Cloud and precipitation summary and recommendations

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Cloud properties & physical parameters from MSI

What are the positive findings about the data quality that can be highlighted?

- Cloud properties & physical parameters retrieved from MSI look reasonable though the calibration still has issue.
- Confirmed by ground-based observation, comparison with GEO satellites and aircraft observations. (Hünerbein, Wang, Muto, Qu)
- Indicating that **Level-2 algorithms work as expected** so far.

What aspects have been identified for improvement?

- COT is overestimated but correlation is quite good. This is confirmed by both JAXA and ESA.

Which L1 and L2 products or aspects are not yet (optimally) validated?

- We welcome your comments

What are the recommendations/suggestions for future L1 / L2 validation activities in terms of validation needs/gaps and for mission planning?

- Completion of MSI calibration
- Continuation of validation activities to see the seasonal characteristics and long-term performance.

CPR only and CPR/ATLID combined products

What are the positive findings about the data quality that can be highlighted?

- **Calibrations of Doppler and reflectivity are converging**: this is the conditio sine qua non all cloud and precipitation retrieval can produce sensible results (Bernat, Lukas, Natan, Jiseob)
- **Mirror images properly identified and flagged** (Aoki's talk)
- **Outstanding co-located in situ microphysical datasets** already collected for several cloud types and conditions (Kamil's talk with VERIFY MetOffice campaign, Zhipeng's talk with EC Ecalot campaign) with different probes measuring both PSD and IWC. Data are fully available.
- **JAXA and ESA L2 products just released and quite reasonable preliminary results** (needs of course more statistics)
- **Simulator from ground based to EC-like fully developed**, also accounting for cloud and precipitation attenuation correction (Ewan's talk, Lukas' talk), vertical correlation needs attention.

What aspects have been identified for improvement and are there clear/proposed ways to address that?

- Converge ASAP to **antenna mispointing correction and radar calibration** (affecting the whole chain) in L2. There is a very clear way forward both from Japanese and European side.
- **CPR receiver noise** characterisation and its utility for 94-GHz Tb measurements (JAXA is working on it)
- **PIA** with ideas coming from mirrors to estimate attenuation profiles (Nobuhiro's poster, Aoki's talk, Susmitha's poster)
- Can we better exploit **datasets merging coincident overpasses** from e.g. pmw radiometers and GPM (already produced by JAXA) ?
- Validation of **separation between air motion and sedimentation velocities** (wind profiler observations, in situ aircraft, ACTRIS profiling and scanning capabilities).
- **Convective motions**. What can we do? Statistical validations (Okamoto's talk), and wind profiler observations, in situ aircraft, ACTRIS profiling and scanning capabilities. Important to define Z-v_T relationship both for stratiform ice and rain
- **Strong convection and folding issues** : dual Doppler or RHI e.g. with phase array following the track scanning capabilities (no action yet on this)

Which L1 and L2 products or aspects are not yet (optimally) validated? (due to e.g. late release to Cal/Val users)

- Testing a-priori of microphysics retrieval Confirm new findings for N0* in ice. (Shannon/Robin's talk).
- Testing ice habits (Okamoto's talk) and hydrometeor classification (Chandra's talk), balloon in situ (Voelger' poster)
- Precipitation (snow and rain), only preliminary for US, Finland, Italy, Austria, Japan, Antartica (Chandra's and Dmitri's talk, Angeloni's poster, Wegenernet poster, Nobuhiro's poster, Bracci's poster). Any other location?
- Raindrop Dm validation (Dmitri's talk) , use e.g. collocated dataset with DPR, in situ PSDs.

What are the recommendations/suggestions for future L1 / L2 validation activities in terms of validation needs/gaps and for mission planning?

- Are there any **other critical a-priori** in the L2 product retrievals we should think about? Developers should highlight a-priori assumptions that need to be refined and microphysical quantities that are critical for their retrievals
- Representativeness of validation sites need to be better assessed (not simply based on spatio-temporal distance but also cloud regime and site location)
- More **validation for warm clouds and mixed-phase clouds**. Also try to confirm location of liquid clouds with cloud boundaries. (spiral flights or coordinated remote sensing/in situ flights).
- **Extinction profiles for CPR** (coordinates flights between two aircrafts, legs at different heights, or overpasses of flights over ground based sites)
- Fill gaps in retrieval or make cal/val users more aware why retrieval is not converging or not attempted (e.g. multiple scattering/no Doppler available)
- More intercomparison studies between Japanese and European and single vs synergistic products

Model session summary (1)

- **Model Intercomparison and Synergy with Observations**
  - ✓ Model intercomparison projects, such as ECOMIP, are valuable for fostering synergetic activities between observational and modeling groups.
  - ✓ Evaluations should incorporate multiple satellite datasets and ground-based observations to improve model accuracy.
  - ✓ ECOMIP also aims to compare aerosol modeling approaches.
  - ✓ The **Global km-Scale Hackathon** (May 12–16, 2025) provides a unique opportunity to gain hands-on experience with global storm-resolving models.
- **High-Resolution Models for Calibration and Validation (Cal/Val)**
  - ✓ High-resolution or Large Eddy Simulation (LES) models can be utilized for Cal/Val purposes, particularly for analyzing cloud motions such as turbulent structures near cloud tops and gravity wave-induced vertical motions.
  - ✓ Models can assist in validating vertical velocity retrievals and help identify robust motion structures that EarthCARE observations might miss due to noise.

Model session summary (2)

- **Improving Vertical Velocity Retrievals**
  - ✓ Vertical velocity retrievals will be refined by leveraging model-based uncertainty estimates of EarthCARE Doppler velocity measurements.
  - ✓ Since vertical velocity remains uncertain in both EarthCARE observations and numerical models, continuous improvement is necessary.
- **Cloud Microphysics and Database Development**
  - ✓ A database of terminal velocity versus radar reflectivity (Doppler velocity *Vd* vs. *dBZ*) is needed for different cloud systems and cloud particle types.
  - ✓ EarthCARE data can be instrumental in improving cloud microphysics schemes within models.
  - ✓ The dataset on cloud size and fall velocity can help refine cloud microphysics parameterizations, ensuring consistency or convergence in cloud particle size distributions within models.

Model session summary (3)

- **Synergistic Use of MSI and CPR**
  - ✓ What are the potential approaches for integrating MSI and CPR data?
  - ✓ By leveraging EarthCARE's multi-sensor capabilities, CFODD analysis can be advanced using MSI and CPR, such as through instantaneous correlations between radar reflectivity and radiation.
- **Comparing Geostationary Satellite and CPR Data**
  - ✓ Geostationary satellite data provide estimates of vertical velocity at cloud tops.
  - ✓ CPR Doppler velocity should be compared with geostationary-derived vertical velocity estimates to improve observational consistency and model validation.