ESA-JAXA Pre-Launch EarthCARE Science and Validation Workshop

13 – 17 November 2023 | ESA-ESRIN, Frascati (Rome), Italy

JAXA EarthCARE Product Overview

Takuji Kubota
JAXA EarthCARE Mission Scientist
Earth Observation Research Center (EORC)
Japan Aerospace Exploration Agency (JAXA)

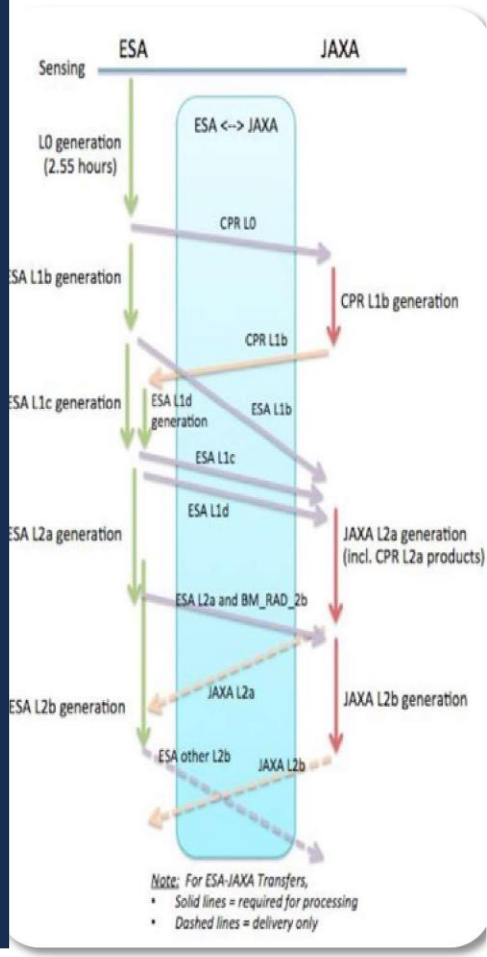
EarthCARE data products are generated by ESA and JAXA

Covered in previous presentation

ATLID	BBR	MSI	CPR
L1	L1	L1	
L2A		L2A	L2A
L2B			

Covered in this presentation

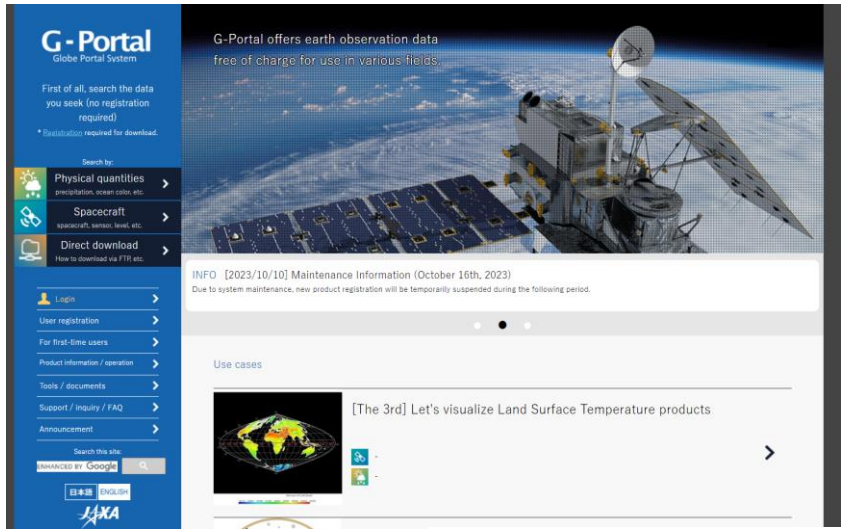
ATLID	BBR	MSI	CPR
			L1
L2A		L2A	L2A
L2B			



