Validating EUMETSAT Cloud and Aerosol Products with EarthCARE: Insights from MTG/FCI Optimal Cloud Analysis

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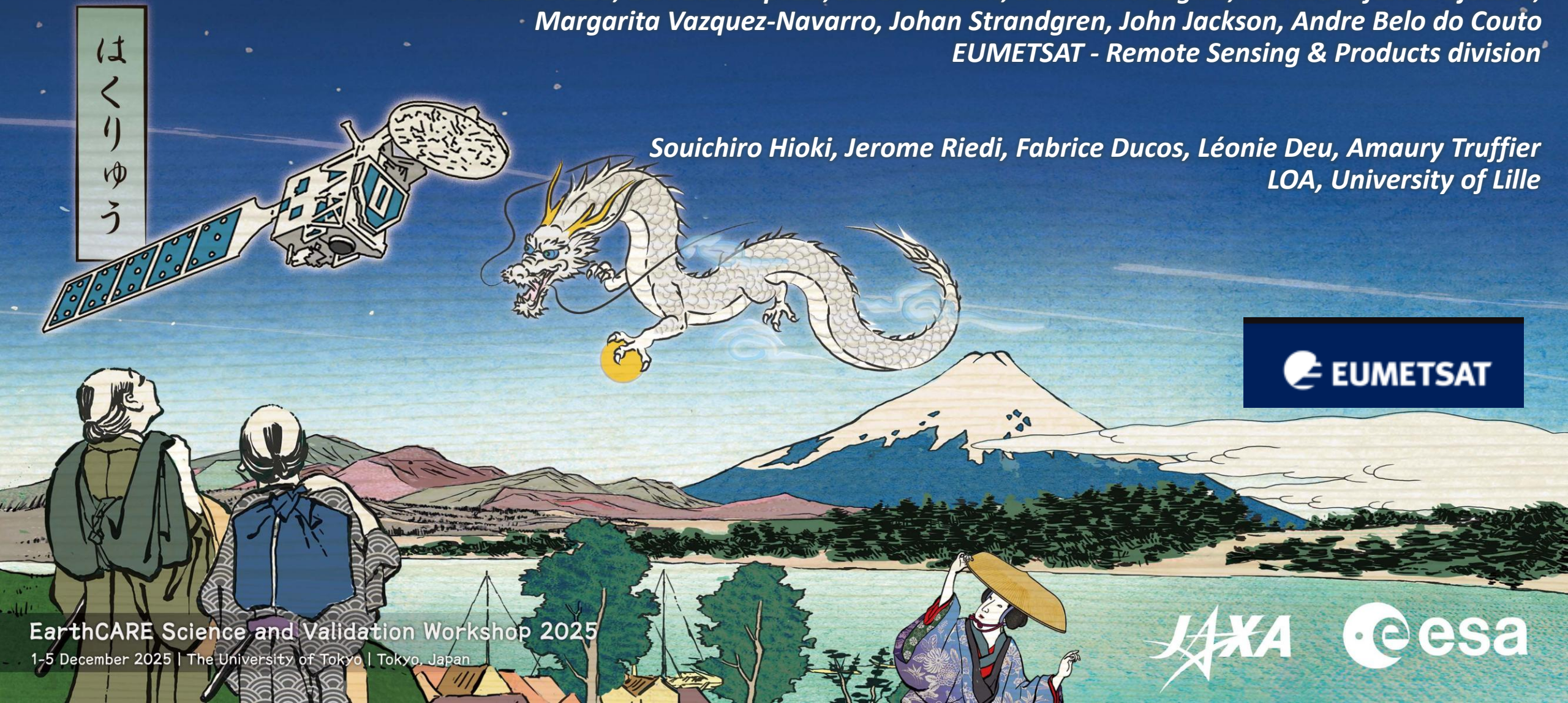

