12.00	8.66	4.48	-1.17
38.	24.95	23.36	21.63	19.72	17.59	15.18	12.37	9.03	4.85	-0.82
39.	25.35	23.76	22.03	20.12	17.98	15.55	12.75	9.39	5.20	-0.49
40.	25.76	24.16	22.42	20.50	18.36	15.93	13.11	9.75	5.53	-0.16
41.	26.15	24.55	22.80	20.88	18.73	16.29	13.46	10.09	5.87	0.16
42.	26.53	24.93	23.18	21.24	19.09	16.64	13.81	10.43	6.20	0.47
43.	26.91	25.30	23.54	21.60	19.44	17.00	14.15	10.76	6.51	0.77
44.	27.27	25.66	23.90	21.96	19.79	17.33	14.48	11.09	6.83	1.07
45.	27.63	26.02	24.25	22.30	20.13	17.66	14.81	11.40	7.14	1.36
46.	27.98	26.36	24.59	22.63	20.46	17.99	15.13	11.71	7.43	1.65
47.	28.32	26.70	24.93	22.97	20.78	18.31	15.44	12.02	7.73	1.93
48.	28.66	27.03	25.25	23.29	21.10	18.62	15.74	12.31	8.02	2.20
49.	28.99	27.35	25.57	23.60	21.41	18.93	16.05	12.60	8.29	2.47
50.	29.31	27.67	25.89	23.92	21.72	19.22	16.33	12.89	8.57	2.73
60.	32.25	30.57	28.75	26.73	24.48	21.94	19.00	15.47	11.07	5.11
70.	34.74	33.04	31.18	29.13	26.84	24.25		17.66	13.19	7.13
80.	36.91	35.18	33.29	31.21	28.88	26.25		19.56	15.03	8.88
90.	38.82	37.07	35.15	33.04	30.68	28.02			16.64	10.42
100.	40.53	38.75	36.81	34.68	32.29	29.59			18.09	11.80

Table 4.13.2 **Mixing ratio as a function of thermodynamic dew-point temperature and pressure**

Rapport de mélange en fonction de la température thermodynamique du point de rosée et de la pression

t_d °C	1050	1000	950	900	850	800	750	700	650	600
	r	*r*	*r*	*r*	*r*	*r*	*r*	*r*	*r*	*r*
Unity — *Unité* : 0.01 g kg⁻¹										
-50	3.788	3.976	4.184	4.415	4.673	4.964	5.294	5.670	6.105	6.611
-49	4.245	4.456	4.689	4.948	5.238	5.563	5.933	6.355	6.842	7.410
-48	4.752	4.988	5.249	5.539	5.863	6.228	6.642	7.114	7.659	8.295
-47	5.314	5.578	5.870	6.194	6.556	6.964	7.427	7.955	8.565	9.276
-46	5.935	6.230	6.556	6.918	7.323	7.779	8.296	8.886	9.566	10.361
-45	6.622	6.951	7.315	7.719	8.171	8.679	9.256	9.914	10.674	11.560
-44	7.380	7.747	8.153	8.603	9.106	9.673	10.316	11.049	11.896	12.884
-43	8.216	8.625	9.076	9.578	10.138	10.769	11.485	12.302	13.244	14.345
-42	9.138	9.592	10.094	10.652	11.275	11.977	12.773	13.681	14.730	15.954
Unity — *Unité* : 0.1 g kg⁻¹										
-41	1.015	1.066	1.121	1.183	1.253	1.331	1.419	1.520	1.636	1.773
-40	1.127	1.183	1.245	1.313	1.390	1.477	1.575	1.687	1.816	1.967
-39	1.249	1.311	1.380	1.456	1.542	1.637	1.746	1.871	2.014	2.181
-38	1.384	1.453	1.529	1.613	1.708	1.814	1.934	2.072	2.231	2.416
-37	1.531	1.607	1.692	1.785	1.890	2.007	2.141	2.293	2.469	2.674
-36	1.693	1.777	1.870	1.973	2.089	2.219	2.366	2.535	2.729	2.956
-35	1.870	1.963	2.065	2.180	2.307	2.451	2.614	2.800	3.014	3.265
-34	2.063	2.166	2.279	2.405	2.546	2.704	2.884	3.089	3.326	3.603
-33	2.274	2.387	2.512	2.652	2.807	2.982	3.180	3.406	3.667	3.972
-32	2.505	2.630	2.767	2.920	3.091	3.284	3.502	3.752	4.039	4.375
-31	2.756	2.894	3.045	3.214	3.402	3.614	3.854	4.129	4.445	4.815
-30	3.031	3.182	3.348	3.534	3.740	3.974	4.237	4.539	4.887	5.294
-29	3.329	3.495	3.678	3.882	4.109	4.365	4.655	4.987	5.369	5.816
-28	3.654	3.836	4.037	4.261	4.510	4.791	5.109	5.474	5.893	6.384
-27	4.007	4.207	4.427	4.672	4.946	5.254	5.604	6.003	6.463	7.001
-26	4.391	4.610	4.851	5.120	5.420	5.758	6.140	6.578	7.082	7.672
-25	4.807	5.047	5.311	5.606	5.934	6.304	6.723	7.202	7.755	8.400
-24	5.259	5.521	5.810	6.132	6.492	6.896	7.355	7.879	8.484	9.190
-23	5.749	6.035	6.351	6.703	7.096	7.538	8.040	8.613	9.274	10.046
-22	6.279	6.591	6.937	7.321	7.751	8.234	8.781	9.408	10.130	10.973
-21	6.853	7.193	7.571	7.990	8.459	8.986	9.584	10.268	11.056	11.977
-20	7.473	7.845	8.256	8.714	9.226	9.800	10.452	11.198	12.058	13.062
-19	8.143	8.549	8.997	9.496	10.054	10.680	11.391	12.204	13.140	14.235
-18	8.867	9.309	9.797	10.340	10.948	11.630	12.404	13.289	14.310	15.502
-17	9.648	10.129	10.661	11.252	11.913	12.655	13.498	14.461	15.572	16.870
Unity — *Unité* : 1 g kg⁻¹										
-16	1.049	1.101	1.159	1.223	1.295	1.376	1.468	1.572	1.693	1.834
-15	1.140	1.197	1.259	1.329	1.407	1.495	1.595	1.709	1.840	1.993
-14	1.238	1.299	1.368	1.443	1.528	1.623	1.732	1.855	1.998	2.165
-13	1.343	1.410	1.484	1.566	1.658	1.762	1.879	2.013	2.168	2.349
-12	1.456	1.529	1.609	1.698	1.798	1.910	2.037	2.183	2.351	2.547
-11	1.578	1.656	1.743	1.840	1.948	2.070	2.208	2.366	2.548	2.761
-10	1.708	1.793	1.888	1.993	2.110	2.241	2.391	2.562	2.759	2.990
-9	1.848	1.941	2.043	2.156	2.283	2.426	2.587	2.773	2.986	3.236
-8	1.999	2.099	2.209	2.332	2.469	2.623	2.798	2.999	3.230	3.500
-7	2.160	2.268	2.387	2.520	2.668	2.835	3.025	3.241	3.491	3.783
-6	2.333	2.450	2.579	2.722	2.882	3.062	3.267	3.501	3.771	4.087
-5	2.518	2.644	2.783	2.938	3.111	3.306	3.527	3.779	4.071	4.412
-4	2.716	2.852	3.002	3.169	3.356	3.566	3.805	4.077	4.392	4.760
-3	2.928	3.074	3.237	3.417	3.618	3.845	4.102	4.396	4.736	5.133
-2	3.155	3.312	3.487	3.681	3.899	4.143	4.420	4.737	5.104	5.532
-1	3.397	3.567	3.755	3.964	4.198	4.462	4.760	5.102	5.497	5.958

Column headings: p, mb

t_d °C	p, mb 1050	1000	950	900	850	800	750	700	650	600
	r	r	r	r	r	r	r	r	r	r
	Unity — *Unité* : 1 g kg^{-1}									
0	3.655	3.838	4.041	4.266	4.518	4.802	5.124	5.492	5.917	6.414
1	3.931	4.128	4.347	4.589	4.860	5.165	5.512	5.908	6.366	6.901
2	4.226	4.438	4.672	4.933	5.225	5.553	5.926	6.352	6.844	7.420
3	4.540	4.768	5.020	5.300	5.614	5.967	6.367	6.826	7.355	7.975
4	4.875	5.119	5.390	5.692	6.028	6.408	6.838	7.331	7.900	8.566
5	5.231	5.494	5.785	6.109	6.470	6.878	7.340	7.870	8.481	9.197
6	5.611	5.893	6.206	6.553	6.941	7.378	7.875	8.443	9.101	9.869
7	6.015	6.318	6.653	7.025	7.442	7.911	8.444	9.055	9.760	10.585
8	6.445	6.769	7.129	7.528	7.975	8.479	9.051	9.705	10.462	11.348
9	6.902	7.250	7.635	8.063	8.543	9.082	9.695	10.397	11.209	12.159
10	7.388	7.761	8.174	8.632	9.146	9.724	10.381	11.134	12.004	13.023
11	7.905	8.304	8.746	9.237	9.787	10.407	11.111	11.917	12.850	13.942
12	8.453	8.880	9.354	9.879	10.468	11.132	11.886	12.750	13.750	14.920
13	9.036	9.492	9.999	10.562	11.192	11.902	12.710	13.635	14.705	15.959
14	9.654	10.142	10.684	11.286	11.960	12.720	13.585	14.575	15.721	17.064
15	10.309	10.831	11.411	12.054	12.776	13.589	14.513	15.573	16.800	18.237
16	11.004	11.562	12.182	12.870	13.641	14.510	15.499	16.633	17.945	19.484
17	11.741	12.337	12.999	13.734	14.558	15.488	16.545	17.757	19.161	20.807
18	12.522	13.159	13.866	14.651	15.531	16.524	17.655	18.951	20.452	22.213
19	13.350	14.029	14.784	15.622	16.562	17.623	18.832	20.216	21.822	23.704
20	14.226	14.951	15.756	16.652	17.655	18.788	20.079	21.559	23.274	25.288
21	15.154	15.928	16.787	17.742	18.814	20.023	21.402	22.982	24.816	26.968
22	16.136	16.961	17.877	18.897	20.041	21.332	22.804	24.491	26.450	28.751
23	17.175	18.055	19.032	20.120	21.340	22.718	24.289	26.091	28.183	30.642
24	18.274	19.212	20.254	21.414	22.715	24.186	25.862	27.786	30.020	32.648
25	19.436	20.437	21.546	22.784	24.171	25.740	27.528	29.582	31.967	34.775
26	20.665	21.732	22.914	24.233	25.712	27.386	29.292	31.484	34.031	37.031
27	21.965	23.100	24.360	25.766	27.342	29.127	31.161	33.499	36.219	39.423
28	23.338	24.548	25.889	27.387	29.067	30.970	33.139	35.634	38.537	41.959
29	24.789	26.077	27.505	29.101	30.891	32.921	35.233	37.895	40.993	44.649
30	26.322	27.693	29.213	30.914	32.821	34.984	37.449	40.289	43.596	47.501
31	27.941	29.402	31.020	32.831	34.863	37.167	39.796	42.825	46.355	50.526
32	29.652	31.206	32.929	34.857	37.021	39.477	42.280	45.511	49.279	53.733
33	31.459	33.112	34.947	36.999	39.304	41.921	44.909	48.356	52.377	57.135
34	33.367	35.126	37.078	39.263	41.718	44.505	47.692	51.369	55.662	60.744
35	35.381	37.252	39.331	41.655	44.271	47.240	50.638	54.560	59.144	64.573
36	37.508	39.498	41.710	44.184	46.970	50.133	53.756	57.941	62.835	68.637
37	39.753	41.870	44.224	46.858	49.824	53.195	57.058	61.524	66.749	72.951
38	42.123	44.375	46.880	49.683	52.842	56.434	60.554	65.320	70.901	77.531
39	44.625	47.020	49.686	52.670	56.035	59.862	64.257	69.343	75.307	82.396
40	47.266	49.813	52.651	55.827	59.411	63.490	68.179	73.609	79.982	87.565
41	50.055	52.763	55.784	59.165	62.984	67.332	72.334	78.133	84.945	93.061
42	52.999	55.880	59.094	62.694	66.763	71.401	76.738	82.931	90.216	98.906
43	56.108	59.171	62.592	66.426	70.763	75.710	81.406	88.024	95.816	105.126
44	59.390	62.649	66.291	70.375	74.997	80.275	86.356	93.429	101.769	111.747
45	62.857	66.324	70.201	74.552	79.480	85.113	91.607	99.171	108.100	118.802
46	66.518	70.207	74.336	78.972	84.228	90.241	97.180	105.272	114.838	126.322
47	70.386	74.312	78.709	83.651	89.258	95.681	103.097	111.758	122.012	134.344
48	74.473	78.652	83.337	88.606	94.590	101.452	109.382	118.658	129.657	142.910
49	78.793	83.242	88.235	93.855	100.243	107.578	116.063	126.003	137.810	152.064
50	83.360	88.098	93.421	99.418	106.240	114.085	123.168	133.827	146.510	161.857

t_d °C	550	500	450	400	350	300	250	200	150	100
	p, mb									
	r	*r*	*r*	*r*	*r*	*r*	*r*	*r*	*r*	*r*
Unity — *Unité* : 0.01 g kg⁻¹										
-50	7.210	7.929	8.808	9.906	11.318	13.200	15.836	19.791	26.383	39.571
-49	8.081	8.887	9.872	11.102	12.685	14.795	17.750	22.182	29.571	44.355
-48	9.047	9.949	11.051	12.429	14.201	16.564	19.872	24.834	33.107	49.660
Unity — *Unité* : 0.1 g kg⁻¹										
-47	1.012	1.113	1.236	1.390	1.588	1.852	2.222	2.777	3.702	5.554
-46	1.130	1.243	1.380	1.553	1.774	2.069	2.482	3.102	4.136	6.204
-45	1.261	1.386	1.540	1.732	1.979	2.309	2.770	3.461	4.615	6.923
-44	1.405	1.545	1.716	1.931	2.206	2.573	3.087	3.858	5.144	7.717
-43	1.564	1.720	1.911	2.150	2.456	2.865	3.437	4.296	5.727	8.593
-42	1.740	1.913	2.125	2.391	2.732	3.186	3.823	4.778	6.370	9.558
-41	1.933	2.126	2.361	2.656	3.035	3.540	4.248	5.309	7.078	10.621
-40	2.146	2.359	2.621	2.948	3.369	3.930	4.715	5.893	7.857	11.791
-39	2.379	2.616	2.906	3.269	3.735	4.357	5.228	6.534	8.713	13.076
-38	2.635	2.898	3.219	3.621	4.138	4.827	5.791	7.239	9.652	14.487
-37	2.916	3.207	3.563	4.007	4.579	5.342	6.409	8.011	10.683	16.035
-36	3.224	3.546	3.939	4.430	5.062	5.906	7.086	8.858	11.813	17.732
-35	3.561	3.916	4.350	4.894	5.592	6.523	7.828	9.785	13.049	19.591
-34	3.929	4.322	4.801	5.400	6.171	7.199	8.639	10.799	14.402	21.624
-33	4.332	4.765	5.293	5.954	6.803	7.937	9.525	11.907	15.881	23.848
-32	4.772	5.248	5.830	6.558	7.494	8.743	10.492	13.117	17.497	26.276
-31	5.251	5.776	6.416	7.218	8.248	9.623	11.548	14.438	19.259	28.928
-30	5.774	6.351	7.055	7.936	9.069	10.581	12.699	15.877	21.181	31.820
-29	6.343	6.977	7.751	8.719	9.964	11.625	13.953	17.446	23.276	34.972
-28	6.963	7.658	8.508	9.571	10.937	12.762	15.317	19.153	25.556	38.405
-27	7.636	8.399	9.331	10.497	11.996	13.997	16.801	21.010	28.036	42.141
-26	8.368	9.204	10.226	11.503	13.147	15.340	18.414	23.028	30.733	46.204
-25	9.162	10.078	11.197	12.596	14.396	16.798	20.165	25.220	33.662	50.620
Unity — *Unité* : 1 g kg⁻¹										
-24	1.002	1.103	1.225	1.378	1.575	1.838	2.206	2.760	3.684	5.542
-23	1.096	1.205	1.339	1.507	1.722	2.010	2.413	3.018	4.029	6.062
-22	1.197	1.317	1.463	1.646	1.881	2.195	2.636	3.297	4.403	6.627
-21	1.306	1.437	1.597	1.796	2.053	2.397	2.877	3.600	4.808	7.239
-20	1.425	1.567	1.742	1.959	2.240	2.614	3.139	3.928	5.247	7.902
-19	1.553	1.708	1.898	2.136	2.441	2.850	3.422	4.282	5.721	8.620
-18	1.691	1.860	2.067	2.326	2.659	3.104	3.728	4.666	6.235	9.397
-17	1.840	2.025	2.250	2.531	2.894	3.378	4.058	5.079	6.789	10.238
-16	2.001	2.202	2.447	2.753	3.148	3.675	4.414	5.526	7.388	11.146
-15	2.175	2.393	2.659	2.992	3.421	3.994	4.798	6.008	8.035	12.128
-14	2.362	2.598	2.888	3.250	3.716	4.339	5.213	6.528	8.733	13.189
-13	2.563	2.820	3.134	3.527	4.033	4.710	5.659	7.088	9.485	14.334
-12	2.779	3.058	3.399	3.825	4.375	5.109	6.140	7.692	10.296	15.570
-11	3.012	3.314	3.684	4.146	4.742	5.538	6.657	8.342	11.170	16.903
-10	3.262	3.590	3.990	4.491	5.137	6.000	7.213	9.041	12.110	18.340
-9	3.531	3.885	4.319	4.862	5.562	6.497	7.811	9.792	13.123	19.890
-8	3.819	4.203	4.672	5.260	6.017	7.030	8.453	10.601	14.212	21.560
-7	4.128	4.543	5.051	5.687	6.506	7.603	9.144	11.469	15.384	23.360
-6	4.460	4.908	5.457	6.145	7.031	8.217	9.884	12.402	16.643	25.298
-5	4.815	5.300	5.893	6.636	7.594	8.876	10.679	13.404	17.997	27.386
-4	5.196	5.719	6.359	7.162	8.197	9.582	11.531	14.478	19.451	29.635
-3	5.603	6.167	6.859	7.725	8.842	10.339	12.445	15.631	21.014	32.055
-2	6.038	6.647	7.393	8.328	9.534	11.149	13.424	16.868	22.691	34.662
-1	6.504	7.161	7.965	8.973	10.274	12.017	14.473	18.194	24.492	37.468

t_d °C	550	500	450	400	350	300	250	200	150	100
	p, mb									
	r	*r*	*r*	*r*	*r*	*r*	*r*	*r*	*r*	*r*
	Unity — *Unité* : 1 g kg^{-1}									
0	7.002	7.709	8.576	9.663	11.066	12.946	15.596	19.614	26.425	40.489
1	7.534	8.296	9.229	10.400	11.912	13.939	16.799	21.137	28.500	43.742
2	8.102	8.922	9.927	11.188	12.817	15.002	18.086	22.768	30.726	47.246
3	8.708	9.591	10.672	12.030	13.784	16.138	19.462	24.514	33.114	51.019
4	9.355	10.304	11.468	12.928	14.817	17.352	20.934	26.385	35.677	55.083
5	10.045	11.065	12.316	13.887	15.920	18.649	22.509	28.387	38.426	59.462
6	10.780	11.876	13.221	14.911	17.097	20.034	24.191	30.530	41.375	64.183
7	11.564	12.741	14.186	16.002	18.353	21.513	25.990	32.823	44.539	69.274
8	12.398	13.662	15.215	17.165	19.693	23.092	27.912	35.278	47.934	74.765
9	13.287	14.644	16.310	18.406	21.122	24.777	29.965	37.905	51.577	80.694
10	14.233	15.689	17.477	19.727	22.646	26.576	32.159	40.716	55.487	87.097
11	15.239	16.801	18.720	21.135	24.270	28.494	34.502	43.725	59.686	94.019
12	16.310	17.985	20.043	22.636	26.001	30.541	37.005	46.945	64.194	101.507
13	17.449	19.244	21.451	24.233	27.846	32.724	39.678	50.391	69.037	109.615
14	18.659	20.583	22.950	25.934	29.812	35.053	42.534	54.080	74.243	118.404
15	19.946	22.007	24.543	27.744	31.906	37.536	45.584	58.031	79.840	127.943
16	21.313	23.520	26.239	29.671	34.136	40.185	48.842	62.262	85.862	138.308
17	22.766	25.129	28.041	31.721	36.512	43.009	52.323	66.794	92.344	149.587
18	24.308	26.839	29.958	33.903	39.043	46.021	56.043	71.652	99.328	161.881
19	25.947	28.655	31.996	36.224	41.738	49.234	60.018	76.860	106.858	175.305
20	27.686	30.584	34.162	38.694	44.609	52.661	64.268	82.447	114.984	189.992
21	29.533	32.634	36.465	41.321	47.667	56.319				
22	31.493	34.811	38.913	44.116	50.925	60.221				
23	33.573	37.123	41.514	47.090	54.396	64.386				
24	35.781	39.578	44.280	50.254	58.094	68.833				
25	38.124	42.186	47.219	53.622	62.036	73.582				
26	40.610	44.955	50.343	57.205	66.238	78.656				
27	43.248	47.896	53.665	61.020	70.718	84.079				
28	46.047	51.019	57.197	65.081	75.497	89.878				
29	49.018	54.336	60.952	69.407	80.597	96.084				
30	52.171	57.861	64.947	74.015	86.041	102.727				
31	55.518	61.606	69.197	78.927	91.856	109.844				
32	59.070	65.586	73.721	84.164	98.070	117.475				
33	62.842	69.817	78.536	89.750	104.714	125.663				
34	66.848	74.315	83.664	95.710	111.823	134.458				
35	71.103	79.100	89.128	102.074	119.436	143.913				
36	75.624	84.191	94.952	108.873	127.594	154.090				
37	80.428	89.610	101.163	116.143	136.344	165.058				
38	85.537	95.381	107.790	123.920	145.739	176.894				
39	90.971	101.530	114.867	132.248	155.838	189.684				
40	96.753	108.085	122.430	141.173	166.705	203.530				
41	102.908	115.076								
42	109.465	122.540								
43	116.455	130.513								
44	123.910	139.037								
45	131.868	148.160								
46	140.370	157.933								
47	149.461	168.413								
48	159.192	179.665								
49	169.619	191.761								
50	180.803	204.784								

Table 4.13.3 Thermodynamic frost-point temperature as a function of mixing ratio and pressure

Température thermodynamique du point de gelée en fonction du rapport de mélange et de la pression

r g kg^{-1}	p, mb 1050	1000	950	900	850	800	750	700	650	600
	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C
0.0003	-80.54									
0.0004	-78.77	-79.06	-79.39	-79.71	-80.05	-80.43				
0.0005	-77.39	-77.69	-77.99	-78.34	-78.69	-79.05	-79.46	-79.87	-80.32	
0.0006	-76.24	-76.55	-76.86	-77.20	-77.57	-77.93	-78.34	-78.76	-79.21	-79.70
0.0007	-75.26	-75.58	-75.89	-76.24	-76.60	-76.96	-77.38	-77.80	-78.26	-78.75
0.0008	-74.41	-74.72	-75.03	-75.39	-75.75	-76.13	-76.54	-76.96	-77.43	-77.92
0.0009	-73.65	-73.95	-74.29	-74.64	-74.99	-75.39	-75.79	-76.23	-76.69	-77.19
0.0010	-72.95	-73.28	-73.61	-73.95	-74.32	-74.71	-75.11	-75.56	-76.01	-76.53
0.002	-68.33	-68.66	-68.99	-69.37	-69.75	-70.15	-70.59	-71.04	-71.54	-72.05
0.003	-65.52	-65.86	-66.21	-66.59	-66.97	-67.40	-67.84	-68.31	-68.81	-69.36
0.004	-63.48	-63.82	-64.19	-64.57	-64.96	-65.40	-65.84	-66.33	-66.84	-67.39
0.005	-61.87	-62.22	-62.59	-62.97	-63.39	-63.81	-64.27	-64.76	-65.28	-65.84
0.006	-60.54	-60.89	-61.27	-61.66	-62.06	-62.51	-62.96	-63.47	-63.98	-64.56
0.007	-59.40	-59.76	-60.13	-60.53	-60.94	-61.39	-61.85	-62.36	-62.88	-63.46
0.008	-58.40	-58.76	-59.14	-59.55	-59.95	-60.41	-60.88	-61.39	-61.91	-62.50
0.009	-57.51	-57.87	-58.26	-58.67	-59.08	-59.54	-60.00	-60.52	-61.05	-61.65
0.010	-56.71	-57.07	-57.47	-57.87	-58.30	-58.75	-59.23	-59.74	-60.29	-60.87
0.02	-51.29	-51.68	-52.08	-52.52	-52.95	-53.44	-53.93	-54.48	-55.04	-55.67
0.03	-47.99	-48.40	-48.81	-49.25	-49.72	-50.20	-50.72	-51.28	-51.86	-52.50
0.04	-45.60	-46.00	-46.44	-46.88	-47.36	-47.85	-48.39	-48.94	-49.55	-50.19
0.05	-43.70	-44.11	-44.56	-45.00	-45.49	-45.99	-46.54	-47.10	-47.72	-48.38
0.06	-42.13	-42.56	-42.98	-43.46	-43.94	-44.46	-44.99	-45.59	-46.20	-46.86
0.07	-40.78	-41.21	-41.66	-42.12	-42.62	-43.13	-43.69	-44.28	-44.90	-45.58
0.08	-39.61	-40.03	-40.49	-40.95	-41.46	-41.97	-42.54	-43.13	-43.77	-44.45
0.09	-38.56	-38.98	-39.45	-39.92	-40.43	-40.95	-41.52	-42.11	-42.75	-43.44
0.10	-37.61	-38.04	-38.51	-38.98	-39.50	-40.02	-40.60	-41.20	-41.84	-42.54
0.11	-36.75	-37.19	-37.65	-38.13	-38.65	-39.18	-39.75	-40.36	-41.00	-41.71
0.12	-35.95	-36.40	-36.86	-37.35	-37.86	-38.41	-38.97	-39.59	-40.24	-40.94
0.13	-35.22	-35.67	-36.13	-36.63	-37.14	-37.69	-38.26	-38.87	-39.54	-40.24
0.14	-34.54	-34.98	-35.46	-35.94	-36.47	-37.01	-37.60	-38.21	-38.87	-39.59
0.15	-33.89	-34.35	-34.82	-35.32	-35.83	-36.39	-36.97	-37.60	-38.26	-38.97
0.16	-33.29	-33.75	-34.22	-34.72	-35.24	-35.80	-36.39	-37.00	-37.68	-38.40
0.17	-32.72	-33.18	-33.66	-34.15	-34.69	-35.24	-35.83	-36.46	-37.13	-37.85
0.18	-32.18	-32.65	-33.12	-33.63	-34.15	-34.72	-35.31	-35.93	-36.61	-37.34
0.19	-31.68	-32.13	-32.62	-33.12	-33.65	-34.21	-34.81	-35.45	-36.11	-36.84
0.20	-31.18	-31.65	-32.13	-32.64	-33.17	-33.74	-34.34	-34.96	-35.65	-36.38
0.21	-30.72	-31.18	-31.67	-32.18	-32.72	-33.28	-33.88	-34.52	-35.20	-35.93
0.22	-30.28	-30.74	-31.23	-31.74	-32.28	-32.84	-33.45	-34.08	-34.77	-35.51
0.23	-29.85	-30.32	-30.80	-31.32	-31.85	-32.43	-33.02	-33.68	-34.36	-35.09
0.24	-29.44	-29.90	-30.40	-30.91	-31.46	-32.02	-32.63	-33.28	-33.96	-34.71
0.25	-29.04	-29.52	-30.00	-30.52	-31.06	-31.64	-32.25	-32.89	-33.59	-34.33
0.26	-28.67	-29.13	-29.63	-30.14	-30.69	-31.27	-31.87	-32.53	-33.22	-33.96
0.27	-28.30	-28.77	-29.26	-29.78	-30.33	-30.90	-31.52	-32.17	-32.86	-33.62
0.28	-27.94	-28.42	-28.91	-29.44	-29.97	-30.56	-31.17	-31.82	-32.53	-33.27
0.29	-27.60	-28.07	-28.57	-29.09	-29.64	-30.22	-30.84	-31.50	-32.19	-32.94
0.30	-27.27	-27.74	-28.24	-28.76	-29.32	-29.89	-30.52	-31.17	-31.87	-32.63
0.31	-26.94	-27.42	-27.92	-28.45	-28.99	-29.59	-30.20	-30.86	-31.56	-32.32
0.32	-26.63	-27.10	-27.61	-28.13	-28.69	-29.28	-29.89	-30.56	-31.26	-32.01
0.33	-26.33	-26.80	-27.31	-27.83	-28.39	-28.97	-29.60	-30.26	-30.96	-31.73
0.34	-26.02	-26.51	-27.01	-27.55	-28.10	-28.69	-29.31	-29.97	-30.68	-31.45
0.35	-25.74	-26.22	-26.73	-27.26	-27.82	-28.41	-29.02	-29.70	-30.41	-31.17
0.36	-25.46	-25.94	-26.45	-26.97	-27.54	-28.13	-28.76	-29.43	-30.13	-30.90
0.37	-25.18	-25.67	-26.18	-26.71	-27.27	-27.86	-28.49	-29.16	-29.87	-30.64
0.38	-24.91	-25.41	-25.91	-26.45	-27.00	-27.61	-28.23	-28.90	-29.62	-30.38
0.39	-24.66	-25.14	-25.66	-26.19	-26.75	-27.35	-27.97	-28.65	-29.37	-30.13

r g kg^{-1}	p, mb 1050	1000	950	900	850	800	750	700	650	600
	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C
0.40	-24.41	-24.89	-25.41	-25.93	-26.51	-27.10	-27.73	-28.41	-29.12	-29.89
0.41	-24.15	-24.65	-25.15	-25.70	-26.26	-26.85	-27.49	-28.16	-28.88	-29.65
0.42	-23.91	-24.41	-24.91	-25.46	-26.01	-26.62	-27.25	-27.92	-28.65	-29.42
0.43	-23.68	-24.16	-24.68	-25.22	-25.79	-26.39	-27.01	-27.70	-28.42	-29.19
0.44	-23.45	-23.93	-24.45	-24.98	-25.56	-26.16	-26.79	-27.47	-28.19	-28.96
0.45	-23.21	-23.71	-24.22	-24.76	-25.34	-25.93	-26.58	-27.25	-27.97	-28.75
0.46	-22.98	-23.49	-23.99	-24.55	-25.11	-25.72	-26.36	-27.03	-27.76	-28.54
0.47	-22.77	-23.27	-23.78	-24.33	-24.90	-25.51	-26.14	-26.82	-27.55	-28.33
0.48	-22.56	-23.05	-23.57	-24.11	-24.69	-25.29	-25.93	-26.62	-27.34	-28.12
0.49	-22.35	-22.84	-23.36	-23.90	-24.48	-25.08	-25.73	-26.41	-27.14	-27.92
0.5	-22.14	-22.64	-23.15	-23.70	-24.28	-24.88	-25.53	-26.21	-26.94	-27.73
0.6	-20.26	-20.76	-21.29	-21.84	-22.43	-23.04	-23.70	-24.39	-25.13	-25.92
0.7	-18.65	-19.16	-19.69	-20.25	-20.84	-21.47	-22.13	-22.83	-23.59	-24.39
0.8	-17.23	-17.75	-18.29	-18.86	-19.46	-20.08	-20.76	-21.47	-22.22	-23.03
0.9	-15.97	-16.50	-17.04	-17.62	-18.22	-18.85	-19.53	-20.25	-21.01	-21.83
1.0	-14.84	-15.37	-15.91	-16.50	-17.10	-17.75	-18.43	-19.15	-19.92	-20.75
1.1	-13.80	-14.33	-14.88	-15.47	-16.08	-16.73	-17.42	-18.14	-18.92	-19.76
1.2	-12.85	-13.38	-13.94	-14.53	-15.14	-15.80	-16.49	-17.22	-18.00	-18.85
1.3	-11.96	-12.50	-13.06	-13.66	-14.28	-14.93	-15.63	-16.37	-17.16	-18.00
1.4	-11.14	-11.68	-12.25	-12.84	-13.47	-14.13	-14.83	-15.58	-16.37	-17.22
1.5	-10.37	-10.91	-11.49	-12.08	-12.71	-13.38	-14.08	-14.83	-15.63	-16.49
1.6	-9.65	-10.19	-10.77	-11.37	-11.99	-12.67	-13.38	-14.13	-14.93	-15.80
1.7	-8.96	-9.51	-10.08	-10.69	-11.33	-11.99	-12.71	-13.47	-14.28	-15.14
1.8	-8.31	-8.86	-9.45	-10.05	-10.69	-11.37	-12.08	-12.84	-13.66	-14.53
1.9	-7.70	-8.25	-8.83	-9.45	-10.08	-10.76	-11.49	-12.25	-13.06	-13.93
2.0	-7.10	-7.67	-8.25	-8.86	-9.51	-10.19	-10.91	-11.68	-12.50	-13.38
2.1	-6.55	-7.10	-7.69	-8.31	-8.95	-9.64	-10.37	-11.13	-11.95	-12.84
2.2	-6.00	-6.57	-7.16	-7.78	-8.43	-9.11	-9.84	-10.62	-11.45	-12.33
2.3	-5.50	-6.05	-6.65	-7.27	-7.92	-8.62	-9.35	-10.12	-10.95	-11.84
2.4	-4.99	-5.57	-6.16	-6.78	-7.44	-8.13	-8.86	-9.65	-10.48	-11.37
2.5	-4.52	-5.09	-5.69	-6.31	-6.96	-7.67	-8.40	-9.18	-10.01	-10.91
2.6	-4.06	-4.63	-5.23	-5.86	-6.52	-7.22	-7.95	-8.74	-9.58	-10.48
2.7	-3.62	-4.19	-4.79	-5.42	-6.08	-6.78	-7.53	-8.31	-9.15	-10.05
2.8	-3.19	-3.76	-4.37	-4.99	-5.66	-6.37	-7.10	-7.89	-8.74	-9.65
2.9	-2.77	-3.35	-3.95	-4.59	-5.26	-5.95	-6.71	-7.50	-8.34	-9.25
3.0	-2.37	-2.95	-3.56	-4.19	-4.86	-5.57	-6.32	-7.11	-7.95	-8.86
3.1	-1.98	-2.57	-3.17	-3.81	-4.48	-5.18	-5.93	-6.73	-7.59	-8.50
3.2	-1.61	-2.18	-2.79	-3.44	-4.10	-4.82	-5.57	-6.37	-7.22	-8.13
3.3	-1.24	-1.82	-2.43	-3.07	-3.75	-4.46	-5.21	-6.01	-6.87	-7.78
3.4	-0.88	-1.47	-2.07	-2.72	-3.40	-4.10	-4.86	-5.67	-6.53	-7.45
3.5		-1.11	-1.73	-2.38	-3.05	-3.77	-4.53	-5.33	-6.19	-7.11
3.6		-0.78	-1.40	-2.03	-2.72	-3.44	-4.20	-5.00	-5.86	-6.79
3.7			-1.06	-1.71	-2.40	-3.11	-3.87	-4.69	-5.55	-6.48
3.8			-0.75	-1.40	-2.07	-2.80	-3.56	-4.38	-5.24	-6.17
3.9				-1.08	-1.77	-2.49	-3.26	-4.06	-4.93	-5.87
4.				-0.78	-1.47	-2.19	-2.95	-3.77	-4.64	-5.58
5.								-1.13	-2.01	-2.96
6.										-0.80

TABLE 4.13 — 14

r g kg⁻¹	p, mb 550	500	450	400	350	300	250	200	150	100
	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C
0.0003		-84.89	-85.50	-86.17	-86.92	-87.79	-88.81	-90.02	-91.60	-93.75
0.0004		-83.21	-83.83	-84.52	-85.29	-86.16	-87.20	-88.45	-90.02	-92.22
0.0005		-81.89	-82.52	-83.21	-83.98	-84.88	-85.92	-87.19	-88.80	-91.01
0.0006	-80.22	-80.80	-81.44	-82.13	-82.91	-83.82	-84.88	-86.16	-87.79	-90.02
0.0007	-79.29	-79.86	-80.51	-81.21	-81.99	-82.91	-83.97	-85.28	-86.91	-89.18
0.0008	-78.47	-79.04	-79.69	-80.41	-81.21	-82.12	-83.20	-84.51	-86.15	-88.45
0.0009	-77.73	-78.32	-78.96	-79.69	-80.50	-81.43	-82.51	-83.82	-85.49	-87.78
0.0010	-77.06	-77.67	-78.32	-79.03	-79.85	-80.79	-81.88	-83.20	-84.87	-87.19
0.002	-72.64	-73.25	-73.92	-74.69	-75.55	-76.52	-77.66	-79.02	-80.78	-83.19
0.003	-69.93	-70.58	-71.28	-72.04	-72.92	-73.92	-75.09	-76.51	-78.31	-80.78
0.004	-67.97	-68.64	-69.35	-70.13	-71.02	-72.04	-73.24	-74.68	-76.51	-79.01
0.005	-66.45	-67.10	-67.82	-68.63	-69.54	-70.57	-71.78	-73.24	-75.08	-77.65
0.006	-65.16	-65.83	-66.57	-67.38	-68.30	-69.34	-70.57	-72.03	-73.91	-76.51
0.007	-64.07	-64.75	-65.49	-66.31	-67.23	-68.29	-69.53	-71.01	-72.91	-75.53
0.008	-63.12	-63.80	-64.55	-65.38	-66.31	-67.38	-68.63	-70.12	-72.03	-74.68
0.009	-62.27	-62.95	-63.71	-64.55	-65.49	-66.56	-67.81	-69.34	-71.26	-73.91
0.010	-61.51	-62.19	-62.95	-63.80	-64.74	-65.82	-67.08	-68.62	-70.56	-73.23
0.02	-56.33	-57.04	-57.85	-58.73	-59.72	-60.85	-62.18	-63.79	-65.82	-68.62
0.03	-53.18	-53.92	-54.75	-55.66	-56.68	-57.84	-59.21	-60.85	-62.93	-65.81
0.04	-50.89	-51.66	-52.49	-53.42	-54.46	-55.65	-57.03	-58.72	-60.85	-63.78
0.05	-49.08	-49.86	-50.71	-51.65	-52.71	-53.91	-55.34	-57.03	-59.20	-62.18
0.06	-47.59	-48.37	-49.23	-50.18	-51.26	-52.49	-53.91	-55.65	-57.83	-60.85
0.07	-46.31	-47.09	-47.96	-48.93	-50.01	-51.26	-52.71	-54.46	-56.67	-59.71
0.08	-45.18	-45.97	-46.86	-47.83	-48.92	-50.18	-51.65	-53.41	-55.65	-58.72
0.09	-44.18	-44.98	-45.87	-46.86	-47.96	-49.22	-50.70	-52.48	-54.73	-57.83
0.10	-43.28	-44.09	-44.98	-45.97	-47.08	-48.37	-49.85	-51.64	-53.91	-57.03
0.11	-42.46	-43.28	-44.18	-45.17	-46.30	-47.58	-49.07	-50.87	-53.16	-56.31
0.12	-41.71	-42.53	-43.44	-44.44	-45.57	-46.85	-48.36	-50.17	-52.48	-55.64
0.13	-40.99	-41.83	-42.75	-43.76	-44.89	-46.18	-47.70	-49.53	-51.84	-55.01
0.14	-40.36	-41.19	-42.10	-43.11	-44.26	-45.57	-47.08	-48.92	-51.25	-54.45
0.15	-39.74	-40.59	-41.51	-42.53	-43.67	-44.97	-46.52	-48.36	-50.70	-53.90
0.16	-39.17	-40.00	-40.93	-41.96	-43.11	-44.44	-45.96	-47.82	-50.17	-53.41
0.17	-38.63	-39.48	-40.41	-41.44	-42.60	-43.91	-45.47	-47.33	-49.69	-52.92
0.18	-38.11	-38.96	-39.90	-40.93	-42.09	-43.43	-44.97	-46.85	-49.22	-52.48
0.19	-37.63	-38.49	-39.43	-40.47	-41.63	-42.95	-44.52	-46.40	-48.78	-52.04
0.20	-37.16	-38.02	-38.96	-40.00	-41.18	-42.52	-44.08	-45.96	-48.36	-51.64
0.21	-36.73	-37.59	-38.53	-39.58	-40.75	-42.09	-43.67	-45.56	-47.95	-51.25
0.22	-36.30	-37.16	-38.11	-39.16	-40.35	-41.69	-43.27	-45.16	-47.57	-50.87
0.23	-35.89	-36.76	-37.71	-38.77	-39.95	-41.31	-42.88	-44.79	-47.20	-50.52
0.24	-35.51	-36.38	-37.33	-38.39	-39.58	-40.93	-42.52	-44.43	-46.85	-50.17
0.25	-35.13	-35.99	-36.95	-38.01	-39.21	-40.58	-42.16	-44.08	-46.51	-49.84
0.26	-34.77	-35.65	-36.61	-37.67	-38.86	-40.23	-41.82	-43.75	-46.18	-49.53
0.27	-34.42	-35.30	-36.26	-37.33	-38.53	-39.89	-41.50	-43.43	-45.86	-49.22
0.28	-34.08	-34.95	-35.92	-36.99	-38.20	-39.58	-41.17	-43.11	-45.56	-48.91
0.29	-33.76	-34.64	-35.61	-36.68	-37.88	-39.26	-40.87	-42.81	-45.26	-48.64
0.30	-33.44	-34.33	-35.30	-36.37	-37.58	-38.95	-40.58	-42.52	-44.97	-48.36
0.31	-33.13	-34.01	-34.98	-36.07	-37.28	-38.67	-40.28	-42.23	-44.70	-48.08
0.32	-32.83	-33.73	-34.70	-35.78	-36.99	-38.39	-39.99	-41.95	-44.43	-47.82
0.33	-32.55	-33.44	-34.42	-35.50	-36.72	-38.10	-39.73	-41.69	-44.16	-47.57
0.34	-32.26	-33.16	-34.13	-35.22	-36.45	-37.84	-39.47	-41.43	-43.91	-47.32
0.35	-31.98	-32.88	-33.87	-34.95	-36.18	-37.58	-39.21	-41.17	-43.67	-47.08
0.36	-31.72	-32.62	-33.61	-34.70	-35.92	-37.33	-38.95	-40.92	-43.43	-46.85
0.37	-31.47	-32.37	-33.35	-34.45	-35.68	-37.07	-38.72	-40.69	-43.18	-46.62
0.38	-31.21	-32.11	-33.10	-34.20	-35.43	-36.83	-38.48	-40.46	-42.95	-46.40
0.39	-30.96	-31.86	-32.85	-33.95	-35.19	-36.60	-38.24	-40.22	-42.73	-46.18

