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DOCUMENT TITLE
METEOROLOGY FOR AUSTRALIA

CHAPTER 2 – STRUCTURE OF THE ATMOSPHERE

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THE TROPOSPHERE

The lowest layer of the atmosphere in contact with the surface of the earth, is known as the troposphere (see diagram 2.c.). Temperature tends to decrease as height increases within the troposphere. There may be minor irregularities in the rate of temperature decrease with height (Environmental Lapse Rate, ELR), but in general the lapse rate is uniform until the tropopause is reached. The lapse rate then remains constant (isothermal) or even increases slightly. This marked change in the lapse rate marks the tropopause which defines the upper limit of the troposphere.

THE TROPOPAUSE

The tropopause inhibits the vertical movement of the air and therefore little weather occurs above the tropopause. The reason the air stops rising at the tropopause will be covered in Chapter 7.

The tropopause marks the upper limit of normal weather and cloud (although large thunderstorms do sometimes extend above it). The lowest temperatures are found at this level, and the strongest winds are usually found just below it. The height of the tropopause and its temperature both vary. Typical approximate values are:

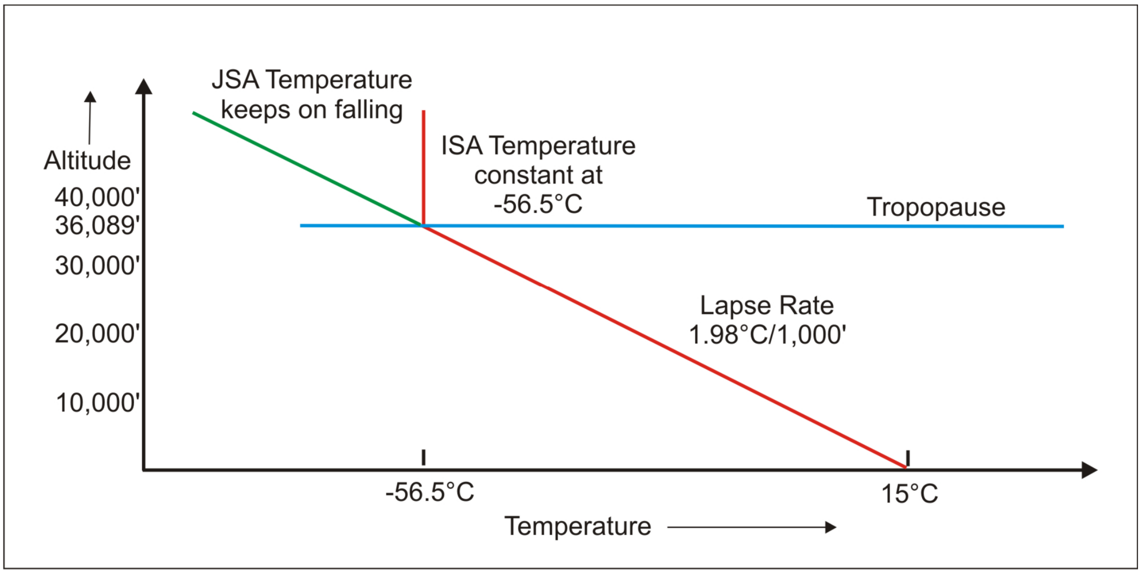
a) at the equator, 56,000 ft, temperature as low as - 75°C;
b) at 50°S, 37,000 ft, temperature above - 55°C;
c) at the poles, 27,000 ft, temperature about - 45°C.

The coldest air at tropopause levels is found above the Equator and the warmest above the poles.

