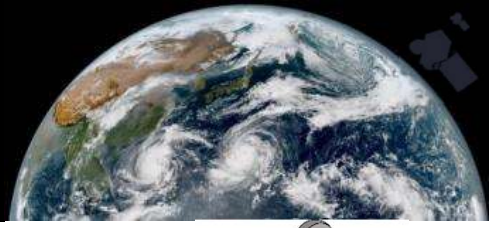
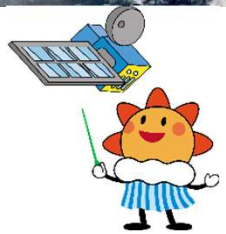
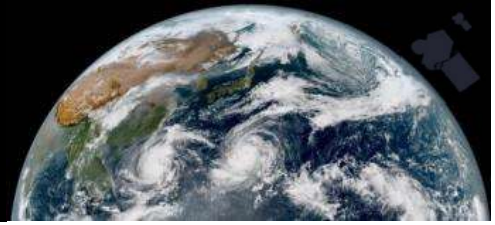




Direct Readout Activity of LEO Satellites and an Overview of the Future Satellite System Himawari-10

Nasu Taiki
Meteorological Satellite Center
Japan Meteorological Agency

Contents



- JMA's Direct Readout Activities
  - Introduction to MSC of JMA
  - Overview of JMA's activities concerning Direct Readout (DR) from LEO satellites
  - Use of CSPP Software in MSC/JMA
  - Use of DR Data in JMA
- Overview of Himawri-10
  - Himawari-10 Overview
  - Sensors on Himawari-10 (GHMI, GHMS)
  - Data Files for Himawari-10 (GHMI, GHMS)

Introduction to MSC of JMA

- Meteorological Satellite Center (MSC) was established as an auxiliary organ of JMA on 1st April 1977.
- The mission of MSC is to observe meteorological and related phenomena from space using satellites, process observation data, and disseminate information and products derived from the data.
- Main activities of MSC of JMA:
  - Operation of the meteorological payloads of Himawari-8/-9
  - Derivation of imagery from Himawari-8/-9
  - Extraction of meteorological parameters
  - Collection and processing of DR data from LEO satellites

