Title: NOAA GML Brush Creek Broadband Solar Radiation Data for SPLASH

Overview: These files contain Surface Energy Balance data at the Brush Creek site as part of NOAA's Global Monitoring Laboratory's deployment in the Sail-SPLASH Campaign between October 2021 through August 2023.

Disclaimer: Due to prolonged periods of network outages, icing of the instruments and the accumulation of snow covering the instrumentation, some data may be "missing" for minutes, hours, days, and in rare cases, weeks.

Campaign and Site Specifications:

Campaign	Site	Identifier	T/RH height
SPLASH	Brush Creek (Crested Butte, CO)	CBC	2 m

FILENAME INFORMATION:

Mobile SURFRAD (M-SURFRAD) data files contain one day of data for one station. The naming convention for M-SURFRAD data filenames is "stayyjjj.dat", where sta is a three-letter station identifier, yy represents the last two digits of the year (i.e., 95 for 1995, 00 for 2000), and jjj is the day of year. A "day of year" in a filename that is less than 100 would be preceded by one or two zeros, e.g., day 75 would appear as 075, day 2 would appear as 002 in the filename. The SURFRAD processing software is year 2000 compliant. The year within the data files is written unambiguously with 4 digits on each line.

The extension ".dat" is used because both radiation and meteorological data are included. The file "cbc21289.dat" contains all of the radiation and meteorological data for Brush Creek on day 289 of 2021.

DATA STRUCTURE:

M-SURFRAD data are organized into daily files of one minute data and are written in ASCII text.

M-SURFRAD data follows the quality control (QC) philosophy of the BSRN (Baseline Surface Radiation Network). Bad data are deleted, but questionable data are only flagged. Integer QC flags follow each data point.

A QC flag of zero indicates that the corresponding data point is good, having passed all QC checks. A value greater than 0 indicates that the data failed one level of QC. For example, a QC value of 1 means that the recorded value is beyond a physically possible range, or it has been affected adversely in some manner to produce a knowingly bad value. A value of 2 indicates that the data value failed the second level QC check, indicating that the data value may be physically possible but should be used with scrutiny, and so on. Missing values are indicated by -9999.9 and should always have a QC flag of 1.

The file structure includes two header records; the first has the name of the station, and the second gives the station's latitude, longitude, elevation above mean sea level in meters, and the version number of the file. These are followed by at most, 1440 lines of 1-min. data. Files are organized in Universal Coordinated Time (UTC). The date and time are given on every line. Data are reported as 1-minute averages of one-second samples. Reported times are the end times of the 1-min. averaging periods, i.e., the data given for 0000 UTC are averaged over the period from 2359 (or 2357) of the previous UTC day, to 0000 UTC. The solar zenith angle is reported in degrees on each line of data. It is computed for the central time of the averaging period of the sampled data. Missing-data periods within the files are not filled in with missing values, therefore, a file with missing periods will have fewer than 1440 lines.

