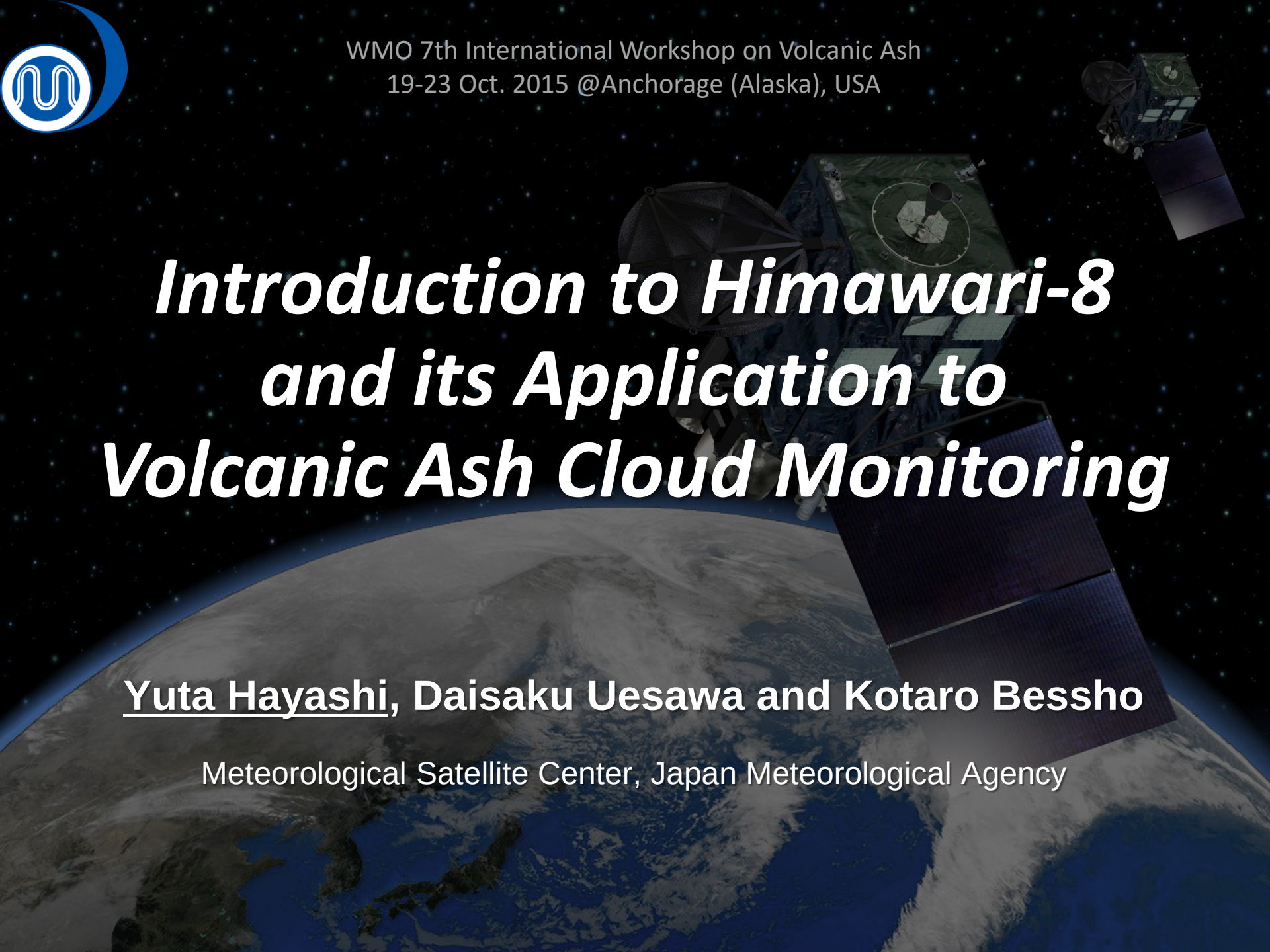
WMO 7th International Workshop on Volcanic Ash
19-23 Oct. 2015 @Anchorage (Alaska), USA

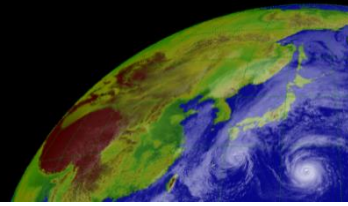


Introduction to Himawari-8 and its Application to Volcanic Ash Cloud Monitoring

Yuta Hayashi, Daisaku Uesawa and Kotaro Bessho

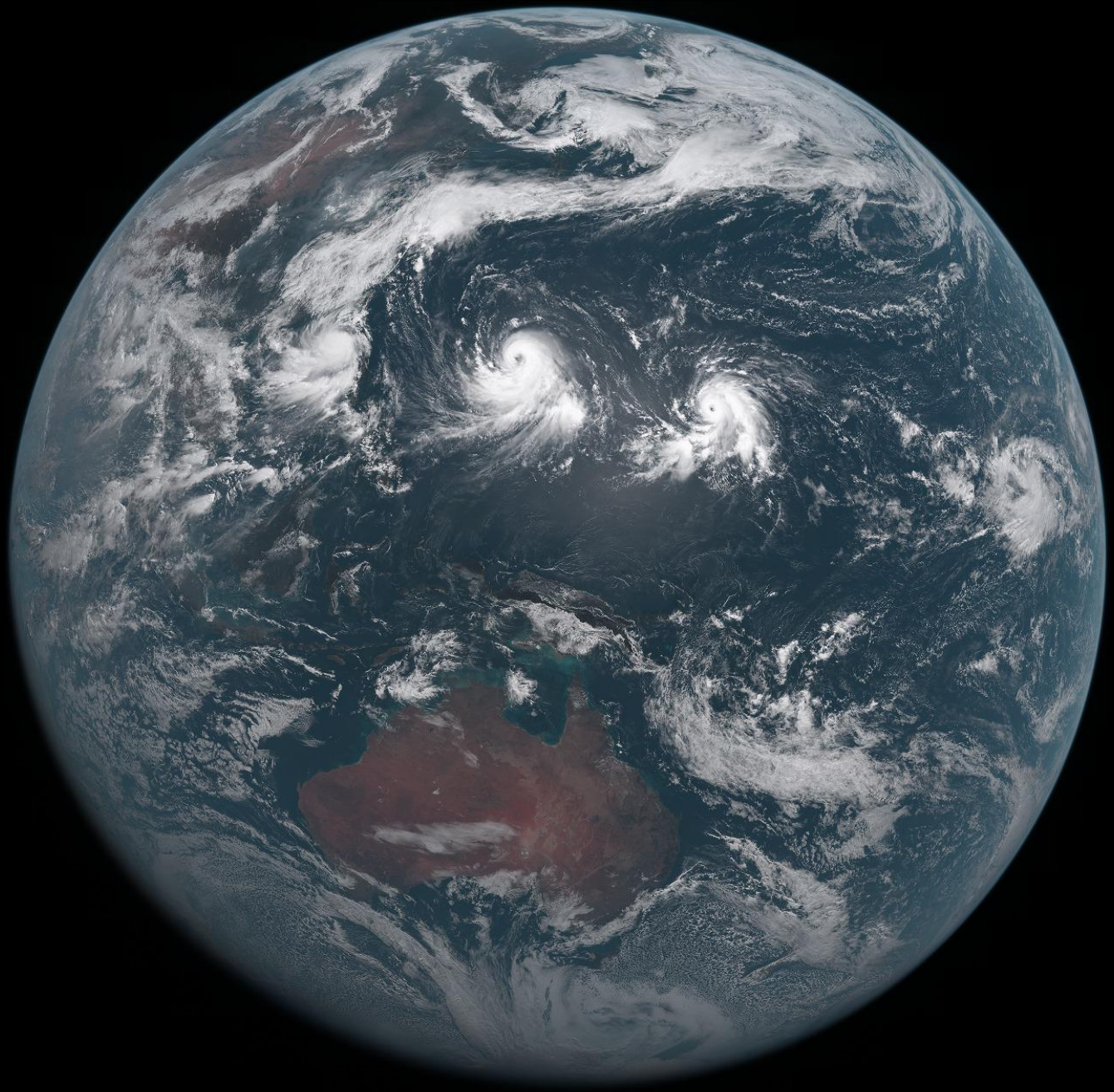
Meteorological Satellite Center, Japan Meteorological Agency