r g kg^{-1}	p, mb									
	550	500	450	400	350	300	250	200	150	100
	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C
0.40	-30.72	-31.63	-32.62	-33.72	-34.95	-36.37	-38.01	-39.99	-42.52	-45.96
0.41	-30.49	-31.40	-32.39	-33.49	-34.73	-36.14	-37.79	-39.78	-42.30	-45.76
0.42	-30.26	-31.16	-32.16	-33.27	-34.51	-35.92	-37.58	-39.57	-42.09	-45.56
0.43	-30.02	-30.93	-31.93	-33.04	-34.29	-35.71	-37.37	-39.36	-41.88	-45.36
0.44	-29.81	-30.72	-31.72	-32.83	-34.07	-35.50	-37.15	-39.15	-41.69	-45.16
0.45	-29.59	-30.51	-31.51	-32.62	-33.86	-35.29	-36.95	-38.95	-41.50	-44.97
0.46	-29.38	-30.30	-31.30	-32.41	-33.66	-35.08	-36.75	-38.76	-41.30	-44.79
0.47	-29.17	-30.08	-31.09	-32.21	-33.46	-34.89	-36.56	-38.57	-41.11	-44.61
0.48	-28.96	-29.88	-30.89	-32.00	-33.26	-34.70	-36.37	-38.38	-40.92	-44.43
0.49	-28.77	-29.69	-30.70	-31.81	-33.06	-34.51	-36.18	-38.19	-40.75	-44.25
0.5	-28.57	-29.50	-30.51	-31.63	-32.88	-34.32	-35.99	-38.01	-40.57	-44.07
0.6	-26.79	-27.72	-28.75	-29.88	-31.16	-32.62	-34.32	-36.37	-38.95	-42.52
0.7	-25.26	-26.20	-27.24	-28.40	-29.69	-31.16	-32.88	-34.95	-37.58	-41.17
0.8	-23.91	-24.87	-25.92	-27.08	-28.39	-29.88	-31.62	-33.72	-36.37	-39.99
0.9	-22.72	-23.69	-24.75	-25.92	-27.24	-28.75	-30.50	-32.62	-35.29	-38.95
1.0	-21.65	-22.62	-23.69	-24.87	-26.20	-27.72	-29.49	-31.62	-34.32	-38.01
1.1	-20.67	-21.65	-22.72	-23.91	-25.25	-26.78	-28.57	-30.72	-33.43	-37.16
1.2	-19.76	-20.75	-21.83	-23.03	-24.39	-25.92	-27.72	-29.88	-32.62	-36.37
1.3	-18.92	-19.91	-21.00	-22.22	-23.58	-25.12	-26.93	-29.11	-31.86	-35.64
1.4	-18.14	-19.14	-20.24	-21.46	-22.82	-24.39	-26.20	-28.40	-31.16	-34.95
1.5	-17.42	-18.42	-19.53	-20.75	-22.12	-23.69	-25.52	-27.72	-30.51	-34.32
1.6	-16.73	-17.74	-18.85	-20.08	-21.46	-23.03	-24.87	-27.09	-29.88	-33.73
1.7	-16.07	-17.09	-18.21	-19.45	-20.84	-22.42	-24.27	-26.50	-29.30	-33.16
1.8	-15.47	-16.49	-17.61	-18.85	-20.25	-21.83	-23.69	-25.92	-28.75	-32.63
1.9	-14.88	-15.91	-17.03	-18.28	-19.69	-21.28	-23.14	-25.39	-28.23	-32.11
2.0	-14.33	-15.36	-16.49	-17.74	-19.15	-20.75	-22.63	-24.88	-27.73	-31.63
2.1	-13.79	-14.83	-15.96	-17.22	-18.64	-20.25	-22.13	-24.39	-27.25	-31.17
2.2	-13.29	-14.33	-15.47	-16.73	-18.15	-19.77	-21.65	-23.92	-26.79	-30.73
2.3	-12.80	-13.84	-14.98	-16.26	-17.68	-19.30	-21.20	-23.48	-26.36	-30.31
2.4	-12.33	-13.38	-14.53	-15.80	-17.23	-18.85	-20.76	-23.04	-25.93	-29.89
2.5	-11.88	-12.93	-14.08	-15.36	-16.79	-18.43	-20.34	-22.63	-25.53	-29.51
2.6	-11.45	-12.50	-13.66	-14.93	-16.38	-18.01	-19.92	-22.23	-25.14	-29.12
2.7	-11.02	-12.08	-13.25	-14.53	-15.97	-17.62	-19.54	-21.85	-24.76	-28.76
2.8	-10.62	-11.69	-12.85	-14.13	-15.59	-17.23	-19.16	-21.48	-24.40	-28.41
2.9	-10.23	-11.30	-12.46	-13.75	-15.20	-16.86	-18.79	-21.11	-24.04	-28.06
3.0	-9.85	-10.91	-12.08	-13.39	-14.84	-16.50	-18.44	-20.77	-23.71	-27.74
3.1	-9.48	-10.55	-11.73	-13.02	-14.49	-16.15	-18.09	-20.43	-23.38	-27.42
3.2	-9.12	-10.20	-11.38	-12.68	-14.14	-15.81	-17.76	-20.09	-23.05	-27.11
3.3	-8.78	-9.85	-11.03	-12.34	-13.81	-15.48	-17.43	-19.78	-22.74	-26.81
3.4	-8.44	-9.52	-10.70	-12.00	-13.48	-15.16	-17.11	-19.47	-22.44	-26.52
3.5	-8.11	-9.19	-10.38	-11.69	-13.16	-14.84	-16.81	-19.17	-22.14	-26.23
3.6	-7.79	-8.87	-10.06	-11.38	-12.85	-14.54	-16.51	-18.87	-21.86	-25.95
3.7	-7.48	-8.57	-9.76	-11.07	-12.56	-14.25	-16.21	-18.59	-21.58	-25.68
3.8	-7.17	-8.26	-9.46	-10.78	-12.26	-13.95	-15.93	-18.31	-21.31	-25.42
3.9	-6.87	-7.96	-9.16	-10.49	-11.97	-13.68	-15.65	-18.03	-21.03	-25.16
4.	-6.59	-7.68	-8.88	-10.21	-11.70	-13.40	-15.38	-17.77	-20.78	-24.90
5.	-3.99	-5.11	-6.34	-7.69	-9.21	-10.94	-12.96	-15.40	-18.47	-22.67
6.	-1.85	-2.98	-4.23	-5.61	-7.14	-8.90	-10.95	-13.43	-16.55	-20.81
7.		-1.16	-2.42	-3.81	-5.38	-7.16	-9.24	-11.74	-14.90	-19.22
8.			-0.83	-2.25	-3.83	-5.64	-7.74	-10.27	-13.46	-17.83
9.				-0.85	-2.45	-4.28	-6.40	-8.95	-12.18	-16.59
10.					-1.21	-3.04	-5.19	-7.77	-11.02	-15.48

r g kg^{-1}	p, mb									
	70	50	30	20	10	7	5	3	2	1
	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C
0.0002	-97.67	-99.35								
0.0003	-95.61	-97.32	-99.86							
0.0004	-94.10	-95.85	-98.45							
0.0005	-92.92	-94.70	-97.32	-99.35						
0.0006	-91.95	-93.75	-96.40	-98.45						
0.0007	-91.12	-92.92	-95.61	-97.67						
0.0008	-90.41	-92.22	-94.90	-96.98						
0.0009	-89.76	-91.60	-94.30	-96.40	-99.86					
0.0010	-89.18	-91.01	-93.75	-95.85	-99.35					
0.002	-85.27	-87.19	-90.01	-92.22	-95.85	-97.67	-99.35			
0.003	-82.90	-84.87	-87.78	-90.01	-93.75	-95.61	-97.32	-99.86		
0.004	-81.19	-83.19	-86.15	-88.44	-92.22	-94.10	-95.85	-98.44		
0.005	-79.84	-81.87	-84.87	-87.18	-91.00	-92.92	-94.70	-97.32	-99.35	
0.006	-78.73	-80.78	-83.81	-86.15	-90.01	-91.95	-93.75	-96.40	-98.44	
0.007	-77.77	-79.84	-82.90	-85.27	-89.17	-91.12	-92.92	-95.61	-97.67	
0.008	-76.93	-79.01	-82.11	-84.50	-88.44	-90.41	-92.22	-94.90	-96.98	
0.009	-76.19	-78.30	-81.41	-83.81	-87.78	-89.76	-91.59	-94.30	-96.40	-99.86
0.010	-75.53	-77.65	-80.78	-83.19	-87.18	-89.17	-91.00	-93.75	-95.85	-99.35
0.02	-71.00	-73.23	-76.51	-79.01	-83.19	-85.27	-87.18	-90.01	-92.22	-95.85
0.03	-68.28	-70.56	-73.91	-76.51	-80.78	-82.90	-84.86	-87.78	-90.01	-93.75
0.04	-66.30	-68.62	-72.02	-74.67	-79.01	-81.19	-83.19	-86.15	-88.44	-92.22
0.05	-64.73	-67.07	-70.56	-73.23	-77.65	-79.84	-81.86	-84.87	-87.18	-91.00
0.06	-63.44	-65.81	-69.33	-72.02	-76.51	-78.72	-80.77	-83.81	-86.15	-90.01
0.07	-62.33	-64.73	-68.28	-71.00	-75.53	-77.77	-79.84	-82.90	-85.27	-89.17
0.08	-61.36	-63.78	-67.37	-70.11	-74.67	-76.93	-79.01	-82.11	-84.50	-88.44
0.09	-60.49	-62.93	-66.55	-69.33	-73.91	-76.19	-78.30	-81.41	-83.81	-87.78
0.10	-59.71	-62.17	-65.81	-68.62	-73.23	-75.53	-77.65	-80.78	-83.19	-87.18
0.11	-58.99	-61.49	-65.14	-67.95	-72.61	-74.91	-77.04	-80.20	-82.63	-86.65
0.12	-58.35	-60.84	-64.53	-67.37	-72.02	-74.36	-76.51	-79.67	-82.11	-86.15
0.13	-57.75	-60.26	-63.95	-66.81	-71.51	-73.84	-75.98	-79.18	-81.64	-85.70
0.14	-57.19	-59.71	-63.44	-66.30	-71.00	-73.36	-75.53	-78.73	-81.19	-85.27
0.15	-56.67	-59.20	-62.93	-65.81	-70.56	-72.90	-75.08	-78.30	-80.78	-84.87
0.16	-56.17	-58.72	-62.48	-65.36	-70.12	-72.49	-74.67	-77.89	-80.39	-84.50
0.17	-55.71	-58.26	-62.02	-64.93	-69.72	-72.08	-74.28	-77.53	-80.00	-84.14
0.18	-55.26	-57.83	-61.62	-64.53	-69.33	-71.71	-73.91	-77.16	-79.67	-83.81
0.19	-54.84	-57.43	-61.22	-64.14	-68.95	-71.36	-73.57	-76.82	-79.34	-83.50
0.20	-54.45	-57.02	-60.84	-63.78	-68.62	-71.00	-73.23	-76.51	-79.01	-83.19
0.21	-54.06	-56.67	-60.49	-63.44	-68.28	-70.69	-72.90	-76.19	-78.73	-82.90
0.22	-53.71	-56.31	-60.14	-63.09	-67.95	-70.38	-72.61	-75.89	-78.44	-82.63
0.23	-53.36	-55.96	-59.82	-62.78	-67.66	-70.07	-72.32	-75.62	-78.16	-82.37
0.24	-53.01	-55.64	-59.51	-62.48	-67.37	-69.79	-72.02	-75.35	-77.89	-82.11
0.25	-52.70	-55.33	-59.20	-62.17	-67.07	-69.52	-71.77	-75.08	-77.65	-81.87
0.26	-52.39	-55.01	-58.90	-61.89	-66.81	-69.25	-71.51	-74.83	-77.40	-81.64
0.27	-52.08	-54.73	-58.63	-61.62	-66.55	-68.99	-71.26	-74.60	-77.16	-81.42
0.28	-51.80	-54.45	-58.35	-61.35	-66.30	-68.75	-71.00	-74.36	-76.93	-81.19
0.29	-51.52	-54.17	-58.08	-61.09	-66.04	-68.52	-70.78	-74.13	-76.72	-80.97
0.30	-51.25	-53.90	-57.83	-60.84	-65.81	-68.28	-70.56	-73.91	-76.51	-80.78
0.31	-50.98	-53.66	-57.59	-60.61	-65.59	-68.05	-70.34	-73.70	-76.30	-80.58
0.32	-50.73	-53.41	-57.35	-60.38	-65.36	-67.84	-70.12	-73.50	-76.09	-80.39
0.33	-50.49	-53.16	-57.11	-60.14	-65.14	-67.63	-69.91	-73.30	-75.89	-80.20
0.34	-50.24	-52.92	-56.88	-59.92	-64.93	-67.43	-69.72	-73.09	-75.71	-80.01
0.35	-50.00	-52.70	-56.67	-59.71	-64.73	-67.22	-69.52	-72.91	-75.53	-79.84
0.36	-49.78	-52.48	-56.45	-59.51	-64.54	-67.02	-69.33	-72.73	-75.35	-79.67
0.37	-49.56	-52.26	-56.24	-59.30	-64.34	-66.83	-69.14	-72.55	-75.17	-79.51
0.38	-49.34	-52.04	-56.03	-59.09	-64.14	-66.66	-68.95	-72.38	-74.99	-79.34
0.39	-49.12	-51.84	-55.83	-58.90	-63.95	-66.48	-68.79	-72.20	-74.83	-79.18

r g kg^{-1}	p, mb 70	50	30	20	10	7	5	3	2	1
	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C
0.40	-48.91	-51.64	-55.64	-58.72	-63.78	-66.30	-68.62	-72.03	-74.68	-79.01
0.41	-48.72	-51.44	-55.45	-58.54	-63.61	-66.12	-68.45	-71.87	-74.52	-78.87
0.42	-48.52	-51.25	-55.27	-58.35	-63.44	-65.95	-68.28	-71.72	-74.36	-78.73
0.43	-48.33	-51.05	-55.08	-58.17	-63.27	-65.79	-68.12	-71.56	-74.21	-78.59
0.44	-48.14	-50.87	-54.90	-57.99	-63.09	-65.63	-67.95	-71.41	-74.05	-78.44
0.45	-47.95	-50.70	-54.73	-57.83	-62.93	-65.48	-67.81	-71.26	-73.91	-78.30
0.46	-47.77	-50.52	-54.56	-57.67	-62.78	-65.32	-67.66	-71.11	-73.77	-78.16
0.47	-47.60	-50.35	-54.40	-57.51	-62.63	-65.16	-67.52	-70.96	-73.64	-78.02
0.48	-47.42	-50.17	-54.23	-57.35	-62.48	-65.01	-67.37	-70.83	-73.50	-77.89
0.49	-47.25	-50.00	-54.06	-57.19	-62.33	-64.87	-67.22	-70.69	-73.37	-77.77
0.5	-47.08	-49.84	-53.91	-57.03	-62.18	-64.73	-67.08	-70.56	-73.23	-77.65
0.6	-45.56	-48.36	-52.48	-55.65	-60.85	-63.44	-65.81	-69.33	-72.03	-76.51
0.7	-44.25	-47.08	-51.25	-54.45	-59.72	-62.33	-64.73	-68.29	-71.01	-75.54
0.8	-43.11	-45.96	-50.18	-53.41	-58.72	-61.36	-63.79	-67.37	-70.12	-74.68
0.9	-42.09	-44.97	-49.22	-52.48	-57.84	-60.50	-62.94	-66.56	-69.34	-73.91
1.0	-41.18	-44.08	-48.36	-51.65	-57.03	-59.72	-62.18	-65.82	-68.62	-73.24
1.1	-40.35	-43.27	-47.58	-50.88	-56.32	-59.00	-61.50	-65.15	-67.96	-72.62
1.2	-39.58	-42.52	-46.85	-50.18	-55.65	-58.36	-60.85	-64.54	-67.38	-72.03
1.3	-38.86	-41.83	-46.19	-49.54	-55.02	-57.76	-60.27	-63.96	-66.82	-71.52
1.4	-38.20	-41.18	-45.57	-48.92	-54.46	-57.20	-59.72	-63.45	-66.31	-71.02
1.5	-37.59	-40.58	-44.98	-48.37	-53.92	-56.68	-59.21	-62.94	-65.82	-70.57
1.6	-36.99	-40.00	-44.44	-47.83	-53.42	-56.18	-58.73	-62.49	-65.38	-70.13
1.7	-36.45	-39.48	-43.92	-47.34	-52.94	-55.72	-58.28	-62.04	-64.94	-69.73
1.8	-35.93	-38.96	-43.44	-46.86	-52.50	-55.28	-57.85	-61.64	-64.55	-69.35
1.9	-35.44	-38.49	-42.96	-46.42	-52.06	-54.86	-57.45	-61.24	-64.16	-68.97
2.0	-34.96	-38.02	-42.54	-45.98	-51.66	-54.47	-57.04	-60.86	-63.80	-68.64
2.1	-34.52	-37.59	-42.11	-45.58	-51.27	-54.08	-56.69	-60.51	-63.46	-68.30
2.2	-34.08	-37.17	-41.71	-45.18	-50.89	-53.73	-56.33	-60.16	-63.11	-67.97
2.3	-33.68	-36.77	-41.32	-44.81	-50.54	-53.38	-55.98	-59.84	-62.80	-67.68
2.4	-33.28	-36.39	-40.94	-44.45	-50.20	-53.04	-55.67	-59.53	-62.50	-67.39
2.5	-32.89	-36.00	-40.60	-44.10	-49.86	-52.72	-55.35		-62.20	-67.10
2.6	-32.53	-35.66	-40.25	-43.77	-49.55	-52.42	-55.04		-61.91	-66.83
2.7	-32.17	-35.31	-39.91	-43.45	-49.25	-52.11	-54.76		-61.65	-66.58
2.8	-31.83	-34.97	-39.60	-43.13	-48.94	-51.83	-54.48		-61.38	-66.33
2.9	-31.51	-34.66	-39.29	-42.83	-48.67	-51.55	-54.20		-61.12	-66.07
3.0	-31.18	-34.34	-38.98	-42.55	-48.39	-51.28	-53.93		-60.87	-65.84
3.1	-30.87	-34.03	-38.70	-42.26	-48.11	-51.01	-53.69		-60.64	-65.62
3.2	-30.57	-33.75	-38.41	-41.98	-47.85	-50.76	-53.44		-60.41	-65.40
3.3	-30.28	-33.46	-38.13	-41.72	-47.61	-50.52	-53.20		-60.18	-65.18
3.4	-29.98	-33.18	-37.87	-41.47	-47.36	-50.28	-52.96		-59.95	-64.96
3.5	-29.71	-32.91	-37.61	-41.21	-47.12	-50.04	-52.74		-59.75	-64.77
3.6	-29.45	-32.65	-37.36	-40.96	-46.88	-49.82	-52.52		-59.54	-64.57
3.7	-29.18	-32.39	-37.11	-40.73	-46.66	-49.60	-52.30			-64.38
3.8	-28.92	-32.14	-36.87	-40.50	-46.44	-49.38	-52.08			-64.18
3.9	-28.67	-31.89	-36.64	-40.27	-46.22	-49.17	-51.88			-63.99
4.	-28.43	-31.66	-36.41	-40.04	-46.00	-48.96	-51.68			-63.82
5.	-26.25	-29.54	-34.37	-38.06	-44.13	-47.14	-49.90			-62.23
6.	-24.45	-27.78	-32.69	-36.44	-42.59	-45.63	-48.43			-60.91
7.	-22.90	-26.28	-31.24	-35.03	-41.26	-44.34	-47.16			-59.79
8.	-21.56	-24.96	-29.97	-33.81	-40.10	-43.21	-46.06			
9.	-20.35	-23.80	-28.85	-32.73	-39.06	-42.20	-45.08			
10.	-19.27	-22.75	-27.84	-31.75	-38.14	-41.30	-44.20			
20.	-11.96	-15.65	-21.03	-25.15	-31.89	-35.22	-38.28			
30.	-7.57	-11.37	-16.93	-21.19	-28.15	-31.58	-34.73			
40.	-4.40	-8.30	-13.99	-18.35	-25.46	-28.96	-32.19			
50.	-1.93	-5.90	-11.70	-16.13	-23.37	-26.93	-30.20			
60.		-3.93	-9.83	-14.32	-21.66	-25.27	-28.59			
70.		-2.28	-8.24	-12.79	-20.21	-23.87	-27.22			
80.		-0.85	-6.87	-11.47	-18.96	-22.66	-26.04			
90.			-5.68	-10.31	-17.87	-21.60	-25.00			
100.			-4.61	-9.28	-16.90	-20.66	-24.09			

Table 4.13.4 **Mixing ratio as a function of thermodynamic frost-point temperature and pressure**

Rapport de mélange en fonction de la température thermodynamique du point de gelée et de la pression

t_f °C	p, mb 1050	1000	950	900	850	800	750	700	650	600
	r	r	r	r	r	r	r	r	r	r
Unity — *Unité* : 0.000 1 g kg^{-1}										
-80	3.267	3.429	3.608	3.807	4.029	4.279	4.563	4.887	5.260	5.697
-79	3.847	4.038	4.249	4.483	4.745	5.040	5.373	5.755	6.195	6.709
-78	4.523	4.747	4.995	5.271	5.579	5.925	6.318	6.766	7.284	7.888
-77	5.309	5.572	5.864	6.187	6.548	6.955	7.416	7.942	8.550	9.259
-76	6.222	6.530	6.872	7.250	7.674	8.151	8.691	9.308	10.020	10.850
-75	7.280	7.641	8.040	8.483	8.979	9.537	10.169	10.891	11.724	12.696
-74	8.504	8.926	9.393	9.911	10.489	11.141	11.879	12.723	13.696	14.831
-73	9.920	10.412	10.956	11.560	12.235	12.996	13.856	14.840	15.976	17.300
Unity — *Unité* : 0.001 g kg^{-1}										
-72	1.155	1.213	1.276	1.346	1.425	1.514	1.614	1.728	1.861	2.015
-71	1.344	1.410	1.484	1.566	1.657	1.760	1.877	2.010	2.164	2.343
-70	1.560	1.637	1.723	1.818	1.924	2.044	2.179	2.334	2.513	2.721
-69	1.809	1.899	1.998	2.108	2.231	2.370	2.527	2.707	2.914	3.155
-68	2.095	2.198	2.313	2.441	2.584	2.744	2.926	3.134	3.374	3.653
-67	2.422	2.542	2.675	2.822	2.987	3.173	3.383	3.624	3.901	4.224
-66	2.796	2.935	3.088	3.259	3.449	3.664	3.906	4.184	4.504	4.878
-65	3.224	3.384	3.561	3.758	3.977	4.224	4.504	4.824	5.194	5.624
-64	3.713	3.897	4.100	4.327	4.580	4.864	5.187	5.555	5.981	6.477
-63	4.269	4.481	4.715	4.976	5.267	5.594	5.965	6.389	6.878	7.448
-62	4.903	5.147	5.415	5.714	6.049	6.424	6.850	7.337	7.899	8.554
-61	5.624	5.903	6.211	6.554	6.938	7.368	7.857	8.416	9.060	9.811
-60	6.442	6.762	7.115	7.508	7.947	8.440	9.000	9.640	10.379	11.239
-59	7.370	7.736	8.140	8.590	9.092	9.657	10.297	11.030	11.875	12.859
-58	8.421	8.839	9.301	9.815	10.389	11.034	11.767	12.603	13.569	14.694
-57	9.611	10.088	10.615	11.201	11.857	12.593	13.429	14.384	15.486	16.770
Unity — *Unité* : 0.01 g kg^{-1}										
-56	1.095	1.150	1.210	1.277	1.352	1.436	1.531	1.640	1.765	1.912
-55	1.247	1.309	1.378	1.454	1.539	1.634	1.743	1.867	2.010	2.176
-54	1.418	1.489	1.567	1.653	1.750	1.859	1.982	2.123	2.285	2.475
-53	1.611	1.691	1.779	1.878	1.988	2.111	2.251	2.411	2.596	2.811
-52	1.828	1.919	2.019	2.130	2.255	2.395	2.554	2.736	2.945	3.190
-51	2.071	2.174	2.288	2.414	2.556	2.715	2.895	3.100	3.338	3.615

t_f °C	*p*, mb 1050 *r*	1000 *r*	950 *r*	900 *r*	850 *r*	800 *r*	750 *r*	700 *r*	650 *r*	600 *r*
	Unity — *Unité* : 0.01 g kg^{-1}									
-50	2.345	2.461	2.590	2.733	2.893	3.073	3.277	3.510	3.779	4.092
-49	2.651	2.783	2.929	3.091	3.271	3.475	3.705	3.969	4.273	4.628
-48	2.995	3.144	3.308	3.491	3.695	3.925	4.186	4.483	4.827	5.227
-47	3.379	3.547	3.733	3.939	4.169	4.429	4.723	5.059	5.446	5.898
-46	3.809	3.998	4.207	4.440	4.700	4.992	5.323	5.702	6.139	6.649
-45	4.289	4.502	4.737	4.999	5.292	5.621	5.994	6.420	6.912	7.486
-44	4.824	5.064	5.329	5.623	5.952	6.322	6.742	7.222	7.775	8.421
-43	5.420	5.690	5.988	6.319	6.688	7.104	7.576	8.115	8.737	9.463
-42	6.084	6.387	6.722	7.093	7.508	7.975	8.505	9.110	9.807	10.623
-41	6.823	7.162	7.538	7.954	8.420	8.943	9.538	10.216	10.999	11.913
-40	7.644	8.024	8.445	8.911	9.433	10.019	10.685	11.445	12.322	13.347
-39	8.556	8.981	9.452	9.974	10.558	11.214	11.960	12.810	13.792	14.939
-38	9.567	10.042	10.569	11.153	11.805	12.540	13.373	14.325	15.422	16.704
	Unity — *Unité* : 0.1 g kg^{-1}									
-37	1.069	1.122	1.181	1.246	1.319	1.401	1.494	1.600	1.723	1.866
-36	1.193	1.252	1.318	1.391	1.472	1.564	1.667	1.786	1.923	2.083
-35	1.330	1.396	1.469	1.551	1.641	1.743	1.859	1.992	2.144	2.323
-34	1.482	1.555	1.637	1.727	1.828	1.942	2.071	2.219	2.389	2.587
-33	1.649	1.731	1.822	1.923	2.035	2.162	2.306	2.470	2.659	2.880
-32	1.834	1.925	2.026	2.138	2.263	2.404	2.564	2.747	2.957	3.203
-31	2.038	2.139	2.251	2.376	2.515	2.671	2.849	3.052	3.286	3.559
-30	2.262	2.375	2.499	2.637	2.792	2.966	3.163	3.388	3.648	3.951
-29	2.509	2.634	2.772	2.925	3.097	3.290	3.508	3.758	4.046	4.383
-28	2.781	2.919	3.072	3.242	3.432	3.646	3.888	4.165	4.484	4.857
-27	3.079	3.232	3.402	3.590	3.800	4.037	4.305	4.612	4.966	5.379
-26	3.407	3.576	3.764	3.972	4.205	4.467	4.764	5.103	5.495	5.952
-25	3.766	3.954	4.161	4.392	4.649	4.938	5.267	5.642	6.075	6.580
-24	4.161	4.368	4.597	4.851	5.136	5.455	5.818	6.233	6.711	7.269
-23	4.592	4.821	5.074	5.355	5.669	6.022	6.422	6.880	7.408	8.024
-22	5.065	5.317	5.596	5.906	6.252	6.642	7.083	7.588	8.170	8.850
-21	5.582	5.860	6.167	6.509	6.891	7.320	7.807	8.363	9.005	9.755
-20	6.147	6.453	6.791	7.168	7.588	8.061	8.597	9.210	9.917	10.743
-19	6.764	7.101	7.473	7.888	8.350	8.871	9.461	10.136	10.914	11.822
-18	7.438	7.808	8.218	8.673	9.182	9.754	10.404	11.146	12.002	13.001
-17	8.173	8.579	9.030	9.530	10.090	10.718	11.432	12.248	13.188	14.287
-16	8.973	9.420	9.915	10.464	11.079	11.769	12.553	13.449	14.482	15.688
-15	9.846	10.336	10.878	11.482	12.156	12.914	13.774	14.757	15.891	17.215
	Unity — *Unité* : 1 g kg^{-1}									
-14	1.080	1.133	1.193	1.259	1.333	1.416	1.510	1.618	1.743	1.888
-13	1.183	1.242	1.307	1.379	1.460	1.552	1.655	1.773	1.910	2.069
-12	1.295	1.360	1.431	1.510	1.599	1.699	1.812	1.942	2.091	2.265
-11	1.417	1.488	1.566	1.653	1.750	1.859	1.983	2.125	2.288	2.479
-10	1.549	1.627	1.712	1.807	1.913	2.033	2.168	2.323	2.502	2.711
-9	1.693	1.777	1.871	1.975	2.091	2.222	2.370	2.539	2.735	2.963
-8	1.849	1.941	2.043	2.156	2.283	2.426	2.588	2.773	2.987	3.236
-7	2.018	2.118	2.230	2.353	2.492	2.648	2.825	3.027	3.260	3.532
-6	2.200	2.310	2.432	2.567	2.718	2.888	3.081	3.302	3.556	3.853
-5	2.398	2.518	2.651	2.798	2.963	3.148	3.358	3.599	3.877	4.201
-4	2.612	2.743	2.887	3.048	3.227	3.429	3.659	3.921	4.224	4.577
-3	2.844	2.986	3.143	3.318	3.514	3.734	3.983	4.269	4.599	4.984
-2	3.094	3.248	3.420	3.610	3.823	4.063	4.334	4.645	5.005	5.424
-1	3.364	3.532	3.718	3.925	4.157	4.418	4.714	5.052	5.443	5.900
0	3.655	3.838	4.041	4.266	4.518	4.801	5.123	5.491	5.916	6.413

t_f °C	550	500	450	400	350	300	250	200	150	100
	p, mb									
	r	*r*	*r*	*r*	*r*	*r*	*r*	*r*	*r*	*r*
Unity — *Unité* : 0.000 01 g kg^{-1}										
-100						2.915	3.497	4.369	5.822	8.729
-99						3.571	4.283	5.351	7.132	10.692
-98						4.364	5.235	6.540	8.716	13.067
-97						5.322	6.383	7.975	10.628	15.934
-96						6.475	7.766	9.703	12.931	19.387
-95						7.861	9.429	11.780	15.699	23.537
-94						9.523	11.422	14.271	19.019	28.515
Unity — *Unité* : 0.000 1 g kg^{-1}										
-93						1.151	1.381	1.725	2.299	3.447
-92						1.389	1.666	2.081	2.774	4.159
-91						1.672	2.006	2.506	3.340	5.007
-90		1.208	1.341	1.508	1.723	2.009	2.410	3.011	4.013	6.017
-89		1.448	1.608	1.809	2.066	2.409	2.890	3.611	4.812	7.215
-88		1.733	1.925	2.165	2.473	2.884	3.459	4.322	5.760	8.636
-87		2.070	2.300	2.586	2.954	3.445	4.132	5.163	6.881	10.316
-86		2.469	2.742	3.083	3.522	4.107	4.927	6.156	8.204	12.301
-85		2.938	3.263	3.669	4.192	4.888	5.864	7.326	9.765	14.640
-84		3.490	3.876	4.359	4.980	5.807	6.966	8.704	11.600	17.393
-83		4.139	4.597	5.169	5.905	6.887	8.261	10.321	13.756	20.626
-82		4.899	5.442	6.119	6.991	8.152	9.779	12.218	16.285	24.417
-81		5.790	6.430	7.231	8.261	9.634	11.556	14.439	19.244	28.854
-80	6.211	6.830	7.586	8.530	9.745	11.365	13.632	17.034	22.702	34.040
-79	7.315	8.043	8.934	10.046	11.477	13.385	16.055	20.061	26.737	40.090
-78	8.601	9.457	10.504	11.812	13.494	15.737	18.877	23.588	31.437	47.138
Unity — *Unité* : 0.001 g kg^{-1}										
-77	1.010	1.110	1.233	1.387	1.584	1.847	2.216	2.769	3.690	5.533
-76	1.183	1.301	1.445	1.625	1.856	2.165	2.597	3.245	4.325	6.485
-75	1.384	1.522	1.691	1.901	2.172	2.533	3.039	3.797	5.061	7.588
-74	1.617	1.778	1.975	2.221	2.538	2.960	3.550	4.436	5.913	8.865
-73	1.887	2.074	2.304	2.591	2.960	3.452	4.141	5.175	6.897	10.341
-72	2.197	2.416	2.684	3.018	3.448	4.021	4.823	6.027	8.033	12.045
-71	2.555	2.810	3.121	3.510	4.010	4.676	5.609	7.010	9.342	14.008
-70	2.967	3.263	3.624	4.076	4.657	5.431	6.514	8.140	10.849	16.268
-69	3.441	3.784	4.203	4.726	5.400	6.297	7.554	9.439	12.581	18.864
-68	3.984	4.381	4.866	5.473	6.252	7.292	8.747	10.930	14.568	21.844
-67	4.607	5.066	5.627	6.328	7.230	8.431	10.114	12.638	16.845	25.259
-66	5.319	5.849	6.497	7.307	8.348	9.736	11.679	14.594	19.451	29.167
-65	6.134	6.745	7.492	8.425	9.626	11.226	13.467	16.828	22.430	33.633
-64	7.063	7.767	8.627	9.702	11.085	12.928	15.508	19.378	25.829	38.732
-63	8.123	8.932	9.922	11.157	12.748	14.867	17.835	22.286	29.705	44.543
-62	9.329	10.259	11.395	12.814	14.641	17.075	20.484	25.595	34.117	51.160
Unity — *Unité* : 0.01 g kg^{-1}										
-61	1.070	1.177	1.307	1.470	1.679	1.959	2.350	2.936	3.913	5.868
-60	1.226	1.348	1.497	1.684	1.924	2.244	2.692	3.363	4.483	6.723
-59	1.402	1.542	1.713	1.926	2.201	2.567	3.080	3.848	5.129	7.692
-58	1.602	1.762	1.957	2.201	2.515	2.933	3.519	4.397	5.861	8.790
-57	1.829	2.011	2.234	2.512	2.870	3.348	4.016	5.019	6.690	10.032
-56	2.085	2.293	2.547	2.864	3.272	3.816	4.578	5.721	7.626	11.436
-55	2.374	2.610	2.899	3.261	3.725	4.345	5.213	6.514	8.683	13.021
-54	2.699	2.968	3.297	3.708	4.237	4.941	5.928	7.408	9.874	14.808
-53	3.066	3.372	3.745	4.212	4.812	5.613	6.734	8.414	11.216	16.821
-52	3.479	3.826	4.249	4.779	5.460	6.368	7.640	9.547	12.726	19.086
-51	3.943	4.336	4.816	5.416	6.188	7.217	8.659	10.820	14.424	21.631

t_f °C	p, mb 550	500	450	400	350	300	250	200	150	100
	r	r	r	r	r	r	r	r	r	r
Unity — *Unité* : 0.01 g kg^{-1}										
-50	4.463	4.908	5.452	6.131	7.005	8.171	9.802	12.249	16.329	24.489
-49	5.047	5.550	6.165	6.934	7.922	9.240	11.085	13.852	18.465	27.694
-48	5.701	6.269	6.964	7.832	8.949	10.437	12.521	15.648	20.859	31.285
-47	6.433	7.074	7.858	8.838	10.098	11.777	14.129	17.657	23.538	35.304
-46	7.251	7.974	8.857	9.962	11.382	13.275	15.926	19.903	26.533	39.797
-45	8.165	8.979	9.973	11.217	12.816	14.948	17.934	22.412	29.877	44.815
-44	9.184	10.099	11.218	12.618	14.417	16.815	20.173	25.211	33.609	50.415
Unity — *Unité* : 0.1 g kg^{-1}										
-43	1.032	1.135	1.261	1.418	1.620	1.890	2.267	2.833	3.777	5.666
-42	1.158	1.274	1.415	1.592	1.819	2.121	2.545	3.180	4.240	6.361
-41	1.299	1.429	1.587	1.785	2.040	2.379	2.854	3.567	4.755	7.134
-40	1.456	1.601	1.778	2.000	2.285	2.665	3.198	3.997	5.328	7.994
-39	1.629	1.792	1.990	2.239	2.558	2.983	3.579	4.474	5.964	8.949
-38	1.822	2.003	2.225	2.503	2.860	3.336	4.003	5.003	6.670	10.009
-37	2.035	2.238	2.486	2.797	3.195	3.727	4.472	5.589	7.452	11.183
-36	2.272	2.498	2.775	3.121	3.567	4.160	4.992	6.239	8.319	12.484
-35	2.533	2.786	3.094	3.481	3.977	4.639	5.567	6.958	9.278	13.924
-34	2.822	3.104	3.448	3.878	4.431	5.169	6.202	7.752	10.338	15.516
-33	3.141	3.455	3.837	4.317	4.932	5.754	6.904	8.630	11.509	17.276
-32	3.493	3.842	4.268	4.801	5.486	6.399	7.679	9.599	12.801	19.218
-31	3.881	4.269	4.742	5.334	6.095	7.111	8.533	10.667	14.227	21.360
-30	4.309	4.739	5.265	5.922	6.767	7.895	9.475	11.844	15.798	23.722
-29	4.780	5.257	5.840	6.570	7.507	8.758	10.511	13.140	17.527	26.323
-28	5.298	5.827	6.473	7.281	8.321	9.708	11.651	14.566	19.431	29.186
-27	5.867	6.453	7.168	8.064	9.215	10.751	12.903	16.133	21.523	32.334
-26	6.491	7.140	7.932	8.923	10.197	11.897	14.280	17.855	23.822	35.795
-25	7.177	7.894	8.770	9.866	11.275	13.155	15.790	19.745	26.346	39.595
-24	7.929	8.721	9.689	10.899	12.456	14.534	17.446	21.818	29.115	43.767
-23	8.752	9.627	10.696	12.032	13.751	16.046	19.261	24.090	32.151	48.342
-22	9.653	10.618	11.798	13.272	15.169	17.701	21.249	26.578	35.477	53.358
Unity — *Unité* : 1 g kg^{-1}										
-21	1.064	1.170	1.300	1.463	1.672	1.951	2.342	2.930	3.912	5.885
-20	1.172	1.289	1.432	1.611	1.842	2.149	2.580	3.228	4.310	6.487
-19	1.290	1.419	1.576	1.773	2.027	2.366	2.840	3.554	4.746	7.145
-18	1.418	1.560	1.733	1.950	2.229	2.602	3.124	3.910	5.222	7.865
-17	1.558	1.714	1.905	2.143	2.450	2.860	3.434	4.298	5.742	8.652
-16	1.711	1.883	2.092	2.354	2.691	3.141	3.773	4.722	6.310	9.512
-15	1.878	2.066	2.296	2.583	2.954	3.448	4.141	5.184	6.930	10.451
-14	2.059	2.266	2.518	2.833	3.239	3.782	4.543	5.688	7.605	11.476
-13	2.257	2.483	2.759	3.105	3.551	4.145	4.980	6.237	8.341	12.594
-12	2.471	2.719	3.022	3.401	3.889	4.541	5.456	6.834	9.143	13.814
-11	2.705	2.976	3.308	3.722	4.257	4.971	5.974	7.484	10.016	15.143
-10	2.958	3.255	3.618	4.072	4.657	5.439	6.537	8.191	10.967	16.593
-9	3.233	3.558	3.955	4.451	5.091	5.947	7.148	8.959	12.001	18.172
-8	3.531	3.886	4.320	4.863	5.562	6.498	7.812	9.794	13.125	19.893
-7	3.855	4.242	4.716	5.309	6.074	7.096	8.533	10.701	14.347	21.767
-6	4.205	4.628	5.145	5.793	6.628	7.745	9.315	11.686	15.676	23.809
-5	4.585	5.046	5.611	6.317	7.229	8.448	10.164	12.754	17.119	26.031
-4	4.996	5.498	6.114	6.885	7.880	9.211	11.083	13.913	18.687	28.451
-3	5.440	5.988	6.659	7.500	8.584	10.036	12.080	15.171	20.389	31.087
-2	5.921	6.518	7.249	8.165	9.347	10.930	13.160	16.534	22.237	33.956
-1	6.440	7.090	7.886	8.884	10.172	11.898	14.329	18.011	24.244	37.081
0	7.001	7.709	8.575	9.662	11.064	12.944	15.595	19.612	26.422	40.485

