Functions for the Calculation of meteorological and climatological quantities used at the Swiss Meteorological Institute

Data Architecture Document 1f.4

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ErstellerIn	Freigabe-datum	Version	Tätigkeit	Anmerkungen
Christian Häberli		1.0	Formelsammlung, Dokumentenerstellung	Directory: '/dabes/doc/Realisierung/Aggr/Dok_Aggr' FM-Dokument 'formel_sammlung.fmx'
Urs Steinegger	12.08. 1997	1.1	Erweiterungen	
Josefa Mettler, Mario Rohrer, Urs Steinegger	06.01. 1998	2.0	Überarbeitung	
Christian Häberli	23.03.2001	2.1	Überarbeitung, Ergänzung	Directory: '/proj/MAZ/MCH-DWH/work/sw_dokumente/aggreg' FM-Dokument 'formel_sammlung.fmx'
Christian Häberli	05.07.2001	2.2	Überarbeitung, Ergänzung	
Josefa Mettler, Christian Häberli	09.2001	2.3	Überarbeitung, Ergänzung; Dokument wird in MCH-DWH Dokumentation übernommen	FM-Dokument 'formula_collection.fmx'
Claudia Mühlhäuser	31.01.2002	2.4	Ergänzung Kapitel 4 'Conversion of Units'	aus dem Aggregierungshandbuch
Christian Häberli	12.02.2002	2.5	completed formula 69 with 'additional condition'	-
Stephan Suter	09.08.2002	2.6	Einfügen und Streichen von Formeln in Kapitel 4 'Conversion of Units;' Formatanpassungen an Formeln	
Stephan Suter	29.08.2002	2.7	Einfügen von Formeln in den Kapiteln 'Aggregation Functions' und 'Conversion of Units'	

ErstellerIn	Freigabe-datum	Version	Tätigkeit	Anmerkungen
Josefa Mettler	06.03.2003	2.7	Umstellung auf FM6 im Einverständnis mit sus	Erstellung eines sauberen FM6-Buches inklusive - Titelblatt (neu), LOT (neu), TOC - verschiedene Kapitel und Anhang (neu) Bereinigung fehlerhafter Formate
Stephan Suter	06.05.2003	2.7	Korrektur Formel 16 Kapitel 9 im Auftrag von chi	
Marc Musa Ch. Häberli	11.06.2003 22.07.2003	2.8	Ergänzung Tage mit Gewitter sowie trübe und heitere Tage in Kapitel 11. Aufnahme copy_value Funktion. Einfügen der Umrechnungsformel für Helligkeit in Lux	Auftrag chi für Berechnung Verlaufsparameter
Stephan Suter	23.04.2004	2.8	Einheit von S in Formel 18 (25) von [h] auf [min] geändert	Auftrag chi
Stephan Suter	27.04.2004	2.8	Formel 24 ‘histogram’ auch mit ‘agg_histo’ bezeichnet, da sie in der libagg unter ‘agg_histo’ läuft.	
Stephan Suter	27.04.2004	2.8	Neues Unterkapitel 5.4 ‘Help Functions for string copying and visual observations’ mit Formeln ‘copy_string’ und ‘visual_param_string’.	Auftrag muc ‘Klebifunktion’, um die einzlenen Augenbeobachtungen wieder ins METEOR-Format zusammenzufassen. Formeln sollten noch durch mik/kng verifiziert werden.
Stephan Suter	27.04.2004	2.8	Hinzufügen der Funktion calc_difference zur Berechnung von Differenzen beliebiger Werte.	
Madlaina Perl	10.06.2004	2.8	Hinzufügen des Kapitels zu den Sequenzparametern der Applikation Climap	Auftrag mam Codierung gemäss Programmcode von kng
Christian Häberli	26.08.2004	2.8	Korrekturen bei den Druckreduktionsformeln	
Christian Häberli	05.04.2005	2.9	Einfügen potentielle und äquivalentpotentielle Temperatur	Zur Realisierung in DWH R5.2
Marc Musa	10.06.2005	3.0	Einfügen neue Formeln und Bereinigung Tabelle 15	Zur Realisierung in DWH R5.2

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Monika Oswald	11.04.2006	3.1	Einfügen neuer Formeln	R6e, Erweiterung aus dem Bedarf TIDOMES
Madlaina Perl	30.04.2007	3.2	Einfügen neuer Formeln zu ‘Present Weather’, ‘Radiation’ und ‘Plain Text Weather Codes’	R6c, Erweiterung Wetteralgorithmen Diese Version wurde zusammen mit dem Pflichtenheft für Release 6c versandt und vom PAB DWH gereviewt.
Madlaina Perl	03.09.2007	3.3	Einfügen neuer Formeln z.B. Sonnenscheindauer aus Globalstrahlung	Ergänzung und Präzisierungen aufgrund der Review und aus der Umsetzung
Madlaina Perl	01.01.2008	4.0	div. kleine Ergänzungen und Präzisierungen	Endzustand Release 6c
Marlen Kube	17.06.2008	4.1	diverse Anpassungen und Erweiterungen nach R6c	
Lukas von Dach	07.08.2008	4.2	Einarbeitung neue Formeln Release 6b	
Lukas von Dach	03.09.2008	4.3	Einfügen Formel 331 für RFT	
Marlen Kube, Michele Matt	03.12.2008	4.5	Aenderungen an Formel 90, Zuordnung von Messstationen zu Modellgitterpunkten	
Lukas von Dach	04.02.2009	4.6	Einfügen Formel 76	
Simon Albrecht, Marc Musa	02.11.2009 17.12.2009	4.7	Einfügen diverser neuer Formeln, sowie Anpassungen im Zusammenhang mit ChangeRequest DWH 03	
M. Kube	08.07.2010	4.8	Korrektur Seite 94	
M. Musa	12.07.2010	4.9	Korrektur msec2beaufort	
L. von Dach	06.12.2010	4.10	Eintragen fehlende Formel 323 agg_poly_average	
L. von Dach	13.01.2011	4.11	Link auf Formelsammlung MG	
M. Musa	18.04.2011	4.12	Einbau Referenzverdunstung nach FAO-56, Korrektur Formel 35	
E. Grüter	28.06.2011	4.13	Einbau Heat index nach Rothfusz	
L. von Dach, M. Kube	13.12.2011	4.14	Erweiterung Formeln 377-385 (CR_D_131 und CR_D_143) Ergänzung 337	
M. Musa, L. Politano	10.07.2012	4.15	Korrektur Formel 384 und Aufnahme Formel 387 bis 390. Löschen der Formeln 385 und 386.	
L.Politano	10.07.2013	4.16	Einfügen der Formeln 396-401.	
S. Vogt	21.05.2014	4.17	Anwendungseinschränkung bei Formel 88 ergänzt.	

ErstellerIn	Freigabe-datum	Version	Tätigkeit	Anmerkungen
I. Eicher	25.07.2014	4.18	Einarbeitung neue Formeln für Strassenwetter und Density altitude.	

Inhaltsverzeichnis

Tabellenverzeichnis

KAPITEL 1 *Introduction*

This document provides an overview of all formula used for meteorological and climatological calculations in the Swiss Meteorological Institute (SMI). The technical documentation about the use of the functions can be found in ....

In the environment of the MeteoSwiss Data Warehouse System, the functions are implemented using the 'formula_nr'. Shaded formula are not yet implemented.

<u>information about the aggregation documentation:</u>

- users can find the project documentation under /dabes/doc/Realisierung/Aggr/doc_Aggr/ ... /proj/zue/MCH-DWH/work/sw_dokumente/aggreg/... or directly in the intranet
- users can find the software documentation under /tools/mch/library/c/doc/ ... resp. /tools/mch/library/c/include ...or directly in the intranet
- restrictions of the realized libagg-functions, remarks on them can also be found in this document
- grey marked functions are not yet realised.

<u>for use of the aggregation library 'libagg', users have to</u>

- read file 'README_d.txt' (german) or 'README_e.txt' (english) in '/tools/sma/library/c' and use the described instructions

KAPITEL 2 *Variable Names*

Name of Variable(s)	Description of Variable(s)	Unit	parameter_id in the MCH-DWH System	Short Name in the MCH-DWH System
	c-factor			
c	c-factor; station dependent constant for calculating daily means of relative humidity at conventional stations	-	-	-
	wind direction			
d	wind direction (symbol is also used in general sense)	deg	-	-
d_d	wind direction	deg	197	dkl010z0
d_g	wind direction of maximal 1s-gust within 10min	deg	102	dkl010z1
	vapour pressure			
e	vapour pressure	hPa	971	pva200s0
e’	vapour pressure deficit	hPa	437	pvd200s0
r	mixing ratio	-	439	pvamixs0
e_w	vapour pressure over water	hPa	440	pvawats0
e_i	vapour pressure over ice	hPa	441	pvaices0

Name of Variable(s)	Description of Variable(s)	Unit	parameter_id in the MCH-DWH System	Short Name in the MCH-DWH System
	wind speed			
f_{kn}	wind speed	kn	-	-
f_{kmh}	wind speed	km/h	-	-
f_v	wind speed, vectorized	m/s	195	fve010z0
f_s	wind speed, scalar (Symbol is also used in general sense)	m/s	196	fkl010z0
f_g	maximal wind speed within 10min (1s gust)	m/s	101	fkl010z1
	height of base of clouds			
h	height of base of deepest cloud above station (normal scale)	Code	134	chh000s0
h_{s1}	height of base of lowest cloud layer above station (reduced scale)	Code	121	ch1000s0
h_{s2}	height of base of middle cloud layer above station (reduced scale)	Code	122	ch2000s0
h_{s3}	height of base of highest cloud layer above station (reduced scale)	Code	123	ch3000s0
h_{s4}	height of base of highest cloud layer above station (reduced scale)	Code	900	ch4000s0
	altitude of ...			
h_b	altitude of the barometer	m a.s.l.	-	-
h_s	altitude of the station	m a.s.l.	-	-
h_e	equivalent height	m a.s.l.	-	-
h_{snow}	altitude of snowline	m a.s.l.	350	hcc000s0

Name of Variable(s)	Description of Variable(s)	Unit	parameter_id in the MCH-DWH System	Short Name in the MCH-DWH System
	intensity of weather event			
i	intensity of weather event (code of Swiss 'National Bulletin EB')	Code	-	-
	k-factor			
k	k-factor; station dependent constant for calculating daily means of temperature at conventional stations	-	-	-
	snow depth			
s_n	depth of fresh snow	cm	155	hns000s0
s_h	total depth of snow cover	cm	156	hto000s0
	wind components			
u	east-component of wind (sign does not correspond to conventional use!)	m/s	564	fea010z0
v	north-component of wind (sign does not correspond to conventional use!)	m/s	565	fna010z0
-v	south-component of wind (sign does not correspond to conventional use!)	m/s	3182	fsa010z0
-u	west-component of wind (sign does not correspond to conventional use!)-	m/s	3181	fwa010z0
	observed weather			
w	weather at time of observation (code of Swiss 'National Bulletin EB')	Code	-	-
wawa	weather at time of observation reported by an automated station	Code	736	wcc001s0

Name of Variable(s)	Description of Variable(s)	Unit	parameter_id in the MCH-DWH System	Short Name in the MCH-DWH System
ww	present weather according to WMO Table 4677	Code	145	wat000s0
w_1	past weather, drizzle or rain	Code	136	w1p000i0
w_2	past weather, rain with snow or snow	Code	137	w2p000i0
w_3	past weather, small hail or hail	Code	138	w3p000i0
w_4	past weather, thunder storm far or close	Code	139	w4p000i0
w_5	past weather, mist or fog	Code	140	w5p000i0
w_6	past weather, dew or hoar frost	Code	141	w6p000i0
w_7	past weather, hoar frost or black ice	Code	142	w7p000i0
w_8	past weather, wind gust greater 30kn, 50kn	Code	143	w8p000i0
W_1	past weather 1	Code	146	ww1000i0
W_2	past weather 2	Code	147	ww2000i0
w_N	fog yes/no	Code	1865	wnd000s0
	lightning			
B_n	close lightning	Number	99	brecloz0
B_f	distant lightning	Number	100	brefarz0
	aerosols			
BC	black carbon	nanogramme per cubicmeter	1715 etc.	xabc00h0 etc.
	type of clouds			

Name of Variable(s)	Description of Variable(s)	Unit	parameter_id in the MCH-DWH System	Short Name in the MCH-DWH System
C_L	clouds of type Sc, St, Cu, Cb (normal scale)	Code	130	ccl000s0
C_M	clouds of type Ac, As, Ns (normal scale)	Code	131	ccm000s0
C_H	clouds of type Ci, Cc, Cs (normal scale)	Code	132	cch000s0
C_1	type of lowest clouds (reduced scale)	Code	127	cc1000s0
C_2	type of middle clouds (reduced scale)	Code	128	cc2000s0
C_3	type of highest clouds (reduced scale)	Code	129	cc3000s0
C_4	type of highest clouds (reduced scale)	Code	901	cc4000s0
C’	type of cloud whose base is below the station	Code	153	cca000s0
CFI	Cloud Free Index	-		
	state of the ground			
E	state of the ground	Code	135	est000s0
E_{ws}	state of the ground without snow and ice	Code	1686	esteees0
E_s	state of the ground with snow and ice	Code	1687	esthees0
	evaporation			
EV	evaporation	mm	110	eva000s0
E_{FAO}	reference evaporation from FAO-56	mm	4818 / 4817	erefaob0 / erefaod0
	foehn			
F	foehn index	Code	741	wcc006s0
FD	foehn duration	min	5375	wcc006b0

Name of Variable(s)	Description of Variable(s)	Unit	parameter_id in the MCH-DWH System	Short Name in the MCH-DWH System
FP	foehn probability	%	5426	wcc007s0
	radiation			
G	global radiation (= SDR)	W/m^2	96	gre000z0
G_c	circum global radiation	W/m^2	172	gci000d0
G_{dir}	direct radiation	W/m^2	754	gredirz0
G_{dif}	diffuse radiation	W/m^2	174 / 755	ods000z0 / gredifz0
G_{or}	global radiation, original value	W/m^2		
LDR	Longwave incomming radiation (downward)	W/m^2	175	oli000z0
LUR	Longwave outgoing radiation (upward)	W/m^2	1531	olo000z0
SDR	Shortwave incomming radiation (downward)	W/m^2	96	gre000z0
SDR_{cor}	multiple reflection corrected global radiation	W/m^2		
SDR_{dif}	Shortwave downward radiation; diffuse, horizontal	W/m^2		
SDR_{dir}	Shortwave downward radiation; direct component, horizontal	W/m^2		
SDR_{dirlow}	Shortwave downward radiation; Limit for SDR_{dir} indicating 0 minutes of SSD below this limit	W/m^2		
SDR_{dirup}	Shortwave downward radiation; Limit for SDR_{dir} indicating 10 minutes of SSD above this limit	W/m^2		
SUR	Shortwave reflected radiation (upward)	W/m^2	1871	osr000z0
Q	radiation balance	W/m^2	391	occ000s0
	altitude of the upper surface of clouds			
H’	altitude of the upper surface of clouds with base below the level of the station	Code	150	cha000s0

Name of Variable(s)	Description of Variable(s)	Unit	parameter_id in the MCH-DWH System	Short Name in the MCH-DWH System
	heating degree day number			
HGTZ	heating-degree-day-number 20/12	°C	446	xno000m0
HDD	heating-degree-day-number 18.3/18.3	°C		
	cooling degree day number			
CDD	cooling-degree-day-number 18.3/18.3	°C		
	density altitude			
DA	density altitude	ft	6078	xdealts0
	luminosity			
L	luminosity	Code	97	lre000s0
	amountof clouds			
N	total cloud amount	Code	119	nto000s0
N_{cc}	total cloud amount; calculated	Code	387	ncc000s0
N_h	amount of all the C_L clouds and of all the C_M clouds	Code	120	nsh000s0
N_d	density of cloudiness	Code	133	cnd000s0
N_{s1}	amount of individual cloud layer indicated by C_L (reduced scale)	Code	124	ns1000s0
N_{s2}	amount of individual cloud layer indicated by C_M (reduced scale)	Code	125	ns2000s0

Name of Variable(s)	Description of Variable(s)	Unit	parameter_id in the MCH-DWH System	Short Name in the MCH-DWH System
N_{s3}	amount of individual cloud layer indicated by C_H (reduced scale)	Code	126	ns3000s0
N_{s4}	amount of individual cloud layer 4th Level (reduced scale)	Code	899	ns4000s0
N’	amount of cloud whose base is below the level of the station	Code	152	nsa000s0
	pressure			
P	pressure at station level (QFE)	hPa	90	prestas0
P_R	pressure at station level, redundant measurement	hPa	-	-
P_{sl}	pressure reduced to mean sea level (QFF)	hPa	968	pp0qffs0
P_{qnh}	pressure reduced to mean sea level without consideration of temperature (QNH)	hPa	967	pp0qnhs0
P_{qnh500}	pressure reduced to the 500m-level without consideration of temperature	hPa	966	pp0500s0
P_{850}	height of the 850 hPa geopotential	m	969	ppz850s0
P_{700}	height of the 700 hPa geopotential	m	970	ppz700s0
	precipitation			
R	precipitation	mm	93	rre150z0
R_{ko}	precipitation (half day) conventional stations	mm	724	rko150a0
R_{Ra}	precipitation, redundant instrument; automatic	mm	178	ra1150z0
R_{Rc}	precipitation, redundant instrument; conventional	mm	177	rc1150d0
	radioactivity			
RA	radioactivity	nSievert	95	are000z0

Name of Variable(s)	Description of Variable(s)	Unit	parameter_id in the MCH-DWH System	Short Name in the MCH-DWH System
	sunshine duration			
S = SSD	sunshine duration	min	94	sre000z0
S_R	sunshine duration, redundant measurement	min	176	sa1000d0
S_a	sunshine duration, astronomical	min	-	-
S_{max}	sunshine duration, maximal	min	-	-
S_{cc}	sunshine duration; calculated	min	351	scc000z0
S_{dir}	direct sunshine			
	temperature			
T	temperature	°C	-	-
T_5	air temperature, 0.05m	°C	92	tre005s0
T_{50}	air temperature, 0.5m; frost warning	°C	103	tre050s0
T_{200}	air temperature, 2.0m; reference	°C	91	tre200s0
T_{-5}	ground temperature, -0.05m	°C	104	tso005s0
T_{-10}	ground temperature, -0.1m	°C	105	tso010s0
T_{-20}	ground temperature, -0.2m	°C	106	tso020s0
T_{-30}	ground temperature, -0.3m	°C	107	tso030s0
T_{-50}	ground temperature, -0.5m	°C	108	tso050s0
T_{-100}	ground temperature, -1.0m	°C	109	tso100s0
T_c	wind-chill temperature	°C		
T_d	dew-point temperature	°C	194	tde200s0

