APPENDIX D

GENERATION OF PAMII DERIVED PARAMETERS

FORMULATION OF STANDARD OUTPUT PARAMETERS FOR

PAM II CMF DATA†

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This note provides description of standard Common Mesonet Format (CMF) output parameters for PAM II. The formulation of project-specific output parameters associated with experimental or user-supplied sensors is described in separate documents.

A. Index of input and output parameters

Symbol	Definition	Value or Formulation	CMF Output Parameter?	CMF Mnemonic
c_p	Specific heat of dry air at constant pressure	1,005.7 J $kg^{-1}°K^{-1}$	No	
c_{pv}	Specific heat of water vapor at constant pressure	1952 J $kg^{-1}°K^{-1}$	No	
c_v	Specific heat of dry air at constant volume	717 J $kg^{-1}°K^{-1}$	No	
ε	Ratio of molecular weight of water to molecular weight of dry air	0.622	No	
e	Vapor pressure	See Note Number 3	Yes	vpres
e_{sw}	Saturation vapor pressure over a plane surface of water	See Note Number 6	Yes	svpres
g	Acceleration of gravity	9.81 m s^{-1}	No	
L_c	Latent heat of condensation	See Note Number 1	No	
P	Ambient total pressure due to vapor and air	mb	Yes	pres
P_{rs}	Total pressure reduced to reference height Z_{rs}	mb, See Note Number 10	Planned	redpres
Raina	Accumulated rainfall	mm	Yes	raina
R_d	Gas constant for dry air	287 J $kg^{-1}°K^{-1}$	No	

† Compiled by P. Herzegh

RH	Relative humidity with respect to water	$RH = (e/e_{sw})\ 100$	Yes	rh
T	Temperature (dry bulb)	°K in CMF calculations °C in output	Yes	tdry
T_d	Dew point temperature	°K in CMF calculations °C in output See Note Number 5	Yes	dp
T_L	Temperature at lifting condensation level	°K in CMF calculations °C in output See Note Number 7	Yes	tlift
T_v	Virtual Temperature	°K in CMF calculations °C in output See Note Number 4	Yes	vt
T_w	Wet bulb temperature	°K in CMF calculations °C in output	Yes	twet
U	Raw U (eastward) component of wind, direct from U-anemometer output	$m\ s^{-1}$	Yes	u_wind
V	Raw V (northward) component of wind direct from V-anemometer output	ms^{-1}	Yes	v_wind
θ_e	Equivalent potential temperature	See Note Number 9	Yes	ept
θ	Potential temperature	See Note Number 8	Yes	pt
w	Mixing ratio for water vapor	See Note Number 2	Yes	mr
Z_{rs}	Height above mean sea level of station chosen to define reference level for reduction of pressure	m	In tape header	
Z_s	Station height above mean sea level	m	In tape header	
wspd	Wind speed	ms^{-1}	Yes	wspd
wdir	Wind direction	°true. Wind from S listed 180°, W listed 270°, etc.	Yes	wdir
wmax	Max 1-second wind speed	ms^{-1}	Yes	wmax

B. Formulation of derived parameters

NOTE 1

Symbol: L_c

Definition: Latent heat of condensation

Units: $J\ kg^{-1}$

Usage: Input to calculation of w, θ_e

Formulation:

From Hess (1959) p. 64, problem 6, the latent heat of condensation in cal g^{-1} is given by the expression

$$597.3 - 0.566\ (T-273)$$

Changing to J kg^{-1}, we get

$$L_c = 4.186 \times 10^3 \left[597.3 - 0.566\ (T-273)\right]$$

$$= 2.500 \times 10^6 - 2369\ (T-273)$$

NOTE 2

Symbol: w

Definition: Mixing ratio for water vapor

Units: g kg^{-1}

Usage: Output variable; input to calculation of θ, θ_e

Formulation:

$$w = \varepsilon \left[\frac{e}{P - e}\right] 1000$$

Reference: Wallace and Hobbs (1977), p. 73.

