EarthCARE commissioning overview of CPR

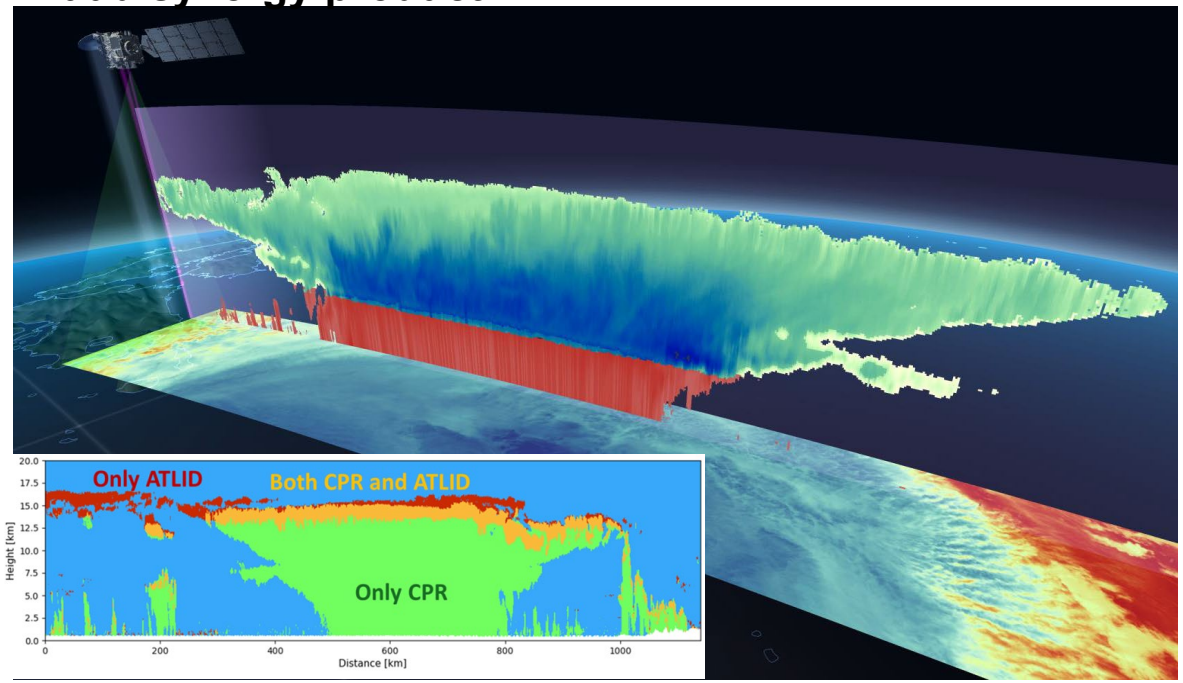
TOMITA Eiichi

EarthCARE/CPR Project Team Japan Aerospace Exploration Agency (JAXA)

1. Initial calibration / validation

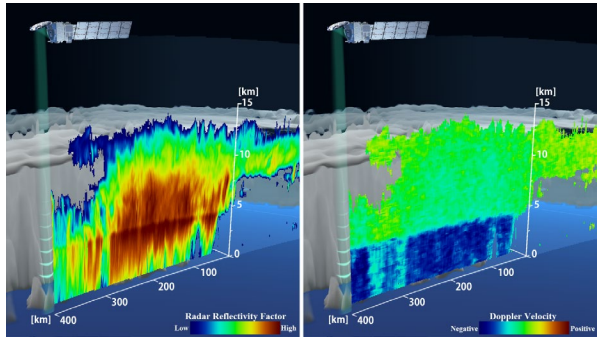
- After the Launch of May 2024, JAXA has been working on initial checkout and initial calibration / validation of CPR with the cooperation of NICT and ESA.
- Durling this period, the first light of CPR was released.
  - The first light of CPR : June 2024.
  - The cloud synergy product and matching product with GPM : October 2024.

