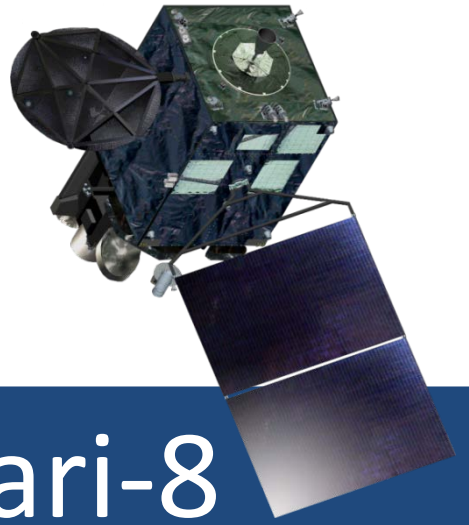


Introduction to Himawari-8

Training on meteorological satellite data usage

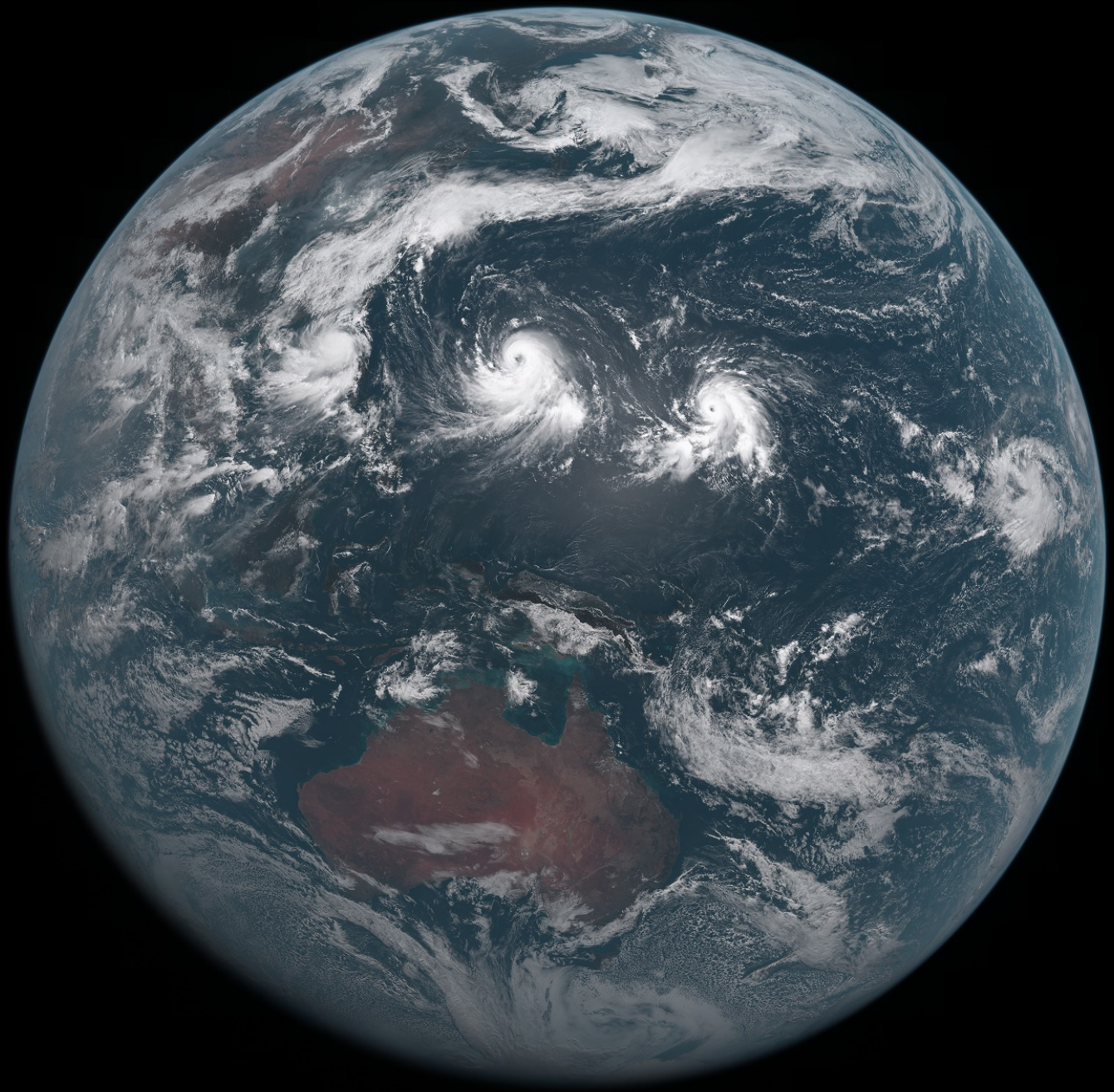
Kotaro BESSHO
Meteorological Satellite Center (MSC)
Japan Meteorological Agency (JMA)

The Sixth Asia/Oceania Meteorological Satellite Users' Conference
Tokyo, Japan
9 – 13 November 2015

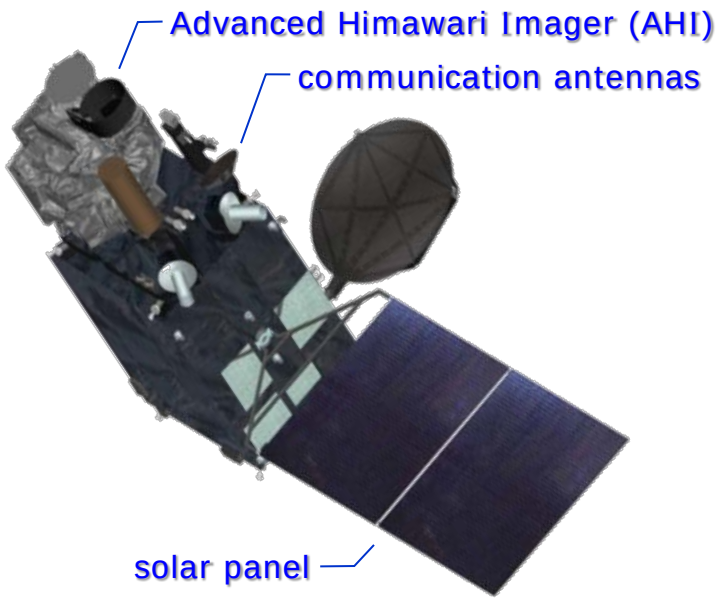
Successful Launch of Himawari-8

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

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

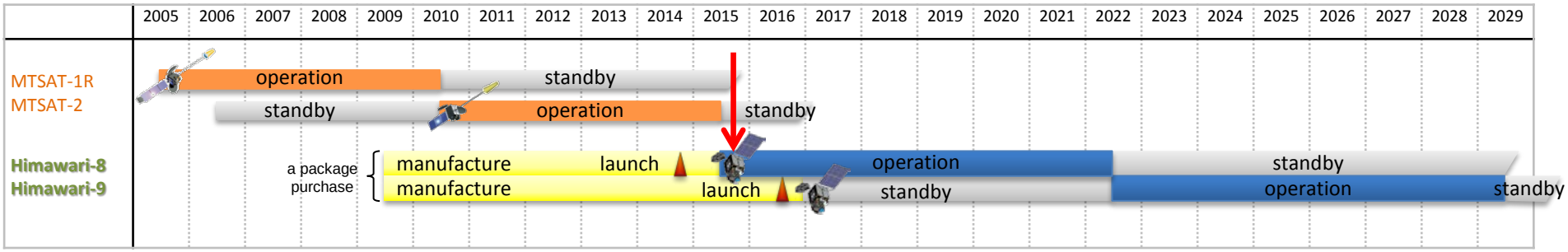


Outline of Himawari-8



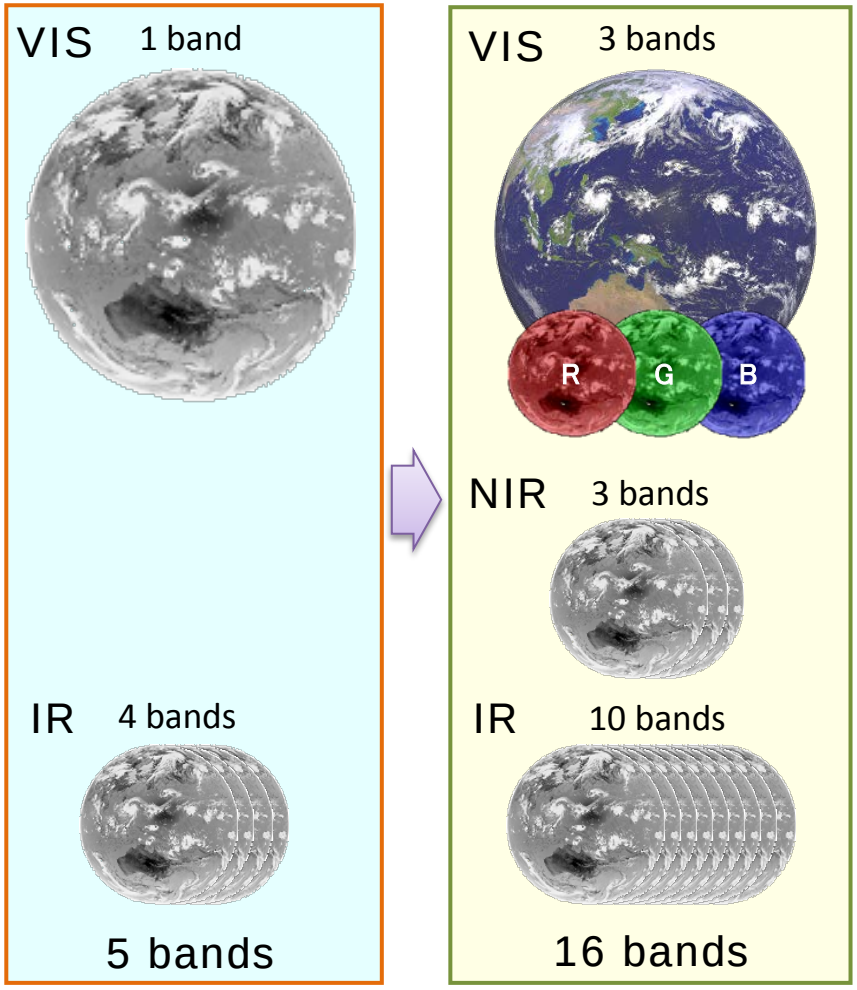
Geostationary position	Around 140.7° E
Attitude control	3-axis attitude-controlled geostationary satellite
Communication	1) Raw observation data transmission Ka-band, 18.1 - 18.4 GHz (downlink)
	2) DCS International channel 402.0 - 402.1 MHz (uplink) Domestic channel 402.1 - 402.4 MHz (uplink) Transmission 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

Spectral



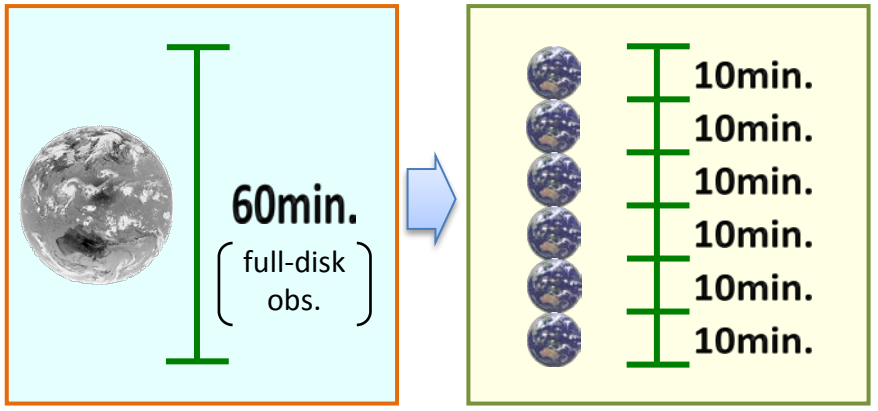
Spatial

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



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

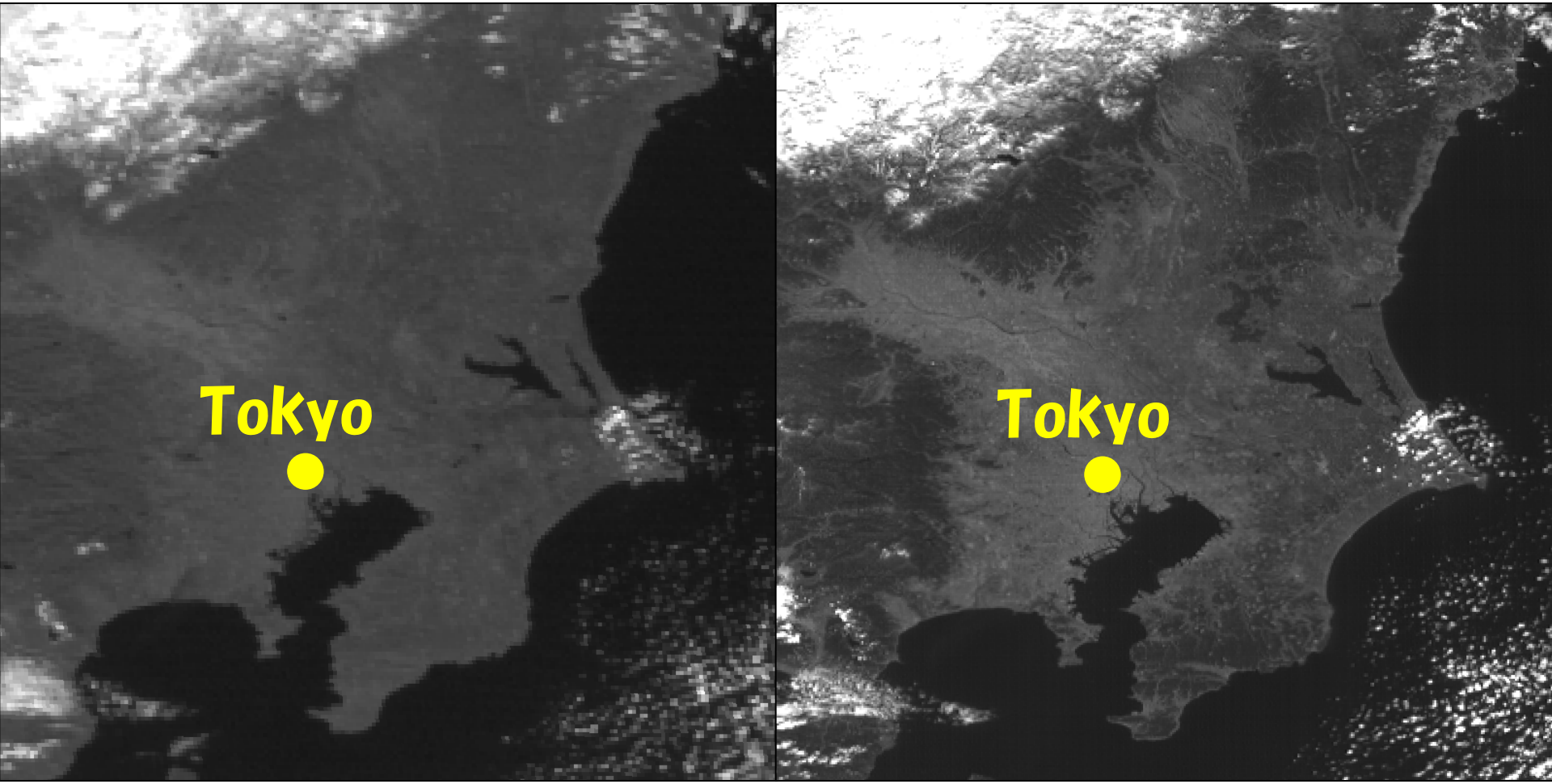
Himawari-8/9 Imager (AHI)

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	Vegetation, 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, SO_2	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	

