

JAXA EarthCARE Product Overview

*Takuji Kubota
on behalf of the joint JAXA-ESA EarthCARE Team*

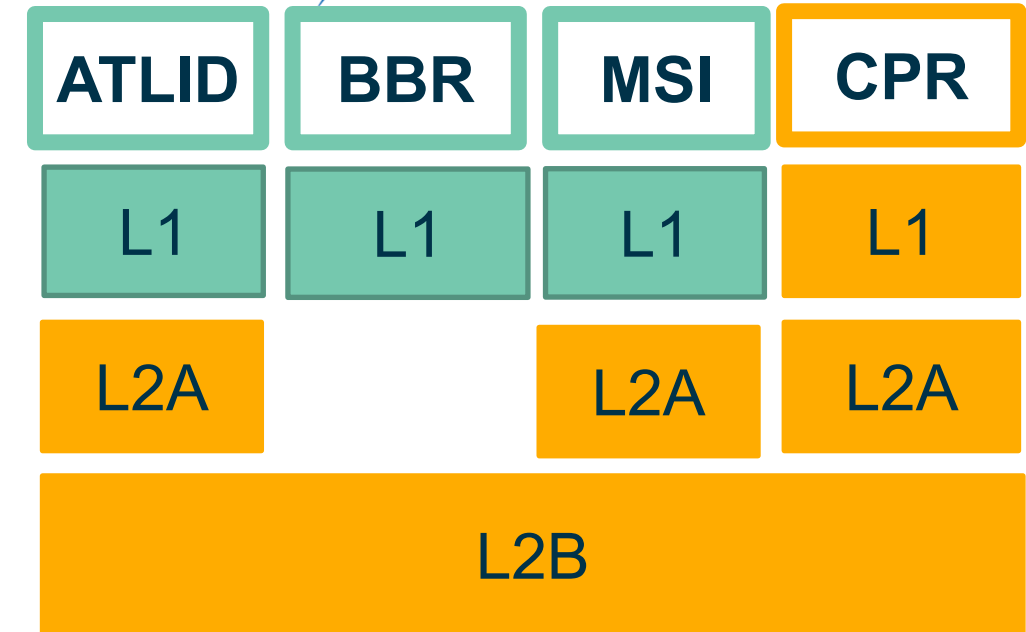
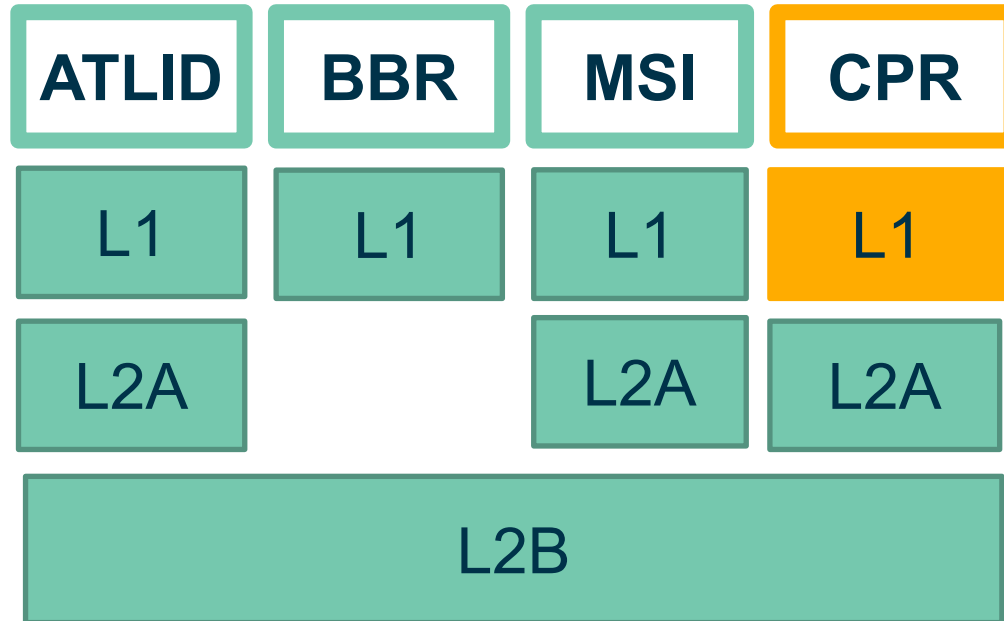
Japan Aerospace Exploration Agency (JAXA)



EarthCARE Science and Validation Workshop 2025

1-5 December 2025 | The University of Tokyo | Tokyo, Japan





Aux Proc

X-JSG

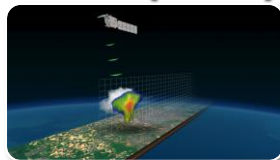
X-MET

- L1 products have been developed by the agency responsible for the instrument.
- As for L2 products, both agencies develop algorithms independently, for collaboration and comparison.
- Each agency coordinates the validation of its own products.

