Current status of Himawari-8/9 products development

Kotaro BESSHO

Meteorological Satellite Center/Japan Meteorological Agency

Contents

What will Himawari-8/9 bring to us?

Upgrade of number of channels

Upgrade of spatial and temporal resolution

B/W TV

HD TV

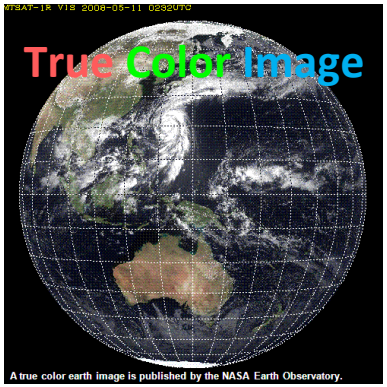
Specification of Himawari-8/9 Imager (AHI)

MTSAT-1R/2

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

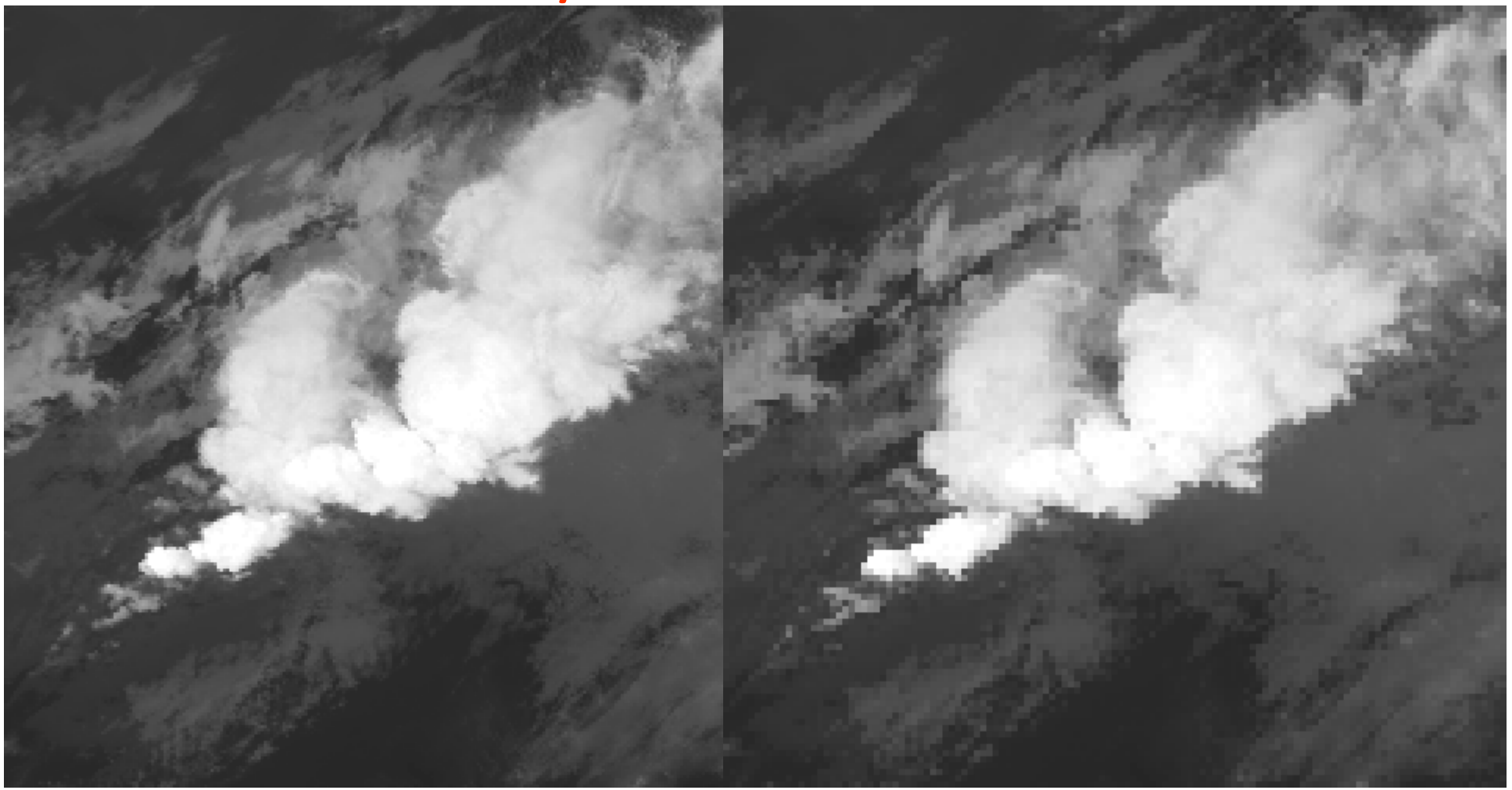
Products

- Volcanic Ash
- Global Instability Index
- Nowcasting
- Typhoon Analysis
- Atmospheric Motion Vector
- Clear Sky Radiance
- Sea Surface Temperature
- Yellow Sands
- Snow and Ice Coverage

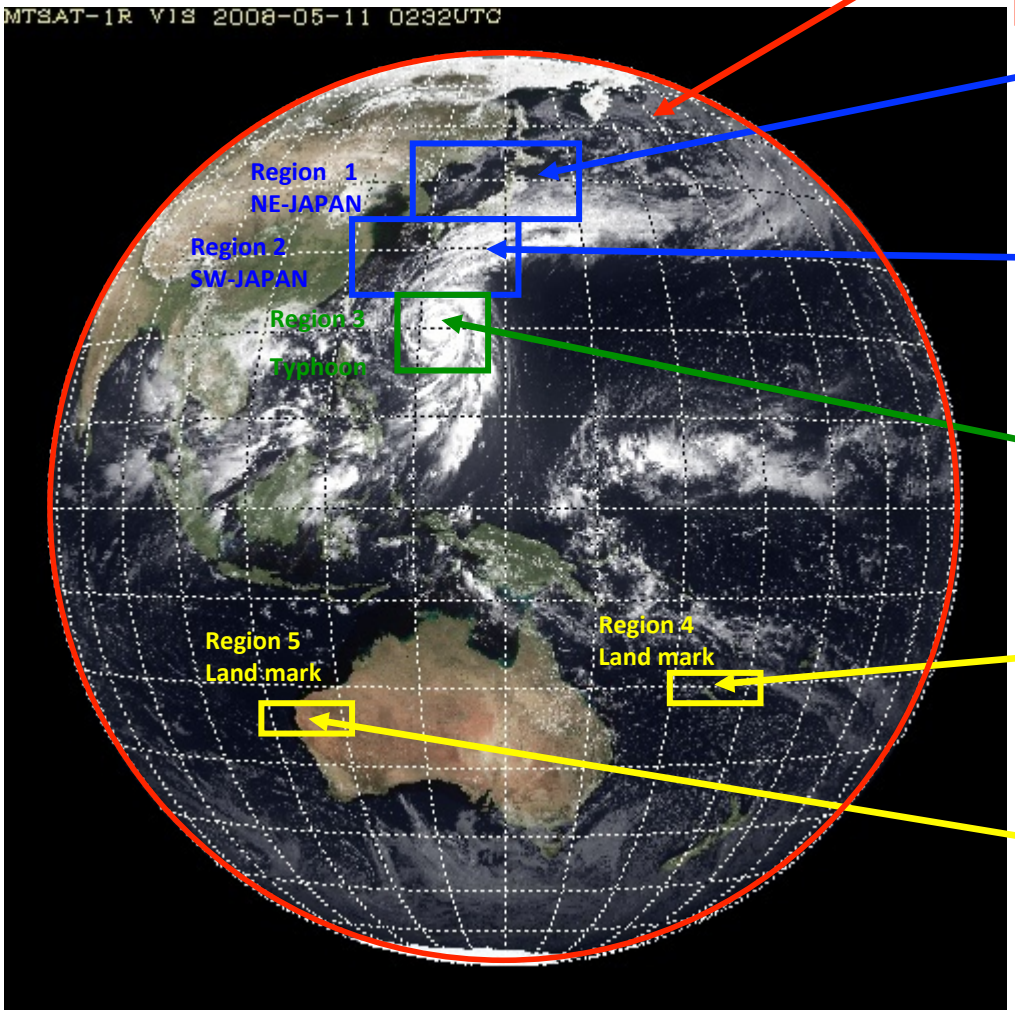
IR image difference of spatial resolution

