S5P and GEMS OCRA cloud fraction comparisons with the GEMS L2 cloud product

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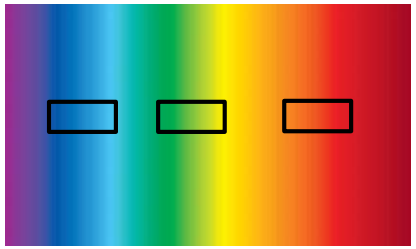
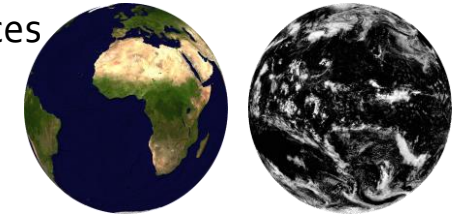
OCRA cloud fraction retrieval – Basic Idea

OCRA
Optical Cloud Recognition Algorithm



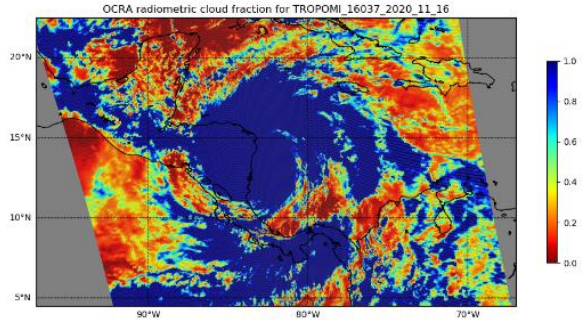
map broad band reflectances to RGB color space



Split a measured scene into a clear-sky background and a contribution by clouds

define lower and upper thresholds

Radiometric cloud fraction

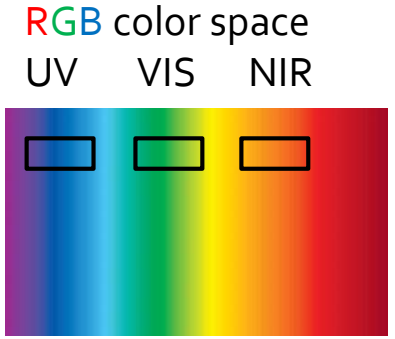


OCRA is used operationally for GOME-2 and Sentinel-5P and will be used operationally for Sentinel-4

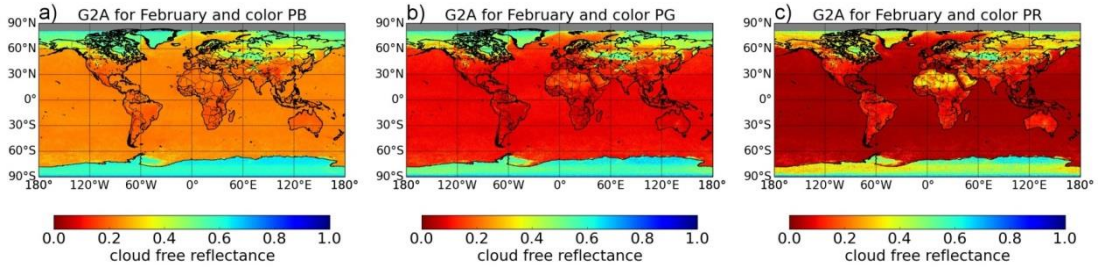
Hurricane Iota
©NASA worldview

OCRA cloud fraction retrieval – Overview

- map measured reflectances to RGB color space

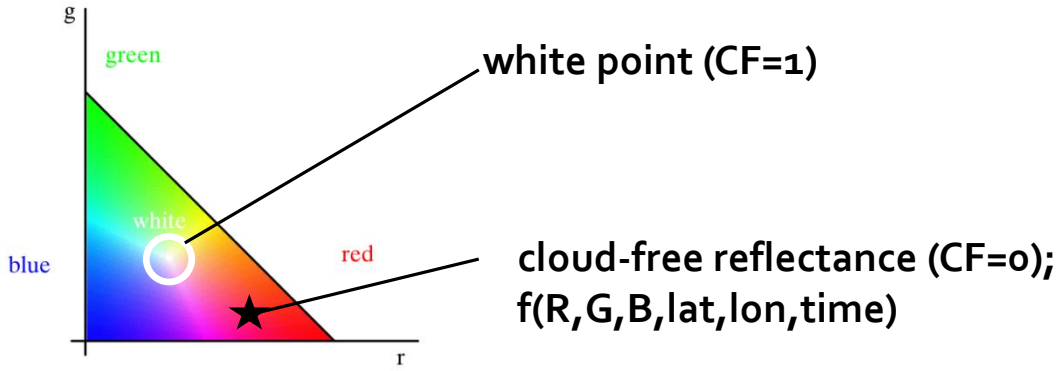


- generate cloud-free reflectance composite maps
  - monthly resolution
  - based on several years of data



- assume a cloud to be „white" in RGB
  - white point defines fully cloudy condition (CF=1)

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



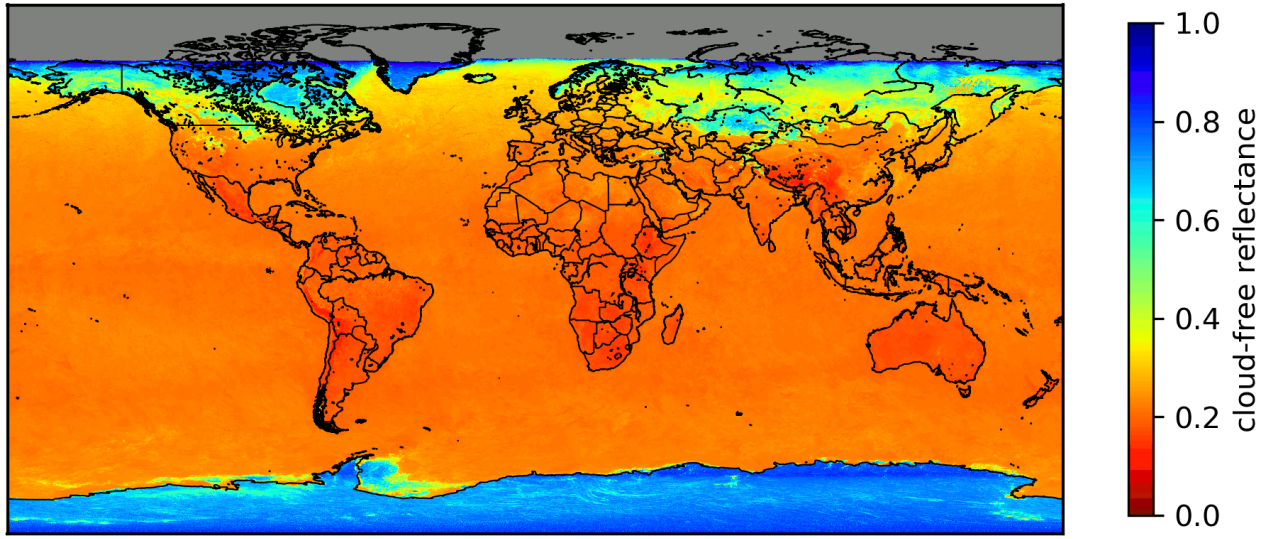
Lutz et al. (2016): OCRA radiometric cloud fractions for GOME-2 on MetOp-A/B, Atmos. Meas. Tech., 9, 2357-2379, https://doi.org/10.5194/amt-9-2357-2016

OCRA – clear-sky composite maps

- OCRA clear-sky maps based on 3 years of **TROPOMI** data (including L1 degradation correction)

