BQC: A WEBSITE TO QUALITY CONTROL SOLAR RADIATION MEASUREMENTS USING SATELLITE-BASED DATABASES

www.bqcmethod.com

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QUALITY CONTROL OF SOLAR IRRADIANCE

Classical QC methods (e.g., BSRN QC) use statistical and physical limits

BUT

There is a wide range of plausible irradiance values

PROBLEM

Measuring errors of low-magnitude (shadows, calibration errors) pass classical QC methods

Need for new QC methods

BIAS-BASED QUALITY CONTROL (BQC) METHOD

Global Horizontal Irradiance (daily)

Flag groups of consecutive days in which the deviations of several independent models are out of the typical values for that region and time of the year

BQC validations

(Urraca et al. 2017) - 335 European stations - 29 stations with errors
(Urraca et al. 2019) - 732 Spanish stations - 264 stations with errors

STRENGTHS of the BQC		**BSRN QC**
Finds low-magnitude defects (e.g. shading, soiling, calibration)	$\leftrightarrow$	ONLY large errors, time lags
G_H deviations + 20-90 days	$\leftrightarrow$	**G_H samples + 1 sample**
Visual flags	$\leftrightarrow$	Numerical flags

OBJECTIVES

OBSTACLES FOR IMPLEMENTING THE BQC

- Download estimations from solar radiation databases.
- Obtain reliable station data to calculate the typical value of the deviations.

SOLUTION

- A **free** web service incorporating the BQC algorithm + databases + station data to quality control any station in Western Europe
- Users only have to upload their data and analyze the visual flags produced.

www.bqcmethod.com

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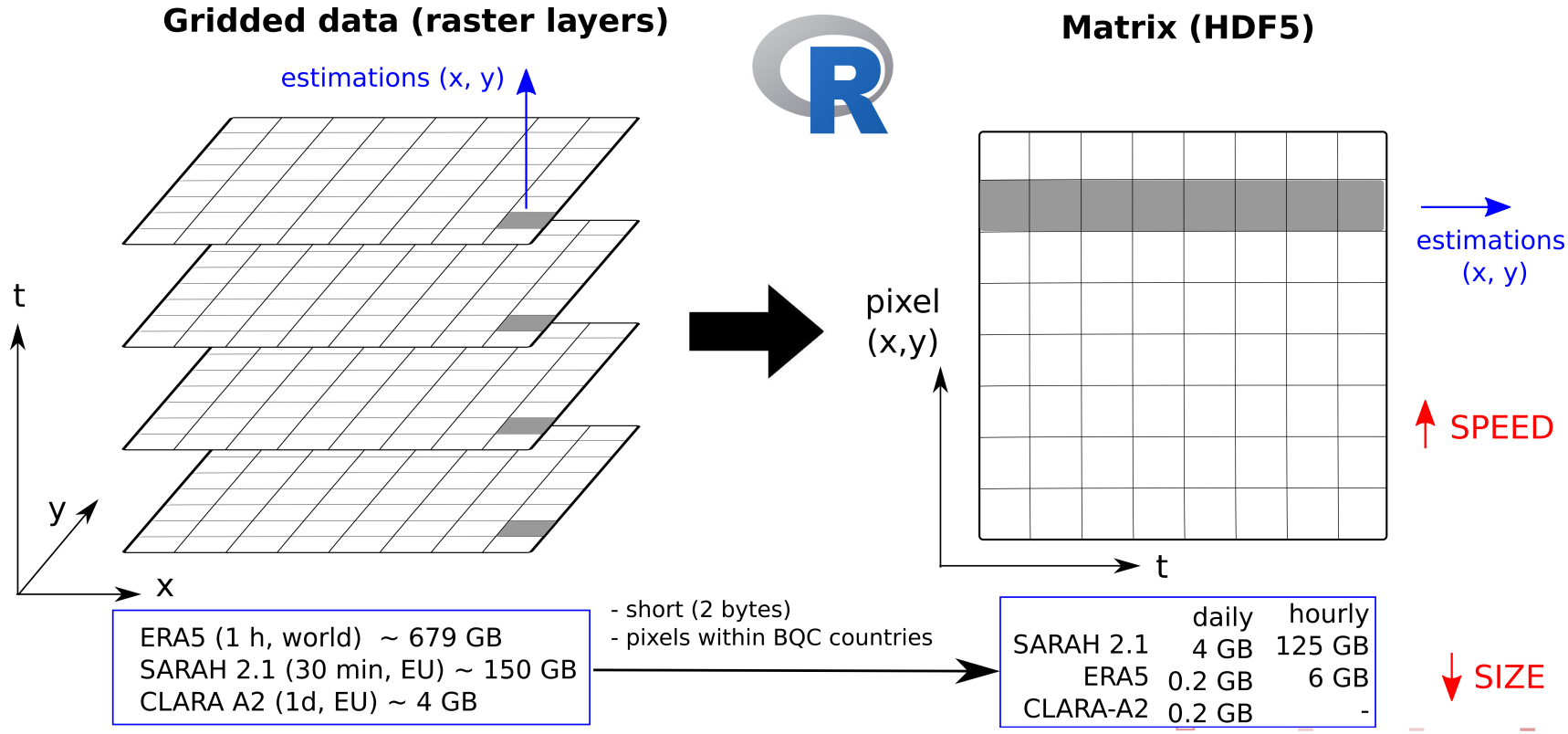
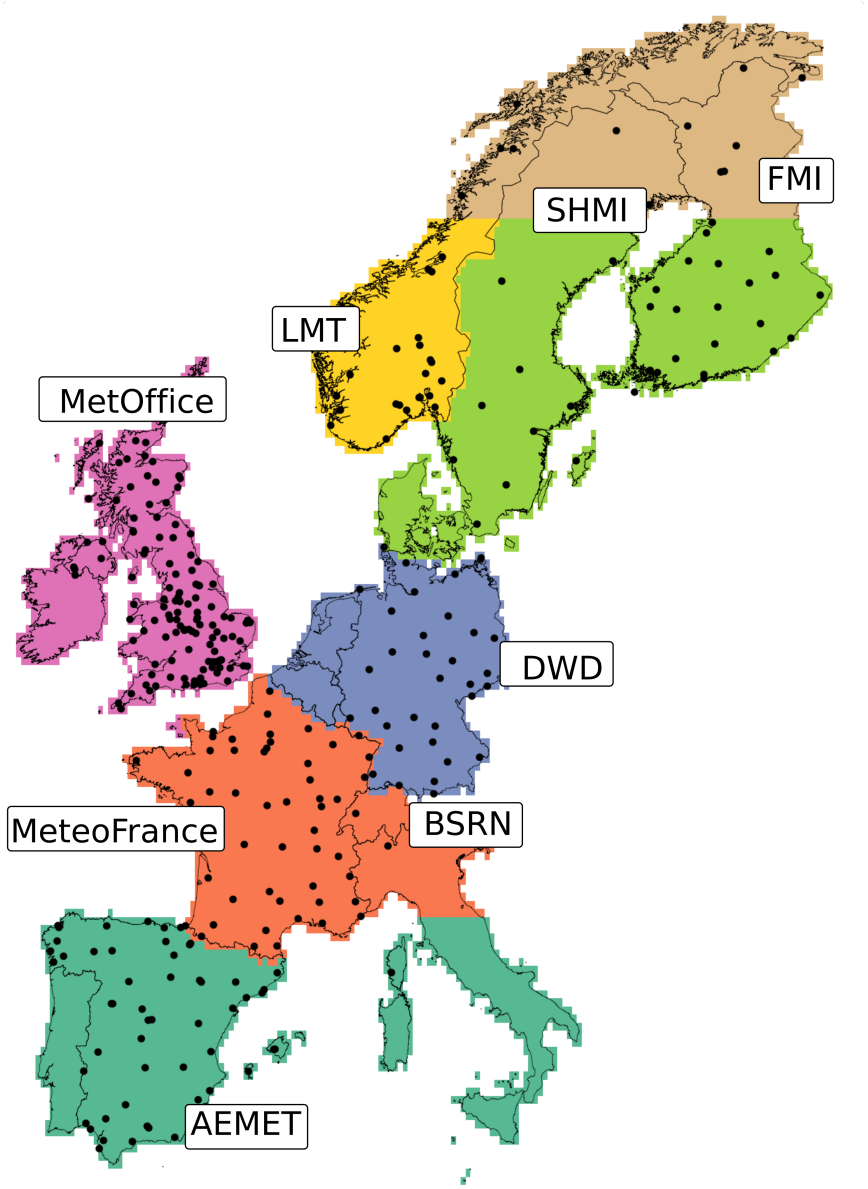
PRE-PROCESSING RADIATION DATABASES

Database	Type	Organization	Spatial coverage	Spatial resolution	Temporal coverage	Temporal resolution
SARAH 2.1	Satellite geostationary	CM SAF	Europe, Africa 65°S - 65°N	5 km	1983-2017	30 min
CLARA-A2	Satellite polar	CM SAF	Global	25 km	1982-2015	1 d
ERA5	Reanalysis	ECMWF	Global	31 km	1977-2018	1 h
					1983-2015	



