



Tarfala Research Station automatic weather station, 2014

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Contents

1	Instrumentation	3
2	Notes on the station data	3
3	Data coverage	3
4	Notes on data storage	5
5	Data files and content	7
5.1	Program for 2014 (same as for 2011) until	10

1 Instrumentation

The TRS met station consisted of the following instruments during 2014

Sensor	Serial number	Remark
Pt100		in Stevenson screen
Pt100		in Young screen
Young Wind Monitor		at 3 m
LiCor Li-200SB pyranometer		at 2 m
Tipping bucket precipitation gauge		at 2 m
Vent HygroClip T/Rh		at 2 m
CR10X-2M data logger		

2 Notes on the station data

- Young tipping was run with old calibration of 0.16 mm per pulse (tip) until approx. 2013-07-05 11:00:00 when the program was switched to new calibration of 0.1 mm per pulse. Raw data uses old calibration while Precipitation data file has been corrected for new calibration from from January to 5 July.
- Wind sensor is unreliable for the entire year. A problem went undiscovered that affected mainly wind speed. The reliability of the numbers must be checked against an independent sensor. During 2013 a new station TRSAWS was installed (2013-09-20 14:15:00) near TRSmet with a functioning wind sensor. Reliable wind data from late September until the end of year is available from this station.

3 Data coverage

- General data gap:
2013-07-10 10:00:00
- Relative humidity data missing from
2013-07-04 19:00:00 to 2013-07-05 11:00:00
2013-07-10 10:00:00
- Temperature data missing from
2013-04-19 07:00:00
2013-05-18 03:00:00 to 2013-05-18 12:00:00
2013-06-16 07:00:00 to 2013-07-05 11:00:00
2013-07-15 15:00:00
2013-09-15 13:00:00
- Wind data missing from
2013-04-30 03:00:00
2013-04-30 08:00:00
2013-05-03 01:00:00
2013-05-10 16:00:00 to 2013-05-10 18:00:00
2013-05-10 21:00:00 to 2013-05-10 23:00:00
2013-05-11 03:00:00 to 2013-05-11 04:00:00
2013-05-11 17:00:00 to 2013-05-11 20:00:00
2013-05-11 23:00:00 to 2013-05-12 00:00:00
2013-05-12 10:00:00
2013-05-12 12:00:00 to 2013-05-12 13:00:00
2013-05-12 16:00:00 to 2013-05-12 18:00:00
2013-05-12 20:00:00 to 2013-05-12 21:00:00
2013-05-13 06:00:00 to 2013-05-13 07:00:00
2013-05-13 13:00:00