EUMETSAT

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JAXA esa

EUMETSAT missions and operational requirements

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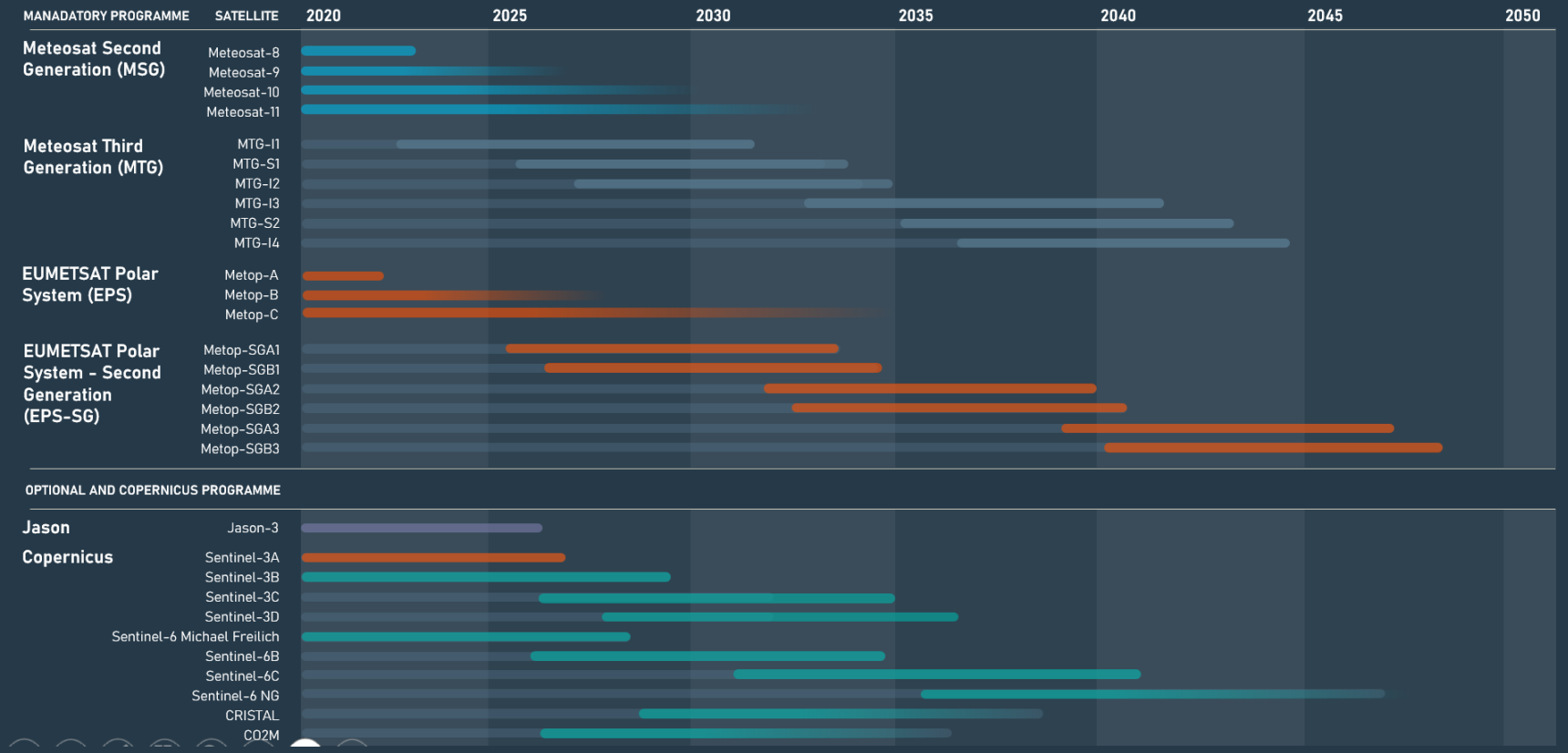
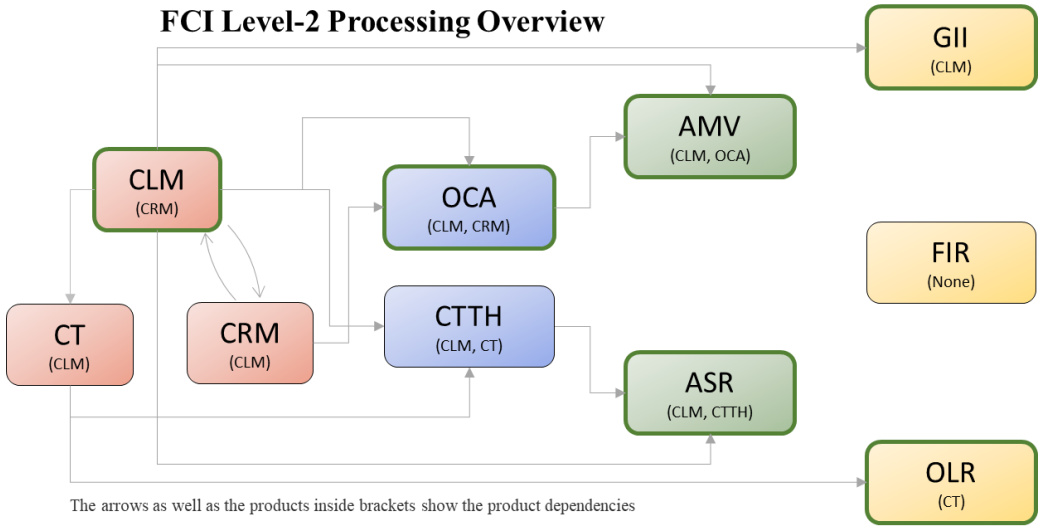
- **Reliability**: more than 99% - 24/7
- **Timeliness**: Near Real Time dissemination from sensing time (~100min for LEO, ~20min for GEO)
- **Quality control**
- **Continuity** over the mission lifetime and consistency between the different systems
- **Accuracy** of the retrieved geophysical parameters within user requirements