Spatial Resolution

MTSAT-2 (VIS)
1km

Himawari-8 (B03)
0.5 km



03:00 UTC on 29 January 2015

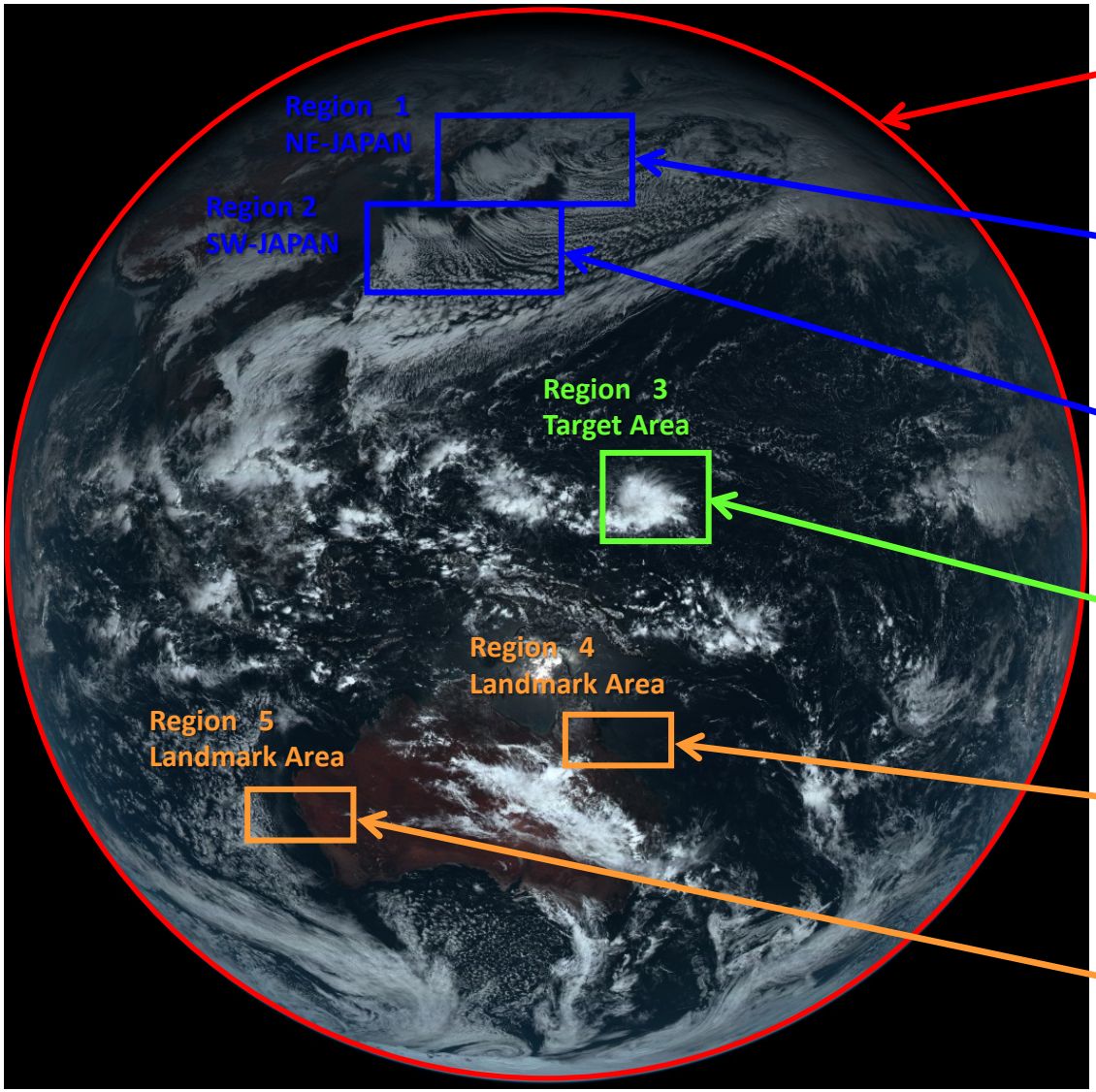
Observation Frequency

MTSAT-2 (VIS)
Hourly in Monochrome

Himawari-8 (Band01-03)
Every 10 minutes in Full-Color

16 UTC on 2nd to 13 UTC on 3rd, April 2015

AHI Observation Modes



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: 1000 x 1000 km

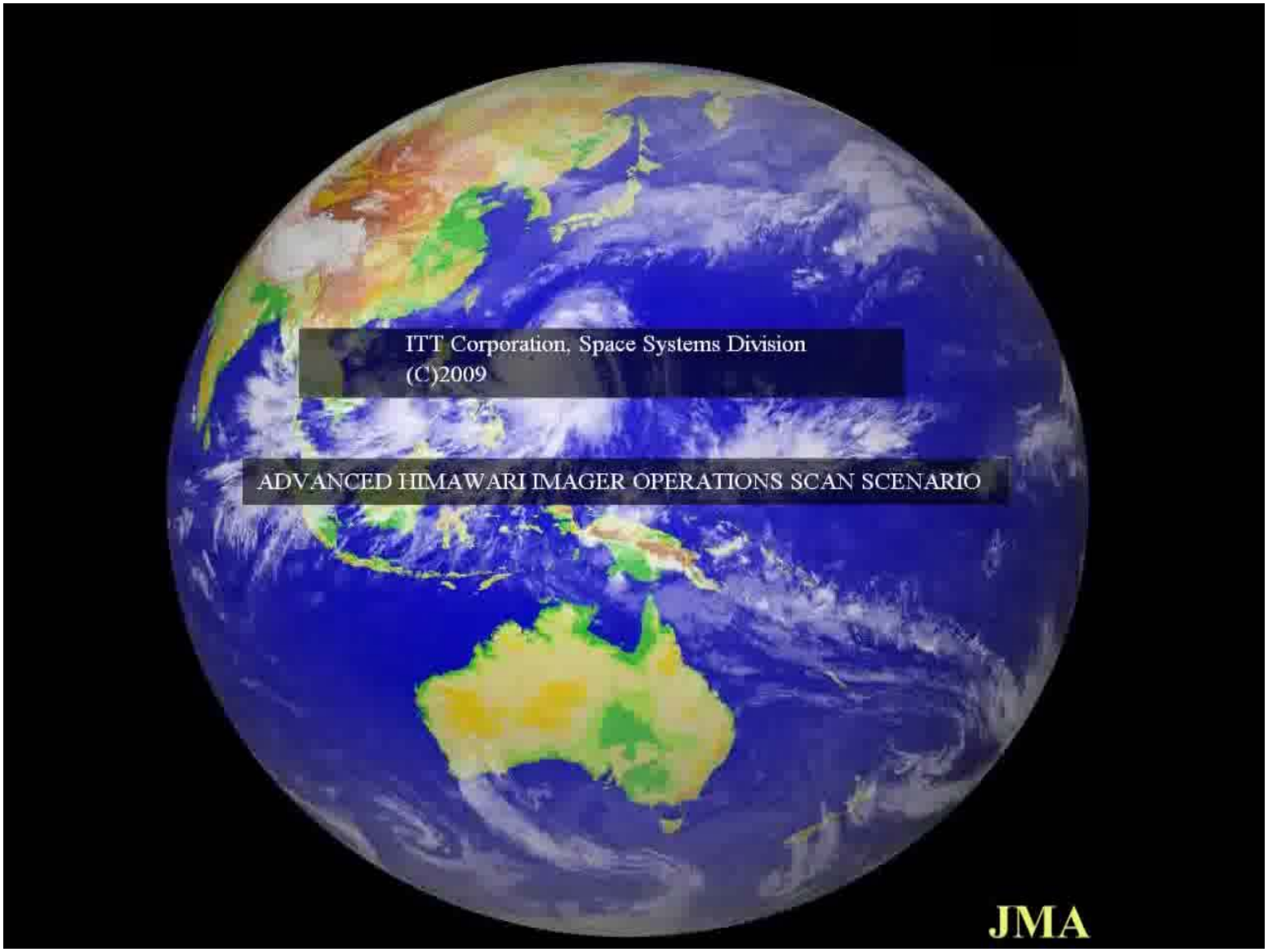
Region 4 Landmark Area

Interval : **0.5 minutes** (20 times in 10 min)
Dimension : EW x NS: 1000 x 500 km

Region 5 Landmark Area

Interval : **0.5 minutes** (20 times in 10 min)
Dimension : EW x NS: 1000 x 500 km

AHI Scan Scenario

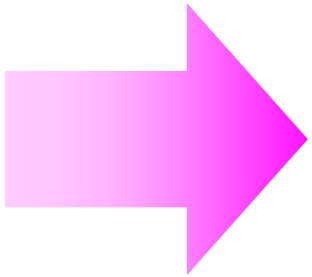


Revolution of Advanced Himawari Imager

Upgrade of	**MTSAT -> Himawari-8/9**
➢Number of bands	**5 -> 16**
➢Spatial resolutions	**VIS: 1 km -> 0.5 or 1.0 km** **IR: 4.0 km -> 2.0 km**
➢Temporal resolutions	**30/60 min -> 10 min**

(Total data size: 50 times!!)

B/W TV



HD TV

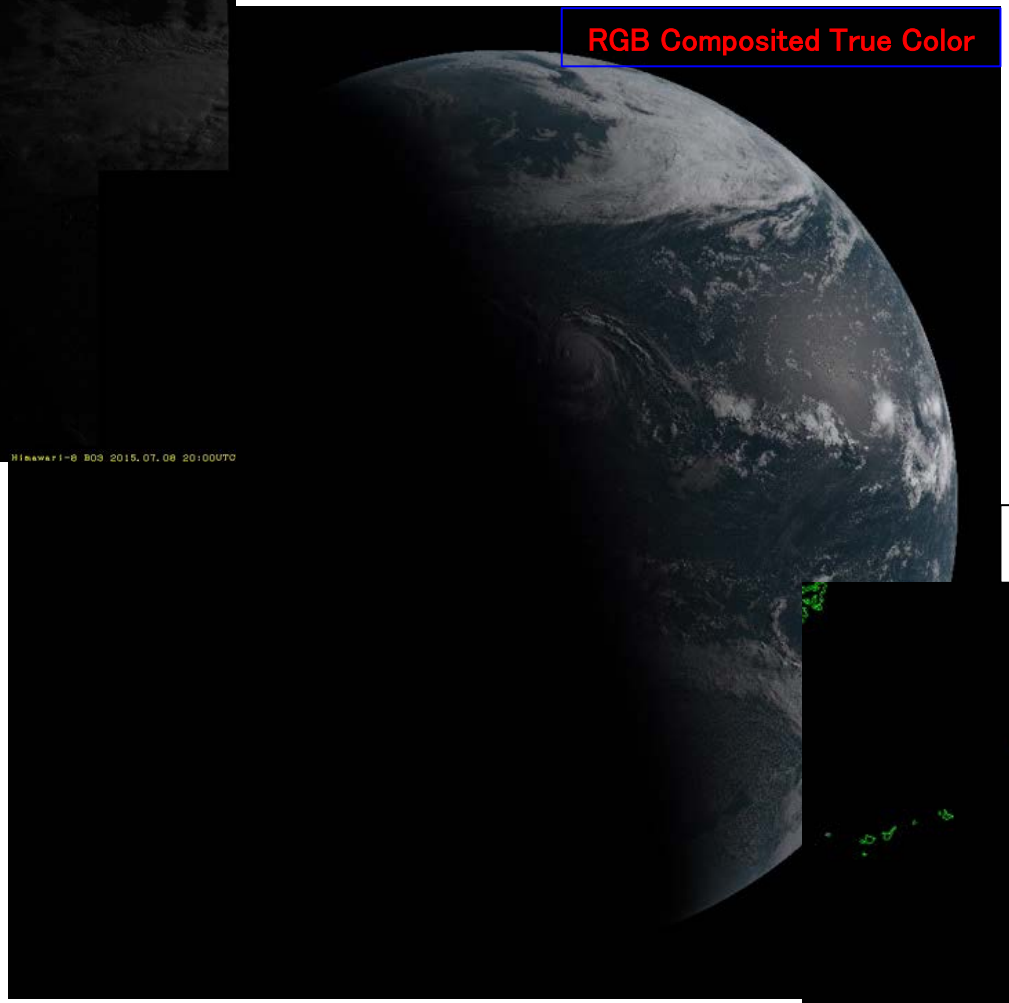
Himawari-8: Observation Area and Interval

in 10 minutes time frame

Visible band

Japan & Vicinity Obs.

RGB Composited True Color



Full Disk Obs.

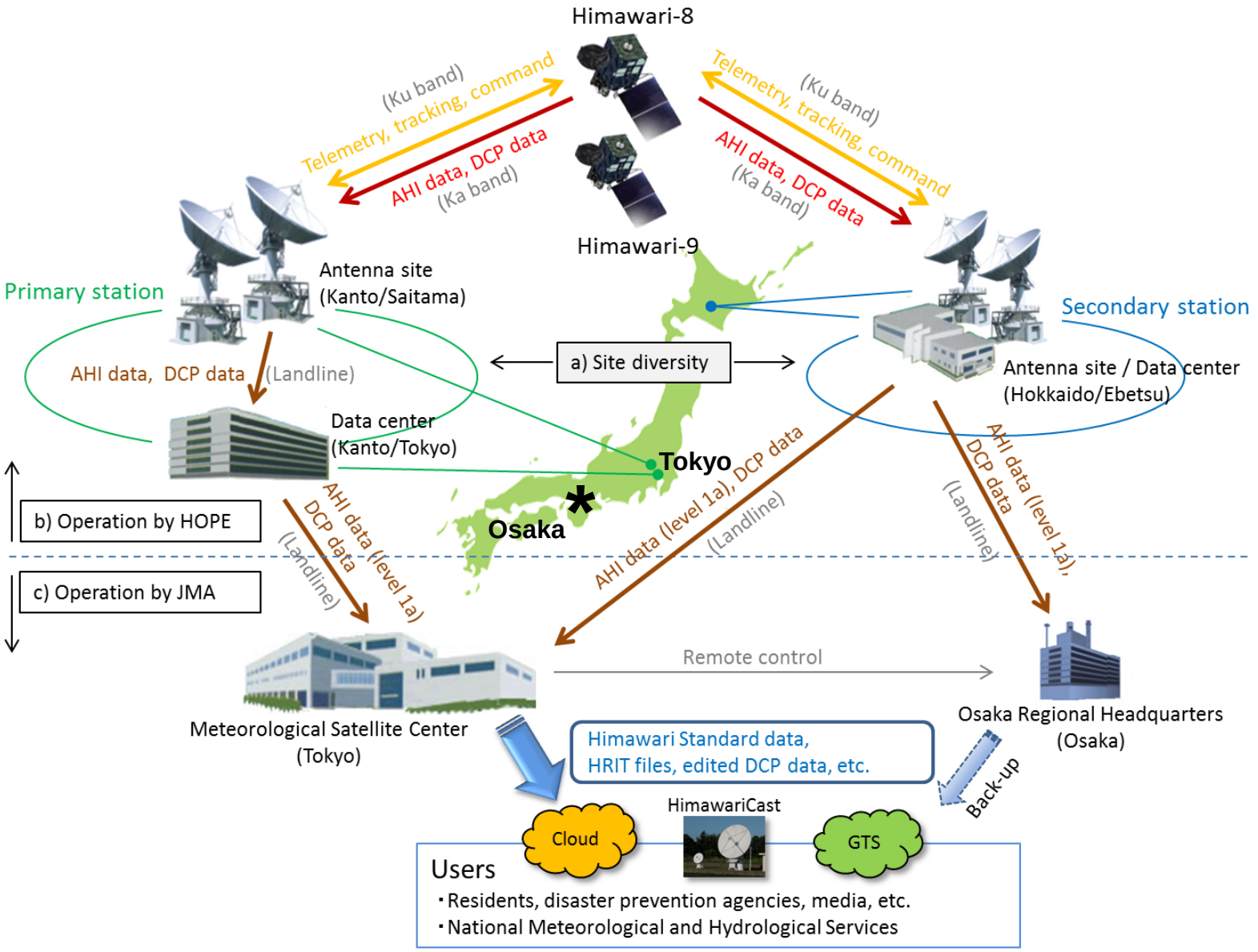
Targeted Area obs.

