



Commission

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Copernicus Atmosphere Monitoring Service



Preparing the CAMS Radiation Service for MTG

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## Outline

- News from CAMS Radiation Service
  - Version 4.0 is online
  - Algorithm changes
  - Validation results v3.2 vs. v4.0
- Preparing for MTG
  - Himawari-8 and GOES-16 evaluation for experimental APOLLO\_NG/Heliosat-4 (DLR)
  - Study based on SEVIRI HRV to quantify the value of higher spatial resolution

















#### irradiance, cloud free irradiance

**method papers** Qu et al., Contrib. Atm. Phys., 2017 Lefèvre et al., Atm. Meas. Tech., 2013 Gschwind et al., Contrib. Atm. Phys., 2019









with ARMINES







![](_page_3_Picture_3.jpeg)

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#### Main method changes

- Time-dependent calibration update following Meirink et al. (KNMI)
- Extension of COT LUTs to 0.001 instead of clipping at 0.5
- Bayesian cloud masks in APOLLO\_NG (Klüser et al., AMT, 2015)
- Cloud probability threshold, very sensitive selection
- Circumsolar correction for DIR

![](_page_4_Figure_7.jpeg)

RMSE for hourly DIR as function of cloud probability threshold

![](_page_4_Picture_9.jpeg)

![](_page_4_Figure_10.jpeg)

optimum apparent COT modification factor in different cloud conditions

![](_page_4_Picture_12.jpeg)

![](_page_4_Picture_13.jpeg)

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![](_page_5_Picture_0.jpeg)

#### **Evaluation results – SEVIRI**

Study design: GHI (Global horizontal irradiation) hourly evaluation; 2004 to 2020 CAMS operational v3.2 (old) CAMS operational v4.0 (online)

Note: Bias correction method as originally developed for v3.2 was updated for v4.0, but is now nearly passive for GHI.

Thanks to BSRN & EnerMENA station teams for providing their data.

![](_page_5_Figure_5.jpeg)

Hourly GHI – rel. bias, rel. RMSE and correlation coefficient change from CRS 3.2 to CRS 4.0

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![](_page_5_Picture_8.jpeg)

![](_page_5_Picture_9.jpeg)

![](_page_5_Picture_10.jpeg)

![](_page_6_Picture_0.jpeg)

#### **Evaluation results – SEVIRI**

Study design: BNI (beam normal irradiation) hourly evaluation; 2004 to 2020 CAMS operational v3.2 (old) CAMS operational v4.0 (online)

Thanks to BSRN & EnerMENA station teams for providing their data.

![](_page_6_Figure_4.jpeg)

Hourly BNI – rel. bias, rel. RMSE and correlation coefficient change from CRS 3.2 to CRS 4.0

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## Preparing for MTG - Evaluation results – Himawari-8

Study design:

hourly evaluation; 6 days/month – each 5/10/15/20/25/30 of each month in 2018 experimental version: APOLLO NG/Heliosat-4(DLR) based on 2 km channels, no bias correction applied

![](_page_7_Figure_4.jpeg)

Hourly GHI and DIR validation for HIMAWARI -8 for the year 2018 - outliers COC and LEA are mixed pixels at the coastline. Station LEA does not provide enough DIR observations and is excluded.

![](_page_7_Picture_6.jpeg)

![](_page_7_Picture_7.jpeg)

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![](_page_8_Picture_0.jpeg)

## Preparing for MTG - Evaluation results – GOES-16

Study design:

hourly evaluation; 6 days/month – each 5/10/15/20/25/30 of each month in 2018 experimental version: APOLLO NG/Heliosat-4(DLR) based on 2 km channels, no bias correction applied

![](_page_8_Figure_4.jpeg)

Hourly GHI and DIR validation for GOES-16 for the year 2018 – long snowy season increases all metrics in BON, BOS, FPE, SXF in 2018; DRA affected by parallax effects in broken cloud conditions

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![](_page_8_Picture_7.jpeg)

![](_page_8_Picture_8.jpeg)

![](_page_9_Picture_0.jpeg)

## Preparing for MTG – Use of higher spatial resolution

Study design:

- TROPOS implementation of CPP/SICCS cloud/irradiance algorithms (!= CAMS algorithm)
- extended to use HRV broad band channel in multi-spectral cloud physical retrieval

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#### Preparing for MTG – Effects of higher spatial resolution

![](_page_10_Figure_2.jpeg)

![](_page_11_Picture_0.jpeg)

#### Preparing for MTG – Use of higher spatial resolution

![](_page_11_Picture_2.jpeg)

Pyranometer network HOPE campaign, 2013

GHI Stations as yellow stars, SEVIRI standard resolution pixel in white solid line HRV pixels in dotted white lines

![](_page_11_Figure_5.jpeg)

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GHI variability Black/grey: ground observation Blue/light blue: 3 km SEVIRI Red/light red: HRV SEVIRI All data resampled to 5 min