Contents



- **Outline of Himawari-8**
- **Improved Resolutions**
  - ✓ ***Spatial***
  - ✓ ***Temporal***
  - ✓ ***Spectral***
- **Application to Volcanic Ash Cloud Monitoring**
  - ✓ ***Volcanic Ash Products of JMA***
  - ✓ ***Features of VOLCAT***
  - ✓ ***Detection of Volcanic Plumes***
- **Future Plan**
- **Summary**

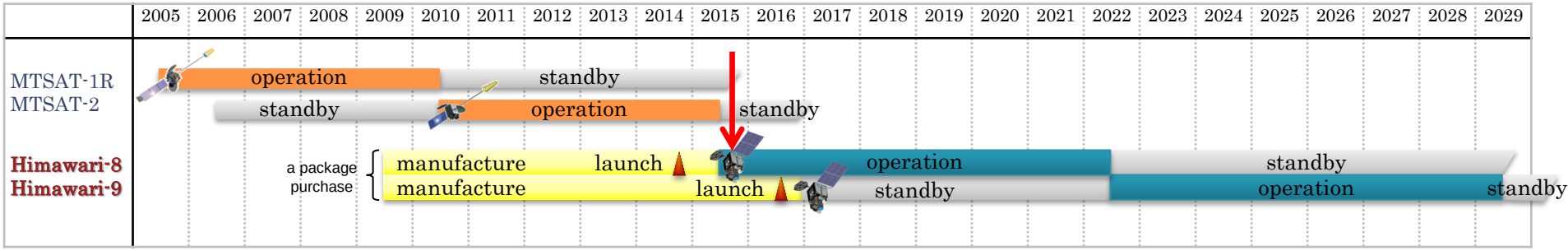
Himawari-8 began operation at 02:00 UTC on 7th July 2015.



Outline of Himawari-8

Geostationary position	Around 140.7° E
Attitude control	3-axis attitude-controlled geostationary satellite
Communication	1) Raw observation data transmission Ka-band, 18.1 - 18.4 GHz (downlink)
	2) DCS International channel 402.0 - 402.1 MHz (uplink) Domestic channel 402.1 - 402.4 MHz (uplink) Transmission to ground segments Ka-band, 18.1 - 18.4 GHz (downlink)
	3) Telemetry and command Ku-band, 12.2 - 12.75 GHz (downlink) 13.75 - 14.5 GHz (uplink)

Himawari-8 began operation on 7 July 2015, replacing the previous MTSAT-2 operational satellite



