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Using the CAMS solar radiation time-series product to model solar PV power potential. Uncertainty evaluation under diverse atmospheric conditions using ground-based measurements.

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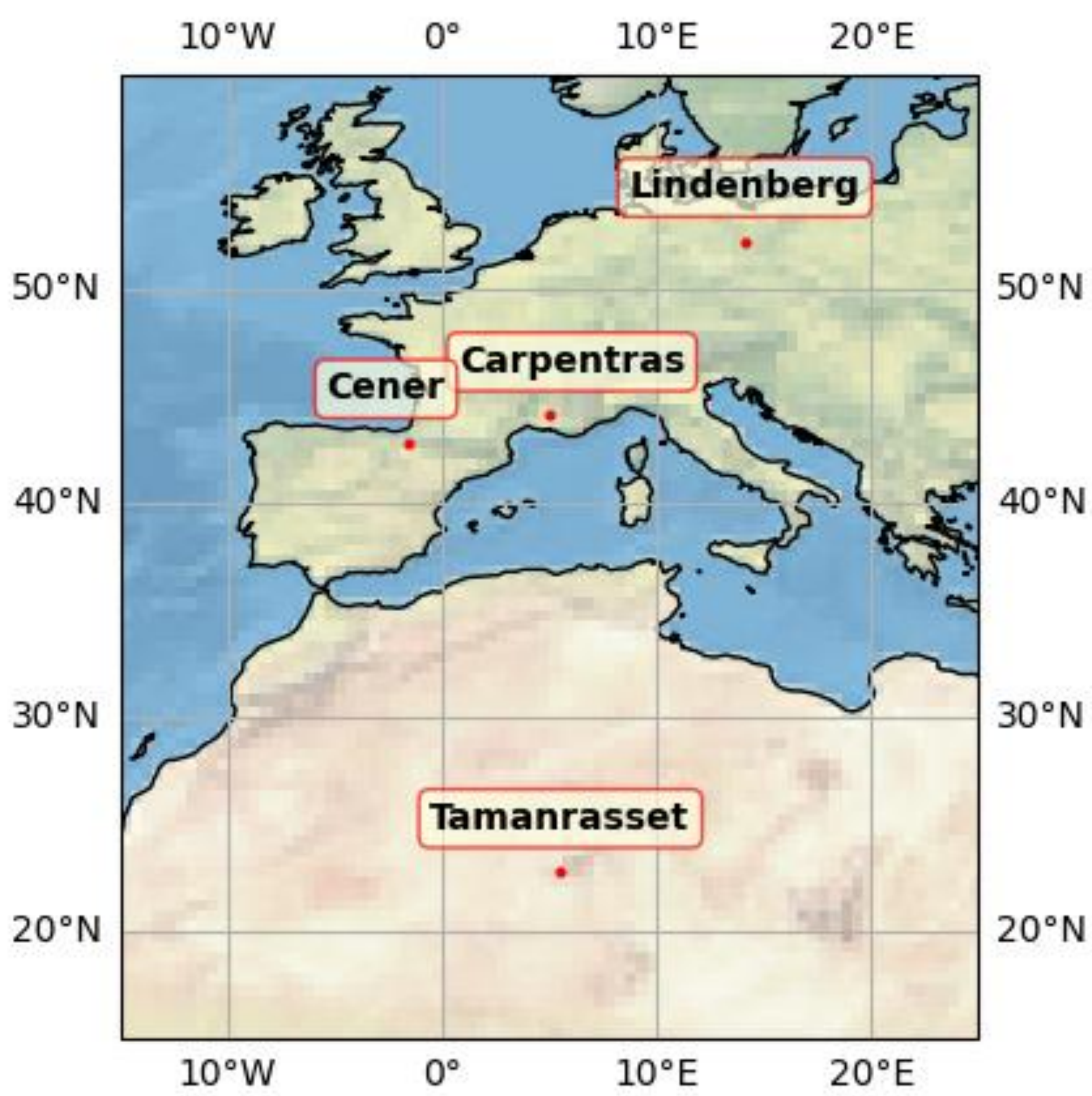
Introduction

