



# Tarfala Research Station automatic weather station, 1994

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# 1 Instrumentation

The TRS met station consisted of the following instruments during 1994

Sensor	Serial number	Remark
Pt100		in Stevenson screen
Pt100		in Young screen added in late season
T/Rh		at 2 m
Young Wind Monitor		at 3 m
LiCor Li-200SB pyranometer		at 2 m
CS Q-7 net radiometer		at 2 m, removed in late season
Tipping bucket precipitation gauge		at 2 m
CR21X and CR10 data logger		Switched in late summer

## 2 Notes on the station data

- Major reprogramming made in fall. Data is missing for most of the fall until early winter when new programming is evident. It is likely that the change in programming also reflects change in logger type. The program reproduced in this report is the CR10 program valid for the fall and winter.
- New, third, temperature measurement added, a Pt100 in a Young unventilated shield
- NOTE 3-hr sampling of data during winter, 1-hr sampling from summer and on
- Some original logger files are missing and existing data files are based on processed data.
- Wind direction sensor misbehaving since 1993 and until 1 August.
- No radiation measurements from December is available (seems like sensor failure or programming error)

## 3 Data coverage

- Breaks in data between  
1994-07-30 12:00:00 and 1994-08-01 15:00:00  
1994-08-26 14:00:00 and 1994-08-27 12:00:00  
1994-09-30 00:00:00 and 1994-11-30 19:00:00
- wind data missing from  
1994-07-02 11:00:00: all wind data 1994-07-10 22:00:00: wind direction and standard deviation of wind direction 1994-07-11 23:00:00: All wind data 1994-07-30 12:00:00 and 1994-08-01 15:00:00  
1994-08-26 11:00:00  
1994-08-26 14:00:00 to 1994-08-27 12:00:00  
Wind measurements changed to save only wind speed and direction after 1994-09-29 23:00:00, changes indicated by NaNs in second and fourth data columns at the end of the year.
- Relative humidity data is missing from  
1994-07-02 11:00:00  
1994-07-11 23:00:00  
1994-07-30 12:00:00 to 1994-08-01 15:00:00  
1994-08-26 14:00:00 to 1994-08-27 12:00:00  
1994-09-30 00:00:00 to 1994-11-30 19:00:00
- Radiation data (mostly net radiation) is missing from  
1994-06-24 11:00:00  
1994-07-01 15:00:00  
1994-07-02 11:00:00 to 1994-07-02 12:00:00  
1994-07-10 22:00:00

1994-07-11 14:00:00  
 1994-07-11 23:00:00  
 1994-07-12 13:00:00  
 1994-07-28 14:00:00  
 1994-07-30 12:00:00 to 1994-08-01 15:00:00  
 1994-08-26 11:00:00  
 1994-08-26 14:00:00 to 1994-08-27 12:00:00  
 1994-09-30 00:00:00 to 1994-11-30 19:00:00  
 Net radiometer removed some time after 1994-09-29 23:00:00, indicated by NaNs in second data column at the end of the year.

- Precipitation data missing from  
 1994-07-02 11:00:00  
 1994-07-10 22:00:00  
 1994-07-11 23:00:00  
 1994-07-30 12:00:00 to 1994-08-01 15:00:00  
 1994-08-26 11:00:00  
 1994-08-26 14:00:00 to 1994-08-27 12:00:00  
 1994-09-30 00:00:00 to 1994-11-30 19:00:00  
 Precipitation intensity removed from program after 1994-09-29 23:00:00, indicated by NaNs in second data column at the end of the year
- Temperature data missing from  
 1994-07-02 11:00:00  
 1994-07-11 23:00:00  
 1994-07-30 12:00:00 to 1994-08-01 15:00:00  
 1994-08-26 14:00:00 to 1994-08-27 12:00:00  
 1994-09-30 00:00:00 to 1994-11-30 19:00:00  
 New temperature sensor (third data column in temperature file) added after 1994-09-29 23:00:00. NaNs prior to this is just padding in the datafile.
- Data missing in Daily data file 1994-06-24 00:00:00: Net radiation  
 1994-07-01 00:00:00: Net radiation  
 1994-07-02 00:00:00: Net radiation  
 1994-07-11 00:00:00: Net radiation  
 1994-07-12 00:00:00: Net radiation  
 1994-07-28 00:00:00: Net radiation  
 1994-07-30 00:00:00: All data  
 1994-07-31 00:00:00: All data  
 Daily data missing after 1994-09-26 00:00:00

## 4 Notes on data storage

Example data line for hourly data before programming change:

1994,185,1300,8.95,9.15,NaN,41.87,1.342,1.342,17.82,0.327,492.6,386,0,0

Column	Example data	Description
01:	1994	Year
02:	185	Day of Year
03:	1300	Hour-minute (hhmm)
04:	8.95	2 Pt100 T in Stevenson screen)
05:	9.15	3 T in Young screen
06:	NaN	4 Pt100 in new Young screen
07:	41.87	5 Rh in Young screen
08:	1.342	6 Mean horizontal wind speed
09:	1.342	7 Resultant mean wind speed
10:	17.82	8 resultant mean wind direction
11:	0.327	9 Standard deviation of wind direction
12:	492.6	10 Global radiation
13:	386.0	11 net radiation
14:	0	12 Precipitation
15:	0	13 Precipitation intensity

Example data line for hourly data after programming change:  
1994,347,600,-7.1,-6.983,-6.781,66.34,11,NaN,81.2,NaN,-17.88,NaN,0,NaN

Column	Example data	Description
01:	1994	Year
02:	347	Day of Year
03:	600	Hour-minute (hhmm)
04:	-7.1	2 Pt100 T in Stevenson screen)
05:	-6.983	3 T in Young screen
06:	-6.781	4 Pt100 in new Young screen
07:	66.34	5 Rh in Young screen
08:	11	6 Mean horizontal wind speed
09:	NaN	7 No data
10:	81.2	8 resultant mean wind direction
11:	NaN	9 No data
12:	-17.98	10 Global radiation
13:	NaN	11 No data
14:	0	12 Precipitation
15:	NaN	13 No data

Example of daily data summaries:  
94,1,-14.55,-14.15,73.4,-10.53,1828,-19.45,1056,7.78,2210,1.998,1.998,15.67,1.248,1.757,-3.669,0,0,23

Column	Example data	Description
01:	94	Year
02:	1	Day of Year
03:	-14.55	2 Daily average T in Stevenson screen)
04:	-14.15	3 Daily T from T/Rh in Young screen
05:	73.4	4 daily average humidity in Young screen
06:	-10.53	5 Daily maximum temperature in Young screen
07:	1828	6 hhmm for maximum daily temperature
08:	-19.45	7 Daily minimum temperature in Young screen
09:	1056	8 hhmm for minimum daily temperature
10:	7.78	9 Maximum wind speed
11:	2210	10 hhmm for maximum wind speed
12:	1.998	11 Mean horizontal wind speed
13:	1.998	12 Resultant mean wind speed
14:	15.67	13 resultant mean wind direction
15:	1.248	14 Standard deviation of wind direction
16:	1.757	15 Mean incoming global radiation
17:	-3.669	16 Mean net radiation
18:	0	17 totalized daily precipitation
19:	0	18 precipitation intensity
20:	2359	19 hhmm for
21:	12.61	20 Battery voltage

## 5 Data files and content

TRSmets1994.csv Raw data file

TRS\_met\_1994\_Precipitation.csv

Date-time, hourly totalized P

1994-01-01 03:00:00,0.00,0.00

TRS\_met\_1994\_Radiation.csv

Date-time, Global radiation, Net radiation

1994-01-01 03:00:00,1.49,-1.99

TRS\_met\_1994\_Relative\_humidity.csv

Date-time, hourly average Rh

1994-01-01 03:00:00,81.3

TRS\_met\_1994\_Temperature.csv

Date-time, hourly average T (Stevenson), hourly average T (Young), hourly average T/Rh (Young)

1994-01-01 03:00:00,-12.88,-12.57,NaN

TRS\_met\_1994\_Wind.csv

Date-time, Mean horizontal wind speed, Resultant mean wind speed, resultant mean wind direction, Standard deviation of wind direction

1994-01-01 03:00:00,1.6,1.6,16.3,1.4

TRS\_met\_1994\_Daily\_data.csv

Data columns follows description above

1994-01-01 00:00:00,-14.55,-14.15,73.4,-10.53,1828,-19.45,1056,7.78,2210,1.998,1.998,15.67,1.248,1.757

The data collected during 1994 is summarized the figure 1 and Table 1.