Improved Resolutions

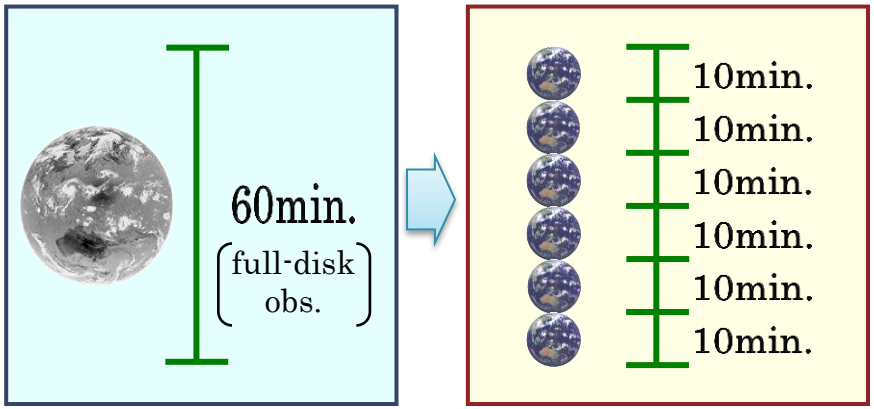
Spatial

At sub-satellite point

MTSAT-1R/2	Himawari-8/9
VIS 1 km	VIS 0.5/1 km
IR 4 km	IR 2 km

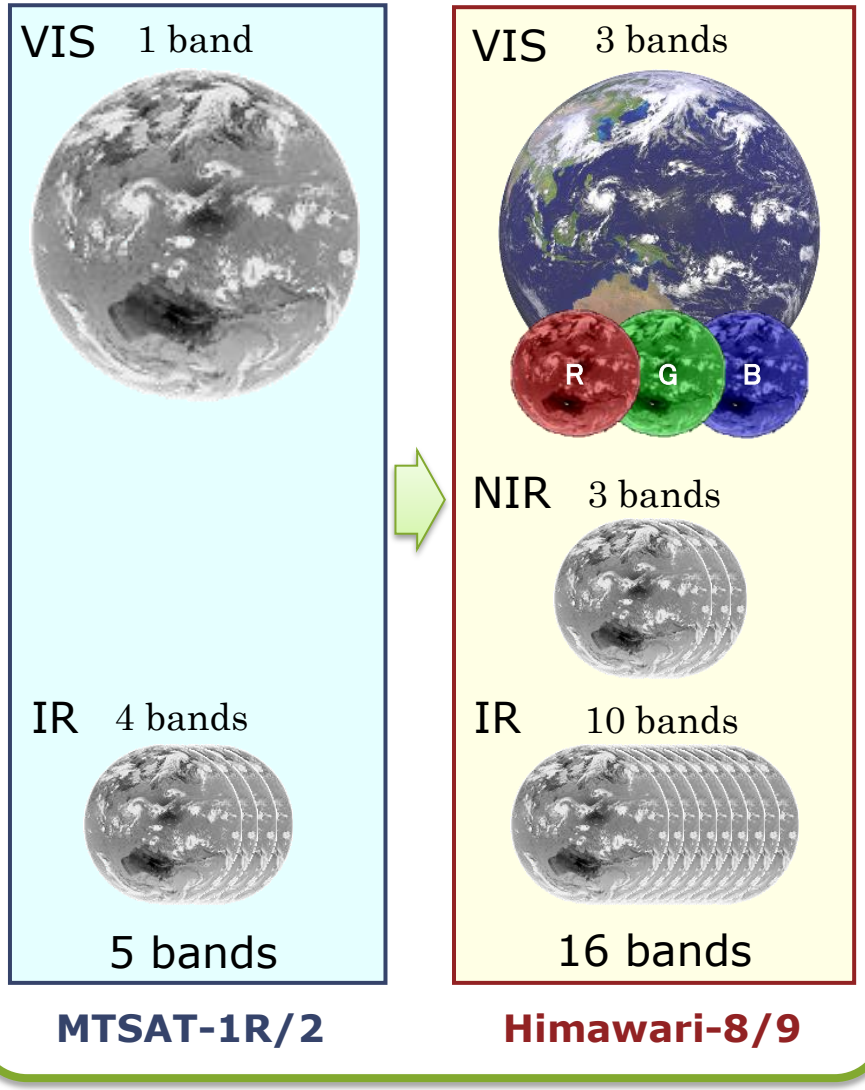
Temporal

Observation Frequency



MTSAT-1R/2 — Himawari-8/9

Spectral

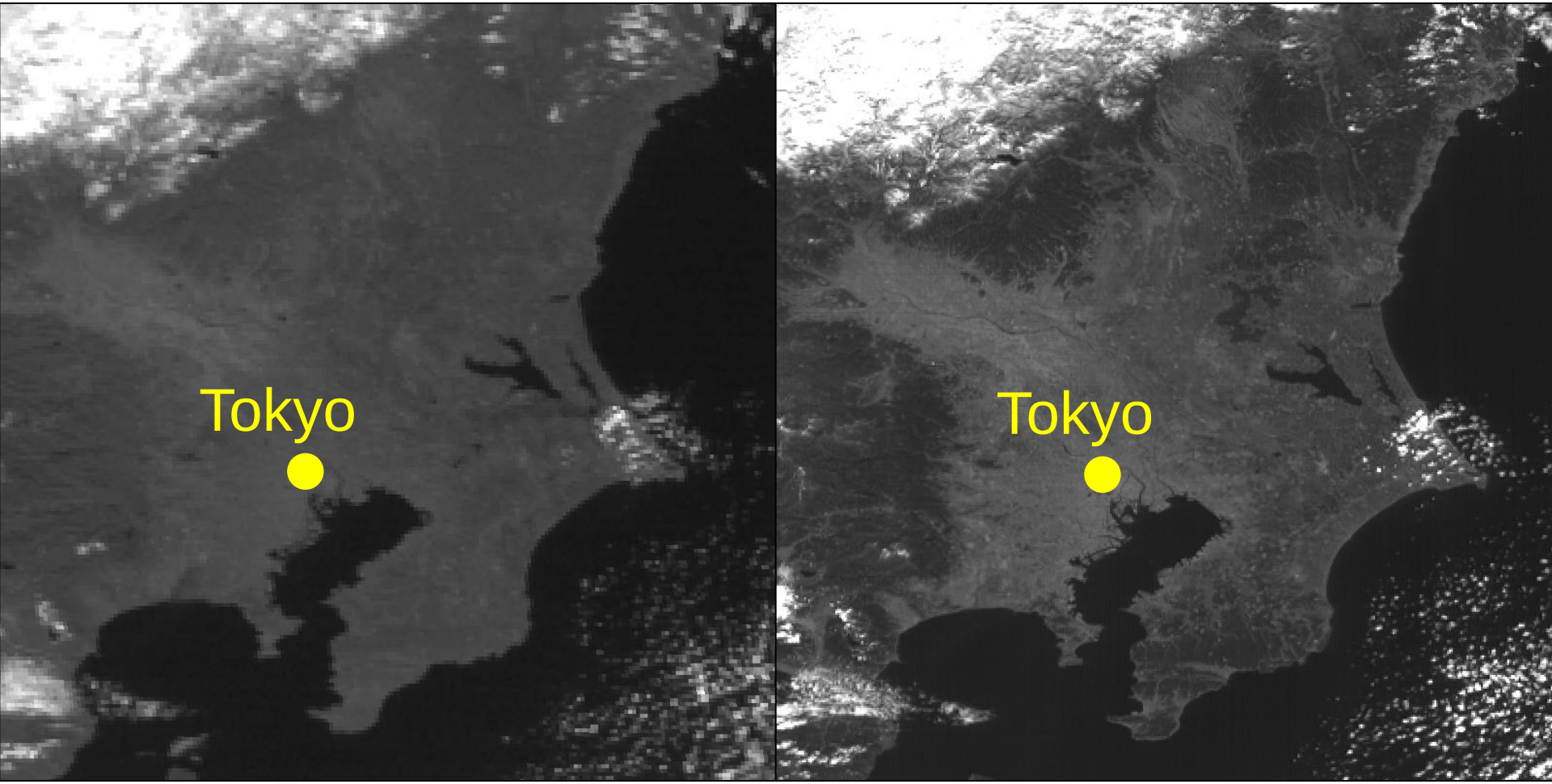


MTSAT-1R/2 — Himawari-8/9

Spatial Resolution

MTSAT-2 (VIS)
1km

Himawari-8 (B03)
0.5 km

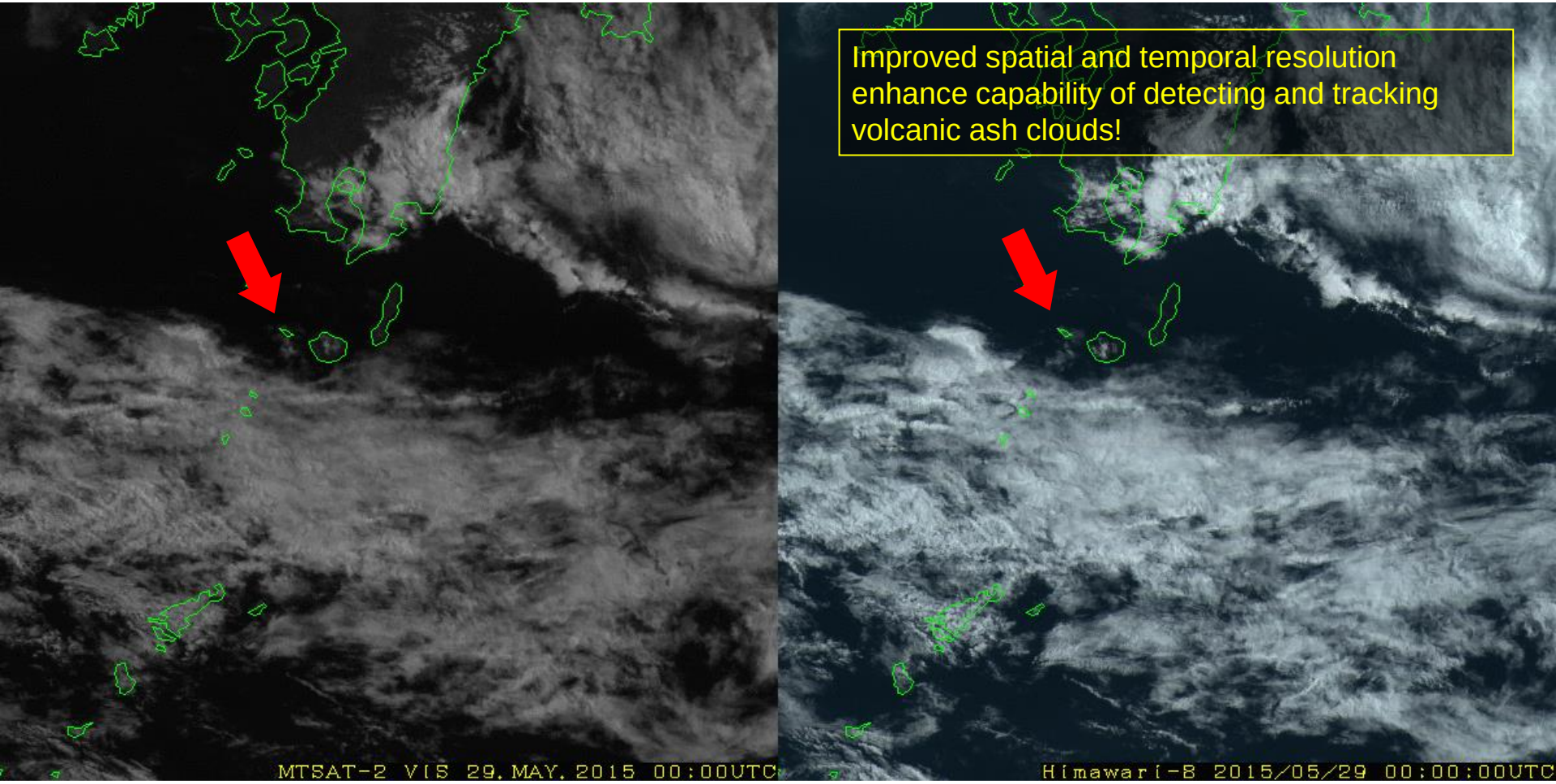


03:00 UTC on 29 January 2015

Observation Frequency

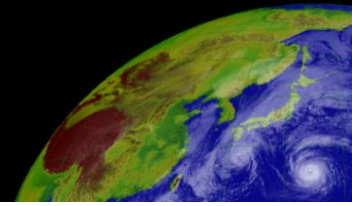
MTSAT-2 (VIS)
Every 30 min. (Japan area)

Himawari-8 (True Color)
Every 2.5 min. (Japan area)



Eruption of Kuchinoerabujima, located south of Kyushu island in Japan, on 29 May 2015.

Spectral Bands



cf. MTSAT-2 Bands

VIS 0.68 μm

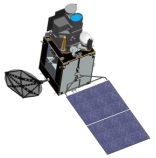
IR4 3.7 μm

IR3 6.8 μm

IR1 10.8 μm

IR2 12.0 μm

Himawari-8/9 Imager (AHI)



Band		Spatial Resolution	Central Wavelength	Physical Properties	
1	Visible	1 km	0.47 μm	vegetation, aerosol	3 Visible Bands
2			0.51 μm	vegetation, aerosol	
