Baseline Surface Radiation Network

a status update

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AOPC 28, Bonn 26-30 Jun 2023

European Commission

About BSRN

- The BSRN project was conceived by the WCRP Working Group on **Broadband solar and infrared 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 (of 76 including closed ones) contributing stations.

- Principles: Traceable to standards, Instr. Redundancy, High temporal resolution, high-quality instruments, QC, accessible, site representativeness, long-term commitment, …

- **30 Years of activity!**

BSRN as a GCOS recognized network

Network	Certificate
Baseline Surface Radiation Network (Accreditation date: 01/09/2022)	

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About BSRN and WRMC

- The archive (World Radiation Monitoring Centre) hosted by AWI, currently stores ~13*k* monthly files of broadband irradiance at 1-min resolution and …
  - Ancillary data, including UV-A and UV-B radiation components, surface meteorology (*T, p, RH*) and upper air soundings, synoptical report, Ceilometer data for selected stations
- Data distribution PANGAEA (doi indexed and snapshots) or FTP archive
  - A BSRN data snapshot was published in March 2023: “Lanconelli, C. et al. (2023): Baseline surface radiation data snapshot 2023-03-31. PANGAEA, https://doi.org/10.1594/PANGAEA.957398” → **C3S2_311_Lot2 (CNR)**

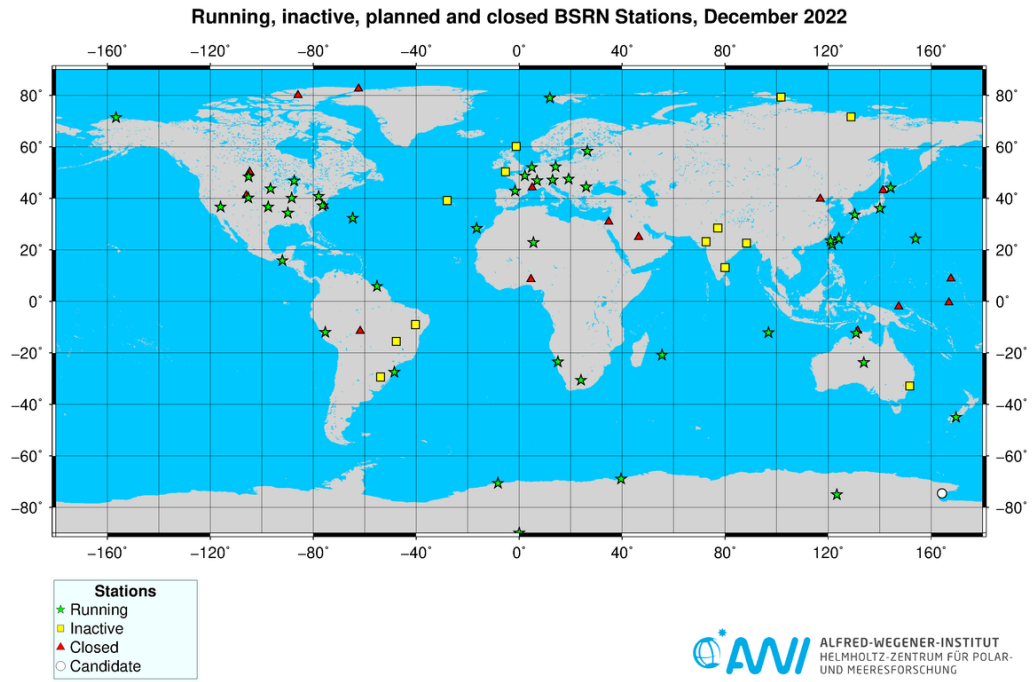
Geographical distribution

- Areas 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 (note: Indian and Russia stations inactive)

- **Candidate** or **pending:** Indonesia, Thailand (Tropics), Korea (East Antarctica), Cyprus, Italy (Mediterraneum), Ireland, Chile

- Expression of interest from China and UAE have also been received



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BSRN Scientific Review and Workshops

- 16th 2020 Interim Virtual
  - Originally planned to be host by the CNR in Bologna (Italy), cancelled due to pandemic related restrictions
- 17th 2022 Hybrid (@JRC, Italy)

  WCRP Report under preparation
- Online link to presentations

  https://bsrn.awi.de/meetings/2020/

  https://bsrn.awi.de/meetings/2022/

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Agenda

Agenda of the 17th WRCP/BSRN Scientific Review and Workshop
June 27-30, 2022, Ispra (VA), Italy.

Version 2022-06-29

All times in CEST: https://time.is/CEST

Where: **European Commission Joint Research Centre**
Bld 36 Modules A/B and virtual
No registration required for remote attendance

- Status of the network
- New stations evaluation
- Network/site operations
- Advancement in measurements
- Remote sensing application CAL/VAL activities
- Renewal energy sector
- Value Added Products
- Climate studies
- Training session
- Working Group reports
- BSRN way forwards

