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Satellite Program Division

Japan Meteorological Agency

STATUS OF HIMAWARI-8/9 AND THEIR FOLLOW-ON SATELLITE HIMAWARI-10

Overview of Himawari-8 and -9

https://www.jstage.jst.go.jp/article/jmsj/94/2/94_2016-009/_article

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Articles

An Introduction to Himawari-8/9— Japan's New-Generation Geostationary Meteorological Satellites

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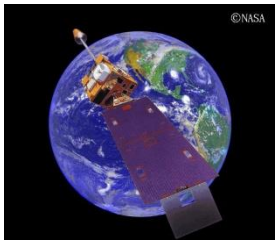
History of Japanese Geostationary-Met. Satellites

GMS (Geostationary Meteorological Satellite)
nicknamed "Himawari"

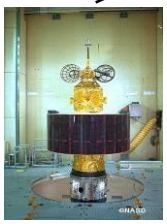


GOES-9

Himawari-8 ***Himawari-9***

Jul 1977	Aug 1981	Aug 1984	Sep 1989	Mar 1995	May 2003	Feb 2005	Feb 2006	Oct 2014	Nov 2016

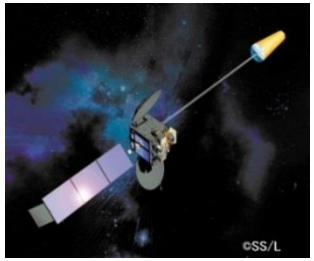
GMS-2
Himawari-2



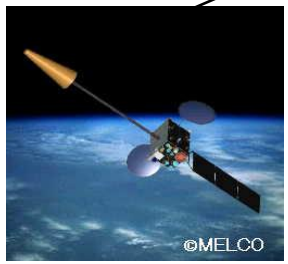
GMS-3
Himawari-3

GMS-4
Himawari-4

GMS-5
Himawari-5



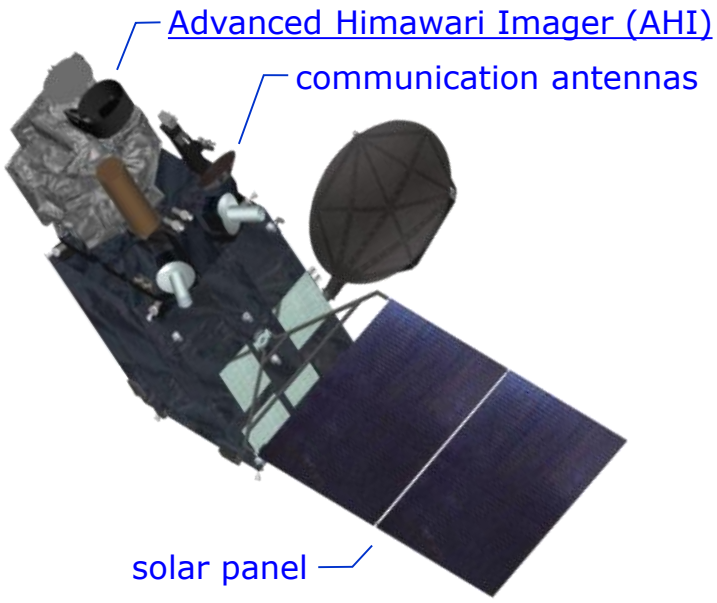
MTSAT-1R
Himawari-6



MTSAT-2
Himawari-7

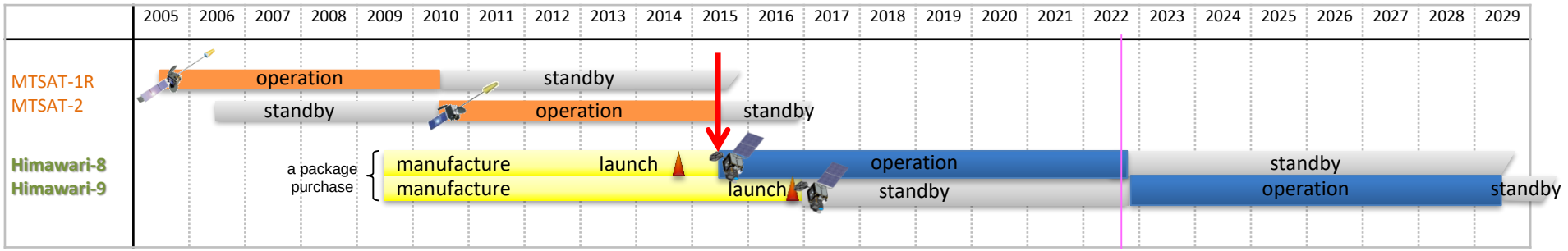
Satellite	Observation period
GMS	1977~1981
GMS-2	1981~1984
GMS-3	1984~1989
GMS-4	1989~1995
GMS-5	1995~2003
GOES-9 *	2003~2005 *
MTSAT-1R	2005~2010
MTSAT-2	2010~2015
Himawari-8	2015~2022
Himawari-9	2022~2029