3		0.5 km	0.64 μm	low cloud, fog	
4	Near Infrared	1 km	0.86 μm	vegetation, aerosol	Addition of NIR Bands
5		2 km	1.6 μm	cloud phase	
6			2.3 μm	particle size	
7	Infrared	2 km	3.9 μm	low cloud, fog, forest fire	
8			6.2 μm	mid- and upper-level moisture	Increase of WV Bands
9			6.9 μm	mid-level moisture	
10			7.3 μm	mid- and lower-level moisture	
11			8.6 μm	cloud phase, SO2	Increase of TIR Bands
12			9.6 μm	ozone content	
13			10.4 μm	cloud imagery, information of cloud top	
14			11.2 μm	cloud imagery, sea surface temperature	
15			12.4 μm	cloud imagery, sea surface temperature	
16			13.3 μm	cloud top height	

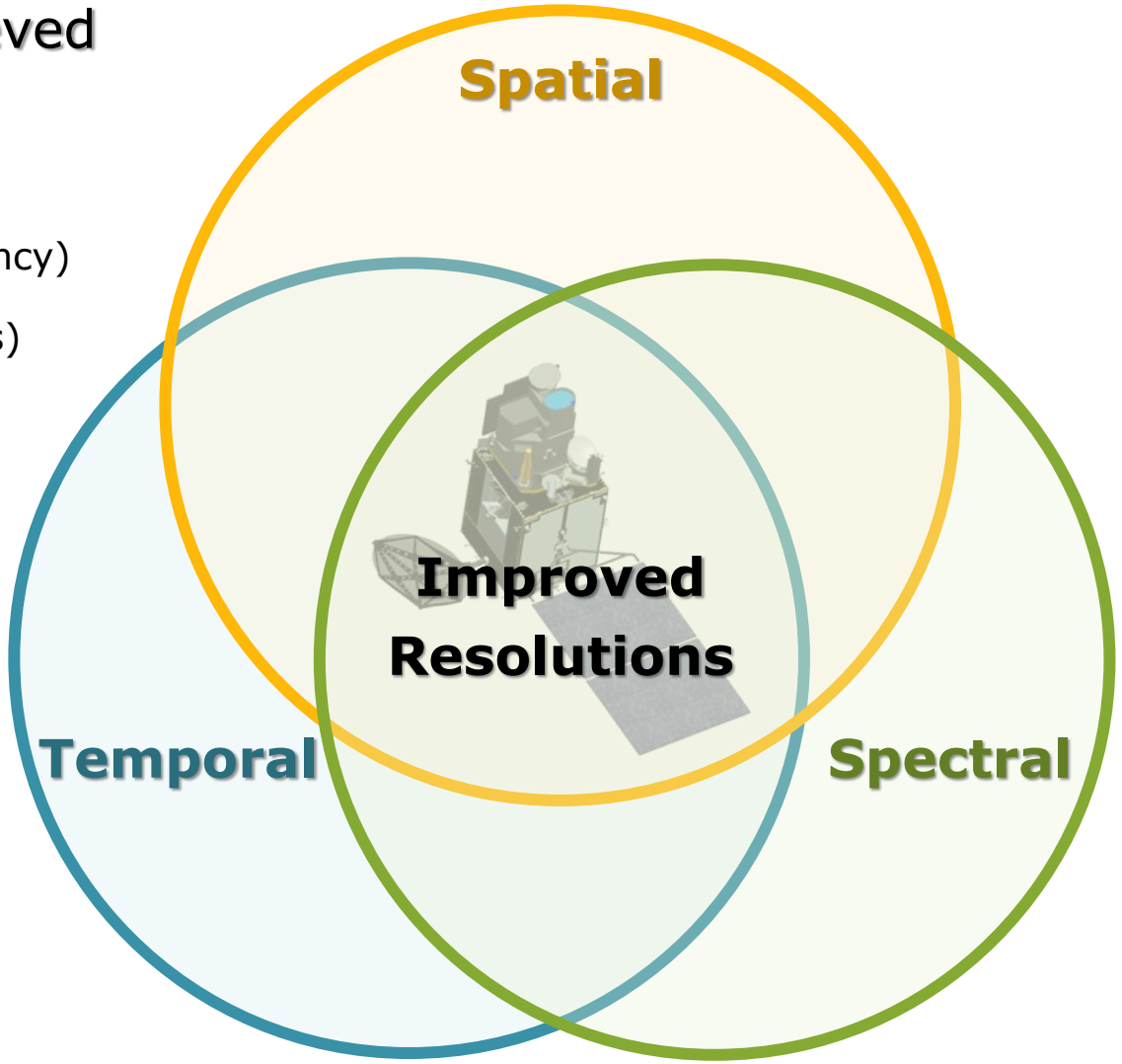
Application to Volcanic Ash Cloud Monitoring

Improved resolutions achieved by Himawari-8

- ✓ Spatial (AHI resolution)
- ✓ Temporal (Observation Frequency)
- ✓ Spectral (Number of AHI bands)

Expected improvements in volcanic ash monitoring

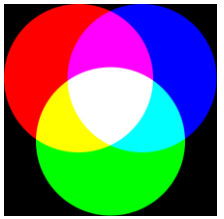
- ➢ Sophistication of detecting and tracking volcanic ash clouds
- ➢ Enhancement of precision in retrieving quantitative information