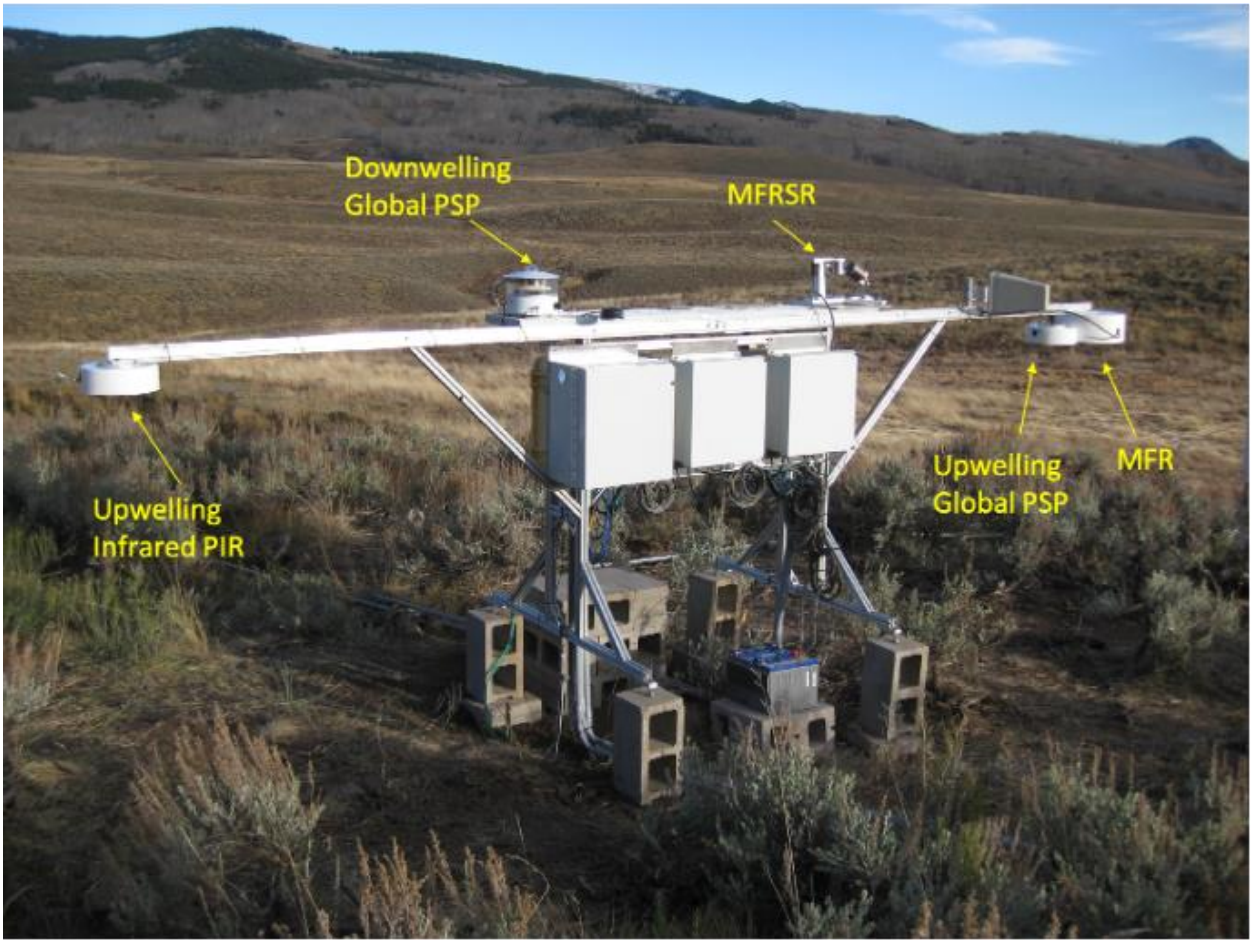
Radiation values are reported to the tenths place. Although this is beyond the accuracy of the instruments, data are reported in this manner in order to maintain the capability of backing out the raw voltages at the accuracy that they were originally reported.

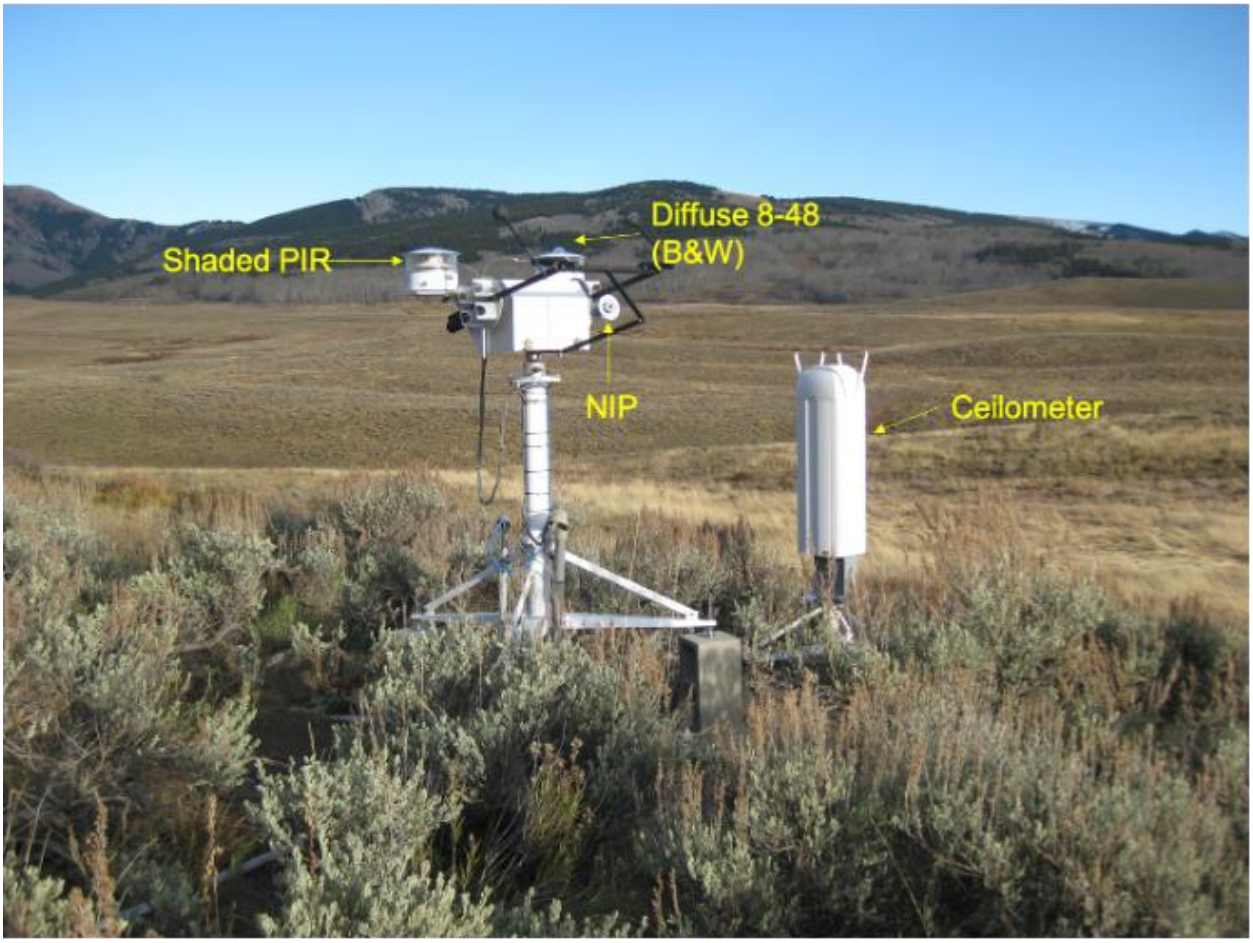
The variables, their data type, and description are given below (note that some sites may not have columns 49-52, or may have them but they will be empty):