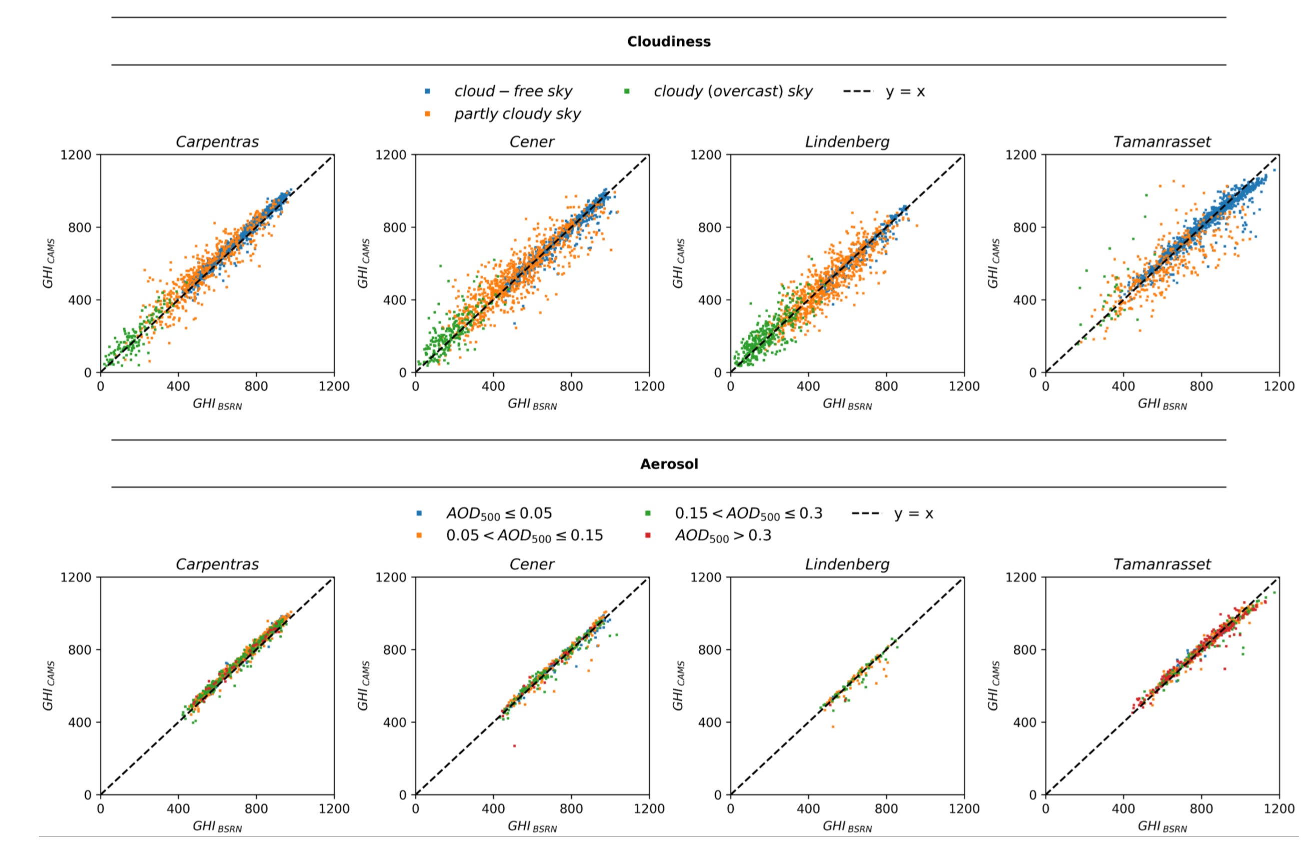
PV power modelling is a valuable tool for expressing solar energy in terms of power generation, offering insights into the optimal siting of PV farms and the long-term estimation of their energy yield. The CAMS solar radiation service provides global, historical data on solar irradiance and its components, freely accessible and easy to integrate into modelling workflows. The Global Solar Energy Estimator (GSEE; Pfenninger & Staffel, 2016), a widely used open-access library, is employed to simulate PV system output using solar irradiance as input, along with defined system characteristics such as panel tilt, orientation, tracking type, capacity, and technology. In this study, we evaluate the reliability of CAMS data for PV power modelling by comparing simulation outputs generated using CAMS data with those based on ground-based measurements.