Claud synergy product

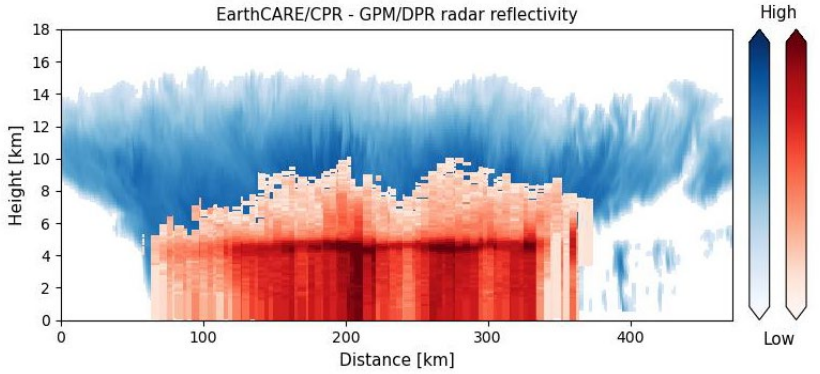


Typhoon “Shanshan” 28th August 2024

CPR first light



the cloud area in a stationary front, called the Baiu front, over the ocean at east of Japan
13rd June 2024



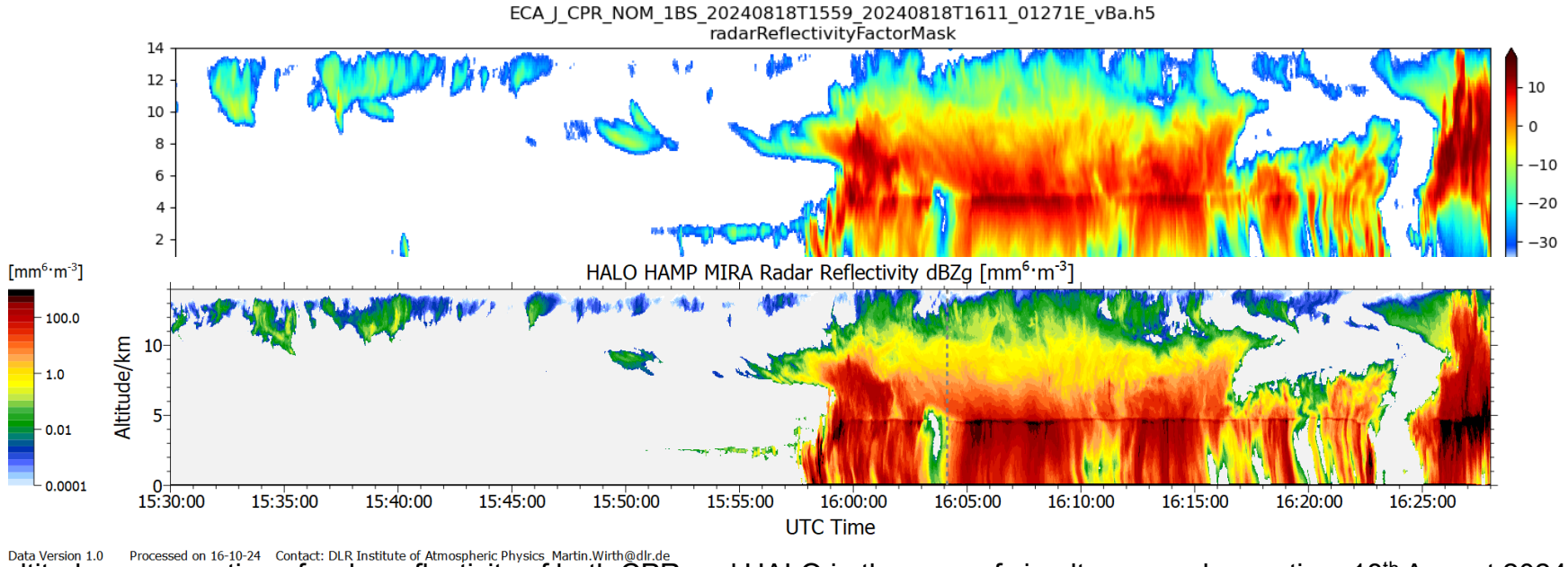
Observation from cloud to Rain by EarthCARE/CPR and GPM/DPR
22nd August 2024

1. Initial calibration / validation (cont'd)

- CPR Initial calibration have been carried out under leadership of NICT.
  - NICT have been working external calibration using ARC "Active Radar Calibrator" and sea surface calibration for initial calibration of CPR.
- CPR Initial validation have been progressed by both NICT and JAXA.
  - NICT is progressing CPR validation using Radar on ground.
  - JAXA is progressing CPR Validation under collaboration with DLR and NOAA as well as ESA.
- December 2024, JAXA confirmed that CPR could be moved to nominal operation phase by completion of the initial check out and initial calibration / validation.