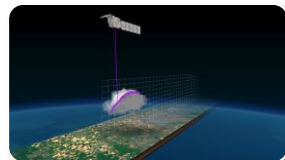
EarthCARE Production Model (JAXA)



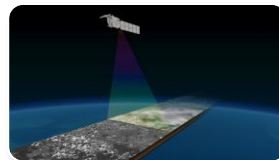
Radar (CPR)



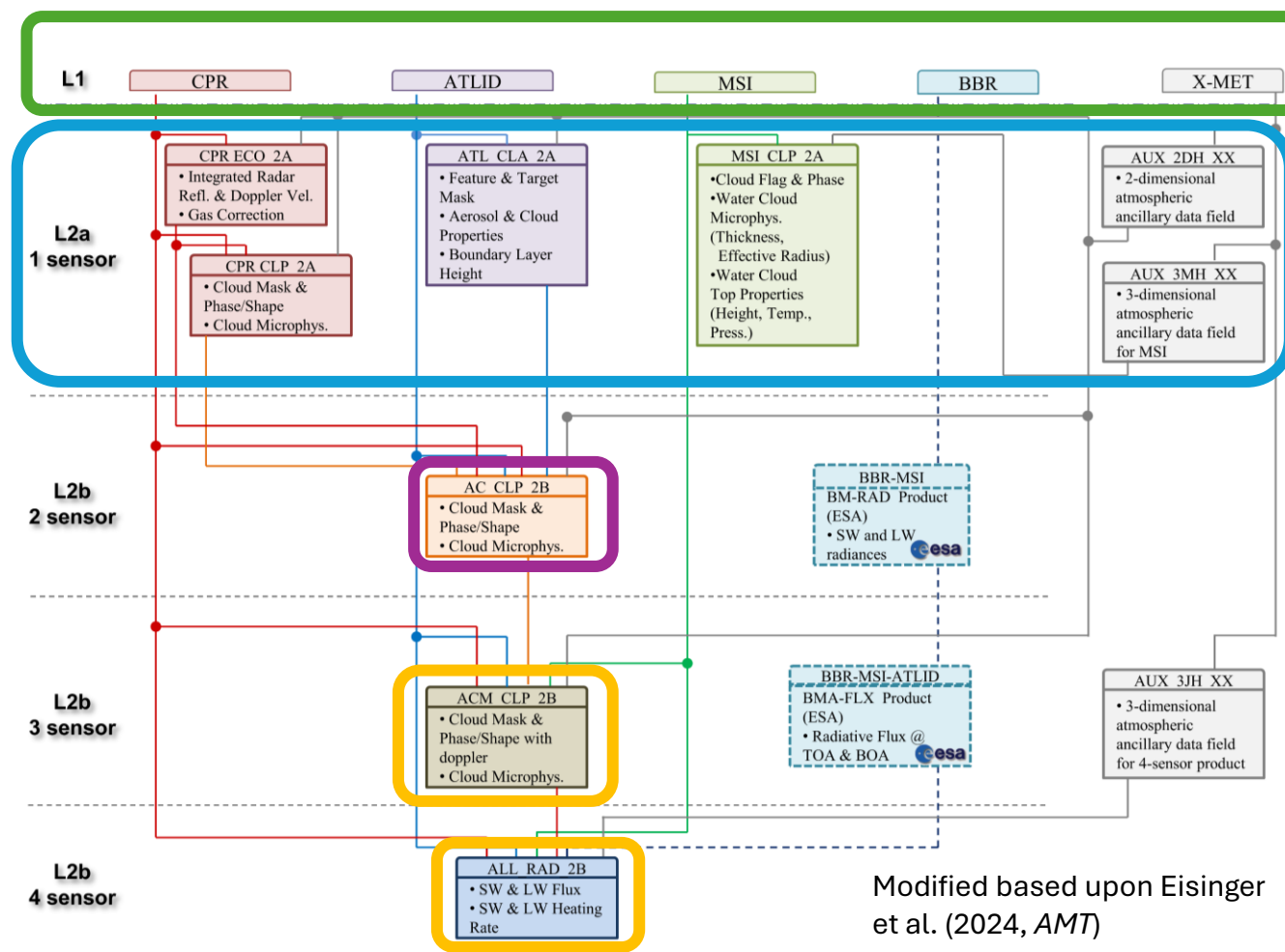
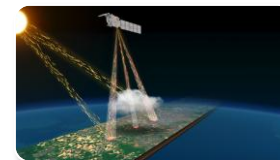
Lidar (ATLID)



Imager (MSI)



Broadband radiometer (BBR)



Modified based upon Eisinger et al. (2024, AMT)