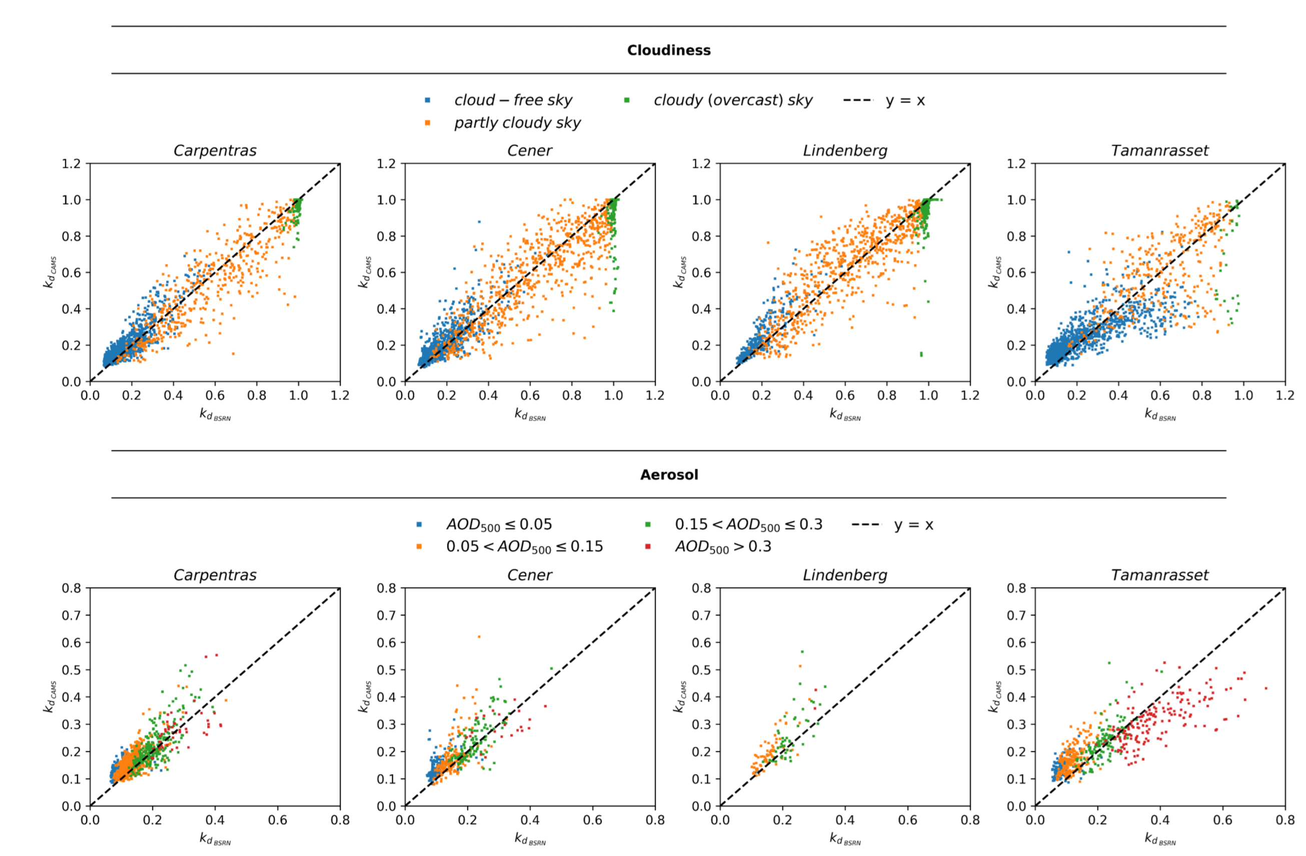
Data and Methodology

- We retrieved high quality measurements of GHI,DHI, DNI and Temperature from 4 stations of the Baseline Surface Radiation Network (BSRN) different aerosol and cloudiness conditions for the year 2017.
- We retrieved hourly time-series of GHI and DHI for all-sky conditions from CAMS, setting the input coordinates to match the locations of the BSRN stations.
- We utilized DNI, to obtain information for cloudiness relying on the conditions stated by WMO (2021), according to which sunshine duration is the total period where DNI exceeds 120 W/m^2.
- For aerosol, we use AOD_{500} as a representative measure for aerosol load
- We perform solar energy simulations with GSEE and we compare the output power

