CAMS Radiation Service for solar energy users – how suitable are typical cloud retrieval schemes?

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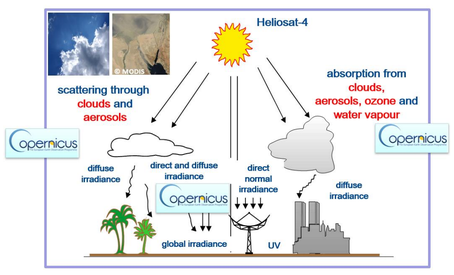
Atmosphere Monitoring Service

atmosphere.copernicus.eu

CAMS Solar Radiation Service

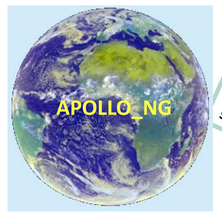
Copernicus Atmospheric Monitoring service (CAMS) offers solar radiation services (CRS) providing information on surface solar irradiance (SSI). The services meet the needs of European and national policy development and the requirements of partly commercial downstream services in the solar energy sector for e.g. planning, monitoring, efficiency improvements, and integration of renewable energies into the energy supply grids. CRS is provided by DLR with MINES Paris, the SoDa team at Vaisala and with FMI (Finnish Meteorological Service).



Data characteristics

- Feb. 2004 up to 2 days behind real time, online
- Global, Diffuse, Direct & Direct normal irradiation
- Temporal resolution: 1 min, 15 min, 1 hour, 1 day, 1 month
- Global coverage for clear sky parameters and all-sky radiation time series within the satellite field of view
- Gridded data for 2005-2022 with 0.2° grid and 15 min resolution for Europe/Africa/Middle East
- Provision of all input data in the expert mode

Method



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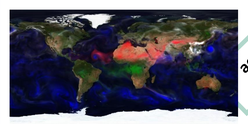
clouds from satellite

Heliosat-4 (physical approach, fast radiative transfer)



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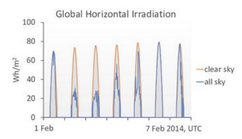
aerosol, H_2O, O_3 from model

Example: SSI



Method papers:

Qu et al., Contrib. Atm. Sci., 2017
Lefèvre et al., Atm. Meas. Tech., 2013
Gschwind et al., Contrib. Atm. Sci., 2019
Schroedter-Homscheidt et al., Contrib Atm. Sci. 2022

Cloud retrieval schemes : CAMS/APOLLO_NG vs CLAAS-3/CPP

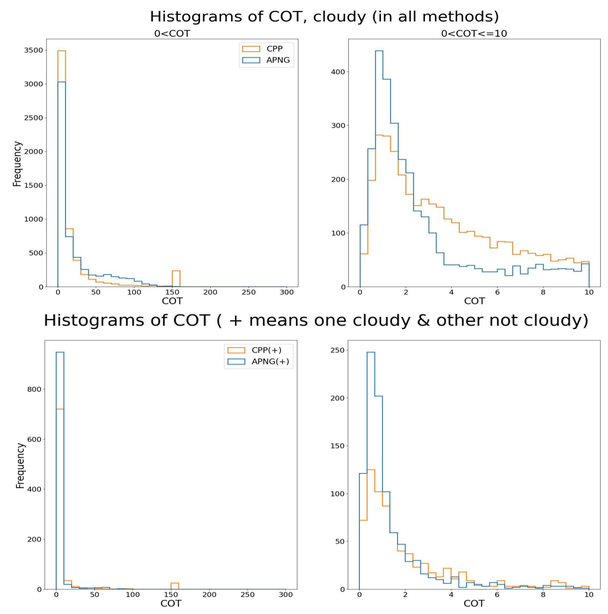
Clouds are the main cause of variability and also the dominant source of errors in the all sky SSI retrieval. The focus of the presented study is the evaluation of the APOLLO-NG cloud properties, as used in the current CRS 4.5, through comparison with the CLAAS-3 (CLoud property dAtAset using SEVIRI - Edition 3) CPP (Cloud Physical Properties) database provided by CM SAF (Satellite Application Facility for Climate Monitoring) services. As Heliosat-4 offers the possibility to use cloud properties from different sources, both products are used in the Heliosat-4 scheme for the SSI assessment.

	CAMS 4.5	CLAAS-3
Calibration	Time-dependent updated calibration coefficients from KNMI based on Meirink et al., 2013 & updates	Time-dependent updated calibration coefficients from KNMI based on Meirink et al. 2013 & updates
Cloud algorithm	APOLLO_NG REL1.1	NWC/PPS version v2018 patch5 + CmsafPpsSeviri 0.5.0 and CPP v6
Cloud masking	Probabilistic cloud mask, uses 5 threshold tests in VIS and IR (Klüser et al., 2015).	Probabilistic cloud mask, trained on collocated cloud observations from CALIOP onboard CALIPSO satellite (Karlsson et al., 2020).
Cloud threshold	1% cloud probability	50% cloud probability
COD/COT retrieval	Single channel approach, VIS 0.6 µm (Stephens et al. 1984)	Two channel approach, VIS/NIR 0.6/1.6 or 0.6/3.8 µm (Nakajima and King, 1990 & Roebling et al., 2006)
Cloud type	low (5), medium (6) and high clouds (7), and thin clouds (8)	Not available
Cloud phase	water (1) and ice (2)	water (1) and ice (2). Extended cloud phase : water (3), supercooled (4), opaque_ice (6), cirrus (7), overlap (8), overshooting_convection (9)

