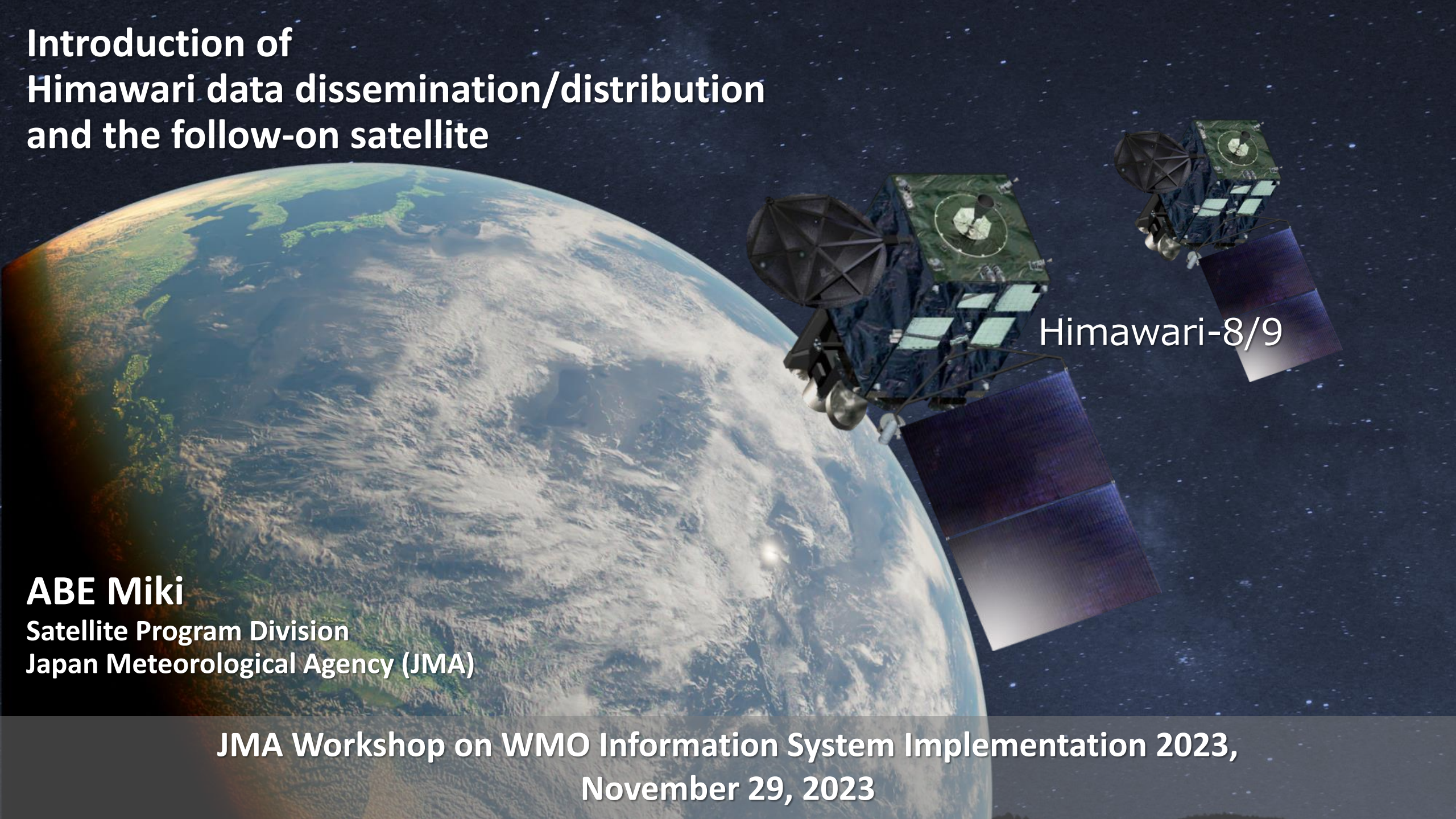
Introduction of Himawari data dissemination/distribution and the follow-on satellite



ABE Miki
Satellite Program Division
Japan Meteorological Agency (JMA)

JMA Workshop on WMO Information System Implementation 2023,
November 29, 2023

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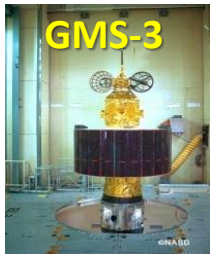
Chronology of Himawari series



1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030

GMS Geostationary Meteorological Satellite

6 April 1978
Three-hourly observation with one visible and one infrared band initiated.

GMS−2

1 March 1987
Hourly observation of the Northern Hemisphere initiated.

GMS−3

5 January 1989
Hourly observation with full-disk imagery initiated.

GMS−4

21 June 1995
Operation of GMS-5 with one visible and three infrared bands (including a new water vapor band) initiated.

GMS−5

22 May 2003
NOAA/NESDIS GOES-9 backup for GMS-5 initiated.

MTSAT Multi−functional Transport Satellite

GMS-5 backup with GOES-9 was operated as a joint effort by JMA and the USA's NOAA/NESDIS to secure coverage over East Asia and the Western Pacific.

15 November 1999
Lost in launch vehicle failure.

MTSAT−1R

26 February 2005
MTSAT-1R launched.
1 July 2010
MTSAT-1R put on standby.

1 July 2010
MTSAT-2 mission initiated.

MTSAT−2

18 February 2006
MTSAT-2 launched.
4 September 2006
MTSAT-2 put on standby.

7 July 2015
MTSAT-2 put on standby.

Himawari−8

7 October 2014
Himawari-8 launched.

Initiation of Himawari-8 operation on 7 July 2015
Himawari-8 has the capacity to perform full-disk observation every 10 minutes, and has 16 observation bands. The spatial resolution is double that of the MTSAT series.

Himawari−9

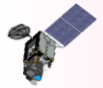
2 November 2016
Himawari-9 launched.
10 March 2017
Himawari-9 put on standby.

13 December 2022
Himawari-9 mission Initiated.

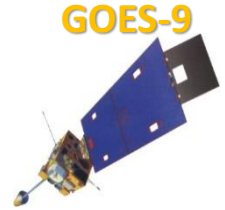
From launch through check-out | Fully operational | Stored | GMS-5 backup with GOES-9 | Operational (telecom function only)

GMS Series
The GMS series were known as spin satellites because they maintained attitude through rotation.

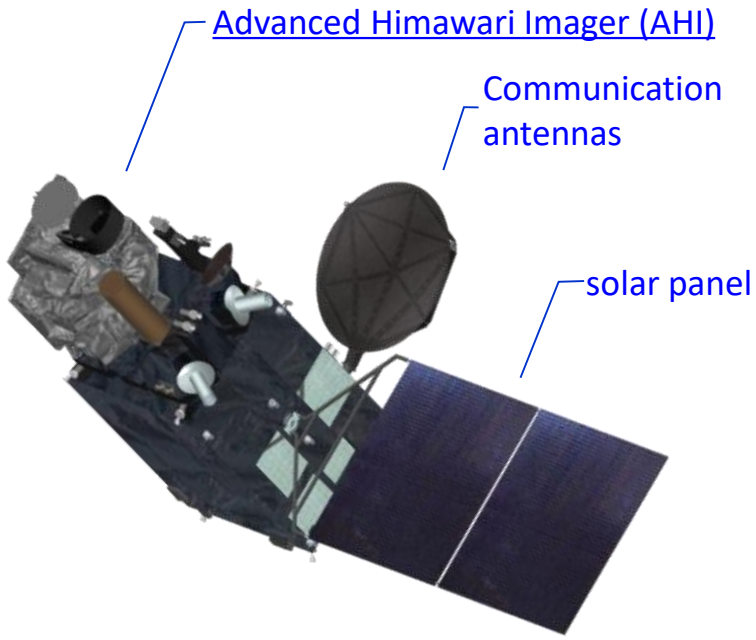
MTSAT Series
MTSAT series satellites are three-axis attitude-controlled geostationary units performing both meteorological and aeronautical missions.



Himawari Series
Himawari-8/9 are dedicated to meteorological missions, and are equipped with highly improved imagers.

