Operational Cloud Products for Sentinel-4/MTG-S

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Sentinel-4

Orbit
geostationary

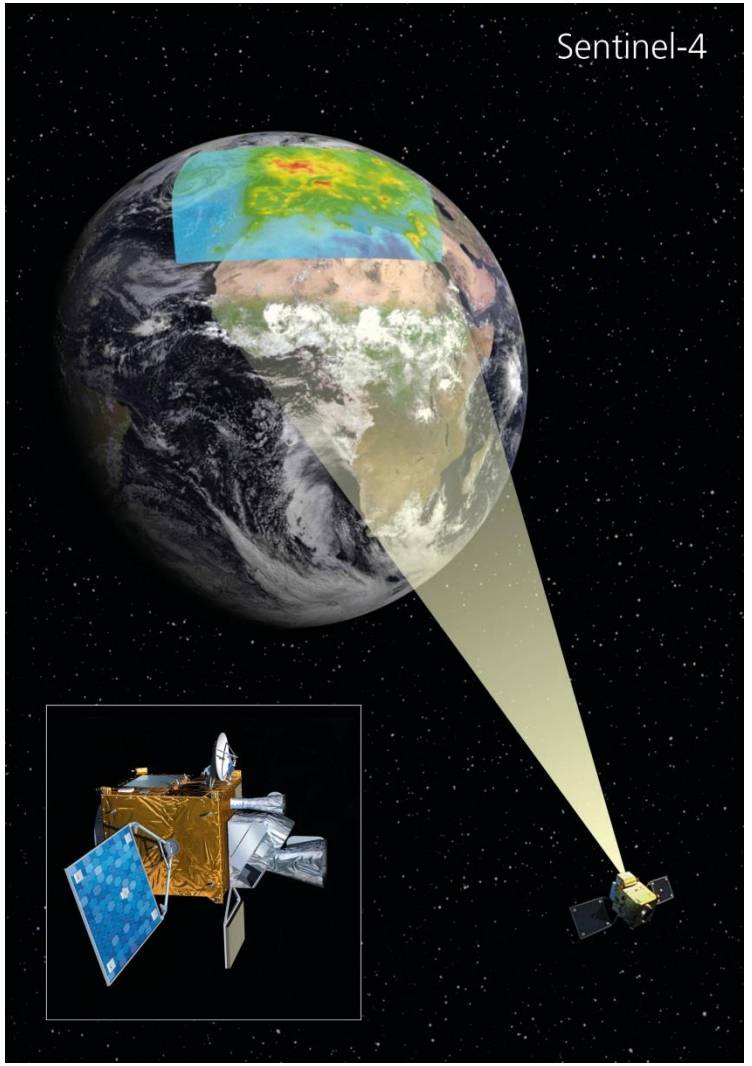
Temporal resolution and coverage
hourly (Europe)

Instrument name
UVN

Spatial resolution
8 x 8 km²

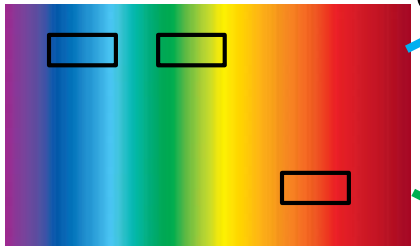
Spectral coverage
UV-VIS-NIR

Spectral resolution in the UVN
0.12-0.5 nm



OCRA & ROCINN – Algorithm Overview

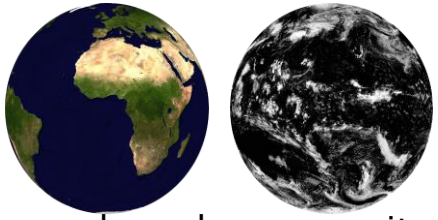
OCRA
Optical Cloud Recognition Algorithm



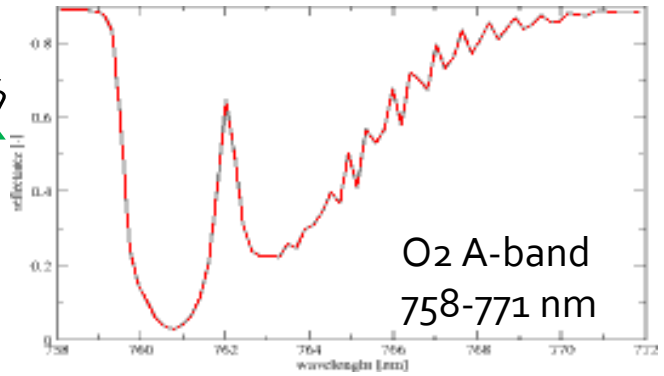
ROCINN
Retrieval of Cloud Information using Neural Networks