CONFIDENCE INTERVALS OF THE MODEL DEVIATIONS



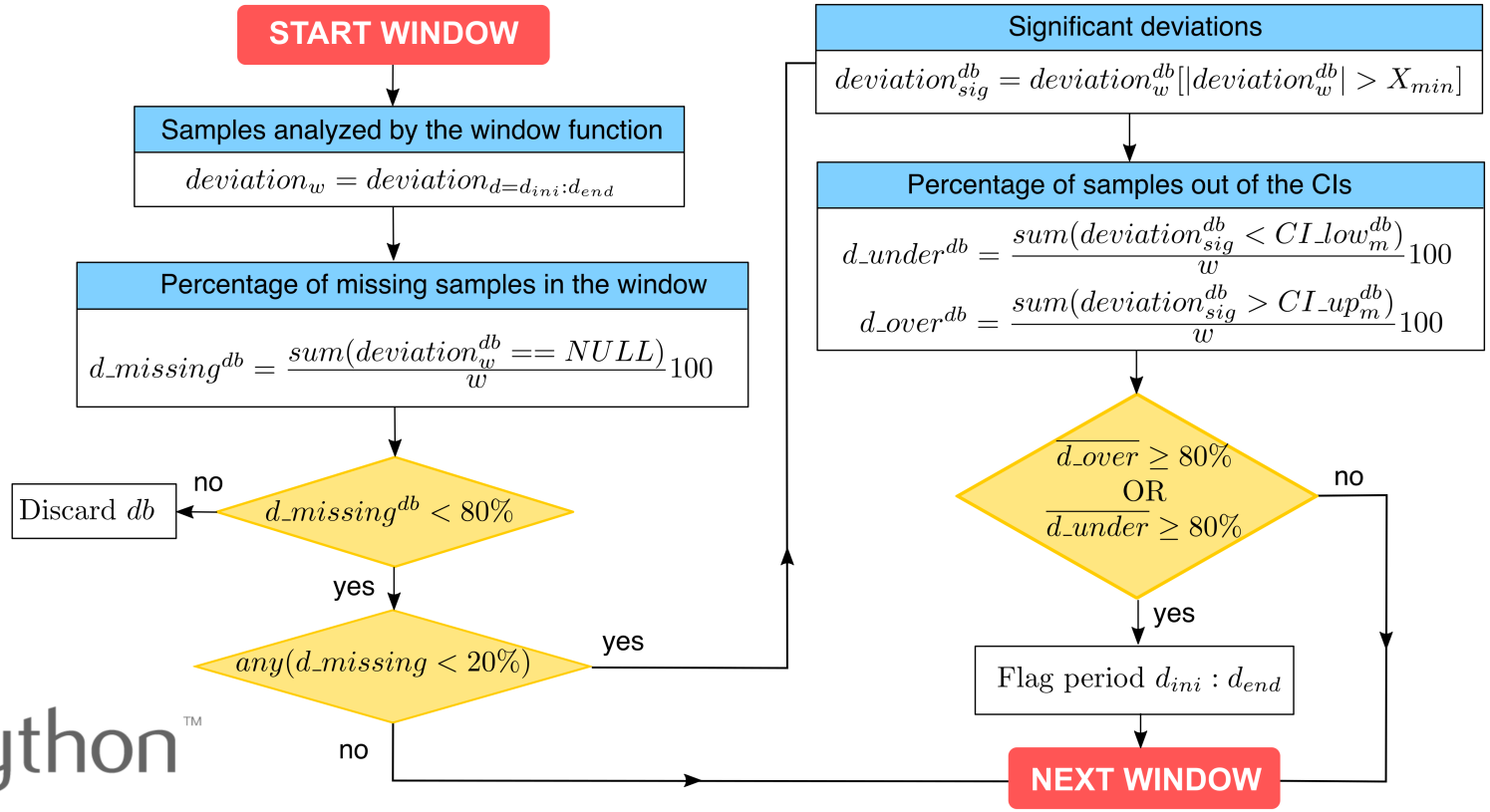
335 quality-controlled stations

CIs for each (i) database, (ii) month, and (iii) spatial region.