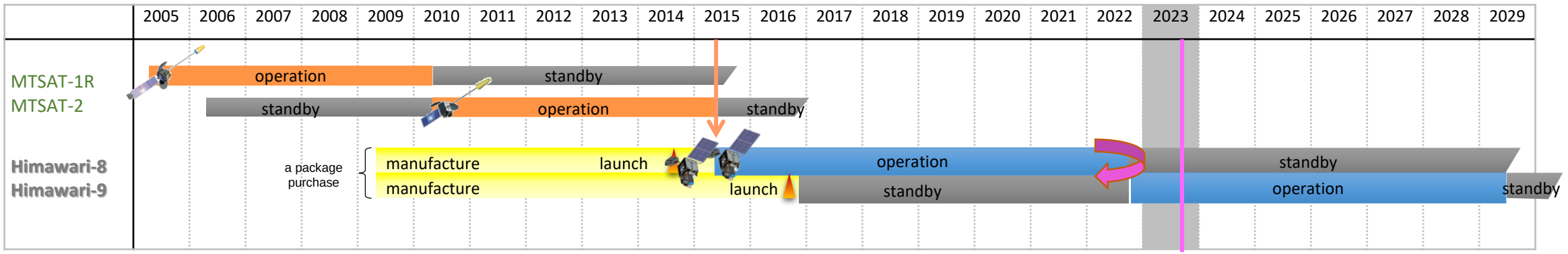


Himawari-8/9

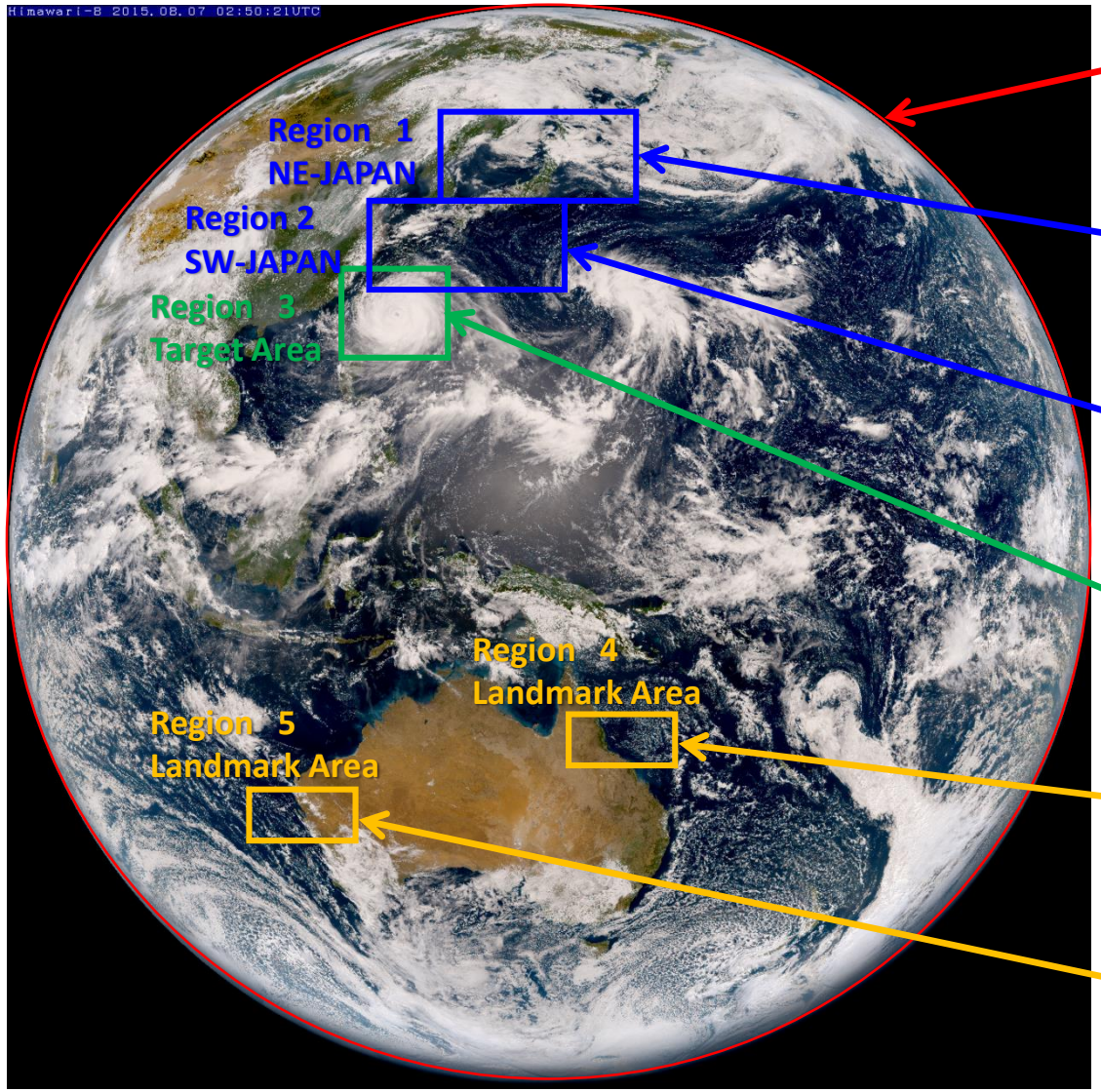


Geostationary position	Around 140.7° E
Attitude control	3-axis stabilization
Communication	1) Raw observation data transmission Ka-band, 18.1 - 18.4 GHz (downlink)
	2) DCS (Data collection System) International channel 402.0 - 402.1 MHz (uplink) Domestic channel 402.1 - 402.4 MHz (uplink) Transmission to ground segments Ka-band, 18.1 - 18.4 GHz (downlink)
	3) Telemetry and command Ku-band, 12.2 - 12.75 GHz (downlink) 13.75 - 14.5 GHz (uplink)

Himawari-8 began operation on 7 July 2015,
switching over to Himawari-9 on 13 December 2022



AHI Observation Modes



Full disk

Interval : **10** minutes (6 times per hour)

Region 1 JAPAN (North-East)

Interval : **2.5** minutes (4 times in 10 min)

Dimension : EW x NS: 2000 x 1000 km

Region 2 JAPAN (South-West)

Interval : **2.5** minutes (4 times in 10 min)

Dimension : EW x NS: 2000 x 1000 km

Region 3 Target Area

Interval : **2.5** minutes (4 times in 10 min)

Dimension : EW x NS: 1000 x 1000 km

Region 4 Landmark Area

Interval : **0.5** minutes (20 times in 10 min)

Dimension : EW x NS: 1000 x 500 km

Region 5 Landmark Area

Interval : **0.5** minutes (20 times in 10 min)

Dimension : EW x NS: 1000 x 500 km

Spectral Bands

cf. MTSAT-2 Bands

VIS 0.68 μm

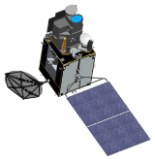
IR4 3.7 μm

IR3 6.8 μm

IR1 10.8 μm

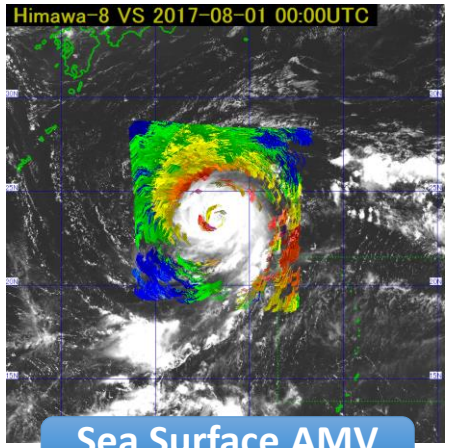
IR2 12.0 μm

Himawari-8/9 Imager (AHI; Advanced Himawari Imager)

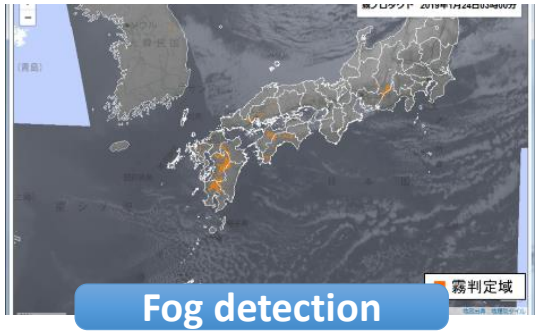


Band		Spatial Resolution	Central Wavelength	Physical Properties	
1	Visible (VIS)	1 km	0.47 μm	vegetation, aerosol	3 Visible Bands
2			0.51 μm	vegetation, aerosol	
3		0.5 km	0.64 μm	Vegetation, low cloud, fog	
4	Near Infrared (NIR)	1 km	0.86 μm	vegetation, aerosol	Addition of NIR Bands
5		2 km	1.6 μm	cloud phase	
6			2.3 μm	particle size	
7	Infrared (IR)	2 km	3.9 μm	low cloud, fog, forest fire	
8			6.2 μm	mid- and upper-level moisture	Increase of WV Bands
9			6.9 μm	mid-level moisture	
10			7.3 μm	mid- and lower-level moisture	
11			8.6 μm	cloud phase, SO_2	Increase of TIR Bands
12			9.6 μm	Ozone content	
13			10.4 μm	cloud imagery, information of cloud top	
14			11.2 μm	cloud imagery, sea surface temperature	
15			12.4 μm	cloud imagery, sea surface temperature	
16			13.3 μm	cloud top height, CO2	