EarthCARE CPR radar reflectivity

HALO MIRA radar reflectivity



Time-altitude cross-section of radar reflectivity of both CPR and HALO in the case of simultaneous observation. 18th August 2024

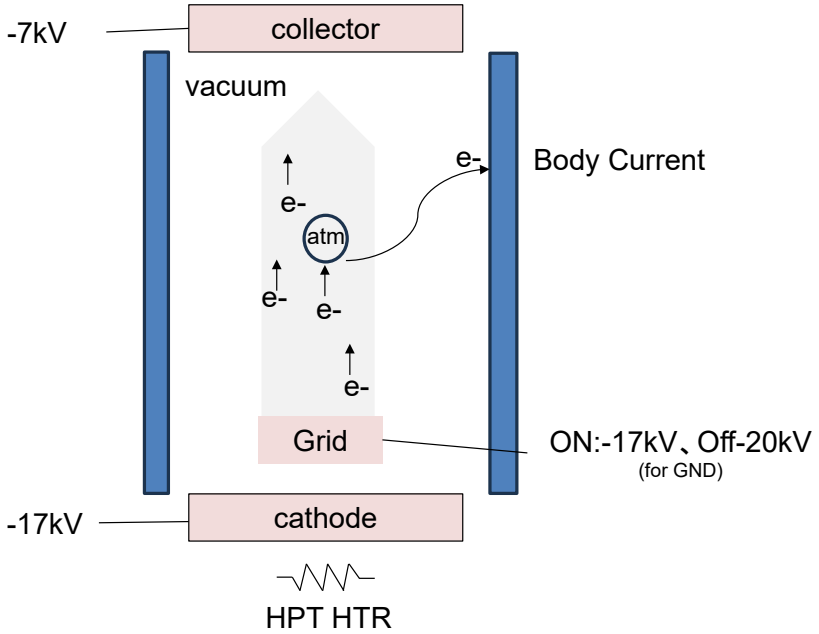
2. Interruption of CPR observation due to the HPT characteristics

- Due to the HPT “high power transmitter” characteristics, CPR observations is interrupted about a few times a month.
- It is known that instantaneous body current caused by floating atoms inside the Klystron make HPT to shut off as normal behavior.
- Adding this, JAXA have hypothesis that there is the instantaneous body current caused by proton on orbit instead of floating atoms. This hypothesis was considered possible by JAXA experts, since solar proton achieved low earth orbit in the polar regions and over South America.
- Currently, CPR observation is recovered by the commands from ESOC operator.
- But JAXA have a plan that implementation of restart commands with onboard software instead of commands from a ground operator can potentially reduce interruptions to observations. It will be realized after agreement with ESA.

2. Interruption of CPR observation due to the HPT characteristics (cont'd)

Instantaneous body current

- Body Current is a part of Beam current from cathode to collector flow on Body of Klystron.
- Generally, body current increase due to degrade of cathode. Therefore, HPT has Body over current protection function that let HPT to shut off when over body current observed.
- On the other hand, it is known that electron constructing Beam current reach body and become Body current due to collision to floating atom inside Klystron.
- In the case of high voltage apply between cathode and collector, charged atoms are absorbed by cathode or collector and non-charged atoms are remain as floating atoms. Therefore, the probability of body current occurring decreases relatively.
- In the case of no high voltage apply, floating atoms are much more than one in the case of high voltage apply. Especially, in the case of cathode heater is on, it is considered that floating atoms are increased.
- When HPT temperature is increased, it is also considered that floating atoms are increased due to out gas inside klystron.



Conceptual diagram of instantaneous body current

3. Nickname “HAKURYU”

JAXA decided to use “HAKURYU” as EarthCARE satellite’s Japanese nickname under agreement with ESA.

- “HAKURYU” means “White Dragon” in Japanese.
- The nickname embodies well the distinctive appearance of the EarthCARE satellite, characterized by its white color and solar panel paddles resembling a long tail.
- In Japan, dragons are revered as divine creatures governing water, aligning well with the EarthCARE mission of elucidating the radiation balance mechanism of the Earth's atmosphere through the interaction of water and ice cloud formations with aerosols.
- Among dragons, HAKURYU is believed to fly faster than others, resonating with the image of satellites orbiting the Earth at high speeds.