2013-05-13 16:00:00 to 2013-05-14 03:00:00
2013-05-19 12:00:00
2013-05-21 02:00:00 to 2013-05-21 04:00:00
2013-05-21 10:00:00
2013-06-01 21:00:00
2013-06-09 04:00:00 to 2013-06-09 06:00:00
2013-06-09 10:00:00 to 2013-06-09 11:00:00
2013-06-09 14:00:00
2013-06-10 05:00:00
2013-06-14 09:00:00
2013-06-14 15:00:00 to 2013-06-14 21:00:00
2013-06-14 23:00:00 to 2013-06-15 10:00:00
2013-06-17 01:00:00 to 2013-06-17 11:00:00
2013-06-18 15:00:00
2013-06-19 03:00:00 to 2013-06-19 04:00:00
2013-06-22 13:00:00 to 2013-06-22 14:00:00
2013-06-22 17:00:00 to 2013-06-22 18:00:00
2013-06-28 09:00:00 to 2013-06-28 10:00:00
2013-06-28 13:00:00
2013-06-28 17:00:00 to 2013-06-28 18:00:00
2013-06-28 20:00:00
2013-06-29 00:00:00 to 2013-06-29 01:00:00
2013-07-05 11:00:00 to 2013-07-11 10:00:00
2013-07-13 08:00:00 to 2013-07-13 12:00:00
2013-07-15 20:00:00 to 2013-07-16 01:00:00
2013-07-18 17:00:00
2013-07-18 20:00:00
2013-07-28 22:00:00 to 2013-07-29 02:00:00
2013-07-29 19:00:00 to 2013-07-29 22:00:00
2013-08-11 16:00:00
2013-08-11 22:00:00 to 2013-08-11 23:00:00
2013-08-12 03:00:00
2013-08-12 09:00:00
2013-08-14 10:00:00 to 2013-08-14 14:00:00
2013-08-14 17:00:00
2013-08-14 23:00:00 to 2013-08-15 08:00:00
2013-08-15 14:00:00
2013-08-16 02:00:00 to 2013-08-16 04:00:00
2013-09-03 10:00:00
2013-09-13 10:00:00
2013-09-15 05:00:00 to 2013-09-15 07:00:00
2013-09-22 01:00:00
2013-09-22 03:00:00 to 2013-09-22 06:00:00
2013-09-22 08:00:00 to 2013-09-22 11:00:00
2013-09-22 17:00:00 to 2013-09-22 19:00:00
2013-09-22 21:00:00
2013-09-22 23:00:00 to 2013-09-23 00:00:00
2013-09-23 05:00:00
2013-09-23 08:00:00 to 2013-09-23 09:00:00
2013-09-28 00:00:00 to 2013-09-28 01:00:00
2013-09-28 14:00:00
2013-09-29 11:00:00 to 2013-09-29 12:00:00
2013-09-29 15:00:00
2013-09-30 16:00:00 to 2013-09-30 17:00:00
2013-10-09 09:00:00 to 2013-10-09 11:00:00
2013-10-09 17:00:00
2013-10-23 08:00:00 to 2013-10-24 02:00:00
2013-10-24 04:00:00 to 2013-10-25 16:00:00

2013-10-26 14:00:00 to 2013-10-26 16:00:00
 2013-10-27 02:00:00
 2013-10-27 04:00:00
 2013-10-29 08:00:00
 2013-11-05 05:00:00 to 2013-11-05 12:00:00
 2013-11-05 16:00:00
 2013-11-06 06:00:00 to 2013-11-06 11:00:00
 2013-11-06 14:00:00 to 2013-11-07 14:00:00
 2013-11-08 03:00:00 to 2013-11-08 07:00:00
 2013-11-08 12:00:00 to 2013-11-08 16:00:00
 2013-11-08 18:00:00 to 2013-11-08 19:00:00
 2013-11-08 21:00:00 to 2013-11-08 22:00:00
 2013-11-09 00:00:00 to 2013-11-09 07:00:00
 2013-11-09 10:00:00 to 2013-11-09 11:00:00
 2013-11-09 13:00:00
 2013-11-09 17:00:00
 2013-12-20 09:00:00 to 2013-12-20 17:00:00

- Daily data missing from
 2013-04-20 00:00:00
 2013-05-19 00:00:00
 2013-06-17 00:00:00 until end of year

4 Notes on data storage

Example of hourly data:

101, 2013, 185, 1300, 11.625, 12.45, NaN, 30.488, 2.3748, 142.69, 0.03002, 191.1, 0, 0, 0, 4.4492, 1227,
 11.98, 12.962, NaN, 26.656, NaN, 1256, NaN, 1200, 884.45

Column	Example data	Description
01:	101	ID
02:	2013	Year
03:	191	Day of Year
04:	1600	hour-minute (hhmm)
05:	11.625	2 Pt100 T in Stevenson screen)
06:	12.45	3 Pt100 in new Young screen
07:	NaN	4 Ventilated T
08:	30.488	5 Ventilated T
09:	2.3748	6 Mean horizontal wind speed
10:	142.69	7 resultant mean wind direction
11:	0.03002	8 Standard deviation of wind direction
12:	191.1	9 Global radiation
13:	0	10 Precipitation
14:	0	11 Not used
15:	0	12 Not used
16:	4.4492	13 hourly max wind speed
17:	1227	14 time for max wind speed
18:	11.98	15 Sample T Stevenson
19:	12.962	16 Sample T Young
20:	NaN	17 Sample ventilated T
21:	26.656	18 Sample ventilated Rh
22:	NaN	19 Max T
23:	1256	20 time for max T
24:	NaN	21 Min T
25:	1200	22 time for min T
26:	884.45	23 Barometric pressure