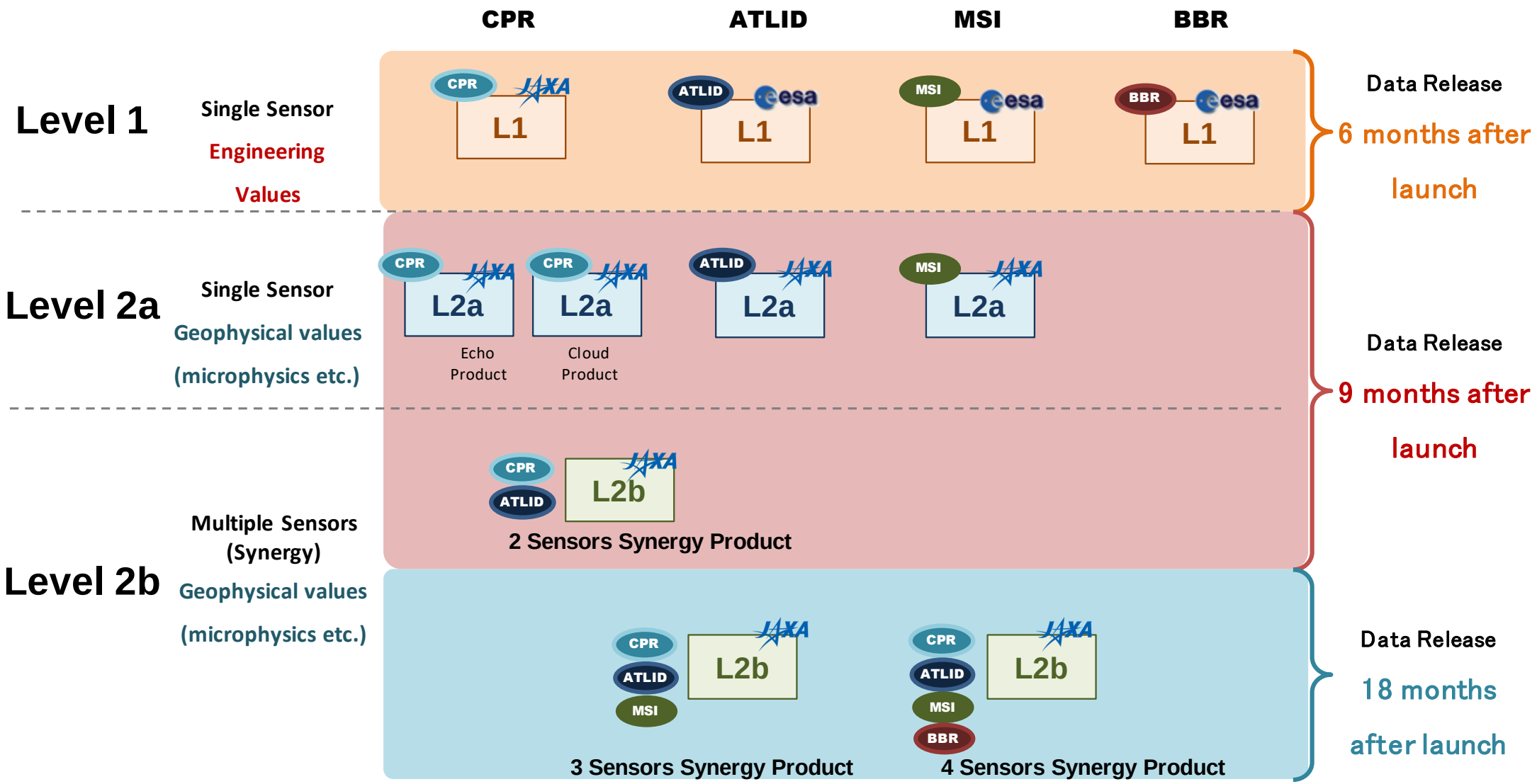
EarthCARE JAXA Product

- Level 1 product will be developed by sensor provider agencies.
  - ✓ i.e. JAXA will provide CPR Level 1 product
- JAXA and ESA develop Level 2 geophysical products individually, and continuous exchange of information is being conducted between Japan and Europe through the Joint Algorithm Development Endeavor (JADE), under the framework of the Joint Mission Advisory Group (JMAG).
- JAXA and ESA products will be distributed by both agencies.
  - ✓ Users can acquire products of both agencies from the websites of both agencies; the ESA website provides JAXA products in addition to ESA products, and the JAXA G-Portal website distributes ESA and JAXA products as well (Wehr et al. 2023, *AMT*).
- For JAXA Level 2 Products, it is consisted by two categories;
  - ☐ **Standard Products**
    - strongly promoted to be developed and released
    - processed and released from JAXA G-Portal
    - all data will be able to be sent to ESA when produced
  - ☐ **Research Products**
    - promoted to be developed
    - released from JAXA Earth Observation Research Center(EORC)
    - some are planned to be upgraded to standard products

JAXA G-Portal (data dissemination system)
https://gportal.jaxa.jp/gpr/?lang=en



EarthCARE science data processing chain (JAXA Standard products)