color space approach

neural network approach

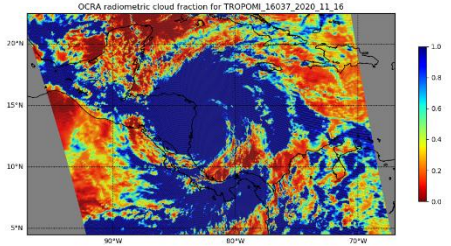


clear-sky composite

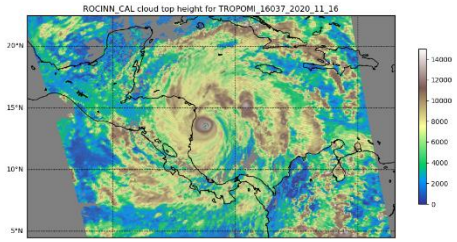


CAL
Clouds as layers

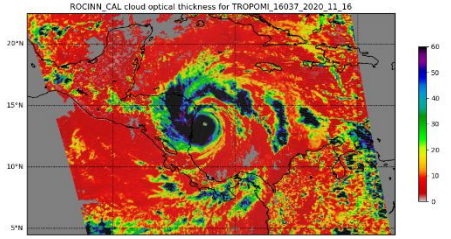
CRB
Clouds as reflecting boundaries



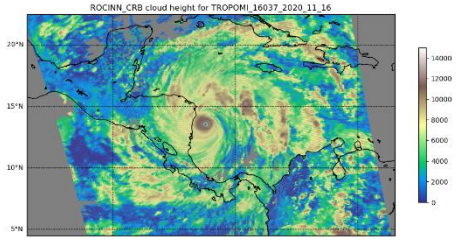
Radiometric cloud fraction



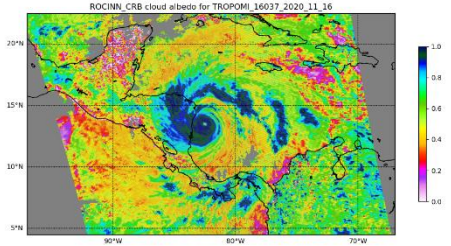
cloud top height



cloud opt. thickness



eff. cloud height

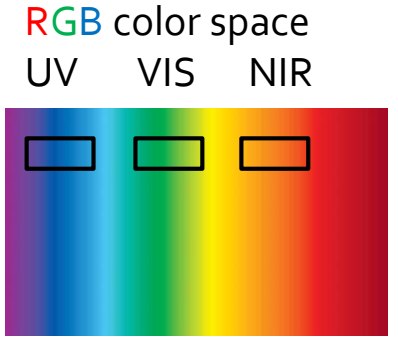


cloud albedo

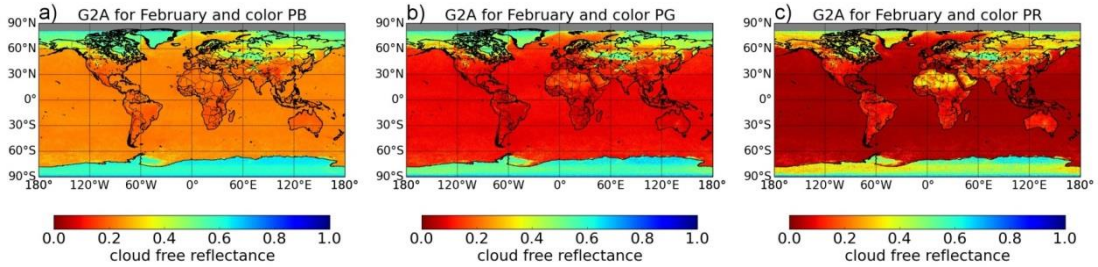
Hurricane Iota
©NASA worldview

OCRA Overview

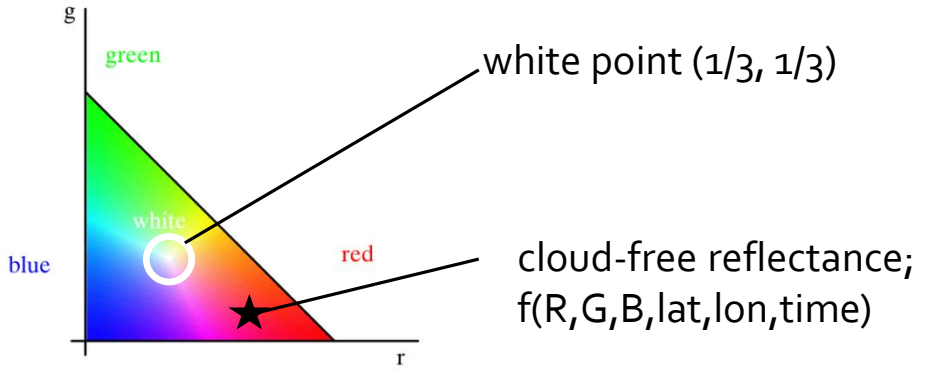
- map measured reflectances to RGB color space



- generate cloud-free reflectance composite maps
  - monthly resolution
  - based on several years of data



- assume a cloud to be „white" in RGB
  - white point defines fully cloudy condition



- radiometric cloud fraction is scaled between the cloud-free reflectance (CF=0) and the „white point" (CF=1)

Lutz et al. (2016): OCRA radiometric cloud fractions for GOME-2 on MetOp-A/B, Atmos. Meas. Tech., 9, 2357-2379, https://doi.org/10.5194/amt-9-2357-2016

OCRA for Sentinel-4

–At mission start (mid 2024) we will need clear-sky composite maps to apply OCRA

–Generate maps based on an instrument with similar characteristics

→EPIC instrument on the DSCOVR platform
- similar wavelength bands and spatial resolution
- hourly temporal resolution

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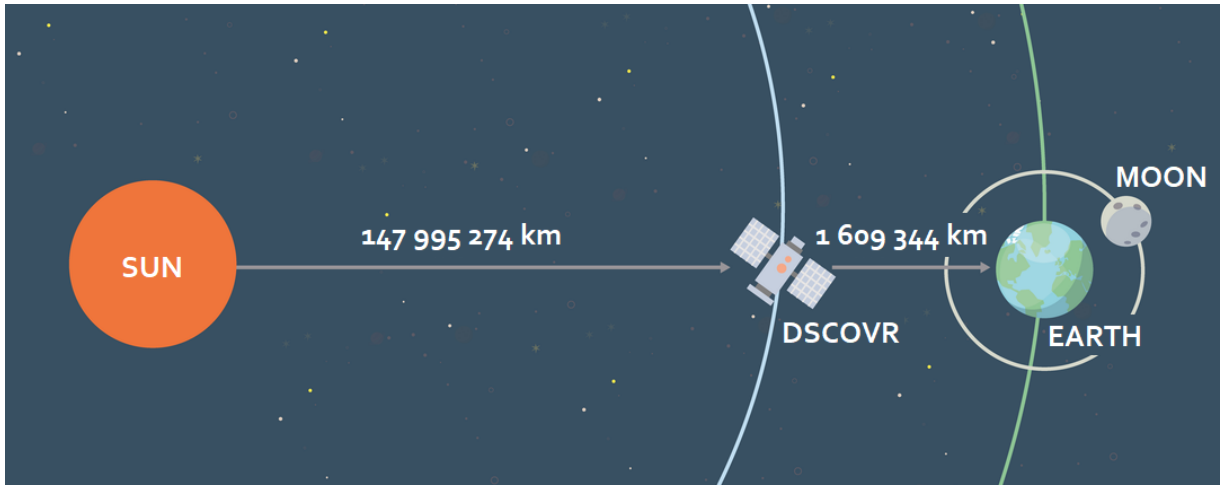
–DSCOVR (Deep Space Climate Observatory)

