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Prepared by JMA
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# JMA report on the status of current and future satellite systems

This document summarizes the status of JMA's current and future GEO satellite systems. The current Himawari-8 satellite located at 140.7°E began operation in imaging and data collection services over the East Asia and Western Pacific regions as a replacement for MTSAT-2 and MTSAT-1R on 7 July 2015. The HimawariCast and HimawariCloud services via which Himawari-8 imagery is distributed involve the use of the communication satellite and the Internet, respectively. MTSAT-2 (145°E) is currently in stand-by as a backup to Himawari-8 until Himawari-9 will is ready for backup service. JMA plans to launch Himawari-9 in 2016.

# JMA report on the status of current and future satellite systems

## 1 INTRODUCTION

The Japan Meteorological Agency (JMA) operates two geostationary satellites known as Himawari-8 and MTSAT-2 (Multi-functional Transport Satellite-2). The operational use of MTSAT-2's imaging function and its data collection services were taken over by Himawari-8 on 7 July 2015, as MTSAT-2's earth imaging sensor had reached the end of its five-year design lifetime. The JMA MTSAT HRIT/LRIT service operated using MTSAT-1R was discontinued on 6 December 2015.

JMA plans to launch Himawari-9 in 2016 as a backup and successor satellite. The new satellite has the same specifications as the currently operational Himawari-8, and will be put into in-orbit standby status as backup for Himawari-8. This will help to ensure the stability of the satellite observation system for the East Asia and Western Pacific regions for a period of 15 years (Figure 1).

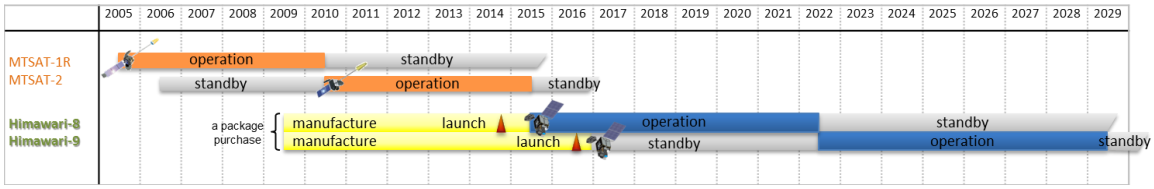


Figure 1: Himawari-8/-9 timeline

## 2 CURRENT SATELLITE SYSTEMS

JMA's current GEO satellites

| Sector | Satellite | Location | Launch date | Access | Payload and status |
|---|---|---|---|---|---|
| East Asia and Western Pacific | Himawari-8 (OP) | 140.7°E | 07/10/2014 | HimawariCast<br>HimawariCloud | 16-channel AHI, DCS, SEDA; operational |
| | MTSAT-2 (B) | 145.0°E | 18/02/2006 | HimawariCast<br>HimawariCloud (backup only) | 5-channel imager, DCS; operational<br>Dissemination via HRIT/LRIT; non-operational |

### 2.1 Himawari-8

Himawari-8 was launched on 7 October 2014 and placed in geostationary orbit at 140.7°E. It has served as the successor satellite to MTSAT-2 since 7 July 2015, and today provides observation and data collection services for the East Asia and Western Pacific regions.

Operational information regarding Himawari-8 is provided on JMA's Meteorological Satellite Center (MSC) web page at http://www.data.jma.go.jp/mscweb/en/operation8/.

Himawari-8 system anomalies:

Unrecoverable:
N/A
Recoverable:

| | |
|---|---|
| 12 November | Image quality degradation |
| 18 December | AHI malfunction |
| 1 January | Ground system malfunction |

With its 16 channels, the AHI (Advanced Himawari Imager) takes 142 full-disk images, 576 images of 3 areas (northeastern Japan, southwestern Japan and target areas for tropical cyclones or volcanic ash) and 2,840 images of smaller areas (on the earth, in space, on the moon and landmarks) per day.
At midnight in the equinox season, sunlight can directly enter the AHI sensor and affect imagery. To prevent this, the AHI has a function by which part of the observation area can be skipped based on prediction of the sun's position and potentially affected areas. As a result, data are missing from some images. Predictions associated with this avoidance function are provided on JMA's Meteorological Satellite Center (MSC) web page at
http://www.data.jma.go.jp/mscweb/en/operation8/equinox/plan.html.

