
# First results and products from Himawari-8

**Presented to CGMS-43 Plenary session, agenda item F.1.7**

**Japan Meteorological Agency**

CGMS-43 JMA-WP-09

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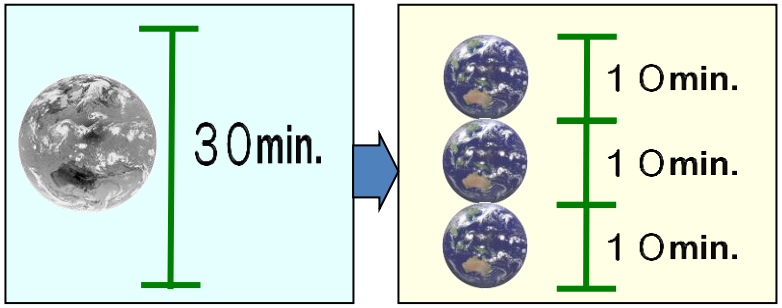
## Introduction

- Himawari-8 was successfully launched on 7 October 2014.
- The satellite will start operation in July 2015.
- Himawari-8 features the new Advanced Himawari Imager (AHI).

### Improved spatial resolution

| MTSAT-1R/2 | Himawari-8/9 |
|---|---|
| VIS 1 km<br>IR 4 km | VIS 0.5/1 km<br>IR 2 km |

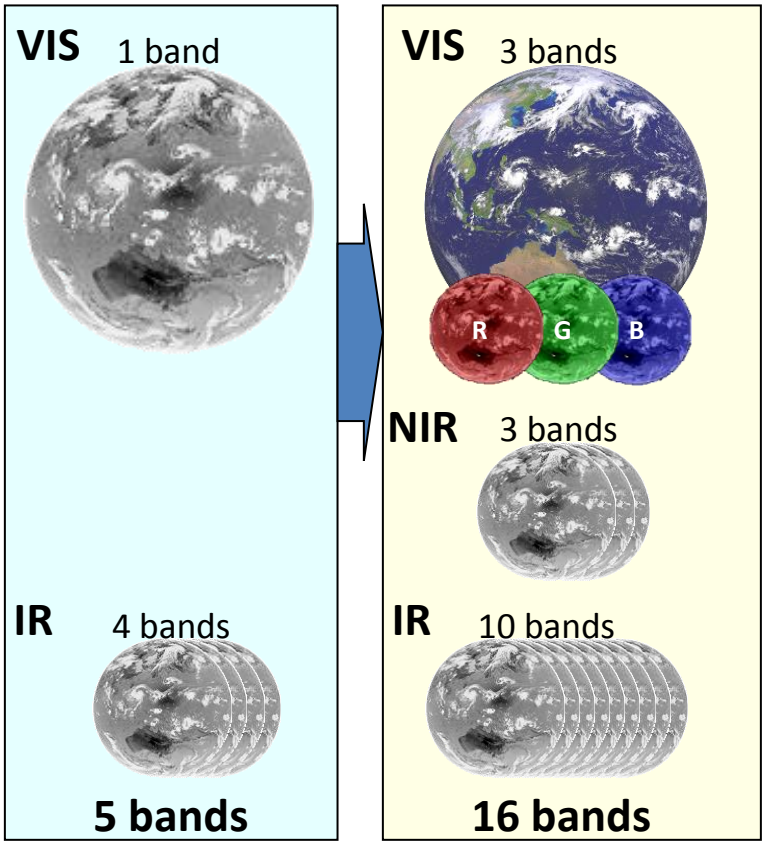
### More frequent observation




### More flexible regional observation

| | |
|---|---|
| Special observation | Target area obs. every 2.5 minutes |

### More spectral bands



# Characteristics of AHI 16 Spectral bands

as of MTSAT-1R/2

| | Band | Wavelength [μm] | Quantization [bit] | Spatial Resolution (km) |
|---|---|---|---|---|
| VIS | 1 | 0.46 | 11 | 1km |
| VIS | 2 | 0.51 | 11 | 1km |
| VIS | 3 | 0.64 | 11 | 0.5km |
| | 4 | 0.86 | 11 | 1km |
| | 5 | 1.6 | 11 | 2km |
| | 6 | 2.3 | 11 | 2Km |
| IR4 | 7 | 3.9 | 14 | 2Km |
| IR3 | 8 | 6.2 | 11 | 2Km |
| IR3 | 9 | 7.0 | 11 | 2Km |
| IR3 | 10 | 7.3 | 12 | 2Km |
| | 11 | 8.6 | 12 | 2Km |
| | 12 | 9.6 | 12 | 2Km |
| IR1 | 13 | 10.4 | 12 | 2Km |
| IR2 | 14 | 11.2 | 12 | 2Km |
| | 15 | 12.3 | 12 | 2Km |
| | 16 | 13.3 | 11 | 2Km |

