Japanese New Generation Geostationary Meteorological Satellite Himawari-8

Daisaku UESAWA
Meteorological Satellite Center (MSC) Japan Meteorological Agency (JMA)

IPET-SUP-1, WMO HQ, Geneva, 16-19 March 2015
Dawn of a ‘New Era’

Himawari-8 was successfully launched using H-IIA Launch Vehicle # 25 from the Tanegashima Space Center in Kagoshima, Japan on 7 October 2014.
First Image of Himawari-8

True-Color Composite
R: Band 3 (0.64um)
G: Band 2 (0.51um)
B: Band 1 (0.47um)
- ‘100-day Running Test’ is ongoing as of IPET-SUP-1
  - Checking satellite and ground system
  - Validating and improving of image navigation and calibration quality
- ‘Experimental Operation’ will start in April 2015
  - Experimentally to provide data to users via e.g. HimawariCloud
- **Full Operation will start in mid-2015** (Himawari-8 to be declared operational)
  - Himawari-8 will take over as the primary operational satellite from MTSAT-2.
**Schedule of Himawari-8/9 and MTSAT-2**

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<td>In-orbit standby</td>
<td>Operation</td>
<td>7 Oct 2014 Launched!</td>
<td>Extended observation</td>
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**Himawari-8 (located at 140.7E)** will take over as the primary operational satellite from MTSAT-2 in the middle of 2015.

Dissemination of MTSAT-2 (located at 145E) image data (via MTSAT-1R) will continue from the start of Himawari-8 operation until around November 2015 (TBD) in order to help users’ smooth transition.

Launch of **Himawari-9** is scheduled in 2016. Himawari-9 will be in-orbit standby at around 140E.

http://www.data.jma.go.jp/mscweb/en/himawari89/fig/transition_plan.png
Advanced Himawari Imager (AHI)

cf. MTSAT-1R/2

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<th>Spatial Resolution</th>
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<td>16</td>
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</table>

Specifications are similar to ABI for GOES-R

RGB band Composited

0.51 µm (Band 2) instead of ABI’s 1.38 µm

Water vapor

SO₂
O₃

Atmospheric Windows

CO₂

SRF and SNR are available at: http://www.data.jma.go.jp/mscweb/en/himawari89/space_segment/spsg_ahi.html

True Color Image
16 Bands of AHI: First Images

Band 01 (0.47µm)
Band 02 (0.51µm)
Band 03 (0.64µm)
Band 04 (0.86µm)
Band 05 (1.6µm)
Band 06 (2.3µm)
Band 07 (3.9µm)
Band 08 (6.2µm)
Band 09 (6.9µm)
Band 10 (7.3µm)
Band 11 (8.6µm)
Band 12 (9.6µm)
Band 13 (10.4µm)
Band 14 (11.2µm)
Band 15 (12.0µm)
Band 16 (13.3µm)

First Images on 0240UTC 18 December 2014
AHI Observation Modes: Areas and Temporal resolution

- **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: 2000 x 1000 km

- **Region 4 Landmark Area**
  - Interval: 30 seconds (20 times in 10 min)
  - Dimension: EW x NS: 1000 x 1000 km

- **Region 5 Landmark Area**
  - Interval: 30 seconds (20 times in 10 min)
  - Dimension: EW x NS: 1000 x 500 km
AHI observation sequence on a 10-minute timeline
MTSAT to *Himawari*: Spatial resolution

MTSAT-2 VIS (0.68um)
1km@SSP

Himawari-8 Band 3 (0.64 um) IOT data
0.5km@SSP

Kanto area, Japan, 03 UTC 29 January 2015
MTSAT to *Himawari*: Temporal resolution

MTSAT-2 IR 1 (10.8 um) Interval: 30-minute
Himawari-8 Band 13 (10.4 um) IOT data Interval (full disk): 10-minute