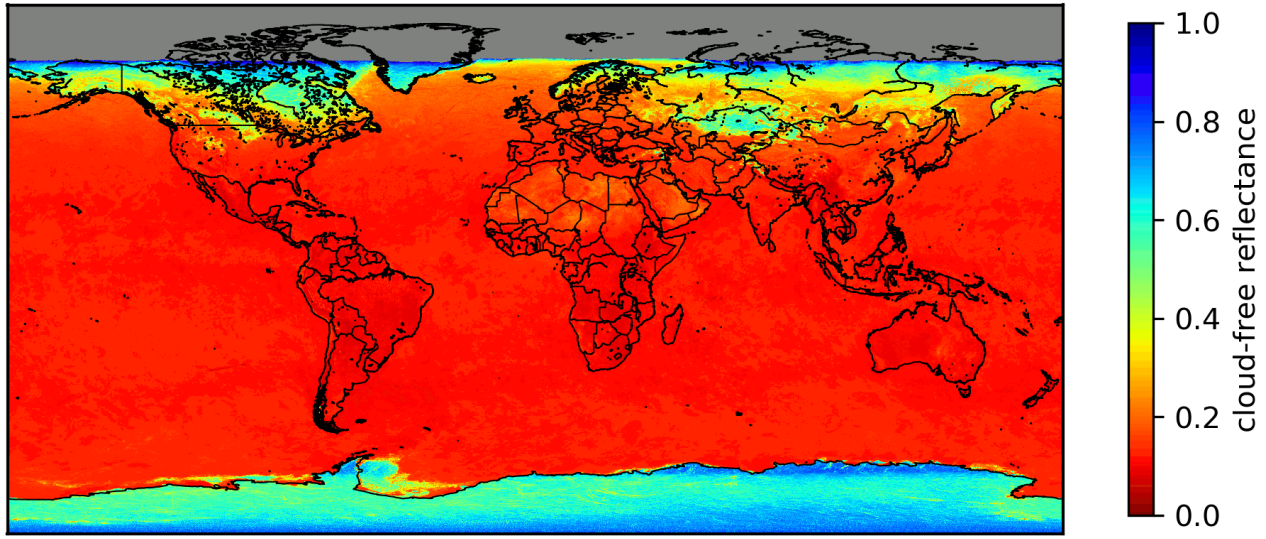
  → the „cleaner" the maps, the better the cloud fraction retrieval, particularly at low cloud coverages

TROPOMI_01_monthly_cloudfree_res02x02deg_3years_mincol_B.txt



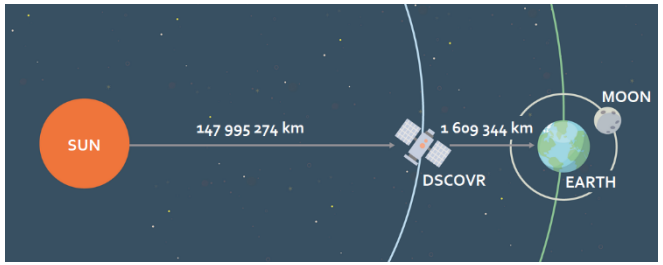
OCRA blue channel

TROPOMI_01_monthly_cloudfree_res02x02deg_3years_mincol_G.txt



OCRA green channel

OCRA – clear-sky composite maps



- OCRA clear-sky maps based on >3 years of **EPIC** data (channels 388, 551, 780 nm), +/- 14 days aggregate, 0.2 degree

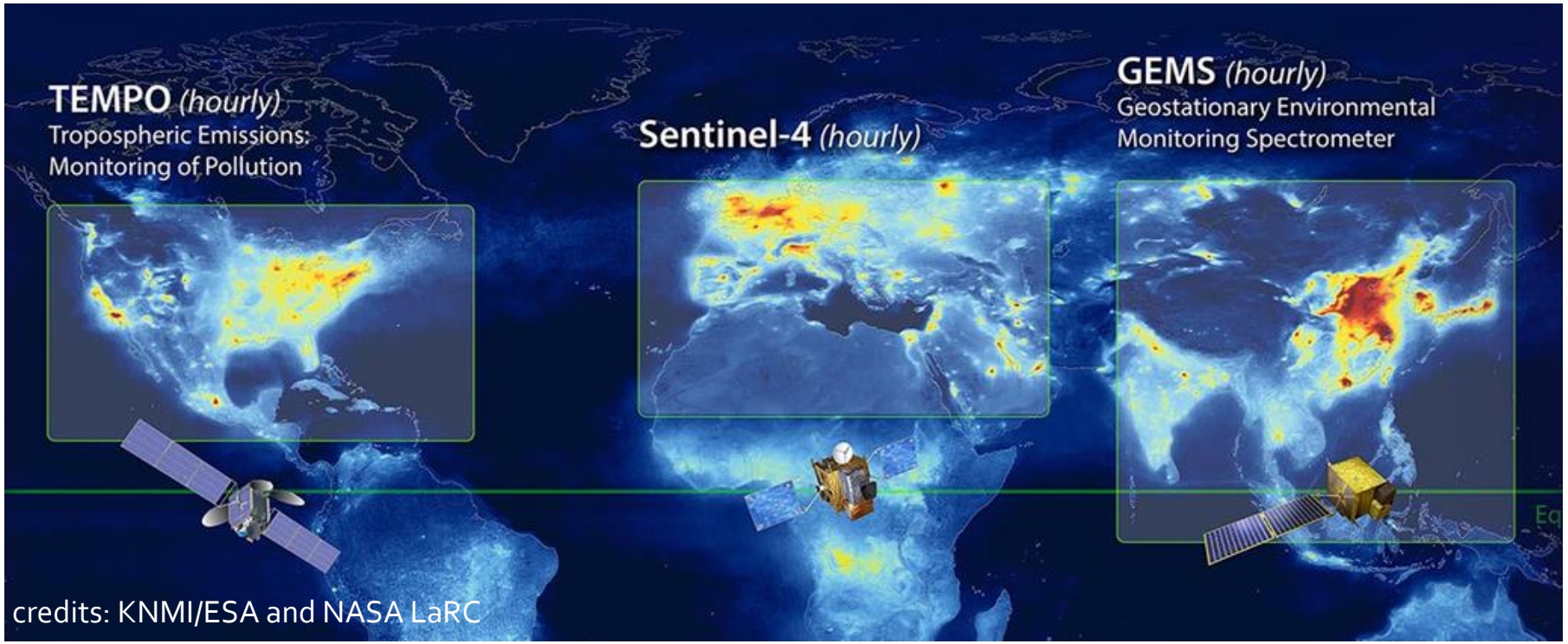
  → the „cleaner" the maps, the better the cloud fraction retrieval, particularly at low cloud coverages