2km for H-8/9

4km for MTSAT



AHI will scan all sectors within 10 minutes



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

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

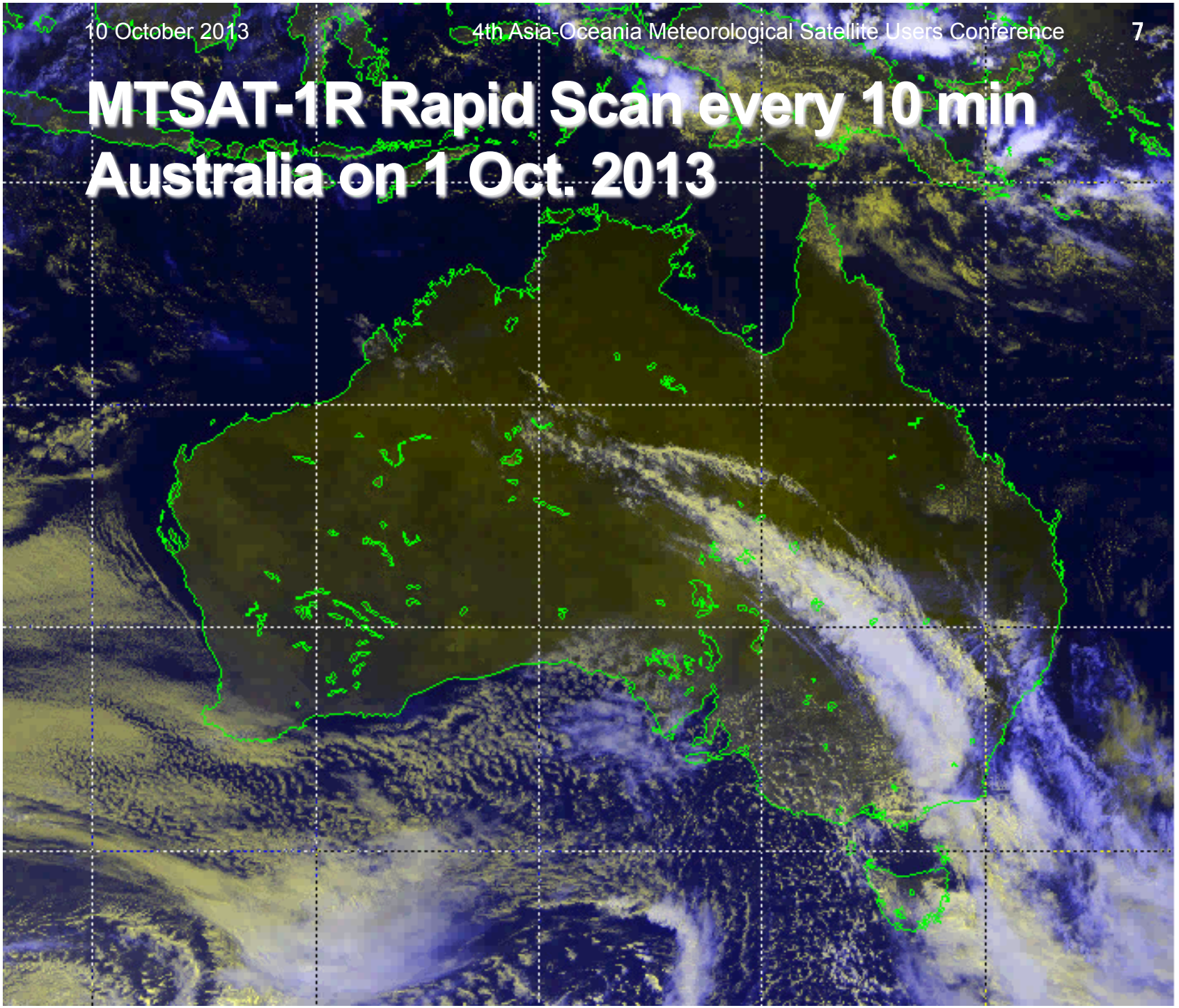
Region 2 JAPAN (South-West)
Interval : **2.5 minutes** (4 times in 10minutes)
Dimension : EW x NS: 2000 x 1000 km
2 swath

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

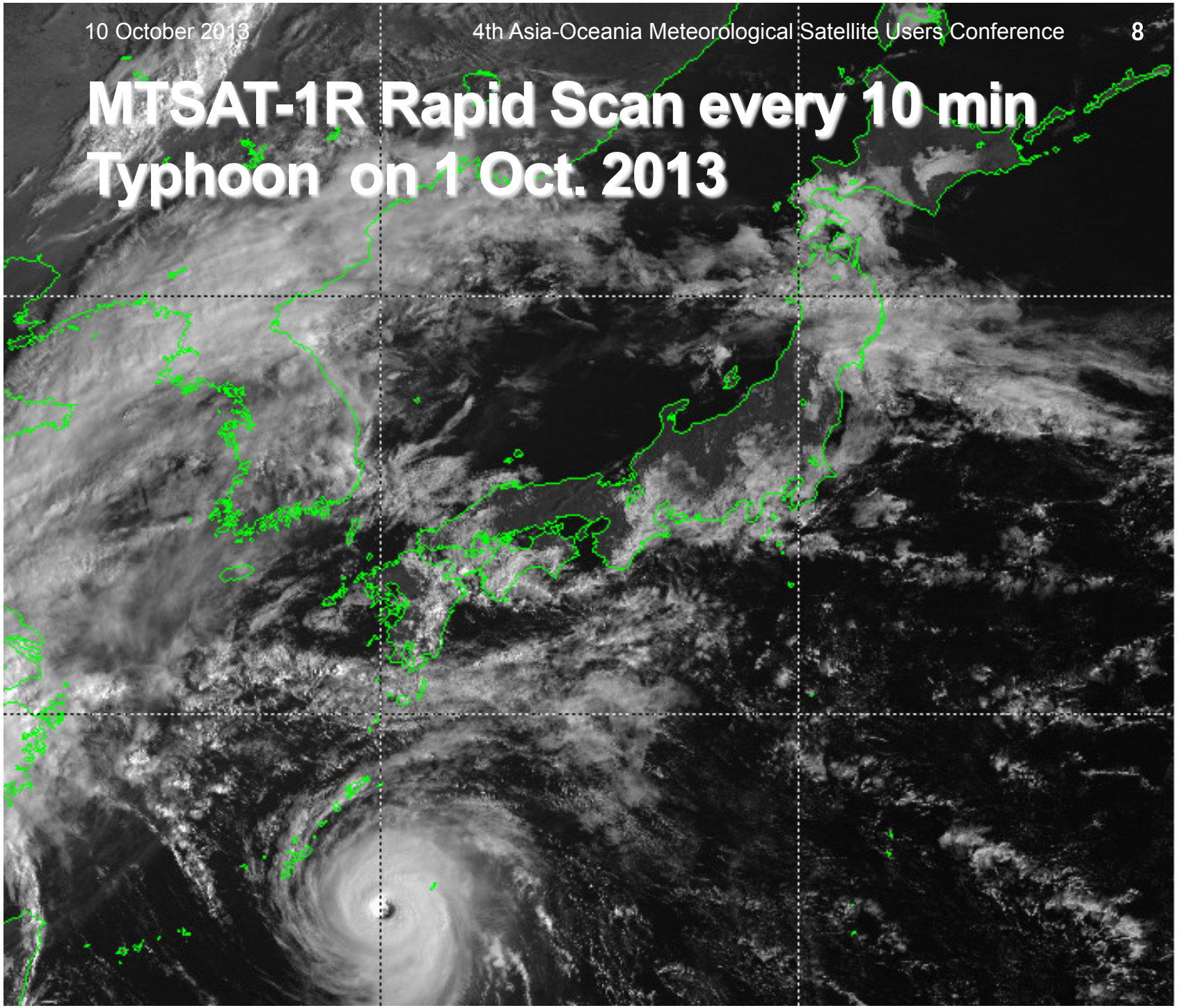
Region 4 Land mark
Interval : **0.5 minutes** (20 times in 10minutes)
Dimension : EW x NS: 1000 x 500 km
1 swath

Region 5 Land mark
Interval : **0.5 minutes** (20 times in 10minutes)
Dimension : EW x NS: 1000 x 500 km
1 swath

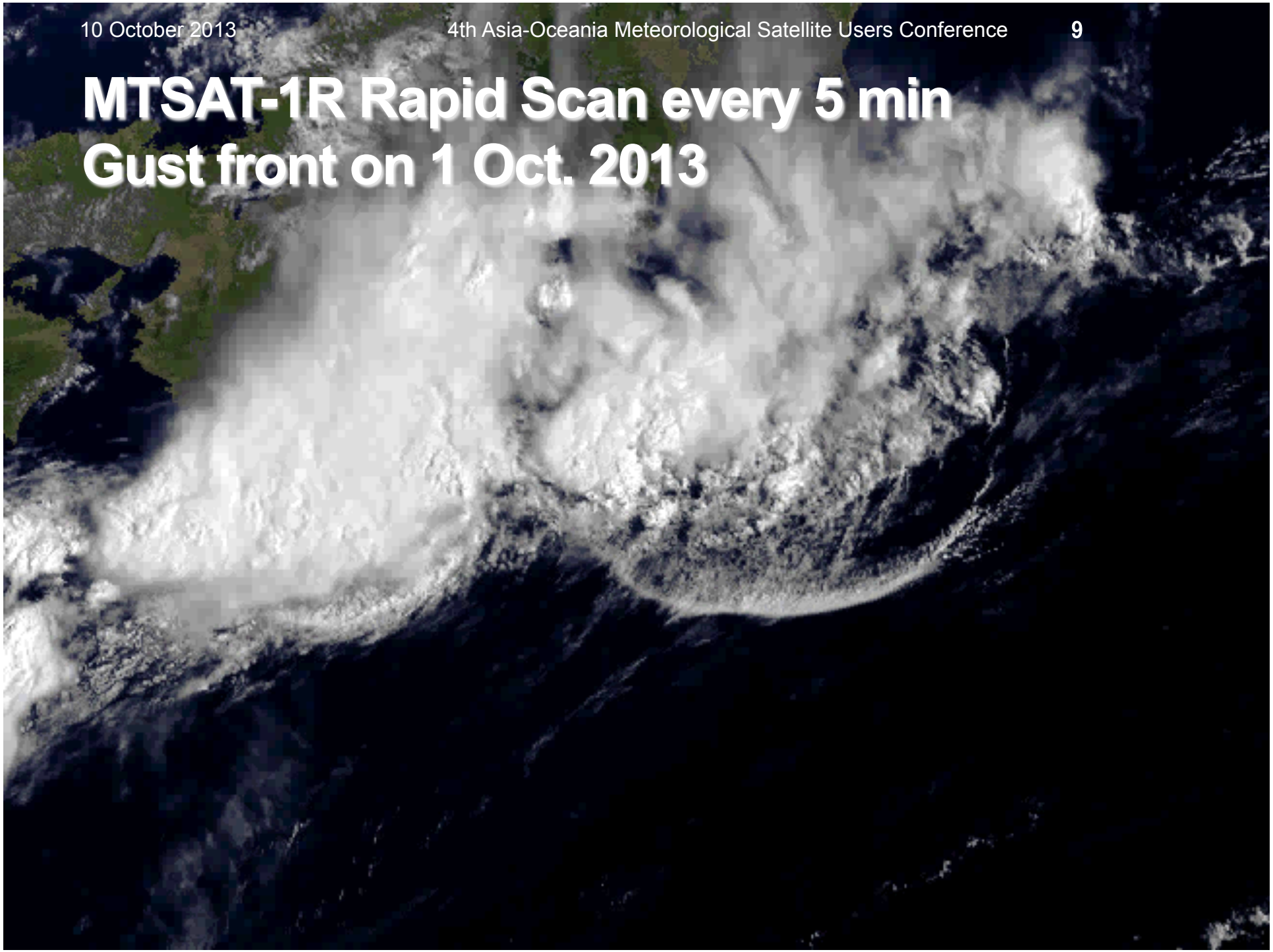
MTSAT-1R Rapid Scan every 10 min Australia on 1 Oct. 2013