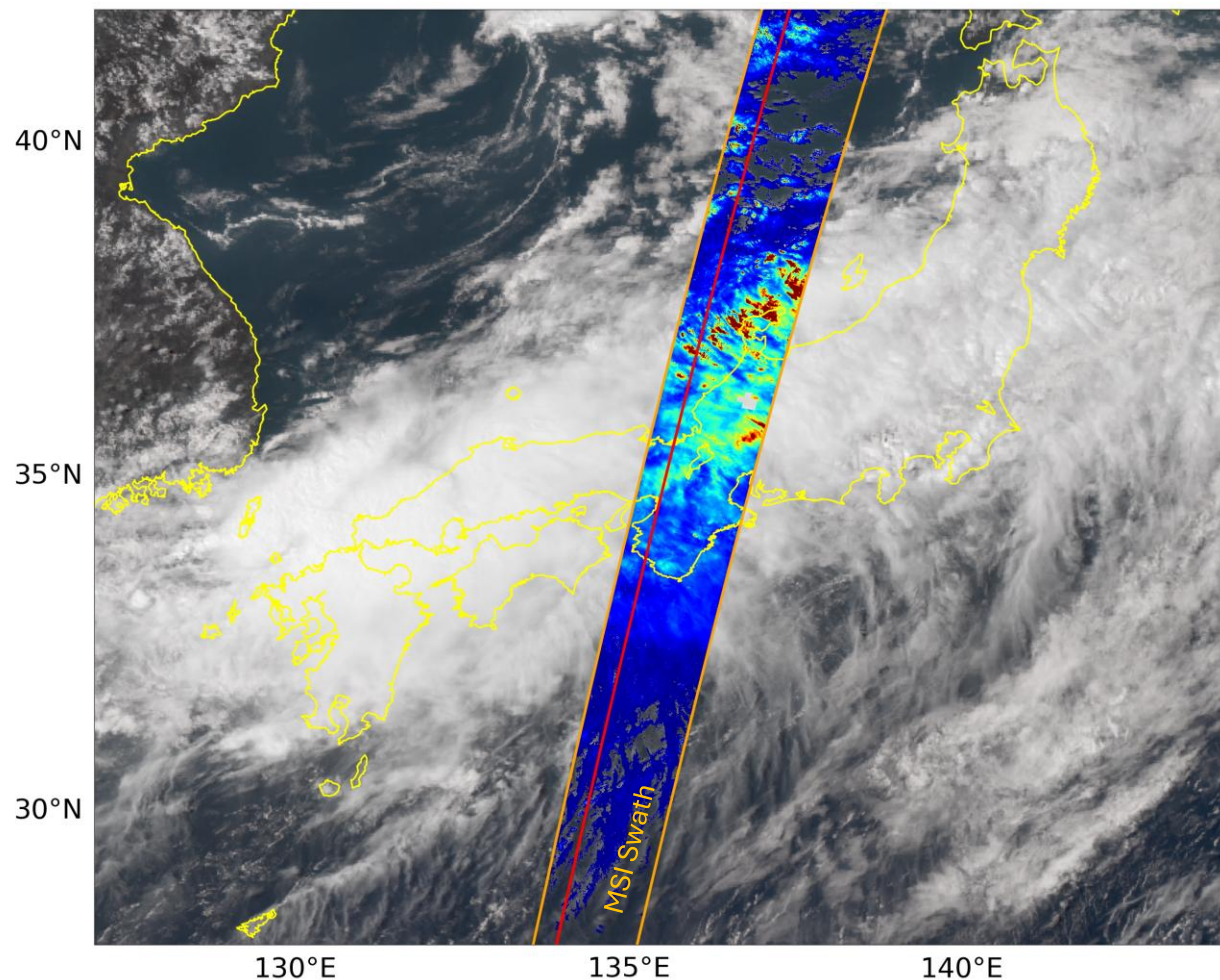
All Observation Data Now Publicly Available!



JAXA's 3-sensor synergy product (ACM_CLP) and 4-sensor synergy product (ALL_RAD)

■ Rain cloud widespread over the Japan Island

EarthCARE orbit



- On **August 10, 2025, at 5UTC**, the EarthCARE satellite passed near Osaka-city in Japan and observed **rain clouds extending from western to eastern Japan**.
- At this time, **localized heavy rainfall systems also formed over northern Kyushu**.
- Here, I introduce **JAXA's 3-sensor synergy product (ACM_CLP)** and **4-sensor synergy product (ALL_RAD)** with this case.

Cloud distribution around the Japan Islands (5UTC, Aug. 10th, 2025)

- The colormap represents **Cloud Optical Thickness (COT)** from **L2a MSI_CLP**.
- The background is an RGB composite image from the Himawari-9 meteorological satellite.



Three-sensor synergy Product “ACM_CLP”

Vertical axis: Cloud effective radius

Arrow: Terminal velocity of cloud and precipitation

Horizontal axis: COT (MSI_CLP)

Small cloud particles at the top

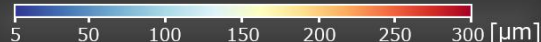
Grow and fall

Forming raindrops

↓ EarthCARE observations can capture internal structures of clouds accurately.
→ Deepen our understanding of **how cloud particles grow into rain.**

Contributing to **improved accuracy in predicting heavy rainfall events** such as localized heavy rains and typhoons.

Vertical axis : Cloud Effective Radius
(CPR-ATLID-MSI Synergy Cloud Product)



Arrow:
Terminal velocity of cloud and precipitation
(CPR-ATLID-MSI Synergy Cloud Product)



Horizontal axis : Cloud Optical Thickness (MSI)



Four-sensor synergy Product “ALL_RAD”

Vertical axis: Net Radiative Heating Rate
Horizontal axis: COT (MSI_CLP)

Cooling effects

Warming effects

- Clouds and aerosols are significantly affecting the Earth's climate and surface temperatures.
- However, **substantial uncertainty remain** in accurately quantifying the impact **clouds and aerosols** have on the climate.