Name of Variable(s)	Description of Variable(s)	Unit	parameter_id in the MCH-DWH System	Short Name in the MCH-DWH System
T_e	equivalent temperature	K		
T_{max}	maximum air temperature (half day) conventional	°C	727	tko200ax
T_{min}	minimum air temperature (half day) conventional	°C	728	tko200an
T_{S0}	temperature of snow at ground level	°C	158	tht000s0
T_{S1}	temperature of snow at level 1	°C	159	tht001s0
T_{S2}	temperature of snow at level 2	°C	160	tht002s0
T_{S3}	temperature of snow at level 3	°C	161	tht003s0
T_w	wet-bulb temperature	°C	972	tps200s0
T_{Ac}	temperature of, ASTA-cabin	°C	166	ta3200s0
T_{Ar}	temperature of ASTA-room	°C	167	ta4200s0
T_H	air temperature, screen	°C	164	ta1200s0
T_H	mean value of air temperature, screen	°C	-	-
T_{HUTC06}	air temperature, screen (UTC 06)	°C	91	tre200s0
T_{HUTC12}	air temperature, screen (UTC 12)	°C	91	tre200s0
T_{HUTC18}	air temperature, screen (UTC 18)	°C	91	tre200s0
T_M	temperature of snow-height meter	°C	157	tsa000s0
T_R	temperature, redundant measurement	°C	-	-
T_{TOW10}	temperature at level 10m (meteorological towers)	°C	111	ta1tows0
T_{TOW110}	temperature at level 110m (meteorological towers), redundant	°C	111 oder 1112	ta1tows0
T_U	temperature of hygrometer shield	°C	165	ta2200s0
T_v	virtual temperature	°C	336	tvi200s0
T_x	temperature at level x (meteorological towers), redundant	°C	112	ta2tows0
θ	potential temperature	K		

Name of Variable(s)	Description of Variable(s)	Unit	parameter_id in the MCH-DWH System	Short Name in the MCH-DWH System
θ_e	equivalent-potential temperature	K		
θ_w	wet-bulb-potential temperature	K		
	humidity			
U_{200}	relative humidity, 2.0m; reference	%	98	ure200s0
U_a	absolute humidity	g/m^3	329	uto200s0
U_s	specific humidity	g/m^3	335	usp200s0
U_{or}	relative humidity, original value	%	321	uor200s0
U_H	relative humidity, screen	%	181	ua1200s0
U_{HUTC06}	relative humidity, screen (UTC 06)	%	98	ure200s0
U_{HUTC12}	relative humidity, screen (UTC 12)	%	98	ure200s0
U_{HUTC18}	relative humidity, screen (UTC 18)	%	98	ure200s0
U_{Hc}	relative humidity, corrected; screen	%	-	-
U_H	mean value of relative humidity, screen	%	-	-
U_x	relative humidity at level x (meteorological towers)	%	764	uretows0
r	mixing ratio	dimensionless		
	horizontal visibility			
V	horizontal visibility at surface	Code	144	vho000s0
	heating power			
Y_r	heating power of precipitation-gauge ring	Code	182	yri150s0

Name of Variable(s)	Description of Variable(s)	Unit	parameter_id in the MCH-DWH System	Short Name in the MCH-DWH System
Y_t	heating power of precipitation-gauge funnel	Code	183	ytr150s0
	control voltage			
Y_+	positive control-voltage (ANETZ)	V	184	yisocps0
Y_-	negative control-voltage (ANETZ)	V	185	yisocos0
	status word THYGAN			
Y_{swTH}	status word THYGAN	Code	190	ythycos0
Y_{swTHx}	status word THYGAN (meteorological towers)	Code	191	ythyc3s0
	The position of the Sun (WMO No,8 Annex 7.D)			
JD	Julian Date		-	
mL	mean Longitude			
g	mean anomaly	-		
eL	ecliptic Longitude			
	Integrated Water Vapour (IWV)			
IWV	Integrated Water Vapour	mm	2537	zxiwvcs0

Tabelle 1. Variable Names

KAPITEL 3 *Aggregation Functions*

i=1 and n are used for fixed and for user-definable terms as well. Therefore the following formular may be used to form hourly, daily, monthly and yearly values. They can also be used to form aggregated values for arbitrary time intervals.

Nr.[a] in DB	Name	Formula	Restrictions/ Remarks
1	arithmetic average agg_average	$\overline{X} = \frac{1}{n}\sum_{i=1}^{n} X_i$ where: X: any parameter for which the formation of an average (mean) value makes sense.	Number of 2^32 -1 values must not be exceeded. This has to be secured by the user of function 1 Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0
390	standard_deviation	$S = \sqrt{S^2} := \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(X_i - \bar{X})^2}$	
323	agg_poly_average	$\overline{X} = \sum_{i=1}^{n} X_{ip}$ p=p[th] Input-Parameter	Number of 2^32 -1 values must not be exceeded. This has to be secured by the user of function! Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0 Number of different Input parameter has to be >0 and < 21

[a] *Formula_nr from table formula*

Nr.[a] in DB	**Name**	**Formula**	**Restrictions/ Remarks**
39	agg_ave_cl	$\overline{X} = \frac{8}{10n}\sum_{i=1}^{n} X_i$ if $X_i = 9 \rightarrow X_i = 8$ where: X: any value for total cloud amount, where unit of cloud amount is in tenth	Number of 2^32 -1 values must not be exceeded. This has to be secured by the user of function 1 Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0
91	agg_ave_cl_10	$\overline{X} = \frac{10}{n}\sum_{i=1}^{n} X_i$ where: X: any value for total cloud amount, where unit of cloud amount is in tenth	Number of 2^32 -1 values must not be exceeded. This has to be secured by the user of function 1 Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0
	moving average		
	median	If n is an odd number of elements, the median X_{med} of any parameter X of a sorted list in increasing order is $X_{med} = X_{\frac{n+1}{2}}$ If n is an even number of elements, the median X_{med} of any parame ter X of a sorted list in increasing order is $X_{med} = \frac{X_{\frac{n}{2}} + X_{\frac{n}{2}+1}}{2}$	Number of 2^32 -1 values must not be exceeded. This has to be secured by the user of function 1 Number of plausible values has to be > 2 Number of single values to be aggregated has to be > 2 See also aggregation handbook

Nr.[a] in DB	Name	Formula	Restrictions/ Remarks
	quartile	**First quartile X_{qua1}:** Value below which 25% of a series of n values in increasing order are found: $X_{qua1} = 0{,}75 \cdot X_k + 0{,}25 \cdot X_{k+1}$ where $k = 0{,}25 \cdot n$ and k being an integer value. If k is a real number then $X_{qua1} = X_{[k+1]}$ where [k+1] denotes a Gaussian bracket meaning that a real number is transformed to an integer by omitting the digits after the decimal point. **Second quartile X_{qua2}:** This is the median. **Third quartile X_{qua3}:** Value below which 75% of a series of n values in increasing order are found: $X_{qua3} = 0{,}25 \cdot X_k + 0{,}75 \cdot X_{k+1}$ where $k = 0{,}75 \cdot n$ and k being an integer value. If k is a real number then $X_{qua3} = X_{[k+1]}$ where [k+1] denotes a Gaussian bracket meaning that a real number is transformed to an integer by omitting the digits after the decimal point.	Number of 2^32 -1 values must not be exceeded. This has to be secured by the user of function 1 Number of plausible values has to be > 3 Number of single values to be aggregated has to be > 3 See also aggregation handbook

Nr.[a] in DB	Name	Formula	Restrictions/ Remarks
	percentile	The percentile X_{per} is a value on a scale of one hundred that indicates the percentage of a distribution of n values that is equal to or below a certain value. For example, the 90th percentile-value means that 90% of the values of a dataset are equal to or below this value. In general, a percentile greater than 75 is considered above normal, a percentile between 25 and 75 is considered normal and a percentile less than 25 is considered below normal. $X_{per} = \frac{(100-q)\cdot X_k + q\cdot X_{k+1}}{100}$ where q is the percentage and $k = 0{,}25 \cdot n$ (k being an integer value). If k is a real number then $X_{per} = X_{[k+1]}$ where [k+1] denotes a Gaussian bracket meaning that a real number is transformed to an integer by omitting the digits after the decimal point.	Number of 2^32 -1 values must not be exceeded. This has to be secured by the user of function 1 See also aggregation handbook
8	weighted average for temperature (so called 'Vierermittel') agg_average_four	$\overline{T} = \frac{T_{UTC06} + T_{UTC12} + 2(T_{UTC20})}{4}$ there have to be 3 valid values for calculation of 'Vierermittel' number of plausible values has to be 3	
6	weighted average for temperature (so called 'k-Faktor Mittel') agg_average_kfac	$\overline{T} = x - (k(x - T_{\min}))$ where: $x = \frac{T_{UTC06} + T_{UTC12} + T_{UTC18}}{3}$ and: T_{min} = minimum temperature between evening observation of the day-1 and the evening observation of the actual day there have to be 3 valid values for calculation of 'k-Faktor Mittel' number of plausible values has to be 3	k factors are stored in MCH DWH System

Nr.[a] in DB	Name	Formula	Restrictions/ Remarks
7	weighted average for humidity (so called 'c-Faktor Mittel') agg_average_cfac	$\overline{U} = x - \left(c\left(x - U_{UTC12}\right)\right)$ where: $x = \frac{U_{UTC06} + U_{UTC12} + U_{UTC18}}{3}$ there have to be 3 valid values for calculation of 'c-Faktor Mittel' number of plausible values has to be 3	c factors are stored in MCH DWH System
59	formation of a special daily value out of term value(s), e.g. formation of a daily snow depth value (Gesamtschneehöhe) agg_average_term	$\overline{X} = \frac{1}{n}\sum_{i=1}^{n} X_i$ where: X: any parameter for which the formation of an average (mean) value makes sense.	Number of 2^32 -1 values must not be exceeded. This has to be secured by the user of function 59 Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0
2	agg_sum	$Sum = \sum_{i=1}^{n} X_i$	Number of 2^32 -1 values must not be exceeded. This has to be secured by the user of function 2 Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0
92	agg_poly_sum	$Sum = \sum_{i=1}^{n} X_{ip}$ p=pth Input-Parameter	Number of 2^32 -1 values must not be exceeded. This has to be secured by the user of function! Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0 Number of different Input parameter has to be >0 and < 21
3	agg_max maxima, number of maxima, indices of maxima	maxima = max($x_1 \ldots x_i \ldots x_n$) number of maxima = length(maxima) indices of the maxima	Number of 2^32 -1 values must not be exceeded. This has to be secured by the user of function 3 Number of plausible values has to be > 0 Extreme value has to be calculated from more than zero values The return values of this function are: -A vector of maxima (if in the input vector several values have the same maximum value); -The number of values in the output vector; -The indices within the input vector of the found maxima. Only important in context with MCH DWH System: if several maxima are found, the last one is put back into MCH DWH System as maximum (e.g. daily maximum)

Nr.[a] in DB	Name	Formula	Restrictions/ Remarks
74	agg_max_n maxima	maxima = $\max(x_1 \ldots x_i \ldots x_n)$	Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user of function 74 Number of plausible values has to be > 0 Extreme value has to be calculated from more than zero values The return value of this function is: - The maxima, if several maxima are found, the last one is ommitted.
75	agg_max_pos indices of maxima	indices of the maxima	Number of 2^32 -1 values must not be exceeded. This has to be secured by the user of function 75 Number of plausible values has to be > 0 Extreme value has to be calculated from more than zero values The return value of this function is: - The indices within the input vector of the last found maxima.
387	agg_max_values_1	Calculation of the maximum value of data 1 at the maximum position	Input= array with single values (wind-speed) Output= pointer to maximum value of data 1 The same rules are applied like in the formula 75 (agg_max_pos), except that pi_error = -4 [all plausible values are equal] Number of plausible values has to be > 0
388	agg_max_values_2	Calculation of the maximum value 2 at the maximum position of value 1	Input = two arrays with single values (wind-speed and wind-direction= Output = pointer to maximum value of data 2 at position of data 1

Nr.[a] in DB	Name	Formula	Restrictions/ Remarks
4	agg_min minima, number of minima, indices of minima	minima = min(x_1...x_i...x_n) number of minima = length(minimum) indices of minima	Number of 2^32 -1 values must not be exceeded. This has to be secured by the user of function 4 Number of plausible values has to be > 0 Extreme value has to be calculated from more than zero values The return values of this function are: - A vector of minima (if in the input vector several values have the same minimum value); - The number of values in the output vector; - The indices within the input vector of the found minima. Only important in context with MCH DWH System: if several minima are found, the last one is put back into MCH DWH System as minimum (e.g. daily minimum)
72	agg_min_n minima	minima = min(x_1...x_i...x_n)	Number of 2^32 -1 values must not be exceeded. This has to be secured by the user of function 72. Number of plausible values has to be > 0 Extreme value has to be calculated from more than zero values The return value of this function is: - The minima, if several minima are found, the last one is ommitted
73	agg_min_pos indices of minima	indices of minima	Number of 2^32 -1 values must not be exceeded. This has to be secured by the user of function 73 Number of plausible values has to be > 0 Extreme value has to be calculated from more than zero values The return value of this function is: - The indices within the input vector of the last found minima
334	agg_variance	$\sigma^2(x) = \sum_{i=1}^{n}(x_i - \bar{x})^2$	Calculation of the variance Number of plausible values has to be > 0
23	calculation of heating degree days agg_heating_deg_days	$HGT = 20 - \bar{T}^*$ if $\bar{T}^* \leq 12°C$ $HGZ = \sum_{i=1}^{n} HGT$ $\bar{T}^*$: daily mean of air temperature	HGT: Heizgradtag (SIA) HGZ:Heizgradzahl (SIA) (monthly or yearly values)

Nr.[a] in DB	Name	Formula	Restrictions/ Remarks
335	calculation of cooling degree days agg_cooling_deg_days	$CDD = \overline{T}^* - 18.3$ if $\overline{T}^* \geq 18.3°C$ $CDZ = \sum_{i=1}^{n} CDD$ $\overline{T}^*$: daily mean of air temperature	CDD: Cooling Degree Day (US) CDZ:Cooling Degree Zahl (US) (monthly or yearly values)
23	calculation of heating degree days (agg_heating_deg_days	$HDD = 18.3 - \overline{T}^*$ if $\overline{T}^* \leq 18.3°C$ $HDZ = \sum_{i=1}^{n} HDD$ $\overline{T}^*$: daily mean of air temperature	HDD: Heating Degree Day (US) HDZ:Heating Degree Zahl (US) (monthly or yearly values)
	average ambient dose rate of radio activity	$Mittel = 1000 \cdot \log\left(\frac{1}{n}\sum_{i=1}^{n} \exp\left(\frac{RA}{1000}\right)\right)$	
22	deviation from reference calc_deviation (from normvalue)	$X_{dev}=X - X_{ref}$ for monthly and yearly values: $X \in \{\overline{T}, \overline{T}_{\max}, \overline{T}_{\min}, ndayTypF, ndayTypE,$ $ndayTypeSo, ndayTypHi, \overline{T}_5, \overline{T}_{5\max}, \overline{T}_{5\min}, \overline{U}, \overline{e},$ $\overline{P}, \overline{P}_{s1}, \overline{EV}, ...\}$	proportion or deviation can only be calculated with valid data values
21	proportion to a reference calc_proportion	$X_{prop}=X/X_{ref}$ for monthly and yearly values: $X \in \{R, S, HGTZ\}$	Also used for relative sunshine duration Reference value has to be > 0 proportion or deviation can only be calculated with valid data values
24	histogram agg_histo	X=hist(Y, breaks=(z_1, z_2, z_3,...)) X=Vector containing the counts of Y which satisfy $z_1 < Y$ & $Y \leq z_2$. X has 1 element more than the number of breaks z_1, z_2, z_3 etc.. Y: vector of data for histogram. z_1, z_2, z_3, ... : break points for the counts of the histogram	VAMP/METEOR 112-137 Number of classes has to be > 1
81	copy_value	makes a copy of a value	This function can be used for copying a value to another parameter.
83	calc_difference (between two parameters)	Calculates difference of two values: diff = value1 - value2 where diff = calculated difference, value1 = first value and value2 = value to be subtracted from value1	error = 0 if all ok error = -35 if ?