East Asia, 26 January 2015
Himawari-8: Japan Areas at 2.5-min interval

Japan Areas (Region 1 & 2) at 2.5-min interval
2000 km x 1000 km x 2
North-Eastern and South-Western Japan Areas

Full disk at 10-min interval

05-07 UTC 6 January 2015
From Himawari-8 IOT data
Band 3 (VIS; 0.64 um)
Band 13 (IR; 10.4 um) @ night
Himawari-8: Target Area at 2.5-min interval

Target Area (Region 3) at 2.5-min interval
1000km x 1000km

The highest priorities for target area selection and scheduling will be given to typhoons and volcanic eruptions monitoring by JMA.

Band3 (VIS; 0.64 um) 00-05 UTC 15 January 2015 from Himawari-8 IOT data
Himawari-8/9 Ground Segment System with redundancy for system reliability and backup

- **Site diversity**
- **Operation by HOPE**
- **Operation by JMA**

**Users**
- Residents, disaster prevention agencies, media, etc.
- National Meteorological and Hydrological Services
New equipment needs to be installed.

C-band antenna
LNB
DVB-S2 receiver
PC & software
Schedule of Data Distribution/Dissemination

- **HimawariCast**: Data Dissemination via communication satellite
  - 29 January 2015: HimawariCast service started; disseminating MTSAT-2 imagery with 5 bands and 30/60-minute intervals
  - Mid-2015: After Himawari-8 becomes operational, Himawari-8 imagery will be disseminated with 14 out of 16 bands and 10-minute intervals.

- **HimawariCloud**: Data Distribution via Internet cloud service
  - March 2015: HimawariCloud service to be started with Himawari-8 in-orbit-test imagery
  - JMA sent registration forms to potential users of HimawariCloud on 12 March.

Parallel Dissemination for users’ smooth transitions

http://www.data.jma.go.jp/mscweb/en/himawari89/fig/transition_plan.png
<table>
<thead>
<tr>
<th>Data type</th>
<th>Format</th>
<th>Notes</th>
</tr>
</thead>
</table>
| Himawari imagery (full disk) | HRIT files | - Interval: 10 minutes  
- (MTSAT-2 observation schedule followed while MTSAT-2 is in operation)  
- Number of bands: 14  
- (5 while MTSAT-2 is in operation)  
- Spatial resolution: band-dependent |
| LRIT files | - Interval: 10 minutes  
- (MTSAT-2 observation schedule followed while MTSAT-2 is in operation)  
- Number of bands: 4 (VIS, IR1, IR3, IR4)  
- Spatial resolution: 5 km |
| Numerical weather prediction products (GPV) | SATAID format | - JMA Global Spectral Model (GSM) products (48-hour forecast)  
- Interval: 6 hours  
- Spatial resolution: 1.25 degrees |
| In-situ observations (SYNOP, TEMP, SHIP) | SATAID format | - Observational data for East Asia and Western Pacific regions  
- Interval: 30 minutes |
| ASCAT ocean surface wind (EUMETSAT) | SATAID format | - Observational data from EUMETSAT's Metop polar-orbiting satellites  
- Interval: 30 minutes |
| Operation plan (MANAM) | Text | - Frequency: twice a day |

<table>
<thead>
<tr>
<th>Observation area and periodicity</th>
<th>Format</th>
<th>Estimated compressed data size (GB/day)</th>
<th>Notes</th>
</tr>
</thead>
</table>
| Full disk (10-minute intervals) | Himawari Standard Data                      | 103                                    | - Number of bands: 16 (VIS: 3; NIR: 3; IR: 10)  
- Spatial resolution: VIS: 0.5–1km; NIR: 1–2km; IR: 2km  
- Divided into 10 segments  
- Compressed using bzip2*                                                                                          |
| Portable Network Graphics (PNG)|                                            | 12                                     | - True-color images (composites of 3 visible bands)  
- Spatial resolution: 1km  
- Not divided                                                                                                           |
| Target area (2.5-minute intervals) | Himawari Standard Data                      | 4                                      | - Number of bands: 16 (VIS: 3; NIR: 3; IR: 10)  
- Spatial resolution: VIS: 0.5–1km; NIR: 1–2km; IR: 2km  
- Not divided                                                                                                           |
|                                 | Network Common Data Form (NetCDF)           | 5                                      | - Compressed using bzip2*                                                                                                                |
|                                 | Portable Network Graphics (PNG)             | 0.5                                    | - True-color images (composites of 3 visible bands)  
- Spatial resolution: 1km  
- Not divided                                                                                                           |

