Introduction to Japanese Geostationary Meteorological Satellites Himawari-8/9 and User Readiness

Data Utilization via HimawariCast and HimawariCloud

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12-15 May 2015
Alaska Aviation Forecast Facility, Anchorage

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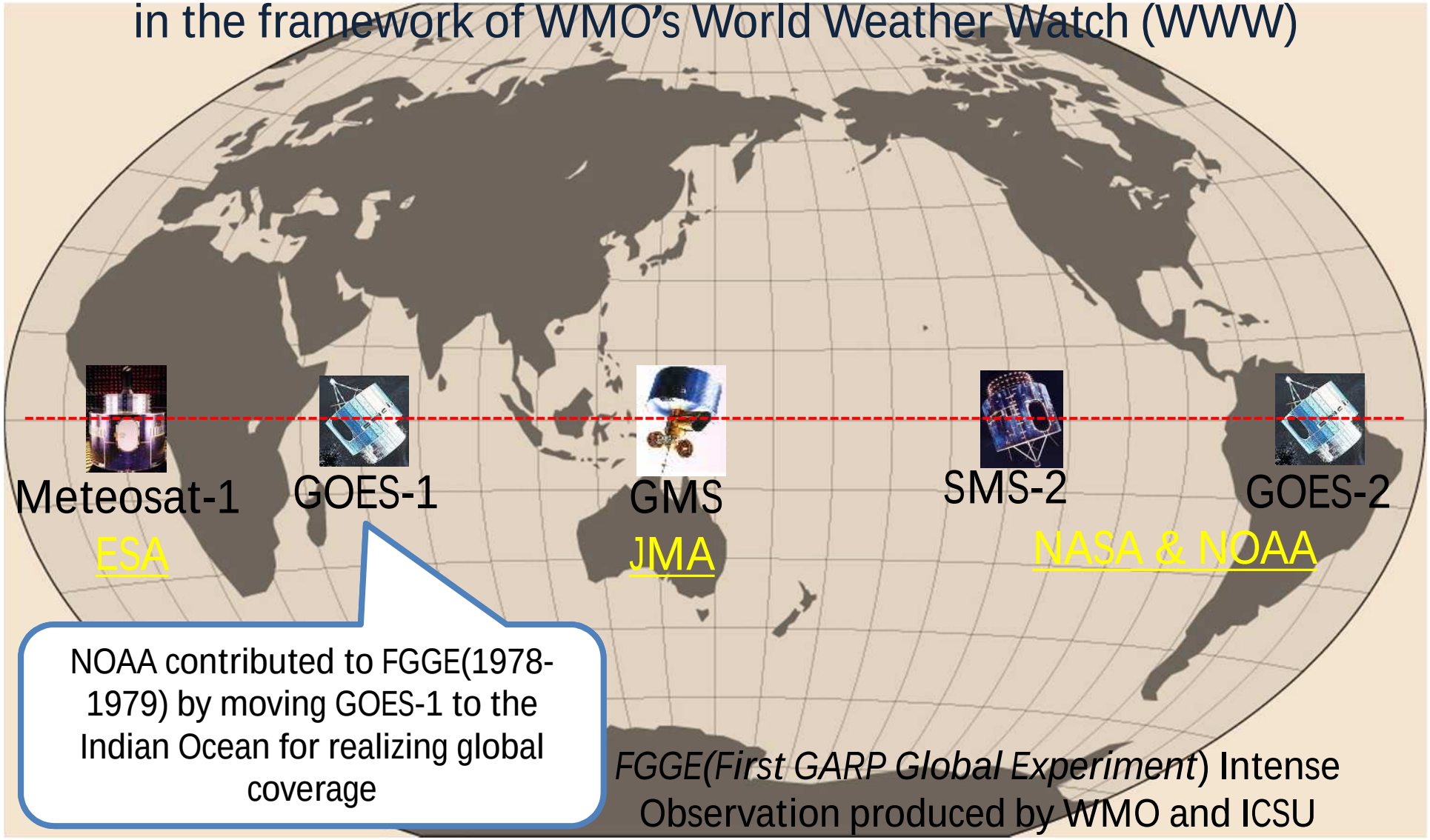
Japan Meteorological Agenc

A History of Japanese Geostationary Meteorological Satellite Project

Cooperative Observation from Geostationary Meteorological Satellites Array in 1978

in the framework of WMO's World Weather Watch (WWW)



NOAA contributed to FGGE(1978-1979) by moving GOES-1 to the Indian Ocean for realizing global coverage

FGGE(First GARP Global Experiment) Intense Observation produced by WMO and ICSU for archiving global dataset (Dec. 1978 - Nov. 1979)

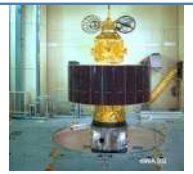
History of Japanese Geostationary Meteorological Satellites (launch year)

NOAA and JMA agree with the mutual geostationary satellite back-up arrangements that serve to mitigate the risk to availability of operational weather data in case of satellite anomaly or launch failure.

Back-up Operation of GMS-5 with GOES-9 by NOAA/NESDIS at 155 deg. E May 2003 - June 2005

Jul 1977

Aug 1981


Aug 1984

Sep 1989

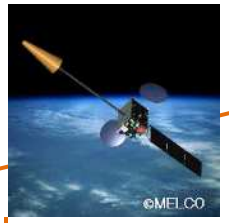
Mar 1995

MTSAT (Multi-functional Transport SATellite)

MTSAT-1R **(Himawari-6)**

Feb 2005

MTSAT-2 **(Himawari-7)**

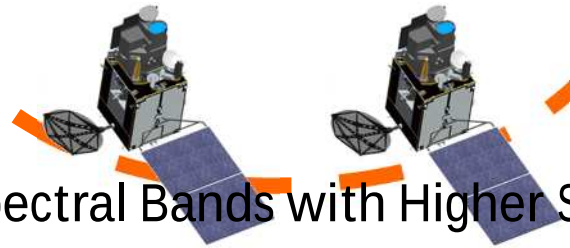


Feb 2006

Himawari

Himawari-8 — 2014

Himawari-9 — 2016



Satellite	Observation Period
GMS	1978 – 1981
GMS-2	1981 – 1984
GMS-3	1984 – 1989
GMS-4	1989 – 1995
GMS-5	1995 – 2003
GOES-9	2003 – 2005
MTSAT-1R	2005 – 2010
MTSAT-2	2010 –
Himawari-8	Launch in 2014
Himawari-9	Launch in 2016 ?

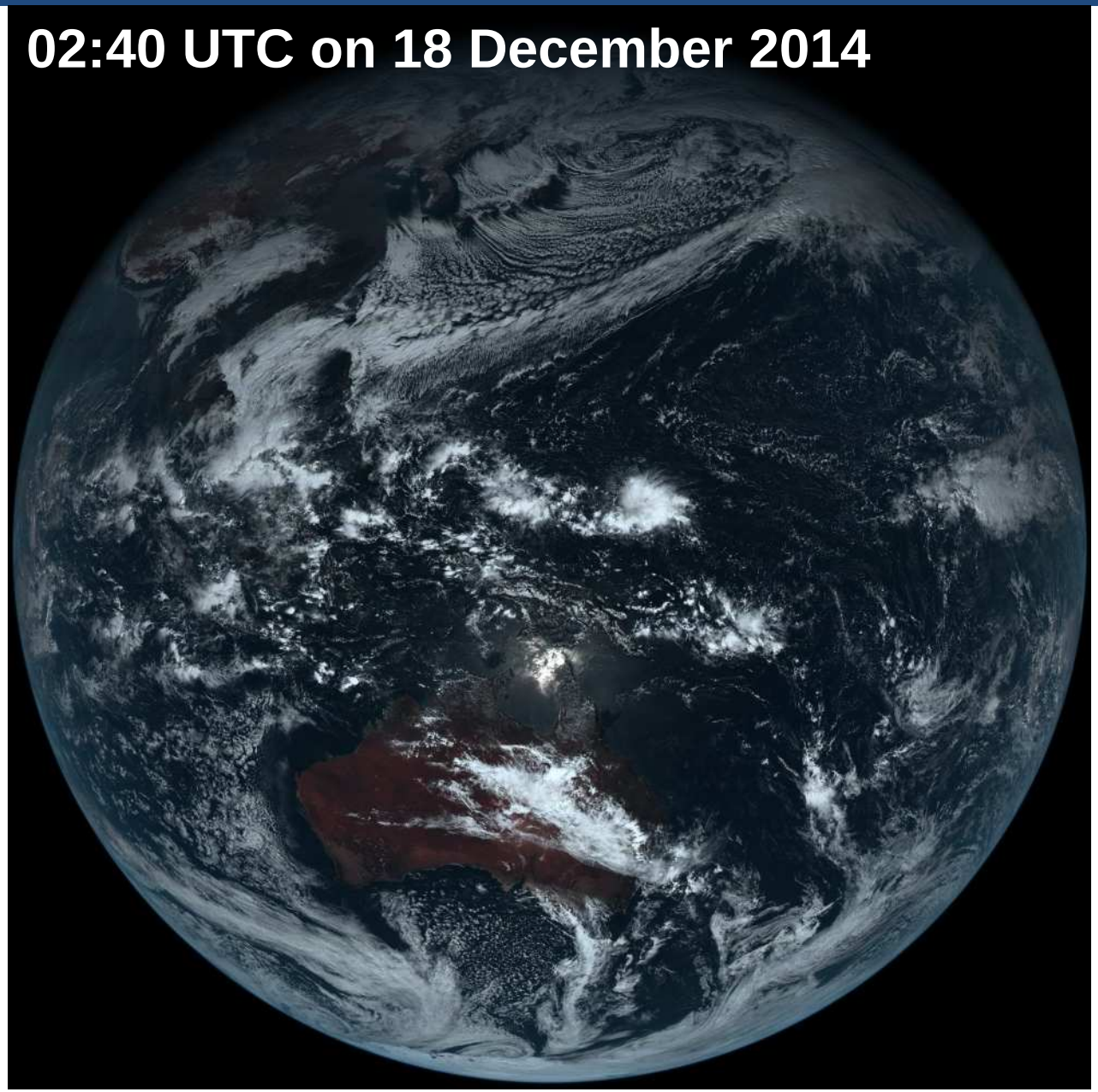
Increased Observation Spectral Bands with Higher Spatial/Temporal Resolution

Introduction to JMA's Next Generation Geostationary Meteorological Satellite Himawari-8/9

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

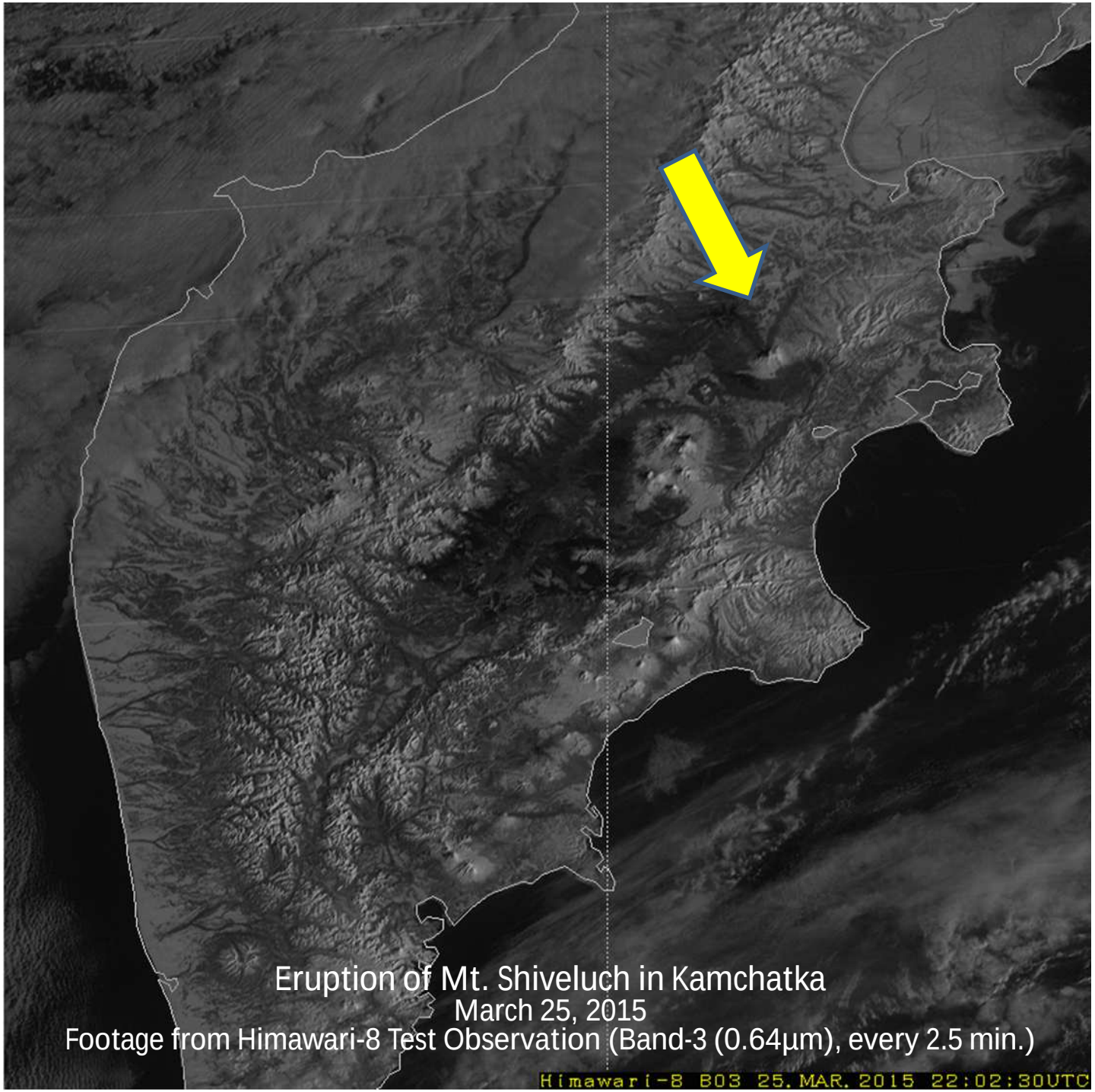
First Shot of Himawari-8



Dawn of a “New Era”

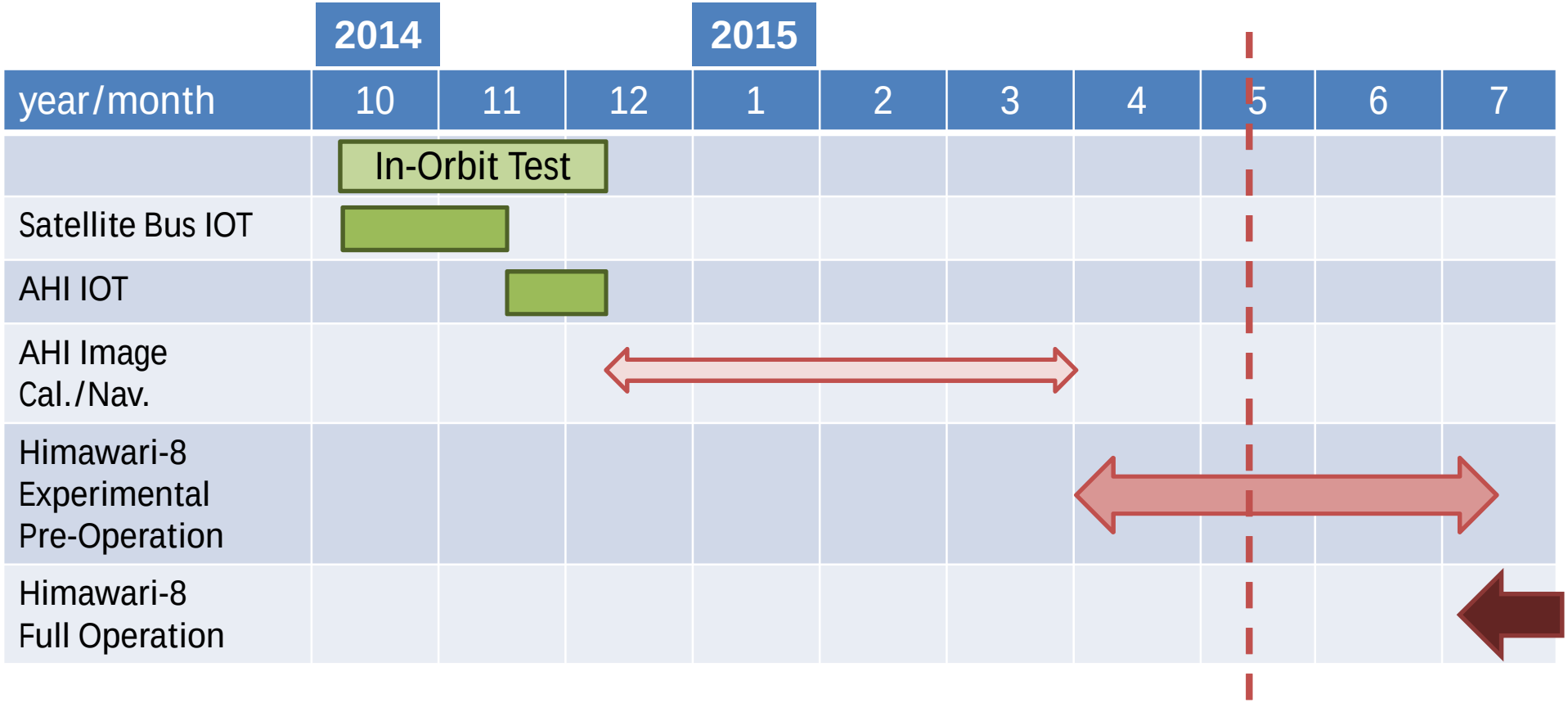
MTSAT-2
Hourly in Monochrome

Himawari-8
every 10 minutes in Full-Color



Eruption of Mt. Shiveluch in Kamchatka
March 25, 2015
Footage from Himawari-8 Test Observation (Band-3 (0.64μm), every 2.5 min.)