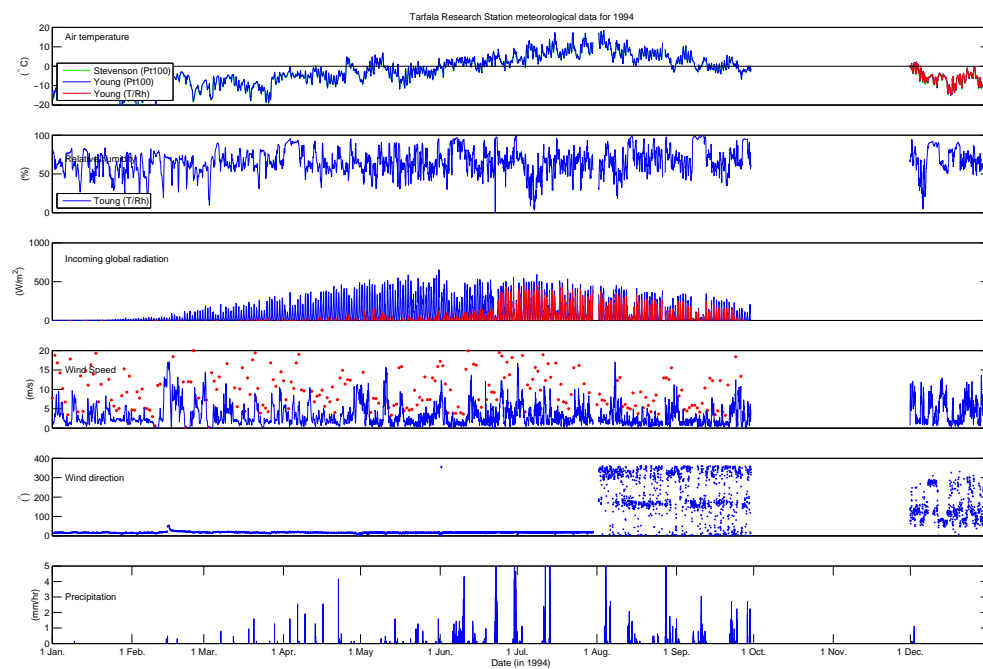


Figure. 1. Summary of meteorological data from Tarfala Research Station automatic weather station 1994.

Table. 1. Monthly averages of meteorological parameters from the Tarfala Research Station automatic weather station 1994.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Average air temperature (Stevenson)												
(°C)	−13.4	−10.2	−9.6	−4.5	−2.8	2.1	7.6	6.7	0.7	—	—	−6.8
<i>n</i>	247	223	255	247	743	743	705	705	719	—	—	748
Average air temperature (Young)												
(°C)	−13.1	−10.0	−9.4	−4.3	−2.6	2.2	7.7	6.8	0.7	—	—	−6.5
<i>n</i>	247	223	255	247	743	743	705	705	719	—	—	748
Average air temperature												
(°C)	—	—	—	—	—	—	—	—	—	—	—	−6.4
<i>n</i>	—	—	—	—	—	—	—	—	—	—	—	748
Average relative humidity												
(°C)	0.0	0.0	0.0	43.9	316.0	1793.5	—	—	1115.1	—	—	—
<i>n</i>	0	0	0	19	132	609	—	—	391	—	—	—
Positive degree sum												
(%)	61	60	66	70	63	71	59	69	73	—	—	69
<i>n</i>	247	223	255	247	743	743	705	705	719	—	—	748
Average incoming global radiation												
(W m <sup>−2</sup> )	2.9	14.4	54.7	113.7	165.7	148.5	151.6	99.8	55.9	—	—	−17.5
<i>n</i>	247	223	255	247	743	743	704	704	719	—	—	455
Global incoming energy sum												
(W m <sup>−2</sup> )	725	3217	13952	28095	123151	110344	—	—	40208	—	—	0
<i>n</i>	247	223	255	247	743	742	—	—	719	—	—	0
Average net radiation												
(W m <sup>−2</sup> )	−4770	−4323	−4083	−3218	−6000	21688	29814	35064	7012	—	—	—
<i>n</i>	247	223	255	247	743	743	704	704	719	—	—	—
Totalized precipitation												
(mm)	0.16	1.12	5.76	17.92	13.60	145.76	40.84	90.08	73.76	—	—	2.88
<i>n</i>	247	223	255	247	743	743	704	704	719	—	—	748
Average wind speed												
(m s <sup>−1</sup> )	3.1	4.2	3.3	3.2	3.1	3.3	3.5	2.6	2.6	—	—	4.5
<i>n</i>	247	223	255	247	743	743	705	705	719	—	—	748

