CAMS radiation service-Analyzing the performance of standard cloud retrieval schemes

Faiza Azam[1], Jorge Lezaca[1], Marion Schroedter-Homscheidt[1], Mireille Lefevre[2], Laurent Saboret[3], Yves-Marie Saint-Drenan[2]

[1]German Aerospace Center (DLR), Institute of Networked Energy Systems, Oldenburg, Germany

[2]MINES Paris, PSL University, France

[3]Vaisala, France

6 Fachtagung Energiemeteorologie, 24.01.2024

Atmosphere Monitoring

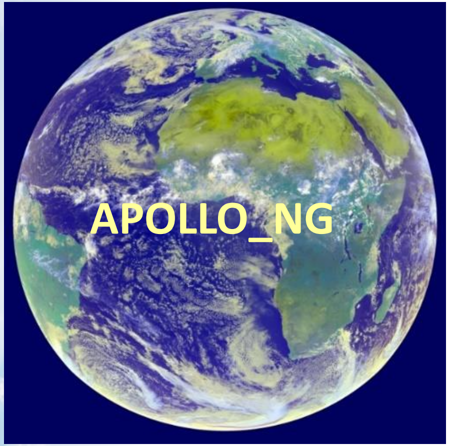
PROGRAMME OF THE EUROPEAN UNION

opernicus Europe's eyes on Earth

IMPLEMENTED BY ECMWF

The CAMS radiation service

Atmosphere Monitoring

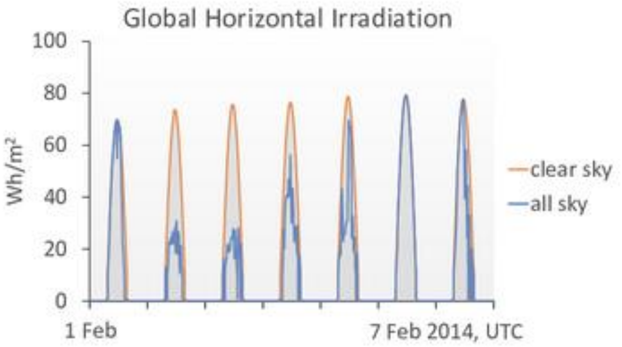


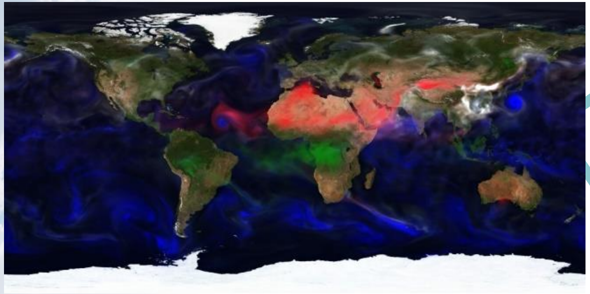
© EUMETSAT/DLR

clouds from satellite

Heliosat-4 (physical approach, fast radiative transfer)

Example Surface Solar Irradiance (SSI)





© MEEO

aerosol H_2O, O_3 from model

method papers:

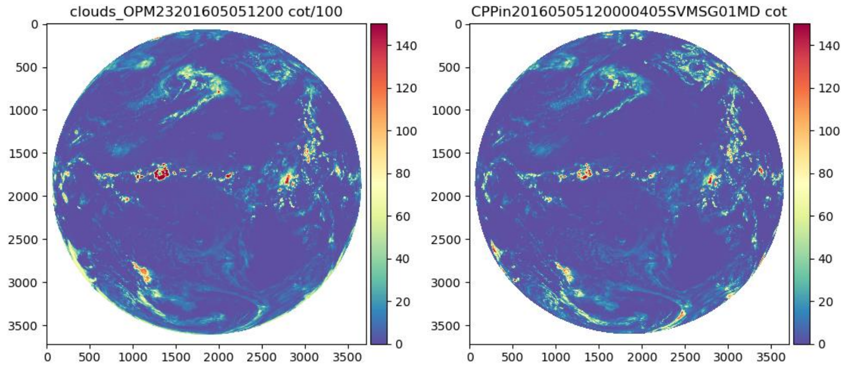
Qu et al., Contrib. Atm. Sci., 2017
Lefèvre et al., Atm. Meas. Tech., 2013
Gschwind et al., Contrib. Atm. Sci., 2019
Schroedter-Homscheidt et al., Contrib Atm. Sci. 2022

Atmosphere Monitoring

Data used

Evaluation of the CAMS radiation service (CRS) APOLLO_NG cloud products and their usage in Heliosat-4

