EarthCARE
Earth Cloud, Aerosol and Radiation Explorer

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JAXA Overview of the EarthCARE

Takuji Kubota
Earth Observation Research Center (EORC)
Japan Aerospace Exploration Agency (JAXA)
March 2023

EarthCARE Satellite

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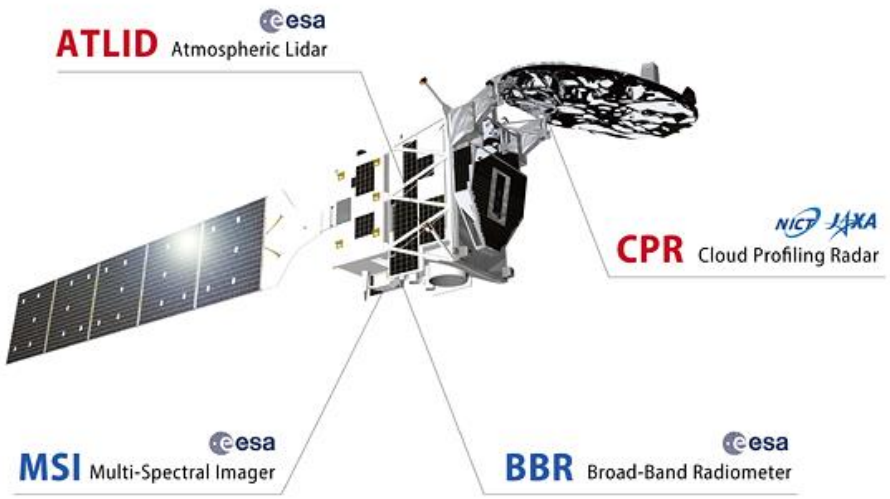

Institutions	European Space Agency（ESA）／National Institute of Information and Communications Technology（NICT）／Japan Aerospace Exploration Agency（JAXA）
Launch	2024
Mission Duration	3-years
Mass	Approx. 2200kg
Orbit	Sun-synchronous sub-recurrent orbit Altitude: approx. 400km Mean Local Solar Time (Descending): 14:00
Repeat Cycle	25 days
Orbit Period	5552.7 seconds
Semi Major Axis	6771.28 km
Eccentricity	0.001283
Inclination	97.050°

Mean Local Time : Approx. 14:00 (Descending)
2:00 (Ascending)

EarthCARE

Earth Clouds, Aerosol and Radiation Explorer

EarthCARE is an earth observation satellite that Japan and Europe have been jointly developing to observe clouds, aerosols and radiation (Illingworth et al. 2015, *BAMS*).

Observation Instruments on EarthCARE

- **CPR** — Cloud Profiling Radar (NICT JAXA)
- **ATLID** — Atmospheric Lidar (esa)
- **MSI** — Multi-Spectral Imager (esa)
- **BBR** — Broadband Radiometer (esa)

Synergetic Observation by 4 sensors

Needs vs EarthCARE

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- Clouds and Aerosols continue to contribute the two largest sources of uncertainty in current climate predictions.
- The need for reliable information on the vertical structure of clouds and aerosol layers

Needs
Observation Needs/Target

Mission objectives: Improving the understanding of cloud-aerosol-radiation interactions so as to include them correctly and reliably in climate and numerical weather prediction models.

Vertical profiles of extinction and characteristics of aerosols	Vertical profiles of liquid, supercooled and ice water, cloud overlap, particle size and extinction	Convective updraft and ice fall speed	Horizontal structure of clouds and aerosols	Shortwave and longwave fluxes at Top of Atmosphere
Techniques Remote Sensing Techniques				
Active: High Spectral Resolution LIDAR (HSRL)	Active: Millimeter-wave RADAR	Active: Doppler RADAR	Passive: Muiltispectral Imager	Passive: Broadband Radiometer
EarthCARE Instruments				
ATLID: Atmospheric Lidar	CPR: Cloud Profiling Radar		MSI: Multispectral Imager	BBR: Broadband Radiometer

Photo of the EarthCARE/CPR

CPR instrument @ JAXA Tsukuba Space center (Sep. 2015)

EarthCARE@Airbus（April.2021）
©Airbus

Wehr et al. (2023, AMT)

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- A paper titled as "**The EarthCARE Mission – Science and System Overview**" by Tobias Wehr, Takuji Kubota et al. is now in revision for AMT (Atmospheric Measurement Techniques)
- A preprint is available from https://doi.org/10.5194/egusphere-2022-1476

Our beloved

Tobias Wehr

Bremen, Germany
19 October 1965

Leiden, Netherlands
1 February 2023

Abby
Isabela
Martin
Yumi
Kyoko

Willem Alexanderstraat 10, 2215 CC Voorhout

He remains in repose at the Afscheidshuis, Herenstraat 51, Voorhout.

Visits are possible on:
Friday, 3th of February 15:00 - 18:00
Saturday, 4th of February 14:00 - 18:00

A Holy Mass will be offered on Monday 6th of February at 13:00 in the church of St. Bartholomeus, Herenstraat 47, Voorhout, before we lay him to rest at the adjacent cemetery.

Reception follows in restaurant Boerhaave, Herenstraat 57, Voorhout.

Precious memories and photos can be shared on https://afscheid.nabestaandenloket.nl/tobias-wehr

Wehr, T., Kubota, T., Tzeremes, G., Wallace, K., Nakatsuka, H., Ohno, Y., Koopman, R., Rusli, S., Kikuchi, M., Eisinger, M., Tanaka, T., Taga, M., Deghaye, P., Tomita, E., and Bernaerts, D.: The EarthCARE Mission – Science and System Overview, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2022-1476, 2023.

Illustrations for EarthCARE Satellite

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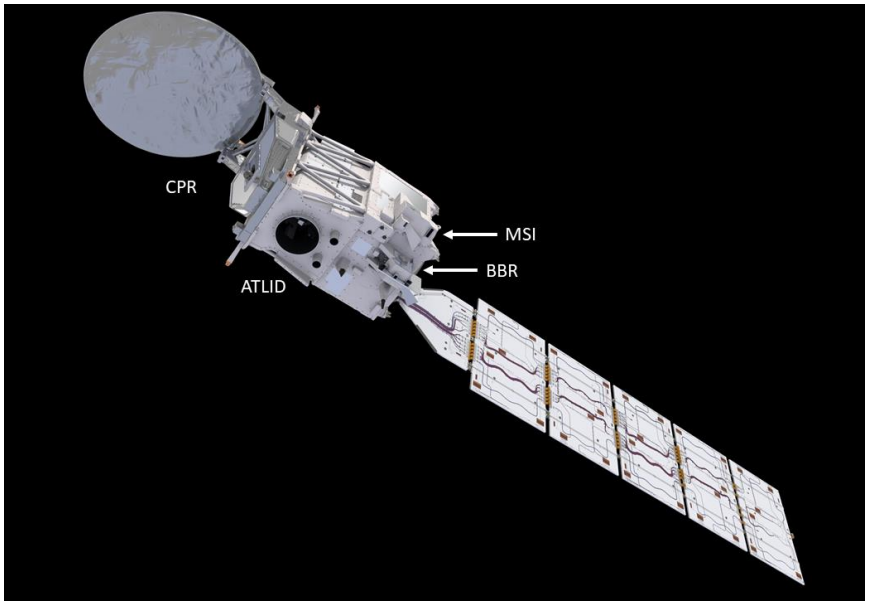


Figure 1. Artist impression of the EarthCARE satellite with the location of the four science instruments. (ESA and ATG Medialab, The Netherlands)

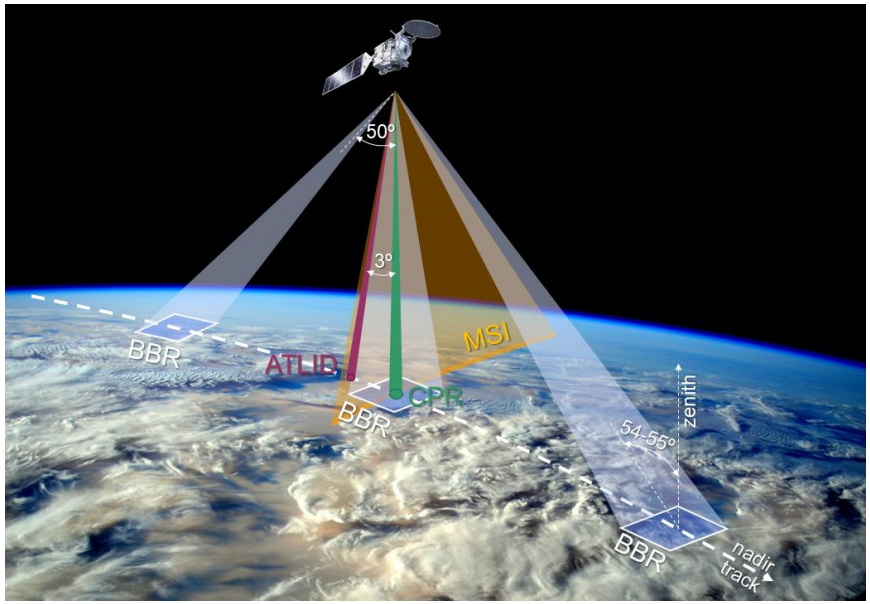


Figure 2. Illustration of viewing geometry (not proportional).