–EPIC (Earth Polychromatic Imaging Camera)
- UV-VIS-NIR CCD camera
- 10 channels ranging from 317 to 780 nm
- 2-5 images per day over Europe
- nadir spatial resolution of about 12 km

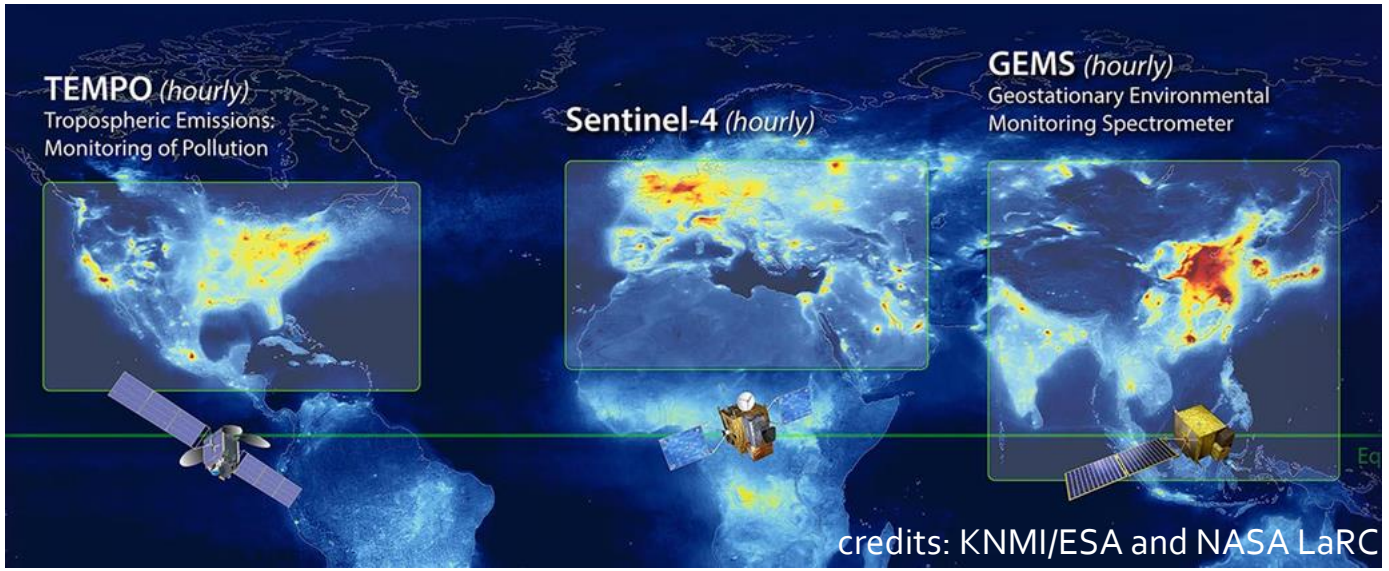


OCRA for Sentinel-4

- Clear-sky maps for EPIC channels (780, 551, 388) nm
- Aggregation of daily maps in intervals of +/- 14 days with 0.2 deg resolution

OCRA adaptation to GEMS

– Together with GEMS and TEMPO, Sentinel-4 forms a geostationary constellation for air quality monitoring



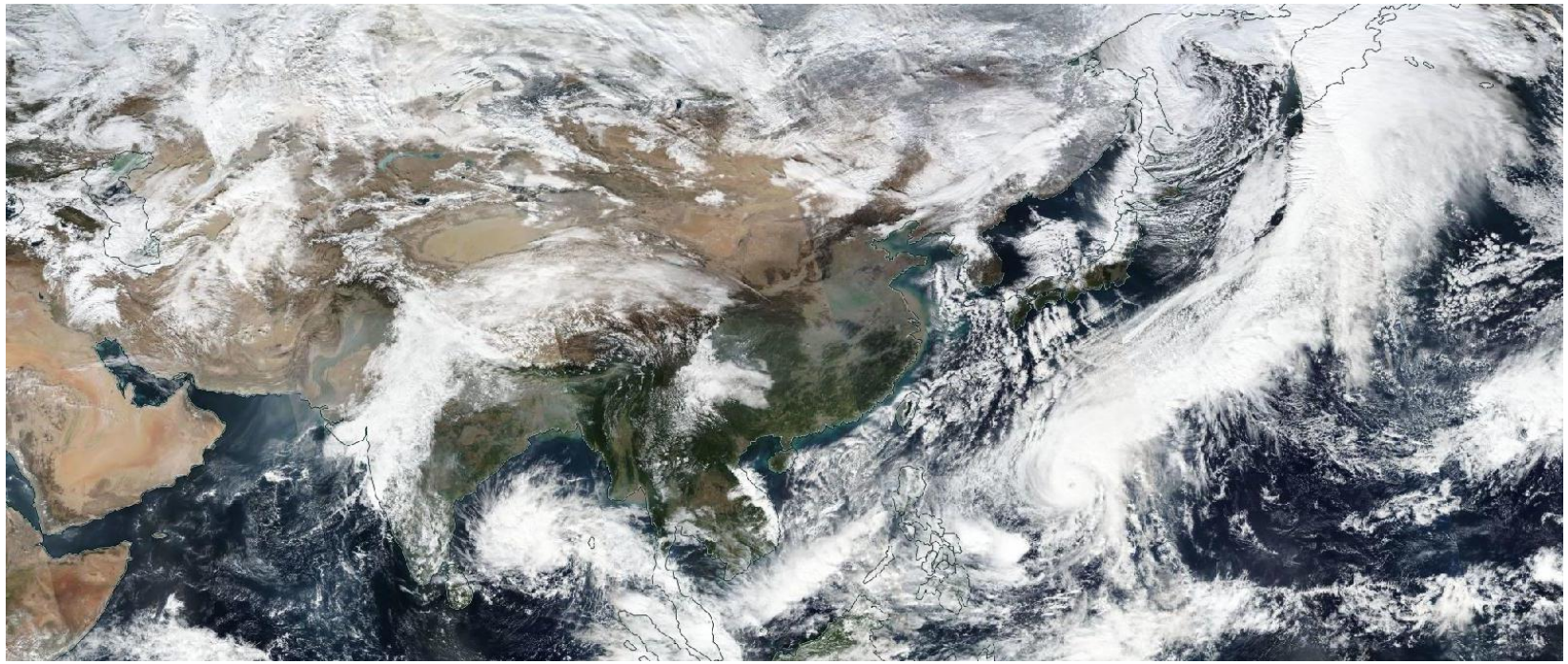
– To prepare our algorithms for Sentinel-4, we also apply OCRA to GEMS data