Similar to ABI for GOES-R

RGB band Composited


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

Water vapor

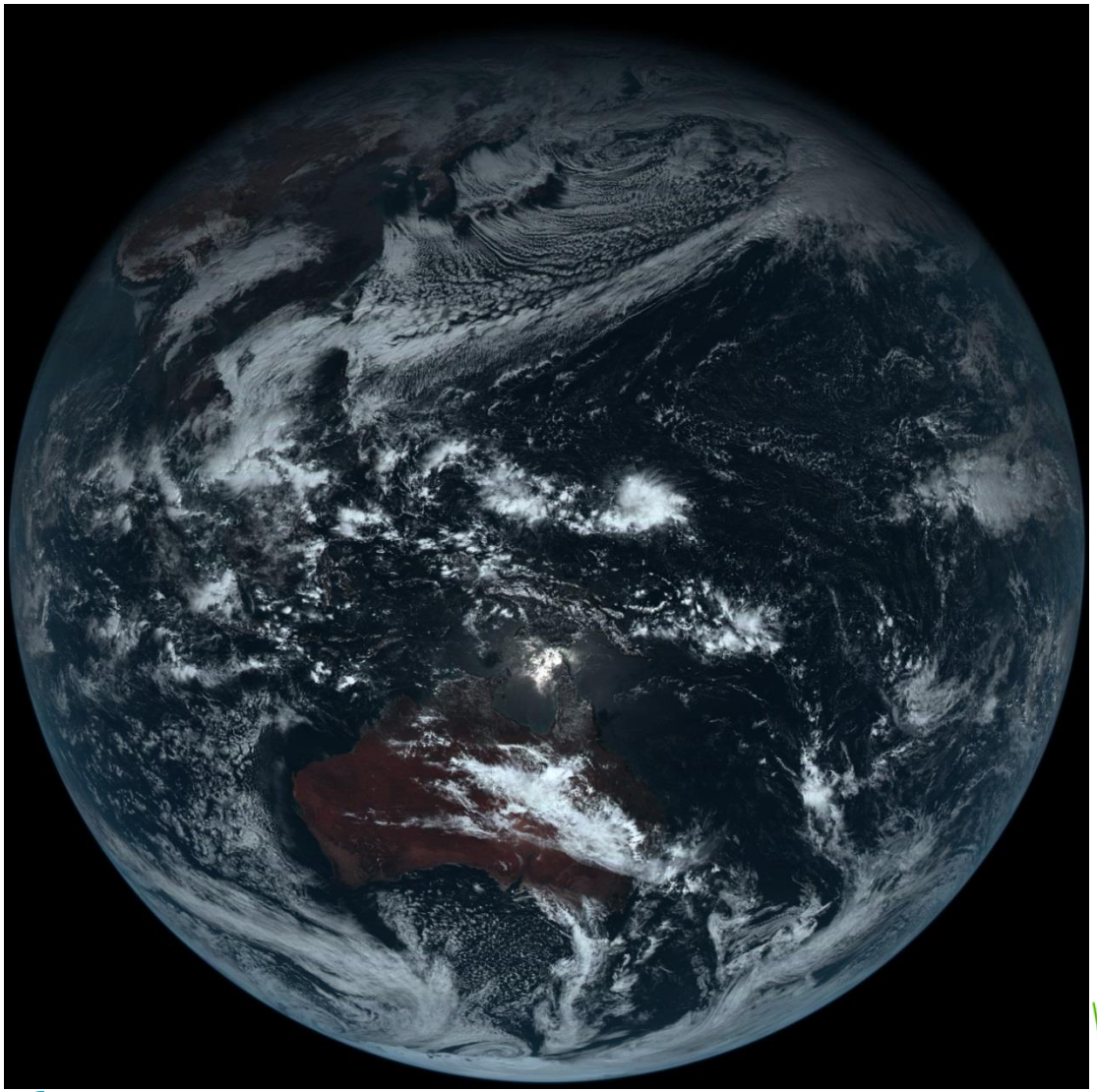
$SO_2$

$O_3$

Atmospheric Windows

$CO_2$

# First Shot of Himawari-8



**02:40 UTC on 18 December 2014**

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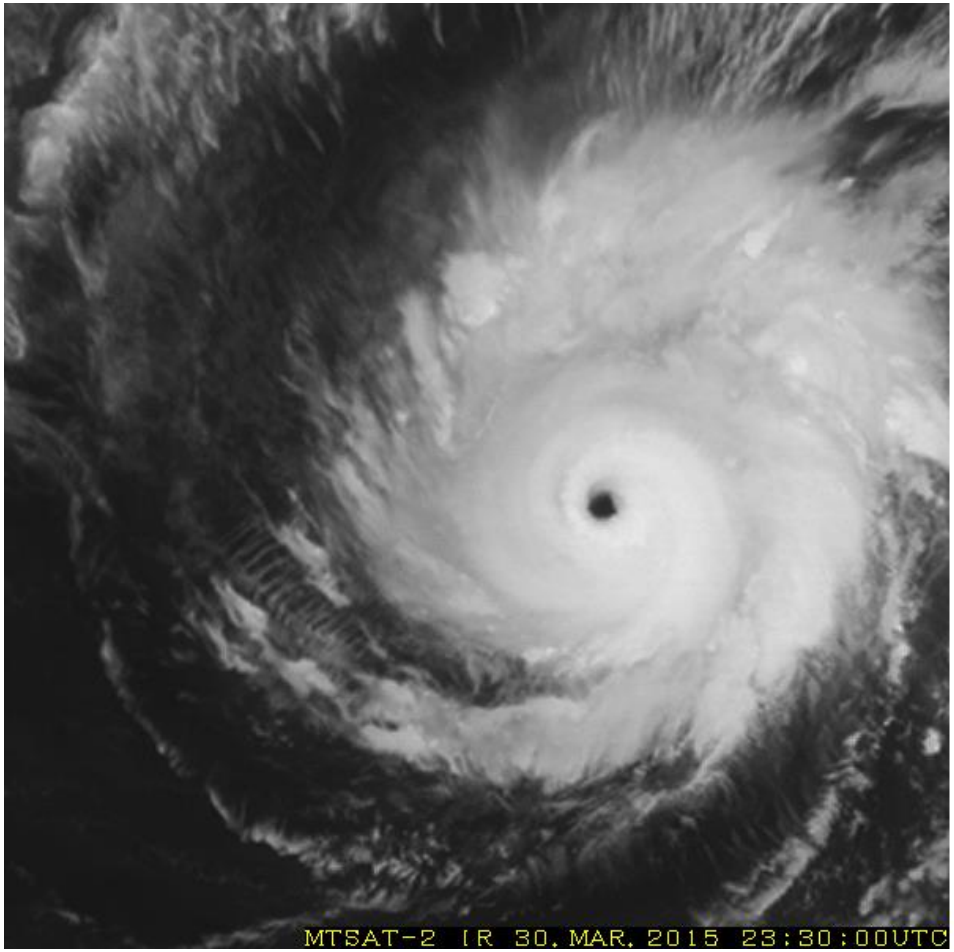
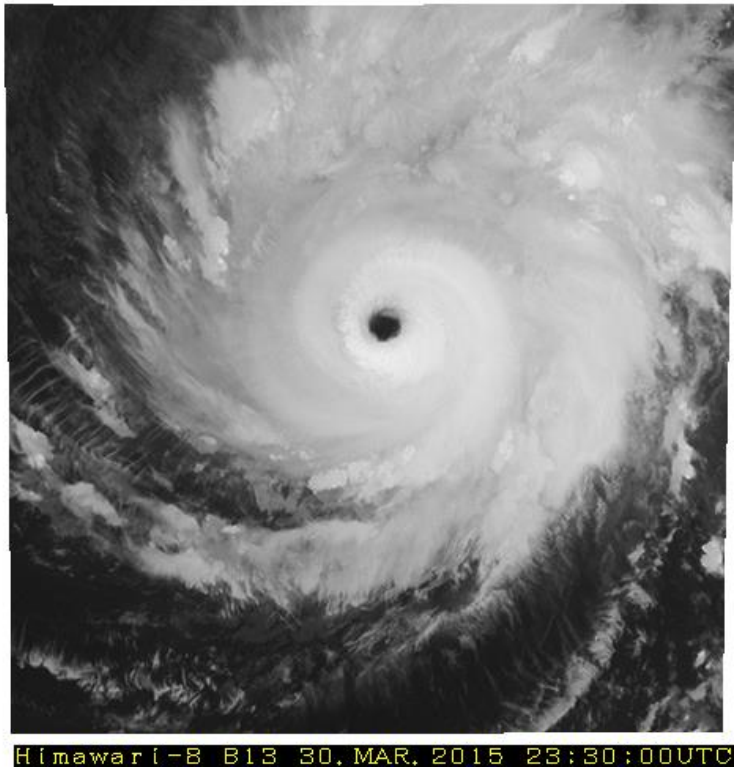
## L1 products (Improvement of temporal resolution)




23:30UTC 30 to 09:00UTC 31 March 2015
MTSAT-2 (IR1)
Every 30 minutes




23:30UTC 30 to 09:00UTC 31 March 2015
Himawari-8 (Band #13)
Every 2.5 minutes

# Himawari-8 Image Navigation & Calibration Status

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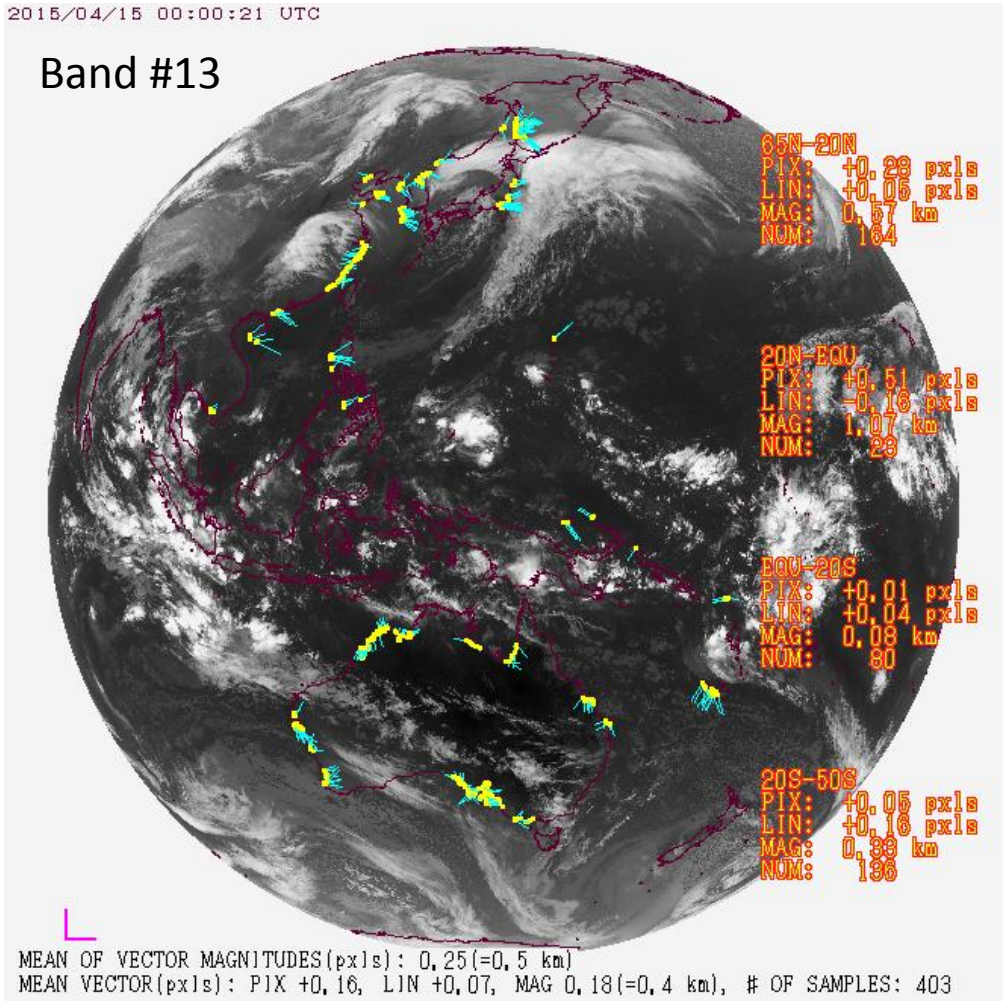
## Navigation

