

Worldwide solar radiation measurement database with quality-control added value

Anne Forstinger,

S. Wilbert, A. R. Jensen, D. Yang, A. Gracia, N. Blum, D. Miranda, E. Collino, D. Ronzio, A. Driesse,
I. Sifnaios, B. Kraas, F. Azam, J. Polo, C. Gueymard, C. F. Peruchena, Y.-M. Saint-Drenan, I. Balog,
J. Peterson, W. van Sark, C. Cornaro, J. Lezaca, T. Schmidt, A. Ghennioui, M. Abriam, J. Alonso-Montesinos

Overview

Framework: worldwide benchmark of modelled solar radiation data (sat./NWP) organized within IEA PVPS Task 16

- Database of solar radiation measurements
- Quality control of solar radiation measurements
 - Automatic tests
 - Manual and visual control
 - For solar radiation ground data sets
 - Global horizontal irradiance (GHI)
 - Direct normal irradiance (DNI)
 - Diffuse horizontal irradiance (DIF)
 - Global fixed tilted irradiance (optional) (GTI)
- Results for complete dataset



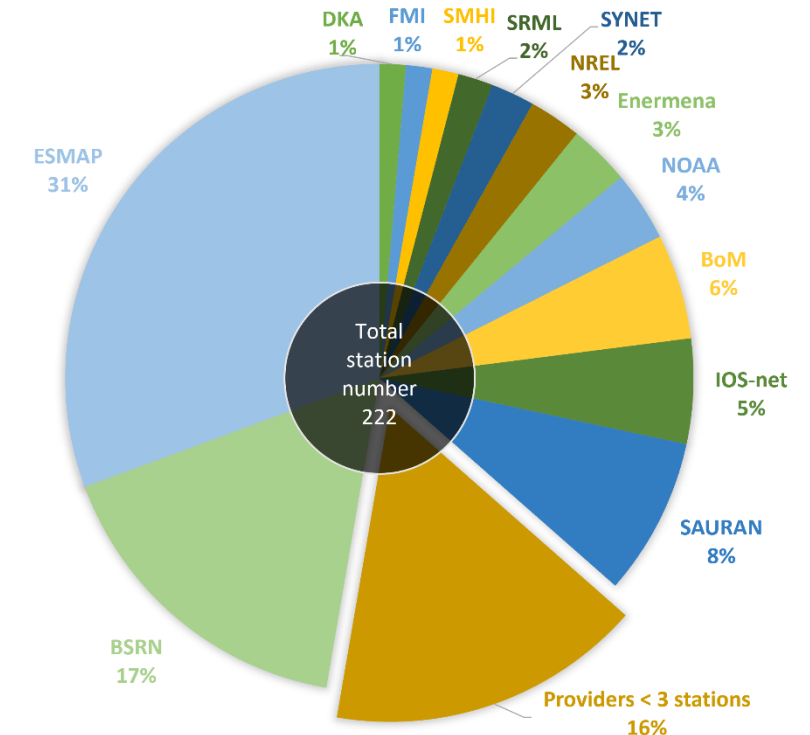
Update of [2023 Benchmark](#)

Novelties:

