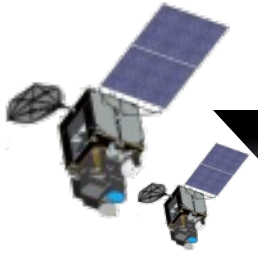
Practical Training on the utilization of Himawari-8,9 Imagery using SATAID

Taro HANDA
Meteorological Satellite Center / Japan Meteorological Agency

AOMSUC-12
11th November 2022



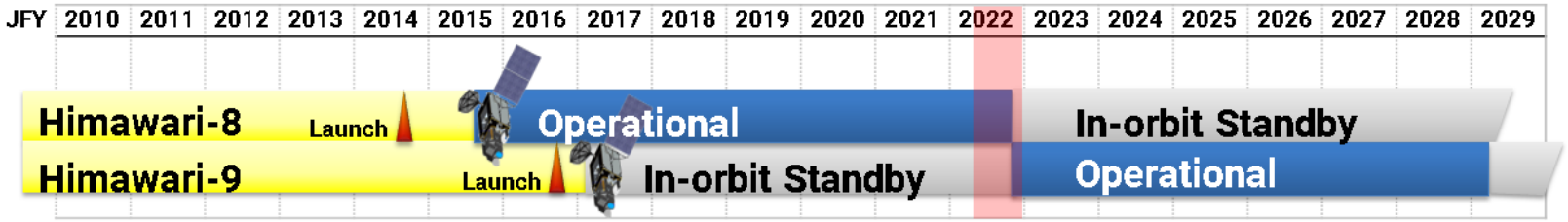
2014 Himawari-8
2016 Himawari-9

Contents

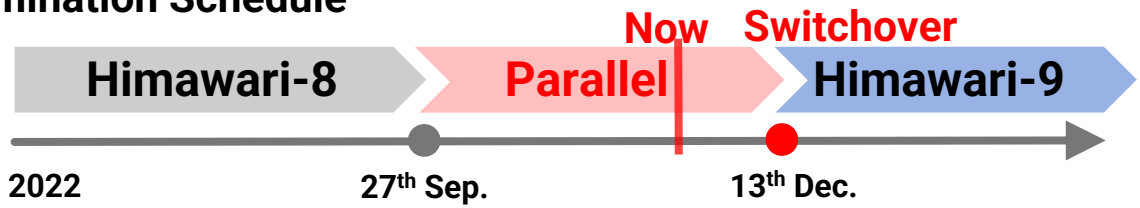
- **Practical Training on the utilization of Himawari-8, 9 Imagery using SATAID HANDA Taro**
  - Overview of Himawari-8/9, RGB composite imagery and RGB quick guides
  - How to display RGB composite imageries etc. using SATAID.
- **Introduction to Himawari-8 imagery applications with case studies**
  - Case1 : Huge Volcanic eruption in Tonga NAIKI Shiho
  - Case2 : Typhoon Nanmadol (T2214) SAITO Kotaro