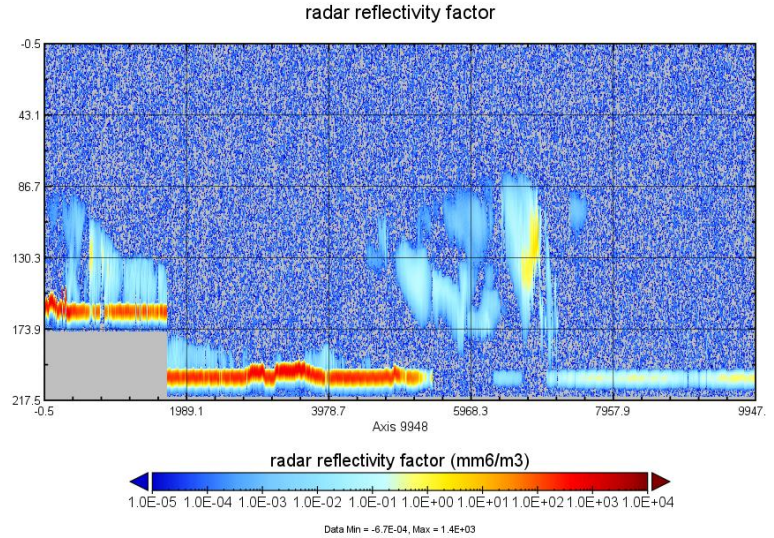


JAXA CPR Level 1 Processor Status

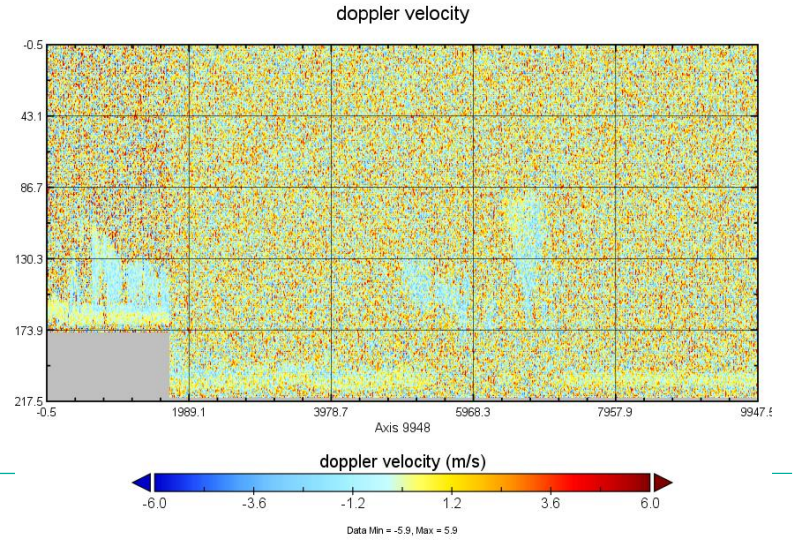
- In CPR level 1b products, received echo power, radar reflectivity factor, Doppler velocity, spectrum width, normalized surface scattering cross section, and data flag are included.
  - ➢ The CPR Level 0 data is delivered from ESA PDGS to JAXA's EarthCARE mission operation system (MOS).
  - ➢ This is then processed by CPR level 1b processor which turns the raw data in engineering units into calibrated parameters, such as received echo power and Doppler velocity, stored in level 1b data products. Geolocations, quality information, and error descriptors are added to the level 1b products as well.
    - ✓ See more descriptions in Eisinger et al. (2023, *AMT*)
  - ➢ CPR Level 1b Processor Version 0.29 was used for the integration test related to the Ground Segment Acceptance Review (GS-AR), and L0-L2 sequential processing chain were verified there.

JAXA L1b processor results using synthetic data (Halifax)