t_f °C	p, mb 70	50	30	20	10	7	5	3	2	1
	r	r	r	r	r	r	r	r	r	r
Unity — *Unité* : 0.000 1 g kg^{-1}										
-100	1.247	1.745	2.908	4.361	8.721	12.459	17.442	29.067	43.601	87.202
-99	1.527	2.137	3.562	5.342	10.683	15.261	21.365	35.606	53.408	106.818
-98	1.866	2.612	4.353	6.529	13.056	18.651	26.111	43.515	65.273	130.548
-97	2.276	3.185	5.308	7.961	15.920	22.743	31.840	53.063	79.595	159.192
-96	2.769	3.876	6.458	9.686	19.371	27.671	38.740	64.563	96.845	193.693
-95	3.361	4.705	7.841	11.760	23.518	33.595	47.033	78.385	117.578	235.159
-94	4.072	5.700	9.499	14.247	28.491	40.699	56.979	94.962	142.444	284.895
-93	4.923	6.891	11.484	17.224	34.444	49.203	68.884	114.804	172.208	344.425
-92	5.940	8.314	13.854	20.780	41.555	59.360	83.104	138.506	207.761	415.536
-91	7.151	10.010	16.681	25.019	50.032	71.469	100.057	166.761	250.145	500.310
-90	8.593	12.027	20.043	30.062	60.118	85.875	120.226	200.379	300.574	601.177
Unity — *Unité* : 0.001 g kg^{-1}										
-89	1.030	1.442	2.404	3.605	7.210	10.298	14.418	24.030	36.046	72.096
-88	1.233	1.726	2.877	4.315	8.629	12.326	17.257	28.762	43.144	86.294
-87	1.473	2.062	3.437	5.155	10.309	14.725	20.616	34.360	51.542	103.092
-86	1.757	2.459	4.098	6.146	12.292	17.558	24.582	40.971	61.458	122.929
-85	2.091	2.927	4.877	7.315	14.630	20.898	29.257	48.763	73.148	146.313
-84	2.484	3.477	5.794	8.690	17.380	24.827	34.758	57.933	86.903	173.830
-83	2.946	4.123	6.871	10.306	20.611	29.442	41.220	68.703	103.060	206.155
-82	3.487	4.881	8.134	12.200	24.400	34.854	48.797	81.333	122.007	244.062
-81	4.121	5.769	9.612	14.417	28.835	41.190	57.667	96.117	144.187	288.441
-80	4.862	6.805	11.340	17.008	34.018	48.593	68.033	113.396	170.110	340.312
-79	5.726	8.015	13.356	20.032	40.065	57.231	80.127	133.556	200.356	400.841
-78	6.733	9.424	15.704	23.553	47.109	67.294	94.215	157.041	235.591	471.361
-77	7.903	11.063	18.434	27.649	55.301	78.996	110.600	184.355	276.574	553.393
-76	9.262	12.965	21.605	32.405	64.813	92.584	129.626	216.073	324.166	648.671
Unity — *Unité* : 0.01 g kg^{-1}										
-75	1.084	1.517	2.528	3.792	7.584	10.834	15.169	25.285	37.935	75.917
-74	1.266	1.772	2.954	4.430	8.861	12.658	17.722	29.543	44.325	88.712
-73	1.477	2.068	3.445	5.168	10.336	14.766	20.674	34.465	51.711	103.508
-72	1.720	2.408	4.013	6.019	12.040	17.199	24.081	40.146	60.239	120.594
-71	2.001	2.801	4.667	7.000	14.003	20.004	28.009	46.695	70.069	140.296
-70	2.324	3.253	5.420	8.130	16.262	23.231	32.529	54.233	81.385	162.984
-69	2.694	3.772	6.285	9.428	18.858	26.941	37.724	62.898	94.395	189.077
-68	3.120	4.368	7.278	10.917	21.838	31.198	43.686	72.845	109.331	219.047
-67	3.608	5.050	8.416	12.624	25.253	36.078	50.521	84.247	126.456	253.428
-66	4.166	5.832	9.718	14.577	29.162	41.664	58.345	97.302	146.067	292.821
-65	4.804	6.725	11.207	16.810	33.630	48.048	67.289	112.229	168.495	337.906
-64	5.532	7.744	12.906	19.359	38.730	55.338	77.501	129.275	194.114	389.444
-63	6.362	8.906	14.843	22.265	44.545	63.649	89.146	148.718	223.344	448.299
-62	7.307	10.229	17.048	25.573	51.167	73.115	102.408	170.868	256.655	515.437
-61	8.382	11.733	19.556	29.335	58.698	83.880	117.496	196.073	294.574	591.951
-60	9.602	13.442	22.404	33.608	67.253	96.110	134.638	224.720	337.691	679.068
Unity — *Unité* : 0.1 g kg^{-1}										
-59	1.099	1.538	2.563	3.846	7.696	10.999	15.409			
-58	1.255	1.758	2.929	4.395	8.796	12.572	17.615			
-57	1.433	2.006	3.344	5.016	10.041	14.352	20.112			
-56	1.633	2.287	3.812	5.719	11.448	16.366	22.937			
-55	1.860	2.604	4.340	6.512	13.038	18.641	26.128			
-54	2.115	2.961	4.937	7.407	14.832	21.208	29.731			
-53	2.403	3.364	5.608	8.415	16.853	24.101	33.794			
-52	2.726	3.817	6.364	9.550	19.129	27.360	38.372			
-51	3.090	4.326	7.213	10.825	21.688	31.026	43.524			

t_f °C	p, mb 70	50	30	20	10	7	5	3	2	1
	r	r	r	r	r	r	r	r	r	r
	Unity — *Unité* : 0.1 g kg⁻¹									
-50	3.498	4.898	8.167	12.258	24.564	35.147	49.317			
-49	3.956	5.540	9.237	13.865	27.792	39.775	55.828			
-48	4.469	6.258	10.436	15.666	31.412	44.967	63.137			
-47	5.044	7.063	11.779	17.683	35.467	50.788	71.336			
-46	5.686	7.962	13.280	19.940	40.007	57.308	80.528			
-45	6.403	8.967	14.958	22.461	45.085	64.605	90.824			
-44	7.203	10.088	16.830	25.277	50.760	72.766	102.351			
-43	8.095	11.338	18.918	28.418	57.097	81.887	115.248			
-42	9.089	12.731	21.245	31.919	64.168	92.073	129.670			
	Unity — *Unité* : 1 g kg⁻¹									
-41	1.019	1.428	2.384	3.582	7.205	10.344	14.579			
-40	1.142	1.600	2.672	4.016	8.084	11.613	16.380			
-39	1.279	1.792	2.992	4.498	9.062	13.027	18.392			
-38	1.431	2.004	3.347	5.034	10.151	14.603	20.638			
-37	1.599	2.240	3.742	5.629	11.361	16.359	23.146			
-36	1.785	2.501	4.179	6.289	12.707	18.314	25.945			
-35	1.991	2.790	4.664	7.021	14.203	20.491	29.070			
-34	2.219	3.110	5.200	7.832	15.865	22.914	32.560			
-33	2.470	3.464	5.794	8.730	17.709	25.612	36.457			
-32	2.748	3.854	6.450	9.724	19.757	28.614	40.811			
-31	3.055	4.285	7.175	10.823	22.030	31.957	45.678			
-30	3.394	4.761	7.975	12.039	24.552	35.678	51.122			
-29	3.767	5.285	8.858	13.381	27.351	39.823	57.218			
-28	4.177	5.863	9.832	14.865	30.457	44.442	64.050			
-27	4.629	6.499	10.906	16.503	33.905	49.592	71.716			
-26	5.125	7.199	12.090	18.310	37.732	55.339	80.333			
-25	5.671	7.968	13.393	20.306	41.982	61.757	90.036			
-24	6.270	8.813	14.827	22.507	46.704	68.934				
-23	6.928	9.742	16.406	24.936	51.954	76.969				
-22	7.650	10.761	18.143	27.615	57.795	85.981				
-21	8.441	11.880	20.054	30.570	64.301	96.107				
-20	9.307	13.108	22.155	33.831	71.555					
-19	10.257	14.453	24.465	37.430	79.652					
-18	11.296	15.928	27.005	41.402	88.707					
-17	12.433	17.544	29.798	45.789	98.852					
-16	13.676	19.315	32.869	50.636						
-15	15.036	21.254	36.245	55.994						
-14	16.523	23.378	39.960	61.922						
-13	18.147	25.703	44.047	68.488						
-12	19.921	28.249	48.546	75.767						
-11	21.859	31.036	53.501	83.848						
-10	23.976	34.088	58.962	92.833						
-9	26.287	37.431	64.985							
-8	28.811	41.092	71.634							
-7	31.567	45.104	78.983							
-6	34.576	49.502	87.116							
-5	37.863	54.325	96.128							
-4	41.453	59.618								
-3	45.377	65.430								
-2	49.666	71.818								
-1	54.356	78.846								
0	59.489	86.587								

Table 4.13.5 **Thermodynamic frost-point temperature as a function of thermodynamic dew-point temperature**

Température thermodynamique du point de gelée en fonction de la température thermodynamique du point de rosée

t_d, °C	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
°C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C	t_f, °C
-50	-46.05									
-49	-45.09	-45.19	-45.29	-45.39	-45.49	-45.58	-45.68	-45.77	-45.86	-45.95
-48	-44.13	-44.23	-44.33	-44.43	-44.53	-44.62	-44.71	-44.81	-44.90	-44.99
-47	-43.18	-43.28	-43.38	-43.47	-43.57	-43.66	-43.76	-43.85	-43.94	-44.03
-46	-42.23	-42.32	-42.42	-42.52	-42.61	-42.71	-42.80	-42.89	-42.98	-43.08
-45	-41.27	-41.37	-41.47	-41.56	-41.66	-41.75	-41.84	-41.93	-42.03	-42.13
-44	-40.32	-40.42	-40.51	-40.61	-40.70	-40.80	-40.89	-40.98	-41.08	-41.18
-43	-39.37	-39.47	-39.56	-39.66	-39.75	-39.84	-39.93	-40.03	-40.13	-40.23
-42	-38.43	-38.52	-38.61	-38.71	-38.80	-38.89	-38.98	-39.08	-39.18	-39.28
-41	-37.48	-37.57	-37.67	-37.76	-37.85	-37.94	-38.04	-38.13	-38.23	-38.33
-40	-36.53	-36.63	-36.72	-36.81	-36.90	-36.99	-37.09	-37.19	-37.29	-37.38
-39	-35.59	-35.68	-35.77	-35.87	-35.96	-36.05	-36.15	-36.25	-36.34	-36.44
-38	-34.65	-34.74	-34.83	-34.92	-35.01	-35.11	-35.21	-35.30	-35.40	-35.50
-37	-33.71	-33.80	-33.89	-33.98	-34.07	-34.17	-34.27	-34.36	-34.46	-34.55
-36	-32.76	-32.86	-32.95	-33.04	-33.14	-33.23	-33.33	-33.42	-33.52	-33.61
-35	-31.83	-31.92	-32.01	-32.10	-32.20	-32.30	-32.39	-32.49	-32.58	-32.67
-34	-30.89	-30.98	-31.07	-31.17	-31.27	-31.36	-31.46	-31.55	-31.64	-31.73
-33	-29.95	-30.04	-30.14	-30.24	-30.33	-30.43	-30.52	-30.61	-30.71	-30.80
-32	-29.02	-29.11	-29.21	-29.31	-29.40	-29.49	-29.59	-29.68	-29.77	-29.86
-31	-28.09	-28.19	-28.28	-28.38	-28.47	-28.56	-28.66	-28.75	-28.84	-28.93
-30	-27.16	-27.26	-27.35	-27.45	-27.54	-27.63	-27.72	-27.81	-27.90	-27.99
-29	-26.24	-26.33	-26.43	-26.52	-26.61	-26.70	-26.79	-26.88	-26.97	-27.07
-28	-25.31	-25.41	-25.50	-25.59	-25.68	-25.77	-25.86	-25.95	-26.05	-26.14
-27	-24.39	-24.48	-24.57	-24.67	-24.76	-24.85	-24.94	-25.03	-25.12	-25.22
-26	-23.47	-23.56	-23.65	-23.74	-23.83	-23.92	-24.01	-24.11	-24.20	-24.30
-25	-22.55	-22.64	-22.73	-22.82	-22.91	-23.00	-23.09	-23.19	-23.28	-23.37
-24	-21.63	-21.72	-21.81	-21.89	-21.98	-22.08	-22.17	-22.27	-22.36	-22.45
-23	-20.71	-20.80	-20.88	-20.97	-21.07	-21.16	-21.26	-21.35	-21.44	-21.53
-22	-19.79	-19.88	-19.96	-20.06	-20.15	-20.25	-20.34	-20.43	-20.52	-20.62
-21	-18.87	-18.96	-19.05	-19.14	-19.24	-19.33	-19.42	-19.52	-19.61	-19.70
-20	-17.95	-18.04	-18.14	-18.23	-18.33	-18.42	-18.51	-18.60	-18.69	-18.78
-19	-17.04	-17.13	-17.23	-17.32	-17.41	-17.51	-17.60	-17.69	-17.78	-17.86
-18	-16.13	-16.23	-16.32	-16.41	-16.50	-16.59	-16.68	-16.77	-16.86	-16.95
-17	-15.23	-15.32	-15.41	-15.50	-15.59	-15.68	-15.77	-15.86	-15.95	-16.04
-16	-14.32	-14.41	-14.50	-14.59	-14.68	-14.77	-14.86	-14.95	-15.04	-15.13
-15	-13.42	-13.51	-13.60	-13.69	-13.78	-13.86	-13.95	-14.04	-14.13	-14.23
-14	-12.51	-12.60	-12.69	-12.78	-12.87	-12.95	-13.05	-13.14	-13.23	-13.32
-13	-11.61	-11.70	-11.79	-11.87	-11.96	-12.05	-12.14	-12.24	-12.33	-12.42
-12	-10.71	-10.79	-10.88	-10.97	-11.06	-11.15	-11.24	-11.34	-11.43	-11.52
-11	-9.80	-9.89	-9.98	-10.07	-10.16	-10.25	-10.35	-10.44	-10.53	-10.62
-10	-8.90	-8.99	-9.08	-9.17	-9.27	-9.36	-9.45	-9.54	-9.63	-9.72
-9	-8.00	-8.09	-8.19	-8.28	-8.37	-8.46	-8.55	-8.64	-8.73	-8.81
-8	-7.11	-7.20	-7.29	-7.38	-7.47	-7.56	-7.65	-7.74	-7.83	-7.92
-7	-6.22	-6.31	-6.40	-6.49	-6.58	-6.67	-6.76	-6.84	-6.93	-7.02
-6	-5.33	-5.42	-5.51	-5.60	-5.69	-5.77	-5.86	-5.95	-6.04	-6.13
-5	-4.44	-4.53	-4.62	-4.70	-4.79	-4.88	-4.97	-5.05	-5.15	-5.24
-4	-3.55	-3.64	-3.73	-3.81	-3.90	-3.99	-4.08	-4.17	-4.26	-4.35
-3	-2.66	-2.75	-2.84	-2.92	-3.01	-3.10	-3.19	-3.28	-3.37	-3.46
-2	-1.77	-1.86	-1.95	-2.03	-2.12	-2.22	-2.31	-2.40	-2.48	-2.57
-1	-0.89	-0.97	-1.06	-1.15	-1.24	-1.33	-1.42	-1.51	-1.60	-1.69
-0	-0.00	-0.09	-0.18	-0.27	-0.36	-0.45	-0.54	-0.63	-0.71	-0.80

Table 4.14.1 **Ratio of absolute potential temperature to absolute temperature for dry air as a function of pressure**

Rapport de la température potentielle absolue à la température absolue pour l'air sec en fonction de la pression

Pressure *Pression* mb	0	1	2	3	4	5	6	7	8	9
0		7.1969	5.9038	5.2580	4.8431	4.5440	4.3133	4.1275	3.9730	3.8415
10	3.7276	3.6275	3.5384	3.4584	3.3859	3.3198	3.2592	3.2032	3.1513	3.1030
20	3.0579	3.0155	2.9757	2.9382	2.9027	2.8690	2.8370	2.8066	2.7776	2.7499
30	2.7234	2.6980	2.6736	2.6502	2.6277	2.6060	2.5851	2.5650	2.5455	2.5267
40	2.5085	2.4908	2.4738	2.4572	2.4411	2.4255	2.4103	2.3955	2.3812	2.3672
50	2.3535	2.3403	2.3273	2.3147	2.3024	2.2903	2.2786	2.2671	2.2558	2.2448
60	2.2341	2.2236	2.2133	2.2032	2.1933	2.1836	2.1741	2.1647	2.1556	2.1466
70	2.1378	2.1292	2.1207	2.1123	2.1042	2.0961	2.0882	2.0804	2.0727	2.0652
80	2.0578	2.0505	2.0433	2.0363	2.0293	2.0225	2.0157	2.0091	2.0025	1.9961
90	1.9897	1.9834	1.9772	1.9711	1.9651	1.9592	1.9533	1.9476	1.9419	1.9362
100	1.9307	1.9252	1.9198	1.9145	1.9092	1.9040	1.8988	1.8937	1.8887	1.8837
110	1.8788	1.8740	1.8692	1.8644	1.8598	1.8551	1.8505	1.8460	1.8415	1.8371
120	1.8327	1.8284	1.8241	1.8198	1.8156	1.8114	1.8073	1.8033	1.7992	1.7952
130	1.7913	1.7873	1.7835	1.7796	1.7758	1.7721	1.7683	1.7646	1.7610	1.7573
140	1.7537	1.7502	1.7466	1.7431	1.7397	1.7362	1.7328	1.7295	1.7261	1.7228
150	1.7195	1.7162	1.7130	1.7098	1.7066	1.7035	1.7003	1.6972	1.6942	1.6911
160	1.6881	1.6851	1.6821	1.6791	1.6762	1.6733	1.6704	1.6676	1.6647	1.6619
170	1.6591	1.6563	1.6536	1.6508	1.6481	1.6454	1.6427	1.6401	1.6374	1.6348
180	1.6322	1.6296	1.6271	1.6245	1.6220	1.6195	1.6170	1.6145	1.6121	1.6096
190	1.6072	1.6048	1.6024	1.6000	1.5977	1.5953	1.5930	1.5907	1.5884	1.5861
200	1.5838	1.5816	1.5793	1.5771	1.5749	1.5727	1.5705	1.5683	1.5662	1.5640
210	1.5619	1.5598	1.5577	1.5556	1.5535	1.5514	1.5494	1.5473	1.5453	1.5433
220	1.5413	1.5393	1.5373	1.5353	1.5334	1.5314	1.5295	1.5275	1.5256	1.5237
230	1.5218	1.5199	1.5181	1.5162	1.5143	1.5125	1.5107	1.5088	1.5070	1.5052
240	1.5034	1.5016	1.4999	1.4981	1.4963	1.4946	1.4929	1.4911	1.4894	1.4877
250	1.4860	1.4843	1.4826	1.4809	1.4793	1.4776	1.4760	1.4743	1.4727	1.4711
260	1.4694	1.4678	1.4662	1.4646	1.4630	1.4615	1.4599	1.4583	1.4568	1.4552
270	1.4537	1.4521	1.4506	1.4491	1.4476	1.4461	1.4446	1.4431	1.4416	1.4401
280	1.4386	1.4372	1.4357	1.4343	1.4328	1.4314	1.4300	1.4285	1.4271	1.4257
290	1.4243	1.4229	1.4215	1.4201	1.4187	1.4174	1.4160	1.4146	1.4133	1.4119
300	1.4106	1.4092	1.4079	1.4066	1.4052	1.4039	1.4026	1.4013	1.4000	1.3987
310	1.3974	1.3961	1.3948	1.3936	1.3923	1.3910	1.3898	1.3885	1.3873	1.3860
320	1.3848	1.3836	1.3823	1.3811	1.3799	1.3787	1.3775	1.3763	1.3751	1.3739
330	1.3727	1.3715	1.3703	1.3691	1.3680	1.3668	1.3656	1.3645	1.3633	1.3622
340	1.3610	1.3599	1.3587	1.3576	1.3565	1.3554	1.3542	1.3531	1.3520	1.3509
350	1.3498	1.3487	1.3476	1.3465	1.3454	1.3443	1.3433	1.3422	1.3411	1.3400
360	1.3390	1.3379	1.3369	1.3358	1.3347	1.3337	1.3327	1.3316	1.3306	1.3296
370	1.3285	1.3275	1.3265	1.3255	1.3245	1.3234	1.3224	1.3214	1.3204	1.3194
380	1.3184	1.3175	1.3165	1.3155	1.3145	1.3135	1.3126	1.3116	1.3106	1.3097
390	1.3087	1.3077	1.3068	1.3058	1.3049	1.3039	1.3030	1.3021	1.3011	1.3002
400	1.2993	1.2983	1.2974	1.2965	1.2956	1.2947	1.2937	1.2928	1.2919	1.2910
410	1.2901	1.2892	1.2883	1.2874	1.2866	1.2857	1.2848	1.2839	1.2830	1.2822
420	1.2813	1.2804	1.2795	1.2787	1.2778	1.2770	1.2761	1.2752	1.2744	1.2735
430	1.2727	1.2718	1.2710	1.2702	1.2693	1.2685	1.2677	1.2668	1.2660	1.2652
440	1.2644	1.2635	1.2627	1.2619	1.2611	1.2603	1.2595	1.2587	1.2579	1.2571
450	1.2563	1.2555	1.2547	1.2539	1.2531	1.2523	1.2515	1.2507	1.2500	1.2492
460	1.2484	1.2476	1.2469	1.2461	1.2453	1.2446	1.2438	1.2430	1.2423	1.2415
470	1.2408	1.2400	1.2393	1.2385	1.2378	1.2370	1.2363	1.2355	1.2348	1.2340
480	1.2333	1.2326	1.2319	1.2311	1.2304	1.2297	1.2289	1.2282	1.2275	1.2268
490	1.2261	1.2254	1.2246	1.2239	1.2232	1.2225	1.2218	1.2211	1.2204	1.2197
500	1.2190	1.2183	1.2176	1.2169	1.2162	1.2156	1.2149	1.2142	1.2135	1.2128
510	1.2121	1.2115	1.2108	1.2101	1.2094	1.2088	1.2081	1.2074	1.2068	1.2061
520	1.2054	1.2048	1.2041	1.2035	1.2028	1.2021	1.2015	1.2008	1.2002	1.1995
530	1.1989	1.1982	1.1976	1.1970	1.1963	1.1957	1.1950	1.1944	1.1938	1.1931
540	1.1925	1.1919	1.1912	1.1906	1.1900	1.1894	1.1887	1.1881	1.1875	1.1869

TABLE 4.14 — 2

Pressure *Pression* mb	0	1	2	3	4	5	6	7	8	9
550	1.1863	1.1857	1.1850	1.1844	1.1838	1.1832	1.1826	1.1820	1.1814	1.1808
560	1.1802	1.1796	1.1790	1.1784	1.1778	1.1772	1.1766	1.1760	1.1754	1.1748
570	1.1742	1.1736	1.1730	1.1725	1.1719	1.1713	1.1707	1.1701	1.1696	1.1690
580	1.1684	1.1678	1.1673	1.1667	1.1661	1.1655	1.1650	1.1644	1.1638	1.1633
590	1.1627	1.1621	1.1616	1.1610	1.1605	1.1599	1.1594	1.1588	1.1582	1.1577
600	1.1571	1.1566	1.1560	1.1555	1.1549	1.1544	1.1539	1.1533	1.1528	1.1522
610	1.1517	1.1511	1.1506	1.1501	1.1495	1.1490	1.1485	1.1479	1.1474	1.1469
620	1.1463	1.1458	1.1453	1.1448	1.1442	1.1437	1.1432	1.1427	1.1422	1.1416
630	1.1411	1.1406	1.1401	1.1396	1.1391	1.1385	1.1380	1.1375	1.1370	1.1365
640	1.1360	1.1355	1.1350	1.1345	1.1340	1.1335	1.1330	1.1325	1.1320	1.1315
650	1.1310	1.1305	1.1300	1.1295	1.1290	1.1285	1.1280	1.1275	1.1270	1.1265
660	1.1261	1.1256	1.1251	1.1246	1.1241	1.1236	1.1231	1.1227	1.1222	1.1217
670	1.1212	1.1207	1.1203	1.1198	1.1193	1.1188	1.1184	1.1179	1.1174	1.1170
680	1.1165	1.1160	1.1156	1.1151	1.1146	1.1142	1.1137	1.1132	1.1128	1.1123
690	1.1118	1.1114	1.1109	1.1105	1.1100	1.1096	1.1091	1.1086	1.1082	1.1077
700	1.1073	1.1068	1.1064	1.1059	1.1055	1.1050	1.1046	1.1041	1.1037	1.1032
710	1.1028	1.1024	1.1019	1.1015	1.1010	1.1006	1.1002	1.0997	1.0993	1.0988
720	1.0984	1.0980	1.0975	1.0971	1.0967	1.0962	1.0958	1.0954	1.0949	1.0945
730	1.0941	1.0937	1.0932	1.0928	1.0924	1.0920	1.0915	1.0911	1.0907	1.0903
740	1.0898	1.0894	1.0890	1.0886	1.0882	1.0877	1.0873	1.0869	1.0865	1.0861
750	1.0857	1.0853	1.0848	1.0844	1.0840	1.0836	1.0832	1.0828	1.0824	1.0820
760	1.0816	1.0812	1.0808	1.0803	1.0799	1.0795	1.0791	1.0787	1.0783	1.0779
770	1.0775	1.0771	1.0767	1.0763	1.0759	1.0755	1.0751	1.0748	1.0744	1.0740
780	1.0736	1.0732	1.0728	1.0724	1.0720	1.0716	1.0712	1.0708	1.0704	1.0701
790	1.0697	1.0693	1.0689	1.0685	1.0681	1.0677	1.0674	1.0670	1.0666	1.0662
800	1.0658	1.0655	1.0651	1.0647	1.0643	1.0639	1.0636	1.0632	1.0628	1.0624
810	1.0621	1.0617	1.0613	1.0609	1.0606	1.0602	1.0598	1.0594	1.0591	1.0587
820	1.0583	1.0580	1.0576	1.0572	1.0569	1.0565	1.0561	1.0558	1.0554	1.0550
830	1.0547	1.0543	1.0540	1.0536	1.0532	1.0529	1.0525	1.0522	1.0518	1.0514
840	1.0511	1.0507	1.0504	1.0500	1.0497	1.0493	1.0489	1.0486	1.0482	1.0479
850	1.0475	1.0472	1.0468	1.0465	1.0461	1.0458	1.0454	1.0451	1.0447	1.0444
860	1.0440	1.0437	1.0433	1.0430	1.0427	1.0423	1.0420	1.0416	1.0413	1.0409
870	1.0406	1.0402	1.0399	1.0396	1.0392	1.0389	1.0386	1 0382	1.0379	1.0375
880	1.0372	1.0369	1.0365	1.0362	1.0359	1.0355	1.0352	1.0349	1.0345	1.0342
890	1.0339	1.0335	1.0332	1.0329	1.0325	1.0322	1.0319	1.0315	1.0312	1.0309
900	1.0306	1.0302	1.0299	1.0296	1.0293	1.0289	1.0286	1.0283	1.0280	1.0276
910	1.0273	1.0270	1.0267	1.0263	1.0260	1.0257	1.0254	1.0251	1.0247	1.0244
920	1.0241	1.0238	1.0235	1.0232	1.0228	1.0225	1.0222	1.0219	1.0216	1.0213
930	1.0210	1.0206	1.0203	1.0200	1.0197	1.0194	1.0191	1.0188	1.0185	1.0181
940	1.0178	1.0175	1.0172	1.0169	1.0166	1.0163	1.0160	1.0157	1.0154	1.0151
950	1.0148	1.0145	1.0142	1.0138	1.0135	1.0132	1.0129	1.0126	1.0123	1.0120
960	1.0117	1.0114	1.0111	1.0108	1.0105	1.0102	1.0099	1.0096	1.0093	1.0090
970	1.0087	1.0084	1.0081	1.0079	1.0076	1.0073	1.0070	1.0067	1.0064	1.0061
980	1.0058	1.0055	1.0052	1.0049	1.0046	1.0043	1.0040	1.0037	1.0035	1.0032
990	1.0029	1.0026	1.0023	1.0020	1.0017	1.0014	1.0011	1.0009	1.0006	1 0003
1000	1.0000	0.99971	0.99943	0.99914	0.99886	0.99858	0.99829	0.99801	0.99773	0.99744
1010	0.99716	.99688	.99660	.99632	.99604	.99576	.99548	.99520	.99492	.99464
1020	.99436	.99408	.99380	.99352	.99325	.99297	.99269	.99242	.99214	.99187
1030	.99159	.99132	.99104	.99077	.99049	.99022	.98995	.98967	.98940	.98913
1040	.98886	.98859	.98831	.98804	.98777	.98750	.98723	.98696	.98669	.98642
1050	0.98616	0.98589	0.98562	0.98535	0.98509	0.98482	0.98455	0.98429	0.98402	0.98375
1060	.98349	.98322	.98296	.98270	.98243	.98217	.98190	.98164	.98138	.98112
1070	.98085	.98059	.98033	.98007	.97981	.97955	.97929	.97903	.97877	.97851
1080	.97825	.97799	.97773	.97748	.97722	.97696	.97670	.97645	.97619	.97593
1090	.97568	.97542	.97517	.97491	.97466	.97440	.97415	.97390	.97364	.97339
1100	0.97314									

Table 4.14.2 **Potential temperature of dry air as a function of pressure and temperature**

Température potentielle de l'air sec en fonction de la pression et de la température

Temperature	Pressure — *pression*, mb											
	1050	950	900	850	800	750	700	600	500	400	350	300
°C	°K	°K	°K	°K	°K	°K	°K	°K	°K	°K	°K	°K
−89												259.8
−88												261.2
−87												262.6
−86												264.0
−85												265.4
−84												266.8
−83												268.2
−82												269.7
−81												271.1
−80												272.5
−79	191.5	197.0	200.1	203.4	206.9	210.8	215.0	224.7	236.7	252.3	262.1	273.9
−78	192.5	198.0	201.1	204.4	208.0	211.9	216.1	225.8	237.9	253.6	263.4	275.3
−77	193.4	199.1	202.2	205.5	209.1	213.0	217.2	227.0	239.1	254.9	264.8	276.7
−76	194.4	200.1	203.2	206.5	210.1	214.1	218.3	228.1	240.3	256.2	266.1	278.1
−75	195.4	201.1	204.2	207.6	211.2	215.1	219.4	229.3	241.6	257.5	267.5	279.5
−74	196.4	202.1	205.3	208.6	212.3	216.2	220.5	230.4	242.8	258.8	268.8	280.9
−73	197.4	203.1	206.3	209.7	213.3	217.3	221.6	231.6	244.0	260.1	270.2	282.3
−72	198.4	204.1	207.3	210.7	214.4	218.4	222.7	232.8	245.2	261.4	271.5	283.8
−71	199.4	205.2	208.3	211.8	215.5	219.5	223.9	233.9	246.4	262.7	272.9	285.2
−70	200.3	206.2	209.4	212.8	216.5	220.6	225.0	235.1	247.7	264.0	274.2	286.6
−69	201.3	207.2	210.4	213.9	217.6	221.7	226.1	236.2	248.9	265.3	275.6	288.0
−68	202.3	208.2	211.4	214.9	218.7	222.7	227.2	237.4	250.1	266.6	276.9	289.4
−67	203.3	209.2	212.5	216.0	219.7	223.8	228.3	238.5	251.3	267.9	278.3	290.8
−66	204.3	210.2	213.5	217.0	220.8	224.9	229.4	239.7	252.5	269.2	279.6	292.2
−65	205.3	211.2	214.5	218.0	221.9	226.0	230.5	240.9	253.7	270.5	281.0	293.6
−64	206.3	212.3	215.6	219.1	222.9	227.1	231.6	242.0	255.0	271.8	282.3	295.0
−63	207.3	213.3	216.6	220.1	224.0	228.2	232.7	243.2	256.2	273.1	283.7	296.5
−62	208.2	214.3	217.6	221.2	225.1	229.3	233.8	244.3	257.4	274.4	285.0	297.9
−61	209.2	215.3	218.7	222.2	226.1	230.3	234.9	245.5	258.6	275.7	286.4	299.3

TABLE 4.14 — 4

Temperature	Pressure — *pression*, mb											
	250	200	175	150	125	100	80	60	50	40	30	20
°C	°K	°K	°K	°K	°K	°K	°K	°K	°K	°K	°K	°K
—109						316.9	337.8	366.8	386.4	411.8	447.1	502.0
—108						318.9	339.9	369.0	388.7	414.3	449.8	505.0
—107						320.8	341.9	371.2	391.1	416.8	452.5	508.1
—106						322.7	344.0	373.5	393.4	419.3	455.2	511.2
—105						324.7	346.0	375.7	395.8	421.8	458.0	514.2
—104						326.6	348.1	377.9	398.1	424.3	460.7	517.3
—103						328.5	350.2	380.2	400.5	426.8	463.4	520.3
—102						330.5	352.2	382.4	402.8	429.4	466.1	523.4
—101						332.4	354.3	384.6	405.2	431.9	468.9	526.4
—100						334.3	356.3	386.9	407.5	434.4	471.6	529.5
— 99		275.8	286.6	299.5	315.5	336.3	358.4	389.1	409.9	436.9	474.3	532.6
— 98		277.4	288.2	301.2	317.3	338.2	360.4	391.3	412.2	439.4	477.0	535.6
— 97		279.0	289.9	302.9	319.1	340.1	362.5	293.6	414.6	441.9	479.8	538.7
— 96		280.6	291.5	304.6	320.9	342.0	364.6	395.8	416.9	444.4	482.5	541.7
— 95		282.2	293.1	306.3	322.7	344.0	366.6	398.0	419.3	446.9	485.2	544.8
— 94		283.8	294.8	308.1	324.5	345.9	368.7	400.3	421.7	449.4	487.9	547.9
— 93		285.3	296.4	309.8	326.3	347.8	370.7	402.5	424.0	451.9	490.6	550.9
— 92		286.9	298.1	311.5	328.2	349.8	372.8	404.7	426.4	454.4	493.4	554.0
— 91		288.5	299.7	313.2	330.0	351.7	374.8	407.0	428.7	456.9	496.1	557.0
— 90		290.1	301.4	314.9	331.8	353.6	376.9	409.2	431.1	459.5	498.8	560.1
— 89	273.7	291.7	303.0	316.7	333.6	255.6	379.0	411.4	433.4	462.0	501.5	563.1
— 88	275.1	293.3	304.7	318.4	335.4	357.5	381.0	413.7	435.8	464.5	504.3	566.2
— 87	276.6	294.8	306.3	320.1	337.2	359.4	383.1	415.9	438.1	467.0	507.0	569.3
— 86	278.1	296.4	308.0	321.8	339.0	361.4	385.1	418.1	440.5	469.5	509.7	572.3
— 85	279.6	298.0	309.6	323.5	340.8	363.3	387.2	420.4	442.8	472.0	512.4	575.4
— 84	281.1	299.6	311.2	325.3	342.6	365.2	389.3	422.6	445.2	474.5	515.2	578.4
— 83	282.6	301.2	312.9	327.0	344.5	367.1	391.3	424.8	447.5	477.0	517.9	581.5
— 82	284.1	302.8	314.5	328.7	346.3	369.1	393.4	427.1	449.9	479.5	520.6	584.5
— 81	285.6	304.3	316.2	330.4	348.1	371.0	395.4	429.3	452.2	482.0	523.3	587.6
— 80	287.0	305.9	317.8	332.1	349.9	372.9	397.5	431.5	454.6	484.5	526.1	590.7
— 79	288.5	307.5	319.5	333.9	351.7	374.9	399.5	433.8	457.0	487.1	528.8	593.7
— 78	290.0	309.1	321.1	335.6	353.5	376.8	401.6	436.0	459.3	489.6	531.5	596.8
— 77	291.5	310.7	322.8	337.3	355.3	378.7	403.7	438.2	461.7	492.1	534.2	599.8
— 76	293.0	312.3	324.4	339.0	357.1	380.7	405.7	440.5	464.0	494.6	536.9	602.9
— 75	294.5	313.8	326.1	340.7	358.9	382.6	407.8	442.7	466.4	497.1	539.7	606.0
— 74	296.0	315.4	327.7	342.5	360.8	384.5	409.8	444.9	468.7	499.6	542.4	609.0
— 73	297.4	317.0	329.3	344.2	362.6	386.4	411.9	447.2	471.1	502.1	545.1	612.1
— 72	298.9	318.6	331.0	345.9	364.4	388.4	413.9	449.4	473.4	504.6	547.8	615.1
— 71	300.4	320.2	332.6	347.6	366.2	390.3	416.0	451.6	475.8	507.1	550.6	618.2
— 70	301.9	321.8	334.3	349.3	368.0	392.2	418.1	453.9	478.1	509.6	553.3	621.2
— 69	303.4	323.3	335.9	351.1	369.8	394.2	420.1	456.1	480.5	512.1	556.0	624.3
— 68	304.9	324.9	337.6	352.8	371.6	396.1	422.2	458.3	482.8	514.6	558.7	627.4
— 67	306.4	326.5	339.2	354.5	373.4	398.0	424.2	460.6	485.2	517.2	561.5	630.4
— 66	307.8	328.1	340.9	356.2	375.2	400.0	426.3	462.8	487.6	519.7	564.2	633.5
— 65	309.3	329.7	342.5	357.9	377.1	401.9	428.4	465.1	489.9	522.2	566.9	636.5
— 64	310.8	331.3	344.2	359.7	378.9	403.8	430.4	467.3	492.3	524.7	569.6	639.6
— 63	312.3	332.9	345.8	361.4	380.7	405.8	432.5	469.5	494.6	527.2	572.3	642.6
— 62	313.8	334.4	347.4	363.1	382.5	407.7	434.5	471.8	497.0	529.7	575.1	645.7
— 61	315.3	336.0	349.1	364.8	384.3	409.6	436.6	474.0	499.3	532.2	577.8	648.8

Temperature	Pressure — *pression* mb											
	1050	950	900	850	800	750	700	600	500	400	350	300
°C	°K	°K	°K	°K	°K	°K	°K	°K	°K	°K	°K	°K
—60	210.2	216.3	219.7	223.3	227.2	231.4	236.0	246.6	259.8	277.0	287.7	300.7
—59	211.2	217.3	220.7	224.3	228.3	232.5	237.1	247.8	261.1	278.3	289.1	302.1
—58	212.2	218.3	221.7	225.4	229.3	233.6	238.2	249.0	262.3	279.6	290.4	303.5
—57	213.2	219.4	222.8	226.4	230.4	234.7	239.4	250.1	263.5	280.9	291.8	304.9
—56	214.2	220.4	223.8	227.5	231.4	235.8	240.5	251.3	264.7	282.2	293.1	306.3
—55	251.1	221.4	224.8	228.5	232.5	236.9	241.6	252.4	265.9	283.5	294.5	307.7
—54	216.1	222.4	225.9	229.6	233.6	237.9	242.7	253.6	267.2	284.8	295.8	309.1
—53	217.1	223.4	226.9	230.6	234.6	239.0	243.8	254.7	268.4	286.1	297.2	310.6
—52	218.1	224.4	227.9	231.7	235.7	240.1	244.9	255.9	269.6	287.4	298.5	312.0
—51	219.1	225.4	229.0	232.7	236.8	241.2	246.0	257.1	270.8	288.7	299.9	313.4
—50	220.1	226.5	230.0	233.8	237.8	242.3	247.1	258.2	272.0	290.0	301.2	314.8
—49	221.1	227.5	231.0	234.8	238.9	243.4	248.2	259.4	273.3	291.3	302.6	316.2
—48	222.0	228.5	232.0	235.9	240.0	244.5	249.3	260.5	274.5	292.6	303.9	317.6
—47	223.0	229.5	233.1	236.9	241.0	245.5	250.4	261.7	275.7	293.8	305.3	319.0
—46	224.0	230.5	234.1	238.0	242.1	246.6	251.5	262.8	276.9	295.1	306.6	320.4
—45	225.0	231.5	235.1	239.0	243.2	247.7	252.6	264.0	278.1	296.4	308.0	321.8
—44	226.0	232.6	236.2	240.0	244.2	248.8	253.7	265.2	279.3	297.7	309.3	323.3
—43	227.0	233.6	237.2	241.1	245.3	249.9	254.9	266.3	280.6	299.0	310.7	324.7
—42	228.0	234.6	238.2	242.1	246.4	251.0	256.0	267.5	281.8	300.3	312.0	326.1
—41	228.9	235.6	239.3	243.2	247.4	252.1	257.1	268.6	283.0	301.6	313.4	327.5
—40	229.9	236.6	240.3	244.2	248.5	253.1	258.2	269.8	284.2	302.9	314.7	328.9
—39	230.9	237.6	241.3	245.3	249.6	254.2	259.3	270.9	285.4	304.2	316.1	330.3
—38	231.9	238.6	242.4	246.3	250.6	255.3	260.4	272.1	286.7	305.5	317.4	331.7
—37	232.9	239.7	243.4	247.4	251.7	256.4	261.5	273.3	287.9	306.8	318.8	333.1
—36	233.9	240.7	244.4	248.4	252.8	257.5	262.6	274.4	289.1	308.1	320.1	334.5
—35	234.9	241.7	245.4	249.5	253.8	258.6	263.7	275.6	290.3	309.4	321.5	335.9
—34	235.9	242.7	246.5	250.5	254.9	259.7	264.8	276.7	291.5	310.7	322.8	337.4
—33	236.8	243.7	247.5	251.6	256.0	260.7	265.9	277.9	292.8	312.0	324.2	338.8
—32	237.8	244.7	248.5	252.6	257.0	261.8	267.0	279.0	294.0	313.3	325.5	340.2
—31	238.8	245.7	249.6	253.7	258.1	262.9	268.1	280.2	295.2	314.6	326.9	341.6
—30	239.8	246.8	250.6	254.7	259.2	264.0	269.3	281.4	296.4	315.9	328.2	343.0
—29	240.8	247.8	251.6	255.8	260.2	265.1	270.4	282.5	297.6	317.2	329.6	344.4
—28	241.8	248.8	252.7	256.8	261.3	266.2	271.5	283.7	298.9	318.5	330.9	345.8
—27	242.8	249.8	253.7	257.9	262.4	267.3	272.6	284.8	300.1	319.8	332.3	347.2
—26	243.7	250.8	254.7	258.9	263.4	268.3	273.7	286.0	301.3	321.1	333.6	348.6
—25	244.7	251.8	255.8	259.9	264.5	269.4	274.8	287.1	302.5	322.4	335.0	350.1
—24	245.7	252.8	256.8	261.0	265.6	270.5	275.9	288.3	303.7	323.7	336.3	351.5
—23	246.7	253.9	257.8	262.0	266.6	271.6	277.0	289.5	304.9	325.0	337.7	352.9
—22	247.7	254.9	258.8	263.1	267.7	272.7	278.1	290.6	306.2	326.3	339.0	354.3
—21	248.7	255.9	259.9	264.1	268.8	273.8	279.2	291.8	307.4	327.6	340.4	355.7
—20	249.7	256.9	260.9	265.2	269.8	274.9	280.3	292.9	308.6	328.9	341.7	357.1
—19	250.6	257.9	261.9	266.2	270.9	275.9	281.4	294.1	309.8	330.2	343.1	358.5
—18	251.6	258.9	263.0	267.3	271.9	277.0	282.5	295.2	311.0	331.5	344.4	359.9
—17	252.6	260.0	264.0	268.3	273.0	278.1	283.6	296.4	312.3	332.8	345.8	361.3
—16	253.6	261.0	265.0	269.4	274.1	279.2	284.8	297.6	313.5	334.1	347.1	362.7
—15	254.6	262.0	266.1	270.4	275.1	280.3	285.9	298.7	314.7	335.4	348.5	364.2
—14	255.6	263.0	267.1	271.5	276.2	281.4	287.0	299.9	315.9	336.7	349.8	365.6
—13	256.6	264.0	268.1	272.5	277.3	282.5	288.1	301.0	317.1	338.0	351.2	367.0
—12	257.5	265.0	269.2	273.6	278.3	283.5	289.2	302.2	318.4	339.3	352.5	368.4
—11	258.5	266.0	270.2	274.6	279.4	284.6	290.3	303.3	319.6	340.6	353.9	369.8