- Method
  - Satellite attitude is determined from information by star tracker, gyro and so force.
  - The attitude is corrected based on landmark analysis.
  - Coregistration process is applied for each band.

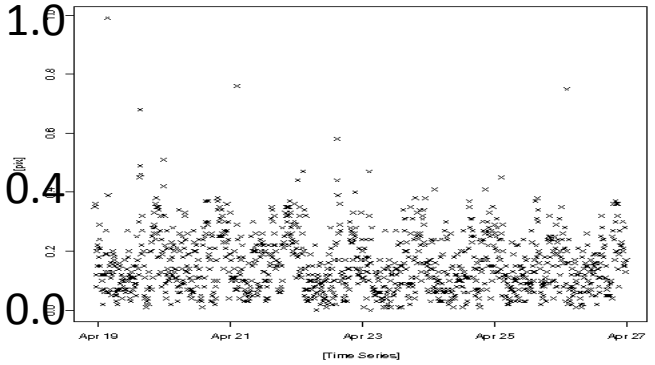
- Status
  - Navigation error is less than 0.5 pixels in 2.0 km-bands
  - Co-registration error is within 0.3 pixels

## Image navigation accuracy

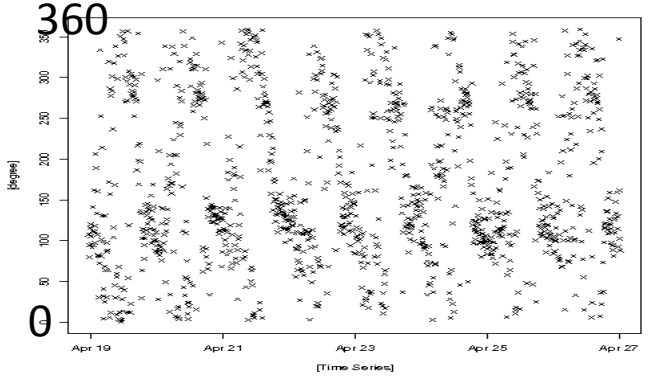
- less than 0.5 pixels in 2.0km-bands.




Nav. Error average (magnitude) [pix]

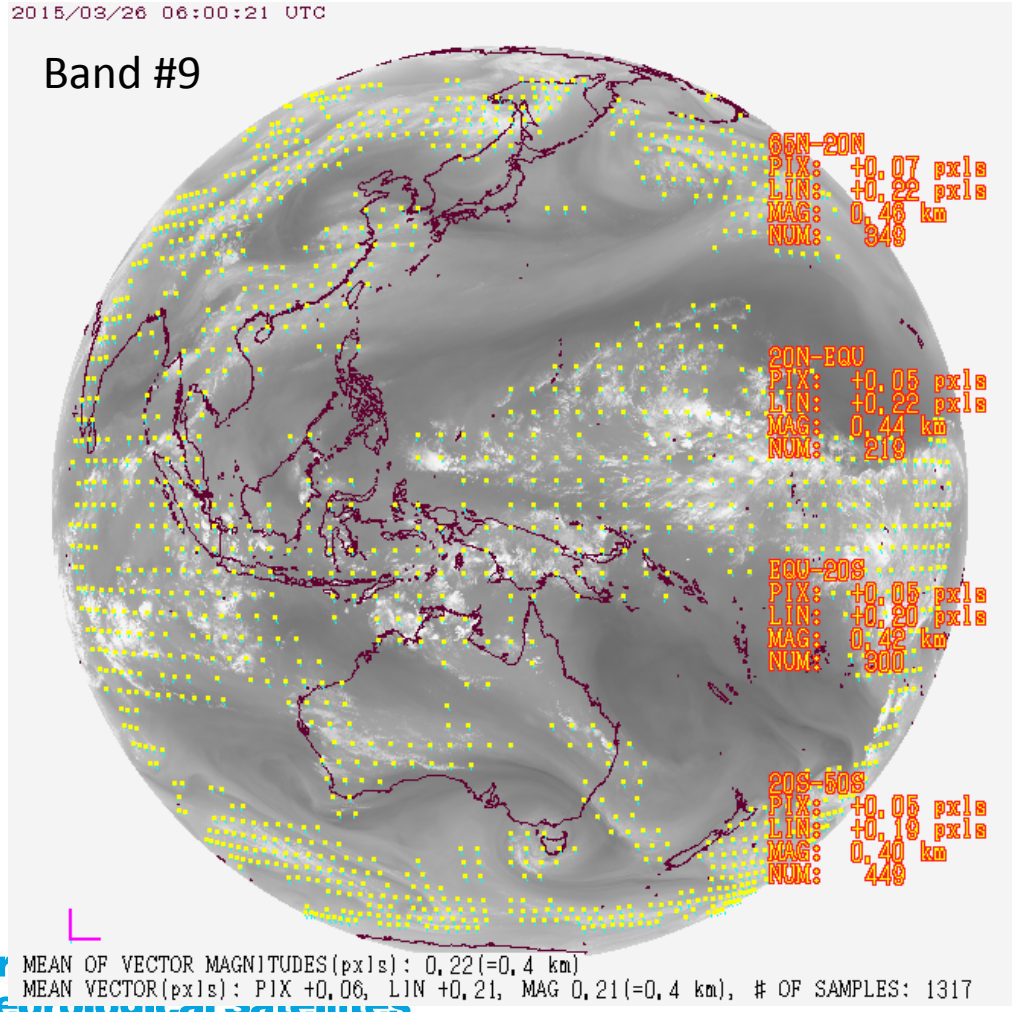


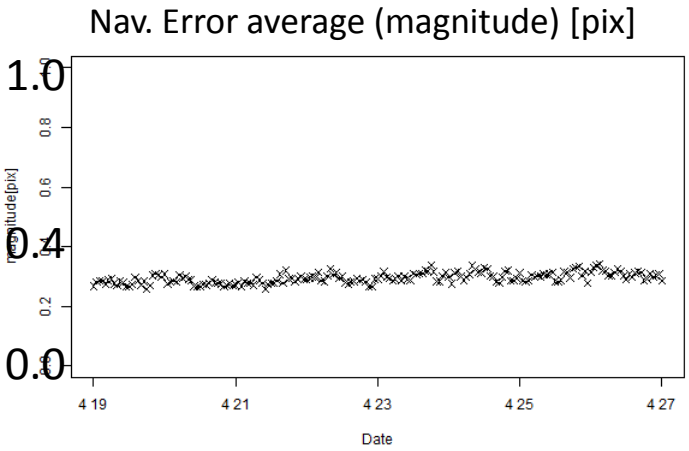

Nav. Error average (direction) [deg]

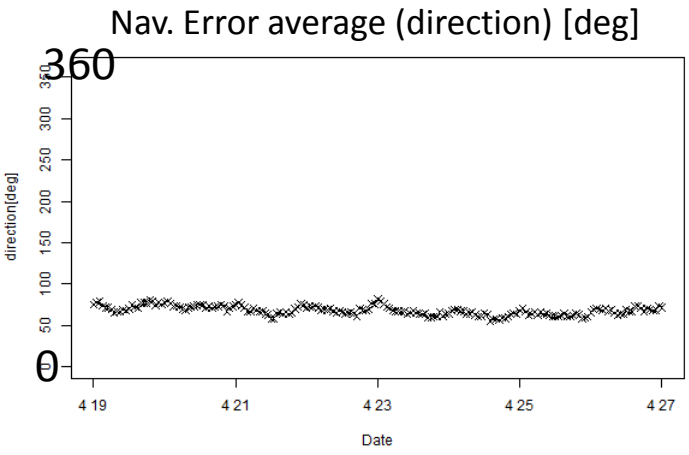


## Co-registration error (comparing with B13)

- less than ~0.3 pixels in 2.0km-bands.