MTSAT-1R Rapid Scan every 10 min Typhoon on 1 Oct. 2013



MTSAT-1R Rapid Scan every 5 min
Gust front on 1 Oct. 2013



Development of products of Himawari-8/9 AHI

Increased observation channels

VIS: 1 -> 3 bands

Higher resolution

Spatial:

1km -> 0.5km for a VIS channel

Temporal:

1 hr -> 10 min for a full disk scan

2.5min for limited areas

Next Weather Satellite Revolution

toward

Examples of expected new/enhanced products

- Cloud Products
- Atmospheric Motion Vectors (AMVs)
- Aerosol (Dust) / Volcanic Ash

the New Era

of

Severe weather monitoring/ nowcasting

Numerical prediction

Climate change monitoring

Yellow sand/ dust storm

Volcano eruption

Ash area detection

Solar energy monitoring

***Mesoscale* Satellite Meteorology**

Status of Product Development for Himawari-8/9

1. Cloud Products
   (Cloud Mask, Cloud Type/Phase, Cloud Top Height)
2. Atmospheric Motion Vector (AMV)
3. Aerosol Product (Asian Dust)
4. Volcanic Ash Product

International Cooperation
for developments of Cloud Product, AMV and volcanic ash product

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

We greatly appreciate kind cooperation of EUMETSAT and NOAA/NESDIS.

Status of Product Development for Himawari-8/9 (1/4)

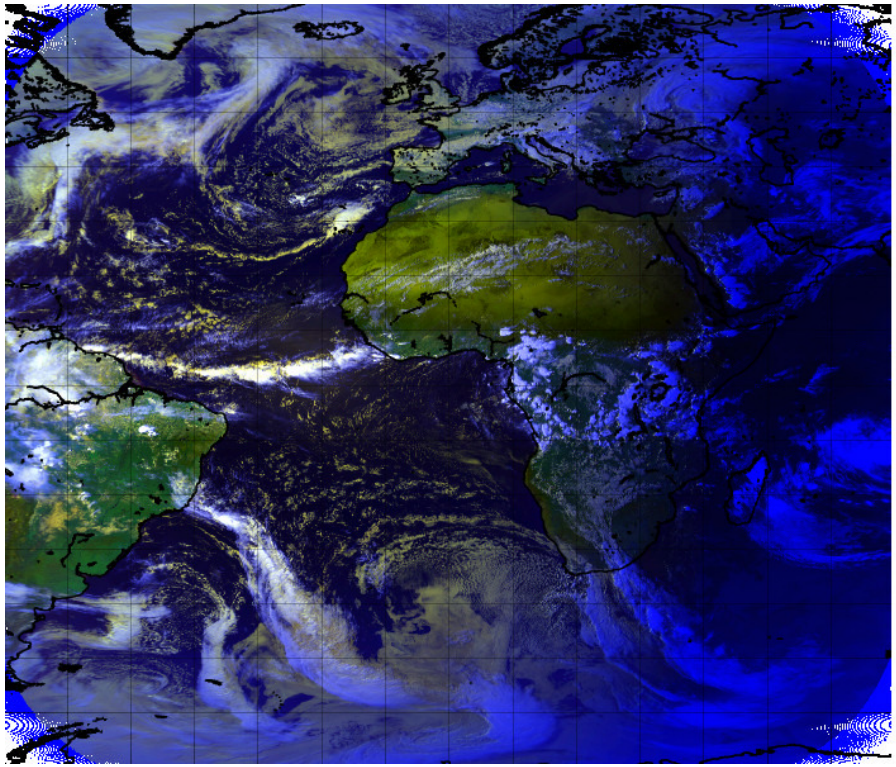
1.Cloud Products

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

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

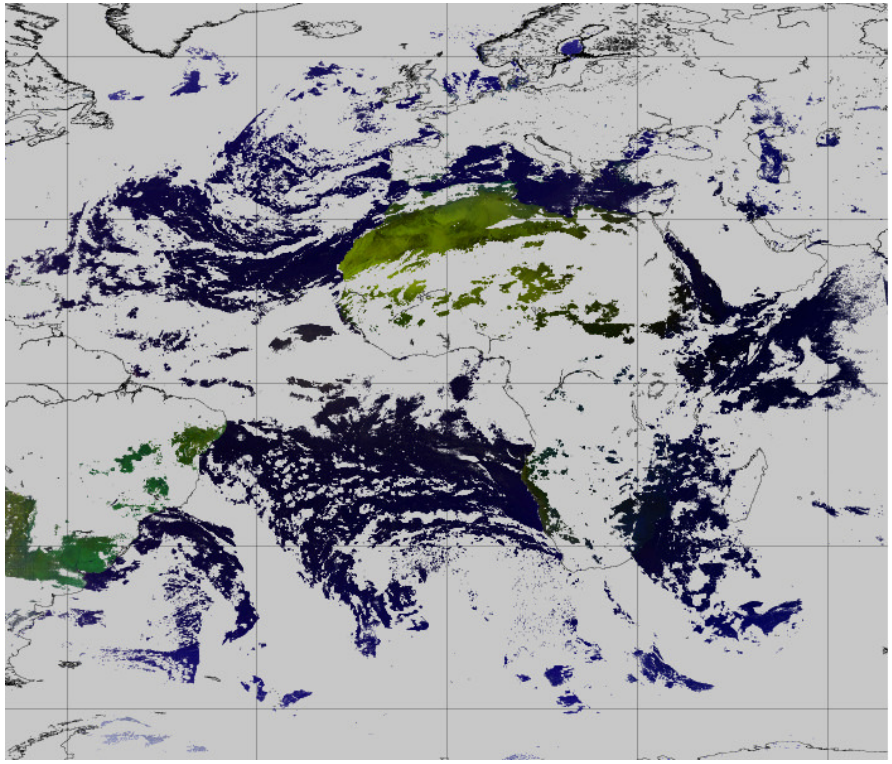
Cloud Products (Prototype)

15:12UTC 7th Apr. 2012, MSG



RGB Image

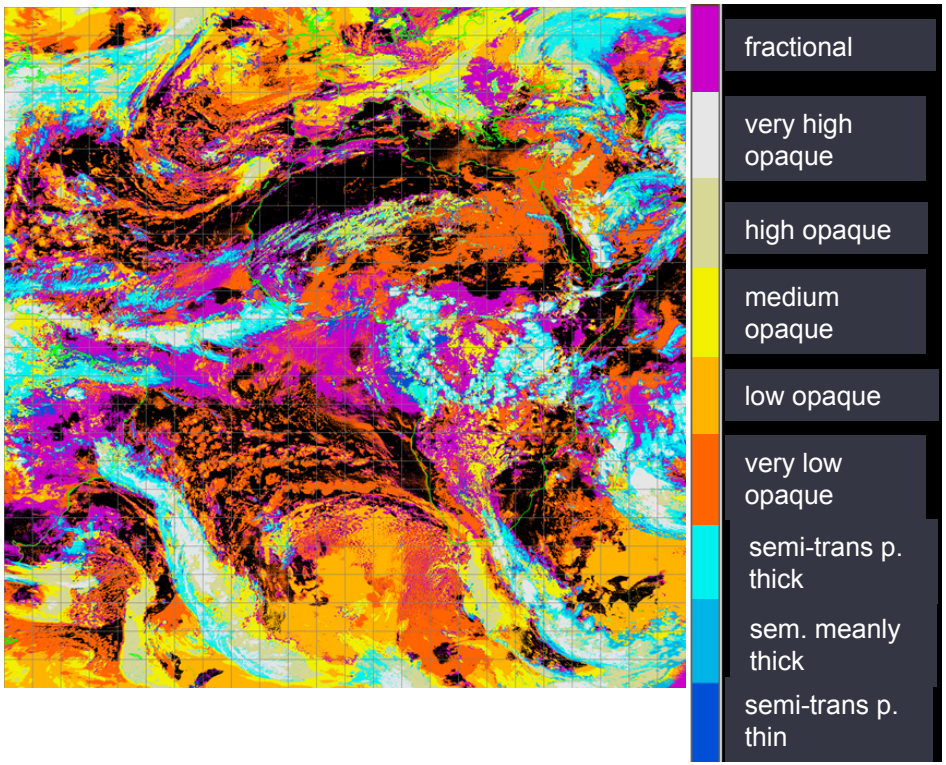
R: 0.64um
G: 0.86um
B: 11.2um



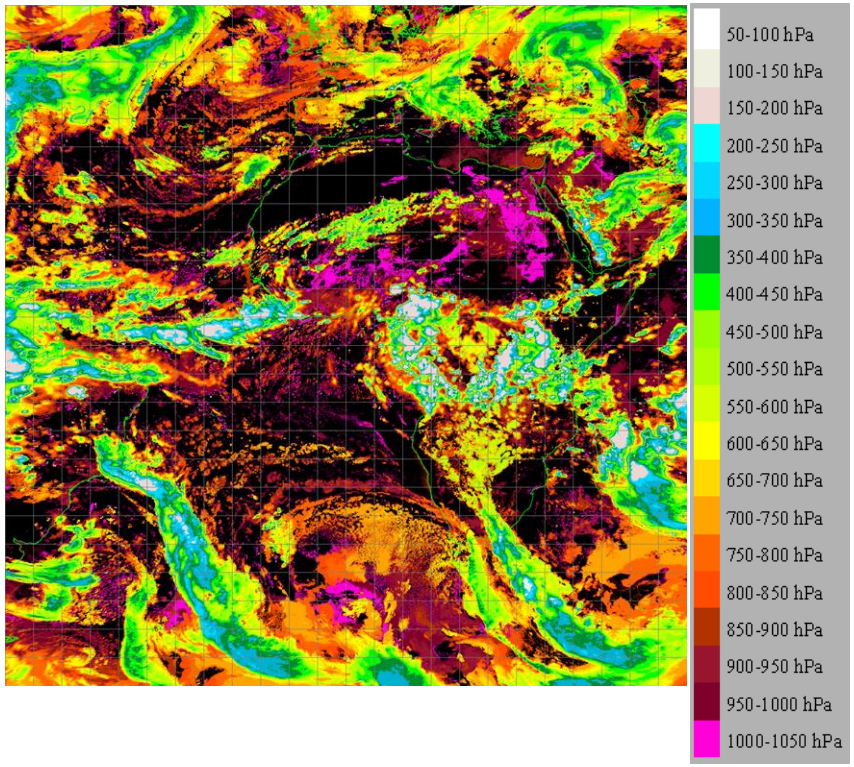
Cloud Mask

Cloud Products (Prototype)