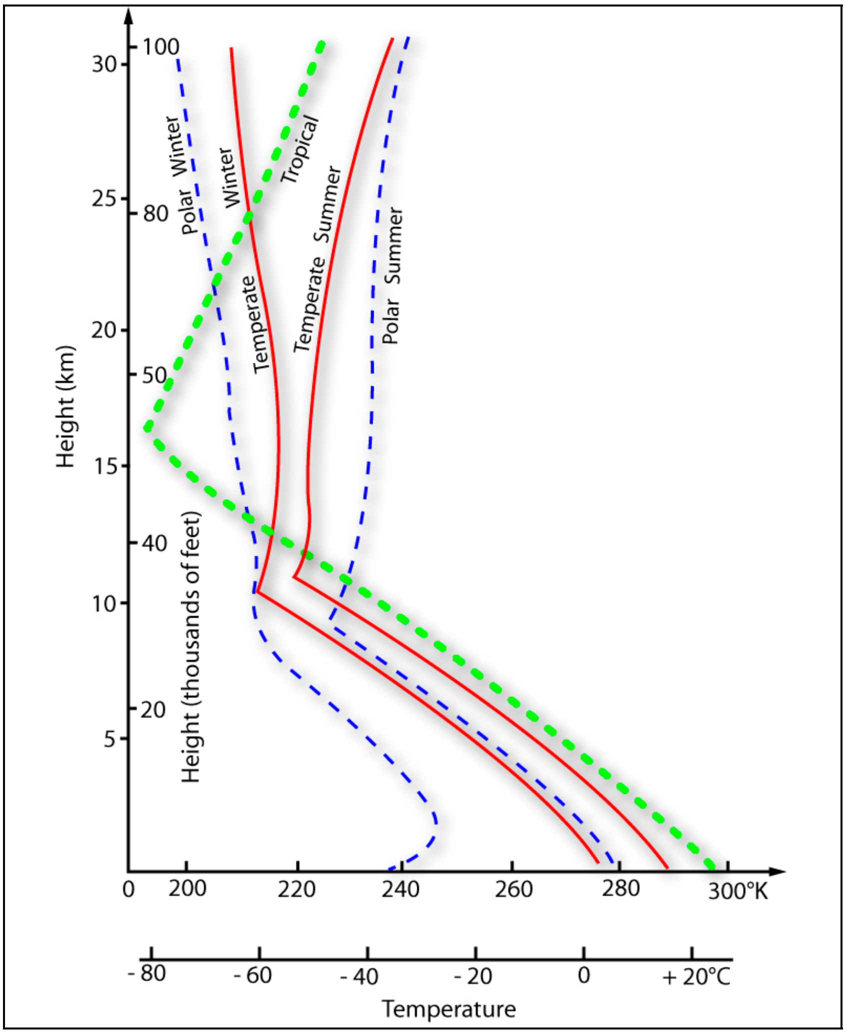
The height of the tropopause varies with latitude and the season. In general it is lowest at the poles and highest at the equator and in latitudes higher than 30° it is lowest in winter and higher in summer. Nearer to the equator the seasonal trend is reversed and the tropopause is slightly higher in winter than in summer. The following table is for the Southern Hemisphere.

	January (winter)	July(summer)
Pole	28,000'	32,000'
60°S	30,000'	35,000'
30°S	55,000'	53,000'
Equator	57,000'	55,000'