- The CPR is pointing exactly nadir (indicated in green). The radar footprint is approximately 700 m (3 dB antenna beam).
- ATLID is pointed 3◦ off-nadir backwards along track to minimise specular reflection from ice crystals. Its telescope footprint is <30 m.
- The MSI swath is 150 km wide, tilted away from the sun glint affected side, so that it extends 35 km to one side of nadir and 115 km to the other.
- The BBR has three fixed telescopes, forward, nadir and back-wards pointing. The scene size is configurable. The nominal size is 10 km × 10 km, but a size of 5 km wide and 21 km long will be used for radiative transfer calculation and closure assessment (Cole et al., 2022). The BBR fore- and aft-views are pointing 50◦ forward and backwards, respectively, leading to a zenith angle on ground of 54-55◦.

Wehr, T., Kubota, T., Tzeremes, G., Wallace, K., Nakatsuka, H., Ohno, Y., Koopman, R., Rusli, S., Kikuchi, M., Eisinger, M., Tanaka, T., Taga, M., Deghaye, P., Tomita, E., and Bernaerts, D.: The EarthCARE Mission – Science and System Overview, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2022-1476, 2023.

Sensors for EarthCARE Satellite (1/2)

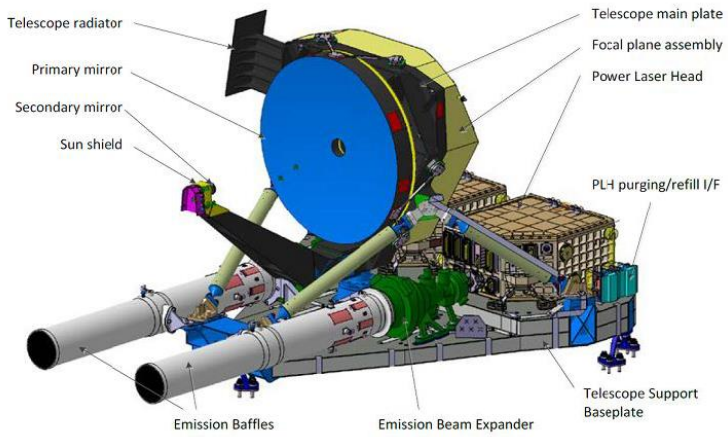


Figure 3. Illustration of ATLID bistatic architecture. This graphic representation shows the two fully redundant transmitting chains including their emission telescopes. The long emission baffles at the exit of the two laser heads minimise risk of LIC for the exit windows. (Courtesy of Airbus DS, France.).

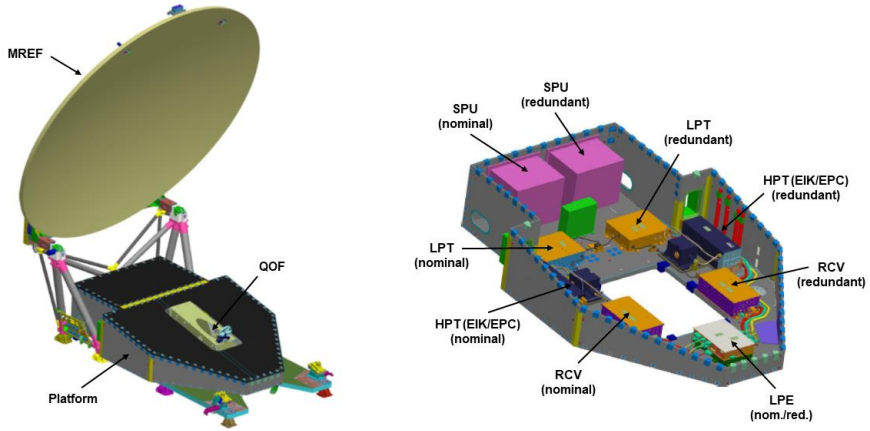


Figure 10. CPR external view with Main Reflector (MREF) deployed (left) and major components layout inside Platform with upper panel opened (right). (Courtesy of NEC)

Wehr, T., Kubota, T., Tzeremes, G., Wallace, K., Nakatsuka, H., Ohno, Y., Koopman, R., Rusli, S., Kikuchi, M., Eisinger, M., Tanaka, T., Taga, M., Deghaye, P., Tomita, E., and Bernaerts, D.: The EarthCARE Mission – Science and System Overview, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2022-1476, 2023.

Sensors for EarthCARE Satellite (2/2)

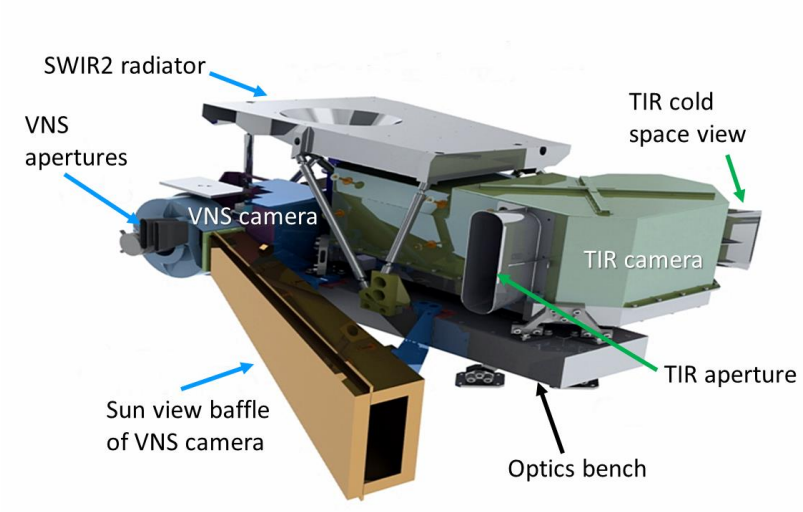


Figure 12. MSI optical bench. VNS stands for Visible-NIR-SWIR camera, TIR stands for Thermal-Infrared camera. (Courtesy of SSTL, UK.)