Tabelle 2. Aggregation Functions

KAPITEL 4 *Conversion of Units*

Nr.[b] in DB	Purpose	Name	Formula	Restriction/ Remarks	Old Name
	mm to cm		X [mm] = X/10 [cm]		
	cm to dm		X [cm] = X/10 [dm]		
	dm to m		X [dm] = X/10 [m]		
	mm to m		X [mm] = X/1000 [m]		
	cm to m		X [cm] = X/100 [m]		
	s to min		X [s] = X/60 [min]		
86	min to h		X [min] = X/60 [h]		
	h to day		X [h] = X/24 [day]		
	s to h		X [s] = X/3600 [h]		
	s to day		X [s] = X/86400 [day]		
61	winddirection from degrees do decadegrees	calc_dd_from_dkl010z0	$d_d = \mathrm{int}\left(\frac{d+5}{10}\right)$	if d_d = 00, d_d = 36 if ff = 00, d_d = 00	VAMP/METEOR B100
80	windspeed from m/s to kn		$f_{kn} = f \cdot 1{,}9438$		VAMP/METEOR B102
336	windspeed from kn to m/s	knoten2msec	$f = \frac{f_{kn}}{1{,}9438}$		
337	windspeed from kn to km/h	knoten2kmh	$f = \frac{f_{kn}}{1{,}9438} \cdot 3.6$		

[b] *formula_nr from table formula*

Nr.[b] in DB	Purpose	Name	Formula	Restriction/ Remarks	Old Name
79	windspeed from m/s to km/h		$f_{kmh} = f \cdot 3{,}6$		
379	windspeed from km/h to m/s	kmh2msec	$f = \frac{f_{kmh}}{3{,}6}$		
378	windspeed from km/h to kn	kmh2knoten	$f = \frac{f_{kmh}}{3{,}6} \cdot 1.9438$		
77	radioactivity from millibel to nanosievert/h		$RA_f = \frac{1}{100} \cdot 10^{\left(\frac{RA_r}{1000}\right)}$		
78	radioactivity from nanosievert/ h to millibel		$RA_r = 1000 \cdot \log\left(100 \cdot RA_f\right)$		
	radioactivity from nanosievert/ h to rem/h		$RA_{rem} = 10^{-7} \cdot RA_f$		
	global radiation from Wm^{-2} to $MJm^{-2}d^{-1}$		$G_{Lj} = \frac{G_L}{11{,}574}$		
	global radiation from Wm^{-2} to cal $cm^{-2}h^{-1}$		$G_{Lcal} = G_L \cdot 0{,}08598$		
	Celsius to Fahrenheit		$T_{fah} = \frac{9}{5} \cdot T + 32$		
30	Celsius to Kelvin		$T_{abs} = T + 273{,}15$		
	Beaufort scale B in wind speed v		$v = A \cdot B^{1{,}498}$	A = 3.0291 km/h = 0.8414 m/s = 1.6354 kn	
338	wind speed v in Beaufort scale B	msec2beaufort	$B = 1.498 * \sqrt{\frac{v}{A}}$	A = 3.0291 km/h = 0.8414 m/s = 1.6354 kn Maximum=12	
	Hekto-Pascal to Nanobar		1 hPa = 1 nbar • 10^{9}		
	mm HG to Nanobar		1 mm HG = 1.333224 mbar		
	Clouds from Promille P to Octas O		O=P/125		

Nr.[b] in DB	Purpose	Name	Formula	Restriction/ Remarks	Old Name
	Clouds from Promille P to Decas D		D=P • 1000		
	Clouds from Octas O to Decas D		D= O • 0.125		
	Clouds from Decas D to Octas O		O=D/0.125		
	Luminosity from [mv] to [lux]		$L[lux]=10^{\frac{L[mV]+245}{100}}$	from ENAD Specification. not implemented. The values are not on the Database with the unit klux, because the mistake of the formula to a certain value is too high.	
339	xy-coordinates to latitude/longitude	xy2latlong	x_km=y_km-koord_nu – 200000) / 1000000 y_km=x_km-koord_nu – 600000) / 1000000 lambda = 2.6779094 + (4.728982 * y_km) + (0.791484 * y_km * x_km) + (0.1306 * y_km * POWER(x_km,2)) - (0.0436 * POWER(y_km,3)) phi = 16.9023892 + (3.238272 * x_km) - (0.270978 * POWER(y_km,2)) - (0.002528 * POWER(x_km,2)) - (0.0447 * x_km * POWER(y_km,2)) - (0.0140 * POWER(x_km,3))	x_km_koord_nu: x-coordinates in m y_km_koord_nu: y-coordinates in m lambda: **longitude** in 0.001" phi: **latitude** in 0.001" 'POWER' is an SQL-expression from ORACLE. Means that 'POWER(x_km,2)' provides the square of x_km. POWER(x_km,2) = (x_km)^2	Algorithm CH1903 ⇔ WGS84 from Swisstopo. This exits in both direction (look at formula 352). Given that MeteoSchweiz interchange the X and Y coordinates, this correspond to aninterchanged formula of the Swisstopo definition. http://www.swisstopo.admin.ch/internet/swisstopo/fr/home/products/software/products/skripts.parsysrelated1.45237.downloadList.79047.DownloadFile.tmp/ch1903wgs84fr.pdf http://www.swisstopo.admin.ch/internet/swisstopo/fr/home/products/software/products/skripts.parsys.00011.downloadList.64947.DownloadFile.tmp/wgs84ch1903cs.zip

Nr.[b] in DB	Purpose	Name	Formula	Restriction/ Remarks	Old Name
352	latitude/longitude to xy-coordinates	latlong2xy	lat_aux = (lat * 3600 – 169028.66) / 10000 lng_aux = ((lng * 3600)– 26782.5) / 10000 y_km = 200147.7 + (308807.95 * lat_aux) + (3745.25 * POWER(lng_aux,2)) + (76.63 * POWER(lat_aux,,2)) - (194.56 * POWER(lng_aux,2) * lat_aux) + 119.79 * POWER(lat_aux,3)) x_km = 600072.37 – (211455.93 * lng_aux) - (10938.51 * lng_aux * lat_aux) - (0.36 * POWER(lat_aux,2) * lng_aux) - (44.54 * POWER(lng_aux,3))	lat: **latitude** in 0.001" lng: **longitude** in 0.001" x_km: x-coordinates in m y_km: y-coordinates in m 'POWER' is an SQL-expression from ORACLE. Means that 'POWER(x_km,2)' provides the square of x_km. POWER(x_km,2) = (x_km)^2	Algorithm CH1903 ⇔ WGS84 from Swisstopo. This exits in both direction (look at formula 339). Given that MeteoSchweiz interchange the X and Y coordinates, this correspond to an interchanged formula of the Swisstopo definition.. http://www.swisstopo.admin.ch/internet/swisstopo/fr/home/products/software/products/skripts.parsysrelated1.45237.downloadList.79047.DownloadFile.tmp/ch1903wgs84fr.pdf http://www.swisstopo.admin.ch/internet/swisstopo/fr/home/products/software/products/skripts.parsys.00011.downloadList.64947.DownloadFile.tmp/wgs84ch1903cs.zip

Tabelle 3. Conversion of Units

KAPITEL 5 *De- and Recoding Functions*

5.1 Recoding of present weather Codes (wi [KA04] → ww/ ND [SYNOP])

wi [KA04]	Description	ww [SYNOP]	N_D [SYNOP]
00	no significant present weather	02	unchanged
01	should not occur		
02	should not occur		
09	no precipitation, thunderstorm within 3 km around the station	17	unchanged
10	drizzle, light	51	unchanged
11	drizzle, moderate	53	unchanged
12	drizzle, heavy	55	unchanged
19	drizzle, thunderstorm within 3 km around the station	95	unchanged
20	rain, light	61	unchanged
21	rain, moderate	63	unchanged
22	rain, heavy	65	unchanged
29	rain, thunderstorm within 3 km around the station	95	unchanged
30	snow and rain, light	68	unchanged
31	snow and rain, moderate	69	unchanged
32	snow and rain, heavy	69	unchanged
39	snow and rain, thunderstorm within 3 km around the station	95	unchanged
40	snowfall, light	71	unchanged
41	snowfall, moderate	73	unchanged
42	snowfall, heavy	75	unchanged
49	snowfall, thunderstorm within 3 km around the station	95	unchanged

wi [KA04]	Description	ww [SYNOP]	N_D [SYNOP]
50	fog, light	45	3
51	fog, moderate	45	4
52	fog, heavy	45	5
59	fog, thunderstorm within 3 km around the station	17	3
60	drizzle (light) and fog	51	add 3 to the actual value
61	drizzle (moderate) and fog	53	add 3 to the actual value
62	drizzle (heavy) and fog	55	add 3 to the actual value
69	drizzle and fog, thunderstorm within 3 km around the station	95	add 3 to the actual value
70	rain (light) and fog	61	add 3 to the actual value
71	rain (moderate) and fog	63	add 3 to the actual value
72	rain (heavy) and fog	65	add 3 to the actual value
79	rain and fog, thunderstorm within 3 km around the station	95	add 3 to the actual value
80	snow and rain (light) and fog	68	add 3 to the actual value
81	snow and rain (moderate) and fog	69	add 3 to the actual value
82	snow and rain (heavy) and fog	69	add 3 to the actual value
89	snow and rain and fog, thunderstorm within 3 km around the station	95	add 3 to the actual value
90	snowfall (light) and fog	71	add 3 to the actual value
91	snowfall (moderate) and fog	73	add 3 to the actual value
92	snowfall (heavy) and fog	75	add 3 to the actual value
99	snowfall and fog, thunderstorm within 3 km around the station	95	add 3 to the actual value

Tabelle 4. Recoding of present weather codes

ww	w	i	Condition
00..16	0	0	
17	0	9	
18..40	0	0	
41	0	0	falls vho000s0 > 09, sonst wie 42..49
42 ..49	5	2	falls vho000s0 = 00..01

ww	w	i	Condition
42 ..49	5	1	falls vho000s0 = 02..04
42 ..49	5	0	falls vho000s0 > 04
50..51	1	0	
52..53	1	1	
54..55	1	2	
56	1	0	
57	1	2	
58	2	0	
59	2	1	
60..61	2	0	
62..63	2	1	
64..65	2	2	
66	2	0	
67	2	2	
68	3	0	
69	2	2	
70..71	4	0	
72..73	4	1	
74..75	4	2	
76	0	0	
77	4	0	
78	0	0	
79	4	0	
80	2	1	
81..82	2	2	
83	3	0	
84	3	2	
85	4	1	
86	4	2	

ww	w	i	Condition
87	4	1	
88	4	2	
89	2	0	
90	2	2	
91	2	0	
92	2	2	
93	3	0	
94	3	2	
95..97	2	9	
98	0	9	

Tabelle 5. Recoding of present weather codes 2

Additional condition: if cnd000s0 ≥ 3 and cnd000s0 ≤ 5 and wi ≤ 50 then wi = wi + 50
The recoding of present weather is performed with the formula ‘calc_w_and i_from_wat000s0’.

5.2 Recoding of Visibility (V [Code KA04] ↔ [m] ↔ VV [Code SYNOP])

Tabelle 7 specifies the recoding of visibility for the functions mentioned in Tabelle 6.

Name	Function	Available Program Code
Vxm	V[KA04] from visibility [m] or [hm]	Program to extract data in KA04 format from MCH DWH System
VVxm	VV[SYNOP] aus Sicht in [m]	
VxVV	V[KA04] aus VV[SYNOP]	Program to extract data in KA04 format from MCH DWH System
VVxV	VV[SYNOP] aus V[KA04]	
mxV	Sicht in [m] aus V[KA04]	
mxVV	Sicht in [m] aus VV[SYNOP	
calc_v_from_vho000s0	Calculation of the Swiss 'Nationales Bulletin EB'-code of horizontal visibility from corresponding SMI-code	Program to extract data in KA04 format from vho000s0

Tabelle 6. Overview of Recoding Functions for Visibility

V [KA04]	visibility	VV [SYNOP]	vho000s0
0	0 - 49 m	00	00
1	50 - 199 m	01	01
2	200 - 499 m	02	02..04
3	500 - 999 m	05	05..09
4	1.0 - 1.999 km	10	10..19
5	2.0 - 4.999 km	20	20..49
6	5.0 - 9.999 km	50	50..59
7	10.0 - 19.999 km	60	60..69
8	20.0 - 49.999 km	70	70..83
9	≥ 50.0 km	84	84..89
/			>89

Tabelle 7. Recoding of Visibility

5.3 Recoding of WMO-Code

Nr.[c] in DB	Name	Function	
60	calc_h_from_ch1000s0	Calculation of the WMO-code of height above station of the lowest cloud base from corresponding SMI-code	
62	calc_a_from_press	Calculation of the WMO-code of tendency of pressure during the last three hours from measurements of atmospheric pressure (10-min values)	
63	calc_a_from_press_2	Calculation of the WMO-code of tendency of pressure during the last three hours from measurements of atmospheric pressure 2 (10-min values)	
64	calc_rrr_and_tr_from_rre150z0	Calculation of the WMO-code of sum of precipitation and its corresponding measurement period from precipitation measurements	
65	calc_3etgn_and_4Esss_from_est000s0	Calculation of the WMO-code of state of ground from the corresponding SMI-code	
66	calc_ss_from_hns000s0	Calculation of the WMO-code of new snow depth from measurements of new snow depth	
67	calc_SpSpspsp_from_spec_weather	Calculation of the WMO-code of special weather events from corresponding SMI-code	

Tabelle 8. Recoding of WMO-Code

[c] *formula_nr from table formula*

5.4 Recoding of Roadweather-Code

Nr.[d] in DB	Name	Function	
340	calc_rrr_from_riicd0s0	Calculation of rain intensity from the precipitation code of road weather stations Code 0 -> 0 mm/h Code 1 -> 0.5 mm/h Code 2 -> 4 mm/h Code 3 -> 10 mm/h	
411	calc_estrs_from_boschung	Surface Status (Boschung) Code 0 -> dry Code 1 -> humid (30 ml/m2) Code 32 -> wet Code 64 -> slippery Code 65 -> snow Code 66 -> ice Code 67 -> frost Code 255 -> unknown	

[d] *formula_nr from table formula*

Nr.[d] in DB	Name	Function	
409	calc_estrs_from_kelag	Surface Condition (Kelag) Code 0 -> dry Code 1 -> moist Code 2 -> wet, wet precip, wet no precip Code 3 -> snow Code 4 -> frost Code 5 -> ice Code 6 -> absorption Code 7 -> dew Code 8 -> absorption at dewpoint Code 9 -> frost above dewpoint Code 10 -> try treated Code 12 -> wet treated, moist treated Code 20 -> probable drying Code 21 -> surface critical Code 22 -> surface alert Code 98 -> sensor_short Code 99 -> sensor_down	
410	calc_estrs_from_micks	Lane Condition (Micks) Code 0 -> trocken Code 1 -> trocken (?) Code 2 -> feucht Code 3 -> feuchtnass Code 4 -> Nass Code 5 -> Schneeglätte-Gefahr Code 6 -> Reifglätte-Gefahr Code 7 -> Glatteis-Gefahr Code 8 -> Eisglätte-Gefahr Code 9 -> unterkühlt Code 10 -> Sonde defekt Code 255 -> unbestimmter Zustand	

Nr.[d] in DB	Name	Function	
415	calc_estrs_from_lufft	Road Condition (Lufft Meteotest) Code 0 -> trocken Code 1 -> feucht Code 2 -> nass Code 3 -> Eis Code 4 -> Schnee Code 5 -> Salzrest Code 6 -> Kritische Nässe Code 7 -> Kritisch Code 91 -> unbestimmt Code 92 -> unbestimmt Code 93 -> unbestimmt Code 94 -> unbestimmt	

Tabelle 9. Recoding of Roadweather-Code

Help Functions for string copying and visual observations

Nr.[e] in DB	Purpose	Name	Formula	Restrictions/ Remarks
84	Dummy-function: copies the input string to the output string. The output string is always null terminated	copy_string	output_string = input_string	error = 0 if all ok error = -1 if input _string is NULL error = -2 if output_string is NULL
85	Prepares a string of 4 characters con taining visual observations. The rules how to prepare the output_string, are different depending on the parameter_id of the output_string. The output string is always null ter minated.	visual_param_string	If out_param_id = 2051+k or 2064+k then output_string (k) = visual_values(1) + ... + visual-val ues (i), where k = 0..12 (total of 13 combined visual observations -> 'b40..52') and i = number of params per combined visual observation 'b40..52'.	error = 0 if all ok error = 1 if an visual_value is out of its range error = -81 if length of output_string should be > 4 error = -82 if visual_values is NULL error = -83 if output_string is NULL error = -84 out_param_id unknown for this method output_string for missing values is '////'

Tabelle 10: Help Functions for string copying and visual observations

[e] *formula_nr from table formula*

KAPITEL 6 *Calculation of ‚Present Weather Information' from Sensor Values*

Nr. in DB	Purpose	Name	Formula	Restrictions/ Remarks
70	Calculation of past weather 'thunder storm' w_4[f] from lightning counts	calc_w4_from_breclo z0_and_brefarz0	The coding follows: $X = \sum_1^{ntermine} B_n$ bzw. $Y = \sum_1^{ntermine} B_f$ XYw_4 000 1..5x2 6..24x4 25..74x6 >74x8 01..51 06..243 025..745 0>747 where: *ntermine*: number of 10'-intervals whithin the time period to cover. - for the 06 UTC term this is from 1741 UTC (previous day) to 0540 - for the 12 UTC term this is from 0541 UTC to 1140 UTC - for the 18 UTC term this is from 1141 UTC to 1740 UTC. *x*: any number.	