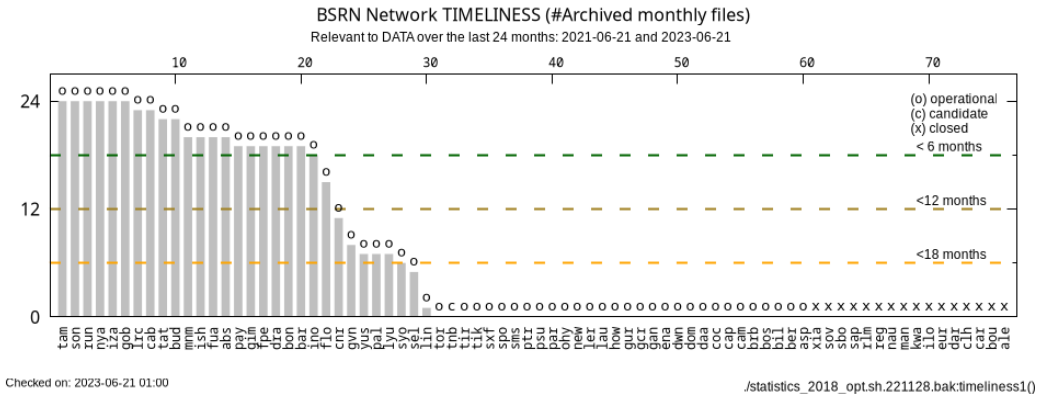
https://bsrn.awi.de/fileadmin/user_upload/bsrn.awi.de/Publications/BSRN_Meeting_Agenda_20220629.pdf

Archive

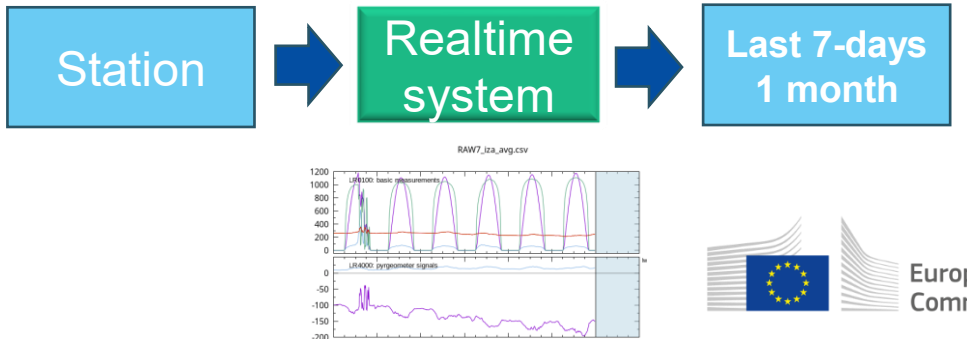
Status 2023 Jun

		LR	Descr.	Monthly Files	Stations
Radiation	1	**LR0100**	**Basic**	**12986**	76
	2	**LR0300** **3010, 3030**	**Upwards**	**3455** **2834, 373**	20 11, 2
	3	**LR4000 (NEW!!)**	**LW raw**	**202**	17
Ancillary	4	LR0500	UVA/UVB	4076	22
	5	LR1000	SYNOP	4592	28
	6	LR1100	Upper air	6195	33
	7	LR1200	Total O3	2050	9
	8	LR1300	Ceilometer	1035	4

Timeliness



Realtime RAW data System (pilot)



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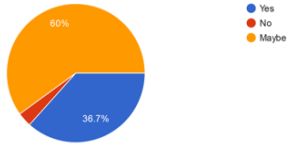
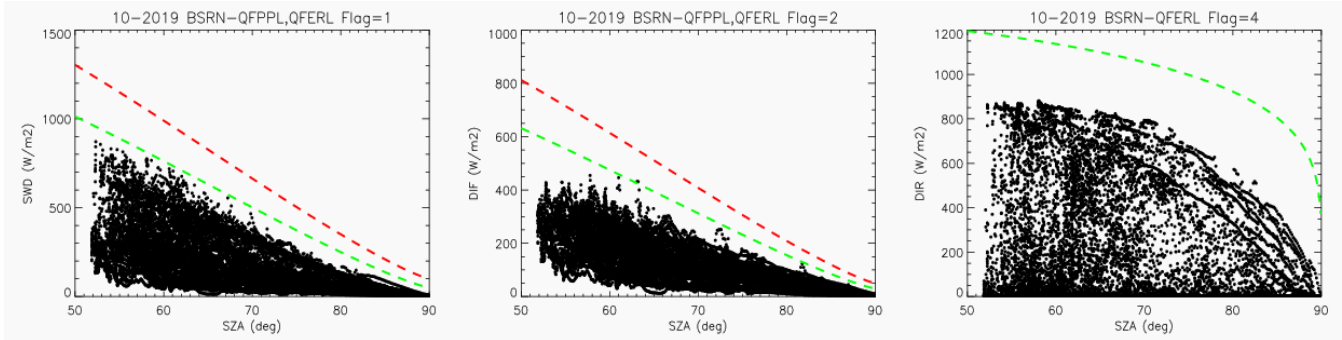
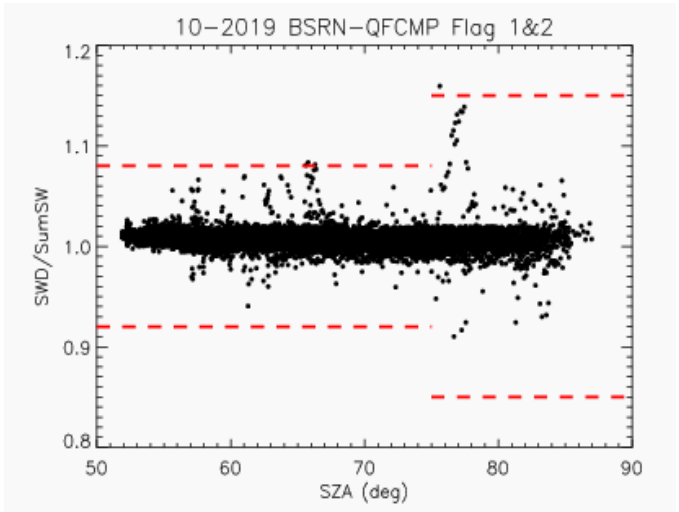
11) Could your data submission process benefit of a centralized QC tool?

