

Multi-Filter Rotating Shadowband Radiometers Mentor Report and Baseline Surface Radiation Network Submission Status

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Overview

Currently 24 multi-filter rotating shadowband radiometers (MFRSRs) operate within the Atmospheric Radiation Measurement (ARM) Program. Eighteen MFRSRs are located at Southern Great Plains (SGP) site, one is located at each of the North Slope of Alaska (NSA) and Tropical Western Pacific (TWP) sites, and one is part of the instrumentation of the ARM Mobile Facility. The SGP site, that has four extended facilities that are equipped for an MFRSR but do not have one due to instrument failure or a lack of spare instruments. Table 1 lists all the sites supporting MFRSRs along with the instrument status. In addition to the MFRSRs, ARM operates three other MFRSR derived instruments: the multi-filter radiometer (MFR), the normal incidence multi-filter radiometer (NIMFR), and the narrow field of view (NFOV) radiometer. All are essentially just the head of an MFRSR used in innovative ways. The MFR is mounted on a tower and pointed at the surface. At the SGP Central Facility there is one at 10 m and one at 25 m. The NSA has an MFR at each station, both at the 10-m level. ARM operates three NIMFRs with one is at the SGP Central Facility and one at each of the NSA sites. There are two NFOVs, which are both at the SGP Central Facility. One is a single-channel (870) and the other uses two channels (673 and 870). A description of MFRSR-derived instrument locations and their status is given in Table 2.

Table 1. The status of all of the ARM MFRSRs is shown.			
Region	Site	Operating Status	Current Problems/Issues
SGP	C1 Central Facility	Yes	-----
SGP	EF-1 Larned KS	Yes	Channel 673 is intermittently noisy
SGP	EF-2 Hillsboro KS	No	Instrument failed and was removed from service July 2003.
SGP	EF-3 LeRoy KS	Yes	-----
SGP	EF-4 Plevna KS	Yes	Frequent drop outs in the head temp and logger voltage
SGP	EF-5 Halstead KS	Yes	-----
SGP	EF-6 Towanda KS	Yes	-----
SGP	EF-7 Elk Falls KS	Yes	Head temp is consistently below minimum
SGP	EF-8 Coldwater KS	Yes	Channel 415 is working intermittently

Table 1. (cont'd)			
Region	Site	Operating Status	Current Problems/Issues
SGP	EF-9 Ashton KS	Yes	-----
SGP	EF-10 Tyro KS	No	Instrument failed and was pulled from service in June 2001
SGP	EF-11 Byron OK	Yes	-----
SGP	EF-12 Pawhuska OK	Yes	-----
SGP	EF-13 Lamont OK	Yes	-----
SGP	EF-15 Ringwood OK	Yes	-----
SGP	EF-16 Vici OK	Yes	-----
SGP	EF-18 Morris OK	Yes	-----
SGP	EF-19 El Reno OK	No	Instrument damaged by lightning and pulled from service June 2004
SGP	EF-20 Meeker OK	No	Instrument failed and was pulled from service July 2003
SGP	EF-21 Okmulgee OK	MFRSR never Installed	NA
SGP	EF-22 Cordell OK	Yes	-----
SGP	EF-24 Cyril OK	Yes	Strange inverse relationship between head temp and logger voltage
SGP	EF-25 Seminole OK	Station not in Operation	Site was decommissioned April 2002
SGP	EF-26 Cement OK	MFRSR never Installed	NA
SGP	EF-27 Earlsboro OK	Yes	-----
NSA	C1 Barrow AK	Yes	-----
NSA	C2 Atqasuk AK	Yes	-----
TWP	C1 Manus	Yes	-----
TWP	C2 Nauru	Yes	-----
TWP	C3 Darwin	Yes	-----

Table 2. The status of all of the ARM instruments derived from the MFRSR.			
Region	Site/Instrument	Operating Status	Current Problems/Issues
SGP	C1 MFR10m	Yes	Data show a small dip close to solar noon. Cause is unknown at this time.
SGP	C1 MFR25m	Yes	Data often show unusual characteristics mid to late morning. Likely the result of surface conditions.
NSA	C1 MFR10m	Yes	-----
NSA	C2 MFR10m	Yes	-----
SGP	C1 NIMFR	Yes	-----
NSA	C1 Barrow NIMFR	Yes	-----
NSA	C2 Atqasuk NIMFR	Yes	-----

