GEO-Ring – Progress, next steps and future opportunities

Presented to CGMS-53 plenary session, agenda item 4

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Executive summary of the WP

CGMS agencies EUMETSAT and NOAA undertake a bilateral activity to reconstruct radiance measurements into a Fundamental Data Record (FDR) from all historical measurements from imagers in geostationary orbit that form the Geostationary Ring or short GEO-Ring. The activity is supported by data and knowledge about them provided by JMA. IMD has started to provide INSAT data prior 1998, which are being analysed by EUMETSAT for inclusion into the GEO-Ring.

The envisioned resulting climatology will initially be served with 30-minute temporal and equal angle 0.05° spatial grid in NetCDF format, being enriched by an HEALPix equal area grid in Zarr format supporting AI/ML applications

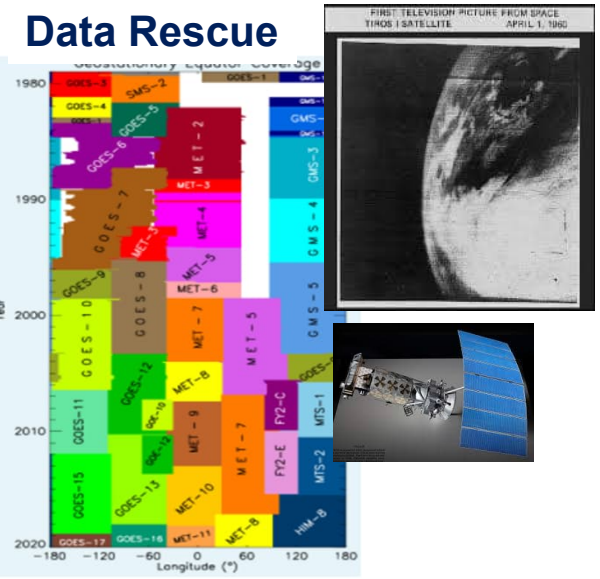
The data coverage starts in the mid-1970s and extends to today's much more advanced measurements spanning 50 years' worth of data. The FDR enables the creation of a large amount of quasi-global atmospheric, oceanic and terrestrial geophysical data records and has also good potential of being used in NWP model-based reanalyses.

The presentation provides a status update on the data rescue activities, test data and increasing planned usage including by CGMS Working Groups ICWG and IPWG and further usage potential. The presentation also includes information on the usage of cloud infrastructure and remaining open points on data policy.

CGMS agencies are invited to contribute to this activity and to its possible extensions such as addition of imager data from polar orbiting satellites and atmospheric sounding instruments in the future.