Himawari-8 Major Products

- Himawari Standard Data
- RGB composite products
- Atmospheric Motion Vector (AMV)
- Clear Sky Radiance (CSR)
- Cloud Product
- Aerosol Product (Asian Dust)
- Volcanic Ash Product, etc.
Himawari Standard Data (HSD)

- HSD is the most fundamental data for users
  - AHI data are processed into ‘Himawari Standard Data (HSD)’ in ‘Himawari Standard Format’ as master data for all products
    - ‘Himawari Standard Format’ is JMA original format
- All Himawari-8/9 products can be created from HSD
- HSD User's Guide and sample decode program are available
  
Himawari-8 RGB products

✓ RGB composite products are experimentally created from Himawari-8 IOT data using WMO standard recipe.
✓ RGBs from Himawari-8 will be provided from the website of Meteorological Satellite Center (MSC) of JMA when Himawari-8 becomes operational.
✓ Contribution to SCOPE-Nowcasting
✓ Australian Bureau of Meteorology and JMA/MSC start a discussion of cooperation on RGB product development.
Himawari-8 RGB Sample (Dust)

Asian dust event on 22 February 2015

Desert Dust RGB
R: Band15 (12.4um) - Band13 (10.4um)  G: Band13 (10.4um) - Band11 (8.6um)  B: Band13 (10.4um)
Objective Cloud Analysis Information (OCAI)

- The OCAI will be produced hourly when Himawari-8 becomes operational.
- Users of Himawari-8 OCAI will include domestic users and NMHSs of Indonesia and Myanmar in response to their inquiries.
Atmospheric Motion Vector

MTSAT IR wind vectors (QI > 80) by current operational MTSAT AMV algorithm

MTSAT IR wind vectors (QI > 80) by new Himawari-8/9 AMV algorithm

JMA/MSC has developed a new algorithm for Himawari-8/9 AMVs (Shimoji 2014) based on an optimal estimation method for full exploitation of satellite data.

Wind vectors by the new algorithm are retrieved over wide areas where none are retrieved by the current version.

Validation results will be informed to NWP users (IWW mailing list)

Himawari-8 AMV product will be provided in BUFR via GTS.

Himawari-8 CSR (Clear Sky Radiance)

- Area averaged clear sky radiance and brightness temperature. Assimilated into NWP model.

- Algorithm
  - Pixels are determined as ‘clear’ if;
    - They are clear pixels in cloud mask product; or
    - They have negligible transmittance of radiation from cloud top to TOA
      - For AHI bands with strong absorption (e.g. water vapor bands), a cloudy pixel can be regarded as a 'clear' pixel when contribution of cloud top emission to total radiance is negligible.
  - Radiances of ‘clear’ pixels in an area (m x n pixel) are averaged.
  - ATBD in preparation

- Product description
  - Spatial resolution (size of area for averaging): 16 x 16 pixel (IR band) (32 x 32 km @SSP)
  - Full disk
  - Hourly produced
  - IR bands (3.9, 6.2, 6.9, 7.3, 8.6, 9.6, 10.4, 11.2, 12.4, 13.3 um)
  - Variables: Brightness temperatures, radiances, standard deviation, clear pixel ratio, latitude, longitude
  - BUFR in format