Table 2. (cont'd)			
Region	Site/Instrument	Operating Status	Current Problems/Issues
SGP	C1 NFOV Single Channel	Yes	Condensation on the inside of the window is being frequently reported
SGP	C1 NFOV Dual Channel	No	Instrument has been pulled from service for maintenance and modifications

Currently, two major projects involving the MFRSR are in progress. The first project is the purchase of replacement interference filters. Some of these instruments have been installed for close to 10 years and ARM is starting to see failures related to the filters. At this time, a bid for the job has been submitted and ARM is arranging to make payment. The goal is to have the purchase completed by the end of fiscal year 2005. The intent is to purchase 100 filter sets, which would be enough to service and repair all the MFRSR and MFRSR derived instruments, as well as providing a supply of replacement sets for future repairs.

The second major project is the conversion to Campbell data loggers from the current Yankee logger boards. Once implemented, the Campbell loggers should prove less costly than maintaining the current loggers. Also, because Campbell loggers are ubiquitous within ARM, more resources and support will be available. In addition to the cost savings, the Campbell loggers will provide improved programming flexibility and sampling rates, and possibly facilitate the installation and alignment of MFRSRs using innovative programming techniques.

Baseline Surface Radiation Network

The biennial Baseline Surface Radiation Network (BSRN) meeting took place July 2004 in Exeter, Devon, United Kingdom. With four stations being submitted, ARM was one of the better-represented organizations within the BSRN community. At the meeting it was agreed that data from ARM's TWP Darwin site should be included. Including Darwin would provide the BSRN community two collocated and independent sites to study. At this time, the formalities for data submission have not been completed, which is why it is not shown in Table 1. Presently, data have been submitted through January 2005 for the four ARM sites currently included in the archive, though the maintainers of the archive have not inserted these datasets into the archive.