The path towards GEO-Ring radiances

Data Rescue



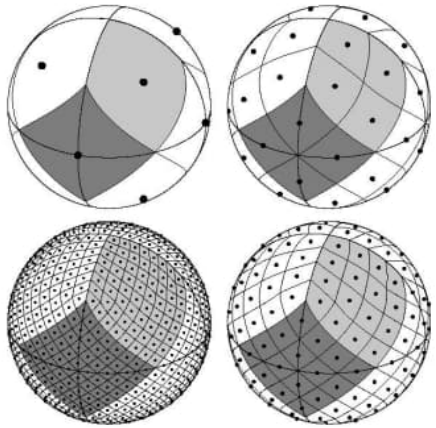
Quality Control

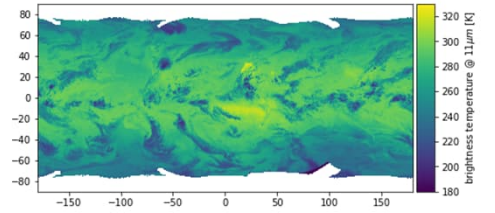
Re- and Cross Calibration

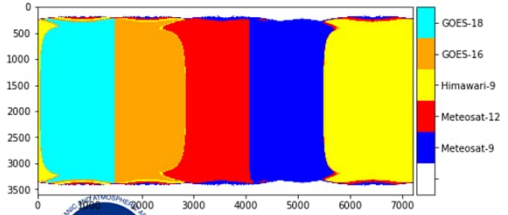
Validation

Evaluation

Product Generation







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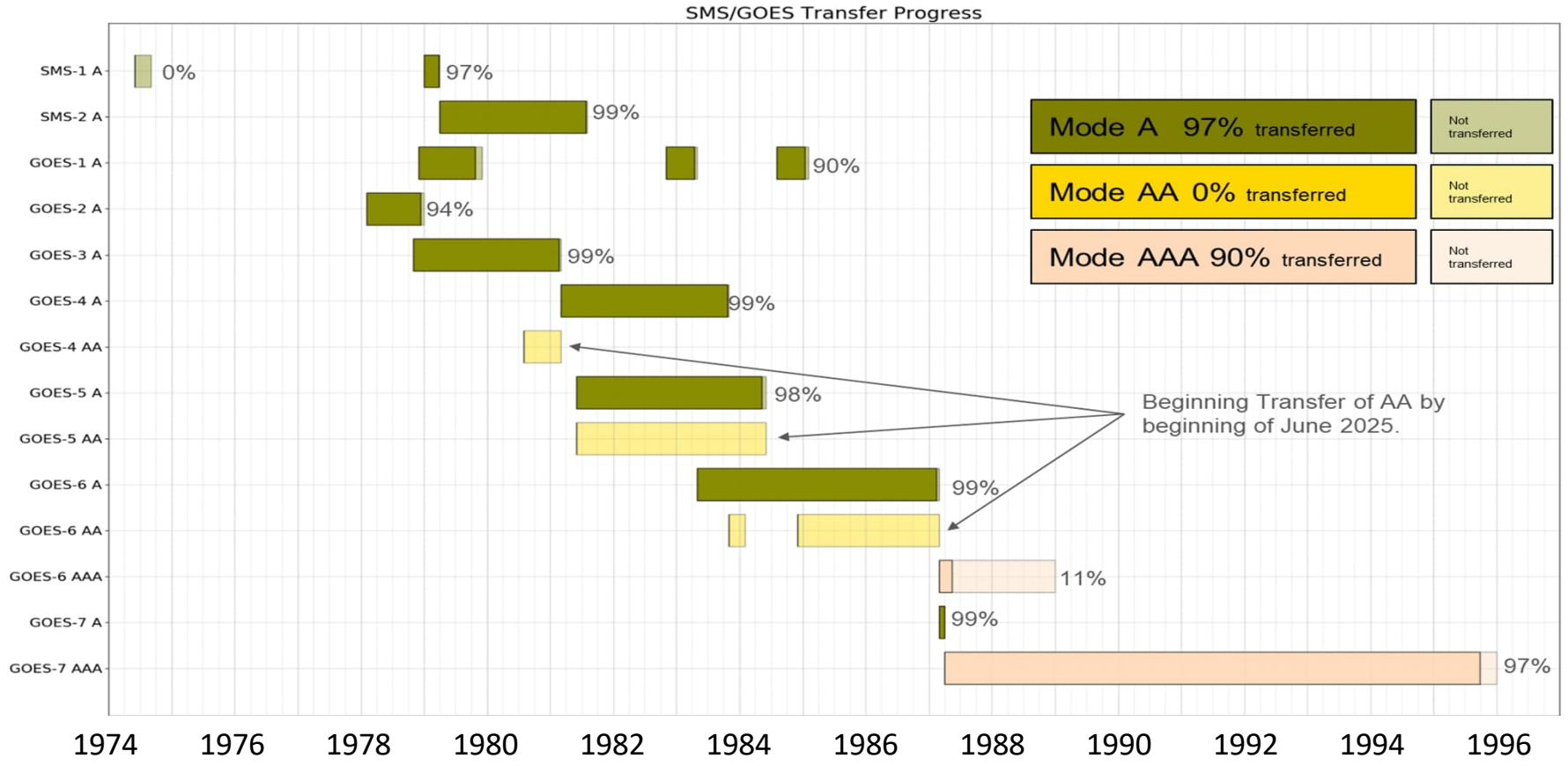
Current status