Himawari-8/9 Schedule toward Operation



- An Experimental Pre-Operation was commenced in April 2015.
- Full-Operation of Himawari-8 will be commenced in July 2015.
- The launch of Himawari-9 for in-orbit standby is scheduled in 2016.
- Himawari-8 and -9 will be in operation around 140 degrees East.

Enhancement on Himawari-8/9 Observation Function powered by AHI (Advanced Himawari Imager)

Spectral Characteristics of AHI in 16 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
IR2	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

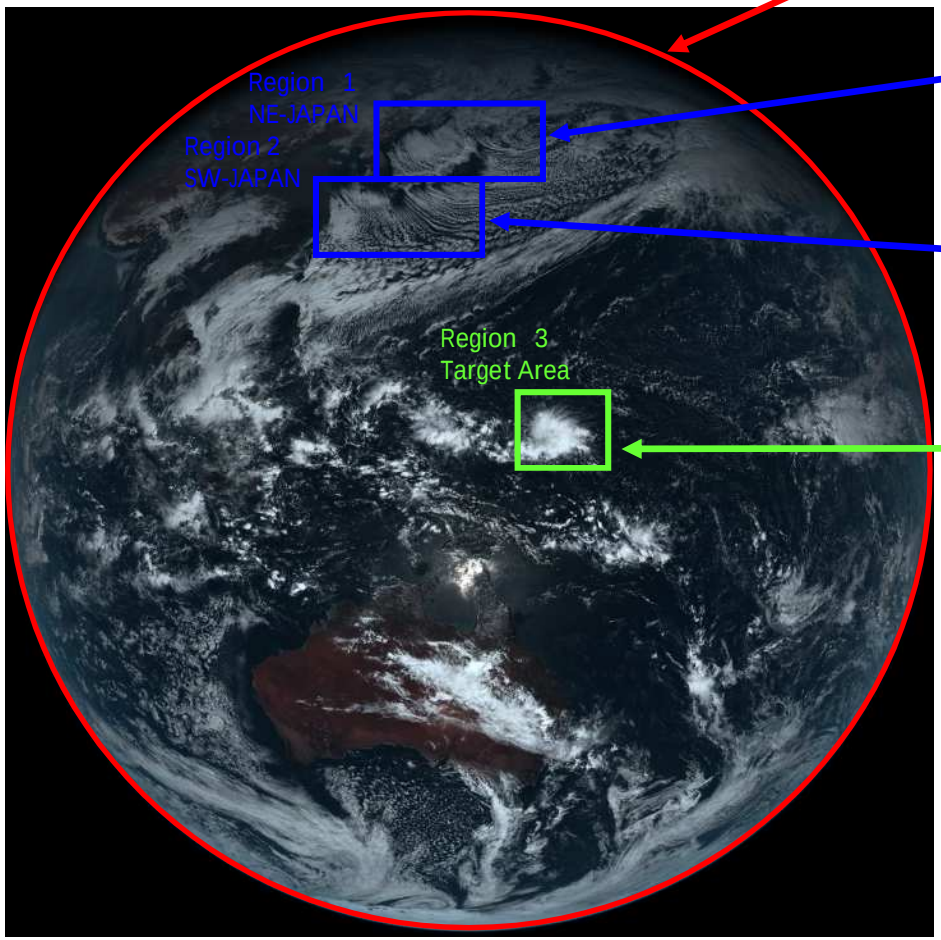
SO_2

O_3

Atmospheric Windows

CO_2

AHI Observation features in 10-minutes time frame



Full disk

Interval : 10 minutes (6 times per hour)

Region 1 JAPAN & Vicinity (North-East)

Interval : 2.5 minutes (4 times in 10 min)

Dimension : EW x NS: 2000 x 1000 km

Region 2 JAPAN & Vicinity (South-West)

Interval : 2.5 minutes (4 times in 10 min)

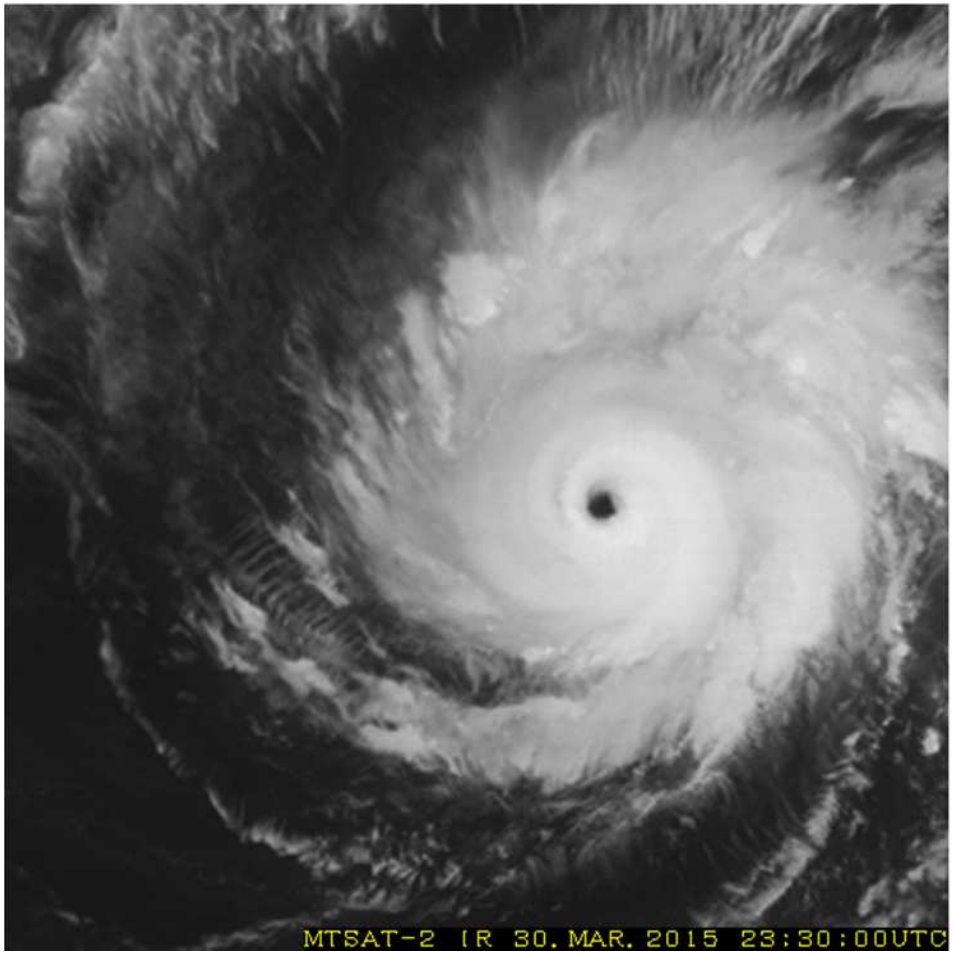
Dimension : EW x NS: 2000 x 1000 km

Region 3 Target Area

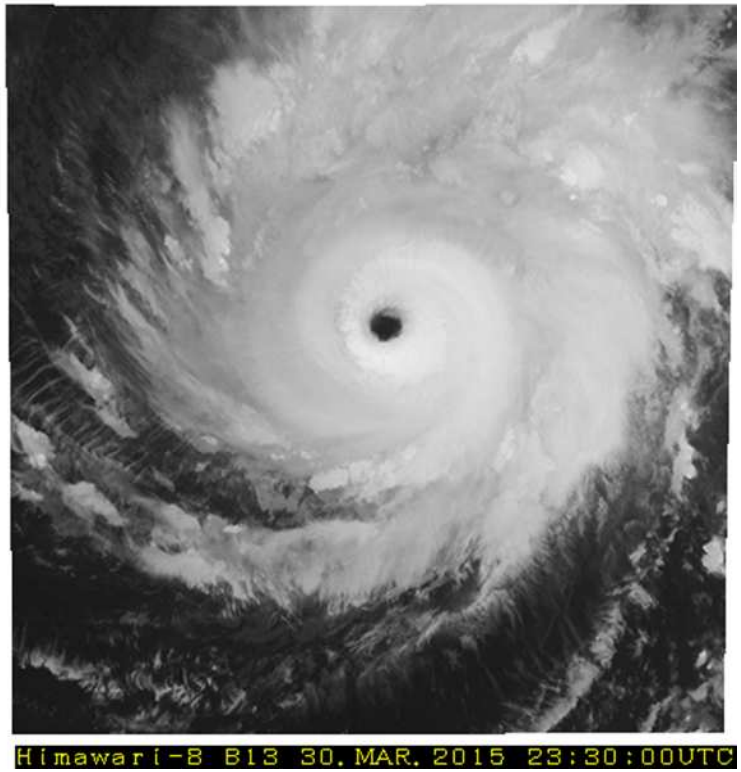
Interval : 2.5 minutes (4 times in 10 min)

Dimension : EW x NS: 1000 x 1000 km

L1 products (Improvement of temporal resolution)



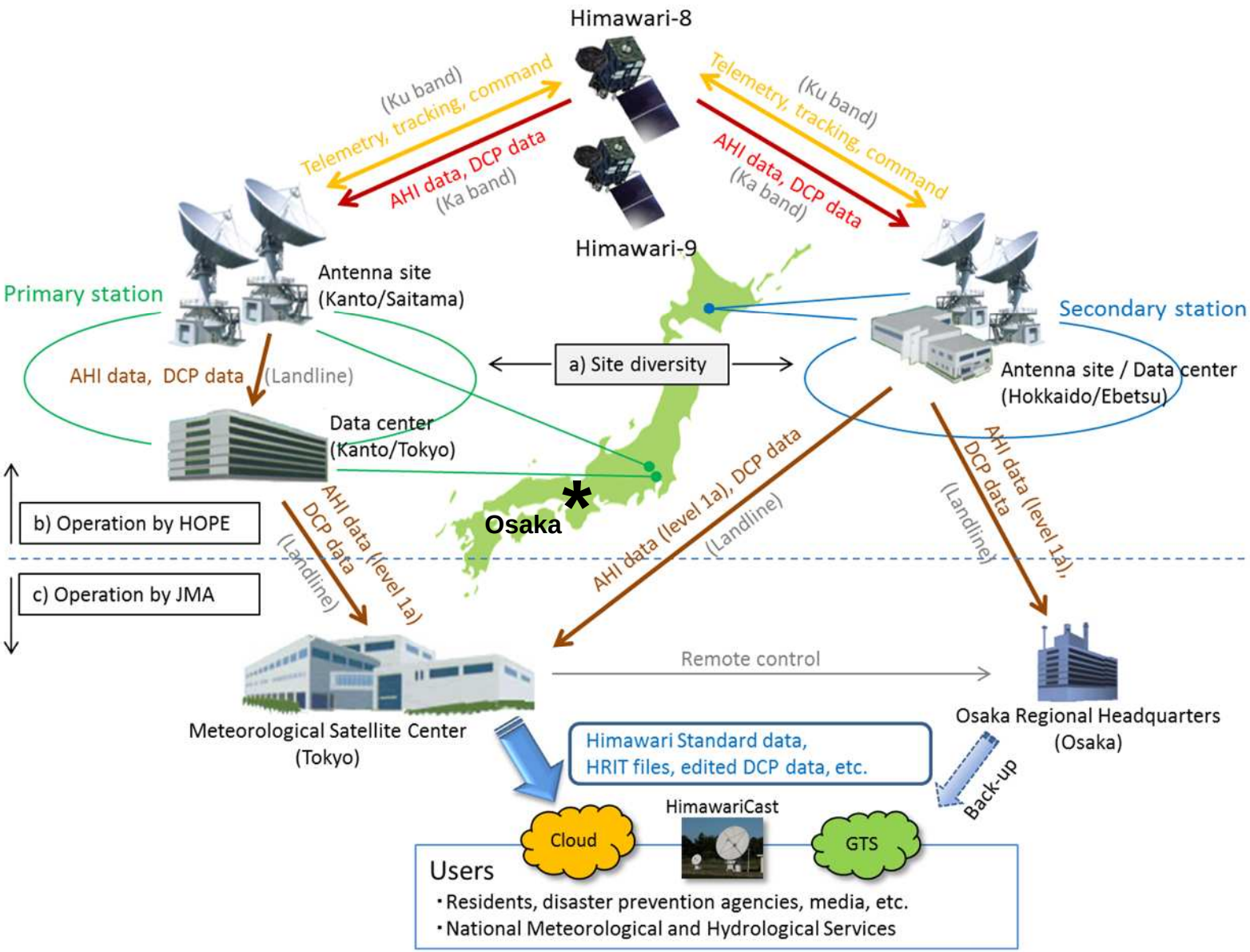
23:30UTC 30 to 09:00UTC 31 March 2015
MTSAT-2 (IR1)
every 30 minutes



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

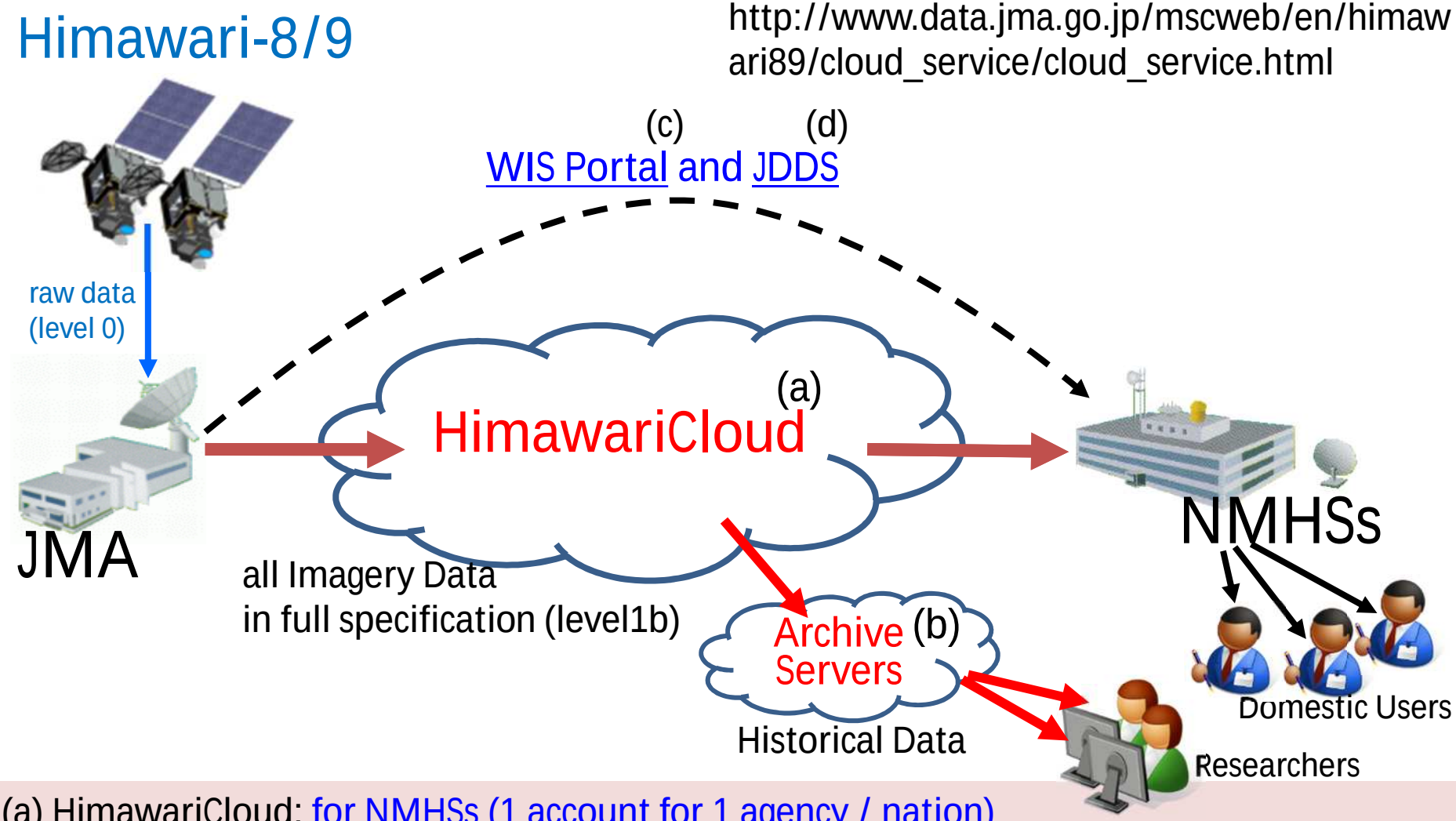
Himawari-8/9 User Readiness
HimawariCloud and HimawariCast

Himawari-8/9 Ground Segment and Operations



HimawariCloud

Himawari-8 Imagery Data Distribution via HimawariCloud (Internet)