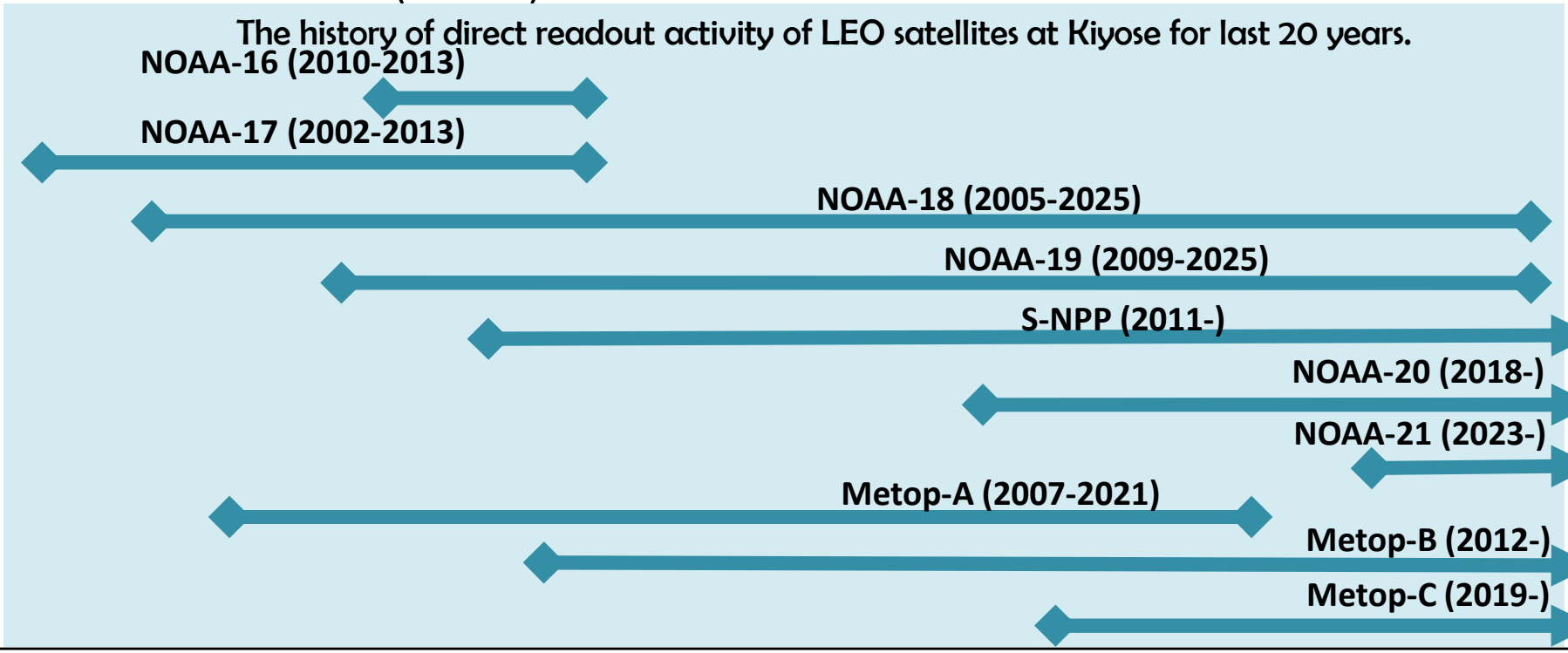
MSC in Spring

Himawari-8/9

DR antenna tower

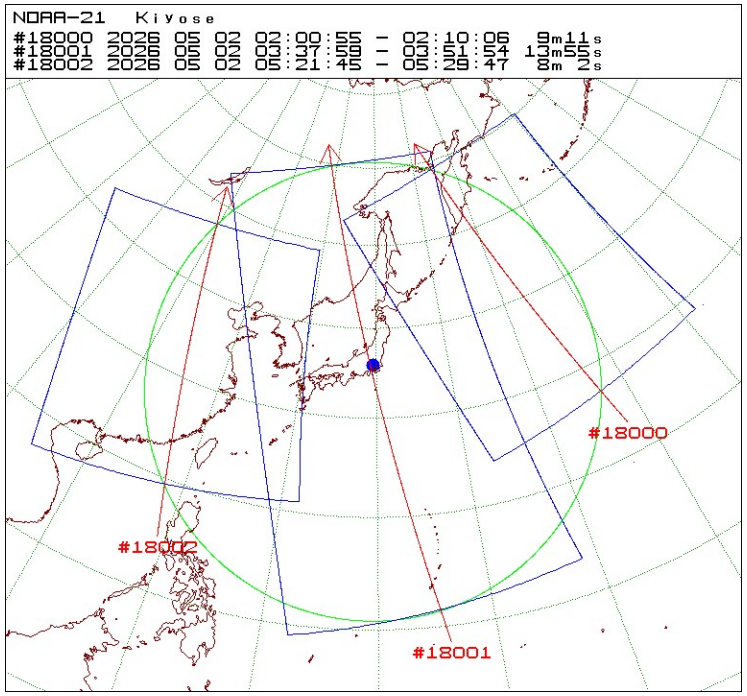
Overview of JMA's activities concerning DR from LEO satellites

- JMA has acquired Direct Readout (DR) data from LEO satellites since 1968 and utilized their products for early detection of extreme weather events such as typhoon and heavy precipitation.
- These low latency products also bring important benefit to numerical weather prediction (NWP) around the world including JMA's.
- JMA processes DR data acquired at Kiyose station (owned by JMA) and Syowa station (owned by a partner organization) and distributes products derived from it to Direct Broadcast Network (DBNet).



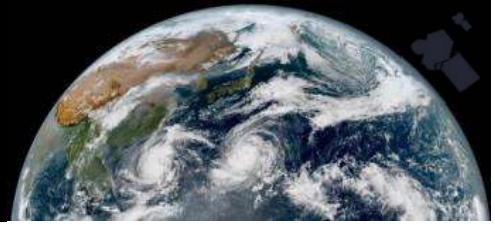
Kiyose station

NOAA-21 Receivable Orbits



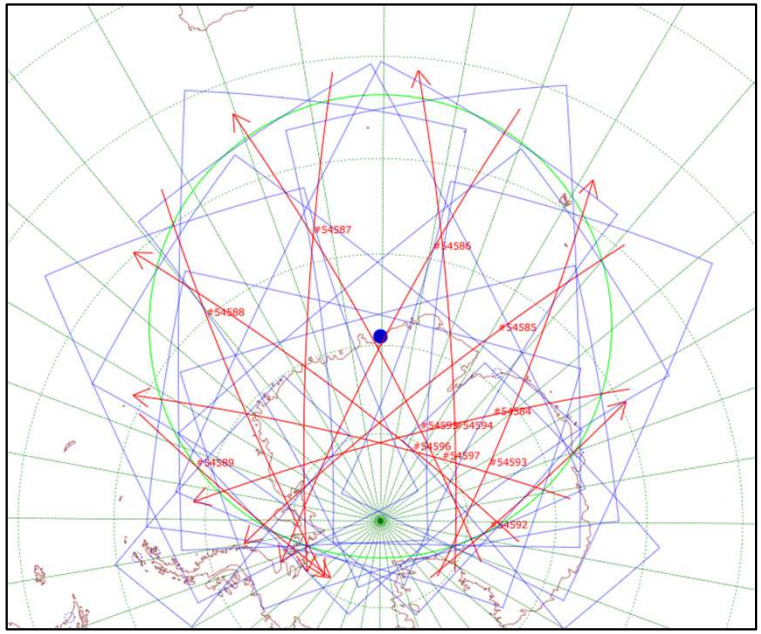
- Operator: JMA
- Location: 35.78N, 139.53E
- 1 antenna
  - Diameter: 3.0m
  - X-band and L-band downlink reception
  - Right-hand circular polarization
- Target satellites:
  - Metop-C, Metop-B, NOAA-21, NOAA-20, S-NPP
  - Add processing Metop-SGA1 and Metop-SGB1 planned

