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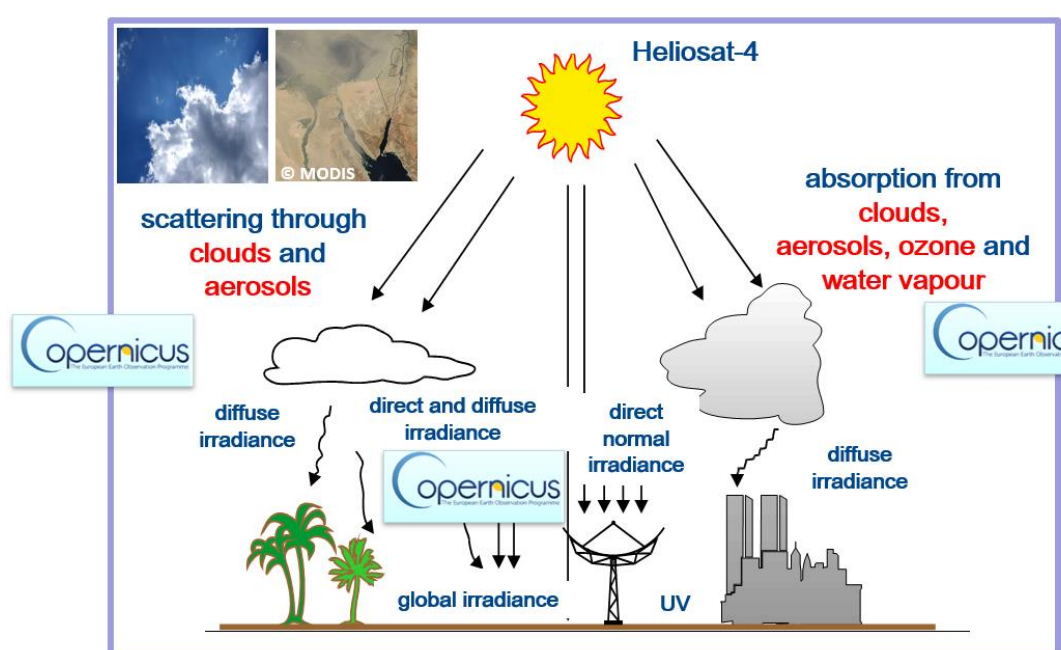
CAMS Radiation Service for solar energy users – how suitable are typical cloud retrieval schemes?

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CAMS Solar Radiation Service

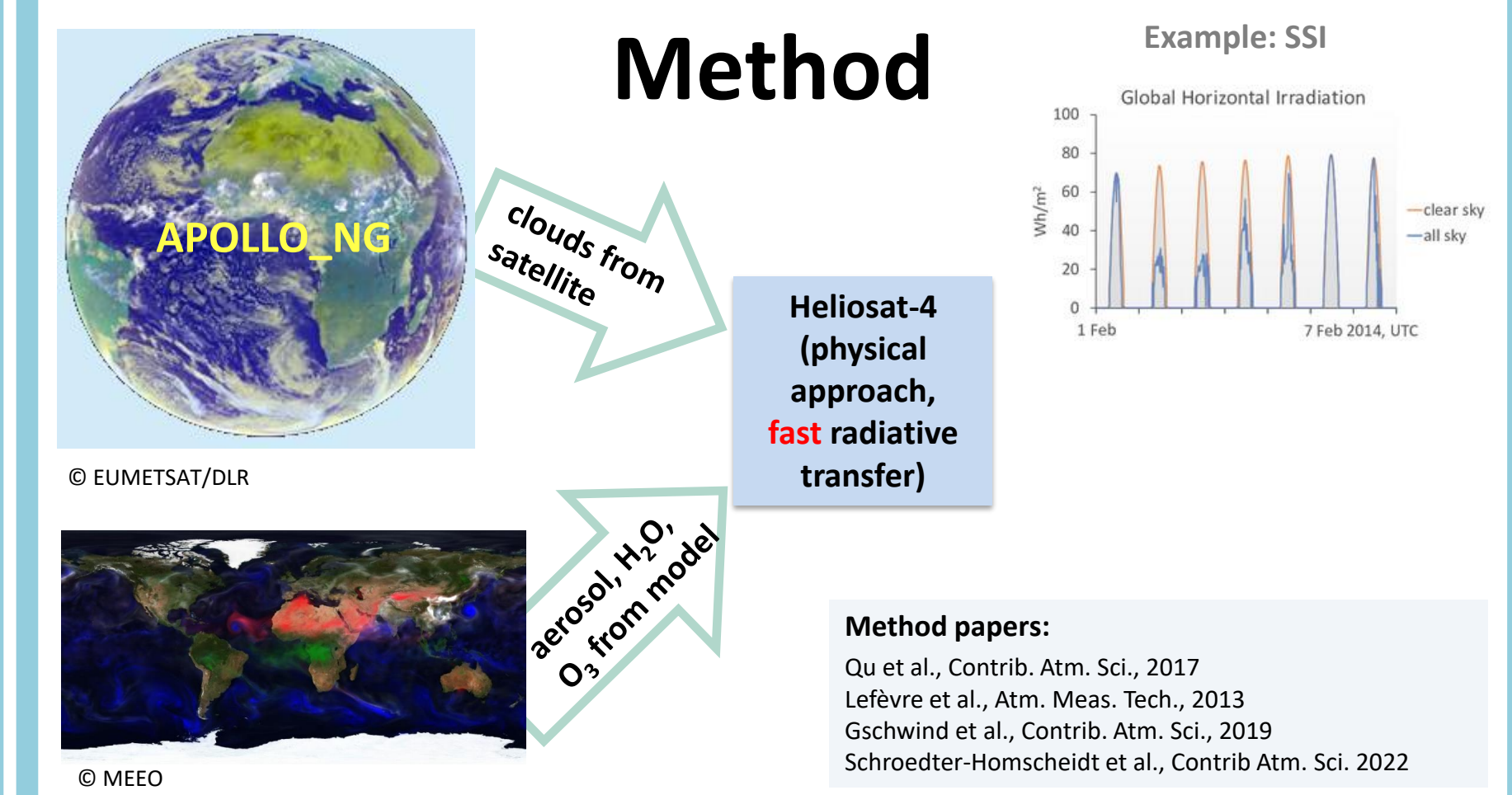
Copernicus Atmospheric Monitoring service (CAMS) offers solar radiation services (CRS) providing information on surface solar irradiance (SSI). The services meet the needs of European and national policy development and the requirements of partly commercial downstream services in the solar energy sector 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 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