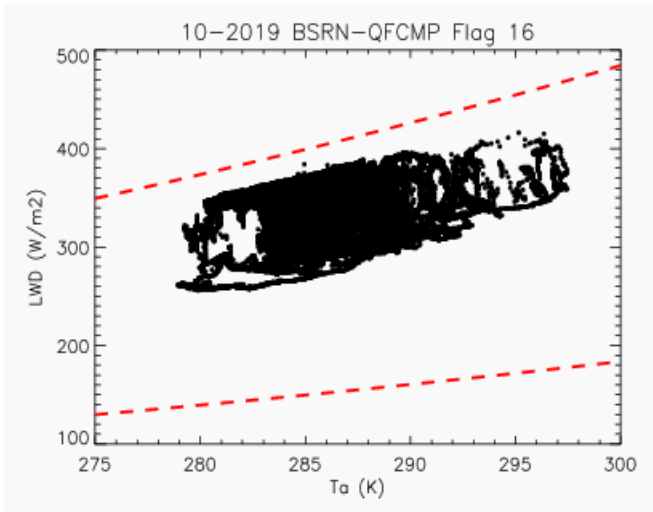


QC and flagging system

Acknowledgements Dr. Wouter Knap KNMI – BSRN DQWG







Quality control BSRN station [redacted] – August 2020

Day view | Month view | QC table | QC graphs | QC info | Time series | Sunshine | date | prev month | next month

```
% Script executed at:    Mon Feb 8 08:36:53 2021 UTC
% Timestamp last sample: Mon Aug 31 23:59:00 2020 UTC
% Station Selegua (MX)
% Latitude 15.784°N
% Longitude 91.990°W
% Refraction: yes
% Processing August 2020
% Missing days in LR0100: 0
% Missing days in LR0300: 0
% Missing records in LR0100: 0
% Missing records in LR0300: 0
```

BSRN quality flags and sunshine duration for August 2020

Date	SD MAX (h)	SD ACT (h)	SD REL (%)	SWD QFPPL Fla=1	SWD QFERL Fla=1	DIF QFPPL Fla=2	DIF QFERL Fla=2	DIR QFPPL Fla=4	DIR QFERL Fla=4	Ratio QFCMP Fla=1	Ratio QFCMP Fla=2	Ratio QFCMP Fla=4	Ratio QFCMP Fla=8	SW QFTRQ Fla=0	LWD QFCMP Fla=16	SWU QFPPL Fla=16	SWU QFERL Fla=16	LWU QFCMP Fla=64	METEO QFPPL Fla=1
1	12.5	11.0	88	0	0	0	124	0	0	0	3	0	0	n/a	0	0	0	0	0
2	12.5	9.0	72	0	11	4	184	0	0	0	0	0	0	n/a	0	0	0	0	0
3	12.5	6.8	54	0	0	0	48	0	0	266	0	11	0	n/a	0	0	0	0	0
4	12.5	7.4	60	4	15	20	194	0	0	250	0	0	0	n/a	0	0	0	0	0
5	12.4	6.7	54	0	0	0	0	0	2	127	0	0	0	n/a	0	0	0	0	0
6	12.4	7.9	64	0	0	0	29	0	1	2	6	0	0	n/a	0	0	0	0	0
7	12.4	2.9	23	0	0	0	39	0	0	3	0	0	0	n/a	0	0	0	0	0
8	12.4	5.9	48	0	0	0	616	0	0	0	0	0	0	n/a	0	0	0	0	0
9	12.4	7.3	59	0	13	9	70	0	0	0	0	0	0	n/a	0	0	0	0	0
10	12.4	4.9	39	0	34	28	46	0	0	0	0	0	0	n/a	0	0	0	0	0
11	12.4	8.8	71	5	14	14	77	0	0	0	0	0	0	n/a	0	0	0	0	0
12	12.4	11.0	89	0	2	0	37	0	0	3	0	0	0	n/a	0	0	0	0	0
13	12.4	9.9	80	0	0	0	85	0	0	0	0	0	0	n/a	0	0	0	0	0
14	12.4	10.4	84	0	0	0	35	0	0	1	2	0	0	n/a	0	0	0	0	0
15	12.3	4.6	37	0	0	0	30	0	0	0	0	0	0	n/a	0	0	0	0	0