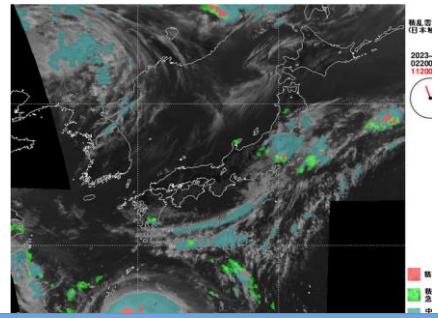
Himawari-8/9 Products



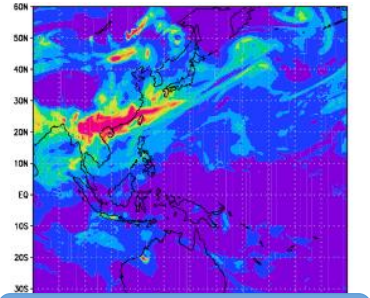
Sea Surface AMV



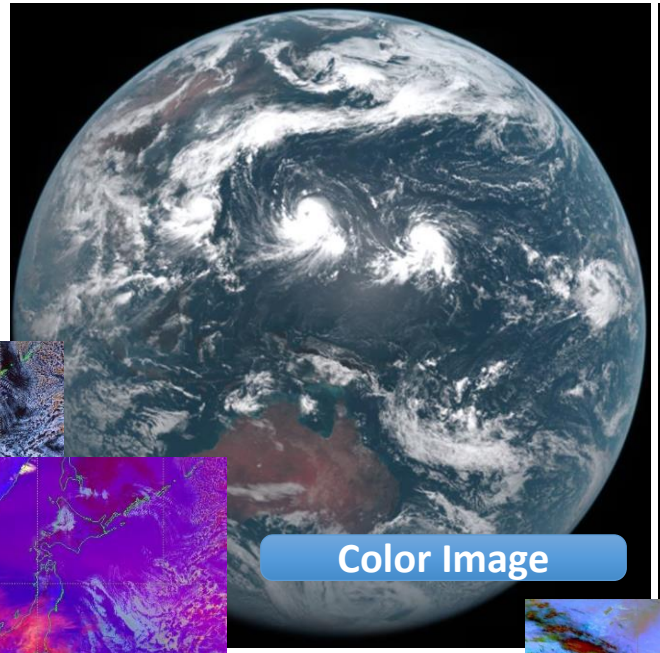
Fog detection



Convective Cloud detection

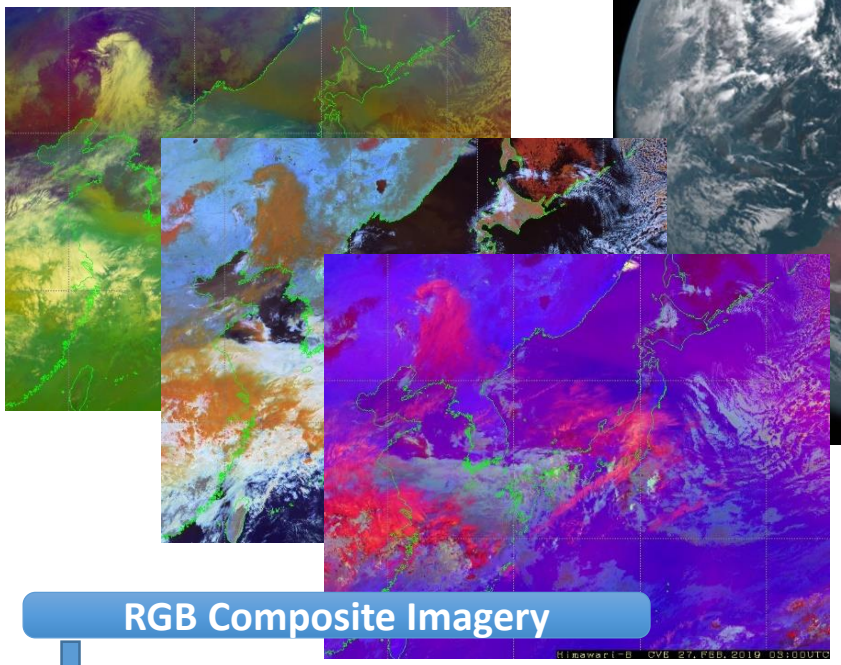


Aerosol analysis



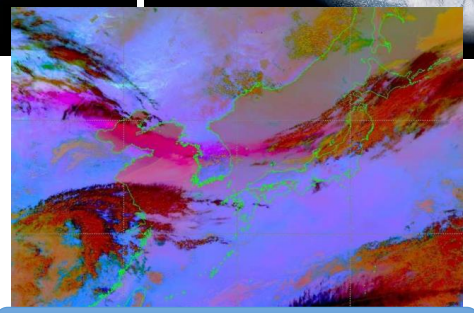
Color Image

True Color Reproduction Image

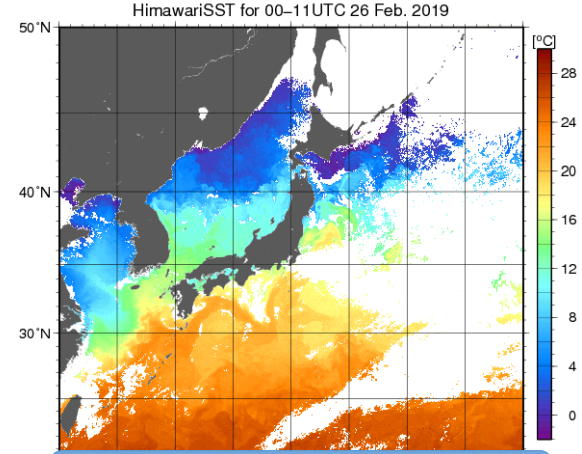


RGB Composite Imagery

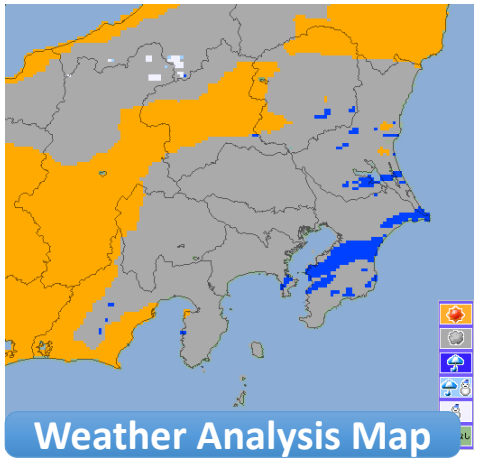
https://www.jma.go.jp/jma/jma-eng/satellite/VLab/RGB_QG.html



Dust and Ash monitoring



Sea Surface Temperature



Weather Analysis Map

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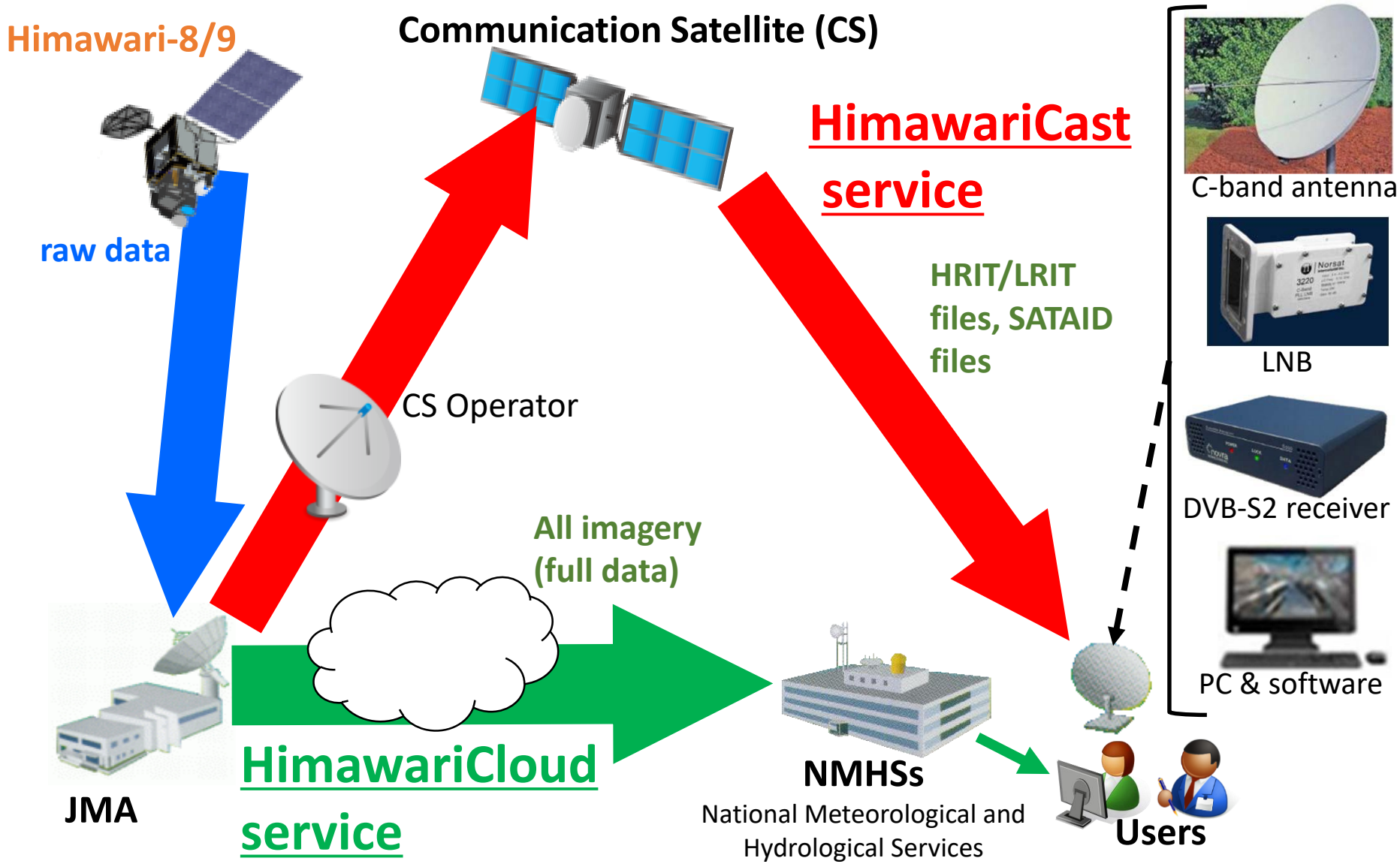
Himawari-8/9 Data Dissemination/Distribution



HRIT:
Medium resolution data, comparable to MTSAT
LRIT:
Low resolution data, comparable to MTSAT

We are considering how to distribute Himawari-10 data appropriately to be committed for user readiness.