- Year analysed: 2016
- Cloud Products:
  - CAMS 4.5 APOLLO_NG COT
  - CLAAS-3 CPP COT from CM-SAF (CLoud property dAtAset using SEVIRI (CLAAS-3) Cloud Physical Properties (CPP))
- SSI Products:
  - SSI resulting from usage of above cloud products in Heliosat-4



Locations analysed

Atmosphere Monitoring

BSRN, Enermena & KNMI stations locations in MSG field of view

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

Atmosphere Monitoring

	CAMS 4.5	CLAAS-3 CPP
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

Atmosphere Monitoring

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

	CAMS 4.5	CLAAS-3
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 in CPP
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 comparisons

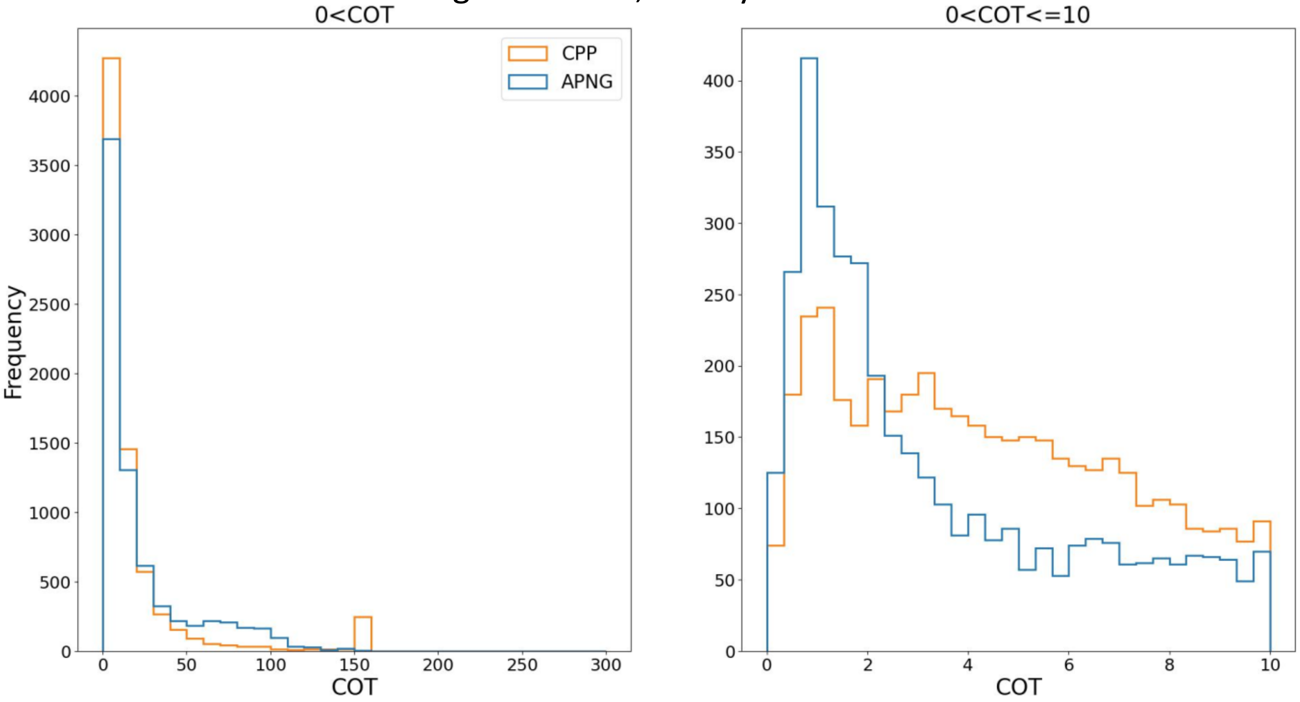
Atmosphere Monitoring

Frequency distribution of the COT values of APOLLO_NG and CPP

- Results shown for incidences where both methods detect cloudy scene
- COT maximum at 150 for CLAAS3-CPP
- APOLLO_NG detects more optically thin clouds for COT<=2 owing to its sensitivity to the cloud detection