[f] *w_4 as determined from measurements is stored in a different DB attribute than the 'observed' w4.*

Nr. in DB	Purpose	Name	Formula	Restrictions/ Remarks
305	Determination of precipitation type using heating power of precipitation-gauge (for ANETZ Type) „Heizleistung der Niederschlagswippe"	prec_type_from_ gauge	$x_1 = x_2 = (4 - T_{200}) \cdot \left(R + 1{,}5 \cdot \sqrt{f_g}\right)$ IF R = 0 THEN: 0 IF R > 0 AND T_{200} > 3 AND Y_r or Y_t > 10 AND T_{200} > 5 THEN: 75 ELSE: 60 IF R > 0 AND T_{200} BETWEEN 0 AND 3 AND Y_r or Y_t > x_1 THEN: 68 ELSE: 60 IF R > 0 AND T_{200} < 0 AND Y_r or Y_t > x_1 THEN: 65 ELSE: 70 (Joss und Gutermann, 1980)	z: Type of Precipitation f_g= maximal wind speed within 10min (1s gust) R: in 0.1 mm P_{03}: T_{200} in 0.1 C P_{09}: f_g in 0.1 m/s P_{22}: Y_r , Y_t $x_{1,2}$: Testgrenzen für Heizleistung Trichter WMO-No. 306, Codetable 4680 0: No Sign. Weather 60: Rain 65: Rain, freezing, moderate 68: Rain or Drizzle and Snow, moderate 70: Snow 75: Ice pellets, moderate

Nr. in DB	Purpose	Name	Formula	Restrictions/ Remarks
341	Determination of precipitation type using heating power of precipitation-gauge (for SMN Type) „Heizleistung der Niederschlagswippe“	prec_type_from_gauge_smn	$x_1 = x_2 = (4 - T_{200}) \cdot (R + 1{,}5 \cdot \sqrt{f_g})$ $Yr_{ANETZ} = -0.000001172 \times Yr^2_{SMN} + 0.03221 \times Yr_{SMN} + 1.37$ $Yt_{ANETZ} = -0.000001172 \times Yt^2_{SMN} + 0.03221 \times Yt_{SMN} + 1.37$ IF R = 0 THEN: 0 IF R > 0 AND T_{200} > 3 AND Y_{rANETZ} or Y_{tANETZ} > 10 AND T_{200} > 5 THEN: 75 ELSE: 60 IF R > 0 AND T_{200} BETWEEN 0 AND 3 AND Y_{rANETZ} or Y_{tANETZ} > x_1 THEN: 68 ELSE: 60 IF R > 0 AND T_{200} < 0 AND Y_{rANETZ} or Y_{tANETZ} > x_1 THEN: 65 ELSE: 70 (Joss und Gutermann, 1980 modifiziert)	z: Type of Precipitation f_g= maximal wind speed within 10min (1s gust) R: in 0.1 mm P_{03}: T_{200} in 0.1 C P_{09}: f_g in 0.1 m/s P_{22}: Y_r , Y_t $x_{1,2}$: Testgrenzen für Heizleistung Trichter WMO-No. 306, Codetable 4680 0: No Sign. Weather 60: Rain 65: Rain, freezing, moderate 68: Rain or Drizzle and Snow, moderate 70: Snow 75: Ice pellets, moderate
342	Determination of precipitation types SN, RS or RA and prec. intensity Determination of precipitation type using snow line	prec_type_from_snow_line	IF precipitation > 0 test precipitation (snow, rain, snow and rain) test precipitation Intensity (light, moderate, heavy) add descriptor if storm or shower IF precipitation = 0 test fog or stratus As function of snow line, the type of precipitation is: h_{side} > h_snow 70 h_{site} + 200 > h_snow > h_{site} 68 h_snow > h_{site} + 200m 60	 h_{side}: height of region h_snow: snow line 68: Rain/Snow / RASN 70: Snow / SN 60: Rain / RA

Nr. in DB	Purpose	Name	Formula	Restrictions/ Remarks
306	Determination of precipitation type from wet-bulb tempera ture	prec_type_from_tps200s0	R > 0 mm and Tw < 1.3 : 70 Tw between 1.3 and 2.0 : 68 Tw > 2.0 : 60	Tw in Grad Celsius 68: Rain/Snow / RASN 70: Snow / SN 60: Rain / RA WMO-No. 306, Codetable 4680
307	Snow Line Detection from wet-bulb temperature	snow_line	$\Delta h = \frac{Tw - 1}{0{,}6}$ Tw > -3 Tw < 6 $h_{snow} = h_s + \Delta h \times 100$ (Steinacker, 1983)	Tw = tps200s0 in Grad Celsius Δh: snow line above ground h_s: height of station h_{snow}: snow line
343	Approximation of height of snow using quantity of precipitation	rain2snow	Q_snow [cm] = Q_prec [mm] * f	Q_snow: height of snow Q_prec: quantity of precipitation f: conversion factor (Tmin+Tmax)/2 < -10°, f=20 (Tmin+Tmax)/2 between -10° and -1°, f=linear from 20 to10 (Tmin+Tmax)/2 between -1° and 0°, f=8 (Tmin+Tmax)/2 between 0° and 1.5°, f=6
308	fog detection from humidity	fog_from_uor200s0	U_{or} < 100 : 0 R > 0 : 0 R = 0 and U_{or} between 100 and 102 : 10 U_{or} > 102 : 20	Coding as with parameter 140 0: kein Nebel 10: nebilg (Sicht 1-2 km) 20: Nebel (Sicht unter 1 km) WMO-No. 306, Codetable 4680

Nr. in DB	Purpose	Name	Formula	Restrictions/ Remarks
309	Calculation of foehn_index for stations ALT, AIG, SIO, VIS, INT, GLA, CHU, VAD, STG, ENG, GUT	foehn_index	Index = 0 Für das Stundenmittel der Windrichtung auf dem Gütsch gilt: $90 \leq d_d \leq 240$ Föhneinsatz an Talstation: d_d innerhalb der Grenze UND $\Delta\theta \geq x$ UND ($f_{max} \geq x$ ODER $fg \geq x$) UND $U_{200} \leq x$ Föhnfortdauer an Talstation: Föhneinsatz erfolgt UND $\Delta\theta \geq x$ UND $U_{200} \leq x$ UND d_d innerhalb der Grenze Föhnende: mindestens ein Kriterium unter „Föhnfortdauer“ oder „Windrichtung Gütsch“ ist verletzt. Wenn Föhn, dann Index= 1. Föhnmass: $F = \Delta\theta + f_g - \frac{3}{80} \cdot \left\| d_d - d_d^* \right\|$ wenn F < 2: Index = 1 wenn $F \geq 2$: Index = 2 Dürr, 2009	dd: dkl010h0 $\Delta\theta$: potential temperature difference between station and Guetsch (tpo200s0) f_{max}: fkl010z1 f_g: U_{200}: ure200s0 x: thresholds for different parameters, see Dürr 2005 d_d^*: Hauptföhnrichtung an der Station Index: 0: kein Föhn an der Station 1: Mischluftföhn an der Station 2: deutlicher Föhn an der Station
384	hourly duration of foehn	foehn_index_hour	Count of foehn index values> 0. Each value correspond to 10 minutes foehn duration. #F>0*10minutes = FD (min) Special cases: 1) If one value is missing and the other values are (1 or 2). Then the missing value is treated like foehn and the result is 60 min. 2) If two values are missing and the other values are equal 2. Then the missing values are treated like foehn and the result is 60 min. In all other cases missing values are treated like 0 minutes foehn.	F=foehn index FD=foehn duration (min) The formula can only be used for hourly aggregation (input 6 tenminutes values).

Nr. in DB	Purpose	Name	Formula	Restrictions/ Remarks
389	calculation of foehn probability	foehn_probability	Calculation of foehn probabilty out of the difference of geopotentioal 850hPa between CIM and NAP and the difference of potential temperature between GUE and the station for which foehn probability is calculated. The value is taken out of a matrix of foehn probability, which depends on the target station and the date (summer or winter half year).	the values in the matrix are smoothed, because of statistical effects in the data!
312	Determination of nocturnal cloud cover	cloud_cover_night	if TIME between SUNSET and SUNRISE IF R = 0 AND $\Delta t \leq 0$ AND $U_{200} \geq 94.5$ AND $f_g \leq 1.2$ THEN: 9 IF R = 0 AND ($\Delta t \leq 0$ AND $U_{200} < 94.5$) OR ($\Delta t \leq 0$ AND $U_{200} \leq 94.5$ AND $f_g > 1.2$) OR $\Delta t \leq 0,8$ THEN: 8 IF R = 0 AND Δt between 0,8 and 1,3 THEN: 7 IF R = 0 AND Δt between 1,3 and 1,7 THEN: 6 IF R = 0 AND Δt between 1,7 and 2,1 THEN: 5 IF R = 0 AND Δt between 2,1 and 2,4 THEN: 4 IF R = 0 AND Δt between 2,4 and 2,6 THEN: 3 IF R = 0 AND Δt between 2,6 and 2,9 THEN: 2 IF R = 0 AND Δt between 2,9 and 3,2 THEN: 1 IF R = 0 AND $\Delta t \geq 3,2$ THEN: 0 Albisser 1983 former Restriction in use: ($G < 5$ W/m^2 and $\sin\Phi < 0.05$)	Δt: Difference between T_5 and T_{200} Φ: Sonnenwinkel Anstatt dem Sonnenwinkel wird in der Formal 312 die Definitaion von Tag / Nacht verwendet. TIME: target time of calculation s_vut: max. possible duration of Sunshine in minutes from 00 am - 11.40 am 11.40 - svut = SUNRISE s_max: max. possible duration of Sunshine in minutes for the whole day Sunrise + s_max = SUNSET

Nr. in DB	Purpose	Name	Formula	Restrictions/ Remarks
331	Classification of precipitation state from Vaisala DRD 11a Sensor to pre cipitation type.	precip_type_from_vai sala_drd11a	If precipiation state (ps) is ...> then precipitation type is .... IF ps = 0,1 THEN: 0 IF ps = 2, 21, 22, 23 THEN: 60 IF ps = 31, 32, 33 THEN: 70	INPUT: precipitation state parameter_id = 1216 short_name = rst000s0 OUTPUT: precipitation type parameter_id = 3144 short_name = rsk000s0 Output Code: 0 = no precipitation 60 = rain 70 = snow
344	Precipitation type determined from intensity of precipitation and time period	prec_type_from_intens _time	If t=6 hours and R between 0.5 and 3 THEN 60 If t=6 hours and R between 3 and 8 THEN 62 If t=6 hours and R >8 THEN 64 If t=12 hours and R between 1 and 5 THEN 60 If t=12 hours and R between 5 and 15 THEN 62 If t=12 hours and R >15 THEN 64 If t=24 hours and R between 1 and 10 THEN 60 If t=24 hours and R between 10 and 30 THEN 62 If t=24 hours and R >30 THEN 64 If t=6 hours and h between 0.5 and 1 THEN 70 If t=6 hours and h between 1 and 3 THEN 72 If t=6 hours and h >3 THEN 74 If t=12 hours and h between 1 and 2 THEN 70 If t=12 hours and h between 2 and 5 THEN 72 If t=12 hours and h >5 THEN 74 If t=24 hours and h between 1 and 2 THEN 70 If t=24 hours and h between 2 and 10 THEN 72 If t=24 hours and h >10 THEN 74	INPUT immer R und h vorhanden!: R=rain [mm] h= snow height [cm] t=timeperiod OUTPUT: precipitation type Output Code 0 = no precipitation 60= rain light 62= rain moderate 64 = rain heavy 70= snow light 72= snow moderate 74=snow heavy

Tabelle 11. Calculation of ‚Observations' from Sensor Values

KAPITEL 7 *Wind*

Nr.[g] in DB	Purpose	Name	Definition	
71	Calculation of the Swiss 'Nationales Bul letin EB' code of maximum wind speed within 1 second from measurements of maximum wind speed within 1 second	calc_w8_from_fkl010z1	w8	fkl010z1 [m/s]
			0	0..14
			1	15..17
			3	18..20
			5	21..22
			7	23..25
			2	26..27
			4	28..30
			6	31..32
			8	> 32

Tabelle 12. Wind

[g] ‘formula_nr’ in Tabelle ‘formula’

Nr[h] in DB	Purpose	Name	Formula	Restrictions/ Remarks	Old Name
10	transformation of wind direction and speed to cartesian coordinates of east- and north-components	polar_cartes	$u = f \cdot \sin\left(d \cdot \left(\frac{\pi}{180}\right)\right)$ $v = f \cdot \cos\left(d \cdot \left(\frac{\pi}{180}\right)\right)$	wind direction has to be between 0 and 360	VAMP/METEOR B001, B002
326	transformation of wind direction and speed to cartesian coordinates of west- and south-components	polar_cartes_2	$-u = u \cdot (-1)$ $-v = v \cdot (-1)$	wind direction has to be between 0 and 360	
5	transformation of cartesian coordinates of east- and north-components to wind direction and speed	cartes_polar	$d = \frac{180}{\pi} \cdot a\tan\left(abs\left(\frac{u}{v}\right)\right)$ $f = \sqrt{\left(u^2 + v^2\right)}$		VAMP/METEOR B100, B102
327	transformation of cartesian coordinates of west- and south-components to wind direction and speed	cartes_polar_2	$d = \frac{180}{\pi} \cdot a\tan\left(abs\left(\frac{-u}{-v}\right)\right)$ $f = \sqrt{\left((-u)^2 + (-v)^2\right)}$		

[h] *'formula_nr' in Tabelle 'formula'*

Nr[h] in DB	Purpose	Name	Formula	Restrictions/ Remarks	Old Name
330	transformation of wind direction and wind speed to 8 classes of wind direction and VRB (variable wind or calm)	wind_classes	if d is equal to ... > then class is ... 337.5° - 22.49° > 1 22.5° - 67.49° > 2 67.5° - 112.49° > 3 112.5° - 157.49° > 4 157.5° - 202.49° > 5 202.5° - 247.49° > 6 247.5° - 292.49° > 7 292.5° - 337.49° > 8 when f < limit, then class is 0 limit = 3.1 kt = 2.1 m/s = 6.1 km/h	INPUT: d = wind direction (0 - 360°) f = wind speed limit = limit value for wind speed OUTPUT: Class 0 = VRB (limit recommendet by WMO No. 306) Class 1 = N Class 2 = NE Class 3 = E Class 4 = SE Class 5 = S Class 6 = SW Class 7 = W Class 8 = NW	

Tabelle 13. Recording of Wind Speed within 1 second

KAPITEL 8 *Indices*

Nr[i] in DB	Purpose	Name	Formula	Restrictions/ Remarks
88	calculation of wind-chill temperature	chill_temperature	$T_C = 13{,}12 + (0{,}6215 \cdot T) - (11{,}37 \cdot f_{kmh}^{0{,}16}) + (0{,}3965 \cdot T \cdot f_{kmh}^{0{,}16})$	PI is kept from f and T units of function input/output: T: [°C] f: [km/h] Formula is calculated only if T > 10.0°C and f > 5 km/h

Tabelle 14. Wind chill

[i] *'formula_nr' in Tabelle 'formula'*

377	calculation of heat index	Heat_index	HI = -42.379 + 2.04901523(T*1.8+32) + 10.14333127U - 0.22475541(T*1.8+32)U – 6.83783x10^{-3}(T*1.8+32)^2 - 5.481717x10^{-2}U^2 + 1.22874x10^{-3}(T*1.8+32)^{2}U + 8.5282x10^{-4}(T*1.8+32)U^2 - 1.99x10^{-6}(T*1.8+32)^{2}U^2	T : [°C] U : [%] The original formula uses T in °F as input. Since T in °F is not available in DWH, a replacement of T by the conversion °F = °C x 1.8 + 32 has taken place. If U < 13 % and T <= 1 12° F subtraction = [(13-RH)/4]*SQRT{[17-ABS(T-95.)]/17} IF U > 85 % and T <= 87°F addition = ADJUSTMENT = [(RH-85)/10] * [(87-T)/5] IF: T < 80°F or < 26.7 ° C - 0.

Tabelle 15: Heat index

380	Berechnung der gefühlten Temperatur	UTCI_direct (gefuehlte_Temperatur)	Formel gemäss libagg unter calc_UTCI (http://cvs.meteoswiss.ch/master/dabes/libsrc/libagg/functions_agg_6.c?rev=1.4;content-type=text%2Fplain) Diese Formel gilt nur für die Stationen, die alle Parameter zur Verfügung haben. Sonst Formel 399-401 benützen.	Die Formel UTCI_direct berücksichtigt direkte Sonneneinstrahlung. → = Parameter XY
381	Berechnung der gefühlten Temperatur	UTCI (gefuehlte_Temperatur)		Die Formel UTCI berücksichtigt direkte Sonneneinstrahlung NICHT. → = Parameter YZ
382	Berechnung der gefühlten Temperatur	mean_radiant_temp_direct (gefuehlte_Temperatur)		Ausgangsformel, im Moment nicht direkt für Aggregate verwendet
383	Berechnung der gefühlten Temperatur	mean_radiant_temp (gefuehlte_Temperatur)		Ausgangsformel, im Moment nicht direkt für Aggregate verwendet
398	Berechnung der gefühlten Temperatur	UTCI_direct_calc_surface	Formel gemäss libagg unter calc_UTCI: http://cvs.meteoswiss.ch/cgi/cvsweb/master/dabes/libsrc/libagg/functions_agg_6.c Der Parameter *olo000z0* (W/m-2)kann man via Stefan-Boltzmann Gesetzt berechnen: $S = e * \sigma * T^4$ → Temperatur in Kelvin: 92 tre005s0 (°C+273.15) → e= 0.99 → $\sigma \approx 5{,}67 \cdot 10^{-8}$ W $m^{-2}K^{-4}$ Der Parameter *osr000z0* (W/m-2): **SWa = SWe*albedo** → Albedo =0.2 Schneefrei und 0.8 bei Schnee → SWe = 96 gre000z0	
399	Berechnung der gefühlten Temperatur	UTCI_calc_surface		
400	Berechnung der gefühlten Temperatur	mean_radiant_temp_direct_calc_surface		
401	Berechnung der gefühlten Temperatur	mean_radiant_temp_calc_surface		

Tabelle 16: Gefühlte Temperatur

KAPITEL 9 *Pressure*

Nr[j] in DB	Purpose	Name	Formula	Restrictions/ Remarks	Old Name
32	calculation of QFF (for stations below 600 m asl)	qff_less600	$P_{s1} = P \cdot \exp\left(\frac{h_b}{30{,}8} \cdot \frac{10{,}5152}{\left(x + T + 2731{,}5 + \frac{h_b}{30{,}8}\right)}\right)$ where: $x = \frac{(T + 2731{,}5)}{P} \cdot \exp\left(\frac{\left(T + 2731{,}5 + \frac{h_b}{30{,}8}\right) \cdot 11{,}5526 - 26821}{T + 2731{,}5 + \frac{h_b}{30{,}8} - 1060}\right)$ units in formula above: P, P_{sl}: [0.1 hPa] h_b: [m] T: [0.1 °C]	units of function input/output: P, P_{sl}: hPa h_b: m T: °C allowed range for input variables: h_b: 0...600 m asl P: T: PI is kept from P barometric reference altitude h_b has to be ≥ 0 station reference air pressure has to be ≥ 0	VAMP/METEOR B108

[j] ‘formula_nr’ in Tabelle ‘formula’

Nr[j] in DB	Purpose	Name	Formula	Restrictions/ Remarks	Old Name
31	calculation of QNH at 0 m	qnh_enet2	$P_{qnh} = P \cdot \exp\left(a \cdot \frac{h_b}{b - h_b}\right)$ where: a=10.5 b=88660 units in formula above: P, P_{qnh}: [0.1 hPa] h_b: [m]	units of function input/output: P, P_{sl}: hPa h_b: m allowed range for input variables: h_b: Meaningful for stations between 0...600 m asl (similar to QFF) but calculated for all stations. The values for stations above 2300 masl are not published on the Internet and only delivered to clients if specifically required.The limit of 2300 masl was chosen based on recommendations concerning AMDAR made by the WMO (WMO 306, FM-42 AMDAR, Section 3, Group Fhdhdhd) P: PI is kept from P qff_less600 reference altitude hb has to be ≥ 0 station reference air pressure has to be ≥ 0	VAMP/METEOR HP275, ENET Z164 Mit dem Entsc heid vom 14.8.07 wird diese Formel ersetzt durch die Formel 317 (CR11 zur Daten bearbeitung).
317	calculation of QNH at 0 m	qnh_smn	$h_e = 44330{,}77 - (11880{,}32) \cdot P^{0{,}190263}$ $P_{QNH} = 1013{,}25 \cdot \left((1 - (0{,}0065)) \cdot \frac{h_e - h_b}{288{,}15}\right)^{5{,}2558}$ WMO CIMO-Guide		This formula replaces the for mula 31 qnh_enet2 (deci tion of CR11 of the Dataquality Tools)