Visible band

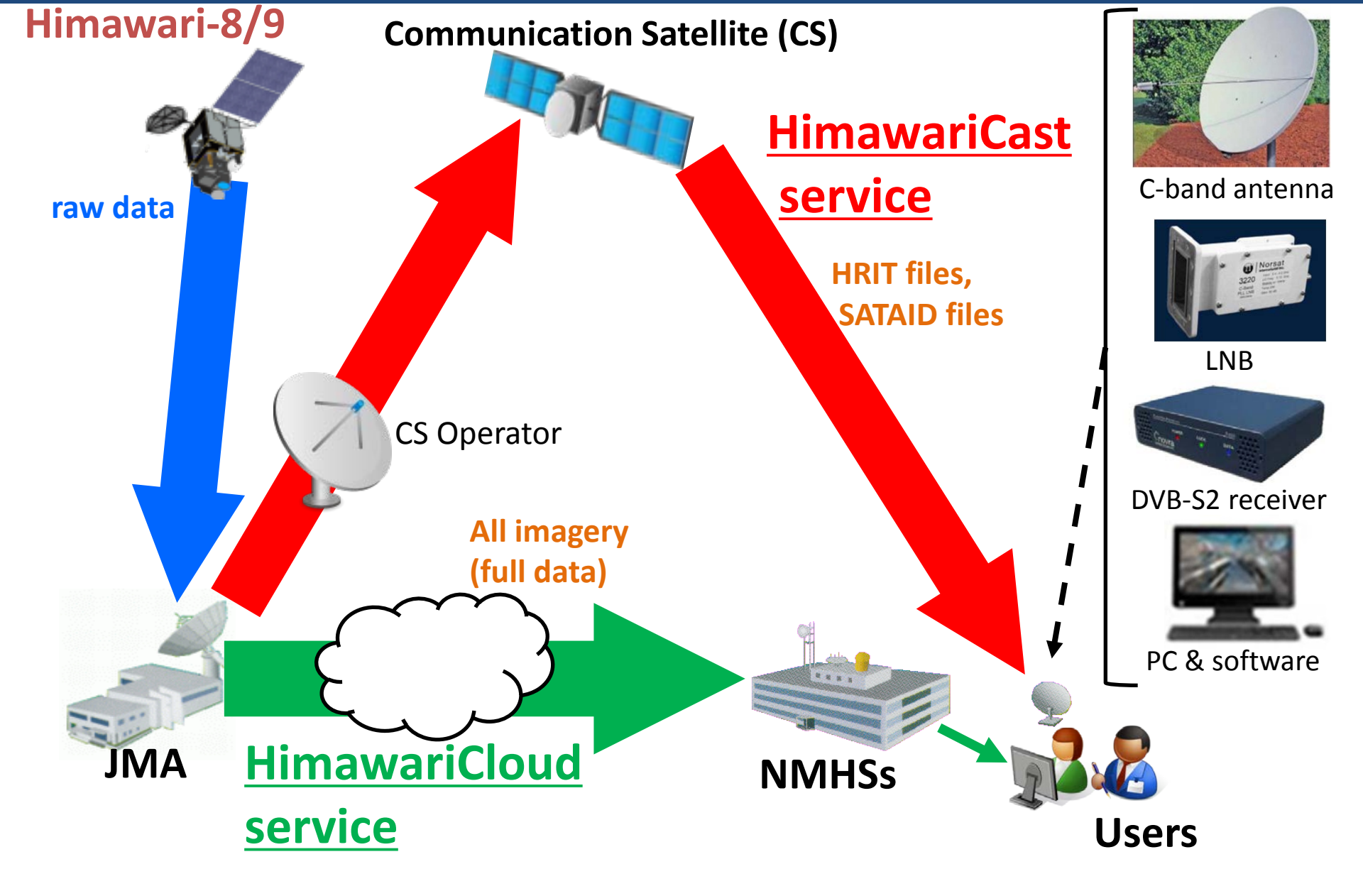
July 9-10, 2015

Himawari-8/9
Ground Segments

Himawari-8/9 Ground Segment and Operations



Two Ways of Data Dissemination/Distribution HimawariCast/HimawariCloud



Data distribution/dissemination methods

Two Ways of Himawari-8/9 Imagery Dissemination/Distribution

HimawariCast via Communication Satellite

- Service for **Everyone**
- **No Pass Code** for Receiving
- **JMA's Baseline** for Imagery Dissemination
- **14 bands** (1 VIS and 13 IR) every **10 minutes** for Full Disk
- Spatial Resolution is same as that of MTSAT **HRIT compatible**

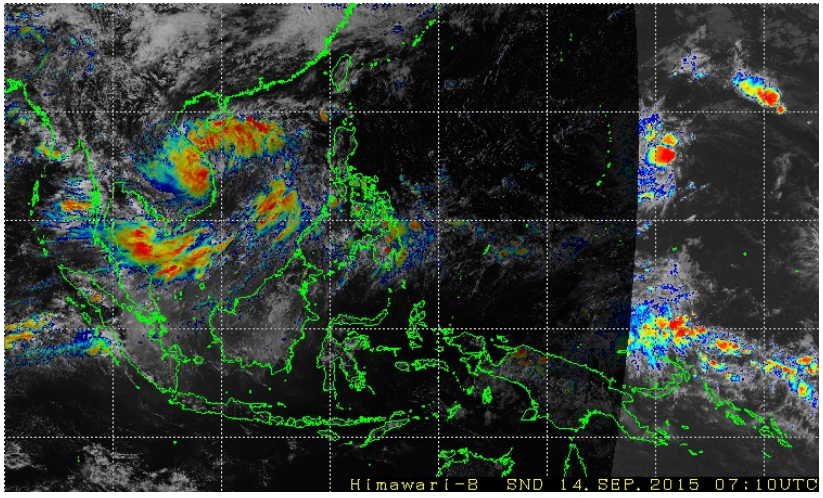
HimawariCloud via Internet Cloud

- Service for **NMHSs** with high-speed Internet access
- All **16 bands** (3 VIS and 13 IR)
- **Full Specification** (temporal and spatial) of Imagery

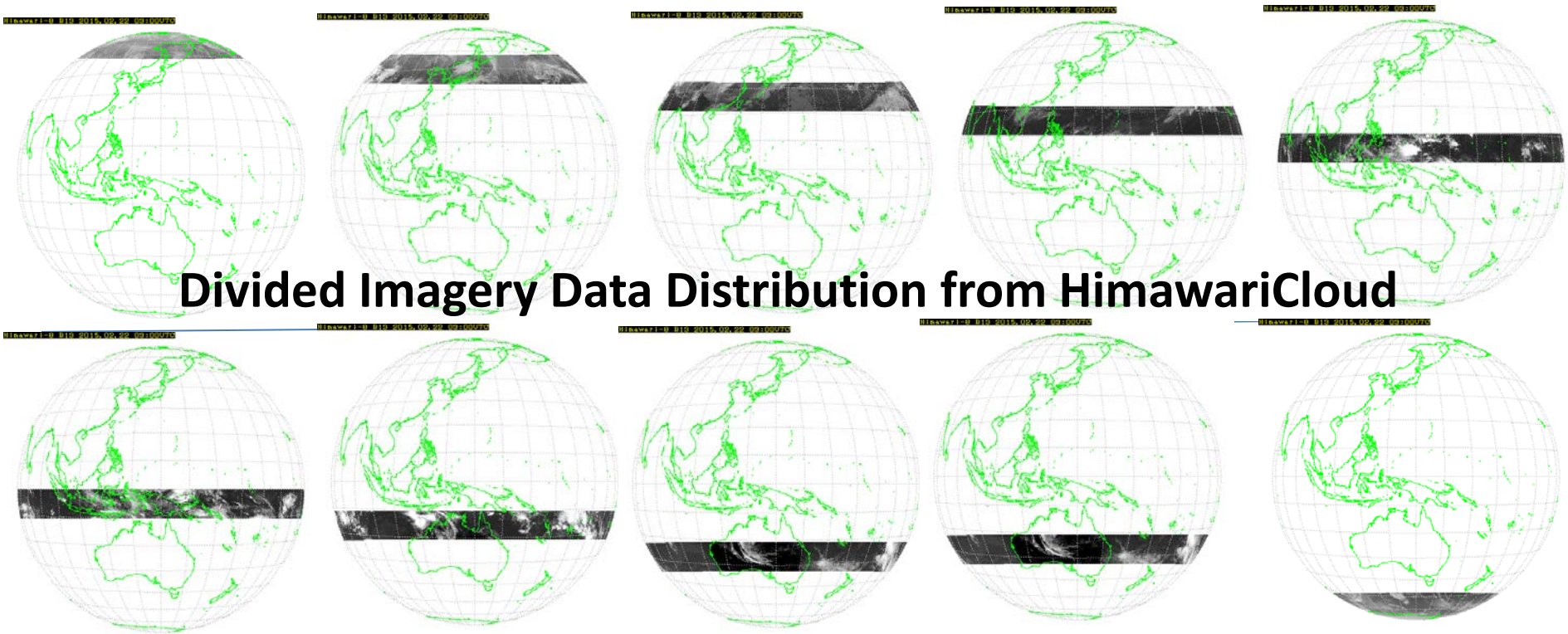
HimawariCast/HimawariCloud: Data spec.

Service	Users	Format	Interval	Band	Resolution	Delivery
HimawariCloud (for advanced usage)	NMHS	HSD (Himawari Standard Data)	10 min	16	VIS: 0.5-1 km IR: 2 km	**High-speed Internet (NTT Communication)**
HimawariCast (for baseline usage)	All	HRIT files (MTSAT Compatible)	10 min	14	VIS: 1 km IR: 4 km	**Communication Satellite (JCSAT-2A/2B)**
Web-based Quick-Look	All	JPEG	10 min	4+	several km	

http://www.data.jma.go.jp/mscweb/data/himawari/sat_img.php?area=se1



Integrated Usage of HimawariCloud and HimawariCast



Divided Imagery Data Distribution from HimawariCloud

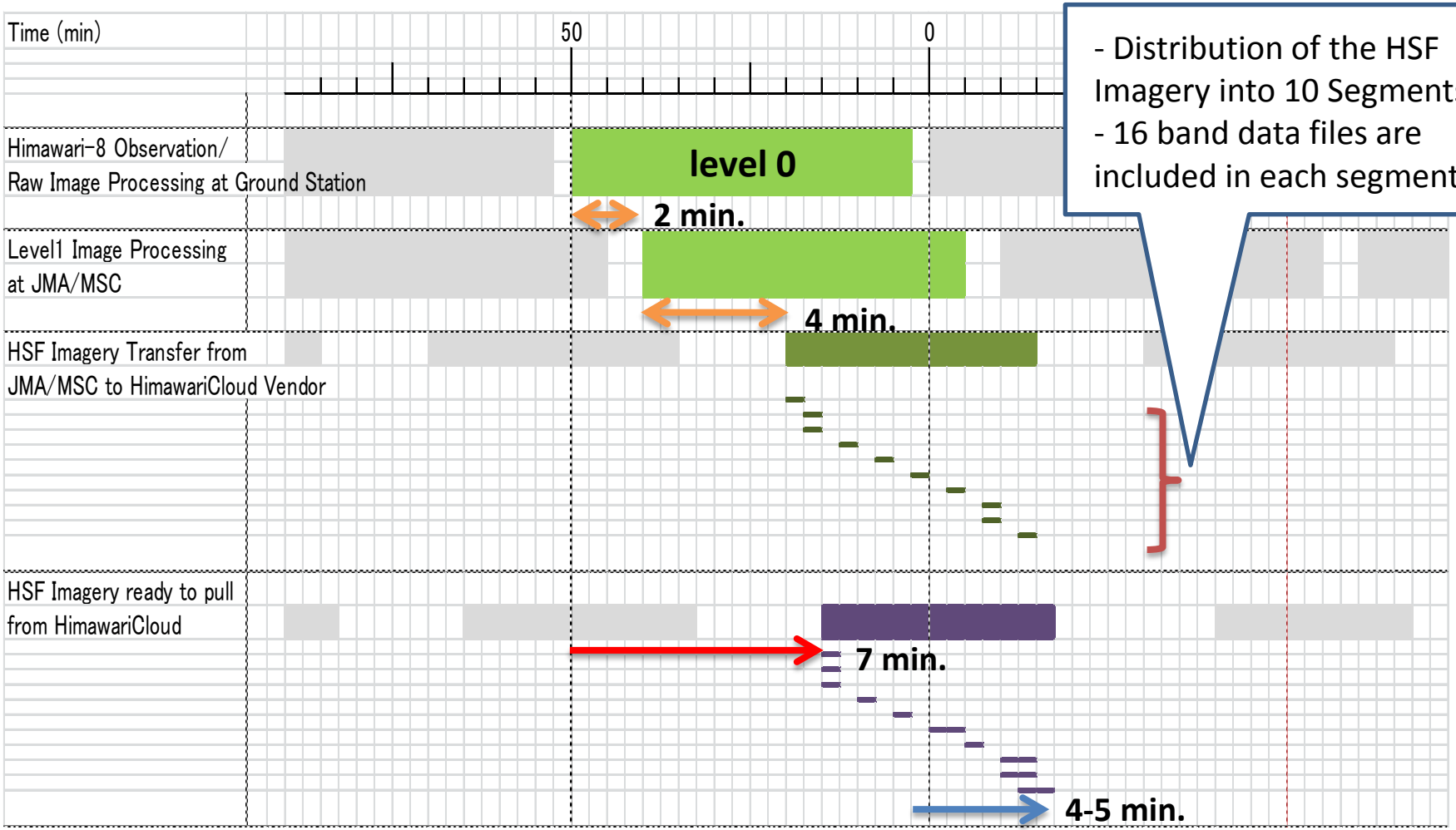
- Full Disk Imagery from HimawariCast
- The Specific Imagery in detail from HimawariCloud

Table. Segment number and approximate coverage in latitude

Segment #	North Edge (lat.)	South Edge (lat.)
1	--	47 deg.N
2	47 deg.N	32 deg.N
3	32 deg.N	21 deg.N
4	21 deg.N	10 deg.N
5	10 deg.N	Equator
6	Equator	10 deg.S
7	10 deg.S	21 deg.S
8	21 deg.S	32 deg.S
9	32 deg.S	47 deg.S
10	47 deg.S	---

Timeline of HimawariCloud HSF Imagery data Distribution

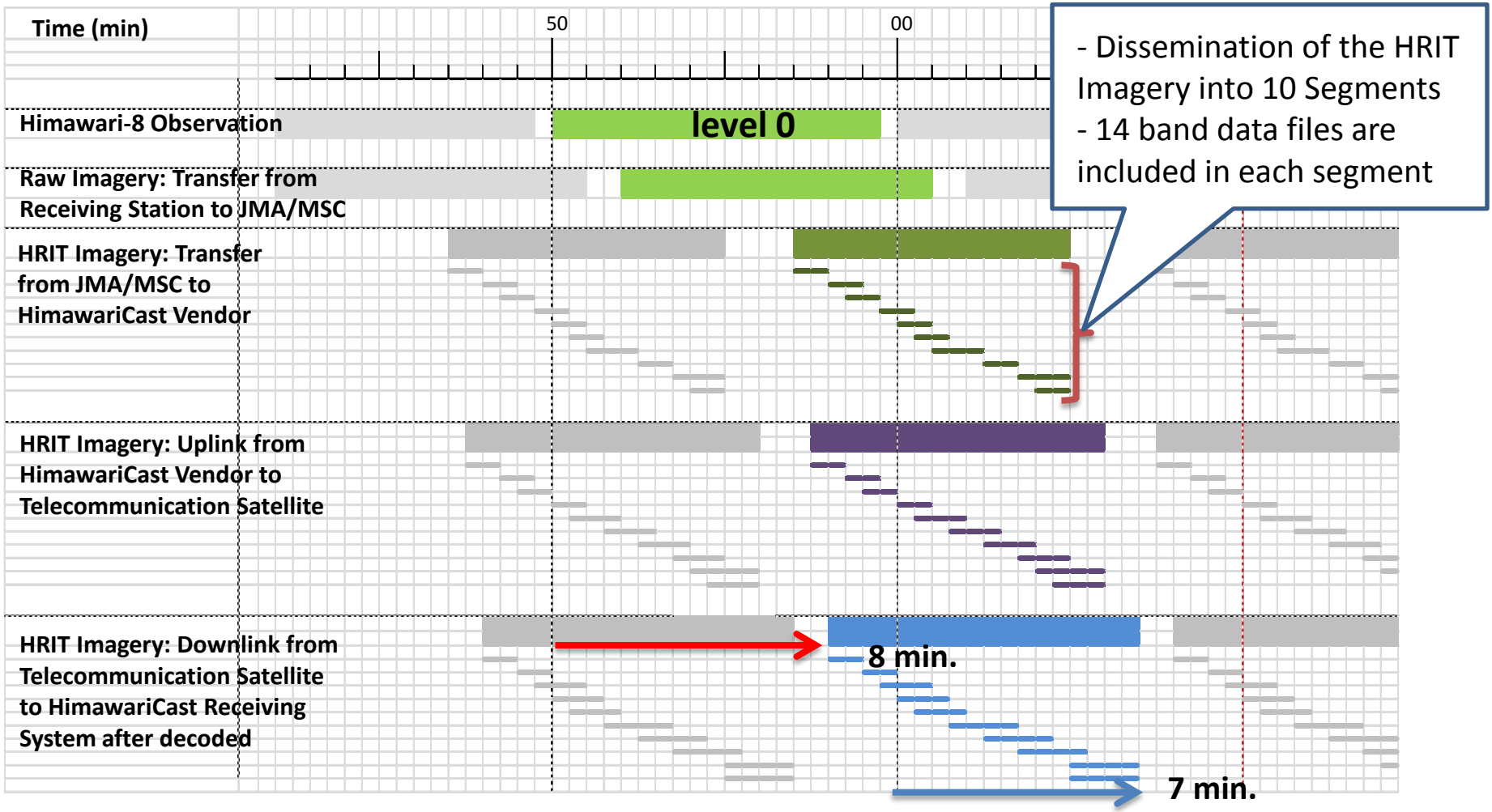
time is rounded in minutes based on the past record at "peak time" (local noon after spring equinox)



The first Segment Imagery Data will be ready to pull within 7 min. after observation start time (the last Segment within 4-5 min. after observation end time)