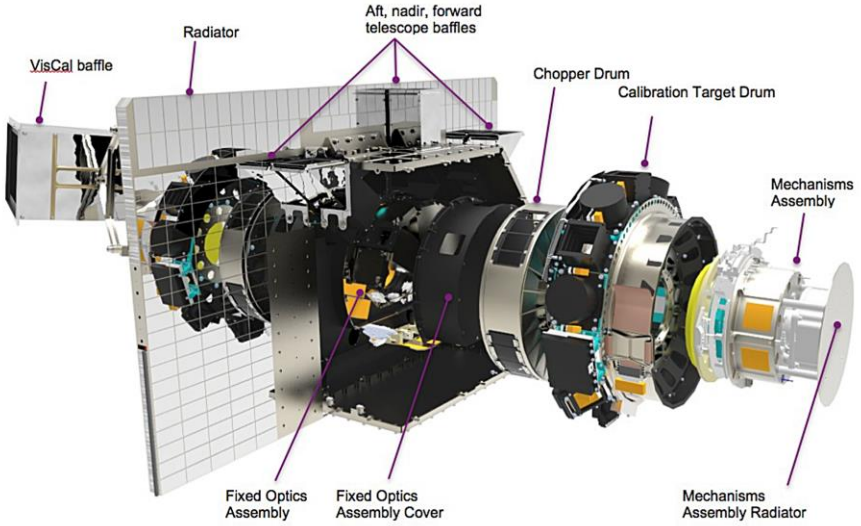
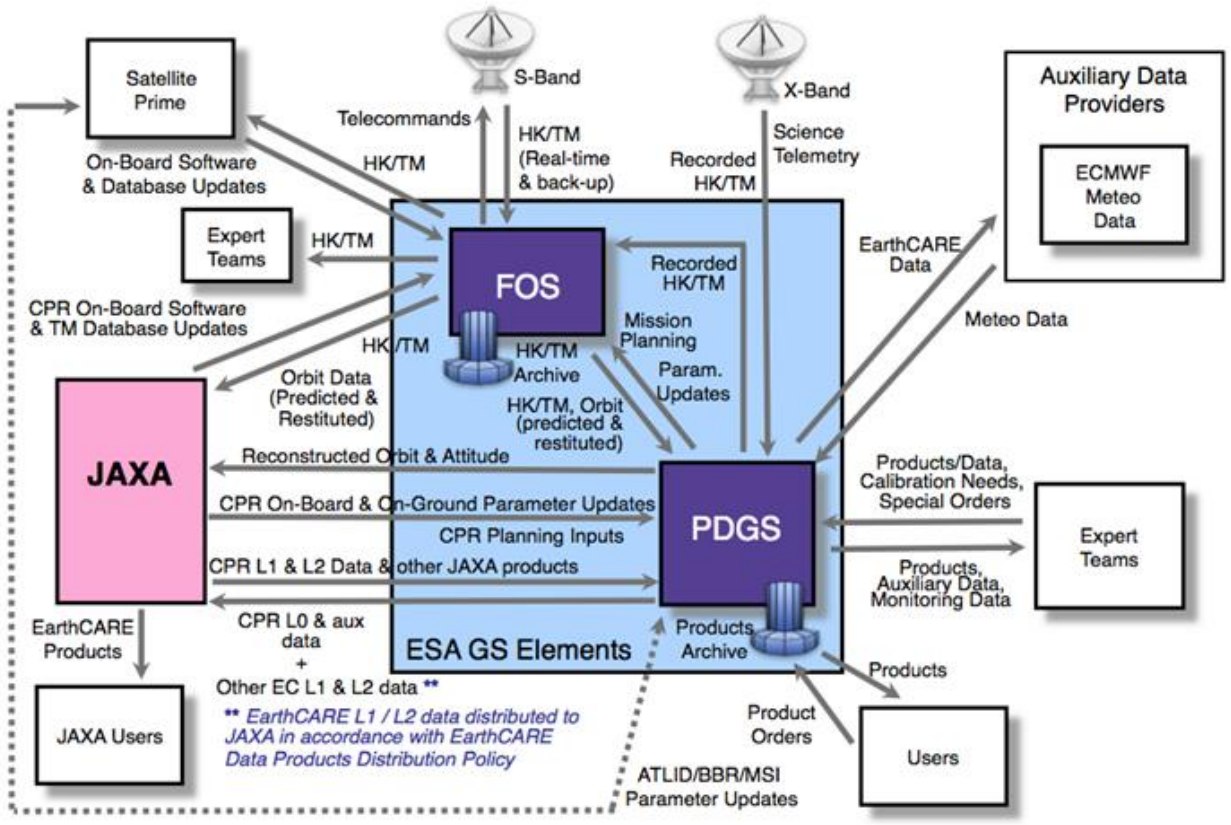


Figure 18. Exploded view of the BBR instrument.
(Courtesy of STFC RAL Space, UK.)

Wehr, T., Kubota, T., Tzeremes, G., Wallace, K., Nakatsuka, H., Ohno, Y., Koopman, R., Rusli, S., Kikuchi, M., Eisinger, M., Tanaka, T., Taga, M., Deghaye, P., Tomita, E., and Bernaerts, D.: The EarthCARE Mission – Science and System Overview, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2022-1476, 2023.

Ground Segment Functional Overview



- The S-Band station, at Kiruna, Sweden, will downlink the Telemetry (TM) data from the satellite and uplink the Telecommand (TC) data.
- The two X-Band stations for transmission of the science data will be located in Kiruna, Sweden, and Inuvik, Canada.

- **The ESA Flight Operations Segment (FOS), located in ESA-ESOC, Darmstadt, Germany.**
- **The ESA Payload Data Ground Segment (PDGS), located in ESA-ESRIN, Frascati, Italy.**
- **The JAXA Satellite Applications and Operations Center (SAOC), located in Tsukuba, Japan**

Figure 23. EarthCARE Ground Segment Functional Overview.

Wehr, T., Kubota, T., Tzeremes, G., Wallace, K., Nakatsuka, H., Ohno, Y., Koopman, R., Rusli, S., Kikuchi, M., Eisinger, M., Tanaka, T., Taga, M., Deghaye, P., Tomita, E., and Bernaerts, D.: The EarthCARE Mission – Science and System Overview, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2022-1476, 2023.

Overview of ESA L2a and L2b data products

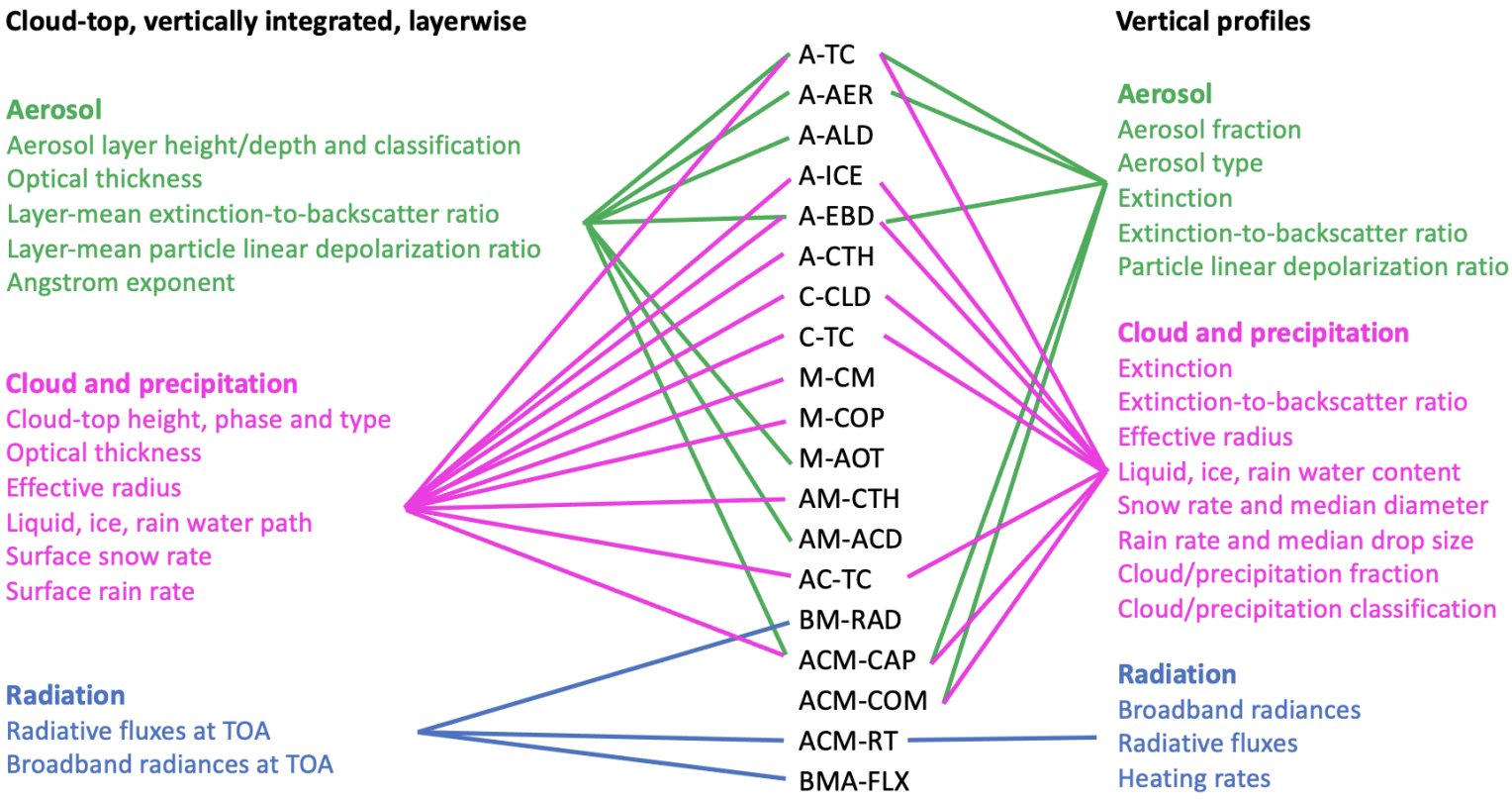


Figure 25. Overview of ESA L2a and L2b data products containing retrieved aerosol, cloud, precipitation and radiation parameters. The column in the middle lists the names of the respective L2 data products.