The method diagram shows the APOLLO-NG satellite and the Heliosat-4 physical approach. It highlights the retrieval of aerosol H₂O and O₃ from the model. An example plot shows Global Horizontal Irradiation (GHI) for 7 Feb 2014, UTC, comparing clear sky and all-sky conditions.

Method papers:
 Qu et al., Contrib. Atmos. Sci., 2017
 Lefevre et al., Atmos. Meas. Tech., 2013
 Gschwind et al., Contrib. Atmos. Sci., 2019
 Schroedter-Homscheidt et al., Contrib. Atmos. Sci., 2022

Cloud retrieval schemes : CAMS/APOLLO-NG vs CLAAS-3/PPP

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 implemented in CMSAF (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.

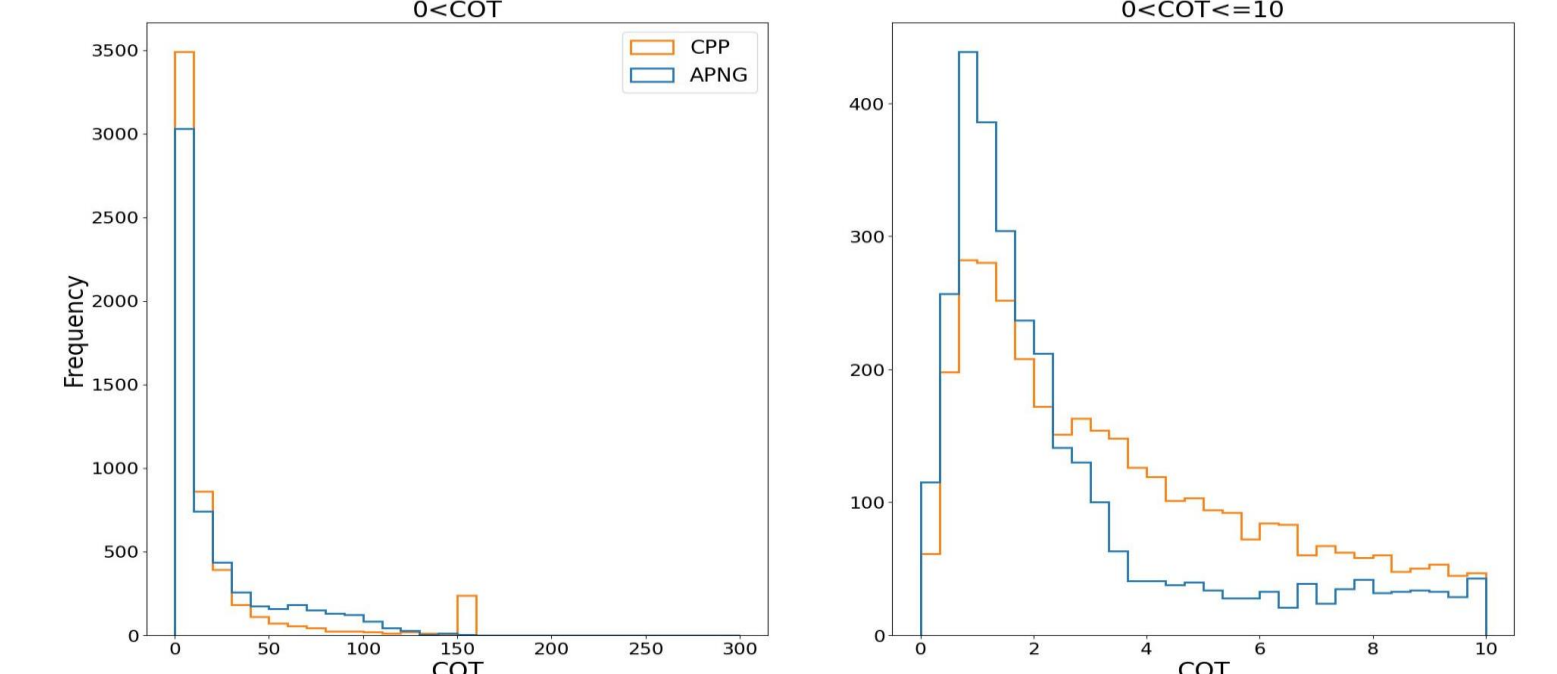
	CAMS 4.5	CLAAS-3
Calibration	Time-dependent updated calibration coefficients from KNMI based on Meirink et al., 2013 & updates	Time-dependent updated calibration coefficients from KNMI based on Meirink et al. 2013 & updates
Cloud algorithm	APOLLO-NG REL1.1	NWC/PPS version v2018 patch5 + CmsafPpsSeviri 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 & Roebeling 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

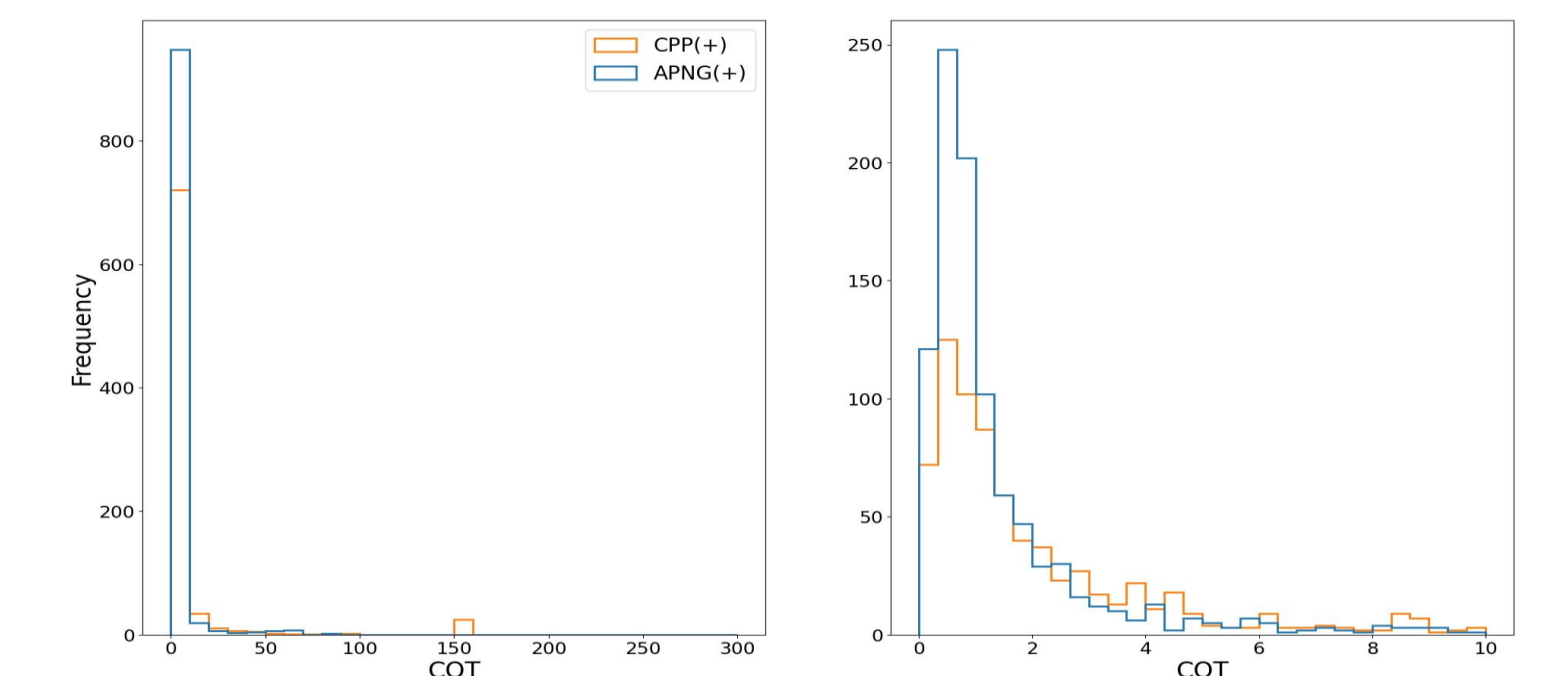
Frequency distribution of the COT values of APOLLO-NG and CPP