CPR L1b Radar reflectivity factor profile



CPR L1b Doppler velocity profile

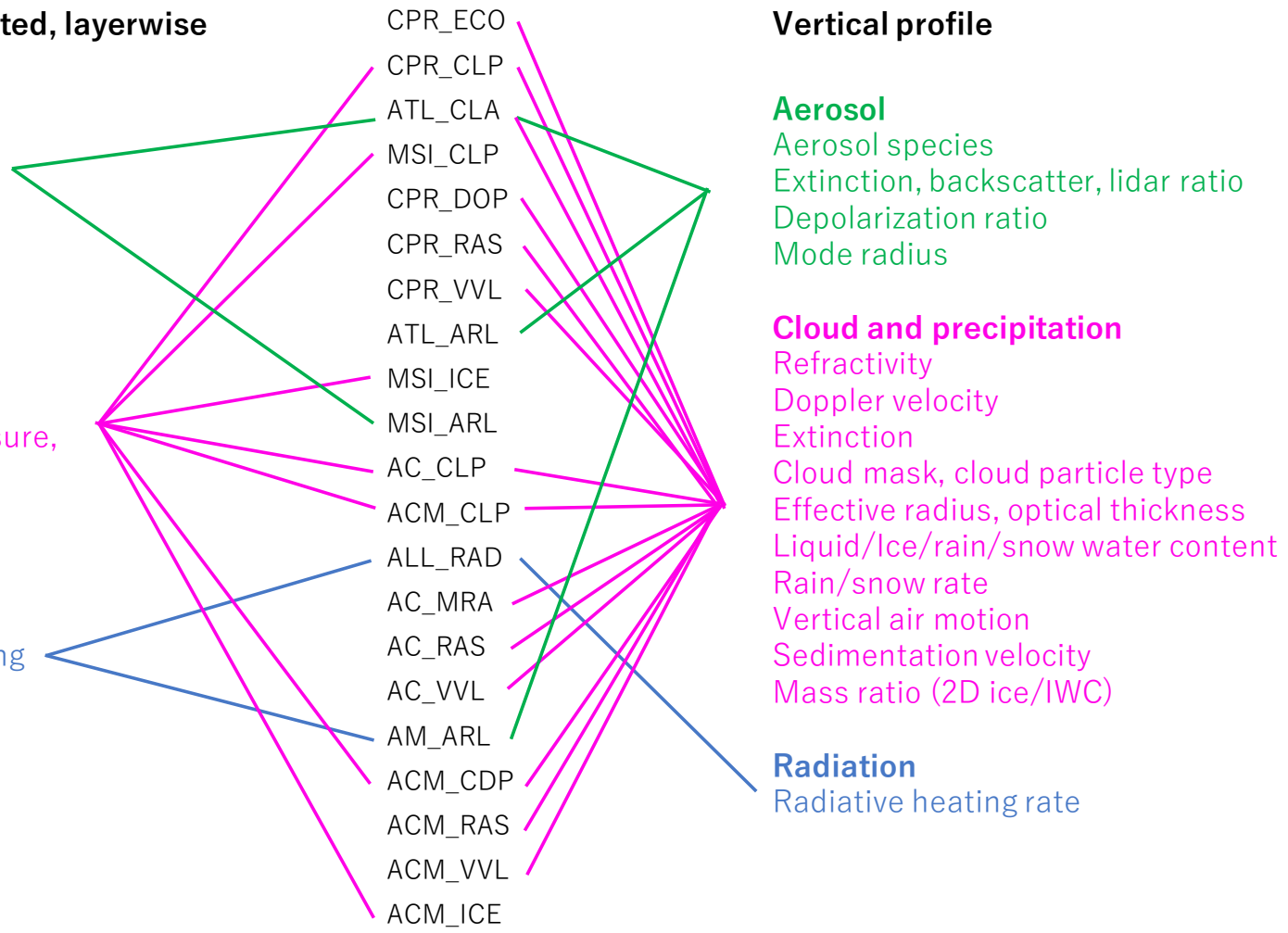


Overview of JAXA L2a and L2b data products

Overview of JAXA L2a and L2b data products containing retrieved aerosol, cloud, precipitation and radiation parameters.

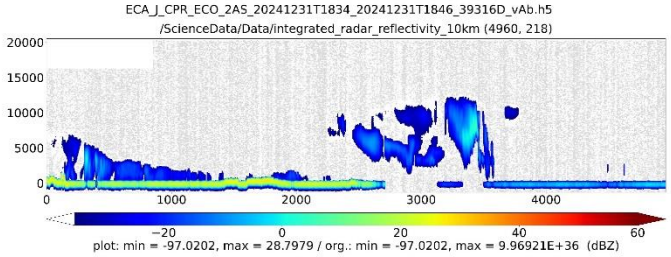
The column in the middle lists the names of the respective L2 data products (Wehr et al. 2023, *AMT*).

Overview of JAXA L2 products

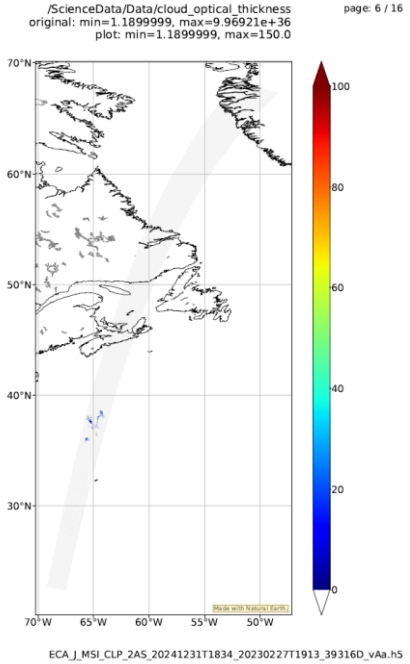


Expected views of JAXA EarthCARE Level 2 products using synthetic L1 data (Halifax)