# Calibration

- Onboard calibration
  - Visible and near infrared bands
    - Deep space observation is performed every swath. The result is applied to determine calibration coefficient (offset).
    - (At present) calibration slope and quadratic term: ground test values.
  - Infrared bands
    - Calibration coefficients are obtained based on blackbody observation performed every 10 minutes and deep space observation performed every swath.
- Status
  - Visible and near infrared bands
    - Bands #3 and #6 have 5 to 10 % discrepancy between observed and expected radiance.
    - Update of calibration coefficients is planned.
  - Infrared bands
    - Brightness temperature bias is within 0.2 K at standard radiance in all bands.
  - Summary of the ground test and IOT are shown in appendix of the JMA-WP-09.

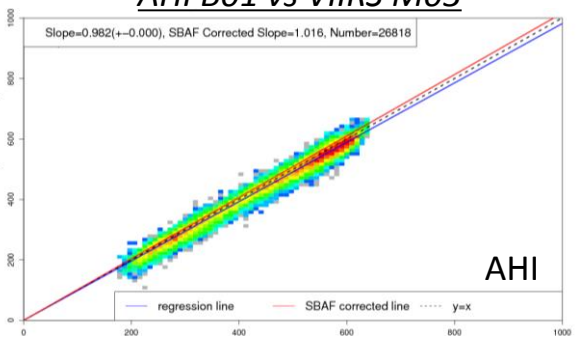
## Validation of VIS/NIR calibration (Ray-matching approach)

- Reference is Suomi-NPP/VIIRS measurements.
- The slope represents discrepancy between observed and expected radiance.
- Bands #3 and #6 show 5 to 10 % discrepancy.
- The result is roughly consistent with the results by RTM based approach.