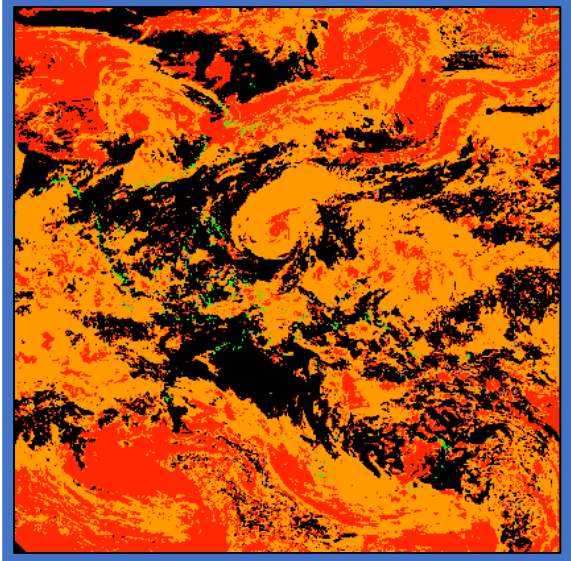
Himawari-8/9 Data Dissemination/Distribution

HimawariJDDS

JDDS: JMA Data Dissemination System

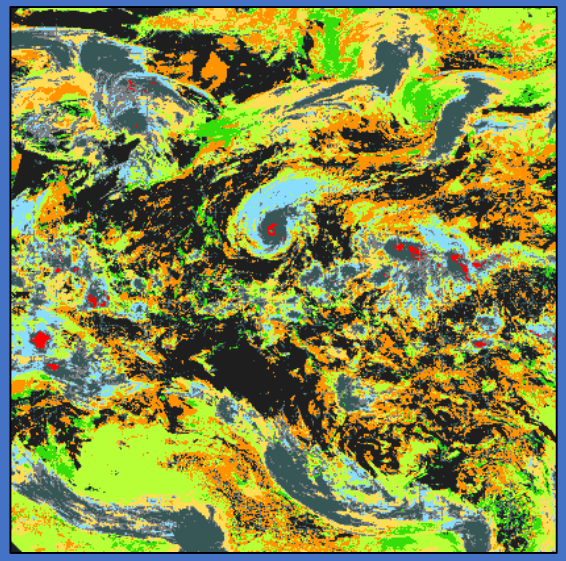
- HRIT files and JPEG files
- Products
  - ASWind: AMV-based Sea-surface Wind
  - HCAI: High-resolution Cloud Analysis Information

Cloud Mask



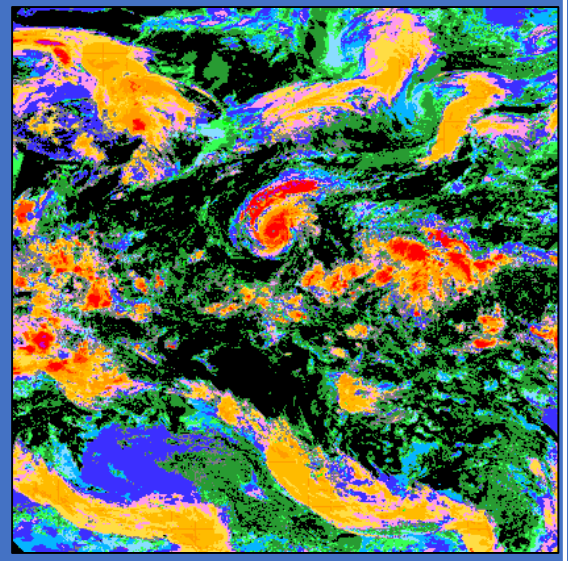
Clear | Mixed | Cloud

Cloud Type



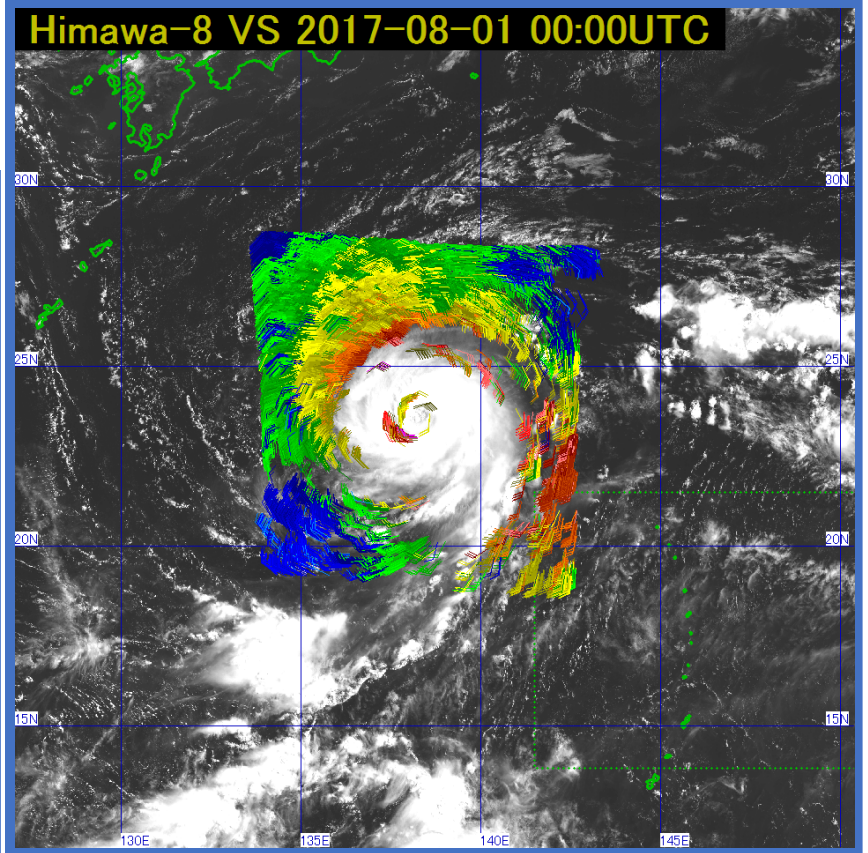
Clear | Cb | Transparent Upper | Mid | Cu | Cs | St | Opaque Upper

Cloud Top Height



0 20 40 60 80 100 120 140 160 180 200 X100m

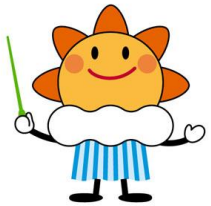
HCAI



ASWind

Himawari-8/9 Data Dissemination/Distribution

JMA is planning to



Terminate the provision service of

LRIT data via HimawariCast

and

HRIT data via HimawariJDDS

The specific date is yet to be decided.

※ LRIT/HRIT: Low/High Rate Information Transmission

To support users of MTSAT-generation format data, we have been providing data as a temporary service until the preparation of Himawari-8/9 data distribution via HimawariCast and HimawariJDDS is completed.

Himawari-8/9 Data Dissemination/Distribution

WIS Portal https://www.wis-jma.go.jp/cms/sataid/data.html

SATAID: SATellite Animation and Interactive Diagnosis

SATAID enables the visualization and manipulation of satellite imagery, NWP (numerical weather prediction) products, observation results and data.

Data for SATAID

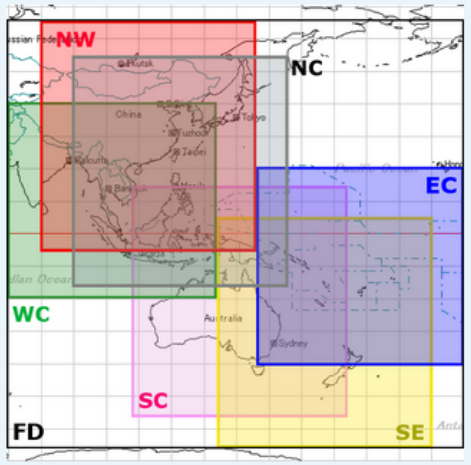
- Before using these data, please check *use conditions of SATAID Service*

Area

Data sets of six areas are provided in this service. Please select *Area Name* from menu bar when you download data.

Definition of areas and information is indicated by right figure and table below.