The EarthCARE mission provides accurate estimates of the **radiative properties of clouds and aerosols**.

→ Contributing to **improving climate modeling**

Vertical axis : Net Radiative Heating Rate
(Four Sensors Synergy Radiation Budget Product)



Horizontal axis : Cloud Optical Thickness (MSI)



- JAXA's All **Level 2a: Single sensor Products** and **Level 2b: two-sensor synergy Products** were updated on **27th November 2025**.
- Please see JAXA/EORC homepage (<https://www.eorc.jaxa.jp/EARTHCARE/index.html>) for details.

Product name	Product ID	Changes
L2a CPR One-sensor Echo Product	CPR_ECO	• Implementation of AW3D DEM, instead of ACE2
		• Improvements of Mirro Echo Flag (2nd Trip Echo, Multiple Scattering, 2.4km Artifact)
		• Improved atmospheric gaseous attenuation calculations
L2a CPR One-sensor Cloud Product	CPR_CLP	• Improved to match MSI optical thickness following vicarious calibration of MSI L1
L2b CPR-ATLID Synergy Cloud Product	AC__CLP	
L2a ATLID One-sensor Cloud and Aerosol Product	ATL_CLA	• Improved lidar detection of the ground surface reduces misidentification of the ground surface as clouds or aerosols
		• Reduced variability in depolarization and lidar ratio
L2a MSI One-sensor Cloud Product	MSI_CLP	• Extending cloud microphysics estimates to solar zenith angles of 70 to 80 degrees
		• Incorporating vicarious calibration results using Himawari-9 observations
ECMWF-AUX-2D Product	AUX__2D	• Changed DEM of AUX2D from ACE2 to AW3D
		• Added output variables
		• Fixed bugs (minor)
ECMWF-AUX-3D Product	AUX__3D	• Fixed bugs (minor)

Re-processing Campaign status



- JAXA's re-processing campaign of past data is beginning on **JAXA Supercomputer System (JSS)**.
- Reprocessing of the past 18-month data is expected to be completed in **five months (around late April 2026)**.
- Re-processed product will be **released once each reprocessing is complete**.

Level	Product ID	Version	Expected date of re-processing completion
L1b	CPR_NOM	vDa	Completed
L2a	CPR_ECO	vCb	Late Jan. 2026
	CPR_CLP	vCa	Mid Feb. 2026
	ATL_CLA	vCb	Late Feb. 2026
	MSI_CLP	vCa	Late Mar. 2026
L2b	AC__CLP	vCa	Mid Mar.2026
	ACM_CLP	vBa	Early Apr. 2026
	ALL_RAD	vBa	Late Apr. 2026
AUX	AUX_2DH	vCa	Early December 2025
	AUX_3JH	vCa	Mid Dec. 2025
	AUX_3MH	vCa	Mid Jan. 2026

JAXA EarthCARE Science Team & EORC for L2 algorithm developments, validations, applications



JAXA EarthCARE Science Team
(lead: Prof. Hajime Okamoto, Kyusyu Univ.)

PIs/CIs by Research Announcement
on the Earth Observations (EO-RA)

4th EO-RA (EO-RA4): JFY2025-2027

- 24 PIs
 - ✓ Algorithm Development : 6
 - ✓ Validation : 4
 - ✓ Application Research : 9
 - ✓ Related Research: 5



MoU



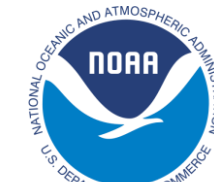
Report

Advise



IA for EarthCARE between JAXA and DLR was
signed in July 2024.

<https://www.satnavi.jaxa.jp/en/news/2024/08/02/9628/index.html>



MoU for EarthCARE between JAXA and NOAA
was signed in Sep. 2024.

JAXA EarthCARE Science Advisory committee (lead: Prof. Masaki Satoh, Univ. Tokyo)

Overview of JAXA L2 products

Cloud-top, vertically integrated, layerwise

Aerosol

Boundary layer height
Aerosol optical thickness
Ångström exponent

Cloud and precipitation

Cloud phase
Optical thickness
Effective radius
Cloud-top temperature, pressure, and height
Liquid, ice water path

Radiation

Radiative flux at TOA/BOA
Aerosol direct radiative Forcing at TOA/BOA

CPR_ECO
CPR_CLP
ATL_CLA
MSI_CLP
CPR_DOP
CPR_RAS
CPR_VVL
ATL_ARL
MSI_ICE
MSI_ARL
AC_CLP
ACM_CLP
ALL_RAD
AC_MRA
AC_RAS
AC_VVL
AM_ARL
ACM_CDP
ACM_RAS
ACM_VVL
ACM_ICE

Vertical profiles

Aerosol

Aerosol species
Extinction, backscatter, lidar ratio
Depolarisation ratio
Mode radius

Cloud and precipitation

Refractivity
Doppler velocity
Extinction
Cloud mask, cloud particle type
Effective radius, optical thickness
Liquid/Ice/rain/snow water content
Rain/snow rate
Vertical air motion
Sedimentation velocity
Mass ratio (2D ice/IWC)