Robust statistics
median $\pm$ **n** $\times$ median absolute deviation

Tuning parameter: n
Restriction level of the CIs

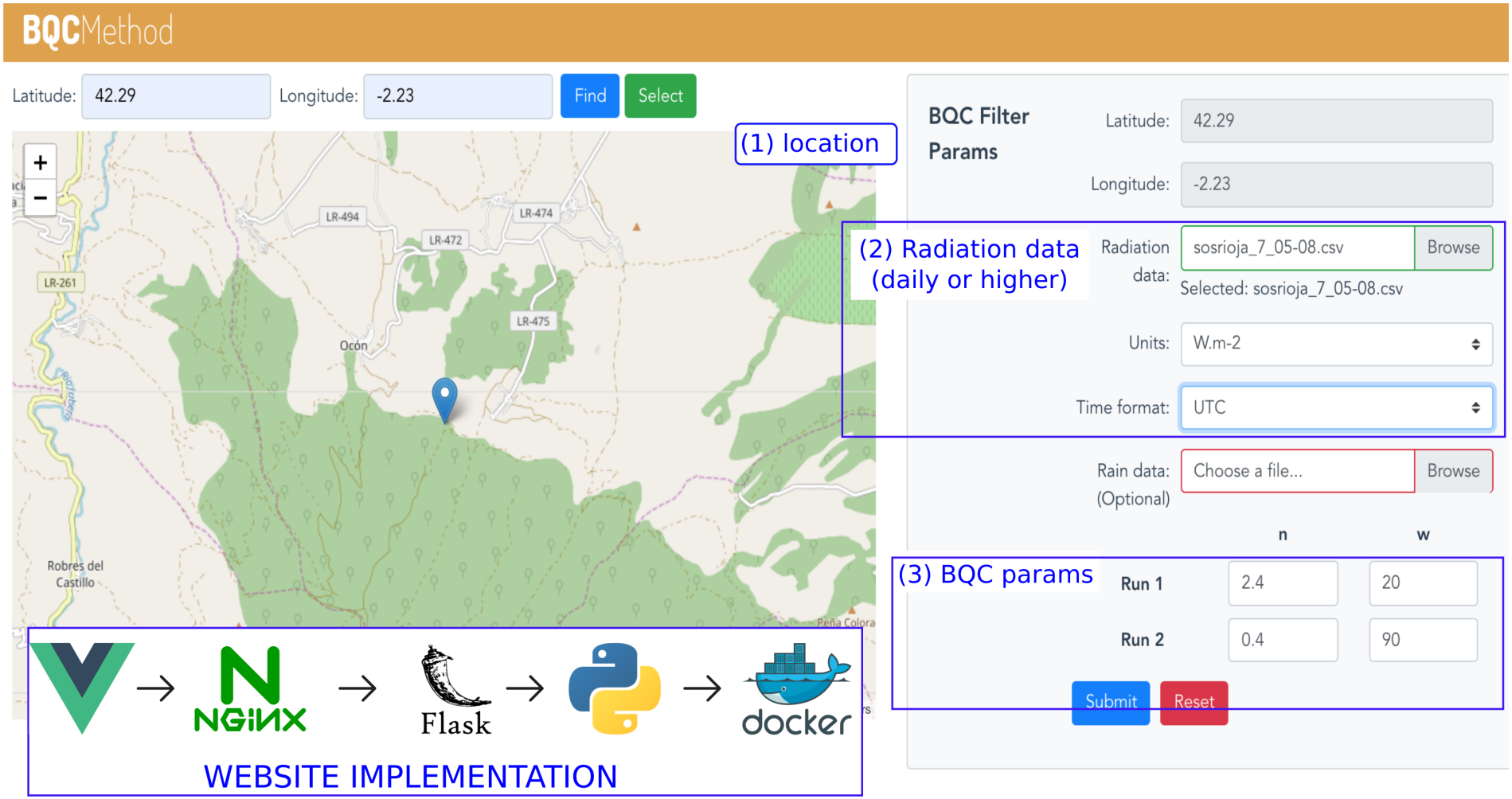
BQC ALGORITHM: WINDOW FUNCTION



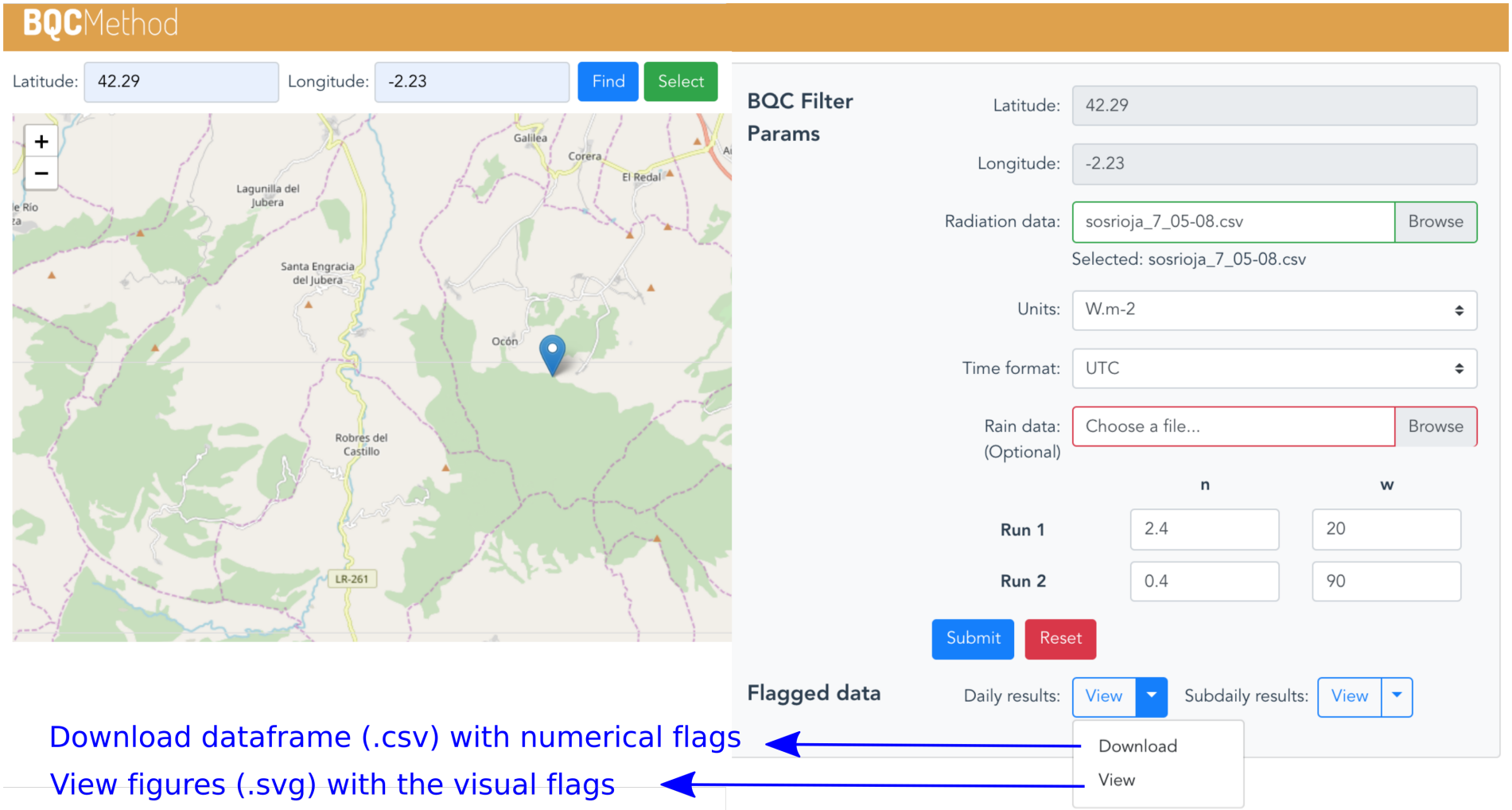
Tuning parameter: w
(window width)
Number of consecutive days analyzed

(run 1) Short-lived defects
w = 20 days, n = 2.4
(run 2) Permanent defects
w = 90 days, n = 0.4

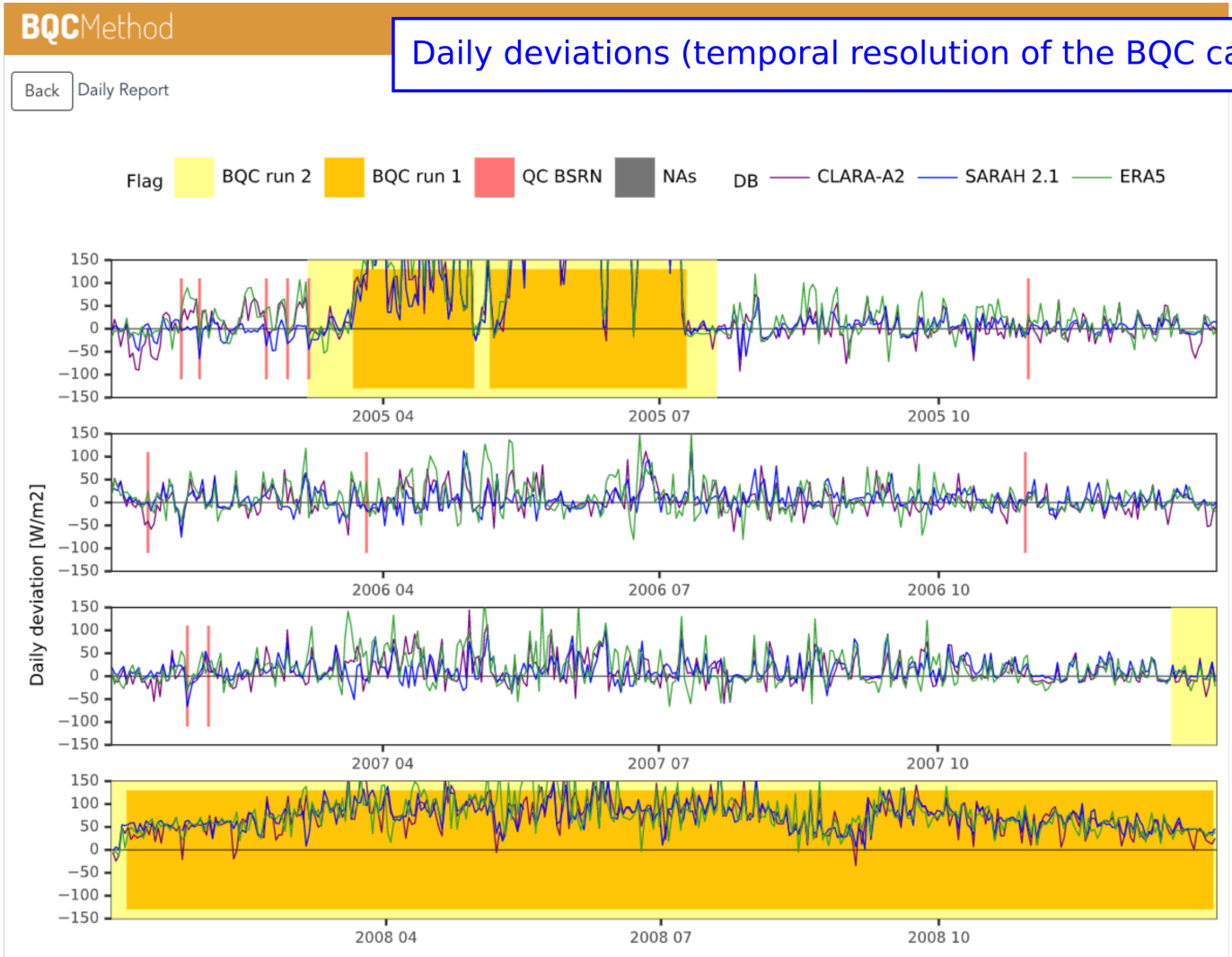
WEB INPUTS (WWW.BQCMETHOD.COM)



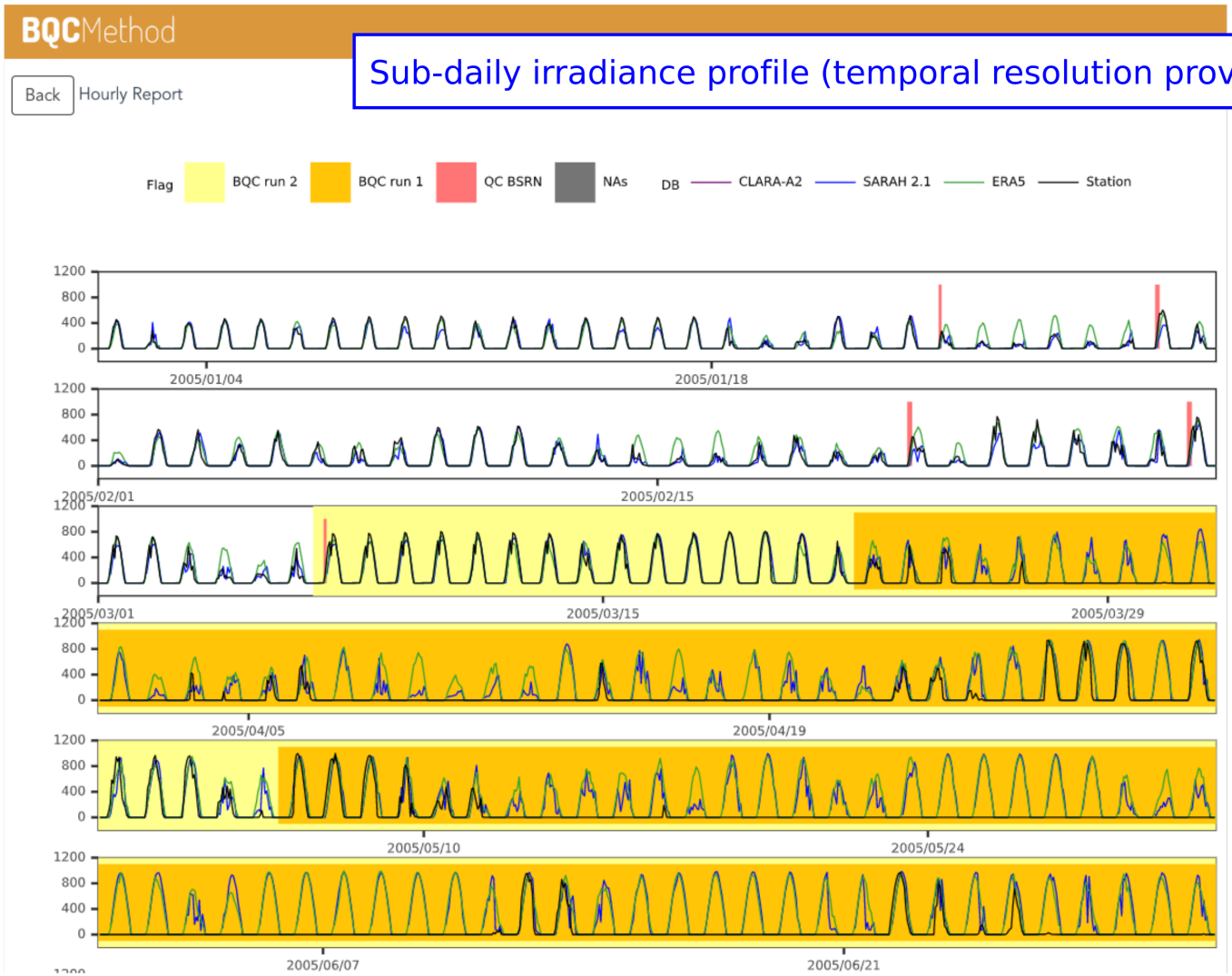
WEB OUTPUTS (WWW.BQCMETHOD.COM)