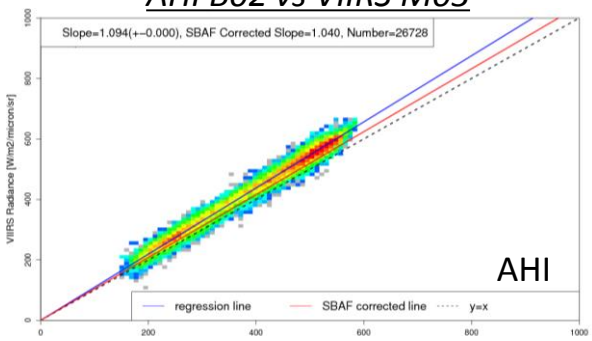
*2 Apr. 2015*

VIIRS radiance

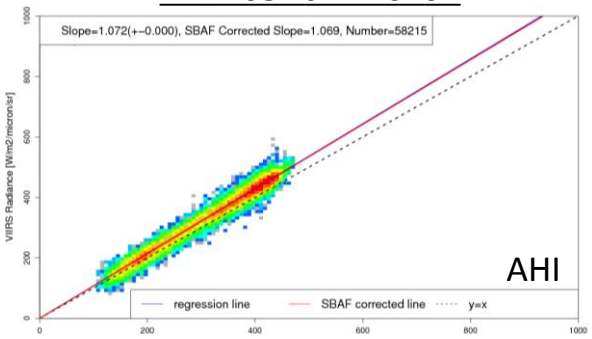
*AHI B01 vs VIIRS M03*




*AHI B02 vs VIIRS M03*

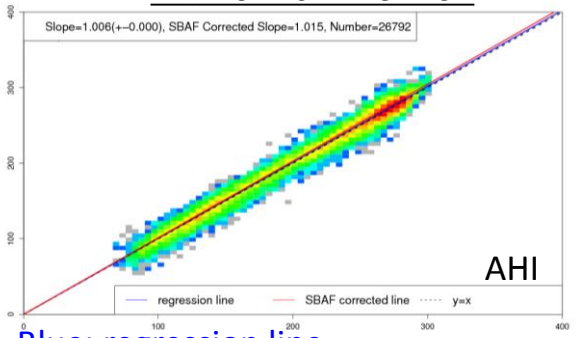



*AHI B03 vs VIIRS I01*

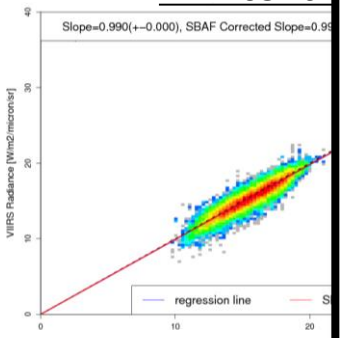


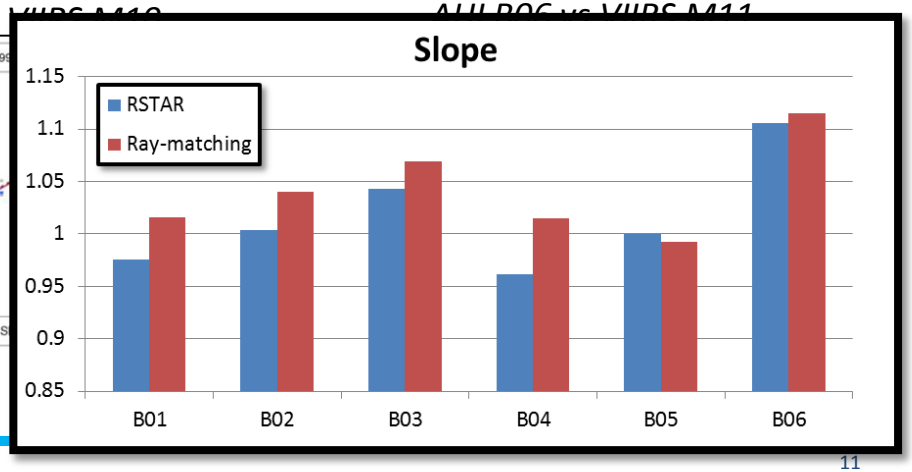

VIIRS radiance

*AHI B04 vs VIIRS M07*




*AHI B05 vs*



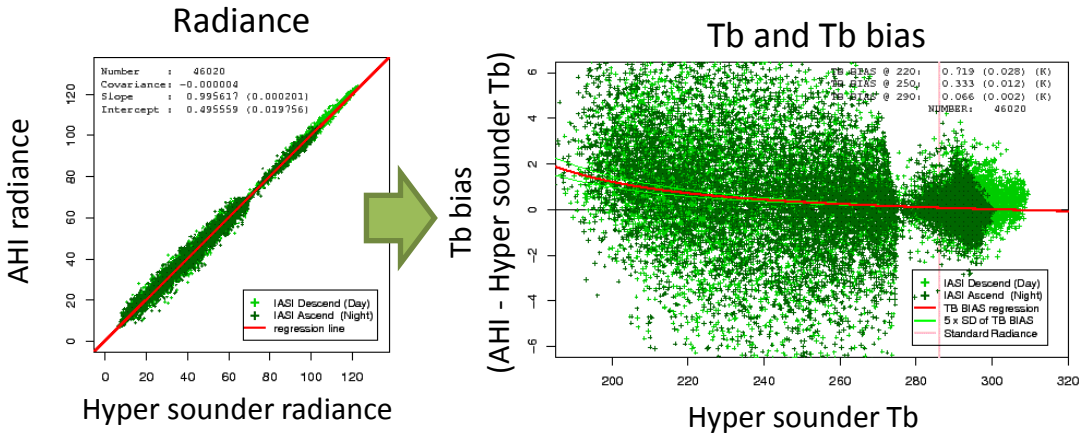



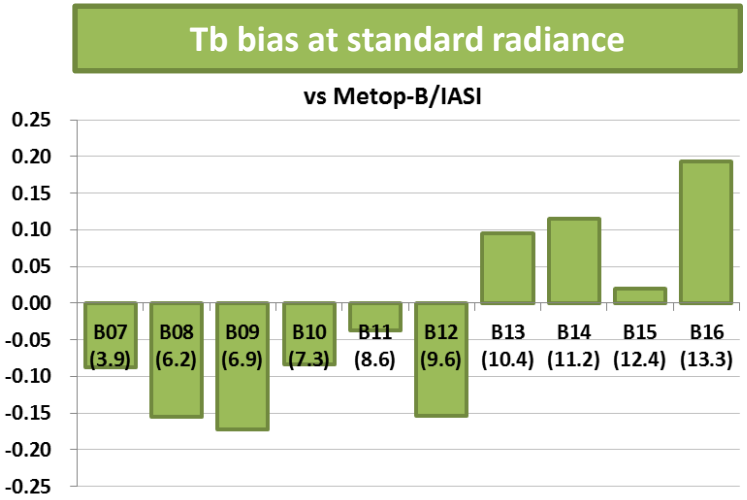

Blue: regression line

Red: regression line corrected with SRF difference

## Validation of IR calibration (Hyper sounder based approach)

- Observation bias is computed from comparison with “pseudo” radiance based on hyper sounder data and SRF of AHI.
- Brightness temperature bias is within 0.2 K at standard radiance in all bands.
- Another validation approach based on a direct comparison with MTSAT-2 represents consistent result.




* Standard radiance was computed by RTTOV11.2 in a 1976 US Standard Atmosphere at nadir, at night, in clear sky, over the sea.

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# Enhancement in Himawari-8 Level-2 Day-1 Products

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# Level-2 DAY-1 Products from Himawari-8/9 AHI

## Increased Observation Spectral Bands

**VIS**: 1 --> 3

**NIR/IR** : 4 --> 13

## with Higher Resolution

**Spatial:**

1km --> 0.5km for a VIS band

4km --> 2 km for IR bands

**Temporal:**

1 hr --> 10 min for "full disk"

2.5min for limited areas

## ..... will Enhance Baseline DAY-1 Products, especially

- Cloud Products (incl. Rapidly Developed Convective Clouds)
- Atmospheric Motion Vectors (AMVs)/Clear Sky Radiances (CSRs)
- Aerosol (incl. Asian Dust) / Volcanic Ash

Numerical Weather Prediction

Severe Weather Monitoring

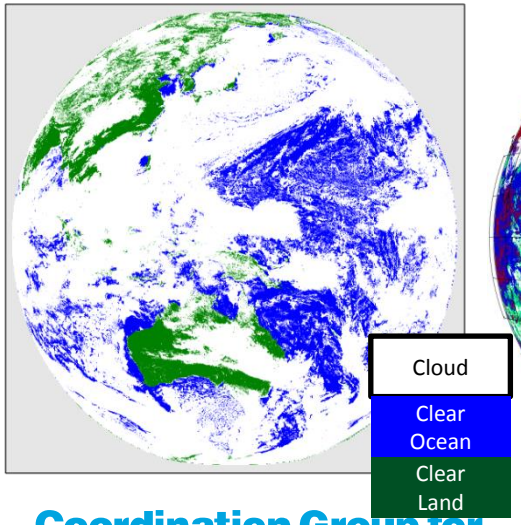
Environmental Monitoring

# Cloud Products from Himawari-8/9 AHI

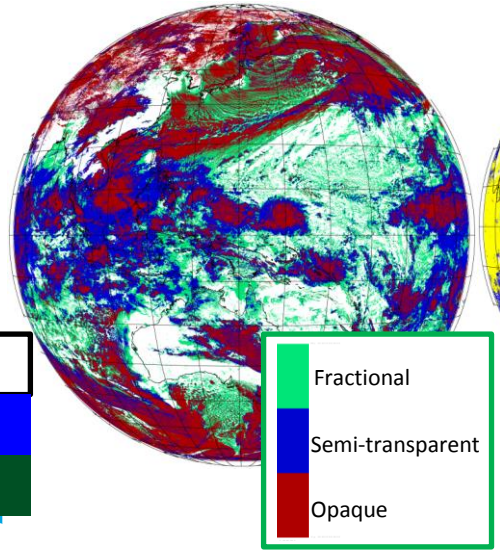
- **Extracted Parameters: Cloud Mask, Type, Phase, and Top Height**
- **Algorithm is based on NWC-SAF*1 and NOAA/NESDIS*2**

(*1) Meteo-France 2012: Algorithm Theoretical Basis Document for "Cloud Products" (CMa-PGE01v3.2, CT-PGE02 v2.2 & CTTH-PGE03 v2.2)
http://www.nwcsaf.org/HD/MainNS.jsp
(*2) Andrew Heidinger, 2011: ABI Cloud Mask, NOAA NESDIS CENTER for SATELLITE APPLICATIONS and RESEARCH ATBD
http://www.goes-r.gov/products/baseline.html