Abbr.	Area Name	Latitude	Longitude	Sum of Size
NC	North Central	55N-15S	90E-155E	2.3 GB/3day
NW	Northwest	65N-5S	80E-145E	2.1 GB/3day
SC	South Central	15N-55S	107.5E-172.5E	2.2 GB/3day
SE	Southeast	6N-65S	135E-200E	2.1 GB/3day
EC	East Central	20N-40S	145E-210E	1.9 GB/3day
WC	West Central	40N-20S	70E-135E	2.0 GB/3day
FD	Full Domain	65N-65S	70E-210E	9.7 GB/3day



Specification

Data of each area includes 1) Satellite Imagery of Himawari-8/9, 2) NWP Products and 3) Observation Data. Specification o in table below.

Satellite Imagery of Himawari-8/9	
List of the channel	Infrared channel-1 (Band 13)
	Infrared channel-2 (Band 15)
	Water Vapor (Band 8)
	Infrared channel-4 (Band 7)
	Visible imagery (Band 3)
Interval	ten minutes each
Size	2-4 MB/file

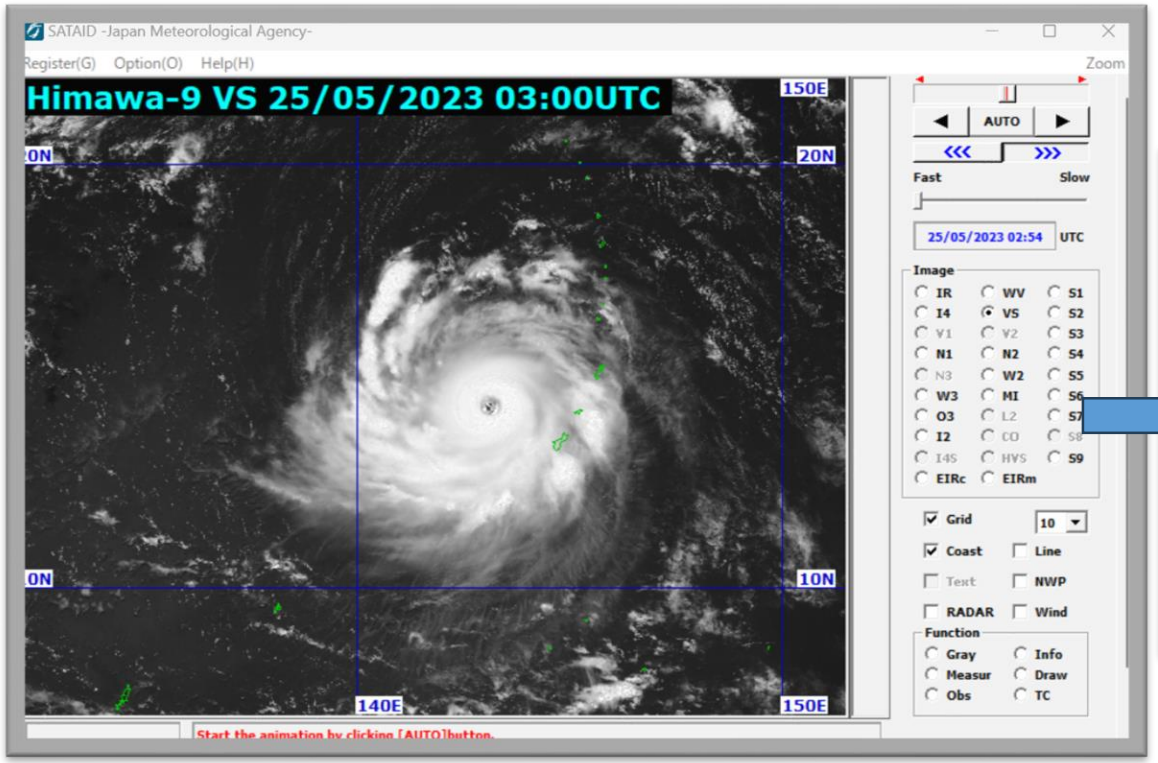
NWP Products	
Resolution	1.25 x 1.25 deg
Forecast hour	up to 48 hours
Initial time	00, 06, 12, 18 UTC
Interval	4 times/day (around 04, 10, 16, 22 UTC)
Size	4 MB/file
	15 MB/file (Full Domain)
SST (Sea surface temperature)	
Interval	Once/day
Size	700 KB/file

Observation	
SYNOP	
Interval	hourly
Size	120-160 KB/file (map time)
	40-70 KB/file (other)
SHIP	
Interval	hourly
Size	20-50 KB/file
METAR	
Interval	hourly
Size	200-270 KB/file
TEMP (A, B)	
Interval	12 hour/day, basically
Size	120 KB/file
ASCAT sea-surface wind	
Interval	hourly
Size	7 MB/file

- Data are stored for 3 days.
- Data format is all for SATAID.

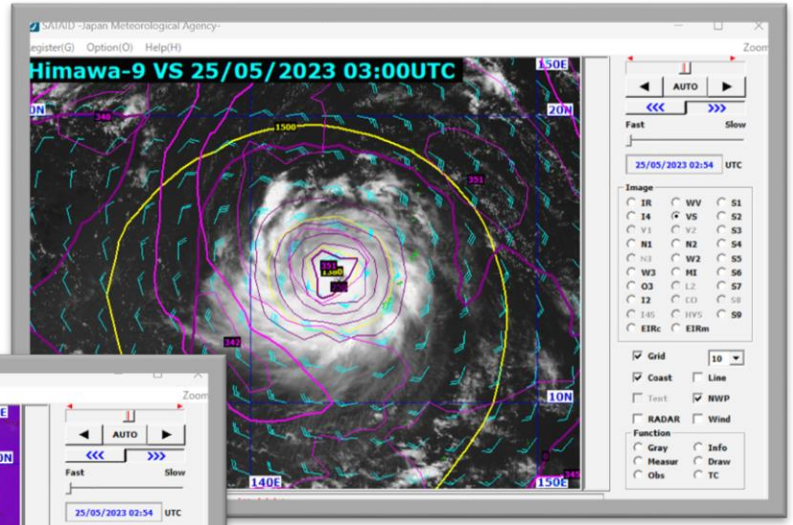
- Data sets of six areas are provided in this service.
- Data of each area includes 1) Satellite Imagery of Himawari-8/9, 2) NWP Products and 3) Observation Data.

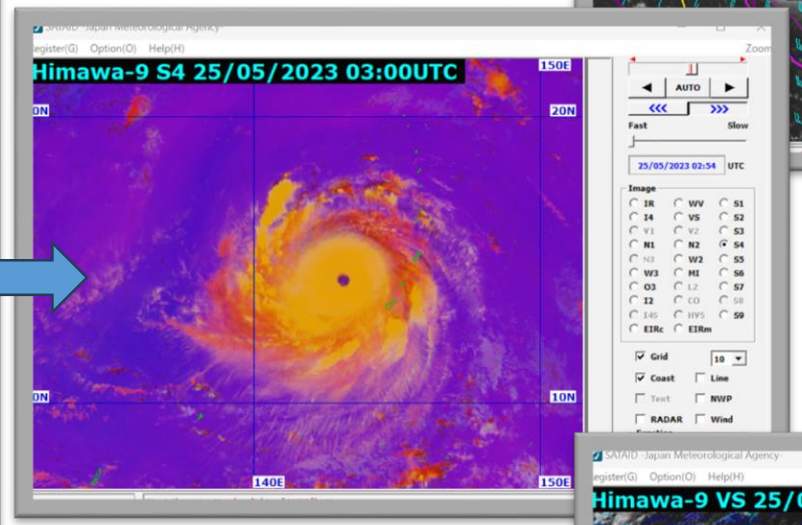
SATAID (SATellite Animation and Interactive Diagnosis)



VIS imagery for Typhoon No. 2 in SATAID
(03UTC on May 25, 2023)

