Climate Files and Flags Documentation

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These tables include descriptions of the parameters reported in the climate files for the Niwot Ridge AmeriFlux ftp site. Table I is a list of the column names (parameters), units, sensor type and location, as well as a footnote describing other comments concerning that measurement. Table II describes a series of flags which correspond to the climate data files. These are included to signify when data was available. The time tags for both tables are contained within the first five columns. The time tag signifies the beginning of the half-hour period for which measurement is relevant. Typical reasons for unavailable data are loss of line power at the site or sensor malfunction. The notes included in Table II also designate how substitute data was used to fill in gaps in our data. In the climate data files, substitute data was typically taken from a nearby meteorlogical station operated by the Niwot LTER known as the C1 met station. This station is located approximately 500 m NE of the tower site. Data logged at this station include temperature, relative humidity, barometric pressure, wind speed and direction and incoming total radiation. Daily precipitation totals are also measured.

Table 1: Climate Data

Parameter	Column Number	Units	Sensor Type	Location (Measurement Height)	Footnote
Year	1				
Julian Day	2				
Hour of Day	3				
Minute	4				
Second	5				
Air Temperature	6	^{o}C	Vaisala HMP-35D	21.5 m	1
Relative Humidity	7	%	Vaisala HMP-35D	21.5 m	1
Barometric Pressure	8	kPa	Vaisala PTB-101B	18 m	2
Wind Speed	9	$m\ s^{-1}$	CSAT-3 or RMY 09101	21.5 m	3

Table 1: Climate Data

Parameter	Column Number	Units	Sensor Type	Location (Measurement Height)	Footnote
Wind Direction	10	^{o} from N	CSAT-3 or RMY 09101	21.5 m	3
u*	11	m s^{-1}	CSAT-3	21.5 m	3
z/L	12	unitless	CSAT-3	21.5 m	3
Precipitation	13	mm	Met One Model 385	10.5 m	4
Dew Point Temperature	14	^{o}C	Vaisala HMP-35D	21.5 m	1
Vapor Pressure Deficit	15	kPa	Vaisala HMP-35D	21.5 m	1
Wetness	16	0 == dry 1 == wet	Campbell Model 237	13.5 m	5
Soil Temperature	17	^{o}C	REBS STP-1	Avg. 0-10 cm belowground	6
Bole Temperature : Pine	18	^{o}C	Campbell Model 107	3 and 7 cm within bole	7
Bole Temperature : Fir	19	^{o}C	Campbell Model 107	3 and 7 cm within bole	7
Bole Temperature : Spruce	20	^{o}C	Campbell Model 107	3 and 7 cm within bole	7
Incoming PPFD	21	μmol m^{-2} s^{-1}	Licor 190-SA	25.5 m	8
% Absorbed PPFD	22	%	Licor 190-SA	25.5 m	8
Net Radiation	23	W m^{-2}	Kipp and Zonen CNR-1 and REBS Q*7.1	25.5 m	9

Table 1: Climate Data

Parameter	Column Number	Units	Sensor Type	Location (Measurement Height)	Footnote
Incoming Short Wave Radiation	24	W m^{-2}	Kipp and Zonen CNR-1	25.5 m	9
Outgoing Short Wave Radiation	25	W m^{-2}	Kipp and Zonen CNR-1	25.5 m	9
Incoming Long Wave Radiation	26	W m^{-2}	Kipp and Zonen CNR-1	25.5 m	9
Outgoing Long Wave Radiation	27	W m^{-2}	Kipp and Zonen CNR-1	25.5 m	9
Air Temperature	28	^{o}C	Vaisala HMP35-D	2 m	10
Air Temperature	29	^{o}C	Vaisala HMP35-D	8 m	10
Relative Humidity	30	%	Vaisala HMP35-D	2 m	10
Relative Humidity	31	%	Vaisala HMP35-D	8 m	10
Volumetric Soil Moisture	32	m^3 m^{-3}	Campbell CS-615	0-15 cm	11