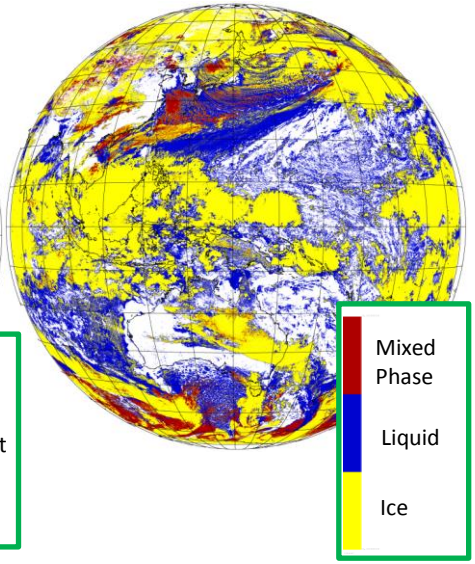
Cloud Mask



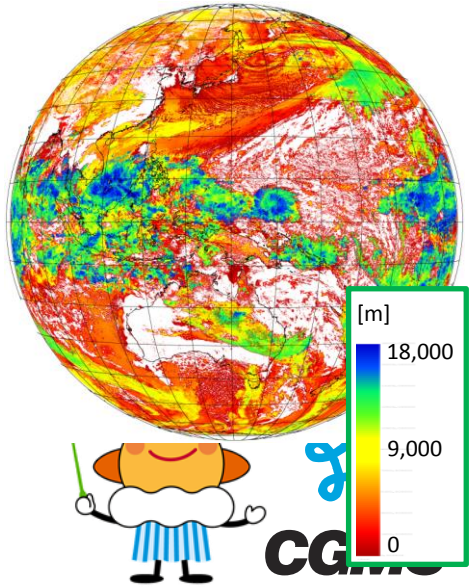

Type




Phase




Cloud Top Height

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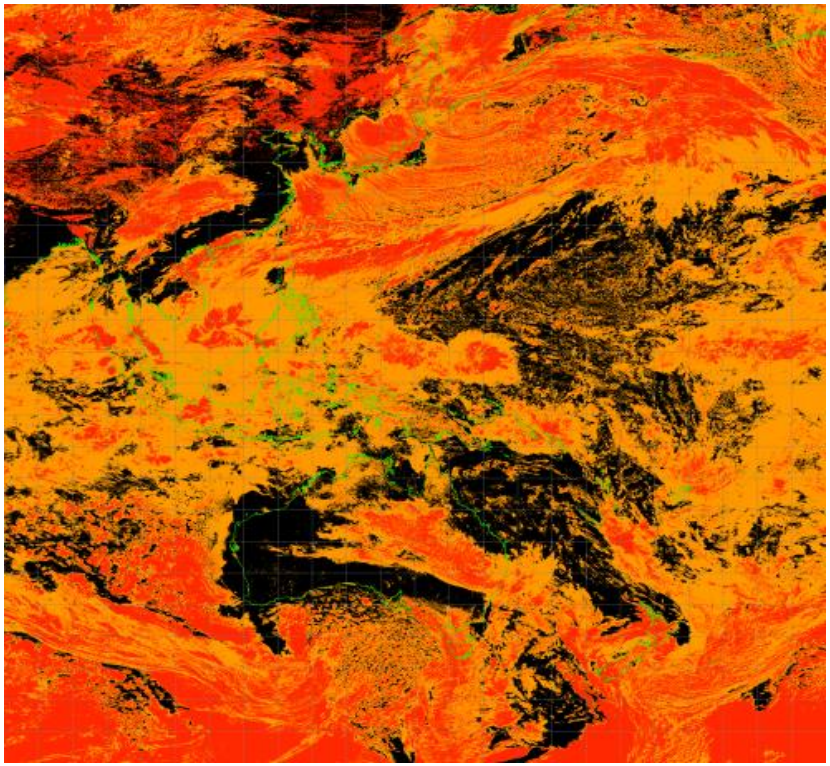
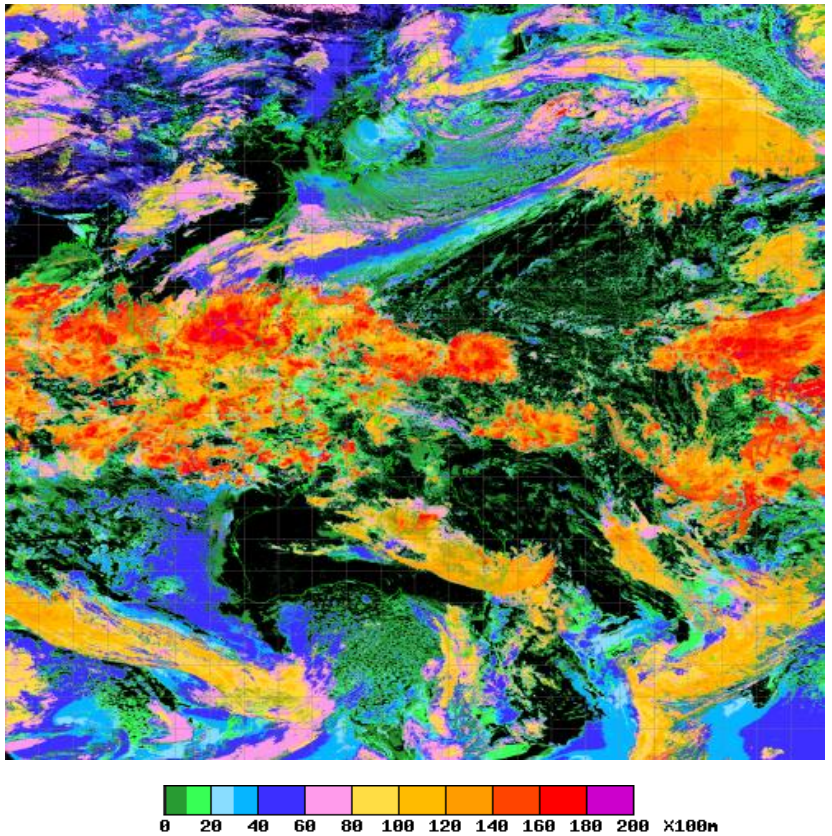
## Objective Cloud Analysis Information (OCAI)

- Basic cloud product with latitude-longitude grid in 0.05 degree.
  - cloud mask, cloud type and cloud top height
- To be produced hourly when Himawari-8 becomes operational.
- Ready to provide to NMHSs, e.g. Indonesia and Myanmar, in response to requests.