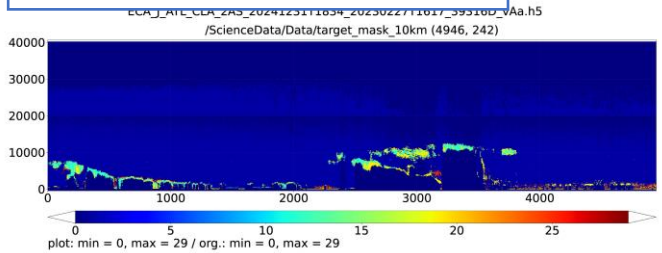
CPR (cloud, doppler velocity)



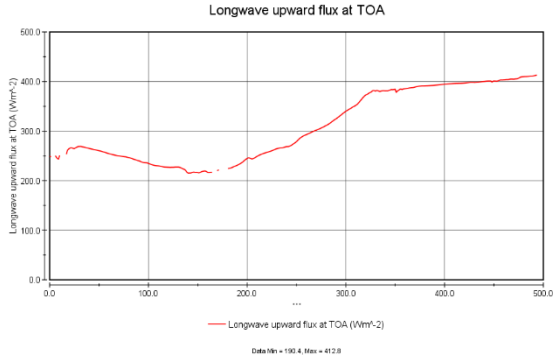
MSI (cloud, aerosol)



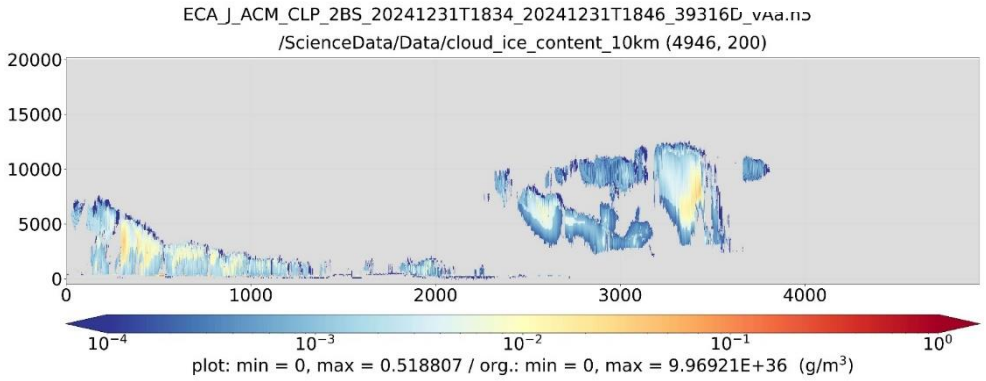
ATLID (cloud, aerosol)



4-sensor synergy (Radiation)



2-sensor synergy (CPR+ATLID) and 3-sensor synergy (CPR+ATLID+MSI)



L2 processor status:

- We completed developments of Level 2 processor Version 0.4 on September 2023.
- Version 0.4 was used for the integration test related to the GS-AR, and L0-L2 sequential processing chain were verified there.

EarthCARE JAXA Science Team Algorithm & Simulator (as of 2023)

PI

CI

EarthCARE JAXA Project Scientist

Hajime Okamoto (Kyushu Univ.)

Algorithm

Standard — CPR

- Hiroaki Horie (NICT)
- Yuichi Ohno (NICT)
- Kenji Sato (NICT)
- Yuichiro Hagihara (JAXA)

Standard — CPR, CPR-ATLID, CPR-ATLID-MSI

- Hajime Okamoto (Kyushu Univ.)
- Kaori Sato (Kyushu Univ.)
- Eiji Oikawa (JMA/MRI)
- Hiroshi Ishimoto (MRI)

Standard — ATLID

- Tomoaki Nishizawa (NIES)
- Rei Kudo (MRI)
- Akiko Higurashi (NIES)
- Yoshitaka Jin (NIES)
- Hitoshi Irie (Chiba Univ.)
- Tetsu Sakai (MRI)

Standard — MSI

- Takashi Nakajima (Tokai Univ.)
- Minrui Wang (Tokai Univ.)

Standard — 4-Sensors

- Kentaroh Suzuki (Tokyo Univ.)
- Akira Yamauchi (Tokyo Univ.)
- Yousuke Satoh (Hokkaido Univ.)
- Eiji Oikawa (Kyushu Univ.)
- Miho Sekiguchi (Tokai Univ.)
- Takashi Nagao (Tokyo Univ.)