Example: BSRN location Cener, 2016

Histogram of COT, cloudy in both methods



COT comparisons

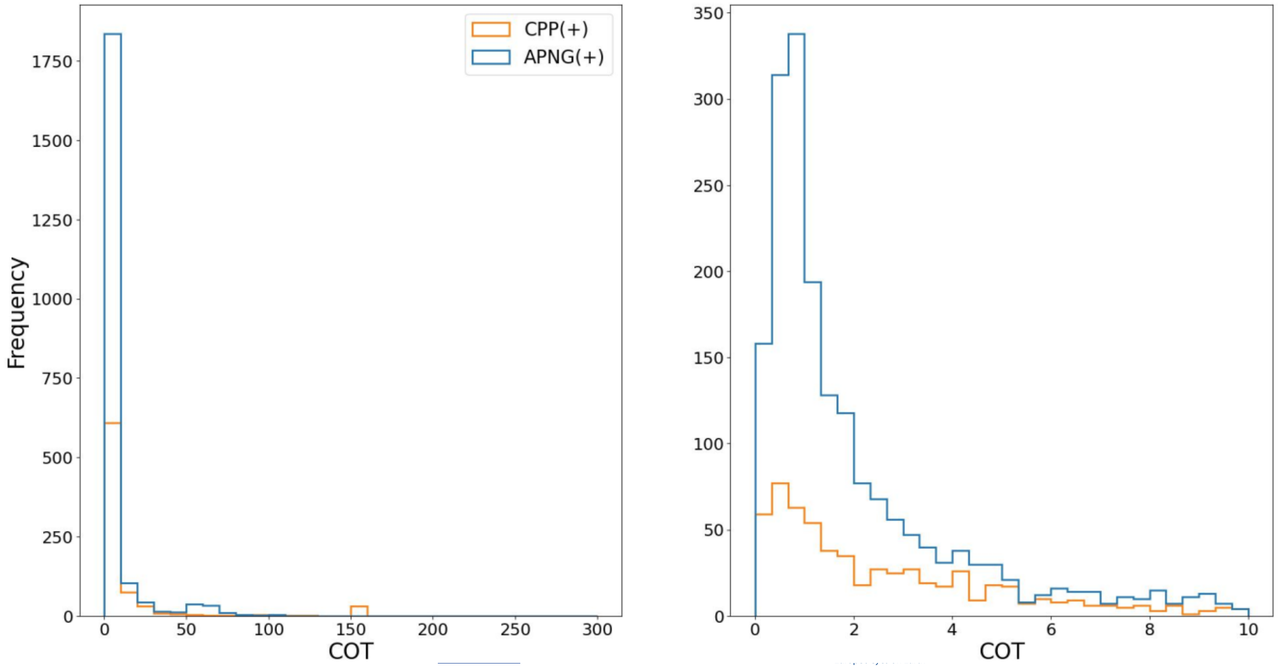
Atmosphere Monitoring

Frequency distribution of the COT values of APOLLO_NG and CPP

- (+) with a method indicates cloudy in that method and clear in the other
- More cases where APOLLO_NG detects clouds and CLAAS3-CPP does not see clouds