Himawari-8/9



Himawari-8 began operation on 7 July 2015, replacing the previous MTSAT-2 operational satellite

Geostationary position	Around 140.7° E
Attitude control	3-axis attitude-controlled geostationary satellite
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)



Switch over from Himawari-8 to Himawari-9

- JMA is currently planning the operational satellite switchover from Himawari-8 to -9 for **13th December 2022**.
- The switch will be almost seamless, with no data format or data dissemination system changes.
- JMA has checked the data and products quality of Himawari-9 including navigation and calibration errors.
  - The results are provided on website of Meteorological Satellite Center of JMA.
    https://www.data.jma.go.jp/mscweb/en/oper/switchover.html
  - **See the presentations by Ms. Sumita and Mr. Koyamatsu on Wed. 16th Nov.**
    S41-03: Pre-Operational Validation of AHI on Himawari-9, in navigation and calibration
    S41-04: Pre-Operational Validation of AHI on Himawari-9, in level 2 products
- Filename for Himawari Standard Data (HSD) and NetCDF via HimawariCloud will change according to the filename convention as :
  HS_H08_yyyymmdd_hhnn_Bbb_cccc_Rjj_Skkll.DAT.bz2 *for H-08 HSD*
  HS_H09_yyyymmdd_hhnn_Bbb_cccc_Rjj_Skkll.DAT.bz2 *for H-09 HSD*
  The same applies to NetCDF files
- Their parallel data distribution of HSD for research purpose via Japanese scientific cooperative institutes mentioned later has already started from 27th September.
  - For more information, please contact metsat@met.kishou.go.jp .