EF-01 MFRSR Direct Narrowband Irradiance 13 January 2005

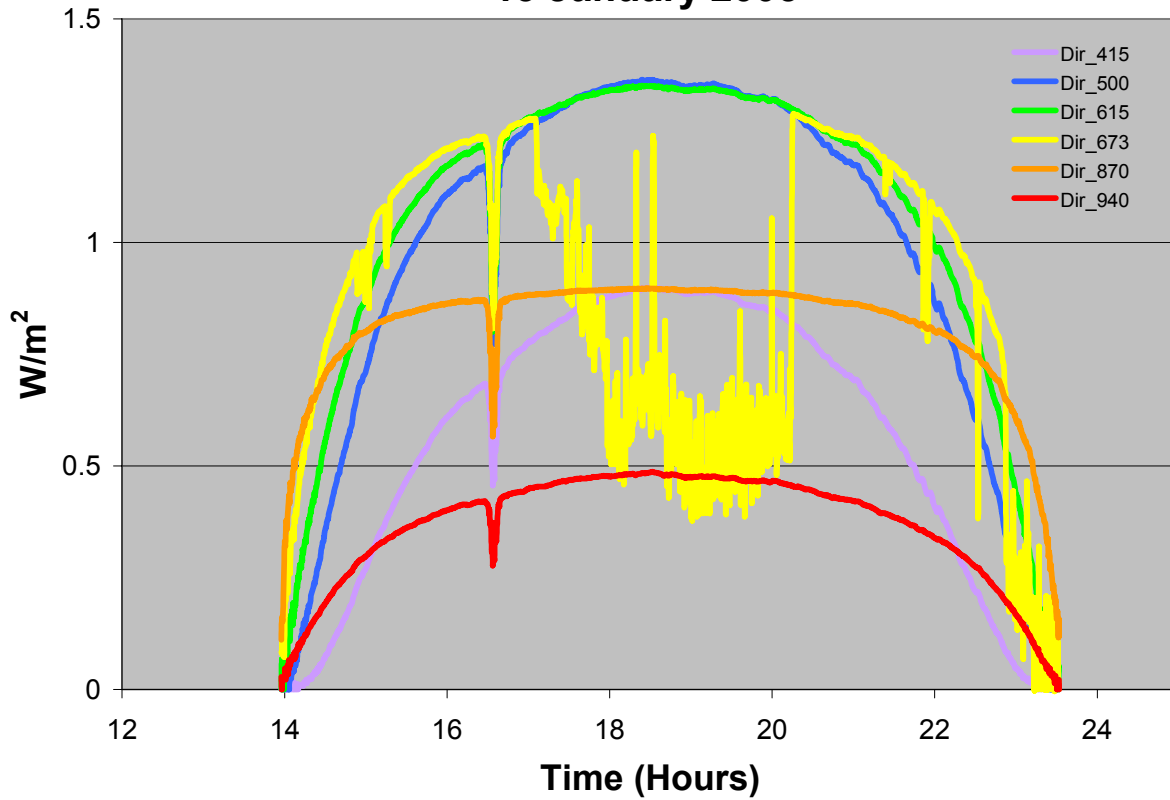


Figure 1a. Examples of some problems described in the table to the left. A plot of narrowband irradiance from the MFRSR located at EF-01 Larned, Kansas. In this plot it is clearly seen that channel 673 is noisy.

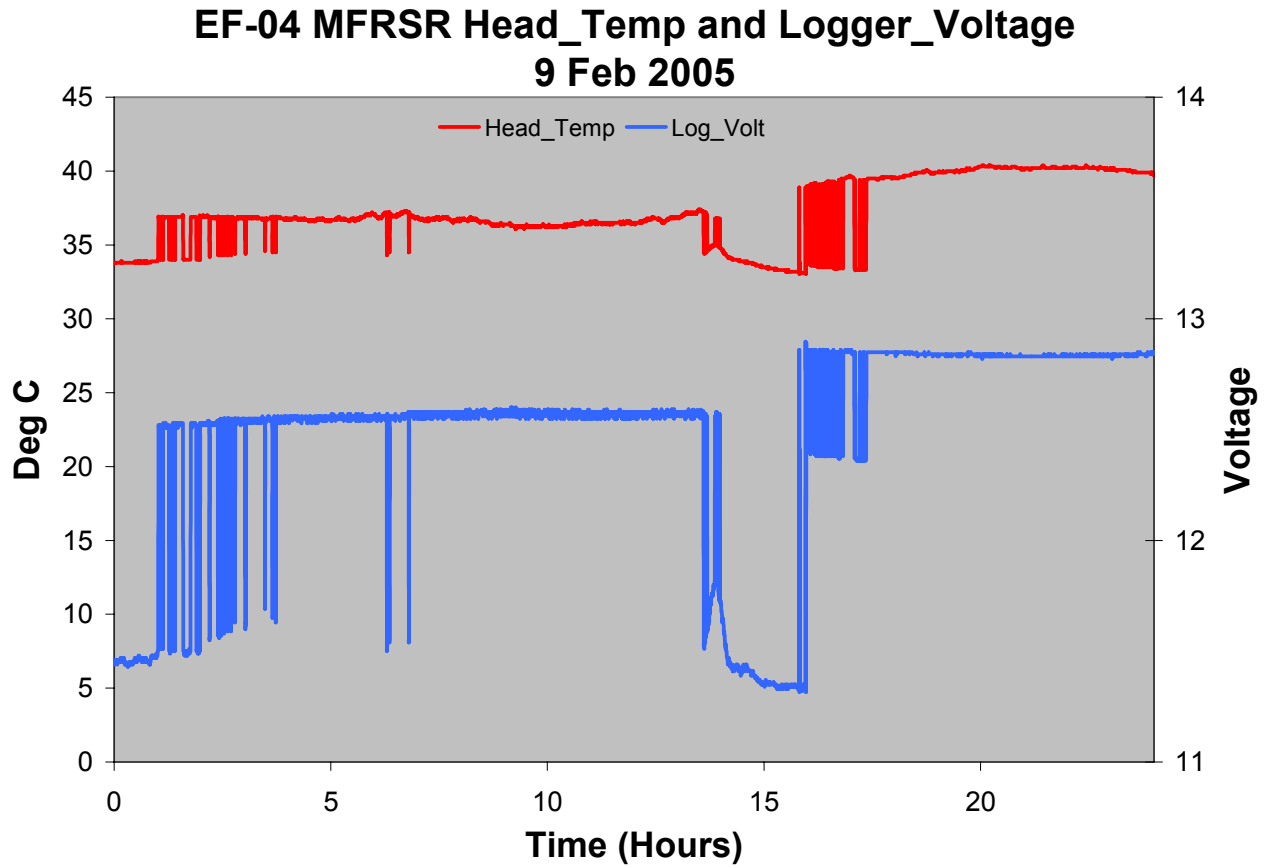


Figure 1b. This figure presents the MFRSR head temperature and logger voltage from EF-04 Plevna, Kansas. A relationship between the voltage drops and temperature drops is evident. Note that the irradiance measurements do not appear to be affected by this.