DLR

OCRA application to GEMS

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

–To prepare our algorithms for Sentinel-4, we apply OCRA to GEMS L1 data



OCRA application to GEMS

– GEMS L1 data provided in the framework of the GEMS VT activities

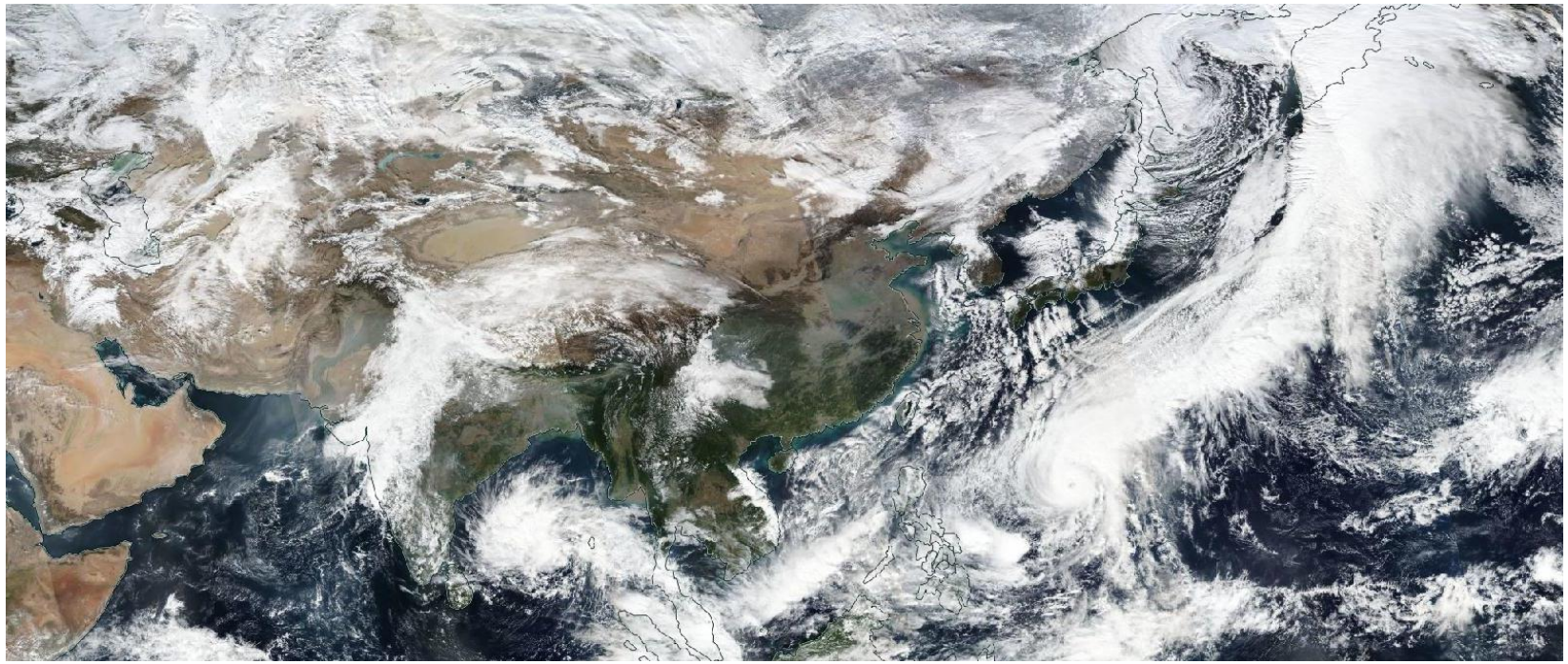
– GEMS L1 version 1.0 is used (both for RAD and IRR)

– Test day: 2 December 2021 (six scans from 00:45 – 05:45 UT)

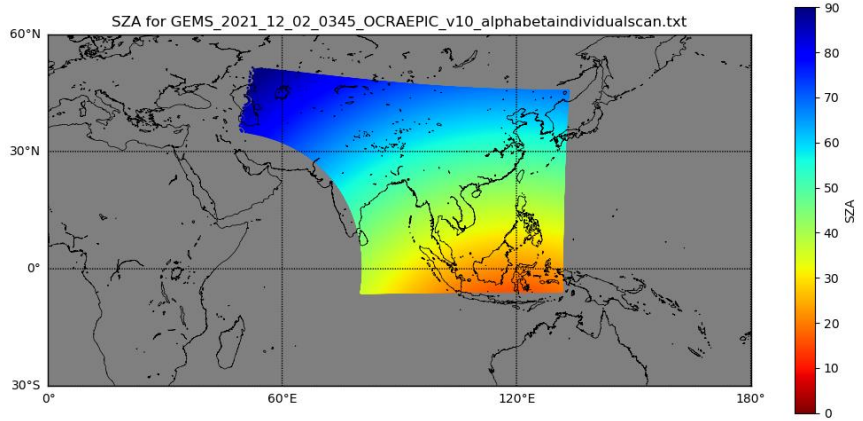
– Clear-sky maps from EPIC are used (with hourly temporal resolution to cover the diurnal cycle)

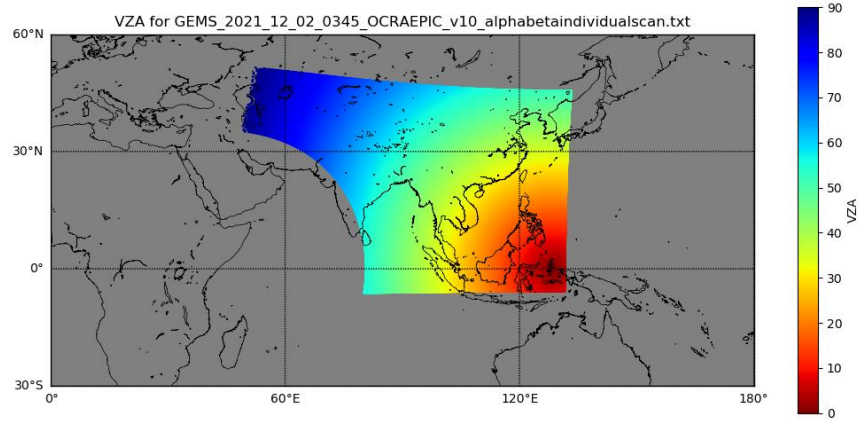
OCRA application to GEMS

– VIIRS RGB of the scene considered:



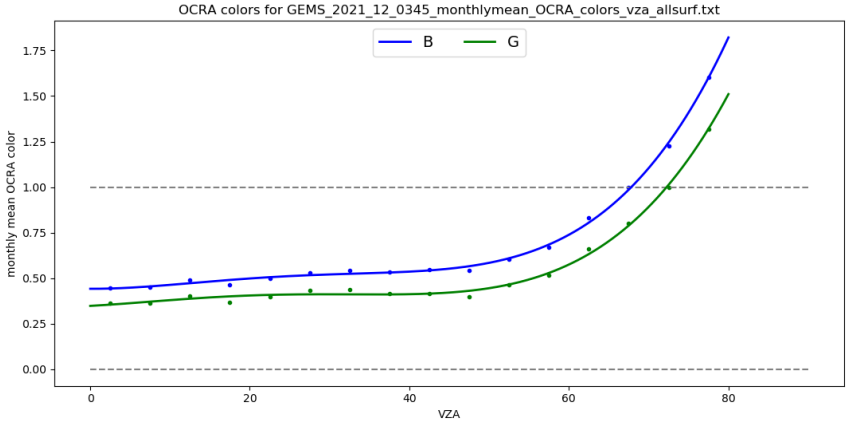
– GEMS viewing conditions:

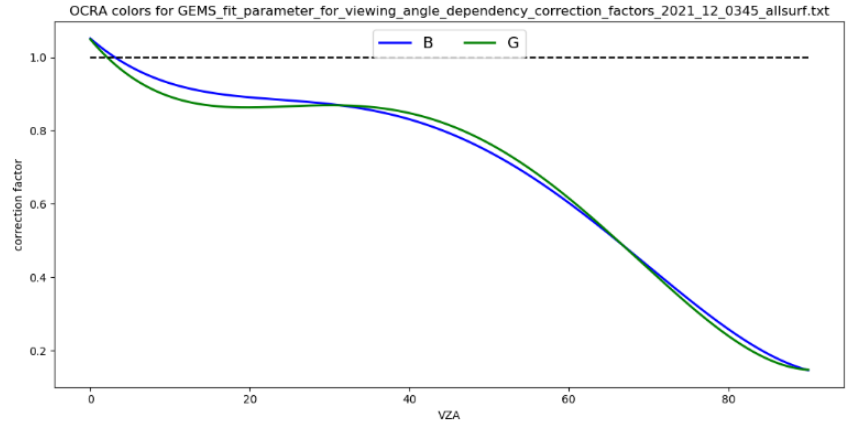


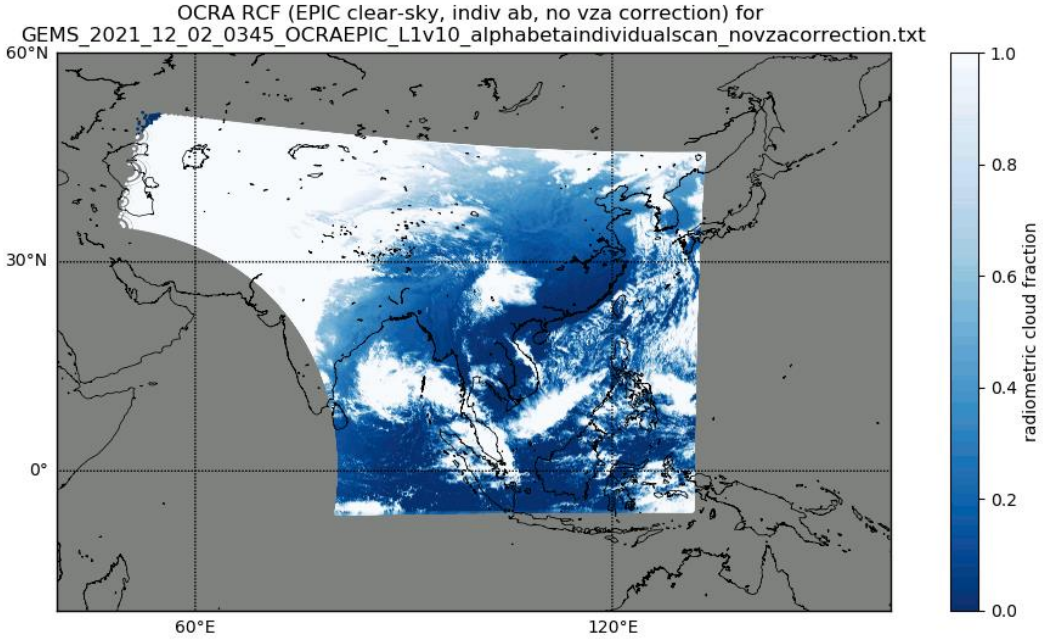


OCRA application to GEMS

– VZA correction based on GEMS data from December 2021

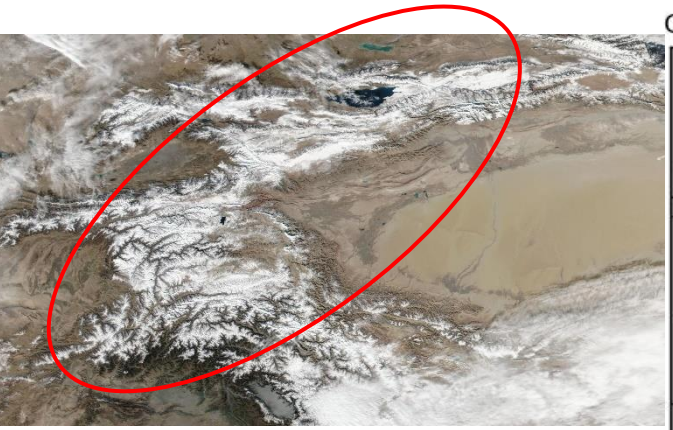




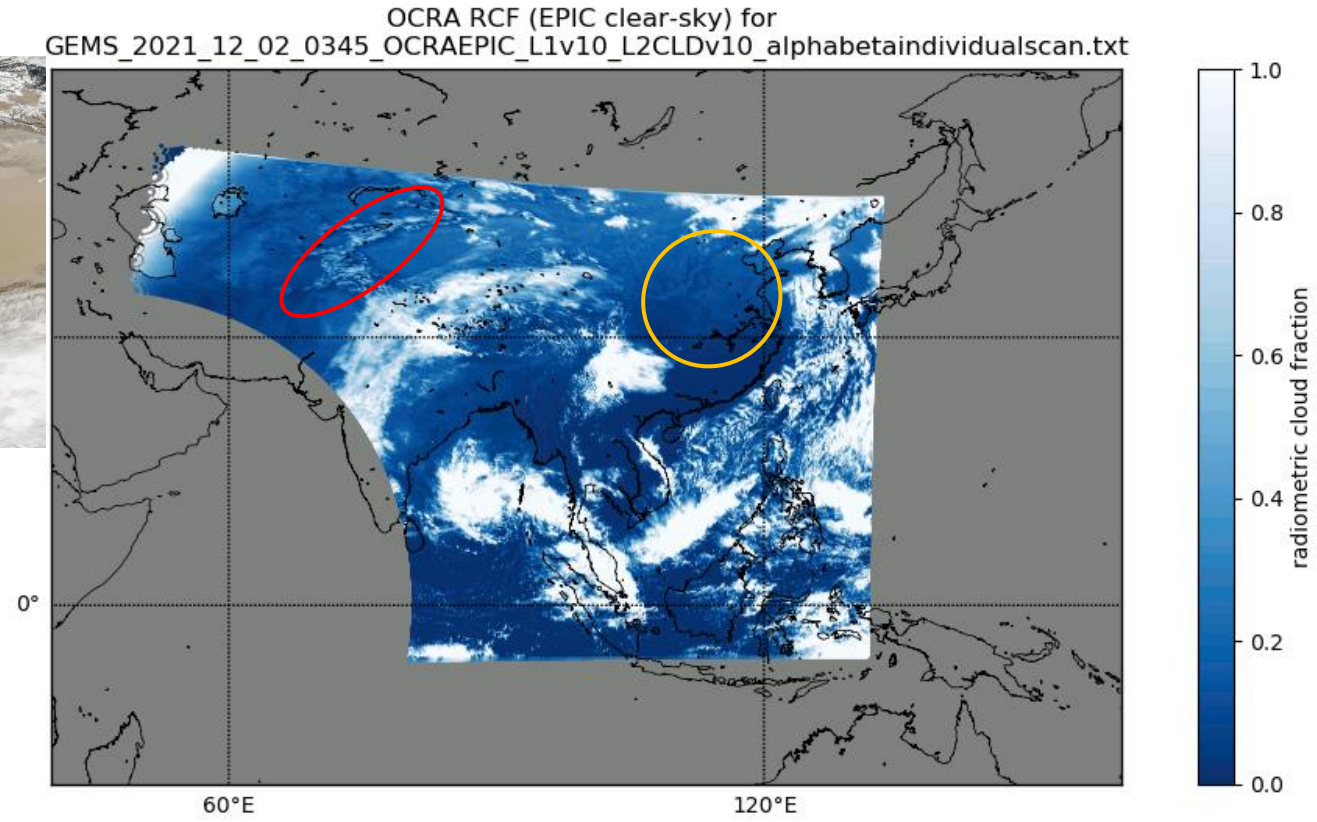


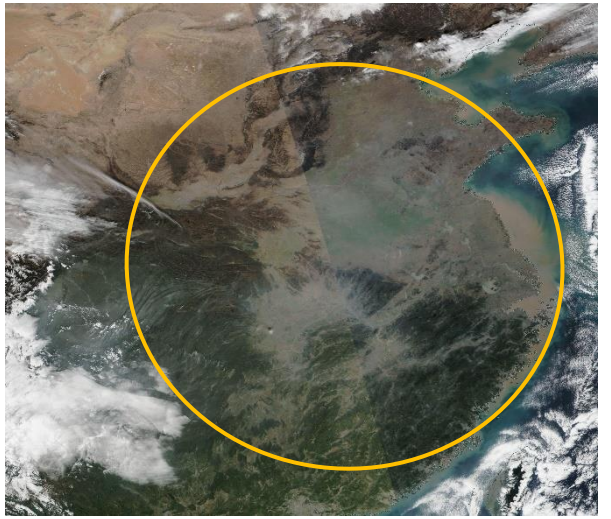
OCRA application to GEMS

– comparison of OCRA with the official GEMS L2 cloud product **version 1.0** (2021-12-02, 03:45)