WEB OUTPUTS: DAILY RESULTS



WEB OUTPUTS: SUB-DAILY RESULTS



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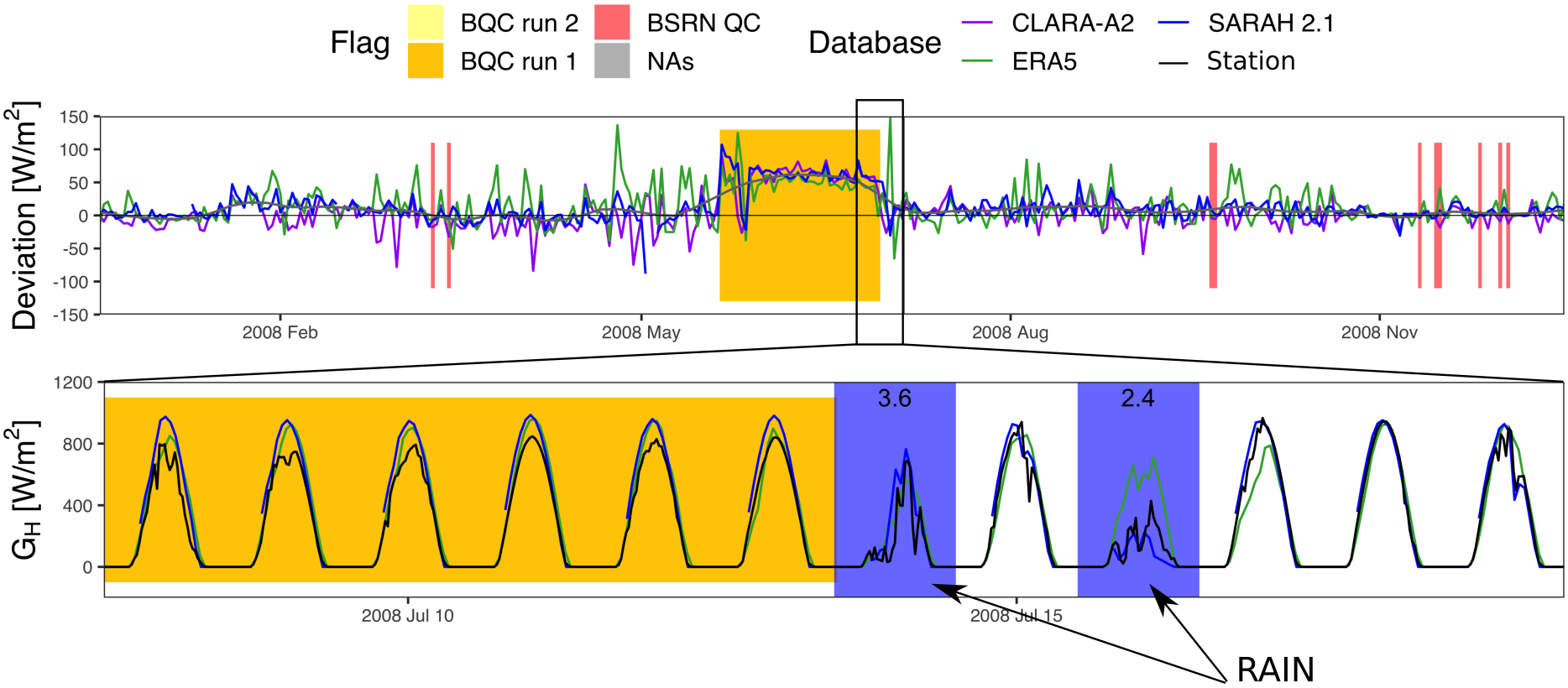
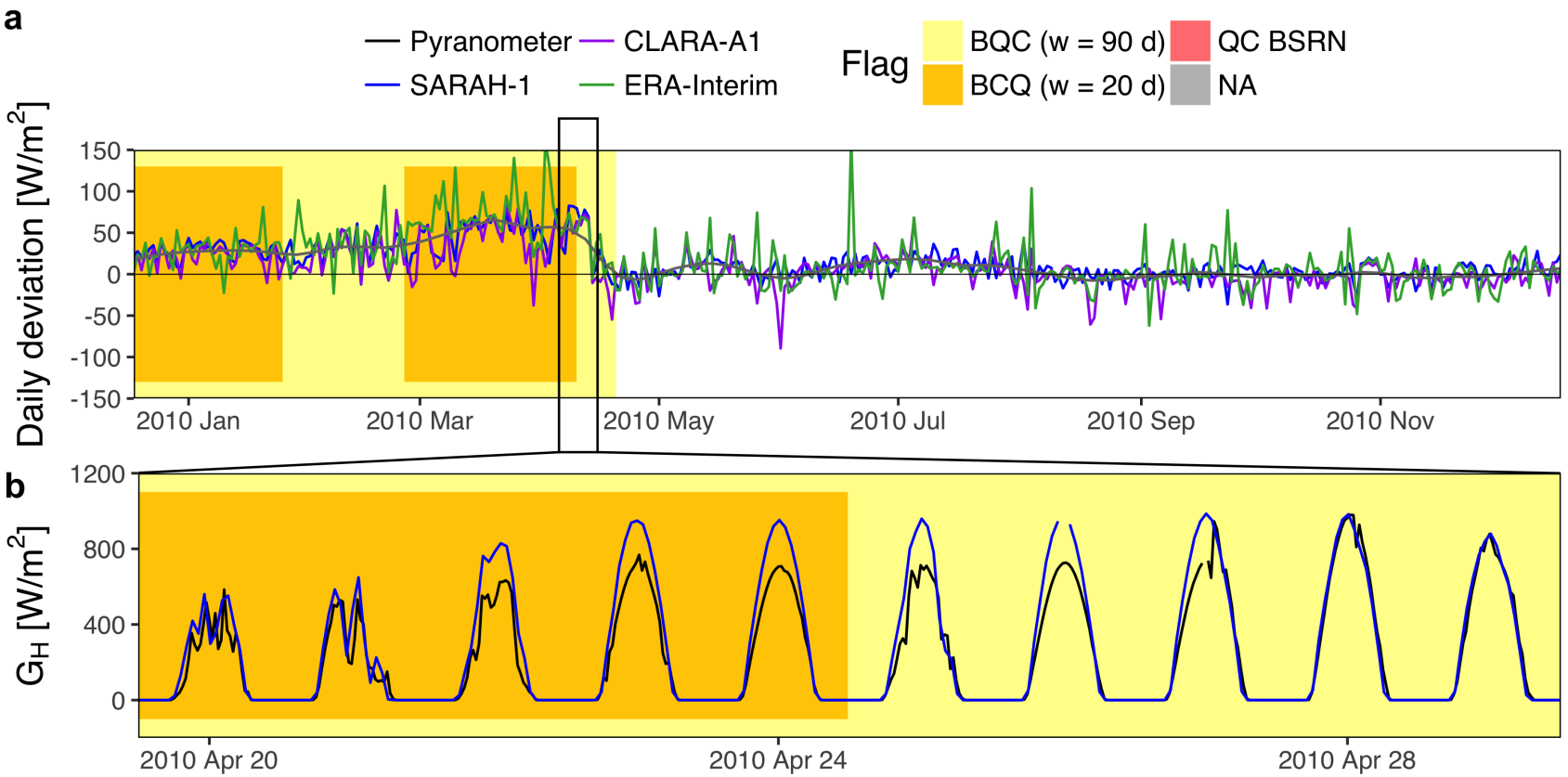
EXAMPLE 1: ACCUMULATION OF DUST (SOILING)



