

Tarfala Research Station automatic weather station, 2011

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November 11, 2014

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1 Instrumentation

The TRS met station consisted of the following instruments during 2011

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

- Wind sensor failed in November 2010 repaired in January 2011

3 Data coverage

- Wind data missing from
2011-01-01 01:00:00 to 2011-01-24 16:00:00
- Daily data missing from
2011-01-02 00:00:00 to 2011-01-25 00:00:00

4 Notes on data storage

Example of hourly data:

101,2011,185,1300,11.739,11.953,10.367,50.191,2.1697,277.48,0.03989,481.55,0,0,0,5.1842,1249,
12.448,13.08,11.221,51.105,11.32,1254,9.6371,1201,890.03

Column	Example data	Description
01:	101	ID
02:	2011	Year
03:	191	Day of Year
04:	1600	hour-minute (hhmm)
05:	11.739	2 Pt100 T in Stevenson screen)
06:	11.953	3 Pt100 in new Young screen
07:	10.367	4 Ventilated T
08:	50.191	5 Ventilated T
09:	2.1697	6 Mean horizontal wind speed
10:	277.48	7 resultant mean wind direction
11:	0.03989	8 Standard deviation of wind direction
12:	481.55	9 Global radiation
13:	0	10 Precipitation
14:	0	11 Not used
15:	0	12 Not used
16:	5.1842	13 hourly max wind speed
17:	1249	14 time for max wind speed
18:	12.448	15 Sample T Stevenson
19:	13.08	16 Sample T Young
20:	11.221	17 Sample ventilated T
21:	51.105	18 Sample ventilated Rh
22:	11.32	19 Max T
23:	1254	20 time for max T
24:	9.6371	21 Min T
25:	1201	22 time for min T
26:	890.03	23 Barometric pressure

Example of daily data summaries:
124,2011,185,2400,9.3552,9.633,8.3079,59.848,13.559,1712,4.4415,338,5.1842,1249,
1.7253,157.41,166.86,0,13.966,0,0,889.77

Column	Example data	Description
01:	124	ID
02:	2011	Year
03:	185	Day of Year
04:	2400	hour-minute (hhmm)
05:	9.3552	2 Daily average T in Stevenson screen)
06:	9.633	3 Daily T from T/Rh in Young screen
07:	8.3079	4 Daily T from ventilated T/Rh
08:	59.848	5 daily average Rh from ventilated T/Rh
08:	13.559	6 Daily maximum temperature in Young screen
10:	1712	7 hhmm for maximum daily temperature
11:	4.4415	8 Daily minimum temperature in Young screen
12:	338	9 hhmm for minimum daily temperature
13:	5.1842	10 Maximum wind speed
14:	1249	11 hhmm for maximum wind speed
15:	1.7253	12 Average wind speed
16:	157.41	13 Average wind direction
17:	166.86	14 Incoming radiation
18:	0	15 Totalized precipitation
19:	13.966	16 Battery voltage
20:	0	17 Not used
21:	0	18 Not used
21:	889.77	18 Average barometric pressure

Example of 'Synoptic' output:
103,2011,185,1300,13.08

Column	Example data	Description
01:	103	ID
02:	2011	Year
03:	185	Day of Year
04:	1300	hour-minute (hhmm)
05:	13.08	Pt100 in Young screen

5 Data files and content

TRSmnet2011.csv Raw data file

TRS_met_2011_Barometric_pressure.csv

2011-01-01 01:00:00,859.9

TRS_met_2011_Precipitation.csv

Date-time, Precipitation

2011-01-01 01:00:00,0.00

TRS_met_2011_Radiation.csv

Date-time, Global radiation

2011-01-01 01:00:00,-4.54

TRS_met_2011_Relative_humidity.csv

Date-time, Vented Rh, ssample ventilated Rh

2011-01-01 01:00:00,86.3,87.3

TRS_met_2011_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

2011-01-01 01:00:00,-9.67,-9.05,-10.48,-9.89,-8.46,-11.00,-9.91,24,-11.30,54

TRS_met_2011_Wind.csv

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

2011-01-01 01:00:00,NaN,NaN,NaN,NaN,0

TRS_met_2011_Daily_data.csv

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

2011-01-02 00:00:00,-6.89,-6.32,-7.45,71.9,-4.93,1656,-10.70,128,NaN,NaN,
NaN,NaN,-4.3,0.0,13.99

TRS_met_2011_Synop_data.csv

Date-time, sample temperature

2011-01-01 01:00:00,-8.46

The data collected during 2011 is summarized the figure 1 and Table 1.