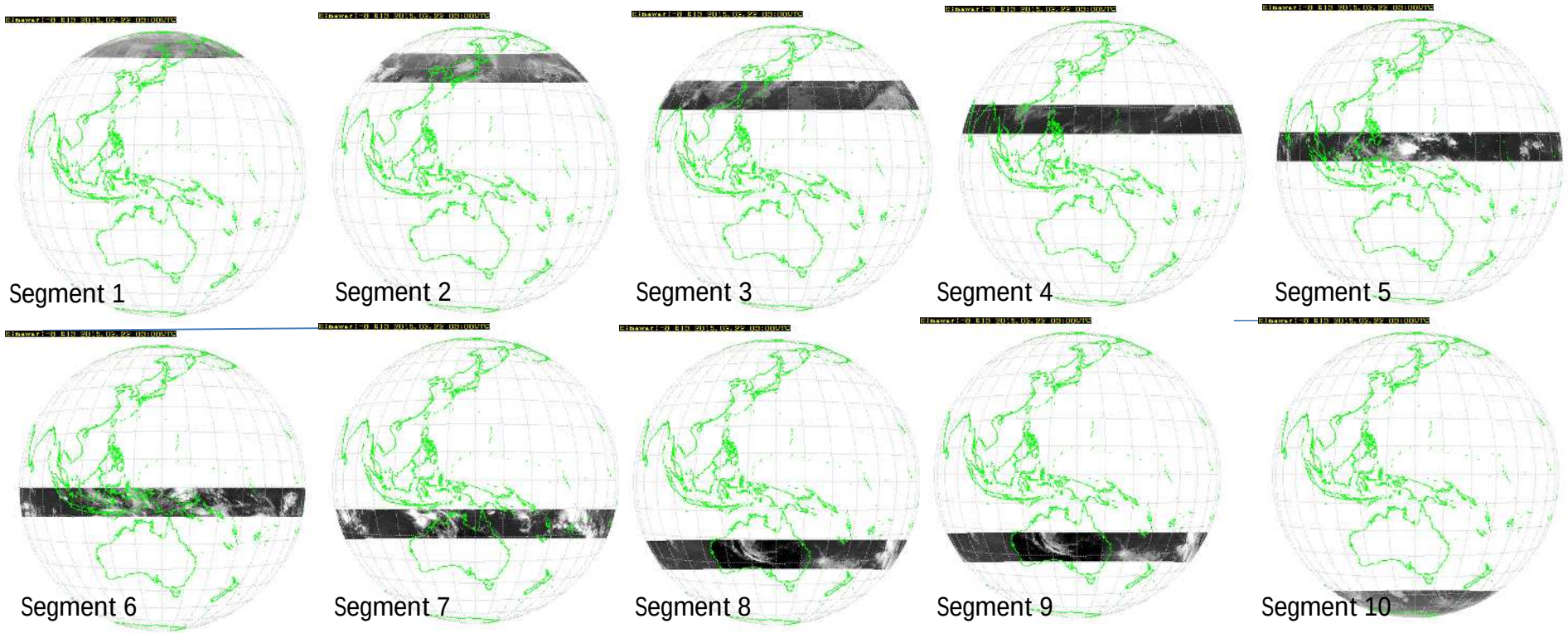


(a) HimawariCloud: for NMHSs (1 account for 1 agency / nation)
(b) Archive Servers: for Non-Profit R&D Users, operated by Japanese Science Group
(c) WIS Portal and (d) JDDS: JMA's Internet FTP service for NMHSs as back-up

HimawariCloud Contents

Format	Area	Data size	Remarks
Himawari Standard Data (HSD)	Full disk Target area	329 GB (1 day) #3: 930 MB (10 min) #1, 2, 4: 230 MB (10 min) #5-16: 60MB (10 min)	- Full disk: every 10 minutes - Target area: every 2.5 minutes - 16 bands - Finest-spatial-resolution data
PNG	Full disk Target area	49 GB (1 day) 350 MB (10 min)	- True color image (composites of 3 visible bands) - Full disk: every 10 minutes - Target area: every 2.5 minutes - Same spatial resolution as HSD
NetCDF	Target area	12 GB (1 day) #3: 8 MB (2.5 min) #1, 2, 4: 2 MB (2.5 min) #5-16: 0.5 MB (2.5 min)	- Every 2.5 minutes - 16 bands - Same spatial resolution as HSD

Full Disk Imagery Data from HimawariCloud

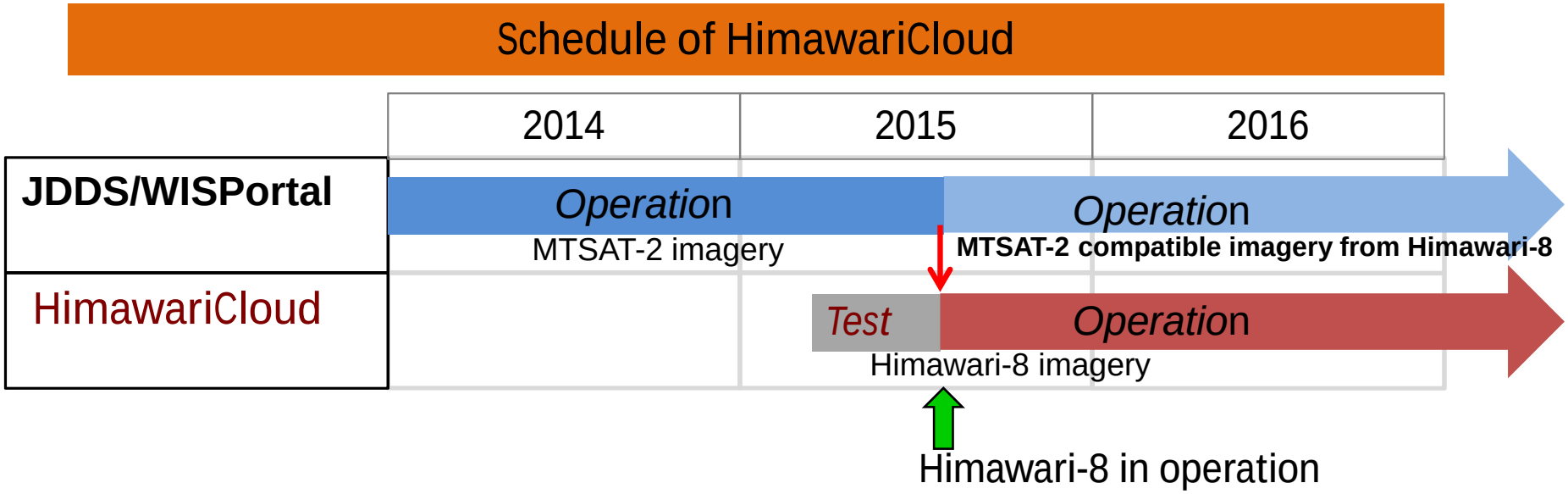


- Full disk imagery is divided into 10 segments for downloading
- Approximate coverage of each segment is shown in latitude at 140 deg.E

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

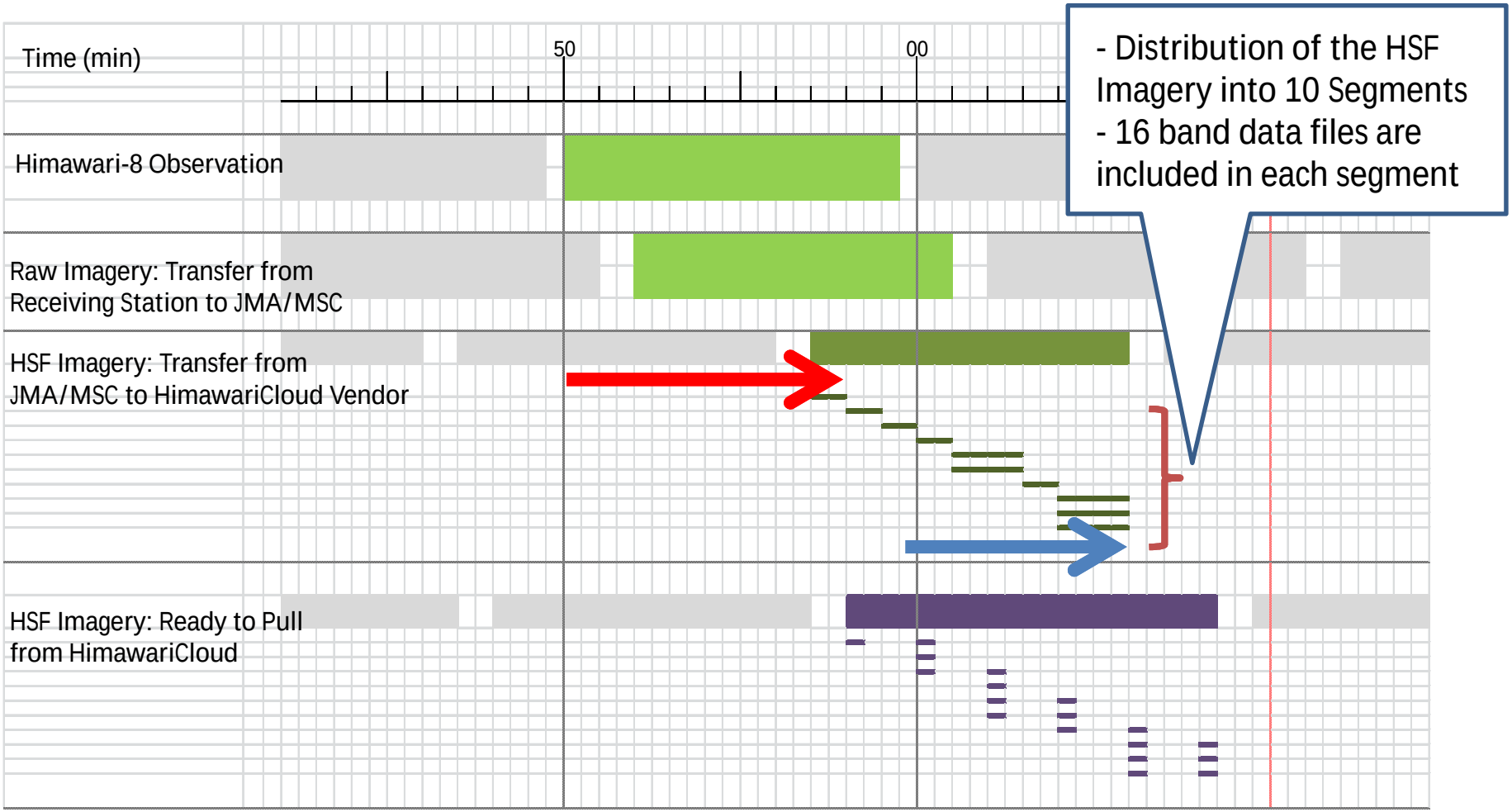
HimawariCloud Schedule

- HimawariCloud test service was commenced in April 2015 for distributing Himawari-8 Imagery in experimental pre-operation phase.
- Each NMHS will be provided one account to access HimawariCloud from JMA.
- JMA will continue JDDS/WIS Portal Service as back-up after HimawariCloud will be in operation



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)

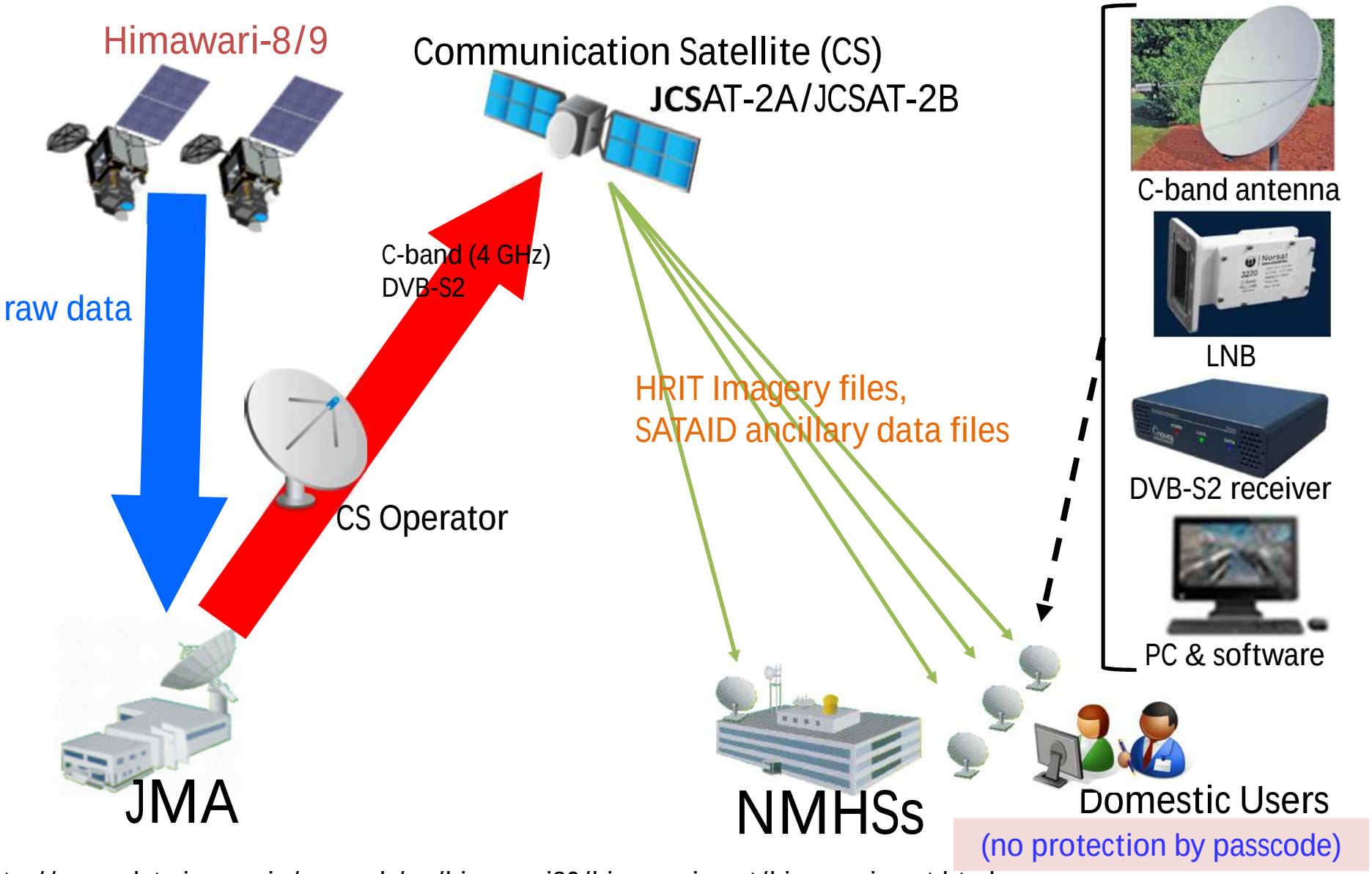


The first segment data is to be ready for pulling within 8 min. after observation start time

(the last segment data within 7 min. after observation end time)

HimawariCast

Himawari-8 Imagery Data Dissemination via HimawariCast



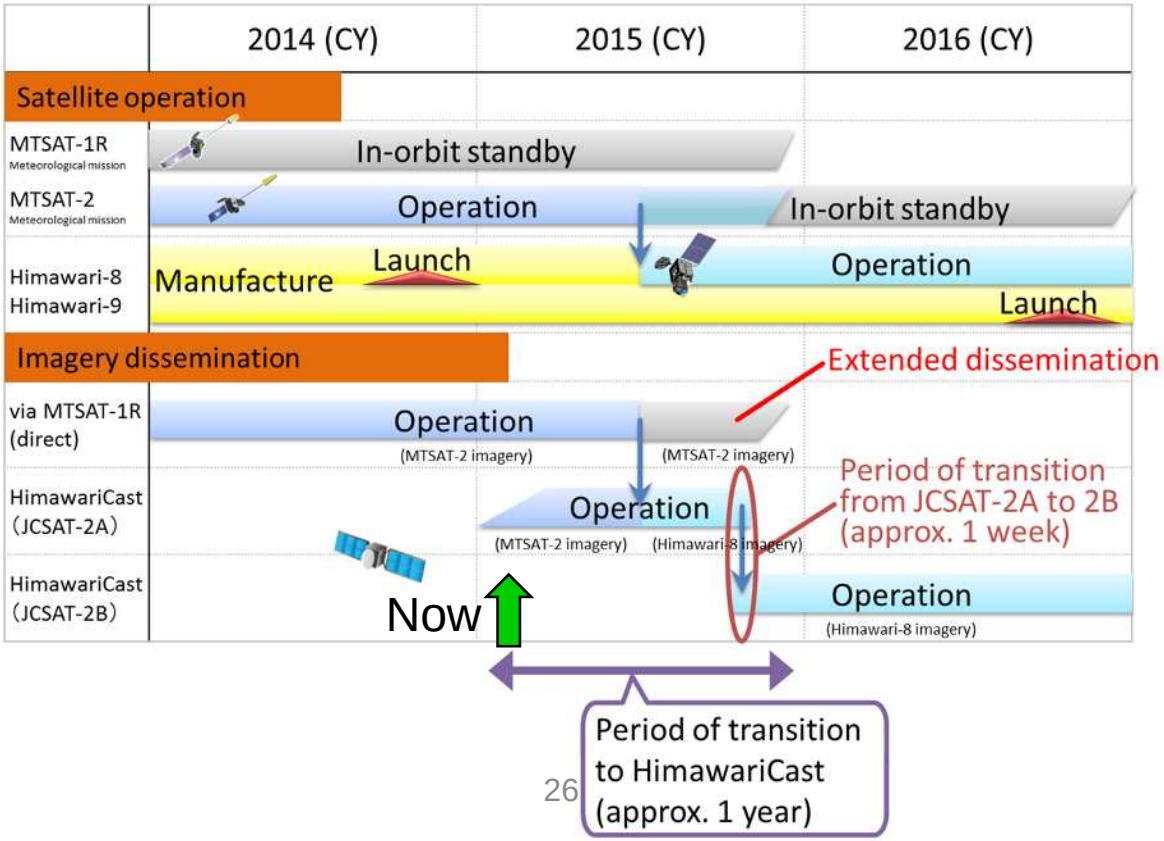
http://www.data.jma.go.jp/mscweb/en/himawari89/himawari_cast/himawari_cast.html

HimawariCast Contents

Data type	Format/size	Remarks
Himawari-8/9 imagery (Full Disk)	HRIT files 145MB (10min) LRIT files 8MB (10min)	- Compatible with current MTSAT HRIT & LRIT - Every 10 minutes - HRIT: 14 bands (1Vis, 13NIR/IR); LRIT: 4 bands - Same resolution as MTSAT HRIT
NWP Products(GPV)	SATAID format 10 MB (6hour)	- JMA's Global Spectral Model (GSM) products - Every 6 hours
In-situ Observations (Surface, upper-air, ships)	SATAID format less than 1 MB (1 hour)	- Observation data collected from the East Asia and Western Pacific regions
ASCAT Ocean Surface Wind	SATAID format 5 MB (1 hour)	- Originally provided by EUMETSAT OSI SAF and converted into SATAID format by JMA