Syowa station

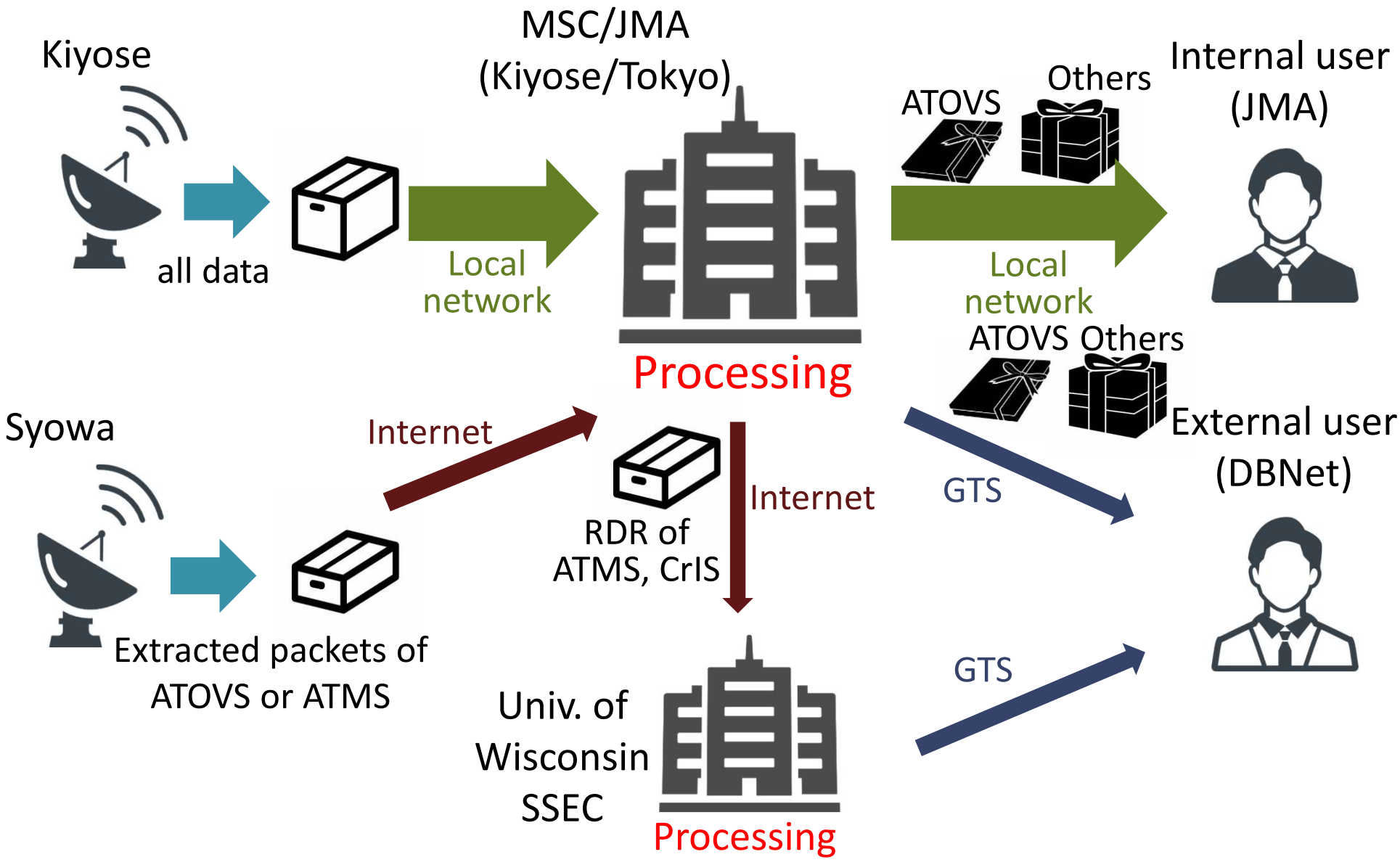


- Operator: National Institute of Polar Research (NIPR)
- Location: 69.00S, 39.58E (Antarctica)
- 2 antennas (for L/S-bands and X-band)
  - Diameter: 1.2m for L/S-bands, 2.4m for X-band
  - Right-hand circular polarization
- Target satellites:
  - Metop-B/C for L/S-bands
  - S-NPP, NOAA-20, Aqua for X-band

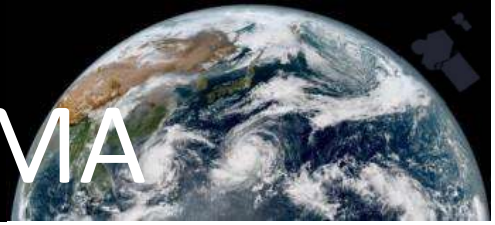
S-NPP, Receivable Orbits



Collection, Processing and Distribution



Use of CSPP Software in MSC/JMA



NOAA-21,
NOAA-20,
S-NPP

Kiyose

Syowa

MSC/JMA's satellite product server

RTSTPS
Ver.7.0

RDR

CSPP SDR
Ver.4.1.1

SDR

AAPP
Ver.8.11

Level1c
(ATMS, CrIS)

Internal Users

NWP model

(VIIRS)

Monitoring
Volcanic Ash

FTP

RDR
(ATMS, CrIS)