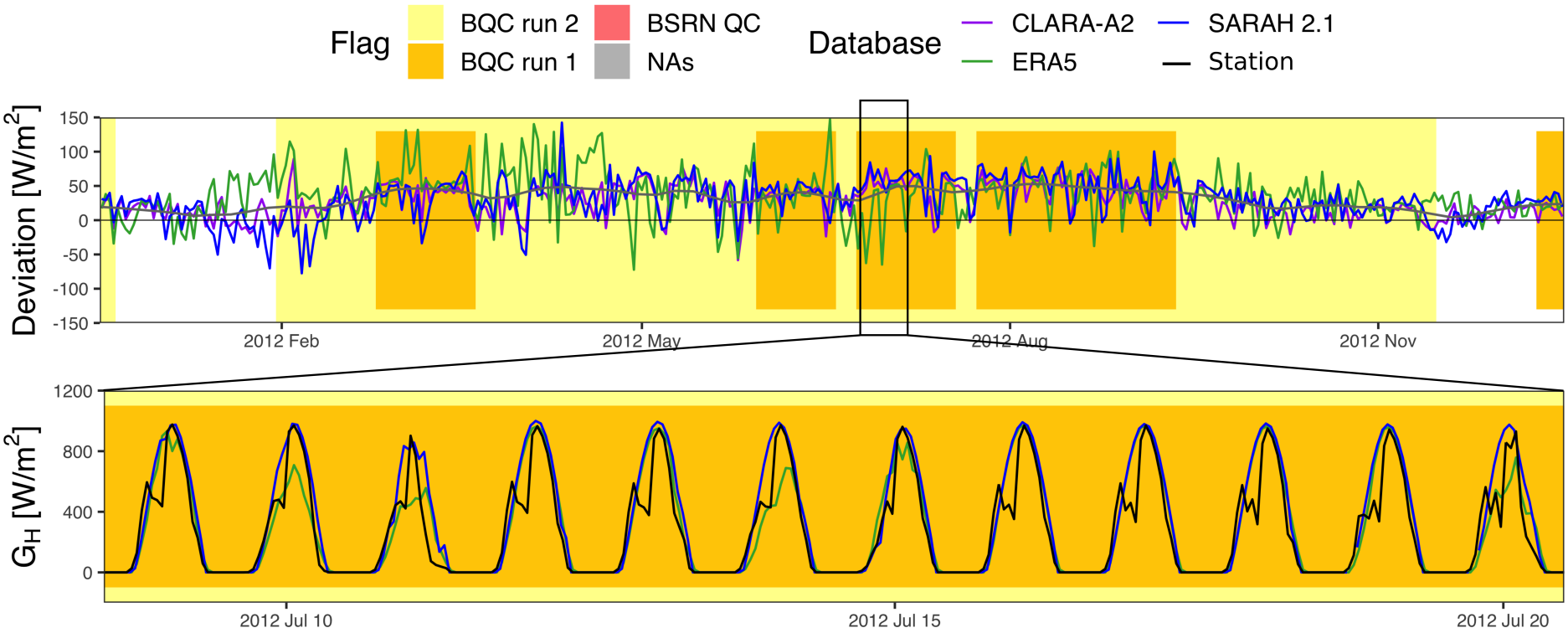
Sensor cleaned by the rain

EXAMPLE 2: ACCUMULATION OF DUST (SOILING)

