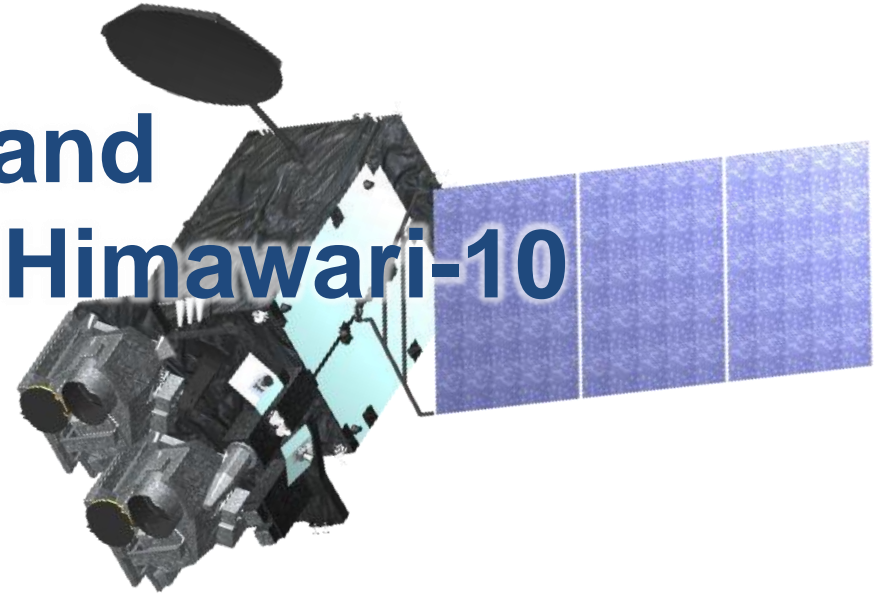
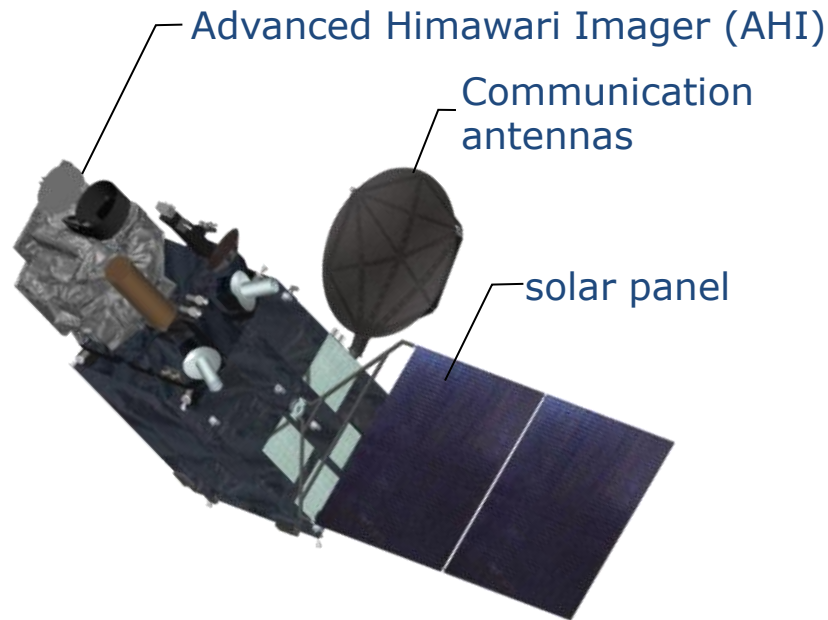


Status of Himawari-8/9 and their follow-on satellite Himawari-10



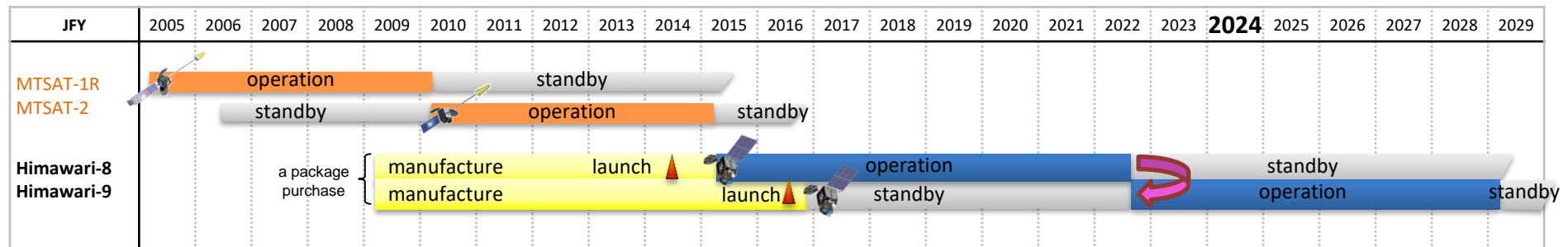
OKUYAMA Arata
Japan Meteorological Agency