Example of daily data summaries:
124,2013,185,2400,9.3932,10.217,NaN,NaN,15.108,1358,5.3009,245,9.3688,526,
2.1094,127.07,120.77,2.72,13.974,0,0,883.86

Column	Example data	Description
01:	124	ID
02:	2013	Year
03:	185	Day of Year
04:	2400	hour-minute (hhmm)
05:	9.3932	2 Daily average T in Stevenson screen)
06:	10.217	3 Daily T from T/Rh in Young screen
07:	NaN	4 Daily T from ventilated T/Rh
08:	NaN	5 daily average Rh from ventilated T/Rh
08:	15.108	6 Daily maximum temperature in Young screen
10:	1358	7 hhmm for maximum daily temperature
11:	5.3009	8 Daily minimum temperature in Young screen
12:	245	9 hhmm for minimum daily temperature
13:	9.3688	10 Maximum wind speed
14:	526	11 hhmm for maximum wind speed
15:	2.1094	12 Average wind speed
16:	127-07	13 Average wind direction
17:	120.77	14 Incoming radiation
18:	2.72	15 Totalized precipitation
19:	13.974	16 Battery voltage
20:	0	17 Not used
21:	0	18 Not used
21:	883.86	18 Average barometric pressure

Example of 'Synoptic' output:

103,2013,185,1300,12.962

Column	Example data	Description
01:	103	ID
02:	2013	Year
03:	185	Day of Year
04:	1300	hour-minute (hhmm)
05:	12.962	Pt100 in Young screen

5 Data files and content

TRSmnet2014.csv Raw data file

TRS_met_2014_Barometric_pressure.csv

2013-01-01 01:00:00,857.2

TRS_met_2014_Precipitation.csv

Date-time, Precipitation

2013-01-01 01:00:00,0.00

TRS_met_2014_Radiation.csv

Date-time, Global radiation

2013-01-01 01:00:00,-4.97

TRS_met_2014_Relative_humidity.csv

Date-time, Vented Rh, ssample ventilated Rh

2013-01-01 01:00:00,97.7,98.3

TRS_met_2014_Temperature.csv

Date-time, hourly average T (Stevenson), hourly average T (Young), hourly average vented T/Rh, sample T (Stevenson), Sample T (Young), sample T vent, max T vent, time for max T vent, min T vent, time for min T vent

2013-01-01 01:00:00,-6.85,-6.55,-7.71,-7.15,-6.51,-7.65,-6.97,19,-8.57,38

TRS_met_2014_Wind.csv

Date-time, Mean horizontal wind speed, resultant mean wind direction, hourly max wind speed, time of max wind spd

2013-01-01 01:00:00,1.3,324.8,0.0361,4.61,29

TRS_met_2014_Daily_data.csv

Data columns follows description above except last two columns (not used)

2013-01-02 00:00:00,-7.97,-7.57,-8.58,94.2,-5.88,16,-11.73,2233,4.6,29,1.1,28.4,-4.8,0.0,13.99

TRS_met_2014_Synop_data.csv

Date-time, sample temperature

2013-01-01 01:00:00,-6.51

The data collected during 2014 is summarized the figure 1 and Table 1.