Temperature	Pressure — *pression*, mb											
	250	200	175	150	125	100	80	60	50	40	30	20
°C	°K	°K	°K	°K	°K	°K	°K	°K	°K	°K	°K	°K
−60	316.8	337.6	350.7	366.5	386.1	411.5	438.6	476.2	501.7	534.7	580.5	651.8
−59	318.2	339.2	352.4	368.2	387.9	413.5	440.7	478.5	504.0	537.2	583.2	654.9
−58	319.7	340.8	354.0	370.0	389.7	415.4	442.8	480.7	506.4	539.7	586.0	657.9
−57	321.2	342.4	355.7	371.7	391.6	417.3	444.8	482.9	508.7	542.2	588.7	661.0
−56	322.7	343.9	357.3	373.4	393.4	419.3	446.9	485.2	511.1	544.7	591.4	664.1
−55	324.2	345.5	359.0	375.1	395.2	421.2	448.9	487.4	513.4	547.3	594.1	667.1
−54	325.7	347.1	360.6	376.8	397.0	423.1	451.0	489.6	515.8	549.8	596.9	670.2
−53	327.2	348.7	362.3	378.6	398.8	425.1	453.0	491.9	518.1	552.3	599.6	673.2
−52	328.6	350.3	363.9	380.3	400.6	427.0	455.1	494.1	520.5	554.8	602.3	676.3
−51	330.1	351.9	365.5	382.0	402.4	428.9	457.2	496.3	522.9	557.3	605.0	679.3
−50	331.6	353.4	367.2	383.7	404.2	430.9	459.2	498.6	525.2	559.8	607.8	682.4
−49	333.1	355.0	368.8	385.4	406.0	432.8	461.3	500.8	527.6	562.3	610.5	685.5
−48	334.6	256.6	370.5	387.2	407.9	434.7	463.3	503.0	529.9	564.8	613.2	688.5
−47	336.1	358.2	372.1	388.9	409.7	436.6	465.4	505.3	532.3	567.3	615.9	691.6
−46	337.6	359.8	373.8	390.6	411.5	438.6	467.4	507.5	534.6	569.8	618.6	694.6
−45	339.0	361.4	375.4	392.3	413.3	440.5	469.5	509.7	537.0	572.3	621.4	697.7
−44	340.5	362.9	377.1	394.0	415.1	442.4	471.6	512.0	539.3	574.8	624.1	700.7
−43	342.0	364.5	378.7	395.8	416.9	444.4	473.6	514.2	541.7	577.4	626.8	703.8
−42	343.5	366.1	380.4	397.5	418.7	446.3	475.7	516.4	544.0	579.9	629.5	706.9
−41	345.0	367.7	382.0	399.2	420.2	448.2	477.7	518.7	546.4	582.4	632.3	709.9
−40	346.5	369.3	383.6	400.9	422.3	450.2	479.8	520.9	548.7	584.9	635.0	713.0
−39	348.0	370.9	384.3	402.6	424.2	452.1	481.9	523.1	551.1	587.4	637.7	716.0
−38	349.4	372.4	386.9	404.4	426.0	454.0	483.9	525.4	553.4	589.9	640.4	719.1
−37	350.9	374.0	388.6	406.1	427.8	456.0	486.0	527.6	555.8	592.4	643.2	722.2
−36	352.4	375.6	390.2	407.8	429.6	457.9	488.0	529.8	558.2	594.9	645.9	725.2
−35	353.9	377.2	391.9	409.5	431.4	459.8	490.1	532.1	560.5	597.4	648.6	728.3
−34	355.4	378.8	393.5	411.2	433.2	461.7	492.1	534.3	562.9	599.9	651.3	731.3
−33	356.9	380.4	395.2	413.0	435.0	463.7	494.2	536.5	565.2	602.4	654.1	734.4
−32	358.4	381.9	396.8	414.7	436.8	465.6	496.3	538.8	567.6	604.9	656.8	737.4
−31	359.9	383.5	398.5	416.4	438.6	467.5	498.3	541.0	569.9	607.5	659.5	740.5
−30	361.3	385.1	400.1	418.1	440.5	469.5	500.4	543.2	572.3	610.0	662.2	743.6
−29	362.8	386.7	401.7	419.8	442.3	471.4	502.4	545.5	574.6	612.5	664.9	746.6
−28	364.3	388.3	403.4	421.6	444.1	473.3	504.5	547.7	577.0	615.0	667.7	749.7
−27	365.8	389.9	405.0	423.3	445.9	475.3	506.5	549.9	579.3	617.5	670.4	752.7
−26	367.3	391.5	406.7	425.0	447.7	477.2	508.6	552.2	581.7	620.0	673.1	755.8
−25	368.8	393.0	408.3	426.7	449.5	479.1	510.7	554.4	584.0	622.5	675.8	758.8
−24	370.3	394.6	410.0	428.4	451.3	481.1	512.7	556.6	586.4	625.0	678.6	761.9
−23	371.7	396.2	411.6	430.2	453.1	483.0	514.8	558.9	588.8	627.5	681.3	765.0
−22	373.2	397.8	413.3	431.9	455.0	484.9	516.8	561.1	591.1	630.0	684.0	768.0
−21	374.7	399.4	414.9	433.6	456.8	486.8	518.9	563.4	593.5	632.5	686.7	771.1
−20	376.2	401.0	416.5	435.3	458.6	488.8	521.0	565.6	595.8	635.1	689.5	774.1
−19	377.7	402.5	418.2	437.0	460.4	490.7	523.0	567.8	598.2	637.6	692.2	777.2
−18	379.2	404.1	419.8	438.7	462.2	492.6	525.1	570.1	600.5	640.1	694.9	780.3
−17	380.7	405.7	421.5	440.5	464.0	494.6	527.1	572.3	602.9	642.6	697.6	783.3
−16	382.1	407.3	423.1	442.2	465.8	496.5	529.2	574.5	605.2	645.1	700.3	786.4
−15	383.6	408.9	424.8	443.9	467.6	498.4	531.2	576.8	607.6	647.6	703.1	789.4
−14	385.1	410.5	426.4	445.6	469.4	500.4	533.3	579.0	609.9	650.1	705.8	792.5
−13	386.6	412.0	428.1	447.3	471.3	502.3	535.4	581.2	612.3	652.6	708.5	795.5
−12	388.1	313.6	429.7	449.1	473.1	504.2	537.4	583.5	614.6	655.1	711.2	798.6
−11	389.6	415.2	431.4	450.8	474.9	506.2	539.5	585.7	617.0	657.6	714.0	801.7

Temperature	Pressure — *pression*, mb											
	1050	950	900	850	800	750	700	600	500	400	350	300
°C	°K	°K	°K	°K	°K	°K	°K	°K	°K	°K	°K	°K
−10	259.5	267.1	271.2	275.7	280.5	285.7	291.4	304.5	320.8	341.9	355.2	371.2
− 9	260.5	268.1	272.2	276.7	281.5	286.8	292.5	305.7	322.0	343.2	356.6	372.6
− 8	261.5	269.1	273.3	277.8	282.6	287.9	293.6	306.8	323.2	344.5	357.9	374.0
− 7	262.5	270.1	274.3	278.8	283.7	289.0	294.7	308.0	324.4	345.8	359.3	375.4
− 6	263.5	271.1	275.3	279.9	284.7	290.1	295.8	309.1	325.7	347.1	360.6	376.9
− 5	264.4	272.1	276.4	280.9	285.8	291.1	296.9	310.3	326.9	348.4	362.0	378.3
− 4	265.4	273.1	277.4	281.9	286.9	292.2	298.0	311.4	328.1	349.7	363.3	379.7
− 3	266.4	274.2	278.4	283.0	287.9	293.3	299.1	312.6	329.3	351.0	364.7	381.1
− 2	267.4	275.2	279.5	284.0	289.0	294.4	300.3	313.8	330.5	352.3	366.0	382.5
− 1	268.4	276.2	280.5	285.1	290.1	295.5	301.4	314.9	331.8	353.6	367.4	383.9
0	269.4	277.2	281.5	286.1	291.1	296.6	302.5	316.1	333.0	354.9	368.7	385.3
1	270.4	278.2	282.5	287.2	292.2	297.7	303.6	317.2	334.2	356.2	370.1	386.7
2	271.4	279.2	283.6	288.2	293.3	298.7	304.7	318.4	335.4	357.5	371.4	388.1
3	272.3	280.2	284.6	289.3	294.3	299.8	305.8	319.5	336.6	358.8	372.8	389.6
4	273.3	281.3	285.6	290.3	295.4	300.9	306.9	320.7	337.9	360.1	374.1	391.0
5	274.3	282.3	286.7	291.4	296.5	302.0	308.0	321.9	339.1	361.4	375.5	392.4
6	275.3	283.3	287.7	292.4	297.5	303.1	309.1	323.0	340.3	362.7	376.8	393.8
7	276.3	284.3	288.7	293.5	298.6	304.2	310.2	324.2	341.5	364.0	378.2	395.2
8	277.3	285.3	289.8	294.5	299.7	305.3	311.3	325.3	342.7	365.3	379.5	396.6
9	278.3	286.3	290.8	295.6	300.7	306.3	312.4	326.5	344.0	366.6	380.9	398.0
10	279.2	287.4	291.8	296.6	301.8	307.4	313.5	327.6	345.2	367.9	382.2	399.4
11	280.2	288.4	292.9	297.7	302.9	308.5	314.7	328.8	346.4	369.2	383.6	400.8
12	281.2	289.4	293.9	298.7	303.9	309.6	315.8	330.0	347.6	370.5	384.9	402.2
13	282.2	290.4	294.9	299.8	305.0	310.7	316.9	331.1	348.8	371.8	386.3	403.7
14	283.2	291.4	295.9	300.8	306.1	311.8	318.0	332.3	350.0	373.1	387.6	405.1
15	284.2	292.4	297.0	301.8	307.1	312.9	319.1	333.4	351.3	374.4	389.0	406.5
16	285.2	293.4	298.0	302.9	308.2	313.9	320.2	334.6	352.5	375.7	390.3	407.9
17	286.1	294.5	299.0	303.9	309.3	315.0	321.3	335.7	353.7	377.0	391.7	409.3
18	287.1	295.5	300.1	305.0	310.3	316.1	322.4	336.9	354.9	378.3	393.0	410.7
19	288.1	296.5	301.1	306.0	311.4	317.2	323.5	338.1	356.1	379.6	394.4	412.1
20	289.1	297.5	302.1	307.1	312.5	318.3	324.6	339.2	357.4	380.9	395.7	
21	290.1	298.5	303.2	308.1	313.5	319.4	325.7	340.4	358.6	382.2	397.1	
22	291.1	299.5	304.2	309.2	314.6	320.5	326.8	341.5	359.8	383.5	398.4	
23	292.1	300.5	305.2	310.2	315.6	321.5	327.9	342.7	361.0	384.8	399.8	
24	293.0	301.6	306.3	311.3	316.7	322.6	329.0	343.8	362.2	386.1	401.1	
25	294.0	302.6	307.3	312.3	317.8	323.7	330.2	345.0	363.5	387.4	402.5	
26	295.0	303.6	308.3	313.4	318.8	324.8	331.3	346.2	364.7	388.7	403.8	
27	296.0	304.6	309.3	314.4	319.9	325.9	332.4	347.3	365.9	390.0	405.2	
28	297.0	305.6	310.4	315.5	321.0	327.0	333.5	348.5	367.1	391.3	406.5	
29	298.0	306.6	311.4	316.5	322.0	328.1	334.6	349.6	368.3			
30	299.0	307.6	312.4	317.6	323.1	329.1	335.7	350.8	369.6			
31	300.0	308.7	313.5	318.6	324.2	330.2	336.8	351.9	370.8			
32	300.9	309.7	314.5	319.7	325.2	331.3	337.9	353.1	372.0			
33	301.9	310.7	315.5	320.7	326.3	332.4	339.0	354.3	373.2			
34	302.9	311.7	316.6	321.8	327.4	333.5	340.1	355.4	374.4			
35	303.9	312.7	317.6	322.8	328.4	334.6	341.2	356.6	375.6			
36	304.9	313.7	318.6	323.8	329.5	335.7	342.3	357.7	376.9			
37	305.9	314.8	319.7	324.9	330.6	336.7	343.4	358.9	378.1			
38	306.9	315.8	320.7	325.9	331.6	337.8	344.5	360.0	379.3			
39	307.8	316.8	321.7	327.0	332.7	338.9	345.7	361.2	380.5			

TABLE 4.14 — 8

Temperature	Pressure — *pression*, mb											
	250	200	175	150	125	100	80	60	50	40	30	20
°C	°K	°K	°K	°K	°K	°K	°K	°K	°K	°K	°K	°K
—10	391.1	416.8	433.0	452.5	476.7	508.1	541.5	587.9	619.3	660.1	716.7	804.7
— 9	392.5	418.4	434.6	454.2	478.5	510.0	543.6	590.2	621.7	662.6	719.4	807.8
— 8	394.0	420.0	436.3	455.9	480.3	511.9	545.6	592.4	624.1	665.2	722.1	810.8
— 7	395.5	421.5	437.9	457.7	482.1	513.9	547.7	594.6	626.4	667.7	724.9	813.9
— 6	397.0	423.1	439.6	459.4	483.9	515.8	549.8	596.9	628.8	670.2	727.6	816.9
— 5	398.5	424.7	441.2	461.1	485.7	517.7	551.8	599.1	631.1	672.7	730.3	820.0
— 4	400.0	426.3	442.9	462.8	487.6	519.7	553.9	601.3	633.5	675.2	733.0	823.1
— 3	401.5	427.9	444.5	464.5	389.4	521.6	555.9	603.6	635.8	677.7	735.8	826.1
— 2	402.9	429.5	446.2	466.3	491.2	523.5	558.0	605.8	638.2	680.2	738.5	829.2
— 1	404.4	431.0	447.8	468.0	493.0	525.5	560.1	608.0	640.5	682.7	741.2	832.2
0	405.9	432.6	449.5	469.7	494.8	527.4	562.1	610.3	642.9	685.2	743.9	835.3
1	407.4	434.2	451.1	471.4								
2	408.9	435.8	452.7	473.1								
3	410.4	437.4	454.4	474.9								
4	411.9	439.0	456.0	476.6								
5	413.3	440.6	457.7	478.3								
6	414.8	442.1	459.3	480.0								
7	416.3	443.7	461.0	481.7								
8	417.8	445.3	462.6	483.5								
9	419.3	446.9	464.3	485.2								
10	420.8	448.5										
11	422.3	450.1										
12	423.7	451.6										
13	425.2	453.2										
14	426.7	454.8										
15	428.2	456.4										
16	429.7	458.0										
17	431.2	459.6										
18	432.7	461.1										
19	434.2	462.7										

	Pressure — *pression*, mb						
	1050	950	900	850	800	750	700
°C	°K	°K	°K	°K	°K	°K	°K
40	308.8	317.8	322.7	328.0	333.8	340.0	346.8
41	309.8	318.8	323.8	329.1	334.8	341.1	347.9
42	310.8	319.8	324.8	330.1	335.9	342.2	349.0
43	311.8	320.8	325.8	331.2	337.0	343.3	350.1
44	312.8	321.9	326.9	332.2	338.0	344.3	351.2
45	313.8	322.9	327.9	333.3	339.1	345.4	352.3
46	314.7	323.9	328.9	334.3	340.2	346.5	353.4
47	315.7	324.9	330.0	335.4	341.2	347.6	354.5
48	316.7	325.9	331.0	336.4	342.3	348.7	355.6
49	317.7	326.9	332.0	337.5	343.4	349.8	356.7
50	318.7	327.9					
51	319.7	329.0					
52	320.7	330.0					
53	321.6	331.0					
54	322.6	332.0					
55	323.6	333.0					
56	324.6	334.0					
57	325.6	335.0					
58	326.6	336.1					
59	327.6	337.1					

Temperature °C	Pressure-*pression* mb 70 °K	Pressure-*pression* mb 10 °K
−109	350.9	611.9
−108	353.1	615.7
−107	355.2	619.4
−106	357.4	623.1
−105	359.5	626.8
−104	361.6	630.6
−103	363.8	634.3
−102	365.9	638.0
−101	368.0	641.7
−100	370.2	645.5
− 99	372.3	649.2
− 98	374.5	652.9
− 97	376.6	656.7
− 96	378.7	660.4
− 95	380.9	664.1
− 94	383.0	667.8
− 93	385.1	671.6
− 92	387.3	675.3
− 91	389.4	679.0
− 90	391.6	682.7
− 89	393.7	686.5
− 88	395.8	690.2
− 87	398.0	693.9
− 86	400.1	697.7
− 85	402.2	701.4
− 84	404.4	705.1
− 83	406.5	708.8
− 82	408.7	712.6
− 81	410.8	716.3
− 80	412.9	720.0
− 79	415.1	723.8
− 78	417.2	727.5
− 77	419.4	731.2
− 76	421.5	734.9
− 75	423.6	738.7
− 74	425.8	742.4
− 73	427.9	746.1
− 72	430.0	749.8
− 71	432.2	753.6
−70	434.3	757.3
−69	436.5	761.0
−68	438.6	764.8
−67	440.7	768.5
−66	442.9	772.2
−65	445.0	775.9
−64	447.1	779.7
−63	449.3	783.4
−62	451.4	787.1
−61	453.6	790.8
−60	455.7	794.6
−59	457.8	798.3
−58	460.0	802.0
−57	462.1	805.8
−56	464.2	809.5
−55	466.4	813.2
−54	468.5	816.9
−53	470.7	820.7
−52	472.8	824.4
−51	474.9	828.1
−50	477.1	831.9
−49	479.2	835.6
−48	481.3	839.3
−47	483.5	843.0
−46	485.6	846.8
−45	487.8	850.5
−44	489.9	854.2
−43	492.0	857.9
−42	494.2	861.7
−41	496.3	865.4
−40	498.4	869.1
−39	500.6	872.9
−38	502.7	876.6
−37	504.9	880.3
−36	507.0	884.0
−35	509.1	887.8
−34	511.3	891.5
−33	513.4	895.2
−32	515.6	898.9
−31	517.7	902.7
−30	519.8	906.4
−29	522.0	910.1
−28	524.1	913.9
−27	526.2	917.6
−26	528.4	921.3
−25	530.5	925.0
−24	532.7	928.8
−23	534.8	932.5
−22	536.9	936.2
−21	539.1	940.0
−20	541.2	943.7
−19	543.3	947.4
−18	545.5	951.1
−17	547.6	954.9
−16	549.8	958.6
−15	551.9	962.3
−14	554.0	966.0
−13	556.2	969.8
−12	558.3	973.5
−11	560.4	977.2
−10	562.6	981.0
− 9	564.7	984.7
− 8	566.9	988.4
− 7	569.0	992.1
− 6	571.1	995.9
− 5	573.3	999.6
− 4	575.4	1003.3
− 3	577.5	1007.0
− 2	579.7	1010.8
− 1	581.8	1014.5
0	584.0	1018.2

Table 4.15.1 Pressure as a function of temperature along saturation pseudo-adiabats

Pression en fonction de la température le long des pseudoadiabatiques de saturation

θ_W: pseudo wet-bulb potential temperature — *température pseudoadiabatique potentielle du thermomètre mouillé*

Temperature °C	θ_W, °C 40	38	36	34	32	30	28	26	24	22
	mb	mb	mb	mb	mb	mb	mb	mb	mb	mb
42	1072.6									
40	1000.0	1071.2								
38	932.0	1000.0	1069.8							
36	868.3	933.2	1000.0	1068.2						
34	808.8	870.7	934.6	1000.0	1066.6					
32	753.4	812.3	873.4	936.0	1000.0	1065.0				
30	701.6	757.7	816.1	876.2	937.6	1000.0	1063.2			
28	653.2	706.8	762.6	820.2	879.2	939.2	1000.0	1061.4		
26	608.1	659.2	712.6	767.8	824.5	882.2	940.8	1000.0	1059.6	
24	566.1	615.0	666.0	718.9	773.4	829.0	885.4	942.5	1000.0	1057.8
22	527.0	573.6	622.6	673.3	725.6	779.2	833.6	888.7	944.2	1000.0
20	490.6	535.2	582.1	630.8	681.2	732.8	785.2	838.4	892.0	946.0
18	456.9	499.4	544.4	591.2	639.7	689.4	740.1	791.4	843.2	895.4
16	425.6	466.2	509.4	554.4	601.0	649.0	698.0	747.5	797.6	848.0
14	396.4	435.4	476.8	520.1	565.0	611.4	658.6	706.5	755.0	803.8
12	369.5	406.8	446.6	488.2	531.5	576.2	621.8	668.2	715.2	762.5
10	344.6	380.2	418.4	458.5	500.3	543.5	587.6	632.5	678.0	723.8
8	321.4	355.6	392.4	431.0	471.3	513.0	555.8	599.2	643.2	687.8
6	300.1	332.8	368.2	405.4	444.3	484.7	526.1	568.2	610.9	654.1
4	280.4	311.8	345.8	381.6	419.3	458.4	498.5	539.2	580.7	622.6
2	262.2	292.3	325.1	359.7	396.1	434.0	472.8	512.3	552.6	593.2
0	245.4	274.3	305.9	339.3	374.6	411.2	448.8	487.2	526.3	565.8
−2	229.9	257.7	288.2	320.4	354.6	390.1	426.6	463.8	501.8	540.1
−4	215.6	242.4	271.8	303.0	336.0	370.5	405.9	442.1	479.0	516.2
−6	202.4	228.2	256.6	286.8	318.8	352.3	386.6	421.8	457.6	493.8
−8	190.4	215.2	242.6	271.9	302.9	335.4	368.8	403.0	437.8	473.0
−10	179.2	203.1	229.6	258.0	288.2	319.7	352.1	385.4	419.2	453.4
−12	169.0	192.0	217.7	245.2	274.4	305.1	336.6	368.9	401.8	435.2
−14	159.5	181.8	206.6	233.4	261.7	291.5	322.1	353.5	385.6	418.0
−16	150.8	172.3	196.4	222.4	249.9	278.8	308.6	339.1	370.3	401.8
−18	142.8	163.6	187.0	212.2	238.9	267.0	296.0	325.6	356.0	386.6
−20	135.4	155.5	178.2	202.6	228.6	256.0	284.1	312.9	342.4	372.2
−22	128.6	148.0	170.0	193.7	219.0	245.6	273.0	301.0	329.7	358.6
−24	122.4	141.2	162.4	185.4	210.0	236.0	262.5	289.7	317.7	345.8
−26	116.6	134.8	155.4	177.8	201.6	226.8	252.6	279.1	306.4	333.8
−28	111.3	128.8	148.8	170.6	193.8	218.3	243.4	269.1	295.6	322.2
−30	106.4	123.4	142.7	163.8	186.4	210.2	234.6	259.6	285.4	311.3
−32	101.8	118.2	137.0	157.5	179.4	202.6	226.4	250.6	275.6	300.8
−34		113.4	131.6	151.6	172.9	195.4	218.4	242.0	266.4	290.8
−36		108.9	126.6	145.9	166.6	188.6	211.0	233.8	257.6	281.3
−38		104.6	121.8	140.5	160.7	182.0	203.8	226.0	249.0	272.2
−40		100.5	117.2	135.4	155.0	175.8	196.9	218.5	240.9	263.4
−42			112.8	130.6	149.6	169.8	190.4	211.3	233.1	254.9
−44			108.8	126.0	144.4	164.2	184.0	204.4	225.6	246.8
−46			104.8	121.5	139.5	158.6	178.0	197.8	218.3	238.8
−48			101.0	117.2	134.7	153.4	172.1	191.4	211.3	231.2
−50				113.1	130.1	148.2	166.4	185.2	204.5	223.9

TABLE 4.15 — 2

Temperature °C	θ_W, °C 20	18	16	14	12	10	8	6	4	2
	mb	mb	mb	mb	mb	mb	mb	mb	mb	mb
22	1055.9									
20	1000.0	1054.0								
18	947.6	1000.0	1052.2							
16	898.7	949.4	1000.0	1050.5						
14	852.9	902.0	951.0	1000.0	1048.8					
12	810.0	857.0	905.2	952.7	1000.0	1047.1				
10	769.9	816.1	862.2	908.4	954.2	1000.0	1045.5			
8	732.4	777.3	822.0	866.8	911.4	955.8	1000.0	1043.8		
6	697.4	741.0	784.4	827.9	871.2	914.4	957.2	1000.0	1042.5	
4	664.7	707.0	749.2	791.4	833.6	875.5	917.2	958.6	1000.0	1041.2
2	634.1	675.2	716.2	757.3	798.2	839.0	879.5	919.8	960.1	1000.0
0	605.5	645.4	685.2	725.2	765.0	804.6	844.0	883.3	922.4	961.3
−2	578.8	617.5	656.2	695.1	733.8	772.4	810.7	848.8	887.0	924.8
−4	553.8	591.4	629.0	666.8	704.4	742.0	779.2	816.4	853.4	890.3
−6	530.4	567.0	603.5	640.2	676.8	713.3	749.6	785.7	821.8	857.6
−8	508.4	544.0	579.6	615.2	650.8	686.3	721.6	756.8	791.9	826.8
−10	488.0	522.5	557.0	591.6	626.3	660.8	695.2	729.4	763.6	797.5
−12	468.7	502.2	535.8	569.4	603.2	636.7	670.2	703.4	736.7	769.7
−14	450.6	483.2	515.8	548.5	581.3	613.9	646.4	678.8	711.2	743.2
−16	433.6	465.2	496.9	528.6	560.6	592.2	623.9	655.4	686.8	718.0
−18	417.4	448.2	479.0	509.8	540.9	571.7	602.5	633.0	663.7	694.0
−20	402.2	432.2	462.0	492.0	522.2	552.2	582.2	611.8	641.6	671.2
−22	387.9	417.0	446.0	475.2	504.6	533.6	562.8	591.6	620.6	649.2
−24	374.3	402.6	430.8	459.1	487.6	516.0	544.2	572.3	600.4	628.3
−26	361.4	388.8	416.2	443.8	471.5	499.0	526.5	553.8	581.1	608.2
−28	349.2	375.8	402.4	429.1	456.0	482.8	509.5	536.0	562.6	588.8
−30	337.4	363.3	389.0	415.0	441.2	467.2	493.2	518.8	544.7	570.2
−32	326.2	351.4	376.3	401.6	427.0	452.2	477.4	502.4	527.4	552.3
−34	315.6	339.9	364.1	388.6	413.2	437.7	462.2	486.4	510.8	535.0
−36	305.3	329.0	352.4	376.2	400.1	423.8	447.6	471.2	494.8	518.3
−38	295.4	318.4	341.1	364.2	387.4	410.4	433.6	456.4	479.4	502.2
−40	286.0	308.2	330.2	352.6	375.2	397.4	419.9	442.0	464.4	486.5
−42	276.9	298.4	319.8	341.5	363.4	385.0	406.7	428.2	449.9	471.3
−44	268.1	289.0	309.6	330.7	351.9	372.8	394.0	414.8	435.8	456.6
−46	259.6	279.8	299.8	320.2	340.8	361.1	381.6	401.8	422.2	442.4
−48	251.4	271.0	290.4	310.1	330.0	349.7	369.6	389.2	409.0	428.4
−50	243.4	262.4	281.2	300.3	319.6	338.6	357.9	376.8	396.0	415.0

Temperature °C	θw, °C 0	—2	—4	—6	—8	—10	—12	—14	—16	—18
	mb	mb	mb	mb	mb	mb	mb	mb	mb	mb
4	1082.0									
2	1039.8	1079.6								
0	1000.0	1038.6	1077.2							
−2	962.4	1000.0	1037.6	1075.1						
−4	926.8	963.4	1000.0	1036.6	1073.2					
−6	893.2	928.8	964.4	1000.0	1035.6	1071.4				
−8	861.5	896.0	930.6	965.3	1000.0	1034.8	1069.9			
−10	831.3	864.8	898.6	932.3	966.1	1000.0	1034.2	1068.6		
−12	802.6	835.2	868.0	900.8	933.8	966.8	1000.0	1033.5	1067.4	
−14	775.2	807.0	838.8	870.8	902.8	935.0	967.4	1000.0	1033.0	1066.3
−16	749.2	780.1	811.0	842.2	873.4	904.8	936.2	967.9	1000.0	1032.5
−18	724.4	754.4	784.5	814.8	845.1	875.6	906.2	937.1	968.4	1000.0
−20	700.6	729.8	759.1	788.6	818.0	847.6	877.5	907.6	938.0	968.8
−22	677.9	706.3	734.8	763.4	792.1	820.9	850.0	879.2	908.7	938.7
−24	656.2	683.8	711.5	739.4	767.2	795.2	823.4	851.8	880.6	909.8
−26	635.2	662.1	689.0	716.2	743.2	770.4	797.9	825.6	853.5	881.8
−28	615.2	641.2	667.4	693.8	720.1	746.6	773.2	800.2	827.4	854.9
−30	595.8	621.2	646.6	672.2	697.8	723.4	749.4	775.6	802.0	828.8
−32	577.1	601.7	626.4	651.3	676.2	701.1	726.4	751.8	777.6	803.6
−34	559.0	583.0	607.0	631.1	655.2	679.4	704.0	728.8	753.8	779.2
−36	541.6	564.8	588.2	611.6	635.0	658.5	682.4	706.4	730.8	755.4
−38	524.8	547.3	569.9	592.6	615.4	638.2	661.4	684.8	708.4	732.4
−40	508.4	530.3	552.2	574.3	596.4	618.5	641.1	663.8	686.8	710.0
−42	492.6	513.8	535.0	556.5	577.9	599.4	621.4	643.4	665.6	688.2
−44	477.2	497.8	518.4	539.2	560.0	580.8	602.2	623.5	645.1	667.0
−46	462.4	482.3	502.3	522.4	542.6	562.8	583.4	604.2	625.2	646.3
−48	447.8	467.2	486.6	506.2	525.6	545.2	565.3	585.4	605.8	626.2
−50	433.8	452.5	471.3	490.2	509.2	528.2	547.6	567.2	586.8	606.8

Temperature °C	θw, °C —20	—22	—24	—26	—28	—30	—32	—34	—36	—38
	mb	mb	mb	mb	mb	mb	mb	mb	mb	mb
−16	1065.4									
−18	1032.1	1064.8								
−20	1000.0	1031.8	1064.2							
−22	969.1	1000.0	1031.5	1063.7						
−24	939.4	969.4	1000.0	1031.3	1063.4					
−26	910.6	939.8	969.6	1000.0	1031.2	1063.2				
−28	882.9	911.2	940.1	969.7	1000.0	1031.1	1063.1			
−30	856.0	883.6	911.6	940.4	969.8	1000.0	1031.0	1063.0		
−32	830.0	856.8	884.0	911.9	940.5	969.8	1000.0	1031.0	1063.1	
−34	804.8	830.8	857.2	884.3	912.1	940.6	969.8	1000.0	1031.1	1063.2
−36	780.3	805.5	831.2	857.5	884.5	912.2	940.6	969.8	1000.0	1031.2
−38	756.6	781.0	806.0	831.5	857.7	884.6	912.2	940.6	969.8	1000.0
−40	733.4	757.2	781.5	806.2	831.6	857.8	884.5	912.0	940.4	969.7
−42	711.0	734.0	757.6	781.6	806.3	831.6	857.6	884.2	911.8	940.2
−44	689.0	711.5	734.4	757.7	781.6	806.2	831.3	857.2	883.9	911.5
−46	667.8	689.6	711.7	734.4	757.6	781.4	805.8	830.8	856.8	883.5
−48	647.0	668.2	689.6	711.6	734.1	757.2	780.8	805.0	830.2	856.2
−50	626.9	647.4	668.2	689.4	711.2	733.6	756.4	780.0	804.4	829.6

Table 4.15.2 **Saturation mixing ratio as a function of temperature along saturation pseudo-adiabats**

Rapport de mélange de saturation en fonction de la température le long des pseudoadiabatiques de saturation

θ_W : pseudo wet-bulb potential temperature — *température pseudoadiabatique potentielle du thermomètre mouillé*

Temperature °C	θ_W, °C 40	38	36	34	32	30	28	26	24	22
	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}
42	51.5									
40	49.5	46.0								
38	47.6	44.1	41.1							
36	45.7	42.3	39.3	36.6						
34	43.8	40.5	37.5	34.9	32.7					
32	41.9	38.7	35.8	33.3	31.1	29.1				
30	40.0	36.9	34.1	31.7	29.5	27.6	25.9			
28	38.2	35.1	32.4	30.1	27.9	26.1	24.4	23.0		
26	36.3	33.4	30.8	28.5	26.4	24.6	23.0	21.7	20.4	
24	34.6	31.7	29.2	26.9	25.0	23.2	21.7	20.3	19.1	18.0
22	32.8	30.0	27.6	25.4	23.5	21.8	20.4	19.1	17.9	16.9
20	31.1	28.4	26.0	23.9	22.1	20.5	19.1	17.8	16.7	15.8
18	29.4	26.8	24.5	22.5	20.7	19.2	17.8	16.6	15.6	14.7
16	27.7	25.2	23.0	21.1	19.4	17.9	16.6	15.5	14.5	13.6
14	26.1	23.7	21.6	19.7	18.1	16.7	15.5	14.4	13.4	12.6
12	24.5	22.2	20.2	18.4	16.8	15.5	14.3	13.3	12.4	11.6
10	23.0	20.7	18.8	17.1	15.6	14.4	13.3	12.3	11.5	10.7
8	21.5	19.3	17.5	15.9	14.5	13.3	12.2	11.3	10.5	9.85
6	20.0	18.0	16.2	14.7	13.4	12.2	11.2	10.4	9.66	9.02
4	18.6	16.6	15.0	13.5	12.3	11.2	10.3	9.52	8.83	8.23
2	17.2	15.4	13.8	12.4	11.3	10.3	9.42	8.69	8.04	7.49
0	15.9	14.2	12.7	11.4	10.3	9.38	8.58	7.90	7.30	6.79
−2	14.6	13.0	11.6	10.4	9.39	8.53	7.79	7.16	6.61	6.14
−4	13.4	11.9	10.6	9.47	8.53	7.72	7.04	6.46	5.96	5.54
−6	12.2	10.8	9.61	8.59	7.72	6.97	6.35	5.81	5.35	4.96
−8	11.1	9.83	8.70	7.75	6.95	6.27	5.70	5.21	4.79	4.43
−10	10.1	8.89	7.85	6.98	6.24	5.62	5.10	4.65	4.28	3.95
−12	9.11	8.01	7.05	6.25	5.58	5.02	4.54	4.14	3.80	3.51
−14	8.20	7.18	6.31	5.58	4.97	4.46	4.03	3.67	3.37	3.10
−16	7.35	6.42	5.62	4.96	4.41	3.95	3.57	3.24	2.97	2.74
−18	6.55	5.71	4.99	4.39	3.90	3.49	3.14	2.85	2.61	2.40
−20	5.82	5.06	4.41	3.87	3.43	3.06	2.76	2.50	2.29	2.10
−22	5.14	4.46	3.88	3.40	3.01	2.68	2.41	2.19	1.99	1.83
−24	4.52	3.91	3.40	2.98	2.63	2.33	2.11	1.90	1.73	1.59
−26	3.96	3.42	2.96	2.59	2.28	2.03	1.82	1.65	1.50	1.38
−28	3.45	2.98	2.57	2.24	1.97	1.75	1.57	1.42	1.29	1.19
−30	2.99	2.57	2.23	1.94	1.70	1.51	1.35	1.22	1.11	1.02
−32	2.58	2.22	1.91	1.66	1.46	1.29	1.16	1.05	0.950	0.871
−34		1.90	1.64	1.42	1.25	1.10	0.988	0.891	0.809	0.741
−36		1.63	1.40	1.21	1.06	0.939	0.839	0.757	0.687	0.629
−38		1.38	1.19	1.03	0.900	0.795	0.710	0.640	0.581	0.531
−40		1.17	1.01	0.870	0.760	0.670	0.598	0.539	0.489	0.447
−42			0.847	0.732	0.639	0.563	0.502	0.452	0.410	0.375
−44			0.709	0.612	0.534	0.470	0.419	0.377	0.342	0.312
−46			0.592	0.510	0.444	0.391	0.348	0.313	0.284	0.260
−48			0.492	0.424	0.369	0.322	0.288	0.259	0.235	0.215
−50				0.350	0.304	0.267	0.238	0.214	0.193	0.177

Temperature °C	θ_w, °C 20	18	16	14	12	10	8	6	4	2
	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}
22	16.0									
20	14.9	14.1								
18	13.8	13.1	12.4							
16	12.8	12.1	11.5	11.0						
14	11.9	11.2	10.6	10.1	9.62					
12	11.0	10.3	9.78	9.29	8.84	8.44				
10	10.1	9.50	8.98	8.52	8.10	7.73	7.39			
8	9.24	8.70	8.22	7.79	7.40	7.06	6.74	6.46		
6	8.45	7.94	7.50	7.10	6.74	6.42	6.13	5.87	5.63	
4	7.70	7.23	6.82	6.45	6.13	5.83	5.56	5.32	5.10	4.89
2	7.00	6.57	6.19	5.85	5.55	5.27	5.03	4.81	4.60	4.42
0	6.34	5.94	5.59	5.28	5.01	4.76	4.53	4.33	4.15	3.98
−2	5.72	5.36	5.04	4.76	4.50	4.28	4.07	3.89	3.72	3.57
−4	5.15	4.82	4.53	4.27	4.04	3.83	3.65	3.48	3.33	3.19
−6	4.61	4.31	4.05	3.82	3.61	3.42	3.26	3.11	2.97	2.85
−8	4.12	3.85	3.61	3.40	3.22	3.05	2.90	2.76	2.64	2.53
−10	3.67	3.43	3.21	3.02	2.86	2.71	2.57	2.45	2.34	2.24
−12	3.26	3.04	2.85	2.68	2.53	2.39	2.27	2.17	2.07	1.98
−14	2.88	2.68	2.51	2.36	2.23	2.11	2.00	1.91	1.82	1.74
−16	2.53	2.36	2.21	2.08	1.96	1.85	1.76	1.67	1.60	1.53
−18	2.22	2.07	1.94	1.82	1.72	1.62	1.54	1.47	1.40	1.34
−20	1.95	1.81	1.69	1.59	1.50	1.42	1.34	1.28	1.22	1.16
−22	1.69	1.58	1.47	1.38	1.30	1.23	1.17	1.11	1.06	1.01
−24	1.47	1.37	1.28	1.20	1.13	1.07	1.01	0.961	0.913	0.875
−26	1.27	1.18	1.10	1.03	0.974	0.920	0.872	0.829	0.790	0.755
−28	1.09	1.02	0.950	0.890	0.838	0.791	0.750	0.713	0.679	0.649
−30	0.939	0.872	0.815	0.763	0.718	0.678	0.642	0.611	0.582	0.556
−32	0.803	0.745	0.696	0.652	0.613	0.579	0.548	0.521	0.496	0.474
−34	0.683	0.634	0.592	0.555	0.522	0.492	0.466	0.443	0.422	0.403
−36	0.580	0.538	0.502	0.470	0.442	0.417	0.395	0.375	0.357	0.341
−38	0.489	0.454	0.424	0.397	0.373	0.352	0.333	0.317	0.302	0.288
−40	0.412	0.382	0.356	0.334	0.314	0.296	0.280	0.266	0.254	0.242
−42	0.345	0.320	0.299	0.280	0.263	0.248	0.235	0.223	0.212	0.203
−44	0.288	0.267	0.249	0.233	0.219	0.207	0.196	0.186	0.177	0.169
−46	0.239	0.222	0.207	0.194	0.182	0.172	0.162	0.154	0.147	0.140
−48	0.197	0.183	0.171	0.160	0.150	0.142	0.134	0.127	0.121	0.116
−50	0.162	0.151	0.141	0.132	0.124	0.117	0.110	0.105	0.0999	0.0953

Temperature g kg	θ_w, °C 0	−2	−4	−6	−8	−10	−12	−14	−16	−18
	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}
4	4.71									
2	4.25	4.09								
0	3.82	3.68	3.55							
−2	3.43	3.30	3.18	3.07						
−4	3.07	2.95	2.84	2.74	2.65					
−6	2.73	2.63	2.53	2.44	2.36	2.28				
−8	2.43	2.33	2.25	2.16	2.09	2.02	1.95			
−10	2.15	2.07	1.99	1.92	1.85	1.79	1.73	1.67		
−12	1.90	1.82	1.75	1.69	1.63	1.57	1.52	1.47	1.43	
−14	1.67	1.60	1.54	1.49	1.43	1.38	1.34	1.29	1.25	1.21
−16	1.46	1.41	1.35	1.30	1.26	1.21	1.17	1.13	1.10	1.06
−18	1.28	1.23	1.18	1.14	1.10	1.06	1.02	0.989	0.957	0.927
−20	1.12	1.07	1.03	0.991	0.955	0.922	0.890	0.861	0.833	0.806
−22	0.968	0.929	0.893	0.860	0.829	0.799	0.772	0.746	0.722	0.699
−24	0.838	0.804	0.773	0.743	0.716	0.691	0.667	0.645	0.624	0.604
−26	0.723	0.693	0.666	0.641	0.617	0.596	0.575	0.556	0.538	0.520
−28	0.621	0.596	0.572	0.550	0.530	0.511	0.494	0.477	0.461	0.447
−30	0.532	0.510	0.490	0.471	0.454	0.438	0.423	0.408	0.395	0.382
−32	0.454	0.435	0.418	0.402	0.387	0.373	0.360	0.348	0.337	0.326
−34	0.386	0.370	0.355	0.341	0.329	0.317	0.306	0.296	0.286	0.277
−36	0.327	0.313	0.301	0.289	0.278	0.269	0.259	0.250	0.242	0.234
−38	0.275	0.264	0.254	0.244	0.235	0.226	0.219	0.211	0.204	0.197
−40	0.231	0.222	0.213	0.205	0.197	0.190	0.184	0.177	0.171	0.166
−42	0.194	0.186	0.178	0.172	0.165	0.159	0.154	0.148	0.143	0.139
−44	0.162	0.155	0.149	0.143	0.138	0.133	0.128	0.124	0.119	0.116
−46	0.134	0.128	0.123	0.119	0.114	0.110	0.106	0.103	0.0991	0.0959
−48	0.111	0.106	0.102	0.0980	0.0944	0.0910	0.0881	0.0847	0.0819	0.0792
−50	0.0912	0.0874	0.0839	0.0807	0.0777	0.0749	0.0722	0.0697	0.0674	0.0652