Nr[j] in DB	Purpose	Name	Formula	Restrictions/ Remarks	Old Name
33 34	calculation of geopotential height at mountain stations	phi850_more600 phi700_more2300	$\Phi = h_b + [2{,}92910 \bullet (x + T + 2731{,}5 + C2 \bullet (\ln(P) + C1)) \bullet (\ln(P) + C1)]$ where: $x = \frac{(T + 2731{,}5)}{P} \times \exp\left(\frac{T + 2731{,}5 + ((\ln(P) + C1) \cdot C2) \cdot 11{,}5526 - 26821}{T + 2731{,}5 + (\ln(P) + C1) \cdot C2 - 1060}\right)$ and for stations with h_s: $600 < h_s < 2300$: C1=ln(1/8500) = -9.04782 C2=-265.06 for stations with h_s: $2300 \leq h_s < 4200$: C1=ln(1/7000) = -8.85366 C2=-255.5 units in formula above: Φ, h_b: [m] T: [0.1 °C] P: [0.1 hPa]	There are 2 functions implemented: 1. for $600 < h_b < 2300$ 2. for $2300 \leq h_b < 4200$ units of function input/output: Φ, h_b: [m] T: [°C] P: [hPa] allowed range for input variables: h_s: depending on function (see above) P: T: PI is kept from P not implemented in the C-library, replaced by implementation of formula_nr 33 and 34: station reference air pressure has to be ≥ 0 station barometric reference altitude h_b has to be ≥ 0	VAMP/METEOR B108

Tabelle 17. Pressure

408	Density altitude	xdealts0	$da = hb + (1013.25 - QNH) * 27 + (T - round(15 - \text{hb} * 0.002)) * 120$	QNH: [hPa] T: [oC] hb: [f] station barometric reference altitude da : [f]

Tabelle 18: Density Altitude

KAPITEL 10 *Radiation*

Nr in DB	Purpose	Name	Formula	Restrictions/ Remarks
345	Relative Sunshine Classes	relative_sunshine_class	0-4.99 % class 1 5-19.99 % class 2 20-49.99 % class 3 50-79.99 % class 4 80-100 % class 5	Per definition the upper limit doesn't belong to the interval, only for 100%.
	Radiation balance		see also Chapter 17	
310	Determination of Radiation Balance by Measurements	radiation_balance	Q = (SDR – SUR + LDR – LUR)	S: Shortwave; L: Longwave; D: Downward; U: Upward; R: Radiation (Irradiance or radiant exitance on horizontal plane, Wm^{-2})

Nr in DB	Purpose	Name	Formula	Restrictions/ Remarks

311	Determination of sunshine duration from global radiation	sunshine_duration	if (SDR_{dir} = NA) then $SSD = NA$
			else if ($\cos(\theta) \leq 0$) then $SSD = 0$
			else if ($\frac{SDR_{dir}}{\cos\theta} > SDR_{dirup}$) then $SSD = 10$
			else if ($\frac{SDR_{dir}}{\cos\theta} < SDR_{dirlow}$) then $SSD = 0$
			else $SSD = round\left(10 \times \frac{\frac{SDR_{dir}}{\cos\theta} - SDR_{dirlow}}{SDR_{dirup} - SDR_{dirlow}}\right)$
			$SDR_{dirlow} = 110 + \Delta SDR_{dir}$
			$SDR_{dirup} = 290 + \Delta SDR_{dir}$
			endif
				SSD: sre000z0
				SDR_{dir}: Shortwave downward radiation, direct component, horizontal
				NA: missing value, not available
				SDR_{dirlow}: Limit for SDR_{dir} indicating 0 minutes of SSD below this limit
				SDR_{dirup}: Limit for SDR_{dir} indicating 10 minutes of SSD above this limit
				ΔSDR_{dir}: Site/station specific offset, Default 0 (Null)
				Kägi and Dürr 2006

315	Reset negative Radiation Values to Zero	reset_radiation	if ($SDR_{org} < 0$) then $SDR = 0$ else $SDR = SDR_{org}$ endif	SDR: global radiation gre000z0 SDR_{org}: global radiation, original value gor000z0

Nr in DB	Purpose	Name	Formula	Restrictions/ Remarks
318	APCADA Automatic Partial Cloud Amount Detection Algorithm	apcada_dwh	$LDR_{cor} = LDR - f_{dir} \cdot \frac{SDR_{dir}}{1000}$ $CFI = \frac{\varepsilon_A}{\varepsilon_{AC}}$, with $\varepsilon_A = \frac{LDR_{cor}}{\sigma \cdot T^4}$ $\varepsilon_{AC} = \varepsilon_{AD} + (k(t) + \Delta k(t)) \cdot \left(\frac{e}{T}\right)^{\frac{1}{7}}$ $e = \frac{RH}{100} \cdot e_S$ $e_S = 6{,}1121 \cdot \exp\left(\frac{17{,}502 \cdot T_{200}}{T_{200} + 240{,}97}\right)$ $k(t) = \overline{k(i)} + k_{amp}(i) \cdot \cos(\omega_1 t - \pi/4)$, $0 \le t \le 143{,}0$, $0 \le i \le 365$ $\overline{k(i)} = (k_{night}(i) + k_{day}(i))/2$ $k_{amp}(i) = k_{night}(i) - \overline{k(i)}$ $k_{day}(i) = \overline{k_{day}} + k_{day,amp} \cdot \cos(\omega_2 i - \pi/4)$, $0 \le i \le 365$ $k_{night}(i) = \overline{k_{night}} + k_{night,amp} \cdot \cos(\omega_2 i - \pi/4)$, $0 \le i \le 365$ $\overline{k_{day}} = (k_{day,summer} + k_{day,winter})/2$ $\overline{k_{night}} = (k_{night,summer} + k_{night,winter})/2$ $k_{day,amp} = k_{day,winter} - \overline{k_{day}}; k_{night,amp} = k_{night,winter} - \overline{k_{night}}$	LDR_{cor}: effect of direct sun on LdR-corrected f_{dir}: site-specific factor, known for all ASRB sites, for SMN CG4 instrument take $f_{dir} = 4$ as default CFI: Cloud Free Index T: in Kelvin = T_{200} + 273,15 ε_A: gemessene spezifische lang-wellige Einstrahlung ε_{AC}: für eine wolkenfreien Himmel berechnete Strahlung ε_{AD}: höhenabhängige spezifische Einstrahlung einer komplett trockenen Atmosphäre σ: Stefan Bolzmann Konstante (5.67E-08) T_{200}: Temperature (deg celsius) RH: Relative humidity = $\omega_1 = 2\pi/144$ $\omega_2 = 2\pi/366$ t: 144 Zehnminutenwerte i: 366 Tage t(0): 00:00 MEZ (MEZ = UTC + 1h) i(0): 1. Januar

Nr in DB	Purpose	Name	Formula	Restrictions/ Remarks
318	Continued: APCADA Automatic Partial Cloud Amount Detection Algorithm	apcada_dwh	$\Delta k(t) = \overline{\Delta k(i)} + \Delta k_{amp}(i) \cdot \cos(\omega_1 t - \pi/4)$, $0 \leq t \leq 143{,}0$, $0 \leq i \leq 365$ $\overline{\Delta k(i)} = (\Delta k_{night}(i) + \Delta k_{day}(i))/2$ $\Delta k_{amp}(i) = \Delta k_{night}(i) - \overline{\Delta k(i)}$ $\Delta k_{day}(t) = \overline{\Delta k_{day}} + \Delta k_{day,amp} \cdot \cos(\omega_2 i - \pi/4)$, $0 \leq i \leq 365$ $\Delta k_{night}(t) = \overline{\Delta k_{night}} + \Delta k_{night,amp} \cdot \cos(\omega_2 i - \pi/4)$, $0 \leq i \leq 365$ $\overline{\Delta k_{day}} = (\Delta k_{day,summer} + \Delta k_{day,winter})/2$ $\overline{\Delta k_{night}} = (\Delta k_{night,summer} + \Delta k_{night,winter})/2$ $\Delta k_{day,amp} = \Delta k_{day,winter} - \overline{\Delta k_{day}}$; $\Delta k_{night,amp} = \Delta k_{night,winter} - \overline{\Delta k_{night}}$ $k_{day, summer}$, $k_{day, winter}$, $k_{night, summer}$, $k_{night, winter}$, $\Delta k_{day, summer}$, $\Delta k_{day, winter}$, $\Delta k_{night, summer}$, $\Delta k_{night, winter}$,	$\omega_1 = 2\pi/144$ $\omega_2 = 2\pi/366$ t: 144 Zehnminutenwerte i: 366 Tage t(0): 00:00 MEZ (MEZ = UTC + 1h) i(0): 1. Januar Stationsspezifische Faktoren, Herleitung gemäss Dürr and Philipona, 2004

Nr in DB	Purpose	Name	Formula	Restrictions/ Remarks

318	Continued: APCADA Automatic Partial Cloud Amount Detection Algorithm	apcada_dwh	$z = \frac{1}{\varepsilon_{AC}} - 1$
			if ((CFI = NA) OR (LDR_{std} = NA)) then PCA = NA
			else if ((CFI ≤ 1) AND (LDR_{std} ≤ 0.5)) then PCA = 0
			else if ((CFI ≤ 1) AND (LDR_{std} > 0.5) AND (LDR_{std} ≤ 2)) then PCA = 1
			else if ((CFI ≤ 1) AND (LDR_{std} > 2)) then PCA = 2
			else if ((CFI >1) AND (CFI ≤ (1+a*z)) AND (LDR_{std} ≤ 1)) then PCA = 1
			else if ((CFI >1) AND (CFI ≤ (1+a*z)) AND (LDR_{std} > 1) AND (LDR_{std} ≤ 2)) then PCA = 2
			else if ((CFI >1) AND (CFI ≤ (1+a*z)) AND (LDR_{std} > 2)) then PCA = 3
			else if ((CFI > (1+a*z)) AND (CFI ≤ (1+b*z)) AND (LDR_{std} ≤ 1)) then PCA = 2
			else if ((CFI > (1+a*z)) AND (CFI ≤(1+b*z)) AND (LDR_{std} > 1)) then PCA = 4
			else if ((CFI > (1+b*z)) AND (CFI ≤ (1+c*z)) AND (LDR_{std} ≤ 4)) then PCA = 5
			else if ((CFI > (1+b*z)) AND (CFI ≤ (1+c*z)) AND (LDR_{std} > 4)) then PCA = 6
			else if ((CFI > (1+c*z)) AND (LDR_{std} > 8)) then PCA = 6
			else if ((CFI > (1+c*z)) AND (LDR_{std} > 2) AND (LDR_{std} ≤ 8)) then PCA = 7
			else if ((CFI > (1+c*z)) AND (LDR_{std} ≤ 2)) then PCA = 8
			endif
				Cascade of tests to obtain the partial cloud amount (PCA) from the Cloud-free Index and the variability of LDR.
				
				LDR_{std}:
				1. Linear regression through the previous 6 LDR 10 minutes values (t, t-1, t-2, t-3, t-4, t-5)
				2. standard deviation of the residuals to the linear fit
				3. if less than 3 of the 6 values are available, then LDR_{std} = NA
				
				a = 0,12
				b = 0,21
				c = 0,38

Nr in DB	Purpose	Name	Formula	Restrictions/ Remarks

321	Separation of shortwave horizontal radiation into the direct and diffuse horizontal radiation components	direct_diffuse_radiation	$SDR_{dif} = SDR - SDR_{dir}$
			
			if (SDR = NA) then $SDR_{dif} = NA$
			else if ((SDR < 1,0) OR (cosθ < 0)) then $SDR_{dif} = 0$ else
			$SDR_{dir} = I_0 \cdot \{Knc - [A+B \cdot exp(((m \cdot C]\} \cdot CM(I,J,K,L)) \cdot cos\theta)$
			endif
			$Knc = 0{,}866 - 0{,}122m + 0{,}0121m^2 - 0{,}000653m^3 + 0{,}000014m^4$
			$m = min(15{,}25\vert(1{,}0/(\cos\theta + 0{,}15 \cdot (93{,}885 - \theta)^{-1{,}253})))$
			$Kt = (SDR_{cor})/(I_0 \cdot max(0{,}0521791\vert\cos\theta))$
			$I_0 = 1367 \cdot d^2$
			
			if (Kt ≤ 0.6) then $A = 0{,}512 - 1{,}560 \cdot Kt + 2{,}286 \cdot Kt^2 - 2{,}222 \cdot Kt^3$
			$B = 0{,}370 - 0{,}962 \cdot Kt$
			$C = -0{,}280 + 0{,}932 \cdot Kt - 2{,}048 \cdot Kt^2$
			else $A = -5{,}743 + 21{,}77 \cdot Kt - 27{,}49 \cdot Kt^2 + 11{,}56 \cdot Kt^3$
			$B = 41{,}40 - 118{,}5 \cdot Kt + 66{,}05\ Kt^2 + 31{,}90 \cdot Kt^3$
			$C = -47{,}01 + 184{,}2 \cdot Kt - 222{,}0 \cdot Kt^2 + 73{,}81 \cdot Kt^3$ endif
			
			if ((SDR = NA) OR (cosθ < 0)) then $Kt_{rel} = NA$ else
			$Kt_{rel} = Kt/(1{,}031 \cdot \exp(-1{,}4/(0{,}9 + 9{,}4/(m \cdot Calt))) + 0{,}1)$ endif
			$Calt = \exp(-0{,}0001184 \cdot h_s)$
				$SDR_{dif:}$: SDR diffuse, horizontal
				NA (missing value, not available)
				SDR: gre000z0
				$SDR_{dir:}$ SDR direct, horizontal plane
				CM: Lookup table [6,6,7,5]
				θ, d^2: Sun zenith angle (degrees) and actual Sun - Earth distance relative to the mean distance (see WMO-No.8, Annex 7.D)
				m: Optical air mass (Kasten and Young, 1989)
				
				h_s: Station altitude (meter)

Nr in DB	Purpose	Name	Formula	Restrictions/ Remarks

321	Continued: Separation of short-wave horizontal radiation into the direct and diffuse horizontal radiation components	direct_diffuse_radiation	IF ((snowdepth_cosmo = 0) OR (SDR = NA) OR (cosθ < 0))
			THEN $SDR_{cor} = SDR$
			ELSE {
			$SDR_{cor} = SDR \cdot (1 - (\alpha_{snow} \cdot \alpha_{sky})$
			if (h_s < 1000) then $\alpha_{snow} = 0{,}30$
			else $\alpha_{snow} = 0{,}50$
			endif
			$\alpha_{sky} = 0{,}6 \cdot PCA/8 + \alpha_{raleigh} \cdot (1-PCA/8)$
			$\alpha_{raleigh} = 0{,}28/(1 + 6{,}43 \cdot \cos\theta)$
			$Kt' = (SDR)/(I_0 \cdot max(0{,}0521791 \mid \cos\theta))$
			$Kt'_{rel} = (Kt')/(1{,}031 \cdot \exp(-1{,}4/(0{,}9 + 9{,}4/(m \cdot Calt))) + 0{,}1)$
			if ($Kt'_{rel} \geq a$) then $PCA = 0$
			else $PCA = \left(\frac{e - Kt'_{rel}}{f}\right)^{\frac{1}{g}}$
			endif
			e = 0,92
			$f = 0{,}85e^{-2}$
			g = 1,98
			
			if (PCA > 8) then $PCA = 8$ endif
			}
			ENDIF
				Correction of multiple reflection part from global radiation (SDR) measured over snow
				
				$SDR_{cor:}$ multiple reflection corrected global radiation
				
				α_{snow}: Mean albedo of snow-covered areas including forests, lakes, ...
				α_{sky}: Sky albedo
				PCA: Partial cloud amount (octas)
				$\alpha_{raleigh}$: Albedo of cloud-free sky
				
				PCA over snow is determined empiri-cally by fitting ASRB SDR 10 min-utes values to APCADA based PCA values at 10 ASRB-sites for periods with snow-cover (based on satellite data) from 2004 - 2006. As a result, the three coefficients a, b, and c were found, which are quite representative for all ASRB sites.
				
				End of multiple reflection correction

Nr in DB	Purpose	Name	Formula	Restrictions/ Remarks

321	Continued: Separation of short-wave horizontal radiation into the direct and diffuse horizontal radiation components	direct_diffuse_radiation	Kt_{bin} = [0,24;0,4;0,56;0,7;0,8;1,0]
			Z_{bin} = [25;40;55;70;80;90]
			DKt_{bin} = [0,015;0,035;0,07;0,15;0,3;1,0]
			$W_{bin} = [1;2;3;1\cdot10^{19}]$
			
			if ((SDR_{t-1} = NA) OR (SDR_{t-2} = NA)) then K = 6 endif
			if ($Kt_{rel;t-2}$ = NA) then $DKt_{rel} = \lvert Kt_{rel;t} - Kt_{rel:t-1}\rvert$
			else if ($Kt_{rel;t-1}$ = NA) then $DKt_{rel} = \lvert Kt_{rel;t} - Kt_{rel:t-2}\rvert$
			else $DKt_{rel} = (\lvert Kt_{rel;t} - Kt_{rel:t-2}\rvert + \lvert Kt_{rel;t} - Kt_{rel:t-1}\rvert)/2$ endif
			K = n
			I = n
			J = n
			if (td = NA) then L = 4
			else $W = \exp(-0{,}075 + 0{,}07 \cdot td)$
			L = n
			
			Endif
				t: present 10 minutes value
				t-1: 10 minutes before present value
				t-2: 20 minutes before present value
				
				$DKt_{bin;n-1} < DKt_{rel} < DKt_{bin;n}$: 0<n<5
				$Kt_{bin;n-1} < Kt_{rel} < Kt_{bin;n}$: 0 < n < 5
				$Z_{bin;n-1} < \theta < Z_{bin;n}$: 0 < n < 5
				
				td: tde000s0 (dewpoint temperature)
				
				$W_{bin;n-1} < W < W_{bin;n}$: 0 < n < 3

322	Sun position and Earth-Sun distance	calc_sun_parameters	The Formula for the calculation of the position of the sun and the actual Earth-Sun distance can be found in WMO-No. 8, Part I, Chapter 7 Measurement of Radiation, Annex 7.D	Time UTC and geographical coordinates of the station needed as input
-	Radiation Components	radiation_components	The Formula for the calculation of radiation componts are based on the recommondations of Antoine Zelenka (2007).	