EF-24 MFRSR Head_Temp and Logger_Voltage 13 January 2005

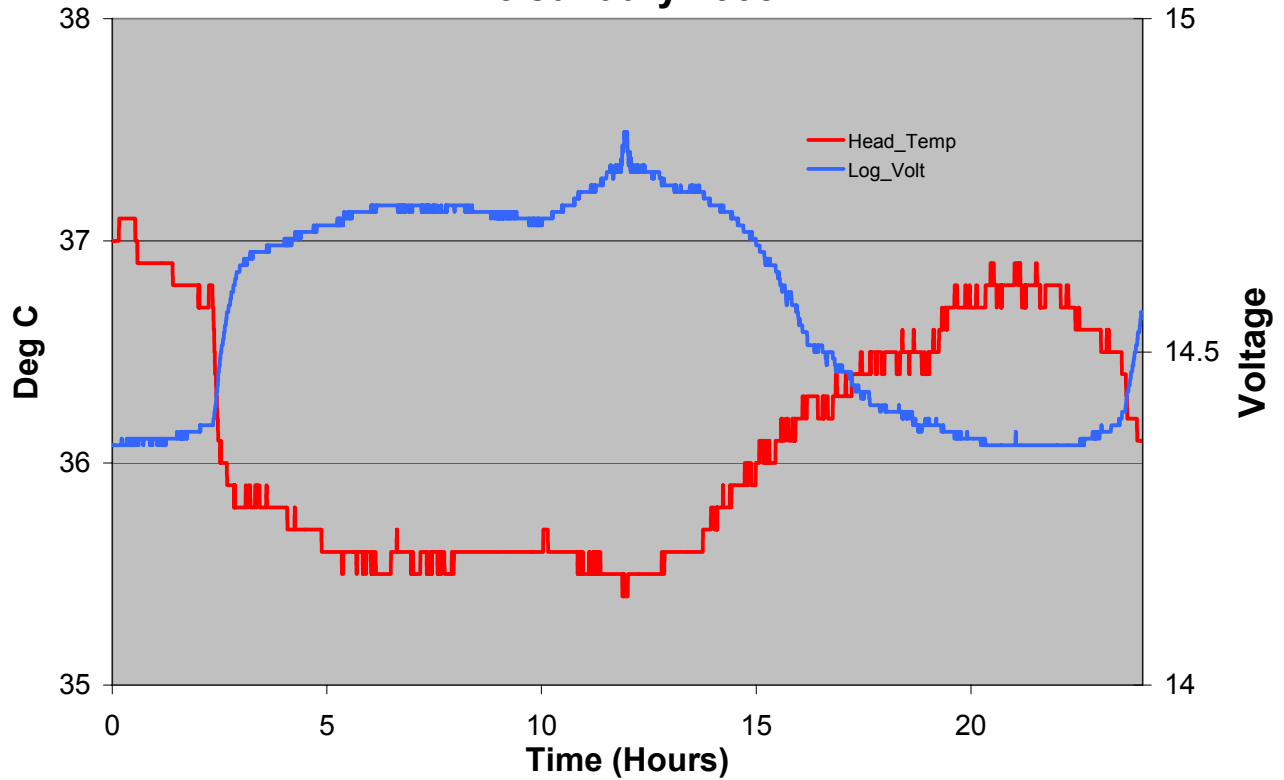


Figure 1c. Shows a strange inverse relationship between the head temperature and logger voltage of the MFRSR located at EF-24 Cyril, Oklahoma. This is the only MFRSR that shows such a relationship. The irradiance data at this site do not seem to be affected.