1512UTC 7th Apr. 2012, MSG



Cloud Type



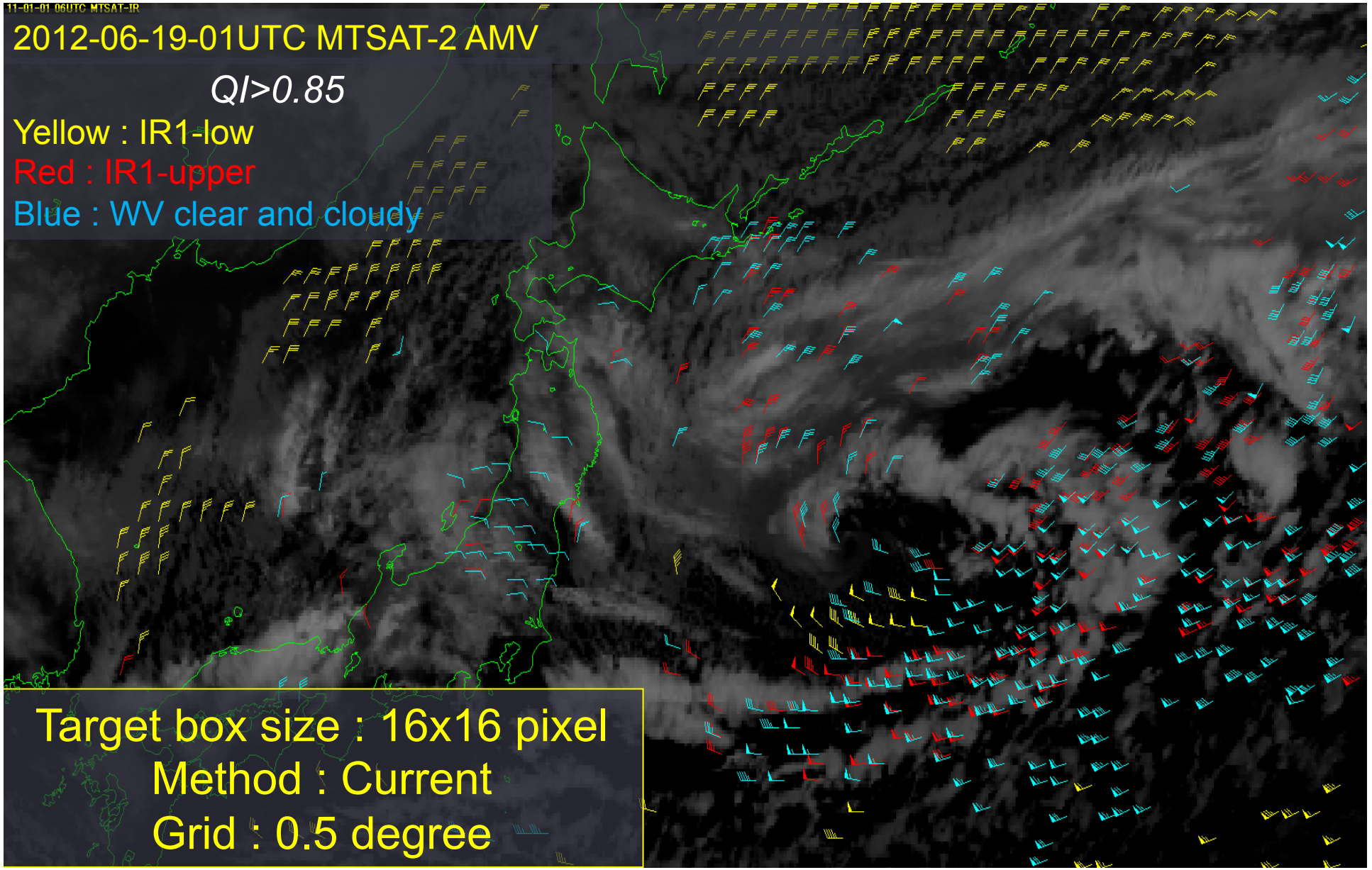
Cloud Top Height (hPa)

Status of Product Development for Himawari-8/9 (2/4)

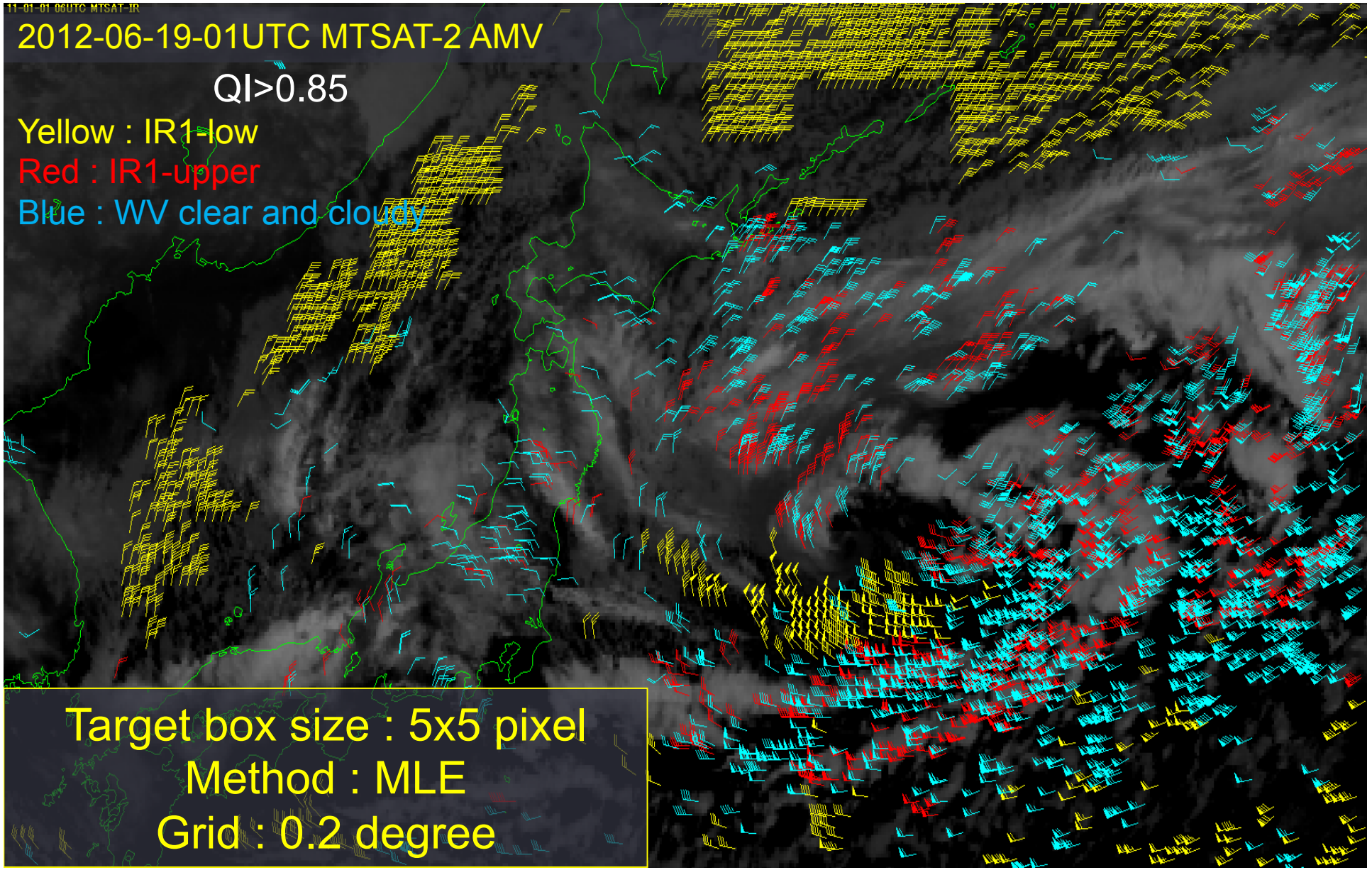
2. Atmospheric Motion Vector (AMV)

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

AMV (Current)


11-01-01 06UTC MTSAT-IR
2012-06-19-01UTC MTSAT-2 AMV
QI>0.85
Yellow : IR1-low
Red : IR1-upper
Blue : WV clear and cloudy
Target box size : 16x16 pixel
Method : Current
Grid : 0.5 degree

AMV (Prototype)