Wehr, T., Kubota, T., Tzeremes, G., Wallace, K., Nakatsuka, H., Ohno, Y., Koopman, R., Rusli, S., Kikuchi, M., Eisinger, M., Tanaka, T., Taga, M., Deghaye, P., Tomita, E., and Bernaerts, D.: The EarthCARE Mission – Science and System Overview, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2022-1476, 2023.

Overview of JAXA L2a and L2b data products

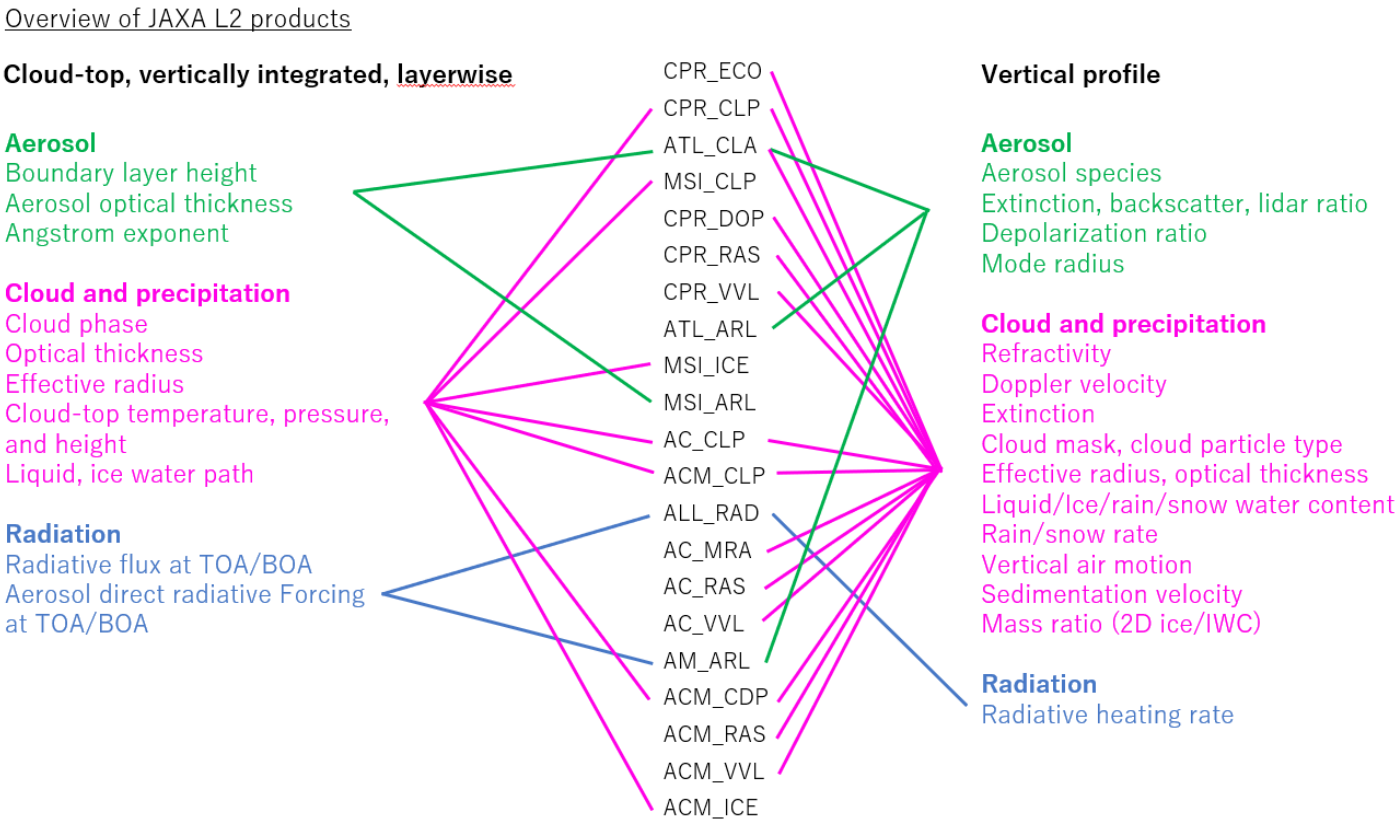


Figure 26. Overview of JAXA L2a and L2b data products containing retrieved aerosol, cloud, precipitation and radiation parameters. The column in the middle lists the names of the respective L2 data products.

Wehr, T., Kubota, T., Tzeremes, G., Wallace, K., Nakatsuka, H., Ohno, Y., Koopman, R., Rusli, S., Kikuchi, M., Eisinger, M., Tanaka, T., Taga, M., Deghaye, P., Tomita, E., and Bernaerts, D.: The EarthCARE Mission – Science and System Overview, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2022-1476, 2023.

JAXA & ESA Level 1 Product & JAXA Standard Level 2 Product

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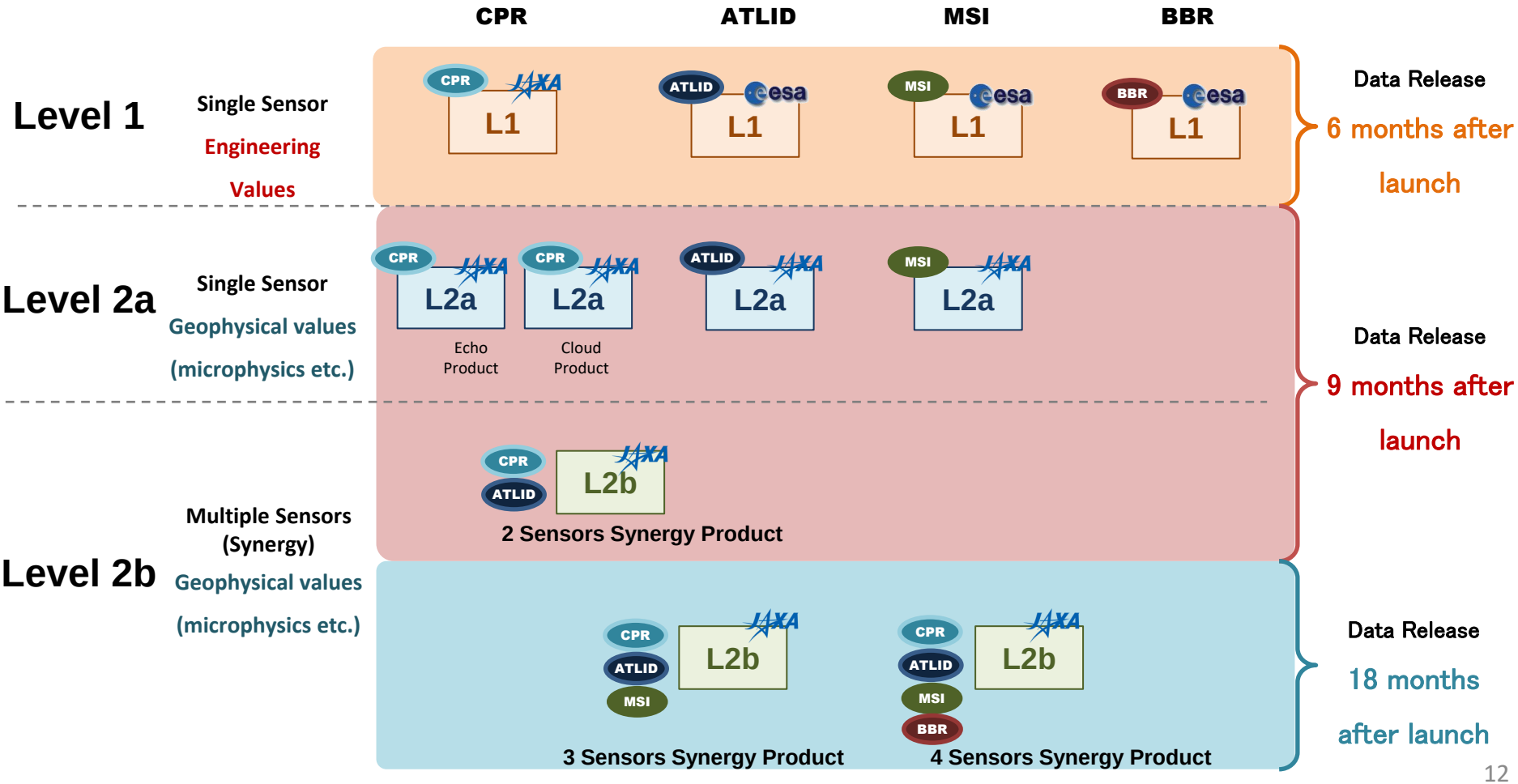
As for L2 products, both agencies (ESA & JAXA) develop algorithms independently, although continuous exchange of information is being conducted between Japan and Europe through the Joint Algorithm Development Endeavor (JADE) under the framework of the Joint Mission Advisory Group (JMAG) (Wehr et al. 2023).