Spectral Bands

cf. MTSAT-2 Bands

VIS 0.68 μm

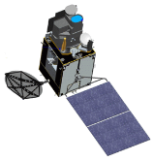
IR4 3.7 μm

IR3 6.8 μm

IR1 10.8 μm

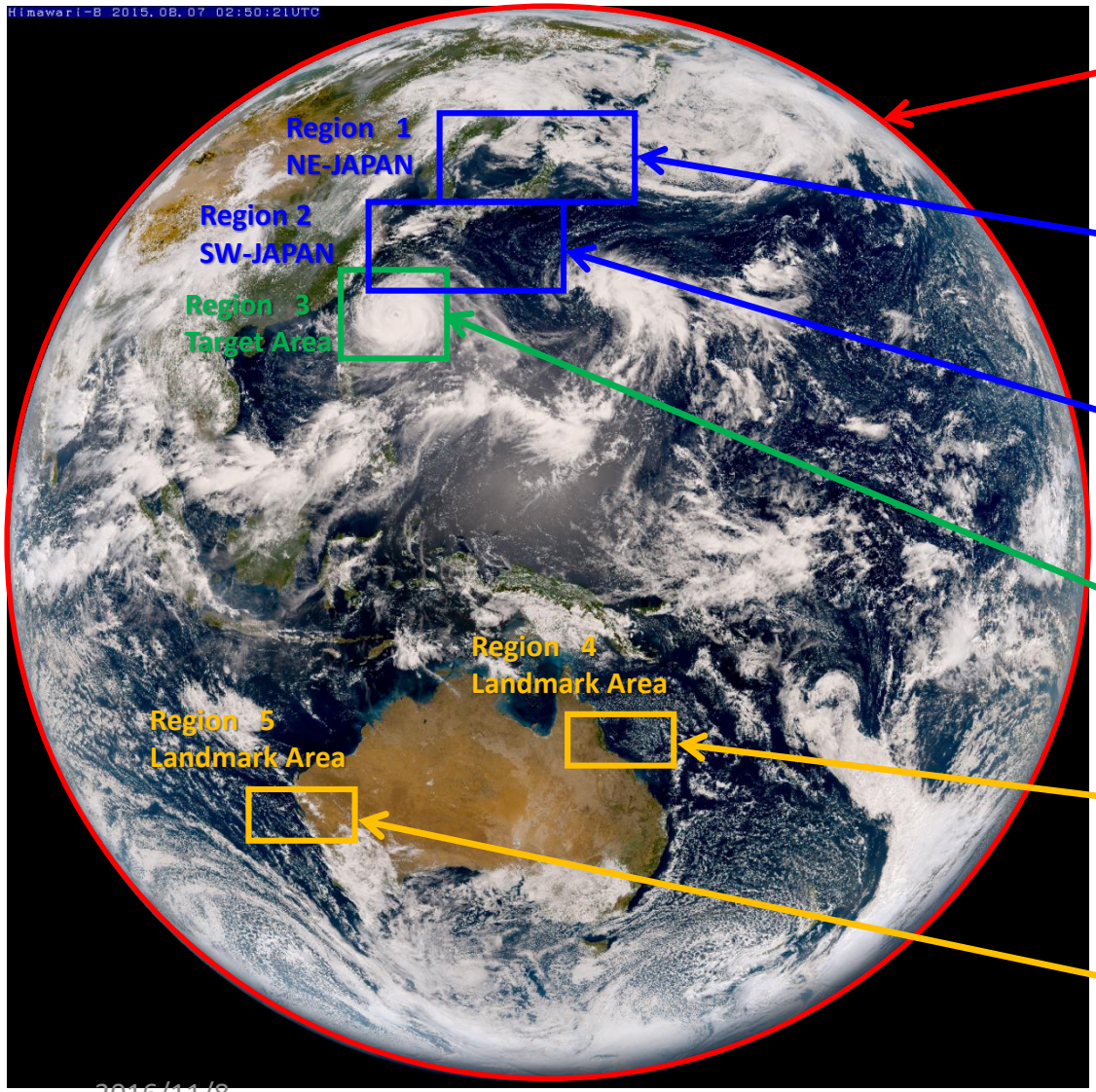
IR2 12.0 μm

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	

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

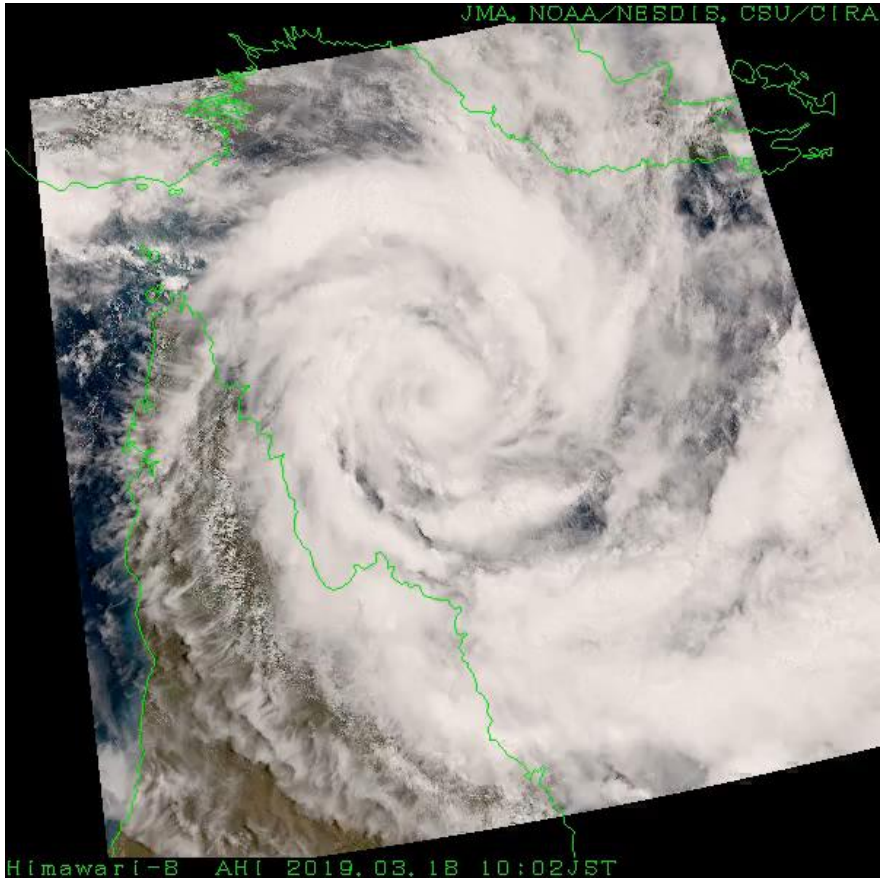
Interval : **0.5 minutes** (20 times in 10 min)
Dimension : EW x NS: 1000 x 500 km