Example: BSRN location Carpentras, 2016

Histograms of COT, cloudy (in all methods)

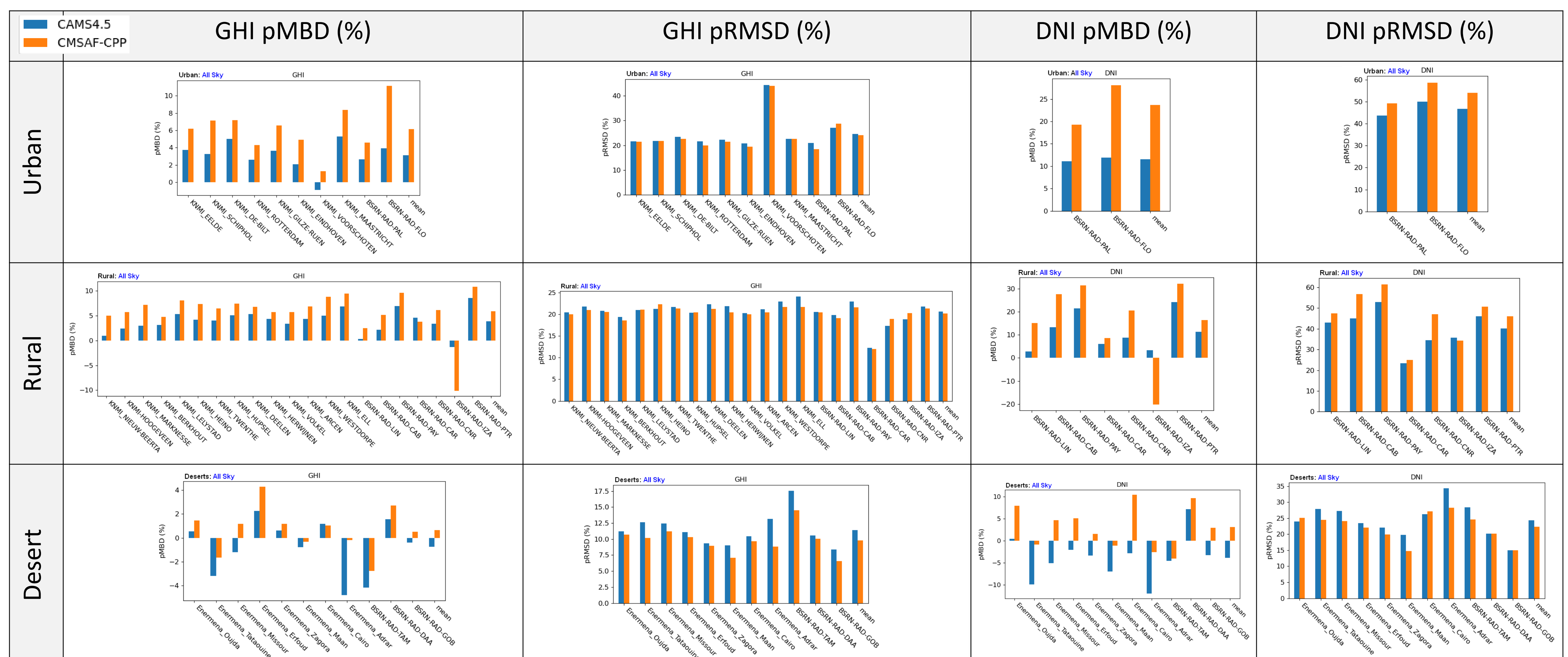


Histograms of COT (+ means one cloudy & other not cloudy)



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, Ennermena 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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