Level-1 Session Summary and Recommendations

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2nd ESA-JAXA EarthCARE In-Orbit Validation Workshop

17 – 20 March 2025 | ESA-ESRIN | Frascati (Rome), Italy

Level 1 session block 1 (BBR, ATLID)

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EarthCARE BroadBand Radiometer (BBR) Level 1 Performance

- The Chopper drum has been running mostly at 75% of CDM speed → along track 1113 m resolution
- Assessment domain used us 5x21 JSG pixels (nadir 8x19 and aft /for 5x19 obs pixels)
- Calibration is performed each 88 sec between cold ~260K and warm ~warm 302 K BB
- B-SGN noise ~0.8 W/m2/sr
- Proposed update of B factors has been given and will result in better values in the SW. C factor will also be updated new value ~1
- Testing on BM-RAD and BMA-FLX impact will start soon.

Since Jan/Feb several L1 data has been missing due to a threshold reached with the CTM encoder. Update on the CCDB will be done to prevent missing more data.

Data will be recovered when reprocessing

Comparison with CERES Flashflux Terra/Aqua and SNPP NOAA20

- Time < 300 sec
- distance centers< 3 km
- angles between viewing < 3 deg
- Validation and verification activities have shown:
  - Detector-to-detector variability (mostly B-SNG)
  - Solar products (L1 & L2) too high: SW RMS 12.58 W m-2 sr-2 bias -7.41 (9% brighter)
  - Thermal products too low : LW 3.54 bias 2.41 (3% lower)

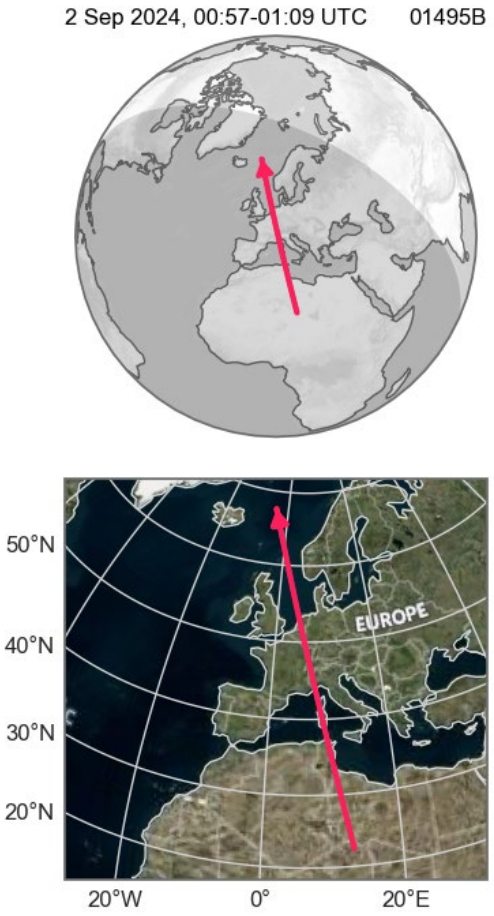
Q: long term plan: are the improvements as good as they can become or should it be better?