GHI_{CAMS} = **f(** GHI_{BSRN} **)** [W/m^2] **(Fig. 1)**

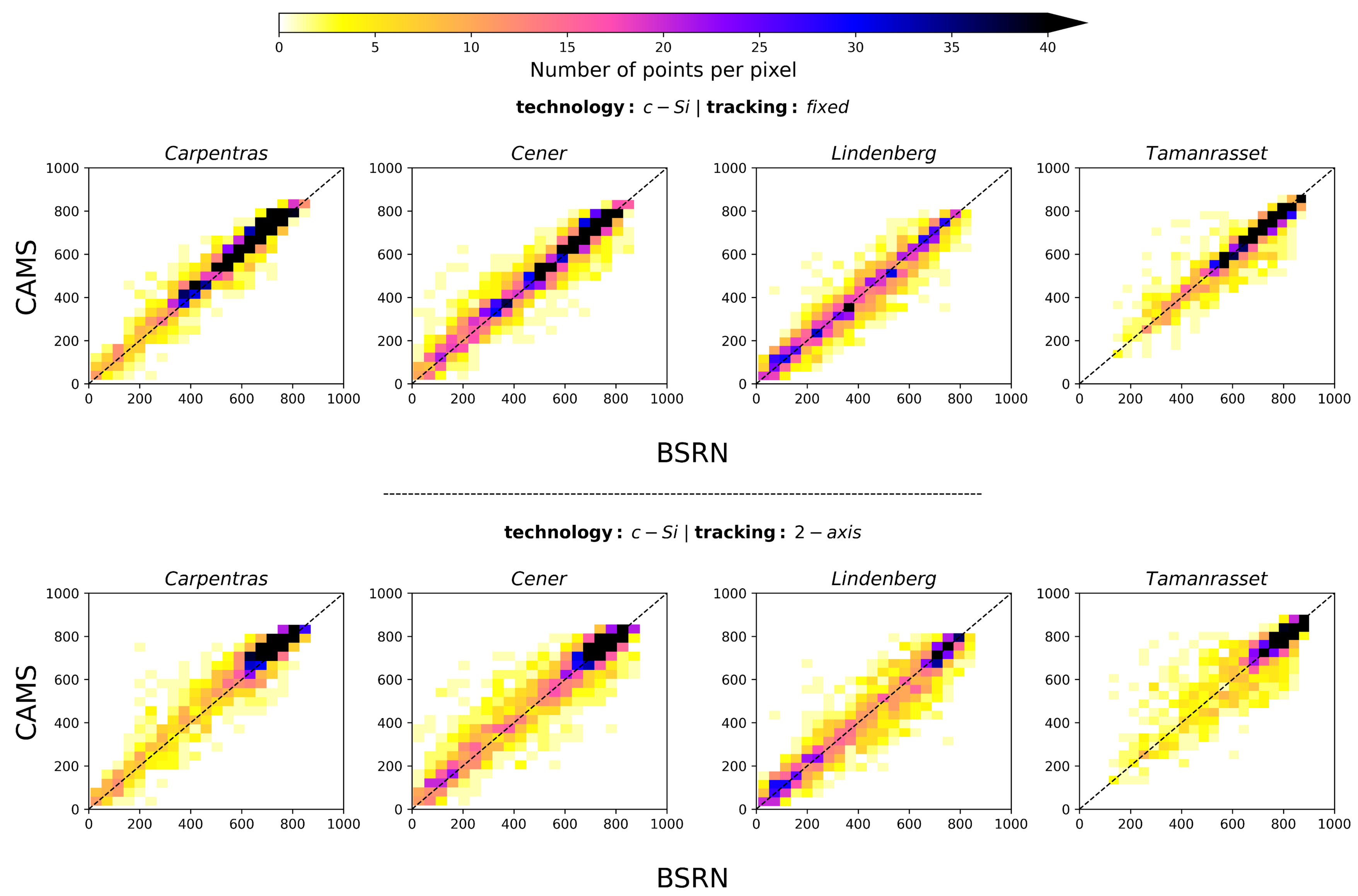


Diffuse Fraction (k_d) $_{CAMS}$ = **f(** Diffuse Fraction (k_d) $_{BSRN}$ **) (Fig. 2)**



Results

PV_{CAMS} = **f(** PV_{BSRN} **)** **[**$Wh/kW_p/hour$**]** **(Fig. 3)**



- GHI from CAMS is generally reliable under all sky conditions, and highly accurate under clear-sky scenarios, where solar resource availability peaks and energy production is high. (See Figure 1)
- The diffuse fraction, which is a key parameter for plane-of-array irradiance calculations (essential for PV modeling), is generally well estimated, though slightly less accurate under high aerosol loading conditions, such as desert dust events. (See Figure 2)
- PV power output derived from CAMS data shows good overall agreement with ground measurements, indicating robust performance for energy yield estimations. (See Figure 3)

Key Findings

- ❖ CAMS serves as a valuable tool for PV power modelling,
- ❖ CAMS cannot fully replace the precision and reliability of using ground-based measurements instead, which remain indispensable for site-specific assessments

References

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