Temperature °C	θ_w, °C −20	−22	−24	−26	−28	−30	−32	−34	−36	−38
	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}
−16	1.03									
−18	0.898	0.870								
−20	0.781	0.757	0.734							
−22	0.677	0.656	0.636	0.617						
−24	0.585	0.567	0.550	0.533	0.517					
−26	0.504	0.488	0.473	0.459	0.445	0.431				
−28	0.432	0.419	0.406	0.394	0.382	0.370	0.359			
−30	0.370	0.358	0.347	0.337	0.326	0.317	0.307	0.298		
−32	0.315	0.305	0.296	0.287	0.278	0.270	0.262	0.254	0.246	
−34	0.268	0.259	0.251	0.244	0.236	0.229	0.222	0.215	0.209	0.203
−36	0.227	0.220	0.213	0.206	0.200	0.194	0.188	0.182	0.177	0.171
−38	0.191	0.185	0.179	0.174	0.168	0.163	0.158	0.154	0.149	0.145
−40	0.160	0.155	0.151	0.146	0.141	0.137	0.133	0.129	0.125	0.121
−42	0.134	0.130	0.126	0.122	0.118	0.115	0.111	0.108	0.105	0.102
−44	0.112	0.108	0.105	0.102	0.0986	0.0956	0.0927	0.0899	0.0872	0.0846
−46	0.0928	0.0899	0.0871	0.0844	0.0818	0.0793	0.0769	0.0746	0.0723	0.0701
−48	0.0767	0.0742	0.0719	0.0697	0.0676	0.0655	0.0635	0.0616	0.0598	0.0579
−50	0.0631	0.0611	0.0592	0.0574	0.0556	0.0539	0.0523	0.0507	0.0492	0.0477

Table 4.16.1 Terminal velocity of fall of pure water droplets in still air

Vitesse limite de chute des gouttelettes d'eau pure en air calme

A Small droplets — *Petites gouttelettes*

d	*v*	*d*	*v*	*d*	*v*
μ	cm s^{-1}	μ	cm s^{-1}	μ	cm s^{-1}
2	0.01197	10	0.2993	40	4.788
4	0.04788	15	0.6734	50	7.482
6	0.1077	20	1.197	60	10.774
8	0.1915	30	2.693	70	14.664
				80	19.154

d : diameter — *diamètre*

v : terminal velocity of fall (computed)
vitesse limite de chute (calculée)

B Medium and large droplets — *Gouttelettes moyennes et grosses*

d	*v*	*m*	*Re*	C_D
cm	cm s^{-1}	μg		
0.01	27	0.524	1.80	15.0
0.02	72	4.19	9.61	4.2
0.03	117	14.14	23.4	2.4
0.04	162	33.5	43.2	1.66
0.05	206	65.5	68.7	1.28
0.06	247	113.1	98.9	1.07
0.07	287	179.6	134	0.926
0.08	327	268	175	.815
0.09	367	382	220	.729
0.10	403	524	269	.671
0.12	464	905	372	0.607
0.14	517	1,437	483	.570
0.16	565	2,140	603	.545
0.18	609	3,050	731	.528
0.20	649	4,190	866	.517
0.22	690	5,580	1,013	0.504
0.24	727	7,240	1,164	.495
0.26	757	9,200	1,313	.494
0.28	782	11,490	1,461	.498
0.30	806	14,140	1,613	.503
0.32	826	17,160	1,764	0.511
0.34	844	20.600	1,915	.520
0.36	860	24,400	2,066	.529
0.38	872	28,700	2,211	.544
0.40	883	33,500	2,357	.559
0.42	892	38,800	2,500	0.575
0.44	898	44,600	2,636	.594
0.46	903	51,000	2,772	.615
0.48	907	57,900	2,905	.635
0.50	909	65,500	3,033	.660
0.52	912	73,600	3,164	0.681
0.54	914	82,400	3,293	.700
0.56	916	92,000	3,423	.727
0.58	917	102,200	3,549	.751

d : equivalent diameter
diamètre équivalent

v : terminal velocity of fall (observed)
vitesse limite de chute (observée)

m : mass of droplet
masse de la gouttelette

Re : computed Reynolds numbers
nombre de Reynolds calculé

C_D : computed drag coefficient
coefficient de traînée calculé

Table 4.16.2 Terminal velocity of fall of ice crystals and solid precipitation in still air

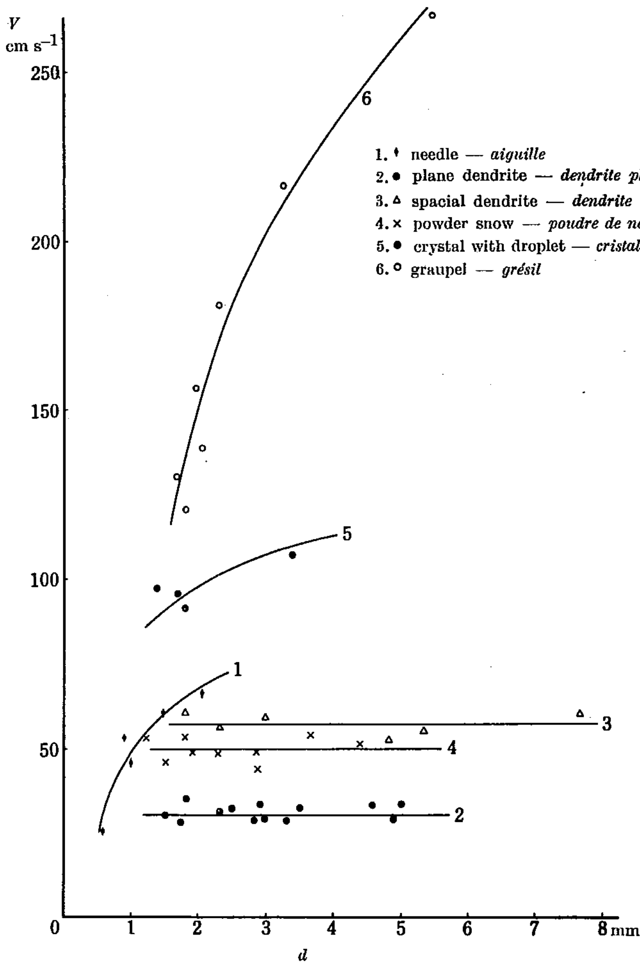
Vitesse limite de chute des cristaux de glace et des précipitations solides en air calme

Snow crystals

Cristaux de neige

Figure (*a*) — Terminal velocity *V* of snow crystals as a function of their linear dimensions *d* (observed)

Vitesse limite V des cristaux de neige en fonction de leur dimension linéaire d (observée)



Snowflakes
Flocons de neige

Figure (*b*.1) — Density of snowflakes as a function of their mean diameter
Masse volumique des flocons de neige en fonction de leur diamètre moyen

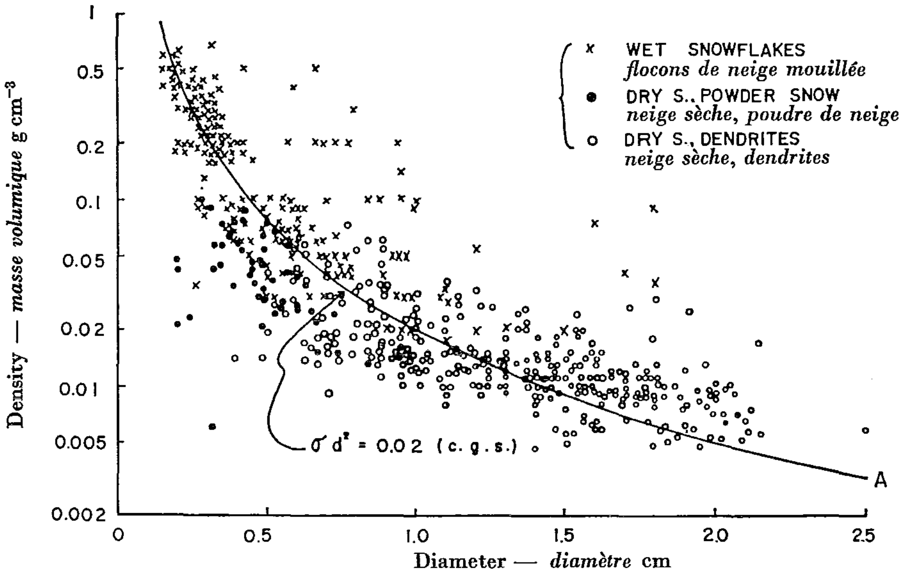
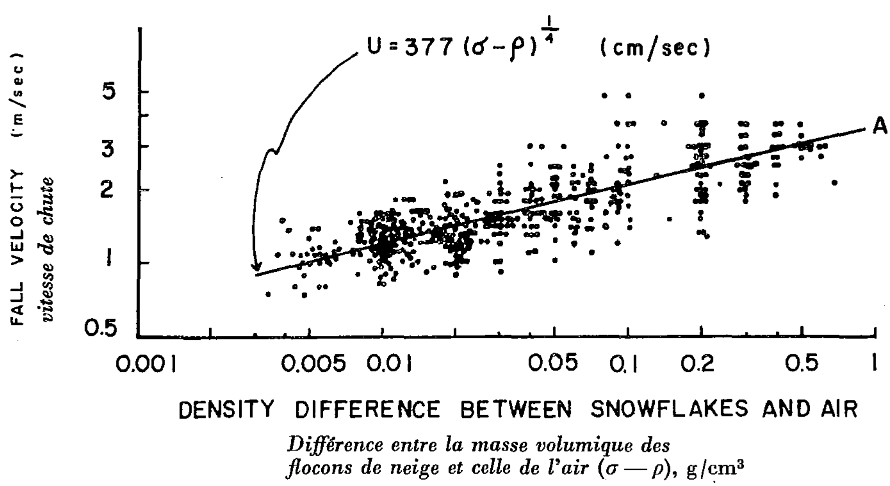


Figure (*b*.2) — Terminal velocity of fall of snowflakes as a function of their density
Vitesse limite de chute des flocons de neige en fonction de leur masse volumique



Hailstones — *Grêlons*

Figure (*c*.1 & *c*.2) — Terminal velocity of fall of smooth spheres as a function of their diameter (computed)
Vitesse limite de chute de sphères lisses en fonction de leur diamètre (calculée)

v : terminal velocity — *vitesse limite*
d : diameter — *diamètre*

S.G. : specific gravity ≈ density in g cm^{-3}
densité relative ≈ *masse volumique en* g cm^{-3}

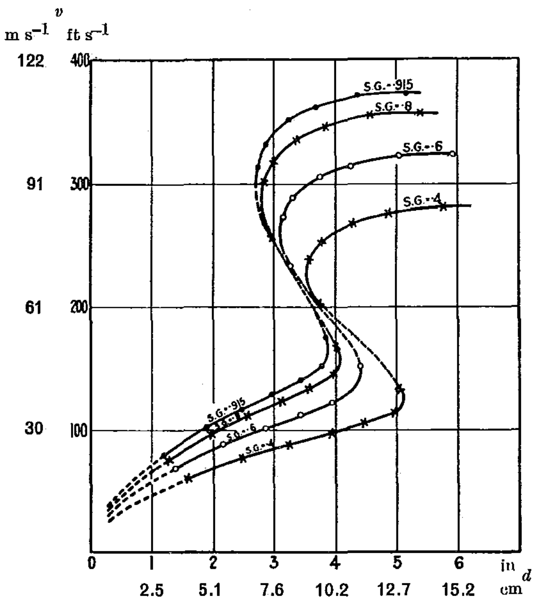


Figure (*c*.1) —
Ground level — *niveau du sol*

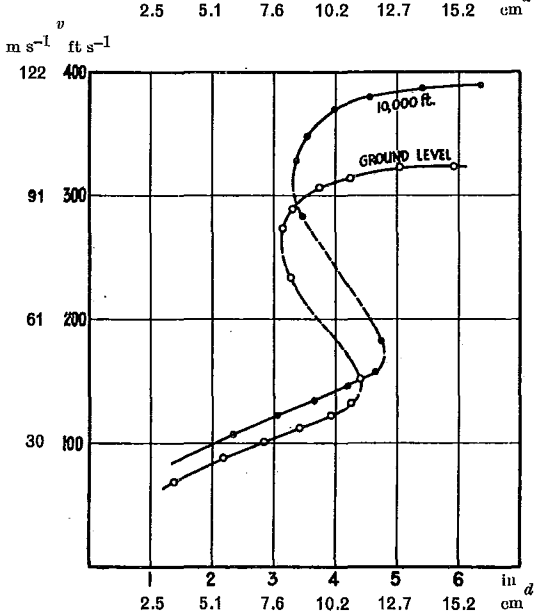
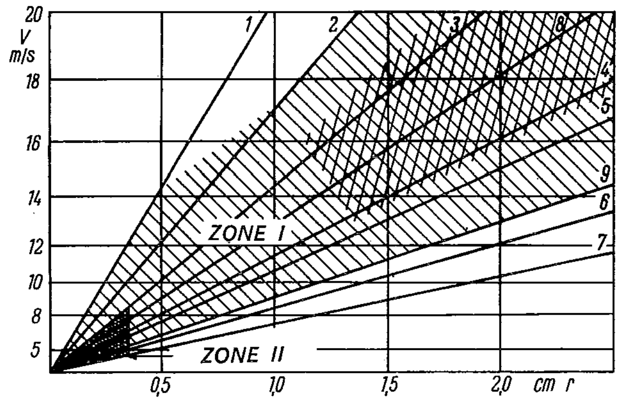


Figure (*c*.2) —
Ground level and 10 000 ft (3 048 m) level — specific gravity ≈ density = 0.6 g cm^{-3}
Niveau du sol et niveau de 10 000 ft *(3 048* m*)* — *densité relative* ≈ *masse volumique* = 0,6 g cm^{-3}

Figure (*d*) — Terminal velocity of fall of hailstones derived from observation
Vitesse limite de chute des grêlons déduite de l'observation

V : Terminal velocity — *vitesse limite*
r : Mean radius of the section facing the direction of flow — *rayon moyen de la section perpendiculaire au courant*
(elevation — *altitude* : 2 665 m)



Curve *Courbe*	Shape	*Forme*	Density *Masse volumique* g cm^{-3}	Drag coefficient *Coefficient de traînée*
1	sphere	*sphère*	0.8	0.5
2	sphere	*sphère*	0.8	0.7
3	sphere	*sphère*	0.8	1.0
4	sphere	*sphère*	0.5	1.0
5	spherical sector central angle 90°	*secteur sphérique angle d'ouverture* 90°	0.8	0.8
6	ditto	*idem*	0.5	0.8
7	spherical sector central angle 70°	*secteur sphérique angle d'ouverture* 70°	0.5	1.0
8	three-axis ellipsoid	*ellipsoïde à trois axes*	0.8	0.7
9	three-axis ellipsoid	*ellipsoïde à trois axes*	0.8	1.4

ZONE I : probable values for hailstones — *valeurs probables pour les grêlons*
ZONE II : probable values for snow pellets — *valeurs probables pour les grains de neige roulée*

Table 4.17 Viscosity and thermal conductivity of dry air. Diffusion of water vapour in air

Viscosité et conductivité thermique de l'air. Diffusion de la vapeur d'eau dans l'air

t: temperature — *température*
η: (dynamic) viscosity (at 1 013.25 mb pressure) — *viscosité (dynamique) (à la pression de* 1 013,25 mb)
λ: thermal conductivity — *conductivité thermique*
D: coefficient of diffusion of water vapour in air at 1 013.25 mb pressure — *coefficient de diffusion de la vapeur d'eau dans l'air à la pression de* 1 013,25 mb

t	η	λ	D
°C	$N\ s\ m^{-2}$	$J\ m^{-1}\ s^{-1}\ °K^{-1}$	$m^2\ s^{-1}$
– 80	1.289×10^{-5}	1.75×10^{-2}	1.22×10^{-5}
– 70	1.347	1.82	1.34
– 60	1.403	1.90	1.45
– 50	1.458	1.99	1.57
– 40	1.512	2.07	1.69
– 30	1.564	2.15	1.82
– 20	1.616	2.23	1.95
– 10	1.667	2.32	2.08
0	1.717	2.40	2.22
10	1.766	2.48	2.36
20	1.815	2.55	2.50
30	1.862	2.63	2.65
40	1.908	2.71	2.80
50	1.954	2.79	2.95
60	2.000	2.86	3.11

Table 4.18 **Characteristics of natural atmospheric aerosols (excluding cloud particles)**

Caractéristiques des aérosols atmosphériques naturels (à l'exception des particules nuageuses)

The first graph of part A and part B gives the quantity $\frac{dN}{d \log r}$ as a function of the radius r, N being the number of particles per cm^3 of air, the radii of which range between 0 and r.

The second graph gives the quantity $\frac{dV}{d \log r}$ as a function of the radius r, V being the volume, in cm^3, occupied by the N particles, the radii of which range between 0 and r.

Le premier graphique de la partie A *et de la partie* B *donne la grandeur* $\frac{dN}{d \log r}$ *en fonction du rayon* r, N *étant le nombre de particules par* cm^3 *d'air dont le rayon est compris entre* 0 *et* r.

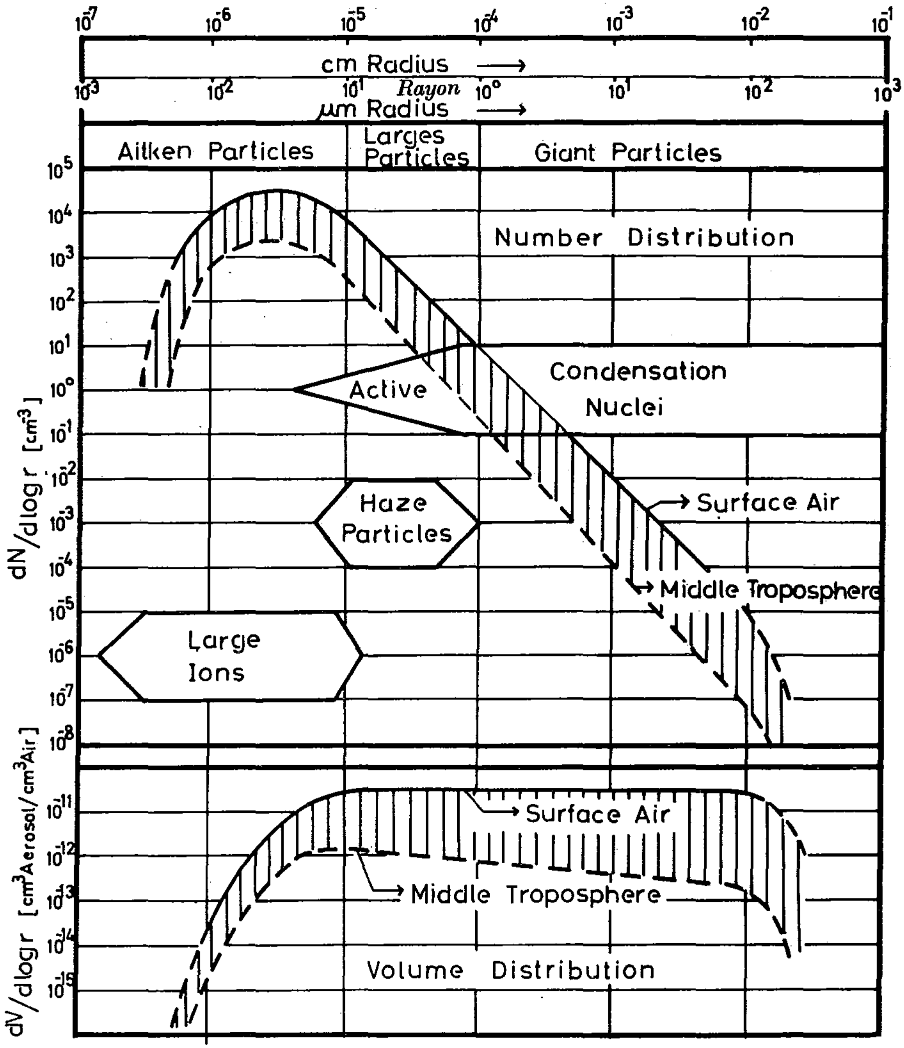
Le second graphique donne la grandeur $\frac{dV}{d \log r}$ *en fonction du rayon* r, V *étant le volume, en* cm^3, *occupé par les* N *particules dont le rayon est compris entre* 0 *et* r.

Table 4.18 was drawn up by E. C. Junge.

La table 4.18 a été établie par E. C. Junge.

A Over land

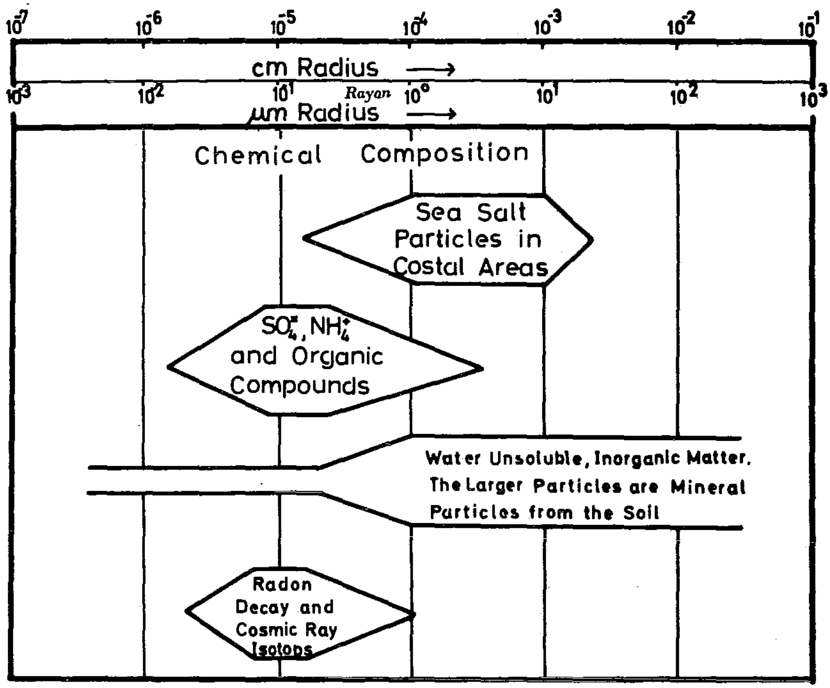
Au-dessus de la terre



Particules d'Aitken — *Grosses particules* — *Particules géantes*

Noyaux de condensation actifs

Gros ions — *Particules de brume sèche* — *Air en surface*, *Troposphère moyenne*



Composition chimique

$SO_4^{=}$, NH_4^{+}
et composés organiques

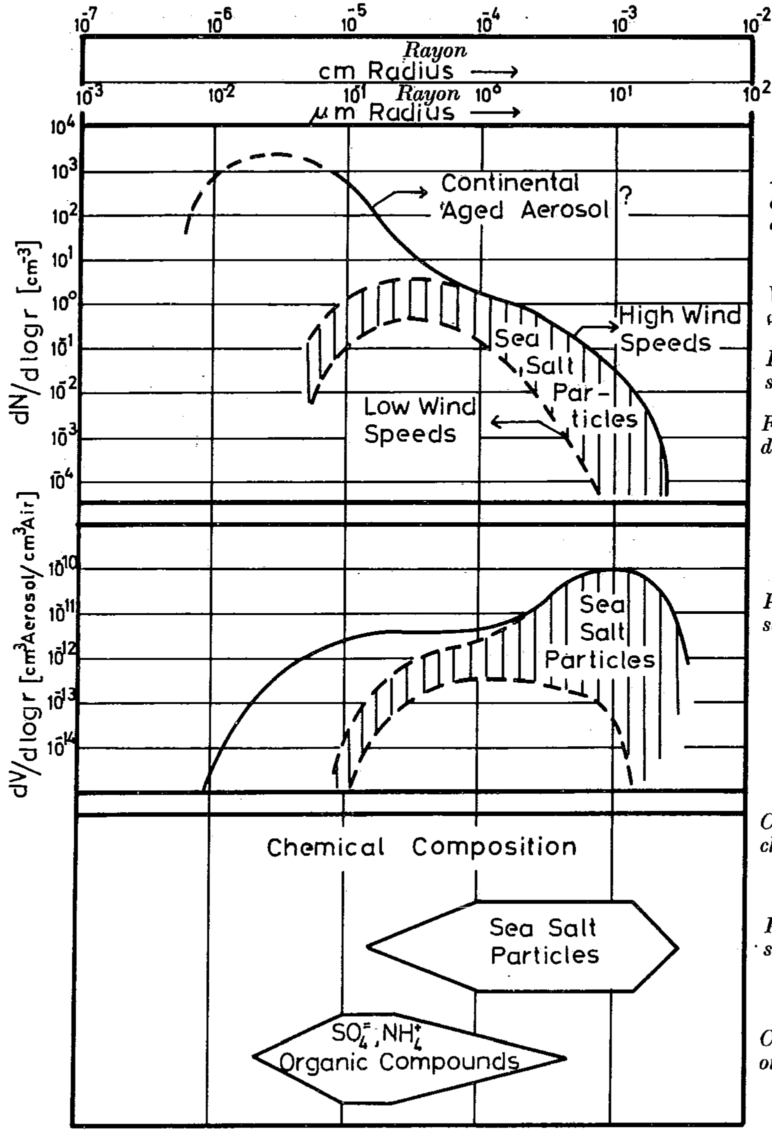
Particules de sel marin dans les régions côtières

Matières inorganiques, insolubles dans l'eau. Les plus grosses particules sont des particules minérales provenant du sol

Produits de désintégration du radon et isotopes formés par les rayons cosmiques

B Over sea

Au-dessus de la mer



Aérosol continental ancien ?

Vitesse du vent élevée

Particules de sel marin

Faible vitesse du vent

Particules de sel marin

Composition chimique

Particules de sel marin

Composés organiques

Table 4.20 Relation between relative humidity and mixing ratio
Relation entre l'humidité relative et le rapport de mélange

U_w : relative humidity with respect to water — *humidité relative par rapport à l'eau*
r : mixing ratio — *rapport de mélange*
r_w : saturation mixing ratio — *rapport de mélange de saturation*

Tabular values — *valeurs tabulaires* : $\Delta U = U_w - 100 \frac{r}{r_w}$, %

r_w g kg⁻¹	r/r_w :	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	U_w, % :	90	80	70	60	50	40	30	20	10
5		0.07	0.13	0.17	0.19	0.20	0.19	0.17	0.13	0.07
10		0.14	0.26	0.34	0.38	0.40	0.38	0.33	0.25	0.14
15		0.22	0.38	0.50	0.57	0.59	0.57	0.50	0.38	0.21
20		0.29	0.51	0.67	0.76	0.79	0.76	0.66	0.50	0.28
25		0.4	0.6	0.8	0.9	1.0	0.9	0.8	0.6	0.3
30		0.4	0.8	1.0	1.1	1.2	1.1	1.0	0.7	0.4
35		0.5	0.9	1.2	1.3	1.4	1.3	1.1	0.9	0.5
40		0.6	1.0	1.3	1.5	1.6	1.5	1.3	1.0	0.5
45		0.6	1.1	1.5	1.7	1.8	1.7	1.4	1.1	0.6
50		0.7	1.3	1.6	1.9	1.9	1.8	1.6	1.2	0.7
55		0.8	1.4	1.8	2.0	2.1	2.0	1.7	1.3	0.7
60		0.9	1.5	2.0	2.2	2.3	2.2	1.9	1.4	0.8
65		0.9	1.6	2.1	2.4	2.5	2.4	2.0	1.5	0.9
70		1.0	1.8	2.3	2.6	2.7	2.5	2.2	1.7	0.9
75		1.1	1.9	2.4	2.8	2.8	2.7	2.3	1.8	1.0
80		1.1	2.0	2.6	2.9	3.0	2.9	2.5	1.9	1.0
85		1.2	2.1	2.8	3.1	3.2	3.0	2.6	2.0	1.1
90		1.3	2.2	2.9	3.3	3.4	3.2	2.8	2.1	1.2
95		1.4	2.4	3.1	3.5	3.5	3.4	2.9	2.2	1.2
100		1.4	2.5	3.2	3.6	3.7	3.5	3.0	2.3	1.3

$\Delta U = 0$ for — *pour* $r/r_w = 0$, $r/r_w = 1$ ($U_w = 0$, $U_w = 100$)

Table 4.21.1 **Relative humidity as a function of temperature and thermodynamic dew-point temperature**

Humidité relative en fonction de la température et de la température thermodynamique du point de rosée

Temperature t, °C	Dew-point depression — *dépression du point de rosée* $t - t_d$, °C											
	0.5	1	1.5	2	3	4	5	6	7	8	9	10
	%	%	%	%	%	%	%	%	%	%	%	%
-48	94.5	89.3	84.4	79.7								
-46	94.6	89.5	84.7	80.1	71.5	63.8						
-44	94.7	89.7	85.0	80.4	72.0	64.4	57.5	51.3				
-42	94.8	89.9	85.2	80.8	72.5	64.9	58.1	52.0	46.4	41.4		
-40	94.9	90.1	85.5	81.1	72.9	65.5	58.8	52.7	47.2	42.2	37.7	33.6
-38	95.0	90.3	85.7	81.4	73.4	66.0	59.4	53.3	47.8	42.9	38.4	34.3
-36	95.1	90.5	86.0	81.7	73.8	66.6	60.0	54.0	48.5	43.6	39.1	35.1
-34	95.2	90.6	86.2	82.1	74.2	67.1	60.6	54.6	49.2	44.3	39.8	35.8
-32	95.3	90.8	86.5	82.4	74.6	67.6	61.1	55.2	49.9	45.0	40.5	36.5
-30	95.4	91.0	86.7	82.7	75.0	68.1	61.7	55.9	50.5	45.7	41.2	37.2
-28	95.5	91.1	86.9	82.9	75.4	68.6	62.2	56.5	51.2	46.3	41.9	37.9
-26	95.5	91.3	87.2	83.2	75.8	69.0	62.8	57.1	51.8	47.0	42.6	38.6
-24	95.6	91.4	87.4	83.5	76.2	69.5	63.3	57.6	52.4	47.6	43.3	39.2
-22	95.7	91.6	87.6	83.8	76.6	69.9	63.8	58.2	53.0	48.3	43.9	39.9
-20	95.8	91.7	87.8	84.0	76.9	70.4	64.4	58.8	53.6	48.9	44.6	40.6
-18	95.8	91.8	88.0	84.3	77.3	70.8	64.9	59.3	54.2	49.5	45.2	41.2
-16	95.9	92.0	88.2	84.5	77.6	71.3	65.4	59.9	54.8	50.2	45.9	41.9
-14	96.0	92.1	88.4	84.8	78.0	71.7	65.8	60.4	55.4	50.8	46.5	42.5
-12	96.1	92.2	88.6	85.0	78.3	72.1	66.3	61.0	56.0	51.4	47.1	43.2
-10	96.1	92.4	88.8	85.3	78.7	72.5	66.8	61.5	56.5	52.0	47.7	43.8
-8	96.2	92.5	88.9	85.5	79.0	72.9	67.2	62.0	57.1	52.6	48.3	44.4
-6	96.2	92.6	89.1	85.7	79.3	73.3	67.7	62.5	57.6	53.1	48.9	45.1
-4	96.3	92.7	89.3	85.9	79.6	73.7	68.1	63.0	58.2	53.7	49.5	45.7
-2	96.4	92.9	89.4	86.2	79.9	74.0	68.6	63.5	58.7	54.3	50.1	46.3
0	96.4	93.0	89.6	86.4	80.2	74.4	69.0	64.0	59.2	54.8	50.7	46.9
2	96.5	93.1	89.8	86.6	80.5	74.8	69.4	64.4	59.7	55.4	51.3	47.5
4	96.5	93.2	89.9	86.8	80.8	75.1	69.8	64.9	60.3	55.9	51.8	48.1
6	96.6	93.3	90.1	87.0	81.1	75.5	70.3	65.3	60.8	56.4	52.4	48.6
8	96.6	93.4	90.2	87.2	81.3	75.8	70.7	65.8	61.2	57.0	53.0	49.2
10	96.7	93.5	90.4	87.4	81.6	76.2	71.0	66.2	61.7	57.5	53.5	49.8
12	96.8	93.6	90.5	87.6	81.9	76.5	71.4	66.7	62.2	58.0	54.0	50.3
14	96.8	93.7	90.7	87.7	82.1	76.8	71.8	67.1	62.7	58.5	54.6	50.9
16	96.8	93.8	90.8	87.9	82.4	77.1	72.2	67.5	63.1	59.0	55.1	51.4
18	96.9	93.9	90.9	88.1	82.6	77.4	72.6	67.9	63.6	59.5	55.6	52.0
20	96.9	94.0	91.1	88.3	82.9	77.8	72.9	68.4	64.0	60.0	56.1	52.5
22	97.0	94.1	91.2	88.4	83.1	78.1	73.3	68.8	64.5	60.5	56.6	53.0
24	97.0	94.1	91.3	88.6	83.3	78.4	73.6	69.2	64.9	60.9	57.1	53.6
26	97.1	94.2	91.5	88.8	83.6	78.6	74.0	69.5	65.4	61.4	57.6	54.1
28	97.1	94.3	91.6	88.9	83.8	78.9	74.3	69.9	65.8	61.8	58.1	54.6
30	97.2	94.4	91.7	89.1	84.0	79.2	74.6	70.3	66.2	62.3	58.6	55.1
32	97.2	94.5	91.8	89.2	84.2	79.5	75.0	70.7	66.6	62.7	59.1	55.6
34	97.2	94.6	91.9	89.4	84.5	79.8	75.3	71.0	67.0	63.2	59.5	56.1
36	97.3	94.6	92.1	89.5	84.7	80.0	75.6	71.4	67.4	63.6	60.0	56.6
38	97.3	94.7	92.2	89.7	84.9	80.3	75.9	71.8	67.8	64.0	60.4	57.0
40	97.4	94.8	92.3	89.8	85.1	80.5	76.2	72.1	68.2	64.5	60.9	57.5
42	97.4	94.9	92.4	90.0	85.3	80.8	76.5	72.5	68.6	64.9	61.3	58.0
44	97.4	94.9	92.5	90.1	85.5	81.0	76.8	72.8	68.9	65.3	61.8	58.4
46	97.5	95.0	92.6	90.2	85.7	81.3	77.1	73.1	69.3	65.7	62.2	58.9
48	97.5	95.1	92.7	90.4	85.8	81.5	77.4	73.5	69.7	66.1	62.6	59.3
50	97.5	95.1	92.8	90.5	86.0	81.8	77.7	73.8	70.0	66.5	63.1	59.8

Temperature t, °C	Dew-point depression — *dépression du point de rosée* $t - t_d$, °C 11	12	13	14	15	16	18	20	22	24	26	28	30
	%	%	%	%	%	%	%	%	%	%	%	%	%
-38	30.7	27.4											
-36	31.4	28.1	25.1	22.4									
-34	32.1	28.8	25.8	23.0	20.6	18.4							
-32	32.8	29.5	26.4	23.7	21.2	19.0	15.1						
-30	33.5	30.1	27.1	24.3	21.8	19.6	15.7	12.5					
-28	34.2	30.8	27.8	25.0	22.5	20.2	16.2	13.0	10.4				
-26	34.9	31.5	28.5	25.7	23.1	20.8	16.8	13.5	10.8	8.6			
-24	35.6	32.2	29.1	26.3	23.8	21.4	17.4	14.0	11.3	9.0	7.2		
-22	36.2	32.9	29.8	27.0	24.4	22.0	18.0	14.6	11.8	9.5	7.6	6.0	
-20	36.9	33.5	30.4	27.6	25.0	22.7	18.5	15.1	12.2	9.9	7.9	6.4	5.1
-18	37.6	34.2	31.1	28.3	25.7	23.3	19.1	15.6	12.7	10.3	8.3	6.7	5.4
-16	38.2	34.9	31.8	28.9	26.3	23.9	19.7	16.2	13.2	10.7	8.7	7.0	5.7
-14	38.9	35.5	32.4	29.6	26.9	24.5	20.3	16.7	13.7	11.2	9.1	7.4	6.0
-12	39.5	36.2	33.1	30.2	27.6	25.1	20.8	17.2	14.2	11.6	9.5	7.8	6.3
-10	40.2	36.8	33.7	30.8	28.2	25.7	21.4	17.8	14.7	12.1	9.9	8.1	6.6
-8	40.8	37.5	34.3	31.5	28.8	26.4	22.0	18.3	15.2	12.6	10.3	8.5	6.9
-6	41.4	38.1	35.0	32.1	29.4	27.0	22.6	18.9	15.7	13.0	10.8	8.9	7.3
-4	42.1	38.7	35.6	32.7	30.1	27.6	23.2	19.4	16.2	13.5	11.2	9.3	7.6
-2	42.7	39.3	36.2	33.4	30.7	28.2	23.8	20.0	16.7	14.0	11.6	9.6	8.0
0	43.3	40.0	36.9	34.0	31.3	28.8	24.4	20.5	17.3	14.5	12.1	10.0	8.3
2	43.9	40.6	37.5	34.6	31.9	29.4	24.9	21.1	17.8	14.9	12.5	10.4	8.7
4	44.5	41.2	38.1	35.2	32.5	30.0	25.5	21.6	18.3	15.4	13.0	10.9	9.1
6	45.1	41.8	38.7	35.8	33.1	30.6	26.1	22.2	18.8	15.9	13.4	11.3	9.4
8	45.7	42.4	39.3	36.4	33.7	31.2	26.7	22.8	19.4	16.4	13.9	11.7	9.8
10	46.3	43.0	39.9	37.0	34.3	31.8	27.3	23.3	19.9	16.9	14.3	12.1	10.2
12	46.8	43.6	40.5	37.6	34.9	32.4	27.9	23.9	20.4	17.4	14.8	12.6	10.6
14	47.4	44.2	41.1	38.2	35.5	33.0	28.4	24.5	21.0	17.9	15.3	13.0	11.0
16	48.0	44.7	41.7	38.8	36.1	33.6	29.0	25.0	21.5	18.4	15.8	13.4	11.4
18	48.5	45.3	42.3	39.4	36.7	34.2	29.6	25.6	22.0	18.9	16.2	13.9	11.8
20	49.1	45.9	42.8	40.0	37.3	34.8	30.2	26.1	22.6	19.4	16.7	14.3	12.2
22	49.6	46.4	43.4	40.6	37.9	35.4	30.8	26.7	23.1	20.0	17.2	14.8	12.7
24	50.2	47.0	44.0	41.1	38.5	35.9	31.3	27.3	23.7	20.5	17.7	15.2	13.1
26	50.7	47.5	44.5	41.7	39.0	36.5	31.9	27.8	24.2	21.0	18.2	15.7	13.5
28	51.2	48.1	45.1	42.3	39.6	37.1	32.5	28.4	24.7	21.5	18.7	16.2	14.0
30	51.8	48.6	45.6	42.8	40.2	37.7	33.0	28.9	25.3	22.0	19.2	16.6	14.4
32	52.3	49.2	46.2	43.4	40.7	38.2	33.6	29.5	25.8	22.5	19.7	17.1	14.8
34	52.8	49.7	46.7	43.9	41.3	38.8	34.2	30.0	26.3	23.1	20.2	17.6	15.3
36	53.3	50.2	47.3	44.5	41.8	39.3	34.7	30.6	26.9	23.6	20.7	18.0	15.7
38	53.8	50.7	47.8	45.0	42.4	39.9	35.3	31.1	27.4	24.1	21.2	18.5	16.2
40	54.3	51.2	48.3	45.6	42.9	40.4	35.8	31.7	28.0	24.6	21.7	19.0	16.6
42	54.8	51.7	48.8	46.1	43.5	41.0	36.4	32.2	28.5	25.2	22.2	19.5	17.1
44	55.3	52.2	49.4	46.6	44.0	41.5	36.9	32.8	29.0	25.7	22.7	20.0	17.6
46	55.7	52.7	49.9	47.1	44.5	42.1	37.5	33.3	29.6	26.2	23.2	20.4	18.0
48	56.2	53.2	50.4	47.6	45.1	42.6	38.0	33.9	30.1	26.7	23.7	20.9	18.5
50	56.7	53.7	50.9	48.2	45.6	43.1	38.5	34.4	30.6	27.2	24.2	21.4	18.9

Table 4.21.2 **Thermodynamic dew-point temperature as a function of relative humidity and temperature**

Température thermodynamique du point de rosée en fonction de l'humidité relative et de la température

