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

Presented to CGMS-51 WG III, agenda item 4.1 (JMA-WP-06)

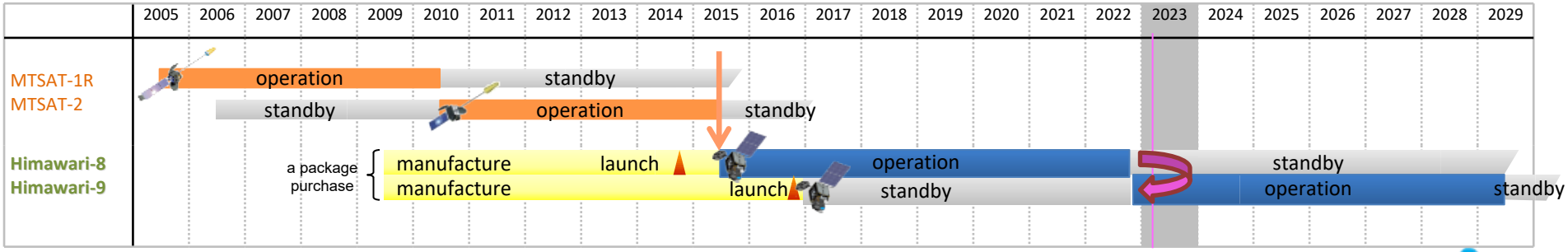
Japan Meteorological Agency

Coordination Group for Meteorological Satellites

Himawari-8/9

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)

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



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Switch over from Himawari-8 to Himawari-9

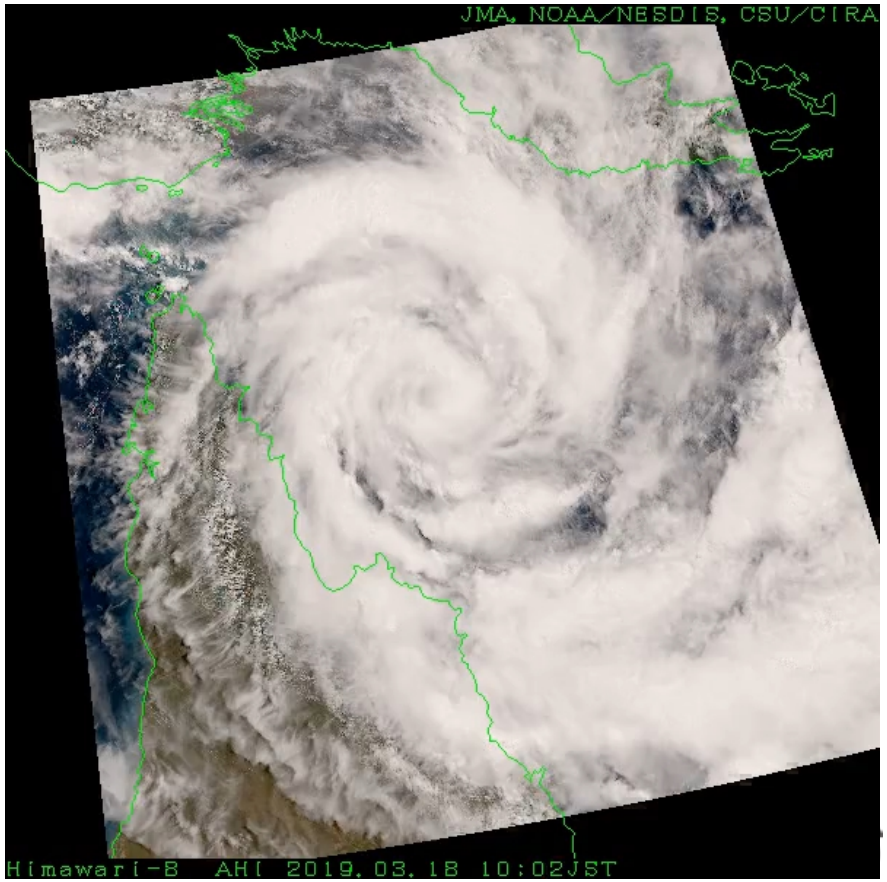
- JMA conducted the operational satellite switchover from Himawari-8 to -9 on **13 December 2022**.
- The switch was almost seamless with no data discontinuity. There were no changes to data format or data dissemination system between Himawari-8 and Himawari-9.
- Filename for Himawari Standard Data (HSD) and NetCDF via HimawariCloud changed 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

- JMA provided parallel distribution of Himawari-9 observation data and products for several months by an additional method before the switchover (27 Sep. – 13 Dec. 2022).

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 5 April 2023
  - Registration: 22 NMHSs
  - **176** requests for TC, volcanic eruption, wildfires, etc.