Example: BSRN location Carpentras, 2016

Histogram of COT



Atmosphere Monitoring

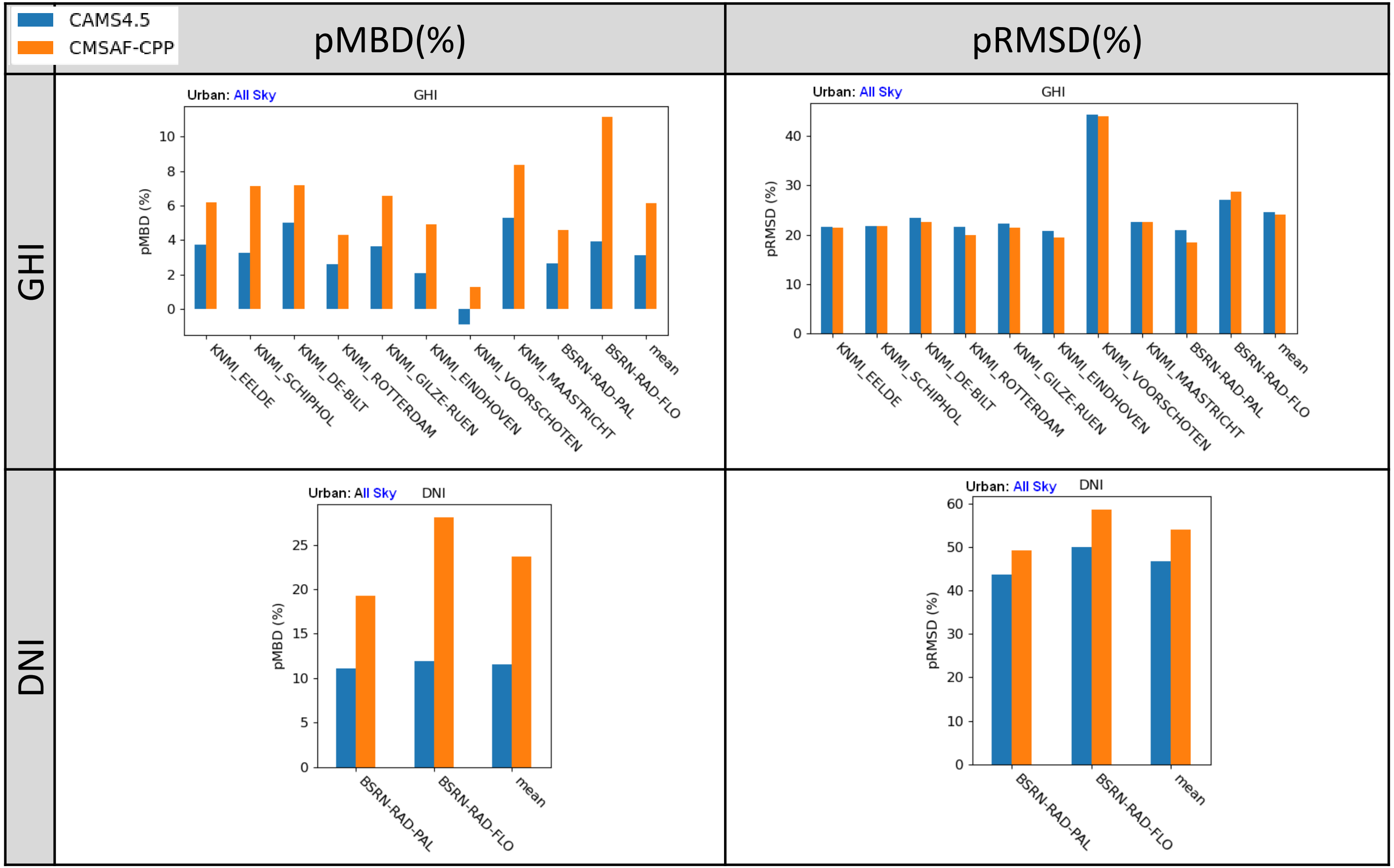
SSI Assessment vs ground observations

- Heliosat-4 offers the possibility to use cloud properties from different sources Cloud parameters required for Heliosat-4:
  - COT and Cloud type
- CLAAS-3 CPP Cloud phase is mapped to APOLLO_NG Cloud type:
  - water and supercooled classes to low clouds
  - opaque_ice, overlap and overshooting _convection to high clouds
  - cirrus to thin clouds
- For 2016, hourly estimates of all-sky GHI and DNI compared to BSRN, Enermena and KNMI stations