Timeline of HimawariCast HRIT Imagery data Dissemination

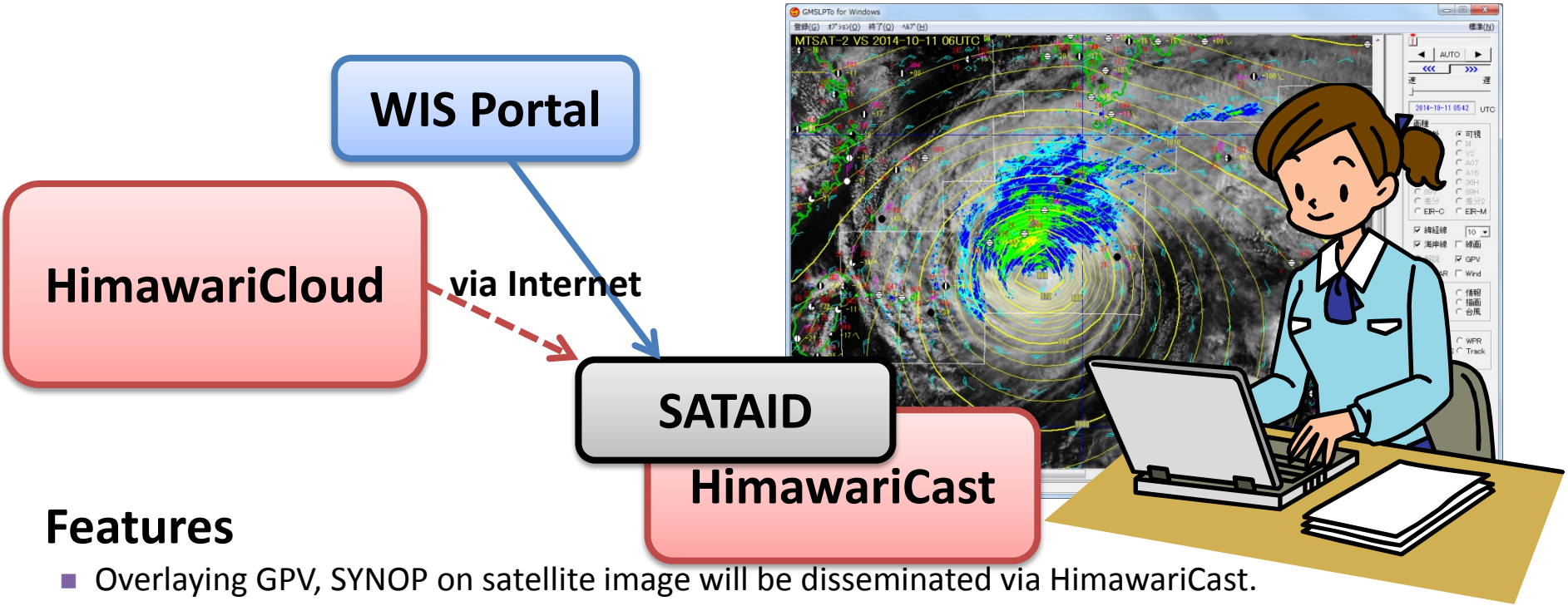
time is rounded in minutes based on the past record at "peak time" (local noon before spring equinox)



The first segment data is to be disseminated within 8 min. after observation start time (the last segment data within 7 min. after observation end time)

HimawariCast with SATAID

HimawariCast provides …….
an Integrated Environment for Satellite Cloud Imagery Analysis with overlaying weather radar, GPV, SYNOP on SATAID system



Features

- Overlaying GPV, SYNOP on satellite image will be disseminated via HimawariCast.
- Satellite image in SATAID format can be downloaded from WIS Portal server, or you can convert from HRIT image data.
- SATAID System will be available from MSC Website with “Source Code”
- Image data format converter between HRIT and SATAID/NetCDF will be provided from MSC Website
- Handling Tools for reading Image Data in NetCDF format will also be provided from MSC Website for the further use in GIS applications.

Archived Servers Operated by Japanese Science Group

The following Himawari Historical Data Servers are operated by Japanese Science Group on a voluntary basis for Non-Profit R&D Users

- **Chiba University Data Server**
  CEReS (Center for Environmental Remote Sensing)
- **NICT Himawari-8 Real-time Web**
  http://himawari8.nict.go.jp/
- **JAXA Himawari Monitor**
  http://www.eorc.jaxa.jp/ptree/index.html
- **University of Tokyo**
  DIAS (Data Integration and Analysis System)
  (in preparation for operation)

HIMAWARI-8 Image Navigation & Calibration Status

Himawari-8 Image Navigation
Estimated from "Coast Line" Analysis

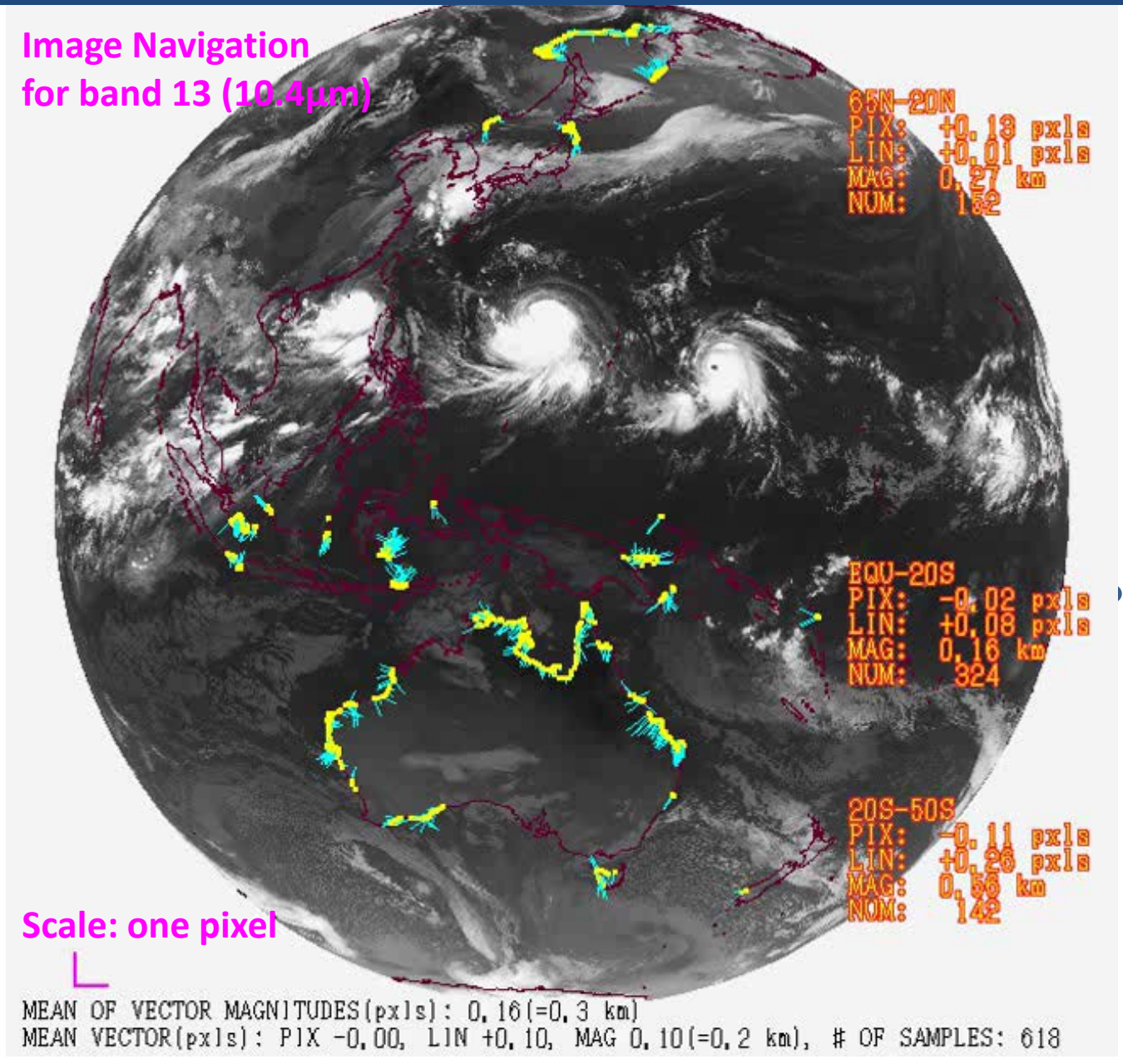
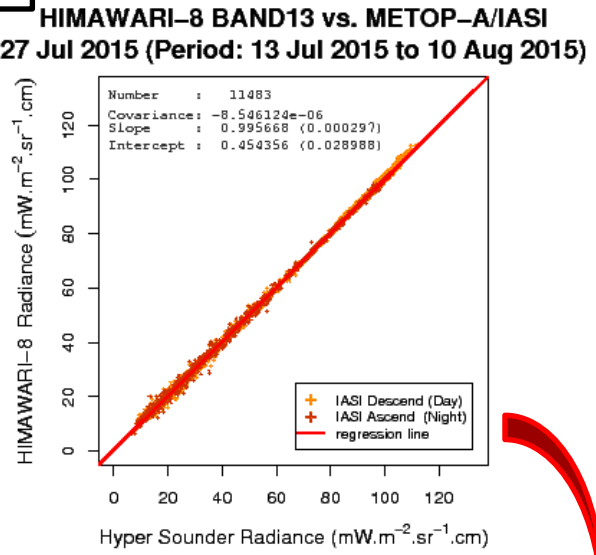


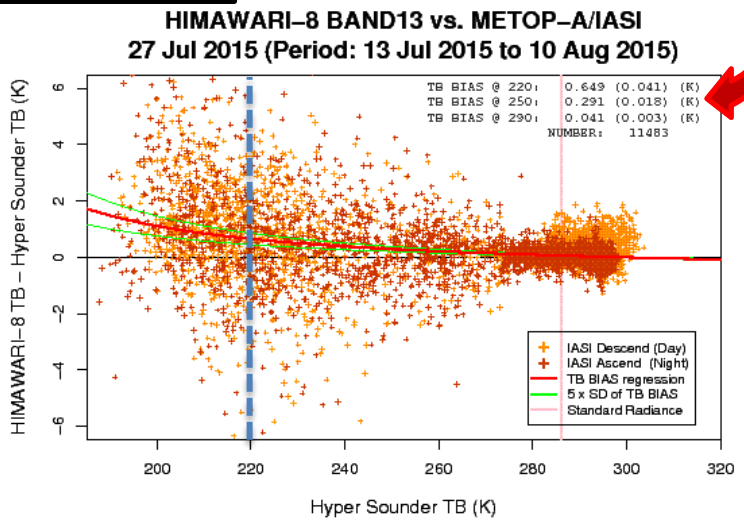
Image navigation accuracy is mostly less than 0.3 pixels

Validation of IR Bands Calibration based on GSICS inter-calibration

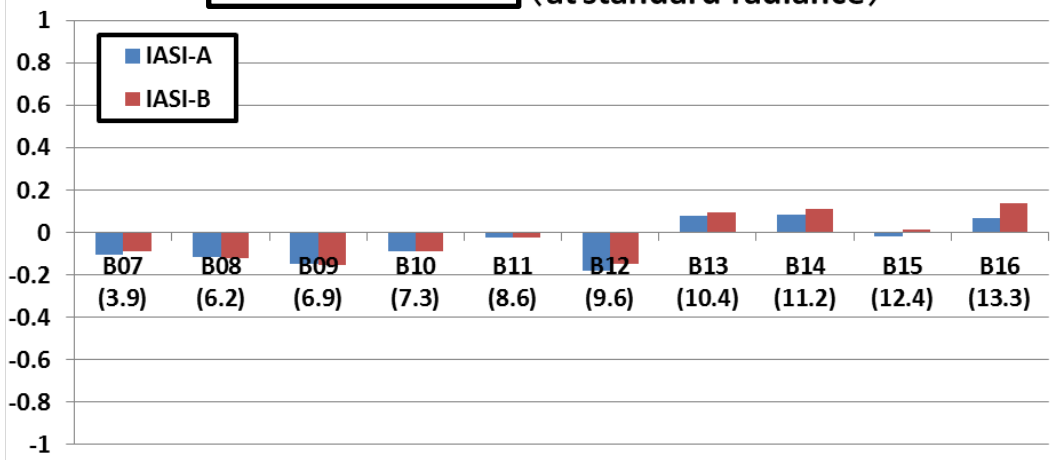
Radiance



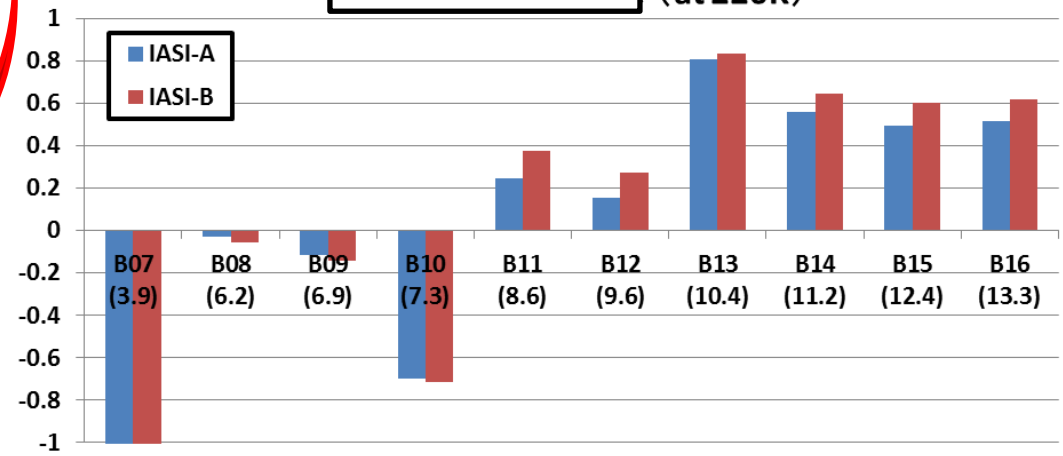
Brightness Temp. (Tb)



Tb Bias （at standard radiance）



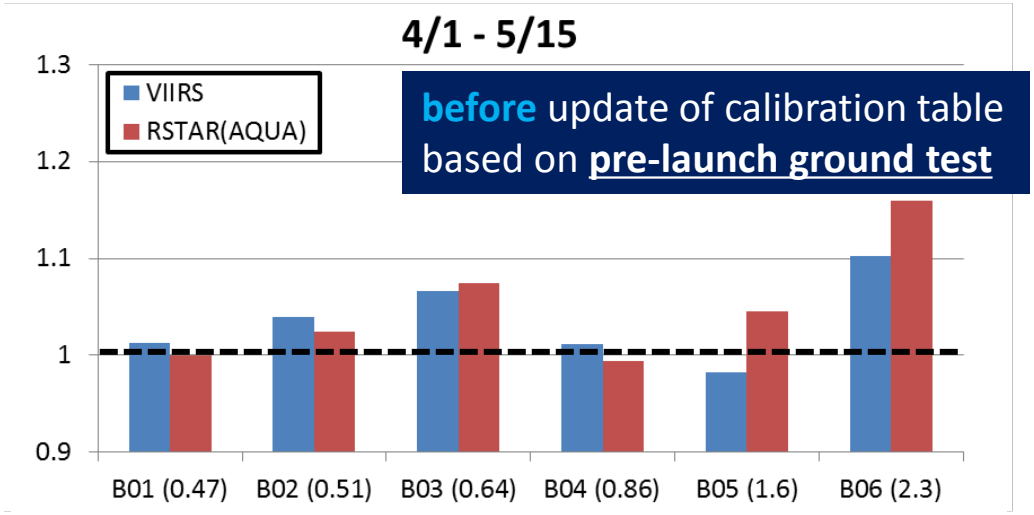
Tb Bias （at 220K）



* Standard Radiance was calculated under clear sky condition over the ocean in nighttime by RTTOV 11.2 with US standard atmosphere (1976)

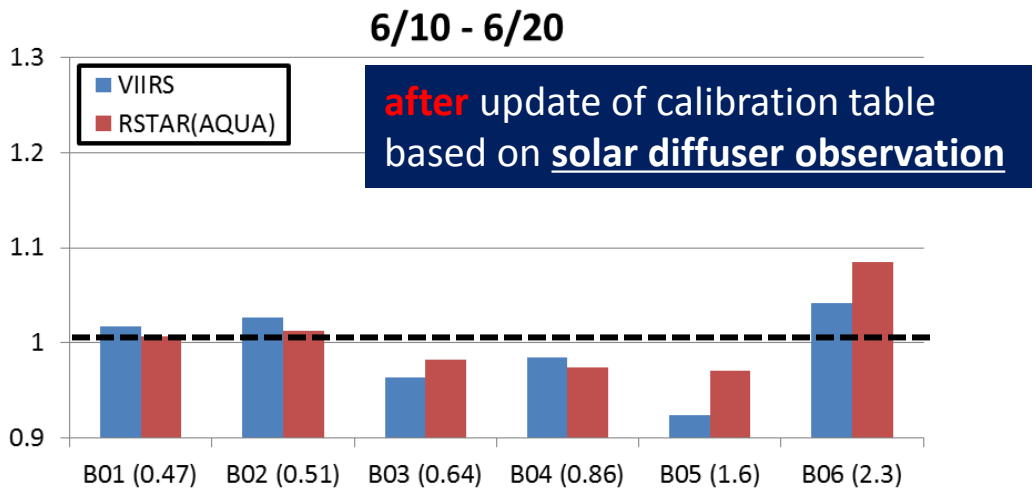
Validation of VIS/NIR Bands Calibration for Himawari-8 Imagery