EarthCARE JAXA Science Team Algorithm & Simulator (as of 2022)

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PI

CI

EarthCARE JAXA Project Scientist
Hajime Okamoto (Kyushu Univ.)

Algorithm

Standard CPR
- Yuichi Ohno (NICT)
- Hiroaki Horie (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
- Tomoyuki 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	■■	■	■■	■	■	■	■■	

JAXA Algorithm development with the Joint-Simulator L1 synthetic data

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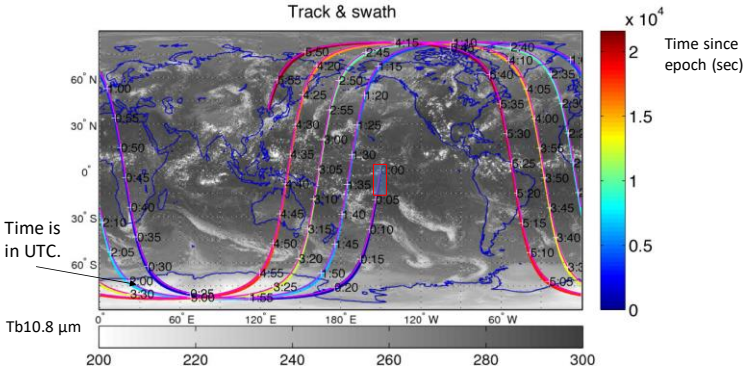
Joint Simulator for Satellite Sensors
Joint-Simulator

- Level 2 algorithm development ongoing
  - Developments by 6 Algorithm PIs are ongoing.
  - Now All JAXA EarthCARE L2 algorithms can input synthetic data with the JAXA/ESA L1 formats from the Joint-Simulator and output physical variables in the JAXA L2 format.
- JAXA L2 ATBD is provided in the JAXA/EORC Website: http://www.eorc.jaxa.jp/EARTHCARE/index.html

EarthCARE L1 data construction in Japan

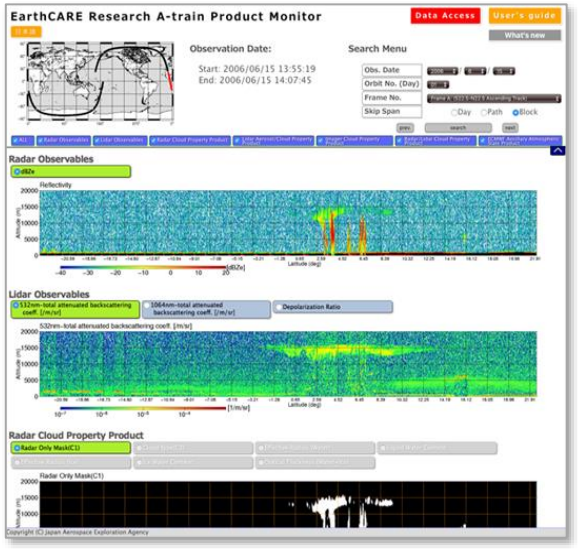
Algorithms have been developed using the synthetic data by the Joint-Simulator in the JAXA EarthCARE Science team.



- 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 14:00 local time in the descending node.

JAXA has provided the "**EarthCARE Research A-Train Product**" since Oct. 2017.

http://www.eorc.jaxa.jp/EARTHCARE/research_product/ecare_monitor_e.html



Roh, W., Satoh, M., Hashino, T., Matsugishi, S., Nasuno, T., and Kubota, T.: Introduction to EarthCARE synthetic data using a global storm-resolving simulation, Atmos. Meas. Tech. Discuss. [preprint], https://doi.org/10.5194/amt-2023-18, in review, 2023.

Joint works with climate model groups

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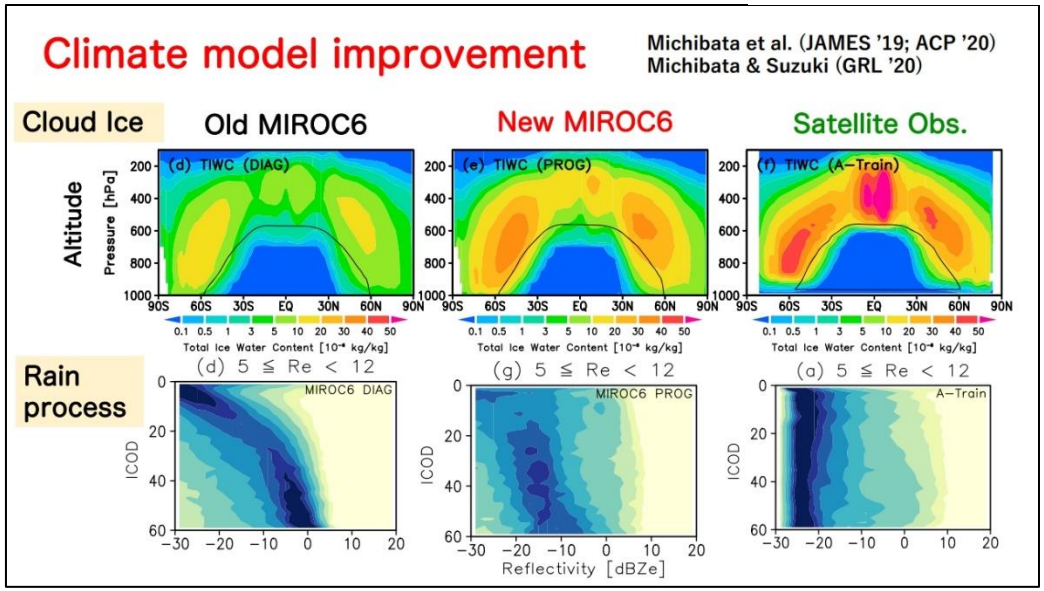
- JAXA is collaborating as "**Japanese office of the EarthCARE-model collaborative project**" with Prof. Suzuki (Univ. Tokyo) group for developing the **Japanese climate model (MIROC),** which is one of the IPCC models**,** for the EarthCARE data utilization.
- This office collaborates groups of Meteorological Research Institute Earth System Model (**MRI-ESM**), which is also one of the IPCC climate models in Japan, and the high-resolution climate model **NICAM**, in order to mutually evaluate the climate models using EarthCARE data.

Provided by Prof. Suzuki (Univ. Tokyo)

The CFMIP Observation Simulator Package (COSP) for **EarthCARE/CPR** will be developed in this office and used to develop an evaluation method for climate models.



Joint works with storm-resolving model groups

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JAXA is collaborating with the **Japanese global storm-resolving model (NICAM)** for the EarthCARE data utilization with the Joint-Simulator.

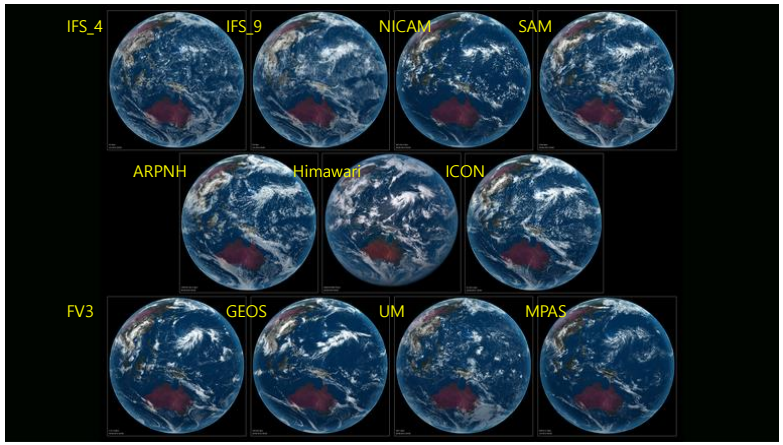
- Prof. Satoh (Univ. Tokyo) group
- Dr. Seiki (JAMSTEC) group
- Dr. Miyoshi (RIKEN) group

"Joint-Simulator" (Hashino et al. (2013, JGR) is helpful for evaluating storm-resolving models.