Pilot: https://bsrn-qc.net

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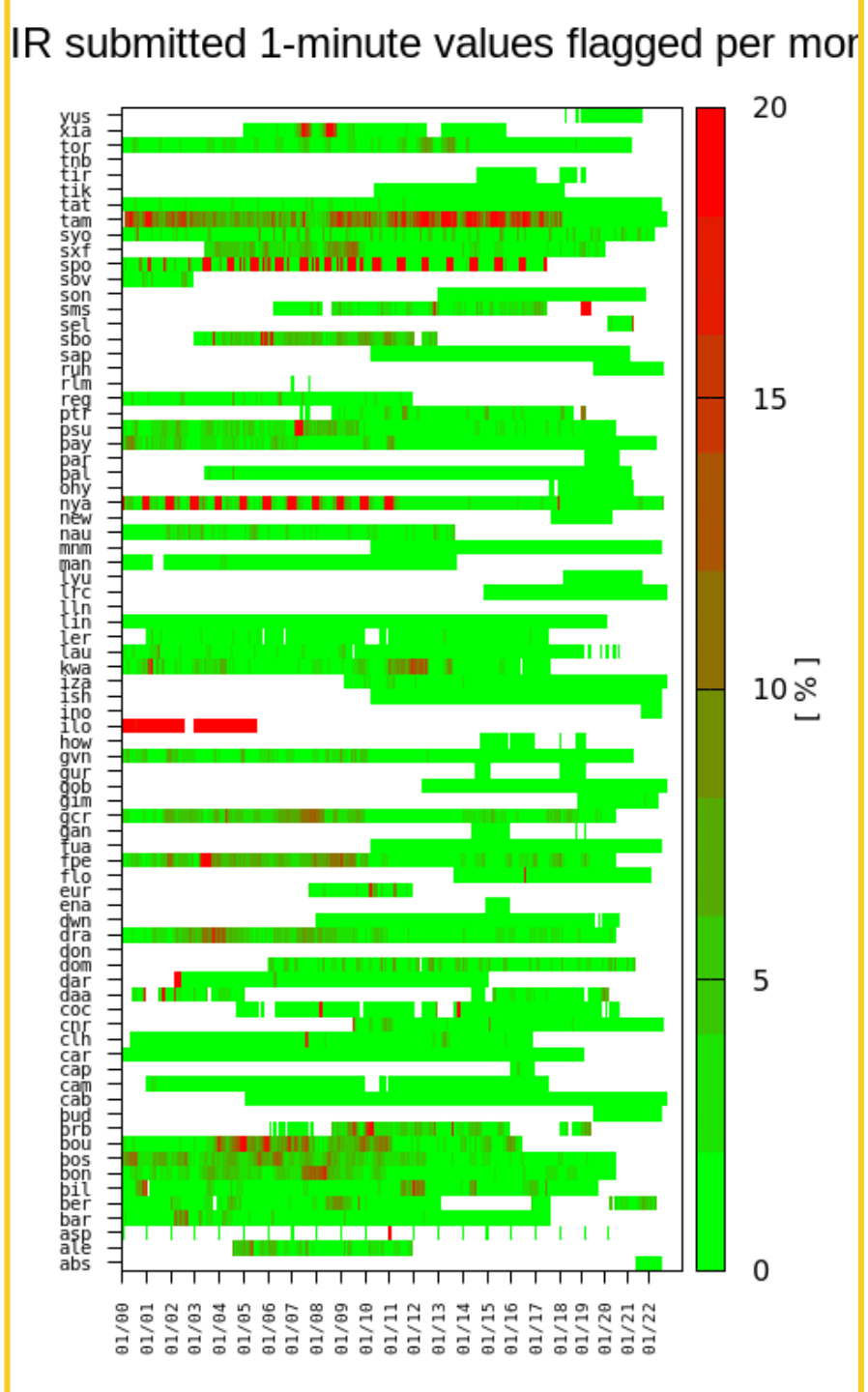

Quality check

- QC based on PPL, ERL, XCO
- DIR, DIF, SWD, LWD, (SWU, LWU)
- Lack of BSRN-QC on ancillary data, including meteo
- **DIR**
  - **Calibration, linearity, dusting**