Region 5 Landmark Area

Interval : **0.5 minutes** (20 times in 10 min)
Dimension : EW x NS: 1000 x 500 km

HimawariRequest

- HimawariRequest was started from January 2018 in cooperation with Bureau of Meteorology (BoM), Australia.
- International service for NMHSs in Himawari-8/-9 coverage area to request Target Area observation (***1,000 x 1,000 km area every 2.5 minutes***).
- JMA expects this service to support ***disaster risk reduction activities in the Asia Oceania*** region.
- Status as of 11 Nov. 2022
  - Registration: **22** NMHSs
  - **148** requests for TC, volcanic eruption, wild fires, etc.



HimawariRequest from BoM on 13-19 Mar. 2019

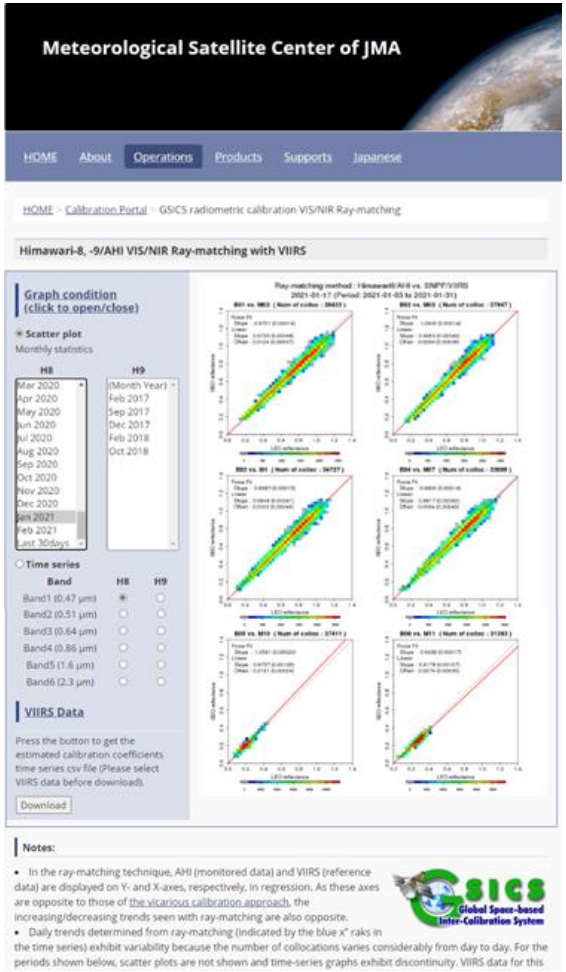
Himawari-8 observation data quality

INR (Image Navigation and Registration)

- Image navigation errors are within 600 m at the sub-satellite point.

Calibration

- Radiometric calibration biases are less than 5% in reflectivity for VNIR bands (bands 1 to 6) and less than 0.3 K in brightness temperature for IR bands (bands 7 to 16).
- Parameters for sensor sensitivity correction for bands 1 to 6 have been updated on annual basis. The last update was implemented on 13 July 2020.
- Provision of reporting on Himawari-8 visible and near infrared band calibration performance validated by a ray-matching approach utilizing VIIRS was commenced in addition to an existing approach using radiative transfer simulation in Q2 2021.



https://www.data.jma.go.jp/mscweb/data/monitoring/navigation.html
https://www.data.jma.go.jp/mscweb/en/oper/calibration/calibration_portal.html

Provision of Himawari Data for Researcher

Himawari-8 data are being redistributed to R&D users by the following Japanese scientific cooperative institutes.