Periodic scheduling for Himawari-8 with suspension of full-disk scan is planned. Every two weeks, station-keeping maneuver sequences are performed. The work involves sequences with one north-south maneuver and two-part east-west maneuvers. On the 7th and 22nd of every month, the visible channel is calibrated.

DCS (Data Collection System): See 2.3.

SEDA (Space Environment Data Acquisition) supports the sensing of proton and electron flux. The energy range of a measured proton flux is 15 – 100 MeV, and that of a measured electron flux is 0.2 – 5 MeV. Data are captured every 10 seconds before being downlinked as satellite telemetry and processed at the ground station to create engineering values formatted as text data. SEDA text data are distributed to NICT (the National Institute of Information and Communications Technology), which is currently considering data to support the development of space weather forecasting. For more information, see the NICT Space Weather Information Center page at http://swc.nict.go.jp/contents/index_e.php.
See JMA-WP-02 for more on JMA's space weather activities.

## 2.2 MTSAT-2

MTSAT-2 was launched on 18 February 2006 and placed in geostationary orbit at 145°E. It has acted as a backup satellite for the imaging function and the data collection services of Himawari-8 since 7 July 2015. In the event of problems with Himawari-8, MTSAT-2 will take over observation duties until the issues are resolved.

No significant anomalies regarding MTSAT-2 have occurred since CGMS-43.

## 2.3 DCS (Data Collection System)

Himawari-8's Data Collection System (DCS) has functioned properly since the satellite took over the operations of MTSAT-2. Although interference has frequently been observed on DCS channels 12, 14 and 33, there has been no negative effect on their operation (channel 12 has not been used for Data Collection Platform (DCP) data since January 2010, and no DCPs are registered on channels 14 and 33). Further information on Himawari-DCS is available in the Monthly Operations Report section of the JMA/MSC website at
http://www.data.jma.go.jp/mscweb/en/operation8/opr_report.html.

See JMA-WP-01 for more information on Himawari-DCS.

## 2.4 LRIT data dissemination from GOES-West

In collaboration with NOAA/NESDIS, provision of MTSAT LRIT full-disk images re-formatted into NOAA GOES LRIT data to Central Pacific island nations was commenced in 2012 using the GOES-West satellite. This service has been continued with LRIT image created from Himawari-8 imagery.

## 2.5 Data distribution/dissemination

JMA distributes Himawari-8 data in two ways. One is the HimawariCast service, by which primary sets of imagery are disseminated as operational meteorological services via a private communication satellite. The other is the HimawariCloud service, by which full sets of imagery are delivered to National Meteorological and Hydrological Services (NMHSs) via a private Internet cloud service.

### 2.5.1 HimawariCast service

JMA started the HimawariCast service on 29 January 2015.

Table 1 shows the dataset disseminated via the service. Himawari imagery in full-disk HRIT/LRIT files is compatible with previous MTSAT HRIT/LRIT data. Files are provided every 10 minutes, and the number of bands for HRIT files is 14 out of Himawari-8's 16. These multi-band high-frequency observation data support the timely creation of RGB products and are expected to contribute to disaster risk reduction in the East Asia and Western Pacific regions.

JMA also disseminates meteorological data and products in Satellite Animation and Interactive Diagnosis (SATAID) format, including numerical weather prediction products and observational data. The Agency's SATAID software enables the superimposition of these data and products onto satellite imagery.