- Data rescue is progressing at NOAA for pre-GVAR (SMS-1/2 and GOES 1-7) era, EUMETSAT is fetching rescued data from NOAA cloud as they arrive
- Quality control of pre-GVAR data is progressing at EUMETSAT, algorithms and tools for this will be ready by end of this year
- Infrared channel calibration developed for Meteosat data is already extended to Himawari data and is being implemented for GOES data
- NOAA has analysed different calibration algorithms available for visible channels, tests supporting a decision of the selection of algorithm is ongoing
- INSAT data prior 1998 from IMD are being analysed at EUMETSAT to check the feasibility of its inclusion into GEO-Ring data record prior to the move Meteosat-5 over Indian Ocean in 1998
- A test dataset for the last six years (2019-2024) is being prepared, processing chain for generating this dataset being set up in EUMETSAT cloud (EWC). Data set will be provided with 30 minutes sampling on Lat/Lon grid in NetCDF format and on HEALPix equal area grid in Zarr format supporting use in AI/ML applications
- EUMETSAT plans a product feedback workshop in 2026

Data Rescue of Early US data



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Filling gaps over the Indian Ocean with INSAT data

- Received small subset of INSAT-1A (1987, 1988, and 1990), INSAT-1B (few files for 1984, 1985, 1992), INSAT-1D (1992, 1993) from IMD
- 3 months of INSAT-1D data was specifically obtained for the end of 1998 (just the time when Meteosat-5 data IODC started) for comparison
- Quality analysis and feasible assessment of including to GEO-Ring is ongoing

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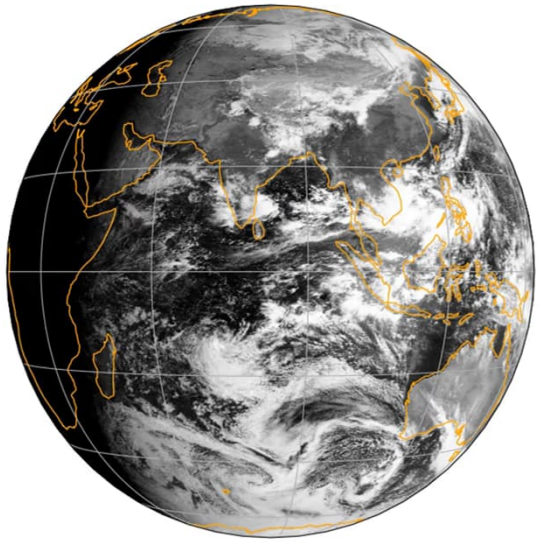

VIS channel, 2.75 km resolution

IR channel, 11 km resolution

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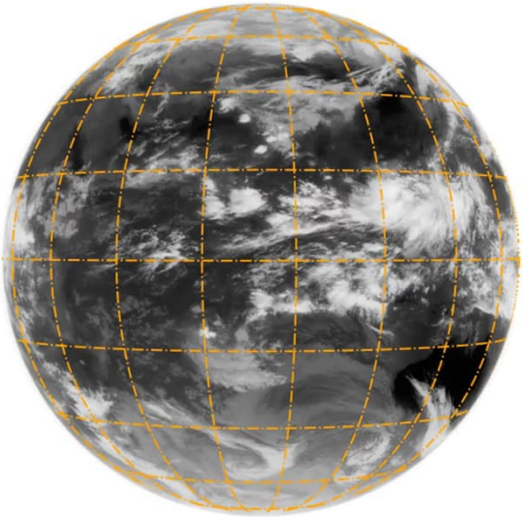