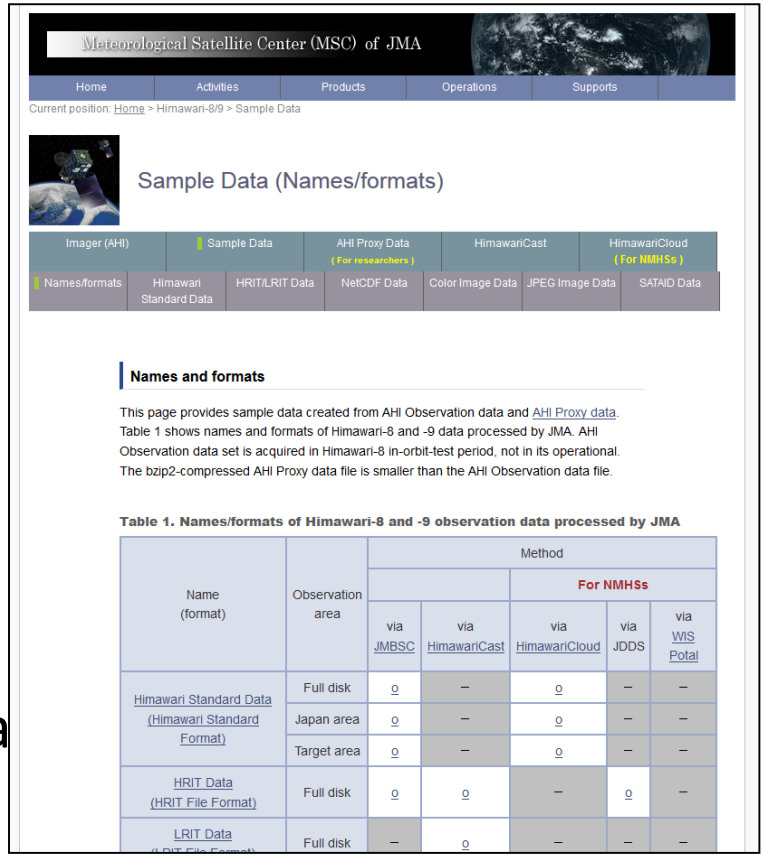
- **NICT (National Institute of Information and Communications Technology)**
  - https://himawari8.nict.go.jp/en/himawari8-image.htm
- **CEReS (Center for Environmental Remote Sensing, Chiba University)**
  - http://www.cr.chiba-u.jp/databases/GEO/H8_9/FD/index_en_V20190123.html
- **DIAS (Data Integration and Analysis System, Japan Agency for Marine-Earth Science and Technology)**
  - https://diasjp.net/en/service/himawari8-data-download/
- **JAXA (Japan Aerospace Exploration / Earth Observation Research Center)**
  - http://www.eorc.jaxa.jp/ptree/index.html

Himawari-8/9 Users Support Information

https://www.data.jma.go.jp/mscweb/en/support/support.html

Contents:

- Overview of satellite observation
- Overview of data dissemination
- Imager (AHI) specifications
- Operational status
- Sample data
- Sample source code to read Himawari-8 data and convert into other formats
  - From HSD or HRIT to NetCDF Data
  - From HSD or HRIT to SATAID Data
  - From HSD to HRIT Data etc.


Meteorological Satellite Center (MSC) of JMA

Home | Activities | Products | Operations | Supports

Current position: Home > Himawari-8/9 > Sample Data

Sample Data (Names/formats)

Imager (AHI) | Sample Data | AHI Proxy Data (For researchers) | HimawariCast | HimawariCloud (For NMHSs)

Names/formats | Himawari Standard Data | HRIT/LRIT Data | NetCDF Data | Color Image Data | JPEG Image Data | SATAID Data

Names and formats

This page provides sample data created from AHI Observation data and AHI Proxy data. Table 1 shows names and formats of Himawari-8 and -9 data processed by JMA. AHI Observation data set is acquired in Himawari-8 in-orbit-test period, not in its operational. The bzip2-compressed AHI Proxy data file is smaller than the AHI Observation data file.