Radiation

Radiative heating rate

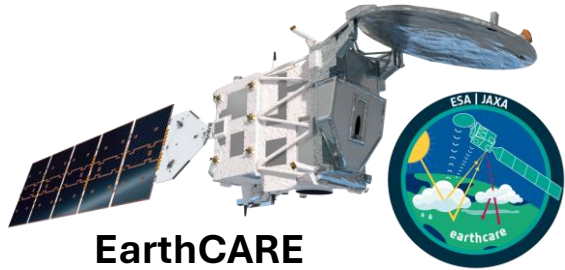
PI for ATL_CLA
T. Nishizawa (NIES)

PI for CPR_ECO
H. Horie (NICT)

PI for CPR_CLP,
AC_CLP, ACM_CLP
**Prof. H. Okamoto
(Kyushu Univ.)**

PI for ALL_RAD:
**Prof. K. Suzuki
(Univ. Tokyo)**

Satellite simulator developments and contributions to improvements of climate models



EarthCARE
2024-

The CFMIP Observation Simulator Package (COSP) for **EarthCARE/CPR** has been developed in Prof. Suzuki (Univ. Tokyo)'s group and used to develop an evaluation method for **IPCC climate models**.

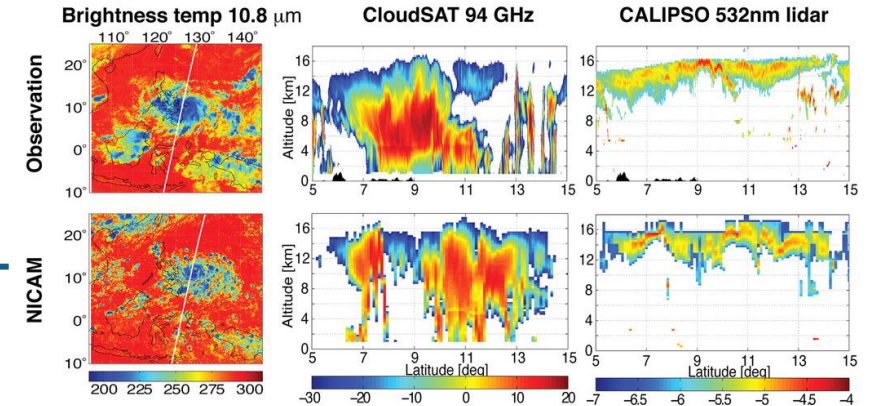
EarthCARE-ORCESTR Model Intercomparison (ECOMIP) for weather and climate modellers to compare to each other and to EarthCARE data, centred on the ORCESTR campaign.

Joint-Simulator (Joint Simulator for Satellite Sensors)

PI. Prof. M. Satoh (Univ. Tokyo)



Joint-Simulator (Hashino et al. 2013, Roh et al. 2023) can simulate EarthCARE observations from numerical weather/climate model outputs, developed by the JAXA EarthCARE mission.



Improvements of climate models which lead to better climate projections

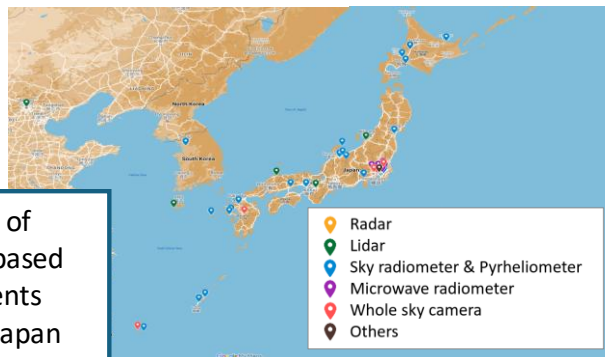
• JAXA's Validation Approach summary

Long-term observation network

- Lidar network (AD-Net) by NIES
 - SKYNET observation stations
 - Wind Profilers (WINDAS) by JMA
- etc.

→ provide detailed
validations of the JAXA
EarthCARE products

Location of
ground-based
instruments
around Japan



Campaign observation

- NICT Koganei validation super site
 - Ground-based doppler CPR developed by NICT, Multiple-field-of-view multiple-scattering polarization lidar (MFMSPL), High spectral resolution lidar (HSRL), Direct Detection Doppler lidar (355nm) by Prof. Okamoto's kakenhi funding.

→ provide multi-sensor-combined
and detailed evaluations

- Airborne campaign
 - Mainly by collaboration with DLR

→ provide abundant number of
matchup data which is important
especially in the early phase

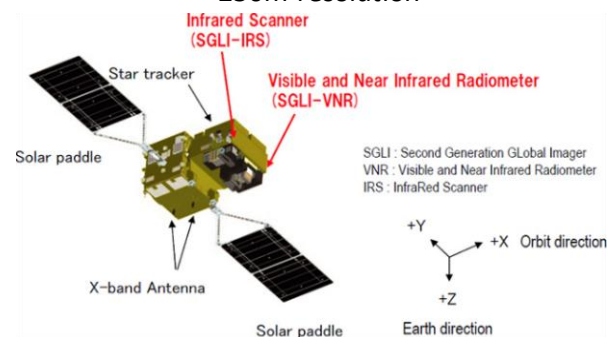


Comparison with other satellite data

- CloudSat, CALIPSO, GCOM-C/SGLI, MODIS, VIIRS, CERES, etc. Himawari/AHI
- provide global evaluations of
the JAXA EarthCARE products