Temperature °C	Relative humidity — *humidité relative*, %								
	95	90	85	80	75	70	65	60	55
	°C	°C	°C	°C	°C	°C	°C	°C	°C
-48	-48.5	-48.9	-49.4	-50.0					
-46	-46.5	-47.0	-47.5	-48.0	-48.6	-49.2	-49.8		
-44	-44.5	-45.0	-45.5	-46.0	-46.6	-47.3	-47.9	-48.6	-49.4
-42	-42.5	-43.0	-43.5	-44.1	-44.7	-45.3	-46.0	-46.7	-47.5
-40	-40.5	-41.0	-41.6	-42.1	-42.7	-43.4	-44.1	-44.8	-45.6
-38	-38.5	-39.0	-39.6	-40.2	-40.8	-41.4	-42.1	-42.9	-43.7
-36	-36.5	-37.1	-37.6	-38.2	-38.8	-39.5	-40.2	-41.0	-41.8
-34	-34.5	-35.1	-35.6	-36.3	-36.9	-37.6	-38.3	-39.1	-39.9
-32	-32.5	-33.1	-33.7	-34.3	-35.0	-35.6	-36.4	-37.2	-38.0
-30	-30.5	-31.1	-31.7	-32.3	-33.0	-33.7	-34.5	-35.3	-36.2
-28	-28.6	-29.1	-29.7	-30.4	-31.1	-31.8	-32.6	-33.4	-34.3
-26	-26.6	-27.2	-27.8	-28.4	-29.1	-29.9	-30.6	-31.5	-32.4
-24	-24.6	-25.2	-25.8	-26.5	-27.2	-27.9	-28.7	-29.6	-30.5
-22	-22.6	-23.2	-23.8	-24.5	-25.2	-26.0	-26.8	-27.7	-28.6
-20	-20.6	-21.2	-21.9	-22.6	-23.3	-24.1	-24.9	-25.8	-26.7
-18	-18.6	-19.2	-19.9	-20.6	-21.3	-22.1	-23.0	-23.9	-24.8
-16	-16.6	-17.3	-17.9	-18.7	-19.4	-20.2	-21.1	-22.0	-23.0
-14	-14.6	-15.3	-16.0	-16.7	-17.5	-18.3	-19.1	-20.1	-21.1
-12	-12.6	-13.3	-14.0	-14.7	-15.5	-16.4	-17.2	-18.2	-19.2
-10	-10.6	-11.3	-12.0	-12.8	-13.6	-14.4	-15.3	-16.3	-17.3
-8	-8.7	-9.3	-10.1	-10.8	-11.6	-12.5	-13.4	-14.4	-15.5
-6	-6.7	-7.4	-8.1	-8.9	-9.7	-10.6	-11.5	-12.5	-13.6
-4	-4.7	-5.4	-6.1	-6.9	-7.8	-8.7	-9.6	-10.6	-11.7
-2	-2.7	-3.4	-4.2	-5.0	-5.8	-6.7	-7.7	-8.7	-9.8
0	-.7	-1.4	-2.2	-3.0	-3.9	-4.8	-5.8	-6.8	-8.0
2	1.3	.5	-.3	-1.1	-2.0	-2.9	-3.9	-4.9	-6.1
4	3.3	2.5	1.7	.9	-.0	-1.0	-2.0	-3.1	-4.2
6	5.3	4.5	3.7	2.8	1.9	.9	-.1	-1.2	-2.4
8	7.2	6.5	5.6	4.8	3.8	2.9	1.8	.7	-.5
10	9.2	8.4	7.6	6.7	5.8	4.8	3.7	2.6	1.4
12	11.2	10.4	9.6	8.7	7.7	6.7	5.6	4.5	3.2
14	13.2	12.4	11.5	10.6	9.6	8.6	7.5	6.4	5.1
16	15.2	14.4	13.5	12.6	11.6	10.5	9.4	8.2	7.0
18	17.2	16.3	15.4	14.5	13.5	12.5	11.3	10.1	8.8
20	19.2	18.3	17.4	16.4	15.4	14.4	13.2	12.0	10.7
22	21.2	20.3	19.4	18.4	17.4	16.3	15.1	13.9	12.6
24	23.1	22.3	21.3	20.3	19.3	18.2	17.0	15.8	14.4
26	25.1	24.2	23.3	22.3	21.2	20.1	18.9	17.6	16.3
28	27.1	26.2	25.2	24.2	23.2	22.0	20.8	19.5	18.1
30	29.1	28.2	27.2	26.2	25.1	23.9	22.7	21.4	20.0
32	31.1	30.1	29.2	28.1	27.0	25.8	24.6	23.3	21.8
34	33.1	32.1	31.1	30.1	28.9	27.7	26.5	25.1	23.7
36	35.1	34.1	33.1	32.0	30.9	29.7	28.4	27.0	25.5
38	37.1	36.1	35.0	33.9	32.8	31.6	30.3	28.9	27.4
40	39.0	38.0	37.0	35.9	34.7	33.5	32.1	30.7	29.2
42	41.0	40.0	38.9	37.8	36.6	35.4	34.0	32.6	31.1
44	43.0	42.0	40.9	39.8	38.6	37.3	35.9	34.5	32.9
46	45.0	44.0	42.9	41.7	40.5	39.2	37.8	36.3	34.8
48	47.0	45.9	44.8	43.6	42.4	41.1	39.7	38.2	36.6
50	49.0	47.9	46.8	45.6	44.3	43.0	41.6	40.1	38.4

Temperature °C	Relative humidity — *humidité relative*, % 50	45	40	35	30	25	20	15	10
	°C	°C	°C	°C	°C	°C	°C	°C	°C
-42	-48.3	-49.3							
-40	-46.5	-47.4	-48.5	-49.6					
-38	-44.6	-45.6	-46.6	-47.8	-49.2				
-36	-42.7	-43.7	-44.8	-46.0	-47.4	-49.0			
-34	-40.8	-41.8	-43.0	-44.2	-45.6	-47.3	-49.2		
-32	-39.0	-40.0	-41.1	-42.4	-43.8	-45.5	-47.5		
-30	-37.1	-38.1	-39.3	-40.6	-42.0	-43.8	-45.8	-48.4	-28.0
-35	-36.3	-37.5	-38.8	-40.3	-42.0	-44.1	-46.7		
-26	-33.4	-34.4	-35.6	-37.0	-38.5	-40.3	-42.4	-45.0	-48.7
-24	-31.5	-32.6	-33.8	-35.2	-36.7	-38.5	-40.7	-43.4	-47.1
-22	-29.6	-30.7	-32.0	-33.4	-34.9	-36.8	-39.0	-41.7	-45.5
-20	-27.8	-28.9	-30.2	-31.6	-33.2	-35.0	-37.2	-40.1	-43.9
-18	-25.9	-27.1	-28.3	-29.8	-31.4	-33.3	-35.5	-38.4	-42.3
-16	-24.0	-25.2	-26.5	-28.0	-29.6	-31.5	-33.8	-36.7	-40.7
-14	-22.2	-23.4	-24.7	-26.2	-27.8	-29.8	-32.1	-35.1	-39.1
-12	-20.3	-21.5	-22.9	-24.4	-26.1	-28.1	-30.4	-33.4	-37.5
-10	-18.5	-19.7	-21.0	-22.6	-24.3	-26.3	-28.7	-31.8	-35.9
-8	-16.6	-17.9	-19.2	-20.8	-22.5	-24.6	-27.1	-30.1	-34.3
-6	-14.7	-16.0	-17.4	-19.0	-20.8	-22.9	-25.4	-28.5	-32.8
-4	-12.9	-14.2	-15.6	-17.2	-19.0	-21.1	-23.7	-26.9	-31.2
-2	-11.0	-12.3	-13.8	-15.4	-17.3	-19.4	-22.0	-25.2	-29.6
0	-9.2	-10.5	-12.0	-13.6	-15.5	-17.7	-20.3	-23.6	-28.0
2	-7.3	-8.7	-10.2	-11.9	-13.8	-16.0	-18.6	-22.0	-26.5
4	-5.5	-6.9	-8.4	-10.1	-12.0	-14.3	-16.9	-20.3	-24.9
6	-3.6	-5.0	-6.6	-8.3	-10.3	-12.5	-15.3	-18.7	-23.4
8	-1.8	-3.2	-4.8	-6.5	-8.5	-10.8	-13.6	-17.1	-21.8
10	.1	-1.4	-3.0	-4.8	-6.8	-9.1	-11.9	-15.5	-20.3
12	1.9	.4	-1.2	-3.0	-5.0	-7.4	-10.3	-13.8	-18.7
14	3.8	2.3	.6	-1.2	-3.3	-5.7	-8.6	-12.2	-17.2
16	5.6	4.1	2.4	.6	-1.6	-4.0	-6.9	-10.6	-15.6
18	7.4	5.9	4.2	2.3	.2	-2.3	-5.3	-9.0	-14.1
20	9.3	7.7	6.0	4.1	1.9	-.6	-3.6	-7.4	-12.5
22	11.1	9.5	7.8	5.9	3.6	1.1	-2.0	-5.8	-11.0
24	12.9	11.3	9.6	7.6	5.4	2.8	-.3	-4.2	-9.5
26	14.8	13.2	11.4	9.4	7.1	4.5	1.3	-2.6	-8.0
28	16.6	15.0	13.2	11.1	8.8	6.2	3.0	-1.0	-6.4
30	18.4	16.8	14.9	12.9	10.5	7.8	4.6	.6	-4.9
32	20.3	18.6	16.7	14.6	12.3	9.5	6.3	2.2	-3.4
34	22.1	20.4	18.5	16.4	14.0	11.2	7.9	3.7	-1.9
36	23.9	22.2	20.3	18.1	15.7	12.9	9.5	5.3	-.4
38	25.8	24.0	22.0	19.9	17.4	14.6	11.2	6.9	1.1
40	27.6	25.8	23.8	21.6	19.1	16.2	12.8	8.5	2.6
42	29.4	27.6	25.6	23.4	20.8	17.9	14.4	10.0	4.1
44	31.2	29.4	27.4	25.1	22.5	19.6	16.0	11.6	5.6
46	33.0	31.2	29.1	26.8	24.2	21.2	17.6	13.2	7.1
48	34.9	33.0	30.9	28.6	25.9	22.9	19.3	14.7	8.6
50	36.7	34.8	32.7	30.3	27.6	24.6	20.9	16.3	10.1

Table 4.22.1.1 Factors for computing mixing ratio as a function of thermodynamic wet-bulb temperature, temperature and pressure

Facteurs pour le calcul du rapport de mélange en fonction de la température thermodynamique du thermomètre mouillé, de la température et de la pression

t_w : thermodynamic wet-bulb temperature — *température thermodynamique du thermomètre mouillé*

t : temperature — *température*

Factor *A* — *facteur A*

t_w °C	$t - t_w$, °C 0.5	1	1.5	2	3	4	5	6	7	8
—50	.00035	.00070	.00105	.00140	.00210	.00280	.00350	.00420	.00489	.00559
—45	.00035	.00071	.00106	.00141	.00212	.00282	.00352	.00422	.00492	.00562
—40	.00036	.00071	.00106	.00142	.00213	.00283	.00354	.00425	.00495	.00565
—35	.00036	.00071	.00107	.00143	.00214	.00285	.00356	.00427	.00498	.00568
—30	.00036	.00072	.00108	.00143	.00215	.00287	.00358	.00429	.00500	.00571
—25	.00036	.00072	.00108	.00144	.00216	.00288	.00360	.00431	.00503	.00574
—20	.00036	.00073	.00109	.00145	.00217	.00289	.00362	.00434	.00505	.00577
—15	.00036	.00073	.00109	.00146	.00218	.00291	.00363	.00436	.00508	.00580
—10	.00037	.00073	.00110	.00146	.00219	.00292	.00365	.00438	.00510	.00583
—5	.00037	.00074	.00110	.00147	.00220	.00294	.00367	.00440	.00513	.00586
0	.00037	.00074	.00111	.00148	.00221	.00295	.00369	.00442	.00515	.00588
5	.00037	.00074	.00111	.00148	.00222	.00296	.00370	.00444	.00518	.00591
10	.00037	.00075	.00112	.00149	.00224	.00298	.00372	.00446	.00520	.00594
15	.00038	.00075	.00112	.00150	.00225	.00299	.00374	.00448	.00523	.00597
20	.00038	.00075	.00113	.00151	.00226	.00301	.00376	.00450	.00525	.00600
25	.00038	.00076	.00114	.00151	.00227	.00302	.00377	.00453	.00528	.00602
30	.00038	.00076	.00114	.00152	.00228	.00304	.00379	.00455	.00530	.00605
35	.00038	.00076	.00115	.00153	.00229	.00305	.00381	.00457	.00533	.00608
40	.00038	.00077	.00115	.00154	.00230	.00307	.00383	.00459	.00535	.00611
45	.00039	.00077	.00116	.00154	.00231	.00308	.00385	.00461	.00538	.00614
50	.00039	.00078	.00116	.00155	.00232	.00310	.00387	.00464	.00541	.00617

t_w °C	$t - t_w$, °C 9	10	11	12	13	14	15	16	17	18
-30	.00642	.00713	.00784	.00855	.00925	.00996	.01066	.01136	.01207	.01277
-25	.00646	.00717	.00788	.00859	.00930	.01001	.01072	.01142	.01213	.01283
-20	.00649	.00720	.00792	.00863	.00935	.01006	.01077	.01148	.01219	.01289
-15	.00652	.00724	.00796	.00867	.00939	.01011	.01082	.01153	.01224	.01296
-10	.00655	.00727	.00800	.00872	.00944	.01015	.01087	.01159	.01230	.01302
-5	.00658	.00731	.00803	.00876	.00948	.01020	.01092	.01164	.01236	.01308
0	.00661	.00734	.00807	.00880	.00953	.01025	.01097	.01170	.01242	.01314
5	.00664	.00738	.00811	.00884	.00957	.01030	.01103	.01175	.01248	.01320
10	.00668	.00741	.00815	.00888	.00961	.01035	.01108	.01181	.01254	.01326
15	.00671	.00745	.00819	.00892	.00966	.01040	.01113	.01186	.01260	.01333
20	.00674	.00748	.00823	.00897	.00971	.01045	.01118	.01192	.01266	.01339
25	.00677	.00752	.00827	.00901	.00975	.01050	.01124	.01198	.01272	.01345
30	.00681	.00756	.00830	.00905	.00980	.01055	.01129	.01203	.01278	.01352
35	.00684	.00759	.00835	.00910	.00985	.01060	.01135	.01209	.01284	.01358
40	.00687	.00763	.00839	.00914	.00990	.01065	.01140	.01215	.01290	.01365

t_w °C	$t - t_w$, °C 20	22	24	26	28	30
10	.01472	.01616	.01761	.01905	.02048	.02191
15	.01479	.01624	.01769	.01914	.02058	.02202
20	.01486	.01632	.01777	.01923	.02068	.02212
25	.01493	.01640	.01786	.01932	.02077	.02222
30	.01500	.01647	.01794	.01941	.02087	.02233

Factor *B* — *facteur B*

t_w °C	$t - t_w$, °C 0.5	1	1.5	2	3	4	5	6	7	8
-50	.19065	.38117	.57155	.76180	1.1419	1.5215	1.9005	2.2790	2.6570	3.0344
-45	.19184	.38355	.57512	.76655	1.1490	1.5309	1.9123	2.2932	2.6735	3.0533
-40	.19298	.38582	.57852	.77109	1.1558	1.5400	1.9236	2.3067	2.6893	3.0713
-35	.19405	.38797	.58175	.77539	1.1623	1.5486	1.9343	2.3195	2.7042	3.0883
-30	.19508	.39003	.58483	.77949	1.1684	1.5568	1.9445	2.3318	2.7185	3.1046
-25	.19607	.39200	.58779	.78343	1.1743	1.5646	1.9543	2.3435	2.7322	3.1202
-20	.19703	.39392	.59067	.78728	1.1801	1.5723	1.9639	2.3550	2.7455	3.1355
-15	.19800	.39586	.59357	.79114	1.1858	1.5800	1.9735	2.3665	2.7589	3.1508
-10	.19896	.39778	.59645	.79497	1.1916	1.5876	1.9831	2.3779	2.7722	3.1660
-5	.19991	.39968	.59929	.79876	1.1973	1.5952	1.9925	2.3893	2.7854	3.1810
0	.20086	.40157	.60213	.80254	1.2029	1.6027	2.0019	2.4005	2.7986	3.1960
5	.20180	.40346	.60496	.80631	1.2086	1.6102	2.0113	2.4118	2.8117	3.2110
10	.20276	.40536	.60782	.81012	1.2143	1.6178	2.0208	2.4231	2.8249	3.2261
15	.20374	.40733	.61076	.81404	1.2202	1.6257	2.0305	2.4348	2.8385	3.2416
20	.20473	.40931	.61373	.81800	1.2261	1.6335	2.0404	2.4466	2.8523	3.2573
25	.20572	.41128	.61669	.82194	1.2320	1.6414	2.0502	2.4584	2.8659	3.2729
30	.20671	.41327	.61966	.82590	1.2379	1.6493	2.0601	2.4702	2.8797	3.2886
35	.20773	.41529	.62270	.82995	1.2440	1.6574	2.0701	2.4823	2.8938	3.3047
40	.20876	.41735	.62578	.83406	1.2501	1.6656	2.0804	2.4945	2.9080	3.3209
45	.20980	.41943	.62890	.83821	1.2563	1.6738	2.0907	2.5069	2.9225	3.3374
50	.21085	.42153	.63206	.84241	1.2626	1.6822	2.1011	2.5194	2.9371	3.3541

t_w °C	$t - t_w$, °C 9	10	11	12	13	14	15	16	17	18
-30	3.4902	3.8752	4.2597	4.6436	5.0270	5.4099	5.7922	6.1739	6.5551	6.9358
-25	3.5077	3.8947	4.2811	4.6669	5.0522	5.4370	5.8212	6.2048	6.5879	6.9705
-20	3.5249	3.9137	4.3020	4.6897	5.0768	5.4634	5.8495	6.2350	6.6199	7.0043
-15	3.5421	3.9328	4.3229	4.7125	5.1015	5.4900	5.8779	6.2652	6.6520	7.0382
-10	3.5591	3.9517	4.3437	4.7352	5.1260	5.5163	5.9061	6.2953	6.6839	7.0719
-5	3.5760	3.9705	4.3643	4.7576	5.1503	5.5424	5.9340	6.3250	6.7154	7.1053
0	3.5929	3.9891	4.3848	4.7799	5.1745	5.5684	5.9618	6.3546	6.7469	7.1385
5	3.6097	4.0078	4.4053	4.8023	5.1986	5.5944	5.9896	6.3842	6.7782	7.1717
10	3.6266	4.0266	4.4260	4.8248	5.2230	5.6206	6.0176	6.4140	6.8099	7.2052
15	3.6441	4.0460	4.4473	4.8479	5.2480	5.6475	6.0464	6.4448	6.8425	7.2396
20	3.6617	4.0655	4.4687	4.8713	5.2734	5.6748	6.0756	6.4758	6.8754	7.2744
25	3.6792	4.0850	4.4901	4.8946	5.2985	5.7018	6.1045	6.5066	6.9081	7.3090
30	3.6969	4.1046	4.5116	4.9180	5.3239	5.7291	6.1337	6.5376	6.9410	7.3438
35	3.7149	4.1246	4.5336	4.9420	5.3497	5.7569	6.1634	6.5694	6.9747	7.3794
40	3.7332	4.1448	4.5559	4.9662	5.3760	5.7851	6.1936	6.6015	7.0088	7.4155

t_w °C	$t - t_w$, °C 20	22	24	26	28	30
10	7.9940	8.7804	9.5646	10.346	11.126	11.903
15	8.0321	8.8223	9.6101	10.396	11.179	11.960
20	8.0707	8.8646	9.6561	10.445	11.232	12.017
25	8.1089	8.9065	9.7018	10.495	11.285	12.073
30	8.1475	8.9489	9.7478	10.544	11.339	12.130

Table 4.22.1.2 **Mixing ratio as a function of thermodynamic wet-bulb temperature and temperature for a pressure of 1 000 mb**

Rapport de mélange en fonction de la température thermodynamique du thermomètre mouillé et de la température pour la pression de 1 000 mb

t_w : thermodynamic wet-bulb temperature — *température thermodynamique du thermomètre mouillé*

t : temperature — *température*

t °C	$t - t_w$, °C 0	1	2	3	4	5	6	7	8	9
	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}
-10	1.793	1.257	.733	.219						
-8	2.099	1.541	.995	.462						
-6	2.450	1.867	1.299	.744	.200					
-4	2.852	2.242	1.648	1.068	.502					
-2	3.312	2.671	2.048	1.441	.849	.271				
0	3.838	3.163	2.506	1.868	1.247	.642	.052			
2	4.438	3.723	3.030	2.357	1.703	1.066	.448			
4	5.119	4.362	3.627	2.915	2.224	1.554	.901	.268		
6	5.893	5.086	4.306	3.551	2.819	2.109	1.421	.753	.103	
8	6.769	5.909	5.077	4.273	3.495	2.743	2.013	1.306	.619	
10	7.761	6.840	5.950	5.093	4.264	3.462	2.687	1.937	1.210	.504
12	8.880	7.892	6.939	6.021	5.134	4.279	3.453	2.654	1.881	1.133
14	10.142	9.078	8.055	7.070	6.120	5.204	4.320	3.468	2.644	1.848
16	11.562	10.416	9.314	8.253	7.233	6.250	5.303	4.390	3.509	2.660
18	13.159	11.920	10.730	9.587	8.488	7.430	6.413	5.433	4.489	3.578
20	14.951	13.610	12.323	11.087	9.900	8.760	7.664	6.609	5.595	4.618
22	16.961	15.506	14.110	12.772	11.489	10.256	9.073	7.936	6.843	5.791
24	19.212	17.631	16.116	14.665	13.272	11.938	10.658	9.428	8.248	7.114
26	21.732	20.010	18.362	16.785	15.273	13.826	12.437	11.106	9.829	8.603
28	24.548	22.670	20.876	19.159	17.514	15.941	14.433	12.989	11.604	10.276
30	27.693	25.644	23.686	21.813	20.023	18.310	16.669	15.099	13.596	12.155
32	31.206	28.966	26.825	24.781	22.827	20.959	19.173	17.463	15.827	14.261
34	35.126	32.672	30.331	28.096	25.960	23.920	21.971	20.106	18.325	16.619
36	39.498	36.808	34.243	31.795	29.459	27.228	25.097	23.062	21.117	19.257
38	44.375	41.422	38.607	35.923	33.363	30.920	28.589	26.363	24.237	22.206
40	49.813	46.567	43.475	40.528	37.718	35.040	32.486	30.048	27.722	25.501

t °C	$t - t_w$, °C 10	11	12	13	14	15	16	17	18	19
	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}
12	.409									
14	1.077	.332								
16	1.838	1.044	.276							
18	2.700	1.853	1.034	.243						
20	3.677	2.769	1.893	1.049	.233					
22	4.780	3.806	2.867	1.962	1.089	.247				
24	6.024	4.976	3.967	2.996	2.060	1.158	.287			
26	7.426	6.295	5.208	4.163	3.157	2.189	1.255	.356		
28	9.003	7.780	6.606	5.478	4.395	3.352	2.349	1.383	.453	
30	10.774	9.449	8.179	6.959	5.789	4.664	3.583	2.543	1.543	.581
32	12.761	11.324	9.946	8.625	7.358	6.141	4.974	3.852	2.774	1.737
34	14.987	13.425	11.928	10.495	9.120	7.803	6.539	5.326	4.161	3.043
36	17.480	15.778	14.149	12.591	11.098	9.668	8.297	6.983	5.723	4.512
38	20.266	18.410	16.637	14.939	13.314	11.760	10.270	8.844	7.476	6.166
40	23.379	21.353	19.418	17.566	15.796	14.103	12.482	10.931	9.445	8.023

t °C	$t - t_w$, °C 20	21	22	23	24	25	26	27	28	29
	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}
32	.740									
34	1.968	.934								
36	3.351	2.235	1.164	.132						

Table 4.22.2.1 **Factors for computing thermodynamic wet-bulb temperature as a function of mixing ratio, temperature and pressure**

Facteurs pour le calcul de la température thermodynamique du thermomètre mouillé en fonction du rapport de mélange, de la température et de la pression

I. Thermodynamic wet-bulb temperature as a function of factor *F* and pressure — *Température thermodynamique du thermomètre mouillé en fonction du facteur F et de la pression*

F	Pressure — *pression*, mb 1050 °C	1000 °C	950 °C	900 °C	850 °C	800 °C	750 °C	700 °C	650 °C	600 °C
-19.0	-49.91	-49.91	-49.92	-49.92	-49.93	-49.94	-49.95	-49.96	-49.97	-49.98
-18.5	-48.53	-48.53	-48.54	-48.55	-48.56	-48.57	-48.58	-48.59	-48.60	-48.62
-18.0	-47.16	-47.17	-47.17	-47.18	-47.19	-47.20	-47.21	-47.23	-47.24	-47.26
-17.5	-45.80	-45.81	-45.81	-45.82	-45.84	-45.85	-45.86	-45.88	-45.90	-45.92
-17.0	-44.45	-44.45	-44.47	-44.48	-44.49	-44.50	-44.52	-44.54	-44.56	-44.58
-16.5	-43.10	-43.11	-43.13	-43.14	-43.15	-43.17	-43.19	-43.21	-43.23	-43.26
-16.0	-41.77	-41.78	-41.79	-41.81	-41.83	-41.85	-41.87	-41.89	-41.92	-41.95
-15.5	-40.45	-40.46	-40.47	-40.49	-40.51	-40.53	-40.56	-40.58	-40.62	-40.65
-15.0	-39.13	-39.15	-39.16	-39.18	-39.21	-39.23	-39.26	-39.29	-39.32	-39.37
-14.5	-37.83	-37.85	-37.87	-37.89	-37.91	-37.94	-37.97	-38.01	-38.05	-38.09
-14.0	-36.53	-36.55	-36.58	-36.60	-36.63	-36.66	-36.70	-36.74	-36.78	-36.83
-13.5	-35.25	-35.27	-35.30	-35.33	-35.36	-35.39	-35.43	-35.48	-35.53	-35.59
-13.0	-33.98	-34.00	-34.03	-34.06	-34.10	-34.14	-34.18	-34.23	-34.29	-34.36
-12.5	-32.72	-32.75	-32.78	-32.81	-32.85	-32.90	-32.95	-33.00	-33.07	-33.14
-12.0	-31.47	-31.50	-31.54	-31.58	-31.62	-31.67	-31.72	-31.79	-31.86	-31.94
-11.5	-30.23	-30.27	-30.31	-30.35	-30.40	-30.45	-30.51	-30.58	-30.66	-30.75
-11.0	-29.01	-29.05	-29.09	-29.14	-29.19	-29.25	-29.32	-29.40	-28.00	-28.34
-10.5	-27.79	-27.84	-27.89	-27.94	-28.00	-28.07	-28.14	-28.22	-29.90	-29.51
-10.0	-26.59	-26.64	-26.70	-26.76	-26.82	-26.90	-26.98	-27.07	-27.46	-27.65
-9.5	-25.41	-25.46	-25.52	-25.59	-25.66	-25.74	-25.83	-25.93	-26.04	-26.18
-9.0	-24.24	-24.30	-24.36	-24.43	-24.51	-24.60	-24.70	-24.81	-24.93	-25.07
-8.5	-23.08	-23.14	-23.22	-23.29	-23.38	-23.47	-23.58	-23.70	-23.84	-23.99
-8.0	-21.94	-22.01	-22.09	-22.17	-22.26	-22.37	-22.48	-22.61	-22.76	-22.92
-7.5	-20.81	-20.89	-20.97	-21.06	-21.16	-21.28	-21.40	-21.54	-21.70	-21.88
-7.0	-19.70	-19.78	-19.87	-19.97	-20.08	-20.20	-20.34	-20.49	-20.66	-20.85
-6.5	-18.60	-18.69	-18.79	-18.90	-19.02	-19.15	-19.29	-19.46	-19.64	-19.84
-6.0	-17.52	-17.62	-17.72	-17.84	-17.97	-18.11	-18.27	-18.44	-18.63	-18.86
-5.5	-16.46	-16.56	-16.68	-16.80	-16.94	-17.09	-17.26	-17.44	-17.65	-17.89
-5.0	-15.41	-15.52	-15.64	-15.78	-15.93	-16.09	-16.27	-16.46	-16.69	-16.94
-4.5	-14.38	-14.50	-14.63	-14.77	-14.93	-15.10	-15.29	-15.50	-15.74	-16.00
-4.0	-13.37	-13.50	-13.64	-13.79	-13.95	-14.14	-14.34	-14.56	-14.81	-15.09
-3.5	-12.37	-12.51	-12.66	-12.82	-13.00	-13.19	-13.40	-13.64	-13.90	-14.20
-3.0	-11.39	-11.54	-11.70	-11.87	-12.06	-12.26	-12.49	-12.74	-13.01	-13.33
-2.5	-10.43	-10.59	-10.75	-10.94	-11.13	-11.35	-11.59	-11.85	-12.14	-12.47
-2.0	-9.49	-9.65	-9.83	-10.02	-10.23	-10.46	-10.71	-10.99	-11.29	-11.63
-1.5	-8.56	-8.74	-8.92	-9.12	-9.34	-9.58	-9.85	-10.14	-10.46	-10.82
-1.0	-7.65	-7.84	-8.03	-8.25	-8.48	-8.73	-9.00	-9.31	-9.64	-10.01
-.5	-6.76	-6.95	-7.16	-7.38	-7.62	-7.89	-8.18	-8.49	-8.84	-9.23
0.0	-5.89	-6.09	-6.31	-6.54	-6.79	-7.07	-7.37	-7.70	-8.06	-8.47
1.0	-4.19	-4.41	-4.65	-4.90	-5.18	-5.47	-5.80	-6.16	-6.55	-6.98
2.0	-2.56	-2.80	-3.05	-3.33	-3.63	-3.95	-4.30	-4.68	-5.10	-5.57
3.0	-.99	-1.25	-1.53	-1.82	-2.14	-2.48	-2.86	-3.27	-3.71	-4.21
4.0	.51	.24	-.06	-.37	-.71	-1.08	-1.48	-1.91	-2.39	-2.91
5.0	1.96	1.66	1.35	1.01	.65	.26	-.16	-.62	-1.12	-1.67
6.0	3.34	3.03	2.70	2.34	1.96	1.55	1.11	.62	.10	-.48
7.0	4.68	4.35	4.00	3.62	3.22	2.79	2.32	1.82	1.27	.66
8.0	5.96	5.61	5.24	4.85	4.43	3.97	3.49	2.96	2.39	1.76
9.0	7.19	6.82	6.44	6.03	5.59	5.12	4.61	4.06	3.46	2.81

TABLE 4.22 — 5

F	Pressure — *pression*, mb									
	1050	1000	950	900	850	800	750	700	650	600
	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
10.0	8.37	7.99	7.59	7.16	6.70	6.21	5.69	5.12	4.50	3.82
11.0	9.51	9.11	8.69	8.25	7.78	7.27	6.72	6.13	5.49	4.80
12.0	10.60	10.19	9.76	9.30	8.81	8.28	7.72	7.11	6.45	5.73
13.0	11.66	11.24	10.79	10.31	9.80	9.26	8.68	8.05	7.37	6.63
14.0	12.68	12.24	11.78	11.29	10.76	10.20	9.61	8.96	8.26	7.50
15.0	13.66	13.21	12.73	12.23	11.69	11.11	10.50	9.84	9.12	8.34
16.0	14.61	14.14	13.65	13.13	12.58	11.99	11.36	10.68	9.95	9.15
17.0	15.52	15.05	14.54	14.01	13.44	12.84	12.19	11.50	10.75	9.94
18.0	16.41	15.92	15.41	14.86	14.28	13.66	13.00	12.29	11.53	10.70
19.0	17.27	16.77	16.24	15.68	15.09	14.46	13.78	13.06	12.28	11.43
20.0	18.10	17.59	17.05	16.48	15.87	15.23	14.54	13.80	13.00	12.14
21.0	18.90	18.38	17.83	17.25	16.63	15.97	15.27	14.52	13.71	12.83
22.0	19.68	19.15	18.59	17.99	17.36	16.70	15.98	15.22	14.39	13.50
23.0	20.44	19.89	19.32	18.72	18.08	17.40	16.67	15.89	15.06	14.15
24.0	21.17	20.62	20.04	19.42	18.77	18.08	17.34	16.55	15.70	14.78
25.0	21.88	21.32	20.73	20.11	19.44	18.74	17.99	17.19	16.33	15.40
26.0	22.58	22.01	21.40	20.77	20.10	19.39	18.62	17.81	16.94	15.99
28.0	23.91	23.32	22.70	22.05	21.35	20.62	19.84	19.01	18.11	17.14
30.0	25.17	24.56	23.93	23.26	22.55	21.79	20.99	20.14	19.22	18.23
32.0	26.37	25.75	25.09	24.41	23.68	22.91	22.09	21.22	20.28	19.26
34.0	27.51	26.87	26.20	25.50	24.76	23.97	23.13	22.24	21.28	20.25
36.0	28.59	27.94	27.26	26.55	25.79	24.99	24.13	23.96	22.25	21.20
38.0	29.63	28.97	28.28	27.54	26.77	25.95	25.09	23.75	23.17	22.10
40.0	30.63	29.95	29.24	28.50	27.71	26.88	26.00	24.05	24.05	22.96
42.0	31.58	30.89	30.17	29.42	28.62	27.77	26.87	25.82	24.89	23.79
44.0	32.49	31.79	31.06	30.29	29.48	28.63	27.71	26.73	25.71	24.59
46.0	33.37	32.66	31.92	31.14	30.32	29.45	28.52	27.54	26.49	25.36
48.0	34.22	33.50	32.74	31.95	31.12	30.24	29.30	28.31	27.24	26.09
50.0	35.03	34.30	33.54	32.74	31.89	31.00	30.05	29.04	27.97	26.81
52.0	35.81	35.08	34.31	33.49	32.64	31.74	30.78	29.76	28.67	27.49
54.0	36.57	35.83	35.05	34.22	33.36	32.45	31.48	30.45	29.34	28.16
56.0	37.30	36.55	35.76	34.93	34.06	33.13	32.15	31.11	30.00	28.80
58.0	38.01	37.25	36.45	35.61	34.73	33.80	32.81	31.76	30.63	29.42
60.0	38.70	37.93	37.12	36.28	35.38	34.44	33.44	32.38	31.25	30.03
62.0	39.36	38.59	37.77	36.92	36.02	35.07	34.06	32.99	31.84	30.61
64.0	40.01	39.22	38.40	37.54	36.63	35.67	34.66	33.57	32.42	31.18
66.0	40.63	39.84	39.01	38.14	37.23	36.26	35.23	34.15	32.98	31.73
68.0	41.24	40.44	39.61	38.73	37.81	36.83	35.80	34.70	33.53	32.27

F	Pressure — *pression*, mb 550	500	450	400	350	300	250	200	150	100
	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
-19.0										
-18.5	-48.64	-48.66	-48.69	-48.72	-48.77	-48.82	-48.90	-49.02	-49.21	-49.56
-18.0	-47.29	-47.31	-47.34	-47.38	-47.43	-47.50	-47.59	-47.72	-47.94	-48.34
-17.5	-45.94	-45.97	-46.01	-46.06	-46.11	-46.19	-46.29	-46.45	-46.69	-47.14
-17.0	-44.61	-44.65	-44.69	-44.74	-44.81	-44.89	-45.01	-45.19	-45.46	-45.97
-16.5	-43.30	-43.33	-43.38	-43.44	-43.52	-43.62	-43.75	-43.94	-44.25	-44.82
-16.0	-41.99	-42.03	-42.09	-42.16	-42.24	-42.35	-42.50	-42.72	-43.07	-43.70
-15.5	-40.70	-40.75	-40.81	-40.88	-40.98	-41.11	-41.28	-41.52	-41.90	-42.60
-15.0	-39.41	-39.47	-39.54	-39.63	-39.74	-39.88	-40.07	-40.34	-40.77	-41.53
-14.5	-38.15	-38.21	-38.29	-38.39	-38.51	-38.67	-38.88	-39.18	-39.65	-40.48
-14.0	-36.89	-36.97	-37.06	-37.16	-37.30	-37.47	-37.71	-38.04	-38.56	-39.46
-13.5	-35.66	-35.74	-35.84	-35.96	-36.11	-36.30	-36.56	-36.93	-37.49	-38.47
-13.0	-34.43	-34.52	-34.63	-34.77	-34.93	-35.15	-35.43	-35.84	-36.45	-37.51
-12.5	-33.22	-33.33	-33.45	-33.59	-33.78	-34.01	-34.33	-34.77	-35.43	-36.57
-12.0	-32.03	-32.14	-32.28	-32.44	-32.64	-32.90	-33.24	-33.72	-34.44	-35.66
-11.5	-30.86	-30.98	-31.12	-31.30	-31.52	-31.81	-32.18	-32.70	-33.47	-34.77
-11.0	-28.68	-29.13	-29.94	-30.19	-30.43	-30.73	-31.14	-31.70	-32.53	-33.91
-10.5	-29.28	-29.14	-29.04	-26.81	-29.35	-29.69	-30.12	-30.72	-31.61	-33.07
-10.0	-27.84	-28.03	-28.22	-28.42	-28.30	-28.66	-29.13	-29.77	-30.71	-32.26
-9.5	-26.34	-26.51	-26.72	-26.96	-27.26	-27.65	-28.15	-28.84	-29.84	-31.47
-9.0	-25.24	-25.43	-25.65	-25.92	-26.25	-26.67	-27.21	-27.94	-29.00	-30.70
-8.5	-24.17	-24.37	-24.61	-24.90	-25.26	-25.70	-26.28	-27.05	-28.17	-29.96
-8.0	-23.12	-23.34	-23.60	-23.91	-24.29	-24.76	-25.37	-26.19	-27.37	-29.24
-7.5	-22.08	-22.32	-22.60	-22.94	-23.34	-23.84	-24.49	-25.35	-26.59	-28.53
-7.0	-21.07	-21.33	-21.63	-21.98	-22.41	-22.95	-23.63	-24.54	-25.83	-27.85
-6.5	-20.08	-20.35	-20.67	-21.05	-21.50	-22.07	-22.79	-23.74	-25.09	-27.19
-6.0	-19.11	-19.40	-19.74	-20.13	-20.62	-21.21	-21.97	-22.97	-24.37	-26.54
-5.5	-18.15	-18.46	-18.82	-19.24	-19.75	-20.38	-21.17	-22.21	-23.67	-25.91
-5.0	-17.22	-17.55	-17.92	-18.37	-18.91	-19.56	-20.39	-21.47	-22.98	-25.30
-4.5	-16.30	-16.65	-17.05	-17.52	-18.08	-18.77	-19.63	-20.76	-22.32	-24.71
-4.0	-15.41	-15.77	-16.19	-16.69	-17.27	-17.99	-18.89	-20.06	-21.68	-24.13
-3.5	-14.53	-14.92	-15.36	-15.87	-16.49	-17.23	-18.17	-19.38	-21.05	-23.57
-3.0	-13.68	-14.08	-14.54	-15.08	-15.72	-16.50	-17.46	-18.72	-20.43	-23.02
-2.5	-12.84	-13.26	-13.74	-14.30	-14.97	-15.78	-16.78	-18.07	-19.84	-22.49
-2.0	-12.02	-12.46	-12.96	-13.55	-14.24	-15.07	-16.11	-17.44	-19.26	-21.97
-1.5	-11.22	-11.67	-12.20	-12.80	-13.52	-14.39	-15.45	-16.83	-18.69	-21.46
-1.0	-10.43	-10.91	-11.45	-12.08	-12.82	-13.72	-14.82	-16.23	-18.14	-20.97
-.5	-9.67	-10.16	-10.72	-11.38	-12.14	-13.06	-14.20	-15.64	-17.60	-20.49
0.0	-8.92	-9.43	-10.01	-10.69	-11.48	-12.43	-13.59	-15.07	-17.07	-20.02
1.0	-7.47	-8.02	-8.64	-9.36	-10.20	-11.20	-12.42	-13.97	-16.06	-19.11
2.0	-6.08	-6.67	-7.33	-8.09	-8.97	-10.02	-11.31	-12.93	-15.09	-18.24
3.0	-4.76	-5.38	-6.07	-6.87	-7.80	-8.90	-10.24	-11.93	-14.16	-17.41
4.0	-3.49	-4.14	-4.87	-5.71	-6.68	-7.83	-9.22	-10.97	-13.28	-16.62
5.0	-2.28	-2.96	-3.73	-4.60	-5.61	-6.81	-8.25	-10.05	-12.43	-15.86
6.0	-1.12	-1.83	-2.63	-3.54	-4.59	-5.83	-7.32	-9.18	-11.62	-15.13
7.0	-.00	-.74	-1.57	-2.52	-3.61	-4.89	-6.42	-8.34	-10.84	-14.43
8.0	1.07	.30	-.56	-1.54	-2.67	-3.98	-5.56	-7.53	-10.09	-13.76
9.0	2.09	1.30	.41	-.60	-1.76	-3.12	-4.74	-6.75	-9.38	-13.11