396	Determination of sunshine region average	rel_sre_region_0_2_days	Echéances D+0, à D+2
			if (watprma0(REF_S)==40 && H_{STA} > cprtophs(REF_S))
			then relSun_morningSTA = sremxmav(Station_ref_altitude);
			else relSun_morningSTA = srpo1mav(REF_S);
			
			if (watprna0(REF_S)==40 && H_{STA} > cprtophs(REF_S))
			then relSun_afternoonSTA =sremxnav(Station_ref_altitude);
			else relSun_afternoonSTA = srpo1nav(REF_S);
			
			relSun_daySTA = 0.5·(relSun_morningSTA + relSun_afternoonSTA)
				Altitude de la station : H_{STA}
				Station_ref_altitude : MLS (pour régions Ouest), SAE (régions Est), CIM (régions Sud)
				Station_ref : REF_S (station de référence dépend de l'échéance – S pour D+0..D+2)

Nr in DB	Purpose	Name	Formula	Restrictions/ Remarks

397	Determination of sunshine region average	rel_sre_region_3_7_days	Echéances D+3 à D+5
			if (watpr0d0(REF $_M$)==40 && H_{STA} > cprtophs(REF $_M$))
			then relSun_day$_{STA}$ = sremaxdv (Station_ref_altitude);
			else relSun_day$_{STA}$ = srpo20dv(REF $_M$);
			
			Echéances D+6 et D+7
			if (watpr0d0(REF $_E$)==40 && H_{STA} > cprtophs(REF $_E$))
			then relSun_day$_{STA}$ = sremaxdv (Station_ref_altitude);
			else relSun_day$_{STA}$ = srpo30dv(REF $_E$);
				Altitude de la station : H_{STA}
				Station_ref_altitude : MLS (pour régions Ouest), SAE (régions Est), CIM (régions Sud)
				Station_ref : $REF_{M,E}$ (station de référence dépend de l'échéance – M pour D+3..D+5 et E pour D+6 et D+7)

Tabelle 19. Radiation

KAPITEL 11 *Thermodynamic Functions*

Nr[k] in DB	Purpose	Name	Formula	Restrictions/ Remarks	Old Name
16	calculation of vapour pressure	vap_pressure	$e = U \cdot c \cdot \exp\left(\frac{a \cdot T}{b + T}\right)$ where: for $T \geq 0$: a = 17.368 b = 2388.3 c = 0.06107 for T < 0: a = 17.856 b = 2455.2 c = 0.06108 units in formula above: T: [0.1 ^{o}C], U: [%] e: [0.1 hPa]	PI is kept from U and T units of function input/output: T: [^{o}C] U: [%] e: [0.1 hPa]	VAMP/METEOR B116
76	calculation of daily average vapour pressure from 3 observations	vap_pressure_conv_stat	For each of the 3 observation times, formula 16 is used to calculate vapour pressure. Their arithmetic mean is the output of formula 76.	Input: Position 1: temperature Position 2: relative humidity	

[k] ‘formula_nr’ in Tabelle ‘formula’

Nr[k] in DB	Purpose	Name	Formula	Restrictions/ Remarks	Old Name
14, 15	correction of relative humidity (special case of SMI)	rel_hum_corr, uu	If T > 0: U > 100 -> U = 100 Bei T ≤ 0: $\bigcup_{i=1}^{n} U_i > x_i = x_i$ where: x = 1000 · 0,999742 · exp(0,000971 · T) units in formula above: T: [0.1 °C] U: [0.1 %]	PI is kept from U units of function input/output: T: [°C] U: [%] station relative humidity (uncorrected) has to be ≥ 0	VAMP/METEOR B005
94	correction of relative humidity if supersaturated	rel_hum_corr_2	$U_{or} \le 100$: $U = U_{or}$ $U_{or} > 100$: $U = 100$	U_{or} = Calculated relative humidity from measured dew point. U = corrected relative humidity	
35	calculation of wet bulb temperature	wet_bulb_temp	$T_w = T_d + \frac{T - T_d}{1 + \frac{1}{PSC} \exp\left(\frac{11,564x}{1742 + x}\right)}$ where: $x = T_d + \frac{(T - T_d)\cdot(420 - T_d)}{1400}$, $PSC = 1,5898 \cdot \exp\left(\frac{h_s}{\frac{h_s}{12,5} - 8351}\right)$ units in formula above: all T: [0.1 °C] h_s: [m]	PI is kept from T and T_d units of function input/output: all T: [°C] h_s: [m] (Stationshöhe) Altitude of the station has to be ≥ 0	VAMP/METEOR B115

Nr[k] in DB	Purpose	Name	Formula	Restrictions/ Remarks	Old Name
	calculation of dewpoint from vapour pressure	vap_dew_point	$$T_d = \frac{((\ln(e) - 4{,}11218) \cdot 2392{,}0)}{21{,}50518 - \ln(e)}$$ units in formula above: T_d: [0.1 °C] e: [hPa]	e > 0 PI is kept from e units of function input/output: T_d: [°C] e: [hPa]	
99	calculation of relative humidity from dewpoint and temperature[1] checkClient()	rel_humidity	$$U = 100 \cdot \exp\left(\frac{a \cdot T_d}{b + T_d} - \frac{a \cdot T}{b + T}\right)$$ IF T ≥ 0: a = 17.368 and b = 238.83 IF T > 0: a = 17.856 and b = 245.52 Dössegger et al. 1992	according to WMO (1986) the constants are (with all T in [°C]): a =17.502 b =240.97 keep PI from Td and T units of function input/output: all T: [°C] U: [%] Die Bedingung: station vapour pressure has to be: e ≥ 0 kann nicht implementiert werden, da sonst mit Formel 16 entsteht.	
19	calculation of dew point from temperature and relative humidity as in Doessegger et al., 1992	dew_point_thyg	$$T_d = b \cdot \ln(gc) \div (a - \ln(gc))$$ $$ga = \frac{a \times T}{b + T}$$ $$gb = U \cdot C \cdot 100 \cdot \exp(ga)$$ $$gc = \frac{gb}{c \cdot 100}$$ IF T ≥ 0: a = 17.368 and b = 238.83 and c = 0.06107 IF T < 0: a = 17.856 and b = 245.52 and c = 0.06108 Dössegger et al. 1992		VAMP/METEOR B117

[1] *will be used when the transmission of dewpoint (instead of rel humidity from THYGAN's) is activated*

Nr[k] in DB	Purpose	Name	Formula	Restrictions/ Remarks	Old Name
300	mixing ratio	mixing_ratio	$r = \frac{0.622 \cdot e}{P - e}$	e = Dampfdruck [Pa] P= Druck [hPa] The official value of 0.622 is 0.62198. Since the result in the DWH is rounded to 1 decimal place, however an accuracy of 0.622 is enough.	
37	equivalent temperature	equivalent_temperature	$T_e = T\left(1 + \frac{Lr}{c_P T}\right)$	$L = 2.54 \cdot 10^6$ J/kg c_p = 1004 J/(kg K) temperatures are in [K] here! Source: Glossary of Meteorology 1959, p 208	
87	potential temperature	potential_temperature	$\theta_e = T\left(\frac{p_0}{p}\right)^{\frac{R}{c_P}}$	p_0 = 1000 hPa (Standardreferenz-druck) R = 287 J/(kg K) c_p = 1004 J/(kg K) T = temperature [K]	
87	equivalent-potential temperature	potential_temperature	$\theta_e = T_e\left(\frac{p_0}{p}\right)^{\frac{R}{c_P}}$	p_0 = 1000 hPa (Standardreferenz-druck) R = 287 J/(kg K) c_p = 1004 J/(kg K) T_e = Temperature in [K] here! Source: Glossary of Meteorology 1959, p 208	
87	wet bulb potential temperature	potential_temperature	$\theta_w = T_w\left(\frac{p_0}{p}\right)^{\frac{R}{c_P}}$	p_0 = 1000 hPa (Standardreferenz-druck) R = 287 J/(kg K) c_p = 1004 J/(kg K) T_w = Temperature in [K] here! Source: Glossary of Meteorology 1959, p 208	
89		wet_bulb_potential_temperature		Formula No. 89 is an alternative based on NOAA's „PROFS LIBRARY OF THERMODYNAMIC SUBPROGRAMS"	Formula 89 was used in metAP-vis. For consistency reasons, it should no longer be used.

Nr[k] in DB	Purpose	Name	Formula	Restrictions/ Remarks	Old Name
95	absolute humidity	absolute_humidity	$U_a = 216{,}68\left(\frac{e}{T_{200} + 273{,}15}\right)$		
96	specific humidity	specific_humidity	$U_s = \frac{0{,}622 \cdot e}{p}$		
97	virtual temperature	virtual_temperatur e	$T_v = \frac{T}{1 - \left(\frac{0{,}378 \cdot e}{p}\right)}$		
98	calculation of vapour pressure deficit	vap_pressure_deficit	e' = E - e	E : saturation vapour pressure	
	vapour pressure over water and over ice		$e = 6.112 \cdot \exp\left(\frac{a \cdot T}{b + T}\right) \cdot \left(1.0016 + 3.15 \cdot 10^{-6} \cdot P - 0.074 \cdot P^{-1}\right)$ where:	formula recommended by WMO No. 8 e, P in hPa T: Temperatur in °C	
301		vap_pressure_over_water	vapour pressure over water (-45 to 60 °C): a = 17.62 b = 243.12		
316		vap_pressure_over_ice	vapour pressure over ice (-65 to 0 °C): a = 22.46 b = 272.62		
328	vapour pressure over water and over ice from dewpoint	vap_pressure_ from_dewpoint	*limit* = 0 if *temperature* > *limit*: use formula *vap_pressure_over_water (301)* if *temperature* ≤ *limit*: use formula *vap_pressure_over_ice (316)*	Input: T_d = dew-point temperature to calculate vapour pressure (inserted for T in the calculation of e in formulas 301 and 316) P = pressure T = temperature, for limit check only limit = limit value of temperature	

Tabelle 20. Thermodynamic Functions

KAPITEL 12 *Aerosol-Functions*

Nr[m] in DB	Purpose	Name	Formula	Restrictions/ Remarks	Old Name
93	calculation of absoption coefficients from measured black carbon	calc_absorption_black_carbon	$Abs_{\lambda} = \frac{a \cdot BC_{\lambda}}{b \cdot \lambda}$	coefficents a and b have to be read from T_CONSTANT_VAL BC: measured black carbon λ: wavelenght in Nm a, b: constants	

Tabelle 21. Aerosol Functions

[m] 'formula_nr' in Tabelle 'formula'

KAPITEL 13 *Evapotranspiration (Daily Sum)*

Nr[n] in DB	Purpose	Name	Formula	Restrictions/ Remarks	Old Name
18	calculation of evapotranspiration (daily values)	evap_primault_ori	$E_p = \left(1{,}03 - \frac{U}{100}\right) \cdot \left(\frac{S}{60} + 2n\right) \cdot C \cdot j$ where: U:relative humidity [%] S:measured sunshine duration [min] n: number of days in reference period (this formula yields best results when used for a period of 5 to 10 days) C:constant for height correction (from Primault, 1981), considering barometer altitude j:constant for seasonal correction (from Primault, 1981), considering barometer altitude Primault (1981) gives a modification of S for stations with low potential sunshine duration (e.g. in deep valleys). $S^* = S \cdot \frac{S_a}{S_{max}}$ if S_{max} < 80% of S_a, S: measured sunshine duration [min] This modification is not implemented in DABES (personal communication J. Brändli of 23.2.98).	use only for stations below 2000m asl $1 \leq U \leq 100$ $S \geq 0$ $n \geq 1$ keep PI from U and S max. sunshine duration has to be > 0	VAMP/METEOR TP138

[n] 'formula_nr' in Tabelle 'formula'

Nr^{n} in DB	Purpose	Name	Formula	Restrictions/ Remarks	Old Name
25	calculation of evapotranspi-ration (daily values)	evap_primault	$E_p = \left(1{,}03 - \frac{U}{100}\right) \cdot \left(\frac{S}{60} + 2n\right) \cdot C \cdot j$ where: U:relative humidity [%] S:measured sunshine duration [min] n: number of days in reference period (this formula yields best results when used for a period of 5 to 10 days) C:constant for height correction (from Primault, 1981), considering barometer altitude j:constant for seasonal correction (from Primault, 1981), considering barometer altitude	use only for stations below 2000m asl $1 \leq U \leq 100$ $S \geq 0$ $n \geq 1$ keep PI from U and S max. sunshine duration has to be > 0	VAMP/METEOR TP138

Tabelle 22. Evapotranspiration (Daily Sum)

KAPITEL 14 *Reference Evaporation form FAO*

Nr[o] in DB	**Purpose**	**Name**	**Formula**	**Restrictions/ Remarks**	**Old Name**
374	calculation of hourly reference evaporation from FAO (with total cloud)	evap_fao_ref_h_nc c	see refernce document FAO-56		
375	calculation of hourly reference evaporation from FAO (without total cloud)	evap_fao_ref_h_def	see refernce document FAO-56		
376	calculation of dayly reference evaporation from FAO	evap_fao_ref_d	see refernce document FAO-56		

Tabelle 23. Reference Evaporation from FAO 56

[o] ‘formula_nr’ in Tabelle ‘formula’

KAPITEL 15 *Functions to determine Day Characteristics*

Nr.[p] in DB	Aggregation level	Description	Aggregation Period[q]	Formula	Old Name
41 2	month year	number of days with $T_n < 0^oC$ (Frosttage)		$tnd00nm0 = \sum_1^{ntag} i$ i=1 if tre200dn < 0 ^oC, otherwise i=0 $tnd00ny0 = \sum_1^{nmon} tnd00nm0$ function 41: max. allowed number of days is 366 function 2: Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP016
41 2	month year	number of days with $T_x < 0^oC$ (Eistage)		$tnd00xm0 = \sum_1^{ntag} i$ i=1 if tre200dx < 0^oC, otherwise i=0 $tnd00xy0 = \sum_1^{nmon} tnd00xm0$ function 41: max. allowed number of days is 366 function 2: Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP019

[p] ‘formula_nr’ from MCH DWH System table ‘formula’

[q] important with aggregation level ‘day’. 00 for observation at midnight, 06 for observation in the morning, etc.

Nr.[p] in DB	Aggregation level	Description	Aggregation Period[q]	Formula	Old Name
40 2	month year	number of days with $T_x \geq 25^oC$ (Sommertage)		$tnd25xm0 = \sum_1^{ntag} i$ i=1 if tre200dx ≥ 25°C, otherwise i=0 $tnd25xy0 = \sum_1^{nmon} tnd25xm0$ for use of function 40, limit has to be set to 24.999 °C function 40: max. allowed number of days is 366 function 2: Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP020-MP021
40 2	month year	number of days with $T_x \geq 30^oC$ (Hitzetage)		$tnd30xm0 = \sum_1^{ntag} i$ i=1 if tre200dx ≥ 30°C, otherwise i=0 $tnd30xy0 = \sum_1^{nmon} tnd30xm0$ for use of function 40, limit has to be set to 29.999 °C function 40: max. allowed number of days is 366 function 2:Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP020-MP021
40 2	month year	number of days with $T_n > 20^oC$ during the night (Tropennächte)	18.01 VT - 06.00 AT	$tnd20nm0 = \sum_1^{ntag} i$ i=1 if tre200nn > 20°C, otherwise i=0 $tnd20ny0 = \sum_1^{nmon} tnd20nm0$ function 40: max. allowed number of days is 366 function 2: Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	

Nr.[p] in DB	Aggregation level	Description	Aggregation Period[q]	Formula	Old Name
41 2	month year	number of days with $\overline{T} \le 12°C$ (Heiztage)		$xdy0ndm0 = \sum_{1}^{ntag} i$ i=1 if tre200d0 ≤ 12°C, otherwise i=0 $xdy0ndy0 = \sum_{1}^{nmon} xdy0ndm0$ for use of function 41, limit has to be set to 12.001 °C function 41: max. allowed number of days is 366 function 2: Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP177
41 2	month year	number of days with $\overline{T} \le 18.3°C$ (Heiztage nach Berechnung USA)		$HDDm0 = \sum_{1}^{ntag} i$ i=1 if tre200d0 ≤ 18.3°C, otherwise i=0 $HDDy0 = \sum_{1}^{nmon} HDDm0$ for use of function 41, limit has to be set to 18.301 °C function 41: max. allowed number of days is 366 function 2: Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	
40 2	month year	number of days with $\overline{T} \ge 18.3°C$ (Kühltage nach Berechnung USA)		$CDDm0 = \sum_{1}^{ntag} i$ i=1 if tre200d0 ≥ 18.3 hPa, otherwise i=0 $CDDy0 = \sum_{1}^{nmon} CDDm0$ for use of function 40, limit has to be set to 18.299 hPa function 40: max. allowed number of days is 366 function 2: Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	

Nr.[p] in DB	Aggregation level	Description	Aggregation Period[q]	Formula	Old Name
40 2	month year	number of days with e ≥ 18.8 hPa (schwüle Tage)		$pva0ndm0 = \sum_1^{ntag} i$ i=1 if pva200d0 ≥ 18.8 hPa, otherwise i=0 $pva0ndy0 = \sum_1^{nmon} pva0ndm0$ for use of function 40, limit has to be set to 18.799 hPa function 40: max. allowed number of days is 366 function 2: Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP054
40 2	month year	number of days with precipitation ≥ threshold		z.B. $rsd001m0 = \sum_1^{ntag} i$ i=1 if rre150d0 ≥ X mm otherwise i=0 X = 0.1 X = 0.3 X = 1 X = 10 z.B. $rsd001y0 = \sum_1^{nmon} rsd001m0$ for use of function 40, limits have to be set to 0.099 mm, 0.299 mm, 0.999 mm, 9.999 mm function 40: max. allowed number of days is 366 function 2: Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP080-MP084
54	day	day_w_rain (Regentag)	06.01 AT - 06.00 FT	w1p012d0=1 if w1p000i0[12AT]=1v w1p000i0[18AT]=1v w1p000i0[06FT]=1v w1p000i0[12AT]=2 v w1p000i0[18AT]=2 v w1p000i0[06FT]=2, otherwise 0 Number of required values = 3 For calculation of aggregation at least 3 valid values and 1 plausible visual observation are needed	