Figure 1 provides an overview of the HimawariCast system structure. The JCSAT-2A (or JCSAT-2B) communication satellite located at 154°E is used to broadcast data for the HimawariCast service.

Users wishing to use the HimawariCast service need an antenna, an LNB, a DVB-S2 receiver and a computer. The typical antenna is 2.4 m in diameter with a performance of 19.6 dB/K. Since KenCast is used as the datacasting system for the HimawariCast service, KenCast Fazzt Professional Client software must be installed on the receiving-station computer.

Up-to-date information, including specifications of equipment needed to receive data via HimawariCast, is available at:

http://www.data.jma.go.jp/mscweb/en/himawari89/himawari_cast/himawari_cast.html.

Table 1: Himawari-8/9 dataset disseminated via HimawariCast

| Data type | Format | Notes |
|---|---|---|
| Himawari imagery (full disk) | HRIT files | - Interval: 10 minutes<br>- Number of bands: 14 (VIS: 1; NIR: 3; IR: 10)<br>- Spatial resolution: VIS: 1 km; NIR: 4 km; IR: 2-4 km |
| | LRIT files | - Interval: 10 minutes<br>- Number of bands: 4 (VIS: 1; IR: 3)<br>- Spatial resolution: 5 km |
| Numerical weather prediction products (GPV) | SATAID format | - JMA Global Spectral Model (GSM) products<br>- Interval: 6 hours<br>- Spatial resolution: 1.25 degrees |
| In-situ observation (surface stations, ships, radiosondes) | SATAID format | - Observational data for East Asia and Western Pacific regions<br>- Interval: 30 minutes |
| ASCAT ocean surface wind (EUMETSAT) | SATAID format | - Observational data from EUMETSAT's Metop polar-orbiting satellites<br>- Interval: 30 minutes |