– Following examples:

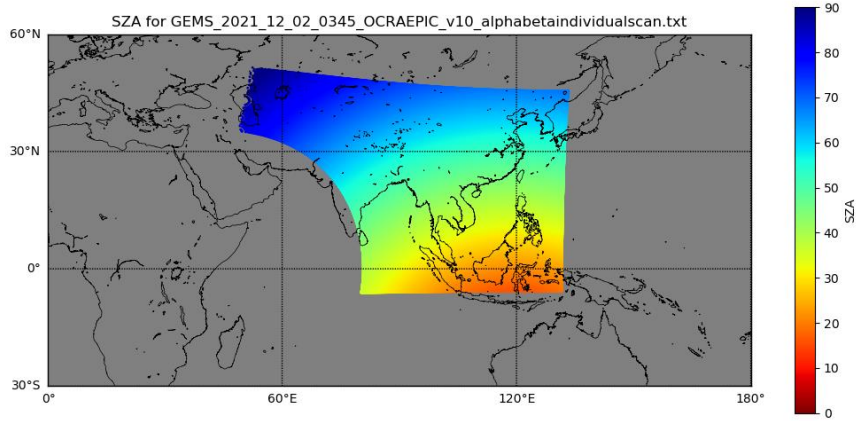
  – six GEMS scans on 2 December 2021 (00:45-05:45), GEMS L1C and IRR products version 1.0

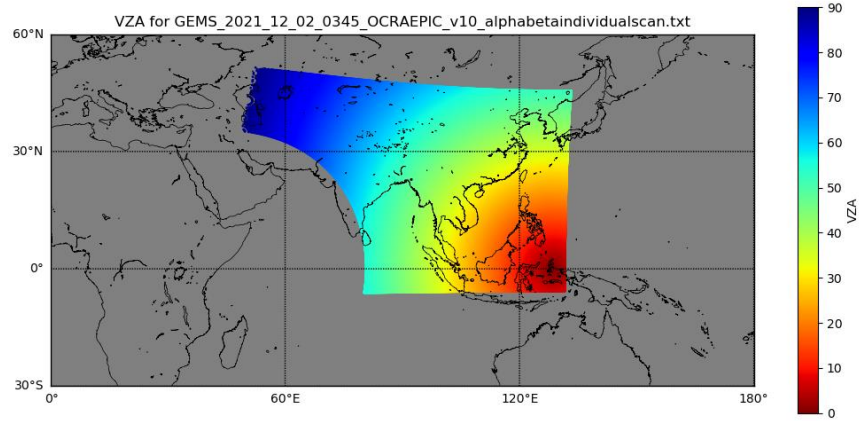
OCRA adaptation to GEMS

– VIIRS RGB of the scene considered:



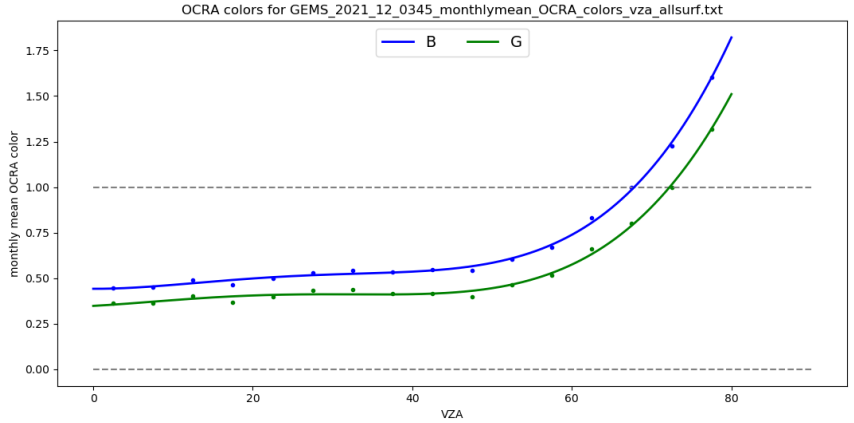
–Viewing conditions:

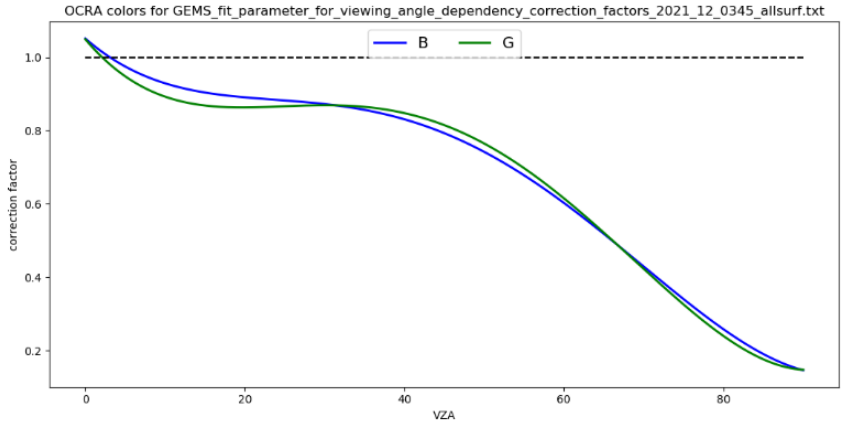


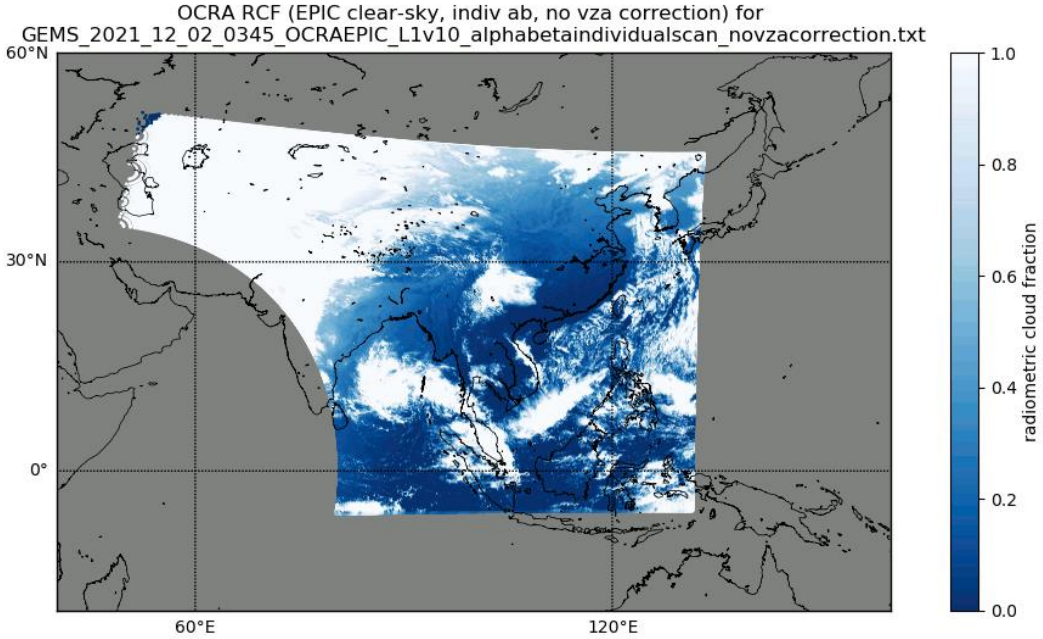


OCRA adaptation to GEMS

– VZA correction based on GEMS data from December 2021

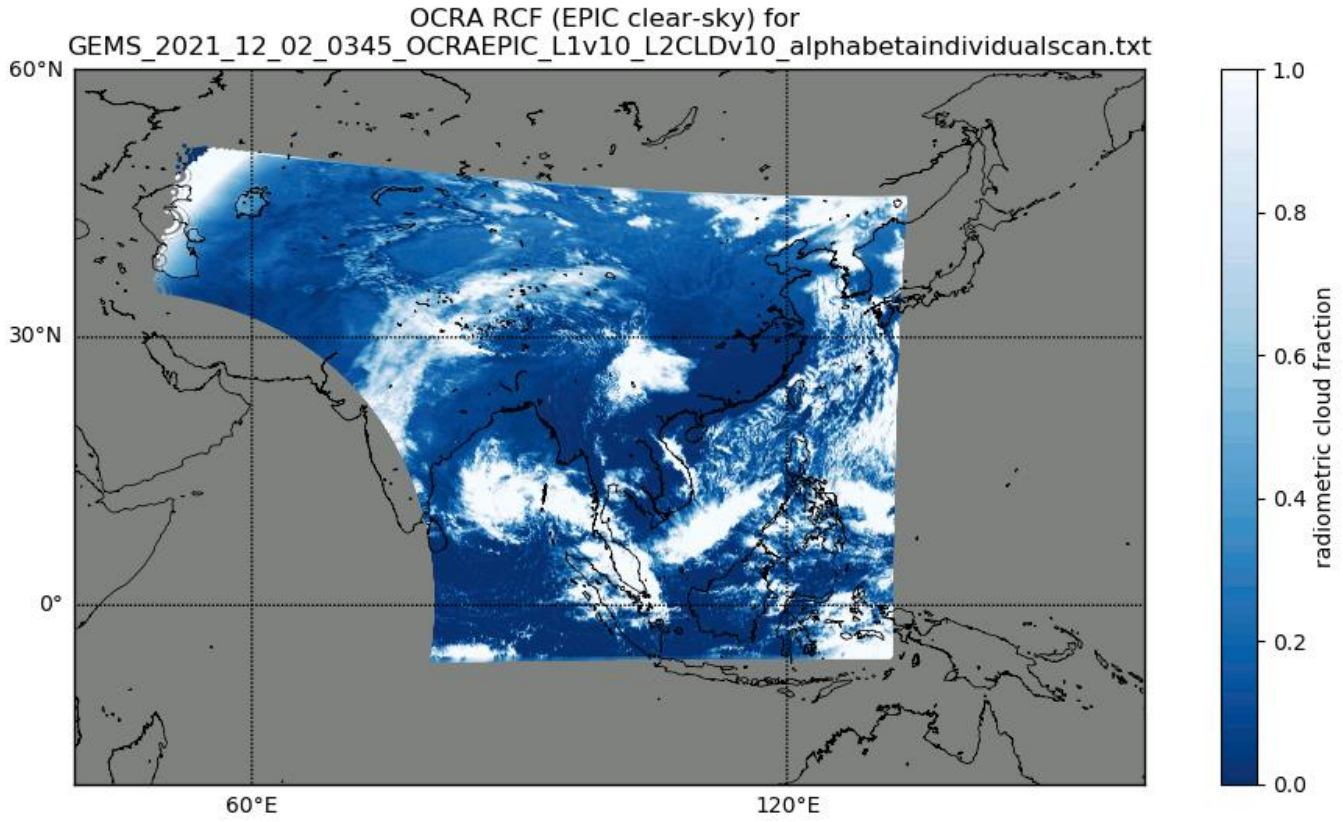






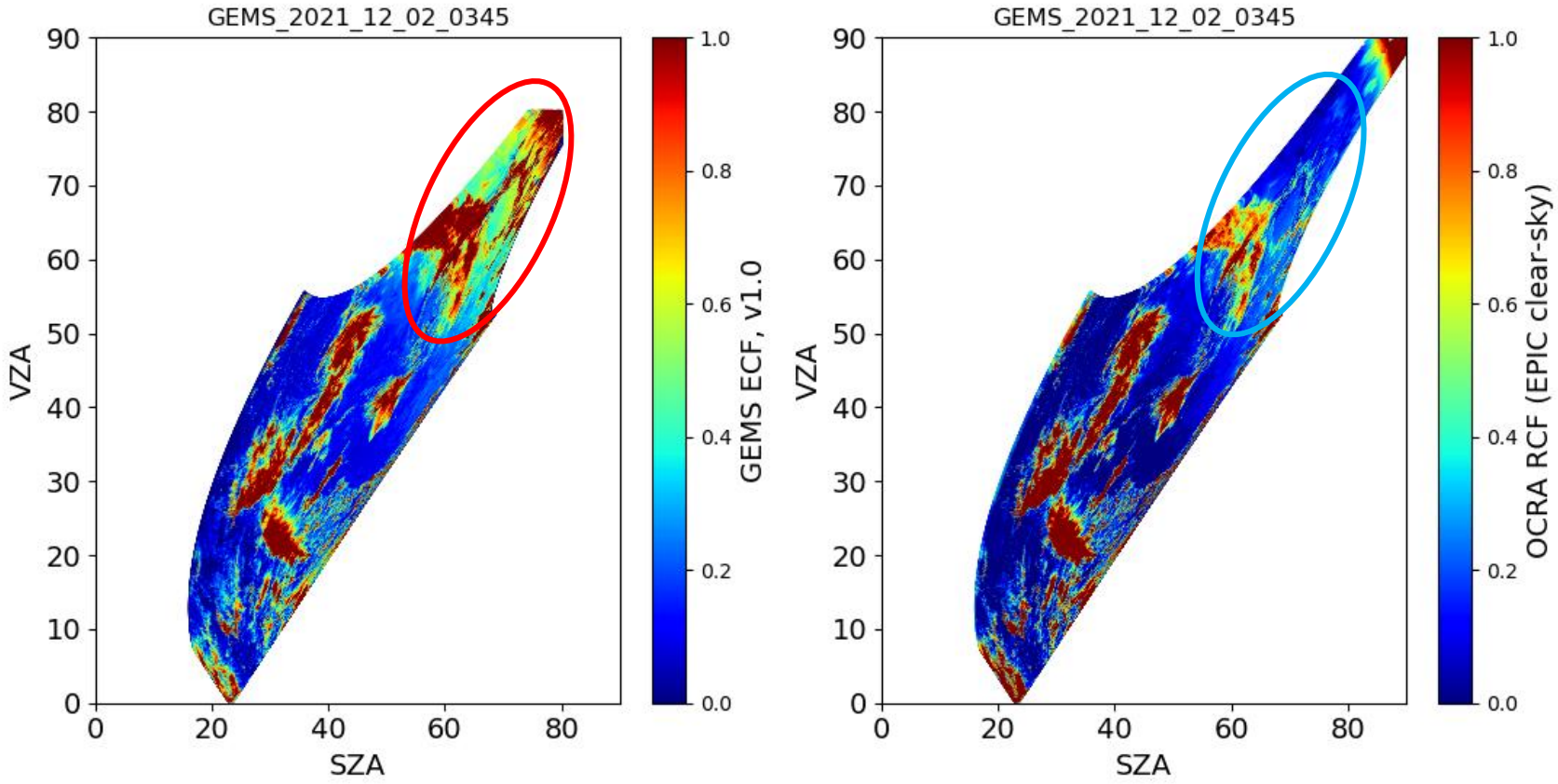