Table 1. Names/formats of Himawari-8 and -9 observation data processed by JMA

Name (format)	Observation area	Method				
				For NMHSs		
		via JMBSC	via HimawariCast	via HimawariCloud	via JDDS	via WIS Potal
Himawari Standard Data (Himawari Standard Format)	Full disk	o	–	o	–	–
	Japan area	o	–	o	–	–
	Target area	o	–	o	–	–
HRIT Data (HRIT File Format)	Full disk	o	o	–	o	–
LRIT Data	Full disk	–	o	–	–	–

Feel free to contact:

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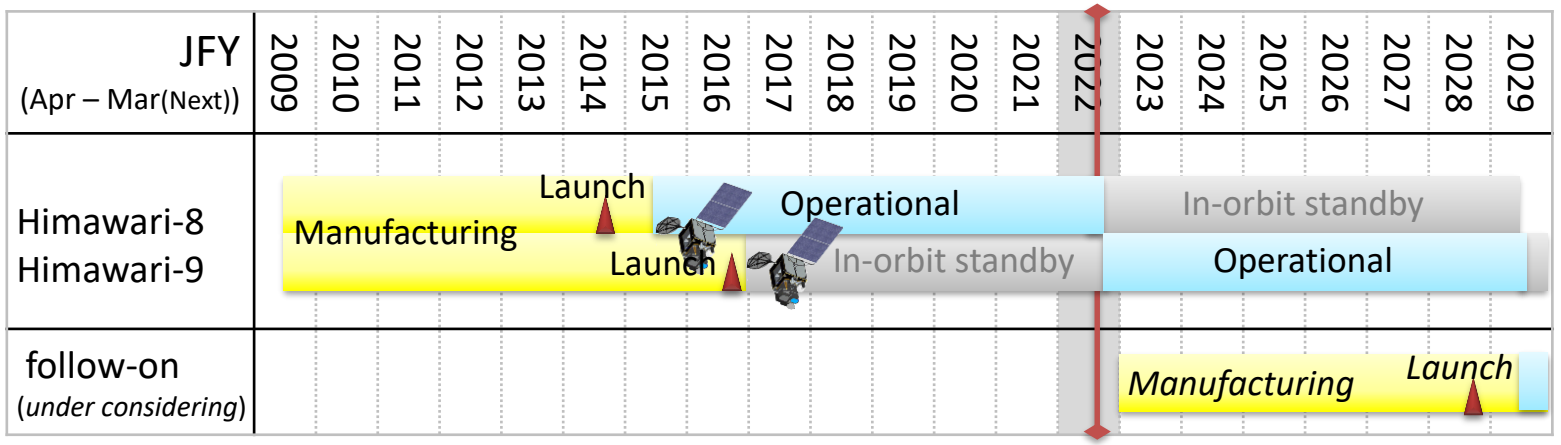
metsat@met.kishou.go.jp

Himawari Follow-on Program

- JFY2018: JMA has started to consider the next GEO satellite (Himawari-10) program.
  - "By *JFY2023* Japan will start manufacturing the Geostationary Meteorological Satellite that will be the successor to Himawari-8/9, aiming to *put it into operation in around JFY2029*"
    Japan's "Basic Plan on Space Policy" (June 2020)
  - JMA will pursue seamless GEO satellite system by considering CGMS baseline and WMO Vision for WIGOS in 2040 to contribute the establishment of Geo-Ring observation.
- JFY2019: Worldwide Technology Trends Survey on Future Satellites/Instruments
- JFY2020: OSSE of hyperspectral IR sounder on JMA NWP systems was implemented.
- JFY2021: Internal, domestic and international user requirements will be summarized.
- **JFY2022: RFI and RFP**
- JFY2023: Start of manufacturing of H-10
- JFY2028: Launch of Himawari-10
- JFY2029: Start of operation of Himawari-10