Himawari-8/9



Switchover of the operational satellite from Himawari-8 to Himawari-9 was conducted on 13th December 2022

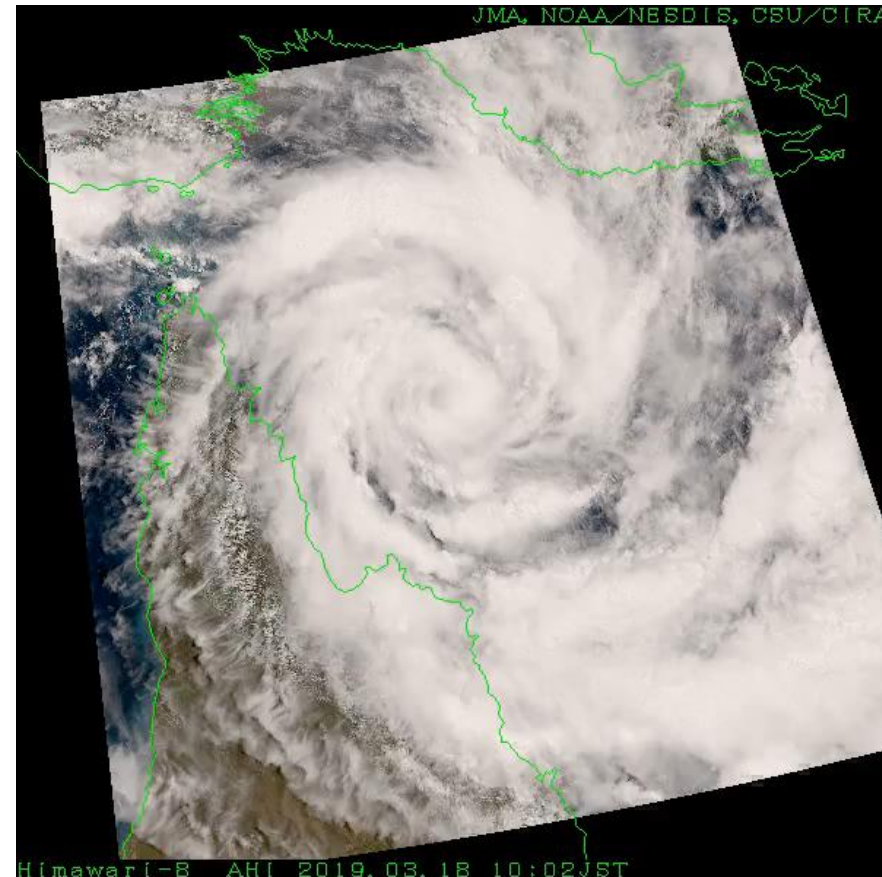
Geostationary position	Around 140.7° E
Attitude control	3-axis stabilization
Communication	1) Raw observation data transmission Ka-band, 18.1 - 18.4 GHz (downlink)
	2) DCS (Data collection System) UHF-band, 402.0 - 402.4 MHz (uplink) Transmission to ground segments Ka-band, 18.1 - 18.4 GHz (downlink)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