- Schedule
  - Mid-2015: BUFR to be distributed via GTS
AMV and CSR parallel distribution for NWP users

to help smooth transition from MTSAT-2 to Himawari-8

- Himawari-8 AMV and CSR will be distributed via GTS when Himawari-8 becomes operational in the middle of 2015.
  - The distribution of MTSAT-2 AMV and CSR via GTS will be terminated at the same time.
- In order to help NWP users' smooth transition from MTSAT-2 to Himawari-8,
  - JMA plans to distribute Himawari-8 AMV and CSR via JDDS (JMA Data Dissemination System) from April 2015 to the middle of 2015.
    - to allow earlier evaluation of Himawari-8 AMV and CSR before Himawari-8 starts its operation
  - After Himawari-8 starts its operation, MTSAT-2 AMV and CSR will be provided via JDDS.
  - A NWP user announcement for JDDS account application will be made in March/April 2015.
    - Posting IWW mailing list and mailing to MTSAT-CSR users
Himawari-8 AOD for Asian dust monitoring

- Aerosol optical depth (AOD) and Ångström exponent (proxy for particle size) to be estimated from Himawari-8/AHI data. Ångström exponent only over the ocean.

- Method: Generate a lookup table which relates Himawari-8/AHI visible and near-infrared bands’ reflectivities to aerosol property using radiative transfer simulation. Estimate aerosol property from Himawari-8/AHI data using the lookup table.
  - AHI bands used: 0.64 and 0.86 um (ocean), 0.64 and 2.25 um (land)
  - Aerosol type is assumed to be Asian dust.
    - Not optimized for other types of aerosol (e.g. haze)

- Validation plan: Comparison with surface observation of AOD

- User: JMA will routinely use Himawari-8 aerosol product for monitoring Asian dust events (‘Kosa’ in Japanese) after validation.
Himawari-8 Volcanic Ash product

- NOAA/NESDIS algorithm will be adopted for Himawari-8 volcanic ash product. Source codes developed by NOAA/NESDIS will be provided to JMA/MSC. JMA/MSC will implement them into JMA/MSC product server system. Many thanks to Mike Pavolonis.

- Himawari-8 volcanic ash product will be provided to a JMA user (Tokyo VAAC).
  - Tokyo VAAC will check the product on a trial basis.
  - Feedback will be given for product improvement

- A ‘test bed’ for algorithm intercomparison will be prepared by JMA/MSC.
Collaborations with Professional Users

- **Australian Bureau of Meteorology** and JMA/MSC start a discussion of cooperation on RGB product development.

- A joint research study was launched in 2014 between Earth Observation Research Center (EORC) of JAXA and JMA/MSC so that Himawari-8 product developers can collaborate closely with product developers and scientists for R&D satellites (GCOM-C, EarthCARE and GOSAT-2).

- A working group for Himawari data application was established. Japanese scientists in the field of satellite remote sensing join the working group and discuss potential application of Himawari-8 data.
Thank you!

For more information
Radiometric Calibration/Comparison of Himawari-8/AHI

<table>
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<tr>
<th>Central Wavelength [µm]</th>
<th>Solar Diffuser</th>
<th>Black Body</th>
<th>GSICS (IR)</th>
<th>GSICS (DCC)</th>
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- Onboard calibration
- Inter-calibration/comparison, vicarious calibration

Courtesy of JMA/MSC GSICS Team
Archive Server candidates

- DIAS and NICT Science Cloud volunteer to act as a server for providing Himawari-8 data to researchers
- They have big storage device more than several peta bytes
- Voluntary and best effort service
- Details are undecided
- Further information will be posted on the JMA/MSC website

**DIAS**  Data Integration and Analysis System


- Managed by the University of Tokyo

**NICT Science Cloud**

[http://sc-web.nict.go.jp/](http://sc-web.nict.go.jp/)

- Managed by National Institute of Information and Communications Technology (NICT)