NOTE 3

Symbol: e

Definition: Vapor pressure

Units: mb

Usage: Input to calculation of RH, T_v, T_d, etc.

Formulation:

$$e = e_w - P\ (T - T_w)\ [0.00066(0.6859 + 0.00115\ T_w)]$$

where $e_w \equiv$ saturation vapor pressure (see Note 6) at temperature $T = T_w$

Reference: Adopted for °K from Ferrel formula used for reduction of psychrometer data (Table 98), Smithsonian Meteorological Tables, Sixth Edition.

NOTE 4

Symbol: T_v

Definition: Virtual temperature

Units: °K

Usage: CMF output parameter; input to P_{rs}

Formulation:

$$T_v = \frac{T}{1 - (e/p)\ (1 - \varepsilon)}$$

Reference: Wallace and Hobbs (1977), p. 52

NOTE 5

Symbol: T_d

Definition: Dew point temperature

Units: °K

~~Usage: Output parameter~~

Formulation:

$$T_d = \frac{237.3\ \ln(e/6.1078)}{17.2694 - \ln(e/6.1078)} + 273.15$$

where $\ln \equiv$ natural log

Performance:

Vapor pressure (mb)	True dew point (°K)	Calculated dew point (°K)
6.5662	274.15	274.15
12.272	283.15	283.14
23.373	293.15	293.14
42.430	303.15	303.15
73.777	313.15	313.16

NOTE 6

Symbol: e_{sw}

Definition: Saturation vapor pressure over a plane surface of water

Units: mb

Usage: Input to calculation RH

Formulation:

$$e_{sw} = E_3 \exp[A \cdot \ln(T_3/T)] \exp[(A + B)(1 - T_3/T)]$$

where $A = 5.0065$, $B = 19.83923$, $E_3 = 6.1078$, $T_3 = 273.15$

$\ln \equiv$ natural log

$T \equiv$ temperature in °K

Source: Herzegh/University of Washington

Performance:

T(°C)	True e_{sw}	Calculated e_{sw}
-20	1.254	1.255
-10	2.863	2.864
0	6.108	6.108
10	12.272	12.268
20	23.373	23.357
30	42.430	42.377
40	73.777	73.628

NOTE 7

Symbol: T_L

Definition: Temperature of lifting condensation level

Units: °K

Usage: Input to calclation of θ_e; Output variable

Formulation:

$$T_L = \left[\frac{1}{T_d - 56} + \frac{\ln(T/Td)}{800}\right]^{-1} + 56$$

where ln ≡ natural log, and T and T_d are in °K

Reference: Bolton (1980)

NOTE 8

Symbol: θ

Definition: Potential temperature

Units: °K

Usage: Input to calculaton of θ_e; Output variable

Formulation:

$$\theta = T\left[\frac{1000}{p}\right]^{(R_d/c_p)(1 - 0.00028\, w)}$$

Reference: Bolton (1980)

NOTE 9

Symbol: θ_e

Definition: Equivalent potential temperature

Units: °K

Usage: Output variable; a standard meteorological parameter

Formulation:

$$\theta_e = \theta \exp\left[\left(\frac{3.376}{T_L} - 2.54 \times 10^{-3}\right) w\, (1 + 0.81 \times 10^{-3} w)\right]$$

where T_L is in °K

Reference: Bolton (1980)

NOTE 10

Symbol: P_{rs}

Definition: Total pressure reduced to reference height Z_{rs}

Units: mb

Usage: Output variable

Formulation:

$$P_{rs} = P \exp\left[\frac{2g\ (Z_s - Z_{rs})}{R_d\ (T_{vs} + T_{vrs})}\right]$$

where $T_{vs} \equiv$ virtual temperature (°K) for the station being reduced

$T_{vrs} \equiv$ virtual temperature (°K) at the reference station, located at height Z_{rs}

Reference: Wallace and Hobbs (1977), pp. 59-60.

C. References

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