SGP C01 MFR 10m Narrowband and Broadband 13 January 2005

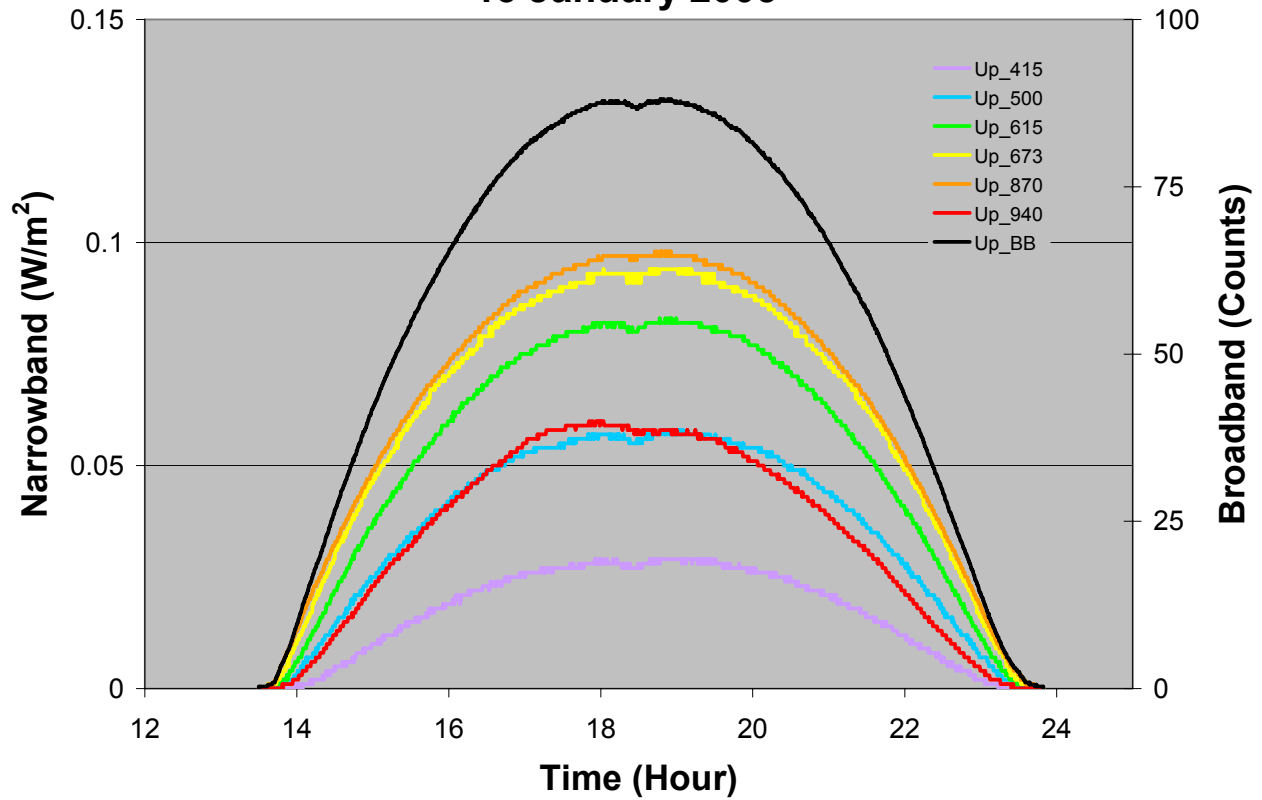


Figure 2a. A plot of the six narrowband channels and the broadband channel from the SGP Central Facility 10-m MFR. Notice that very near solar noon there is a slight dip across all channels. This dip is consistently seen on clear days during the winter months and goes back at least 2 year. Preliminary investigation has not revealed why this occurs.