HimawariCast Schedule

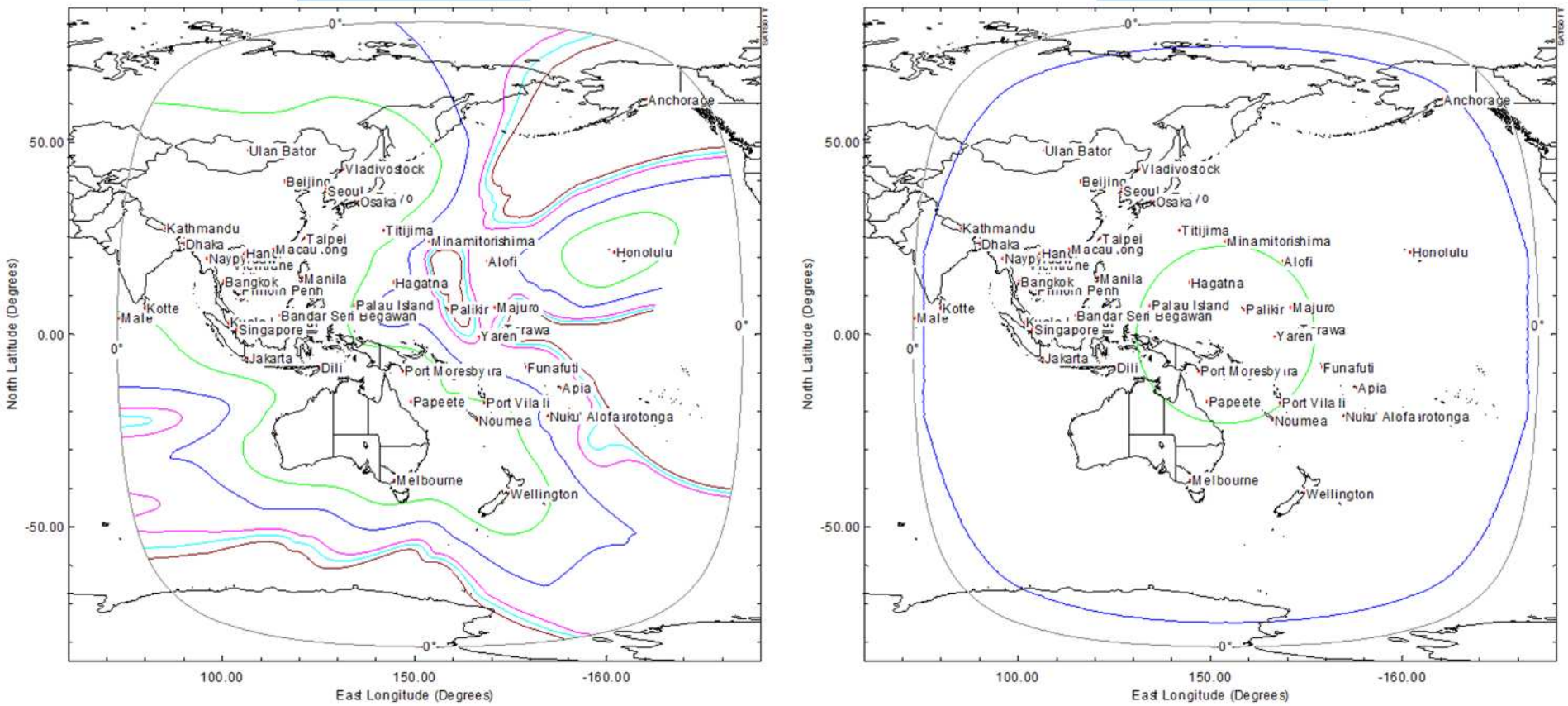
- HimawariCast disseminates Himawari-8 imagery data in MTSAT compatible HRIT data format using a communication satellite, JCSAT.
- JMA started HimawariCast service in January 2015.
- Users need to install new equipment (C-band antenna and receiver).
- MTSAT-2 images will be disseminated via HimawariCast until Himawari-8 becomes operational.



Coverage of HimawariCast

The JCSAT-2B will then take over from JCSAT-2A in Q4 of 2015 at 154 deg. E

JCSAT-2A → JCSAT-2B



1.8 mΦ (16.5 dB/K)

2.4 mΦ (19.6 dB/K)

3.8 mΦ (23.0 dB/K)

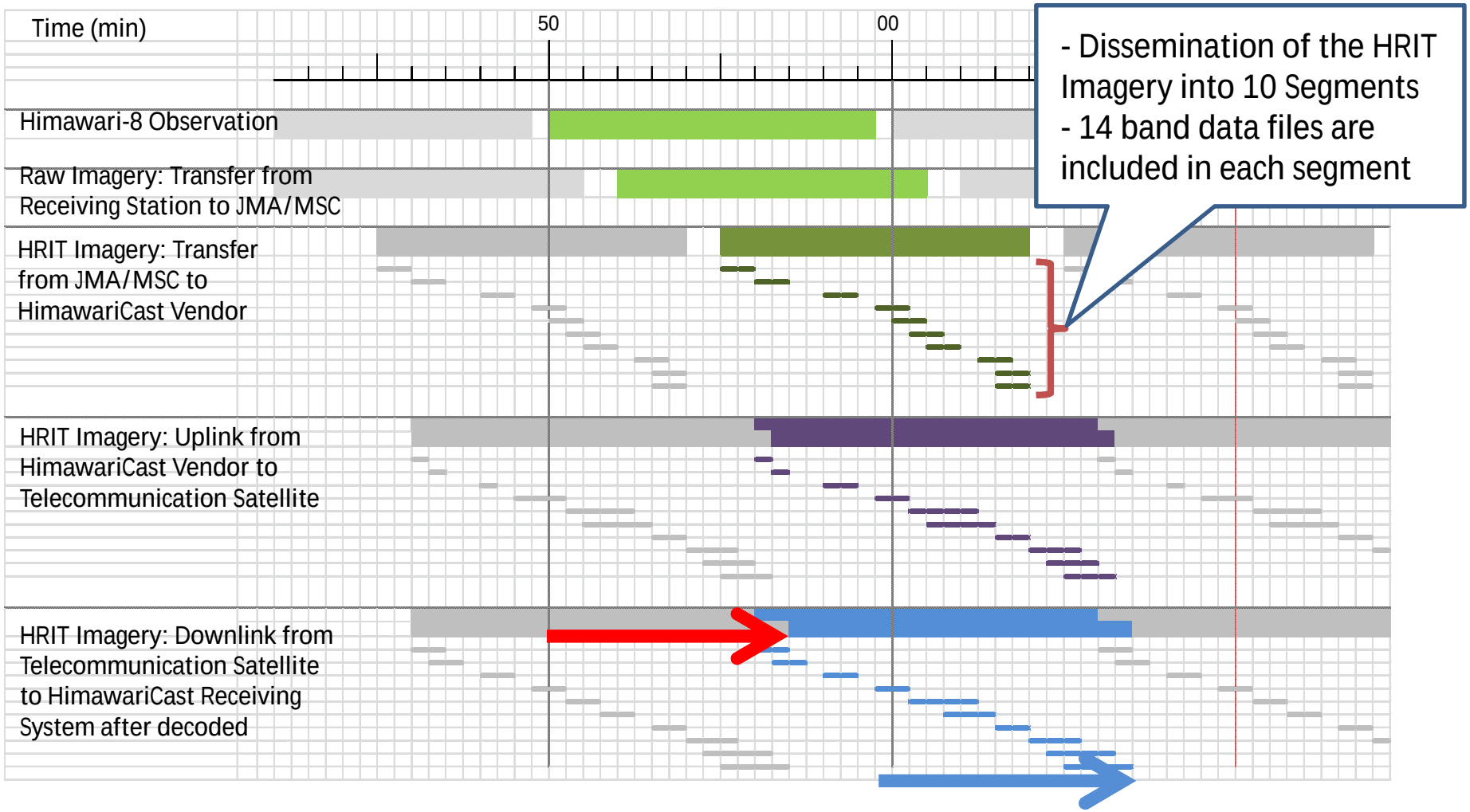
4.5 mΦ (24.8 dB/K)

5.0 mΦ (26.0 dB/K)

Diameters of antennas

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)



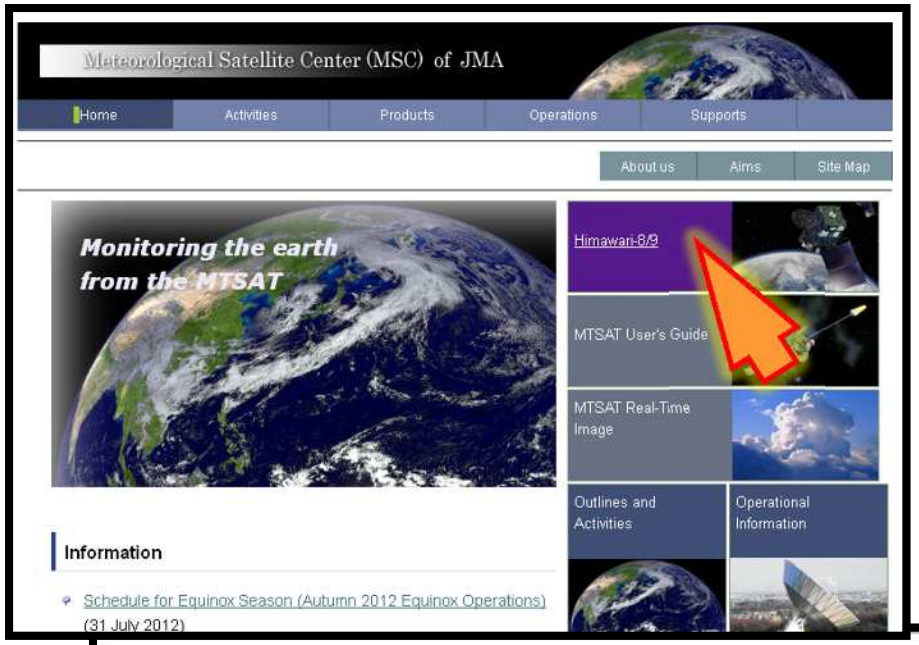
The first segment data is to be disseminated within 7 min. after observation start time

(the last segment data within 7 min. after observation end time)

MSC Website for Himawari-8/9 Information

Contents:

- Overview of satellite observations
- Overview of Himawari-8/9 data dissemination
- Plan for transition from MTSAT-2 to Himawari-8
- Overview of the Himawari-8/9 ground segment and operations
- Sample Imagery data
- Sample program with source code to read Imagery data
- Other Utilities for User's Convenience

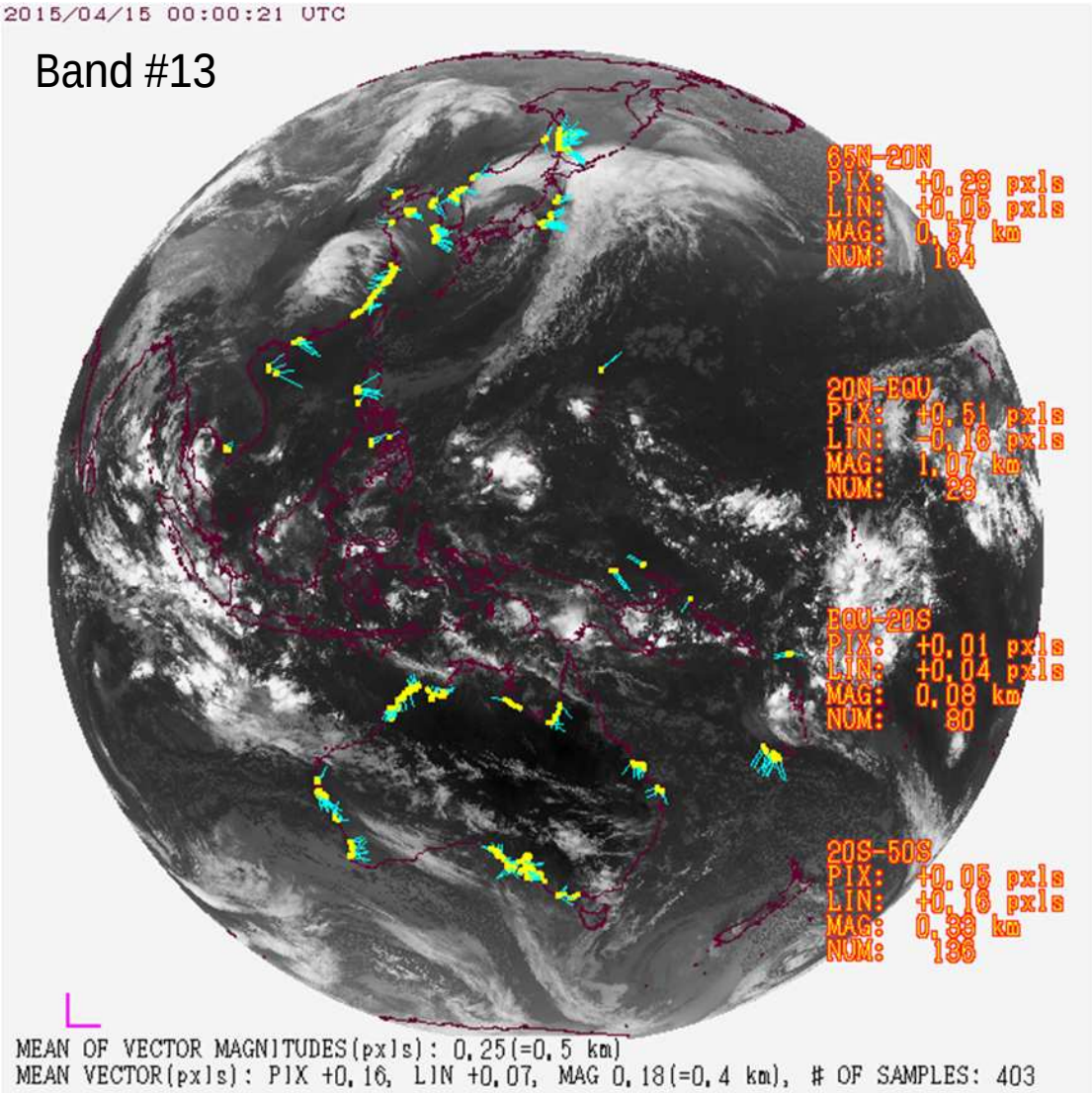


http://www.jma-net.go.jp/msc/en/

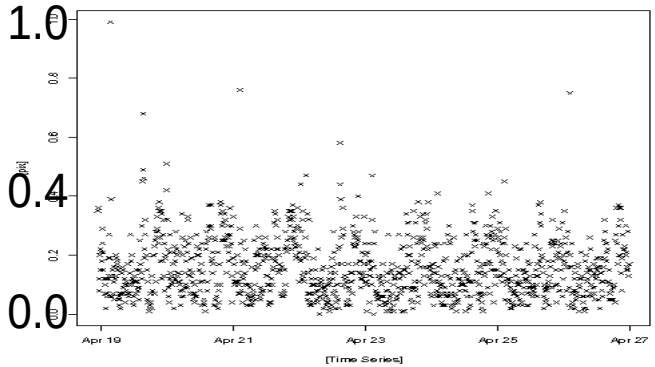
Himawari-8 Image Navigation & Calibration Status

Navigation Error

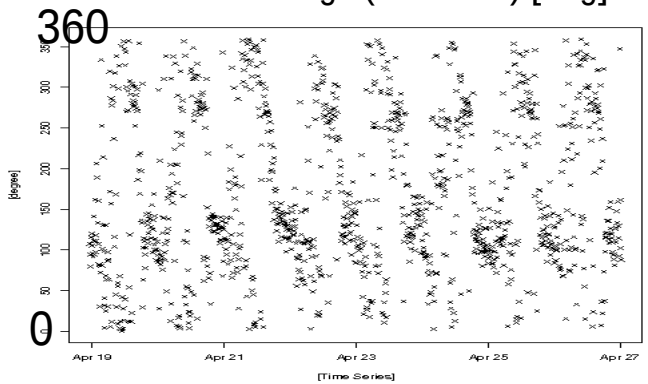
- Displacement is less than 0.5 pixels in 2.0km-bands.