F	550	500	450	400	350	300	250	200	150	100
	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
10.0	3.08	2.26	1.34	.30	-.89	-2.28	-3.95	-6.00	-8.68	-12.49
11.0	4.03	3.18	2.24	1.17	-.05	-1.48	-3.18	-5.28	-8.01	-11.88
12.0	4.94	4.07	3.10	2.01	.75	-.71	-2.44	-4.59	-7.37	-11.30
13.0	5.82	4.93	3.93	2.81	1.53	.04	-1.73	-3.92	-6.75	-10.74
14.0	6.67	5.76	4.74	3.59	2.28	.76	-1.05	-3.27	-6.14	-10.19
15.0	7.49	6.56	5.51	4.34	3.00	1.46	-.38	-2.64	-5.56	-9.66
16.0	8.28	7.33	6.26	5.07	3.71	2.13	.26	-2.04	-5.00	-9.15
17.0	9.05	8.07	6.99	5.77	4.38	2.78	.88	-1.45	-4.45	-8.66
18.0	9.79	8.79	7.69	6.45	5.04	3.41	1.48	-.88	-3.92	-8.17
19.0	10.51	9.49	8.37	7.11	5.68	4.02	2.06	-.33	-3.41	-7.71
20.0	11.20	10.17	9.03	7.75	6.29	4.61	2.63	.20	-2.91	-7.25
21.0	11.88	10.83	9.67	8.37	6.89	5.19	3.18	.73	-2.42	-6.81
22.0	12.53	11.47	10.29	8.97	7.47	5.75	3.71	1.23	-1.95	-6.38
23.0	13.16	12.08	10.89	9.55	8.04	6.29	4.23	1.72	-1.49	-5.96
24.0	13.78	12.69	11.48	10.12	8.59	6.82	4.74	2.20	-1.04	-5.55
25.0	14.38	13.27	12.04	10.67	9.12	7.34	5.23	2.67	-.60	-5.15
26.0	14.97	13.84	12.60	11.21	9.64	7.84	5.71	3.12	-.18	-4.76
28.0	16.09	14.94	13.66	12.25	10.64	8.80	6.63	4.00	.64	-4.01
30.0	17.15	15.98	14.68	13.23	11.60	9.72	7.51	4.84	1.42	-3.30
32.0	18.17	16.97	15.64	14.17	12.50	10.59	8.35	5.63	2.17	-2.61
34.0	19.13	17.91	16.56	15.06	13.37	11.43	9.15	6.39	2.89	-1.95
36.0	20.05	18.81	17.44	15.92	14.20	12.23	9.92	7.12	3.57	-1.33
38.0	20.94	19.67	18.28	16.74	14.99	13.00	10.65	7.82	4.23	-.72
40.0	21.78	20.50	19.09	17.52	15.75	13.73	11.36	8.50	4.86	-.14
42.0	22.60	21.30	19.87	18.27	16.49	14.44	12.04	9.14	5.47	.42
44.0	23.38	22.06	20.61	19.00	17.19	15.12	12.69	9.77	6.06	.96
46.0	24.13	22.80	21.33	19.70	17.87	15.77	13.32	10.37	6.62	1.48
48.0	24.85	23.50	22.02	20.37	18.52	16.40	13.93	10.95	7.17	1.99
50.0	25.55	24.19	22.69	21.02	19.15	17.01	14.52	11.51	7.70	2.47
52.0	26.23	24.85	23.33	21.65	19.76	17.60	15.08	12.05	8.21	2.95
54.0	26.88	25.48	23.95	22.26	20.35	18.18	15.63	12.57	8.70	3.40
56.0	27.51	26.10	24.56	22.84	20.92	18.73	16.17	13.08	9.18	3.85
58.0	28.12	26.70	25.14	23.41	21.48	19.26	16.68	13.57	9.65	4.28
60.0	28.71	27.28	25.71	23.97	22.01	19.78	17.18	14.05	10.10	4.70
62.0	29.28	27.84	26.26	24.50	22.53	20.29	17.67	14.52	10.54	5.10
64.0	29.84	28.39	26.79	25.02	23.04	20.78	18.14	14.97	10.97	5.50
66.0	30.38	28.92	27.31	25.53	23.53	21.25	18.60	15.41	11.38	5.89
68.0	30.91	29.43	27.81	26.02	24.01	21.72	19.05	15.83	11.79	6.26

(Column heading: Pressure — *pression*, mb)

II. Factors $\frac{10^3 c_p}{L_v(t_w)}$ and $\frac{c_{pv}}{L_v(t_w)}$ / Facteurs $\frac{10^3 c_p}{L_v(t_w)}$ et $\frac{c_{pv}}{L_v(t_w)}$

t_w °C	$\frac{10^3 c_p}{L_v(t_w)}$	$\frac{c_{pv}}{L_v(t_w)}$	t_w °C	$\frac{10^3 c_p}{L_v(t_w)}$	$\frac{c_{pv}}{L_v(t_w)}$
-50	.38143	.000702	0	.40186	.000740
-49	.38192	.000703	1	.40224	.000740
-48	.38240	.000704	2	.40262	.000741
-47	.38288	.000705	3	.40300	.000742
-46	.38335	.000706	4	.40338	.000743
-45	.38382	.000707	5	.40376	.000743
-44	.38428	.000707	6	.40414	.000744
-43	.38474	.000708	7	.40452	.000745
-42	.38520	.000709	8	.40490	.000745
-41	.38565	.000710	9	.40528	.000746
-40	.38609	.000711	10	.40567	.000747
-39	.38653	.000712	11	.40605	.000747
-38	.38697	.000712	12	.40644	.000748
-37	.38740	.000713	13	.40683	.000749
-36	.38782	.000714	14	.40722	.000750
-35	.38825	.000715	15	.40761	.000750
-34	.38867	.000715	16	.40801	.000751
-33	.38908	.000716	17	.40841	.000752
-32	.38949	.000717	18	.40881	.000753
-31	.38990	.000718	19	.40922	.000753
-30	.39031	.000718	20	.40962	.000754
-29	.39071	.000719	21	.41001	.000755
-28	.39110	.000720	22	.41041	.000755
-27	.39150	.000721	23	.41080	.000756
-26	.39189	.000721	24	.41119	.000757
-25	.39228	.000722	25	.41158	.000758
-24	.39267	.000723	26	.41198	.000758
-23	.39306	.000724	27	.41238	.000759
-22	.39344	.000724	28	.41278	.000760
-21	.39383	.000725	29	.41318	.000761
-20	.39421	.000726	30	.41358	.000761
-19	.39460	.000726	31	.41398	.000762
-18	.39498	.000727	32	.41438	.000763
-17	.39537	.000728	33	.41478	.000764
-16	.39576	.000729	34	.41518	.000764
-15	.39615	.000729	35	.41558	.000765
-14	.39653	.000730	36	.41600	.000766
-13	.39692	.000731	37	.41641	.000767
-12	.39730	.000731	38	.41683	.000767
-11	.39768	.000732	39	.41725	.000768
-10	.39807	.000733	40	.41767	.000769
-9	.39845	.000733	41	.41808	.000770
-8	.39883	.000734	42	.41848	.000770
-7	.39921	.000735	43	.41889	.000771
-6	.39959	.000736	44	.41930	.000772
-5	.39997	.000736	45	.41971	.000773
-4	.40035	.000737	46	.42013	.000773
-3	.40073	.000738	47	.42056	.000774
-2	.40111	.000738	48	.42099	.000775
-1	.40149	.000739	49	.42142	.000776
			50	.42186	.000777

Table 4.22.2.2 **Thermodynamic wet-bulb temperature as a function of mixing ratio and temperature for a pressure of 1 000 mb**

Température thermodynamique du thermomètre mouillé en fonction du rapport de mélange et de la température pour la pression de 1 000 mb

t_w : thermodynamic wet-bulb temperature — *température thermodynamique du thermomètre mouillé*

t : temperature — *température*

Table gives values of $t - t_w$ – *la table donne les valeurs de* $t - t_w$

	Mixing ratio — *rapport de mélange*, g kg^{-1}									
t	0	1	2	3	4	5	6	7	8	9
°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
-10	3.4	1.5								
-8	3.9	2.0	.2							
-6	4.4	2.5	.8							
-4	4.9	3.1	1.4							
-2	5.5	3.7	2.1	.5						
0	6.1	4.4	2.8	1.2						
2	6.7	5.1	3.5	2.0	.6					
4	7.4	5.8	4.3	2.9	1.5	.2				
6	8.2	6.6	5.2	3.8	2.4	1.1				
8	8.9	7.4	6.0	4.7	3.3	2.1	.9			
10	9.7	8.3	6.9	5.6	4.3	3.1	1.9	.8		
12	10.6	9.2	7.8	6.6	5.3	4.2	3.0	1.9	.9	
14	11.5	10.1	8.8	7.6	6.4	5.2	4.1	3.1	2.1	1.1
16	12.4	11.1	9.8	8.6	7.4	6.3	5.3	4.2	3.2	2.3
18	13.3	12.0	10.8	9.7	8.5	7.5	6.4	5.4	4.5	3.5
20	14.3	13.1	11.9	10.7	9.7	8.6	7.6	6.6	5.7	4.8
22	15.3	14.1	13.0	11.9	10.8	9.8	8.8	7.9	6.9	6.1
24	16.3	15.2	14.1	13.0	12.0	11.0	10.0	9.1	8.2	7.4
26	17.4	16.3	15.2	14.2	13.2	12.2	11.3	10.4	9.5	8.7
28	18.5	17.4	16.4	15.3	14.4	13.4	12.5	11.7	10.8	10.0
30	19.6	18.6	17.5	16.6	15.6	14.7	13.8	13.0	12.1	11.3
32	20.8	19.7	18.7	17.8	16.9	16.0	15.1	14.3	13.5	12.7
34	21.9	20.9	20.0	19.0	18.1	17.3	16.4	15.6	14.8	14.1
36	23.1	22.2	21.2	20.3	19.4	18.6	17.8	17.0	16.2	15.5
38	24.3	23.4	22.5	21.6	20.7	19.9	19.1	18.4	17.6	16.9
40	25.6	24.7	23.8	22.9	22.1	21.3	20.5	19.7	19.0	18.3

Mixing ratio — *rapport de mélange*, g kg^{-1}

t	10	11	12	13	14	15	16	17	18	19
°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
16	1.4	.5								
18	2.6	1.8	.9	.1						
20	3.9	3.1	2.3	1.5	.7					
22	5.2	4.4	3.6	2.8	2.1	1.4	.7			
24	6.5	5.7	5.0	4.2	3.5	2.8	2.1	1.4	.8	.1
26	7.9	7.1	6.3	5.6	4.9	4.2	3.5	2.9	2.2	1.6
28	9.2	8.4	7.7	7.0	6.3	5.6	5.0	4.3	3.7	3.1
30	10.6	9.8	9.1	8.4	7.7	7.1	6.4	5.8	5.2	4.6
32	12.0	11.2	10.5	9.8	9.2	8.5	7.9	7.3	6.7	6.1
34	13.4	12.6	12.0	11.3	10.6	10.0	9.4	8.8	8.2	7.6
36	14.8	14.1	13.4	12.7	12.1	11.5	10.9	10.3	9.7	9.1
38	16.2	15.5	14.8	14.2	13.6	13.0	12.4	11.8	11.2	10.7
40	17.6	17.0	16.3	15.7	15.1	14.5	13.9	13.3	12.8	12.2

Mixing ratio — *rapport de mélange*, g kg^{-1}

t	20	21	22	23	24	25	26	27	28	29
°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
26	1.0	.4								
28	2.5	1.9	1.4	.8	.3					
30	4.0	3.4	2.9	2.4	1.8	1.3	.8	.3		
32	5.5	5.0	4.4	3.9	3.4	2.9	2.4	1.9	1.4	1.0
34	7.1	6.5	6.0	5.5	5.0	4.5	4.0	3.5	3.0	2.6
36	8.6	8.1	7.5	7.0	6.5	6.0	5.6	5.1	4.6	4.2
38	10.1	9.6	9.1	8.6	8.1	7.6	7.2	6.7	6.3	5.8
40	11.7	11.2	10.7	10.2	9.7	9.2	8.8	8.3	7.9	7.4

Mixing ratio — *rapport de mélange*, g kg^{-1}

t	30	31	32	33	34	35	36	37	38	39
°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
32	0.0	0.0								
34	.5	.1								
36	2.1	1.7	1.3	.9	.5	.1				
38	3.8	3.3	2.9	2.5	2.1	1.7	1.3	.9	.6	.2
40	7.0	6.6	6.2	5.8	5.4	5.0	4.6	4.3	3.9	3.5

Table 4.22.3 **Thermodynamic dew-point temperature as a function of thermodynamic wet-bulb temperature and temperature for a pressure of 1 000 mb**

Température thermodynamique du point de rosée en fonction de la température thermodynamique du thermomètre mouillé et de la température pour la pression de 1 000 mb

t_w : thermodynamic wet-bulb temperature — *température thermodynamique du thermomètre mouillé*

t : temperature — *température*

	$t - t_w$, °C									
t	1	2	3	4	5	6	7	8	9	10
°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
-25	-45.1									
-24	-40.5									
-23	-37.1									
-22	-34.3									
-21	-31.9									
-20	-29.8									
-19	-27.8									
-18	-26.0									
-17	-24.3	-45.5								
-16	-22.7	-38.3								
-15	-21.2	-33.8								
-14	-19.8	-30.3								
-13	-18.4	-27.4								
-12	-17.0	-25.0								
-11	-15.7	-22.8	-40.8							
-10	-14.4	-20.8	-33.9							
-9	-13.1	-18.9	-29.4							
-8	-11.9	-17.2	-26.0							
-7	-10.7	-15.6	-23.1	-45.6						
-6	-9.5	-14.0	-20.6	-34.8						
-5	-8.3	-12.5	-18.4	-29.1						
-4	-7.1	-11.1	-16.4	-25.1						
-3	-6.0	-9.7	-14.5	-21.8	-41.2					
-2	-4.9	-8.3	-12.7	-19.1	-31.7					
-1	-3.7	-7.0	-11.1	-16.7	-26.3					
0	-2.6	-5.7	-9.5	-14.5	-22.3	-47.6				
1	-1.5	-4.4	-8.0	-12.5	-19.1	-32.8				
2	-.4	-3.2	-6.5	-10.7	-16.4	-26.3				
3	.7	-2.0	-5.1	-8.9	-14.0	-21.9	-48.1			
4	1.8	-.8	-3.7	-7.3	-11.8	-18.4	-31.8			
5	2.8	.4	-2.4	-5.7	-9.8	-15.4	-25.1			
6	3.9	1.6	-1.1	-4.2	-7.9	-12.9	-20.5	-41.4		
7	5.0	2.7	.2	-2.7	-6.2	-10.6	-16.9	-28.9		
8	6.0	3.9	1.5	-1.3	-4.5	-8.5	-13.9	-22.7		
9	7.1	5.0	2.7	.1	-2.9	-6.6	-11.3	-18.3	-33.9	

t	$t - t_w$, °C 1	2	3	4	5	6	7	8	9	10
°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
10	8.2	6.1	3.9	1.4	-1.4	-4.8	-9.0	-14.9	-25.0	
11	9.2	7.3	5.1	2.8	.1	-3.1	-6.9	-12.0	-19.6	-41.2
12	10.2	8.4	6.3	4.0	1.5	-1.4	-5.0	-9.4	-15.7	-27.3
13	11.3	9.5	7.5	5.3	2.9	.1	-3.1	-7.1	-12.4	-20.8
14	12.3	10.5	8.6	6.5	4.2	1.6	-1.4	-5.0	-9.6	-16.3
15	13.4	11.6	9.8	7.8	5.6	3.1	.3	-3.0	-7.2	-12.7
16	14.4	12.7	10.9	9.0	6.8	4.5	1.8	-1.2	-4.9	-9.7
17	15.4	13.8	12.0	10.2	8.1	5.9	3.4	.5	-2.9	-7.1
18	16.5	14.9	13.1	11.3	9.4	7.2	4.8	2.2	-1.0	-4.7
19	17.5	15.9	14.3	12.5	10.6	8.5	6.3	3.7	.8	-2.6
20	18.5	17.0	15.4	13.6	11.8	9.8	7.7	5.3	2.6	-.6
21	19.6	18.0	16.5	14.8	13.0	11.1	9.0	6.7	4.2	1.3
22	20.6	19.1	17.5	15.9	14.2	12.3	10.3	8.2	5.8	3.0
23	21.6	20.1	18.6	17.0	15.3	13.5	11.6	9.5	7.3	4.7
24	22.6	21.2	19.7	18.1	16.5	14.8	12.9	10.9	8.7	6.3
25	23.6	22.2	20.8	19.2	17.6	15.9	14.2	12.2	10.1	7.9
26	24.7	23.3	21.8	20.3	18.8	17.1	15.4	13.5	11.5	9.4
27	25.7	24.3	22.9	21.4	19.9	18.3	16.6	14.8	12.9	10.8
28	26.7	25.3	24.0	22.5	21.0	19.4	17.8	16.1	14.2	12.2
29	27.7	26.4	25.0	23.6	22.1	20.6	19.0	17.3	15.5	13.6
30	28.7	27.4	26.1	24.7	23.2	21.7	20.2	18.5	16.8	14.9
31	29.7	28.4	27.1	25.7	24.3	22.8	21.3	19.7	18.0	16.2
32	30.8	29.5	28.2	26.8	25.4	24.0	22.5	20.9	19.3	17.5
33	31.8	30.5	29.2	27.9	26.5	25.1	23.6	22.1	20.5	18.8
34	32.8	31.5	30.2	28.9	27.6	26.2	24.7	23.2	21.7	20.0
35	33.8	32.5	31.3	30.0	28.6	27.3	25.9	24.4	22.9	21.3
36	34.8	33.6	32.3	31.0	29.7	28.4	27.0	25.5	24.0	22.5
37	35.8	34.6	33.3	32.1	30.8	29.5	28.1	26.7	25.2	23.7
38	36.8	35.6	34.4	33.1	31.8	30.5	29.2	27.8	26.4	24.9
39	37.8	36.6	35.4	34.2	32.9	31.6	30.3	28.9	27.5	26.0
40	38.8	37.6	36.4	35.2	34.0	32.7	31.4	30.0	28.6	27.2
41	39.8	38.7	37.5	36.3	35.0	33.7	32.4	31.1	29.8	28.3
42	40.8	39.7	38.5	37.3	36.1	34.8	33.5	32.2	30.9	29.5
43	41.9	40.7	39.5	38.3	37.1	35.9	34.6	33.3	32.0	30.6
44	42.9	41.7	40.5	39.4	38.1	36.9	35.7	34.4	33.1	31.7
45	43.9	42.7	41.6	40.4	39.2	38.0	36.7	35.5	34.2	32.9
46	44.9	43.7	42.6	41.4	40.2	39.0	37.8	36.6	35.3	34.0
47	45.9	44.7	43.6	42.4	41.3	40.1	38.9	37.6	36.4	35.1
48	46.9	45.8	44.6	43.5	42.3	41.1	39.9	38.7	37.4	36.2
49	47.9	46.8	45.6	44.5	43.3	42.2	41.0	39.8	38.5	37.3
50	48.9	47.8	46.7	45.5	44.4	43.2	42.0	40.8	39.6	38.4

TABLE 4.22 — 13

t	$t - t_w$, °C 11	12	13	14	15	16	17	18	19	20
°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
14	-29.5									
15	-21.7									
16	-16.6	-31.5								
17	-12.8	-22.3								
18	-9.6	-16.8	-32.8							
19	-6.8	-12.6	-22.5							
20	-4.4	-9.3	-16.6	-33.3						
21	-2.2	-6.5	-12.3	-22.2						
22	-.1	-3.9	-8.9	-16.1	-32.6					
23	1.8	-1.6	-5.9	-11.8	-21.5					
24	3.6	.5	-3.3	-8.2	-15.4	-31.1				
25	5.3	2.4	-1.0	-5.3	-11.0	-20.4				
26	6.9	4.2	1.1	-2.6	-7.5	-14.4	-28.8			
27	8.5	6.0	3.1	-.3	-4.5	-10.1	-19.0			
28	10.0	7.6	5.0	1.9	-1.8	-6.5	-13.2	-26.2		
29	11.5	9.2	6.7	3.9	.5	-3.6	-9.0	-17.4	-47.5	
30	12.9	10.8	8.4	5.7	2.7	-.9	-5.5	-11.9	-23.4	
31	14.3	12.3	10.0	7.5	4.7	1.4	-2.6	-7.8	-15.6	-35.9
32	15.7	13.7	11.6	9.2	6.6	3.6	.1	-4.4	-10.4	-20.7
33	17.0	15.1	13.1	10.8	8.4	5.6	2.4	-1.5	-6.4	-13.7
34	18.3	16.5	14.5	12.4	10.1	7.5	4.6	1.1	-3.1	-8.8
35	19.6	17.8	15.9	13.9	11.7	9.3	6.6	3.4	-.3	-5.0
36	20.9	19.1	17.3	15.4	13.3	11.0	8.5	5.6	2.2	-1.8
37	22.1	20.4	18.7	16.8	14.8	12.6	10.2	7.6	4.5	.9
38	23.3	21.7	20.0	18.2	16.3	14.2	11.9	9.5	6.6	3.4
39	24.5	22.9	21.3	19.5	17.7	15.7	13.6	11.2	8.6	5.7
40	25.7	24.2	22.6	20.9	19.1	17.2	15.1	12.9	10.5	7.8
41	26.9	25.4	23.8	22.2	20.4	18.6	16.7	14.6	12.3	9.7
42	28.1	26.6	25.1	23.5	21.8	20.0	18.1	16.1	13.9	11.6
43	29.2	27.8	26.3	24.7	23.1	21.4	19.6	17.6	15.6	13.3
44	30.4	28.9	27.5	26.0	24.4	22.7	21.0	19.1	17.1	15.0
45	31.5	30.1	28.7	27.2	25.6	24.0	22.3	20.5	18.6	16.6
46	32.6	31.3	29.9	28.4	26.9	25.3	23.7	21.9	20.1	18.2
47	33.8	32.4	31.0	29.6	28.1	26.6	25.0	23.3	21.5	19.7
48	34.9	33.5	32.2	30.8	29.3	27.8	26.3	24.6	22.9	21.1
49	36.0	34.7	33.3	31.9	30.5	29.1	27.5	25.9	24.3	22.5
50	37.1	35.8	34.5	33.1	31.7	30.3	28.8	27.2	25.6	23.9

t	$t - t_w$, °C 21	22	23	24	25	26	27	28	29	30
°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
33	-29.3									
34	-18.0									
35	-11.7	-24.4								
36	-7.2	-15.3	-38.9							
37	-3.6	-9.7	-20.3							
38	-.5	-5.5	-12.8	-28.6						
39	2.2	-2.1	-7.7	-16.8						
40	4.6	.9	-3.8	-10.4	-22.5					
41	6.8	3.5	-.5	-5.8	-13.7	-33.5				
42	8.9	5.9	2.3	-2.1	-8.1	-17.9				
43	10.8	8.1	4.8	1.0	-3.9	-10.8	-24.4			
44	12.7	10.1	7.2	3.8	-.4	-5.8	-14.1	-38.8		
45	14.4	12.0	9.3	6.2	2.6	-2.0	-8.1	-18.6		
46	16.1	13.8	11.3	8.5	5.2	1.3	-3.7	-10.8	-25.5	
47	17.7	15.5	13.2	10.5	7.6	4.1	-.1	-5.6	-14.2	-43.4
48	19.2	17.2	14.9	12.5	9.8	6.7	3.0	-1.6	-7.9	-18.7
49	20.7	18.7	16.6	14.3	11.8	9.0	5.7	1.7	-3.3	-10.6
50	22.2	20.3	18.3	16.1	13.7	11.1	8.1	4.6	.4	-5.2

Table 4.23.1.1 Factors for computing mixing ratio as a function of thermodynamic ice-bulb temperature, temperature and pressure

Facteurs pour le calcul du rapport de mélange en fonction de la température thermodynamique du thermomètre recouvert de glace, de la température et de la pression

t_i : thermodynamic ice-bulb temperature — *température thermodynamique du thermomètre recouvert de glace*

t : temperature — *température*

Factor A' — *facteur* A'

t_i °C	$t-t_i$, °C 0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
-100	.00007	.00013	.00020	.00026	.00033	.00039	.00046	.00052	.00059	.00065
-95	.00007	.00013	.00020	.00026	.00033	.00039	.00046	.00052	.00059	.00065
-90	.00007	.00013	.00020	.00026	.00033	.00039	.00046	.00052	.00059	.00065
-85	.00007	.00013	.00020	.00026	.00033	.00039	.00046	.00052	.00059	.00065
-80	.00007	.00013	.00020	.00026	.00033	.00039	.00046	.00052	.00059	.00065
-75	.00007	.00013	.00020	.00026	.00033	.00039	.00046	.00052	.00059	.00065
-70	.00007	.00013	.00020	.00026	.00033	.00039	.00046	.00052	.00059	.00065
-65	.00007	.00013	.00020	.00026	.00033	.00039	.00046	.00052	.00059	.00065
-60	.00007	.00013	.00020	.00026	.00033	.00039	.00046	.00052	.00059	.00065
-55	.00007	.00013	.00020	.00026	.00033	.00039	.00046	.00052	.00059	.00065
-50	.00007	.00013	.00020	.00026	.00033	.00039	.00046	.00052	.00059	.00065
-45	.00007	.00013	.00020	.00026	.00033	.00039	.00046	.00052	.00059	.00065
-40	.00007	.00013	.00020	.00026	.00033	.00039	.00046	.00052	.00059	.00065
-35	.00007	.00013	.00020	.00026	.00033	.00039	.00046	.00052	.00059	.00065
-30	.00007	.00013	.00020	.00026	.00033	.00039	.00046	.00052	.00059	.00065
-25	.00007	.00013	.00020	.00026	.00033	.00039	.00046	.00052	.00059	.00065
-20	.00007	.00013	.00020	.00026	.00033	.00039	.00046	.00052	.00059	.00065
-15	.00007	.00013	.00020	.00026	.00033	.00039	.00046	.00052	.00059	.00065
-10	.00007	.00013	.00020	.00026	.00033	.00039	.00046	.00052	.00059	.00065
-5	.00007	.00013	.00020	.00026	.00033	.00039	.00046	.00052	.00059	.00065
0	.00007	.00013	.00020	.00026	.00033	.00039	.00046	.00052	.00059	.00065

t_i °C	$t-t_i$, °C 2	3	4	5	6	7	8	9	10	11
-60	.00130	.00195	.00260	.00325	.00390	.00454	.00519	.00584	.00648	.00712
-55	.00130	.00195	.00260	.00325	.00390	.00454	.00519	.00583	.00648	.00712
-50	.00130	.00195	.00260	.00325	.00390	.00454	.00519	.00583	.00648	.00712
-45	.00130	.00195	.00260	.00325	.00390	.00454	.00519	.00583	.00647	.00712
-40	.00130	.00195	.00260	.00325	.00390	.00454	.00519	.00583	.00647	.00712
-35	.00130	.00195	.00260	.00325	.00390	.00454	.00519	.00583	.00647	.00712
-30	.00130	.00195	.00260	.00325	.00390	.00454	.00519	.00583	.00647	.00712
-25	.00130	.00195	.00260	.00325	.00390	.00454	.00519	.00583	.00647	.00712
-20	.00130	.00195	.00260	.00325	.00390	.00454	.00519	.00583	.00648	.00712
-15	.00130	.00195	.00260	.00325	.00390	.00454	.00519	.00583	.00648	.00712
-10	.00130	.00195	.00260	.00325	.00390	.00454	.00519	.00584	.00648	.00712
-5	.00130	.00195	.00260	.00325	.00390	.00454	.00519	.00584	.00648	.00712
0	.00130	.00195	.00260	.00325	.00390	.00455	.00519	.00584	.00648	.00713

Factor B' — *facteur* B'

t_1 °C	$t - t_1$, °C 0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
-100	.03559	.07118	.10676	.14233	.17791	.21347	.24904	.28459	.32015	.35570
-95	.03555	.07109	.10663	.14216	.17769	.21322	.24874	.28425	.31976	.35527
-90	.03554	.07107	.10660	.14212	.17764	.21316	.24867	.28417	.31967	.35517
-85	.03552	.07103	.10653	.14204	.17753	.21303	.24851	.28400	.31948	.35495
-80	.03549	.07098	.10646	.14193	.17740	.21287	.24833	.28379	.31924	.35469
-75	.03547	.07093	.10639	.14185	.17730	.21274	.24819	.28362	.31905	.35448
-70	.03545	.07090	.10635	.14179	.17722	.21265	.24808	.28350	.31892	.35433
-65	.03544	.07088	.10631	.14173	.17716	.21257	.24799	.28339	.31880	.35420
-60	.03543	.07085	.10627	.14168	.17709	.21250	.24790	.28329	.31868	.35407
-55	.03542	.07083	.10623	.14163	.17703	.21242	.24781	.28319	.31857	.35394
-50	.03541	.07081	.10620	.14160	.17698	.21237	.24775	.28312	.31849	.35385
-45	.03540	.07080	.10619	.14158	.17696	.21234	.24772	.28309	.31845	.35381
-40	.03540	.07080	.10619	.14158	.17696	.21234	.24771	.28308	.31844	.35380
-35	.03540	.07080	.10619	.14158	.17696	.21234	.24771	.28308	.31845	.35381
-30	.03540	.07080	.10619	.14158	.17696	.21234	.24771	.28308	.31844	.35380
-25	.03540	.07080	.10619	.14158	.17696	.21234	.24771	.28308	.31845	.35381
-20	.03541	.07081	.10620	.14160	.17698	.21237	.24775	.28312	.31849	.35385
-15	.03542	.07083	.10624	.14164	.17704	.21243	.24782	.28320	.31858	.35396
-10	.03543	.07085	.10627	.14168	.17709	.21250	.24790	.28329	.31868	.35407
-5	.03543	.07086	.10628	.14169	.17711	.21251	.24792	.28332	.31871	.35410
0	.03545	.07090	.10635	.14179	.17722	.21265	.24808	.28350	.31892	.35433

t_1 °C	$t - t_1$, °C 2	3	4	5	6	7	8	9	10	11
-60	.70767	1.06082	1.41350	1.76573	2.11750	2.46881	2.81967	3.17007	3.52002	3.86951
-55	.70743	1.06045	1.41301	1.76512	2.11677	2.46796	2.81870	3.16898	3.51881	3.86818
-50	.70725	1.06018	1.41266	1.76467	2.11623	2.46734	2.81799	3.16818	3.51792	3.86721
-45	.70716	1.06005	1.41249	1.76446	2.11598	2.46704	2.81765	3.16780	3.51750	3.86674
-40	.70715	1.06003	1.41246	1.76443	2.11594	2.46699	2.81759	3.16774	3.51743	3.86667
-35	.70716	1.06004	1.41247	1.76444	2.11596	2.46702	2.81762	3.16777	3.51746	3.86670
-30	.70715	1.06003	1.41246	1.76443	2.11594	2.46699	2.81759	3.16774	3.51743	3.86667
-25	.70716	1.06004	1.41247	1.76444	2.11596	2.46702	2.81762	3.16777	3.51746	3.86671
-20	.70725	1.06018	1.41266	1.76467	2.11623	2.46734	2.81799	3.16818	3.51792	3.86721
-15	.70746	1.06050	1.41307	1.76520	2.11686	2.46807	2.81882	3.16911	3.51896	3.86835
-10	.70767	1.06082	1.41350	1.76573	2.11750	2.46881	2.81967	3.17007	3.52002	3.86951
-5	.70774	1.06091	1.41363	1.76589	2.11769	2.46904	2.81992	3.17036	3.52034	3.86986
0	.70820	1.06160	1.41455	1.76703	2.11906	2.47063	2.82175	3.17240	3.52261	3.87236

Table 4.23.1.2 Mixing ratio as a function of thermodynamic ice-bulb temperature and temperature for a pressure of 1 000 mb

Rapport de mélange en fonction de la température thermodynamique du thermomètre recouvert de glace et de la température pour la pression de 1 000 mb

t_i : thermodynamic ice-bulb temperature — *température thermodynamique du thermomètre recouvert de glace*

t : temperature — *température*

t °C	$t - t_i$, °C 0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}
-40	.08024	.04394	.00764								
-38	.10043	.06391	.02740								
-36	.12521	.08844	.05169	.01495							
-34	.15554	.11846	.08141	.04438	.00736						
-32	.19252	.15508	.11767	.08028	.04291	.00557					
-30	.23747	.19959	.16175	.12393	.08614	.04837	.01064				
-28	.29191	.25352	.21516	.17683	.13853	.10027	.06204	.02384			
-26	.35765	.31864	.27967	.24073	.20183	.16298	.12415	.08537	.04662	.00791	
-24	.43677	.39703	.35733	.31768	.27807	.23851	.19899	.15951	.12007	.08068	.04133
-22	.53171	.49111	.45056	.41006	.36961	.32921	.28886	.24857	.20832	.16812	.12796
-20	.64531	.60369	.56213	.52063	.47919	.43781	.39649	.35522	.31401	.27286	.23176
-18	.78083	.73801	.69527	.65260	.60999	.56745	.52498	.48258	.44024	.39797	.35577
-16	.94204	.89783	.85370	.80965	.76568	.72179	.67797	.63424	.59058	.54700	.50349
-14	1.13329	1.08745	1.04170	.99605	.95048	.90501	.85962	.81433	.76913	.72401	.67898
-12	1.35959	1.31184	1.26421	1.21668	1.16926	1.12194	1.07473	1.02762	.98061	.93371	.88690
-10	1.62664	1.57669	1.52686	1.47716	1.42757	1.37811	1.32878	1.27956	1.23046	1.18147	1.13261
-8	1.94099	1.88849	1.83612	1.78390	1.73181	1.67987	1.62807	1.57640	1.52487	1.47348	1.42222
-6	2.31015	2.25468	2.19938	2.14424	2.08927	2.03445	1.97979	1.92529	1.87095	1.81677	1.76274
-4	2.74266	2.68378	2.62508	2.56657	2.50825	2.45012	2.39216	2.33439	2.27680	2.21940	2.16217
-2	3.24830	3.18547	3.12286	3.06046	2.99828	2.93631	2.87455	2.81300	2.75167	2.69053	?.62961
0	3.83829	3.77089	3.70375	3.63686	3.57022	3.50382	3.43767	3.37176	3.30609	3.24066	3.17547

t °C	$t - t_i$, °C 2	3	4	5	6	7	8	9	10	11
	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}	g kg^{-1}
-16	.07249									
-14	.23340									
-12	.42431									
-10	.65022	.17866								
-8	.91684	.42396								
-6	1.23075	.71313	.20890							
-4	1.59941	1.05318	.52235	.00589						
-2	2.03134	1.45207	.89052	.34547						
0	2.53622	1.91886	1.32186	.74383	.18347					
2	3.12509	2.46382	1.82599	1.20997	.61424	.03742				
4			2.41374	1.75401	1.11761	.50291				
6					1.70425	1.04606	.41106			
8							.99660	.33993		
10									.29079	

Table 4.23.2.1 **Factors for computing thermodynamic ice-bulb temperature as a function of mixing ratio, temperature and pressure**

Facteurs pour le calcul de la température thermodynamique du thermomètre recouvert de glace en fonction du rapport de mélange, de la température et de la pression

I. Thermodynamic ice-bulb temperature as a function of factor F_i and pressure — *température thermodynamique du thermomètre recouvert de glace en fonction du facteur* F_i *et de la pression*

F_i	Pressure — *pression*, mb									
	1050	1000	950	900	850	800	750	700	650	600
	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
-25.0	-70.51	-70.51	-70.51	-70.51	-70.51	-70.51	-70.51	-70.51	-70.51	-70.51
-24.5	-69.11	-69.11	-69.11	-69.11	-69.11	-69.11	-69.11	-69.11	-69.11	-69.11
-24.0	-67.71	-67.71	-67.71	-67.71	-67.71	-67.71	-67.71	-67.71	-67.72	-67.72
-23.5	-66.31	-66.31	-66.31	-66.31	-66.31	-66.31	-66.31	-66.32	-66.32	-66.32
-23.0	-64.91	-64.91	-64.91	-64.91	-64.91	-64.91	-64.91	-64.91	-64.92	-64.92
-22.5	-63.51	-63.51	-63.51	-63.51	-63.51	-63.51	-63.51	-63.51	-63.51	-63.52
-22.0	-62.10	-62.10	-62.11	-62.11	-62.11	-62.11	-62.11	-62.11	-62.11	-62.11
-21.5	-60.70	-60.70	-60.70	-60.70	-60.70	-60.70	-60.71	-60.71	-60.71	-60.71
-21.0	-59.29	-59.30	-59.30	-59.30	-59.30	-59.30	-59.30	-59.30	-59.31	-59.31
-20.5	-57.89	-57.89	-57.90	-57.90	-57.90	-57.90	-57.90	-57.90	-57.91	-57.91
-20.0	-56.49	-56.49	-56.49	-56.50	-56.50	-56.50	-56.50	-56.51	-56.51	-56.51
-19.5	-55.09	-55.09	-55.09	-55.10	-55.10	-55.10	-55.10	-55.11	-55.11	-55.12
-19.0	-53.69	-53.69	-53.69	-53.70	-53.70	-53.70	-53.71	-53.71	-53.71	-53.72
-18.5	-52.29	-52.29	-52.30	-52.30	-52.30	-52.31	-52.31	-52.31	-52.32	-52.33
-18.0	-50.89	-50.89	-50.90	-50.90	-50.91	-50.91	-50.92	-50.92	-50.93	-50.94
-17.5	-49.49	-49.50	-49.50	-49.51	-49.51	-49.52	-49.52	-49.53	-49.54	-49.55
-17.0	-48.10	-48.10	-48.11	-48.11	-48.12	-48.12	-48.13	-48.14	-48.15	-48.16
-16.5	-46.70	-46.71	-46.71	-46.72	-46.73	-46.73	-46.74	-46.75	-46.76	-46.78
-16.0	-45.31	-45.32	-45.32	-45.33	-45.34	-45.35	-45.36	-45.37	-45.38	-45.40
-15.5	-43.92	-43.93	-43.93	-43.94	-43.95	-43.96	-43.97	-43.99	-44.00	-44.02
-15.0	-42.53	-42.54	-42.55	-42.56	-42.57	-42.58	-42.59	-42.61	-42.63	-42.65
-14.5	-41.15	-41.16	-41.17	-41.18	-41.19	-41.20	-41.22	-41.24	-41.26	-41.28
-14.0	-39.77	-39.78	-39.79	-39.80	-39.82	-39.83	-39.85	-39.87	-39.90	-39.92
-13.5	-38.39	-38.40	-38.42	-38.43	-38.45	-38.47	-38.49	-38.51	-38.54	-38.57
-13.0	-37.02	-37.04	-37.05	-37.07	-37.09	-37.11	-37.14	-37.16	-37.20	-37.23
-12.5	-35.66	-35.67	-35.69	-35.71	-35.74	-35.76	-35.79	-35.82	-35.86	-35.90
-12.0	-34.30	-34.32	-34.34	-34.36	-34.39	-34.42	-34.45	-34.49	-34.53	-34.58
-11.5	-32.95	-32.97	-33.00	-33.02	-33.05	-33.09	-33.13	-33.17	-33.22	-33.27
-11.0	-31.61	-31.64	-31.66	-31.69	-31.73	-31.77	-31.81	-31.86	-31.91	-31.98
-10.5	-30.28	-30.31	-30.34	-30.37	-30.41	-30.46	-30.51	-30.56	-30.62	-30.70
-10.0	-28.96	-28.99	-29.03	-29.07	-29.11	-29.16	-29.21	-29.28	-29.35	-29.43
-9.5	-27.65	-27.68	-27.73	-27.77	-27.82	-27.88	-27.94	-28.01	-28.09	-28.18
-9.0	-26.35	-26.39	-26.44	-26.49	-26.54	-26.61	-26.68	-26.76	-26.85	-26.95
-8.5	-25.06	-25.11	-25.16	-25.22	-25.28	-25.35	-25.43	-25.52	-25.62	-25.73
-8.0	-23.79	-23.85	-23.91	-23.97	-24.04	-24.12	-24.21	-24.30	-24.41	-24.54
-7.5	-22.54	-22.60	-22.66	-22.73	-22.81	-22.90	-23.00	-23.11	-23.23	-23.37
-7.0	-21.30	-21.37	-21.44	-21.52	-21.60	-21.70	-21.81	-21.93	-22.06	-22.22
-6.5	-20.08	-20.15	-20.23	-20.32	-20.42	-20.52	-20.64	-20.77	-20.92	-21.09
-6.0	-18.88	-18.96	-19.05	-19.14	-19.25	-19.36	-19.49	-19.64	-19.80	-19.98
-5.5	-17.69	-17.78	-17.88	-17.98	-18.10	-18.23	-18.37	-18.53	-18.70	-18.90

TABLE **4.23** — 5

F_i	Pressure — *pression*, mb									
	1050	1000	950	900	850	800	750	700	650	600
	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
-5.0	-16.53	-16.63	-16.73	-16.85	-16.98	-17.11	-17.27	-17.44	-17.63	-17.85
-4.5	-15.39	-15.49	-15.61	-15.73	-15.87	-16.02	-16.19	-16.37	-16.58	-16.81
-4.0	-14.27	-14.38	-14.51	-14.64	-14.79	-14.96	-15.14	-15.33	-15.56	-15.81
-3.5	-13.17	-13.29	-13.43	-13.58	-13.74	-13.91	-14.11	-14.32	-14.56	-14.82
-3.0	-12.09	-12.23	-12.37	-12.53	-12.70	-12.89	-13.10	-13.33	-13.58	-13.87
-2.5	-11.04	-11.19	-11.34	-11.51	-11.70	-11.90	-12.12	-12.36	-12.63	-12.93
-2.0	-10.01	-10.17	-10.34	-10.52	-10.71	-10.93	-11.16	-11.42	-11.71	-12.03
-1.5	-9.01	-9.17	-9.35	-9.54	-9.75	-9.98	-10.23	-10.50	-10.81	-11.14
-1.0	-8.03	-8.20	-8.39	-8.60	-8.82	-9.06	-9.32	-9.61	-9.93	-10.28
-.5	-7.07	-7.26	-7.46	-7.67	-7.91	-8.16	-8.44	-8.74	-9.08	-9.45
0.0	-6.14	-6.33	-6.54	-6.77	-7.02	-7.29	-7.58	-7.90	-8.25	-8.64
.5	-5.22	-5.43	-5.66	-5.90	-6.16	-6.44	-6.74	-7.07	-7.44	-7.85
1.0	-4.34	-4.56	-4.79	-5.04	-5.31	-5.61	-5.93	-6.27	-6.66	-7.08
1.5	-3.47	-3.70	-3.95	-4.21	-4.50	-4.80	-5.13	-5.50	-5.89	-6.33
2.0	-2.63	-2.87	-3.13	-3.40	-3.70	-4.02	-4.36	-4.74	-5.15	-5.61
2.5	-1.81	-2.06	-2.33	-2.62	-2.92	-3.25	-3.61	-4.00	-4.43	-4.90
3.0	-1.01	-1.27	-1.55	-1.85	-2.17	-2.51	-2.88	-3.29	-3.73	-4.22
3.5	-.24	-.51	-.80	-1.10	-1.43	-1.79	-2.18	-2.59	-3.05	-3.55
4.0			-.06	-.38	-.72	-1.09	-1.48	-1.92	-2.38	-2.90
4.5					-.03	-.40	-.81	-1.26	-1.74	-2.27
5.0							-.16	-.61	-1.11	-1.65
5.5									-.50	-1.05
6.0										-.47