OCRA adaptation to GEMS

– comparison of our OCRA adaptation with the official GEMS L2 cloud product (2021-12-02, 03:45)



OCRA adaptation to GEMS

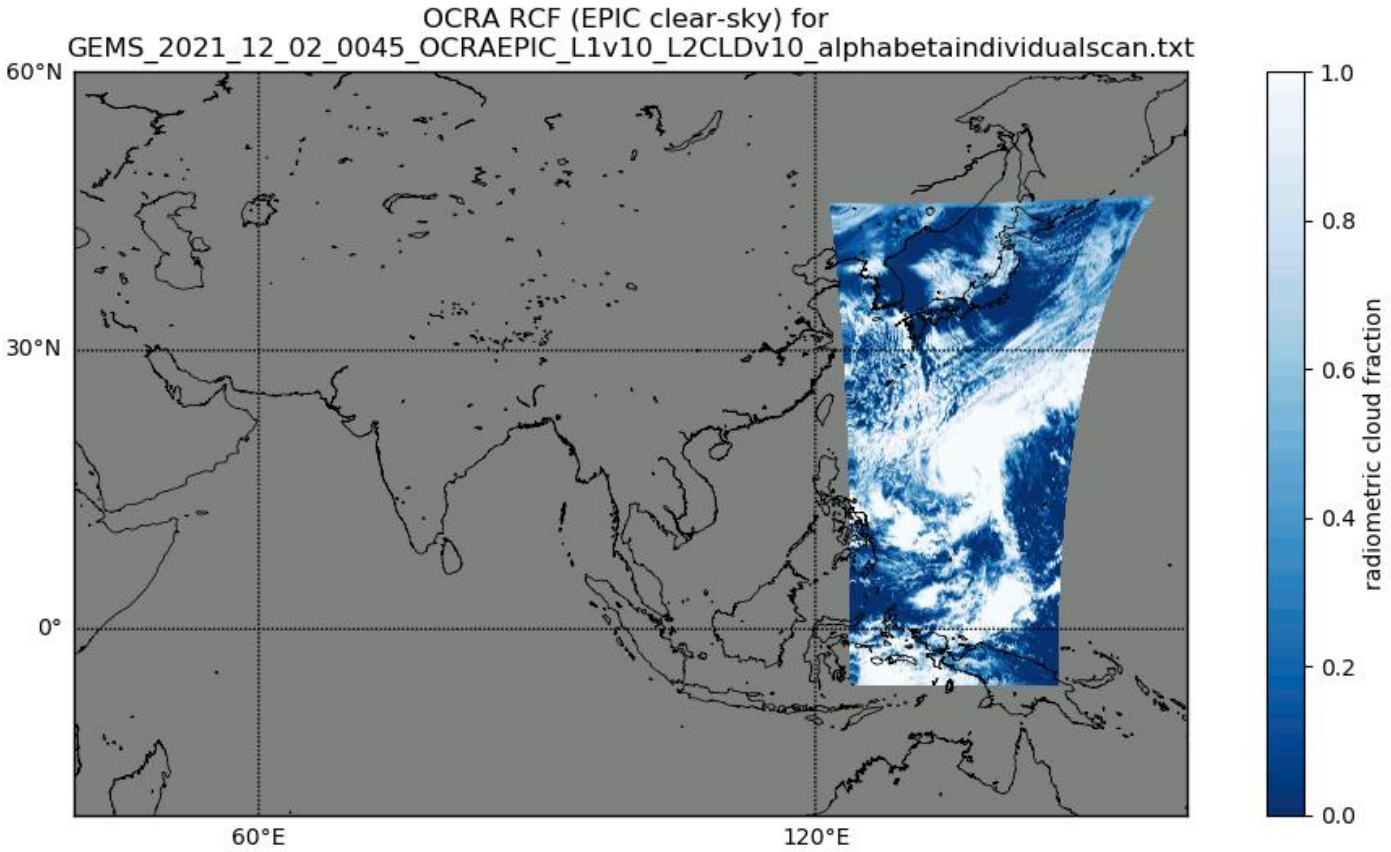
– GEMS: slight overestimation at very large SZA/VZA