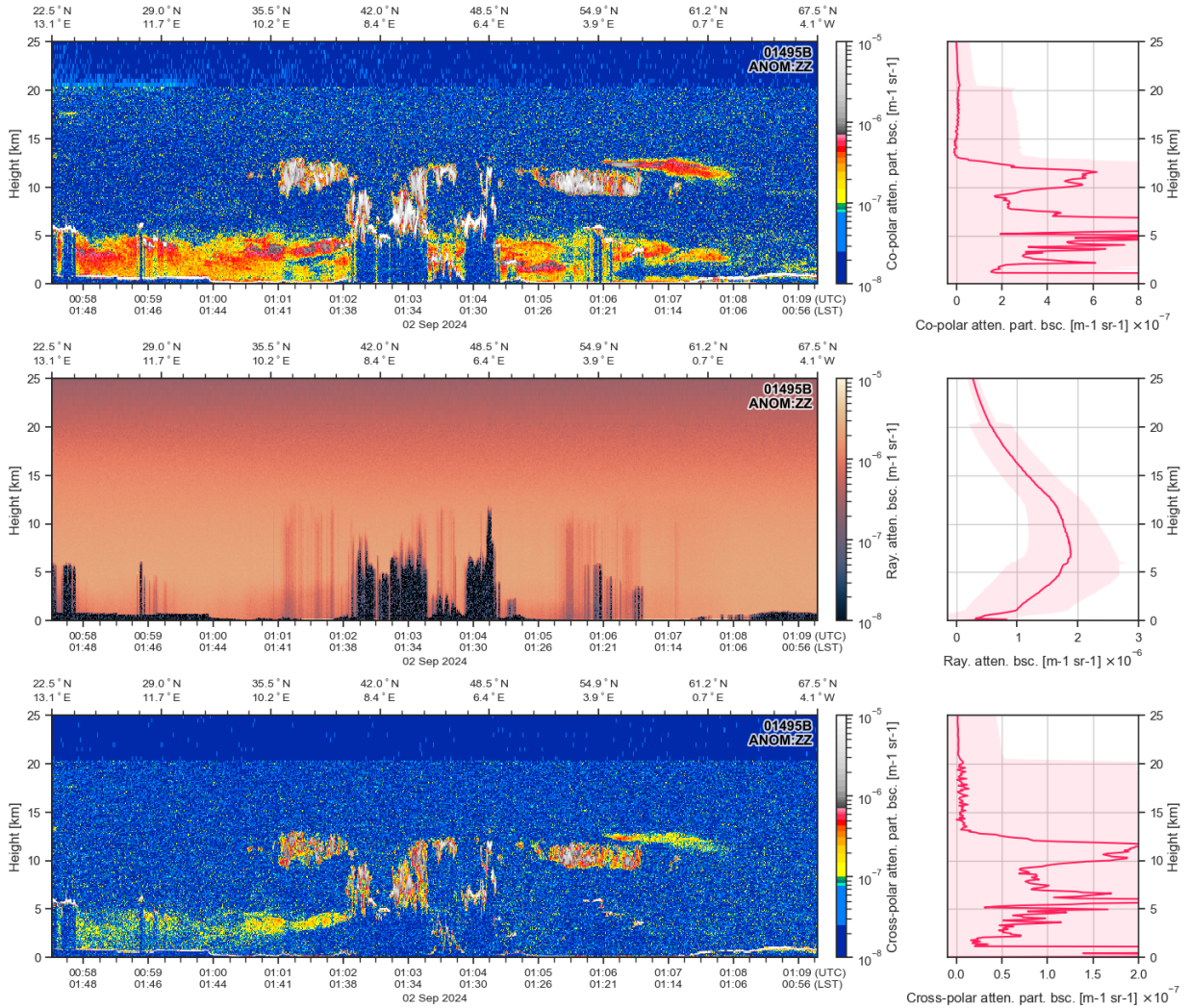
A: Nicolas: Update plans is more something for the QWG to decide. No big changes are expected/planned at the moment

ATLID level 1 session

- Dave Donovan described all the updates which have taken place since the beginning (Noise spikes, discontinuities, 20km feature)
- Hot pixels (nasty) → regular operartional dark count measurements
- Health of every pixel has to be tracked!
- Depol ratio was too low, hopefully now better results (TBD)
- Status of L1 AE: L1 data looks to be of good quality !

ATLID Level 1, Baseline AE, Frame 01495B





ATLID L1 products are of very good quality
see also Wirth et al. – Monday, 13:05

Ulla Wandinger

Mark Fielding:

- ECMWF QC: Rapid detection of instrument issues, continuous evaluation
- There are good signs that the assimilation is working and improving cloud fields
- ATL L1b total backscatter evaluation is stable for ice clouds and very close to the Calipso measurements
- Bias in the arctic in AE looks a lot better since AD, also the SA anomaly seen in AC is gone

Q: Which forward model are you using and ice & how is multiple scattering handled

A : In house model different ice cloud properties, now using the same as in ACM-CAP. MS: Simple approach , screen out difficult cases, no polarization is done yet.