Nav. Error average (magnitude) [pix]

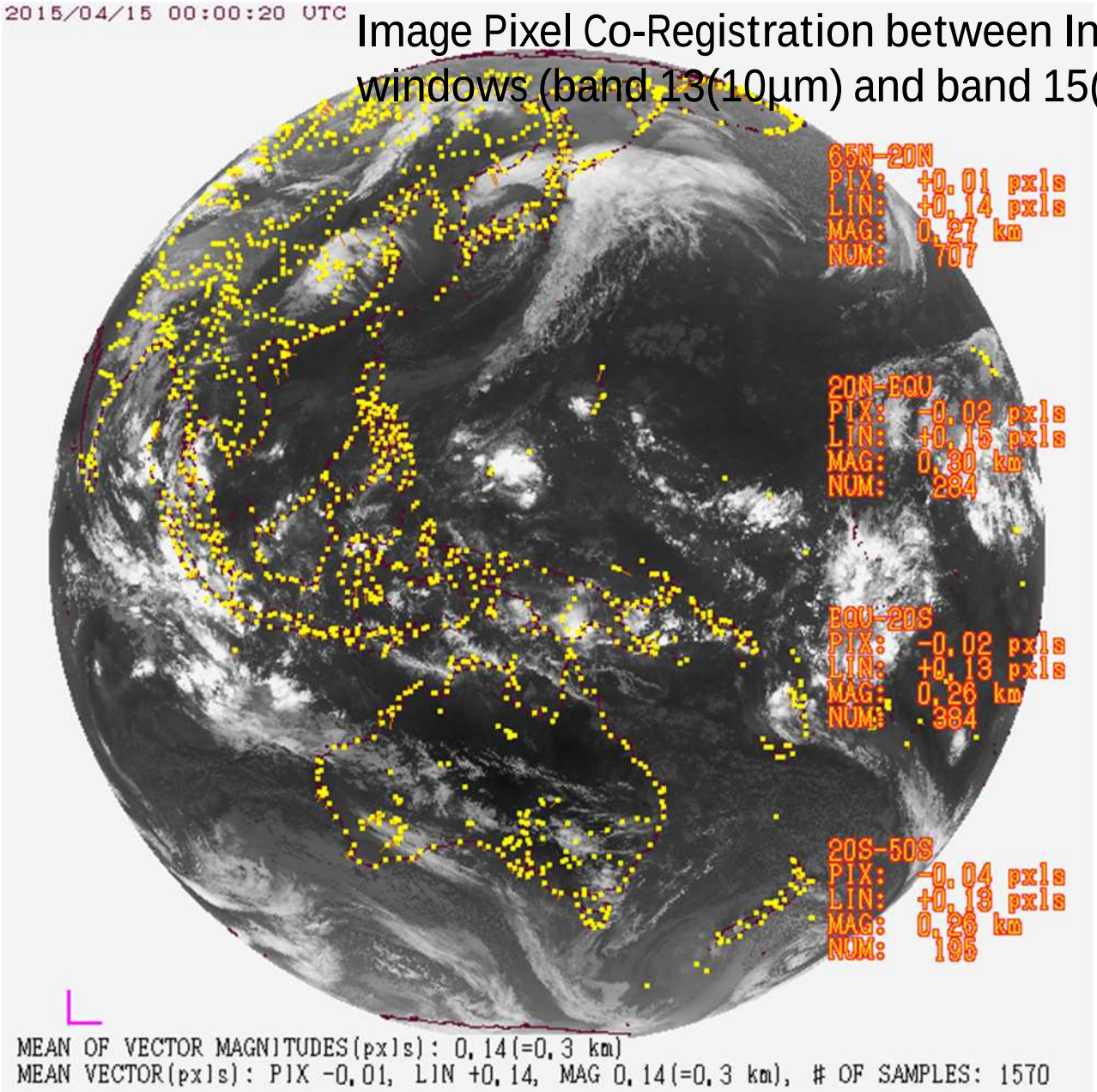


Nav. Error average (direction) [deg]



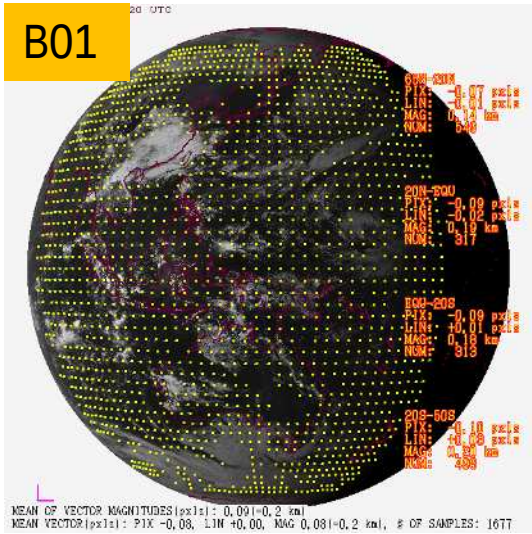
Himawari-8 Image Co-Registration between bands

Image Pixel Co-Registration between Infrared Split-windows (band 13(10µm) and band 15(12µm))

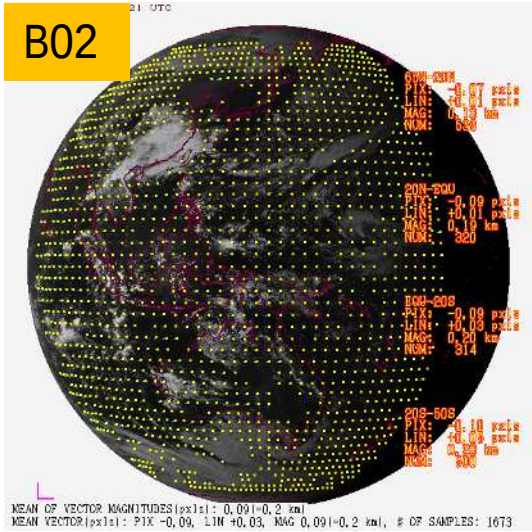


Co-registration error (comparing with B13)

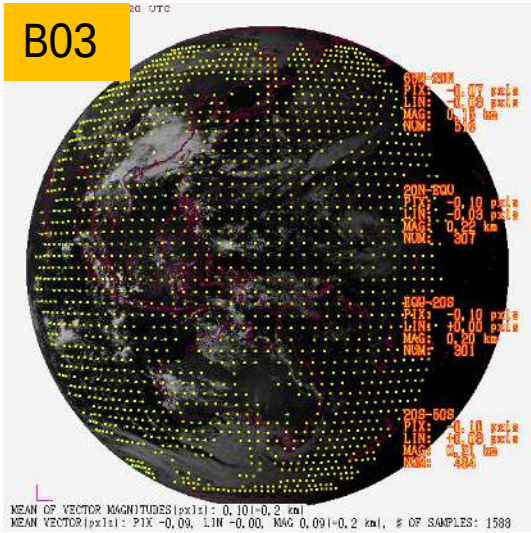
B01



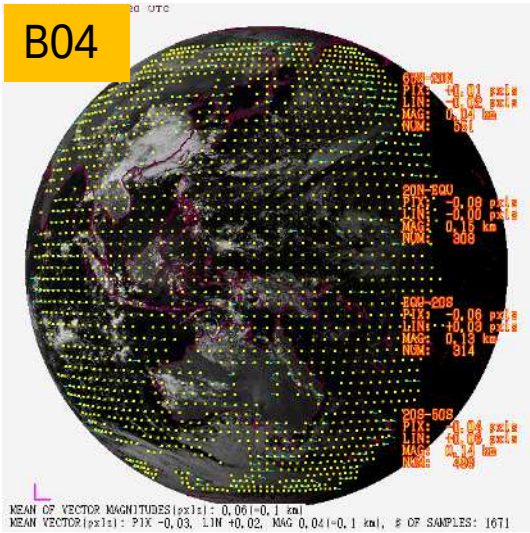
B02



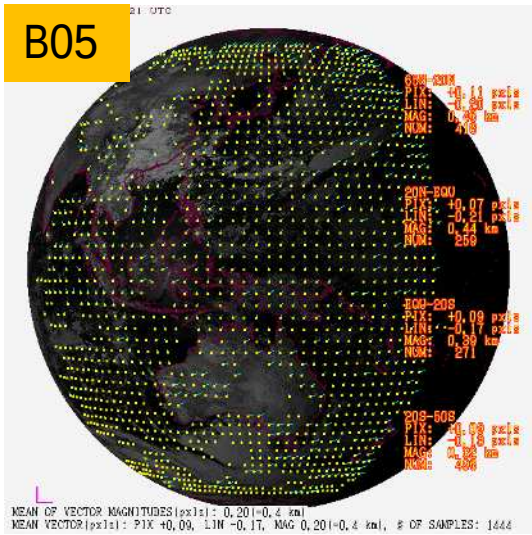
B03



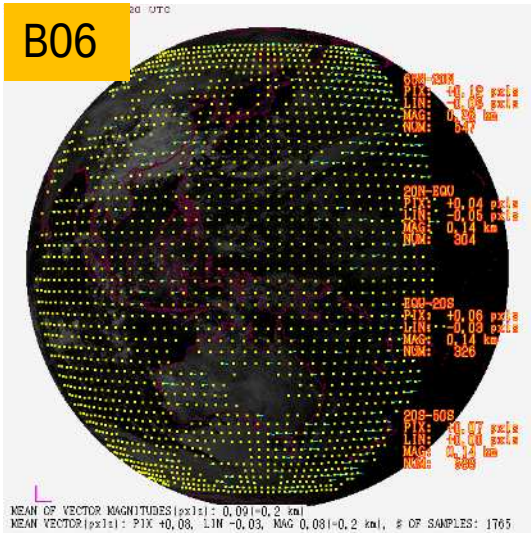
B04



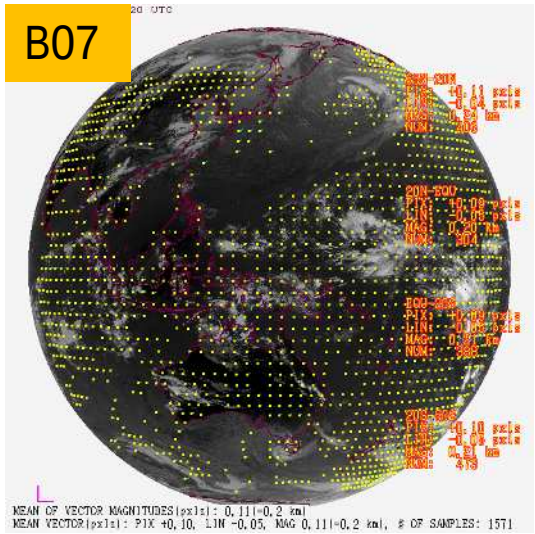
B05

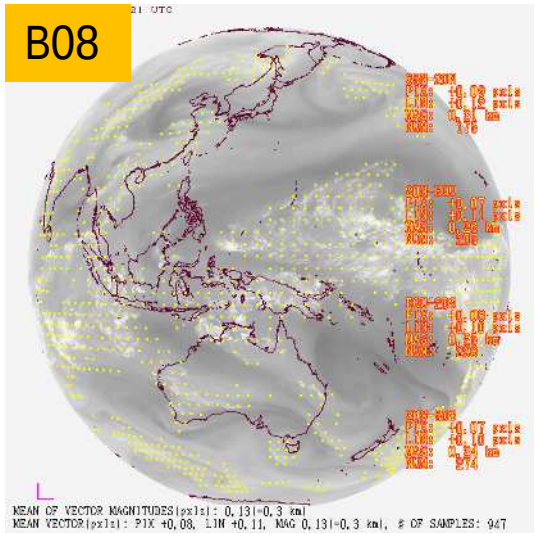


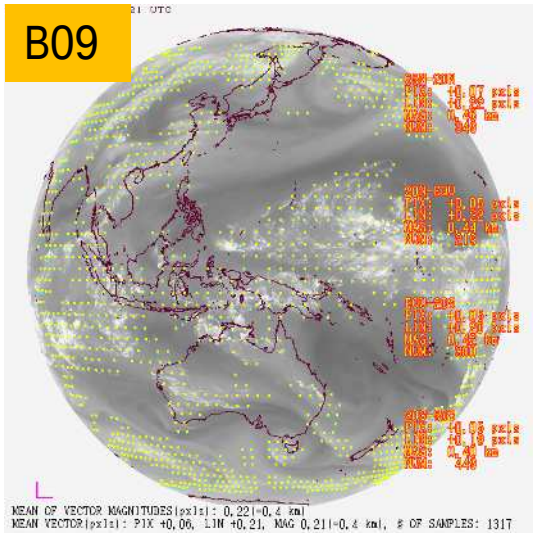
B06

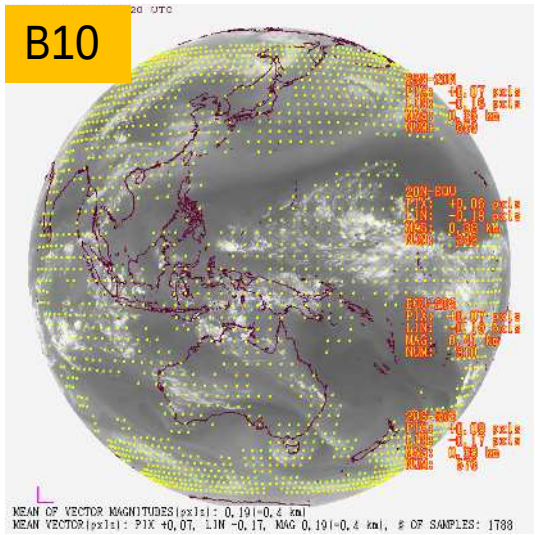


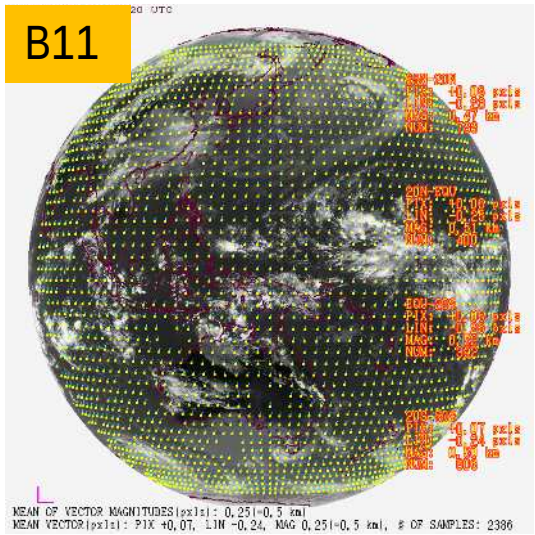
Co-registration error (comparing with B13)

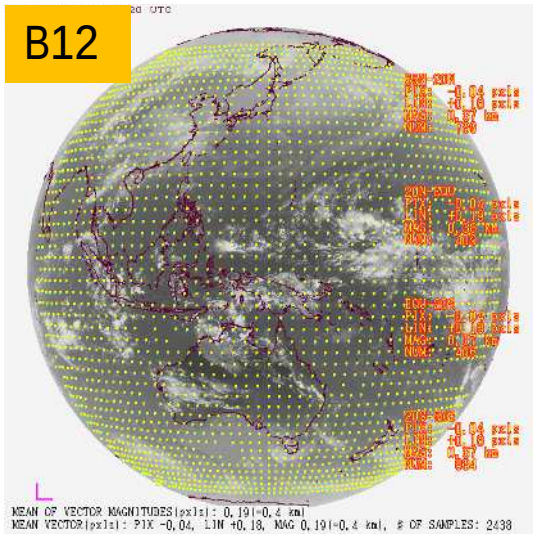






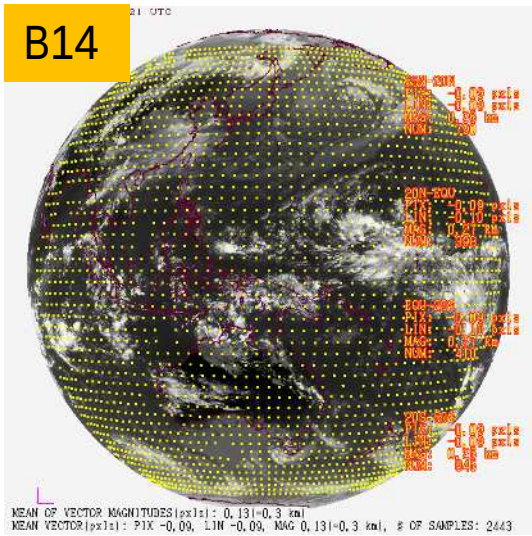


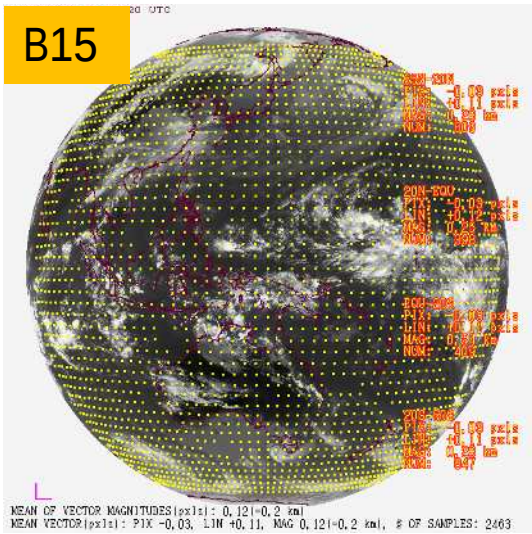


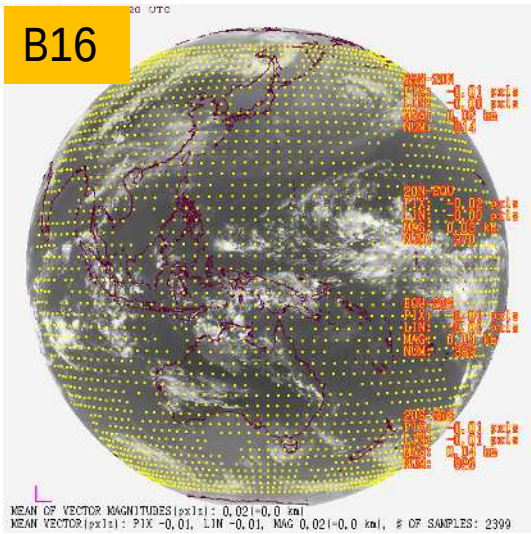


Co-Registration Error (comparing with B13)

- Displacement is around 0.2 pixels in all bands.







Onboard Calibration

Visible and Near Infrared bands

- Deep space observation is performed every swath.
- The result is applied to determine calibration coefficients.
- Some calibration coefficients are previously decided based on ground test.

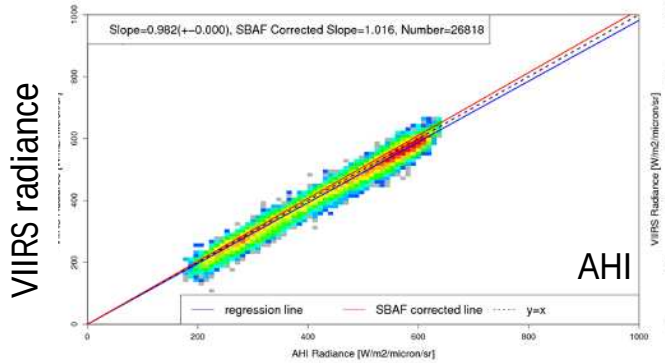
Infrared bands

- Calibration coefficients are obtained based on blackbody observation performed every 10 minutes and deep space observation performed every swath.

