Current status of Himawari-8/9 products development

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• What will Himawari-8/9 bring to us?
  • Upgrade of number of channels
  • Upgrade of spatial and temporal resolution

• Status of Primary Product Development of JMA
  • International cooperation
  • Cloud product
  • Atmospheric Motion Vector (AMV)
  • Aerosol product (Asian Dust)
  • Volcanic Ash product

• Summary
What will Himawari-8/9 bring to us?

Upgrade of number of channels

Upgrade of spatial and temporal resolution
### Specification of Himawari-8/9 Imager (AHI)

<table>
<thead>
<tr>
<th>Band</th>
<th>Wavelength [µm]</th>
<th>Spatial Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.46</td>
<td>1Km</td>
</tr>
<tr>
<td>2</td>
<td>0.51</td>
<td>1Km</td>
</tr>
<tr>
<td>3</td>
<td>0.64</td>
<td>0.5Km</td>
</tr>
<tr>
<td>4</td>
<td>0.86</td>
<td>1Km</td>
</tr>
<tr>
<td>5</td>
<td>1.6</td>
<td>2Km</td>
</tr>
<tr>
<td>6</td>
<td>2.3</td>
<td>2Km</td>
</tr>
<tr>
<td>7</td>
<td>3.9</td>
<td>2Km</td>
</tr>
<tr>
<td>8</td>
<td>6.2</td>
<td>2Km</td>
</tr>
<tr>
<td>9</td>
<td>7.0</td>
<td>2Km</td>
</tr>
<tr>
<td>10</td>
<td>7.3</td>
<td>2Km</td>
</tr>
<tr>
<td>11</td>
<td>8.6</td>
<td>2Km</td>
</tr>
<tr>
<td>12</td>
<td>9.6</td>
<td>2Km</td>
</tr>
<tr>
<td>13</td>
<td>10.4</td>
<td>2Km</td>
</tr>
<tr>
<td>14</td>
<td>11.2</td>
<td>2Km</td>
</tr>
<tr>
<td>15</td>
<td>12.3</td>
<td>2Km</td>
</tr>
<tr>
<td>16</td>
<td>13.3</td>
<td>2Km</td>
</tr>
</tbody>
</table>

Similar to ABI for GOES-R

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

Products:
- Volcanic Ash
- Global Instability Index
- Nowcasting
- Typhoon Analysis
- Atmospheric Motion Vector
- Clear Sky Radiance
- Sea Surface Temperature
- Yellow Sands
- Snow and Ice Coverage
IR image difference of spatial resolution

2km for H-8/9     4km for MTSAT
AHI will scan all sectors within 10 minutes

- **Full disk**
  - Interval: **10 minutes** (6 times per hour)
  - 23 swath

- **Region 1 JAPAN (North-East)**
  - Interval: **2.5 minutes** (4 times in 10 minutes)
  - Dimension: EW x NS: 2000 x 1000 km
  - 2 swath

- **Region 2 JAPAN (South-West)**
  - Interval: **2.5 minutes** (4 times in 10 minutes)
  - Dimension: EW x NS: 2000 x 1000 km
  - 2 swath

- **Region 3 Typhoon**
  - Interval: **2.5 minutes** (4 times in 10 minutes)
  - Dimension: EW x NS: 1000 x 1000 km
  - 2 swath

- **Region 4 Land mark**
  - Interval: **0.5 minutes** (20 times in 10 minutes)
  - Dimension: EW x NS: 1000 x 500 km
  - 1 swath

- **Region 5 Land mark**
  - Interval: **0.5 minutes** (20 times in 10 minutes)
  - Dimension: EW x NS: 1000 x 500 km
  - 1 swath
MTSAT-1R Rapid Scan every 10 min
Australia on 1 Oct. 2013
MTSAT-1R Rapid Scan every 10 min
Typhoon on 1 Oct. 2013
MTSAT-1R Rapid Scan every 5 min
Gust front on 1 Oct. 2013
Development of products of Himawari-8/9 AHI

Next Weather Satellite Revolution

toward

the New Era

of

Mesoscale Satellite Meteorology

Increased observation channels
- VIS: 1 -> 3 bands

Higher resolution
- Spatial: 4km -> 1km for a VIS channel
- Temporal: 1hr -> 10min for a full disk scan, 2.5min for limited areas

Examples of expected new/enhanced products
- Cloud Products
- Atmospheric Motion Vectors (AMVs)
- Aerosol (Dust) / Volcanic Ash

Severe weather monitoring/nowcasting
- Numerical prediction

Climate change monitoring
- Yellow sand/dust storm

Volcano eruption
- Ash area detection
- Solar energy monitoring

10 October 2013
4th Asia-Oceania Meteorological Satellite Users Conference
Status of Product Development for Himawari-8/9