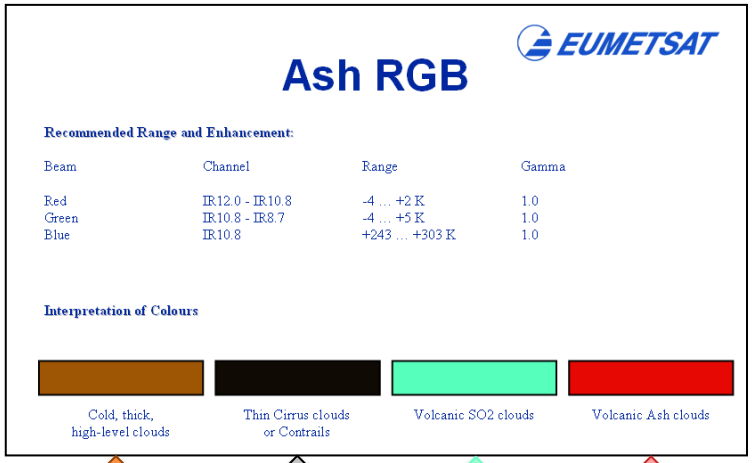


Ash RGB

RGB Composite Imagery

Full-color imagery which implements the information of 3 different channels or combined channels and mark each part in red, green and blue color.





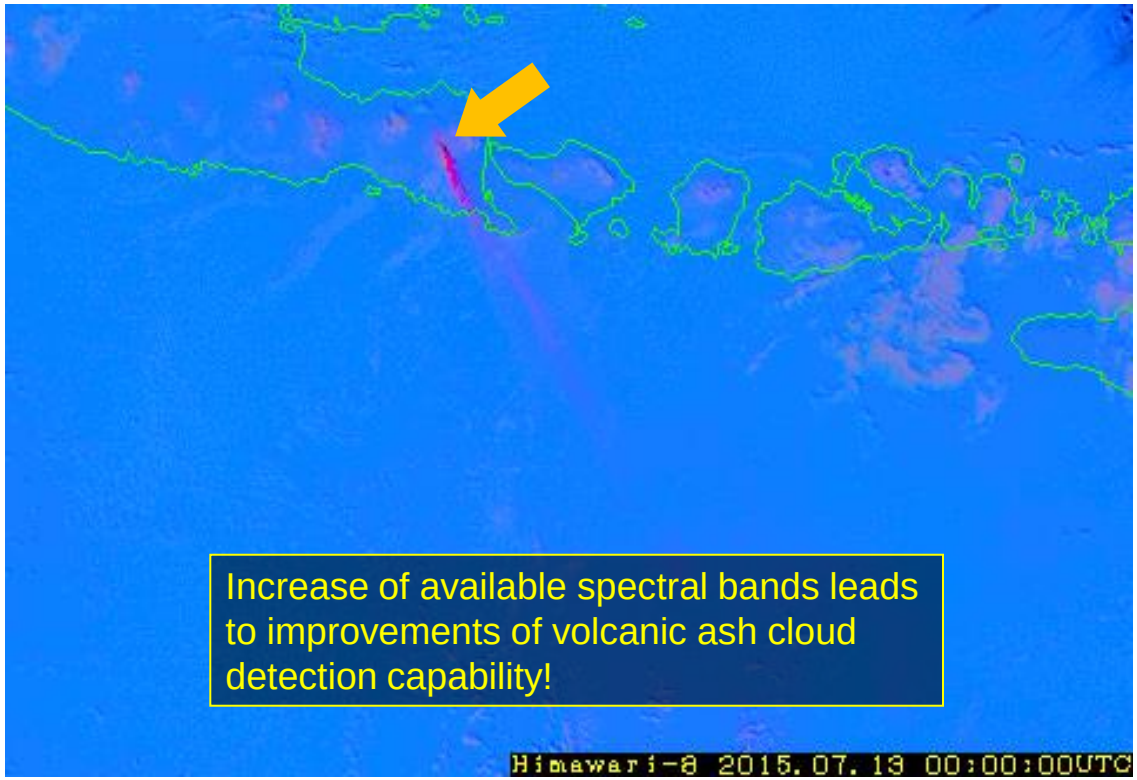
Cold, thick, high-level clouds

Thin Cirrus clouds or contrails

Volcanic SO_2 clouds

Volcanic ash clouds

R : B15 (12.4μm) - B13 (10.4μm)
G : B13 (10.4μm) - B11 (8.6μm)
B : B13 (10.4μm)



Continuous eruption of Mt. Raung, Indonesia on 13 July 2015

Volcanic Ash Products of JMA

➢ JMA+EUMETSAT Algorithm (for **MTSAT-1R/2**)

- ✓ Yukio Kurihara developed the algorithm based on look-up tables provided by EUMETSAT
- ✓ Output: cloud top height, AOD, effective radius, mass loading, probability
- ✓ Products are experimentally provided to Tokyo VAAC for evaluation and verification

EUMETSAT

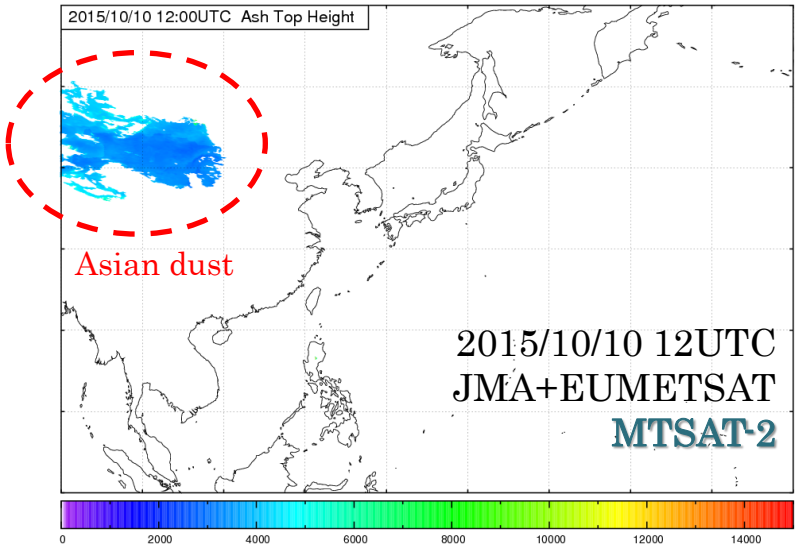
➢ NOAA/NESDIS Algorithm (for **Himawari-8/9**)

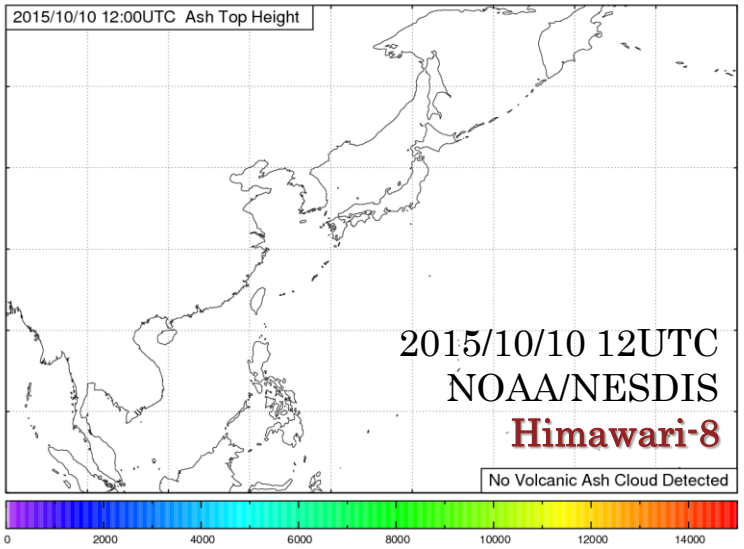
- ✓ Developed as a software package named VOLCAT (VOLcanic Cloud Analysis Toolkit) by NOAA/NESDIS
- ✓ Utilize combination of several techniques to identify volcanic ash (and dust) clouds
- ✓ Output: cloud top height, AOD, effective radius, mass loading, probability
- ✓ Implementation into JMA/MSC system is in progress
- ✓ Outputs will be experimentally provided to Tokyo VAAC for evaluation and verification

Many thanks to Dr. Pavolonis and Dr. Sieglaff !