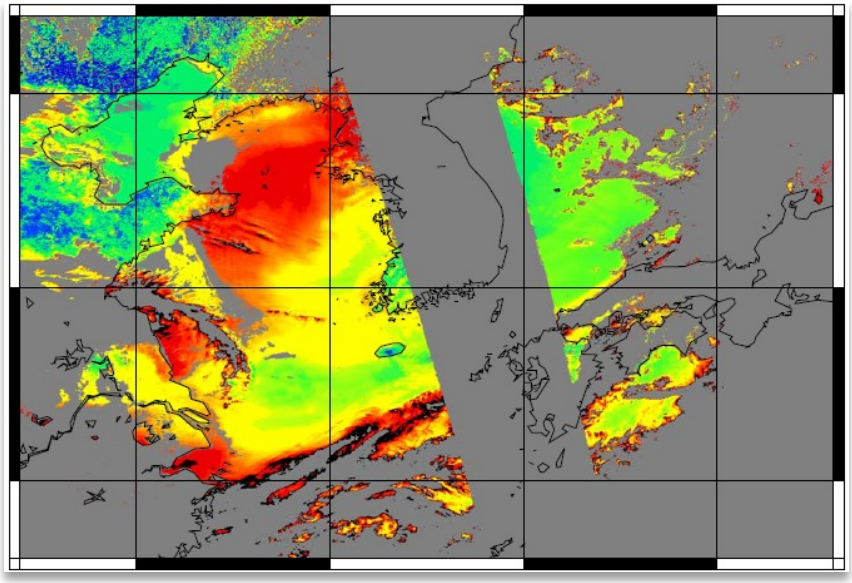
Status of Product Development for Himawari-8/9 (3/4)

3. Aerosol Product (Asian Dust)

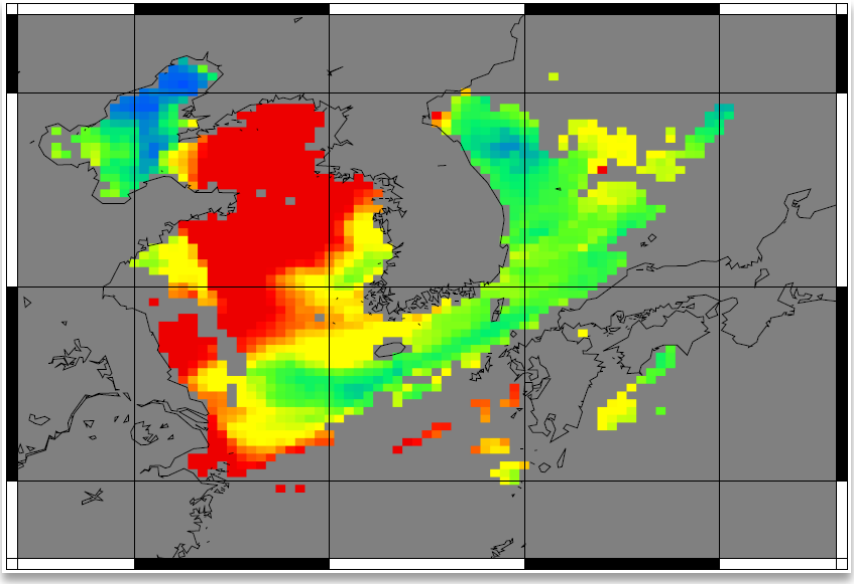
Satellite : Himawari-8/9
Improvement : Retrieval of physical quantities for land surface
Algorithm : Y.Mano (JMA/MRI)
Reference :
NOAA/NESDIS/GOES-R algorithm
NASA/GSFC/MODIS algorithm
Status : Created prototype software

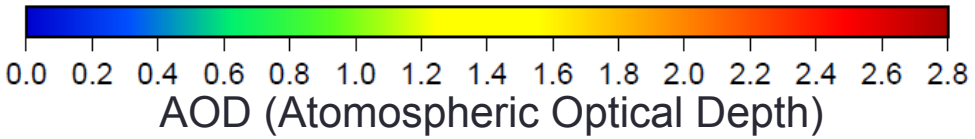
Aerosol Product (Prototype)

Prototype (MODIS/Terra)



Current (MTSAT-2)





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

Current Algorithm with MTSAT-2 (0500 UTC)

Aerosol Product / Current Status and Plan

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

Status of Product Development for Himawari-8/9 (4/4)

4. Volcanic Ash Product

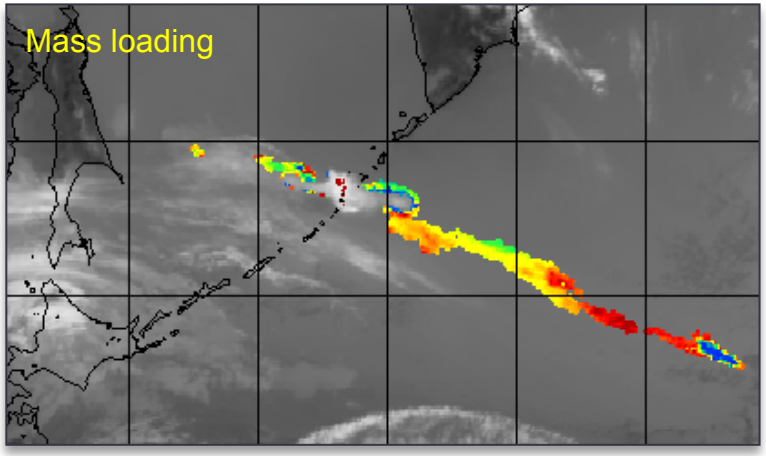
Satellite : MTSAT-2, Himawari-8/9

Improvement : New product
(Optical Depth, Particle Radius, Mass Loading,
Ash cloud top height)

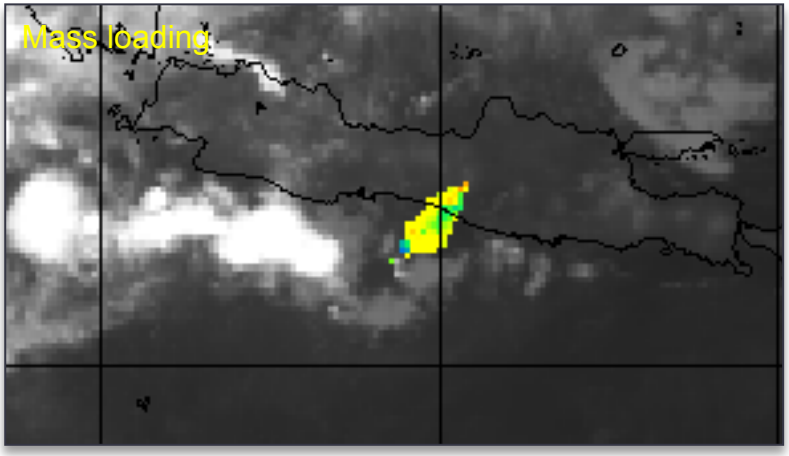
Algorithm : Ash cloud detection
(M.Pavolonis/NOAA/NESDIS, S.Mackie/Univ.of Bristol)
Retrieval processing (F.Prata/NILU)

Status : Preparing for operational generating.
Discussing about validation with Tokyo VAAC.

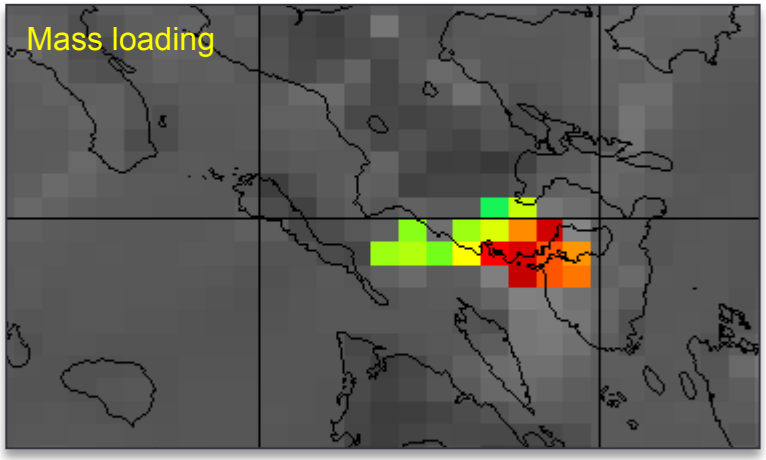
Volcanic Ash Product



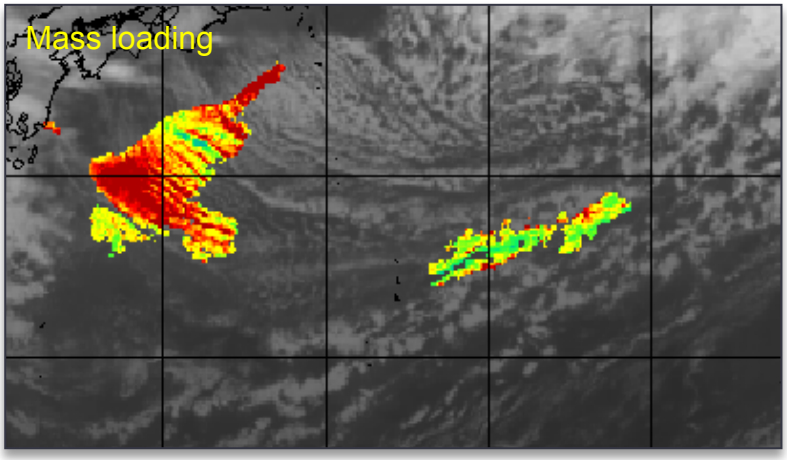
Sarychev 2009.6.14 0300UTC, MTSAT-1R



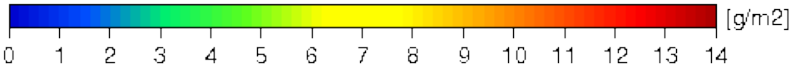
Mt. Merapi 2010.11.11 2000UTC, MTSAT-1R



Bulusan 2011.2.21 0400UTC, MTSAT-2



Shinmoe-dake 2011.1.27 0000UTC, MTSAT-2



Volcanic Ash Product / Current Status and Plan

Step 1: Introducing EUMETSAT Volcanic Ash Retrieval software for MSG in JMA/MSC by March 2013

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

Step 2: Introducing NOAA/NESDIS Volcanic Ash Retrieval software in JMA/MSC in collaboration with NOAA/NESDIS

