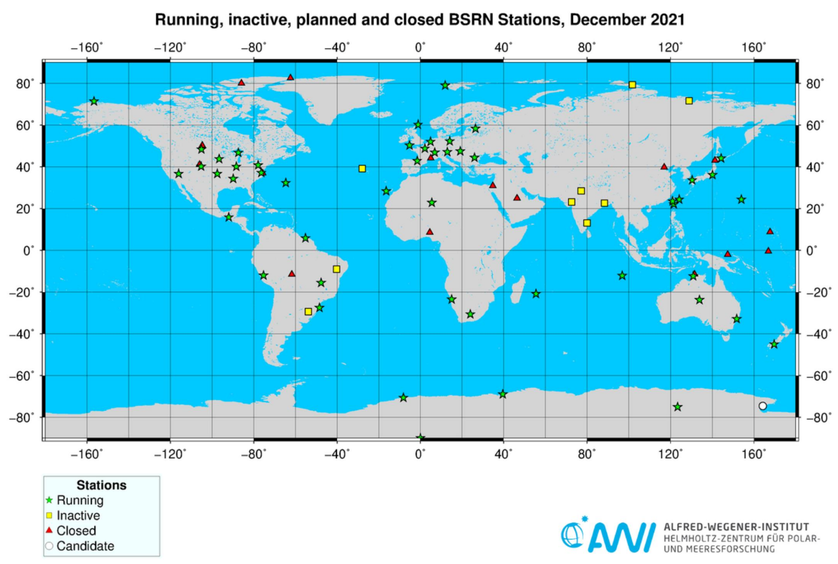
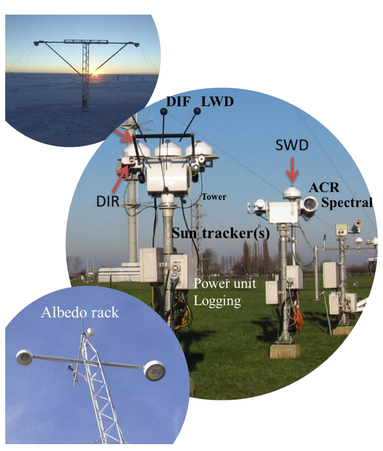
Thirty years of WCRP/GEWEX Baseline Surface Radiation Network (BSRN): activities, current operations, and new challenges

Operations and Network Logistics

The BSRN project was conceived by the WCRP Working Group on Radiative Fluxes in 1988 to address extensive concerns about the overall lack of high-quality, in-situ surface irradiance observations at global scale. It began operations in 1992 with nine worldwide stations and continues **today with 51 active contributing stations**.

While continents such as Northern America, Europe, Eastern Asia and Oceania are well covered, the network is still facing a lack of coverage over Africa, South America and Central Asia, though some effort to reduce this long-lasting limitation have been established. Currently, candidates from Cyprus, Indonesia, Thailand, and Korea (the latter to cover East Antarctica), Italy, Ireland and Chile are in a review phase (7 sta-tions). Promising expressions of interest from China and UAE has also been received.

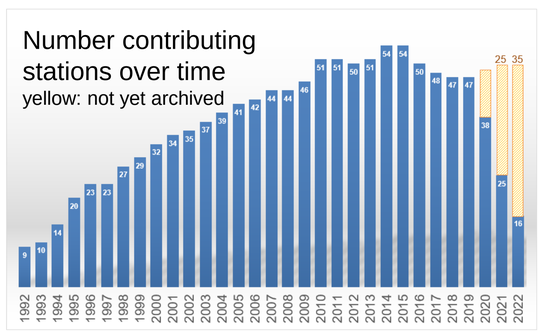




BSRN Field Observations

During the thirty years the network delivered monthly data at 1-min resolution of **solar and infrared broadband irradiance (LR0100) and surface radiation balance (LR03xx) at the surface, measured by 76 stations** (including the closed ones). The archive **(World Radiation Monitoring Centre) hosted by AWI**, currently stores more than **12,500 monthly files of irradiance at 1-min resolution and ancillary data**, including ancillary data as UV-A and UV-B radiation components (LR0500), surface meteorology (T,p,RH: LR0100) and upper air soundings (LR1000), synoptical report (LR1000), Ozonosondes (LR1200) and Ceilometer data (LR1300) for selected stations. Data are distributed by AWI as compressed ascii files by means of an FTP server or the https://dataportals.pangaea.de/bsrn/ web service.