- Two ways of validation results are well agreed
- Ratio to observed AHI reflectivity are around 1.0 for all VIS/IR bands
- However, it differs in property between B01-04 and B05-06



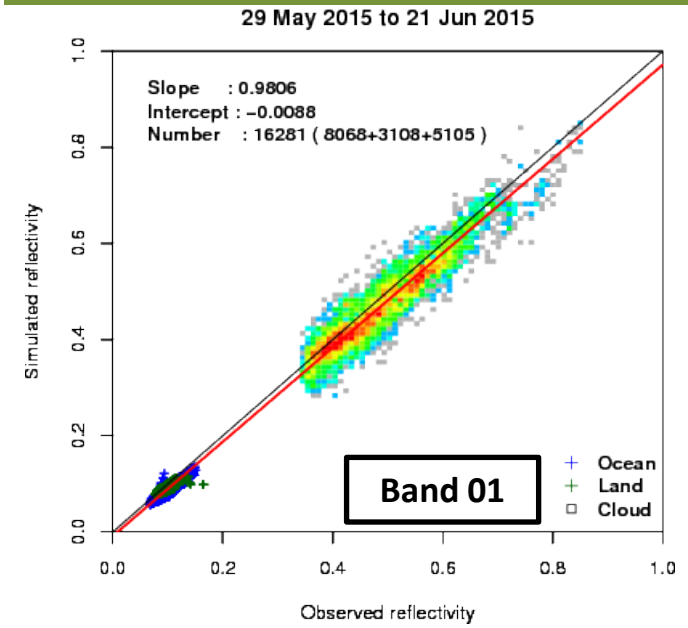
before update of calibration table based on **pre-launch ground test**

Updating calibration coefficients on 8 June,2015

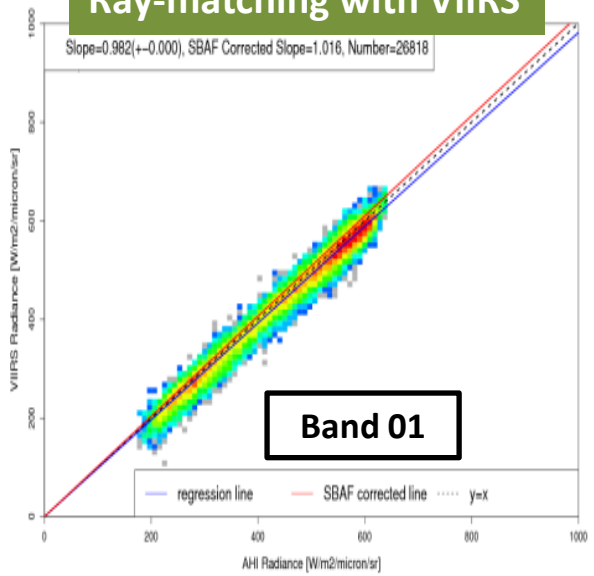


after update of calibration table based on **solar diffuser observation**

Radiative Transfer Simulation with RSTAR



Ray-matching with VIIRS

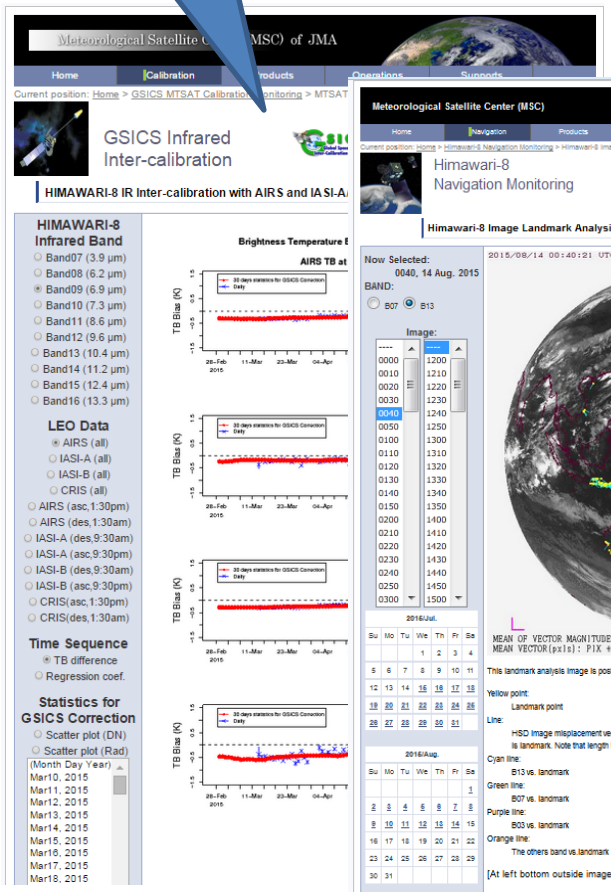


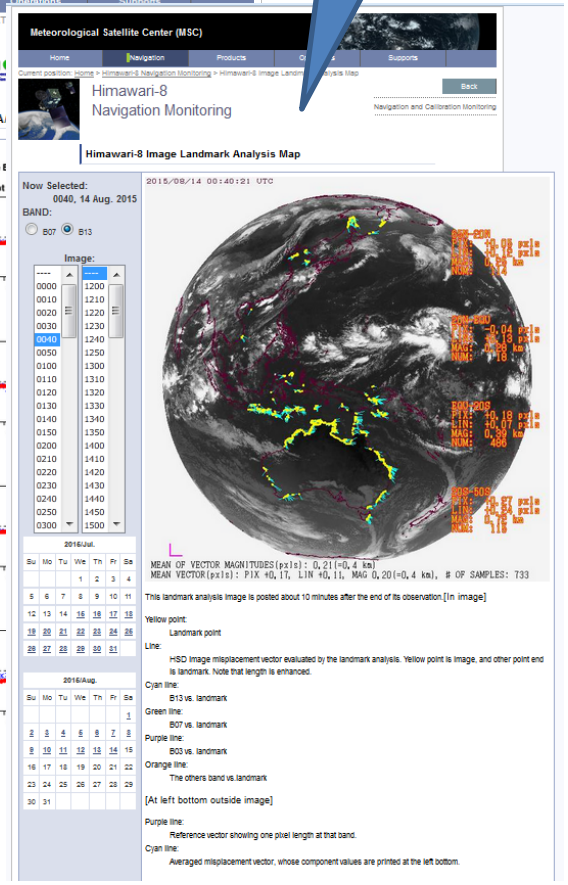
Himawari Operation Status and Imagery Calibration/Navigation Monitoring from MSC Web

Himawari-8 Operation Status

Imagery Calibration

Imagery Navigation





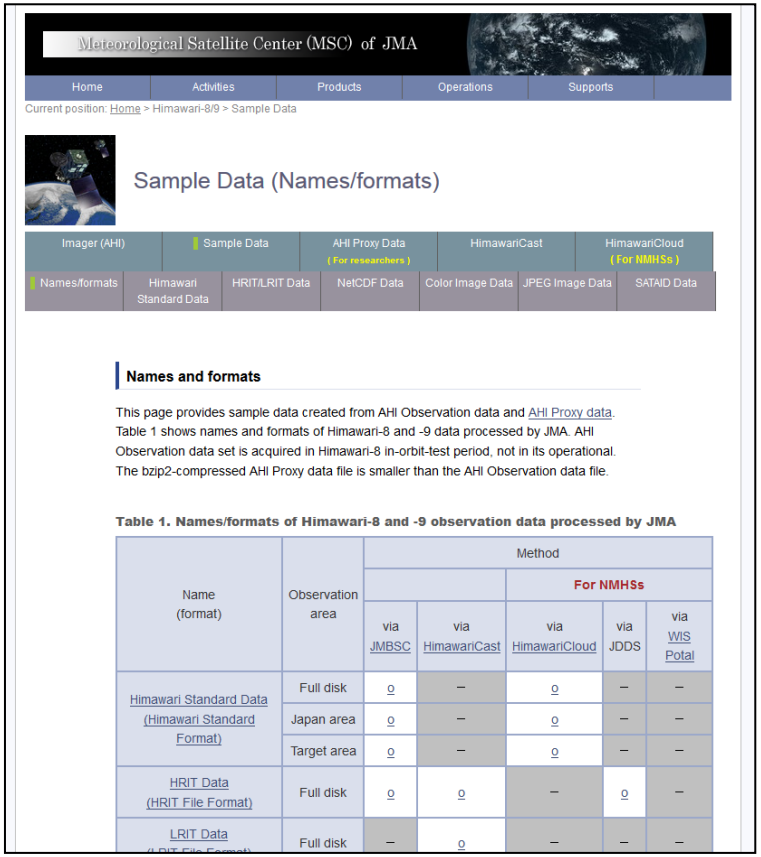
http://www.jma-net.go.jp/msc/en/index.html

Himawari-8/9 Users Support Information

http://www.jma-net.go.jp/msc/en/support/

Contents:

- Overview of satellite observation
- Overview of data dissemination
- Imager (AHI) specifications
- Operational status
- Sample data
- Sample source code to read Himawari-8 data and convert into other formats



Feel free to contact:

Satellite Program Division, Japan Meteorological Agency

metsat@met.kishou.go.jp

Enhancement in HIMAWARI-8 Level-2 Products

Development of L2 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 channel

4km --> 2 km for IR channels

Temporal:

1 hr --> 10 min for a full disk scan

2.5min for limited areas

Development of Baseline Products, focusing on

- Atmospheric Motion Vectors (AMVs)
- Cloud Properties (incl. Rapidly Developed Convective Clouds)
- Aerosol (incl. Asian Dust) / Volcanic Ash

Numerical Prediction

Severe Weather Monitoring

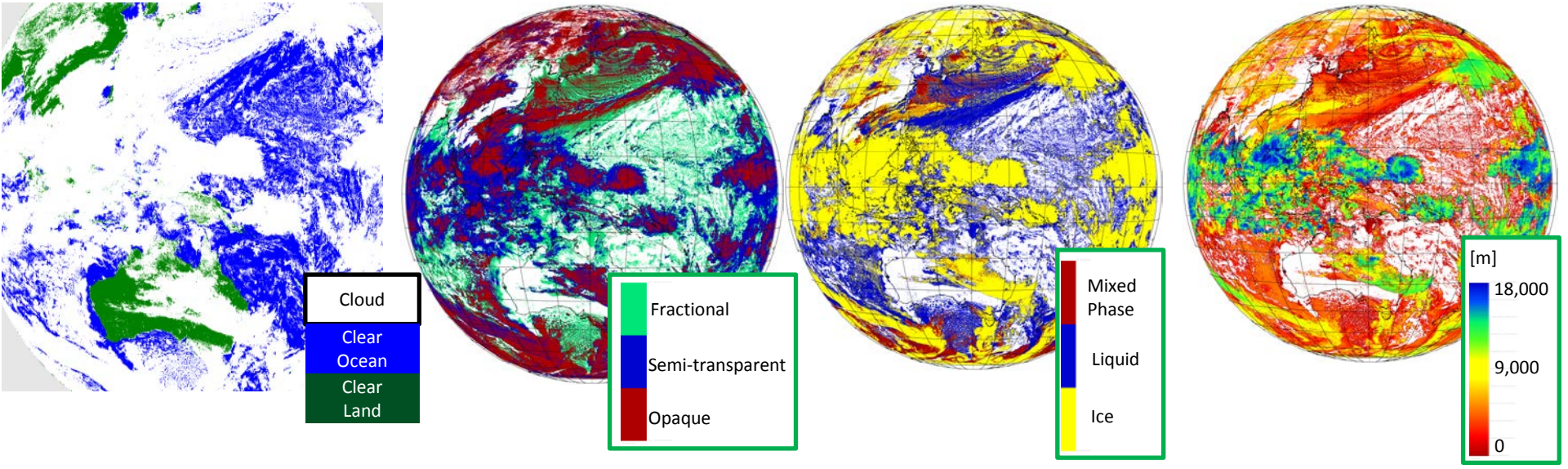
Environmental Monitoring

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

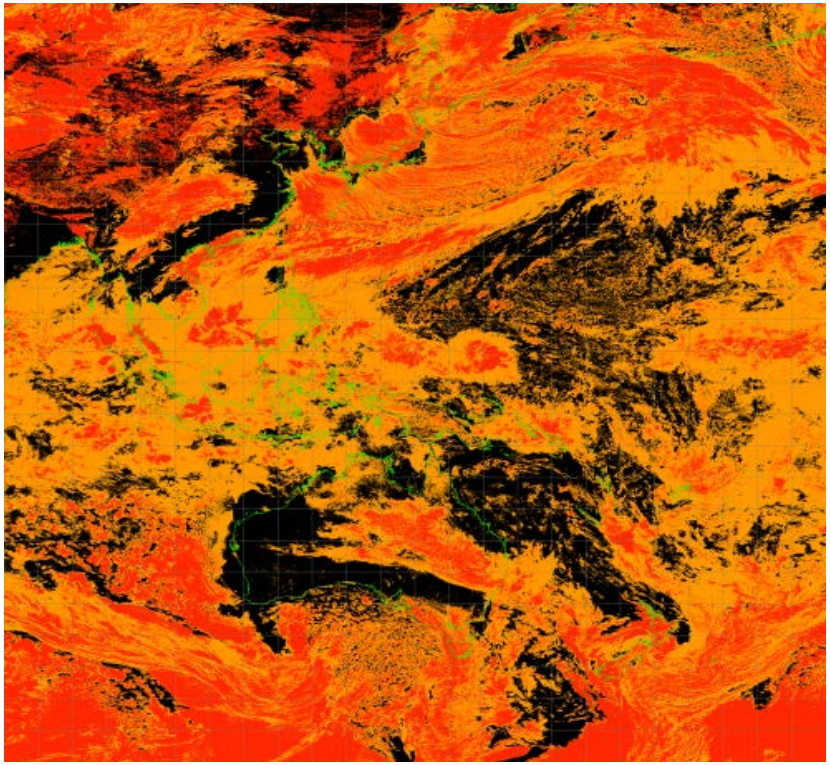
Cloud Mask | Type | Phase | Cloud Top Height



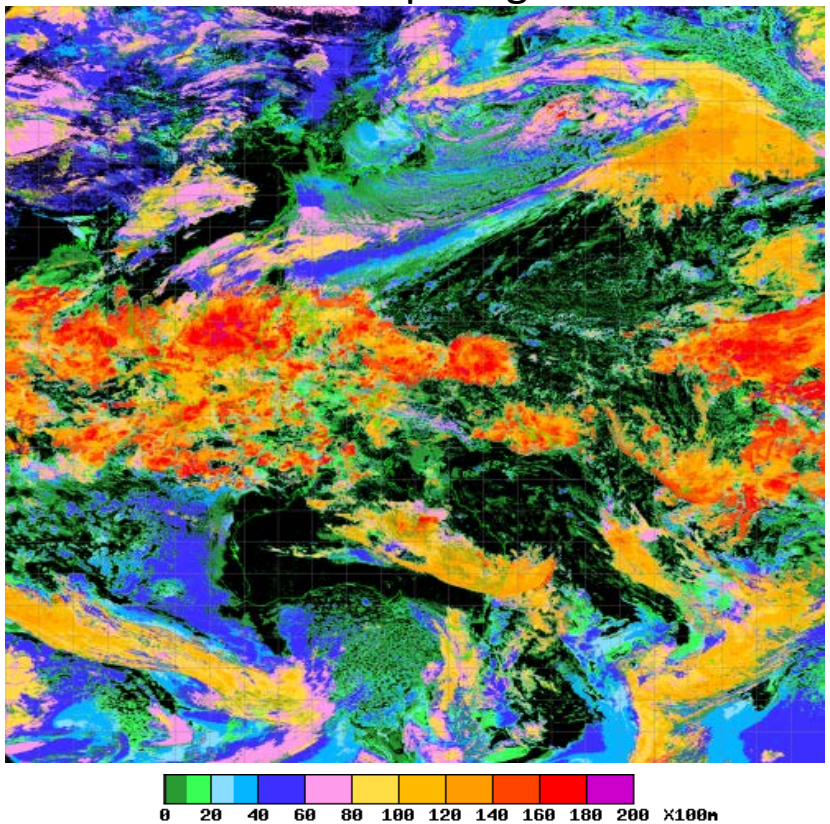
Objective Cloud Analysis Information (OCAI)

- Basic cloud product with latitude-longitude grid in 0.05 degree.
  - cloud mask, cloud type and cloud top height
- Be produced hourly
- Started to provide to NMHSs, e.g. Indonesia and Myanmar, in response to requests.