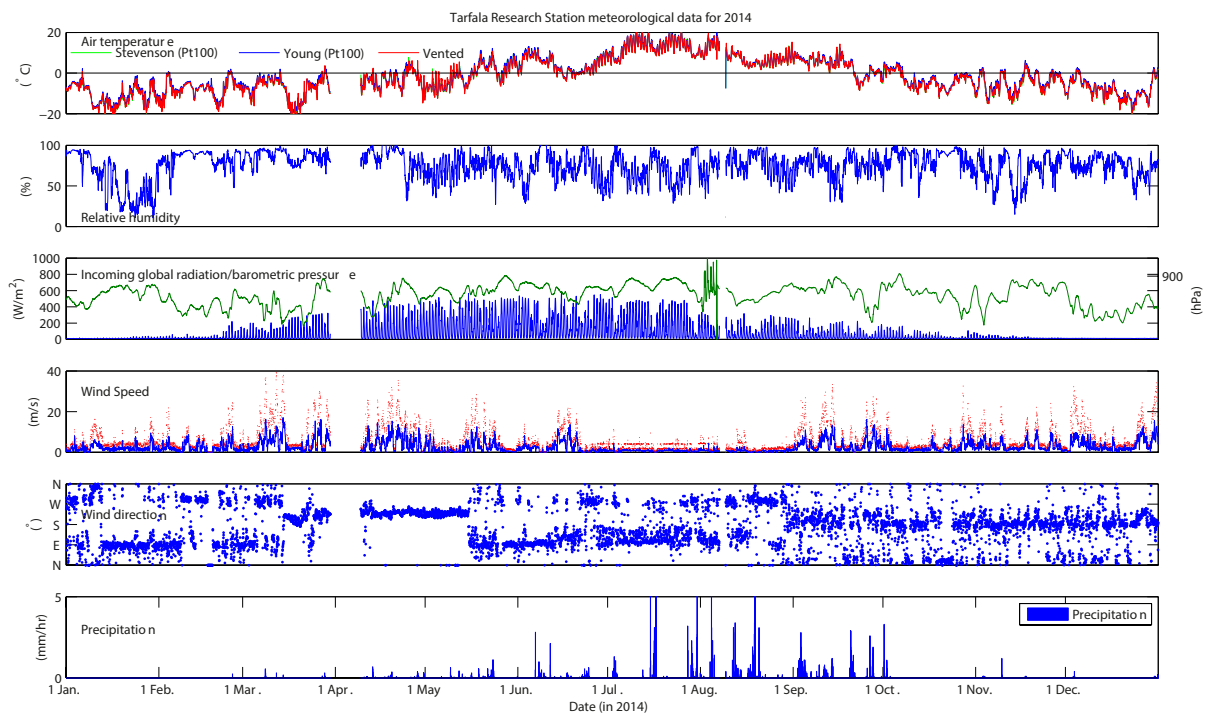


Figure. 1. Summary of meteorological data from Tarfala Research Station automatic weather station 2014.

Table. 1. Monthly averages of meteorological parameters from the Tarfala Research Station automatic weather station 2014.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Average air temperature (Stevenson)												
(°C)	−11.3	−8.2	−7.8	−3.3	−1.0	4.1	12.7	7.8	3.5	−3.7	−5.4	−8.4
<i>n</i>	743	671	728	516	743	743	742	714	743	767	743	765
Average air temperature (Young)												
(°C)	−10.4	−7.6	−7.1	−2.8	−0.7	4.5	13.0	286.7	4.0	−3.0	−4.4	−7.8
<i>n</i>	743	671	728	516	743	743	742	718	743	767	743	765
Average air temperature												
(°C)	−11.3	−8.4	−8.0	−3.4	−1.2	3.8	12.5	8.0	3.5	−3.8	−5.4	−8.6
<i>n</i>	743	671	728	516	743	743	743	718	743	767	743	765
Positive degree sum												
(°C)	1	4	25	187	1154	3004	9307	—	3110	291	140	52
<i>n</i>	2	14	20	100	331	617	743	717	583	135	116	48
Average relative humidity												
(%)	58.4	83.7	86.1	84.0	73.1	72.5	69.5	75.8	74.9	83.4	70.2	75.3
<i>n</i>	743	671	728	516	743	743	743	718	743	767	743	765
Average incoming global radiation												
(W m ^{−2})	11.5	18.4	56.9	124.0	162.7	159.8	146.5	72.9	45.4	25.8	14.9	11.8
<i>n</i>	743	671	728	516	743	743	743	717	743	767	743	765
Global incoming energy sum												
(W m ^{−2})	8554	12362	41428	—	120921	118767	108876	—	33704	19773	11088	9049
<i>n</i>	743	671	728	516	743	743	743	717	743	767	743	765
Totalized precipitation												
(mm)	0.00	0.25	2.94	6.56	11.94	18.06	81.41	98.00	90.10	8.50	2.40	1.10
<i>n</i>	743	671	728	516	743	743	743	718	743	767	743	765
Average wind speed												
(m s ^{−1})	2.0	2.2	4.2	4.7	2.2	2.3	0.7	0.7	3.7	2.2	2.8	3.7
<i>n</i>	743	671	728	516	743	743	743	718	743	767	743	765
Average barometric pressure												
(hPa)	880.2	868.2	869.6	877.3	884.4	884.8	889.7	879.3	883.0	881.1	882.9	864.2
<i>n</i>	743	671	728	516	743	743	743	718	743	767	743	765