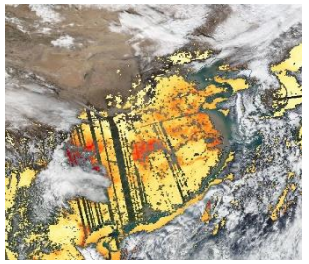


– clear-sky over snow/ice covered mountains



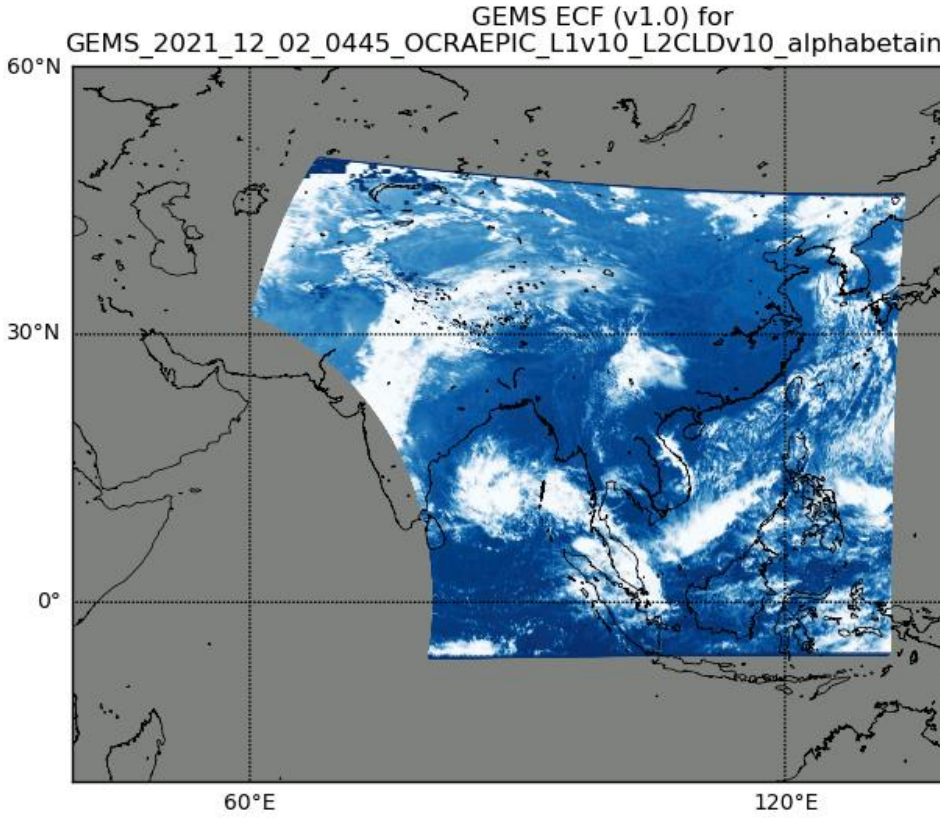


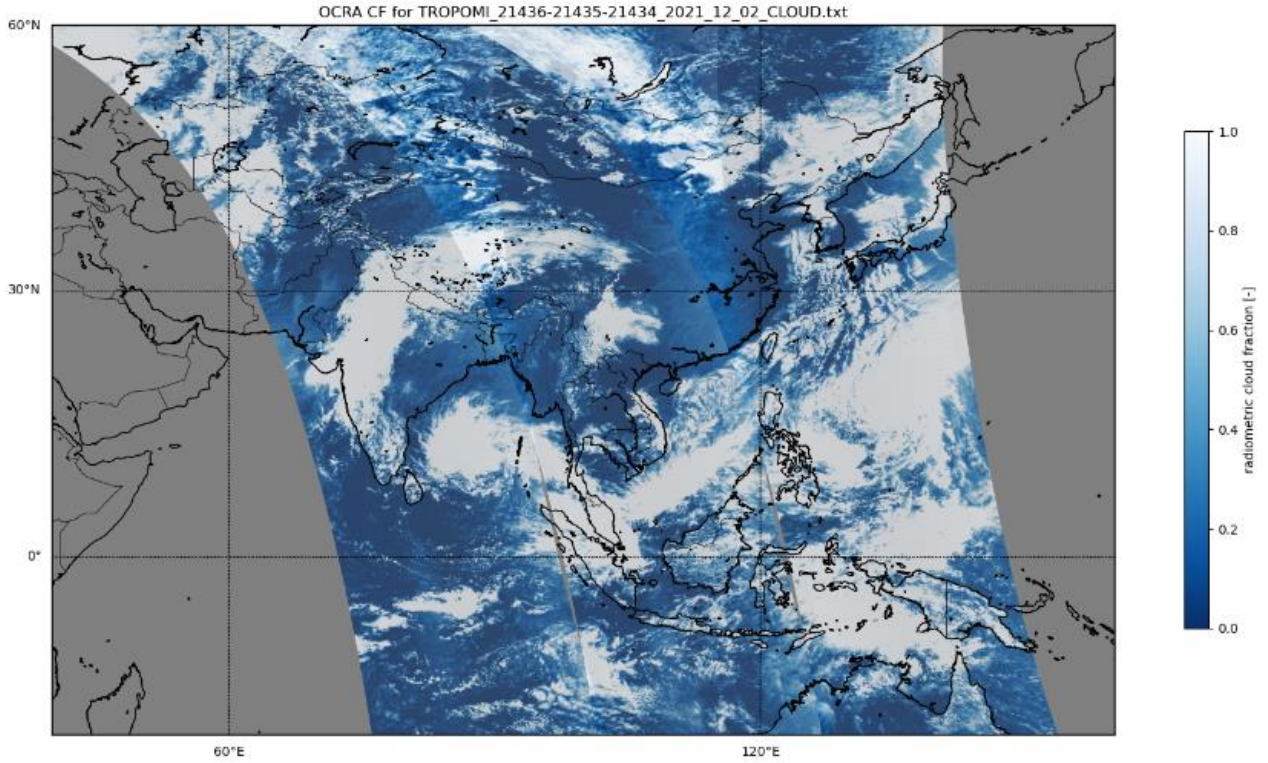
– enhanced backround due to aerosols?