Cloud Mask



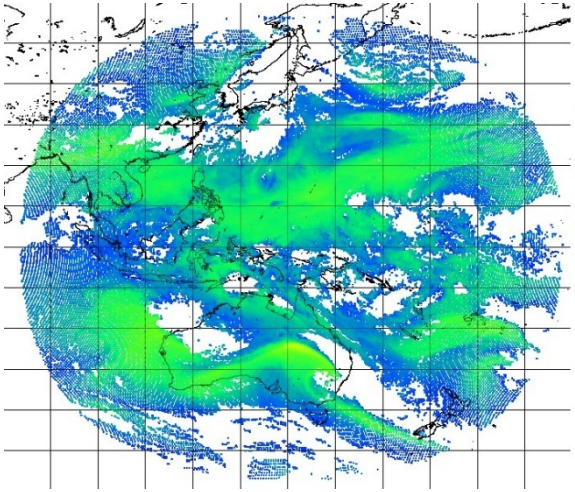
Cloud Top Height



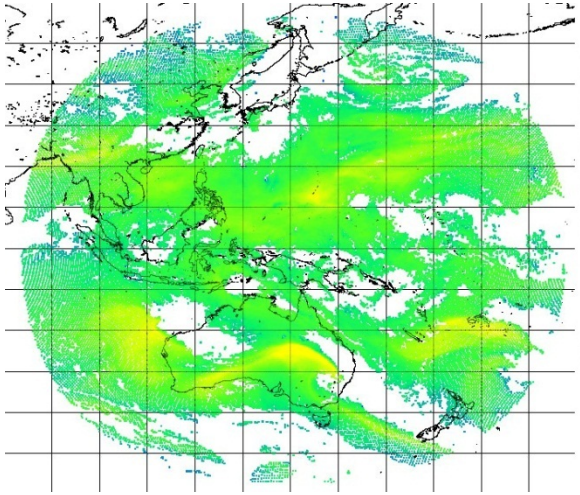
Clear Sky Radiances (CSRs)

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

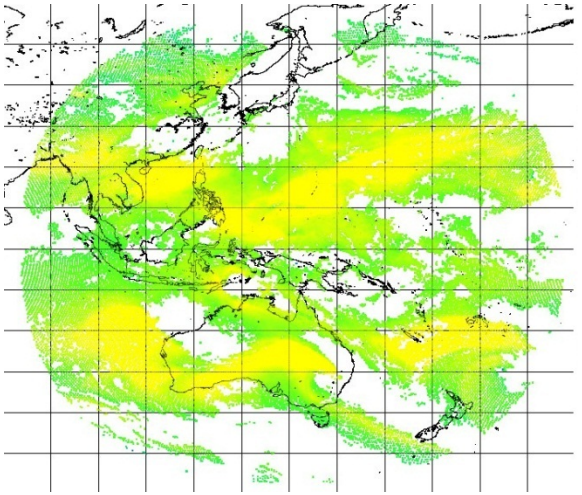
Band #8 (6.2 um)

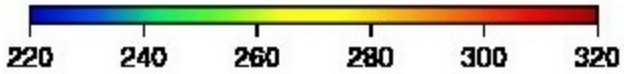


Band #9 (6.9 um)



Band #10 (7.3 um)



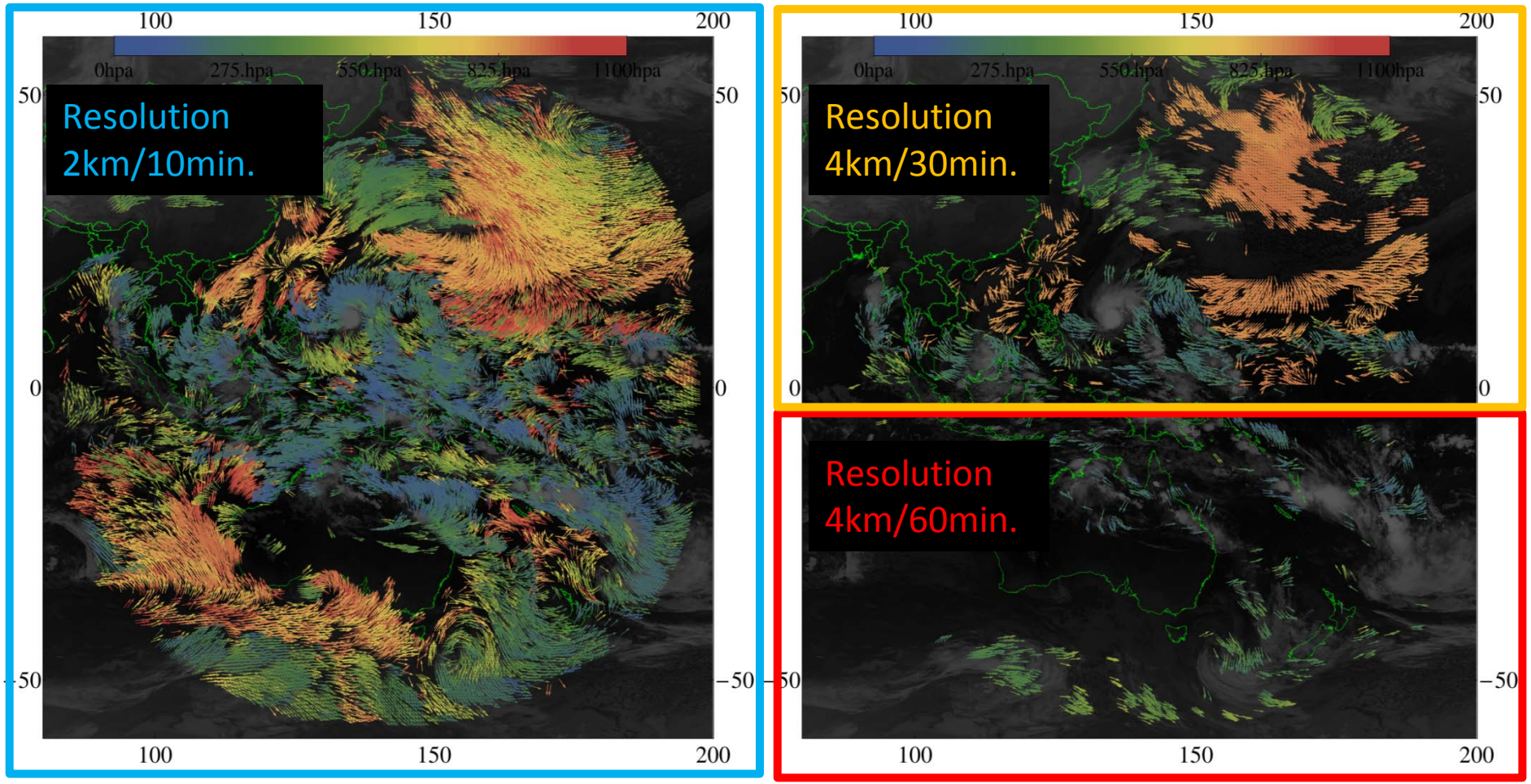


03 UTC 20 April 2015

Improvement in Atmospheric Motion Vectors (AMVs) Retrieval

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

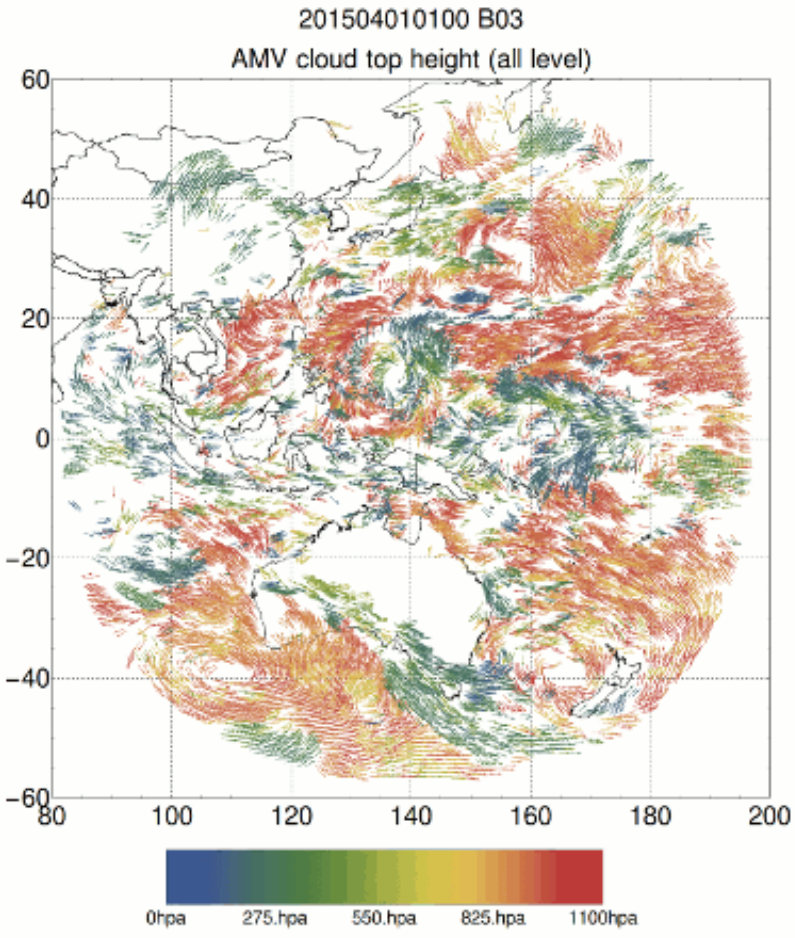
MTSAT-2 AMVs derived from MTSAT-2 imagery and heritage algorithm

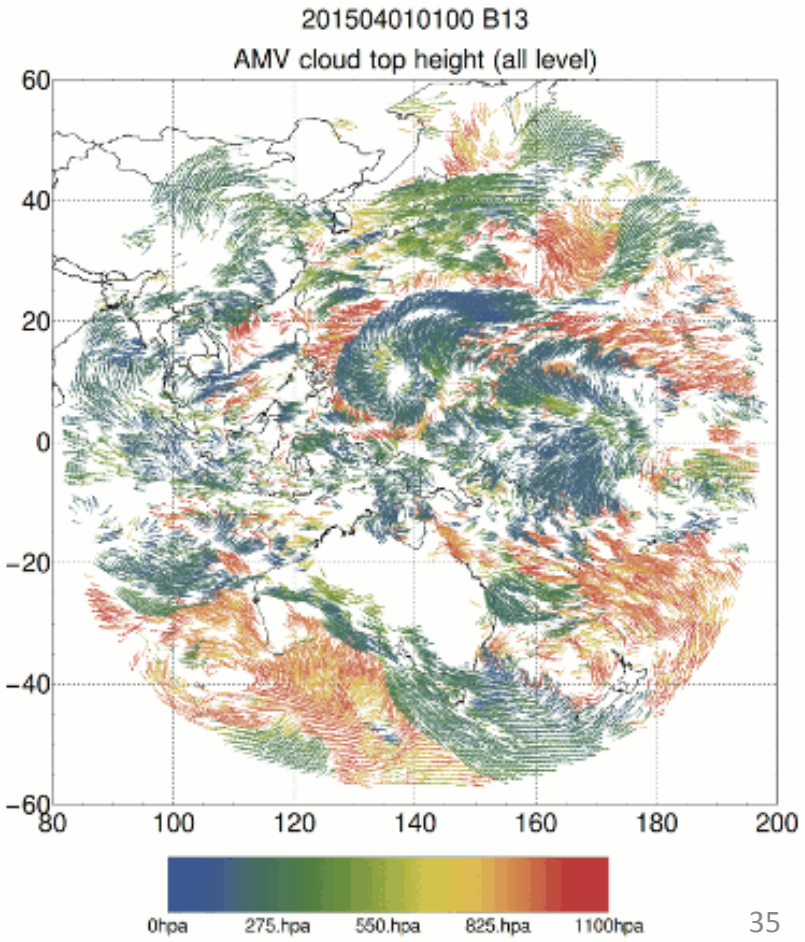


Himawari-8 and MTSAT-2 IR AMV (QI>60, 2015 01 14 1700UTC)

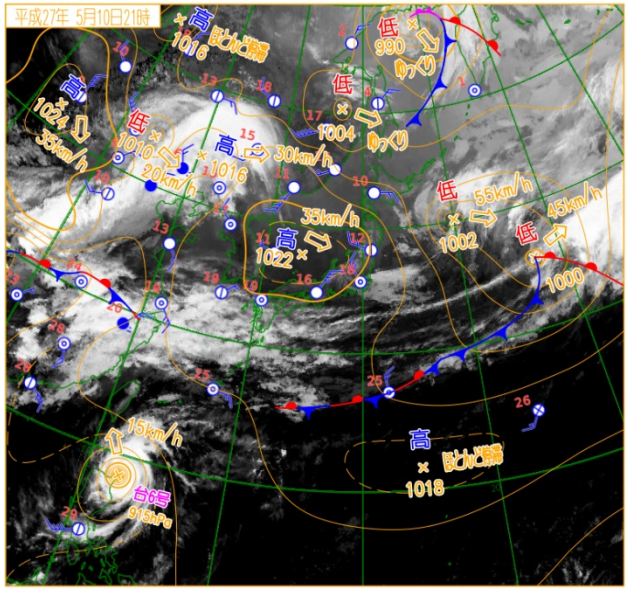
Atmospheric Motion Vectors (AMVs)

- 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 are informed to NWP users (IWW mailing list)



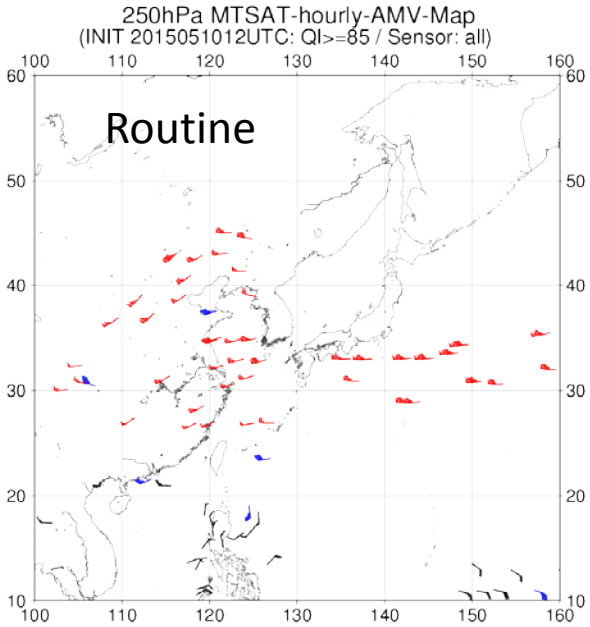


Case Study on Impact of Himawari-8 AMVs using JMA's global NWP system
A sample of the assimilated data distribution (12 UTC, 10 May 2015)

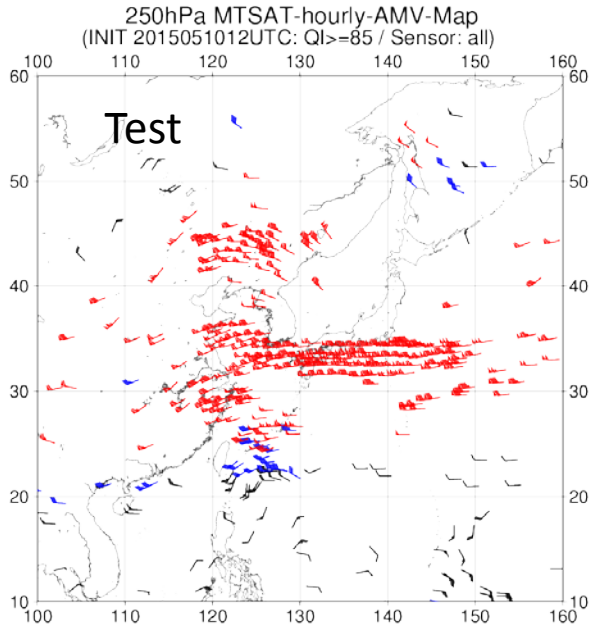


Weather chart with MTSAT-2 infrared satellite image

Red :	≧	50kt
Blue :	≧	30kt
Black :	<	30kt



MTSAT-2 AMVs on 250 hPa in vicinity of Japan, which were assimilated into the routine system

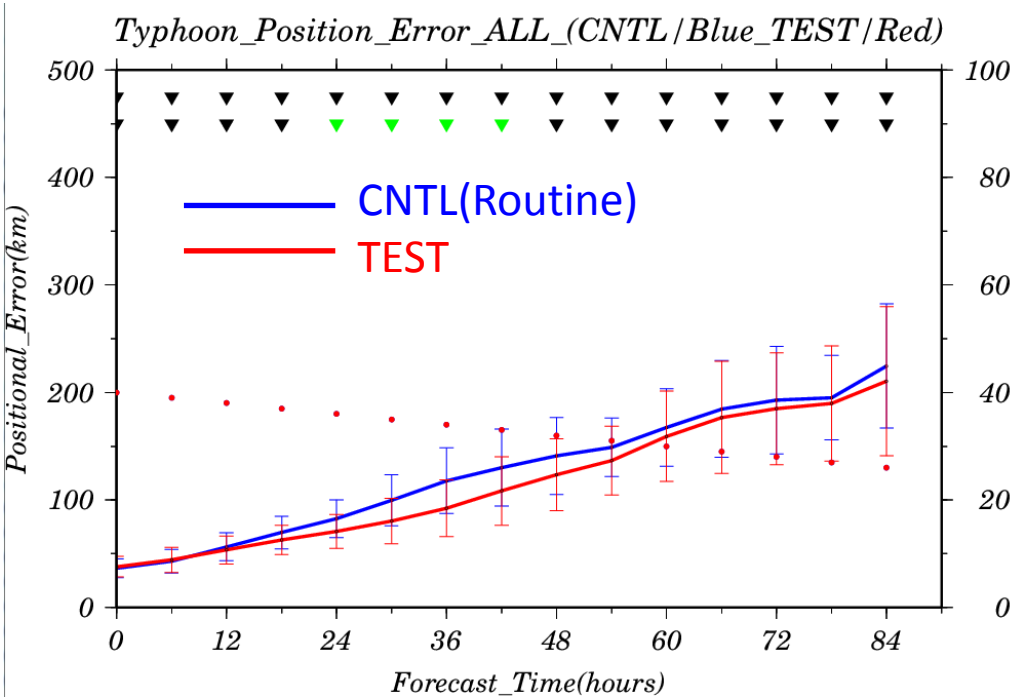


Himawari-8 AMVs on 250 hPa in vicinity of Japan, which were assimilated into the test system