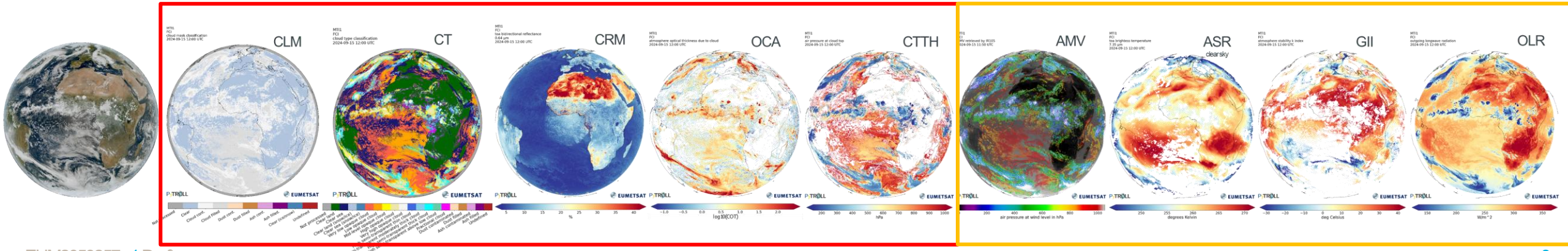
EUMETSAT Central Facility FCI L2 products

- A total of 10 products from start of operations
- Day-1 priority: ensure SEVIRI continuity → FCI's full potential not yet fully exploited
- Operational (or pre-op) since Nov 2025 (CLM, OCA, ASR, GII, OLR)
- Reference for commissioning validation:
  - MODIS, VIIRS, ACTRIS/CLOUDNET