OCRA application to GEMS

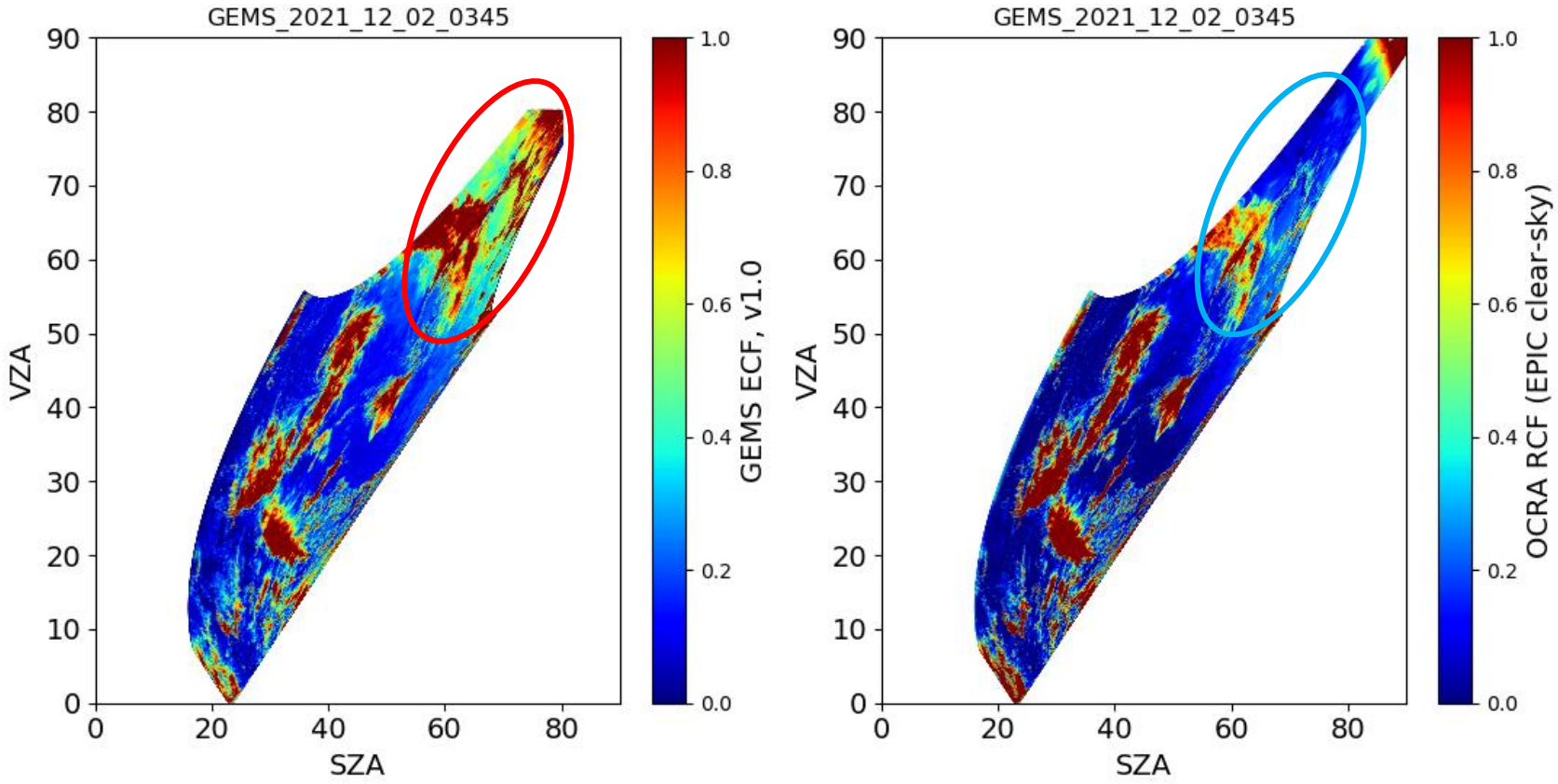
– comparison with TROPOMI orbits 21434 (-25min), 21435 (+75min) and 21436 (+175min)





OCRA application to GEMS

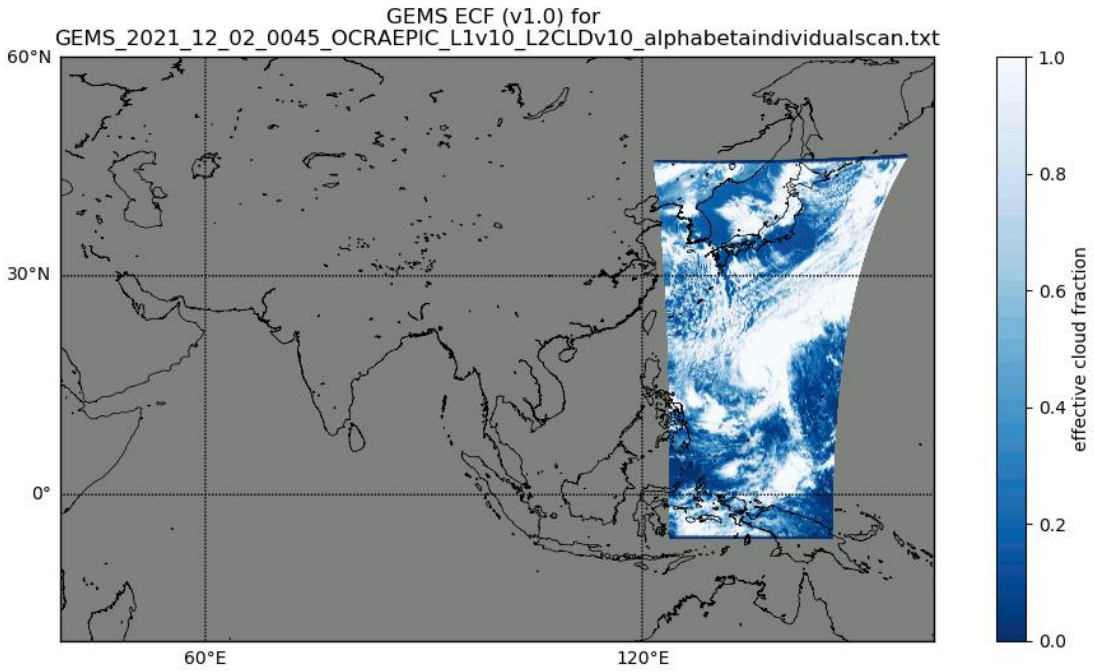
– GEMS: slight overestimation at very large SZA/VZA



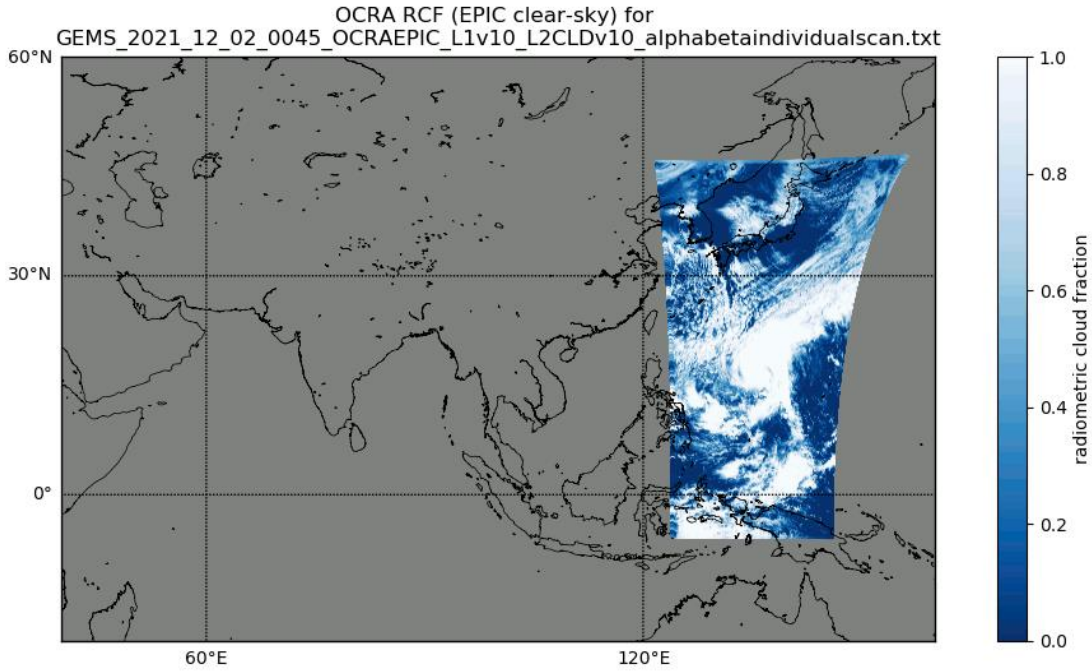
– OCRA: less overestimation at very large SZA/VZA after VZA correction