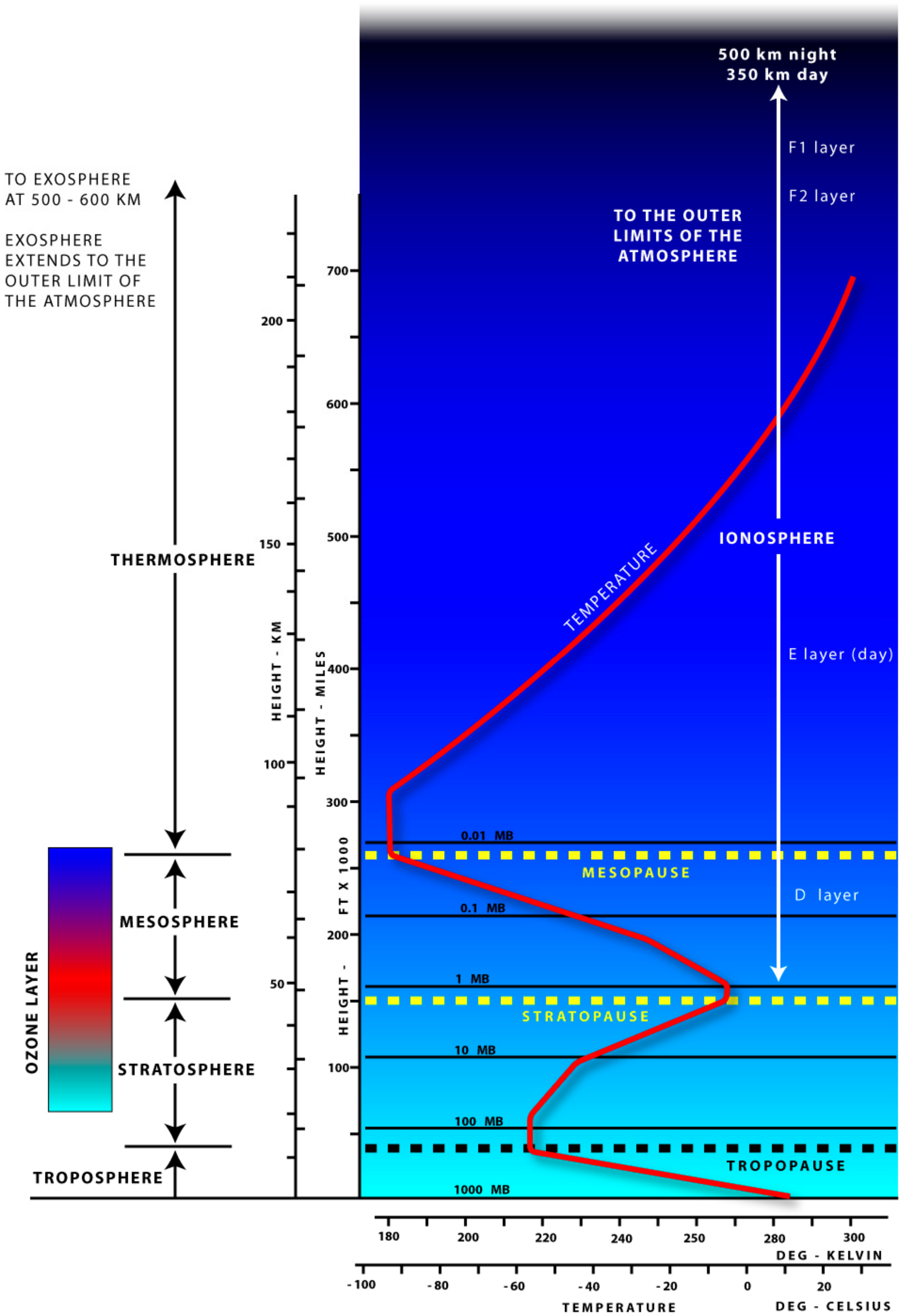
TEMPERATURE VARIATION IN ISA AND JSA



2. a. Temperature Variation in ISA and JSA

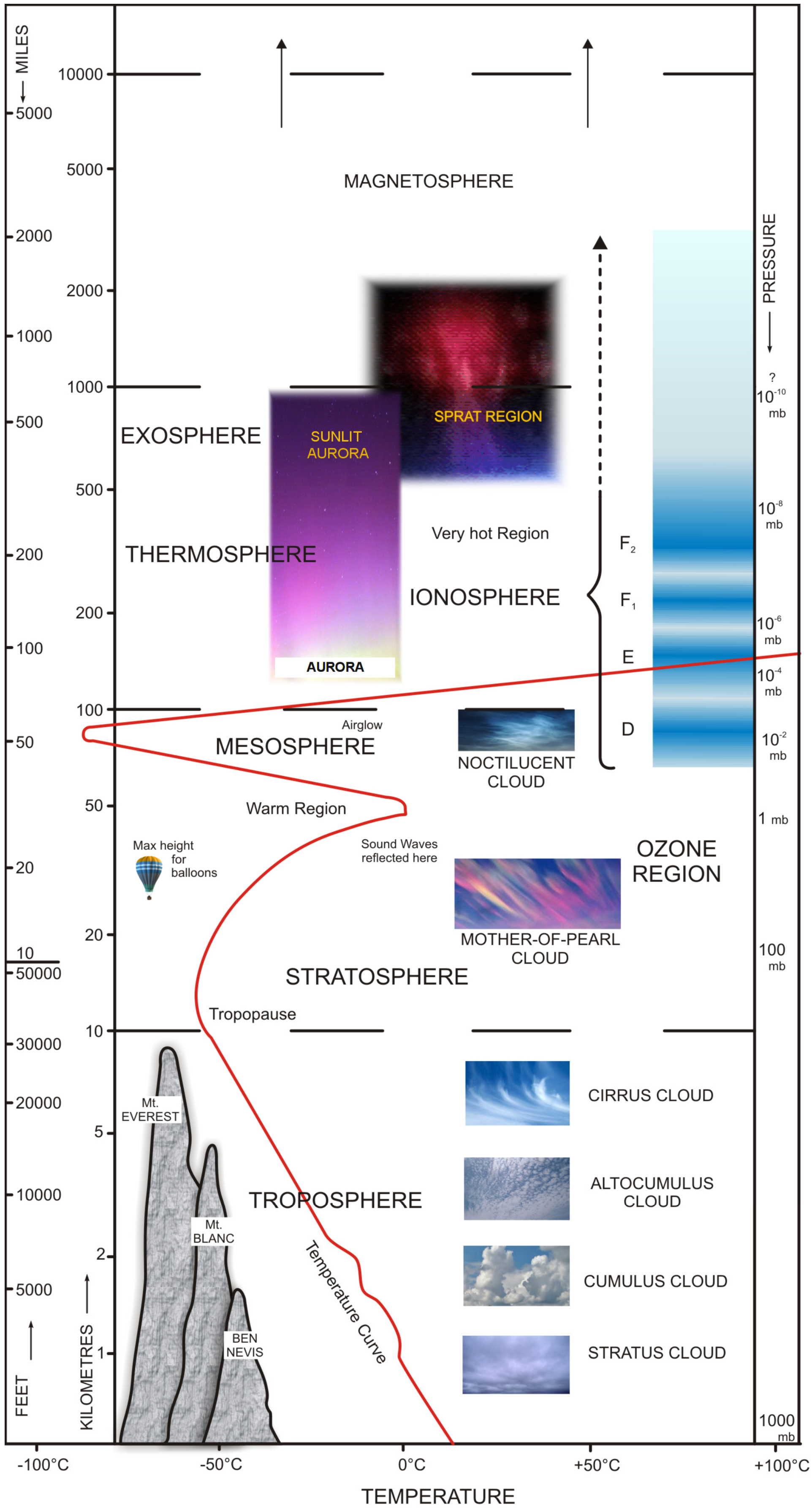


2. b. Average Curves of Temperature with Height



2. c. Structure of the Atmosphere (i)

2. d. Structure of the Atmosphere (ii)


MILES
FEET
KILOMETRES
PRESSURE
MAGNETOSPHERE
EXOSPHERE
SUNLIT
AURORA
SPRAT REGION
THERMOSPHERE
Very hot Region
IONOSPHERE
F_2
F_1
E
D
AURORA
Airglow
MESOSPHERE
NOCTILUCENT
CLOUD
Warm Region
Max height
for
balloons
Sound Waves
reflected here
OZONE
REGION
MOTHER-OF-PEARL
CLOUD
STRATOSPHERE
Tropopause
Mt.
EVEREST
CIRRUS CLOUD
ALTOCUMULUS
CLOUD
Mt.
BLANC
TROPOSPHERE
Temperature Curve
CUMULUS CLOUD
BEN
NEVIS
STRATUS CLOUD
10000
5000
2000
1000
500
200
100
50
20
10
5
2
1
5000
2000
1000
500
200
100
50
20
10
50000
30000
20000
10000
5000
?
10^{-10} mb
10^{-8} mb
10^{-6} mb
10^{-4} mb
10^{-2} mb
1 mb
100 mb
1000 mb
-100°C
-50°C
0°C
+50°C
+100°C
TEMPERATURE

THE STRATOSPHERE

Above the tropopause, temperature tends to increase to values similar to those experienced on the surface, up to a level known as the stratopause, or warm ozone region. Ozone is merely a particular variety of oxygen, but one which absorbs ultra-violet radiation, turning harmful radiation into heat.

Although turbulence in the Stratosphere is less frequent than in the troposphere, it is by no means negligible. It can be found in or above Cb clouds. Mountain waves and waves above Cb which protrude into the stratosphere can be turbulent at time.

Concentrations of O_3 above the tolerable limit are normal from 50,000' to 100,000'. Air used for pressurisation may need to be filtered but usually the high temperatures in the compressor from where the cabin air is bled will assist in the breakdown of the O_3.