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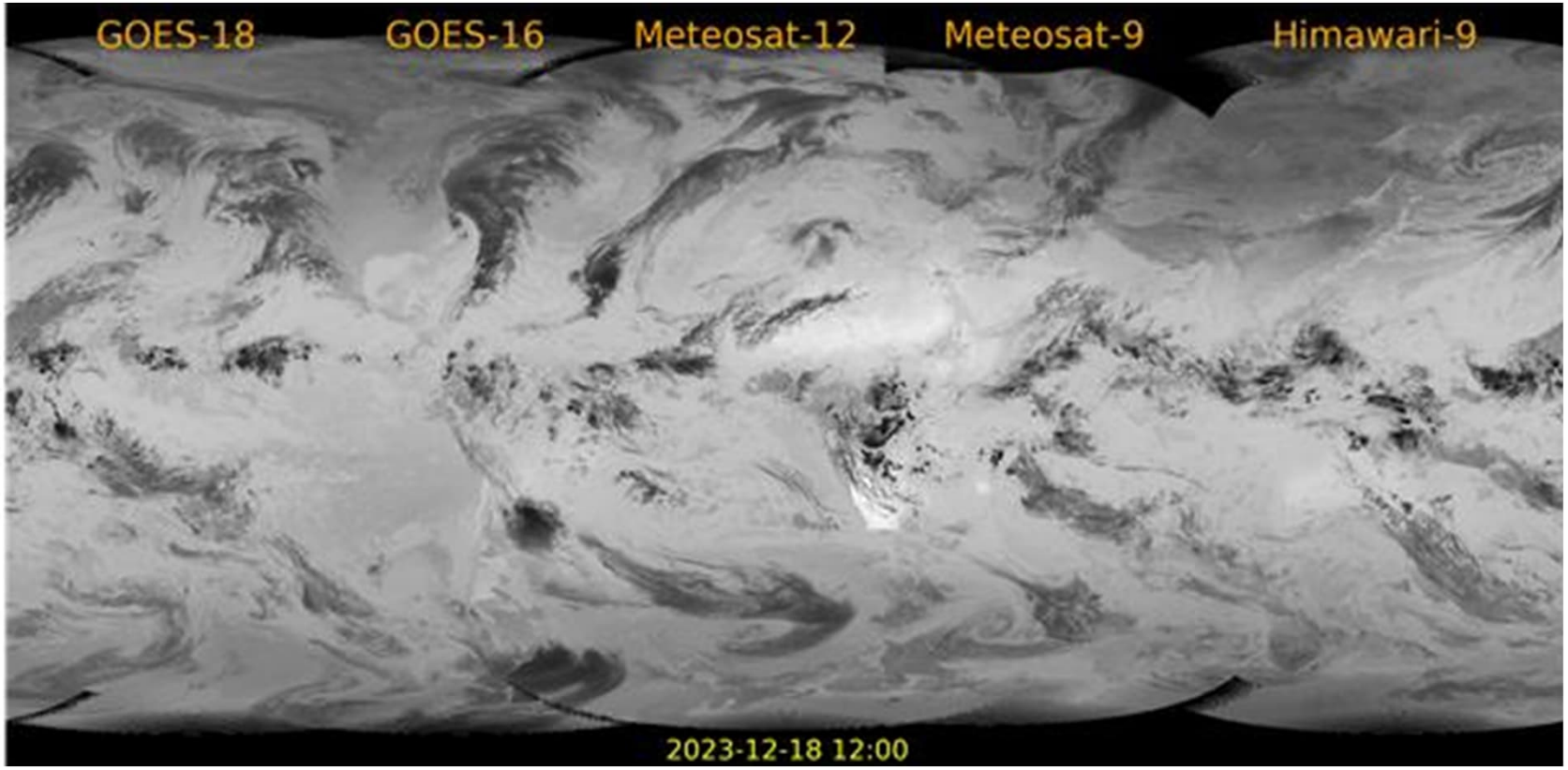
Test data is being prepared

Consistently quality controlled, recalibrated and remapped radiances – Test data (2019-2024) will be ready in Q4/2025