SGP C1 MFR 25m Narrowband and Broadband 22 January 2005

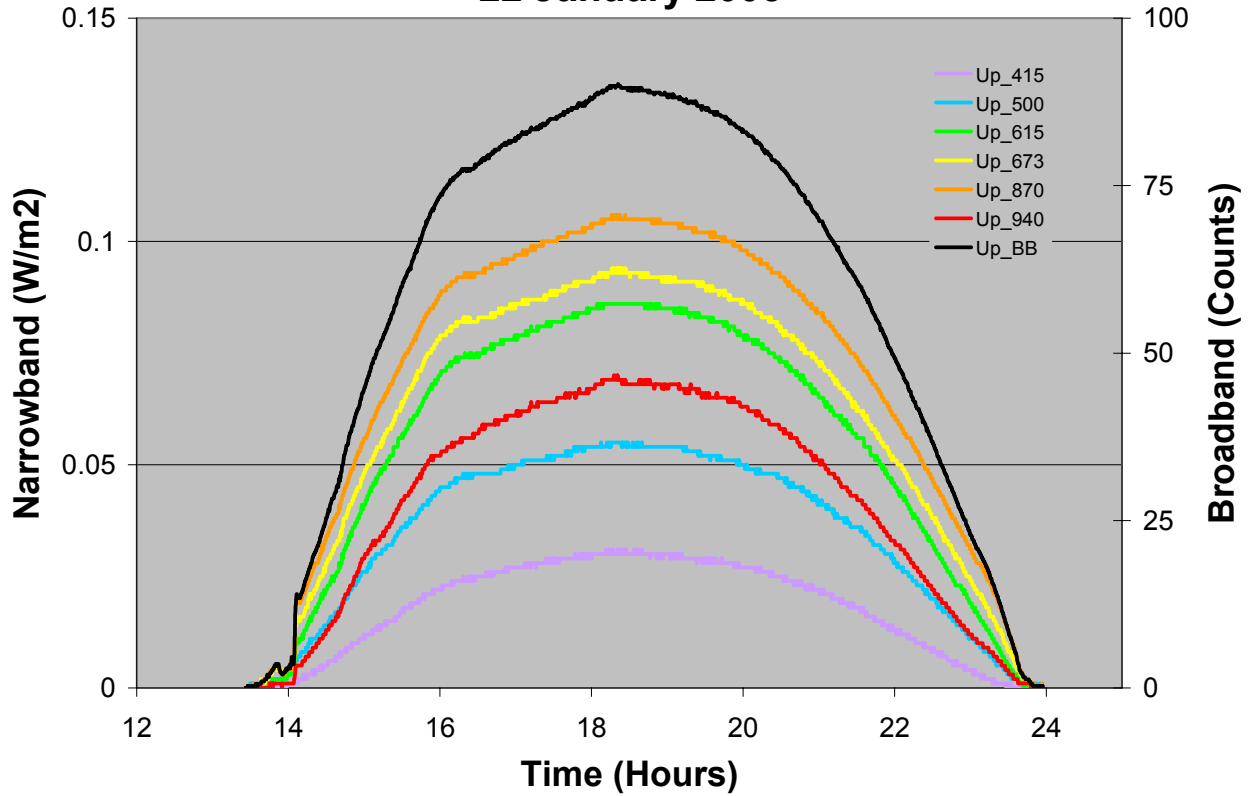


Figure 2b. Presents data from the SGP Central Facility 25-m MFR. In this plot a mostly linear rise in the data is observed between about 1600 Universal Time Coordinates (UTC) and 1900 UTC. Similar features can be seen on other, but not all, clear days. Though this has not been investigated fully, it probably results from inhomogeneous surface conditions around the base of the 60-m tower. Please note that the 10-m MFR is located on the EF-13 tower, and thus is seeing a completely different surface than the 25-m MFR.



Figure 3. Photos of the various MFRSR-derived instruments. Figure 3a shows the NIMFR that is located at the SGP Central Facility. This instrument is located on the EF-13 solar tracker.



Figure 3b. An MFR – this instrument is mounted on towers pointed at the surface to provide data on reflected irradiances.



Figure 3c. An MFR contained in an insulated housing required for deployments in the NSA.



Figure 3d. The single-channel and two-channel NFOV instruments.



Figure 3e. A standard MFRSR in a typical deployment.

BSRN

Baseline Surface Radiation Network

Baseline Surface Radiation Network (BSRN) World Radiation Monitoring Center (WRMC)

BSRN is a project of the [World Climate Research Programme \(WCRP\)](#) and the [Global Energy and Water Experiment \(GEWEX\)](#) and as such is aimed detecting important changes in the earth's radiation field at the earth's surface which may related to climate changes. The data are of primary importance in supporting the validation and confirmation of satellite and computer model estimates of these quantities. At a small number of stations (currently fewer than 40) in contrasting climatic zones, covering a latitude range from 80°N to 90°S (see [station maps](#)), solar and atmospheric radiation is measured with instruments of the highest available accuracy and with high time resolution (1 to 3 minutes). The BSRN was recently (early 2004) designated as the global baseline network for surface radiation for the [Global Climate Observing System \(GCOS\)](#). The GCOS monitoring principles are shown [here](#).

The radiation data are stored together with collocated surface and upper-air meteorological observations and station `metadata' in an integrated database here at ETH Zurich, which has been designated as the World Radiation Monitoring Center (WRMC).