Himawari-8 AMVs were derived from three sequential satellite images with 10-minute time interval by a new retrieval method based on maximum likelihood estimation.
MTSAT-2 AMVs were derived from three sequential satellite images with 15- or 30-minute time interval.
（Himawari-8 and MTSAT-2 AMVs used for this study were produced by Meteorological Satellite Center of JMA.）

Typhoon track forecasts using Himawari-8 AMVs

Impact of Himawari-8 AMVs compared to routine



Typhoon track forecast errors averaged for NOUL (T1506)

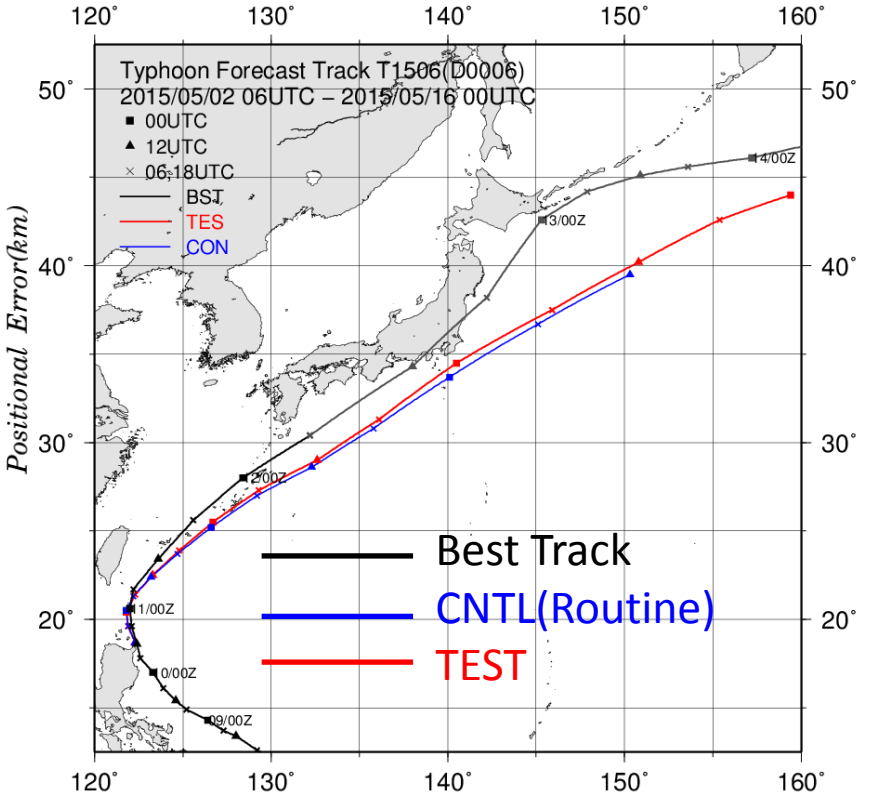
CNTL(Routine): Result by assimilating MTSAT-2 AMVs

TEST: Result by assimilating Himawari-8 AMVs

Period:

Assimilation : From 1 to 24 May 2015

Forecast : From 2 to 12 May 2015



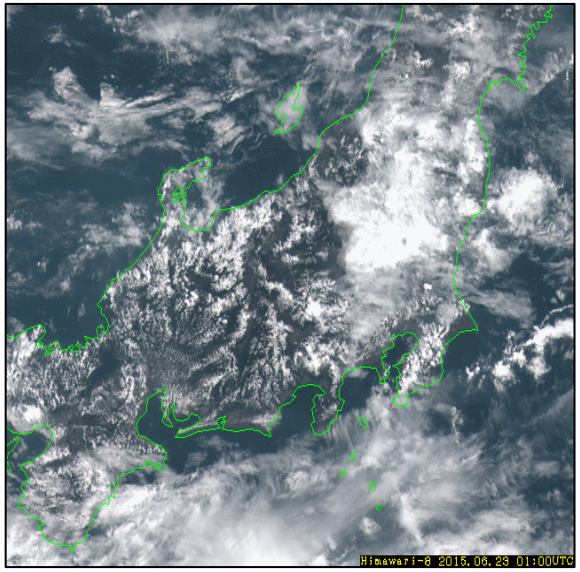
Typhoon track forecast of NOUL (T1506) initialized at 12 UTC on 10 May 2015.

Black is the best track. CNTL(Routine) and TEST are same to the left panel.

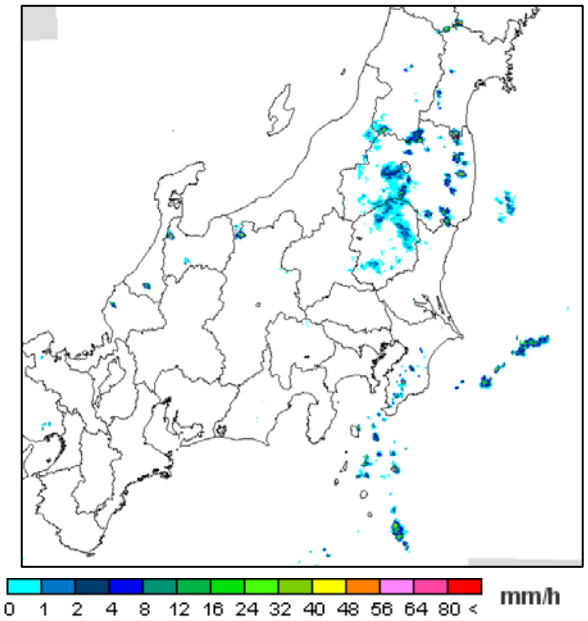
Mr Koji Yamashita (Numerical Prediction Division, JMA)

Detection of Rapidly Developed Convective Clouds

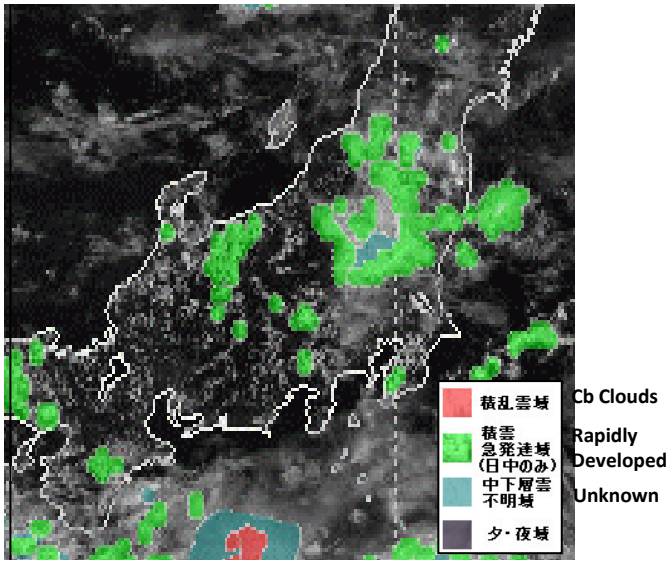
Himawari-8 Imagery



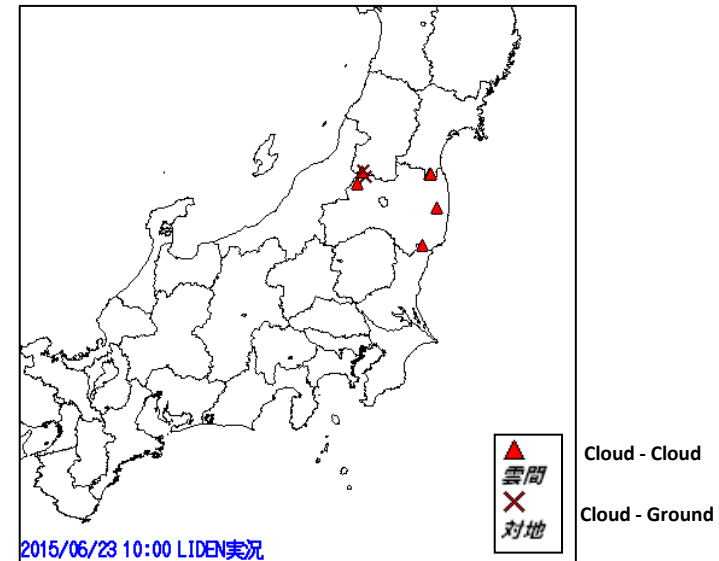
JMA's Weather Radar System



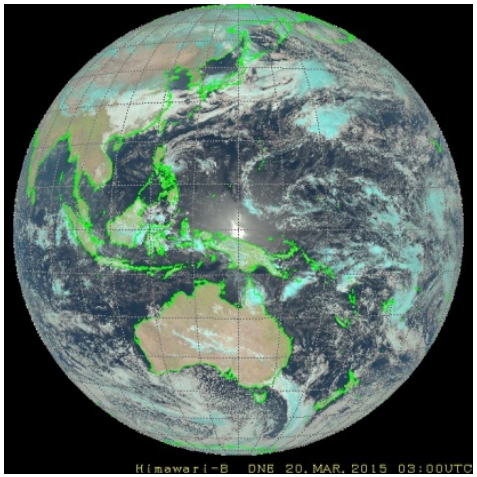
Information on Potential Area for Rapidly Developed Convective Cloud Area



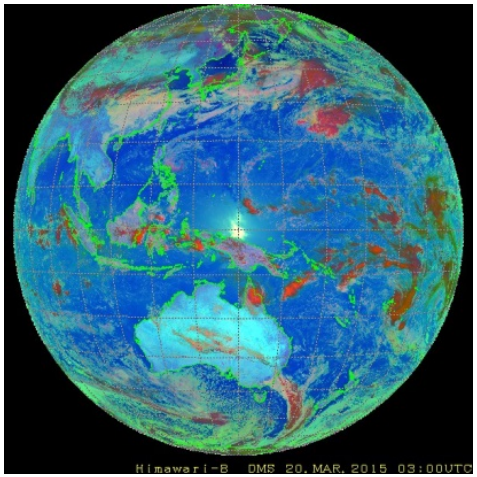
JMA's Lightning Detection System (LIDEN)