Artem Feofilov

Using a Daily Flow of lL1 and L2 Data for Statistically Based Calibration/Validation Control of ATLID.

- Daily files of Lat/Alt are provided and checked

L1 results, combining all baselines in time showing the evolution.

- Baseline AD show a day/night bias, the bias is removed when moving to AE baseline
- Mean stratospheric signals are quite stable, both daytime and nighttime ones
- Seasonal behavior of daytime noise is observed in all 3 channels

L2:

- L2 analysis with clusters shows stable behavior starting from Baseline AB (using A-EBD)

Martin Wirth:

Validation of ATLID L1 from the HALO aircraft PERCUSION campaign comparing baselines: ATLID L1 data proof very good performance !

- AA: showed Mie signals in Rayleigh channel & depolarization << halo
- AB: improvement in cross talk correction, depol improved but still smaller
- AE: Mie signals still below zero in clean atmospheric region ! Depol further increased in the expected range

Sometimes still visible cross-talk from Mie to Rayleigh channel, but greatly enhanced from baseline AC on, but still not perfect in AE.

Signals are sometimes significantly negative, or positive where they should be zero (e.g. below opaque clouds), even for baseline AE.

Q: Dave: is it per profile or statistical. A: Statistically

Remark Eleni: Golden cases can be added still, please provide the frame info and reasoning to the Cal-Val team.

Oliver Reitebuch

The ATLID laser beam observed by the cosmic ray observatories Pierre Auger (Argentina) and Telescope Array (USA)

- First measurements of the Aeolus UV lidar beam. They could measure the exact energy in the beam
- ATLID much easier to observe due to nighttime overpass every 25 days. Never Calipso since they observe in the UV
- Laser energy show oscillations between 31.3 and 33,0 mJ (specific for ATLID)
- Median departure geolocation < 100 m (preliminary)
- Reconstruction of laser beam and energy is on-going work
- In Baseline AD there was a timeshift by 66 seconds
- ATLID can be used as calibration star for astronomy!

Level 1 session block 2 (ATLID, MSI)

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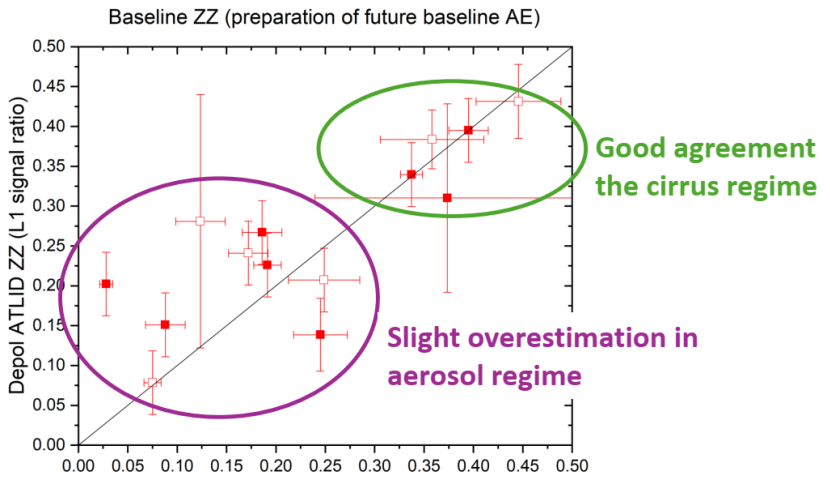
Summary Monday 17 March L1-Block-2 on ATLID