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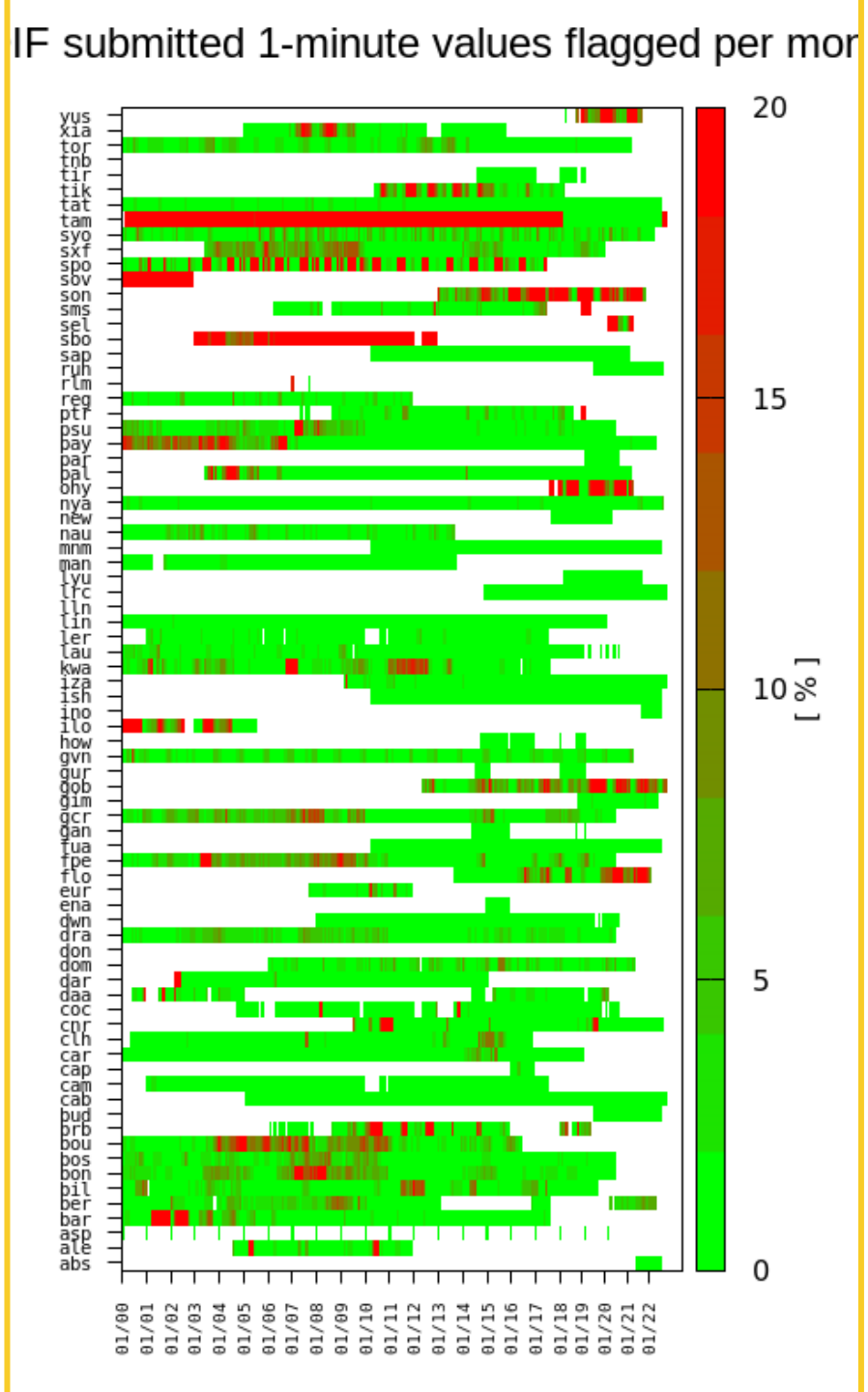

Quality check

- QC based on PPL, ERL, XCO
- DIR, DIF, SWD, LWD, (SWU, LWU)
- Lack of BSRN-QC on ancillary data, including meteo
- **DIF**
  - **+ Levelling, +thermal offset**

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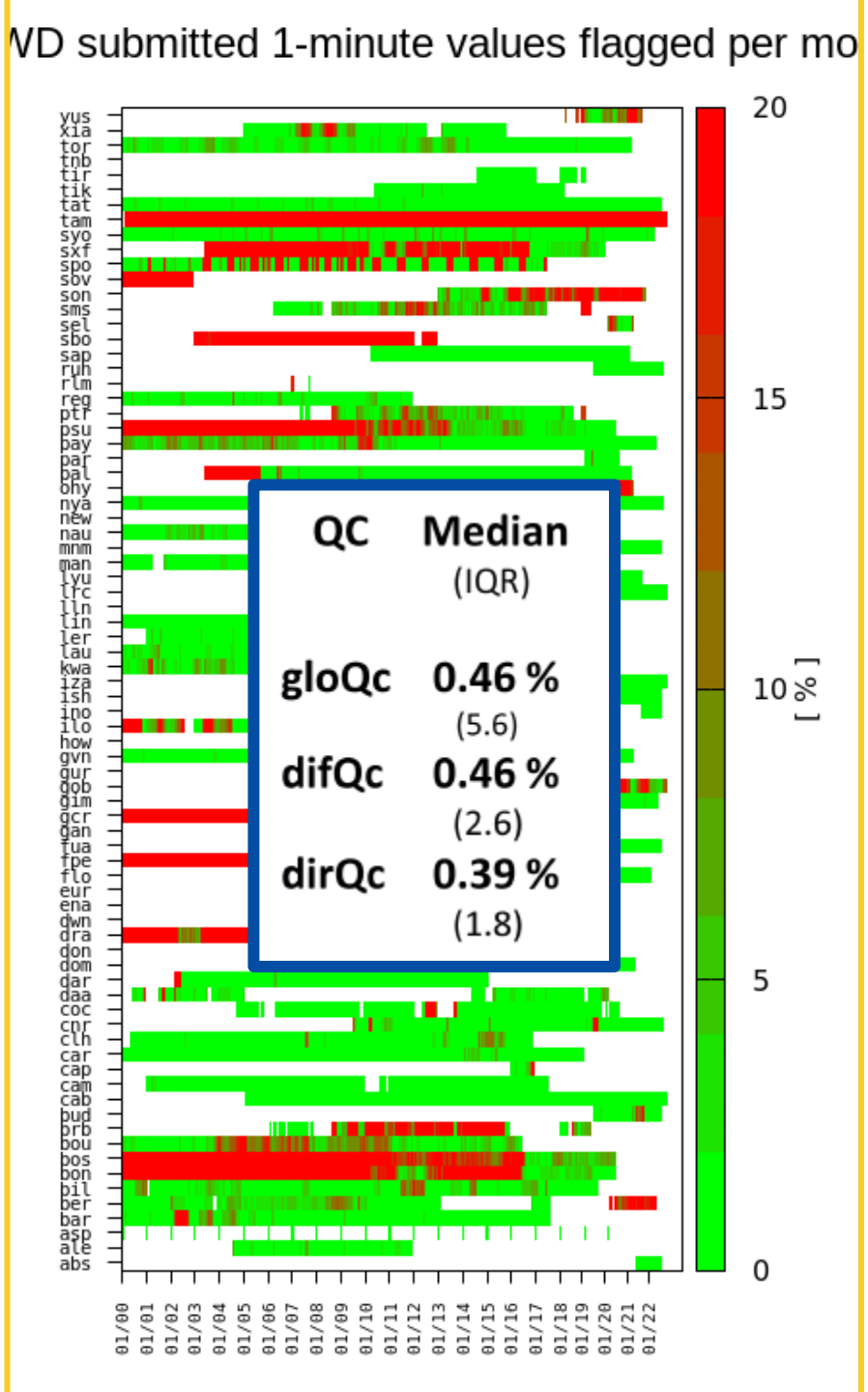