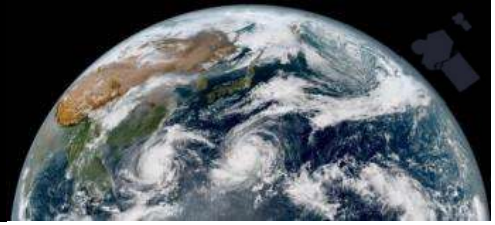
University of Wisconsin

DBNet

Specifications of the server

CPU	Intel Xeon Gold 5318Y x 2
Mem.	251GiB
OS	RHEL 8.6

Use of DR Data in JMA



- JMA uses the DR data for a variety of applications.
  - Numerical Weather Prediction (NWP)
  - Volcanic Ash Monitoring
  - Sea Ice Monitoring

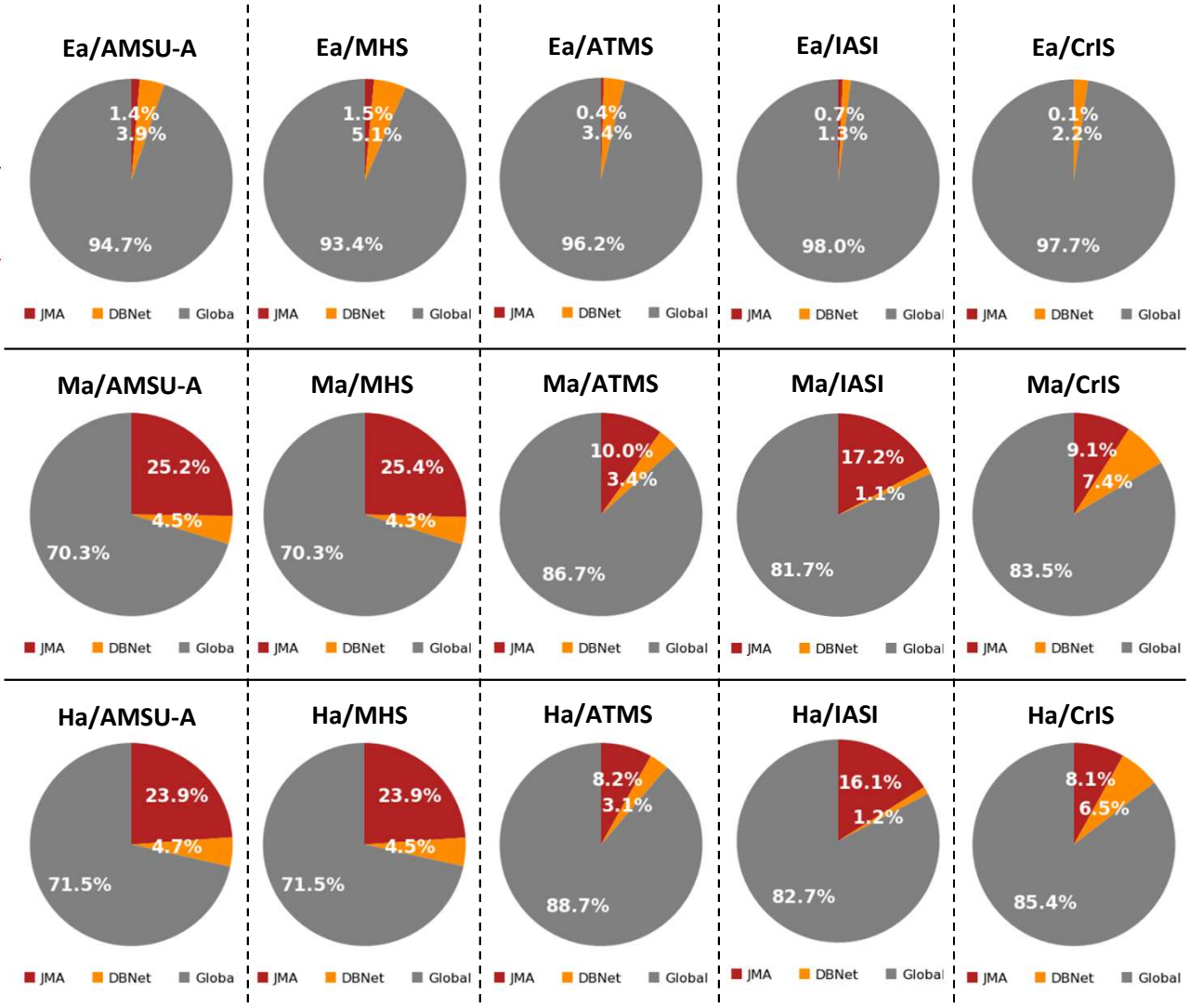
Use of DR Data in JMA: NWP

2025.07.01 - 10.31

JMA Global early analysis (6 hourly)
data cut-off 2 hr. 20min.

JMA Meso-scale analysis (3 hourly)
data cut-off 50 min.

JMA Local analysis (hourly)
data cut-off 30 min.