Vision for WIGOS in 2040 for GEO

	Application	Satellite/Instrument
VIS/IR Imager w/ rapid repeat cycles	Cloud amount/type/top height/temperature, wind, sea/land surface temperature, precipitation, aerosols, snow cover, vegetation cover, albedo, atmospheric stability, fires, volcanic ash, sand/dust storm, convective initiation	• **NOAA: GOES-16,17/ABI** • **JMA: Himawari-8,9/AHI** • **KMA: GK-2A/AMI** • **CMA: FY-4A,4B/AGRI** • **EUMETSAT: MTG-I1/FCI (2022)**
Hyperspectral IR Sounder	Atmospheric temperature/humidity, wind, rapidly evolving mesoscale features, sea/land surface temperature, cloud amount/top height/temperature, atmospheric composition	• **NOAA: N/A** • **JMA: N/A** • **KMA: N/A** • **CMA: FY-4A,4B/GIIRS** • **EUMETSAT: MTG-S1/IRS (2024)**
Lightning Mapper	Lightning, location of intense convection, life cycle of convective systems	• **NOAA: GOES-16,17/GLM** • **JMA: N/A** • **KMA: N/A** • **CMA: FY-4A/LMI** • **EUMETSAT: MTG-I1/LI (2022)**
UV/VNIR Sounder	Ozone, trace gases, aerosol, humidity, cloud top height	• **NASA: TEMPO (2023)** • **JMA: N/A** • **KMA: GK-2B/GEMS** • **CMA: N/A** • **EUMETSAT: MTG-S1/UVN (2024)**

Collecting user requirements for H-10

- JMA internal group (users/developers of satellite data/products)
  - Weather, aviation, ocean, atmospheric environment, volcano and climate
- Himawari data utilization promotion group (JMA internal/external scientists)
  - Activities under advisory panel on JMA's geostationary meteorological satellites
- Mission Investigation Team (MInT)
  - Volunteer group of Japanese remote sensing scientists including JAXA, research organizations and universities to propose recommendations for Himawari follow-on satellite and future Japanese geostationary Earth observation satellites
- Australia
  - Bureau of Meteorology and scientists in Australia (EOA survey)
- Domestic/International meetings
  - Spring/Autumn conferences of Meteorological Society of Japan
  - Annual meeting of Japan Geoscience Union
  - Asia-Oceania Meteorological Satellite Users' Conference