SSI Assessment vs ground observations

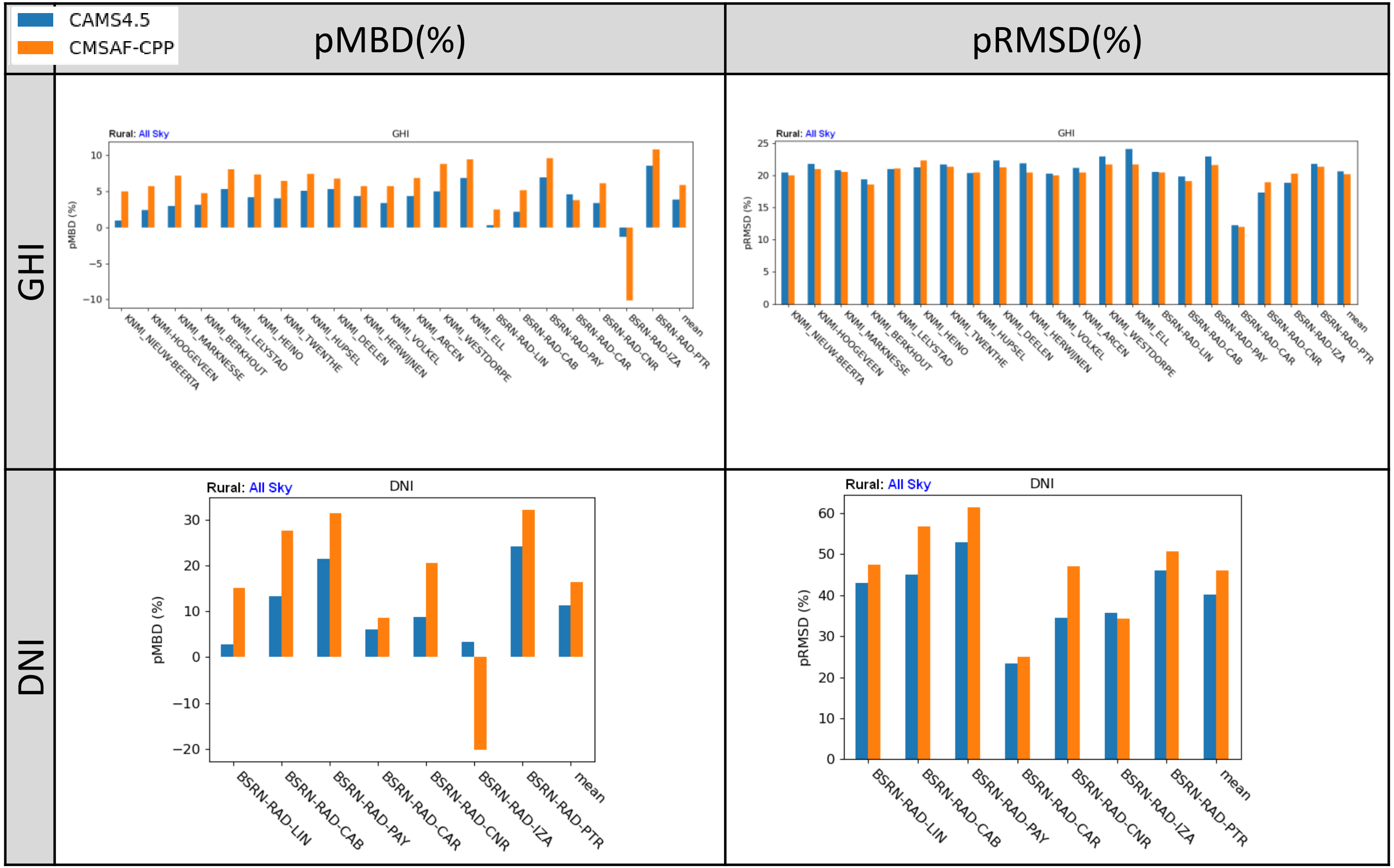
Atmosphere Monitoring

- Urban region all-sky GHI and DNI
- pMBD: CAMS4.5 APOLLO_NG lower bias compared to CLAAS-3 CPP
- pRMSD: CAMS4.5 slightly more for GHI and less for DNI



SSI Assessment vs ground observations

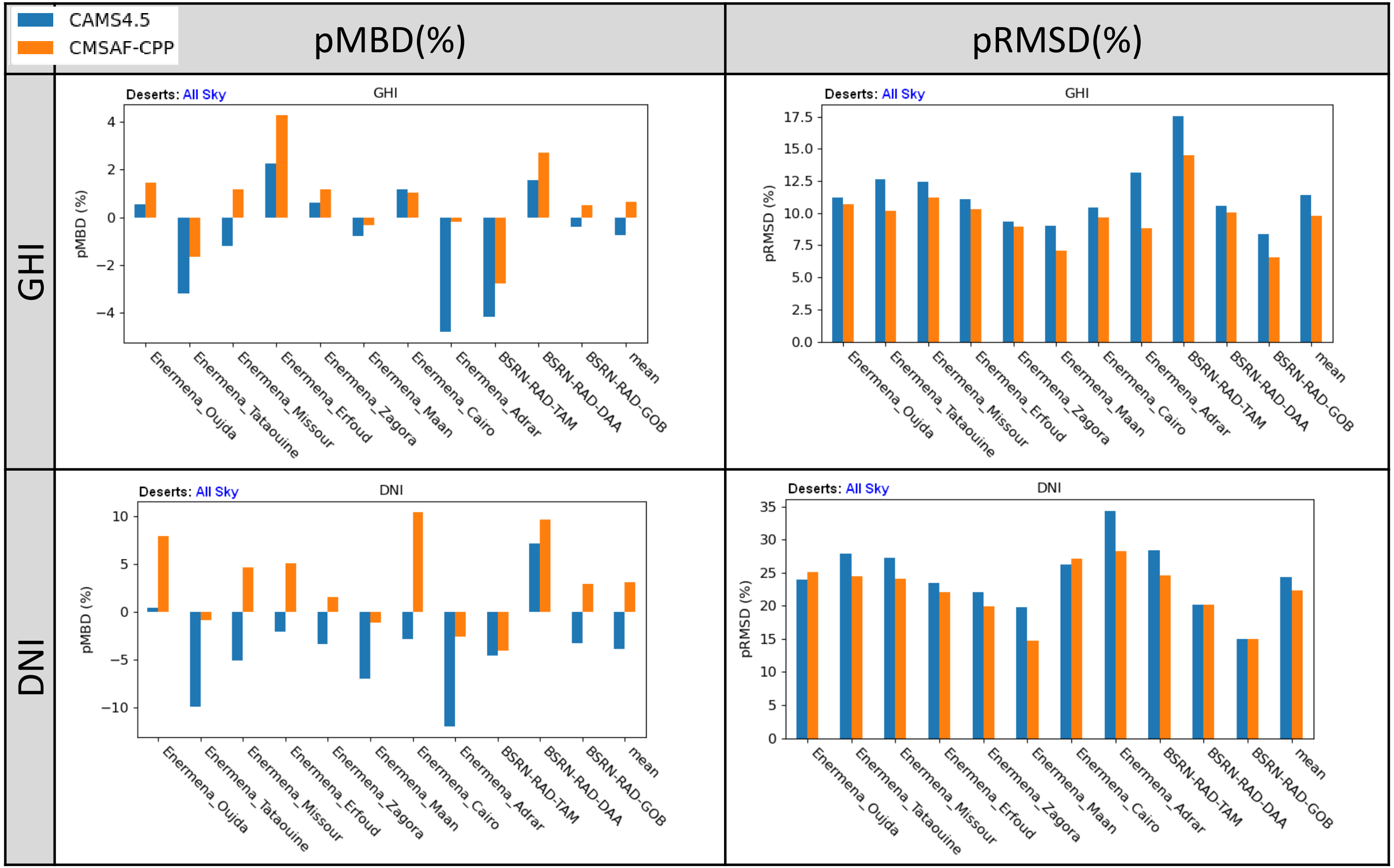
- Rural region all-sky GHI and DNI
- pMBD: CAMS4.5 APOLLO_NG lower bias compared to CLAAS-3 CPP
- pRMSD: CAMS4.5 slightly more for GHI and less for DNI