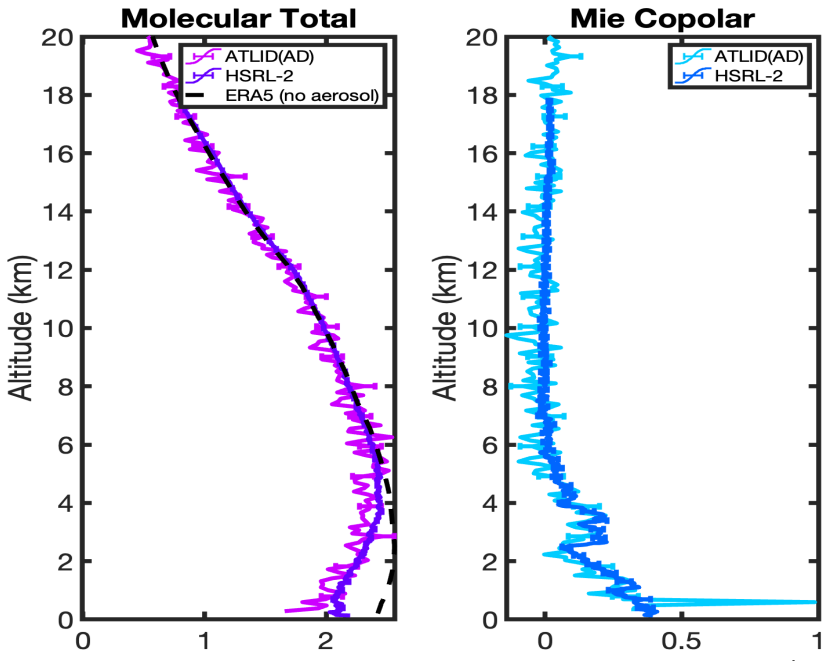
- **Moritz Haarig, TROPOS:** reported about validation of the depolarization ratio from comparison with ground-based lidars – and also provided a statistical comparison of baseline AC, AD and AE:
  - Baseline AC:
    - Daytime depolarization ratio too low (offset bug) → fixed in baseline AD
    - Depolarization in cirrus too low → fixed in baseline AE
  - However, depolarization ratio in aerosol regime (<30%) seems to be overestimated in baseline AE → needed to be checked



- **David Winker, NASA:** provided insights into the depolarization calibration using the polarization gain ratio for CALIOP
  - inserting an inserting a depolarizer into the receive-optics that both channels see the same signal
  - Daytime PGR using the Cirrus background method (Liu et al. 2004)
  - Opaque Water Cloud (OWC) method (day/night) (Y Hu et al. 2007) – also applicable for ATLID, but it was discussed, how the methods performs with the larger Rayleigh signal background in the UV.

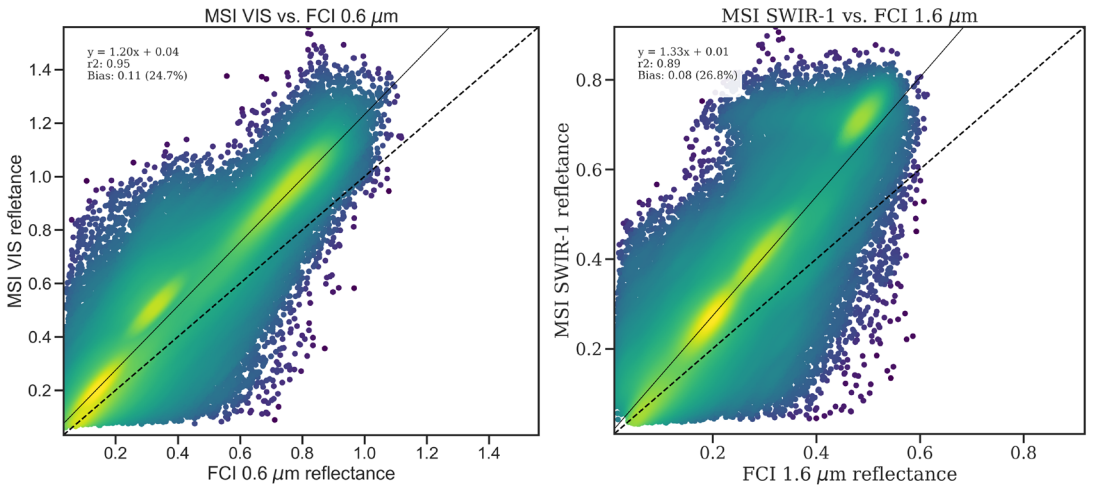
Summary Monday 17 March L1-Block-2 on ATLID