Simulator

Joint-Simulator

- Masaki Satoh (Tokyo Univ.)
- Roh Woosub (Tokyo Univ.)
- Tampei Hashino (Koch Univ. of Technorgy)
- Toshihisa Matsui (NASA)

	CPR	ATLID	MSI	BBR	CPR-ATLID	ATLID-MSI	CPR-ATLID-MSI	4-Sensor
Standard	■■	■	■		■		■	■
Research	■■	■	■■	■	■	■	■■	

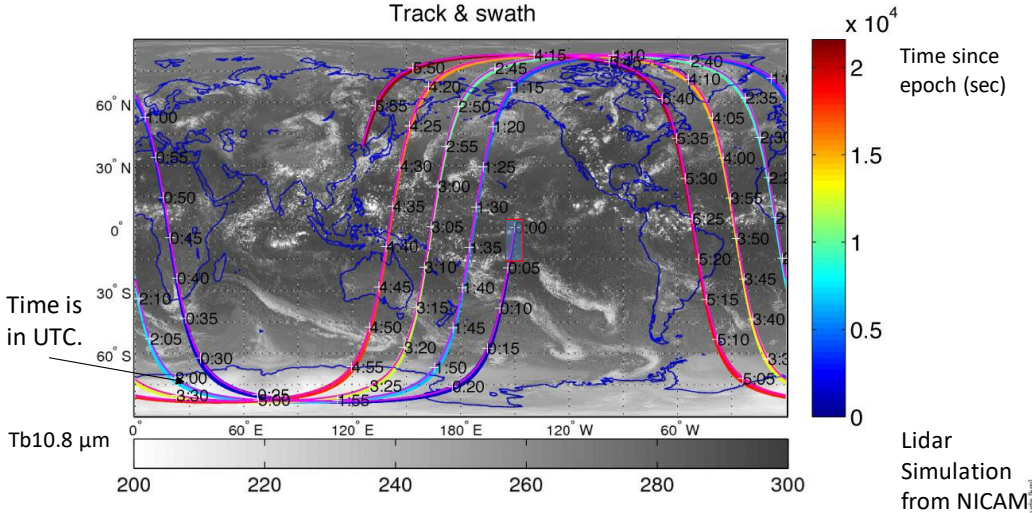
Japanese synthetic data for algorithm development

- EarthCARE synthetic data using a global storm-resolving (NICAM) and Joint-Simulator (J-Sim) have been developed in Japan and used in the JAXA L2 algorithm developments.
  - ✓ Synthetic data description paper, Roh et al. (2023, *AMT*) was published in the AMT.

Introduction to EarthCARE synthetic data using a global storm-resolving simulation.
Roh et al., *Atmos. Meas. Tech.*, 16, 3331–3344, https://doi.org/10.5194/amt-16-3331-2023

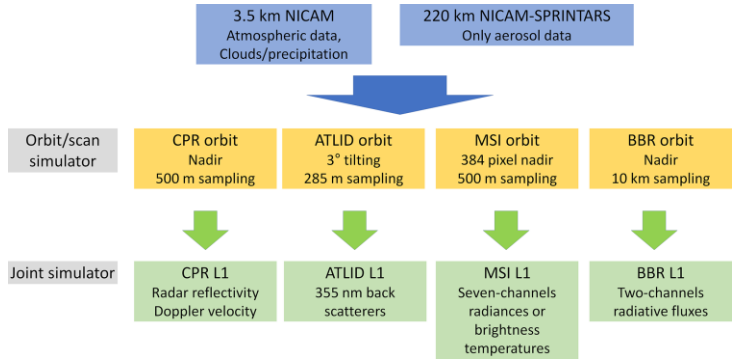
EarthCARE L1 data construction in Japan

Algorithms have been developed using the synthetic data by the Joint-Simulator in the JAXA EarthCARE Science team.

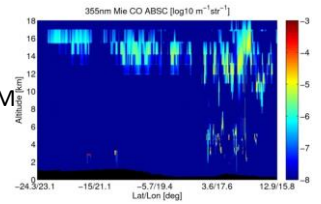


- NICAM 3.5 km simulation, 2008 June 19th 00Z
- The data was interpolated based on the sampling procedure of each sensor.
- The orbit was simulated such a way that EarthCARE passes equator at 14:0 local time in the descending node.

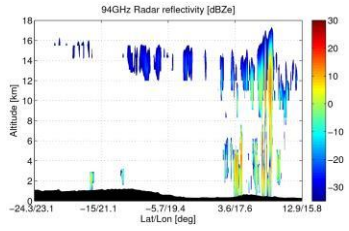
EarthCARE L1 data simulated by Joint-Simulator (J-Sim) with NICAM-SPRINTARS