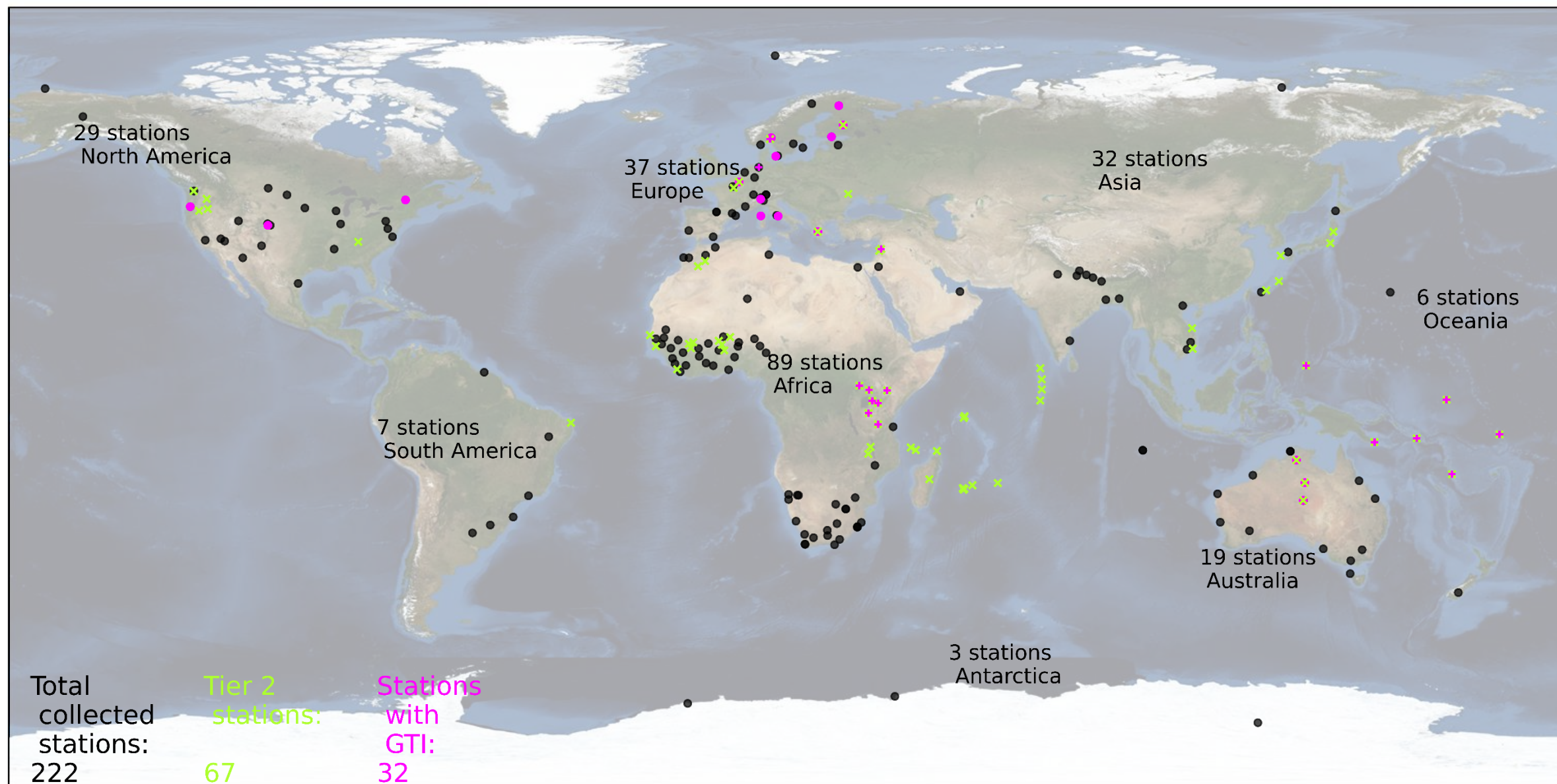
- GTI included
- Many new measurement sites
- More commercial data providers in Benchmark

Database of solar radiation measurements

- **Data in 1 minute resolution**
- **Time period 2018 to 2023 incl.**
- Worldwide
- At least two components (GHI and DNI and/or DIF)
 - GTI if available
- Focus on small station networks
 - **Total number of 222 stations worldwide** → Previous Benchmark: 129
 - 36 stations of providers with 1 or 2 stations
 - Only 37 BSRN stations are used
- Gathering of all available other (meta) data
- **One common data format** (incl. standardized headers)
 - including QC flags
 - further measurement data



Sources of ground measurement stations in the dataset. Total number of stations is 222.