SSI Assessment vs ground observations

Atmosphere Monitoring

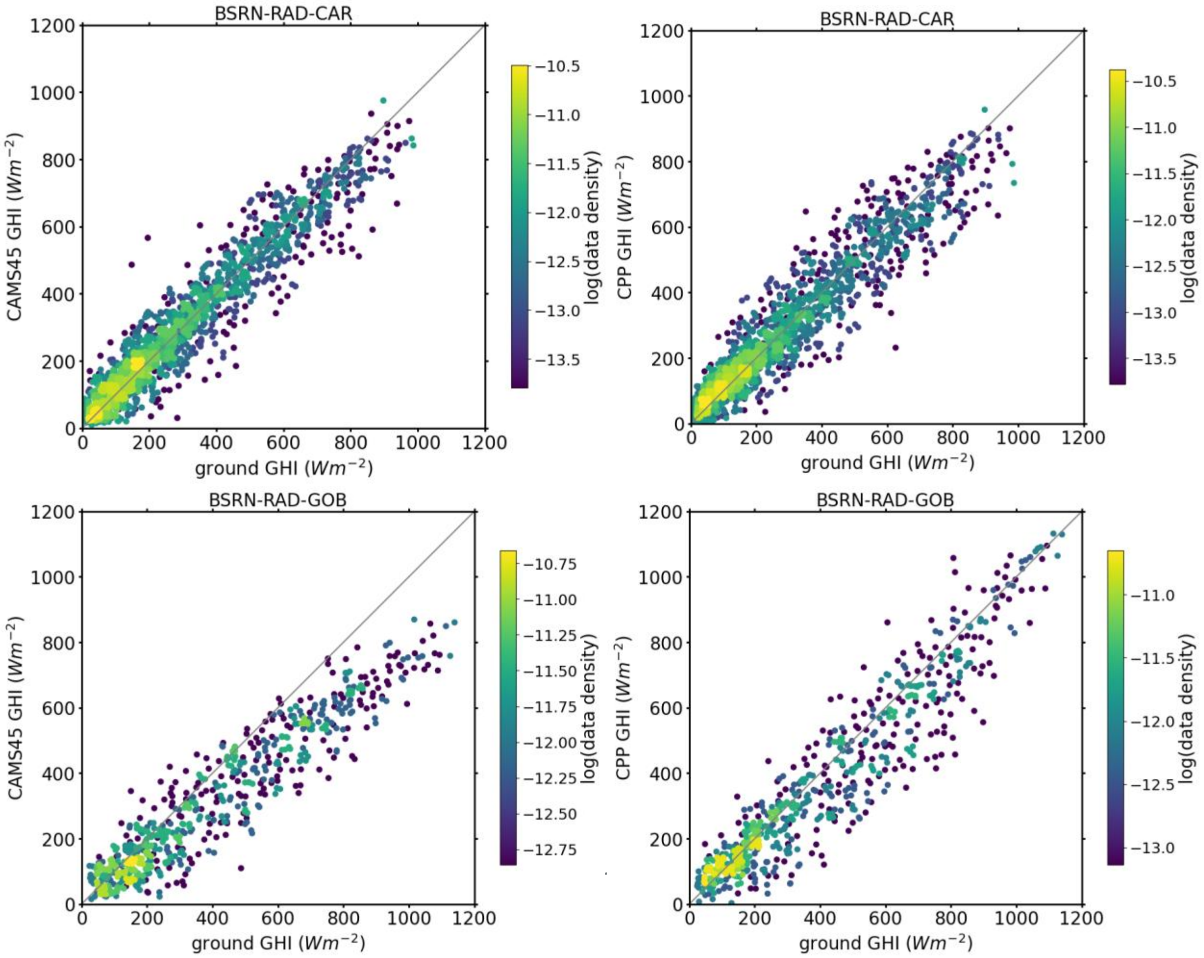
- Desert region all-sky GHI and DNI
- pMBD: different results for different locations
- pRMSD: CAMS4.5 slightly more for GHI and DNI