Data Availability and Quality

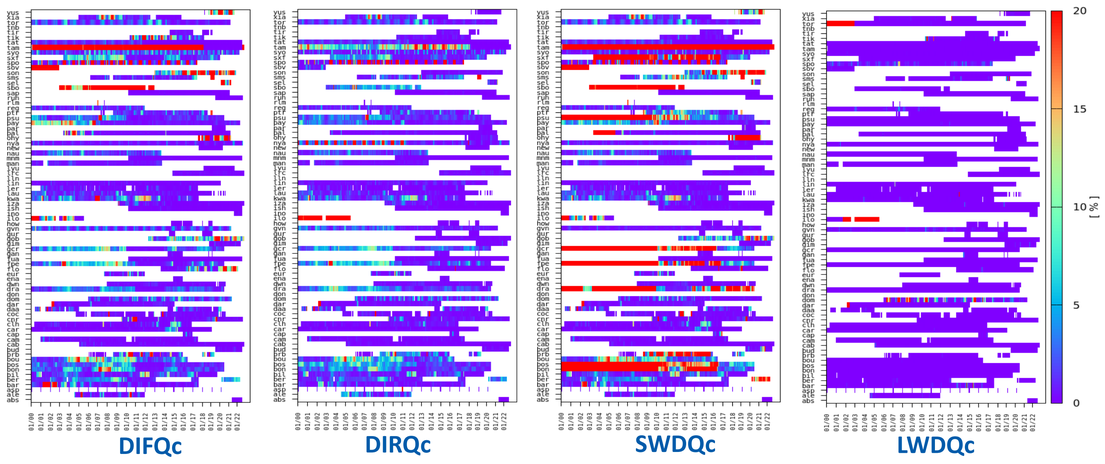


	Logical Record: description (all-time table: 2022 Aug)	#Stations (not closed)	Monthly LR
1	LR **0100**: Basic Measurements	**76 (60)**	**12358**
2	LR **0300**: Reflex SW, LW up	**19 (17)**	**3343**
3	LR **0500**: UV	**13**	2813
4	LR **1000**: SYNOP	**15**	4492
5	LR **1100**: Upper air soundings	**33**	5741
6	LR **1200**: Total ozone	**9**	2001
7	LR **1300**: Ceilometer data	**3**	996
8	LR **3010**: Tower Upwelling LR **3030**:	**11 (10)** **2 (1)**	**2448** **361**

BSRN adopted and contributed to develop the **state-of-the-art observation principles** concerning radiation observations. Secondary standard instruments (for SW observation, **ISO-9060**), and in general **best quality market instruments**, are mostly **directly** traceable to the WRR (for SW) and WISG (for LW) maintained by the PMOD/WRC in Davos.

Redundancy of the component measurements is implemented to guarantee the quality of the data and reduce data gaps. **Quality controls** developed in the frame of BSRN (and the associated contributing partners) are based on PPL, ERL and cross comparison, can be calculated using the official **BSRN_Toolbox**.

Flaggin'system an overview



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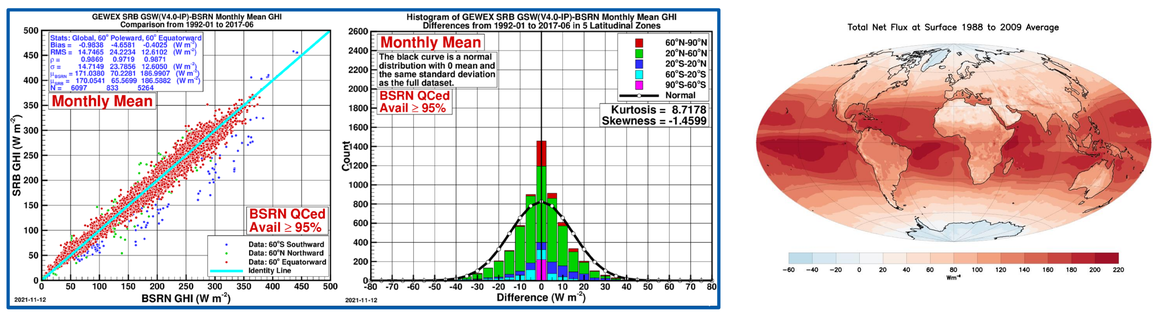
The role of BSRN in climate observation and future challenges