- JMA/MSC and NOAA/NESDIS had a technical meeting on the Volcanic Ash Retrieval algorithm and software
- Procedure to install NOAA/NESDIS software is ongoing

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

Step 4: Further verification and improvements will be done in cooperation with EUMETSAT and NOAA/NESDIS

Simulated AHI images for new products development

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

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

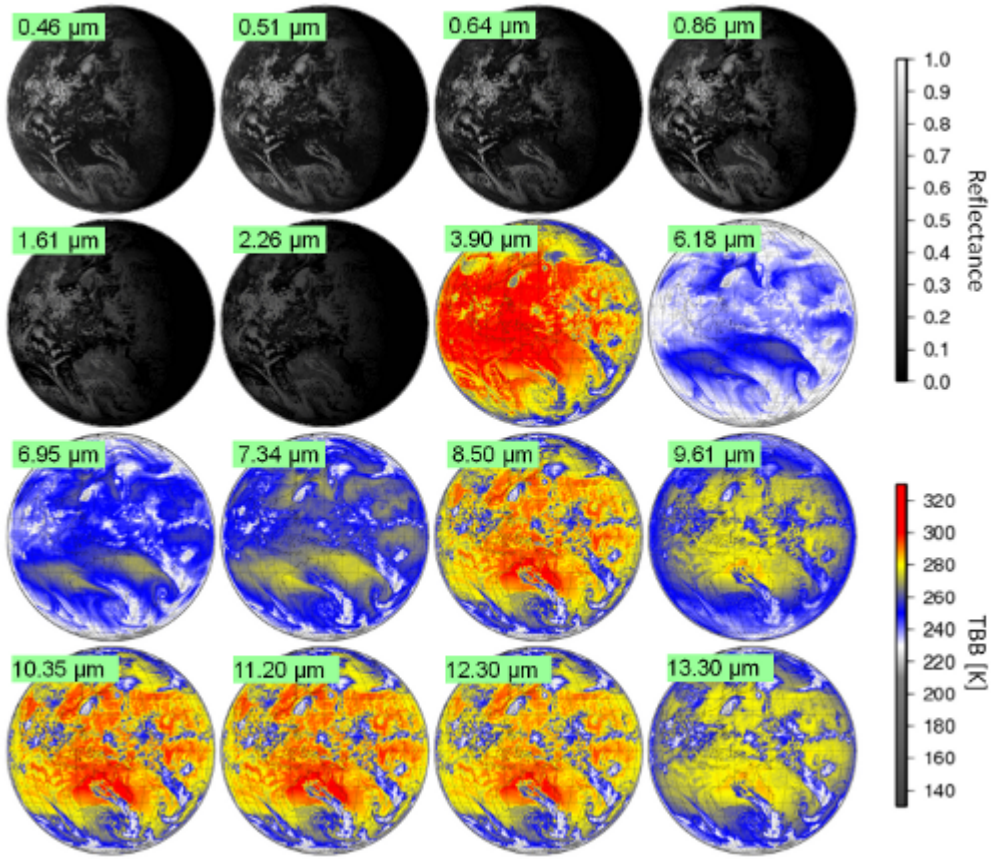
Radiance for each AHI band is calculated by using RTM with JMA NWP and some LEO satellites data.

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

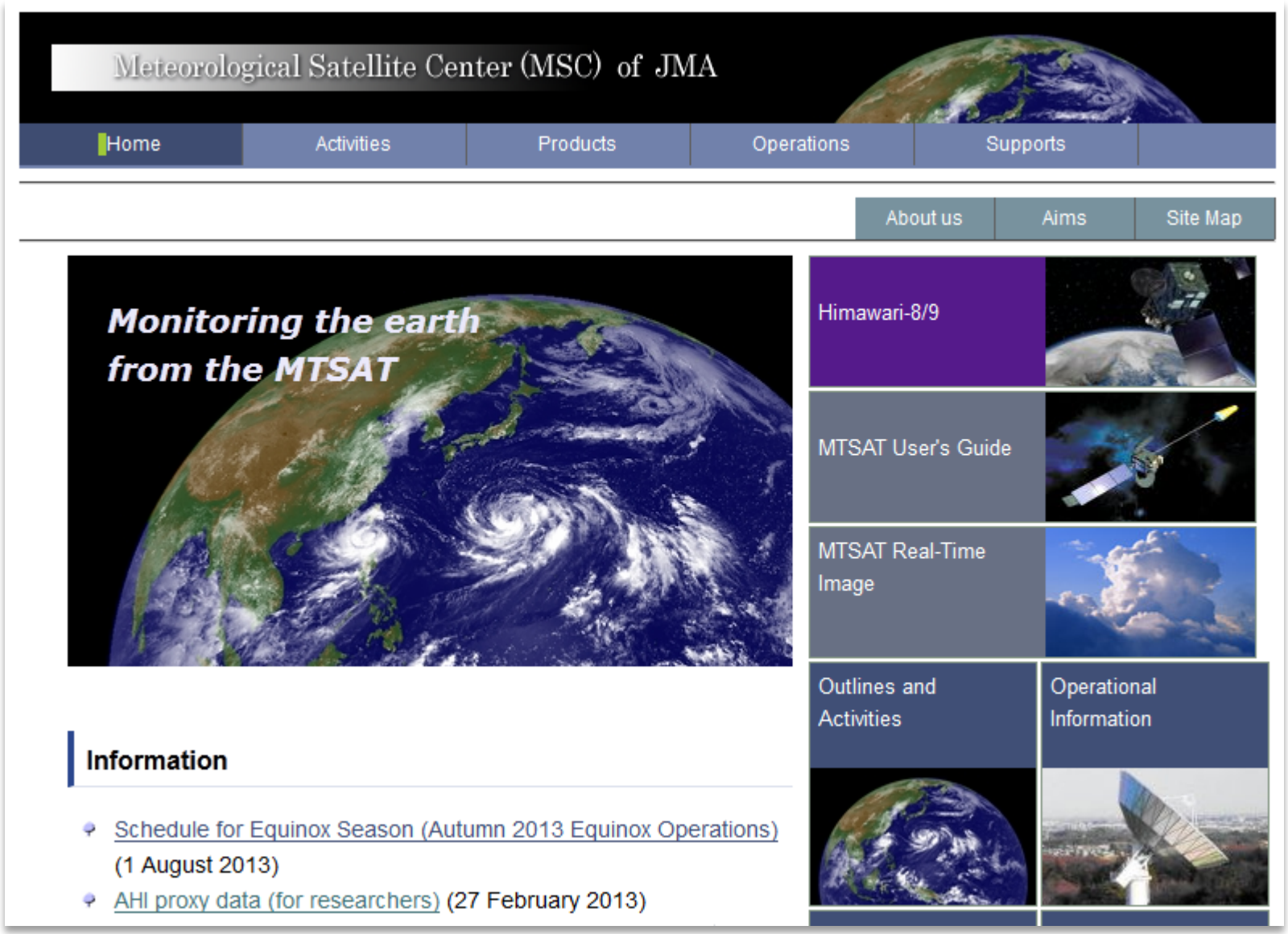
Configuration for RT Simulation

RT Model	**RSTAR** **(Nakajima and Tanaka, 1986)**
NWP	JMA GSM (horizontal resolution: 20km)
Surface Parameters	Wind: JMA GSM Albedo: MODIS MOD09

RT simulated images for **Himawari-8/9's 16 AHI** bands



http://mscweb.kishou.go.jp/index.htm



Summary

- Himawari-8/9 will bring us Mesoscale Satellite Meteorology.
- JMA Primary Product development is on going.
- We will just do it!!

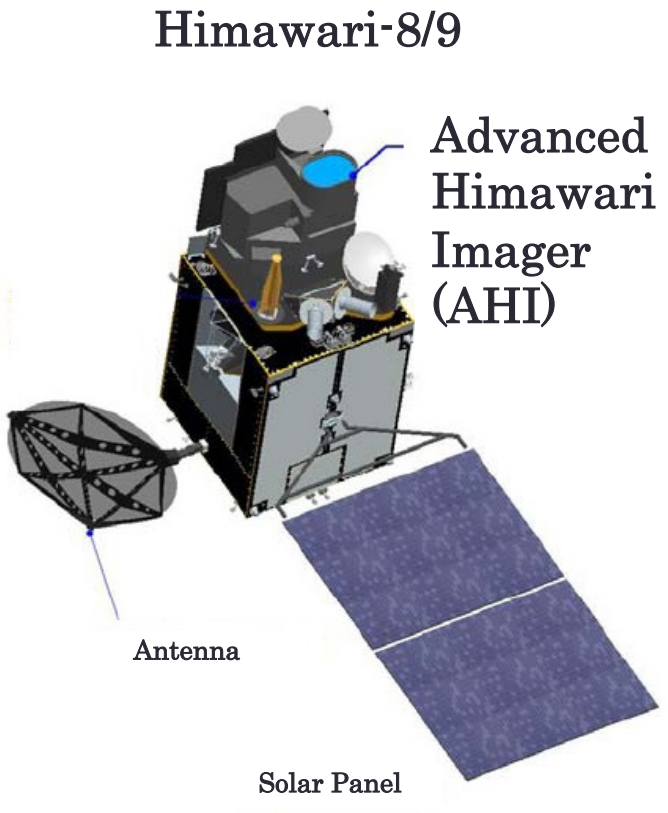
Thank you for your attention.