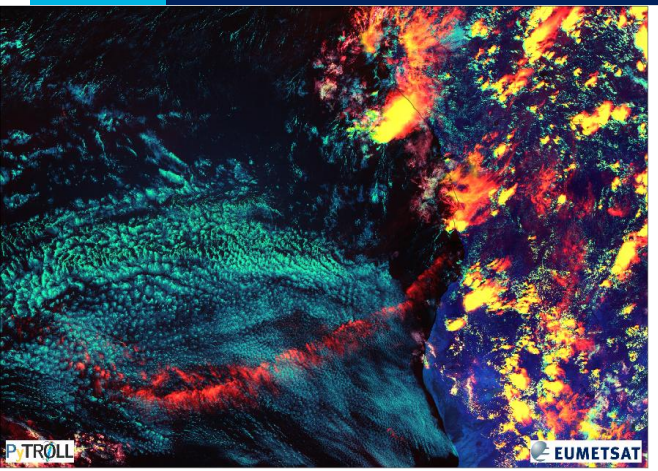


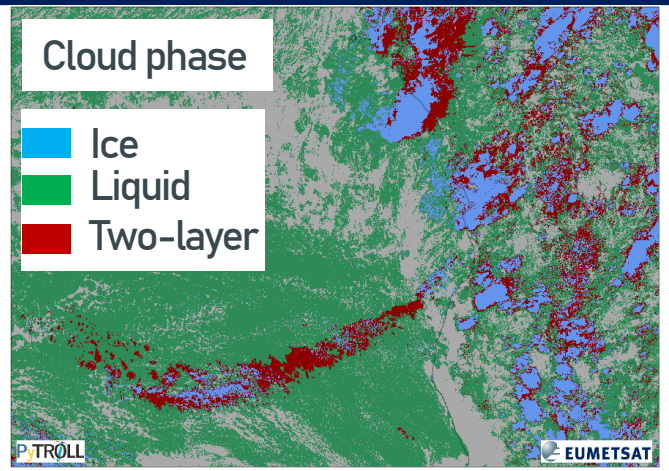
Cloud products

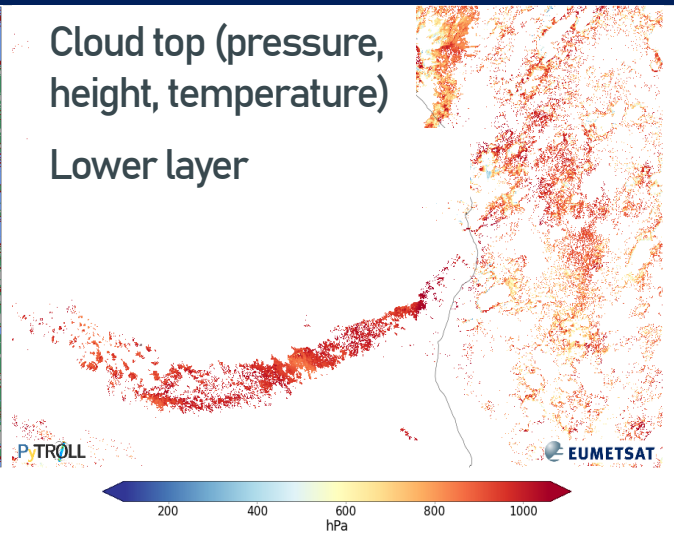
Applications depending on cloud products