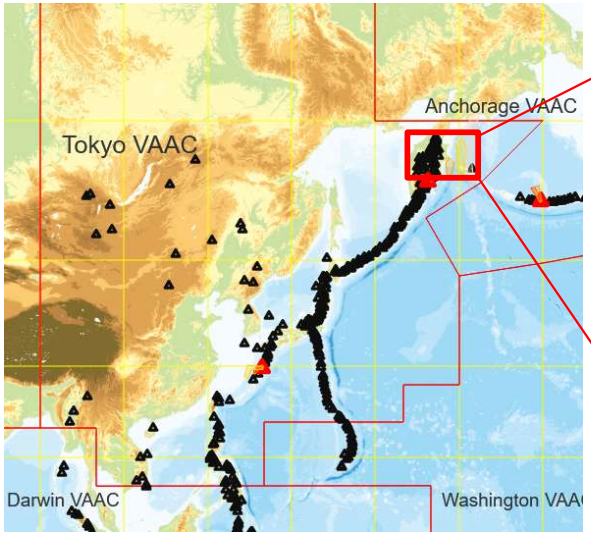
: JMA
: DBNet (except JMA)
: Global

"JMA" in the pie charts means Direct readout data from Kiyose station and Syowa (Antarctica) station.
All EARS data are grouped under "Global", and the DBNet ratio may be slightly larger than shown in the chart, particularly for "Ea".

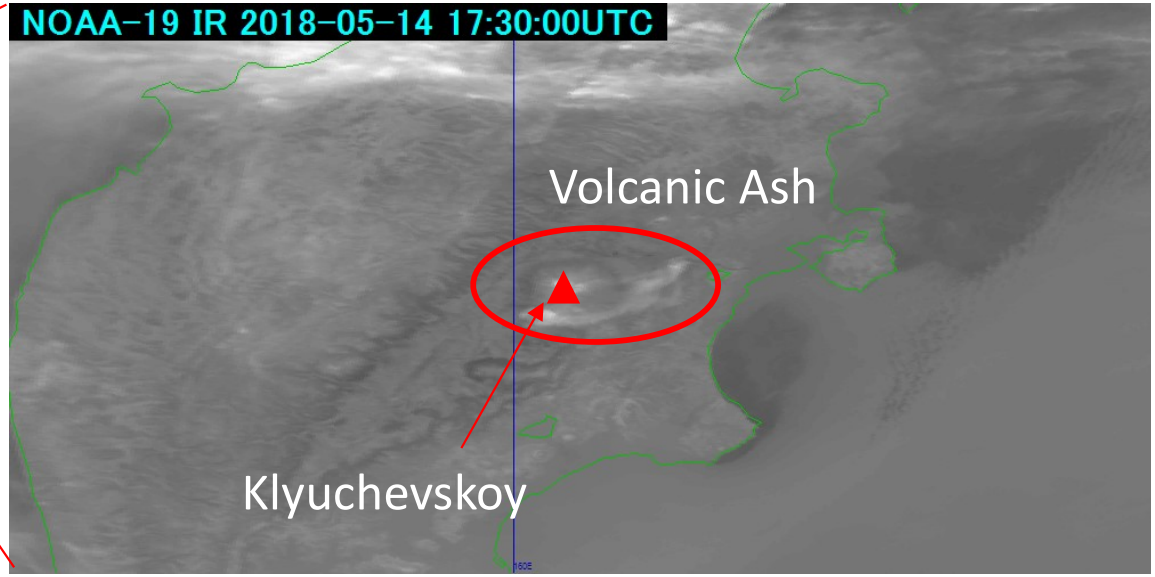
Ratio of available direct readout data including DBNet in the operational Global, Meso-scale, and Local analysis.

Direct readout data is valuable for operational NWP system, especially for short data cut off time system.

Use of DR Data in JMA: Volcanic Ash



Area of Responsibility of Tokyo VAAC



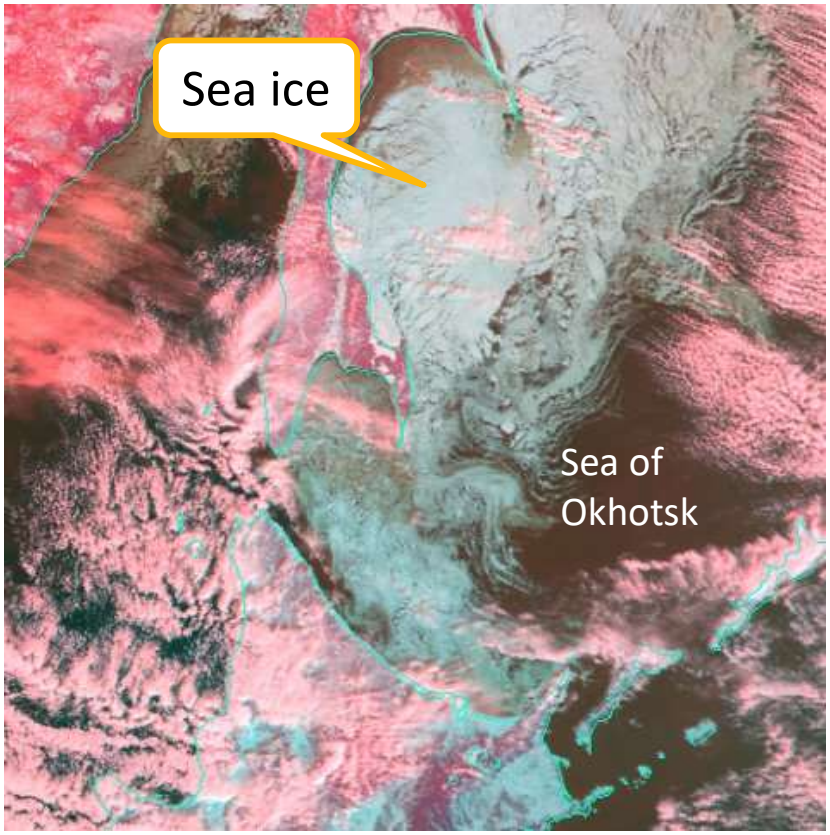
2018.05.14, NOAA-19, Infrared

- JMA operates Tokyo VAAC and provides Volcanic Ash Advisories (VAAs) in the East Asia, Northwest Pacific region and part of the Arctic Circle.
- Tokyo VAAC uses satellite data to monitor volcanic ash in the regions.
- DR data from LEO satellites are particularly useful for monitoring high-latitude regions, where GEO satellites have low resolution.