HimawariRequest

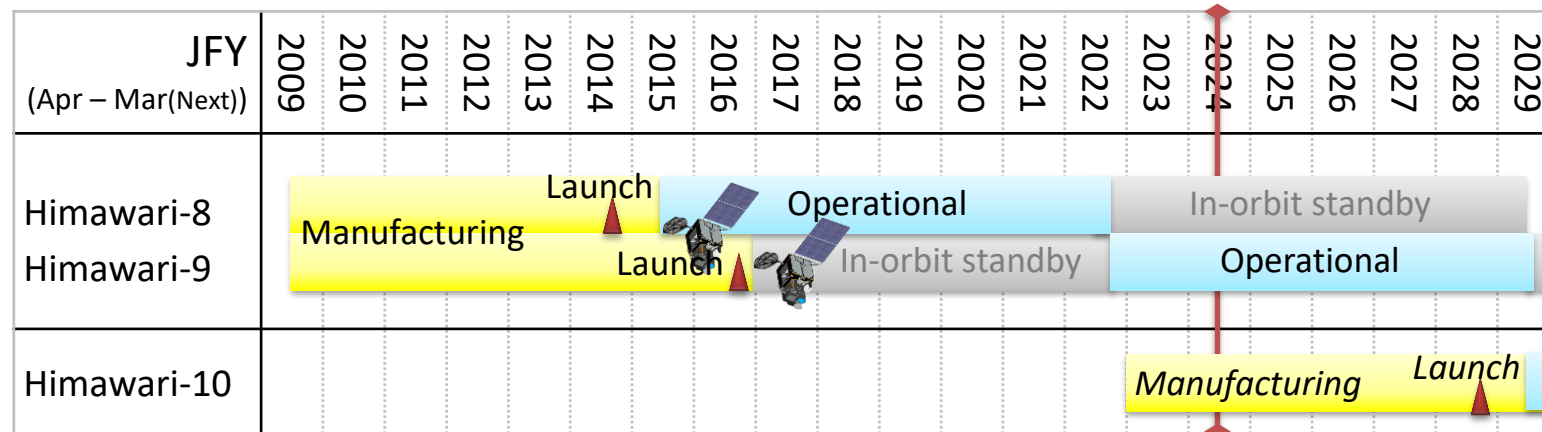
- JMA started HimawariRequest from January 2018 in cooperation with Bureau of Meteorology (BoM), Australia.
- International service for NMHSs in Himawari-8/9 coverage area to request Target Area observation (1,000 x 1,000 km area every 2.5 minutes).
- JMA expects this service to support disaster risk reduction activities in the Asia Oceania region.
- Status as of July 1st, 2024
 - Registration: 22 NMHSs
 - 233 requests for TC, volcanic eruption, wildfires, etc.

HimawariRequest from BoM
on 13-19 Mar. 2019



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”, 2020)
 - JMA will pursue seamless GEO satellite system by considering CGMS baseline and 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 were summarized.
- JFY2022: RFI, RFP and Start of manufacturing of Himawari-10
- JFY2028: Launch of Himawari-10
- JFY2029: Start of operation of Himawari-10

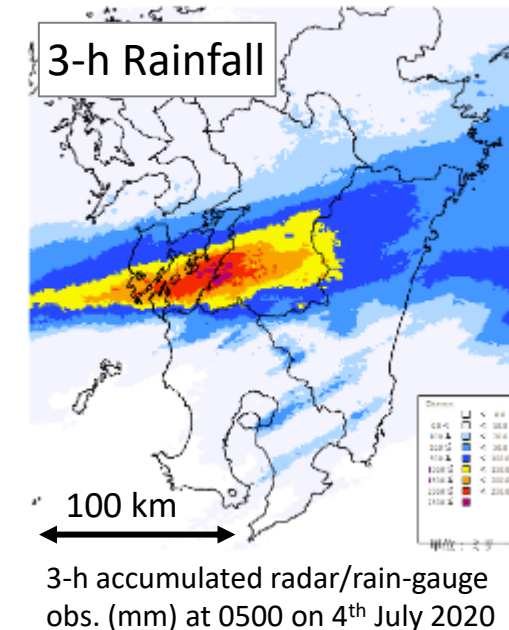


Vision for WIGOS in 2040 for GEO

	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	<ul style="list-style-type: none"> • NOAA: GOES-16,17,18/ABI • JMA: Himawari-8,9/AHI • KMA: GK-2A/AMI • CMA: FY-4A,4B/AGRI • EUMETSAT: MTG-I1/FCI
Hyperspectral IR Sounder	Atmospheric temperature/humidity, wind, rapidly evolving mesoscale features, sea/land surface temperature, cloud amount/top height/temperature, atmospheric composition	<ul style="list-style-type: none"> • NOAA: GeoXO/GXS (2035) • JMA: Himawari-10/GHMS (2029) • KMA: N/A • CMA: FY-4A,4B/GIIRS • EUMETSAT: MTG-S1/IRS (2025)
Lightning Mapper	Lightning, location of intense convection, life cycle of convective systems	<ul style="list-style-type: none"> • NOAA: GOES-16,17,18/GLM • JMA: N/A • KMA: N/A • CMA: FY-4A/LMI • EUMETSAT: MTG-I1/LI
UV/VNIR Sounder	Ozone, trace gases, aerosol, humidity, cloud top height	<ul style="list-style-type: none"> • NASA: TEMPO • JMA: N/A • KMA: GK-2B/GEMS • CMA: N/A • EUMETSAT: MTG-S1/UVN (2025)