Backgroundmap: Stöckli et.al. 2005

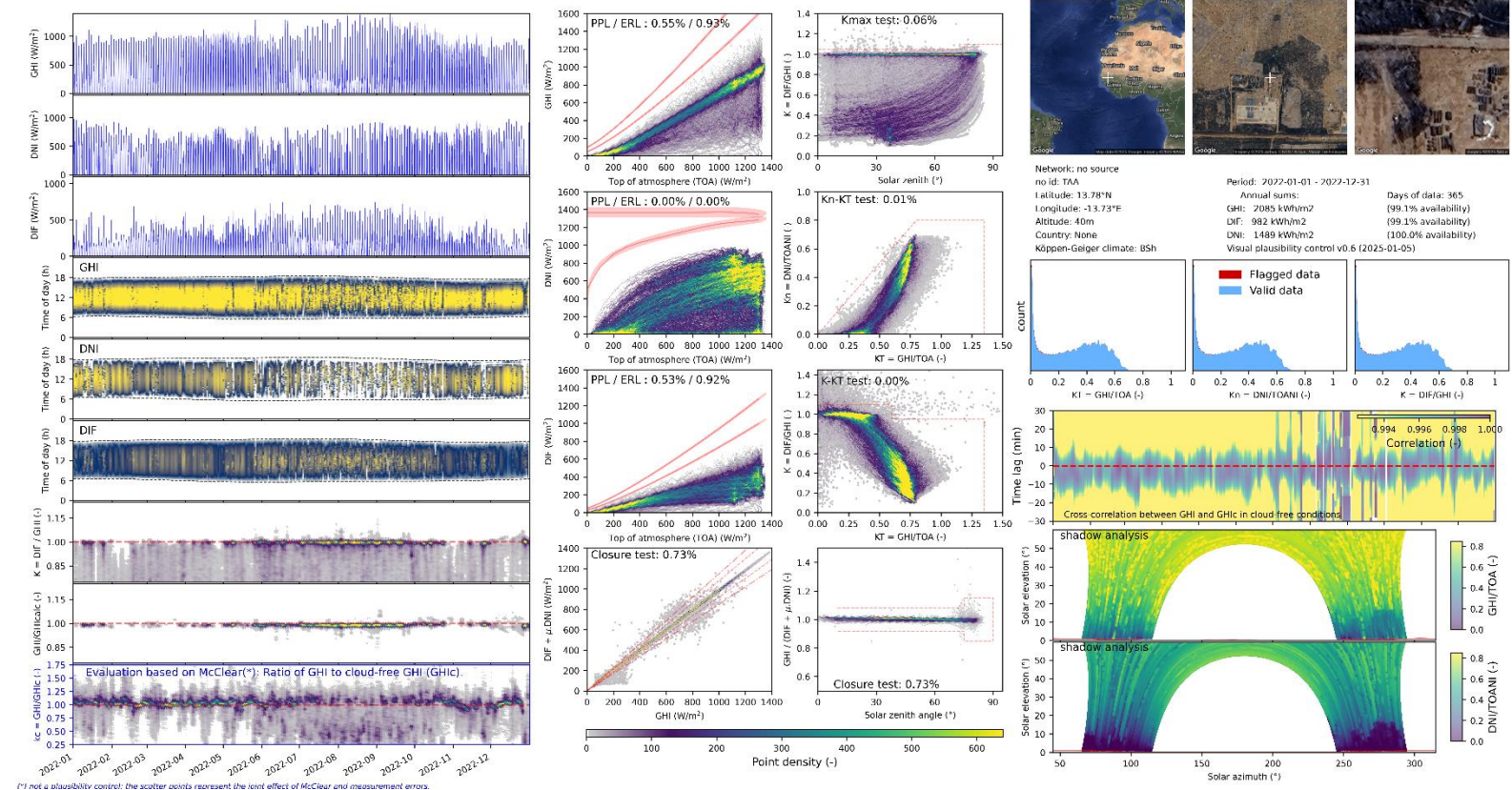
Overview

Framework: worldwide benchmark of modelled solar radiation data (sat./NWP) organized within IEA PVPS Task 16

- Database of solar radiation measurements
- Quality control of solar radiation measurements
 - Automatic tests
 - Manual and visual control
 - For solar radiation ground data sets
 - Global horizontal irradiance (GHI)
 - Direct normal irradiance (DNI)
 - Diffuse horizontal irradiance (DIF)
 - Global fixed tilted irradiance (optional) (GTI)
- Results for complete dataset

Quality control of solar radiation measurements

- One common QC for entire dataset
- Automatic QC according to (Forstinger et.al., SWC 2021)
- Manual QC with multiplot
- 15 Automatic flags + 1 manual flag
 - For GHI, DNI and DIF