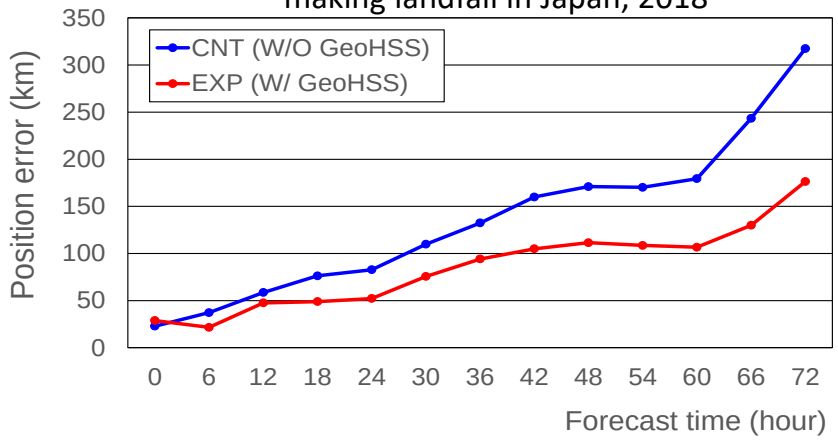
JMA internal Requirements for Imager

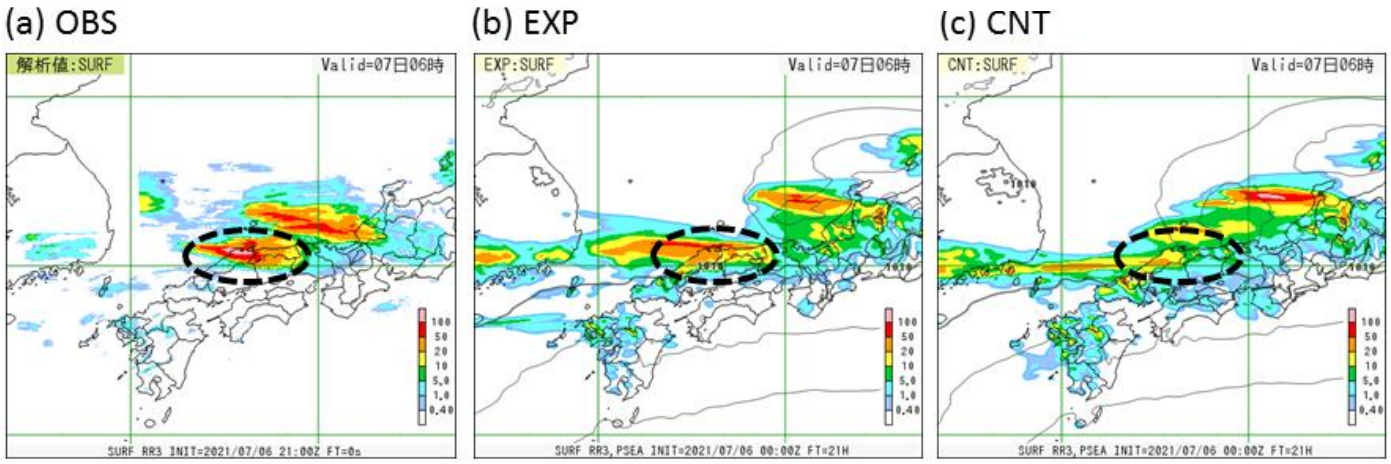
- Keeping current spectral bands (incl. 3 WV bands) as possible
- Adding 1.38 μm band for weather/aviation apps
  - Cloud mask: detection of thin cirrus and cloud identification over snow/ice-covered surfaces
  - Sunshine duration and weather estimation: reducing false alarms over snow-covered surface
- Shifting central wavelength of green band (from 0.51 to 0.55 μm)
  - Advantages in ocean color and land apps + true color imagery
- Upgrading spatial resolution (from 2 km to 1 km)
  - 1.6 μm: Sunshine duration, convective initiation, cloud microphysics (e.g. icing and supercooled cloud), SW radiation, snow/ice, RGB imagery (e.g. sea ice), volcanic activities monitoring, etc.
  - 3.9 μm: nighttime low-level AMV, low-level cloud/fog, RGB, volcanic activities monitoring, etc.
  - 2.26 μm: cloud microphysics (e.g. effective radius)
- Expanding rapid scanning (regional observation) capability
  - Monitoring weather around Japan, tropical cyclones, volcanos (incl. ash), researches in convection lifecycle,
- Improving latency: specific value TBD
- L1B reprocessing: re-analysis, L2 products (e.g. SST, aerosol)
- DNB capability (if possible): weather/marine monitoring, L2 products (cloud, fog, SST, etc.)

OSSE of hyperspectral IR sounder

- Several experiments were implemented with Okamoto *et al.* (2020)
  - Operational DA configuration (incl. use of AIRS/CrIS/IASI in global model)
  - Hypothetical IRS on GEO at 140.7 E, hourly full-disk obs w/ 30 km spatial resolution from ERA5
- Global DA (upper figure)
  - ~140 km improvement in typhoon position for 3-d forecast (time of landing)
- Regional DA (bottom figures)
  - Better location of the heaviest rain area which caused devastating floods

Averaged track forecast errors (4 typhoons) making landfall in Japan, 2018





Three-hour accumulated rainfall (mm) valid at 2100 UTC 06 July 2021

Concept of Himawari-10

- **Mission Instrument(s)**
  - AHI-class or FCI-class VIS/IR imager (with optional improved capabilities)
  - New instrument (under consideration)
    - ✓ Hyperspectral IR sounder
    - ✓ Space Environmental Suite by MIC/NICT as hosted payloads
- **Orbital location**
  - Around 140 degrees East
- **Design lifetime**
  - 15 years (10-year in-orbit operation and 5-year in-orbit storage)
- **Communication subsystems**
  - Ka-band (18 GHz) for mission raw data downlink
  - Ku-band (12-14 GHz) for telemetry, tracking & command
  - Data Collection System (collection of in-situ meteorological data)

Thank you!!

The first image of Himawari-9
02:40 UTC, 24 Jan. 2017

True Color Reproduction imagery

This imagery was developed on the basis of collaboration between the JMA Meteorological Satellite Center and the NOAA/NESDIS GOES-R Algorithm Working Group imagery team.