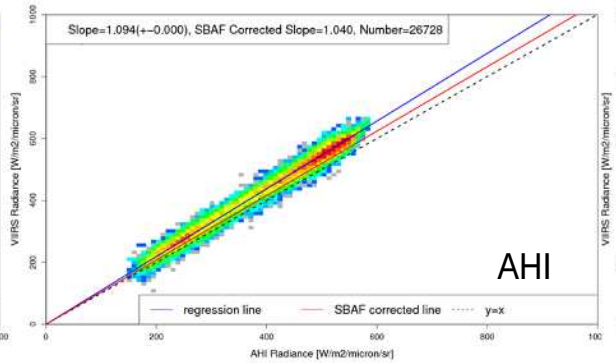
Validation of VIS/NIR calibration ("Ray-matching" approach, collocated with Suomi-NPP/VIIRS as reference)

2 Apr. 2015

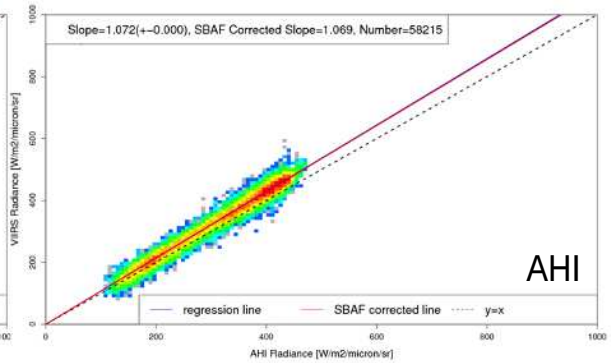
AHI B01 vs VIIRS M03



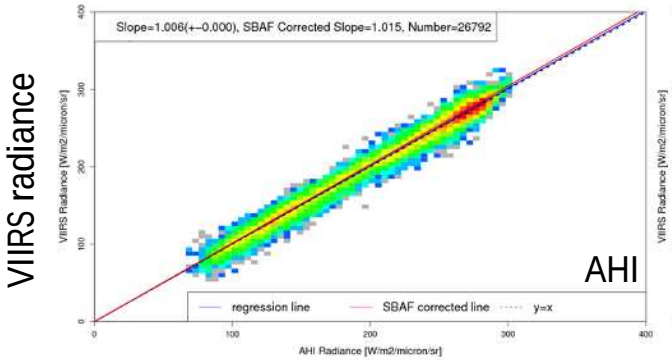
AHI B02 vs VIIRS M03



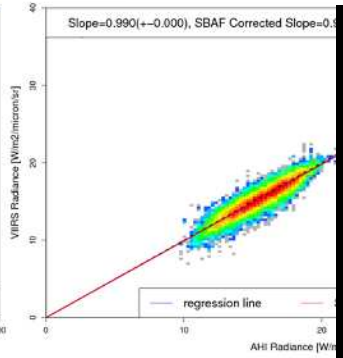
AHI B03 vs VIIRS I01



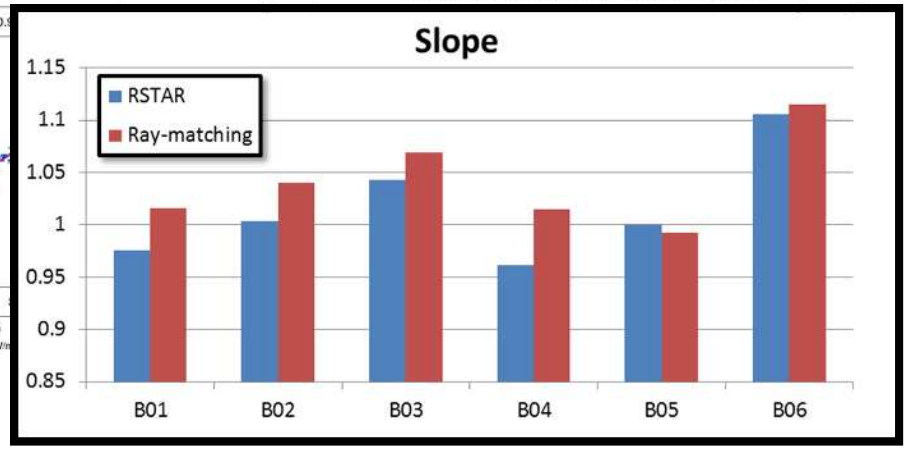
AHI B04 vs VIIRS M07



AHI B05 vs VIIRS M10



AHI B06 vs VIIRS M11



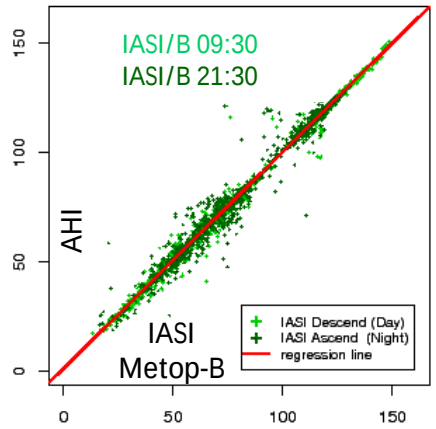
Blue: regression line

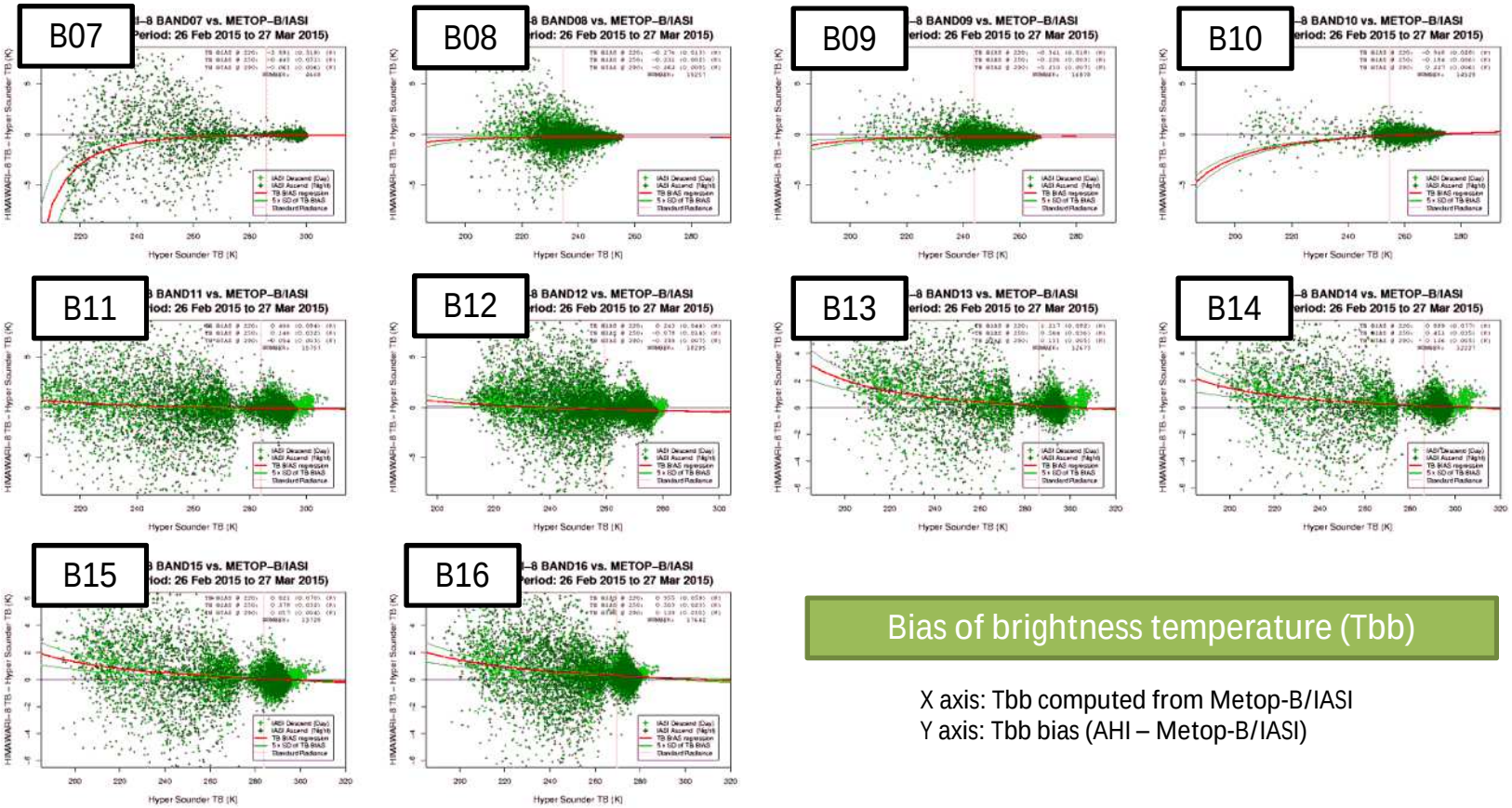
Red: regression line corrected with SRF difference

Validation of IR Calibration based on GSICS Intercomparison

- Observation bias is computed from comparison with "pseudo" radiance based on hyper-spectral infrared sounder IASI data previously fitted to SRF of AHI.
- There is no significant bias vs Metop-B/IASI

Radiance (band 13)





Bias of brightness temperature (Tbb)

X axis: Tbb computed from Metop-B/IASI
Y axis: Tbb bias (AHI – Metop-B/IASI)

Enhancement in HIMAWARI-8 Level-2 Day-1 Products

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 channel

4km --> 2 km for IR channels

Temporal:

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

2.5min for limited areas

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

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

Numerical Prediction

Severe Weather Monitoring

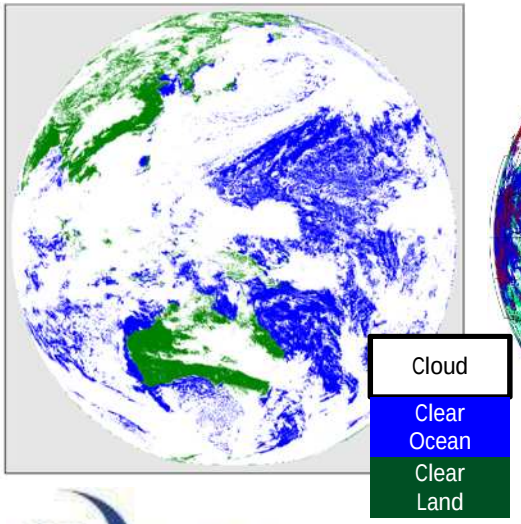
Environmental Monitoring

Cloud Products from Himawari-8/9 AHI

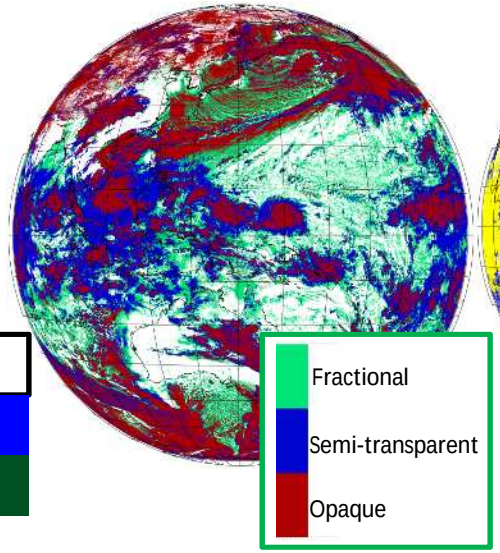
- Extracted Parameters: Cloud Mask, Type, Phase, and Top Height
- Algorithm is based on NWC-SAF*1 and NOAA/NESDIS*2

(*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

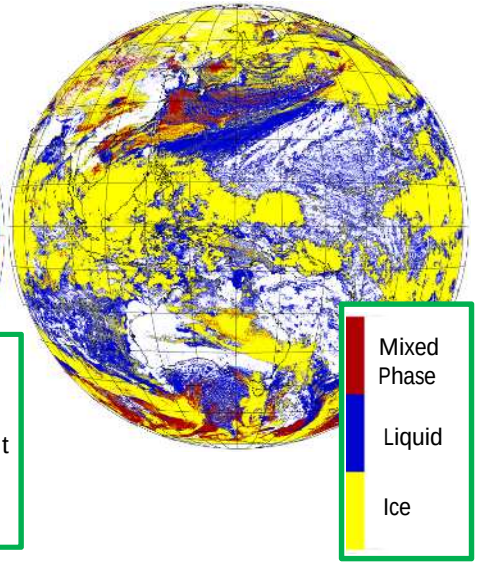
Cloud Mask



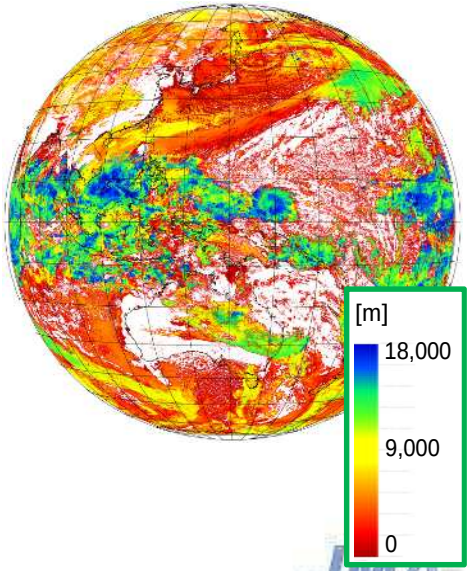
Type



Phase



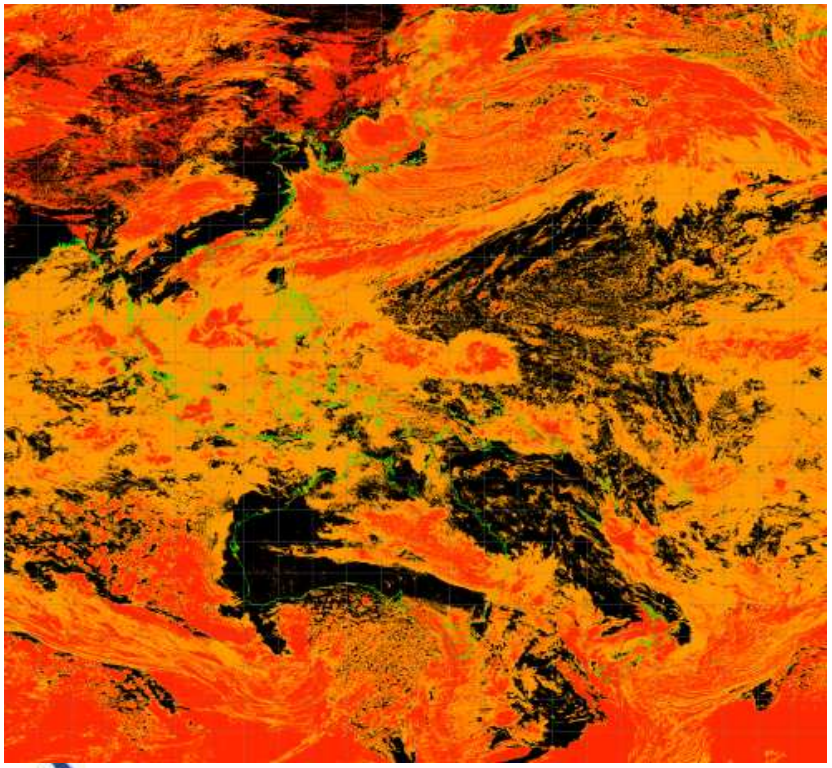
Cloud Top Height



Objective Cloud Analysis Information (OCAI)

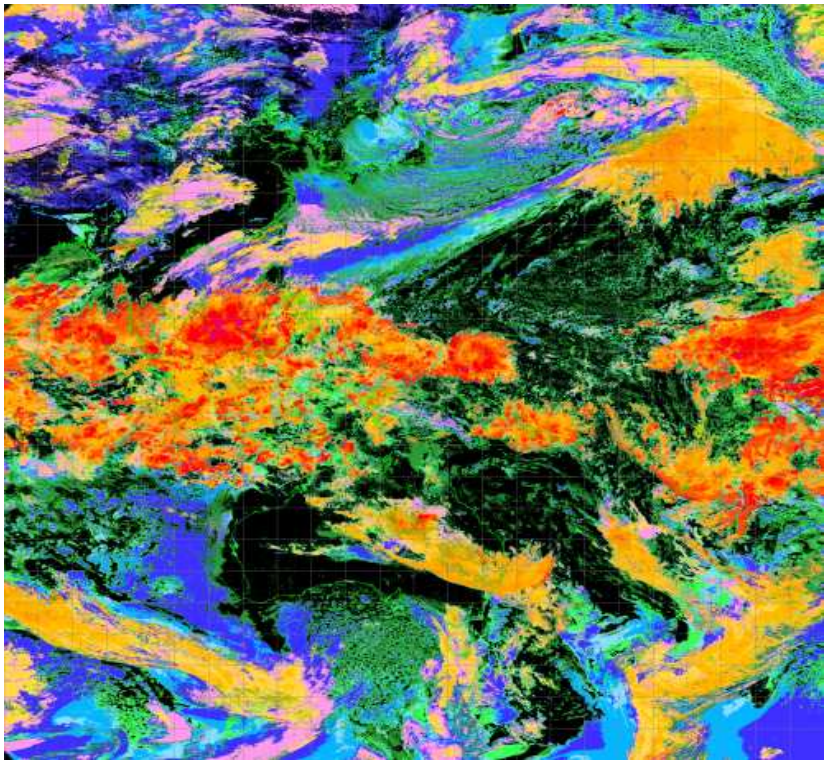
- Basic cloud product with latitude-longitude grid in 0.05 degree.
  - cloud mask, cloud type and cloud top height
- To be produced hourly when Himawari-8 becomes operational.
- Ready to provide to NMHSs, e.g. Indonesia and Myanmar, in response to requests.