Toward Better Prediction for Stationary Linear Mesoscale Convective Systems

- High-impact weather events in recent years have resulted in a demand for improving JMA's weather forecasts/warnings.
- Torrential rain events during East Asian rainy season further enhanced this demand.
 - Mainly caused by stationary linear mesoscale convective systems
- JMA established a WG with external experts and internal TF to improve the prediction system to issue warnings with extended lead time by
 - Introducing advanced observation technologies such as GNSS receivers on vessels (short-term subject) and **geostationary IR sounders (long-term subject)**
 - Improving NWP models
- Enhanced collaboration with academia.



Himawari-10 Overview

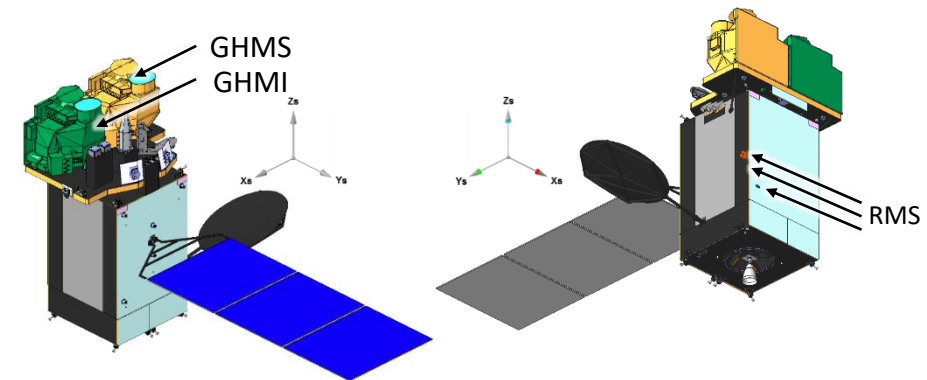
Missions

- **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.
- **Radiation Monitors for Space weather (RMS)**
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	DS2000 standard satellite platform developed by Mitsubishi Electric
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 18-band imager based on the same concept with its GeoXO Imager (GXI) selected by NASA
- Observing sequence & band configuration changed for Himawari-10

GHMI Observing Area & Interval

Observing Area (minimum coverage)	Interval
Full Disk	10 min
Japan	2.5 min
(EW 2500 km x NS 2000 km)	
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

Values in the tables show JMA requirements.

Improvements from
Himawari-8/9

Geostationary HiMawari Sounder (GHMS)

GHMS Observing Area & Interval

Observing Area (minimum coverage)	Interval
Sounding Disk (zenith angle ≤ 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).

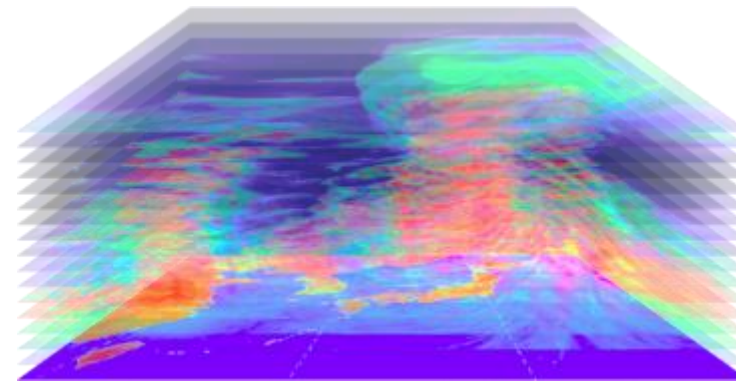
GHMS Spatial & Spectral characteristics

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}

Values in the tables show JMA requirements.