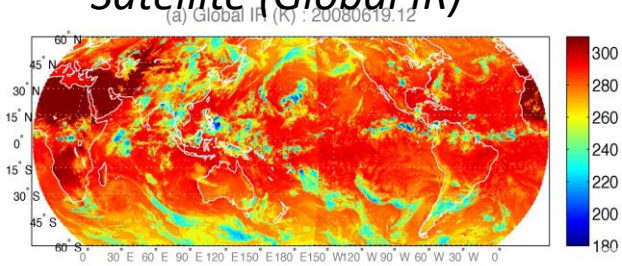
Source codes of the Joint-Simulator are open for science community with registration from
http://www.eorc.jaxa.jp/theme/Joint-Simulator/userform/js_userform.html
Team home page:
https://sites.google.com/site/jointsimulator/

NICAM has attended the DYAMOND activity.
DYAMOND: *The DYnamics of the Atmospheric general circulation Modeled On Non-hydrostatic Domains*
(Stevens et al. 2019)

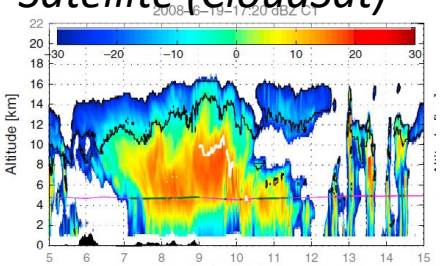
Snapshot of high-resolution DYAMOND models



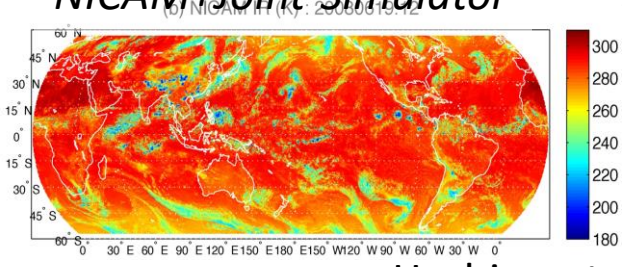
Satellite (Global IR)



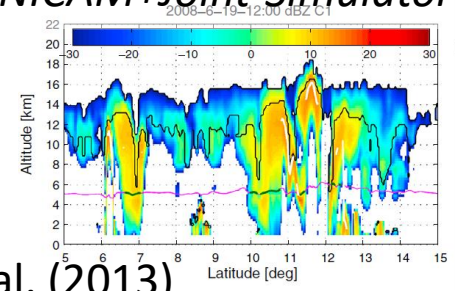
Satellite (CloudSat)



NICAM+Joint-Simulator



NICAM+Joint-Simulator



Hashino et al. (2013)

Joint works with weather/aerosol model & polar research groups

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JAXA started joint works for Numerical Weather Prediction (NWP), aerosol monitoring & prediction, and polar research in April 2022.

- Joint research with the Japan Meteorological Agency (JMA) Meteorological Research Institute (MRI) for the NWP
  - We will evaluate and improve the cloud and precipitation processes of numerical models and develop assimilation techniques of EarthCARE data for the NWP systems.
    - PI: Dr. K. Okamoto (JMA/MRI) for global JMA model
    - PI: Dr. Y. Ikuta (JMA/MRI) for regional JMA model
- Aerosol monitoring and prediction
  - Aeolian Dust (Kosa) Prediction
    - PI: Prof. K. Yumimoto (Kyusyu Univ.)
  - Air pollution prediction
    - PI. Dr. D. Goto (National Institute for Environmental Studies/ NIES)
  - Volcanic ash monitoring
    - PI: Dr. H. Ishimoto (JMA/MRI) (as the GCOM-C PI)
- Polar research
  - PI: Prof. N. Hirasawa (National Institute of Polar Research/NIPR)

Summary

EarthCARE
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- EarthCARE Overview
  - EarthCARE is an earth observation satellite that Japan and Europe have been jointly developing to observe clouds, aerosols and radiation. (Overview paper: Illingworth et al. 2015, BAMS, https://doi.org/10.1175/BAMS-D-12-00227.1)
  - A paper titled as "The EarthCARE Mission – Science and System Overview" by Tobias Wehr, Takuji Kubota et al. is now in revision for AMT.
- Algorithm status
  - Developments by 6 Algorithm PIs are ongoing in JAXA.
  - JAXA L2 ATBD is provided in the JAXA/EORC Website: http://www.eorc.jaxa.jp/EARTHCARE/index.html
  - JAXA A-Train Product for EarthCARE
    - http://www.eorc.jaxa.jp/EARTHCARE/research_product/ecare_monitor_e.html
- Applications with weather/climate models, polar research
- Coming events
  - ESA-JAXA EarthCARE Pre-Launch Science and Validation Workshop, 13-17 November 2023, ESRIN, Frascati, Italy.

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Appendix:
JAXA EarthCARE Product list

EarthCARE JAXA Product

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- 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, under the framework of the Joint Mission Advisory Group (JMAG).
- JAXA and ESA products will be distributed by both agencies.

- 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

EarthCARE Products

JAXA & ESA Product (L1b/c:Stand-alone)

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Sensor(s)	Processing Level	Product Name (Product ID for ESA)	Primary Parameter	Grid Spacing		File Unit File Format	Data Volume per day*
				Horizontal	Vertical		
CPR	L1b	CPR One-Sensor Received Power and Doppler Product	Received Echo Power / Radar Reflectivity Factor / Doppler Velocity / Pulse Pair Covariance / Spectrum Width	0.5 km	0.1 km	1/8 orbit HDF	51.3GB
			Surface Radar Cross Section	0.5 km	–		
ATLID	L1b	A-NOM	Rayleigh and Mie Backscattering coefficient * Mie component has horizontal and vertical depolarization component	0.285 km	0.103 km	1/8 orbit netCDF	91.6GB
MSI	L1b	M-NOM	Radiation Intensity * Visible(0.67μm), Near IR(0.865μm), SW IR(1.65μm, 2.21μm), LW IR(8.80μm, 10.80μm, 12.00μm)	0.5 km	–	1/8 orbit netCDF	83.9GB
BBR	L1b	B-NOM	SW and LW Radiation (Forward, Nadir, Backward)	10 km	–	1/8 orbit netCDF	2.3GB

Sensor(s)	Processing Level	Product Name (Product ID for ESA)	Primary Parameter	Grid Spacing		File Unit File Format	Data Volume per day*
				Horizontal	Vertical		
MSI	L1c	M-NOM	L1b Radiation Intensity (interpolated to the location of a reference band)	0.5 km	–	1/8 orbit netCDF	18.3GB

* 125 files per day is assumed without compression. ATLID, MSI, BBR is ESA product.

JAXA Standard Products (L2a:Stand-alone)

EarthCARE
Earth Cloud, Aerosol and Radiation Explorer
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Sensor(s)	Processing Level	Product Name	Primary Parameter (Red: Spatial-integrated values will be also generated)	Grid Spacing		File Unit File Format	Data Volume per day*
				Horizontal	Vertical		
CPR	L2a	CPR One-sensor Echo Products	Integrated Radar Reflectivity Factor Integrated Doppler Velocity Gas Correction Factor	1 km	0.1 km	1/8 orbit HDF	116.0GB
CPR	L2a	CPR One-sensor Cloud Products	Cloud Mask / Cloud Particle Type / Liquid Water Content / Ice Water Content / Effective Radius of Liquid Water Cloud / Effective Radius of Ice Water Cloud	1 km	0.1 km	1/8 orbit HDF	131.8GB
			Optical Thickness	1 km	–		
ATLID	L2a	ATLID One-sensor Cloud and Aerosol Products	Feature Mask	0.2 km	0.1 km	1/8 orbit HDF	70.8GB
			Target Mask	1 km	0.1 km		
			Aerosol Extinction Coeff. / Aerosol Backscat. Coeff. / Aerosol Lidar Ratio / Aerosol Depolarization Ratio	10km	0.1 km		
			Cloud Extinction Coeff. / Cloud Backscat. Coeff. / Cloud Backscat. Coeff. / Cloud Depolarization Ratio	1 km	0.1 km		
			Cloud Depolarization Ratio	1 km	0.1 km		
MSI	L2a	MSI One-sensor Cloud Products	Cloud Flag including Cloud Phase / Optical Thickness of Liquid Water Cloud / Effective Radius of Liquid (1.6 μm) / Effective Radius of Liquid (2.2 μm) / Cloud Top Temperature / Cloud Top Pressure / Cloud Top Height	0.5 km	–	1/8 orbit HDF	163.6GB

* 125 files per day is assumed without compression.