Cloud Mask



Clear | Mixed | Cloud

Cloud Top Height

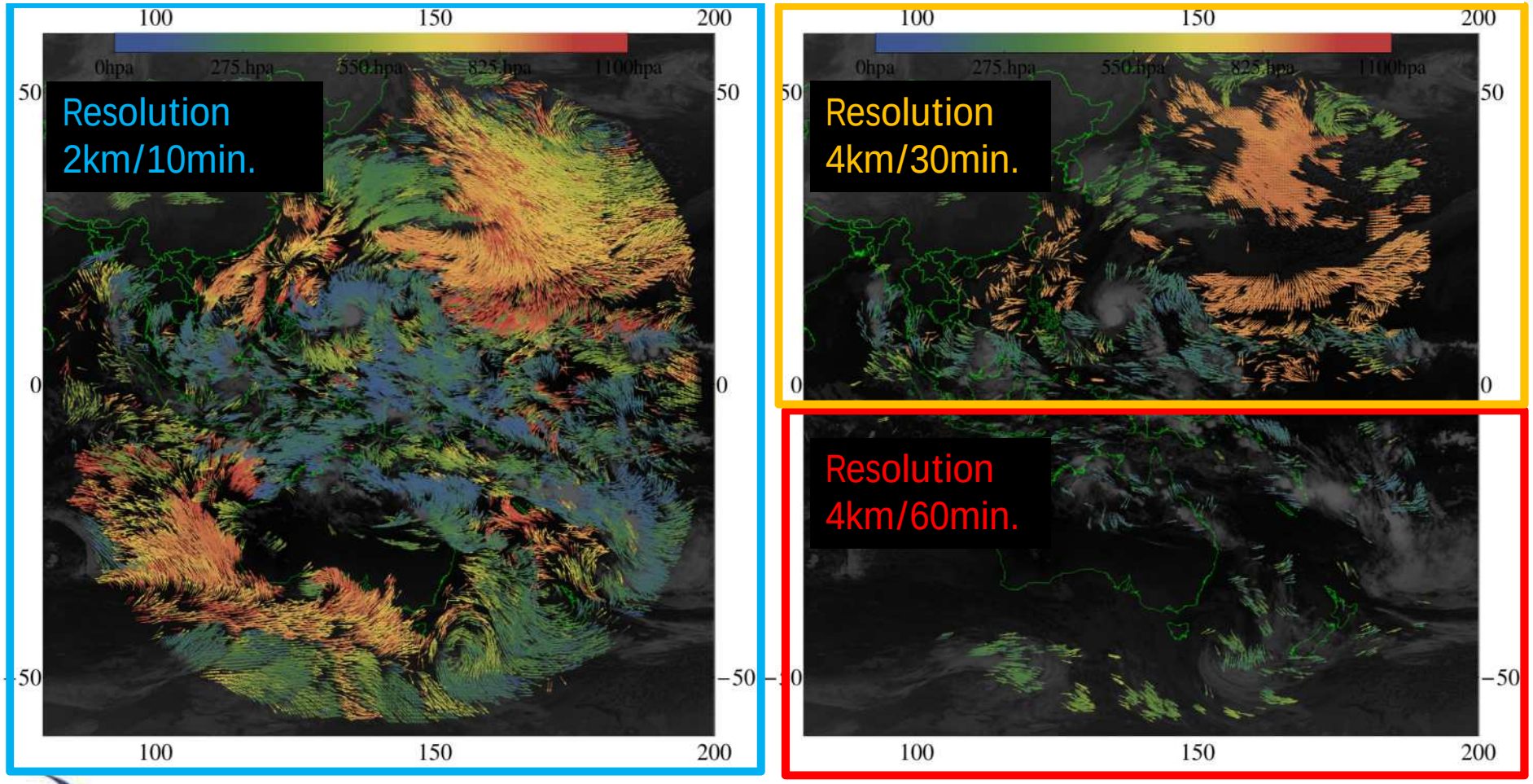


0 20 40 60 80 100 120 140 160 180 200 X100m

Improvement in Atmospheric Motion Vectors (AMVs) Retrieval

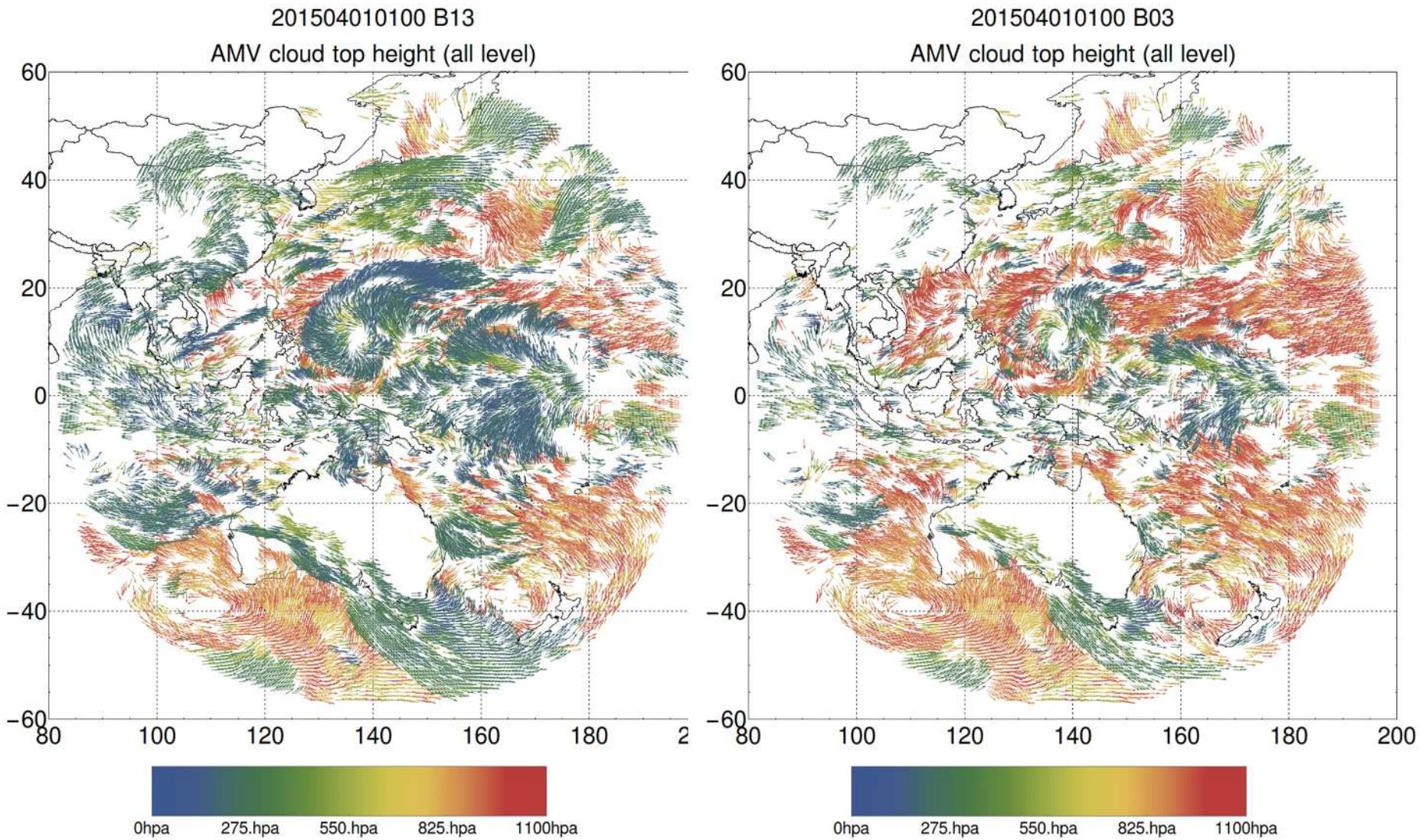
Himawari-8 AMVs derived from Himawari-8 imagery with new algorithm

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



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

Himawari-8 Derived AMVs



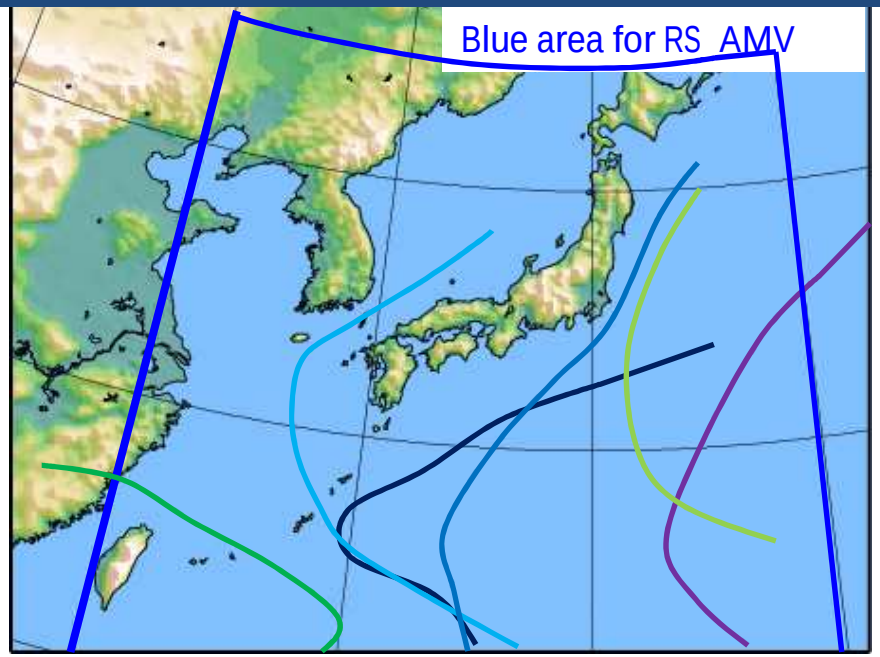
- ✓ Validation results will be informed to NWP users (IWW mailing list)
- ✓ Himawari-8 AMV product will be provided in BUFR via GTS.

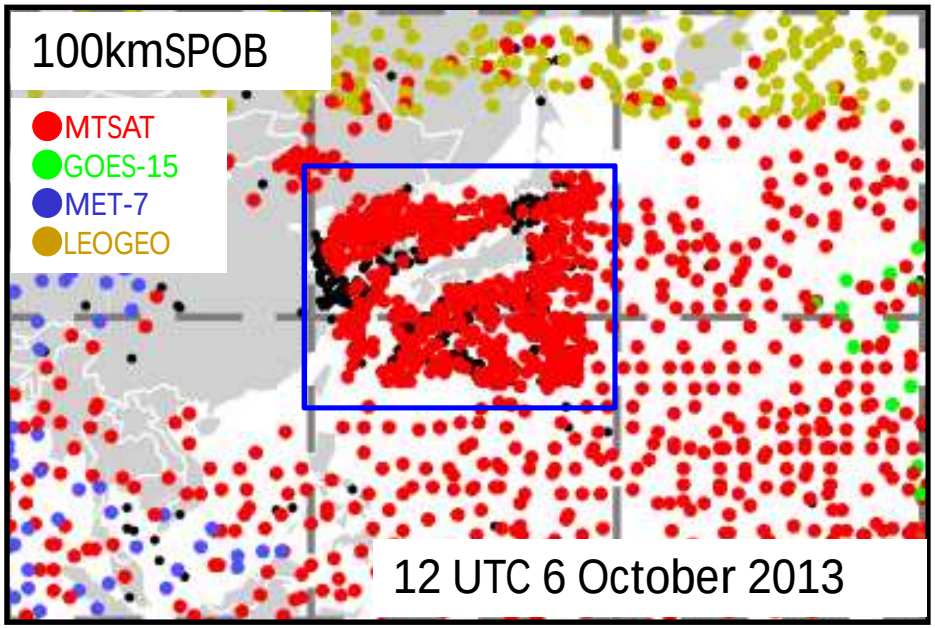
Shimoji, K., 2014: Motion tracking and cloud height assignment methods for Himawari-8 AMV. Proc. 12th IWW, S2-07.

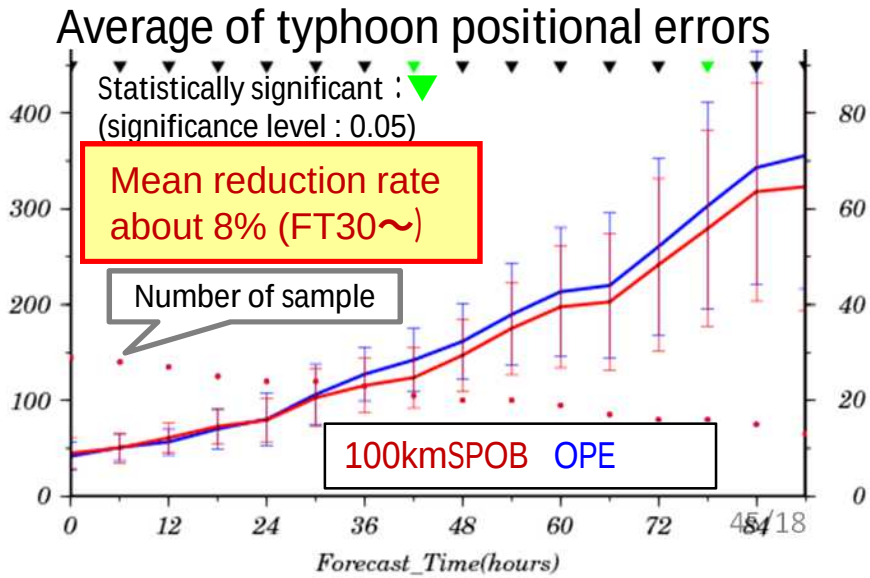
Contribution of Himawari-8/9 AMVs to Improvement of NWP Model for Typhoon Forecast

High Spatial Resolution AMVs from Himawari-8/9 will contribute to Improvement of NWP Model to decrease the positional forecast errors of Typhoon;

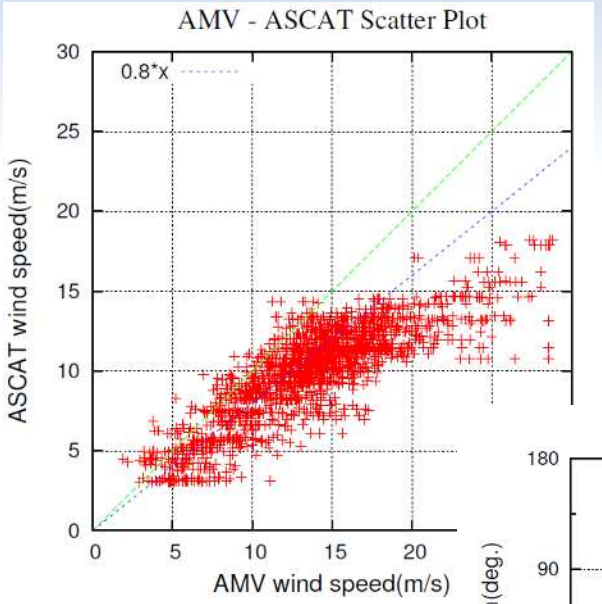
Case Study for six Typhoons in Oct. 2013



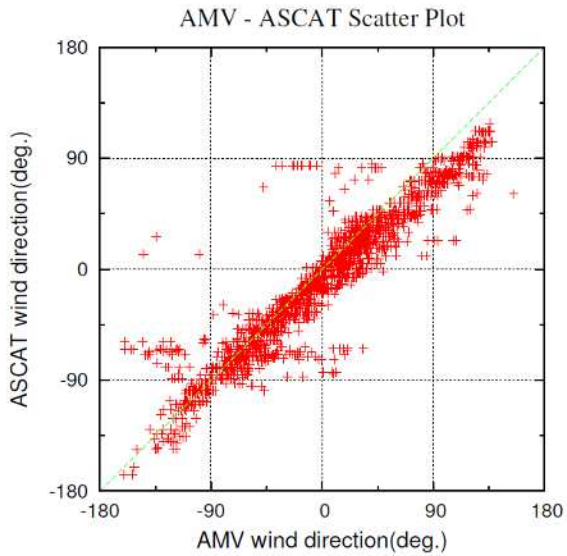


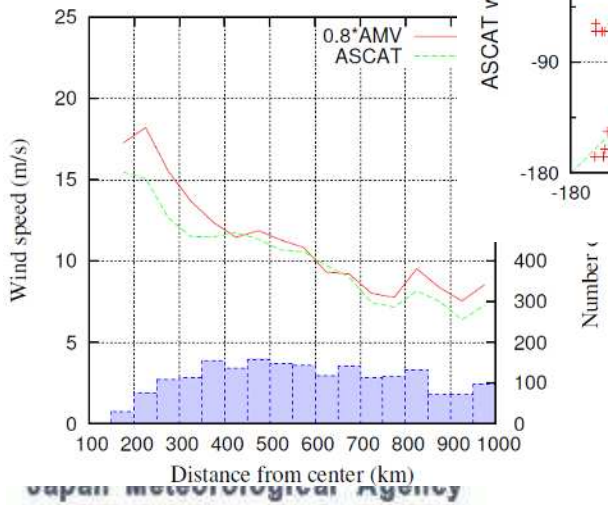


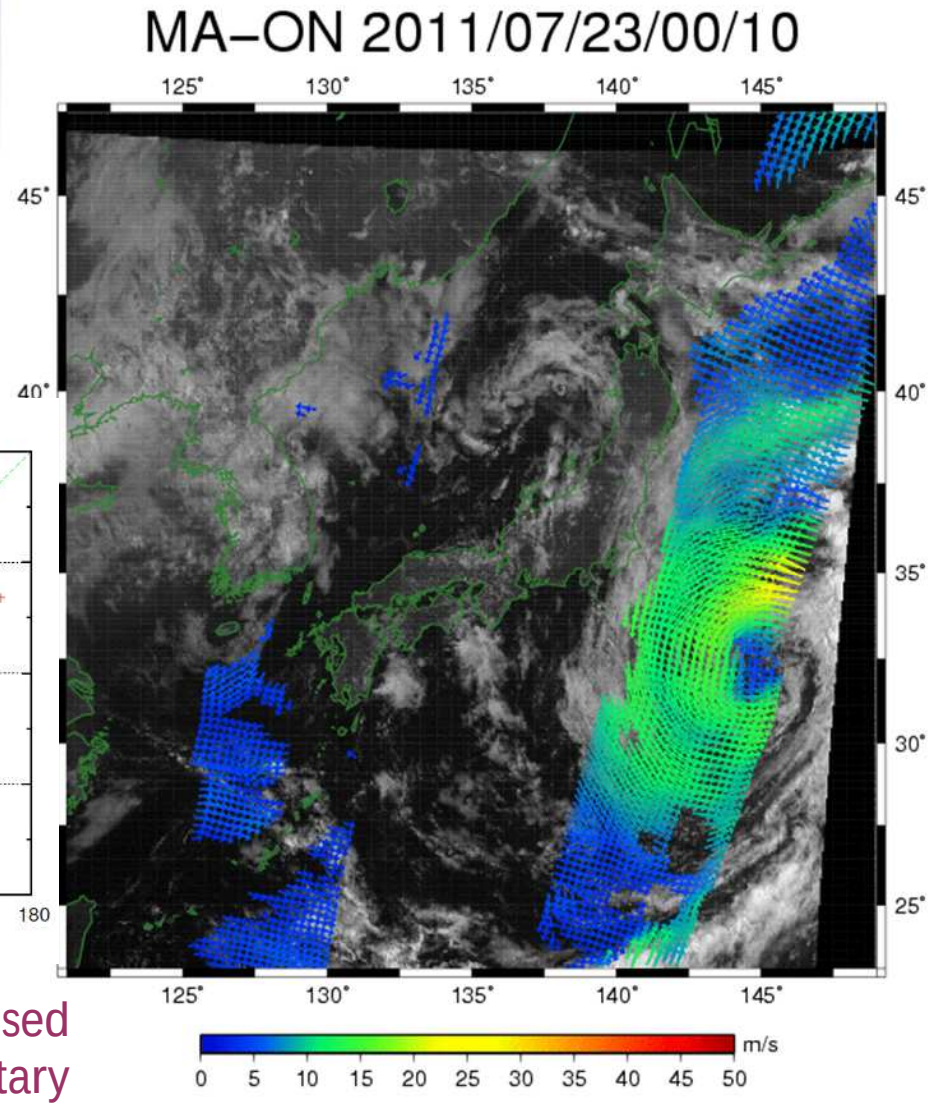
Contribution of Himawari-8/9 AMVs to Improvement of Nowcasting wind fields around Tyhoon