* FWHM: Full Width Half Maximum

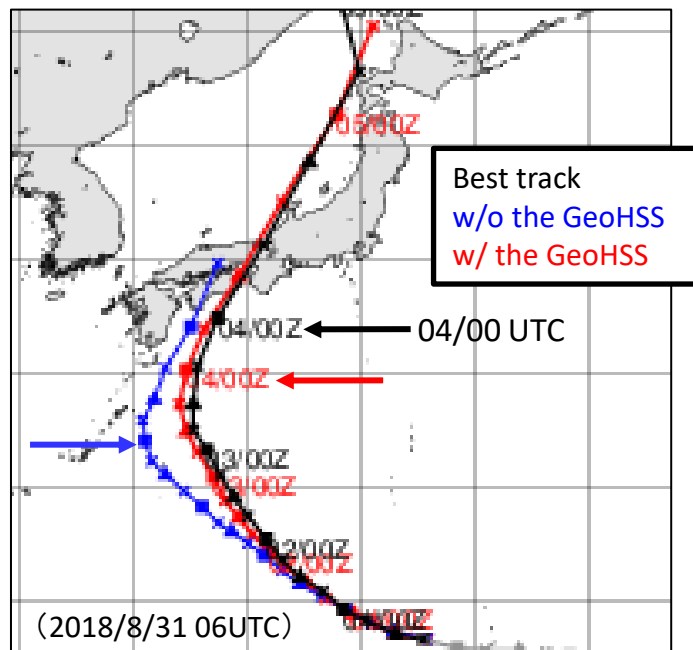
- L3Harris's infrared FTS sounder



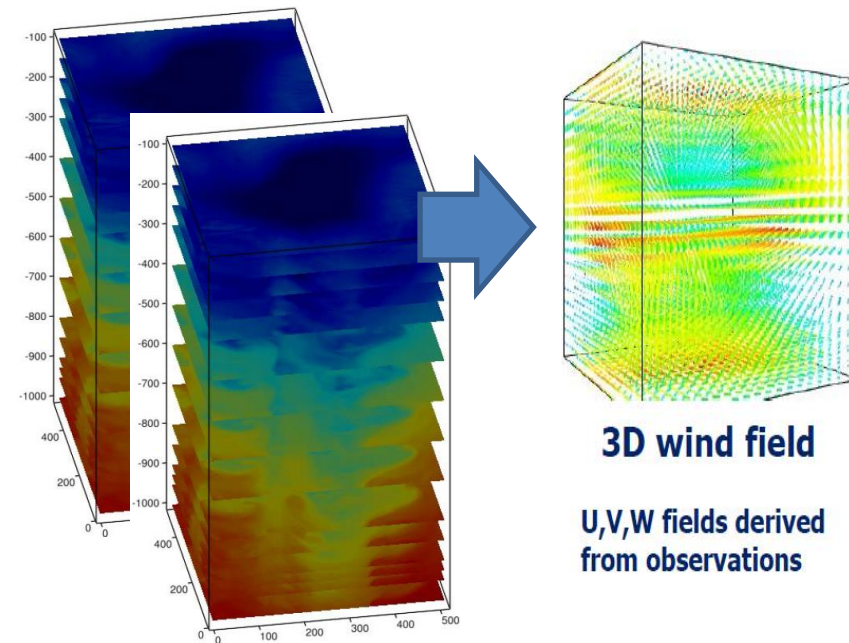
Contribution of hyper spectral IR sounder

- GHMS is expected to contribute to significantly improving weather forecast accuracy through data assimilation.
- JMA prepared a simulated GHMS observation dataset to support development of GHMS data application in advance of its operation start.

OSSE for typhoon "Jebi" in 2018



Okamoto, et al., 2020: ひまわり 8・9 号後継衛星検討のための ハイパー
スペクトル赤外サウンダの数値予報インパクト調査, 測候時報第87巻