HimawariRequest from BoM on 13-19 Mar. 2019

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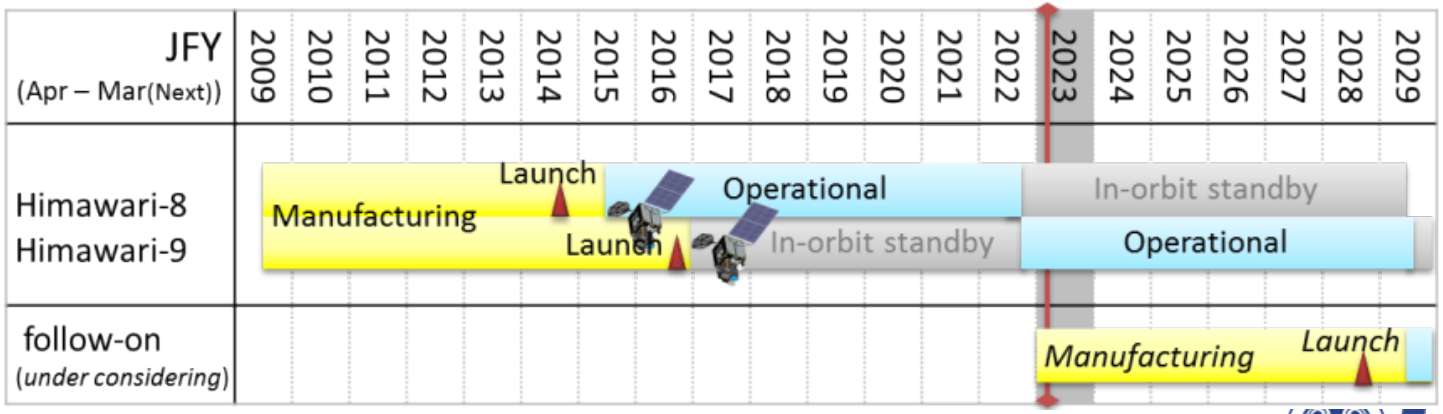
Himawari Follow-on Program

- 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, RFP and Start of manufacturing of H-10 using supplemental budget**
- JFY2028: Launch of Himawari-10
- JFY2029: Start of operation of Himawari-10



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WMO 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 (2022) • JMA: N/A • KMA: GK-2B/GEMS • CMA: N/A • EUMETSAT: MTG-S1/UVN (2024)

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JMA's 10-Year Strategy Toward 2[illegible]

1. Technology Developments

- Application of latest sci & tech;
  - ✓ Advanced ***satellites***, remote sensing, big data
  - ✓ NWP and other prediction tech.
  - ✓ Collaboration etc.
- Improvement of forecasts
  - ✓ Nowcast up to 1 hour
  - ✓ ***12-hour forecast of localized heavy rain***
    (stationary linear mesoscale convective systems)
  - ✓ ***3-day typhoon forecast*** etc.

Synergy

2. Promotion of Effective Utilization of Info./Data

- Build environment for better usage
  - ✓ Larger data flow
  - ✓ Easier access
- Raise capacity for the utilization
  - ✓ Literacy about disaster, safety, etc.
  - ✓ Application technology/skill

Met. Services for Better Society

3. Contribution to Disaster Resiliency

- JMA to Contribute to "Disaster Awareness Society" and to play the leading role in met. services
  - ✓ Improved impact-based warnings on the basis of advanced sci & tech
  - ✓ Collaborate with stake-holders to build local decision making capacity
  - ✓ Raise individual disaster awareness and response capacity

We need to observe 3-D humidity information to improve these forecasts

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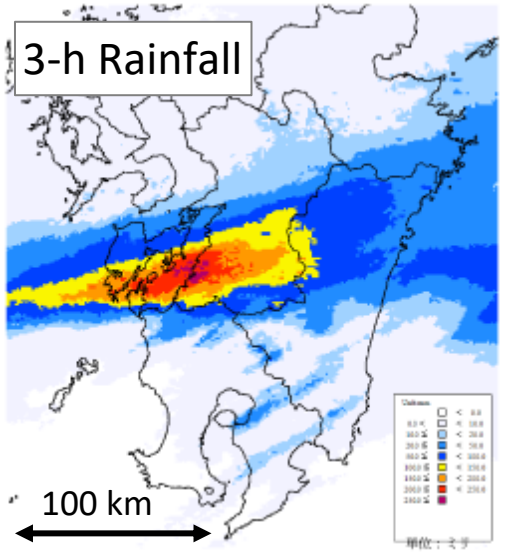
Toward Better Prediction for Stationary Linear Mesoscale Convective Systems

- 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 in 2020 and 2021 further enhanced this demand
  - ✓ Mainly caused by stationary linear mesoscale convective systems
- JMA established 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.