Nr.[p] in DB	Aggregation level	Description	Aggregation Period[q]	Formula	Old Name
2	month/year	number of days with rain		$w1p0ndm0 = \sum_1^{ntag} w1p012d0$ $w1p0ndy0 = \sum_1^{nmon} w1p0ndm0$ Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP197
44	day	day_w_snowrain (Schneeregentag)	06.01 AT - 06.00 FT[r]	w2p001d0=1 if w2p000i0[12AT]=1 v w2p000i0[18AT]=1 v w2p000i0[06FT]=1, otherwise 0 Number of required values = 3 For calculation of aggregation at least 3 valid values and 1 plausible visual observation are needed	
2	month/year	numbers of days with snowrain		$w2pnd1m0 = \sum_1^{ntag} w2p001d0$ $w2pnd1y0 = \sum_1^{nmon} w2pnd1m0$ Nnumber of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP198
40	day	day with fresh snow (from meas-urement) (water equivalent ≥ 0.3 mm) (Schneefalltag)	06.01 AT - 06.00 FT	$w2p000d0 = \sum_1^{ntag} i$ i=1 if hns000d0 ≥ 1 cm, otherwise i=0 or i=1 if rwe000d0 ≥ 0.3 mm, otherwise i=0 ? For use of function 40, limit has to be set to 0.999 cm resp. 0.299 mm Max. allowed number of days is 366	

[r] *FT=following day (Folgetag)*

Nr.[p] in DB	Aggregation level	Description	Aggregation Period[q]	Formula	Old Name
45	day	day_w_snowfall (from past weather) (Schneefalltag)	06.01 AT - 06.00 FT	w2p002d0=1 if w2p000i0[12AT]=2 v w2p000i0[18AT]=2 v w2p000i0[06FT]=2, otherwise 0 Number of required values = 3 For calculation of aggregation at least 3 valid values and 1 plausible visual observation are needed	
2	month/year	number of days with snow fall (from past weather)		$w2pnd2m0 = \sum_1^{ntag} w2p002d0$ $w2pnd2y0 = \sum_1^{nmon} w2pnd2m0$ Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP199
46	day	day_w_sleets (Tag mit Graupelfall)	06.01 AT - 06.00 FT	w3p001d0=1 if w3p000i0[12AT]=1 v w3p000i0[18AT]=1v w3p000i0[06FT]=1, otherwise 0 Number of required values = 3 For calculation of aggregation at least 3 valid values and 1 plausible visual observation are needed	
2	month/year	number of days with sleets		$w3pnd1m0 = \sum_1^{ntag} w3p001d0$ $w3pnd1y0 = \sum_1^{nmon} w3pnd1m0$ Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP 210
47	day	day_w_hail (Hageltag)	06.01 AT - 06.00 FT	w3p002d0=1 if w3p000i0[12AT]=2 v w3p000i0[18AT]=2 v w3p000i0[06FT]=2, otherwise 0 Number of required values = 3 For calculation of aggregation at least 3 valid values and 1 plausible visual observation are needed	

Nr.[p] in DB	Aggregation level	Description	Aggregation Period[q]	Formula	Old Name
2	month/year	number of days with hail		$w3pnd2m0 = \sum_{1}^{ntag} w3p002d0$ $w3pnd2y0 = \sum_{1}^{nmon} w3pnd2m0$ Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP200
40 2	month year	number of days with thunderstorm within 3 km around the station (determined from measurement) (Tage mit Nahgewitter, bestimmt aus Messung)	23:41 VT -23:40 AT	$bndclom0 = \sum_{1}^{ntag} i$ i=1 if breclod0 ≥ 1, otherwise i=0 $bndcloy0 = \sum_{1}^{nmon} bndclom0$ For use of function 40, limit has to be set to 0.999 function 40: max. allowed number of days is 366 function 2: Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	
57	day	day with value greater than number of days with thunderstorm within 3 km around the station (determined from measurement) (Tage mit Nahgewitter, bestimmt aus Messung) for ANETZ stations	23:41 VT -23:40 AT	w4pclod0 = 1 if breclod0 >= 1, otherwise 0	
48	day	day_w_thunrst_obn (thunderstorm within 3 km around the stationn determined from past weather)[s] (Tag mit Nahgewitter, bestimmt aufgrund Beobachtung) only for KLIMA konv stations	06.01 AT - 06.00 FT	w4pclod0 = 1 if w4p000i0[12AT] ε {2,4,6,8} ∨ w4p000i0[18AT] ε {2,4,6,8} ∨ w4p000i0[06FT] ε {2,4,6,8}, otherwise 0 Number of required values = 3 For calculation of aggregation at least 3 valid values and 1 plausible visual observation are needed	

[s] *If this function is used to calculate the 'conventional (or classical)' number of days with thunderstorm (on the base of measurements, see formula on Seite* ***Error! Bookmark not defined.****) the results have to be stored in a new DB field.*

Nr.[p] in DB	Aggregation level	Description	Aggregation Period[q]	Formula	Old Name
2	month/year	number of days with thunderstorm within 3 km around the station (determined from past weather) (Tage mit Nahgewitter, bestimmt aufgrund Beobachtung)		$w4pcndm0 = \sum_{1}^{ntag} w4pclod0$ $w4pcndy0 = \sum_{1}^{nmon} w4pclom0$ Number of single values to be aggregated has to be > 0	
40 2	month year	number of days with thunderstorm more than 3 km from station (determined from measurement) (Tage mit Ferngewitter, bestimmt aus Messung)	23:41 VT -23:40 AT	$bndfarm0 = \sum_{1}^{ntag} i$ i=1 if brefard0 ≥ 1 otherwise i=0 $bndfary0 = \sum_{1}^{nmon} bndfarm0$ For use of function 40, limit has to be set to 0.999 function 40: max. allowed number of days is 366 function 2: Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	
57	day	day with value greater than number of days with thunderstorm more than 3 km around the station (determined from measurement) (Tage mit Ferngewitter, bestimmt aus Messung) for ANETZ stations	23:41 VT -23:40 AT	w4pfard0 = 1 if brefard0 ≥ 1, otherwise 0	
49	day	day_w_thunrst_obf (thunderstorm more than 3 km from station determined from past weather) (Tag mit Ferngewitter, bestimmt aus Beobachtung) for KLIMA konv stations	06.01 AT - 06.00 FT	w4pfard0=1 if w4p000i0[12AT] ε {1,3,5,7} ∨ w4p000i0[18AT] ε {1,3,5,7} ∨ w4p000i0[06FT] ε {1,3,5,7}, otherwise 0 Number of required values = 3 For calculation of aggregation at least 3 valid values and 1 plausible visual observation are needed	

Nr.[p] in DB	Aggregation level	Description	Aggregation Period[q]	Formula	Old Name
2	month/year	number of days with thunderstorm more than 3 km from station (determined from past weather) (Tage mit Ferngewitter, bestimmt aus Beobachtung)		$w4pfndm0 = \sum_{1}^{ntag} w4pfard0$ $w4pcfndy0 = \sum_{1}^{nmon} w4pfarm0$ Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	
50	day	day_w_fog (Nebeltag)	18.01 VT - 18.00 AT	w5p002d0 = 1 if w5p000i0[06AT]=2 v w5p000i0[12AT]=2 v w5p000i0[18AT]=2, otherwise 0 Number of required values = 3 For calculation of aggregation at least 3 valid values and 1 plausible visual observation are needed	
2	month/year	number of days with fog		$w5pnd2m0 = \sum_{1}^{ntag} w5p002d0$ $w5pnd2y0 = \sum_{1}^{nmon} w5pnd2m0$ Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP201
58	day	number of clear days (heitere Tage)	23:41 VT -23:40 AT	nto002d0 = 1 if nto000d0 <= 20 % , otherwise i=0	
2 2	month year	number of clear days (heitere Tage)		$ntond2m0 = \sum_{1}^{ntag} nto002d0$ $ntond2y0 = \sum_{1}^{nmon} ntond2m0$ For use of function 41, limit has to be set to 20.1 % function 41: max. allowed number of days is 366 function 2: Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP202

Nr.[p] in DB	Aggregation level	Description	Aggregation Period[q]	Formula	Old Name
57	day	number of overcast days (trübe Tage)	23:41 VT -23:40 AT	nto008d0 = 1 if nto000d0 ≥ 80 % , otherwise i=0	
2 2	month year	number of overcast days (trübe Tage)		$ntond8m0 = \sum_{1}^{ntag} nto008d0$ $ntond8y0 = \sum_{1}^{nmon} ntond8m0$ For use of function 40, limit has to be set to 79.9 % function 40: max. allowed number of days is 366 function 2: Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP204
56	day	day_w_snowcover (from observa-tion) (Schneedeckentag)		$est000d0 = \sum_{1}^{ntag} i$ i=1 if est000s0[06AT] ≥ 5, otherwise i=0 Number of required values = 1 there has to be at least 1 valid value to calculate aggregation	

90	day	day_w_snowcover_2 (from observation) (Schneedeckentag)		$est000d0 = \sum_{1}^{ntag} i$ i=null if estheesw = null and esthees0 = null; i=1 if esthees0[06AT] ≥ 2, otherwise i=0 Number of required values = 1 there has to be at least 1 valid value to calculate aggregation Remark: This formula is also used to calculate the parameter Day with fog at the Station Mormont: (Input 2x Parameter 1769, Output Parameter 913)	
2	month/year	number of days with snowcover (from observation) (Schneedeckentag)		$est000m0 = \sum_{1}^{ntag} est000d0$ $est000y0 = \sum_{1}^{nmon} est000m0$ Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP205
51	day	day_w_dewform (Tag mit Tau)	18.01 VT - 18.00 AT	w6p001d0 = 1 if w6p000i0[06AT]=1 v w6p000i0[12AT]=1 v w6p000i0[18AT]=1, otherwise 0 Number of required values = 3 For calculation of aggregation at least 3 valid values and 1 plausible visual observation are needed	
2	month/year	number of days with dew		$w6pnd1m0 = \sum_{1}^{ntag} w6p001d0$ $w6pnd1y0 = \sum_{1}^{nmon} w6p001m0$ Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP206
52	day	day_w_hoarfrost (Tag mit Reif)	18.01 VT - 18.00 AT	w6p002d0 = 1 if w6p000i0[06AT]=2 v w6p000i0[12AT]=2 v w6p000i0[18AT]=2, otherwise 0 Number of required values = 3 For calculation of aggregation at least 3 valid values and 1 plausible visual observation are needed	

2	month/year	number of days with hoarfrost		$w6pnd2m0 = \sum_{1}^{ntag} w6p002d0$ $w6pnd2y0 = \sum_{1}^{nmon} w6p002m0$ Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP207
53	day	day_w_rimeform (Tag mit Rauheif)	18.01 VT - 18.00 AT	w7pat1d0 = 1 if w7p000i0[06AT]=1 v w7p000i0[012AT]=1 v w7p000i0[18AT]=1, otherwise 0 Number of required values = 3 For calculation of aggregation at least 3 valid values and 1 plausible visual observation are needed	
2	month/year	number of days with rime		$w7pnd1m0 = \sum_{1}^{ntag} w7pat1d0$ $w7pnd1y0 = \sum_{1}^{nmon} w7pnd1m0$ Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP208
55	day	day_w_glazeform (Tag mit Glatteis)	18.01 VT - 18.00 AT	w7pat2d0 = 1 if w7p000i0[06AT]=2 v w7p000i0[12AT]=2 v w7p000i0[18AT]=2, otherwise 0 Number of required values = 3 For calculation of aggregation at least 3 valid values and 1 plausible visual observation are needed	
2	month/year	number of days with glaze		$w7pnd2m0 = \sum_{1}^{ntag} w7pat2d0$ $w7pnd2y0 = \sum_{1}^{nmon} w7pnd2m0$ Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP209

40 2	month year	number of days with windspeed ≥ threshold (Tage mit Windgeschwindigkeit ≥ Schwellwert)		$fk\ln d1m0 = \sum_1^{ntag} i$ i=1 if fkl010d1 ≥ X m/s, otherwise i=0 X = beliebiges Uebergabeargument (?) $fk\ln d1y0 = \sum_1^{nmon} fk\ln d1m0$ For use of function 40, limit has to be set to threshold minus 0.001 m/s function 40: max. allowed number of days is 366 function 2: Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP109- MP 111
-	day	day with wind	original value from KA13	-	
40 2	month year	number of days with snow cover (measurement) (Tage mit Schnee am Pegel)		$hnd000m0 = \sum_1^{ntag} i$ i=1 if hto000d0 > 0, otherwise i=0 $hnd000y0 = \sum_1^{nmon} hnd000m0$ function 40: max. allowed number of days is 366 function 2: Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP178
40 2	month year	number of days with fresh snow (from measurement) (Tag mit Neuschnee)		$hatnd0m0 = \sum_1^{ntag} i$ i=1 if hns000d0 > 0, otherwise i=0 $hatnd0y0 = \sum_1^{nmon} hatnd0m0$ function 40: max. allowed number of days is 366 function 2: Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	

41 2	month year	number of days with minimum of airtemperature at 0.05m < 0.0°C		$tnd005mn = \sum_1^{ntag} i$ i=1 if tre005dn < 0, otherwise i=0 $tnd005yn = \sum_1^{nmon} tnd005mn$ function 41: max. allowed number of days is 366 function 2: Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP036
41 2	month year	number of days with maximum of airtemperature at 0.05m < 0.0°C		$tnd005mx = \sum_1^{ntag} i$ i=1 if tre005dx < 0, otherwise i=0 $tnd005yx = \sum_1^{nmon} tnd005mx$ function 41: max. allowed number of days is 366 function. 2: Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	VAMP/MET. MP037
41 2	month year	number of days with minimum of soiltemperature at -0.05m < 0.0°C		$tsond5m0 = \sum_1^{ntag} i$ i=1 if tso005dx < 0, otherwise i=0 $tsond5y0 = \sum_1^{nmon} tsond5m0$ function 41: max. allowed number of days is 366 function 2: Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	

41 2	month year	number of days with minimum of soiltemperature at -0.1m < 0.0°C		$tson10m0 = \sum_{1}^{ntag} i$ i=1 if tso010dx < 0, otherwise i=0 $tson10y0 = \sum_{1}^{nmon} tson10m0$ function 41: max. allowed number of days is 366 function 2: Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	
41 2	month year	number of days with minimum of soiltemperature at -0.2m < 0.0°C		$tson20m0 = \sum_{1}^{ntag} i$ i=1 if tso020dx < 0, otherwise i=0 $tson20y0 = \sum_{1}^{nmon} tson20m0$ function 41: max. allowed number of days is 366 function 2: Number of 2^{32} -1 values must not be exceeded. This has to be secured by the user Number of plausible values has to be > 0 Number of single values to be aggregated has to be > 0	

Tabelle 24. Functions to determine Day Characteristics

KAPITEL 16 *Decision Algorithm for the Calculation of Thermodynamic Quantities from THYGAN*

16.1 Introduction

For stations which measure temperature and humidity with a THYGAN (Thermo-Hygrometer ANETZ) the calculation of all thermodynamic parameters should be performed with respect of the value of the THYGAN status parameter (short name in MeteoSwiss DWH System: ythycos0) or the calculated pquality information. The status parameter is a string of length 4. In the following decision algorithm only the first two characters are used. Tabelle 25 gives the rules to be applied for the calculation of the thermodynamic parameters.

With the new SwissMetNet, a new model of THYGAN was realised. With this new THYGAN the staus word has changed. The new status word is a 9 Bit word with the decimal values 0 until 512.

More details about the THYGAN status parameter can be found in Chapter 15.3.

16.2 Decision Table

value of the THYGAN status parameter at position[t]				shaded cells: do not calculate the parameter. If it is an original parameter: flag the value using the PI (Plausibilitätsinforma tion) given in the cell. If it is a calculated value: set to indef and flag using the PI given in the cell.				
1	2	3	4	temperature	rel. humidity	vapor pressure	dewpoint	wet bulb temperature
0	0	x	x					

[t] *x means: any value at this position*

value of the THYGAN status parameter at position[t]				shaded cells: do not calculate the parameter. If it is an original parameter: flag the value using the PI (Plausibilitätsinforma tion) given in the cell. If it is a calculated value: set to indef and flag using the PI given in the cell.				
1	x	x	x	hard limit	hard limit	hard limit	hard limit	hard limit
2	x	x	x		hard limit[u]	hard limit2	hard limit2	hard limit2
3	x	x	x	hard limit	hard limit	hard limit	hard limit	hard limit
4	x	x	x					
5	x	x	x	hard limit	hard limit	hard limit	hard limit	hard limit
6	x	x	x		hard limit2	hard limit2	hard limit2	hard limit2
7	x	x	x	hard limit	hard limit	hard limit	hard limit	hard limit
8	x	x	x	hard limit	hard limit	hard limit	hard limit	hard limit
9	0	0	0	hard limit	hard limit	hard limit	hard limit	hard limit
x	1	x	x					
x	2	x	x					
x	3	x	x					
x	4	x	x		hard limit	hard limit	hard limit	hard limit
x	5	x	x		hard limit	hard limit	hard limit	hard limit
x	6	x	x		hard limit	hard limit	hard limit	hard limit
x	7	x	x		hard limit	hard limit	hard limit	hard limit
x	8	x	x	hard limit	hard limit	hard limit	hard limit	hard limit

Tabelle 25. Decision Table

16.3 Coding of the THYGAN Status Parameter

Die THYGAN Kontrollkennziffer enthält folgende Information (more details see Ruppert, 1991 und Dössegger et al. 1992)

1. Stelle:

0 oder blank: Messwert in Ordnung

[u] *parameters are suppressed only, if the absolute difference of relative humidity between the actual value and the arithmetic mean of the actual value and the last value is smaller than 30%.*

1: Streuung der Lufttemperatur > 2 C innerhalb eines Messintervalls
2: Streuung der Taupunktstemperatur > 2 C innerhalb eines Messintervalls
4: Heiz- und Ventilatorspannung ausgefallen
8: Datenübertragung Geber-Interface unterbrochen
9: Steuerungsprogramm neu gestartet (Initialisierung)
Kombinationen von 1+2+4 sind möglich

2. Stelle:

0 oder blank: Wasser auf dem Taupunktspiegel
1: Eis auf dem Taupunktspiegel
2: Alterung der Lichtquelle
4: Spiegel wurde gereinigt
8: Ventilator nicht in Ordnung
Kombinationen von 1+2+4 sind möglich

3. Stelle: Temperaturunterschied dT des Gebergehäuses zur Luft, wobei

0: $dT \leq -1.5$ C
1: -1.5 C $< dT \leq -0.5$ C
2: -0.5 C $< dT \leq 0.5$ C
3: 0.5 C $< dT \leq 1.5$ C
4: 1.5 C $< dT \leq 2.5$ C
5: 2.5 C $< dT \leq 3.5$ C
6: 3.5 C $< dT \leq 4.5$ C
7: 4.5 C $< dT \leq 5.5$ C
8: 5.5 C $< dT \leq 6.5$ C
9: 6.5 C $< dT$

4. Stelle: Information über die Anzahl der Heizzyklen.

H = INT ((tg+6)/7)
tg: Anzahl 10s Einschaltzyklen innert 10 Minuten

Spezielle Zahlenkombinationen:

32767: Messung fehlt
9000: Geber initialisiert
8000: Geber gibt keine Antwort

KAPITEL 17 *Sequence-Parameter of the Application CLIMAP*

The Application CLIMAP provides the possibility to calculate sequences of the parameters listed below (Tabelle 26). These parameters are implemented similar to these known from the METEOR-System (BS2000). This information is also described in the document /proj/MAZ/MCH-DWH/doc/CLIMCP/Manual/BenutzerhandbuchClimap.doc. For decoding see the Tabelle 27.