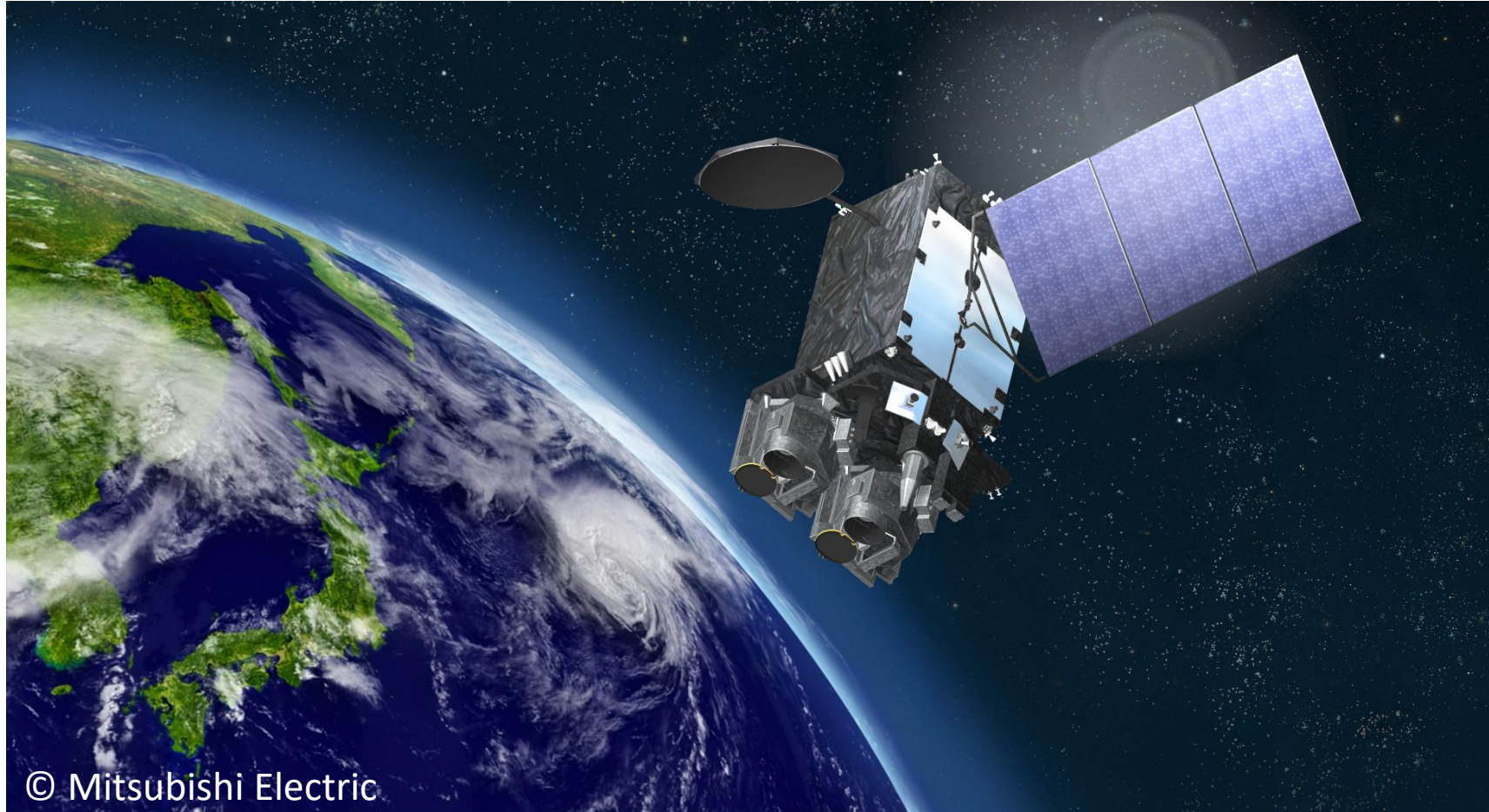
Hautecoer, O., R. Borde and P. Héas, 2018: 3D Winds derivation from infrared sounders from the model concept to the product. The 14th International Winds Workshop, Korea

Summary

- Since 2022, Himawari-9 has been an operational observation satellite. Himawari-8 is now back-up satellite.
- JMA started manufacturing of the follow-on satellite “Himawari-10” in JFY 2022.
- Himawari-10 is scheduled to be launched in JFY 2028 and begin operating in JFY 2029.
- Himawari-10 will carry Geostationary HiMawari Imager (GHMI), Geostationary HiMawari Sounder (GHMS), Data Collection System, and Radiation Monitors for Space weather (RMS).
- GHMS is expected to contribute to significantly improve weather forecast accuracy through data assimilation. JMA prepared a simulated GHMS observation dataset to support development of GHMS data application in advance of its operation start.

Thank you!!

Himawari-10



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