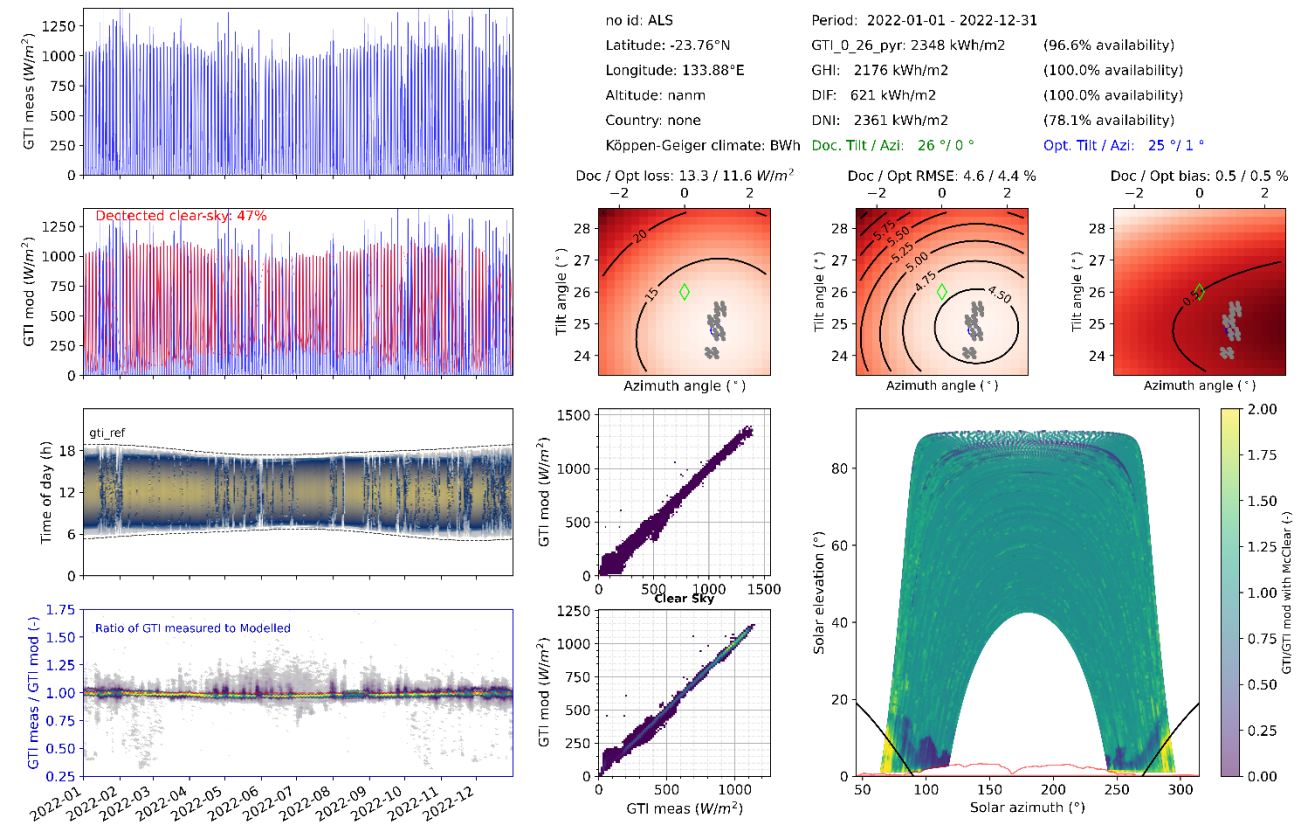


Multiplot for the quality control of GHI, DNI and DIF. Generated for all stations in the data set in the same way.

Quality control of solar radiation measurements

- Separate QC for GTI
 - Automatic QC
 - Separate multiplot
 - Manual QC
 - Flags for each GTI sensor

→ novel GTI QC currently under publication



Multiplot for the quality control of GTI. Generated for all stations and GTI orientations in the data set in the same way.