Features of VOLCAT

- The Spectrally Enhanced Cloud Objects algorithm※ is adopted
- Globally applicable (day and night)
- Wide range of low earth orbit and geostationary satellite sensors and combinations of them can be supported as inputs
- Identify volcanic ash clouds with a very low false alarm rate



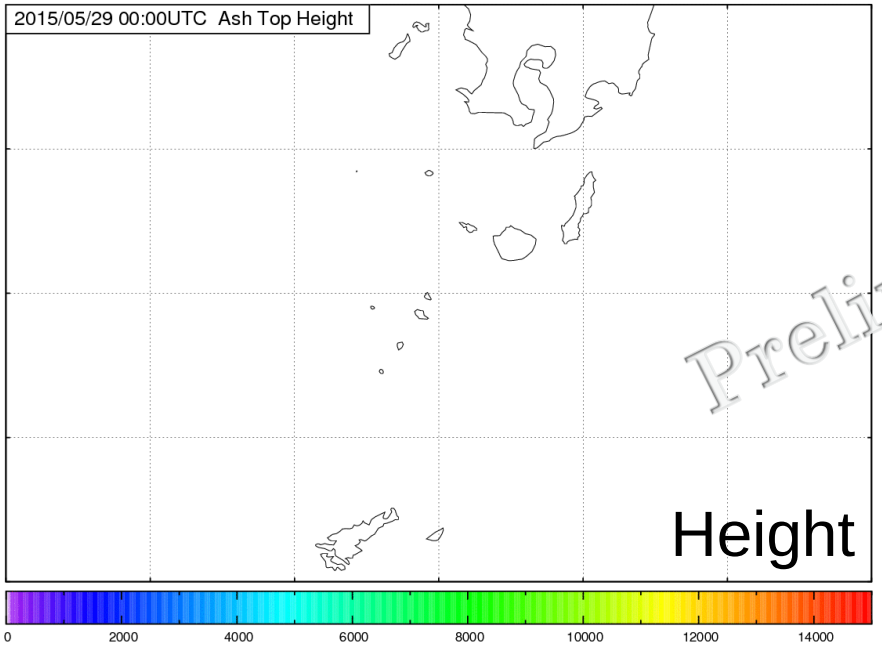


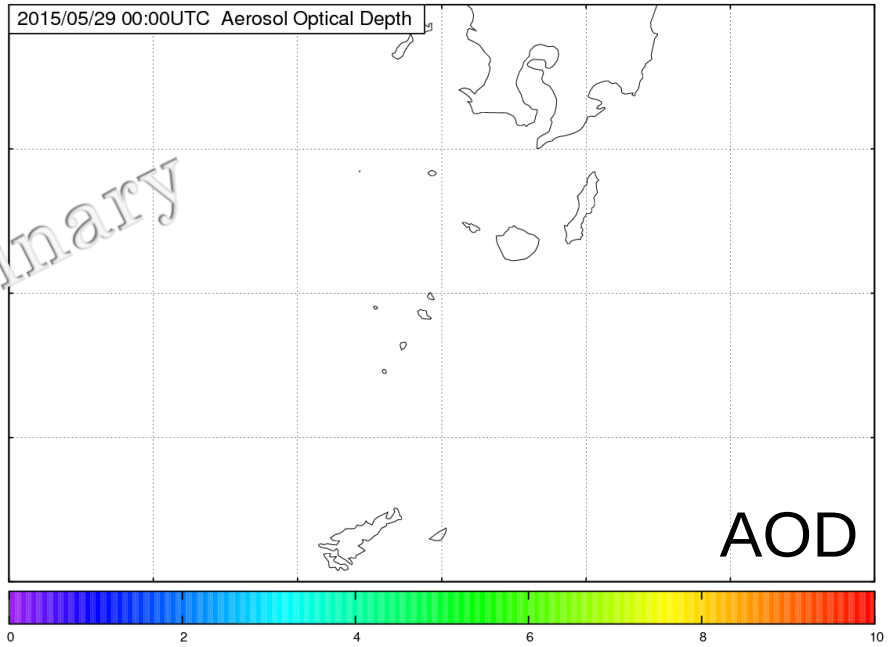
※ Refrences (Most recent)

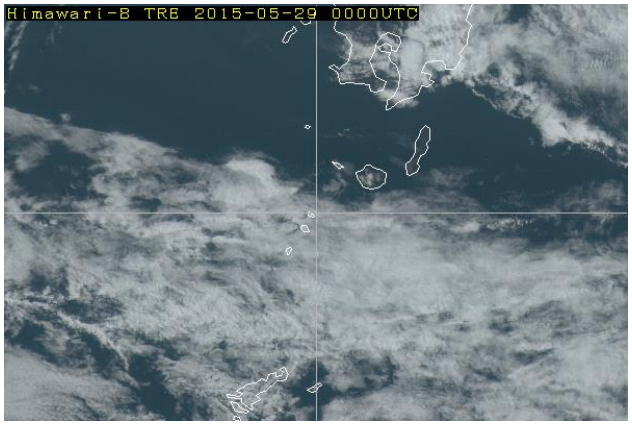
- Pavolonis, M. J., J. Sieglaff, and J. Cintineo (2015), Spectrally Enhanced Cloud Objects—A generalized framework for automated detection of volcanic ash and dust clouds using passive satellite measurements: 1. Multispectral analysis, J. Geophys. Res. Atmos., 120, 7813–7841.
- Pavolonis, M. J., J. Sieglaff, and J. Cintineo (2015), Spectrally Enhanced Cloud Objects—A generalized framework for automated detection of volcanic ash and dust clouds using passive satellite measurements: 2. Cloud object analysis and global application, J. Geophys. Res. Atmos., 120, 7842–7870.

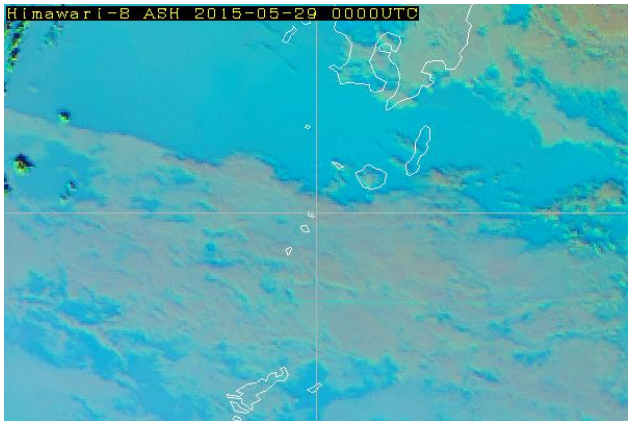
VOLCAT Output Examples

Eruption of Kuchinoerabujima on 29 May 2015.