JAXA Standard Products (L2b:Synergy)

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Sensor(s)	Processing Level	Product Name	Primary Parameter (Red: Spatial-integrated values will be also generated)	Grid Spacing		File Unit File Format	Data Volume per day*
				Horizontal	Vertical		
CPR + ATLID	L2b	CPR-ATLID Synergy Cloud Products	Cloud Mask / Cloud Particle Type / Radar Reflective Factor with Attenuation / Liquid Water Content / Ice Water Content / Effective Radius of Liquid Water Cloud / Effective Radius of Ice Water Cloud	1 km	0.1 km	1/8 orbit HDF	136.7GB
			Optical Thickness	1 km	–		
CPR + ATLID + MSI	L2b	CPR-ATLID-MSI Synergy Cloud Products	Cloud Mask / Cloud Particle Type / Radar Reflective Factor with Attenuation / Liquid Water Content / Ice Water Content / Effective Radius of Liquid Water Cloud / Effective Radius of Ice Water Cloud	1 km	0.1 km	1/8 orbit HDF	136.7GB
			Optical Thickness / Liquid Water Path / Ice Water Path	1 km	–		
4 sensors	L2b	Four Sensors Synergy Radiation Budget Products	SW Radiative Flux / LW Radiative Flux	10 km	–	1/8 orbit HDF	7.3GB
			SW Radiative Heating Rate / LW Radiative Heating Rate	10 km	0.5 km		

* 125 files per day is assumed without compression.

JAXA Research Products (L2a:Stand-alone)

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Sensor(s)	Processing Level	Status	Product Name	Primary Parameter (Red: Spatial-integrated values will be also generated)	Grid Spacing		File Unit File Format
					Horizontal	Vertical	
CPR	L2a	Red R	CPR One-sensor Doppler Products	Doppler velocity correction value (considering inhomogeneity) / Doppler velocity unfolding Value / Radar Reflective Factor with Attenuation	1 km	0.1 km	1/8 orbit HDF
		ER	CPR One-sensor Rain and Snow Products	Rain Water Content / Snow Water Content / Rain Rate / Snow Rate	1 km	0.1 km	1/8 orbit HDF
		ER	CPR One-sensor Vertical Velocity Products	Vertical Air Motion / Sedimentation Velocity	1 km	0.1 km	1/8 orbit HDF
ATLID	L2a	ER	ATLID One-sensor Aerosol Extinction Products	Aerosol Extinction Coefficient (Water Soluble) / Aerosol Extinction Coefficient (Dust) / Aerosol Extinction Coefficient (Sea Salt) / Aerosol Extinction Coefficient (Black Carbon)	1 km	0.1 km	1/8 orbit HDF
MSI	L2a	ER	MSI One-sensor Ice Cloud Products	Optical Thickness of Ice Cloud with Reflection method / Effective Radius of Ice Cloud (1.6 μm) / Effective Radius of Ice Cloud (2.2 μm) / Ice Cloud Top Temperature / Ice Cloud Top Pressure / Ice Cloud Top Height	0.5 km	–	1/8 orbit HDF
		ER	MSI One-sensor Aerosol Products	Aerosol Optical Thickness (Ocean) / Aerosol Optical Thickness(Land) / Angstrom Exponent (Ocean)	0.5 km	–	1/8 orbit HDF

"Red R" = Research product, would be processed in JAXA EORC Research and Application System, and to be upgraded to standard after one year or later when the release accuracy is approved.
"ER" = Research product, would be processed in JAXA EORC Research and Application System. "LR" = Research product, would be processed in Japanese Laboratories

JAXA Research Products (L2b:Synergy)

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Sensor(s)	Processing Level	Status	Product Name	Primary Parameter (Red: Spatial-integrated values will be also generated)	Grid Spacing		File Unit File Format
					Horizontal	Vertical	
CPR + ATLID	L2a	Red R	CPR-ATLID Synergy Particle Mass Ratio Products	Mass Ratio (2D_Ice/IWC)	1 km	–	1/8 orbit HDF
		ER	CPR-ATLID Synergy Rain & Snow Products	Rain Water Content / Snow Water Content / Rain Rate / Snow Rate	1 km	0.1 km	1/8 orbit HDF
		ER	CPR-ATLID Synergy Vertical Velocity Products	Vertical Air Motion / Sedimentation Velocity	1 km	0.1 km	1/8 orbit HDF
ATLID + MSI	L2a	ER	ATLID-MSI synergy Aerosol Components Products	Aerosol Extinction Coefficient (Water Soluble)／Aerosol Extinction Coefficient (Dust)／Aerosol Extinction Coefficient (Sea Salt)／Aerosol Extinction Coefficient (Black Carbon)／Mode Radius	10 km	0.1 km	1/8 orbit HDF
CPR + ATLID + MSI	L2a	LR	CPR-ATLID-MSI Synergy Cloud Doppler Products	Cloud Mask / Cloud Particle Type / Liquid Water Content / Ice Water Content / Effective Radius of Liquid Water Cloud / Effective Radius of Ice Water Cloud (with Doppler)	1 km	0.1 km	1/8 orbit HDF
				Optical Thickness／Liquid Water Path／Ice Water Path (with Doppler)	1 km	–	1/8 orbit HDF
		LR	CPR-ATLID-MSI Synergy Rain and Snow Products	Rain Water Content / Snow Water Content / Rain Rate / Snow Rate	1 km	0.1 km	1/8 orbit HDF
		LR	CPR-ATLID-MSI Synergy Vertical Velocity Products	Vertical Air Motion / Sedimentation Velocity	1 km	0.1 km	1/8 orbit HDF
		LR	CPR-ATLID-MSI Synergy Emission Method Products	Effective Radius of Ice Cloud derived from Emission Method／Optical Thickness of Ice Cloud derived from Emission	0.5 km	–	1/8 orbit HDF