Quality check

- QC based on PPL, ERL, XCO
- DIR, DIF, SWD, LWD, (SWU, LWU)
- Lack of BSRN-QC on ancillary data, including meteo
- **SWD (G2)**
  - **+ cosine response**

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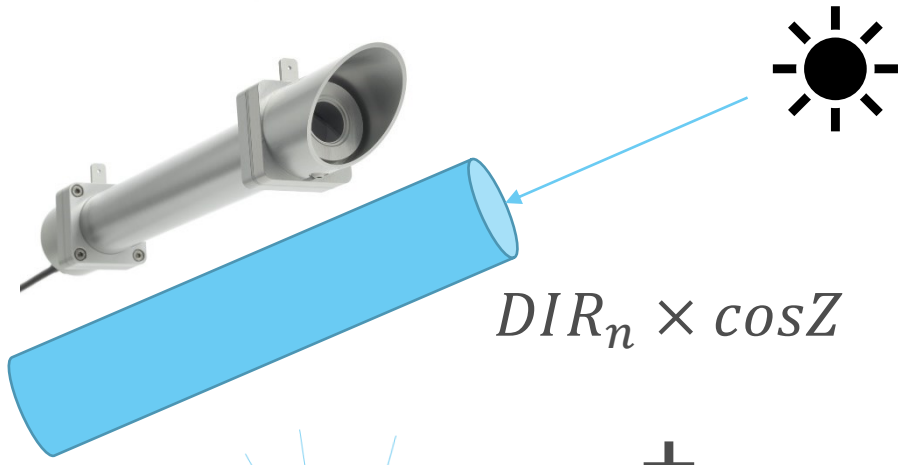
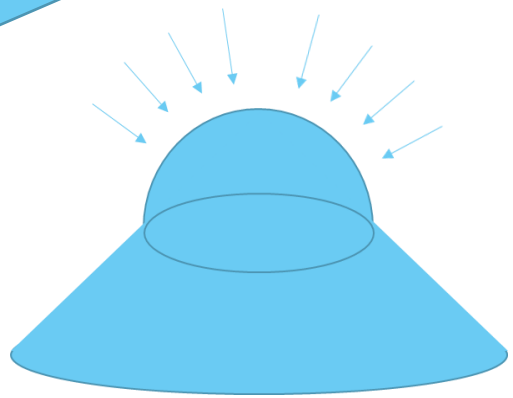
FRM: Redundancy and uncertainties evaluation