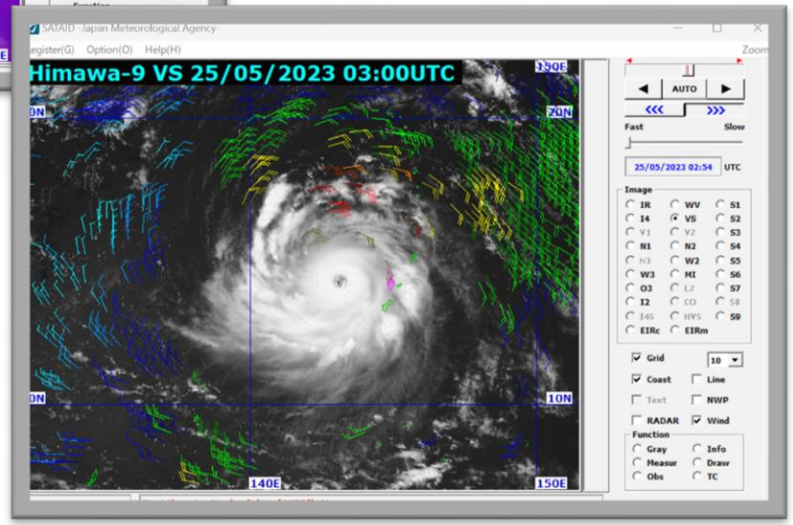
NWP data overlaid
on the VIS imagery





Day Convective Stomes
RGB composite imagery

ASWind data overlaid
on the VIS imagery

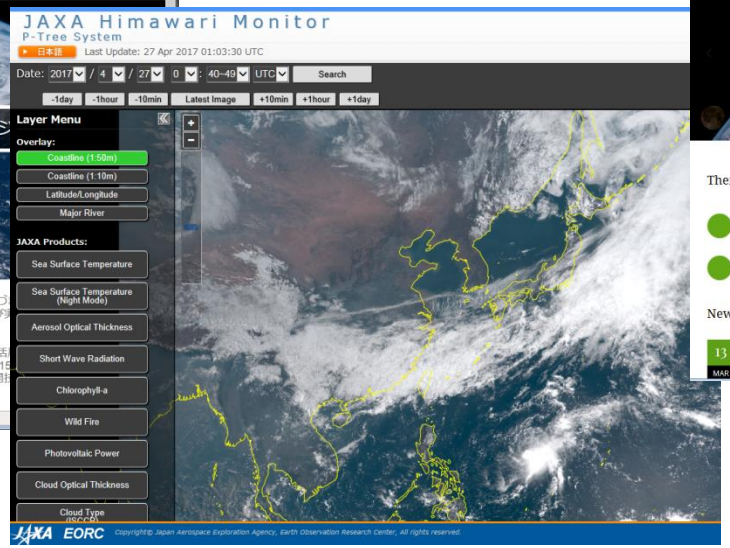


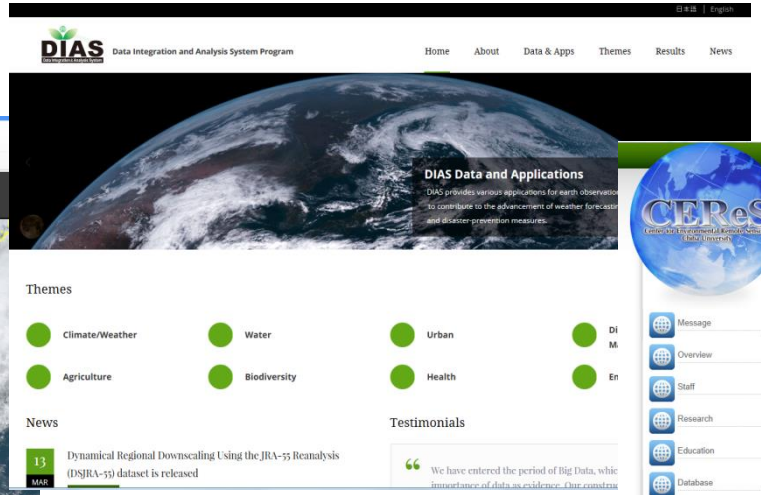
Himawari-8/9 Data Dissemination/Distribution

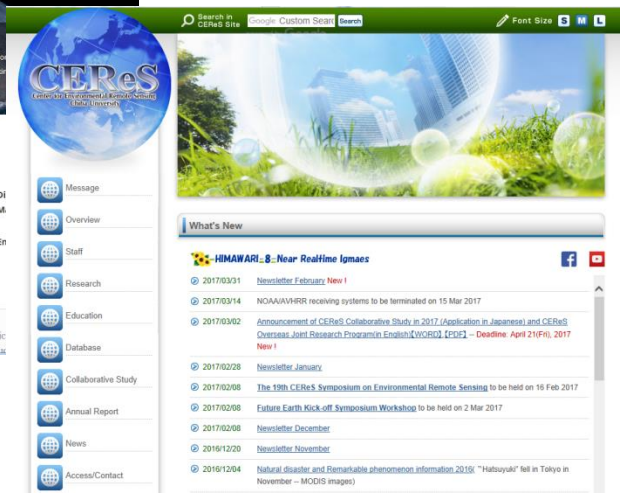
Himawari-8/9 data is being redistributed to foreign and domestic R&D users by the following Japanese scientific institutes.

- NICT* (via Science Cloud)
- JAXA** (via Himawari Monitor)
- JAMSTEC (via DIAS; Data Integration and Analysis System)
- Chiba University CEReS***

* National Institute of information and Communications Technology
** Japan Aerospace Exploration Agency
*** Center for Environmental Remote Sensing