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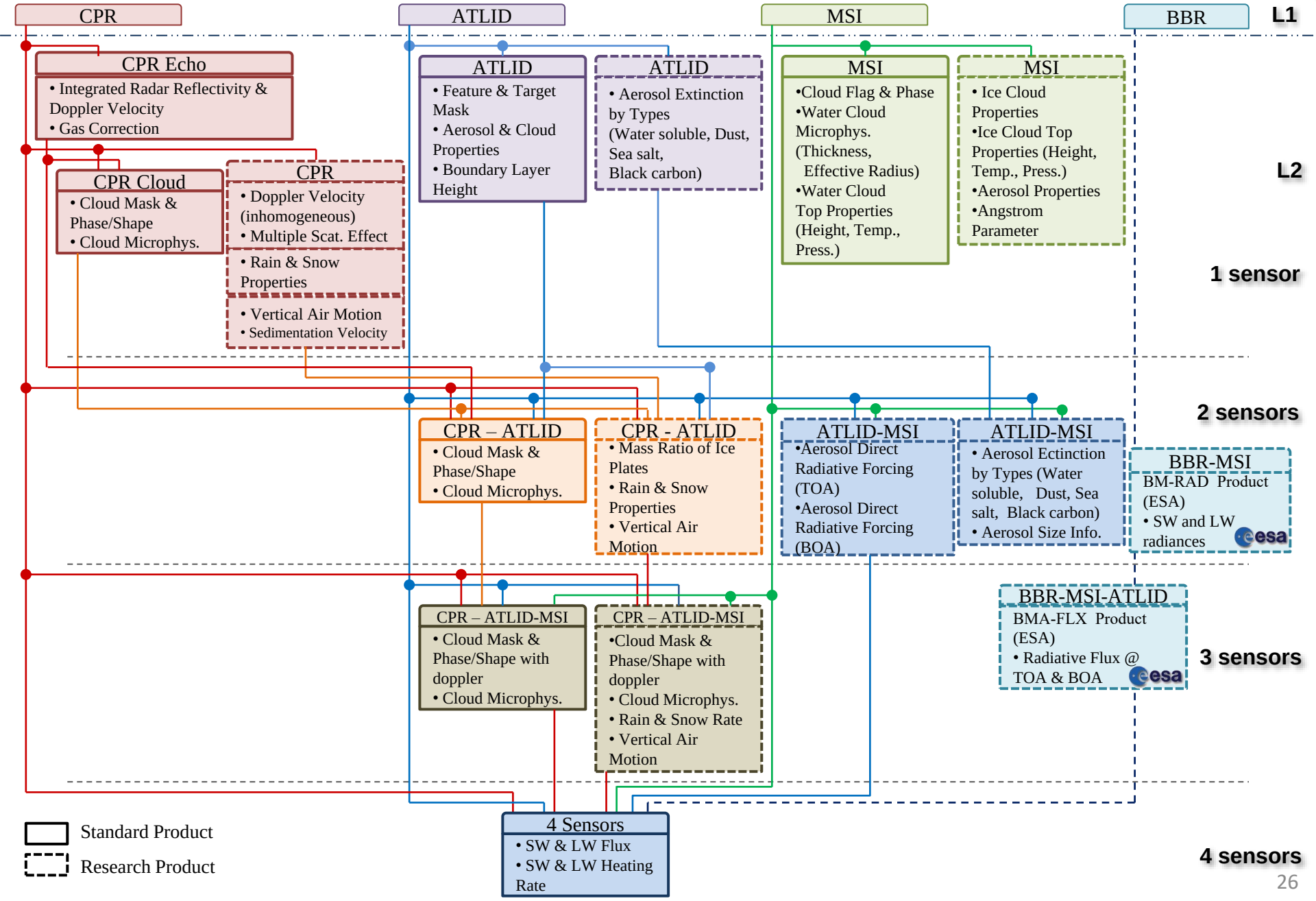
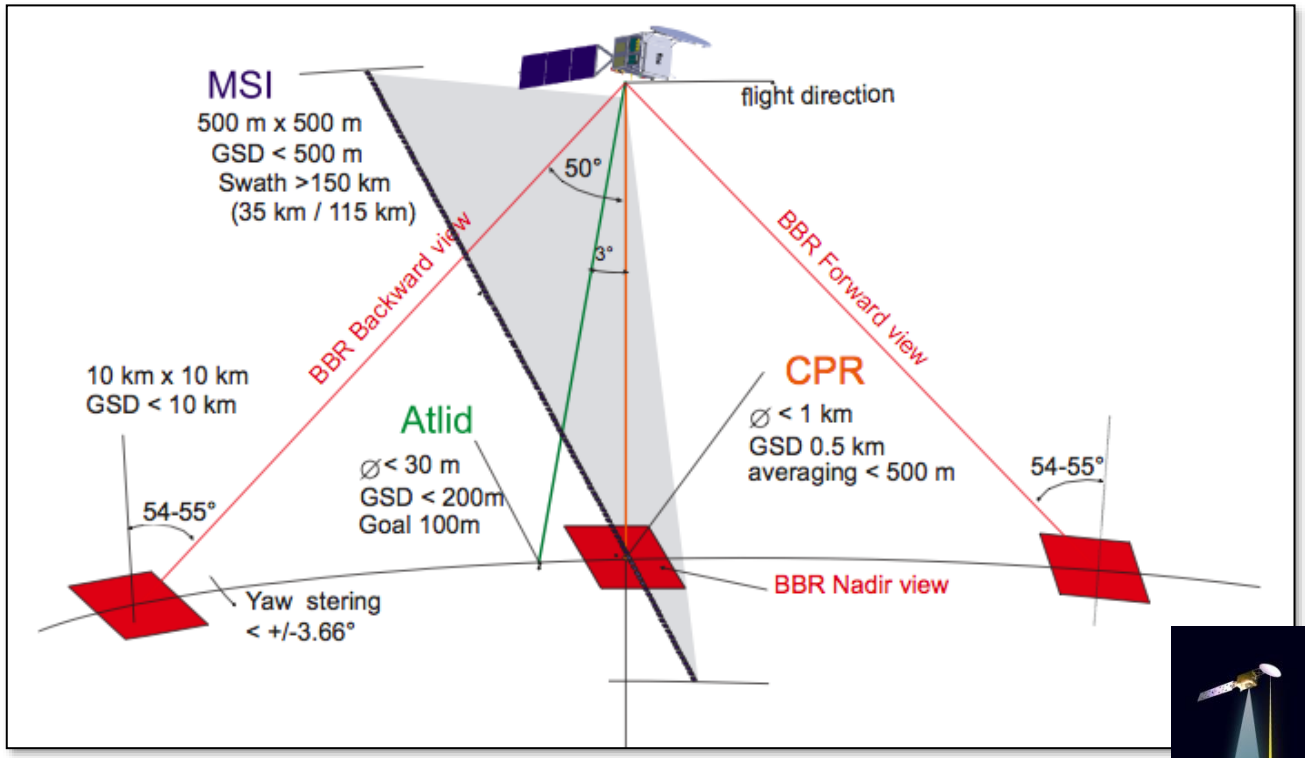
"ER" = Research product, would be processed in JAXA EORC Research and Application System. "LR" = Research product, would be processed in Japanese Laboratories

EarthCARE JAXA L2 Production Model

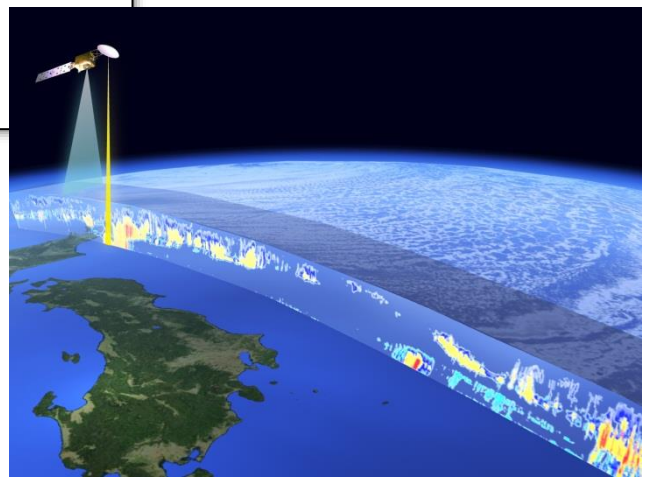


- Backup slides

Strategy



Observation of 4 sensors (movie)
https://www.eorc.jaxa.jp/EARTHCARE/museum/movie_gallary.html



Synergetic Observation by 4 Sensors on Global Scale

- 3-dimentional structure of aerosol and cloud including vertical motion
- Radiation flux at top of atmosphere
- Aerosol – cloud – radiation interactions

EarthCARE Orbit & Data latency

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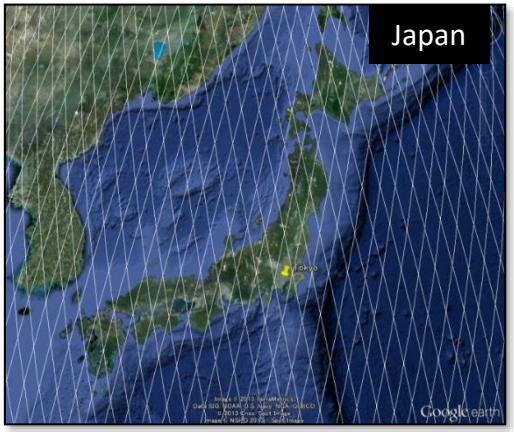
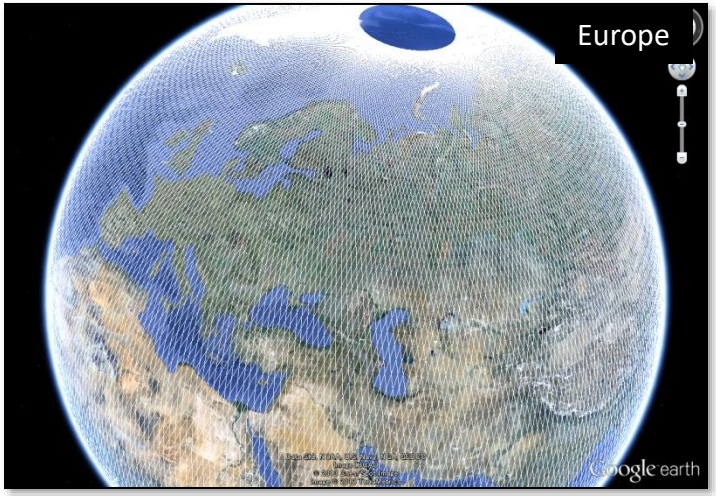
Mean Local Time : Approx. 14:00 (Descending)
2:00 (Ascending)





- **Stations:**
  - **Esrange/Kiruna & Inuvik (SSC)**
  - **Two 13-m antenna at each GS location**

- **Data latency**
- **a. Nominal (60% of data) : max. 93 minutes**
- **b. Worst case (blind orbits): 203 minutes max**