Pyrheliometer: Direct Normal



$DIR_n \times cosZ$

+



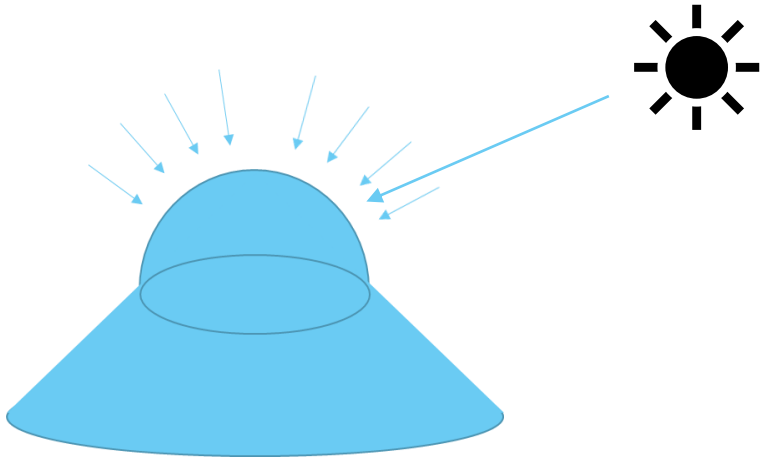
DIF

Shaded pyranometer: Diffuse

Sun tracker

=

See Vuilleumier WG report on Thu
Join him for a shore WG breakout session



Unshaded pyranometer: Global

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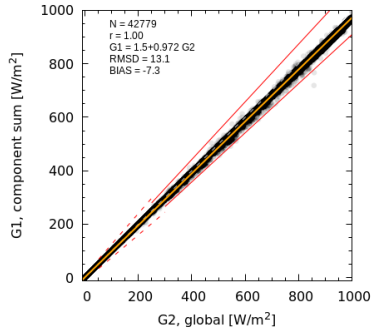
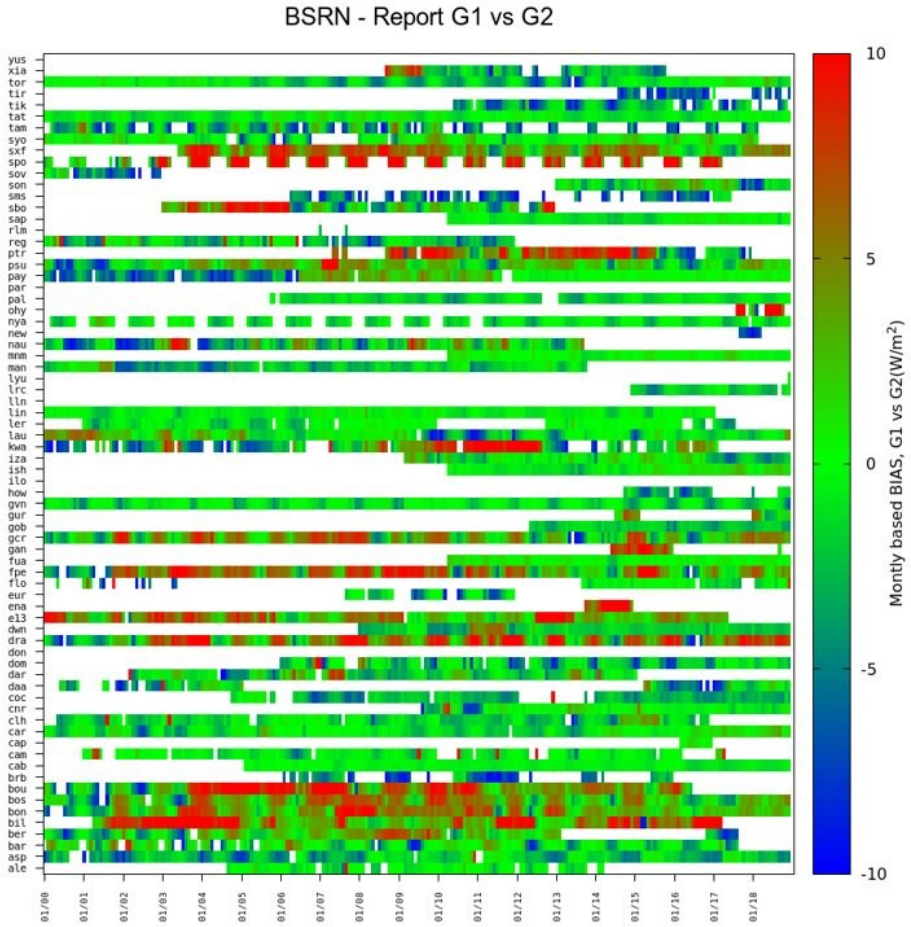
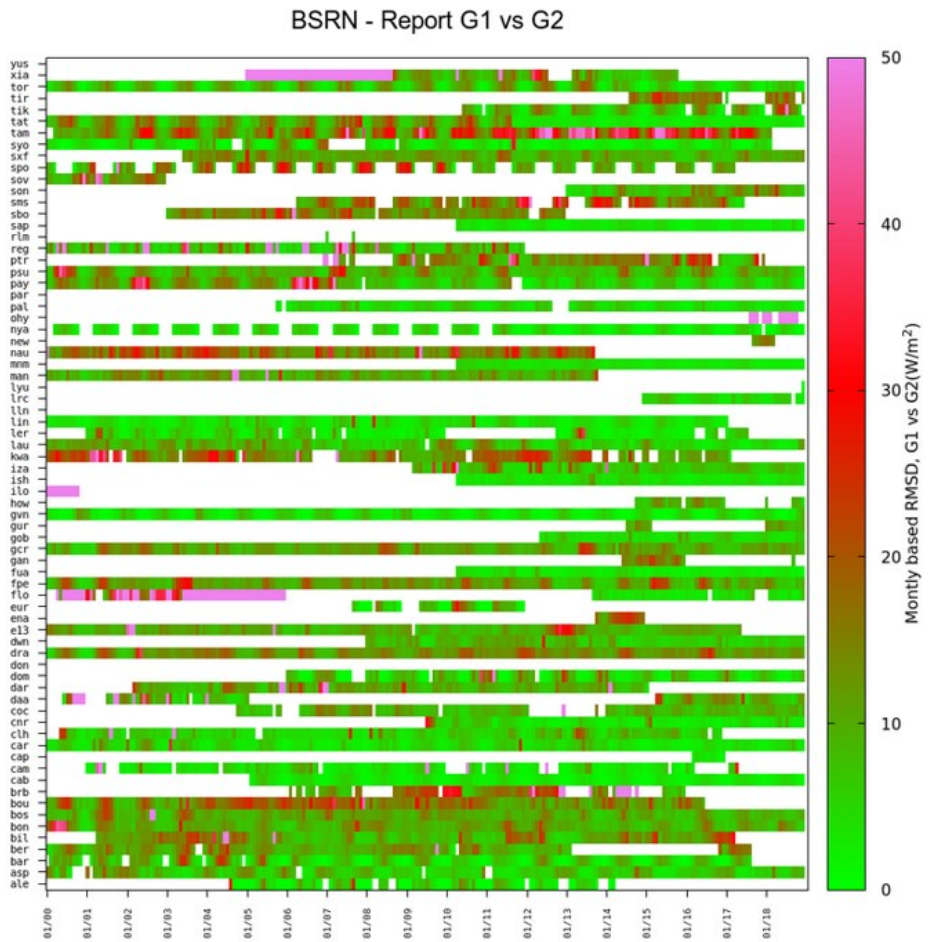
Redundancy *(BIAS, RMSD)* ***2000-2018***