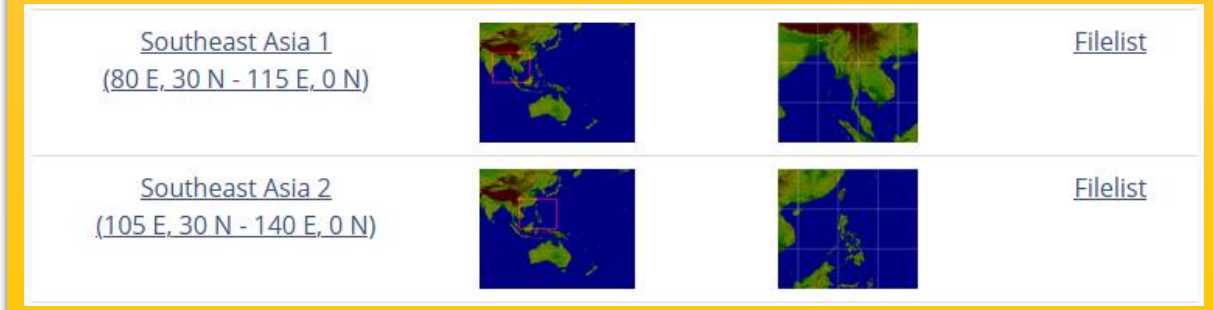


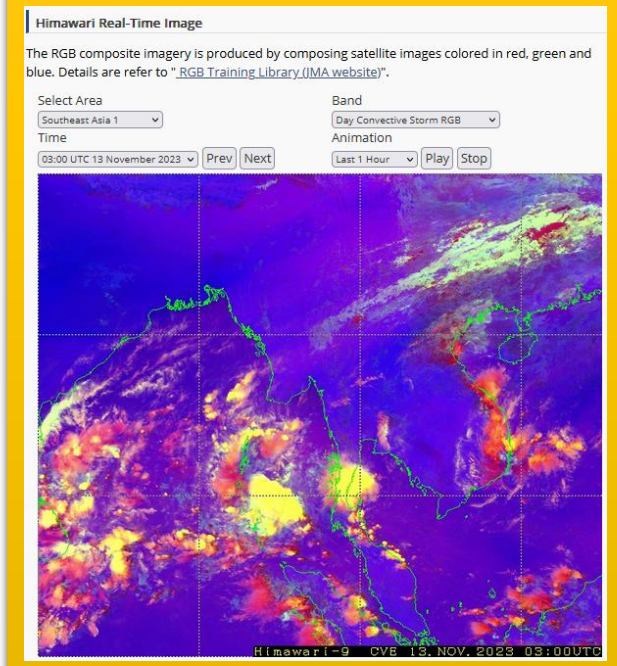


Himawari-8/9 Data Dissemination/Distribution

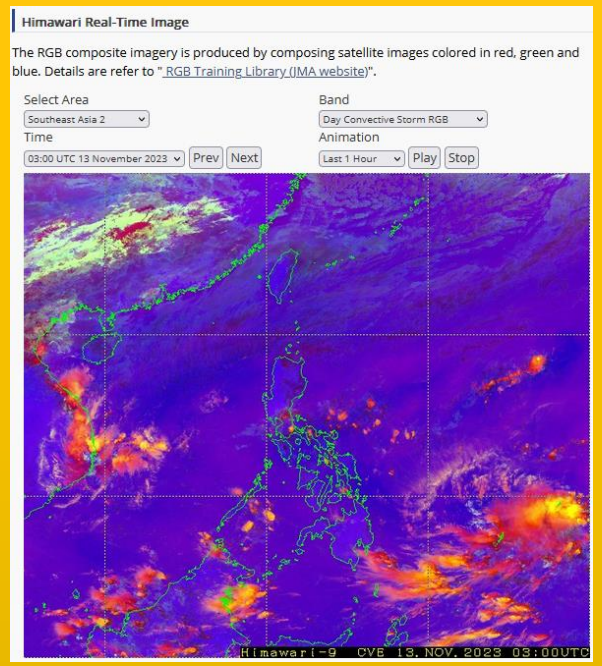
Real-Time Image

https://www.data.jma.go.jp/mscweb/data/himawari/index.html





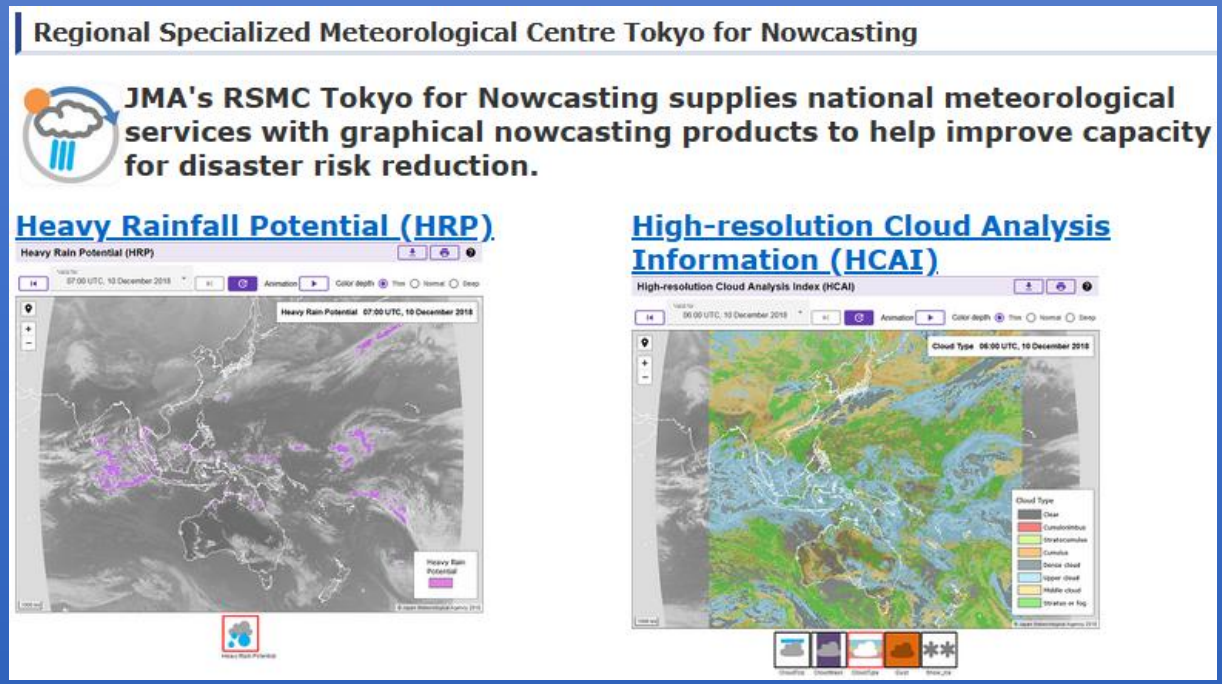
Southeast Asia 1



Southeast Asia 2

RSMC Tokyo for Nowcasting

https://www.jma.go.jp/jma/jma-eng/jma-center/nowcasting/



HCAI is also provided via HimawariJDDS service, which is one of the data distribution methods for NMHSs.

Himawari-8/9 Data Dissemination/Distribution

HimawariCast Receiving Systems

34 users

HimawariCloud accounts

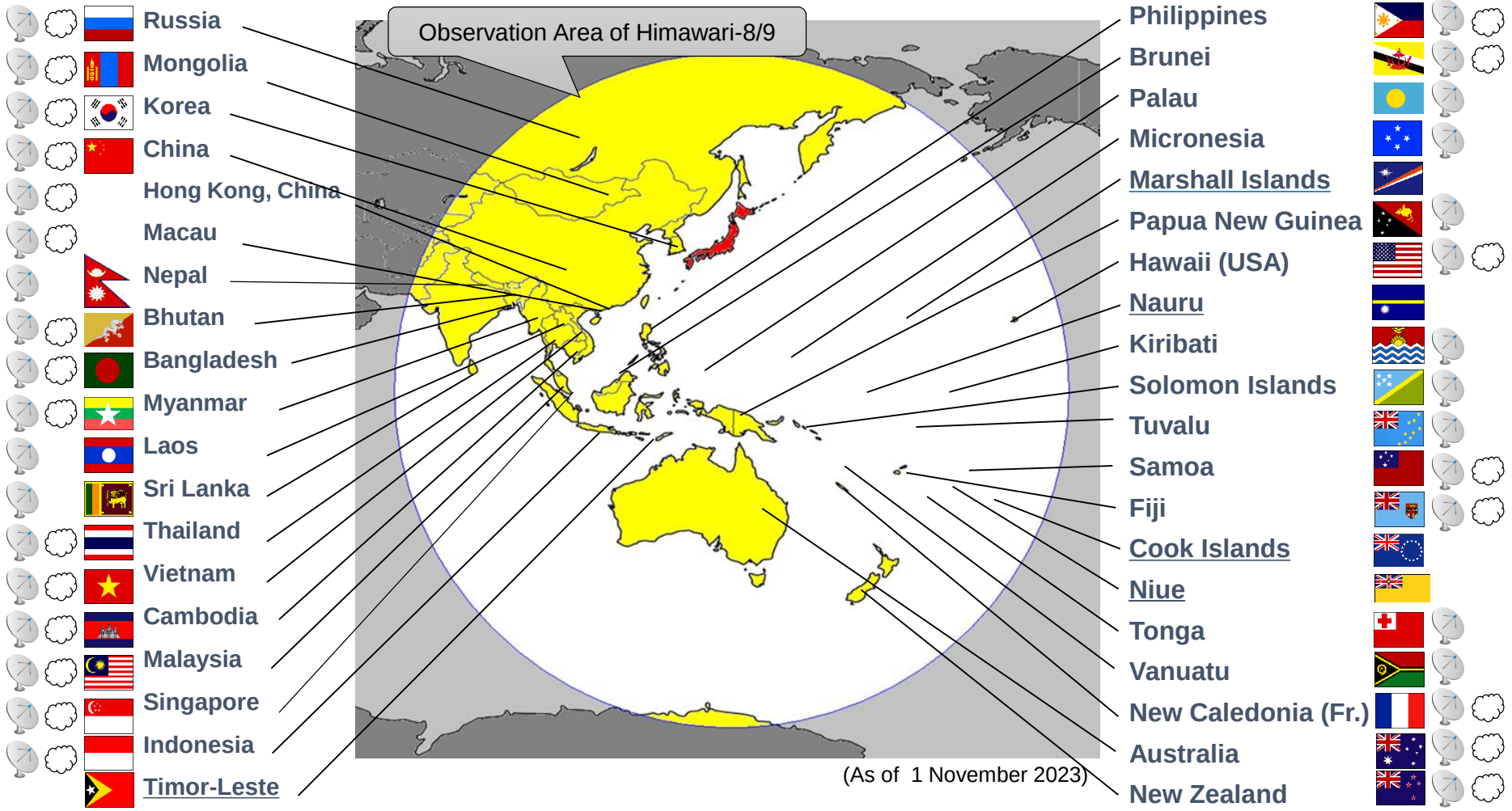
23 users

(In addition to these, EUMETSAT have accounts.)

Web service covers

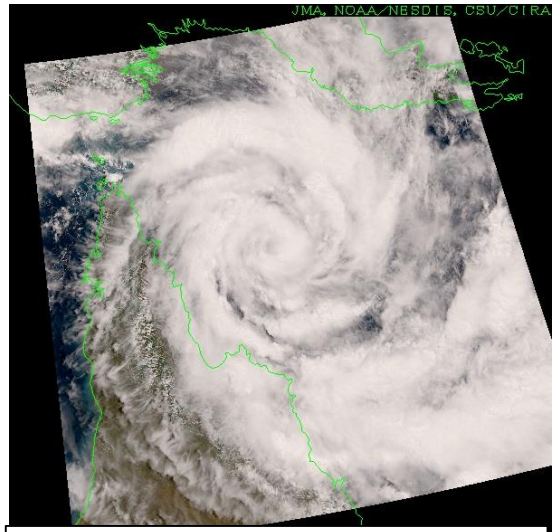
42 areas

(including Timor-Leste, Nauru, Marshall Islands, Cook Islands and Niue)



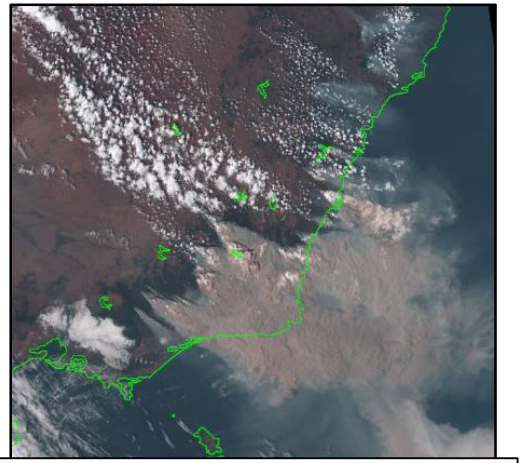
(As of 1 November 2023)

HimawariRequest

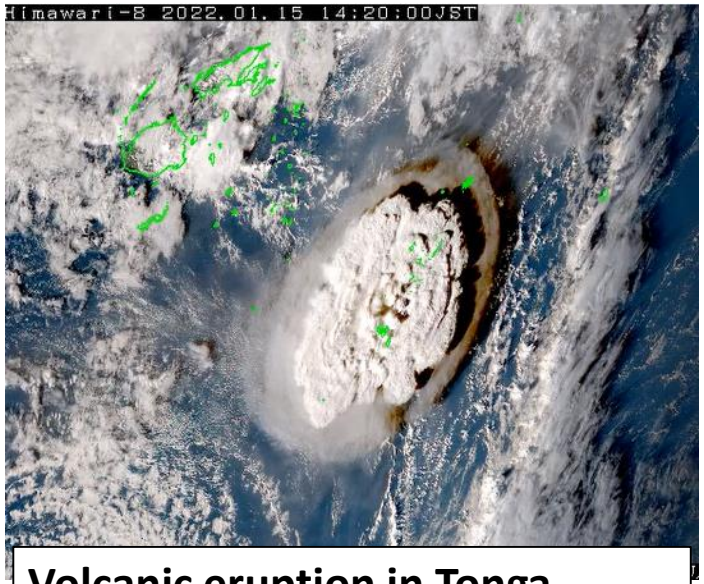


Cyclone in Australia (March 2019)