Daily mean RMSE for GHI Averaging periods from 5 to 60 min

HRV/3km combination performs better in this case, note: this is not valid for all days evaluated

![](_page_11_Picture_9.jpeg)

Deneke et al., AMT, 2021

![](_page_11_Picture_11.jpeg)

![](_page_11_Picture_12.jpeg)

![](_page_11_Picture_13.jpeg)

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### Conclusions

The CAMS Radiation Service Version 4.0 update (active since 28 June 2021)

- Applies probabilistic cloud mask of APOLLO\_NG
- Several bug fixes (no COD clipping for small values anymore)
- Direct irradiance adapted for circumsolar radiation so that pyrheliometer observation is met
- Validated for SEVIRI

Preparations for MTG

- Validated for SEVIRI, Himawari-8, and GOES-16 without any bias correction
- Quantification of cloud optical depth as function of spatial resolution
- Study on impact of HRV spatial resolution merged with standard 3 km SEVIRI channel resolution

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aufgrund eines Beschlusses

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## Contact point & references

- General inquiries and user requests: <u>copernicus-support@ecmwf.int</u>
- Specific for the Solar Radiation Service team: marion.schroedter-homscheidt@dlr.de
- See additional slides on data access
- User's Guide at <a href="http://atmosphere.copernicus.eu/documentation">http://atmosphere.copernicus.eu/documentation</a>
- Heliosat-4 method: Qu et al., Fast radiative transfer parameterisation for assessing the surface solar irradiance: The Heliosat-4 method, Contrib. Atm. Phys./ Meteorol. Z., 2017
- McClear method: Lefèvre et al., McClear: a new model estimating downwelling solar radiation at ground level in clear-sky conditions, AMT, 2013
   Gschwind et al., Improving the McClear model estimating the downwelling solar radiation at ground level in cloud-free conditions – McClear-v3, Contrib. Atm. Phys./Meteorol. Z., 2019
- UV and broadband irradiation evaluation: Quarterly validation reports at <u>https://atmosphere.copernicus.eu/supplementary-services</u>

![](_page_13_Picture_9.jpeg)

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#### Additional slides – data access

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#### Gridded datasets

![](_page_15_Figure_2.jpeg)

- 15 min temporal resolution
- 2005-2017
- 0.2° gridded data

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Figures: Monthly average GHI for Africa and BNI for Europe for January

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![](_page_15_Picture_9.jpeg)

![](_page_15_Picture_10.jpeg)

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# Time series of total- sky irradiation in Europe/Africa/Middle East

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	5 radiation serv	ice has been upgraded to version 3 (bias correc	tion and <u>CAM5 McClear version 3 m</u>	odel) during the Oct. 2017 releas	e.		The CAMS Radiation	User's Guide to the
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• start in 2004

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- after 1-2 days delay online
- global, diffuse, direct and direct normal irradiation
- time series

With ARMINES

- 1 min, 15 min, 1 hour, 1 day, 1 month temporal resolution
- CAMS Atmospheric Data Store (https://ads.atmosphere.copernicus.eu)
- interactive and OGC script access possible

![](_page_16_Picture_10.jpeg)

![](_page_16_Picture_11.jpeg)

![](_page_16_Picture_12.jpeg)

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# Clear sky (cloud-free) irradiation in global coverage – time series at location of interest

![](_page_17_Picture_2.jpeg)

- start in 2004
  - after 1-2 days delay online
- global, diffuse, direct and direct normal irradiation
- time series

with ARMINES

- 1 min, 15 min, 1 hour, 1 day, 1 month temporal resolution
- CAMS Atmospheric Data Store (https://ads.atmosphere.copernicus.eu)
- interactive and OGC script access possible

![](_page_17_Picture_10.jpeg)

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Detailed	<pre># Columns: # 1. Observation period (ISO 8601) # 2. TOA. Irradiation on horizontal plane at the top of atmosphere (Wh/m2)</pre>						
expert mode	<pre># 3. Clear sky GHI. Clear sky global irradiation on horizonta (Wh/m2) # 4. Clear sky BHI. Clear sky beam irradiation on horizontal (Wh (m2))</pre>						
	<pre>(Wn/m2) # 5. Clear sky DHI. Clear sky diffuse irradiation on horizontal plane at ground level (Wh/m2) # 6. Clear sky BNI. Clear sky beam irradiation on mobile plane following the sun at normal incidence (Wh/m2)</pre>						
maximum transparency	<pre># 7. GHI. Global irradiation on horizontal plane at ground # 8. BHI. Beam irradiation on horizontal plane at ground 16 # 9. DHI. Diffuse irradiation on horizontal plane at ground 16 # 10. BNI. Beam irradiation on mobile plane following the sun at normal incidence (Wh/m2)</pre>						
<ul> <li>all input values</li> </ul>	<pre>#11. Reliability. Proportion of reliable data in the su #12. sza. Solar zenith angle for the middle of the summ #13. atm. Atmospheric profile code: afglus=U.S. standar afglms=midlatitude summer afglmw=midlatitude winter afg</pre>						
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