Status of Next Generation Japanese Geostationary Meteorological Satellites Himawari-8/9 and Their Products

Masaya Takahashi Meteorological Satellite Center / Japan Meteorological Agency (MSC/JMA)

JMA

Abstract

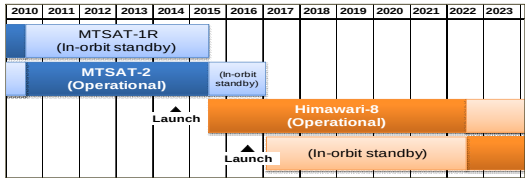
JMA plans to launch **Himawari-8** in summer 2014 and commence its operation in 2015, when MTSAT-2 is scheduled to complete its period of operation. The Agency also plans to launch Himawari-9 in 2016. In July 2009, JMA completed contract arrangements for the manufacture of Himawari-8 and -9, which have identical specifications. Then, the preliminary design review (PDR) was conducted in January 2011, and the critical design review (CDR) was conducted in January 2012. Currently, the satellites are **in the production phase**.

Himawari-8/9 carry **Advanced Himawari Imager (AHI)** units comparable to the Advanced Baseline Imager (ABI) on board GOES-R to enable enhanced nowcasting, Numerical Weather Prediction (NWP) and climate/environment monitoring. The difference of AHI from ABI is in an observing band. AHI has 0.51 µm observing band instead of ABI's 1.38 µm one. Using AHI, JMA plans to capture **full disk images every 10 minutes** and regional images around Japan every 2.5 minutes.

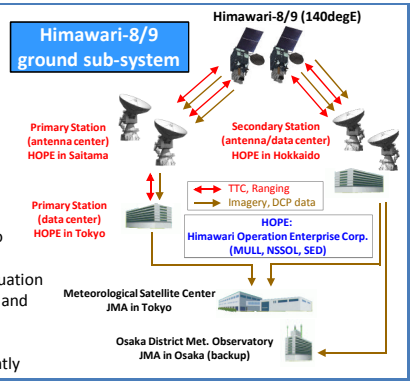
The development of products for Himawari-8/9 is ongoing. JMA makes a strong effort to upgrade **Atmospheric Motion Vector** (AMV)s and develop **volcanic ash/yellow sand analysis product** and **nowcast product** for aviation users and weather forecasters.

Himawari-8/9 schedule and operation

Himawari-8/9 schedule



- ✓ Himawari-8 : Launch in 2014, Start of operation in 2015
- ✓ Himawari-9: Launch in 2016
- ✓ Himawari-8/9 will be in operation around 140 degrees East covering the East Asia and the Western Pacific



- ✓ Satellites controlled from two ground stations
- ✓ "Site Diversity" for rain attenuation on Ka-band used for imagery and DCP data downlink
- ✓ Facilities of each station and networks equipped redundantly

Himawari-8/9 imagery data dissemination plan

- ✓ No on-board transponder equipped on Himawari-8/9 for imagery data direct-dissemination
- ✓ All the imagery data in full specification will be available via the Internet
- ✓ Feasibility study of data dissemination via commercial telecommunication satellite just started in JMA (No budget commitment at present)

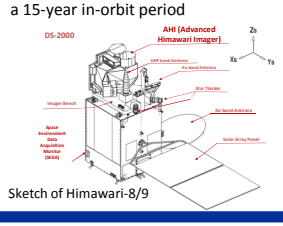
A Transition Plan for MTSAT-1R/2 MDUS/SDUS Users to Himawari-8/9

- ✓ Direct dissemination from MTSAT-1R/2 to MDUS/SDUS users will be finished in summer 2015 after Himawari-8 will be in operation
- ✓ Integrated Himawari-8/9 imagery data dissemination system will be implemented no later than JFY2014
- ✓ JMA will make an announcement to MSUD/SDUS users on the detailed schedule of transition in JFY2013

Specification of AHI on board Himawari-8/9

Mission of Himawari-8/9

- ✓ To sustain and improve the observation for disaster prevention and weather forecast.
- ✓ To enrich capabilities for nowcasting, particularly for the detection and prediction of severe weather.
- ✓ To improve the accuracy of Numerical Weather Prediction.
- ✓ To enhance climate and environment monitoring.
- ✓ Lifetime: 8 years of in-orbit operation out of a 15-year in-orbit period



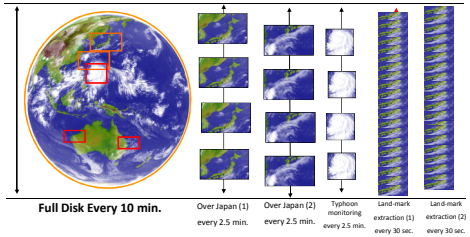
Sketch of Himawari-8/9

Imager channels

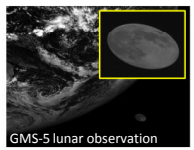
Wavelength (µm)	Himawari-8/9		MTSAT-1R/2		GOES-R		MSG	MTG
0.46	●	1			●	1		●
0.51	●	1						●
0.64	●	0.5	●	1	●	0.5	●	●
0.86	●				●	1	●	●
0.96								●
1.3					●	2		●
1.6	●				●	1	●	●
2.3	●				●			●
3.9	●		●		●		●	●
6.2	●		●		●		●	●
7.0	●	2		4	●			
7.3	●				●		●	●
8.6	●				●	2	●	●
9.6	●				●		●	●
10.4	●				●		●	●
11.2	●		●		●			
12.3	●		●		●		●	●
13.3	●				●		●	●

Spatial resolution (km)

A sequence of AHI observation in 10 minutes time frame



Lunar observation to support solar channel calibration



Himawari-8/9: Small-scale observations are planned to capture moon images in operation.