Intercomparisons of cloud fraction – GEMS L2 versus OCRA application

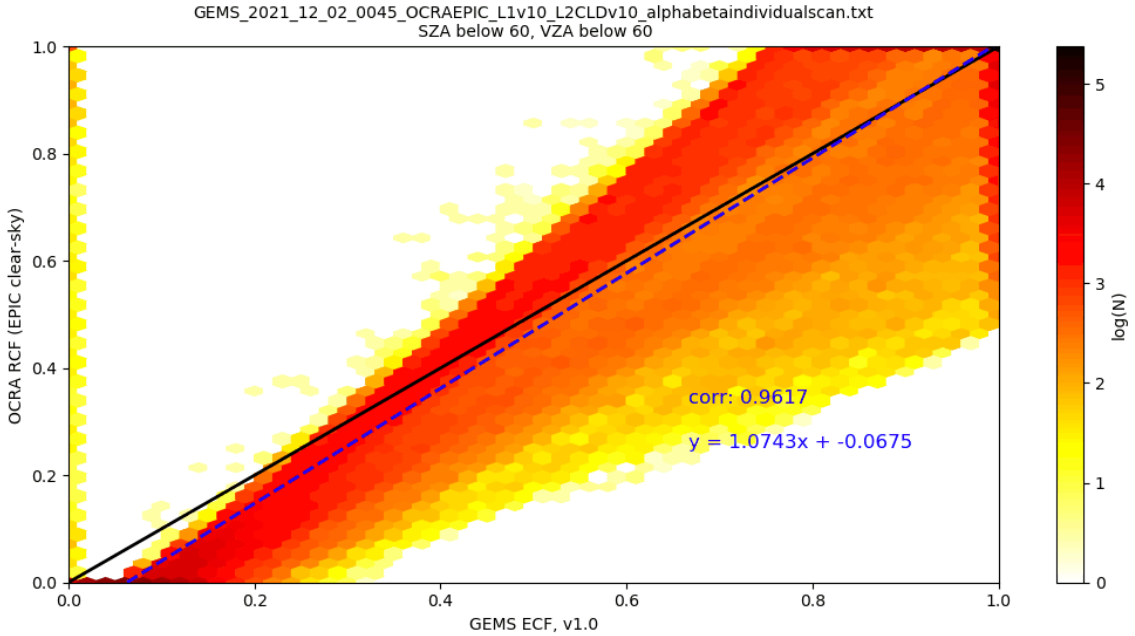
GEMS L2 Cloud product (version 1.0)