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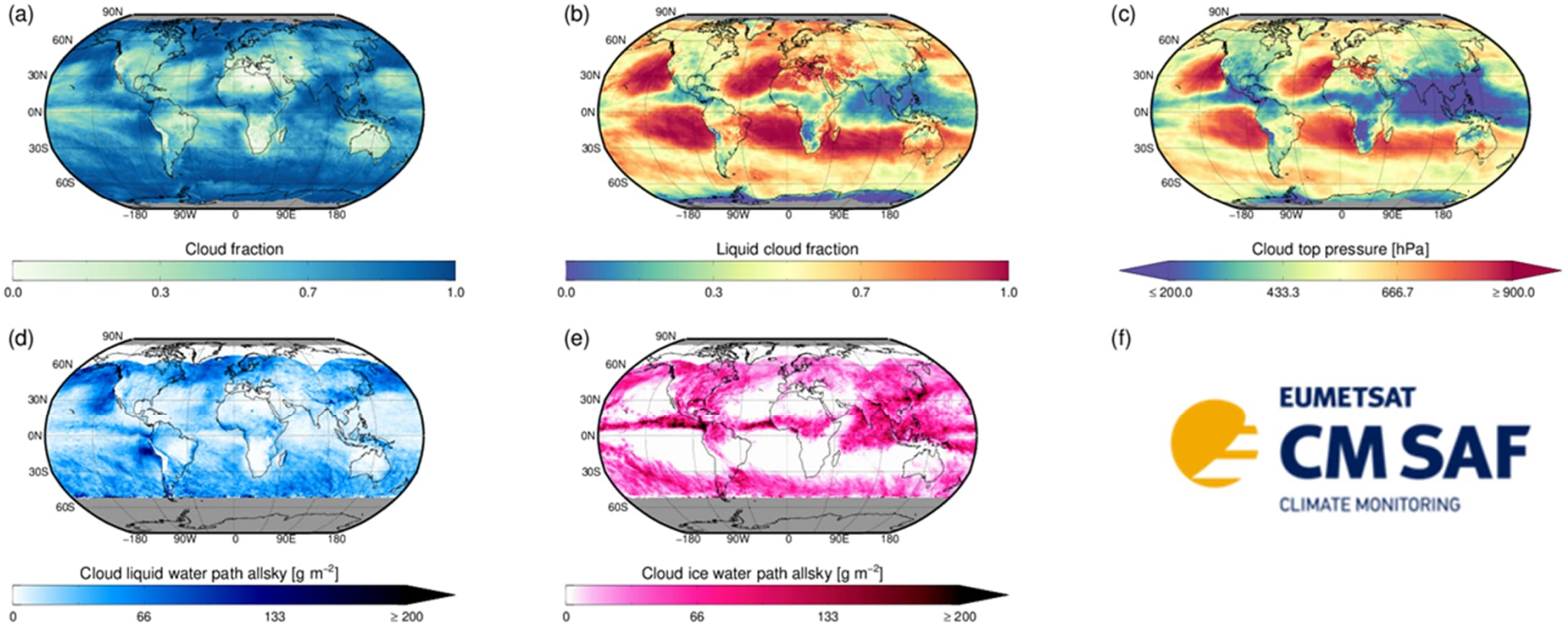
Prototyping ISCCP-NG cloud products for ICWG