Use of DR Data in JMA: Sea Ice

Sea ice in the sea of Okhotsk

The Sea of Okhotsk is the southernmost sea in the Northern Hemisphere where sea ice is observed across a wide area. Sea ice hinders marine output, damages fishing facilities and can obstruct shipping lanes, leading to accidents at sea.



2016.02.26, Metop-B, AVHRR

JMA uses DR data to monitor sea ice around Japan.

Himawari-10 Overview

Missions

- **Geostationary HiMawari Sounder (GHMS)**

Hyperspectral infrared sounder providing **vertical profiles of atmospheric temperature and water vapor**

Assimilation of GHMS data into numerical weather prediction models

Weather forecasting enhancement

JMA is developing GHMS data application technology using simulated observation data.

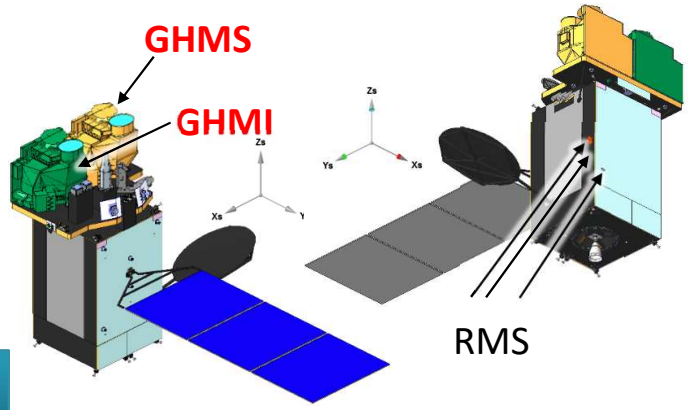
- **Geostationary HiMawari Imager (GHMI)**

Visible and infrared imager for weather monitoring/nowcasting

- **Data Collection System**
- **Radiation Monitors for Space weather (RMS)**

Proton & electron flux equipment by NICT

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
Location	Geostationary orbit at around 140.7 deg. E

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 (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