COT comparison

Frequency distribution of the COT values of APOLLO_NG and CPP

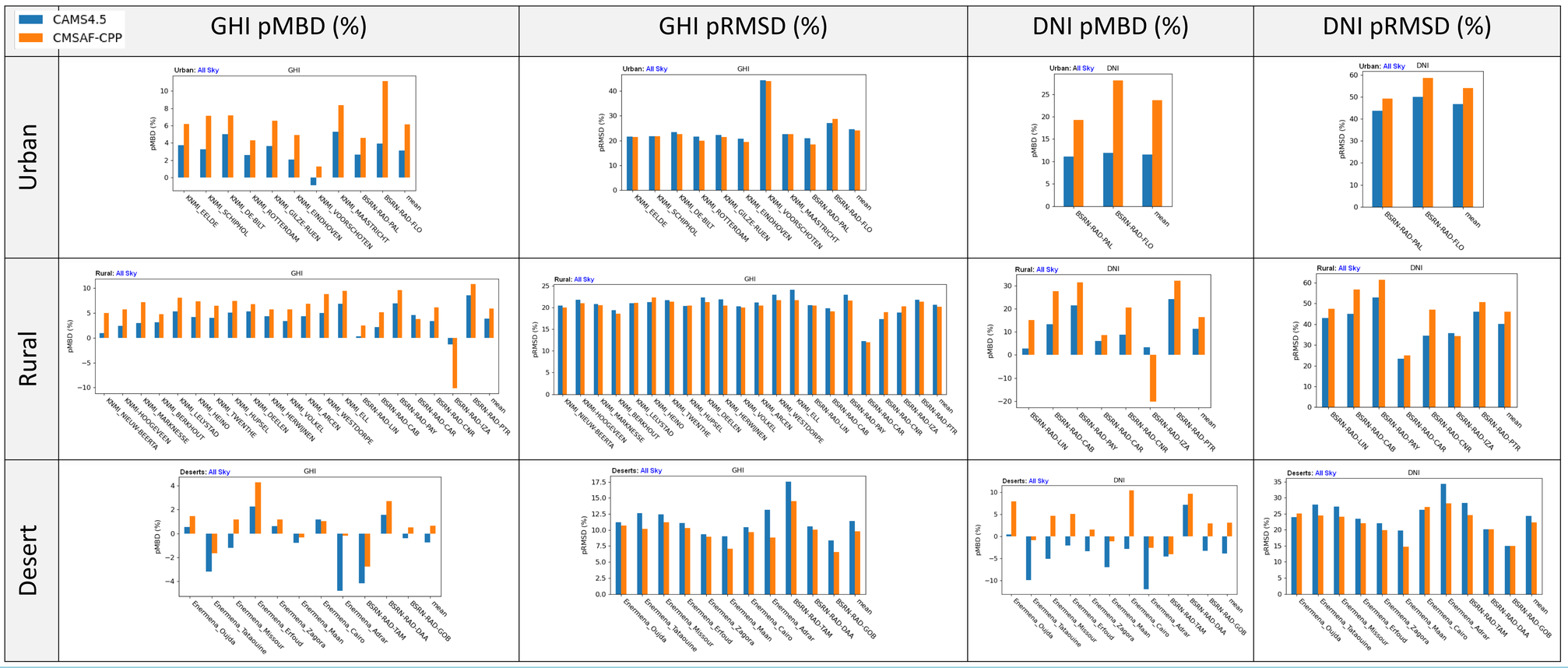
Example: BSRN location Carpentras, 2016



Assessment of SSI obtained from CAMS4.5 APOLLO_NG and CLAAS-3 CPP vs ground observations

- Cloud parameters required for Heliosat-4 are COT and Cloud type. CLAAS-3 CPP Cloud phase is mapped to APOLLO_NG Cloud type by setting water and supercooled classes to low clouds; opaque_ice, overlap and overshooting _convection to high clouds; and cirrus to thin clouds
- 2016, hourly estimates of all-sky GHI and DNI compared to BSRN, Enermena and KNMI stations pMBD: CAMS 4.5 APOLLO_NG performs better compared to CLAAS-3 CPP in urban and rural regions. Inconclusive results in desert regions
- pRMSD: In general CAMS4.5 values are slightly higher with the exception of DNI in rural and urban areas

Study is ongoing with deeper analysis into impact of different cloudy conditions



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Acknowledgments

- This work is supported by the CAMS program, which is part of the EU Copernicus Program and implemented by ECMWF on behalf of the EU.
- We are thankful to: KNMI and DWD for providing the CLAAS-3 CPP cloud products; the ground stations operators Baseline Surface Radiation Network (BSRN) and Enermena for providing the GHI and DNI measurements and Royal Netherlands Meteorological Institute (KNMI) for GHI data.