JAXA's GCOM-C satellite

carrying a visible-infrared imager, SGLI
250m resolution



*GCOM-C: Global Change
Observation Mission-Climate



Collaboration with ESA



- ✓ ESA-JAXA Validation Implementation Plan
- ✓ Validation workshops

Collaboration with DLR

- ✓ DLR research aircraft HALO (High Altitude and Long Range Aircraft)
- ✓ <https://www.satnavi.jaxa.jp/en/news/2024/08/02/9628/index.html>

Collaboration with NOAA

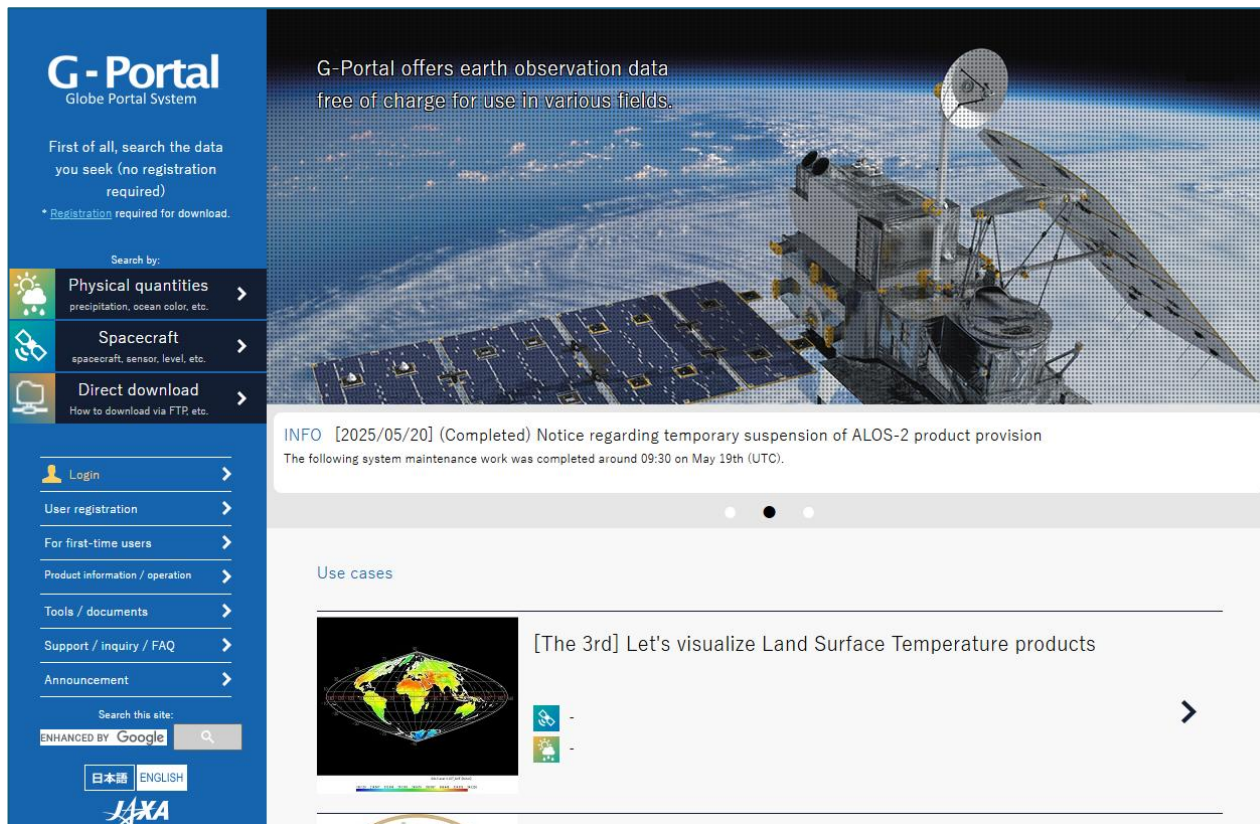
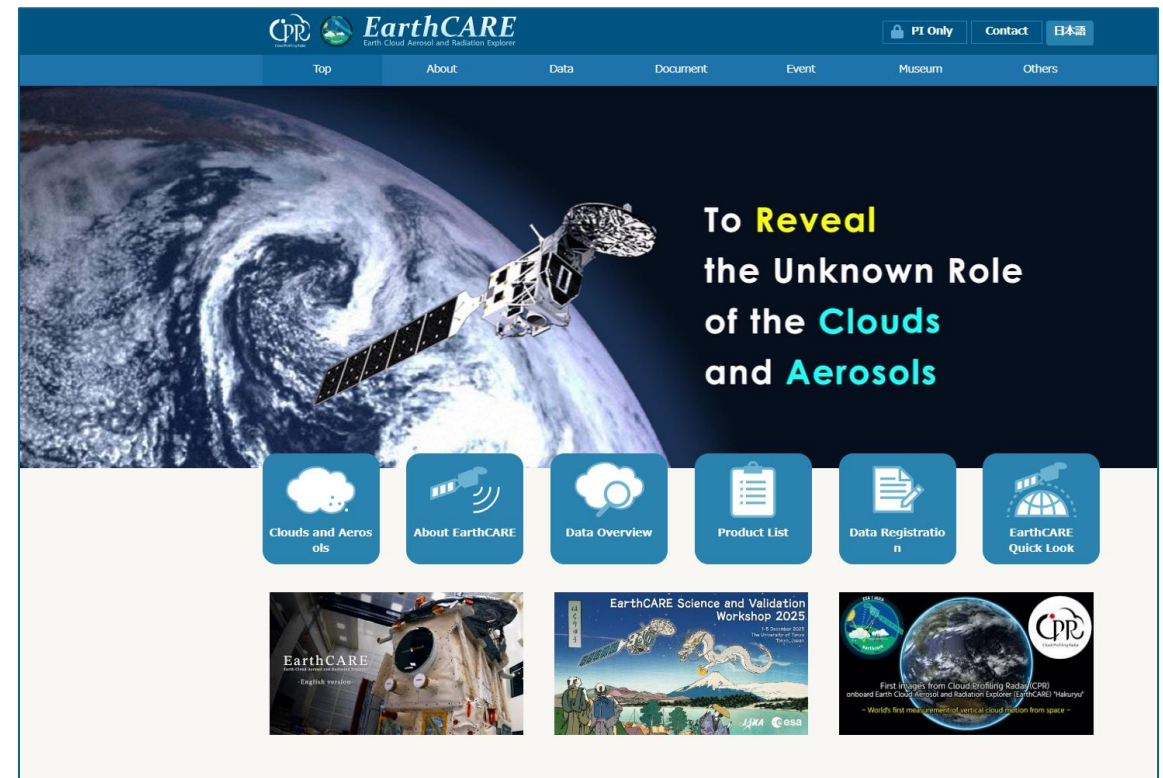
Websites to obtain EarthCARE data and provide references