## Logger program

```
;{CR10}
*Table 1 Program
  01: 10.0000   Execution Interval (seconds)

1:  Batt Voltage (P10)
  1: 10        Loc [ Batteri_V ]

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

3:  3W Half Bridge (P7)
  1: 1         Reps
  2: 33        25 mV 50 Hz Rejection Range
  3: 1         SE Channel
  4: 1         Excite all reps w/Exchan 1
  5: 2100      mV Excitation
  6: 21        Loc [ Rs_Ro_T1 ]
  7: 100       Mult
  8: 0.0000    Offset

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: 22        Loc [ Rs_Ro_T2 ]
  7: 100.00    Mult
  8: 0.0000    Offset

5:  Temperature RTD (P16)
  1: 2         Reps
  2: 21        R/R0 Loc [ Rs_Ro_T1 ]
  3: 1         Loc [ T1_bur__C ]
  4: 1         Mult
  5: 0.0000    Offset

6:  Do (P86)
  1: 41        Set Port 1 High

7:  Excitation with Delay (P22)
  1: 1         Ex Channel
  2: 200       Delay W/Ex (0.01 sec units)
  3: 25        Delay After Ex (0.01 sec units)
  4: 1         mV Excitation

8:  Volt (Diff) (P2)
  1: 2         Reps
  2: 35        2500 mV 50 Hz Rejection Range
  3: 3         DIFF Channel
  4: 3         Loc [ T3_Rot__C ]
  5: 0.1       Mult
  6: 0.0000    Offset
```

```

9: Do (P86)
  1: 51      Set Port 1 Low

10: Pulse (P3)
  1: 1      Reps
  2: 1      Pulse Input Channel
  3: 21     Low Level AC, Output Hz
  4: 5      Loc [ Vhast_m_s ]
  5: 0.0098 Mult
  6: 0      Offset

11: Excite-Delay (SE) (P4)
  1: 1      Reps
  2: 5      2500 mV Slow Range
  3: 9      SE Channel
  4: 3      Excite all reps w/Exchan 3
  5: 2      Delay (0.01 sec units)
  6: 2500   mV Excitation
  7: 6      Loc [ Vrikt____ ]
  8: 0.142  Mult
  9: 0.0000 Offset

12: Volt (SE) (P1)
  1: 1      Reps
  2: 33     25 mV 50 Hz Rejection Range
  3: 10     SE Channel
  4: 7      Loc [ Sol__W_m_ ]
  5: 116.55 Mult
  6: 0.0000 Offset

13: Pulse (P3)
  1: 1      Reps
  2: 2      Pulse Input Channel
  3: 2      Switch Closure, All Counts
  4: 8      Loc [ Nederb_mm ]
  5: 0.16   Mult
  6: 0.0000 Offset

14: Internal Temperature (P17)
  1: 9      Loc [ Logtemp_C ]

15: If time is (P92)
  1: 0      Minutes (Seconds --) into a
  2: 60     Interval (same units as above)
  3: 10     Set Output Flag High

16: Set Active Storage Area (P80)
  1: 1      Final Storage Area 1
  2: 101    Array ID

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

18: Average (P71)
  1: 4      Reps
  2: 1      Loc [ T1_bur__C ]

```

```

19: Wind Vector (P69)
   1: 1      Reps
   2: 1      Samples per Sub-Interval
   3: 1      S, é1 Polar
   4: 5      Wind Speed/East Loc [ Vhast_m_s ]
   5: 6      Wind Direction/North Loc [ Vrikt____ ]

20: Average (P71)
   1: 1      Reps
   2: 7      Loc [ Sol__W_m_ ]

21: Totalize (P72)
   1: 1      Reps
   2: 8      Loc [ Nederb_mm ]

22: Serial Out (P96)
   1: 71     Storage Module

23: If time is (P92)
   1: 0      Minutes (Seconds --) into a
   2: 1440   Interval (same units as above)
   3: 10     Set Output Flag High

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

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

26: Average (P71)
   1: 4      Reps
   2: 1      Loc [ T1_bur__C ]

27: Maximum (P73)
   1: 1      Reps
   2: 10     Value with Hr-Min
   3: 2      Loc [ T2_skyd_C ]

28: Minimum (P74)
   1: 1      Reps
   2: 10     Value with Hr-Min
   3: 2      Loc [ T2_skyd_C ]

29: Maximum (P73)
   1: 1      Reps
   2: 10     Value with Hr-Min
   3: 5      Loc [ Vhast_m_s ]

30: Wind Vector (P69)
   1: 1      Reps
   2: 1      Samples per Sub-Interval
   3: 1      S, é1 Polar
   4: 5      Wind Speed/East Loc [ Vhast_m_s ]
   5: 6      Wind Direction/North Loc [ Vrikt____ ]

31: Average (P71)
   1: 1      Reps