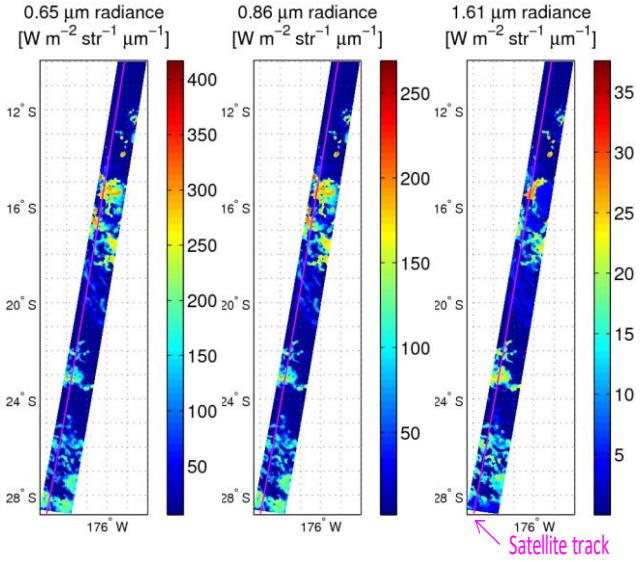
Lidar Simulation from NICAM



CPR Radar reflectivity Simulation from NICAM



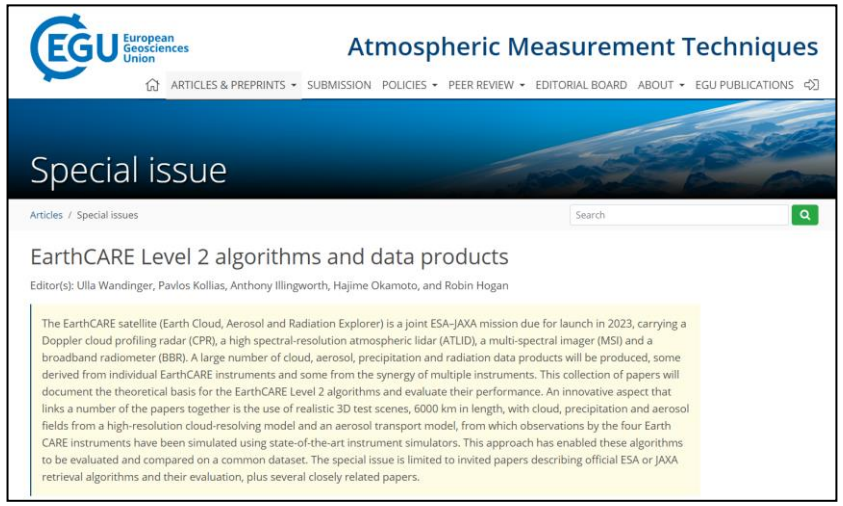
MSI radiance simulation from NICAM



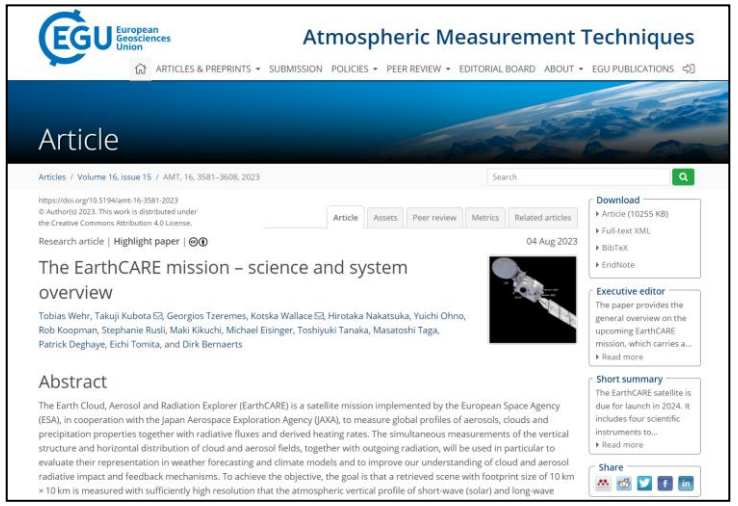
EarthCARE Special issue in AMT

- **A special issue in on-going as "EarthCARE Level 2 algorithms and data products" in the EGU journal Atmospheric Measurement Techniques (AMT).**
  - ✓https://amt.copernicus.org/articles/special_issue1156.html
- **ESA/JAXA/NICT paper**
  - ✓ The EarthCARE mission – science and system overview, Tobias Wehr, Takuji Kubota, Georgios Tzeremes, Kotska Wallace, Hirotaka Nakatsuka, Yuichi Ohno, Rob Koopman, Stephanie Rusli, Maki Kikuchi, Michael Eisinger, Toshiyuki Tanaka, Masatoshi Taga, Patrick Deghaye, Eichi Tomita, and Dirk Bernaerts, Atmos. Meas. Tech., 16, 3581–3608, https://doi.org/10.5194/amt-16-3581-2023, 2023
  - ✓ The EarthCARE Mission: Science Data Processing Chain Overview, Michael Eisinger, Fabien Marnas, Kotska Wallace, Takuji Kubota, Nobuhiro Tomiyama, Yuichi Ohno, Toshiyuki Tanaka, Eichi Tomita, Tobias Wehr, and Dirk Bernaerts, EGUsphere, https://doi.org/10.5194/egusphere-2023-1998, 2023

We really appreciate efforts by Editors: Drs. Ulla Wandinger, Pavlos Kollias, Anthony Illingworth, Hajime Okamoto, and Robin Hogan.