TABLE **4.23** — 6

F_i	Pressure — *pression*, mb									
	550	500	450	400	350	300	250	200	150	100
	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
-25.0	-70.51	-70.52	-70.52	-70.52	-70.52	-70.52	-70.52	-70.53	-70.53	-70.55
-24.5	-69.12	-69.12	-69.12	-69.12	-69.12	-69.12	-69.13	-69.13	-69.14	-69.16
-24.0	-67.72	-67.72	-67.72	-67.72	-67.72	-67.73	-67.73	-67.74	-67.75	-67.77
-23.5	-66.32	-66.32	-66.32	-66.32	-66.33	-66.33	-66.34	-66.34	-66.36	-66.38
-23.0	-64.92	-64.92	-64.92	-64.92	-64.93	-64.93	-64.94	-64.95	-64.96	-65.00
-22.5	-63.52	-63.52	-63.52	-63.53	-63.53	-63.54	-63.54	-63.55	-63.57	-63.61
-22.0	-62.12	-62.12	-62.12	-62.13	-62.13	-62.14	-62.15	-62.16	-62.18	-62.23
-21.5	-60.71	-60.72	-60.72	-60.73	-60.73	-60.74	-60.75	-60.77	-60.80	-60.85
-21.0	-59.31	-59.32	-59.32	-59.33	-59.33	-59.34	-59.36	-59.38	-59.41	-59.48
-20.5	-57.91	-57.92	-57.92	-57.93	-57.94	-57.95	-57.97	-57.99	-58.03	-58.11
-20.0	-56.52	-56.52	-56.53	-56.54	-56.55	-56.56	-56.58	-56.61	-56.66	-56.75
-19.5	-55.12	-55.13	-55.14	-55.15	-55.16	-55.17	-55.20	-55.23	-55.29	-55.40
-19.0	-53.73	-53.73	-53.74	-53.76	-53.77	-53.79	-53.82	-53.86	-53.93	-54.06
-18.5	-52.33	-52.34	-52.35	-52.37	-52.39	-52.41	-52.44	-52.49	-52.57	-52.73
-18.0	-50.94	-50.96	-50.97	-50.99	-51.01	-51.04	-51.07	-51.13	-51.23	-51.41
-17.5	-49.56	-49.57	-49.59	-49.61	-49.63	-49.66	-49.71	-49.78	-49.89	-50.11
-17.0	-48.17	-48.19	-48.21	-48.23	-48.26	-48.30	-48.35	-48.43	-48.56	-48.81
-16.5	-46.79	-46.81	-46.83	-46.86	-46.89	-46.94	-47.00	-47.10	-47.25	-47.54
-16.0	-45.41	-45.43	-45.46	-45.49	-45.53	-45.59	-45.66	-45.77	-45.95	-46.28
-15.5	-44.04	-44.06	-44.10	-44.13	-44.18	-44.24	-44.33	-44.46	-44.66	-45.04
-15.0	-42.67	-42.70	-42.74	-42.78	-42.84	-42.91	-43.01	-43.16	-43.39	-43.82
-14.5	-41.31	-41.35	-41.39	-41.44	-41.50	-41.59	-41.70	-41.87	-42.14	-42.63
-14.0	-39.96	-40.00	-40.04	-40.10	-40.18	-40.27	-40.41	-40.60	-40.90	-41.46
-13.5	-38.61	-38.66	-38.71	-38.78	-38.87	-38.98	-39.13	-39.35	-39.69	-40.31
-13.0	-37.28	-37.33	-37.39	-37.47	-37.57	-37.69	-37.87	-38.11	-38.50	-39.19
-12.5	-35.95	-36.01	-36.08	-36.17	-36.28	-36.43	-36.62	-36.90	-37.34	-38.10
-12.0	-34.64	-34.71	-34.79	-34.89	-35.02	-35.18	-35.40	-35.71	-36.20	-37.04
-11.5	-33.34	-33.42	-33.51	-33.62	-33.77	-33.95	-34.20	-34.55	-35.08	-36.01
-11.0	-32.05	-32.14	-32.24	-32.37	-32.53	-32.74	-33.02	-33.40	-33.99	-35.00
-10.5	-30.78	-30.88	-31.00	-31.14	-31.32	-31.55	-31.86	-32.29	-32.93	-34.03
-10.0	-29.52	-29.64	-29.77	-29.93	-30.13	-30.39	-30.73	-31.20	-31.90	-33.08
-9.5	-28.29	-28.41	-28.56	-28.74	-28.96	-29.25	-29.62	-30.13	-30.90	-32.17
-9.0	-27.07	-27.21	-27.37	-27.57	-27.82	-28.13	-28.54	-29.10	-29.92	-31.28
-8.5	-25.87	-26.02	-26.20	-26.42	-26.69	-27.03	-27.48	-28.09	-28.97	-30.42
-8.0	-24.69	-24.86	-25.06	-25.30	-25.60	-25.97	-26.45	-27.10	-28.05	-29.59
-7.5	-23.53	-23.72	-23.94	-24.20	-24.52	-24.93	-25.45	-26.15	-27.16	-28.79
-7.0	-22.39	-22.60	-22.84	-23.13	-23.48	-23.91	-24.47	-25.22	-26.30	-28.01
-6.5	-21.28	-21.50	-21.77	-22.08	-22.46	-22.92	-23.52	-24.32	-25.46	-27.26
-6.0	-20.19	-20.44	-20.72	-21.05	-21.46	-21.96	-22.60	-23.45	-24.65	-26.53
-5.5	-19.13	-19.39	-19.70	-20.06	-20.49	-21.03	-21.71	-22.61	-23.87	-25.83

TABLE **4.23** — 7

F_i	Pressure — *pression*, mb 550	500	450	400	350	300	250	200	150	100
	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
-5.0	-18.09	-18.37	-18.70	-19.09	-19.55	-20.12	-20.84	-21.79	-23.11	-25.14
-4.5	-17.08	-17.38	-17.73	-18.14	-18.64	-19.24	-20.00	-20.99	-22.37	-24.49
-4.0	-16.09	-16.41	-16.78	-17.22	-17.75	-18.38	-19.18	-20.22	-21.66	-23.85
-3.5	-15.12	-15.47	-15.86	-16.33	-16.88	-17.55	-18.39	-19.47	-20.97	-23.23
-3.0	-14.19	-14.55	-14.97	-15.46	-16.04	-16.74	-17.62	-18.75	-20.30	-22.63
-2.5	-13.27	-13.66	-14.10	-14.62	-15.23	-15.96	-16.88	-18.05	-19.65	-22.05
-2.0	-12.38	-12.79	-13.26	-13.80	-14.43	-15.20	-16.15	-17.37	-19.02	-21.49
-1.5	-11.52	-11.95	-12.44	-13.00	-13.67	-14.46	-15.45	-16.71	-18.41	-20.95
-1.0	-10.68	-11.13	-11.64	-12.23	-12.92	-13.75	-14.77	-16.07	-17.82	-20.42
-.5	-9.86	-10.33	-10.86	-11.48	-12.20	-13.06	-14.11	-15.45	-17.25	-19.90
0.0	-9.07	-9.56	-10.11	-10.75	-11.49	-12.38	-13.47	-14.85	-16.69	-19.41
.5	-8.30	-8.80	-9.38	-10.04	-10.81	-11.73	-12.85	-14.26	-16.15	-18.92
1.0	-7.55	-8.07	-8.67	-9.35	-10.15	-11.09	-12.24	-13.69	-15.63	-18.45
1.5	-6.82	-7.36	-7.98	-8.68	-9.50	-10.48	-11.66	-13.14	-15.12	-17.99
2.0	-6.11	-6.67	-7.31	-8.04	-8.88	-9.88	-11.09	-12.61	-14.62	-17.55
2.5	-5.42	-6.00	-6.66	-7.40	-8.27	-9.29	-10.53	-12.09	-14.14	-17.11
3.0	-4.75	-5.35	-6.02	-6.79	-7.68	-8.73	-10.00	-11.58	-13.67	-16.69
3.5	-4.10	-4.72	-5.41	-6.20	-7.11	-8.18	-9.47	-11.08	-13.21	-16.28
4.0	-3.47	-4.10	-4.81	-5.62	-6.55	-7.64	-8.96	-10.60	-12.77	-15.88
4.5	-2.85	-3.50	-4.23	-5.05	-6.00	-7.12	-8.46	-10.14	-12.33	-15.49
5.0	-2.25	-2.91	-3.66	-4.50	-5.47	-6.61	-7.98	-9.68	-11.91	-15.10
5.5	-1.67	-2.34	-3.10	-3.97	-4.96	-6.12	-7.51	-9.24	-11.50	-14.73
6.0	-1.10	-1.79	-2.57	-3.44	-4.45	-5.63	-7.05	-8.80	-11.09	-14.37
6.5	-.54	-1.25	-2.04	-2.94	-3.96	-5.16	-6.60	-8.38	-10.70	-14.01
7.0	-.01	-.73	-1.53	-2.44	-3.49	-4.70	-6.16	-7.97	-10.32	-13.66
7.5		-.21	-1.03	-1.96	-3.02	-4.26	-5.74	-7.56	-9.94	-13.32
8.0			-.55	-1.49	-2.56	-3.82	-5.32	-7.17	-9.58	-12.99
8.5			-.08	-1.03	-2.12	-3.39	-4.91	-6.79	-9.22	-12.67
9.0				-.58	-1.69	-2.98	-4.52	-6.41	-8.87	-12.35
9.5				-.14	-1.26	-2.57	-4.13	-6.04	-8.53	-12.04
10.0					-.85	-2.17	-3.75	-5.68	-8.19	-11.73

II. Factors / *Facteurs* $\frac{10^3 c_p}{L_s(t_i)}$ and / *et* $\frac{c_{pv}}{L_s(t_i)}$

t_i °C	$\frac{10^3 c_p}{L_s(t_i)}$	$\frac{c_{pv}}{L_s(t_i)}$	t_i °C	$\frac{10^3 c_p}{L_s(t_i)}$	$\frac{c_{pv}}{L_s(t_i)}$
-80	.35492	.000653	-40	.35404	.000652
-79	.35488	.000653	-39	.35403	.000652
-78	.35484	.000653	-38	.35403	.000652
-77	.35480	.000653	-37	.35404	.000652
-76	.35477	.000653	-36	.35404	.000652
-75	.35473	.000653	-35	.35404	.000652
-74	.35469	.000653	-34	.35404	.000652
-73	.35466	.000653	-33	.35404	.000652
-72	.35462	.000653	-32	.35404	.000652
-71	.35459	.000653	-31	.35404	.000652
-70	.35456	.000653	-30	.35404	.000652
-69	.35452	.000653	-29	.35404	.000652
-68	.35449	.000653	-28	.35404	.000652
-67	.35445	.000652	-27	.35405	.000652
-66	.35442	.000652	-26	.35405	.000652
-65	.35439	.000652	-25	.35405	.000652
-64	.35436	.000652	-24	.35406	.000652
-63	.35434	.000652	-23	.35406	.000652
-62	.35432	.000652	-22	.35407	.000652
-61	.35431	.000652	-21	.35408	.000652
-60	.35430	.000652	-20	.35409	.000652
-59	.35427	.000652	-19	.35410	.000652
-58	.35425	.000652	-18	.35411	.000652
-57	.35423	.000652	-17	.35413	.000652
-56	.35421	.000652	-16	.35414	.000652
-55	.35419	.000652	-15	.35416	.000652
-54	.35417	.000652	-14	.35419	.000652
-53	.35415	.000652	-13	.35421	.000652
-52	.35413	.000652	-12	.35424	.000652
-51	.35411	.000652	-11	.35427	.000652
-50	.35409	.000652	-10	.35430	.000652
-49	.35407	.000652	-9	.35433	.000652
-48	.35406	.000652	-8	.35436	.000652
-47	.35405	.000652	-7	.35439	.000652
-46	.35404	.000652	-6	.35443	.000652
-45	.35403	.000652	-5	.35446	.000652
-44	.35403	.000652	-4	.35450	.000653
-43	.35403	.000652	-3	.35454	.000653
-42	.35403	.000652	-2	.35458	.000653
-41	.35403	.000652	-1	.35463	.000653
			0	.35456	.000653

Table 4.23.2.2 Thermodynamic ice-bulb temperature as a function of mixing ratio and temperature for a pressure of 1 000 mb

Température thermodynamique du thermomètre recouvert de glace en fonction du rapport de mélange et de la température pour la pression de 1 000 mb

t_i : thermodynamic ice-bulb temperature — *température thermodynamique du thermomètre recouvert de glace*

t : temperature — *température*

Table gives values of $t - t_i$ – *la table donne les valeurs de* $t - t_i$

Mixing ratio — *rapport de mélange*, g kg^{-1}

t	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
-40	.22									
-38	.28	.00								
-36	.34	.07								
-34	.42	.15								
-32	.51	.25								
-30	.63	.36	.10							
-28	.76	.50	.24							
-26	.92	.66	.40	.15						
-24	1.11	.85	.60	.34	.09					
-22	1.32	1.07	.82	.57	.32	.08				
-20	1.57	1.32	1.08	.83	.59	.35	.11			
-18	1.85	1.61	1.37	1.13	.90	.66	.42	.19		
-16	2.17	1.94	1.70	1.47	1.24	1.01	.78	.55	.32	.10
-14	2.53	2.30	2.08	1.85	1.62	1.40	1.18	.95	.73	.51
-12	2.94	2.71	2.49	2.27	2.05	1.83	1.62	1.40	1.19	.97
-10	3.38	3.17	2.95	2.74	2.53	2.32	2.11	1.90	1.69	1.48
-8	3.88	3.67	3.46	3.26	3.05	2.84	2.64	2.44	2.23	2.03
-6	4.42	4.22	4.02	3.82	3.62	3.42	3.22	3.03	2.83	2.64
-4	5.01	4.82	4.62	4.43	4.23	4.04	3.85	3.66	3.47	3.29
-2	5.63	5.44	5.26	5.08	4.90	4.72	4.53	4.35	4.17	3.98
0	6.53	6.23	5.96	5.72	5.53	5.36	5.22	5.07	4.91	4.75
2	7.07	6.89	6.71	6.54	6.37	6.20	6.02	5.85	5.68	5.52
4	7.84	7.67	7.51	7.34	7.17	7.00	6.84	6.68	6.51	6.35
6	8.67	8.50	8.34	8.18	8.02	7.86	7.70	7.54	7.38	7.23
8	9.53	9.37	9.22	9.06	8.91	8.75	8.60	8.45	8.30	8.14
10	10.44	10.29	10.14							

Mixing ratio — *rapport de mélange*, g kg^{-1}

t	1.0	1.5	2.0	2.5	3.0	3.5
°C	°C	°C	°C	°C	°C	°C
-14	.3					
-12	.8					
-10	1.3	.3				
-8	1.8	.8				
-6	2.4	1.5	.6			
-4	3.1	2.2	1.3	.4		
-2	3.8	2.9	2.1	1.2	.4	
0	4.6	3.7	2.9	2.1	1.3	.5
2	5.3	4.5	3.7	2.9	2.2	
4	6.2	5.4	4.6			

Table 4.24.1 **Heat capacity at constant pressure residual of (1 + r) kg of moist air**

Capacité thermique à pression constante résiduelle de (1 + r) kg d'air humide

p : pressure — *pression* ; t : temperature ; r : mixing ratio — *rapport de mélange*
r_w : saturation mixing ratio — *rapport de mélange de saturation*

p mb	t °C	J K^{-1}
0	−100	−2.5
300		0
700		3.8
1 100		7.1
0	−90	−2.5
300		−0.4
700		2.5
1 100		5.4
0	−80	−2.5
300		−0.4
700		1.7
1 100		4.2
0	−70	−2.1
300		−0.8
700		1.3
1 100		3.3
0	−60	−2.1
300		−0.8
700		0.8
1 100		2.9
0	−50	−2.1
300		−0.8
700		0.8
1 100		2.1
0	−40	−2.1
300		−0.8
700		0.4
1 100		1.7
0	−30	−1.7
300		−0.8
700		0.4
1 100		1.7
0	−20	−1.7
300		−0.8
700		0.4
1 100		1.3
0	−10	−1.3
300		−0.4
700		0.4
1 100		1.3

p	t	r/r_w				
		0	0.25	0.50	0.75	1
mb	°C	J K^{-1}	J K^{-1}	J K^{-1}	J K^{-1}	J K^{-1}
0	0	−0.8				
300		−0.4	−0.4	0	0	0
700		0.4	0.4	0.4	0.4	0.8
1 100		1.3	1.3	1.3	1.3	1.3
0	10	−0.4				
300		0	0	0.4	0.4	0.8
700		0.8	0.8	0.8	0.8	1.3
1 100		1.7	1.7	1.7	1.7	1.7
0	20	0				
300		0.4	0.8	1.3	1.7	2.5
700		1.3	1.3	1.3	1.7	2.1
1 100		1.7	1.7	2.1	2.1	2.5
0	30	0.4				
300		0.8	1.7	2.5	4.2	5.9
700		1.3	1.7	2.1	2.9	3.3
1 100		2.1	2.1	2.5	2.9	3.3
0	40	0.8				
300		1.3	2.9	5.9	9.6	14.7
700		1.7	2.5	3.3	5.0	6.7
1 100		2.5	2.9	3.3	4.2	5.4
0	50	1.7				
300		1.7				
700		2.5	3.8	6.3	9.6	13.4
1 100		2.9	3.8	5.0	7.1	9.6
0	60	2.1				
300		2.5				
700		2.9	6.3	11.7	19.3	28.5
1 100		3.3	5.4	8.4	12.6	18.0

Table 4.24.2 **Enthalpy residual of (1 + r) kg of moist air**
Enthalpie résiduelle de (1 + r) kg *d'air humide*

p : pressure — *pression* ; t : temperature ; r : mixing ratio — *rapport de mélange*
r_w : saturation mixing ratio — *rapport de mélange de saturation*

p mb	t °C	10^3 J
0	−100	0.21
300		0.00
700		−0.29
1 100		−0.59
0	−90	0.17
300		0
700		−0.25
1 100		−0.50
0	−80	0.13
300		−0.04
700		−0.25
1 100		−0.46
0	−70	0.13
300		−0.04
700		−0.21
1 100		−0.42
0	−60	0.08
300		−0.04
700		−0.21
1 100		−0.42
0	−50	0.08
300		−0.04
700		−0.21
1 100		−0.38
0	−40	0.04
300		−0.04
700		−0.21
1 100		−0.38
0	−30	0.04
300		−0.04
700		−0.21
1 100		−0.33
0	−20	0.04
300		−0.08
700		−0.21
1 100		−0.33
0	−10	0.00
300		−0.08
700		−0.21
1 100		−0.33

p mb	t °C	r/r_w 0	0.25	0.50	0.75	1
		10^3 J	10^3 J	10^3 J	10^3 J	10^3 J
0	0	0.00				
300		−0.08	−0.08	−0.08	−0.08	−0.08
700		−0.21	−0.21	−0.21	−0.21	−0.21
1 100		−0.29	−0.29	−0.29	−0.29	−0.29
0	10	0.00				
300		−0.08	−0.08	−0.08	−0.08	−0.08
700		−0.17	−0.17	−0.21	−0.21	−0.21
1 100		−0.29	−0.29	−0.29	−0.29	−0.29
0	20	0.00				
300		−0.08	−0.08	−0.08	−0.08	−0.13
700		−0.17	−0.17	−0.17	−0.17	−0.21
1 100		−0.25	−0.25	−0.29	−0.29	−0.29
0	30	0.00				
300		−0.08	−0.08	−0.08	−0.13	−0.17
700		−0.17	−0.17	−0.17	−0.17	−0.21
1 100		−0.25	−0.25	−0.25	−0.25	−0.29
0	40	0.00				
300		−0.08	−0.04	−0.08	−0.17	−0.29
700		−0.13	−0.13	−0.17	−0.21	−0.25
1 100		−0.21	−0.25	−0.25	−0.25	−0.29
0	50	0.00				
300		−0.04				
700		−0.13	−0.13	−0.17	−0.29	−0.42
1 100		−0.21	−0.21	−0.25	−0.29	−0.38
0	60	0.04				
300		−0.04				
700		−0.08	−0.13	−0.25	−0.50	−0.84
1 100		−0.17	−0.17	−0.25	−0.42	−0.63

Table 4.24.3 **Entropy residual of (1 + r) kg of moist air**
Entropie résiduelle de (1 + r) kg *d'air humide*

p : pressure — *pression* ; t : temperature ; r : mixing ratio — *rapport de mélange*
r_w : saturation mixing ratio — *rapport de mélange de saturation*

p mb	t °C	J K⁻¹
0	−100	0.92
300		0.04
700		−1.13
1 100		−2.26
0	−90	0.75
300		0.04
700		−0.96
1 100		−1.93
0	−80	0.63
300		0.00
700		−0.84
1 100		−1.67
0	−70	0.50
300		−0.04
700		−0.75
1 100		−1.51
0	−60	0.42
300		−0.04
700		−0.71
1 100		−1.34
0	−50	0.33
300		−0.08
700		−0.67
1 100		−1.21
0	−40	0.25
300		−0.13
700		−0.63
1 100		−1.13
0	−30	0.17
300		−0.17
700		−0.63
1 100		−1.09
0	−20	0.08
300		−0.21
700		−0.63
1 100		−1.00
0	−10	0.04
300		−0.25
700		−0.59
1 100		−0.96

p mb	t °C	r/r_w = 0 (J K⁻¹)	0.25 (J K⁻¹)	0.50 (J K⁻¹)	0.75 (J K⁻¹)	1 (J K⁻¹)
0	0	0.00				
300		−0.25	−0.25	−0.25	−0.25	−0.25
700		−0.59	−0.59	−0.59	−0.59	−0.59
1 100		−0.92	−0.92	−0.92	−0.92	−0.92
0	10	−0.04				
300		−0.25	−0.25	−0.25	−0.25	−0.25
700		−0.54	−0.54	−0.54	−0.59	−0.59
1 100		−0.88	−0.88	−0.88	−0.88	−0.88
0	20	−0.04				
300		−0.25	−0.25	−0.25	−0.25	−0.29
700		−0.54	−0.50	−0.54	−0.54	−0.54
1 100		−0.80	−0.80	−0.80	−0.84	−0.84
0	30	−0.04				
300		−0.25	−0.21	−0.21	−0.29	−0.38
700		−0.50	−0.50	−0.50	−0.50	−0.59
1 100		−0.75	−0.75	−0.75	−0.80	−0.80
0	40	−0.04				
300		−0.21	−0.13	−0.17	−0.38	−0.67
700		−0.42	−0.42	−0.46	−0.50	−0.67
1 100		−0.67	−0.67	−0.67	−0.75	−0.84
0	50	0.00				
300		−0.17				
700		−0.38	−0.33	−0.42	−0.63	−0.92
1 100		−0.59	−0.59	−0.63	−0.75	−0.96
0	60	0.08				
300		−0.08				
700		−0.29	−0.21	−0.46	−0.96	−1.72
1 100		−0.50	−0.46	−0.59	−0.92	−1.34

Table 4.24.4 **Mixing entropy of (1 + r) kg of moist air**
Entropie de mélange de (1 + r) kg d'air humide

S_m : mixing entropy of (1 + r) kg of moist air — *entropie de mélange de* (1 + r) *kg d'air humide*
r : mixing ratio — *rapport de mélange* (kg kg^{-1})

r	S_m J K^{-1}	r	S_m J K^{-1}	r	S_m J K^{-1}	r	S_m J K^{-1}
0	0	0.025	48.86	0.115	147.29	0.20	210.5
0.000 5	1.88	0.026	50.33	0.120	151.52	0.22	223.2
0.001 0	3.43	0.027	51.83	0.125	155.71	0.24	235.3
0.001 5	4.86	0.028	53.26	0.130	159.77	0.26	247.0
0.002 0	6.24	0.029	54.72	0.135	163.79	0.28	257.9
0.002 5	7.54	0.030	56.14	0.140	167.72	0.30	268.4
0.003 0	8.79	0.031	57.57	0.145	171.62	0.32	278.4
0.003 5	9.96	0.032	58.95	0.150	175.43	0.34	288.5
0.004 0	11.18	0.033	60.33	0.155	179.20	0.36	297.7
0.004 5	12.31	0.034	61.71	0.160	182.88	0.38	306.9
0.005	13.44	0.035	63.10	0.165	186.48	0.40	315.7
0.006	15.62	0.036	64.44	0.170	190.08	0.42	324.1
0.007	17.75	0.037	65.78	0.175	193.60	0.44	332.4
0.008	19.80	0.038	67.07	0.180	197.07	0.46	340.4
0.009	21.77	0.039	68.41	0.185	200.51	0.48	348.3
0.010	23.70	0.040	69.71	0.190	203.86	0.50	355.9
0.011	25.62	0.045	76.03	0.195	207.21	0.52	363.0
0.012	27.47	0.050	82.15	0.200	210.47	0.54	370.5
0.013	29.27	0.055	88.05			0.56	377.2
0.014	31.02	0.060	93.74			0.58	384.3
0.015	32.78	0.065	99.27			0.60	390.6
0.016	34.50	0.070	104.63			0.62	397.3
0.017	36.17	0.075	109.82			0.64	403.6
0.018	37.85	0.080	114.93			0.66	409.9
0.019	39.48	0.085	119.87			0.68	415.8
0.020	41.11	0.090	124.68			0.70	421.6
0.021	42.71	0.095	129.42			0.72	427.5
0.022	44.25	0.100	134.02			0.74	433.3
0.023	45.80	0.105	138.54			0.76	438.8
0.024	47.35	0.110	142.94			0.78	444.2
						0.80	449.7

Table 6.1 Scale variation of recommended map projections
Variation d'échelle pour les projections cartographiques recommandées

(The Earth is assumed to be spherical — *La Terre est supposée sphérique*)

Latitude degrees *degrés*	Scale factor — *Facteur d'échelle k*			
	Mercator Standard parallel: *Parallèle standard :* 22° ½	Polar stereographic *Stéréographique polaire* Standard parallel: *Parallèle standard :* 60°	Lambert's conformal conic *Conique conforme de Lambert* Standard parallels: *Parallèles standard :* 30° - 60°	10° - 40°
0	0.924	1.866	1.283	1.062
5	0.927	1.716	1.210	1.027
10	0.938	1.590	1.149	1.000
15	0.956	1.482	1.099	0.981
20	0.983	1.390	1.058	0.970
25	1.019	1.312	1.025	0.966
30	1.067	1.244	1.000	0.969
35	1.128	1.186	0.982	0.980
40	1.206	1.136	0.970	1.000
45	1.307	1.093	0.966	1.030
50	1.437	1.057	0.968	1.072
55	1.611	1.026	0.979	1.130
60	1.848	1.000	1.000	1.209
65	2.186	0.979	1.033	1.319
70	2.701	0.962	1.084	1.478
75	3.570	0.949	1.162	1.723
80	5.320	0.940	1.293	2.157
85	10.600	0.935	1.566	3.193

Table 6.2 Length of one degree on a parallel and on a meridian
Longueur d'un degré sur un parallèle et sur un méridien

On a parallel / *Sur un parallèle*

Latitude	m	Latitude	m
0°	111324	45	78850
1	111307	46	77467
2	111257	47	76060
3	111172	48	74629
4	111055	49	73175
5	110903	50	71699
6	110718	51	70201
7	110500	52	68681
8	110248	53	67140
9	109962	54	65579
10	109644	55	63997
11	109292	56	62396
12	108907	57	60775
13	108489	58	59136
14	108038	59	57478
15	107555	60	55803
16	107039	61	54110
17	106490	62	52401
18	105909	63	50675
19	105296	64	48934
20	104651	65	47178
21	103975	66	45407
22	103266	67	43622
23	102527	68	41824
24	101756	69	40012
25	100954	70	38189
26	100122	71	36353
27	99259	72	34506
28	98366	73	32648
29	97443	74	30781
30	96490	75	28904
31	95508	76	27017
32	94497	77	25123
33	93457	78	23220
34	92389	79	21311
35	91292	80	19395
36	90168	81	17472
37	89016	82	15545
38	87836	83	13612
39	86630	84	11675
40	85398	85	9735
41	84139	86	7792
42	82855	87	5846
43	81545	88	3898
44	80210	89	1949

On a meridian / *Sur un méridien*

Latitude	m	Latitude	m
0–1°	110575.6	45–46	111145.2
1–2	110576.3	46–47	111164.8
2–3	110577.6	47–48	111184.4
3–4	110579.7	48–49	111203.9
4–5	110582.4	49–50	111223.4
5–6	110585.8	50–51	111242.7
6–7	110589.8	51–52	111261.9
7–8	110594.5	52–53	111281.0
8–9	110599.9	53–54	111299.9
9–10	110605.9	54–55	111318.6
10–11	110612.5	55–56	111337.1
11–12	110619.8	56–57	111355.4
12–13	110627.8	57–58	111373.4
13–14	110636.3	58–59	111391.1
14–15	110645.4	59–60	111408.5
15–16	110655.2	60–61	111425.5
16–17	110665.5	61–62	111442.3
17–18	110676.4	62–63	111458.6
18–19	110687.9	63–64	111474.6
19–20	110699.9	64–65	111490.1
20–21	110712.4	65–66	111505.2
21–22	110725.4	66–67	111519.9
22–23	110739.0	67–68	111534.1
23–24	110753.0	68–69	111547.8
24–25	110767.5	69–70	111561.0
25–26	110782.5	70–71	111573.7
26–27	110797.9	71–72	111585.9
27–28	110813.7	72–73	111597.5
28–29	110829.9	73–74	111608.5
29–30	110846.4	74–75	111619.0
30–31	110863.3	75–76	111628.9
31–32	110880.6	76–77	111638.2
32–33	110898.2	77–78	111646.8
33–34	110916.0	78–79	111654.9
34–35	110934.2	79–80	111662.3
35–36	110952.6	80–81	111669.1
36–37	110971.2	81–82	111675.2
37–38	110990.0	82–83	111680.6
38–39	111009.0	83–84	111685.4
39–40	111028.2	84–85	111689.5
40–41	111047.5	85–86	111693.0
41–42	111066.9	86–87	111695.7
42–43	111086.4	87–88	111697.8
43–44	111105.9	88–89	111699.2
44–45	111125.5	89–90	111699.9

Table 6.3.1 **Acceleration of gravity at mean sea-level as a function of latitude** *

Accélération de la pesanteur au niveau moyen de la mer en fonction de la latitude *

Latitude	0′	10′	20′	30′	40′	50′
	cm sec $^{-2}$	cm sec $^{-2}$	cm sec $^{-2}$	cm sec $^{-2}$	cm sec $^{-2}$	cm sec $^{-2}$
0°	978.036	978.036	978.036	978.036	978.036	978.037
1	978.037	978.038	978.038	978.039	978.040	978.041
2	978.042	978.043	978.044	978.045	978.047	078.048
3	978.050	978.051	978.053	978.055	978.057	978.059
4	978.061	978.063	978.065	978.067	978.070	978.072
5	978.075	978.077	978.080	978.083	978.086	978.089
6	978.092	978.095	978.098	978.102	978.105	978.109
7	978.112	978.116	978.120	978.123	978.127	978.131
8	978.135	978.140	978.144	978.148	978.153	978.157
9	978.162	978.166	978.171	978.176	978.181	978.186
10	978.191	978.196	978.201	978.207	978.212	978.218
11	978.223	978.229	978.234	978.240	978.246	978.252
12	978.258	978.264	978.271	978.277	978.283	978.290
13	978.296	978.303	978.310	978.316	978.323	978.330
14	978.337	978.344	978.351	978.358	978.366	978.373
15	978.381	978.388	978.396	978.403	978.411	978.419
16	978.427	978.435	978.443	978.451	978.459	978.468
17	978.476	978.484	978.493	978.501	578.510	578.519
18	978.528	978.536	978.545	978.554	978.563	978.572
19	978.582	978.591	578.600	978.610	978.619	978.629
20	978.638	978.648	978.658	978.667	978.677	978.687
21	978.697	978.707	978.717	978.728	978.738	978.748
22	978.759	978.769	978.780	978.790	978.801	978.812
23	978.822	978.833	978.844	978.855	978.866	978.877
24	978.888	978.899	978.911	978.922	978.933	978.945
25	978.956	978.968	978.979	978.991	979.002	979.014
26	979.026	979.038	979.050	979.062	979.074	979.086
27	979.098	979.110	979.122	979.135	979.147	979.159
28	979.172	979.184	979.197	979.209	979.222	979.234
29	979.247	979.260	979.273	979.286	979.298	979.311
30	979.324	979.337	979.350	979.364	979.377	979.390
31	979.403	979.416	979.430	979.443	979.456	979.470
32	979.483	979.497	979.510	979.524	979.538	979.551
33	979.565	979.579	979.593	979.606	979.620	979.634
34	979.648	979.662	979.676	979.690	979.704	979.718
35	979.732	979.746	979.760	979.775	979.789	979.803
36	979.817	979.832	979.846	979.860	979.875	979.889
37	979.904	979.918	979.933	979.947	979.962	979.976
38	979.991	980.005	980.020	980.035	980.049	980.064
39	980.079	980.093	980.108	980.123	980.138	980.152
40	980.167	980.182	980.197	980.212	980.226	980.241
41	980.256	980.271	980.286	980.301	980.316	980.331
42	980.346	980.361	980.376	980.391	980.406	980.421
43	980.436	980.451	980.466	980.481	980.496	980.511
44	980.526	980.541	980.556	980.571	980.586	980.601
45	980.616	980.631	980.646	980.661	980.676	980.691
46	980.706	980.721	980.736	980.751	980.766	980.781
47	980.796	980.811	980.826	980.841	980.856	980.871
48	980.886	980.901	980.916	980.931	980.946	980.961
49	980.976	980.991	981.006	981.021	981.036	981.050
50	981.065	981.080	981.095	981.110	981.124	981.139

* See note page 4 - *voir note page 4.*

Latitude	0′ cm sec⁻²	10′ cm sec⁻²	20′ cm sec⁻²	30′ cm sec⁻²	40′ cm sec⁻²	50′ cm sec⁻²
50°	981.065	981.080	981.095	981.110	981.124	981.139
51	981.154	981.169	981.183	981.198	981.213	981.227
52	981.242	981.257	981.271	981.286	981.300	981.315
53	981.329	981.344	981.358	981.373	981.387	981.401
54	981.416	981.430	981.444	981.459	981.473	981.487
55	981.501	981.515	981.529	981.544	981.558	981.572
56	981.586	981.600	981.613	981.627	981.641	981.655
57	981.669	981.683	981.696	981.710	981.724	981.737
58	981.751	981.764	981.778	981.791	981.805	981.818
59	981.831	981.845	981.858	981.871	981.884	981.897
60	981.911	981.924	981.937	981.950	981.962	981.975
61	981.988	982.001	982.014	982.026	982.039	982.051
62	982.064	982.076	982.089	982.101	982.114	982.126
63	982.138	982.150	982.162	982.175	982.187	982.198
64	982.210	982.222	982.234	982.246	982.258	982.269
65	982.281	982.292	982.304	982.315	982.327	982.338
66	982.349	982.360	982.371	982.382	982.393	982.404
67	982.415	982.426	982.437	982.448	982.458	982.469
68	982.479	982.490	982.500	982.511	982.521	982.531
69	982.541	982.551	982.561	982.571	982.581	982.591
70	982.601	982.610	982.620	982.629	982.639	982.648
71	982.658	982.667	982.676	982.685	982.694	982.703
72	982.712	982.721	982.730	982.738	982.747	982.756
73	982.764	982.772	982.781	982.789	982.797	982.805
74	982.813	982.821	982.829	982.837	982.845	982.852
75	982.860	982.868	982.875	982.882	982.890	982.897
76	982.904	982.911	982.918	982.925	982.932	982.938
77	982.945	982.952	982.958	982.965	982.971	982.977
78	982.983	982.990	982.996	983.001	983.007	983.013
79	983.019	983.024	983.030	983.035	983.041	983.046
80	983.051	983.056	983.061	983.066	983.071	983.076
81	983.081	983.085	983.090	983.094	983.099	983.103
82	983.107	983.111	983.116	983.119	983.123	983.127
83	983.131	983.134	983.138	983.141	983.145	983.148
84	983.151	983.154	983.157	983.160	983.163	983.166
85	983.168	983.171	983.174	983.176	983.178	983.181
86	983.183	983.185	983.187	983.189	983.190	983.192
87	983.194	983.195	983.197	983.198	983.199	983.201
88	983.202	983.203	983.204	983.204	983.205	983.206
89	983.206	983.207	983.207	983.208	983.208	983.208
90	983.208					

Table 6.3.2 Decrease of the acceleration of gravity in the free air as a function of altitude and latitude *

*Diminution de l'accélération de la pesanteur en atmosphère libre en fonction de l'altitude et de la latitude **

Altitude	Latitude									
m	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
	cm s^{-2}	cm s^{-2}	cm s^{-2}	cm s^{-2}	cm s^{-2}	cm s^{-2}	cm s^{-2}	cm s^{-2}	cm s^{-2}	cm s^{-2}
100	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031
200	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062
300	0.093	0.093	0.093	0.093	0.093	0.093	0.093	0.093	0.092	0.092
400	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123
500	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154
600	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185
700	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216
800	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.247
900	0.278	0.278	0.278	0.278	0.278	0.278	0.278	0.277	0.277	0.277
1000	0.309	0.309	0.309	0.309	0.309	0.308	0.308	0.308	0.308	0.308
1100	0.340	0.340	0.340	0.339	0.339	0.339	0.339	0.339	0.339	0.339
1200	0.370	0.370	0.370	0.370	0.370	0.370	0.370	0.370	0.370	0.370
1300	0.401	0.401	0.401	0.401	0.401	0.401	0.401	0.401	0.401	0.401
1400	0.432	0.432	0.432	0.432	0.432	0.432	0.432	0.432	0.432	0.432
1500	0.463	0.463	0.463	0.463	0.463	0.463	0.462	0.462	0.462	0.462
1600	0.494	0.494	0.494	0.494	0.494	0.493	0.493	0.493	0.493	0.493
1700	0.525	0.525	0.525	0.525	0.524	0.524	0.524	0.524	0.524	0.524
1800	0.556	0.556	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555
1900	0.586	0.586	0.586	0.586	0.586	0.586	0.586	0.586	0.586	0.586
2000	0.617	0.617	0.617	0.617	0.617	0.617	0.617	0.616	0.616	0.616
3000	0.926	0.926	0.926	0.925	0.925	0.925	0.925	0.924	0.924	0.924
4000	1.234	1.234	1.234	1.233	1.233	1.233	1.233	1.232	1.232	1.232
5000	1.542	1.542	1.542	1.541	1.541	1.541	1.540	1.540	1.540	1.540
6000	1.850	1.850	1.850	1.849	1.849	1.848	1.848	1.848	1.847	1.847
7000	2.158	2.158	2.157	2.157	2.157	2.156	2.155	2.155	2.155	2.155
8000	2.466	2.465	2.465	2.465	2.464	2.463	2.463	2.462	2.462	2.462
9000	2.773	2.773	2.773	2.772	2.771	2.771	2.770	2.769	2.769	2.769
10000	3.080	3.080	3.080	3.079	3.079	3.078	3.077	3.076	3.076	3.076
15000	4.615	4.615	4.615	4.614	4.613	4.611	4.610	4.609	4.609	4.609
20000	6.147	6.146	6.145	6.144	6.143	6.141	6.140	6.139	6.138	6.138
25000	7.674	7.674	7.673	7.671	7.670	7.668	7.666	7.664	7.663	7.663
30000	9.198	9.198	9.197	9.195	9.193	9.190	9.188	9.186	9.185	9.185
35000	10.719	10.718	10.717	10.715	10.712	10.710	10.707	10.705	10.704	10.703
40000	12.236	12.235	12.234	12.231	12.228	12.225	12.222	12.220	12.218	12.218
45000	13.749	13.748	13.747	13.744	13.741	13.737	13.734	13.731	13.730	13.729
50000	15.259	15.258	15.256	15.253	15.250	15.246	15.242	15.239	15.237	15.237
55000	16.765	16.765	16.762	16.759	16.755	16.751	16.747	16.744	16.742	16.741
60000	18.268	18.267	18.265	18.262	18.257	18.253	18.248	18.245	18.242	18.242
65000	19.768	19.767	19.764	19.760	19.756	19.751	19.746	19.742	19.740	19.739
70000	21.263	21.262	21.260	21.256	21.251	21.245	21.240	21.236	21.234	21.233
75000	22.756	22.755	22.752	22.748	22.742	22.736	22.731	22.727	22.724	22.723
80000	24.245	24.244	24.241	24.236	24.230	24.224	24.218	24.214	24.211	24.210
85000	25.730	25.729	25.726	25.721	25.715	25.708	25.702	25.697	25.694	25.693
90000	27.212	27.211	27.208	27.202	27.196	27.189	27.183	27.178	27.174	27.173
95000	28.691	28.690	28.686	28.681	28.674	28.667	28.660	28.654	28.651	28.650
100000	30.166	30.165	30.161	30.155	30.148	30.141	30.134	30.128	30.124	30.123

* See note page 4 - *voir note page 4.*

Note : Tables 6.3.1 and 6.3.2 show theoretical values of the gravity acceleration established on the meteorological gravity system ; formula (1), Table 3.8.2, and formula (i 3), Introduction 3.8, have been used respectively.

Linear interpolation is practicable throughout both tables.

Values read in Table 6.3.2 are to be subtracted from values of Table 6.3.1 to obtain the theoretical values of the acceleration of gravity in free air at various altitudes for a given latitude.

Table 6.3.1 is reproduced from SMT 167. Table 6.3.2 has been computed by the Environmental Science Services Administration (U.S. Department of Commerce) on a CDC 6600 computer; the programme, established in Fortran language, is kept at the WMO Secretariat.

Note : *Les tables 6.3.1 et 6.3.2 indiquent les valeurs théoriques de l'accélération de la pesanteur établies dans le système météorologique d'accélération de la pesanteur ; les formules (1), table 3.8.2, et (i 3), introduction 3.8, ont été respectivement utilisées.*

L'interpolation linéaire est applicable dans les deux tables.

Les valeurs figurant dans la table 6.3.2 doivent être soustraites des valeurs de la table 6.3.1 pour obtenir les valeurs théoriques de l'accélération de la pesanteur en atmosphère libre à différentes altitudes pour une latitude donnée.

La table 6.3.1 est une reproduction de la SMT 167. La table 6.3.2 a été calculée par l'Environmental Science Services Administration (U.S. Department of Commerce) sur un ordinateur CDC 6600; le programme, établi en langage Fortran, est déposé au Secrétariat de l'OMM.