```

```

2: 7          Loc [ Sol__W_m_ ]

32: Totalize (P72)
1: 1          Reps
2: 8          Loc [ Nederb_mm ]

33: Average (P71)
1: 1          Reps
2: 9          Loc [ Logtemp_C ]

34: Sample (P70)
1: 1          Reps
2: 10         Loc [ Batteri_V ]

35: Serial Out (P96)
1: 71         Storage Module

36: If time is (P92)
1: 60         Minutes (Seconds --) into a
2: 1440        Interval (same units as above)
3: 10         Set Output Flag High

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

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

39: Sample (P70)
1: 1          Reps
2: 2          Loc [ T2_skyd_C ]

40: If time is (P92)
1: 240         Minutes (Seconds --) into a
2: 1440        Interval (same units as above)
3: 10         Set Output Flag High

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

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

43: Sample (P70)
1: 1          Reps
2: 2          Loc [ T2_skyd_C ]

44: If time is (P92)
1: 420         Minutes (Seconds --) into a
2: 1440        Interval (same units as above)
3: 10         Set Output Flag High

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

```

```

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

47: Sample (P70)
   1: 1         Reps
   2: 2         Loc [ T2_skyd_C ]

48: If time is (P92)
   1: 600       Minutes (Seconds --) into a
   2: 1440      Interval (same units as above)
   3: 10        Set Output Flag High

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

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

51: Sample (P70)
   1: 1         Reps
   2: 2         Loc [ T2_skyd_C ]

52: If time is (P92)
   1: 780       Minutes (Seconds --) into a
   2: 1440      Interval (same units as above)
   3: 10        Set Output Flag High

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

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

55: Sample (P70)
   1: 1         Reps
   2: 2         Loc [ T2_skyd_C ]

56: If time is (P92)
   1: 960       Minutes (Seconds --) into a
   2: 1440      Interval (same units as above)
   3: 10        Set Output Flag High

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

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

59: Sample (P70)
   1: 1         Reps
   2: 2         Loc [ T2_skyd_C ]

60: If time is (P92)
   1: 1140      Minutes (Seconds --) into a
   2: 1440      Interval (same units as above)

```

```

3: 10      Set Output Flag High

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

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

63: Sample (P70)
  1: 1      Reps
  2: 2      Loc [ T2_skyd_C ]

64: If time is (P92)
  1: 1320   Minutes (Seconds --) into a
  2: 1440   Interval (same units as above)
  3: 10     Set Output Flag High

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

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

67: Sample (P70)
  1: 1      Reps
  2: 2      Loc [ T2_skyd_C ]

```

```

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

```

```

*Table 3 Subroutines

```

```

End Program

```

1	[ T1_bur__C ]	RW--	2	1	Start	-----	---
2	[ T2_skyd_C ]	RW--	12	1	-----	-----	End
3	[ T3_Rot__C ]	RW--	2	1	Start	-----	---
4	[ rH_Rot___ ]	RW--	2	1	-----	-----	End
5	[ Vhast_m_s ]	RW--	3	1	-----	-----	---
6	[ Vrikt_____ ]	RW--	2	1	-----	-----	---
7	[ Sol__W_m_ ]	RW--	2	1	-----	-----	---
8	[ Nederb_mm ]	RW--	2	1	-----	-----	---
9	[ Logtemp_C ]	RW--	1	1	-----	-----	---
10	[ Batteri_V ]	RW--	2	1	-----	-----	---
11	[ _____ ]	----	0	0	-----	-----	---
12	[ _____ ]	----	0	0	-----	-----	---
13	[ _____ ]	----	0	0	-----	-----	---
14	[ _____ ]	----	0	0	-----	-----	---
15	[ _____ ]	----	0	0	-----	-----	---
16	[ _____ ]	----	0	0	-----	-----	---
17	[ _____ ]	----	0	0	-----	-----	---
18	[ _____ ]	----	0	0	-----	-----	---
19	[ _____ ]	----	0	0	-----	-----	---
20	[ _____ ]	----	0	0	-----	-----	---
21	[ Rs_Ro_T1 ]	RW--	1	1	-----	-----	---

22	[ Rs_Ro_T2 ]	RW--	1	1	-----	-----	---
23	[ ----- ]	----	0	0	-----	-----	---
24	[ ----- ]	----	0	0	-----	-----	---
25	[ ----- ]	----	0	0	-----	-----	---
26	[ ----- ]	----	0	0	-----	-----	---
27	[ ----- ]	----	0	0	-----	-----	---
28	[ ----- ]	----	0	0	-----	-----	---