



Tarfala Research Station automatic weather station, 2009

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1 Instrumentation

The TRS met station consisted of the following instruments during 2009

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

- Long break in data during winter due to power failure

3 Data coverage

- General data gap:
2009-01-07 17:00:00 to 2009-03-27 10:00:00

4 Notes on data storage

Example of hourly data:

101,2009,185,1300,8.7021,8.8221,7.6951,58.49,3.4295,135.64,0.03752,356.5,0,0,0,10.153,1249,
8.6837,8.895,7.8562,57.586,8.4004,1221,7.0976,1213,883.69

Column	Example data	Description
01:	101	ID
02:	2009	Year
03:	191	Day of Year
04:	1600	hour-minute (hhmm)
05:	8.7021	2 Pt100 T in Stevenson screen)
06:	8.8221	3 Pt100 in new Young screen
07:	7.6951	4 Ventilated T
08:	58.49	5 Ventilated T
09:	3.4295	6 Mean horizontal wind speed
10:	135.64	7 resultant mean wind direction
11:	0.03752	8 Standard deviation of wind direction
12:	365.5	9 Global radiation
13:	0	10 Precipitation
14:	0	11 Not used
15:	0	12 Not used
16:	19.153	13 hourly max wind speed
17:	1249	14 time for max wind speed
18:	8.6837	15 Sample T Stevenson
19:	8.895	16 Sample T Young
20:	7.8562	17 Sample ventilated T
21:	57.586	18 Sample ventilated Rh
22:	8.4004	19 Max T
23:	1221	20 time for max T
24:	7.0976	21 Min T
25:	1213	22 time for min T
26:	883.69	23 Barometric pressure

Example of daily data summaries:
124, 2009, 185, 2400, 7.5788, 7.8442, 6.8219, 62.238, 11.134, 1551, 4.3545, 131, 12.799, 245,
4.0137, 121.46, 180.49, 0, 14.007, 0, 0, 883.37

Column	Example data	Description
01:	124	ID
02:	2009	Year
03:	185	Day of Year
04:	2400	hour-minute (hhmm)
05:	7.5788	2 Daily average T in Stevenson screen)
06:	7.8442	3 Daily T from T/Rh in Young screen
07:	6.8219	4 Daily T from ventilated T/Rh
08:	62.238	5 daily average Rh from ventilated T/Rh
08:	11.134	6 Daily maximum temperature in Young screen
10:	1551	7 hhmm for maximum daily temperature
11:	4.3545	8 Daily minimum temperature in Young screen
12:	131	9 hhmm for minimum daily temperature
13:	12.799	10 Maximum wind speed
14:	245	11 hhmm for maximum wind speed
15:	4.0137	12 Average wind speed
16:	121.46	13 Average wind direction
17:	180.49	14 Incoming radiation
18:	0	15 Totalized precipitation
19:	14.007	16 Battery voltage
20:	0	17 Not used
21:	0	18 Not used
21:	893.37	18 Average barometric pressure

Example of 'Synoptic' output:
103, 2009, 185, 1300, 8.895

Column	Example data	Description
01:	103	ID
02:	2009	Year
03:	185	Day of Year
04:	1300	hour-minute (hhmm)
05:	8.895	Pt100 in Young screen

5 Data files and content

TRSmnet2009.csv Raw data file

TRS_met_2009_Barometric_pressure.csv

2009-01-01 01:00:00,876.7

TRS_met_2009_Precipitation.csv

Date-time, Precipitation

2009-01-01 01:00:00,0.00

TRS_met_2009_Radiation.csv

Date-time, Global radiation

2009-01-01 01:00:00,-1.05

TRS_met_2009_Relative_humidity.csv

Date-time, Vented Rh, ssample ventilated Rh

2009-01-01 01:00:00,78.2,83.9

TRS_met_2009_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
2009-01-01 01:00:00,-13.16,-12.82,-13.50,-12.95,-12.48,-13.64,-13.15,3,-13.81,45

TRS_met_2009_Wind.csv

Date-time, Mean horizontal wind speed, resultant mean wind direction, hourly max wind speed, time of max wind
spd
2009-01-01 01:00:00,1.9,311.2,0.0328,4.00,3

TRS_met_2009_Daily_data.csv

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

2009-01-02 00:00:00,-12.52,-12.14,-12.93,71.0,-11.15,757,-13.41,1340,13.8,1659,
2.7,193.3,-0.8,0.0,12.57

TRS_met_2009_Synop_data.csv

Date-time, sample temperature

2009-01-01 01:00:00,-12.48

The data collected during 2009 is summarized the figure 1 and Table 1.