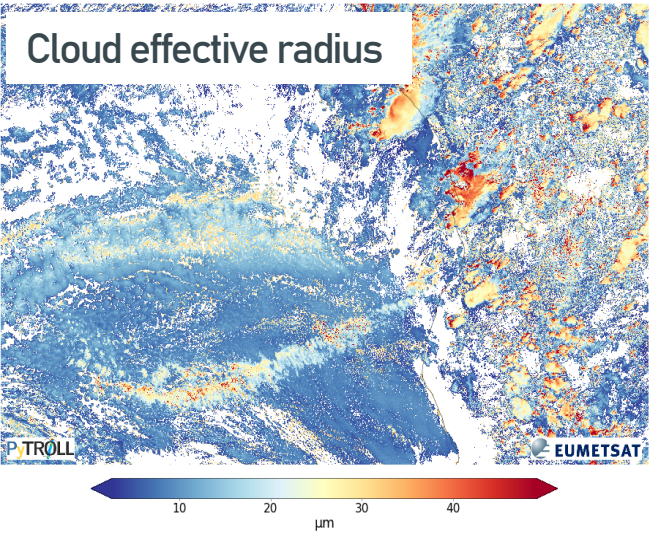


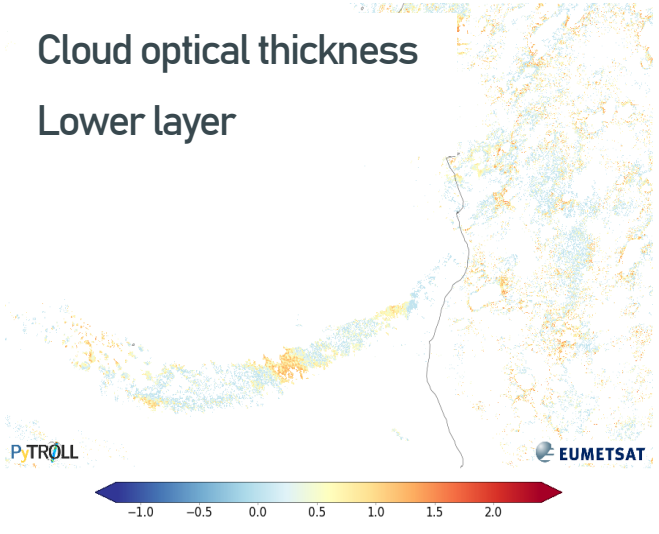
FCI Optimal Cloud Analysis product





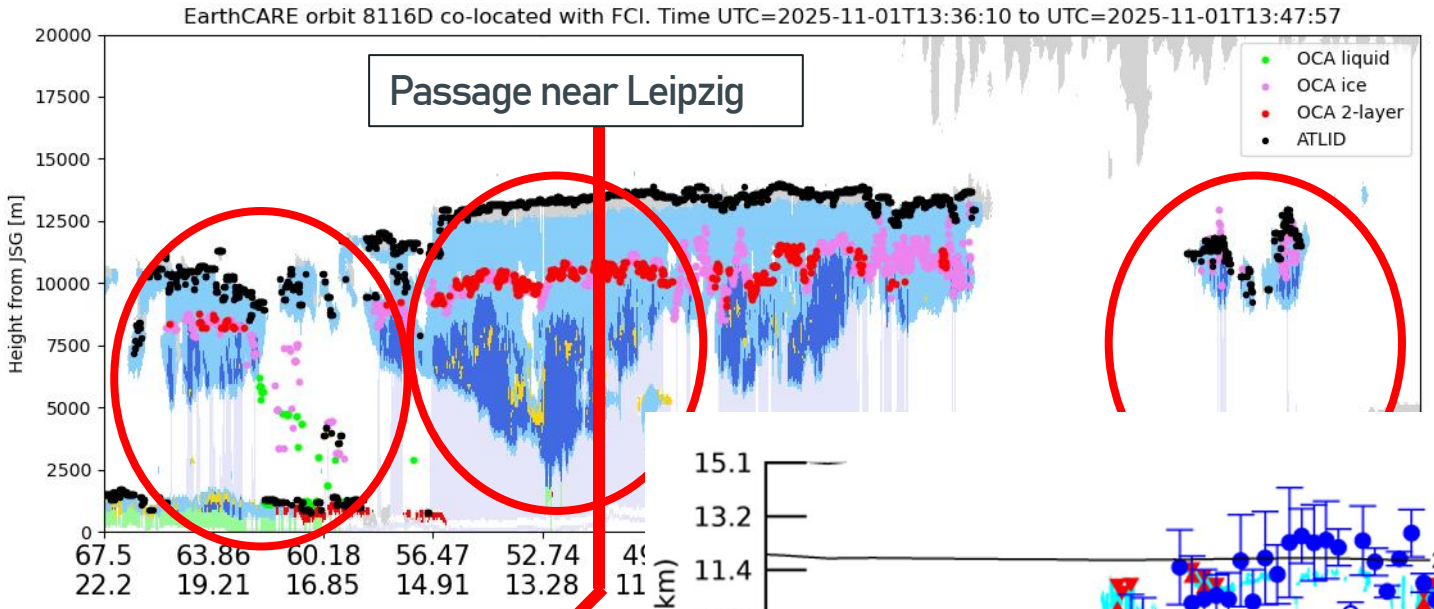


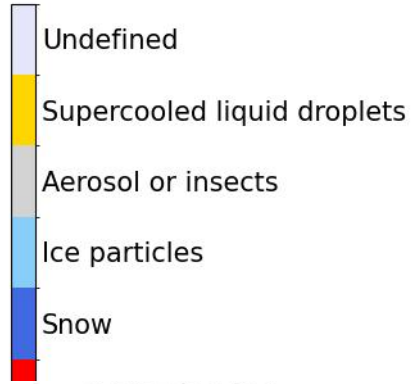


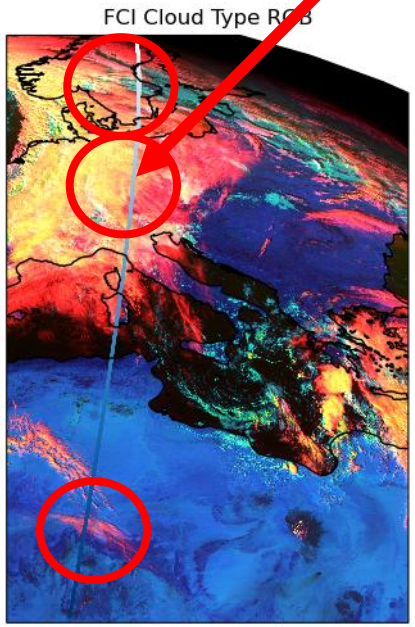


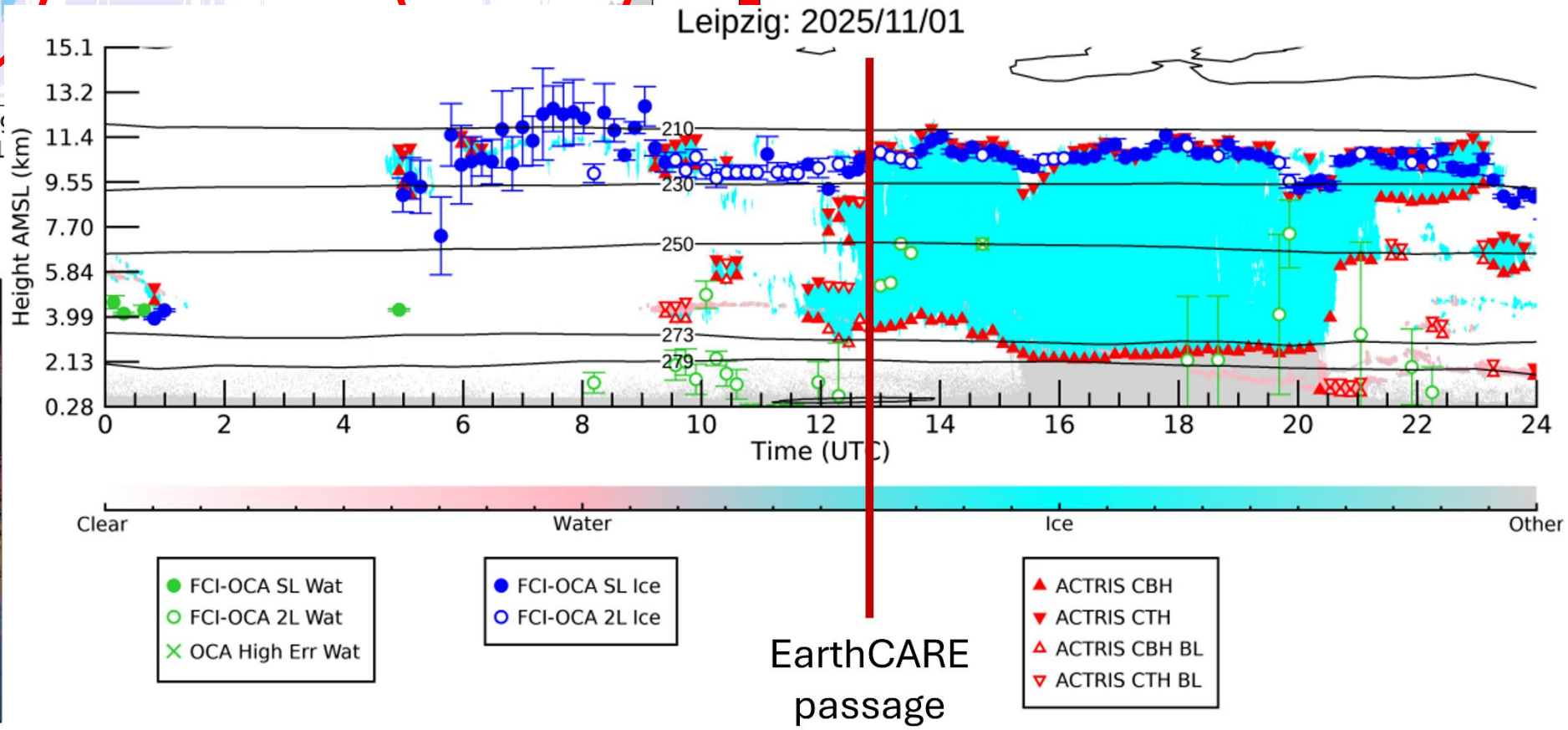
- 1DVar inversion of VIS+IR imagery measurements (Watts et al. 2011, Bozzo et al. 2024):
  - Detects and retrieves properties of overlapping clouds:
    - COT, R_{eff}, CTP for single and two layers
  - Solution 'Cost' + linear error estimate
- Multi-mission cloud product for GEO and LEO optical imagers. SEVIRI, FCI, METimage, Georing
- Main usage:
  - Operational height assignment for AMV
  - Parallax correction for MTG lightning imager (LI)
  - Support for climate studies