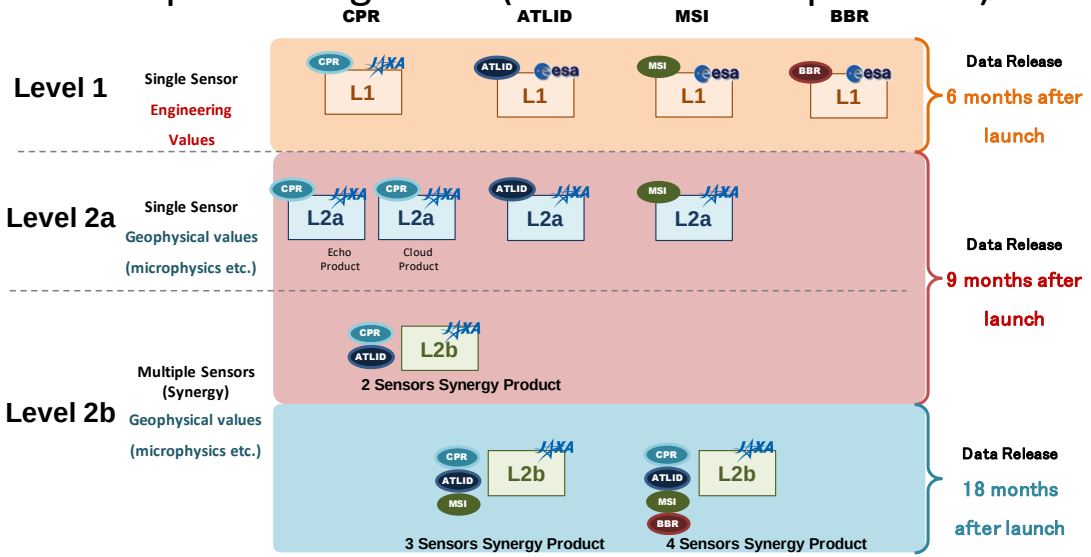


Wehr et al. (2023) for EarthCARE Science and system overview paper by ESA/JAXA/NICT was **selected as "Highlight paper" in the AMT.**

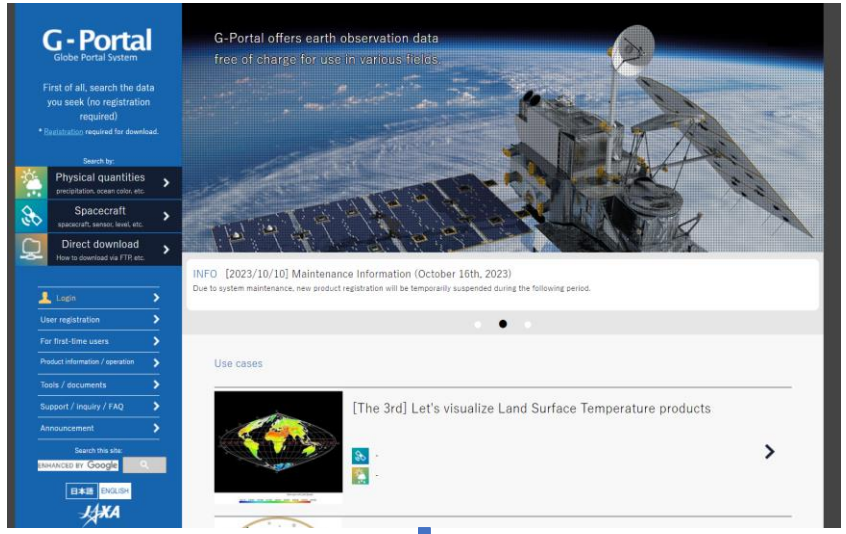


Summary + Flow of EarthCARE data utilization

EarthCARE science data product and processing chain (JAXA Standard products)



JAXA G-Portal (data dissemination system) & the ESA website



- Cloud/Aerosol/ Radiation research groups
- Climate model group (Univ. Tokyo, JMA/MRI, JAMSTEC, NIES, …)
- Storm-resolving model groups (Univ. Tokyo, JAMSTEC, RIKEN, …)
- Weather model groups (JMA/MRI, RIKEN, …)
- Aerosol model groups (NIES, JMA/MRI, Kyusyu Univ., …)

Appendix:
JAXA EarthCARE Product Model

EarthCARE JAXA L2 Production Model