SSI Assessment vs ground observations

Atmosphere Monitoring

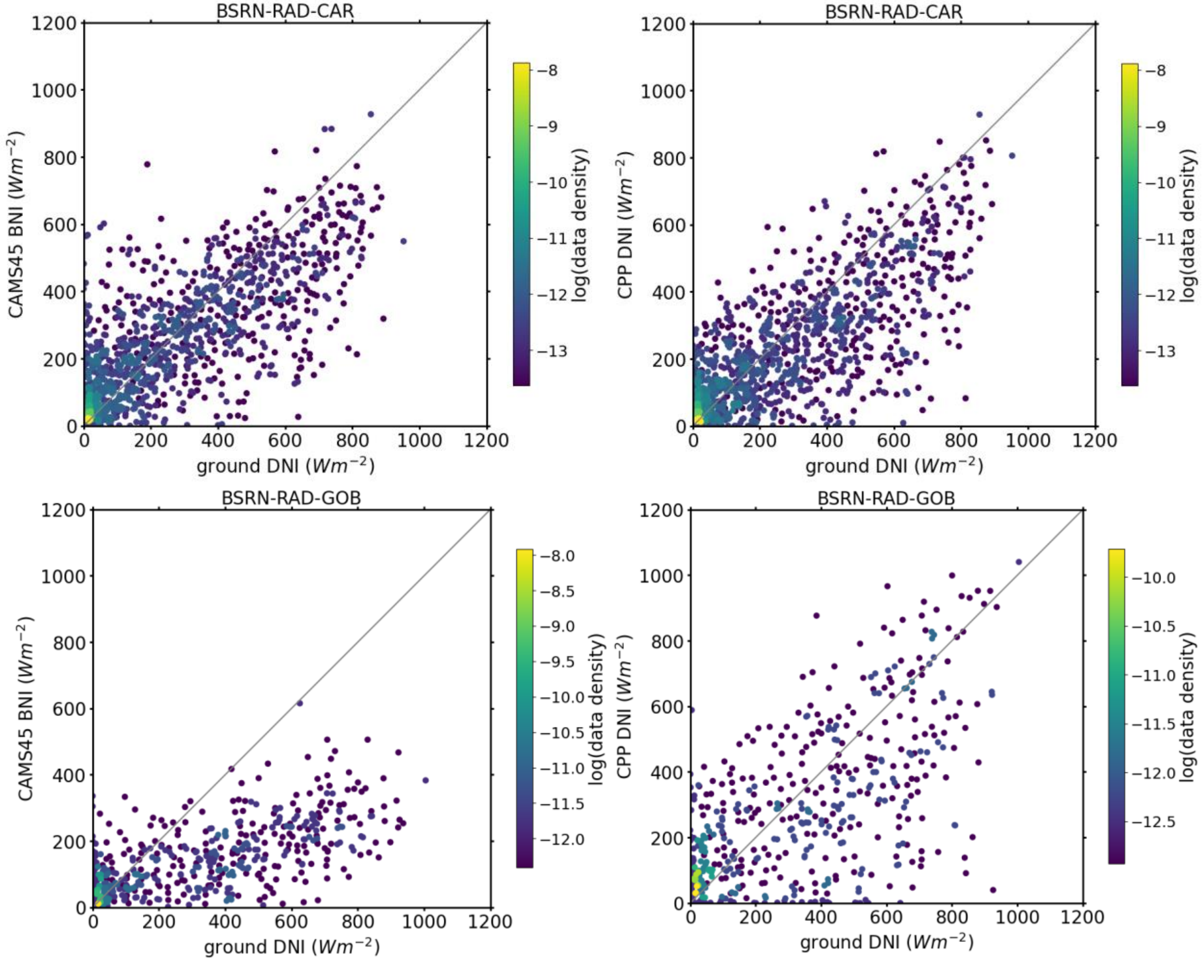
- Scatter plots Examples: BSRN-RAD_CAR & BSRN-RAD-GOB
- GHI from both methods vs ground data
- The values are included in the results where both APOLLO_NG and CLAAS3-CPP observe cloudy scenes
- CAMS 4.5 is better than CLAAS3-CPP at CAR
- CAMS4.5 underestimates at GOB towards higher GHI