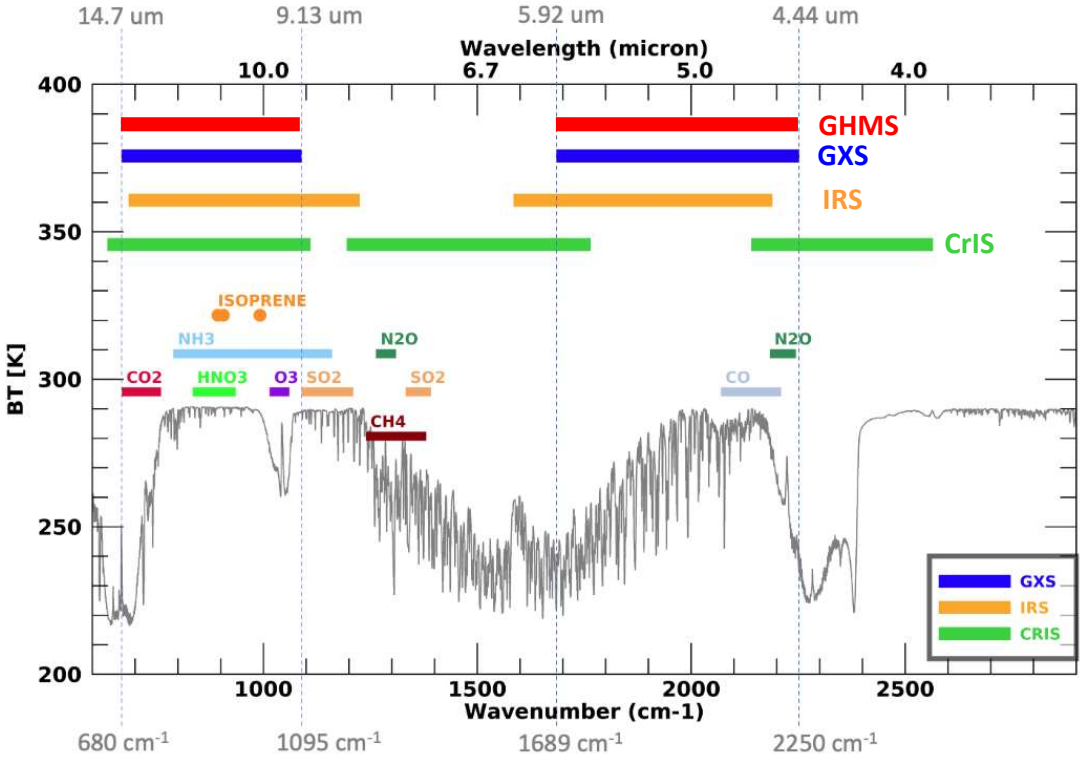
*Mainly used for CAL/VAL activities

	Center Wavelength [μm]	Band width [μm]	Spatial resolution at nadir [km]
VIS	0.46 - 0.48	≤ 0.07	0.5
	0.54 - 0.56 (Change in center wavelength)	≤ 0.05	0.5
	0.63 - 0.65	≤ 0.12	0.25
NIR	0.85 - 0.87	≤ 0.06	1
	1.375 - 1.385 (New band)	≤ 0.04	2
	1.60 - 1.62	≤ 0.08	1
	2.24 - 2.27	≤ 0.06	1
IR	3.75 - 3.95	≤ 0.50	1
	5.10 - 5.20 (New band)	≤ 0.20	1
	6.05 - 6.45	≤ 1.20	2
	6.90 - 7.00	≤ 0.50	1
	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	1
	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.

Geostationary HiMawari Sounder (GHMS)

- L3Harris's infrared FTS sounder



GHMS is added to Heidinger et al., ITSC-24

GHMS Spatial & Spectral specifications

Spatial (horizontal) resolution		4.1 km
Spectral Coverage	LWIR About 650 channels	680 - 1095 cm^{-1} (14.7 - 9.13 µm)
	MWIR About 900 channels	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

GHMS Observation Areas & Time Interval

Observation Areas (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).

This plan is subject to a major change.

L1 Data File for GHMI (Draft)

Himawari-8,-9/AHI

L1 Data File Format

Many types of data format depending on the resolution etc.

Himawari Standard data (HSD)

HSD: JMA's proprietary format
Used for Himawari-8 and Himawari-9

HRIT/LRIT

HRIT/LRIT: High/Low Rate Information Transmission

NetCDF

NetCDF: Network Common Data Form

Himawari-10/GHMI

New L1 Data File Format

Unified data format (NetCDF)

- Used for GOES-16,17,18/ABI and MTG/FCI,/IRS

NetCDF*

*Note: The data components of new NetCDF format will be different from current NetCDF format for Himawari-8/9.

This plan is subject to a major change.

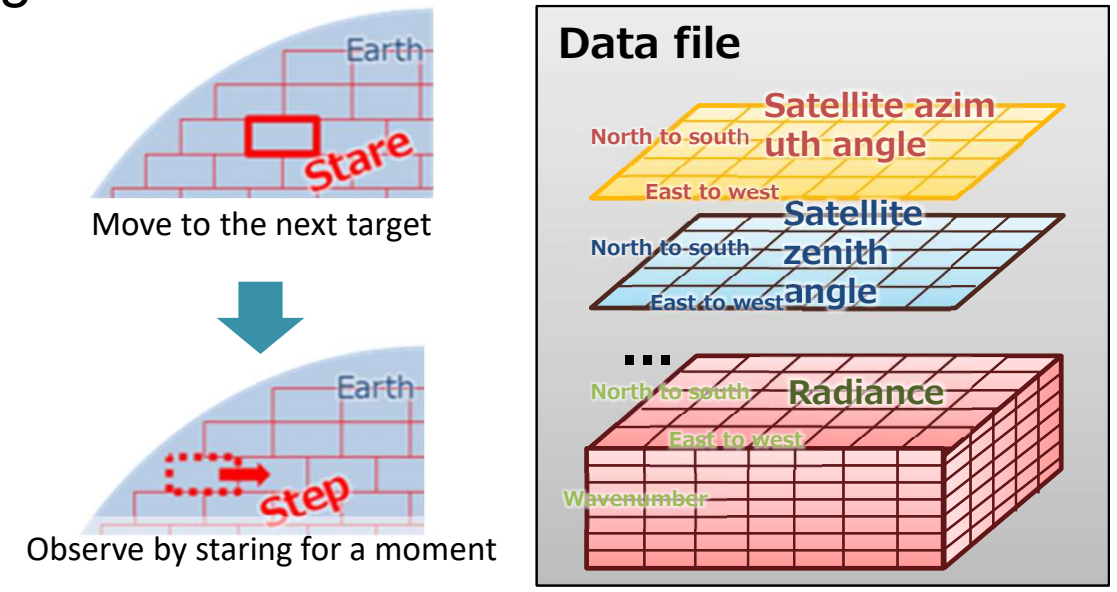
Data File for GHMS (Draft)

Overview of GHMS observation

- **"Step and Stare observation"** with an area sensor.
- One stare can observe a range of about 1,000 km from east to west and about 500 km from north to south at nadir.
- The number of stares required for each observation area every one hour is 154 for full-disc, 12 (4 rows x 3 cols) x 3 for Japan area and 2 (2 rows x 1 cols) x 4 for target area.

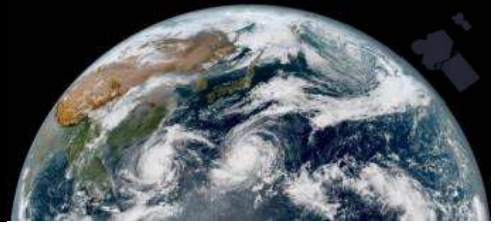
L1 Data File Format

- Unified data format (NetCDF)
- Smallest unit of data is a single file for each stare.
- Principal component analysis (PCA) data will be distributed to NMHSs.
- Details of stored data are under consideration.