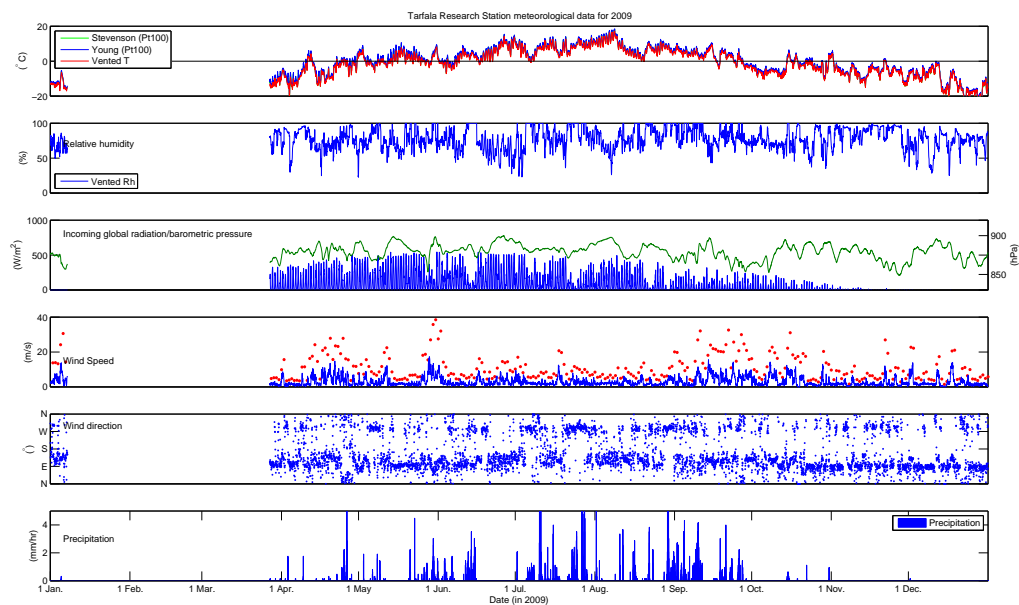


Figure. 1. Summary of meteorological data from Tarfala Research Station automatic weather station 2009.

Table. 1. Monthly averages of meteorological parameters from the Tarfala Research Station automatic weather station 2009.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Average air temperature (Stevenson)												
(°C)	—	—	—	−5.6	1.8	4.1	7.9	8.5	3.3	−3.5	−5.8	−12.0
<i>n</i>	—	—	—	743	743	743	743	767	743	767	743	767
Average air temperature (Young)												
(°C)	—	—	—	−5.1	2.4	4.6	8.2	8.9	3.8	−3.0	−5.2	−11.4
<i>n</i>	—	—	—	743	743	743	743	767	743	767	743	767
Average air temperature												
(°C)	—	—	—	−6.4	0.9	3.3	7.1	7.7	2.6	−4.1	−6.2	−12.3
<i>n</i>	—	—	—	743	743	743	743	767	743	767	743	767
Positive degree sum												
(°C)	—	—	—	111	1204	2860	5257	5923	2332	174	116	0
<i>n</i>	—	—	—	85	434	553	731	760	579	100	61	0
Average relative humidity												
(%)	—	—	—	75.3	77.0	71.1	82.2	80.4	82.5	73.9	86.1	71.7
<i>n</i>	—	—	—	743	743	743	743	767	743	767	743	767
Average incoming global radiation												
(W m ^{−2})	—	—	—	103.2	149.3	158.1	105.3	80.0	37.9	21.2	−1.8	−4.1
<i>n</i>	—	—	—	743	743	743	743	767	743	767	743	767
Global incoming energy sum												
(W m ^{−2})	—	—	—	76992	111029	117482	78348	61691	28667	17930	1152	5
<i>n</i>	—	—	—	496	651	736	681	548	411	290	111	5
Totalized precipitation												
(mm)	—	—	—	36.16	61.44	66.72	197.92	138.08	201.44	9.12	1.28	0.16
<i>n</i>	—	—	—	743	743	743	743	767	743	767	743	767
Average wind speed												
(m s ^{−1})	—	—	—	3.5	3.4	2.9	2.7	2.4	4.5	3.5	1.9	2.5
<i>n</i>	—	—	—	743	743	743	743	767	743	767	743	767
Average barometric pressure												
(hPa)	—	—	—	880.1	882.2	885.8	882.6	883.6	872.8	878.6	872.5	876.9
<i>n</i>	—	—	—	743	743	743	743	767	743	767	743	767

Logger program

5.1 Program for 2009 (same as for end of 2008)

```
;{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      -----

```