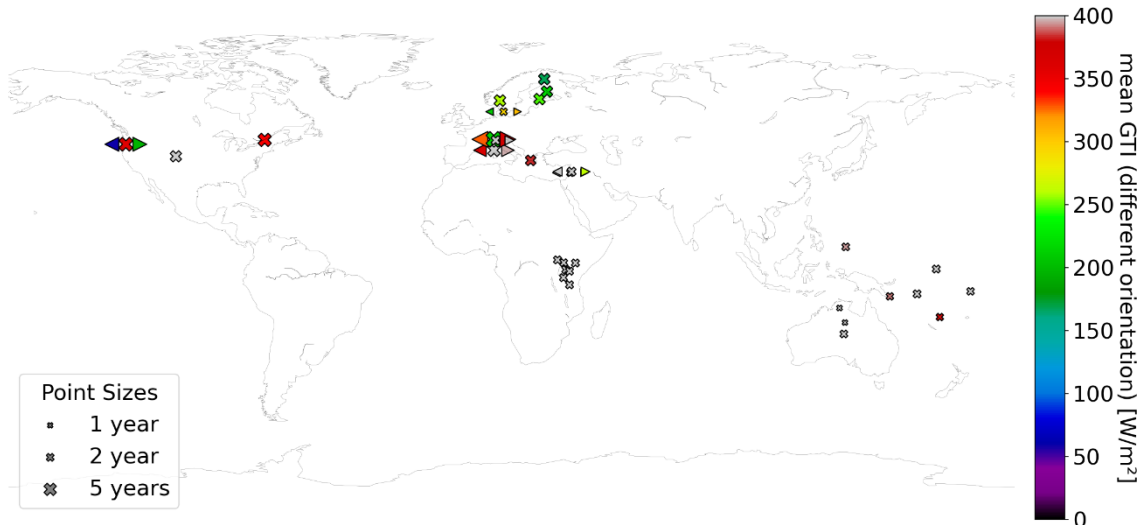
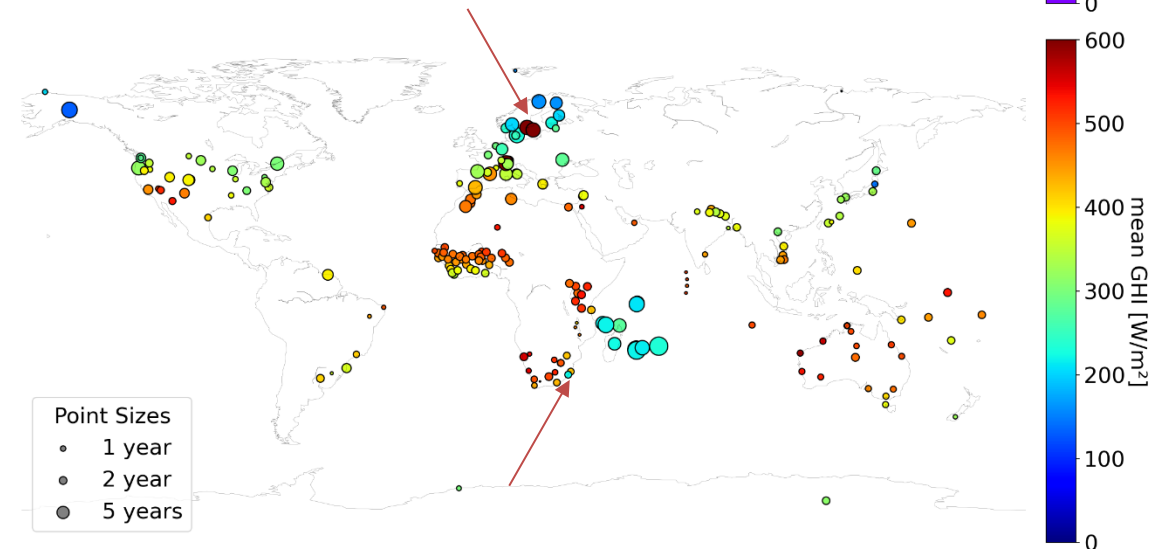
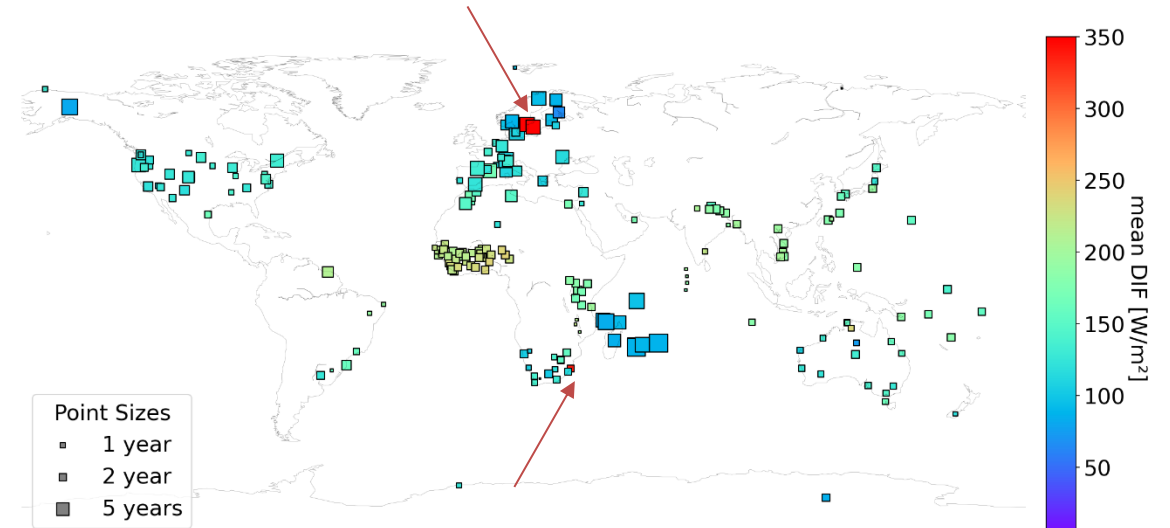
Overview