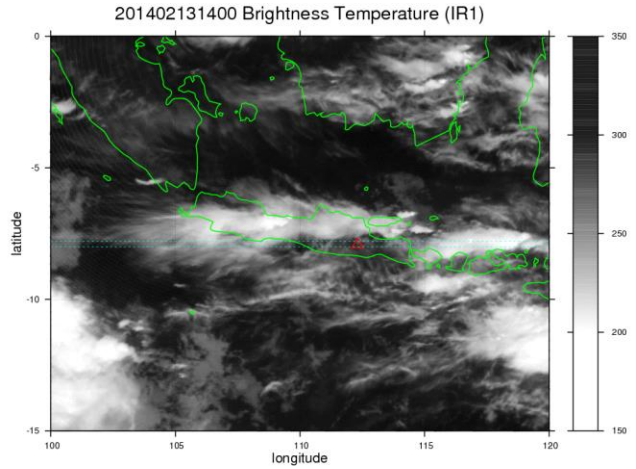




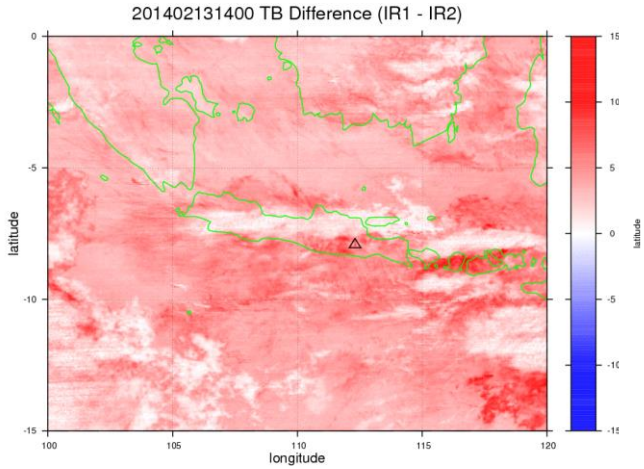


Detection of Volcanic Plumes

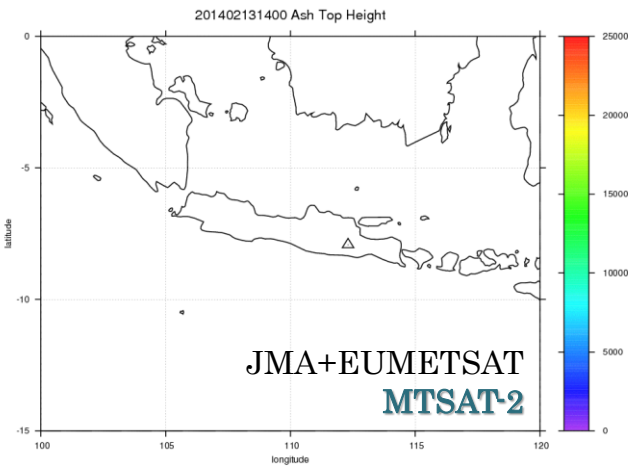
- Volcanic plumes (eruption column), especially those reach the stratosphere, are difficult to detect as volcanic ash clouds
  - ✓ Optically thick cloud has no signal in brightness temperature difference (BTD) as volcanic ash, and cannot distinguish from deep cumulonimbus (Cb) clouds



BT(10.8μm)



BTD(10.8μm-12.0μm)



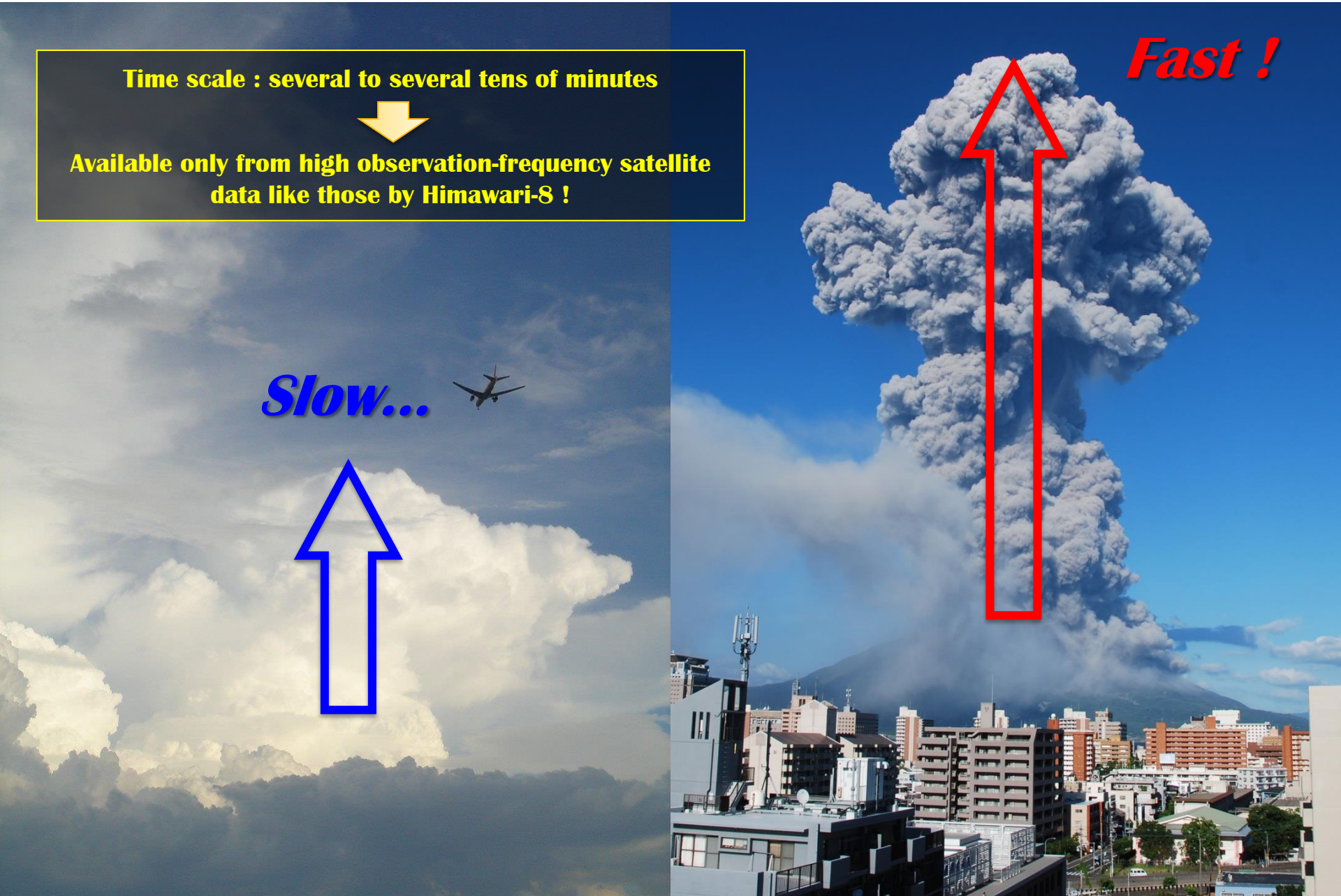
Ash Top Height

Eruption of Mt. Kelut, Indonesia on 13 February 2014
(Eruption Column : 17-25 km a.s.l.)

While the eruption occurs around 17 UTC (analysis by Darwin VAAC), JMA+EUMETSAT product cannot detect volcanic ash cloud until BTD becomes negative at 20 UTC.