Early comparison – cloud height and total optical thickness



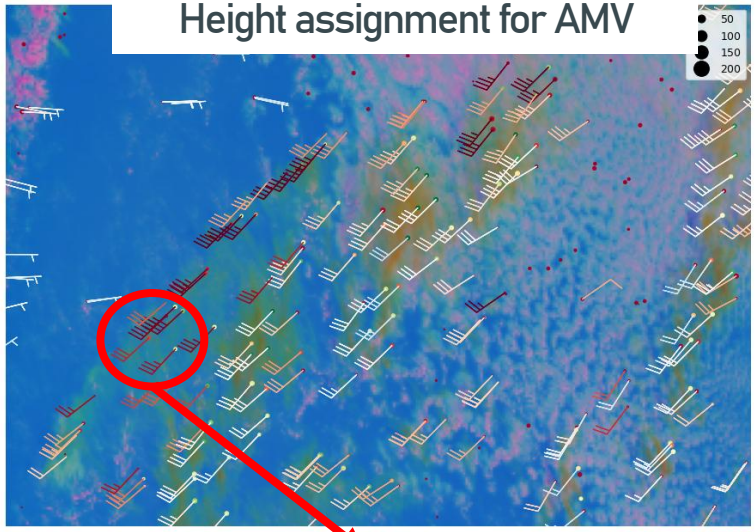




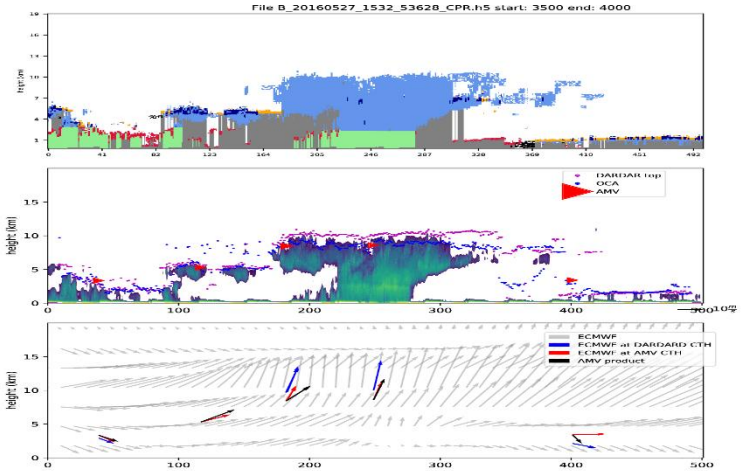


Application-oriented product validation

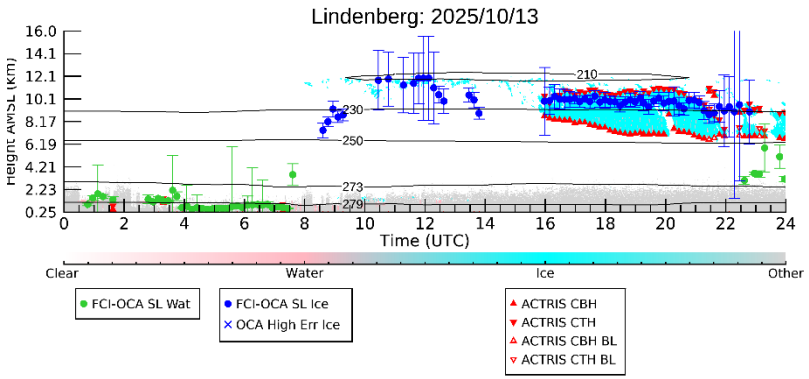
Height assignment for AMV



RED = Large speed bias -> wrong height assignment

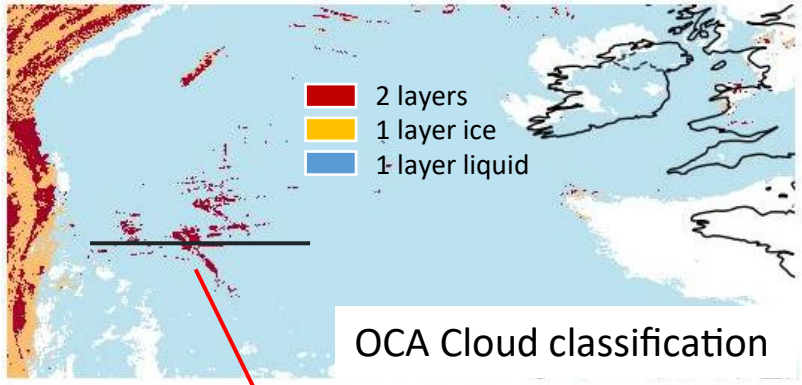


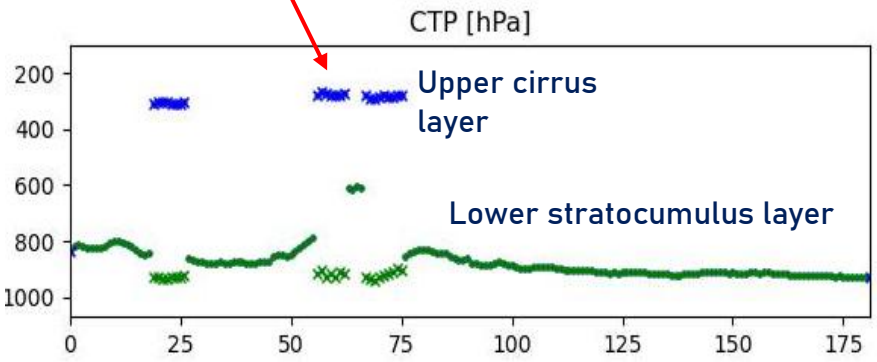
Retrieval uncertainty validation



Active sensors as independent reference for the validation of the retrieval uncertainty. OCA uncertainty used for product quality control