Framework: worldwide benchmark of modelled solar radiation data (sat./NWP) organized within IEA PVPS Task 16

- Database of solar radiation measurements
- Quality control of solar radiation measurements
 - Automatic tests
 - Manual and visual control
 - For solar radiation ground data sets
 - Global horizontal irradiance (GHI)
 - Direct normal irradiance (DNI)
 - Diffuse horizontal irradiance (DIF)
 - Global fixed tilted irradiance (optional) (GTI)
- Results for complete dataset

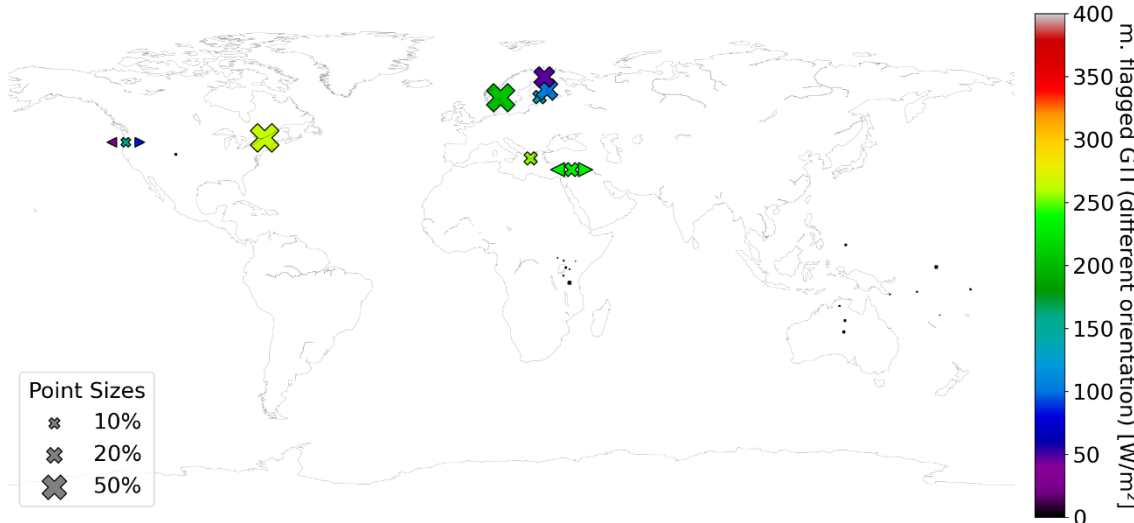
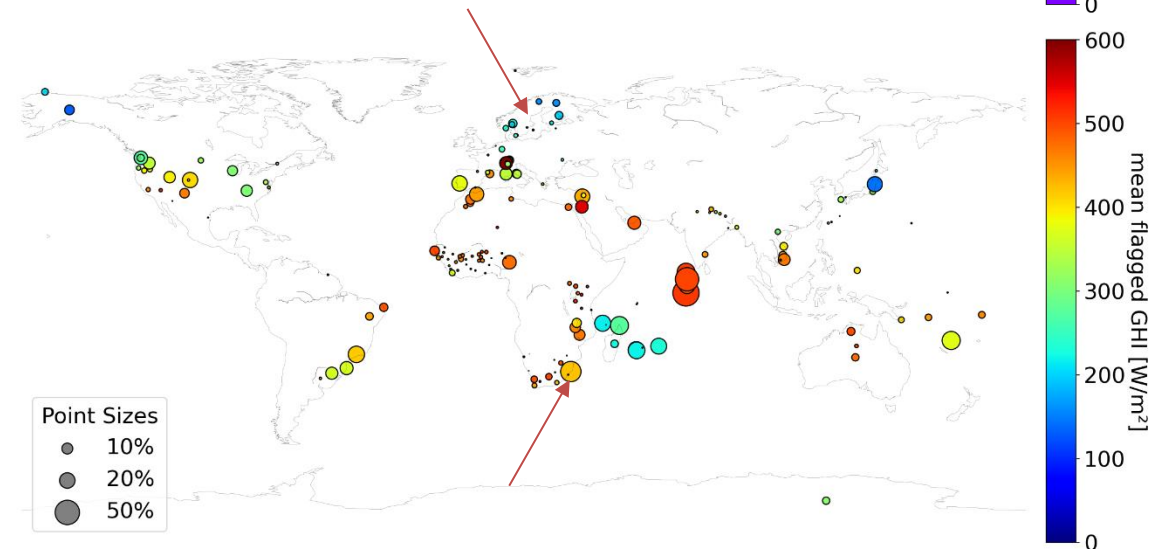
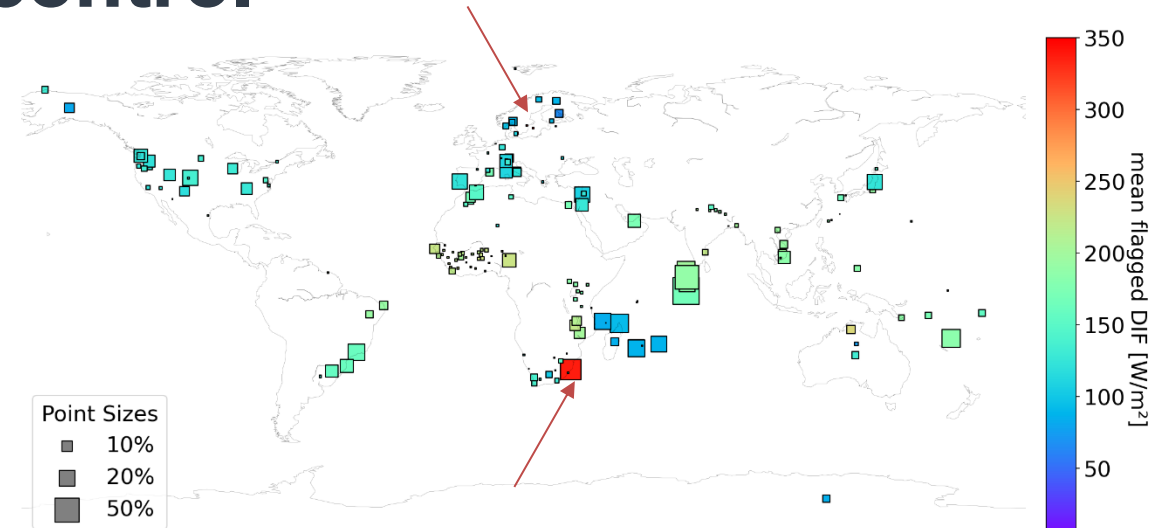
Global data set results