– OCRA: no overestimation at very large SZA/VZA after VZA correction

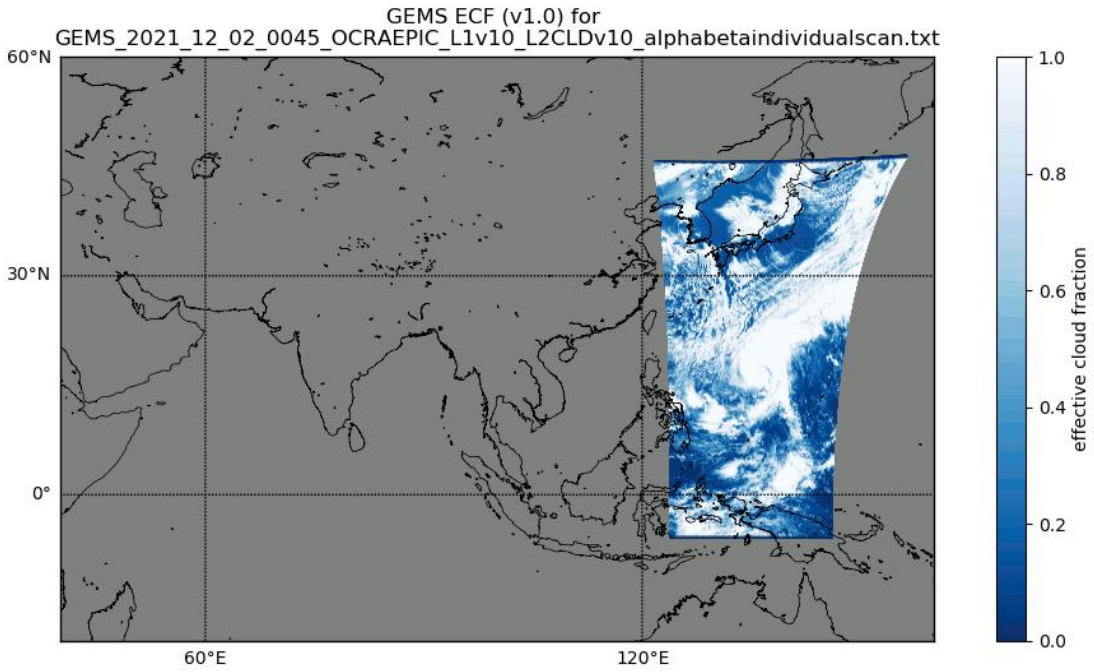
OCRA adaptation to GEMS

2021-12-02

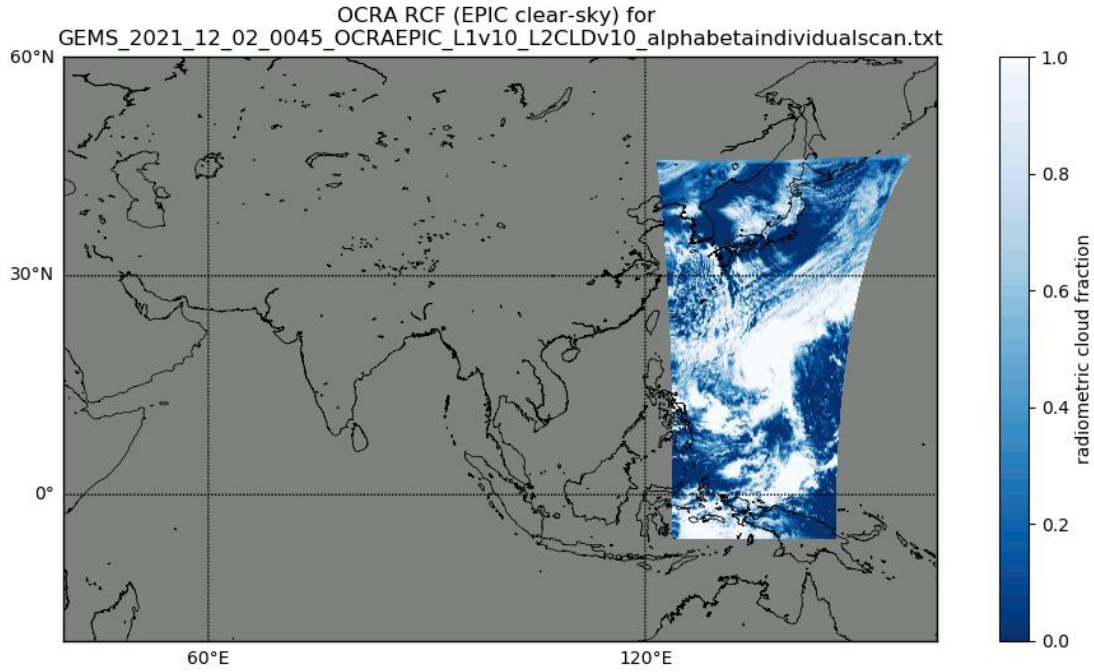


Intercomparisons of cloud fraction – GEMS L2 versus OCRA application

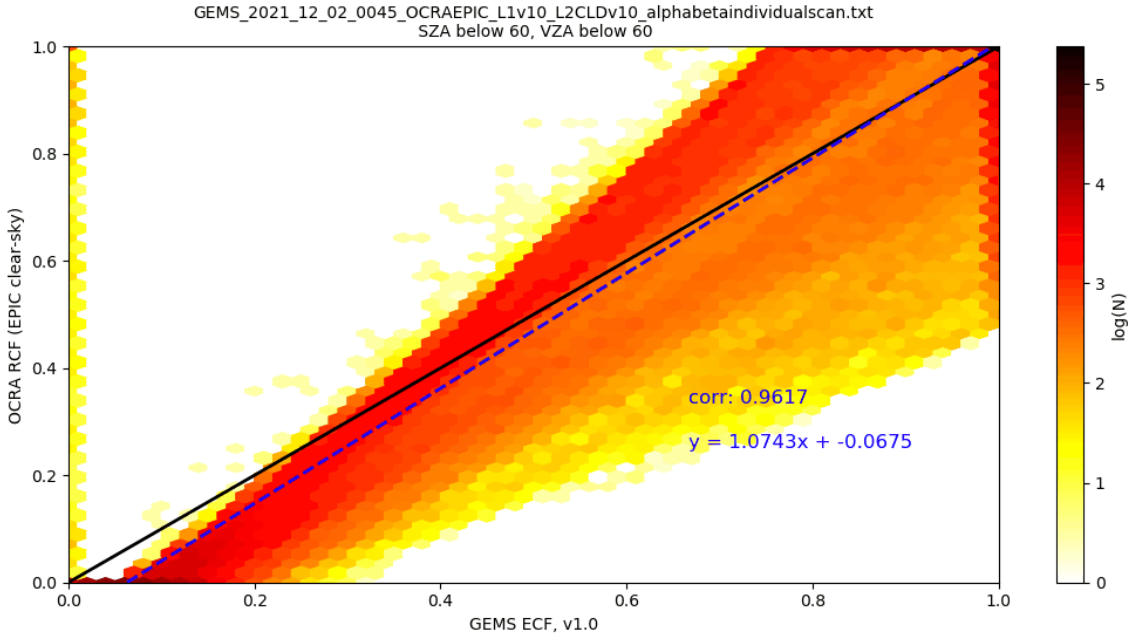
GEMS L2 Cloud product

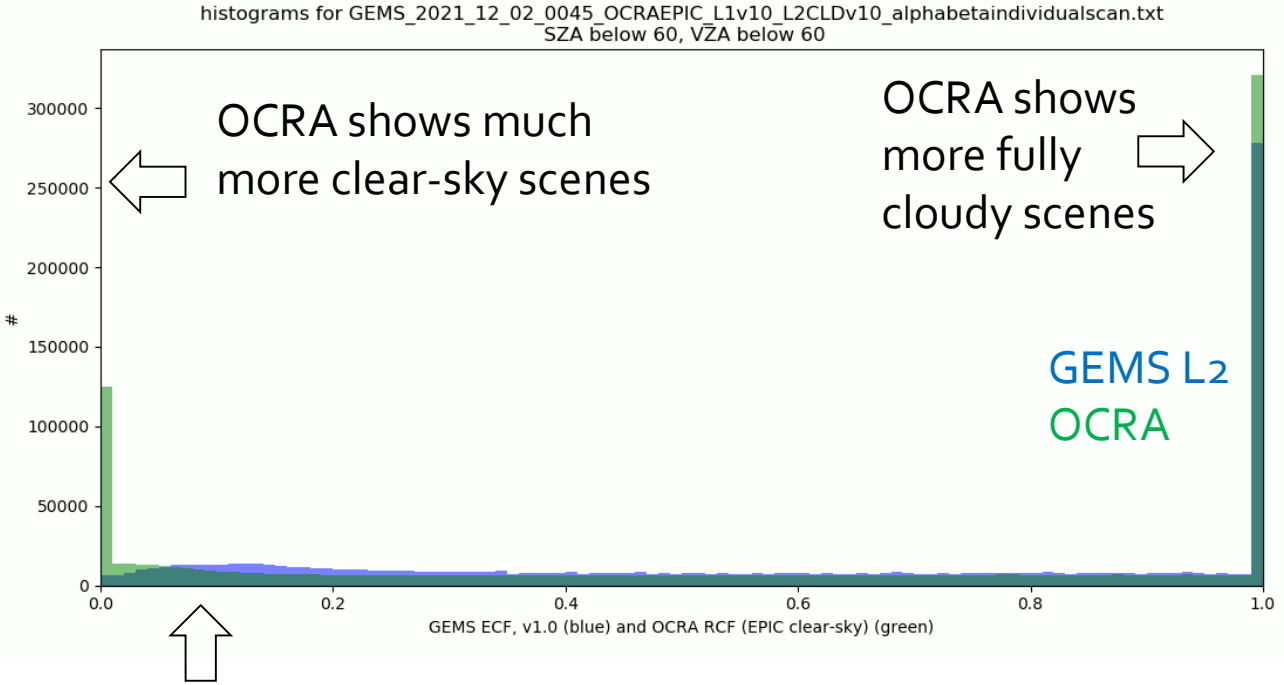


OCRA adapted to GEMS L1



Intercomparisons of cloud fraction – GEMS L2 versus OCRA application





- correlation coefficients for all scans are >0.96

GEMS L2 shows very few clear scenes, but a pronounced peak around 0.1

2021-12-02	00:45	01:45	02:45	03:45	04:45	05:45
correlation	0.962	0.961	0.977	0.974	0.964	0.974
mean difference	0.02	0.00	0.04	0.01	-0.05	-0.01

Conclusion and Outlook

Conclusion

- OCRA/ROCINN has been successfully implemented for several **LEO** missions in an **operational environment**
- Application of OCRA to the **geostationary** GEMS instrument looks very promising
- Comparisons with the official GEMS L2 cloud fraction product look good
- OCRA/ROCINN is ready to be used **operationally for the geostationary Sentinel-4**

Outlook

- OCRA/ROCINN long-term cloud data records are already available for **GOME, SCIAMACHY, GOME-2**
- These data-sets are being continued with **Sentinel-5P** and, in the future, will be extended with **Sentinel-4**

Thank you for your attention!

DLR-Atmos:
https://atmos.eoc.dlr.de/calendar

Interested in quicklooks and L3 data?
Check the INPULS project:
https://atmos.eoc.dlr.de/inpuls/