Backup Slides

Status of Manufacture

★ Major characteristics of Himawari-8/9 ★

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



Advanced Himawari Imager (AHI)	
Channels	Visible (4 channels) Infrared (12 channels)
Resolutions	0.5 Km, 1 Km and 2 Km
Brightness levels	>= 11 bits

AMV / Algorithm improvement (JMA Original)

- Upgrade to tracking algorithm based in maximum likelihood estimation method (MLE)

  -> for high spatial resolution AMV

- Installation of cloud height assignment algorithm based on optimal estimation (NEW)

  -> for decreasing wind speed BIAS and RMSVD caused from height estimation error

Maximum Likelihood Approach to Cloud Motion Estimation

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

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

3. To search position that shows maximum cross-correlation (maximum likelihood)

AMV derivation experiment using new tracking and HA technique

Satellite : MTSAT-2

Period : July 2012 (summer) and January 2013 (winter)

- Tracking method

RTN : Cross-Correlation, 16x16 pixels

TEST : Cross-Correlation, MLE using 5x5 and 15x15 pixels

- Height assignment method

RTN : operational method

TEST :

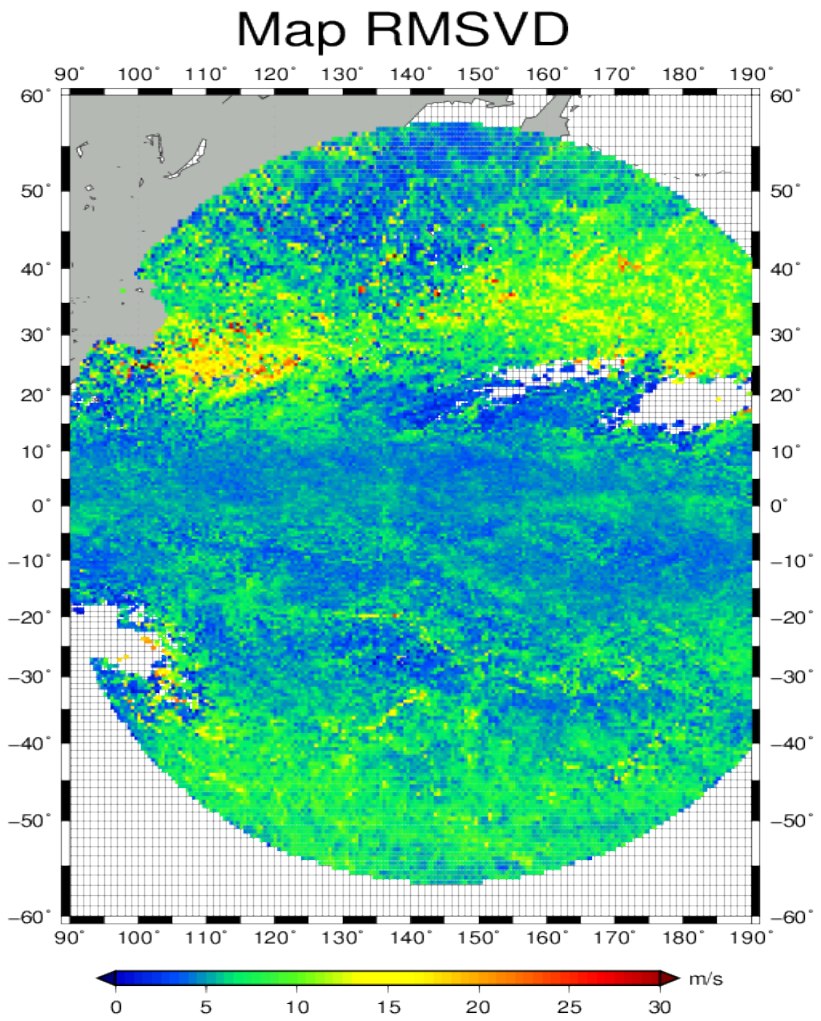
Cloud alignment model : 3 layers

PDF : multivariate student t distribution (t=1)