Logger program

5.1 Program for 2014 (same as for 2011) until

```

;{CR10X}
*Table 1 Program
01: 10.0000 Execution Interval (seconds)

;-----
; Check battery voltage
; and stop execution if lower than 9.7V
1: Batt Voltage (P10)
1: 10 Loc [ Battery ]

2: If (X<=>F) (P89)
1: 10 X Loc [ Battery ]
2: 4 <
3: 9.7 F
4: 0 Go to end of Program Table

;-----
; A I R T E M P E R A T U R E
; Measure R/R0 for old met cage Rt100
3: 3W Half Bridge (P7)
1: 1 Reps
2: 33 25 mV 50 Hz Rejection Range
3: 1 SE Channel
4: 2 Excite all reps w/Exchan 2
5: 2100 mV Excitation
6: 22 Loc [ R_R0_T_1 ]
7: 95.969 Mult
8: 0 Offset

; Meaasure R/R0 for Young screen Rt100
4: 3W Half Bridge (P7)
1: 1 Reps
2: 33 25 mV 50 Hz Rejection Range
3: 3 SE Channel
4: 2 Excite all reps w/Exchan 2
5: 2100 mV Excitation
6: 23 Loc [ R_R0_T_2 ]
7: 100.2 Mult
8: 0 Offset

; Calculate T for both Rt100
5: Temperature RTD (P16)
1: 2 Reps
2: 22 R/R0 Loc [ R_R0_T_1 ]
3: 1 Loc [ T_1 ]
4: 1 Mult
5: 0 Offset

;-----
; V E N T I L A T E D T & Rh
; Measure temperature from ventilated
; HygroClip sensor
6: Volt (Diff) (P2)
1: 1 Reps
2: 35 2500 mV 50 Hz Rejection Range
3: 3 DIFF Channel
4: 3 Loc [ T_vent ]
5: .1 Mult
6: -40 Offset

; Measure humidity from ventilated
; HygroClip sensor
7: Volt (Diff) (P2)
1: 1 Reps
2: 35 2500 mV 50 Hz Rejection Range
3: 4 DIFF Channel
4: 4 Loc [ rH_vent ]
5: .1 Mult
6: 0.0 Offset

;-----
; W I N D
; Measure wind speed on Young Wind Monitor
8: Pulse (P3)
1: 1 Reps
2: 1 Pulse Channel 1
3: 21 Low Level AC, Output Hz
4: 5 Loc [ Wind_spd ]
5: .098 Mult
6: 0 Offset

; Measure wind direction on Young Wind Monitor
```

```

9: Excite-Delay (SE) (P4)
1: 1      Reps
2: 5      2500 mV Slow Range
3: 9      SE Channel
4: 1      Excite all reps w/Exchan 1
5: 2      Delay (0.01 sec units)
6: 2500   mV Excitation
7: 6      Loc [ Wind_dir ]
8: .142   Mult
9: -135   Offset

; Make corrections to wind direction
10: If (X<=>F) (P89)
1: 6      X Loc [ Wind_dir ]
2: 4      <
3: 0      F
4: 30     Then Do

11: Z=X+F (P34)
1: 6      X Loc [ Wind_dir ]
2: 360    F
3: 6      Z Loc [ Wind_dir ]

12: End (P95)

;-----
; G L O B A L   R A D I A T I O N
; Measure Li200s Pyranometer
13: Volt (SE) (P1)
1: 1      Reps
2: 33     25 mV 50 Hz Rejection Range
3: 10     SE Channel
4: 7      Loc [ Li200S ]
5: 116.55 Mult
6: 0      Offset

;-----
; P R E C I P I T A T I O N
; Measure tipping bucket rain gauge
14: Pulse (P3)
1: 1      Reps
2: 2      Pulse Channel 2
3: 2      Switch Closure, All Counts
4: 8      Loc [ Precip ]
5: .16    Mult
6: 0      Offset

;-----
; I N T E R N A L   T E M P E R A T U R E
15: Internal Temperature (P17)
1: 9      Loc [ T_int ]

;-----
; B A R O M E T R I C   P R E S S U R E
16: If time is (P92)
1: 59     Minutes (Seconds --) into a
2: 60     Interval (same units as above)
3: 48     Set Port 8 High

17: If time is (P92)
1: 0      Minutes (Seconds --) into a
2: 60     Interval (same units as above)
3: 30     Then Do

18: Volt (SE) (P1)
1: 1      Reps
2: 15     2500 mV Fast Range
3: 11     SE Channel
4: 11     Loc [ P_mb ]
5: 0.2    Mult
6: 600    Offset

19: Do (P86)
1: 58     Set Port 8 Low

20: End (P95)

;-----
; H O U R L Y   O U T P U T
21: If time is (P92)
1: 0      Minutes (Seconds --) into a
2: 60     Interval (same units as above)
3: 10     Set Output Flag High (Flag 0)

22: Set Active Storage Area (P80)
1: 1      Final Storage Area 1