M-SURFRAD Output File Columns					
Output Column	Column Title	Description	Units	Data Type	Notes
1	yyyy	year, i.e., 1995	year	int	
2	jday	Julian day (1 through 365 [or 366])		int	
3	month	number of the month (1-12)	month	int	
4	day	day of the month(1-31)	day	int	
5	hour	hour of the day (0-23)	hr	int	
6	min	minute of the hour (0-59)	minute	int	
7	dt	decimal time (hour.decimalminutes, e.g., 23.5 = 2330)	hr	Float	
8	SZA	solar zenith angle	Degrees	Float	Calc From Timestamp and Lat/Lon
9	dw_solar	downwelling global solar	W/m^2	Float	QC = Col 10, measured by a pyranometer
11	uw_solar	upwelling global solar	W/m^2	Float	QC = Col 12
13	Direct_normal	Direct normal solar	W/m^2	Float	QC = Col 14
15	Diffuse	Downwelling diffuse solar	W/m^2	Float	QC = Col 16
17	dw_ir	downwelling thermal infrared	W/m^2	Float	QC = Col 18
19	DwCaseTemp	downwelling IR case temp.	Kelvin	Float	QC = Col 20
21	DwDomeTemp	downwelling IR dome temp.	Kelvin	Float	QC = Col 22
23	uw_ir	upwelling thermal infrared	W/m^2	Float	QC = Col 24
25	UwCaseTemp	upwelling IR case temp.	Kelvin	Float	QC = Col 26
27	UwDomeTemp	upwelling IR dome temp.	Kelvin	Float	QC = Col 28
29	UVB	global UVB	W/m^2	Float	QC = Col 30, not always measured with M-SURFRAD
31	PAR	photosynthetically active radiation	W/m^2	Float	QC = Col 32, not always measured with M-SURFRAD
33	NetSolar	net solar (dw_solar - uw_solar)	W/m^2	Float	QC = Col 34
35	NetIR	net infrared (dw_ir - uw_ir)	W/m^2	Float	QC = Col 36

37	TotalNet	net radiation (netsolar+netir)	W/m^2	Float	QC = Col 38
39	AirTemp	10-meter or 2-meter air temperature	Celcius	Float	QC = Col 40
41	RH	relative humidity	%	Float	QC = Col 42
43	WindSpd	wind speed	m/s	Float	QC = Col 44
45	WindDir	wind direction	Degrees	Float	QC = Col 46
47	Baro	station pressure	mBar	Float	QC = Col 48
49	SPN1_total_Avg	Total irradiance as measured by SPN1	W/m^2	Float	QC = Col 50, not measured for M-SURFRAD
51	SPN1_diffuse_Avg	Diffuse irradiance as measured by SPN1	W/m^2	Float	QC = Col 52, not measured for M-SURFRAD

INSTRUMENTS:





1. The Eppley PSP pyranometer

Pyranometers measure global downwelling and upwelling solar irradiance on M-SURFRAD systems. These instruments are sensitive to the shortwave broadband spectral range of 280 to 3000 nm. M-SURFRAD systems use Eppley PSP pyranometers to measure the SW broadband irradiance. They are calibrated on a yearly basis.