EarthCARE data can be downloaded from JAXA's Earth observation satellite data provision system G-Portal (<https://gportal.jaxa.jp/gpr/>) and the ESA homepage (<https://earth.esa.int/eogateway/missions/earthcare>).

Information such as Products Definitions Documents (PDD) and Algorithm Description Documents (ATBD) can be viewed on the JAXA/EORC EarthCARE homepage.

<https://www.eorc.jaxa.jp/EARTHCARE/index.html>

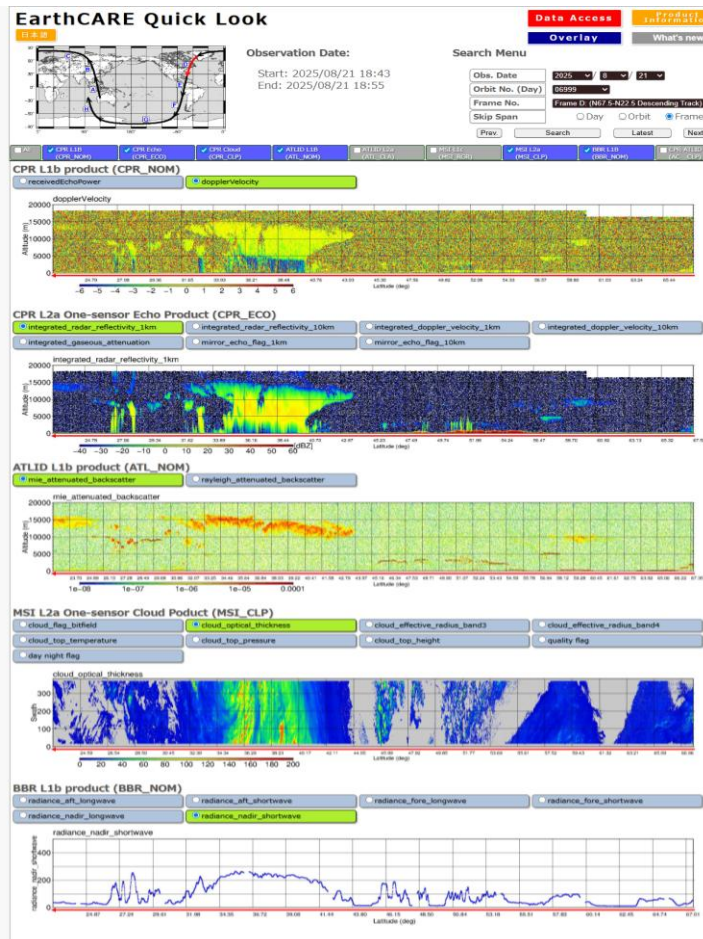
The screenshot shows the G-Portal website. The header includes the G-Portal logo and a search bar. The main content area features a large image of a satellite in orbit over Earth, with text stating "G-Portal offers earth observation data free of charge for use in various fields." Below this, there is a section for "Use cases" with a thumbnail image of a globe showing land surface temperature products. The left sidebar contains navigation links for Physical quantities, Spacecraft, Direct download, Login, User registration, For first-time users, Product information / operation, Tools / documents, Support / inquiry / FAQ, and Announcement.The screenshot shows the EarthCARE homepage. The header includes the EarthCARE logo and navigation links for Top, About, Data, Document, Event, Museum, and Others. The main content area features a large image of a satellite in orbit over Earth, with text stating "To Reveal the Unknown Role of the Clouds and Aerosols". Below this, there is a row of six icons representing different aspects of the mission: Clouds and Aerosols, About EarthCARE, Data Overview, Product List, Data Registration, and EarthCARE Quick Look. The bottom section contains three images: a satellite, a workshop poster, and a globe showing EarthCARE data.