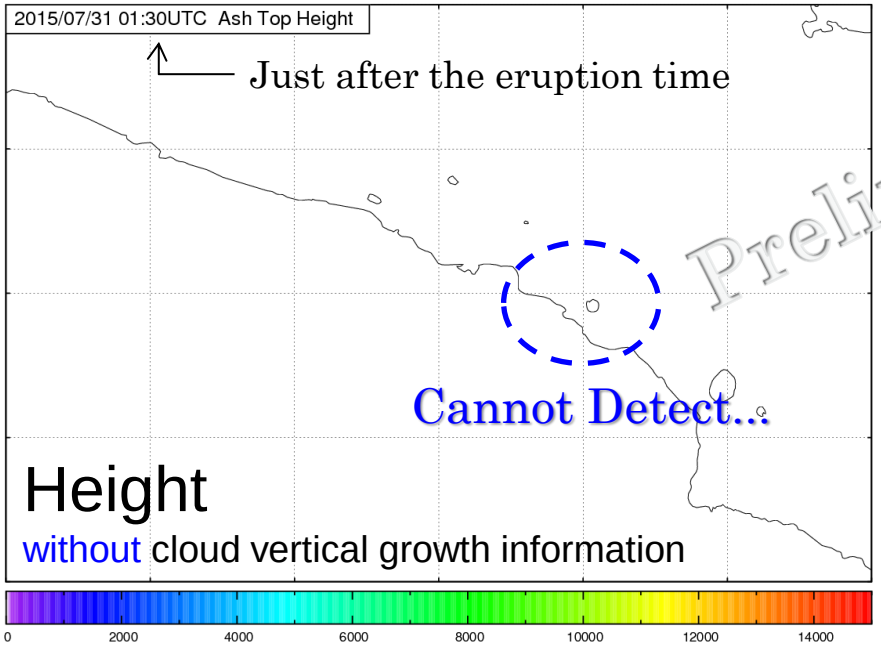
Idea :

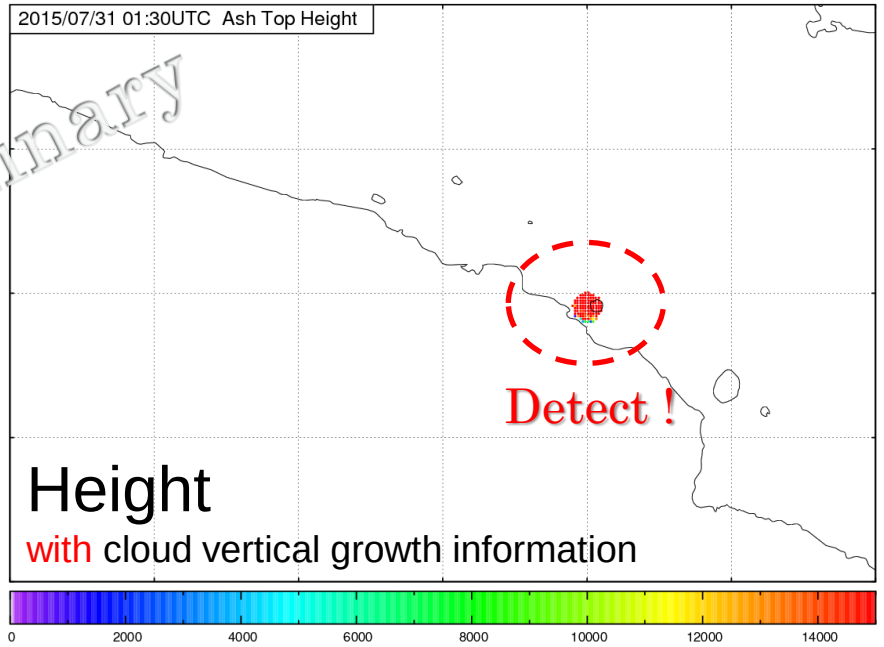
Using cloud vertical growth information from time-series satellite data



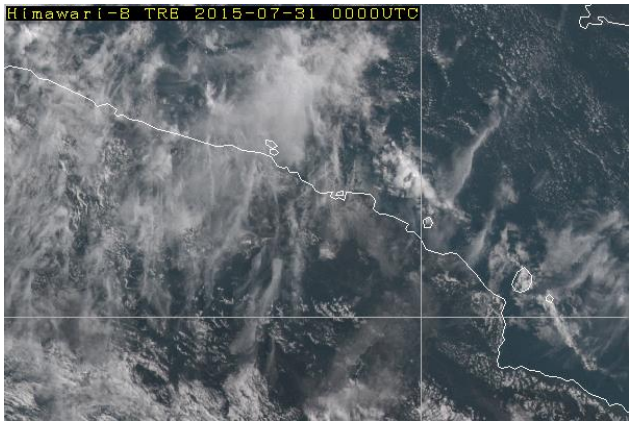
Volcanic Plume Detection by Cloud Vertical Growth Information

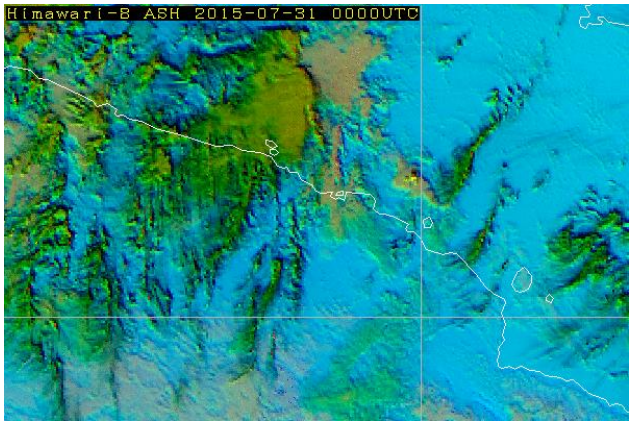
Eruption of Mt. Manam, Papua New Guinea on 31 May 2015.



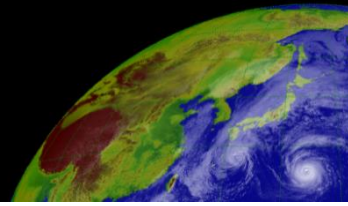


Eruption Column
65000FT (19800 m a.s.l.)





Future Plan



- **Replacement of ancillary data**
  - ✓ SST: Daily MGDSST by JMA
  - ✓ LST: GSM forecast by JMA
  - ✓ Atmospheric Profiles: GSM forecast by JMA
- **Experimental provision to Tokyo VAAC**
  - ✓ Evaluation and Validation
  - ✓ Feedback to NOAA/NESDIS for further improvement
- **Intercomparison environment**
  - ✓ Different algorithms
  - ✓ Different parameter settings
  - ✓ Different ancillary data

Summary

- **Introduction to Himawari-8**
  - ✓ Remarkable advantage in resolutions
    - Spatial (AHI resolution)
    - Temporal (Observation Frequency)
    - Spectral (Number of AHI bands)

- **Applications to Volcanic Ash Cloud Monitoring**
  - ✓ Himawari-8 can greatly contribute improvements on volcanic ash cloud monitoring and analysis
    - Detection and tracking
    - Retrieval of quantitative information (height, AOD, etc.)
  - ✓ NOAA/NESDIS algorithm is adopted for Himawari-8 volcanic ash product of JMA/MSC
  - ✓ Volcanic plumes can be detected by use of cloud vertical growth information

End

Thank you for your kind attention !