An inherent problem with solid black thermopile pyrometers is that their sensor cools to space (if it is directed upward) and that causes a negative signal. This is apparent at night where it shows up as an erroneous negative irradiance that can be as great as -30 Wm^-2. A correction can be applied to mitigate this error. It is done in downstream processing, however, rather than in this.

2. The Eppley Normal Incidence Pyrheliometer (NIP)

The NIP measures direct-normal solar radiation in the broadband spectral range from 280 to 3000 nm. Those used at SURFRAD stations are calibrated on a yearly basis.

3. Eppley 8-48 "black and white" pyranometer

This pyranometer has been used for the diffuse solar measurement since 2001. The 8-48 has been found to have desirable properties for this measurement because it does not use a solid black surface for the detector and thus does not have the "nighttime" offset problem. These instruments are sensitive to the same broadband spectral range as the NIP and solar, 280 to 3000 nm. They are also calibrated on a yearly basis.

4. Precision Infrared Radiometer (PIR)

Two PIRs measure upwelling and downwelling thermal infrared irradiance.
They are sensitive to the spectral range from 3000 to 50,000 nm. NOAA maintains three standard PIRs that are calibrated annually by a world-reputable organization. These standards are used to calibrate field PIRs.

DATA PROCESSING:

1. Calculating the best downwelling SW

A higher quality downwelling SW measurement can be calculated from the sum of the diffuse and direct normal irradiance measurements than the PSP measurement. This calculation is done in the QCRAD processing which is completed after the campaign, but it can also easily be done by the user following this formula:

downwelling SW = diffuse horizontal + direct normal*cos(Solar Zenith Angle)

2. Net radiation processing:

Net radiation, net solar, net infrared, and total net (net solar + net infrared) are computed and reported in the daily processed files. In computing net solar (downwelling solar - upwelling solar) the best measure of downwelling solar is used. When direct-normal and diffuse solar are available, and deemed to be of good quality, their sum (direct-normal*cosSZA + diffuse) is used for the downwelling solar in the net solar calculation. Whenever any of the solar measurements are negative (owing to cooling of the thermopile near dusk and dawn), they are set to 0 before computing the net radiation.

Net solar is computed for solar zenith angles between 0 and 96 degrees. The net solar calculation is extended beyond 90, to 96 degrees to account for civil twilight.

All radiation parameters, except UVB, are reported in units of Watts m^-2;
UVB is reported in milliWatts m^-2.

QUALITY CONTROL AND QUALITY ASSURANCE

NOAA has attempted to produce the best data set possible; however the data quality is constrained by measurement accuracies of the instruments and the quality of the calibrations. Regardless, NOAA attempts to ensure the best quality possible through quality assurance and quality control. The data are subjected to automatic procedures as the daily files are processed. At present, they are subjected only to this first-level check, and a daily "eye" check before being released, however, as quality control procedures become more refined, they will be applied, and new versions of the data files will be generated.

Quality assurance methods are in place to ensure against premature equipment failure in the field and post deployment data problems. For example, all instruments at each station are exchanged for newly calibrated instruments on an annual basis. Calibrations are performed by world-recognized organizations. Pyranometers have been calibrated at the World Meteorological Organization's (WMO) Region 4 Regional Solar Calibration Center at NOAA in Boulder, CO.

M-SURFRAD pyrgeometers are calibrated using three standards maintained at NOAA's Field Test and Calibration Facility at Table Mountain near Boulder, CO. M-SURFRAD pyrgeometer standards' calibrations are traceable to the WISG world standard device in Davos, Switzerland, where they are calibrated annually. In general, all of the standards at NOAA/Boulder are traceable to world standards or an equivalent. Calibration factors for the UVB instrument are transferred from three standards maintained by NOAA's National UV Calibration Facility in Boulder. Finally, to maintain continuity between the returned instruments and their replacements, all instruments are gauged against three standard instruments before and after field deployment.