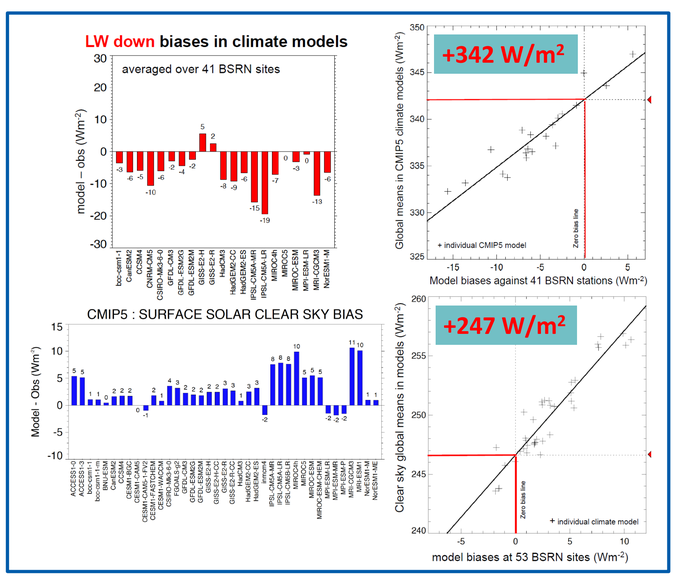
The BSRN is endorsed by the WCRP (GEWEX/GDAP) and recently applied to renew its membership as a **GCOS recognized reference networks**. Its data are used, along with other data sources, to constrain, over land, the satellite and modelling products which are used to define the surface energy budget. Their eight quality, combined with the high temporal resolution, with respect to other data, allows researchers to separate between clear and all-sky event and evaluate the surface cloud radiative forcing [see Reference section below for an entry point list [Zhang et al. (2013, 2019), Wild et al. (2013, 2019), Kato et al. (2020)].

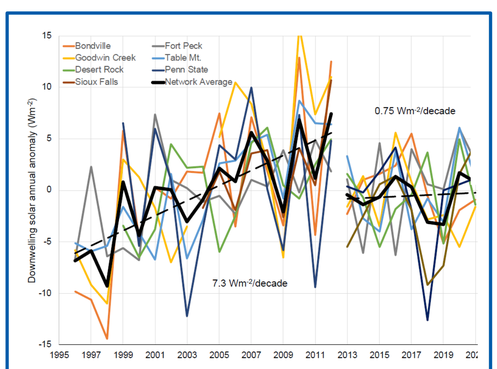


Courtesy Zhang et al., BSRN workshop (2022)

https://science.larc.nasa.gov/gewex-srb/

In the IPCC AR 6 assessment report the global energy balance is assessed by means of satellite derived products such as the CERES EBAF at TOA and by means of modelling (CMIP) and surface data including BSRN. Below a graphical representation on the methodology adopted to derive the best estimation of all-sky global SWD and LWD by constraining the model output bias with respect to the BSRN stations (**Wild et al. 2013, 2019, left panel below**).





Using SURFRAD/BSRN data J Augustine (2020) highlighed the cheasing of surface brightening over US around 2013 and suggested that the brightening-dimming cycle might be connected with the Pacific Decadal Oscillation (PDO), which drives the SST of the NH Pacific Ocean

BSRN working groups activities

The current list of 10 working groups appears as follows: **Infrared, Spectral/UV, Broadband, Uncertainties, BSRN and Renewable Energy, Data Quality, Ocean, Albedo/satellite, Value Added Products** (the last three just established).

They are facing different challenges among which we would like to mention:

- Traceability of the archive to any change of the international standards (LW in particular)
- Liaising with ocean community to adopt common best practices as far as possible, extending BSRN over existing ocean sites
- Providing centralized support to the station-scientists with the data quality check of their data
- Defining the path towards a Fiducial Reference Measurement compliancy (full uncertainty budget)
- Provide user with analysis ready data (ARD), in terms of time averages, cloud-id and clear sky models for either SW and LW.
- Improve the network timeliness which currently vary from few day to few years dep on site
- Covering the geographical gaps (Africa, Asia, South America), possibly with a stronger interaction with other community, exploiting either public or private initiatives.

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