1. Cloud Products
   (Cloud Mask, Cloud Type/Phase, Cloud Top Height)
2. Atmospheric Motion Vector (AMV)
3. Aerosol Product (Asian Dust)
4. Volcanic Ash Product
International Cooperation for developments of Cloud Product, AMV and volcanic ash product

- **Nov. 2012** Look Up Table (LUT) and software for Volcanic Ash retrieval was provided from EUMETSAT.
- **Jan. 2013** JMA invited scientists from EUMETSAT and UK Met Office.
  - Dr. Hans-Joachim Lutz (EUMETSAT)
  - Dr. Régis Borde (EUMETSAT)
  - Dr. Peter Francis (UK Met Office)
- **Feb. 2013** JMA invited scientist from NOAA/NESDIS
  - Dr. Andrew Heidinger (NOAA/NESDIS)
  - Dr. Mike Pavolonis (NOAA/NESDIS)
- **April-May 2013** JMA/MSC scientist visited EUMETSAT for the development of OCA and AMV.
  - Mr. Masahiro Hayashi (JMA/MSC)

We greatly appreciate kind cooperation of EUMETSAT and NOAA/NESDIS.
Status of Product Development for Himawari-8/9 (1/4)

1. Cloud Products

(Mask, Type/Phase, Cloud Top Temperature/Pressure)

- **Satellite**: Himawari-8/9
- **Improvement**: Common product for generating other products
- **Algorithm**: Based on EUMETSAT/NWC-SAF/MSG algorithm. Partly introduced NOAA/NESDIS/GOES-R algorithm (A. Heidinger et.al) for Mask and Type determinations.
- **Status**: Created prototype software for MSG area
Cloud Products (Prototype)

15:12UTC 7th Apr. 2012, MSG

RGB Image
- R: 0.64um
- G: 0.86um
- B: 11.2um

Cloud Mask
Cloud Products (Prototype)

1512UTC 7th Apr. 2012, MSG

Cloud Type

Cloud Top Height (hPa)
Status of Product Development for Himawari-8/9 (2/4)

2. Atmospheric Motion Vector (AMV)

- **Satellite**: MTSAT-2, Himawari-8/9
- **Improvement**: High spatial resolution AMV
- **Algorithm**: Pattern recognition technique using Maximum likelihood estimation method (JMA)
- **Status**: Created prototype software
AMV (Current)

2012-06-19-01UTC MTSAT-2 AMV

QI > 0.85

Yellow : IR1-low
Red : IR1-upper
Blue : WV clear and cloudy

Target box size : 16x16 pixel
Method : Current
Grid : 0.5 degree
AMV (Prototype)

2012-06-19-01UTC MTSAT-2 AMV
QI>0.85
Yellow : IR1-low
Red : IR1-upper
Blue : WV clear and cloudy

Target box size : 5x5 pixel
Method : MLE
Grid : 0.2 degree
### Status of Product Development for Himawari-8/9 (3/4)

#### 3. Aerosol Product (Asian Dust)

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Himawari-8/9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improvement</td>
<td>Retrieval of physical quantities for land surface</td>
</tr>
<tr>
<td>Algorithm</td>
<td>Y.Mano (JMA/MRI)</td>
</tr>
</tbody>
</table>

**Reference:**
- NOAA/NESDIS/GOES-R algorithm
- NASA/GSFC/MODIS algorithm

**Status:** Created prototype software
Aerosol Product (Prototype)

Prototype (MODIS/Terra)

Trial processing with MODIS/Terra (0430 UTC), without cloud mask

Current (MTSAT-2)

Current Algorithm with MTSAT-2 (0500 UTC)
Aerosol Product / Current Status and Plan

• Reviewed ATBD for NOAA/NESDIS aerosol product (2012.4-6)
• Designed LUT for aerosol retrieval and generated the 1st version of LUT (2012.8-11)
• Experimental retrieval from MODIS L1B data (2012.12)
• Software and/or LUT will be adjusted using Himawari-8 data after the data becomes available.
• JMA will also introduce NOAA/NESDIS volcanic ash algorithm.
Status of Product Development for Himawari-8/9 (4/4)

4. Volcanic Ash Product

<table>
<thead>
<tr>
<th>Satellite</th>
<th>MTSAT-2, Himawari-8/9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improvement</td>
<td>New product</td>
</tr>
<tr>
<td></td>
<td>(Optical Depth, Particle Radius, Mass Loading, Ash cloud top height)</td>
</tr>
<tr>
<td>Algorithm</td>
<td>Ash cloud detection</td>
</tr>
<tr>
<td></td>
<td>(M.Pavolonis/NOAA/NESDIS, S.Mackie/Univ.of Bristol) Retrieval processing (F.Prata/NILU)</td>
</tr>
<tr>
<td>Status</td>
<td>Preparing for operational generating. Discussing about validation with Tokyo VAAC.</td>
</tr>
</tbody>
</table>
Volcanic Ash Product