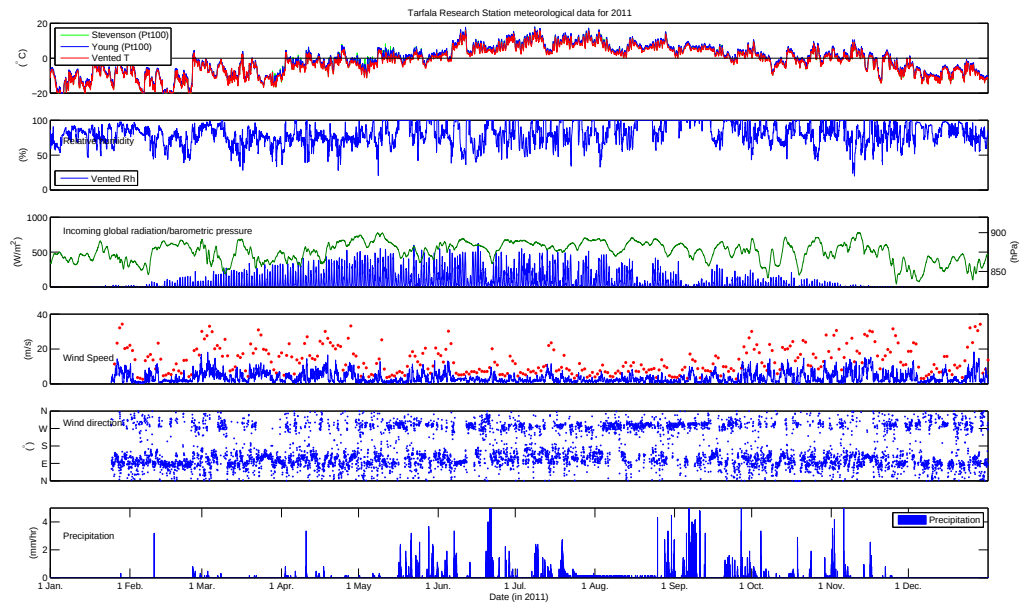


Figure 1: Summary of meteorological data from Tarfala Research Station automatic weather station 2011.

Table 1: Monthly averages of meteorological parameters from the Tarfala Research Station automatic weather station 2011.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Average air temperature (Stevenson)												
(°C)	−10.6	−12.3	−8.4	−2.2	−0.1	6.3	9.5	7.1	4.1	0.2	−1.2	−8.1
<i>n</i>	743	671	767	743	743	743	743	767	743	767	743	767
Average air temperature (Young)												
(°C)	−9.9	−11.7	−7.9	−1.8	0.2	6.8	9.9	7.5	4.6	0.8	−0.5	−7.5
<i>n</i>	743	671	767	743	743	743	743	767	743	767	743	767
Average air temperature												
(°C)	−11.1	−12.8	−8.9	−3.2	−1.3	5.4	8.6	6.3	3.3	−0.4	−1.7	−8.5
<i>n</i>	743	671	767	743	743	743	743	767	743	767	743	767
Positive degree sum												
(°C)	0	18	10	224	449	4097	6367	4804	2572	934	770	0
<i>n</i>	0	17	9	112	300	697	743	767	657	351	321	2
Average relative humidity												
(%)	78.4	74.8	75.9	72.4	84.2	77.0	80.7	86.8	92.0	80.4	78.1	83.7
<i>n</i>	743	671	767	743	743	743	743	767	743	767	743	767
Average incoming global radiation												
(W m ^{−2})	−3.4	8.9	48.5	99.1	127.9	132.0	108.7	63.9	27.8	15.8	−1.5	−4.4
<i>n</i>	743	671	767	743	743	743	743	767	743	767	743	767
Global incoming energy sum												
(W m ^{−2})	346	8025	38941	74735	95442	98101	80997	49925	22157	14108	1451	0
<i>n</i>	58	190	360	469	595	696	635	507	369	280	121	1
Totalized precipitation												
(mm)	0.32	6.56	2.88	14.56	101.76	205.12	132.16	62.08	225.92	57.92	75.36	0.00
<i>n</i>	743	671	767	743	743	743	743	767	743	767	743	767
Average wind speed												
(m s ^{−1})	—	2.7	5.1	4.4	2.7	3.1	2.5	2.2	3.2	4.2	4.9	3.6
<i>n</i>	—	671	767	743	743	743	743	767	743	767	743	767
Average barometric pressure												
(hPa)	869.3	874.4	869.4	876.6	881.4	883.0	884.7	883.8	876.9	872.7	875.4	857.2
<i>n</i>	743	671	767	743	743	743	743	767	743	767	743	767

Logger program

5.1 Program for 2011 (same as for 2010)

```

;{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

; Measure 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

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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      -----

```