MTSAT-2: can capture moon images in full disk obs.

MTSAT-1R: can not capture because of its scan pattern.

New/Enhanced Products from Himawari-8/9

Development of products by 2015

Improvements

- Nowcasting
- Typhoon Analysis
- **Atmospheric Motion Vector**
- Clear Sky Radiance
- Sea Surface Temperature
- Yellow Sands
- Snow and Ice Coverage
- **Detection of rapidly developing cumulus areas from short-time interval images**

New Products

- **Volcanic Ash**
- **Global Instability Index**

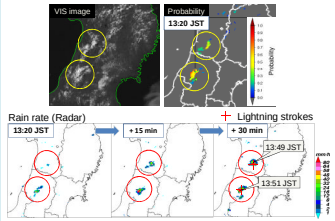
Atmospheric Motion Vector

- ✓ Develop AMV derivation algorithm for Himawari-8/9 by using EUMETSAT NWC SAF algorithm and software.
- ✓ Derivation of small-scale AMVs from rapid-scan
- ✓ Increase of derived vectors by using high resolution images

Detection of rapidly developing cumulus areas from short-time interval images

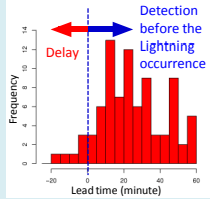
- ✓ Object: To capture air-mass thunderstorms from short-time interval images for aviation users
- ✓ Method: Logistic regression using VISR , IR BT, etc.
- ✓ Operation: Summer from 2012 using MTSAT-1R rapid scanning observation of five-minute intervals.

Predicted probability from MTSAT-1R rapid scan obs.



Lead time for lightning

- ✓ Mean lead time ≈ 20 minutes
- ✓ 86cases in summer 2011



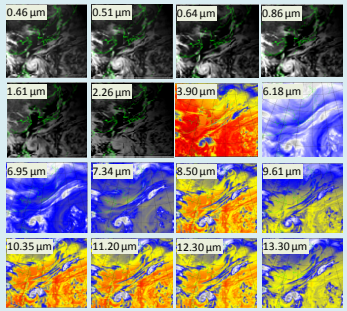
Simulated satellite images for new product development

- ✓ To support the development of Himawari-8/9 products, simulated images are necessary.
- ✓ IR simulated images from convolved hyper sounder data (Metop-A/IASI)
- ✓ Radiative transfer simulated images
- ✓ RTM: RSTAR (Nakajima and Tanaka, 1986), RTTOV, CRTM
- ✓ NWP: JMA operational models

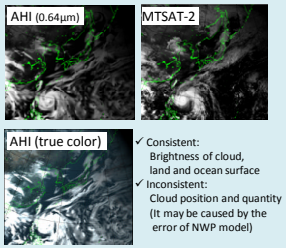
Model	Domain	Horizontal Resolution
GSM	Global	20km
MSM	Japan and its surrounding area	5km

Sample of radiative transfer simulated images for Himawari-8/9's 16 AHI bands

- ✓ RTM: RSTAR, Input NWP: GSM
- ✓ Surface parameters: Wind: JMA NWP, Albedo: MODIS MOD09
- ✓ Use of trace gases and Aerosol information is planned.



Comparison of simulated AHI and MTSAT-2 observation

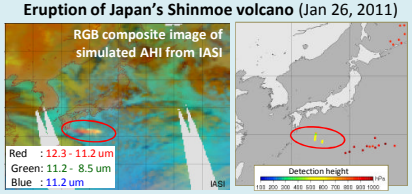


- ✓ Consistent: Brightness of cloud, land and ocean surface
- ✓ Inconsistent: Cloud position and quantity (It may be caused by the error of NWP model)

Volcanic Ash detection: height and mass loading

- ✓ NOAA's provisional algorithm for GOES-R
  - 8.5, 11.2, 12.3 µm for volcanic ash detection
  - 11.2, 12.3, 13.3 µm for height and mass loading

Eruption of Japan's Shinmoe volcano (Jan 26, 2011)

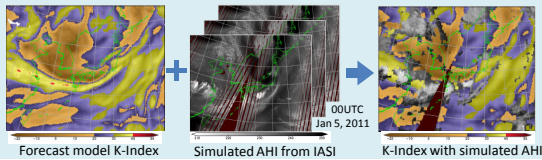


Global Instability Index

- ✓ Object: Early detection of severe weather phenomena
- ✓ Method
  - 1D-Var: by using RTTOV
  - Input: JMA NWP
- ✓ Output: K-Index, Lifted Index, etc.

Under developing

- Verification against obs. (RAOB, TPW, Lightning)
- Cloud screening
- Emissivity on the land
- Observation error and background error
- Bias collection



Forecast model K-Index | Simulated AHI from IASI | K-Index with simulated AHI

NOAA Satellite Science Week: GOES-R Algorithm Working Group (AWG), Proving Ground, and Risk Reduction annual meetings, Kansas City, MO, Apr. 30 - May 4, 2012

Reference: Nakajima, T., and M. Tanaka, 1986: Matrix formulation for the transfer of solar radiation in a plane-parallel scattering atmosphere, J. Quant. Spectrosc. Radiat. Transfer, 35, 13-21.