- Some sites with multiple GTI measurements
- Many data sources with 1-2 years of availability
- Mean irradiance **of raw data**
- Suspicious means uncoverable from regional context



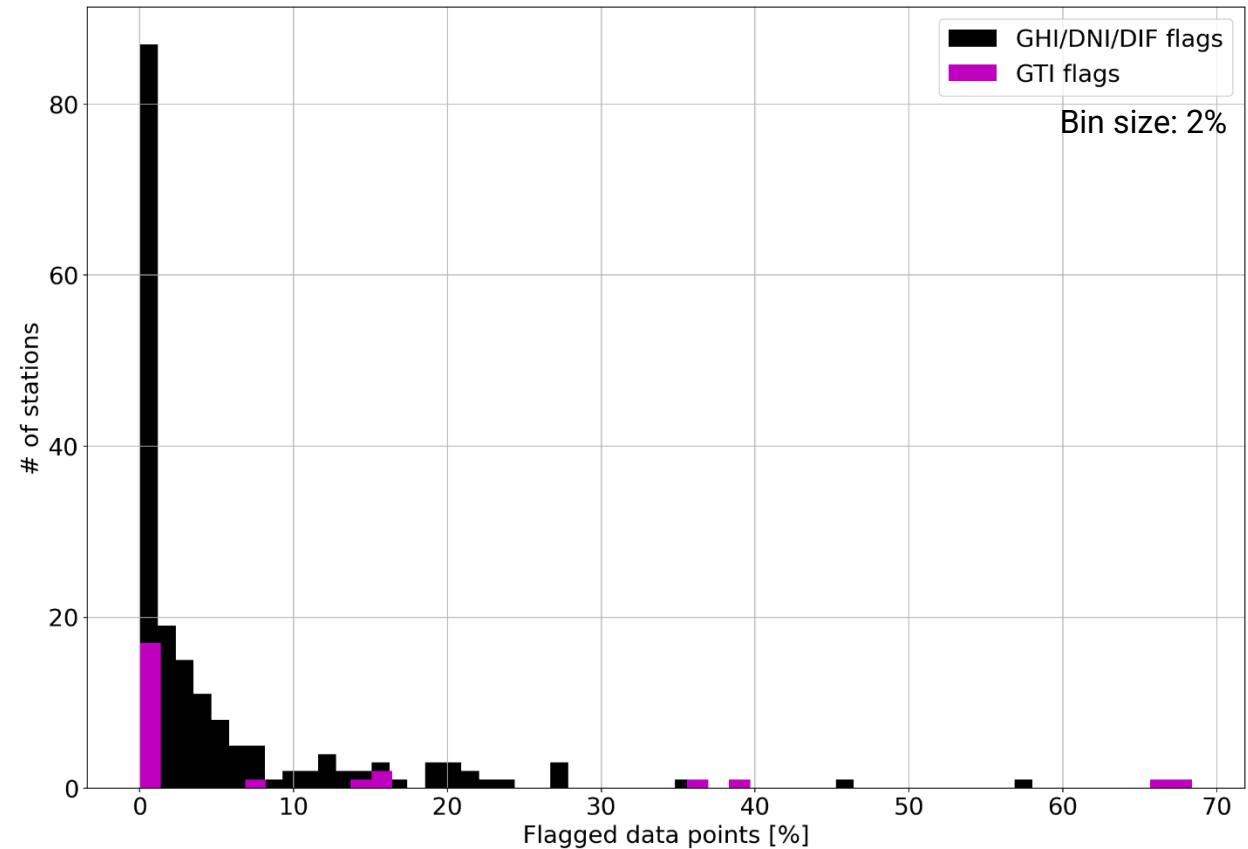
Global data set results Quality control

- Even few data points can lead to suspicious means
 - QC flags are essential to avoid large errors



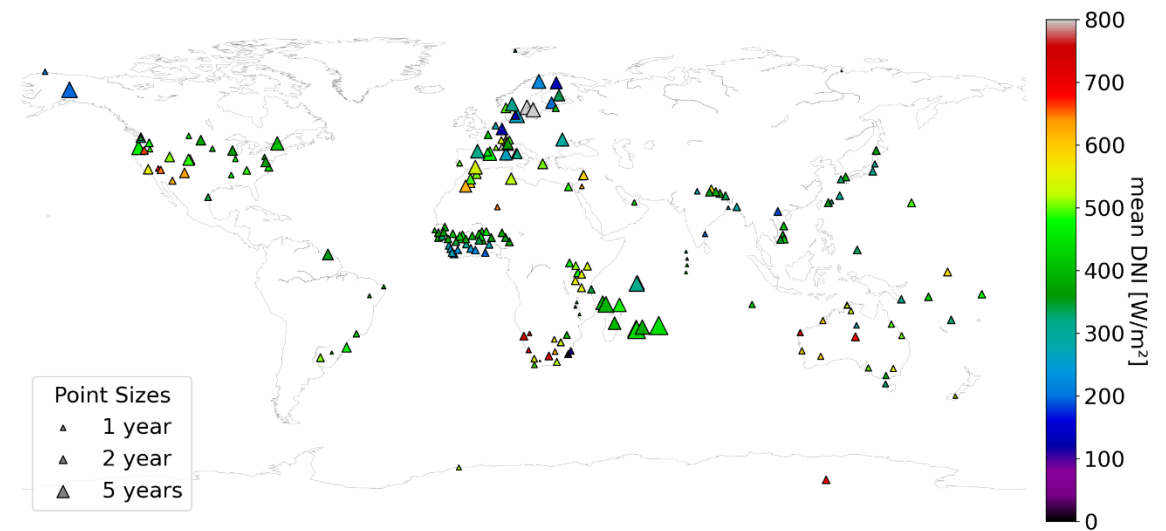
Global data set results Quality control

- Even few data points can lead to suspicious means
 - QC flags are essential to avoid large errors
- Majority of 222 stations < 10 % flagged data points



Conclusion and outlook

- Global data base with quality-controlled data in 1 minute resolution
 - GHI, DNI, DIF and GTI (fixed, multiple orientations)
 - Same format
 - Data visualization
 - 16 QC flags including expert flags
 - 222 stations
 - Will be published as a data article
- Large errors possible if raw data is used
- Majority of stations with small number of flags
 - **Nonetheless: QC flags must not be ignored**



Thank you very much for your attention!

Supported by:



Federal Ministry
for Economic Affairs
and Climate Action

on the basis of a decision
by the German Bundestag

CSP Services and DLR thank the German Ministry for Economic Affairs and Climate Action for funding this study within the SOLREV-2 project (contract number 03EE1195).



Contact:



Anne Forstinger

CPS Services GmbH

Friedrich-Ebert-Ufer 30

51143 Cologne

Germany

Phone: +49 2203 958 9198

www.cspservices.de