High accuracy BSRN radiation measurements are described in these pages and have been used to validate the radiation schemes in global climate models and satellite algorithms and are beginning to develop into and extensively documented and widely representative surface radiation data set. Further participation in the program by well supported long-term measurement programs, like those traditionally maintain by national governments and located in regions not currently well represented (see maps) is encouraged. Participation in BSRN permits direct interactions with a world community of surface radiation scientists and significant contribution to several international climate research programs.

For questions or comments about the BSRN data or this web site, please contact the WRMC data manager at `bsrnadm[at]env.ethz.ch' (mailto:bsrnadm[at]env.ethz.ch) (mailto tool at bottom of left frame). For questions concerning the quality flags applied to the relational database please contact the WRMC quality manager at `muller[at]env.ethz.ch'. Data quality flags associated with the FTP accessible data base are described [here](#). Other questions should be directed as appropriate to the individuals identified under [contacts](#).

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Figure 4a. A screen capture of the BSRN home page <<http://bsrn.ethz.ch>>.

STATION	YEAR														TOTAL
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	
ASP	-	-	-	12	12	12	12	12	12	12	12	1	-	-	97
FLO	-	-	6	12	12	12	12	12	-	-	-	-	-	-	66
REG	-	-	-	12	12	12	12	12	-	-	-	-	-	-	60
TOR	-	-	-	-	-	-	-	12	12	12	12	9	-	-	57
CAR	-	-	-	-	4	12	12	12	5	-	-	-	-	-	46
NYA	5	12	12	12	12	12	12	12	12	12	12	12	-	-	137
LIN	-	-	3	12	12	12	12	12	12	12	12	5	-	-	104
GVN	9	12	12	12	12	12	12	12	12	12	12	12	-	-	141
TAT	-	-	-	-	11	12	12	12	12	12	12	12	3	-	103
SYO	-	-	12	12	12	12	12	12	12	12	12	-	-	-	108
PAY	3	12	12	12	12	12	12	12	12	12	12	12	4	-	139
BAR	12	12	12	12	12	12	12	12	12	12	12	12	-	-	144
BOU	12	12	12	12	12	12	12	12	12	12	12	12	-	-	144
BER	12	12	12	12	12	12	12	12	12	12	12	12	-	-	144
KWA	9	12	12	12	12	12	12	12	12	12	12	12	-	-	141
SPQ	12	12	12	12	12	12	12	12	12	12	12	12	-	-	144
E13	-	-	-	-	-	4	12	12	12	12	12	12	3	-	79
BIL	-	6	12	12	12	12	12	12	12	12	12	12	3	-	129
MAN	-	-	-	-	3	12	12	12	12	12	12	12	3	-	90
NAU	-	-	-	-	-	-	2	12	12	12	12	12	3	-	65
FPE	-	-	-	12	12	12	12	12	12	12	12	1	-	-	97
BON	-	-	-	12	12	12	12	12	12	12	12	1	-	-	97
GCR	-	-	-	12	12	12	12	12	12	12	12	1	-	-	97
BOS	-	-	-	5	12	12	12	12	12	12	12	1	-	-	90
DRA	-	-	-	-	-	-	10	12	12	12	12	1	-	-	59
PSU	-	-	-	-	-	-	7	12	12	12	12	1	-	-	56
CAN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
LLO	4	12	12	5	-	-	-	-	-	-	-	-	-	-	33
CLH	-	-	-	-	-	-	-	-	6	12	12	12	6	-	48
DAA	-	-	-	-	-	-	-	-	7	12	12	12	1	-	44
SOV	-	-	-	-	-	-	4	12	12	12	12	-	-	-	52
TAM	-	-	-	-	-	-	-	-	10	12	12	-	-	-	34
SBO	-	-	-	-	-	-	-	-	-	-	-	12	5	-	17
CAM	-	-	-	-	-	-	-	-	-	7	-	-	-	-	7
LER	-	-	-	-	-	-	-	-	-	6	-	-	-	-	6
ALB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
LAU	-	-	-	-	-	-	-	5	12	12	12	1	-	-	42
PAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Total	78	114	141	214	234	256	237	329	323	349	336	214	36	0	2916

Figure 4b. The site status page. Note that the status page does not reflect all the files that have been submitted. Currently, all ARM sites have been submitted through January 2005 and are awaiting insertion into the database. The ARM sites are E13, BIL, MAN, and NAU. It is hoped that this year Darwin data submissions to the BSRN archive will begin.