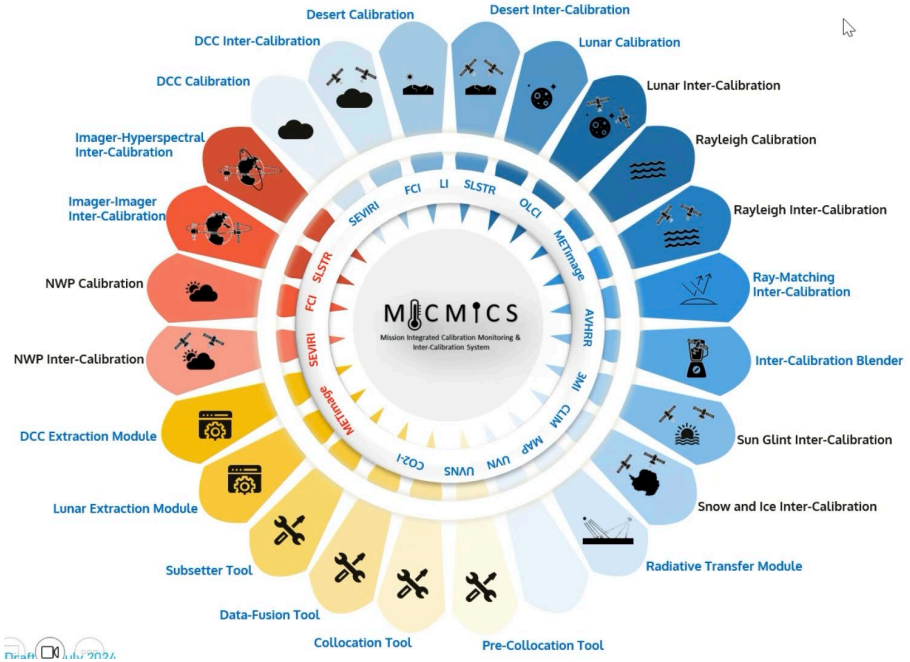
- **Chris Hostetler (on behalf of John Hair), NASA:** highlighted the results from the validation of ATLID using NASA´s UV HSRL-2 on the high-flying aircraft ER-2 and from the HALO-lidar instrument (on GIII)from 4 airborne campaigns starting in August 2024.
  - Very impressive comparisons were shown for L1 products (Ray and Mie co-polar ATB´s), and the derived scattering ratio – even below clouds and for low values of the scattering ratio
  - For the Mie cross-polar channel lower values are seen by ATLID as compared to airborne HSRL-2
  - An upcoming airborne campaign is planned from Bermudas mainly focusing on night-time flights in September 2025 with the UV- HSRL-2 on the NASA Gulfstream III.