Footnotes to Table 1

(1) Measurements of Relative Humidity began on November 4, 1998. Temperature measurements with the Vaisala sensor began on November 30, 1998. From Nov. 4 - 30, 1998, sonic temperature (corrected to real temperature - see Fluxes documentation file) was used as the measured temperature. The sensor is located in an RM Young Gill-type aspirated shield. From November 4, 1998 - June 23, 1999, this sensor was at a measurement height of 18 m. Dew Point Temperature and Vapor Pressure Deficit is calculated using the 21.5 m temperature and relative humidity. The H_2O vapor pressure is first calculated and dew point is then calculated using the fit to the data of Goff and Gratch, 1946 reported by Licor (Li6262 manual, Publication #9003-59, pp 3-7). Vapor Pressure Deficit is calculated by assuming that H_2O vapor pressure within the needles is fully satu-

rated. The Vapor Pressure Deficit is then the difference between saturation vapor pressure and the H_2O vapor pressure derived from the relative humidity measurement.

(2) Measurements of Barometric Pressure began on November 4, 1998.

(3) Wind Speed, Wind direction, u* and z/L are typically taken from the primary operating sonic anemometer (CSAT-3). However, during bad weather when the sonic data is unavailable, wind speed and direction are taken from an RM Young propvane (Model 09101) located at 25.5 m.

u* is calculated by : $u^* = \{(u'w')^2 + (v'w')^2\}^{0.25}$ (Stull, 1988). Please note that upon coordinate rotation which forces $\bar{w}$ and $\bar{v}$ to zero, $v'w'$ typically becomes negligibly small. The stability parameter z/L is more accurately described as $(z_m - d)/L$ where z_m is the measurement height, d is the displacement height and L is the Obukov length as defined in Stull, 1988. The displacement height was measured to be 7.8 m for our site in the fall of 1999 by using a log wind profile. Before November of 1999, $(z_m - d)/L$ was calculated using an "estimated" value of d = 10 m.

(4) Precipitation measurements began in late July, 1999. Malfunctioning of the heater element in September and October of 1999 caused a large underestimation of precipitation and data from the nearby C1 met station was used during these periods.

(5) Wetness measurements began in July 1999, This Wetness Sensor does not adequately reflect the nature of the needles. It is merely a guide to when instrumentation and the forest MAY be wet. A value of 1 indicates that the wetness sensor was giving a positive indication for wetness for > 10% of the half hour time period.

(6) Measurements began on July 1, 1999. Measurements prior to this time have not yet been incorporated into the main data bank, but will be added at a later date. Soil Temperature was measured by 5 REBS STP-1 platinum resistance thermometers which give an average temperature over the top 10 cm of soil. Data reported is the average of all 5 sensors.

(7) Measurements began on July 1, 1999. Measurements prior to this time have not yet been incorporated into the main data bank, but will be added at a later date. Bole Temperatures were measured with thermocouples in the three dominant species of trees at the Niwot Ridge site : Lodgepole Pine, Subalpine Fir, and Englemann Spruce. Measurements were made on 3 trees of each type varying in diameter. In each tree, two temperatures were measured, one at a depth of 2-4 cm (within the sapwood) and one at a depth of 6-8 cm (within the heartwood). The data reported is the average of the 6 measurements made within each species.

(8) PPFD measurements began on July 1, 1999. Prior to this, a linear relationship between incoming PPFD and net radiation (measured during the months of July and August, 1999) was used to estimate PPFD. Both an upwards facing quantum sensor and a co-located downward facing quantum sensor are used to calculate the % absorbed PPFD.

(9) Net radiation measurements using the REBS Q*7.1 began on November 4, 1998. The Kipp and Zonen CNR-1 was added on July 12, 1999. Comparison of these two radiometers in July and

August of 1999 indicated agreement to within about 3.5 %. Some prior measurements with the CNR-1 were made and will be incorporated into the main data bank at a later date. The separation of incoming/outgoing shortwave and long wave radiation is only measured by the CNR-1; therefore this data is only available after July 12, 1999.

(10) Measurement of relative humidity at these lower heights began on November 4, 1998. Temperature measurements began on November 30, 1998. Both sensors are housed in RM Young aspirated shields.

(11) Measurement of soil volumetric soil moisture began in December of 2001. Data is the average of 7 sensors located within a 15x15 m study area. Locations were chosed to give a variety of soil conditions (near trees, within gaps, etc.). Probes are 30 cm long and inserted at approximately 45 degree angles - thus the measurement is an average over the top 15 cm of soil. No corrections due to temperature were applied to the measurements.