Validation of multi layer detection for thin cirrus clouds





Conclusions I - Clouds

- EarthCARE L2 products for continuous monitoring and development of operational LEO/GEO L2 cloud and radiation products
- Assessment of the retrieval uncertainty quality
- Exploring the possibility to use FCI-OCA products in combination with EarthCARE products for reconstructing 3D cloud maps using ML approaches **(lead by LOA, Lille University)**
- Use of geostationary L2 to enhance collocated EarthCARE products for cloud cycle studies (e.g. contrail cirrus radiative forcing or low clouds evolution)
- Support for development/validation of synergy products for optical + microwave sensors on EPS-SG satellites (MWI, ICE, METimage) and new 3MI and S3 cloud products

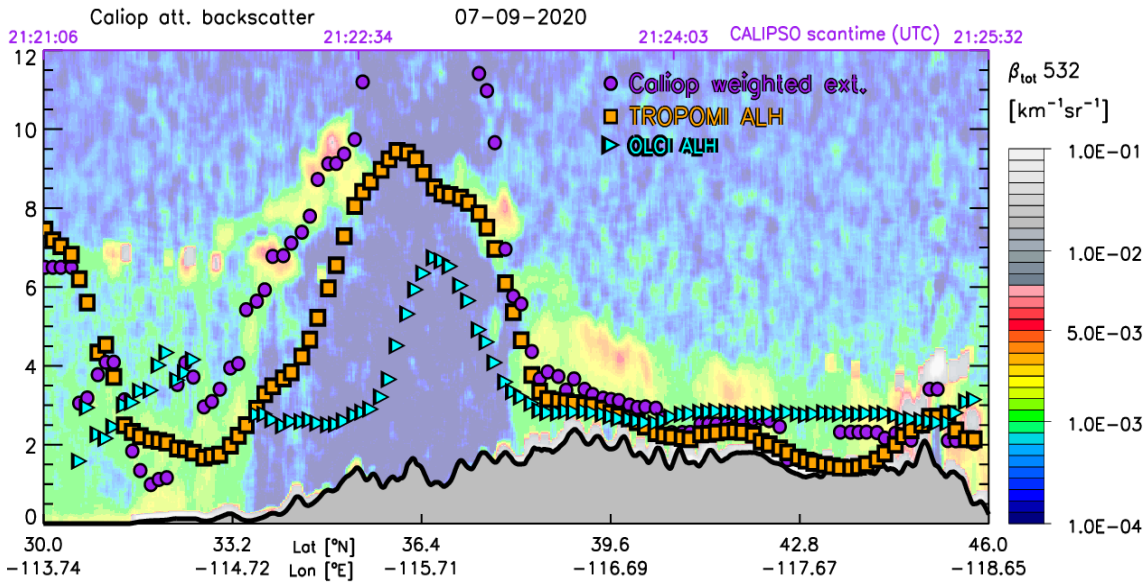
Conclusions II - Aerosol

Support the development of aerosol products:

- Provide a description of the vertical distribution which must be considered in the aerosol retrieval
  - Consolidation of the definition of the vertical distribution and layer height
  - Deep interpretation of complex cases (multi-layers) and test cases
- Contribute to the qualitative and quantitative validation of the Aerosol Layer Height (ALH) or Aerosol Profile products (eg dust profile)
- Provide an important diagnosis for the interpretation when different sources of measurements sensitive to the aerosol height & profile:
  - UV (S5, S4), O2 absorption (S3, 3MI), polarisation (3MI), TIR profiling (IASI-NG, IRS)…
  - especially in the context of synergy (S3-syn, EPS-SG/MAP)

Example with the validation of S3/OLCI Aerosol Layer Height (ALH) product [OLCOAH]

- Provide a description of the vertical distribution which must be considered in the aerosol retrieval
  - California wildfires – 07.09.2020
  - Comparison of Sentinel-3 OLCI ALH (prototype) with Sentinel-5P ALH and CALIOP Total Attenuated Backscatter @532nm



Contribution from Gijsbert Tilstra, Martin de Graaf (KNMI)

Thank you!

Questions are welcome.