Summary Monday 17 March L1-Block-2 on MSI

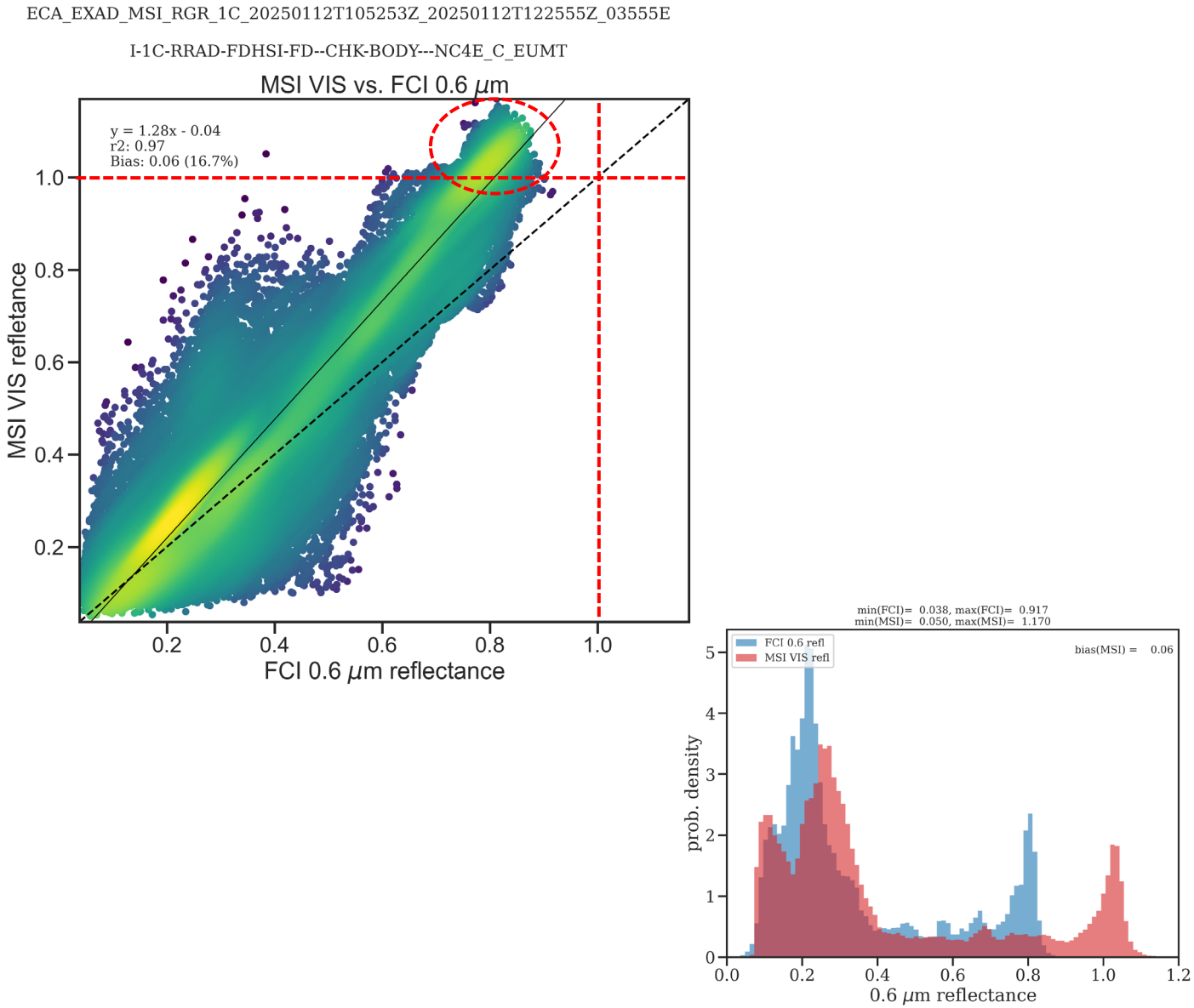
- **Rene Preusker, ESA DISC team:** reported the results of MSI L1c radiometric verification after baseline AF update. Various methods of vicarious calibration for MSI L1c is also mentioned.
  - Still MSI VNS bands are systematically too high compared to SEVIRI and FCI (~25%).
  - Although the 'solar irradiance measurement' is only 5-6% off, the reflectance is 20% too high in VIS and 33% higher at 1.6µm.
  - The diffusor (ground) characterization can not be trusted, and calibration is necessary particularly for VNS band.





Summary Monday 17 March L1-Block-2 on MSI

- **Sebastian Bley, German Initiative for Validation of EarthCARE, EarthCARE DISC:** highlighted the results of cross-satellite validation of MSI L1 with SEVIRI and FCI observations.
  - VNS bands too bright in contrast to SEVIRI (17 % for VIS)
  - VNS bands too bright in contrast to FCI (25 % for VIS)
  - Excellent agreement for TIR bands (both vs SEVIRI and vs FCI).
  - Uncertainties in L1 data will directly affect L2 products



Summary for MSI Level-1

1. L1b and L1c (NOM <->RGR) products are consistent
2. Data flagging monitoring+ statistics does not indicate flaws (ongoing development)
3. Geolocation & co-registration, of MSI is within specs
4. MSI L1c radiometric verification
   a. radiometric calibration of thermal bands is working very well (based on satellite intercomparison with FCI)
   b. radiometric calibration of VNS bands seem to have issues (based on satellite intercomparison with FCI). A possible reason is that the on-ground characterisation of the diffusors is not applicable anymore. Further we found temporal variations of up to 2% in the measured solar in-band irradiance (via diffusor), that causes are currently unclear
5. Way forward: Vicarious Calibrations (in particular satellite intercomparisons, and pseudo invariant desert sites) to have a diffusor-independent source for (reflectance) calibration