Useful JAXA's websites (Quicklook & Tropical Cyclone DB)



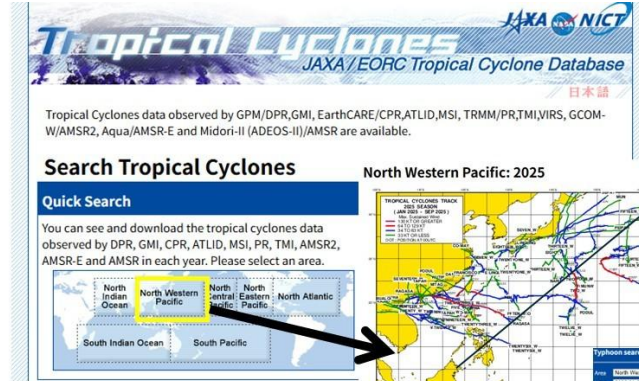
JAXA EarthCARE Quicklook

<https://www.eorc.jaxa.jp/EARTH/CARE/Quicklook/index.html>



EarthCARE satellite observation data has been added to the "**JAXA/EORC Tropical Cyclone Database**" to promote the use of such data in typhoon research.

https://sharaku.eorc.jaxa.jp/TYP_DB/index.html



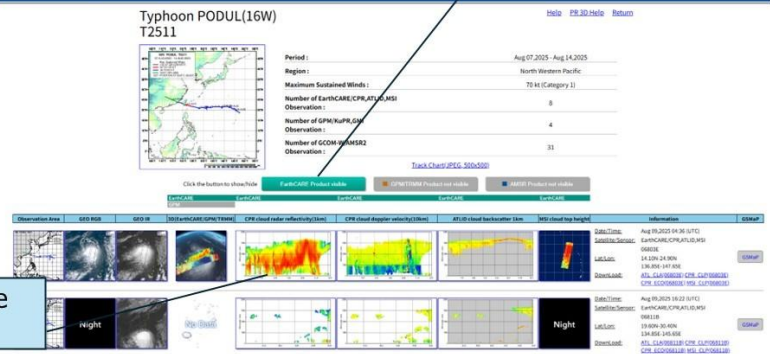
Automatically creates a list of satellite observations of areas near typhoons, and publishes observation images, videos, and data on a website.

Select the name of the satellite you want to view and the typhoon observation images from that satellite will be displayed.



Type	Number	Name	Japanese name	Pt
TY	01W	WUTIP	T2501	Jun 10, 2025
TS	02W	SEPT	T2502	Jun 22, 2025
TS	03W	THREE_W	-	Jun 25, 2025
TS	04W	MUN	T2503	Jul 01, 2025
TY	05W	DANAS	T2504	Jul 04, 2025
TS	06W	NARI	T2505	Jul 11, 2025
TS	07W	SEVEN_W	-	Jul 12, 2025
TS	08W	EIGHT_W	-	Jul 15, 2025
TS	09W	WIPIHA	T2506	Jul 18, 2025
TS	10W	FRANCISCO	T2507	Jul 22, 2025
TY	11W	CO-MAY	T2508	Jul 23, 2025
TY	12W	KROSA	T2509	Jul 23, 2025

Click on the images and videos to enlarge and download them



<https://www.satnavi.jaxa.jp/en/news/2025/10/01/11416/index.html>

The EarthCARE satellite has captured the "**eye**" of **Hurricane Humberto**, and the JAXA published a quick report (<https://earth.jaxa.jp/en/earthview/2025/10/01/9051/index.html>).

- **All of the JAXA standard products have been released to the users:**
 - CPR Level-1: 14/03/2025
 - Level-2a + two-sensor Level-2b synergy: 17/03/2025
 - Three- and four-sensor L2b synergy products planned for: **Today!**
- **Very promising early product quality and offering significant scientific opportunities.**
- **EarthCARE data can be downloaded from JAXA's Earth observation satellite data provision system G-Portal (<https://gportal.jaxa.jp/gpr/>) and the ESA homepage (<https://earth.esa.int/eogateway/missions/earthcare>).**
 - JAXA EarthCARE Quicklook (<https://www.eorc.jaxa.jp/EARTHCARE/Quicklook/index.html>)
 - JAXA/EORC Tropical Cyclone Database (https://sharaku.eorc.jaxa.jp/TYP_DB/index.html)
- **JAXA/EORC and JAXA EarthCARE Science Team continues to ..**
 - Monitor the product quality and provide regular reports to users
 - Continuously enhance the quality of existing processors and products, building on the valuable findings and recommendations of the Validation Teams.
 - Provide User support