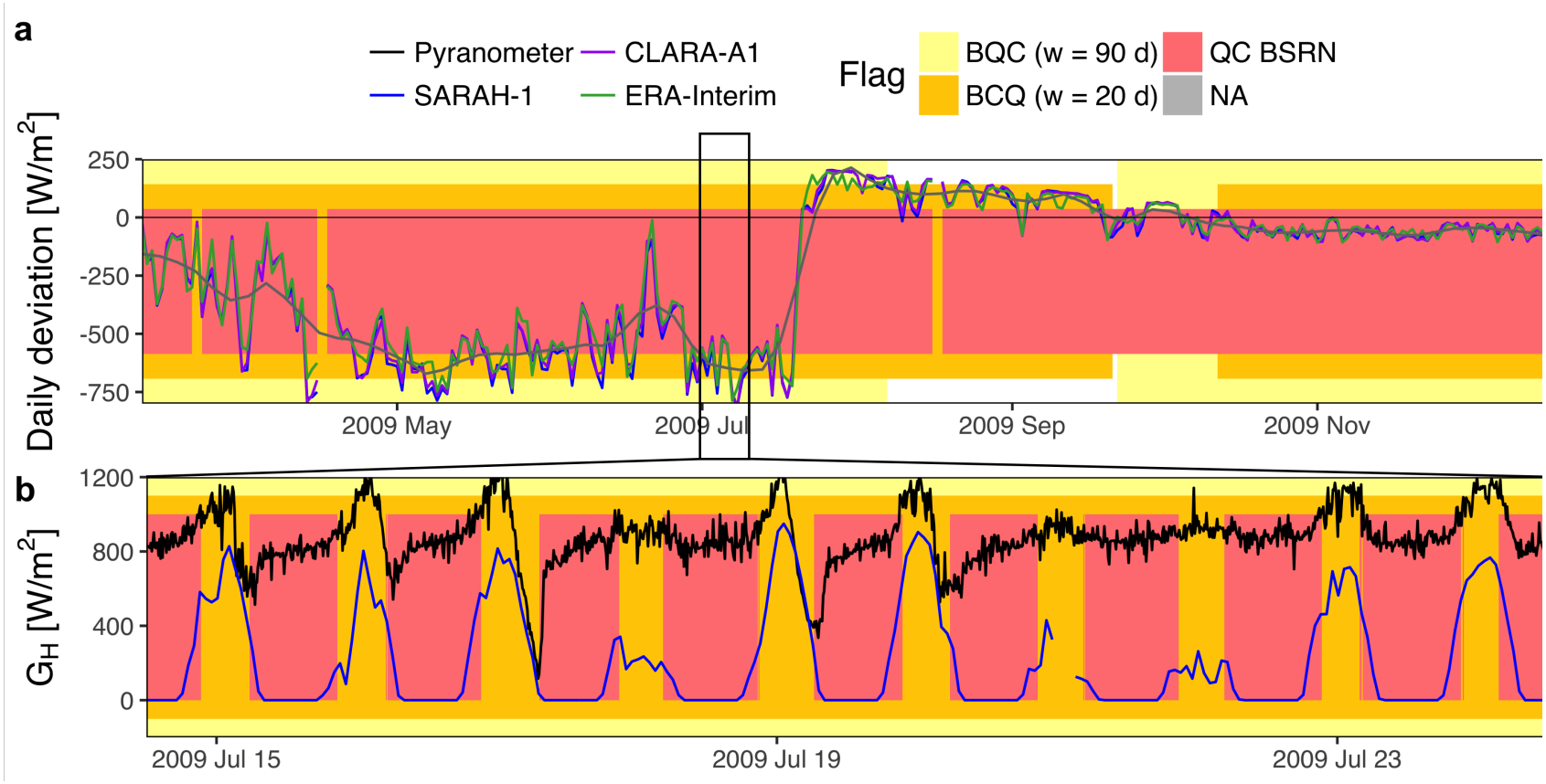


Sensor manually cleaned

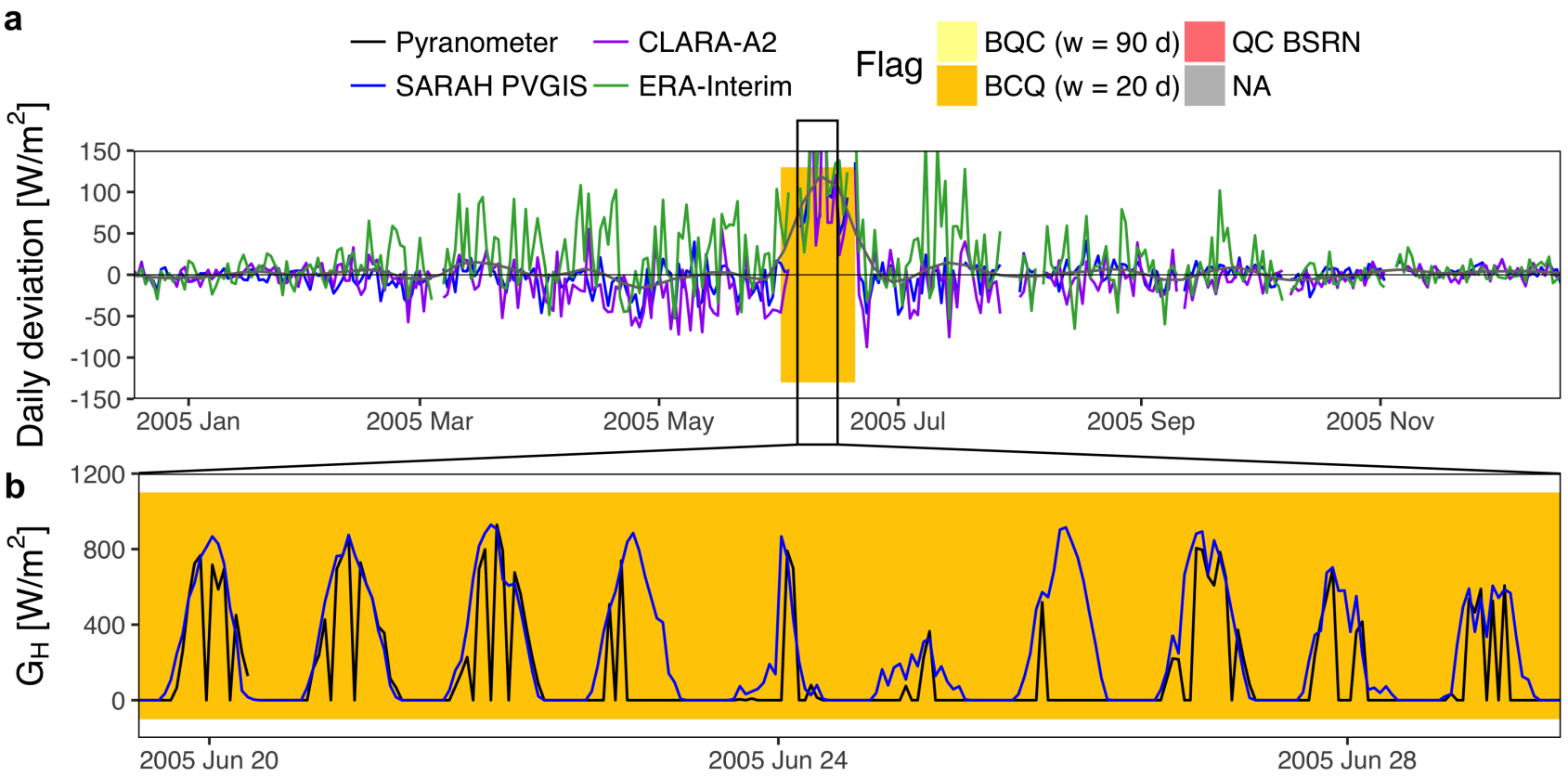
EXAMPLE 3: SHADOWS



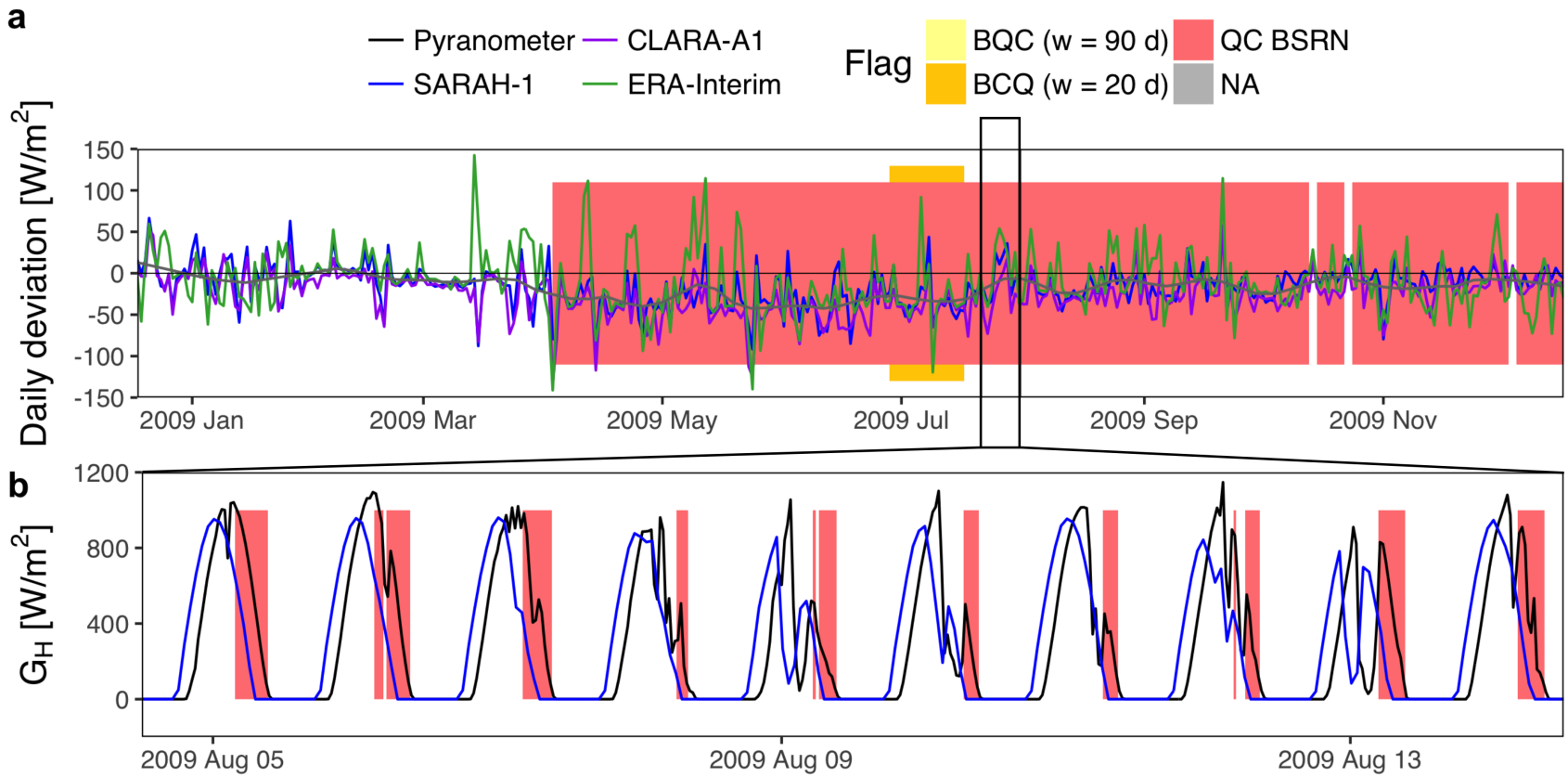
EXAMPLE 4: LARGE ERRORS



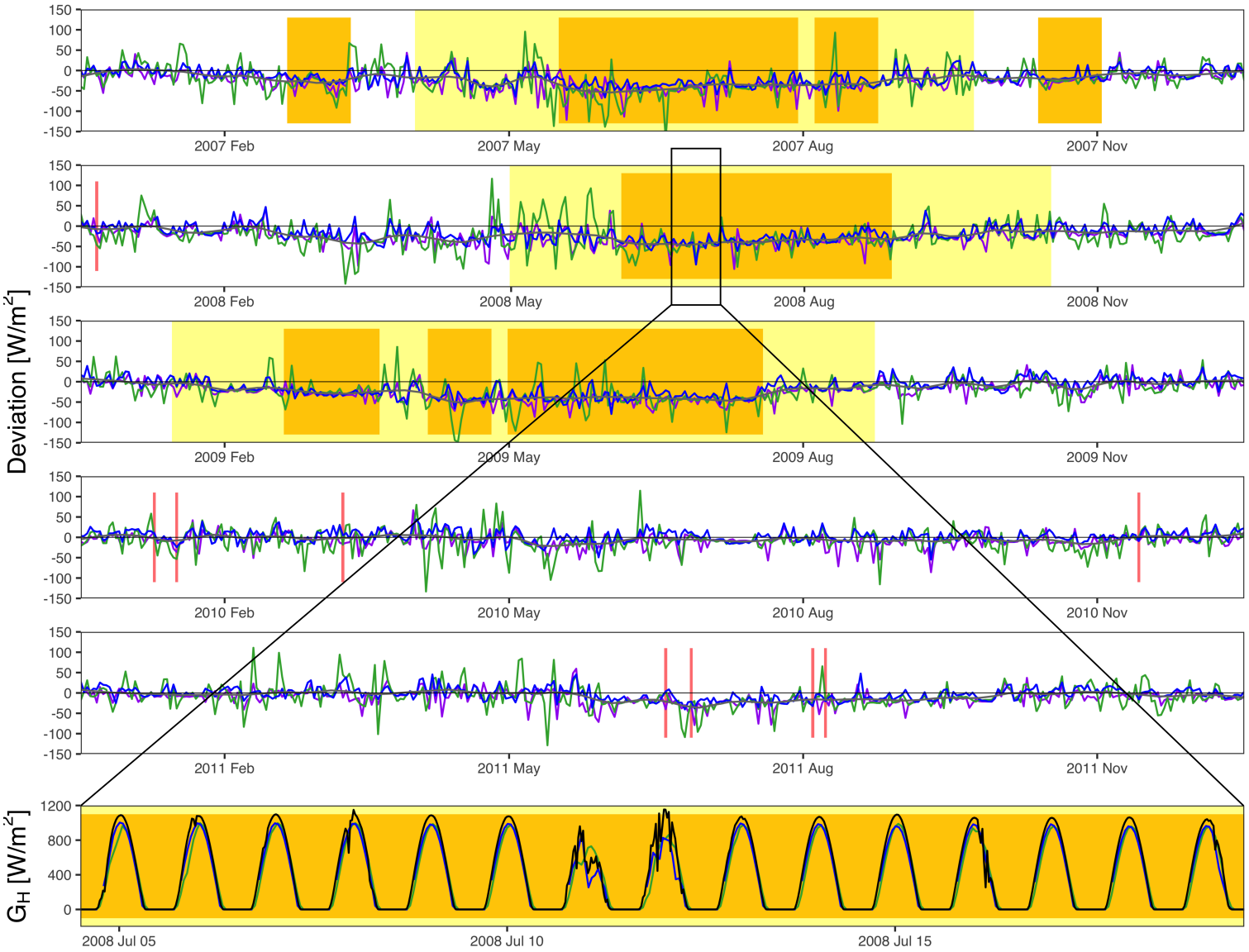
EXAMPLE 5: DIURNAL IRRADIANCE EQUAL 0



EXAMPLE 6: TIME LAG

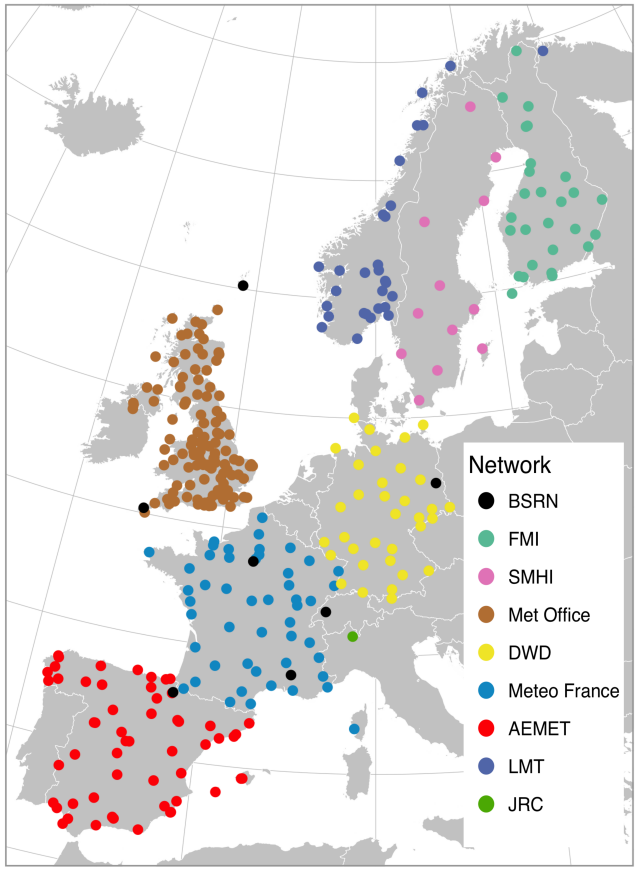


EXAMPLE 7: PYRANOMETER ERROR



ANALYSIS OF MONITORING NETWORKS

(Urraca et al. 2017) 335 stations
26 stations with defects (7.8%)