- Discussion, Questions from audience:
- Why using FCI for intercomparisons (high temporal data availability + high spatial resolution)
- SWIR (1.6µm + 2.2µm) verification using cloud microphysics in stable regions

Level 1 session block 3 (CPR)

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Level-1 summary and recommendations (CPR)

Luca Baldini, Pavlos Kollias, Hiroaki Horie

Level 1 session block 3 Co-chairs: Pavlos Kollias and Hiroaki Horie			
16:45	10	CPR processor & product overview	Nobuhiro Tomiyama
16:55	10	Near-real time monitoring of CPR L1 data using NWP	Mark Fielding
17:05	10	Intercomparison of spaceborne cloud radar data between CloudSat and EarthCARE with AMSR2 data	Kaya Kanemaru
17:15	10	Comparison of Doppler velocity measurement across CPR observation modes	Yuki Imura
17:25	15	CPR External Calibration by Active Radar Calibrator and CPR Level 1/ Level 2 Product Validation	Hiroaki Horie
17:40	15	Assessing CPR radar reflectivity and doppler products with airborne observations from the PERCUSION campaign	Florian Ewald

N. Tomiyama

- Introduced CPR L1b update plan from vCa to vCb with calibration factor (-1.60dB)
- Since early December the I/Q offset is not an issue any more
- Update plan Antenna beam pointing correction (L+18M)
- Target accuracy check plan (L+3Y), first confirmation (L+18M)

M. Filelding

- Near Realtime power calibration monitoring using the CloudSat database and the ECMWF data assimilation system
- Known issue (2nd trip echo and around 2500m height echo) are removed.
- 12 hour-mean ice cloud retrieval 4dB difference to CPR L1b (vBa)

K. Kanemaru

- NRCS compared to CloudSat under same wind condition using AMSR - 1.70dB difference (vCa)
- Gas attenuation calculation differ from CloudSat (2B-GEOPROF) and CPR (JAXA L2 ECO).

- **Y. Imura**
- Accuracies of Doppler velocity at 3 observation mode are checked. 18km mode is also good performance.
- Contamination of mirror echo at 18km mode is only 0.34%. The 18km mode is recommended
- **H. Horie**
- Calibration Factor by ARC External calibration is proposed to -4.0dB (included to vCb)
- Compare Z factor and Doppler velocity to NICT HG-SPIDER. They are agreed (L2 vBa euqiv).
- **F. Ewald**
- HALO 35GHz radar data converted at 94 GHz using (Pfitzenmaier et al.) are compared to CPR (4dB difference) Sensitivity of ~-36dBZ is confirmed.
- NRCS with incidence angle data are obtained by roll flight

- What are the positive findings about the data quality that can be highlighted?
- The different power calibration methods (use of the ARC, use of CloudSat's sigma-0 and ice clouds climatology) agree within 0.5 dB or better regarding the power calibration of the CPR.
- Since early December, the IQ imbalance issue that affected the Doppler velocity quality at dBZ's lower than -10 is fixed. Now the Doppler is recoverable down to -20 to -25 dBZ.
- Algorithms to identify (and mitigate) mirror images due to the use of a high PRF have been developed.

- What aspects have been identified for improvement and are there clear/proposed ways to address that?
  The antenna mispointing correction in L1b (JAXA, L+18M)

- Which L1 and L2 products or aspects are not yet (optimally) validated? (due to e.g. late release to Cal/Val users)
  - Microphysical retrievals
    - Raindrop/particle sizes (using weather radar networks) (Level 2)
    - McGill's Doppler velocity antenna pointing corrections
  - CPR receiver noise and its utility for 94-GHz Tb measurements
- What are the recommendations/suggestions for future L1 / L2 validation activities in terms of validation needs/gaps and for mission planning?
  - High latitude mixed-phase clouds
  - Marine clouds
  - ……