Table 2: Flags for Climate Data

Flag Name (Parameter)	Column Number	Value	Note(s)
Year	1		
Julian Day	2		
Hour of Day	3		
Minute	4		
Second	5		
Air Temperature at 21 m	6	1 == Tower data 0 == C1 data	1
Relative Humidity at 21 m	7	1 == Tower data 0 == C1 data	1
Barometric Pressure	8	1 == Data available 0 == C1 data	1
Wind Speed	9	1 == Data available 0 == C1 data	2
Wind Direction	10	1 == Data available 0 == C1 data	2
u*	11	1 == Data available 0 == C1 data	2

Table 2: Flags for Climate Data

Flag Name (Parameter)	Column Number	Value	Note(s)
z/L	12	1 == Data available 0 == Not available	3
Precipitation	13	1 == Data available 0 == C1 data	4
Dew Point Temperature	14	1 == Data available 0 == C1 data	1
Wetness	15	1 == Data available 0 == Not available	5
Soil Temperature	16	4 == Not available 3 == spline fit 2 == 10-day average 1 == Data available	6
Pine Temperature	17	4 == Not available 3 == spline fit 2 == 10-day average 1 == Data available	6
Fir Temperature	18	4 == Not available 3 == spline fit 2 == 10-day average 1 == Data available	6
Spruce Temperature	19	4 == Not available 3 == spline fit 2 == 10-day average 1 == Data available	6
PPFD flag	20	1 == Data available 0 == C1 data	7
PPFD/Rnet flag	21	1 == Data available 2 == Rnet substitution	8
% abs. PPFD flag	22	1 == Data available 0 == Not available	9
Rnet flag	23	1 == Data available 0 == C1 data	10
Short/Long wave flag	24	1 == Data available 0 == Not available	11

Table 2: Flags for Climate Data

Flag Name (Parameter)	Column Number	Value	Note(s)
Air Temperature at 2 m	25	1 == Data available 0 == Not available	12
Air Temperature at 8 m	26	1 == Data available 0 == Not available	12
Relative Humidity at 2 m	27	1 == Data available 0 == Not available	12
Relative Humidity at 8 m	28	1 == Data available 0 == Not available	12
Volumetric Soil Moisture	29	1 == Data available 0 == Not available	12

Footnotes to Table 2.

(1) Temperature, Relative Humidity and Barometric pressure are substituted for using the C1 data. Since sensor height and local environments between our tower and C1 typically cause slight differences in the measurements, a monthly regression of each of these parameters is computed and used for substituion into data gaps at the tower site. Substitute dew point temperatures and vapor pressure deficit were calculated using temperature and relative humidity from C1.

(2) Wind speed and u* are substituted for by computing a monthly regression of these parameters vs. the C1 wind speed. Note that the C1 wind speed is measured a lower height than at the tower and is typically about 25-30 % smaller. Wind direction is substituted directly from the C1 data.

(3) No suitable substitute is currently available for z/L.

(4) Before precipitation data was collected (July 1999), data from C1 is used exclusively. Due to sensor error, C1 data was also used in the months of September and October, 1999.

(5) No suitable substitute is currently available for wetness.
(6) Soil and bole temperatures are not currently available before July 1, 1999. If the number of missing data points is less than 3 in a diurnal cycle, substitution is made by using a spline fit to existing data. If more data points are missing, substitution is made by using a 10 day average.

(7) Substitution for PPFD is made by using a monthly linear regression vs. the total incoming radiation measured at C1.

(8) Before July 1, 1999, PPFD were unavailable and were estimated by using net radiation. A linear regression of PPFD vs. Rnet for the months of July and August was used to back-calculate PPFD values prior to July 1, 1999.

(9) No suitable substitute is currently available for % absorbed PPFD.

(10) Substitution for net radiation is made by using a monthly linear regression vs. the total incoming radiation measured at C1.

(11) No substitution has been currently made for incoming/outgoing short wave radiation or incoming/outgoing long wave radiation.

(12) No substitution has been currently made for temperatures and relative humidities at lower heights or for volumetric soil moisture.

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