```

```

2: 101      Array ID

23: Real Time (P77)
1: 1220      Year,Day,Hour/Minute (midnight = 2400)

24: Resolution (P78)
1: 1      High Resolution

; Store average unvent and vent T and Rh
25: Average (P71)
1: 4      Reps
2: 1      Loc [ T_1      ]

26: Resolution (P78)
1: 1      High Resolution

; Store wind speed, dir and std dev
27: Wind Vector (P69)
1: 1      Reps
2: 1      Samples per Sub-Interval
3: 0      S, theta(1), sigma(theta(1)) with polar sensor
4: 5      Wind Speed/East Loc [ Wind_spd ]
5: 6      Wind Direction/North Loc [ Wind_dir ]

28: Resolution (P78)
1: 1      High Resolution

; Store average global rad
29: Average (P71)
1: 1      Reps
2: 7      Loc [ Li200S      ]

; Store hourly precipitation
30: Totalize (P72)
1: 1      Reps
2: 8      Loc [ Precip      ]

; no data
31: Average (P71)
1: 2      Reps
2: 12     Loc [ _____ ]

32: Resolution (P78)
1: 1      High Resolution

; Store maximum wind speed during last hour
33: Maximum (P73)
1: 1      Reps
2: 10     Value with Hr-Min
3: 5      Loc [ Wind_spd ]

34: Resolution (P78)
1: 1      High Resolution

; Store transient unvent and vent T and Rh
35: Sample (P70)
1: 4      Reps
2: 1      Loc [ T_1      ]

36: Resolution (P78)
1: 1      High Resolution

; Store max vent T
37: Maximum (P73)
1: 1      Reps
2: 10     Value with Hr-Min
3: 3      Loc [ T_vent      ]

38: Resolution (P78)
1: 1      High Resolution

; Store min vent T
39: Minimum (P74)
1: 1      Reps
2: 10     Value with Hr-Min
3: 3      Loc [ T_vent      ]

40: Resolution (P78)
1: 1      High Resolution

41: Sample (P70)
1: 1      Reps
2: 11     Loc [ P_mb      ]

;-----
; D A I L Y   O U T P U T
42: If time is (P92)