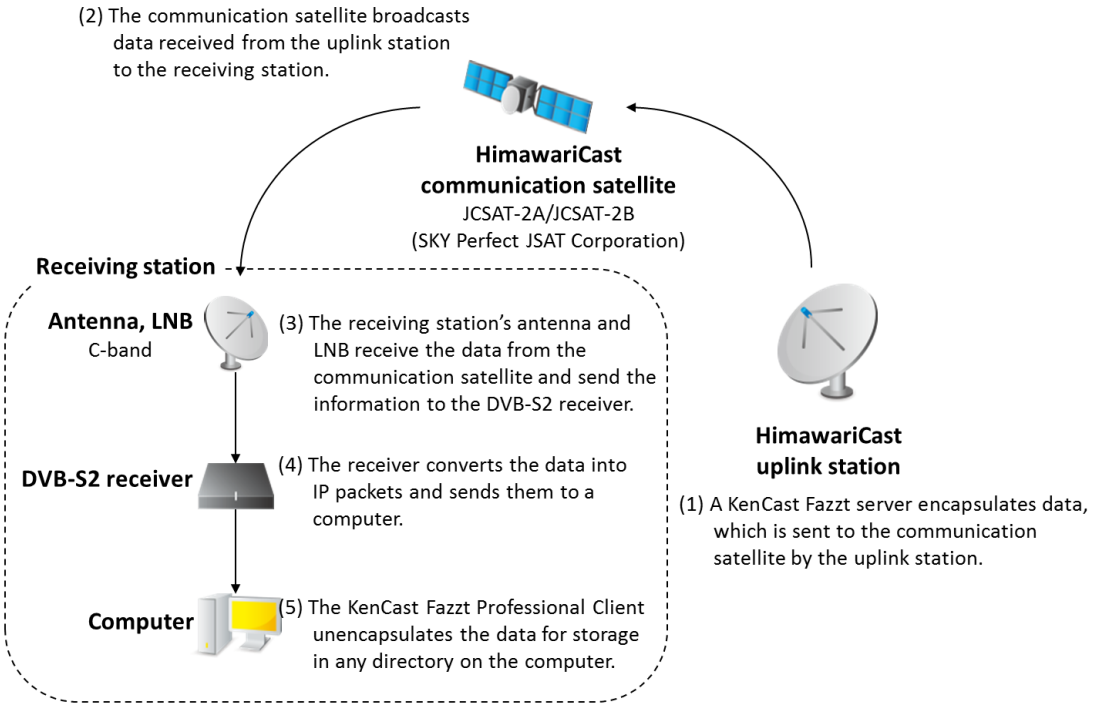


Figure 2: HimawariCast system structure

The JCSAT-2B satellite launched in May 2016 is scheduled to replace JCSAT-2A as the HimawariCast service communication satellite. The polarization directions of the two satellites are offset from each other by 90 degrees. Current JCSAT-2A users will need to perform the relevant transition work between 03 UTC on 6 July and 03 UTC on 20 July 2016 to be able to receive HimawariCast data via JCSAT-2B.

### 2.5.2 HimawariCloud service

JMA launched the HimawariCloud service on 8 April 2015 with the distribution of Himawari-8 in-orbit-test imagery.

Table 2 shows data distributed via the HimawariCloud service. Himawari Standard Data are used as master data from all 16 bands with the finest spatial resolution to create all products related to Himawari-8/9. True-color images composed of data from three visible bands are provided in Portable Network Graphics (PNG) format. In addition, images of target areas in Network Common Data Form (NetCDF) are also created and distributed.

NMHSs in the Himawari-8/9 coverage area can access HimawariCloud and retrieve data using an HTTP 1.1 client such as a Web browser or Wget. A minimum of 20 Mbps throughput between HimawariCloud and the user client is needed to download all data provided via the HimawariCloud service. It should be noted that HimawariCloud is not a data archive service. Data can be downloaded for 72 hours after receipt by the HimawariCloud server, and are then deleted.

The following web page provides technical information on how to access/download data and other matters via HimawariCloud:

http://www.data.jma.go.jp/mscweb/en/himawari89/cloud_service/cloud_service.html

Table 2: Himawari-8/9 data distributed via HimawariCloud

| Observation area and period | Format | Notes |
|---|---|---|
| Full disk (10-minute intervals) | Himawari Standard Data | - Number of bands: 16 (VIS: 3; NIR: 3; IR: 10)<br>- Spatial resolution: VIS: 0.5 – 1 km; NIR: 1 – 2 km; IR: 2 km |
| | PNG | - True-color images (composites of 3 visible bands)<br>- Spatial resolution: 1 km |
| Target area (2.5-minute intervals) | Himawari Standard Data | - Number of bands: 16 (VIS: 3; NIR: 3; IR: 10)<br>- Spatial resolution: VIS: 0.5 – 1 km; NIR: 1 – 2 km; IR: 2 km |
| | NetCDF | |
| | PNG | - True-color images (composites of 3 visible bands)<br>- Spatial resolution: 1 km |

The following four Japanese institutions have launched Himawari-8 data archiving and redistribution services provided on a best-effort basis for the research community:

- NICT Science Cloud http://sc-web.nict.go.jp/himawari/ (Japanese)
- CEReS http://www.cr.chiba-u.jp/english/
- EDITORIA-DIAS http://www.diasjp.net/en/
- JAXA-EORC http://www.eorc.jaxa.jp/ptree/index.html

## 2.6 User support

To support users preparing for Himawari-8/9 data utilization, JMA provides Himawari-8/9 information on the Himawari User's Guide page. The information encompasses the schedule, spacecraft/AHI specifications including estimated spectral response functions (SRFs), sample data in various file formats, data distribution/dissemination methods, and reference software for data reading/conversion. JMA also posts Himawari-8/9 information on its Satellite User Readiness Navigator (SATURN) resource. See also the following web pages:

http://www.jma-net.go.jp/msc/en/support/
https://www.wmo-sat.info/satellite-user-readiness/topic/satellites/himawari-8/