Tarfala Research Station automatic weather station, 2013

Peter Jansson

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Contents

1 Instrumentation

The TRS met station consisted of the following instruments during 2013

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 to2013-10-26 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 pressuree

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

`TRSmet2013.csv` Raw data file

`TRS_met_2013_Barometric_pressure.csv`
`2013-01-01 01:00:00,857.2`
`TRS_met_2013_Precipitation.csv`
Date-time, Precipitation
`2013-01-01 01:00:00,0.00`

`TRS_met_2013_Radiation.csv`
Date-time, Global radiation
`2013-01-01 01:00:00,-4.97`

`TRS_met_2013_Relative_humidity.csv`
Date-time, Vented Rh, ssample ventilated Rh
`2013-01-01 01:00:00,97.7,98.3`

`TRS_met_2013_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_2013_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_2013_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_2013_Synop_data.csv`
Date-time, sample temperature
`2013-01-01 01:00:00,-6.51`

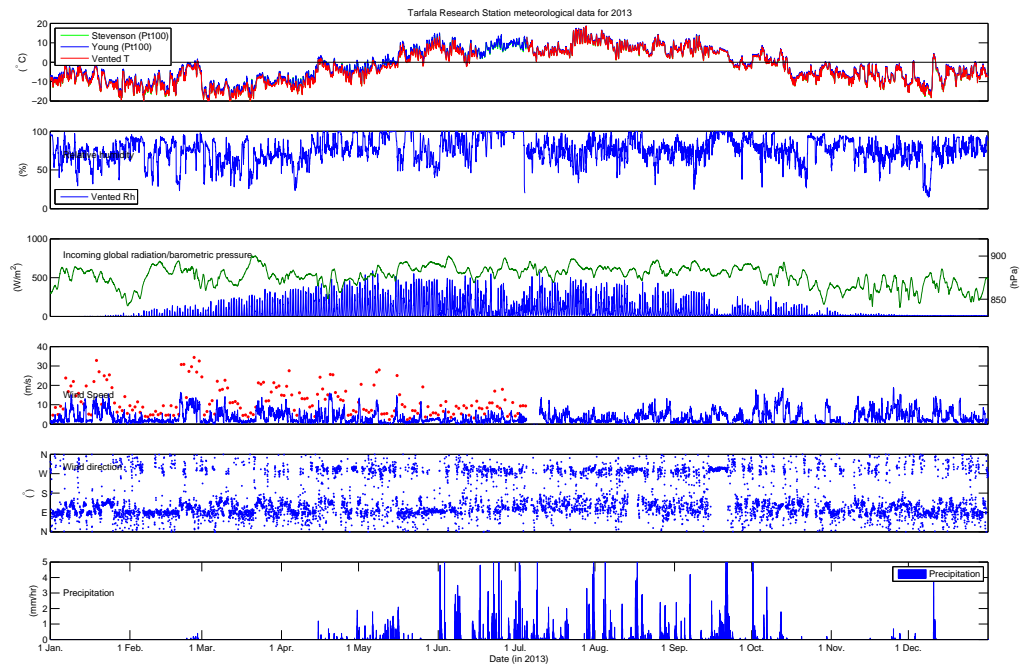The data collected during 2013 is summarized the figure 1 and Table 1.

Figure. 1. Summary of meteorological data from Tarfala Research Station automatic weather station 2013.

Table. 1. Monthly averages of meteorological parameters from the Tarfala Research Station automatic weather station 2013.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Average air temperature (Stevenson)												
(°C)	−8.5	−9.4	−12.5	−6.2	1.8	6.9	8.3	8.1	4.4	−2.5	−6.9	−7.6
n	743	671	767	742	733	743	739	767	742	767	743	767
Average air temperature (Young)												
(°C)	−7.8	−8.6	−11.9	−5.7	2.4	7.3	8.7	8.5	4.8	−2.0	−6.3	−6.9
n	743	671	767	743	743	743	739	767	742	767	743	767
Average air temperature												
(°C)	−8.9	−9.8	−13.2	−7.2	0.7	5.3	8.0	8.0	4.3	−2.7	−6.9	−7.6
n	743	671	767	743	743	390	634	767	743	767	743	767
Positive degree sum												
(°C)	0	3	0	34	1871	2086	−	6120	3498	691	0	61
n	1	6	0	37	370	369	−	767	582	239	0	32
Average relative humidity												
(%)	69.7	74.1	65.7	75.0	80.1	87.9	75.5	77.2	82.2	76.7	74.7	72.1
n	743	671	767	743	743	743	725	767	743	767	743	767
Average incoming global radiation												
(W m^{-2})	−3.4	8.1	47.3	101.7	144.8	108.2	115.3	90.2	53.6	29.1	13.3	10.7
n	743	671	767	743	743	743	742	767	743	767	743	767
Global incoming energy sum												
(W m^{-2})	470	7594	38111	76724	108067	80505	NaN	69203	39819	22319	9902	8183
n	70	193	358	474	597	679	731	767	743	767	743	767
Totalized precipitation												
(mm)	0.00	1.40	0.00	12.70	55.60	153.90	170.80	162.70	147.90	50.60	3.50	15.20
n	743	671	767	743	743	743	742	767	743	767	743	767
Average wind speed												
(m s^{-1})	4.2	3.7	3.7	3.8	2.5	2.1	3.1	3.4	2.8	5.1	4.8	3.8
n	743	671	767	741	700	690	643	742	712	699	677	758
Average barometric pressure												
(hPa)	872.4	877.6	877.7	872.8	883.6	885.1	884.2	883.4	884.6	873.3	863.7	863.4
n	743	671	767	743	743	743	742	767	743	767	743	767

Logger program

5.1 Program for 2013 (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
```

11

```
 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_R0_T_1 ]  RW--   1       1       ----- ------ ---
23      [ R_R0_T_2 ]  RW--   1       1       ----- ------ ---
```