3–h accumulated radar/rain–gauge obs. (mm) at 0500 on 4th July 2020

Houses submerged by the Kuma River on 4 July 2020 (MLIT)

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Himawari-10 Overview

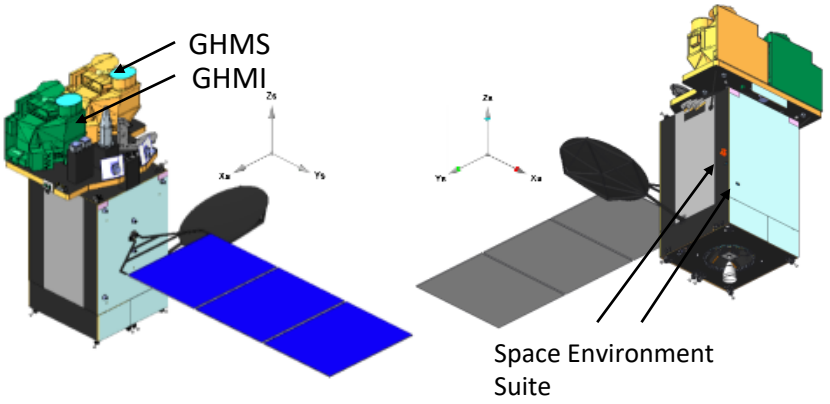
Missions

- **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

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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 Improvement from Himawari-8/9
- Values in the tables show JMA requirements

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) being 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}

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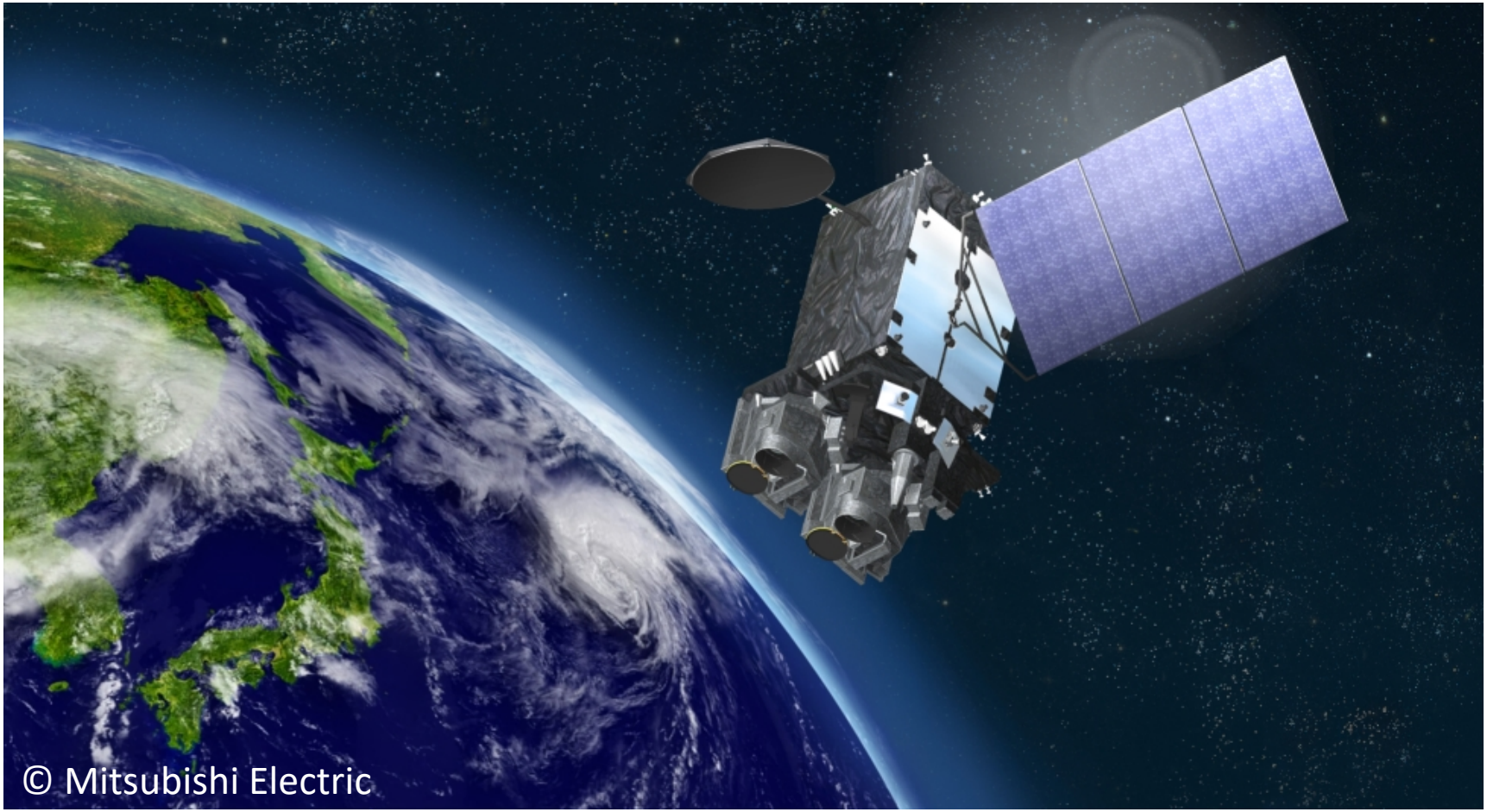
Thank you!!

Himawari-10 Perspective image



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