DWH-ID	origin Parameter	Sequence-Parameter	Description	Coding Type
1815	tre205s0	tre205vs	Difference temperature 5cm - temperature 2m: current value	temp
1816	tre205h0	tre205vh	Difference temperature 5cm - temperature 2m: hourly avarage	temp
1919	rre150s0	rre150vz	Precipitation: ten minute total	rain
1920	rre150h0	rre150vh	Precipitaion: hourly total	rain
1921	fkl010z1	fkl010vz	Gust peak (one second): maximum	wind
1922	fkl010h1	fkl010vh	Gust peak (one second): hourly maximum	wind
1923	lre000s0	lre000vz	Lumination: current value	lum
1924	lre000h0	lre000h0	Lumination: hourly avarage	lum
1925	tps200s0	tps200vz	Psychrometer temperature: current value	temp
1926	tps000h0	tps200vh	Psychrometer temperature: hourly avarage	temp
1927	sre000s0	sre000vz	Sunshine duration: ten minute total	sun
1928	sre000h0	sre000vh	Sunshine duration: hourly total	sun
1929	tre005s0	tre005vz	Temperature 5cm above grass; current value	temp
1930	tre005h0	tre005vh	Temperature 5cm above grass; hourly avarage	temp
2049	w4p000z0	w4p000vz	Close range / distant lightning: ten minute total	storm
2050	w4p000h0	w4p000vh	Close range / distant lightning: hourly total	storm

Tabelle 26. List of implemented Sequence-Parameters of the Application CLIMAP

temp [1]	**code**	**rain** [2]	**code**	**sun** [3]	**code**	**lum** [4]	**code**	**wind** [5]	**code**	**storm**	**code**
t > 4.5	+	0	-	0	-	< 0.2	9	0	/	no lightning	-
3.5 - 4.4	4	0 - 0.9	0	0 - 9.9	0	0.21 - 0.4	8	0 - 9.9	0		
2.5 - 3.4	3	1 - 1.9	1	10 - 19.9	1	0.41 - 0.8	7	10 - 19.9	1	close range lightning	N
1.5 - 2.4	2	2 - 2.9	2	20 - 29.9	2	0.81 - 1.6	6	20 - 29.9	2		
0.5 - 1.4	1	3 - 3.9	3	30 - 39.9	3	1.61 - 3.0	5	30 - 39.9	3		
-0.4 - 0.4	0	4 - 4.9	4	40 - 49.9	4	3.01 - 6.0	4	40 - 49.9	4		
-1.4 - -0.5	9	5 - 5.9	5	50 - 59.9	5	6.01 - 12.0	3	50 - 59.9	5	distant lightning	F
-2.4 - -1.5	8	6 - 6.9	6	60 - 69.9	6	12.01 - 25.0	2	60 - 69.9	6		
-3.4 - -2.5	7	7 - 7.9	7	70 - 79.9	7	25.01 - 50.0	1	70 - 79.9	7		
-4.4 - -3.5	6	8 - 8.9	8	80 - 89.9	8	> 50.0	0	80 - 89.9	8		
t < -4.5	-	9 - 9.9	9	90 - 100	9			90 - 99.9	9		
		>= 10	+					>= 100	+		

Tabelle 27. Coding of the diffrent Types of Sequence Parameters

1 Temperature in °C

2 Precipitation in mm

3 in %: The sunshine duration which is measured in minutes is here used in %. So it is the similar coding for ten minute values as for the hourly values.

4 in klx: The lumination is stored as code in the DWH. For this Coding it is converted to k lux.

5 in knots: The wind velocity is measured in meters per second and is used here in knots.

KAPITEL 18 *Diffusion Parameters*

Détermination des catégories de dispersion (Tercier, 1994).

The Diffusion Classes A to F depend to the wind speed f, the Difference between Temparatur at 2m and Temperatur at 5cm ΔT and the radiation balance Q.

Daytime: Q_{day} = -13,6 + 0,6·G

Nighttime: $\Delta T = T_{200} - T_{05}$ und Q_{night} = -10,79 – 10,36· ΔT

Tower: $\frac{K}{100m} = T_{TOW110} - T_{TOW10}$

Day and Night are defined by Radiationvalue G in W/m^2.
Day = G > 5
Night = G ≤ 5

Formula_ID: 302

Q: W/m2 **ΔT: K**	**> 390**	**390 ... 240**	**240 ... 80**	**80 ... 5**	**5 ... -7** **≤ 0.6**	**-7 ... -28** **0.6...1.5**	**<-28** **> 1.5**
f_v: 0.0 ... 0.9	A	A	B	C	E	F	F
f_v: 1.0... 1.9	A	B	B	C	E	E	F
f_v: 2.0 ... 2.9	A	B	C	C	D	D	E
f_v: 3.0 ... 4.9	A	B	C	C	D	D	D
f_v: 5.0 ... 6.9	B	C	D	D	D	D	D
f_v: ≥ 7.0 m/s	D	D	D	D	D	D	D

Tabelle 28. TIDOMES Parameter 282: TALuft

Formula_ID: 303

Class f_v in m/s	**A**	**B**	**C**	**D**	**E**	**F**
0.0 ... 0.9	≤ −1.13	−1.12...−1.03	−1.02...−0.91	−0.90...−0.37	−0.36...+0.78	+0.78
1.0 ... 1.9	≤ −1.18	−1.17...−1.05	−1.04...−0.91	−0.90...−0.22	−0.21...+1.12	+1.12
2.0 ... 2.9	≤ −1.39	−1.38...−1.18	−1.17...−0.97	−0.96...−0.16	−0.15...+1.25	+1.25
3.0 ... 3.9	≤ −1.61	−1.60...−1.33	−1.32...−1.00	−0.99...−0.10	−0.09...+1.32	+1.32
4.0 ... 4.9	≤ −1.82	−1.81...−1.48	−1.47...−1.04	−1.03...−0.04	−0.03...+1.39	+1.39
5.0 ....5.9		≤−1.62	−1.61... −1.08	-1.07...+0.02	+0.03...+1.46	+1.46
6.0 ....6.9		≤−1.77	−1.76... −1.16	−1.15...+0.08	>+0.08	
7.0 ....7.9			≤−1.25	≤−1.25		
8.0 ....9.9			≤−1.40	≤−1.40		
≥ 10.0 m/s	Alle Werte in der Kategorie D					

Tabelle 29. TIDOMES Parameter: Schema von Polster (Temperaturgradient) zur Bestimmung der Ausbreitungskategorien mit den Klassengrenzen der HSK basieren auf der Kta 1508. Nur für KKW Turmstationen zu benutzen.

Formula_ID: 304

Q: W/m^2 **dT: (K)**	**> 460**	**460 ... 240**	**240 ... 110**	**110 ... 5**	**5 ... -15** **≤ 1.0**	**-15 ... -40** **1.0...2.2**	**<-40** **> 2.2**
f_v : 0.0 ... 0.7	A	B	B	C	F	F	F
f_v : 0.8 ... 1.4	A	B	B	C	D	F	F
f_v : 1.5 ... 2.9	A	B	C	D	D	E	F
f_v : 3.0 ... 4.4	B	C	C	D	D	E	E
f_v : 4.5 ... 5.9	C	C	D	D	D	D	D
f_v ≤ 6.0 m/s	D	D	D	D	D	D	D

Tabelle 30. TIDOMES Parameter 286: Schema von Polster und Ausbreitungskoeffizienten Pasquill-Turner zur Bestimmung der Ausbreitungskategorien

KAPITEL 19 *Plain Text Weather Codes*

By „Klartextwetter“ one understands a weather information in plain text. This is needed in different products for several customers. The project comittee of MeteoSwiss Data Warehouse Project assigned to consolidate the „Plain Text Weather Codes“ Programs at Mars 28, 2007.

Some adjustments will be made to be in agreement with the activity of the project „Methodes“.

Variant / Formula	Input Values	Input Stations	Output	Comments
Simple Version 313	SYNOP Observations	Observation Stations	wca004h0	value all 6 hours (6am, 12am, 6pm)
Complex Version 314	Sensordata	Automated Stations and Observation Stations	wca005s0	Ten_minute value

Tabelle 31. To possible Version for Input Values and Stations to detect plain weather information

(different Autors from Federal Office of Meteorology and Climatology)

Nr in DB	Purpose	Name	Formula	Restrictions/ Remarks
313	Determination of plain text weather information by observations wca004h0	plain_text_1	IF ww 17 gewitterhaft Code 91 42 ... 49 Nebel Code 30 50 ... 59 Nebelregen Code 50 60 ... 69, 91, 92 Regen Code 60 70 ... 75 Schneefall Code 70 80 ... 82 Regenschauer Code 82 83, 84 Regenschauer mit Schnee vermischt Code 68 85 ... 86 Schneeschauer Code 87 87 ... 88 Graupel- und Schneeschauer Code 75 89 ... 90 Hagelschauer Code 89 93 ... 98 Gewitter Code 90 99 Hagelgewitters Code 96 ELSE IF N’ > 4 Nebelmeer / Höhe des Nebelmeers Code 36 ELSE IF N_h 0 ... 3 schön Code 101 4 ... 5 leicht bewölkt Code 102 6 ... 8 bewölkt Code 103 ELSE IF N 0 ... 1 schön Code 101 2... 3 leicht bewölkt Code 102 4... 5 bewölkt Code 103 6 ...7 stark bewölkt Code 104 8 bedeckt Code 105 9 Nebel Code 30	ww: wat000sw oder wawa00s0 (Wetter zur Zeit der Synop Beobachtung9 N: nto000s0 Code Gesamtbewölkung N_h: nsh000s0 Code alle Wolken des Typs CICm (WMO 2700) N’: nsa000s0 (Betrag der Wolken unterhalb der Station) bzw H’: cha000s0 (Wolkenobergrenze unterhalb der Station) Please find the german, french, english and italien descriptions of weather text in Table T_OBS_CODE_REF.
346	Determination of ww-code by decision of (1) fog or stratus, or (2) stratus and its height.	plain_text_from_fog_stratus_height	If weather is given by low clouds, type of fog or stratus (WW=40) and a value of the top of stratus is introduced, 2 cases are distinguished: - fog or stratus - stratus If ww=40: top < 900m ww=40 top=> 900m ww=100	

Nr in DB	Purpose	Name	Formula	Restrictions/ Remarks
314	Determination of plain text weather information by sensor data wca005s0	plain_text_2	IF wca004h0 is null THEN IF R = 0 AND $B_{f\,OR}\,B_n$ > 0: gewitterhaft Code 91 IF R > 0 AND $B_{f\,OR}\,B_n$ > 0: Gewitter Code 90 IF R = 0 AND U_{200} > 94.7: 9 Nebel Code 30 ELSE FOR Daytime: S (sunshine possible) 0 bedeckt Code 105 1 ... 2 stark bewölkt Code 104 3 ... 5 bewölkt Code 103 6 ... 8 leicht bewölkt Code 102 9 ... 10 schön 101 FOR Nighttime: N_{noc} 0 ... 1 schön Code 101 2... 3 leicht bewölkt Code 102 4... 5 bewölkt Code 103 6 ...7 stark bewölkt Code 104 8 bedeckt Code 105 9 Nebel Code 30 IF R 0.1 ... 0.3 AND U_{200} > 94.7: 9 Nebelregen Code 50 ELSE IF T_W < 1.3 Schneefall Code 70 1.3 ... 2 Regenschauer mit Schnee vermischt Code 68 > 2 Regen Code 60 IF R > 0.4 AND T_W < 1.3 Schneeschauer Code 87 1.3 ... 2 Graupel- und Schneeschauer Code 75 > 2 Regenschauer Code 82	wca004h0 (SYNOP-Observation-code) R: precipitation 10 min) U_{200}: rel. humidity 2m over Soil N_{noc}: night cloud cover S: duration of sunshine T_W: Feuchttemperatur 10min B_n: Nahblitz B_f: Fernblitz Please find the german, french, english and italien descriptions of weather text in Table T_OBE_CODE_REF. TIME: target time of calculation s_vut: max. possible duration of Sunshine in minutes from 00 am - 11.40 am (11.40-svut = Sunrise) s_max: max. possible duration of Sunshine in minutes for the whole da (Sunrise+s_max = Sunset)
tbd	Determination of complex plain text weather information from present weather sensor and ceilometer	tbd	tbd	see description of SMART Algorithm

Tabelle 32. Specification of Plain Text Weather Information

KAPITEL 20 *Integrated Water Vapour (Wasserdampfkolonne)*

Nr in DB	Purpose	Name	Formula	Restrictions/ Remarks	Old Name
329	calculates integrated water vapour (IWV) from total zenital delay	integrated water vapour	$f(\theta)=1-\left(0.00226\cdot\cos\left(2\cdot\frac{lat\cdot Pi}{180}\right)\right)-\left(0.00028\cdot\frac{h_S}{1000}\right)$ $K=461.51\cdot\frac{10^5}{\left(\frac{3.776\times10^5}{T+22}\right)}$ $ZHD=0.0022768\cdot\left(\frac{P}{f(\theta)}\right)$ $ZWD=\frac{TZD}{1000}-ZDH$, $IVW=1000\cdot ZWD\cdot K$	Input: P = pressure at station (QFE) in hPa T = temperature in Grad Kelvin TZD = total zenital delay in mm lat = latitude of the station in degrees h_s = altitude of the station in meters f(θ) = gravitational variation	

Tabelle 33. Specification of integrated water vapour

KAPITEL 21 *Vertical Temperature Interpolation Functions*

Nr in DB	Purpose	Name	Formula	Restrictions/ Remarks
347	temperature correction as function of first guess and validated source at reference station	temp_corr_station	ΔT_{corr} = T(VS,station_ref) – T(FG,station_ref)	T: min. or max. temperature ΔT_{corr}: correction brought by the forecaster with regard to first guess at given date (due date) VS: validated source FG: first guess station_ref: reference station of the region (station with validated source by forecaster – depends on due date)
348	validated temperature as function of first guess and temperature correction	temp_validated_station	T(Validated, station) = T(FG,station) + ΔT_{corr}	

349	selection of the station as function of stratus height	selection_of_station	Absence of stratus or 'station_close' and 'site' above or under stratus:
			IF ($h_{site} < h_{stratus}$ AND $h_{station\_close} < h_{stratus}$)
			OR ($h_{site} > h_{stratus}$ AND $h_{station\_close} > h_{stratus}$)
			THEN station_int = station_close
			
			'Site' and 'station_close' separated by limit of stratus:
			IF ($h_{site} < h_{stratus}$ AND $h_{station\_close} > h_{stratus}$)
			THEN station_int = station_low
			
			IF ($h_{site} > h_{stratus}$ AND $h_{stratus} > h_{station\_close}$)
			THEN station_int = station_hight
				$h_{stratus}$: top altitude of stratus, only used if <3000m and weather type is 40.
				site: region, which the interpolation is carried out for
				station_close: closest station of the prediction matrix in same region
				station_int: station used for the interpolation
				station_low: plain station of the region
				station_hight: top station of the region

350	temperature as function of temperature correction and station selection	temp_tcorr_station	T = T(FG,station_int) + ΔT_{corr} – 0.6/100*(h_{site} - $h_{station\_int}$) T = T(Validated, station_int) – 0.6/100*(h_{site} - $h_{station\_int}$)	

Nr in DB	Purpose	Name	Formula	Restrictions/ Remarks
351	Extreme temperature interpolation at any site defined by its position (x;y) and height (h_{site})	temp_interpolation _any_position	$T_{\mathbf{SEC}} = T_{\mathbf{REF}}$ + Correction(month, {SEC-REF},min¦max) $T_{site} = T_{\mathbf{SEC}} + 0.006*(h_{\mathbf{SEC}} - h_{site})$	Tmin and Tmax 2m temperatures values at reference stations (REF) of a Method region are validated by forecasters and written in MK120. REF stations are dependent on the lead time of the forecasts. The secondary stations (SEC), are the SMN stations which are the closest and in the same region Method of the site to be interpolated. In some cases REF is the same as SEC. Corrections are estimated for couple of stations (REF – SEC) in monthly base and separatly for min and max extremes. (month, {SEC-REF},min¦max): Es ist ein Tabelle mit monatlichen Werten von der Differenz der mittlere Werte von min SEC respektive REF. Beispiel; GVE ist ein SEC und PAY die REF Station. Januar, Tmax ist 1° mehr in GVE als in PAY, Tmin 1.6° mehr. 'GVE_PAY' => [[1.0, 1.0, 0.9, 1.3, 1.2, 1.3, 1.4, 1.2, 1.3, 1.3, 1.1, 1.3], [1.6, 1.4, 1.1, 0.8, 1.0, 1.4, 1.3, 1.4, 1.3, 1.3, 1.5, 1.6]],

Tabelle 34. Vertical Temperature Interpolation Functions

KAPITEL 22 *Formulas used for the project Methods*

These formulas are not implemented in libagg for MeteoSwiss Data Warehouse yet. They are used in MG for the production of forecast values.

Detailes about the used formulas can be found in the Document:

Cattani, Daniel: Algorithmes de production de Méthodes. Interpolation températures et type de temps. MeteoGenève, Genève 2009.

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