Cloud Mask



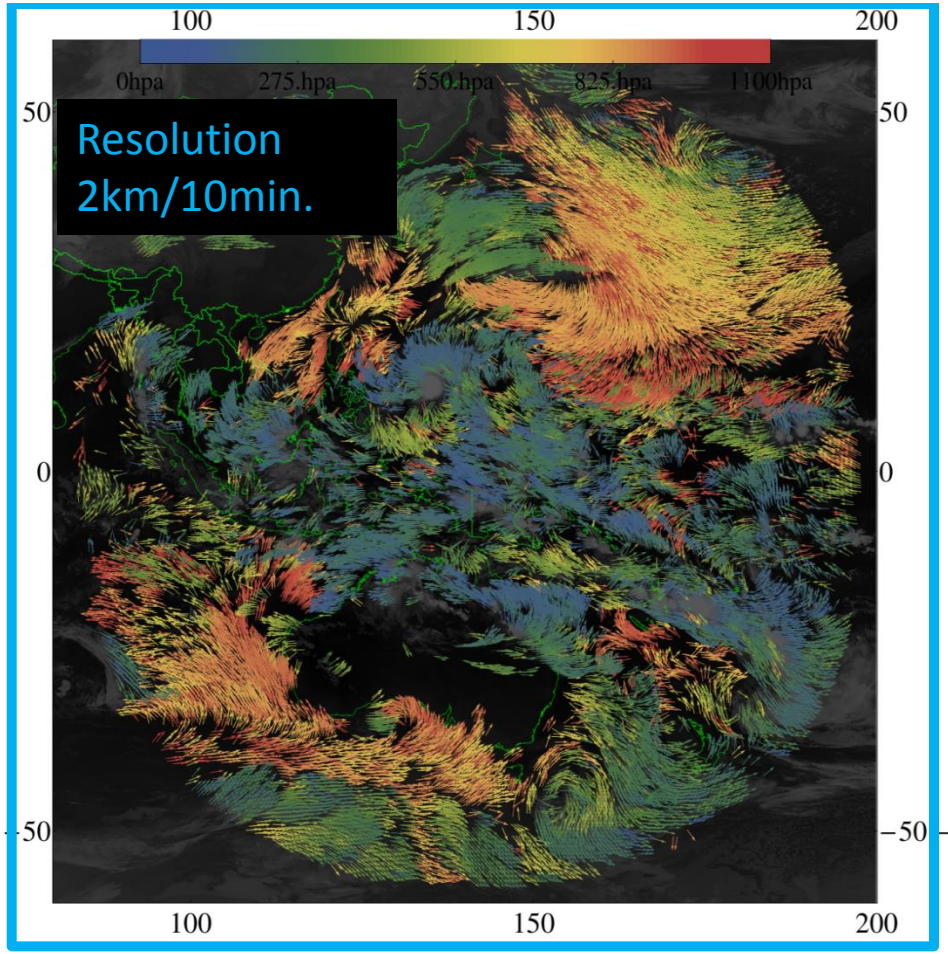

Cloud Top Height

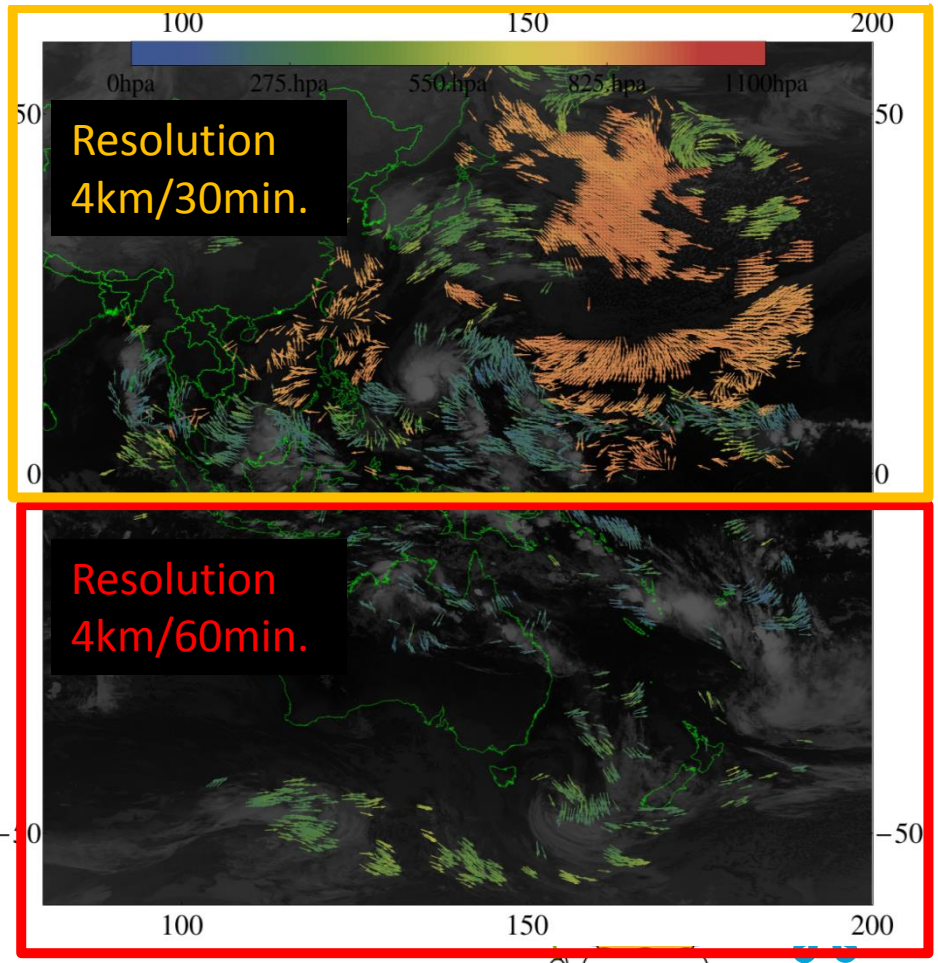


# Improvement in Atmospheric Motion Vectors (AMVs) Retrieval

**Himawari-8 AMVs** derived from Himawari-8 imagery with new algorithm

**MTSAT-2 AMVs** derived from MTSAT-2 imagery and heritage algorithm




Himawari-8 and MTSAT-2 IR AMV (QI>60, 2015 01 14 1700UTC)

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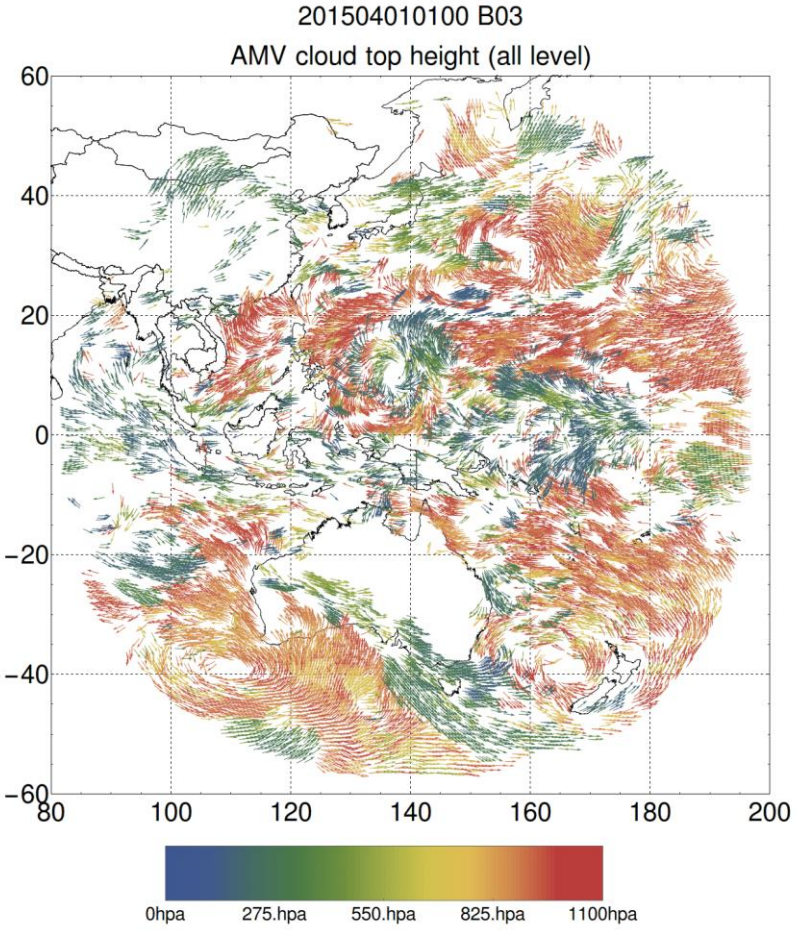
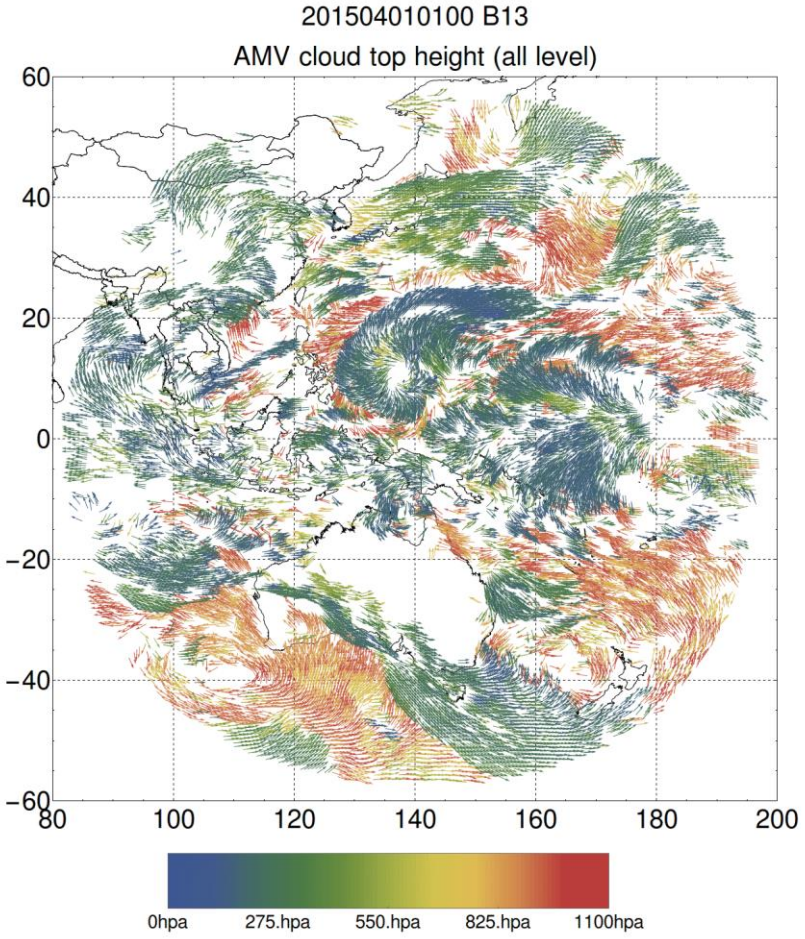
## Atmospheric Motion Vectors (AMVs)

- JMA/MSC has developed a new algorithm for Himawari-8 AMVs based on an optimal estimation method for full exploitation of satellite data (Shimoji 2014).
- Validation results will be informed to NWP users (IWW mailing list)