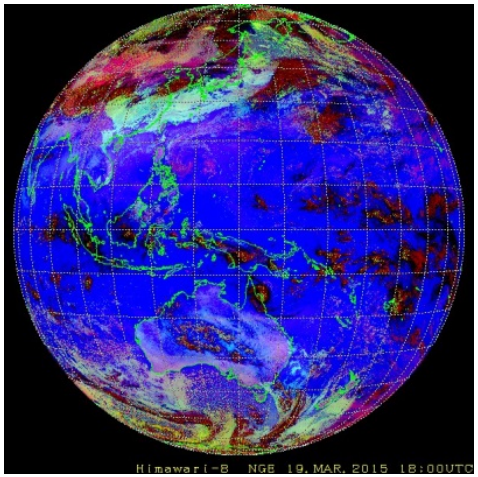
WMO/EUMETSAT RGBs Recipe



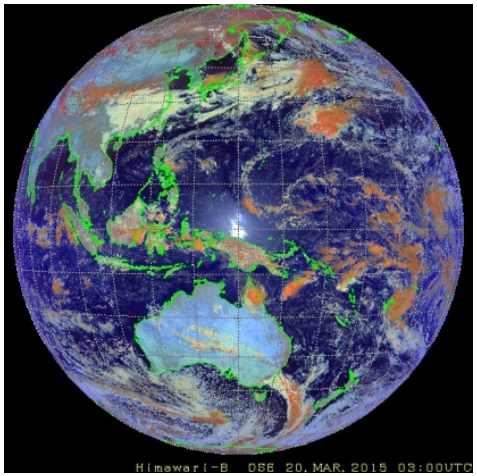
Day Natural Colors



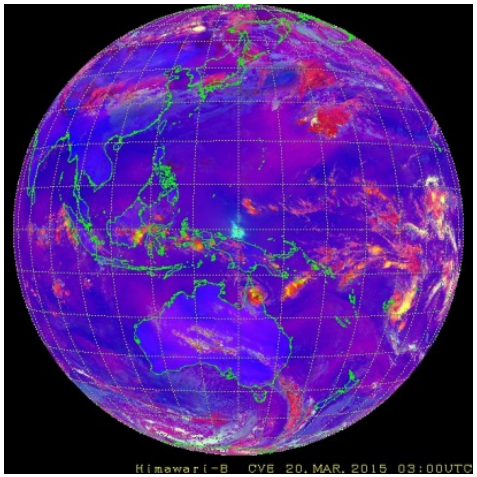
Day Microphysics



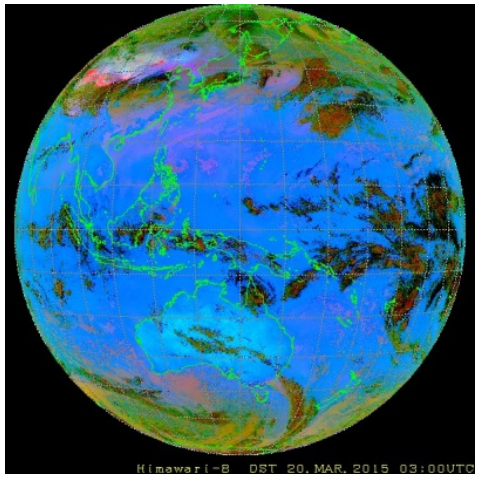
Night Microphysics



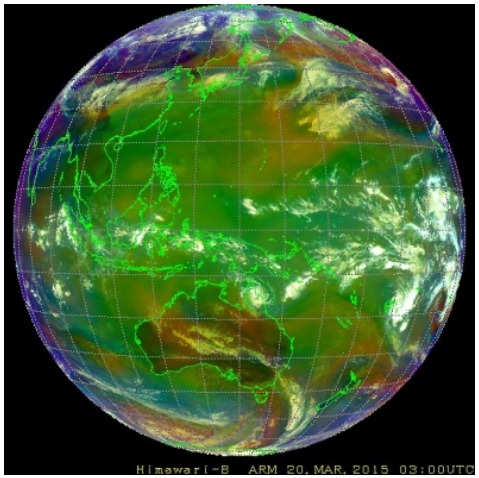
Day Solar



Convective Storms



Dust

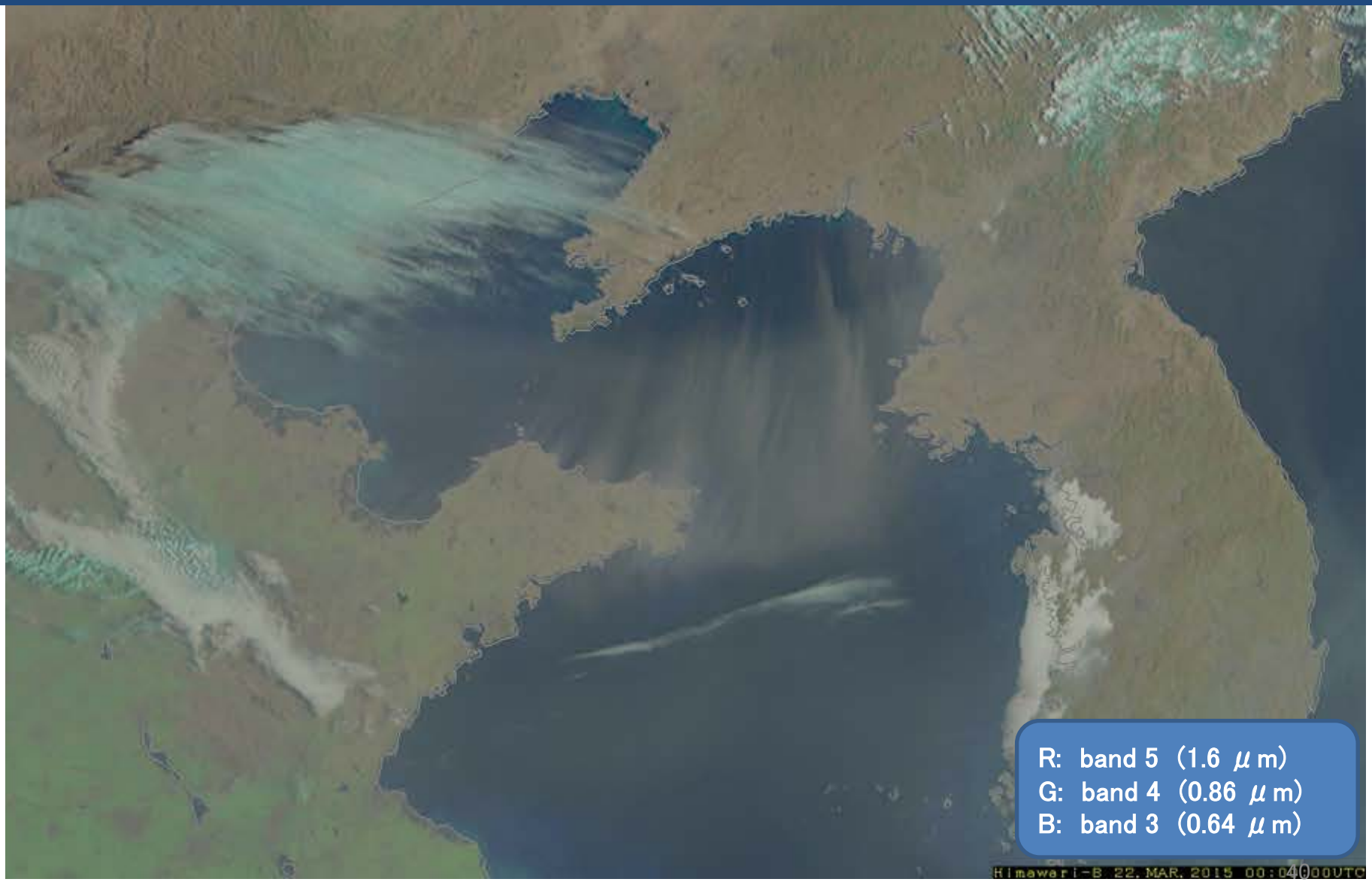


Airmass

http://oiswww.eumetsat.org/IPPS/html/MSG/RGB/

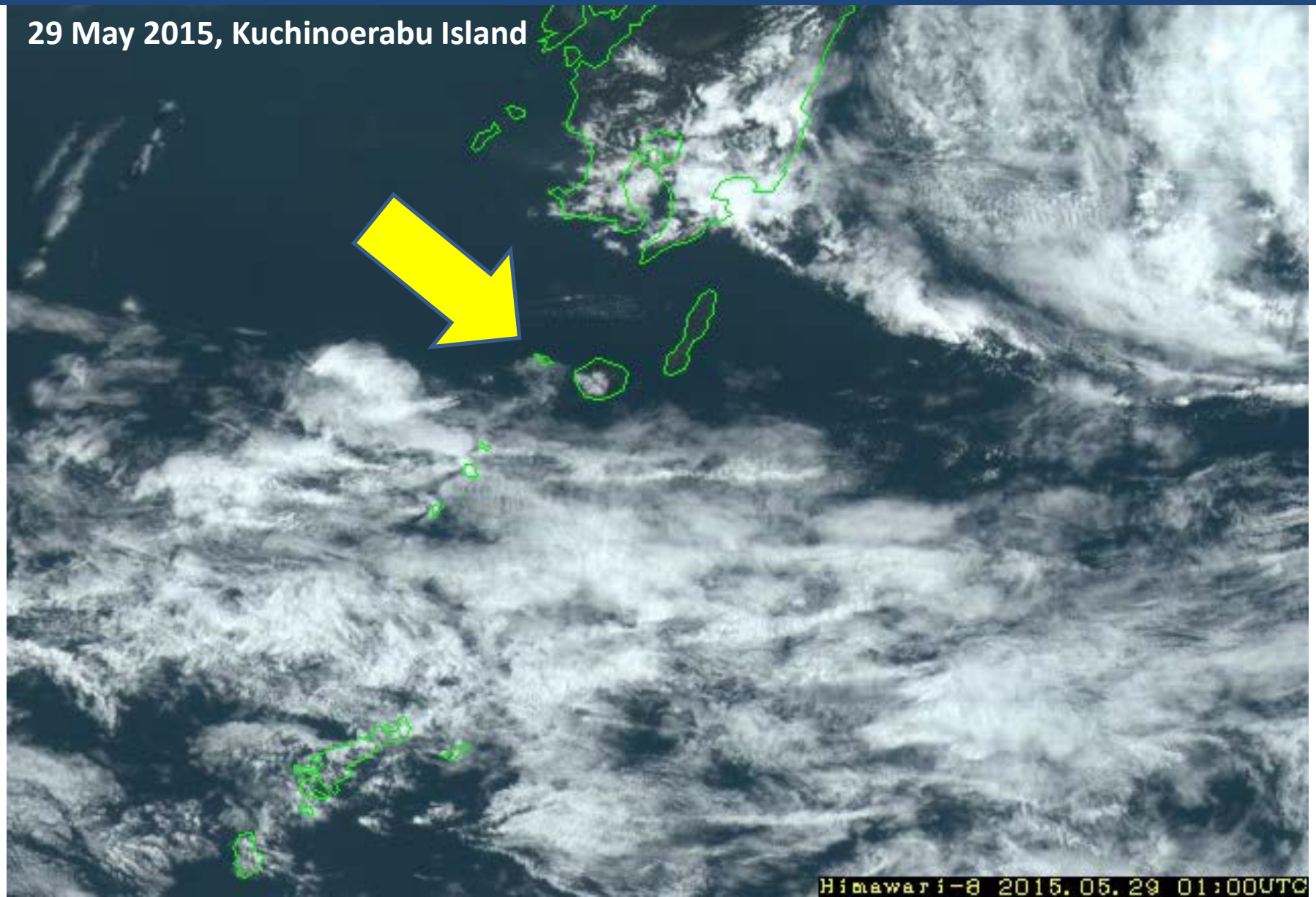
Utilization of RGB Imagery: Visible and Near Infrared

Detection of Aerosol (Asian Dust)



Utilization of RGB Imagery: Visible True Color

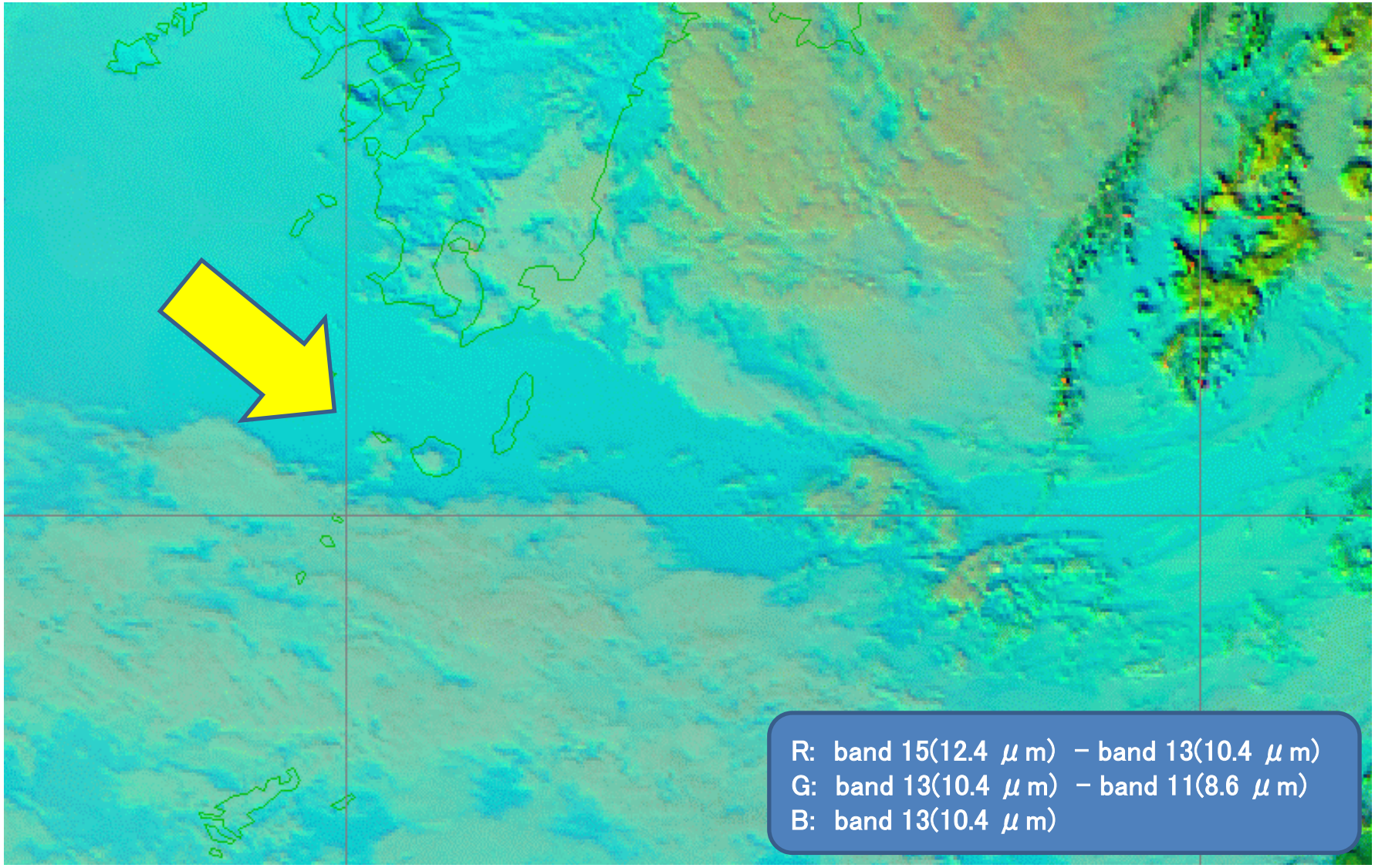
Detection of Volcanic Ash and Gas from Volcano Eruption



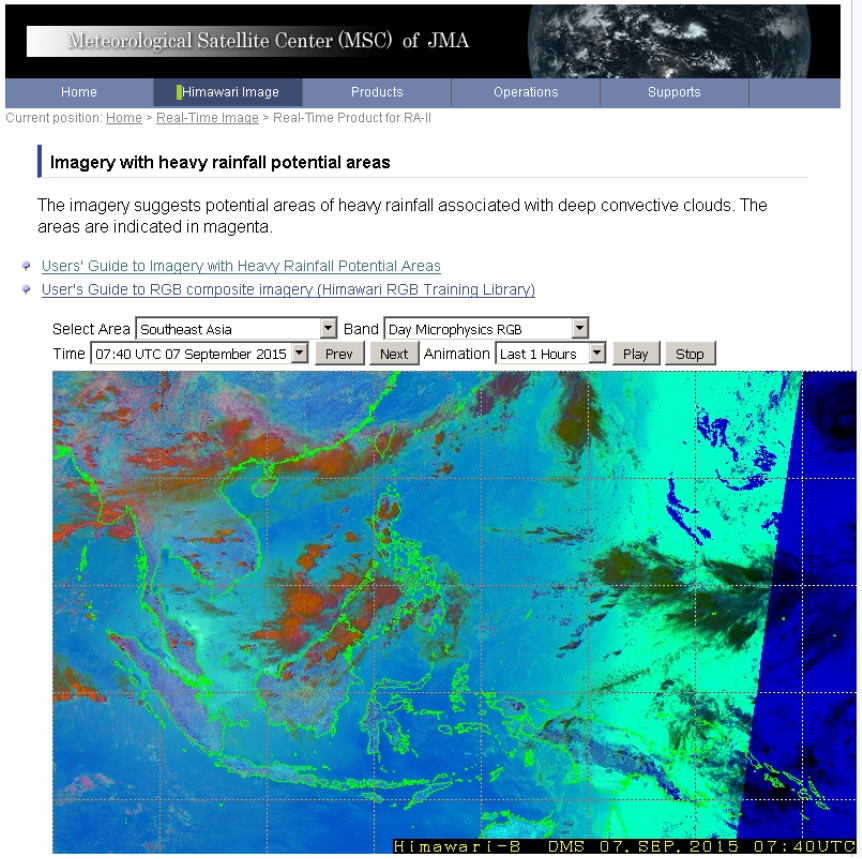
Utilization of RGB Imagery: SO_2 Band (8.6 μm)

Detection of Volcanic Ash and Gas from Volcano Eruption

29 May 2015, Kuchinoerabu Island



JMA real-time RGB Website for supporting SWFDP in RA II and SWFDDP in RA V



Day Microphysics RGB

JMA provides the Web site and the User's Guide documentation.

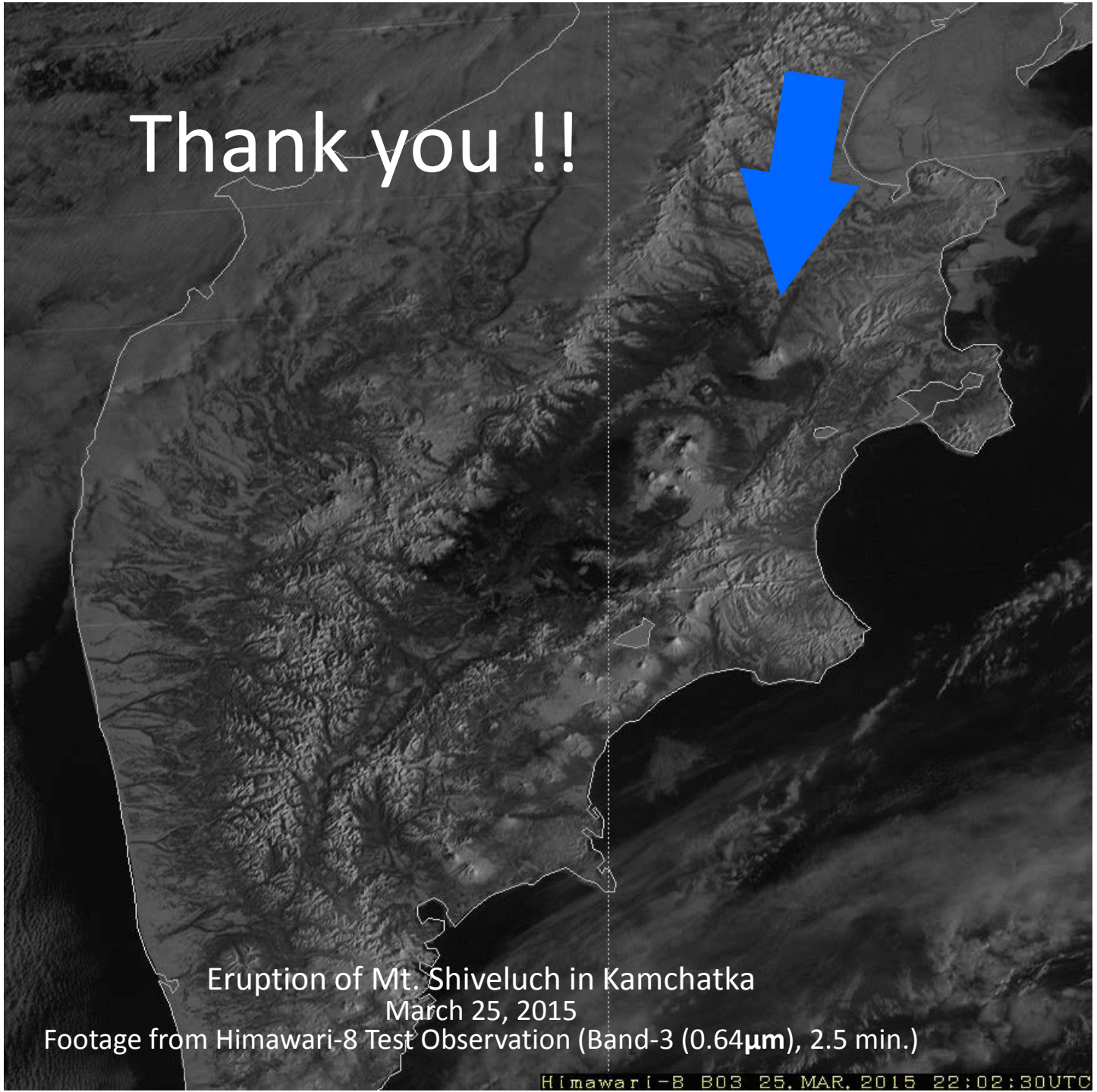
- RGB composite imagery based on the WMO standard recipe are produced from Himawari-8 imagery.
  e.g. Day Microphysics, Night Microphysics.
- Products are provided for supporting SWFDP in RA II/RA V region.
- IR(10.8um), IR(3.9um), WV(6.8um), VIS(0.68um), and **Sandwich Imagery** are also provided.

Future plan

- Development of new RGB imagery or "localization" for typical weather phenomena in Asia/Oceania regions.

RGB Imagery are available from:

http://www.data.jma.go.jp/mscweb/data/himawari/sat_hrp.php?area=r2s
http://www.data.jma.go.jp/mscweb/data/himawari/sat_hrp.php?area=r5s


Thank you !!
Eruption of Mt. Shiveluch in Kamchatka
March 25, 2015
Footage from Himawari-8 Test Observation (Band-3 (0.64μm), 2.5 min.)
Himawari-8 B03 25.MAR.2015 22:02:30UTC