(Urraca et al. 2019) 732 stations
264 stations with defects (36%)

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CONCLUSIONS

A **free** web service (www.bqcmethod.com) that implements the BQC method and incorporates the databases and station data required to analyze any Western European station from 1983 to 2015

FUTURE WORK

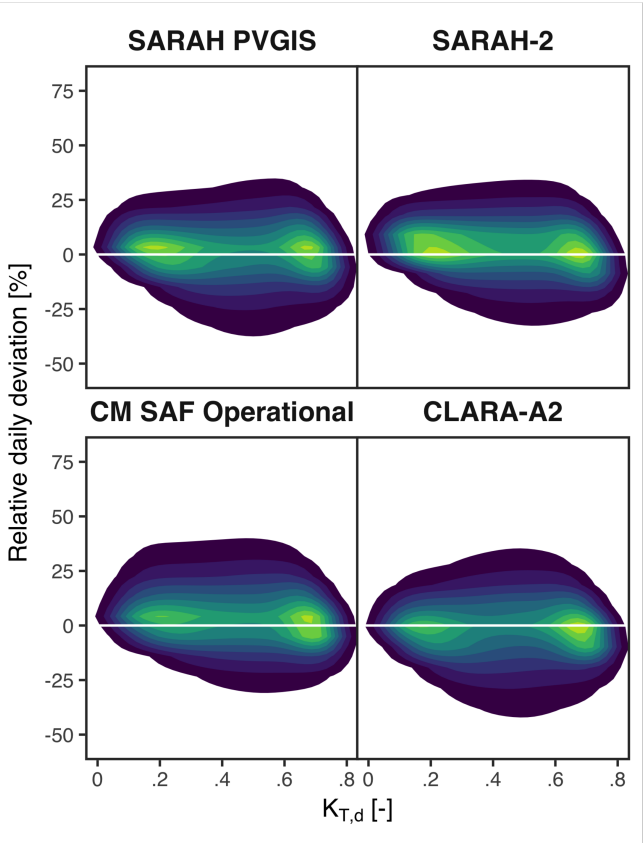
- Include field descriptions and a tutorial of the website
- Speed-up the website
- Extend the website to Eastern Europe (station data required)
- Extend the website to other atmospheric variables (e.g., temperature)

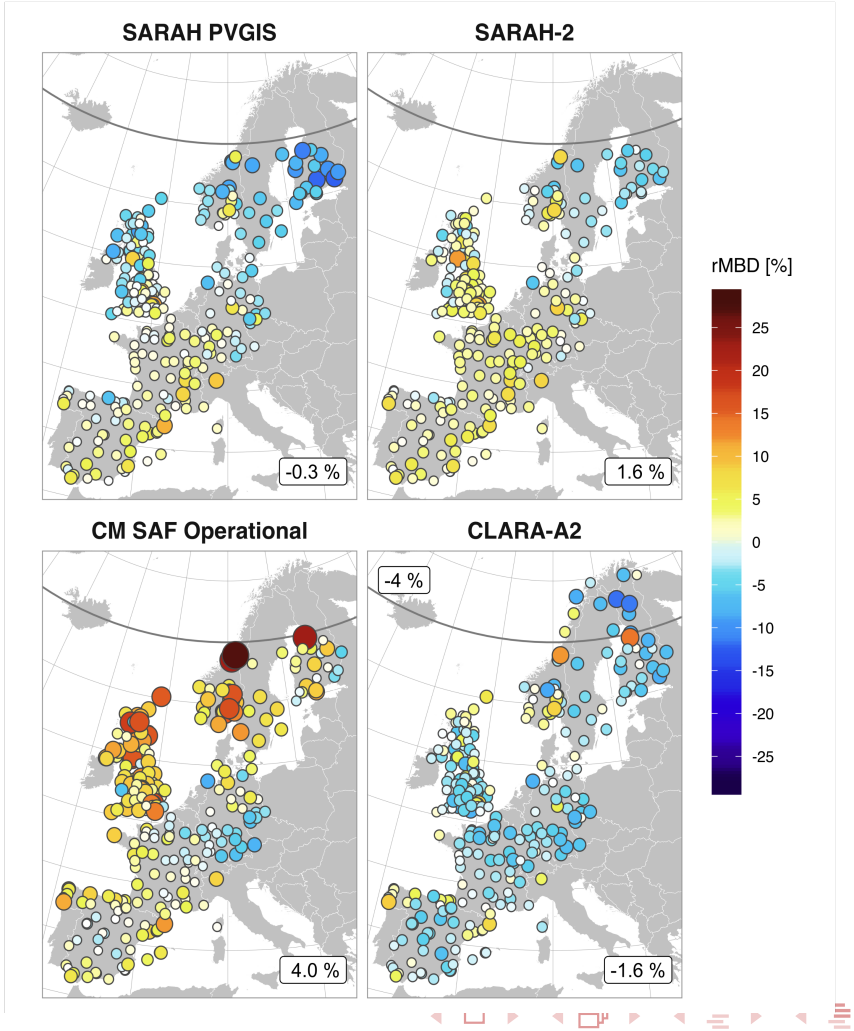
CONTENTS

Urraca R, Gracia-Amillo AM, Koubli E, Huld T, Trentmann J, Riihelä A, Lindfors AV, Palmer D, Gottschalg, R, Antonanzas-Torres F. Extensive validation of CM SAF surface radiation products over Europe. ***Remote Sensing of Environment*** 2017;199:171-186.

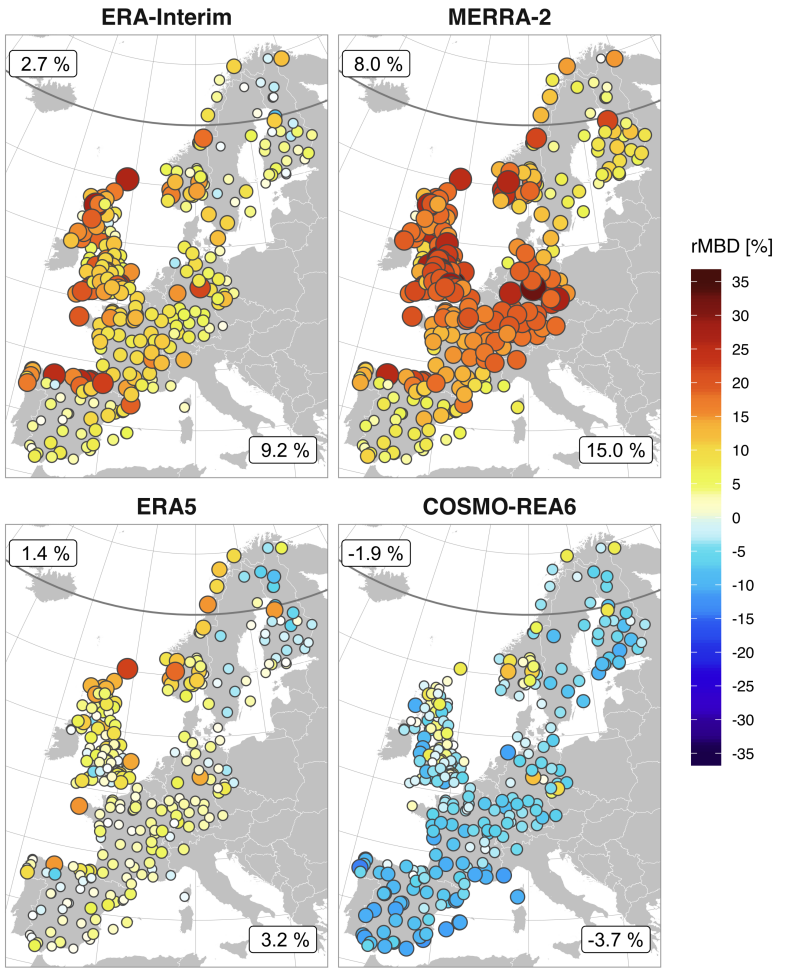
Validation of CM SAF databases over 312 European stations