CM SAF ISCCP-NG prototype monthly mean cloud properties for July 2020



EUMETSAT CM SAF CLIMATE MONITORING

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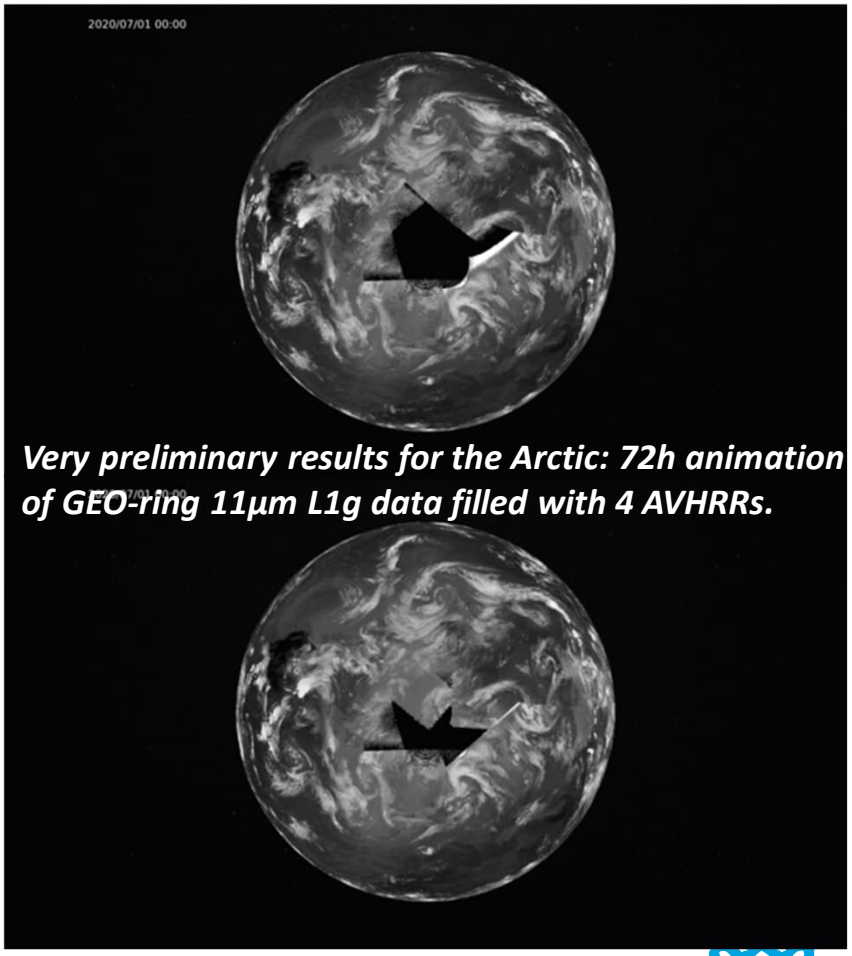
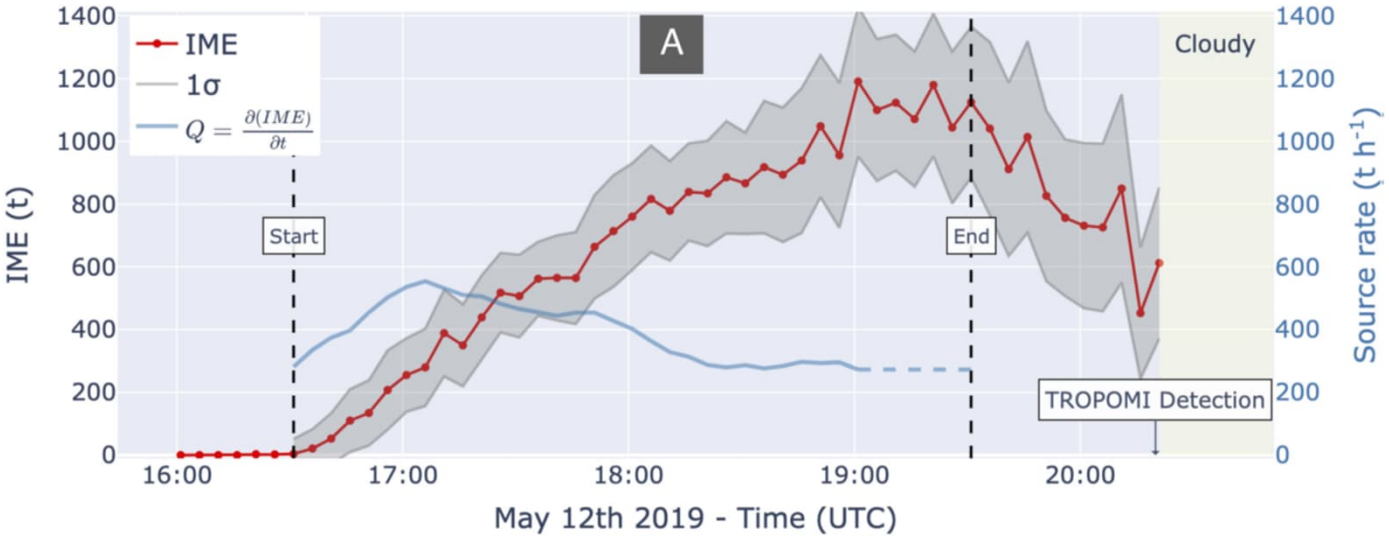
Opportunities - Polar gaps filling in L1g