BIAS → 0 ± 2 W/m²

RMSD→ 5 ± 7 W/m²

Uncertainty (example components considered)

$$U_I = \sqrt{(\partial_S)^2 u_S^2 + (\partial_U)^2 u_U^2 + (\partial_{OS})^2 u_{OS}^2 + u_{stat}^2 + \sum u_{op}^2}$$

- Sensitivity • u_S
  - calibration uncertainty — from calibration instit
  - cosine response — non-negligible
  - non-linearity
  - temperature dependence — from
  - aging
  - tilt influence
  - spectral respons
- Signal • u_U
  - DAC
  - facturer technical data
  - egligible
- Statistical • — estimated from (stable direct) data
- Systematic • u_{OS} — set — estimated from (night) data
- Operational • u_{op}
  - ling — more important for direct (literature + data)
  - leveling-induced error — non-negligible only for global (data)

on sensitivity: on signal measurement; on thermal offset; statis-tical; opera-tional

Maintenance

Uncertainty summary table for solar

Direct normal irradiance ~1.5%,

Global (diffuse) irradiance ~2%

(Vuilleumier et al., 2014)

Small signal: 50 Wm^{-2}

Large signal: 1000 Wm^{-2} (global, direct)

500 Wm^{-2} (diffuse)

		standard (Wm^{-2})		expanded (Wm^{-2})		expanded (%)	
		small signal	large signal	small signal	large signal	small signal	large signal
global	not corrected	5.7-7.5	9.0-11.6	11-15	18-23	22-30	1.8-2.3
	corrected	5.0-7.0	7.2-8.7	10-14	14-17	20-28	1.4-1.7
direct	not corrected	3.0	8.3	5.8	16.3	11.6	1.6
	corrected	2.9	6.5	5.8	12.8	11.6	1.3
diffuse	not corrected	3.6-4.0	4.9-6.0	7.1-7.9	10-12	14-16	2.0-2.4
	corrected	2.2-2.8	4.0-4.2	4.4-5.6	7.9-8.2	9-11	1.6

BSRN and Ocean measurements

AOPC OOPC

- Efforts underway to better integrate land and ocean surface broadband radiation measurement
  - community paper on best practices for ocean radiation measurements
  - Seek GOOS endorsement for those best practices
  - Intercomparison experiments to better evaluate the impact of best practices and new technologies
- Integrate land and ocean radiation measurements into a truly global dataset
  - Ocean site into BSRN
  - BSRN shore site to host intercomparison

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On going activities and plans

1. BSRN Manual and GCOS-174 review

2. Release Time Aggregated data through the Copernicus CDS (Value Added Product WG) **see F Madonna (… then VAP)**

3. Interaction with Ocean community initiatives (Radiation measurements best practice white paper lead by Riihimaki NOAA) (**Ocean WG**)

4. Release QC files and update them with a firm schedule (**DQWG**)

5. Define quantitative indicators to determine when data submission can be ingested into BSRN archive (**DQWG**)

On going activities and plans

6. Associate quantitative estimation of the uncertainty to each component following metrological approach whenever possible, or indicators obtained from redundant measurement (**Uncertainty WG**).

7. Expand albedo measurements (tower/drones?) (**Albedo WG**)

8. Associate spatial/temporal representativeness indicator to each BSRN site for irradiance, albedo and cloudiness validation (**Albedo WG, JRC**).

9. Harmonize measurements, implement ground meteorological traceability (T, p, RH) (**DQWG**).

10. Exploiting collaboration/interaction/partnership with other GCOS networks **at any tier**

Thank you

European Commission

2019 stuff below

The current eight BSRN Working Groups

Infrared J. Gröbner (PMOD/WRC)	Spectral Kathy Lantz (NOAA)	Broadband A. McComiskey (Brookhaven Nat. Lab.)	Uncertainties N. Hyett (Aus. BOM)
Cold Climate Issues Chris Cox (NOAA)	**Use of BSRN in Solar Renewable Energy E. Pereira (INPE)**	**BSRN manual review committee G. Hodges (NOAA)**	**Data quality W. Knap (KNMI)**

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GDAP point related to BSRN (Credits: T. L'Ecuyer)

- Reiterated value of BSRN as calibration standard for global surface radiation products and studies
- Strong support for ongoing efforts to establish absolute IR calibration standards
- Request from global surface radiation product developers for BSRN sites to add 2m temperature and humidity to standard BSRN observation suite
- Need to establish accuracy standards for oceanic (buoy) sites
  - GDAP could oversee a community survey to define current capabilities and reasonable target
  - Follow-up workshop to define standards

Final remarks

- **Reinforce the Data Quality check (Data Quality WG) (*)**
- **Reinforce the knowledge exchanges with WMO-CIMO with direct BSRN membership within Task Team/Expert Team (*)**
- **BSRN Manual Update (*)**
- **Establish Web meetings for WG progress discussion (*)**
- **Nominate a deputy BSRN Project Manager (*)**
- **Setup a knowledge expertize network to support station leaders and data users**
- **Promote the use of dismissed, unwanted equipment to increase upwelling components coverage through BSRN stations**
- **Share of data analysis computer code/station-to-archive formatters (to support early release of data)**
- **Promoting coverage of geographical gaps of the network? Which $ support? Capacity building/Africa framework**
- **Promote community join scientific/best practice publication/docs/CIMO/GCOS**
- **Establish L2 BSRN product (monthly avgs, clearId, early-release, ...)**