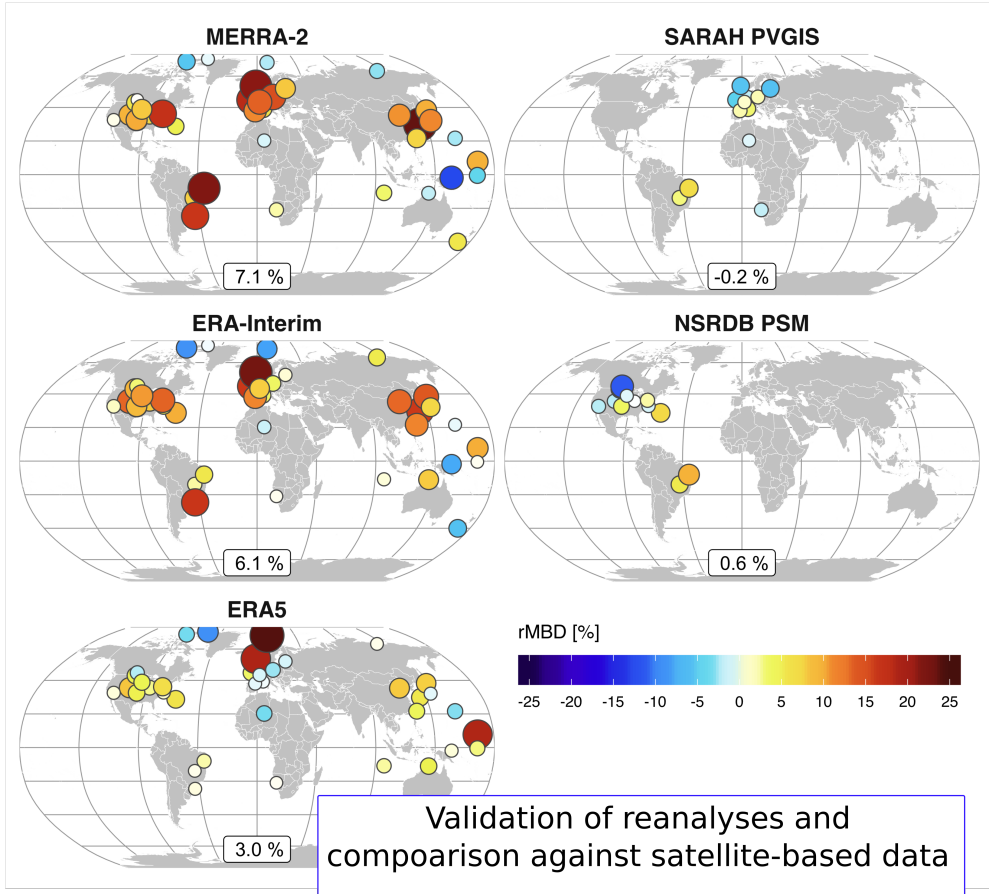
(Global horizontal irradiance)





Urraca R, Huld T, Gracia-Amillo A, Martinez-de-Pison FJ, Kaspar F, Sanz-Garcia A. Evaluation of global horizontal irradiance estimates from ERA5 and COSMO-REA6 reanalyses using ground and satellite-based data. ***Solar Energy*** 2018;164:339-354.

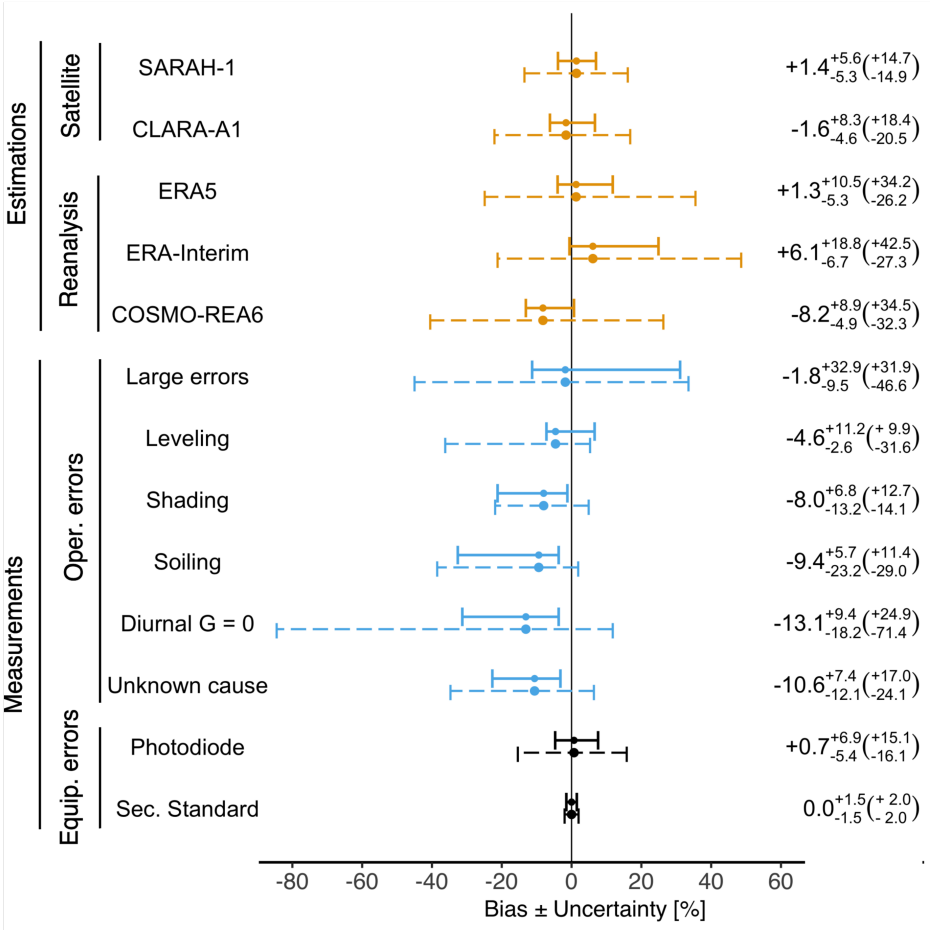




Validation of reanalyses and compoarison against satellite-based data

(Global horizontal irradiance)

Urraca R, Huld T, Martinez-de-Pison FJ, Sanz-Garcia A. Sources of uncertainty in annual global horizontal irradiance data. ***Solar Energy*** 2018;170:873-884.



Global horizontal irradiance

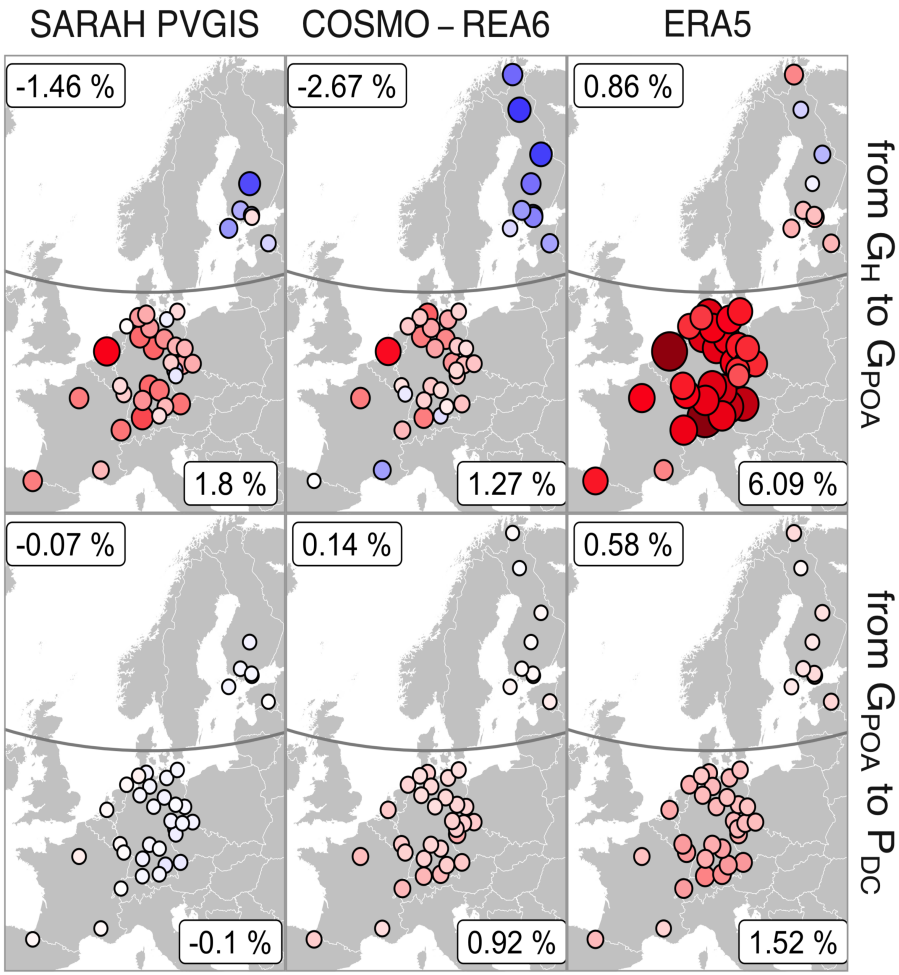
(annual and daily uncertainty)

Uncertainty of measurements
(types of pyranometer, measuring errors)

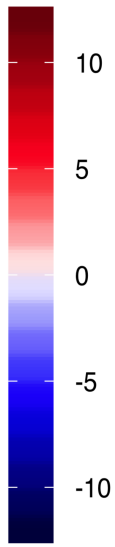
VS.

Uncertainty of estimations
(type of model)

Urraca R, Huld T, Lindfors AV, Riihelä A, Martinez-de-Pison FJ, Sanz-Garcia A. Quantifying the amplified bias of PV system simulations due to uncertainties in solar radiation estimates. ***Solar Energy*** 2018;176:663-677



Estimating the PV output with solar radiation databases



PVGIS

BIAS PROPAGATION

Global, diffuse, beam horizontal

↓

Global on the plane-of-the-array

↓

PV output

ACKNOWLEDGEMENTS

Databases

EUMETSAT CM SAF CLIMATE MONITORING

ECMWF

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www.larioja.org

Instituto de Estudios Riojanos

SCAYLE SUPERCOMPUTACIÓN CASTILLA Y LEÓN

Collaborations

Iñigo Sanz-Garcia (Website development)
Thomas Huld and Ana Gracia-Amillo (BQC algorithm)