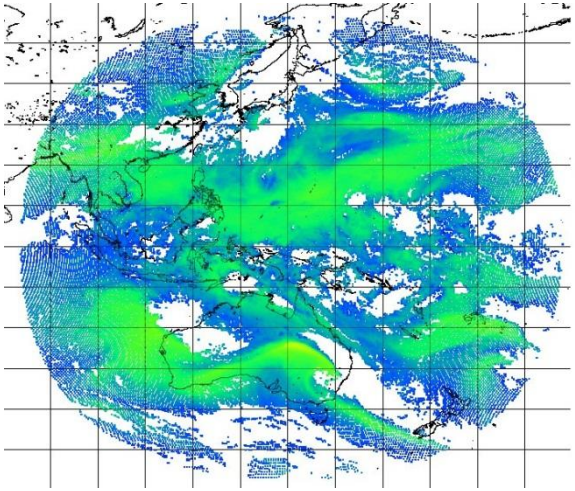


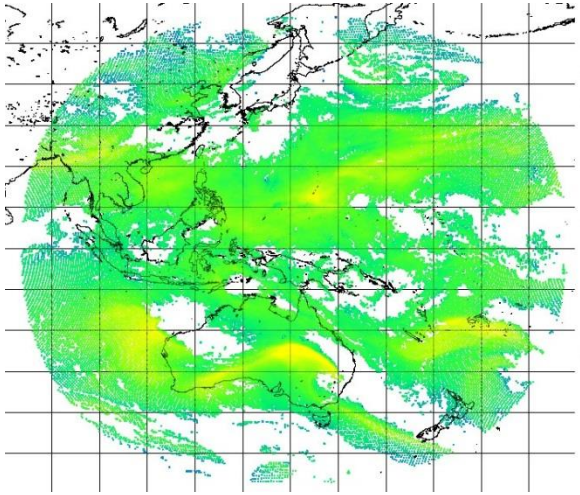
## Clear Sky Radiances (CSRs)

- Area averaged clear sky radiance and brightness temperature.
- Specifications:
  - Spatial resolution (size of area for averaging): 16 x 16 pixel (IR)  (32 x 32 km @SSP)
  - Full disk, Hourly produced
  - All IR bands (3.9, 6.2, 6.9, 7.3, 8.6, 9.6, 10.4, 11.2, 12.4, 13.3 um)

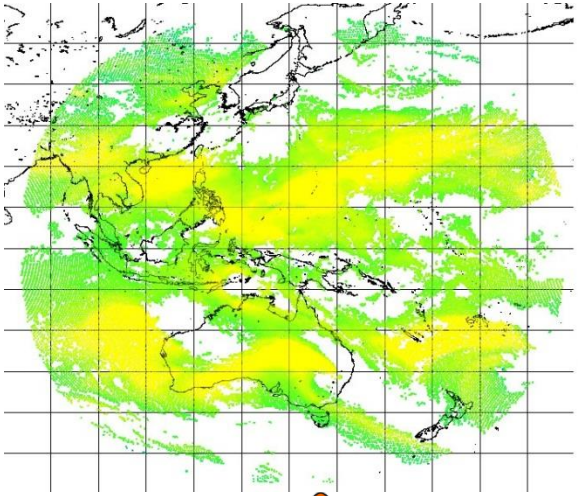
Band #8 (6.2 um)

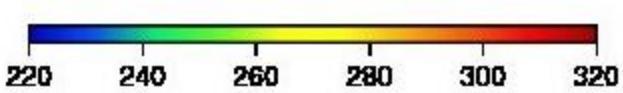


Band #9 (6.9 um)



Band #10 (7.3 um)






03 UTC 20 April 2015

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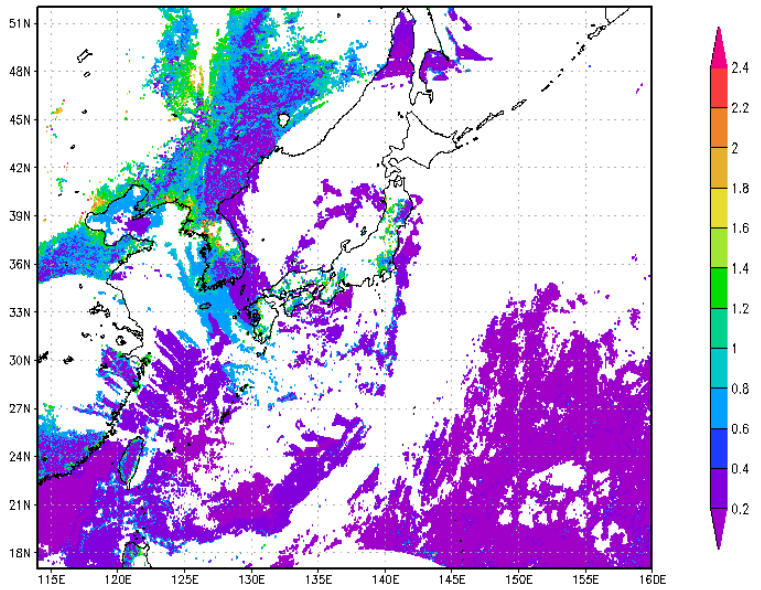
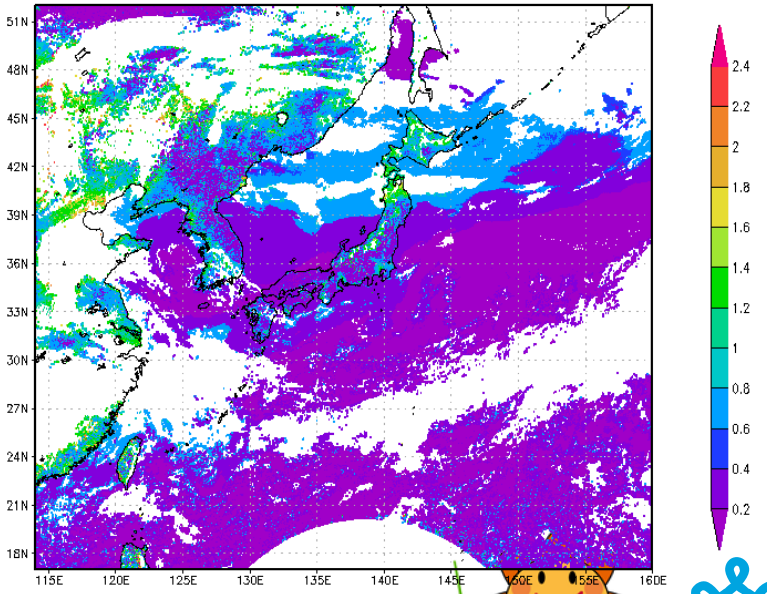
## Aerosol Optical Depth (for Asian dust monitoring)

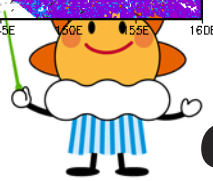
- Aerosol optical depth (AOD) and Ångström exponent (proxy for particle size) to be estimated. Ångström exponent only over the ocean.
- The aerosol type is assumed to be Asian dust, and the algorithm is not optimized for other types (e.g., haze).
- JMA will use Himawari-8 AOD to monitor Asian dust.
- Ready to provide to NMHSs in response to requests.

AOD at 03 UTC on 15 Apr 2015




AOD at 03 UTC on 27 Apr 2015



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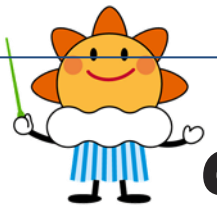
## Summary

- Navigation
  - Image navigation accuracy: less than 0.5 pixels
  - Co-registration error: less than 0.3 pixels
- Calibration
  - Some of visible and near-infrared bands exhibit discrepancies of several percent between measured and expected radiance. The calibration coefficients are still tuning.
  - There is no significant bias and diurnal variation in IR bands.

- The AHI's observation function is improved over that of the imager on board MTSAT-2 in terms of spatial resolution, observation frequency, the number of bands and other specifications.
- Himawari-8 AMV and CSR products will be distributed via GTS when Himawari-8 becomes operational.
- The AHI's capability for such multi-band observation is beneficial for environmental monitoring and operational weather services.



# Thank you !!

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