```

```

1: 0      Minutes (Seconds --) into a
2: 1440   Interval (same units as above)
3: 10     Set Output Flag High (Flag 0)

43: Set Active Storage Area (P80)
1: 1      Final Storage Area 1
2: 124    Array ID

44: Real Time (P77)
1: 1220   Year,Day,Hour/Minute (midnight = 2400)

45: Resolution (P78)
1: 1      High Resolution

; Store daily average unvent and vent T & Rh
46: Average (P71)
1: 4      Reps
2: 1      Loc [ T_1      ]

47: Resolution (P78)
1: 1      High Resolution

; Store daily max unvent T
48: Maximum (P73)
1: 1      Reps
2: 10     Value with Hr-Min
3: 2      Loc [ T_2      ]

49: Resolution (P78)
1: 1      High Resolution

; Store daily min unvent T
50: Minimum (P74)
1: 1      Reps
2: 10     Value with Hr-Min
3: 2      Loc [ T_2      ]

51: Resolution (P78)
1: 1      High Resolution

; Store daily max wind speed
52: Maximum (P73)
1: 1      Reps
2: 10     Value with Hr-Min
3: 5      Loc [ Wind_spd  ]

53: Resolution (P78)
1: 1      High Resolution

; Store average wind vector
54: Wind Vector (P69)
1: 1      Reps
2: 1      Samples per Sub-Interval
3: 1      S, theta(1) with polar sensor
4: 5      Wind Speed/East Loc [ Wind_spd  ]
5: 6      Wind Direction/North Loc [ Wind_dir ]

55: Resolution (P78)
1: 1      High Resolution

; Store daily avg global radioation
56: Average (P71)
1: 1      Reps
2: 7      Loc [ Li200S    ]

; Store daily precipitation
57: Totalize (P72)
1: 1      Reps
2: 8      Loc [ Precip    ]

; Store sample of battery voltage
58: Sample (P70)
1: 1      Reps
2: 10     Loc [ Battery   ]

; no data
59: Average (P71)
1: 2      Reps
2: 12     Loc [ ----- ]

60: Resolution (P78)
1: 1      High Resolution

61: Average (P71)
1: 1      Reps
2: 11     Loc [ P_mb      ]

```

```

;-----
; S Y N O P T I C O U T P U T
; transient T data is stored every 3 hrs
; according to synoptic standards.
62: If time is (P92)
1: 60      Minutes (Seconds --) into a
2: 180     Interval (same units as above)
3: 10      Set Output Flag High (Flag 0)

63: Set Active Storage Area (P80)
1: 1       Final Storage Area 1
2: 103     Array ID

64: Real Time (P77)
1: 1220    Year,Day,Hour/Minute (midnight = 2400)

65: Resolution (P78)
1: 1       High Resolution

66: Sample (P70)
1: 1       Reps
2: 2       Loc [ T_2      ]

*Table 2 Program
01: 0.0000  Execution Interval (seconds)

*Table 3 Subroutines

End Program

1  [ T_1      ] RW--  3      1      Start ----- ---
2  [ T_2      ] RW--  6      1      ----- End
3  [ T_vent   ] RW--  5      1      -----
4  [ rH_vent  ] RW--  3      1      -----
5  [ Wind_spd ] RW--  4      1      -----
6  [ Wind_dir ] RW--  4      2      -----
7  [ Li200S   ] RW--  2      1      -----
8  [ Precip   ] RW--  2      1      -----
9  [ T_int    ] -W--  0      1      -----
10 [ Battery  ] RW--  2      1      -----
11 [ P_mb     ] RW--  2      1      -----
12 [         ] R---  2      0      -----
13 [         ] R---  2      0      -----
14 [         ] ----  0      0      -----
15 [         ] ----  0      0      -----
16 [         ] ----  0      0      -----
17 [         ] ----  0      0      -----
18 [         ] ----  0      0      -----
19 [         ] ----  0      0      -----
20 [         ] ----  0      0      -----
21 [         ] ----  0      0      -----
22 [ R_RO_T_1 ] RW--  1      1      -----
23 [ R_RO_T_2 ] RW--  1      1      -----

```