SSI Assessment vs ground observations

Atmosphere Monitoring

- Scatter plots Examples: BSRN-RAD_CAR & BSRN-RAD-GOB
- DNI from both methods vs ground data
- The values are included in the results where both APOLLO_NG and CLAAS3-CPP observe cloudy scenes
- Better results at BSRN-RAD-CAR compared to BSRN-RAD-GOB



Next steps

- Conclusions:

  Assessment of SSI obtained from CAMS4.5 APOLLO_NG and CLAAS-3 CPP vs ground observations shown for the all-sky radiation

    - CAMS 4.5 APOLLO_NG performs better compared to CLAAS-3 CPP in urban and rural regions.
    - Different results for different location in desert regions

- Outlook:
  - Evaluate the cloud mask for APOLLO_NG vs CLAAS-3 PPS product
  - Analyse different cloud conditions and cloud types
  - APOLLO_NG COT and corresponding SSI evaluation vs NWCSAF products and in HIMAWARI field of view.

References

Atmosphere Monitoring

- Kriebel et al., 1989: Optical Properties of Clouds Derived from Fully Cloudy AVHRR Pixels. Beiträge zur Physik der Atmosphäre, Vol. 62, No. 3, pp. 165-171, August 1989
- Klüser et al., 2015: APOLLO_NG – a probabilistic interpretation of the APOLLO legacy for AVHRR heritage channels, Atmos. Meas. Tech., 8, 4155-4170
- Lefèvre et al., 2013: McClear: a new model estimating downwelling solar radiation at ground level in clear-sky conditions, AMT, 2013
- Gschwind et al., 2019: Improving the McClear model estimating the downwelling solar radiation at ground level in cloud-free conditions – McClear-v3, Contrib. Atm. Phys./Meteorol. Z., 2019
- Stephens et al., 1984: A Shortwave Parameterization Revised to Improve Cloud Absorption, Journ. Atm. Scienc., Vol 41, no 4, 687-690
- Schroedter-Homscheidt, M., et al., 2018: Classifying ground-measured 1 minute temporal variability within hourly intervals for direct normal irradiances. – Meteorol. Z. 27, 2, 160–179. DOI:10.1127/metz/2018/0875
- Schroedter-Homscheidt, M.; Azam, F.; Betcke, J.; Hanrieder, N.; Lefèvre, M.; Saboret, L.; Saint-Drenan, Y.-M., Surface solar irradiation retrieval from MSG/SEVIRI based on APOLLO Next Generation and HELIOSAT-4 methods, Meteorologische Zeitschrift Vol. 31 No. 6 (2022), p. 455 – 476, DOI: 10.1127/metz/2022/1132
- Meirink, J.F., et al., 2013: Inter-calibration of polar imager solar channels using SEVIRI, Atmos. Meas. Tech., 6, 2495-2508.
- Qu et al., 2017: Fast radiative transfer parameterisation for assessing the surface solar irradiance: The Heliosat-4 method, Contrib. Atm. Phys./ Meteorol. Z., 2017
- User's Guide at http://atmosphere.copernicus.eu/documentation

Atmosphere
Monitoring

Acknowledgements

This work is supported EU Copernicus Programme (CAMS implemented on behalf of EU by ECMEF)

Thanks to CAMS2-73 team at:

DLR
MINES Paris / Armines
Transvalor

Special thanks to the Baseline Surface Radiation Netwrok (BSRN) and Enermena and KNMI stations for the ground measuremnts of GHI and DNI data

Thanks to Martin Stengel from CM-SAF team at DWD for CLAAS-3 CPP data provision

PROGRAMME OF
THE EUROPEAN UNION

Europe's eyes on Earth

IMPLEMENTED BY
ECMWF

Atmosphere Monitoring

PROGRAMME OF THE EUROPEAN UNION

Europe's eyes on Earth

IMPLEMENTED BY ECMWF