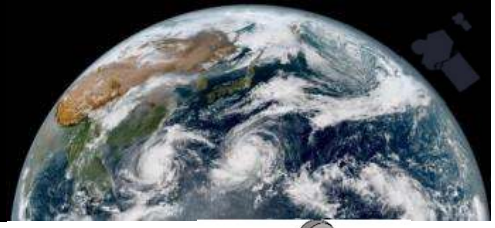
Schematic image of observation and stored data

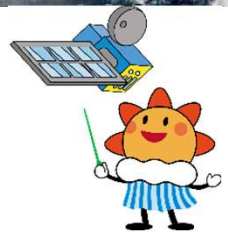
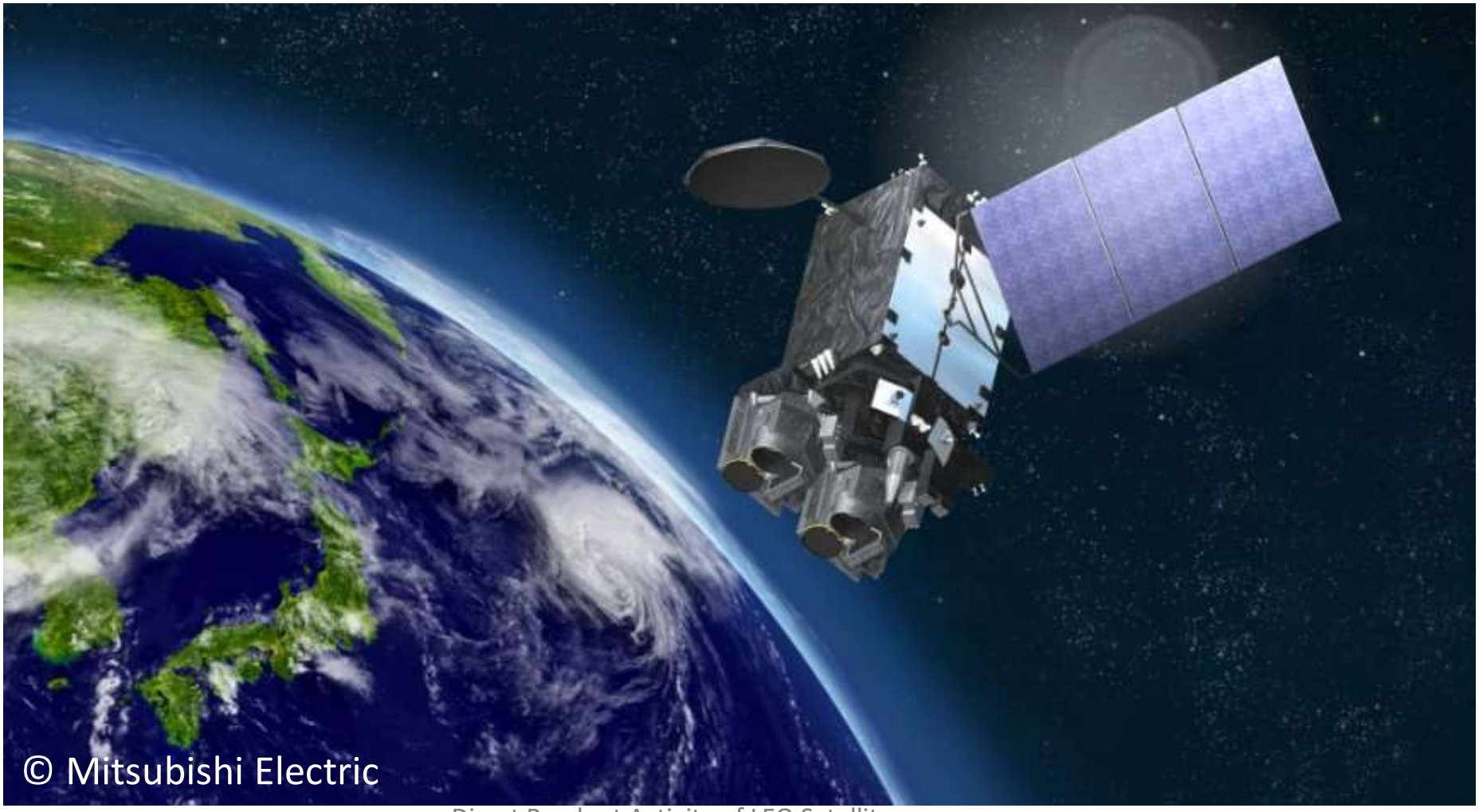
Total Summary



- At MSC, direct broadcast data from JPSS-series satellites received at the Kiyose and Syowa stations are processed using CSPP.
- The processed data are used within JMA for weather forecasting and disaster risk reduction and distributed to NWP centers.
- In the future, MSC plans to receive the DB data from Metop-SG and JPSS-4.

- JMA is manufacturing its future satellite system, Himawari-10.
- Himawari-10 will carry an 18-band imager (GHMI) and a hyperspectral infrared sounder (GHMS).





Thank you for your attention!