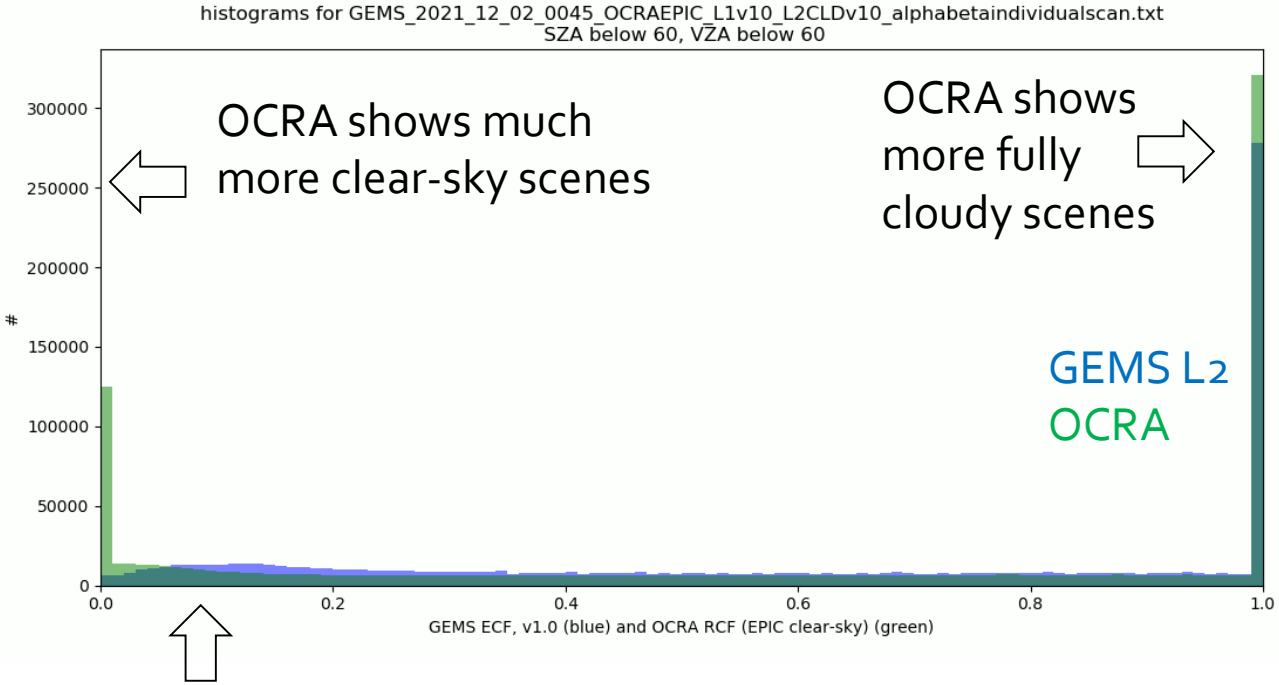


OCRA adapted to GEMS L1



Intercomparisons of cloud fraction – GEMS L2 versus OCRA application



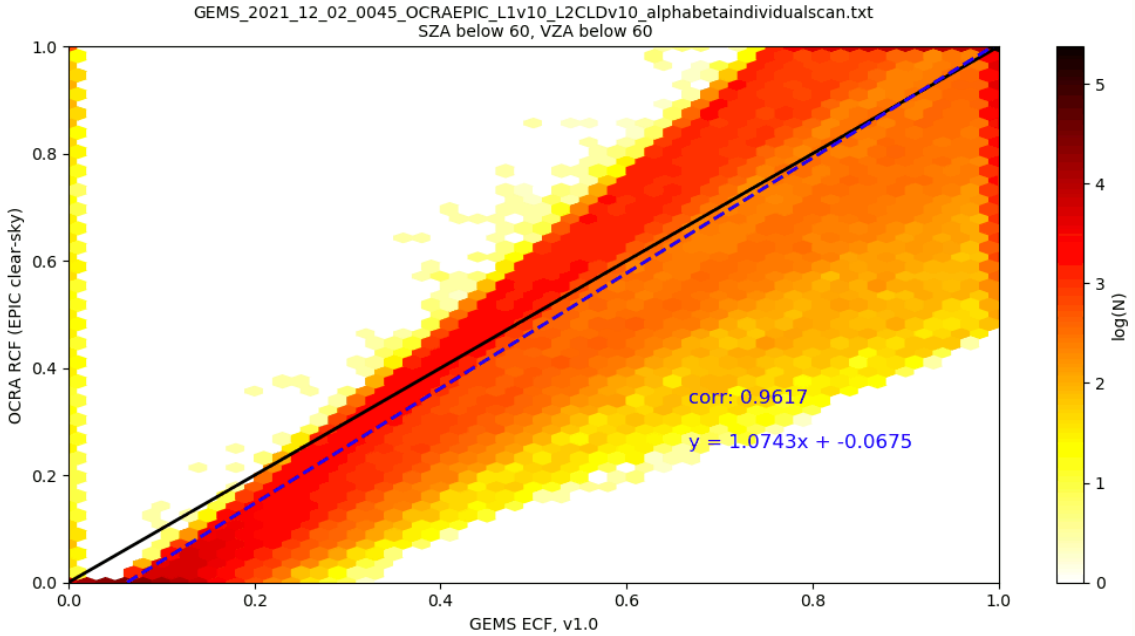


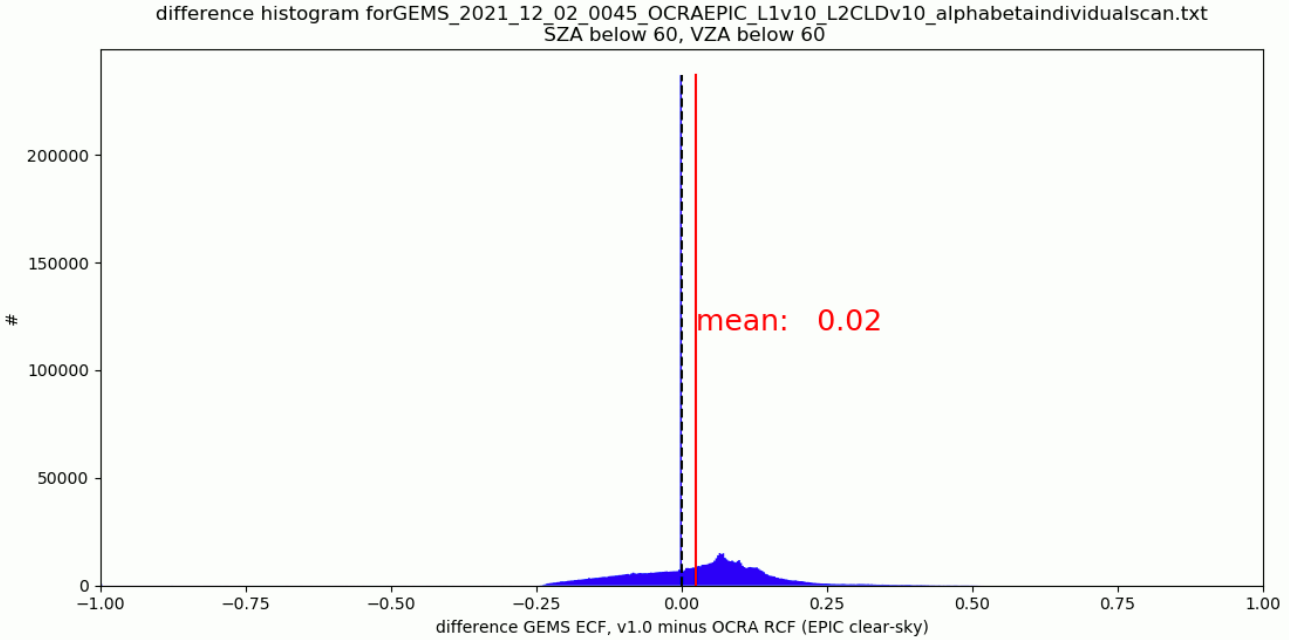
- correlation coefficients for all scans are >0.96

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

Intercomparisons of cloud fraction – GEMS L2 versus OCRA application



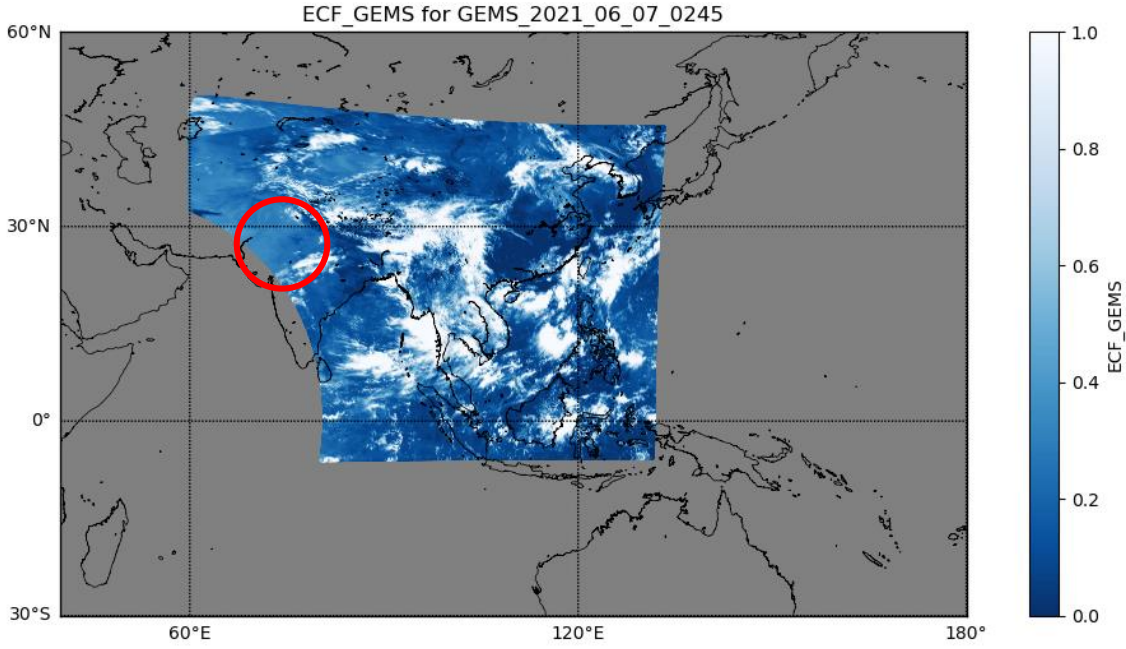


- correlation coefficients for all scans are >0.96

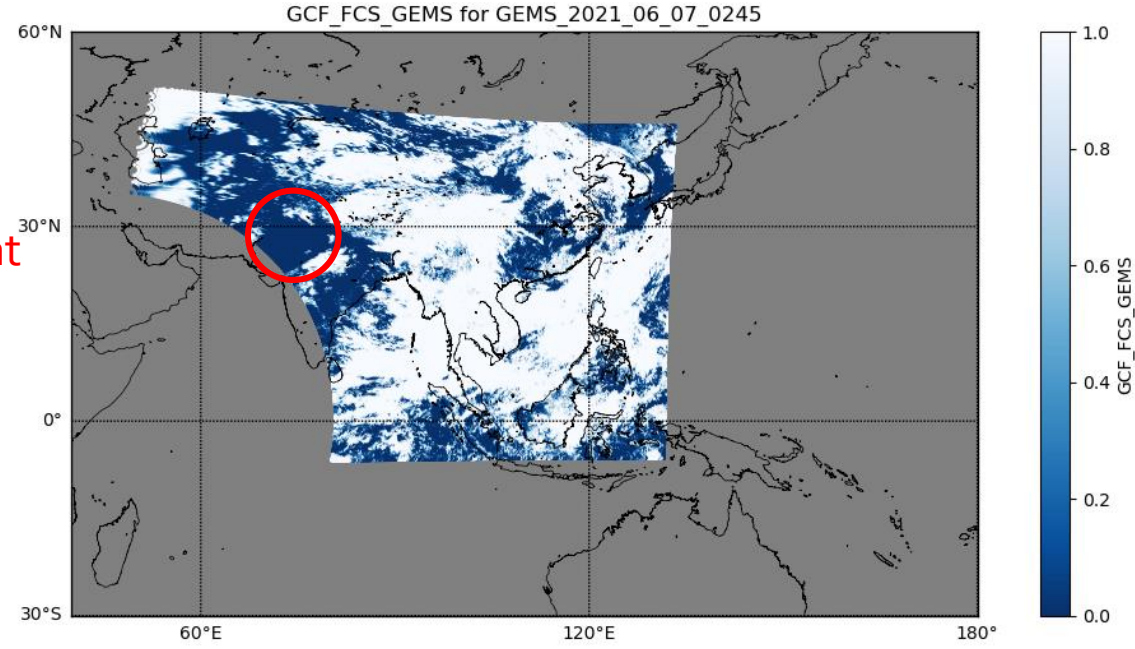
Distribution of differences shows some diurnal variation

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

Intercomparisons with cloud fraction from AMI (based on cloud masks)



CF over-estimation at clear-sky scenes



GEMS L2 effective cloud fraction

Regridded AMI product from RAL (based on S4 FCS processor) from three masks:

- Cloud-filled
- Cloud-contaminated
- Cloud-free

Conclusion and Outlook

Conclusion

- OCRA cloud fraction retrieval is highly flexible and can be adapted to different instruments
- VZA dependency correction reduces overestimation at extreme geometries
- Comparison with GEMS L2 cloud product is overall very good and shows promising results
- Differences appear over bright surfaces (snow/ice), at large geometries and at low cloud coverages

Outlook

- Extend the comparisons to include cloud information from the AMI imager (on GK2A)
- Extend the comparisons to the cloud pressure and cloud height

Thank you for your attention!

Interested in TROPOMI quicklooks?

Check the DLR-Atmos website:

https://atmos.eoc.dlr.de/calendar

Interested in TROPOMI animations?

Check the INPULS project:

https://atmos.eoc.dlr.de/inputs/

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