Sarychev 2009.6.14 0300UTC, MTSAT-1R

Mt. Merapi 2010.11.11 2000UTC, MTSAT-1R

Bulusan 2011.2.21 0400UTC, MTSAT-2

Shinmoe-dake 2011.1.27 0000UTC, MTSAT-2
Volcanic Ash Product / Current Status and Plan

**Step 1:** Introducing EUMETSAT Volcanic Ash Retrieval software for MSG in JMA/MSC by March 2013
- JMA/MSC has installed software on the computer system and applied it to MTSAT-2 in collaboration with EUMETSAT
- The new volcanic ash product started to be provided for VAAC/Tokyo in pre-operation mode (March, 2013)

**Step 2:** Introducing NOAA/NESDIS Volcanic Ash Retrieval software in JMA/MSC in collaboration with NOAA/NESDIS
- JMA/MSC and NOAA/NESDIS had a technical meeting on the Volcanic Ash Retrieval algorithm and software
- Procedure to install NOAA/NESDIS software is ongoing

**Step 3:** JMA/MSC will operate above two products in parallel and provide to VAAC/Tokyo after Himawari-8 will be in operation

**Step 4:** Further verification and improvements will be done in cooperation with EUMETSAT and NOAA/NESDIS
Simulated AHI images for new products development

http://mscweb.kishou.go.jp/himawari89/space_segment/spsg_ahi_proxy.html

To support the development of Himawari-8/9 products such as AMV, SST and aerosol, simulated satellite images are necessary.

Radiance for each AHI band is calculated by using RTM with JMA NWP and some LEO satellites data.

Sample simulation data have been made public for use in AHI research and development on the website.

### Configuration for RT Simulation

<table>
<thead>
<tr>
<th>RT Model</th>
<th>RSTAR (Nakajima and Tanaka, 1986)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NWP</td>
<td>JMA GSM (horizontal resolution: 20km)</td>
</tr>
<tr>
<td>Surface Parameters</td>
<td>Wind: JMA GSM Albedo: MODIS MOD09</td>
</tr>
</tbody>
</table>

RT simulated images for **Himawari-8/9’s 16 AHI bands**
Monitoring the earth from the MTSAT

Information

- Schedule for Equinox Season (Autumn 2013 Equinox Operations) (1 August 2013)
- AHI proxy data (for researchers) (27 February 2013)
Summary

• Himawari-8/9 will bring us Mesoscale Satellite Meteorology.

• JMA Primary Product development is on going.

• We will just do it!!
Thank you for your attention.
Backup Slides
★ Major characteristics of Himawari-8/9 ★

- Contractor: MELCO (Mitsubishi Electric Corporation)
- Attitude control: Three-axis stabilization
- Launch Schedule: 2014 (Himawari-8)
  2016 (Himawari-9)
- Communication: 402 MHz (UHF-band)
  13, 14/12 GHz (Ku-Band)
  18 GHz (Ka-band)

<table>
<thead>
<tr>
<th>Advanced Himawari Imager (AHI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channels</td>
</tr>
<tr>
<td>Visible (4 channels)</td>
</tr>
<tr>
<td>Infrared (12 channels)</td>
</tr>
<tr>
<td>Resolutions</td>
</tr>
<tr>
<td>0.5 Km, 1 Km and 2 Km</td>
</tr>
<tr>
<td>Brightness levels</td>
</tr>
<tr>
<td>&gt;= 11 bits</td>
</tr>
</tbody>
</table>
AMV / Algorithm improvement  (JMA Original)

- Upgrade to tracking algorithm based in maximum likelihood estimation method (MLE)
  -> for high spatial resolution AMV

- Installation of cloud height assignment algorithm based on optimal estimation (NEW)
  -> for decreasing wind speed BIAS and RMSVD caused from height estimation error
Maximum Likelihood Approach to Cloud Motion Estimation

1. To equate cross-correlation value with likelihood
   - cross-correlation is large -> matching probability is large

2. To compute posterior probability from prior probability and auxiliary information
   - prior probability: correlation surface from small target box
   - auxiliary information: correlation surface from large target box
   - Posterior probability is computable by averaging two matching surface

3. To search position that shows maximum cross-correlation (maximum likelihood)
AMV derivation experiment using new tracking and HA technique

Satellite : MTSAT-2
Period : July 2012 (summer) and January 2013 (winter)

• Tracking method
  RTN : Cross-Correlation, 16x16 pixels
  TEST : Cross-Correlation, MLE using 5x5 and 15x15 pixels

• Height assignment method
  RTN : operational method
  TEST :
    Cloud alignment model : 3 layers
    PDF : multivariate student t distribution (t=1)
    Optimization method : Nelder-Mead
IR upper level AMV O-B statistics for January 2013

RTN

Map RMSVD

NEW

Map RMSVD
IR upper level AMV O-B statistics for January 2013
IR upper level AMV O-B statistics for July 2012
IR upper level AMV O-B statistics for July 2012