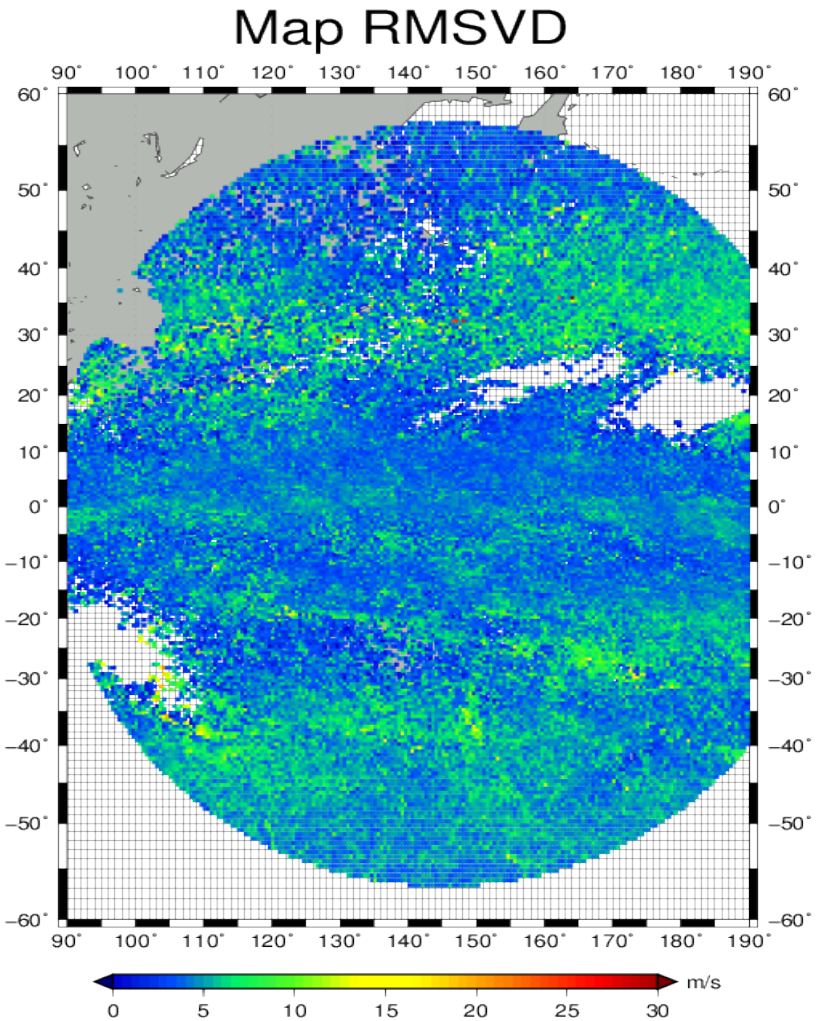
Optimization method : Nelder-Mead

IR upper level AMV O-B statistics for January 2013

RTN

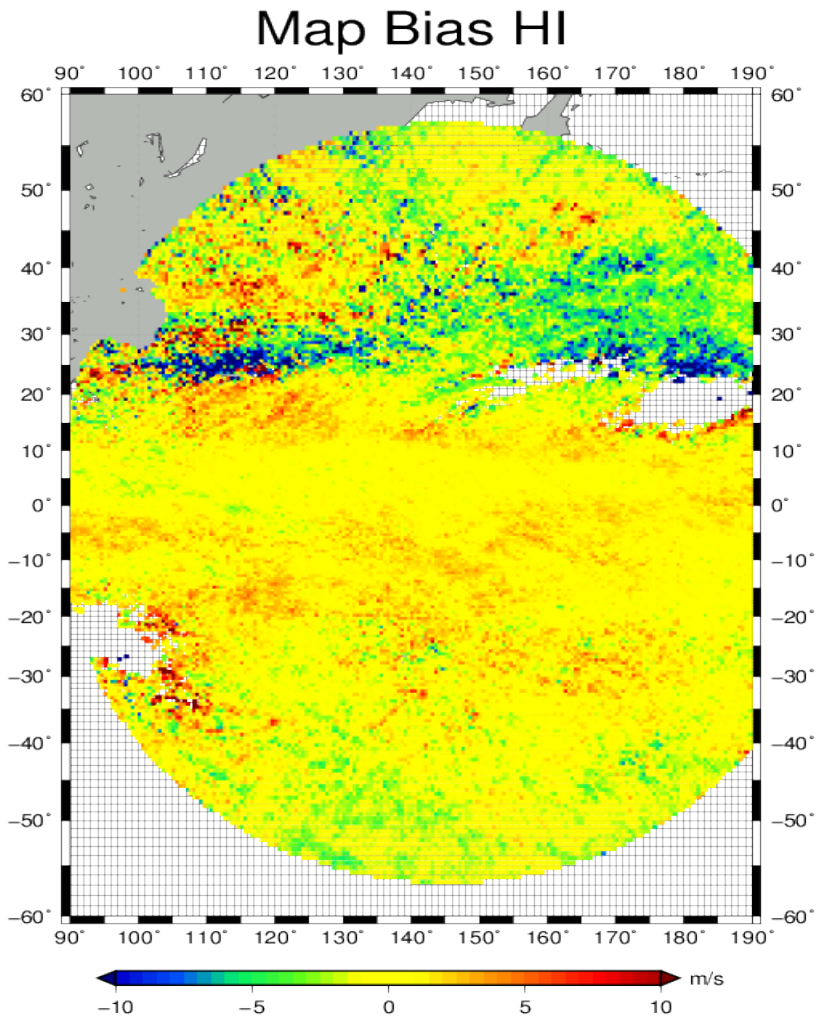


NEW

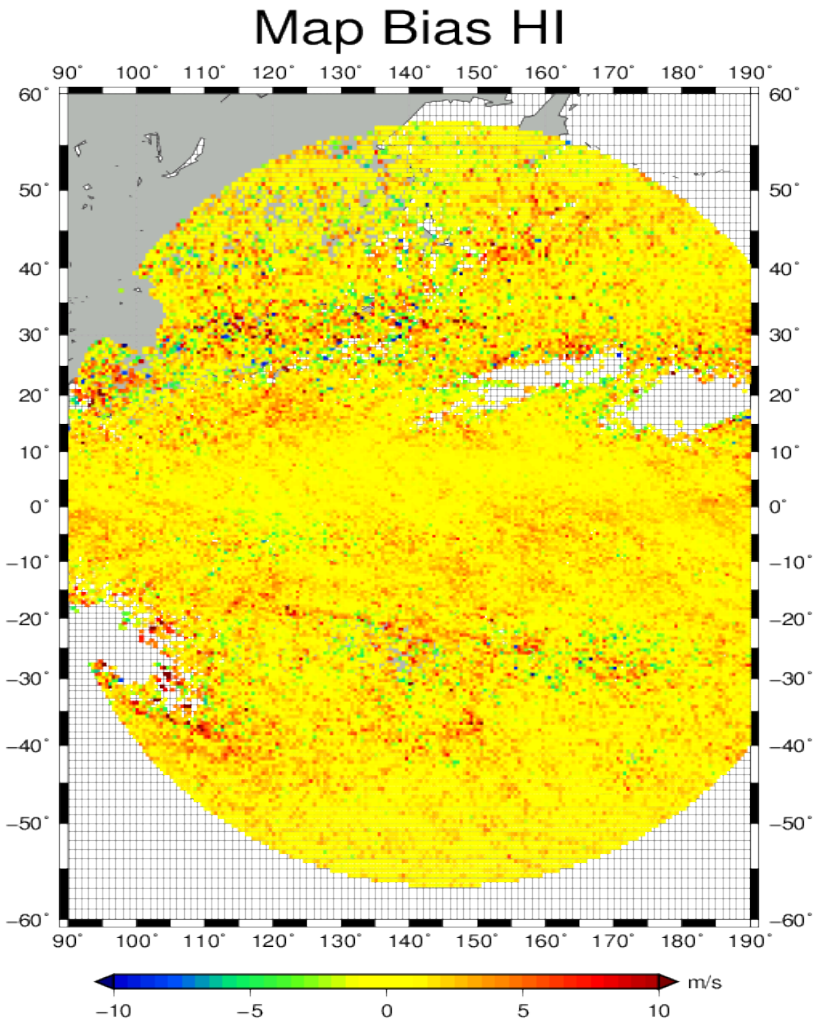


IR upper level AMV O-B statistics for January 2013

RTN

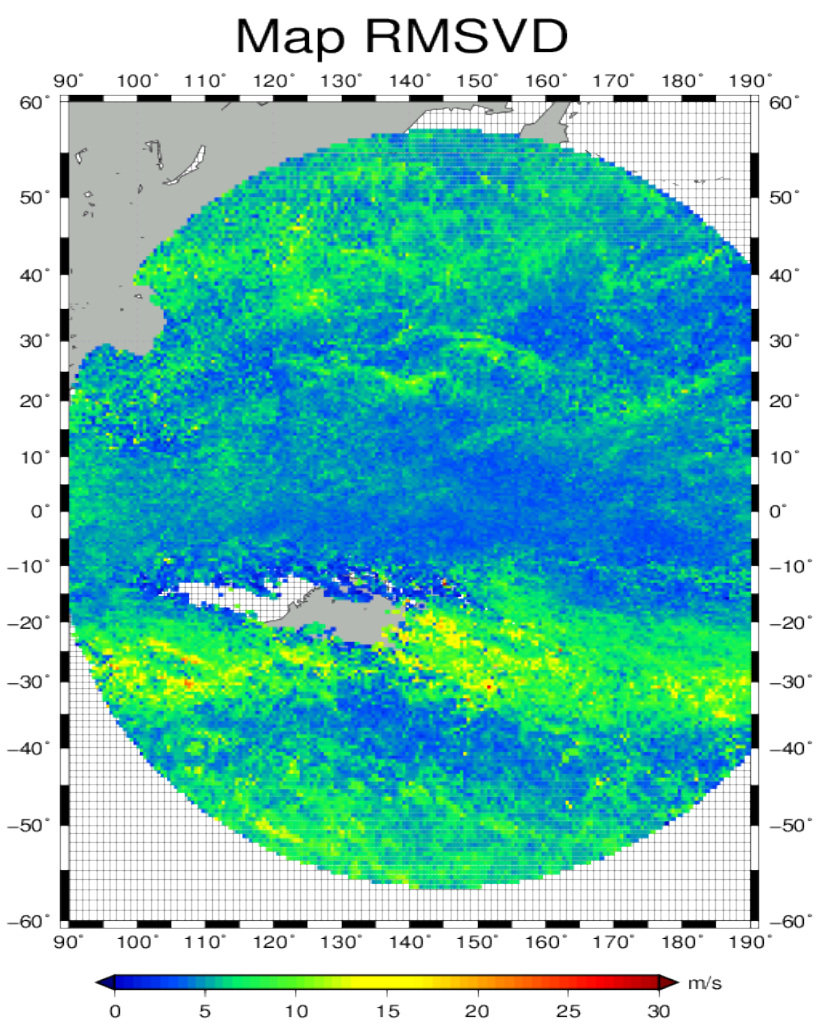


NEW

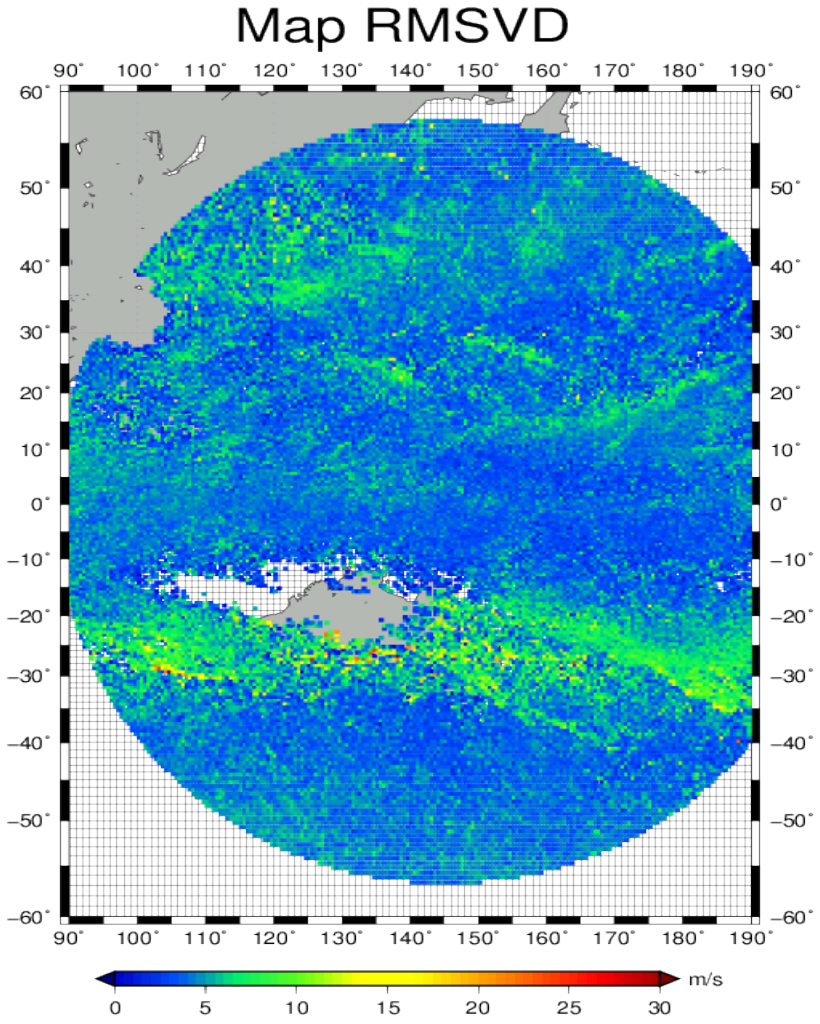


IR upper level AMV O-B statistics for July 2012

RTN

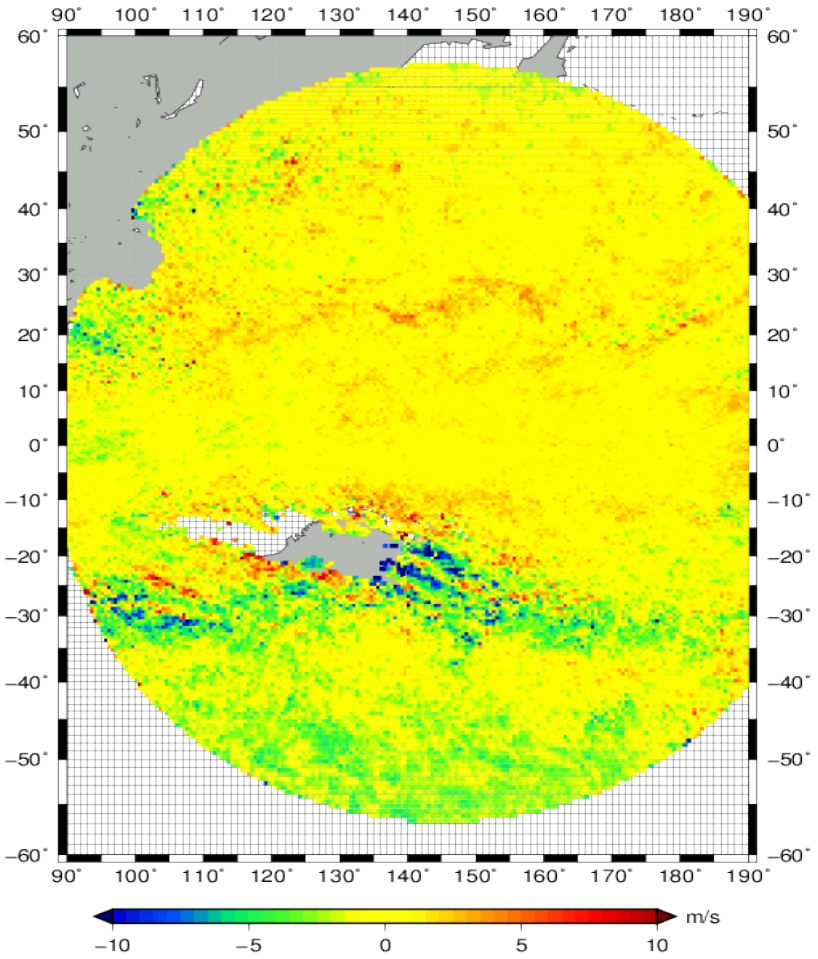


TEST



IR upper level AMV O-B statistics for July 2012

RTN



TEST