- Request-based high-frequency observation for NMHSs (1,000 x 1,000 km every 2.5 minutes) launched in 2018
- Actioning of 188 observation requests from the US, Australia, New Zealand, the Philippines, Singapore, Indonesia, India and Fiji
- Monitoring of cyclones, volcanoes, smoke, bushfires and other phenomena



Bushfire in Australia (December 2019)

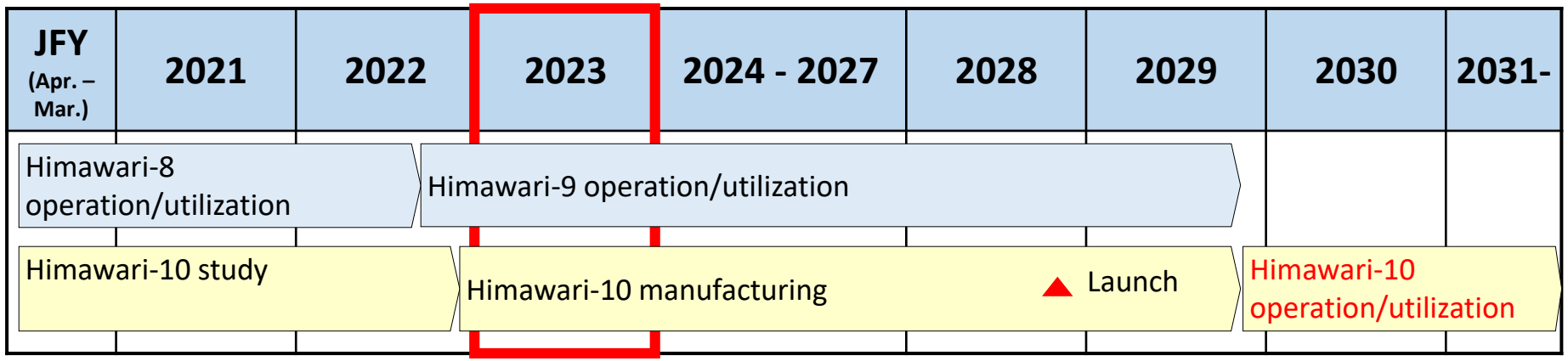


Volcanic eruption in Tonga (January 2022)

Contents

Himawari-10 Program

- Himawari-8/9 GEO follow-on program research
  - ✓ Commencement of consideration for the next GEO satellite (Himawari-10) program in JFY 2018
  - ✓ JMA pursuit of a seamless GEO satellite system based on consideration of a CGMS baseline and the WMO Vision for WIGOS in 2040 toward Geo-Ring observation
  - ✓ OSSE for the hyperspectral IR sounder on JMA NWP systems
- Himawari-10 Program
  - ✓ RFI, RFP and commencement of H-10 manufacture based on supplemental budget spending in JFY 2022
  - ✓ Commencement of operation in JFY 2029



Himawari-10 Overview

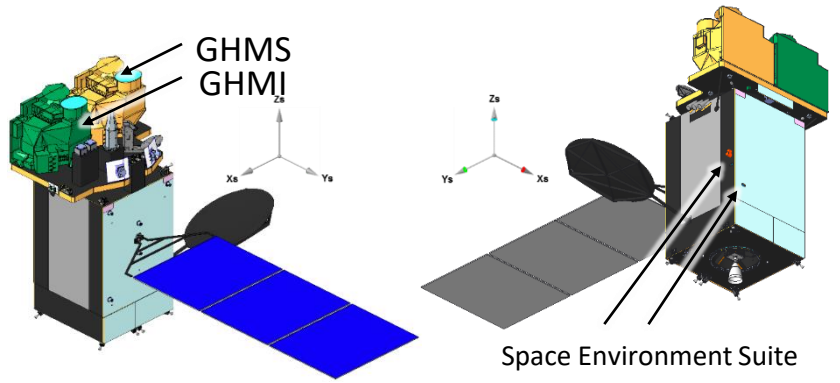
Missions

- **Geostationary HiMawari Imager (GHMI)**
  Measures visible & infrared radiance for weather monitoring/nowcasting & other applications.
- **Geostationary HiMawari Sounder (GHMS)**
  Measures high-spectral-resolution infrared radiance to collect vertical information of atmospheric temperature & water vapor, which improve weather forecasting by assimilating to numerical weather prediction models.
- **Data Collection System**
  Relays surface-based Data Collection Platforms (DCPs) data.
- **Space Environment Suite**
  Measures proton & electron flux in geostationary orbit, as a government furnished equipment by NICT.

Location

- Geostationary orbit at around 140.7 deg. E

Satellite Outline



Satellite Design	
Spacecraft	MELCO standard DS2000 bus
Mass (approx.)	2.4 t (dry), 6.1 t (with propellant)
Size (approx.)	4 m x 3 m x 6 m (folded), 11 m (deployed)
Design life	≥ 15 years (mission period ≥ 10 years)
Communications	Ka-band: Mission data downlink Ku-band: TT/C uplink & downlink UHF-band: DCP uplink

Geostationary HiMawari Imager (GHMI)

- L3Harris's new 18-band imager based on the same concept with its GeoXO Imager (GXI) selected by NASA
- Observing sequence & band configuration changed for Himawari-10
- Values in the tables show JMA requirements

Improvement from Himawari-8/9

GHMI Observing Area & Interval

Observing Area (minimum coverage)	Interval
Full Disk	10 min
Japan (EW 2500 km x NS 2000 km)	2.5 min
Target Area1 (EW 1000 km x NS 1000 km)	2.5 min
Target Area2 (EW 1000 km x NS 1000 km)	2.5 min
Target Area3 (EW 1000 km x NS 1000 km	2.5 min
Target Area4 (EW 1000 km x NS 1000 km)	2.5 min
Target Area5 (*) (EW 1000 km x NS 500 km)	30 sec

*Mainly used for CAL/VAL activities

GHMI Spectral band characteristics

	Center Wavelength [μm]	Band width [μm]	Spatial resolution at nadir [km]
VIS	0.46 - 0.48	≤ 0.07	≤ 1
	0.54 - 0.56	≤ 0.05	≤ 1
	0.63 - 0.65	≤ 0.12	≤ 0.5
NIR	0.85 - 0.87	≤ 0.06	≤ 1
	1.375 - 1.385	≤ 0.04	≤ 2
	1.60 - 1.62	≤ 0.08	≤ 2
	2.24 - 2.27	≤ 0.06	≤ 2
IR	3.75 - 3.95	≤ 0.50	≤ 1
	5.10 - 5.20	≤ 0.20	≤ 1
	6.05 - 6.45	≤ 1.20	≤ 2
	6.90 - 7.00	≤ 0.50	≤ 2
	7.27 - 7.43	≤ 0.60	≤ 2
	8.44 - 8.76	≤ 0.50	≤ 2
	9.55 - 9.70	≤ 0.50	≤ 2
	10.3 - 10.5	≤ 0.90	≤ 2
	11.1 - 11.3	≤ 1.00	≤ 2
	12.25 - 12.55	≤ 1.20	≤ 2
	13.2 - 13.4	≤ 0.70	≤ 2

Geostationary HiMawari Sounder (GHMS)

- L3Harris's new infrared FTS sounder based on the same concept with its GeoXO Sounder (GXS) proposed to NASA
- Observing sequence changed for Himawari-10
- Values in the tables show JMA requirements

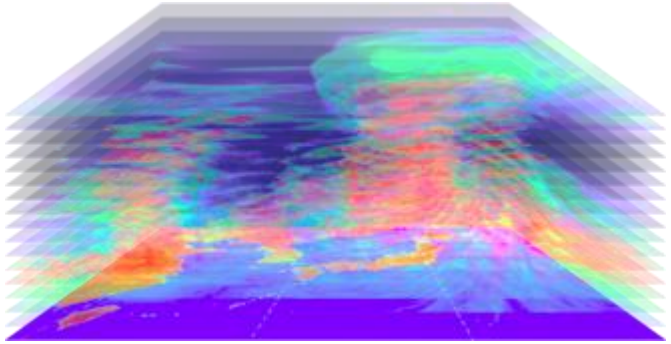
GHMS Observing Area & Interval

Observing Area (minimum coverage)	Interval
Sounding Disk (LZA ≤ 60 deg)	60 min
Japan (EW 2500 km x NS 2000 km)	15 min※
Target Area (EW 1000 km x NS 1000 km)	15 min

※ Sounding Disk observation over Japan area is regarded as one of the "Japan" observations in the 60-min repeat cycle (i.e., three "Japan" observations to be conducted in 60 minutes).

GHMS Spatial & Spectral characteristics

Spatial (horizontal) resolution		≤ 4.2 km
Spectral Coverage	LWIR	680 - 1095 cm^{-1} (14.7 - 9.13 μm)
	MWIR	1689 - 2250 cm^{-1} (5.92 - 4.44 μm)
Spectral Resolution (FWHM)		≤ 0.754 cm^{-1}
Spectral Sampling Distance		≤ 0.625 cm^{-1}



Thank you!!

Himawari-10 Perspective image