DEFINITIONS

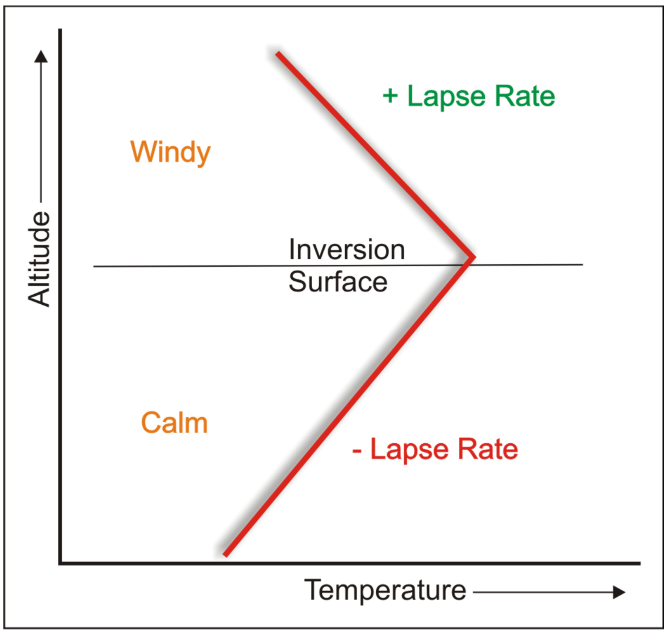
a) Lapse Rate: is the rate at which the temperature increases or decreases with an increase in height.

positive lapse rate = temperature decreases with height
negative lapse rate = temperature increases with height

b) Isothermal: temperature remains constant with a change in height.

c) Inversion: (- lapse rate) Warm air on top of cold air. Very stable.

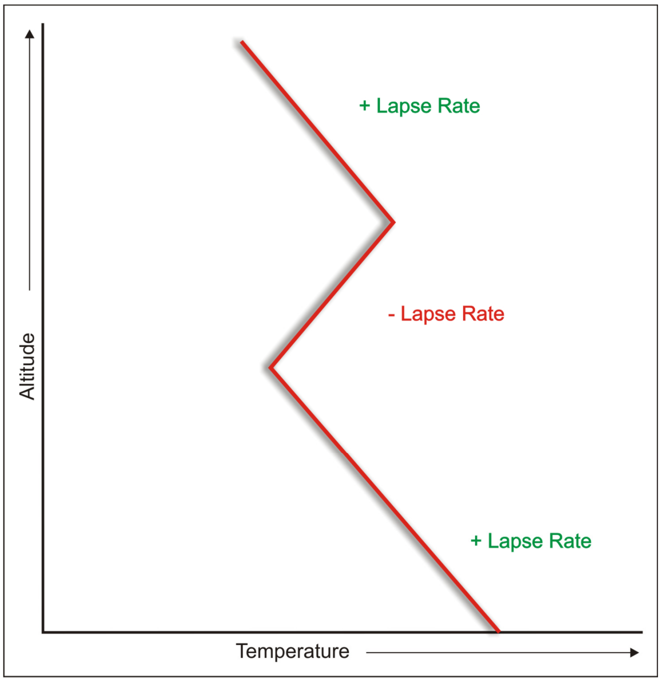
GROUND INVERSION



A ground inversion forms in the early morning after a cold, clear night under the influence of a High Pressure system (HP).

The ground cools by radiation and the air in contact with the ground cools by conduction. The cold, dense, stable air may trap smoke and other wastes to form smog. **Turbulence (windshear) occurs at the inversion surface.** Calm conditions prevail near the surface as the cold dense air lies close to the ground. Wind may be blowing at a higher altitude.

UPPER AIR INVERSION (SUBSIDENCE INVERSION OR INVERSION ALOFT)



2. e. Upper Air Inversion

An upper air inversion forms in high pressure systems. A characteristic of anti-cyclones is that the air within it sinks (subsidence). This compression of the air causes adiabatic warming. Usually the top of the layer subsides more than the bottom and hence warms more rapidly. So, when the top reaches a higher temperature, an inversion forms. A typical subsidence inversion occurs at an altitude of 4,000’ to 6,000’ in mid-latitudes and is not as strong as well developed surface inversions. The significance of such inversions to aviation is twofold:

a) They provide a lid to haze and smoke layers so that descent through the inversion is coincident with marked reduced visibility.

b) They tend to inhibit convective currents so that the low level convective cloud has limited vertical development.