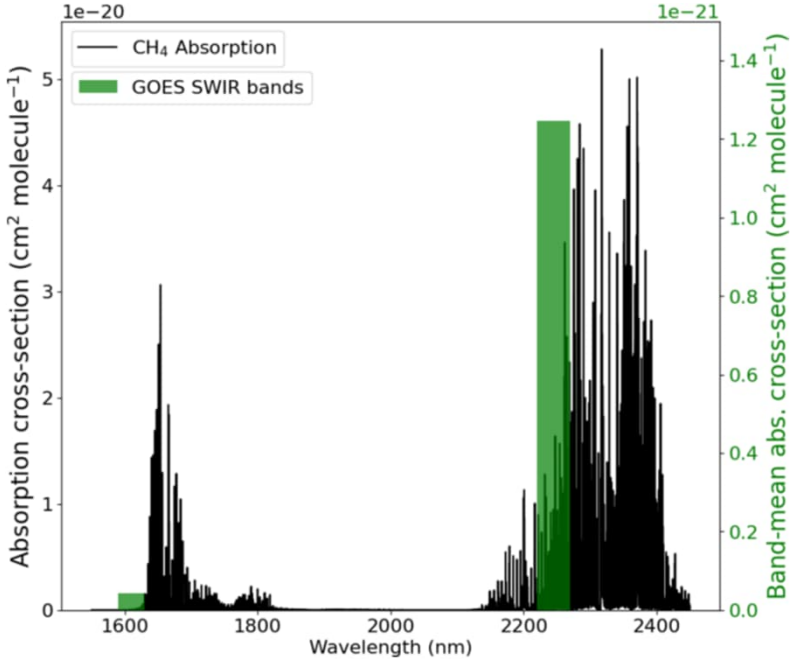
- ESA Cloud-CCI+ project started conducting a feasibility study on filling the polar gaps in L1g data with LEO data.
- Different missions and merging approaches will be considered
- 4 months of prototype, true-global L1g data are planned to be made available until end of 2025
- New sets of spectral band adjustment coefficients will be determined including GEO-ring and polar missions
- EUMETSAT is committed to implement and further develop it from 2027 onward



Very preliminary results for the Arctic: 72h animation of GEO-ring 11µm L1g data filled with 4 AVHRRs.