Comparison between ASCAT and MTSAT-1R Rapid-scan VIS wind





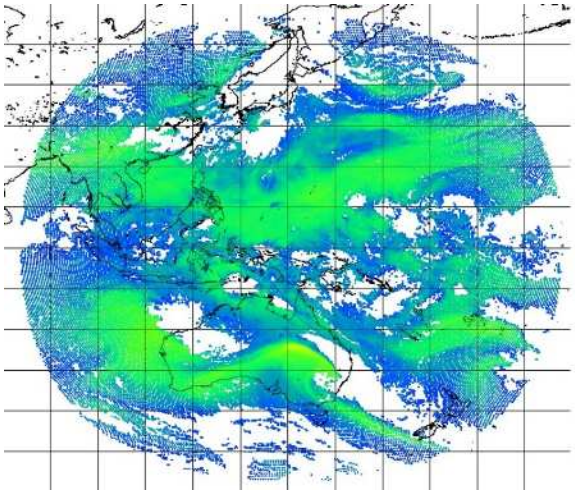


expected to be used as a complementary information of ASCAT

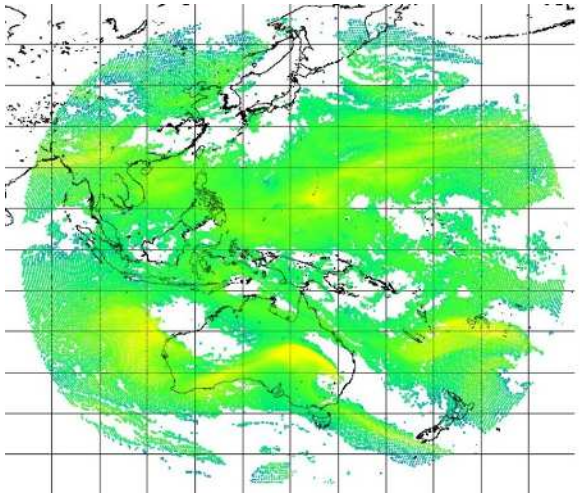
Improvement in Clear Sky Radiances (CSRs)

- 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)

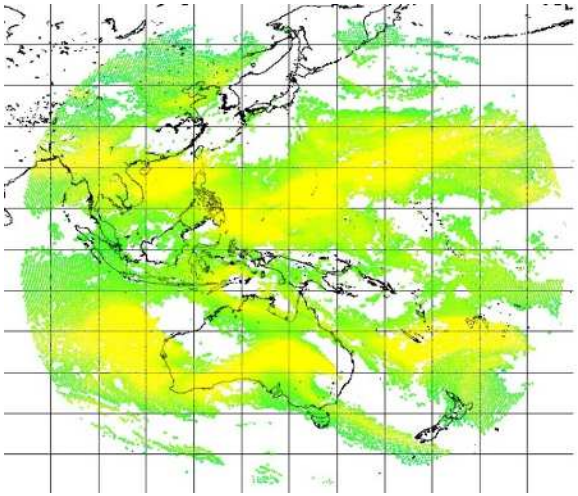
Band #8 (6.2 um)



Band #9 (6.9 um)



Band #10 (7.3 um)

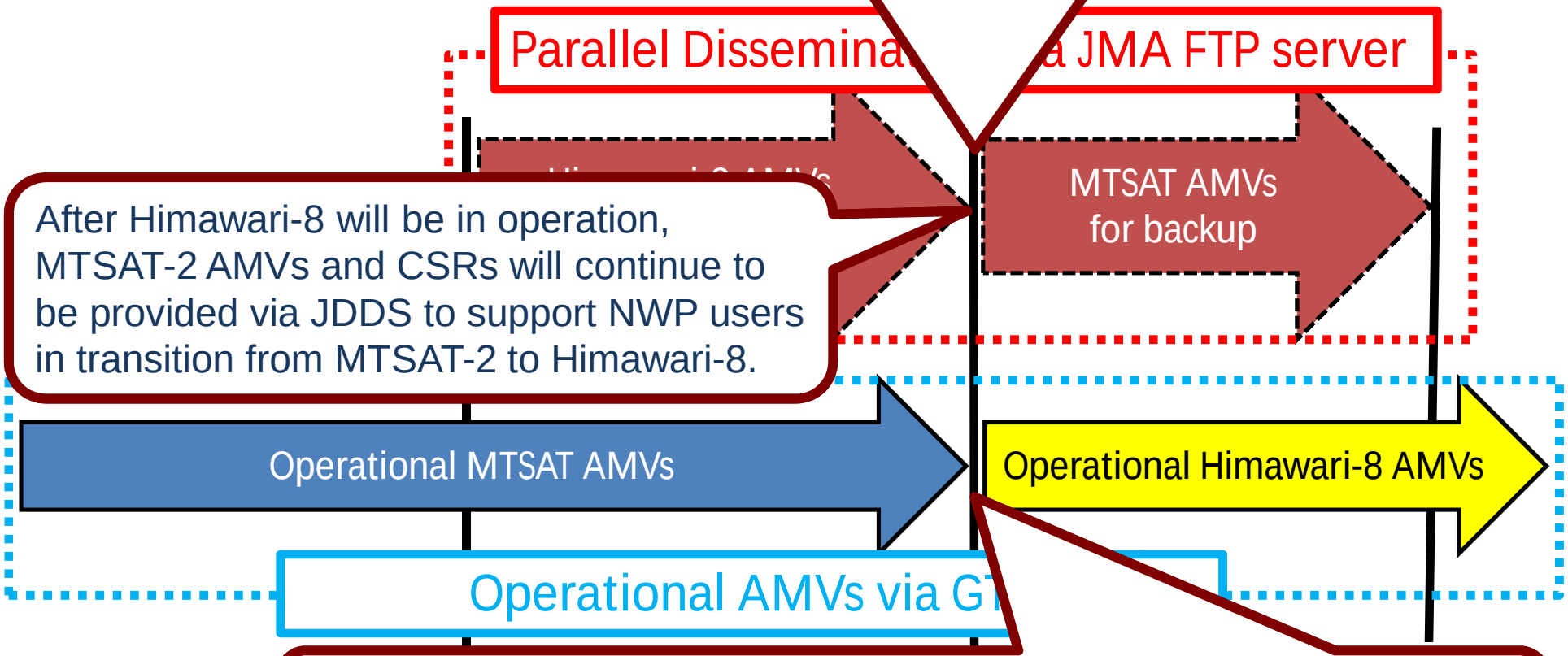


03 UTC 20 April 2015

Support for User Readiness: Parallel Dissemination of AMVs and CSRs

JMA plans to distribute Himawari-8 AMVs and CSRs via JDDS (the JMA Data Dissemination System) from May to July 2015, so that NWP users can evaluate the products in advance.

- ed in parallel for user transition.



After Himawari-8 will be in operation, MTSAT-2 AMVs and CSRs will continue to be provided via JDDS to support NWP users in transition from MTSAT-2 to Himawari-8.

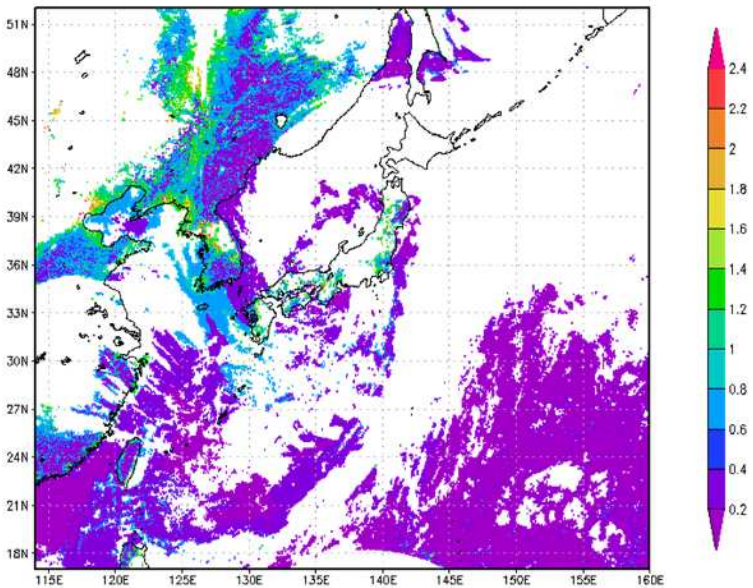
Himawari-8 AMVs and CSRs products will be distributed via GTS when Himawari-8 becomes operational. The distribution of MTSAT-2 AMVs and CSRs via GTS will be terminated at the same time

気象庁
Japan Meteorological Agency

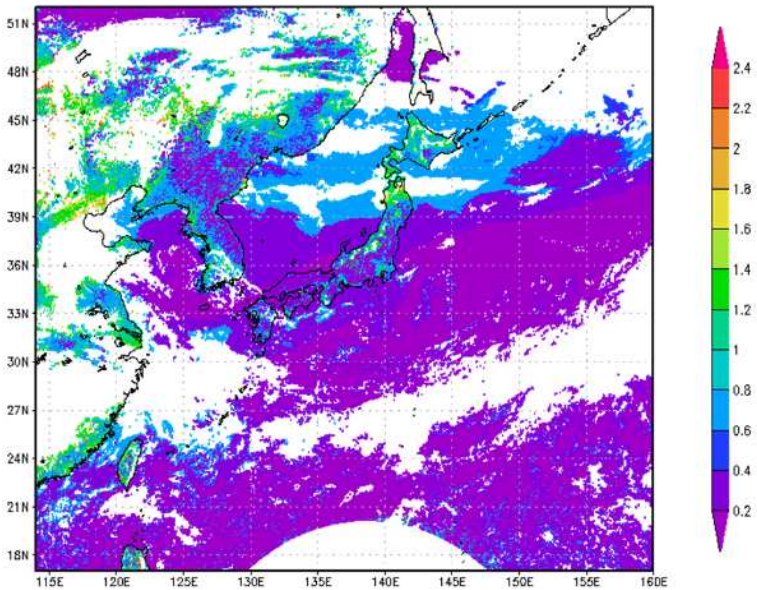
Aerosol Optical Depth (for Asian dust monitoring)

- 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, e.g. Indonesia, in response to requests.

AOD at 03 UTC on 15 Apr 2015



AOD at 03 UTC on 27 Apr 2015



AOMSUC-6

The Sixth Asia Oceania Meteorological Satellite Users' Conference (AOMSUC-6)

9 - 13 November 2015 in Tokyo, Japan

Hosted by

Japan Meteorological Agency (JMA)

Co-sponsored by

- Australian Bureau of Meteorology (AuBoM)
- China Meteorological Administration (CMA)
- Korea Meteorological Administration (KMA)
- Russian Federal Service for Hydrometeorology and Environmental Monitoring (ROSHYDROMET)
- Group on Earth Observations (GEO)
- World Meteorological Organization (WMO)

The Sixth Asia/Oceania Meteorological Satellite Users' Conference (AOMSUC-6)

9 - 13 November 2015 in Tokyo, Japan

Current Topics

(a) Current and future meteorological satellite programs
(b) Facilitation of data access and utilization
(c) Atmospheric parameters derived from satellite observations
(d) Application of satellite data to weather analysis and disaster monitoring
(e) Application of satellite data to numerical weather prediction
(f) Application of satellite data to climate and environmental monitoring
(g) Land surface and ocean parameters derived from satellite observations
(h) Capacity building and training activities
(i) Himawari-8, related status and application

The Sixth Asia/Oceania Meteorological Satellite Users' Conference (AOMSUC-6)

9 - 13 November 2015 in Tokyo, Japan

Schedule

Date	
Monday 9	Training on meteorological satellite data usage (1) - Utilization of RGB Composite Image, etc
Tuesday 10	Plenary session (1)
Wednesday 11	Plenary session (2)
Thursday 12	Plenary session (3)
Friday 13	Training on meteorological satellite data usage (2) - Himawari-8 Imagery Data Utilization, etc

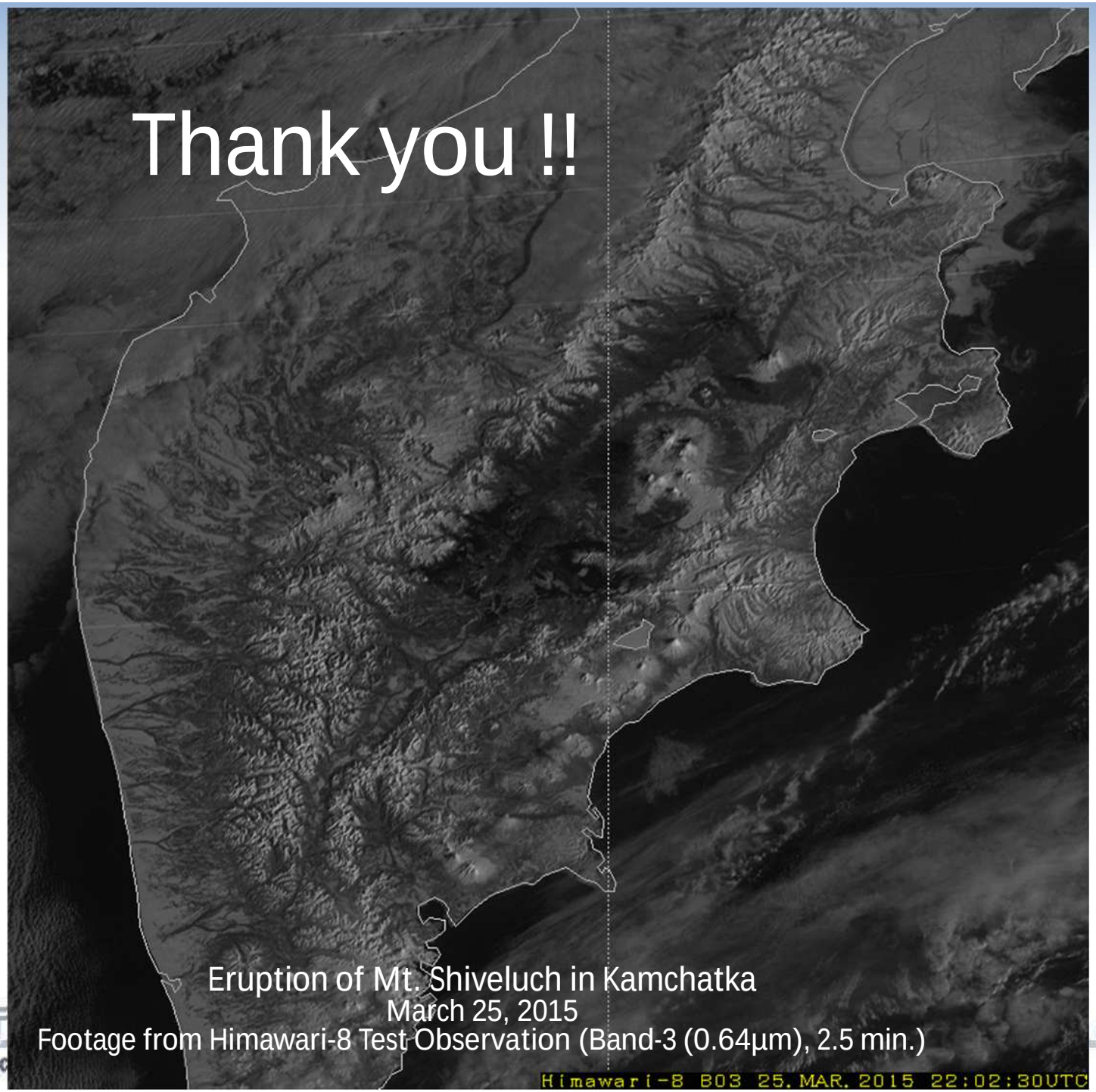
Call for papers

The deadline for submission: 31 July 2015

for more information;

http://www.jma-net.go.jp/msc/en/aomsuc6/index.html

Thank you !!



Eruption of Mt. Shiveluch in Kamchatka
March 25, 2015
Footage from Himawari-8 Test Observation (Band-3 (0.64μm), 2.5 min.)

気象庁
Japan Meteorologic

JMA