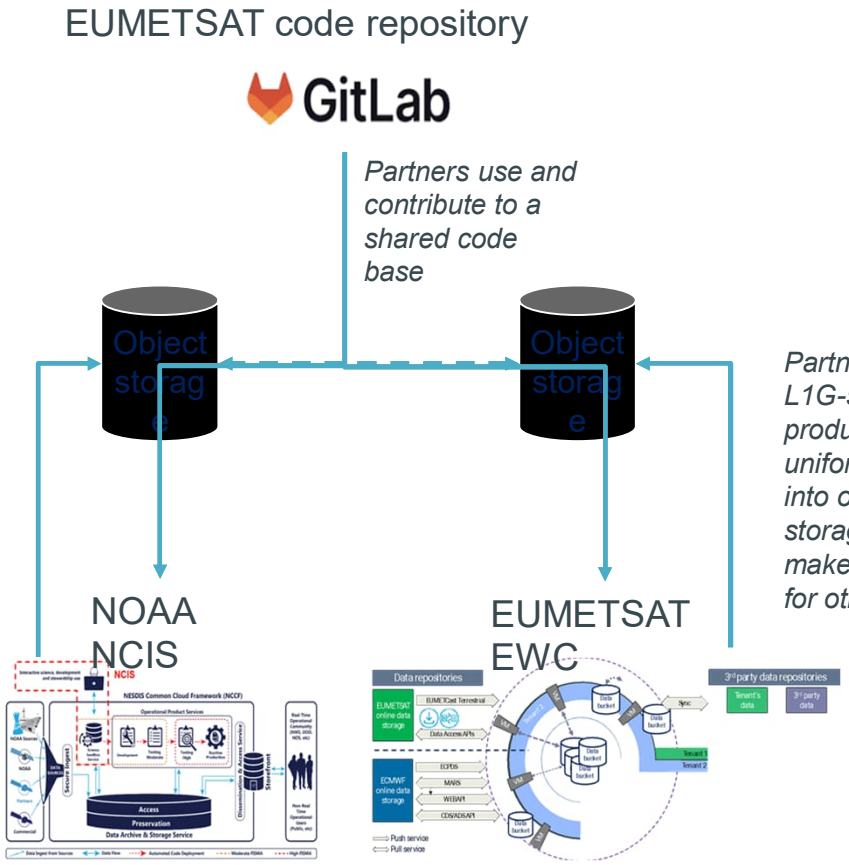
Additional Application Opportunity





M. Watine-Guiu, D.J. Varon, I. Irakulis-Loitxate, N. Balasus, & D.J. Jacob, Geostationary satellite observations of extreme and transient methane emissions from oil and gas infrastructure, Proc. Natl. Acad. Sci. U.S.A. 120 (52) e2310797120, https://doi.org/10.1073/pnas.2310797120 (2023).

Usage of Cloud infrastructure and data policy



- NOAA and EUMETSAT use cloud infrastructure:
  - to transfer rescued SMS and GOES data to EUMETSAT
  - to co-develop processing elements in the European Weather Cloud (EWC)
  - to disseminate test data (and later the full product) via the EWC and NOAA cloud
- Addressing Action A52.03, the data policy for the use and distribution of products has been reviewed, with two issues still to be resolved:
  - Distribution of products in data stores that are accessible by commercial users
  - Redistribution of EUMETSAT data with a temporal resolution better than hourly

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Key issues of relevance to CGMS:

- Data processing and distribution via cloud systems is ongoing, a 6-year GEO-Ring test data set will become available at the end of 2025
- A few data policy issues for the GEO-Ring products including rights required for redistributing the data of another agency are being addressed
- Integration of IMD INSAT data into the GEO-Ring is planned for a second release of the dataset following quality analysis and needed agreements with IMD on the usage and distribution of the data
- CGMS ICWG has started to use prototype data for producing ISCPP-NG cloud products and plans cloud product assessment for GEWEX based on GEO-Ring data
- CGMS IPWG sees GEO-Ring radiance data set as very useful and asks for availability at low latency (maximum 3 hr but wish for 15 min) for internal member use in precipitation products
- EUMETSAT plans a product feedback workshop in 2026
- Encouraged lesson learnt activity is planned for 2027 after the release of the complete data record

To be considered by CGMS:

Coordination of GEO-Ring work

- EUMETSAT/NESDIS have partnered together in a Bilateral Activity
- JMA has contributed data to both the GEO-Ring FCDR and ISCCP-NG
- IMD has started to contribute data to the GEO-Ring FCDR
- KMA and CMA have expressed interest in GEO-Ring/ISCCP-NG L1g activities
- PoC: Jörg Schulz, EUMETSAT and Andrew Heidinger, NOAA

Potential Extension of GEO-Ring activities

- GEO-Ring imaging data records could be produced at low latency (~5 days for ICDRs) and potentially real time to satisfy needs of IPWG. It is recommended to assess feasibility first
- Receive support from ESA CCI+ project on prototyping for filling polar gaps with LEO satellites, EUMETSAT plans implementation beyond 2027
- Additional applications come up of the GEO-Ring data set, e.g., as input to foundational ML models for training and in the detection of extreme and transient methane emissions from oil and gas infrastructure for the most recent years since 2018
- GEO-Ring data sets can be envisaged also for atmospheric sounding instrument data