Overview of Himawari-8, 9

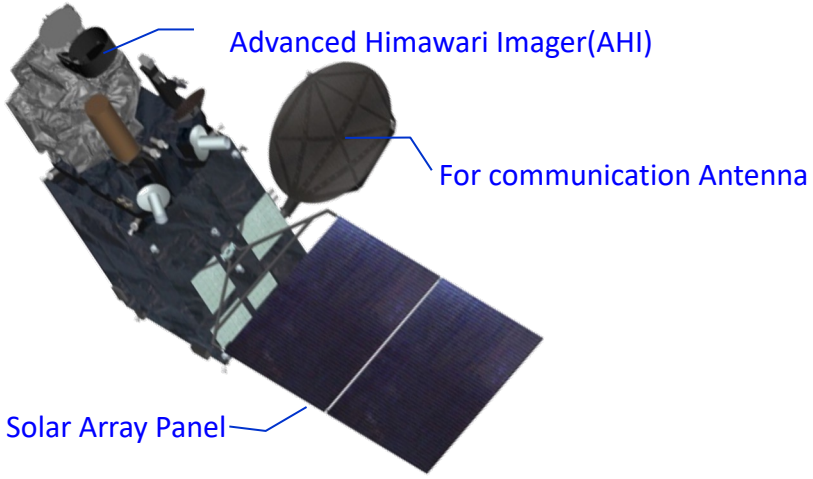
★Himawari-8, 9 Operation Plan



Dissemination Schedule



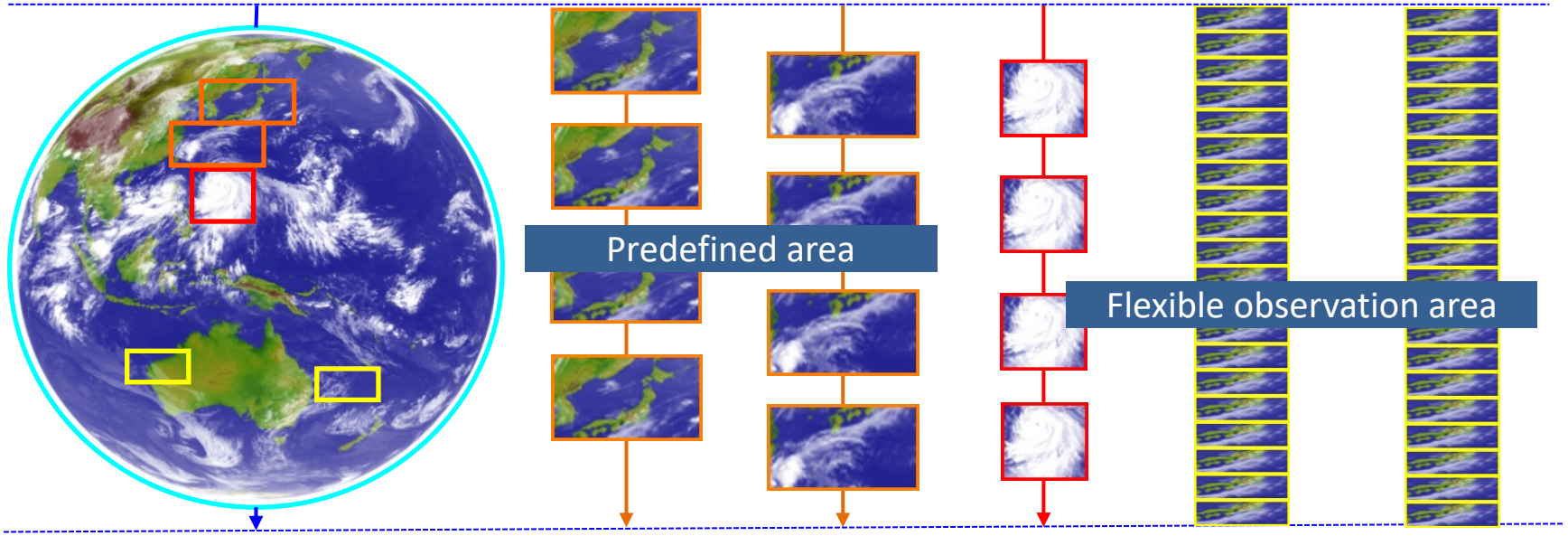
★Satellite conceptual diagram



★Satellite spec

Total length	Approx. 8m
Weight	Approx. 3,500kg (including fuel) Approx. 1,300kg (only main unit)
Initial generated power	Approx. 2.6kW
Design lifetime	Over 15 years (main unit) Over 8 years (observation functions)

Overview of the Himawari-8 observation (10 minutes Repeat Cycle)



Full Disk Observation every 10 min.

Region 1	Region 2	Region 3	Region 4	Region 5
2000 x 1000km (NE Japan)	2000 x 1000km (SW Japan)	1000 x 1000 km (Target Area)	1000 x 500 km (Landmark Area)	1000 x 500 km (Landmark Area)
Every **2.5 min.**	Every **2.5 min.**	Every **2.5 min.**	Every **30 sec.**	Every **30 sec.**

- AHI (Advanced Himawari Imager) on Himawari-8 has the ability of various scans during 10 minutes Full Disk observation.
- AHI can flexibly change the scan range of "Target Area" for observation of phenomena such as **typhoons** and active volcanoes.
- Lunar observation: performed using Landmark Area (Region 5)

AHI Spectral Bands
(5 bands -> 16bands)

cf. MTSAT-2 Bands

VIS 0.68 μm

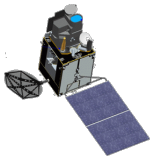
IR4 3.7 μm

IR3 6.8 μm

IR1 10.8 μm

IR2 12.0 μm

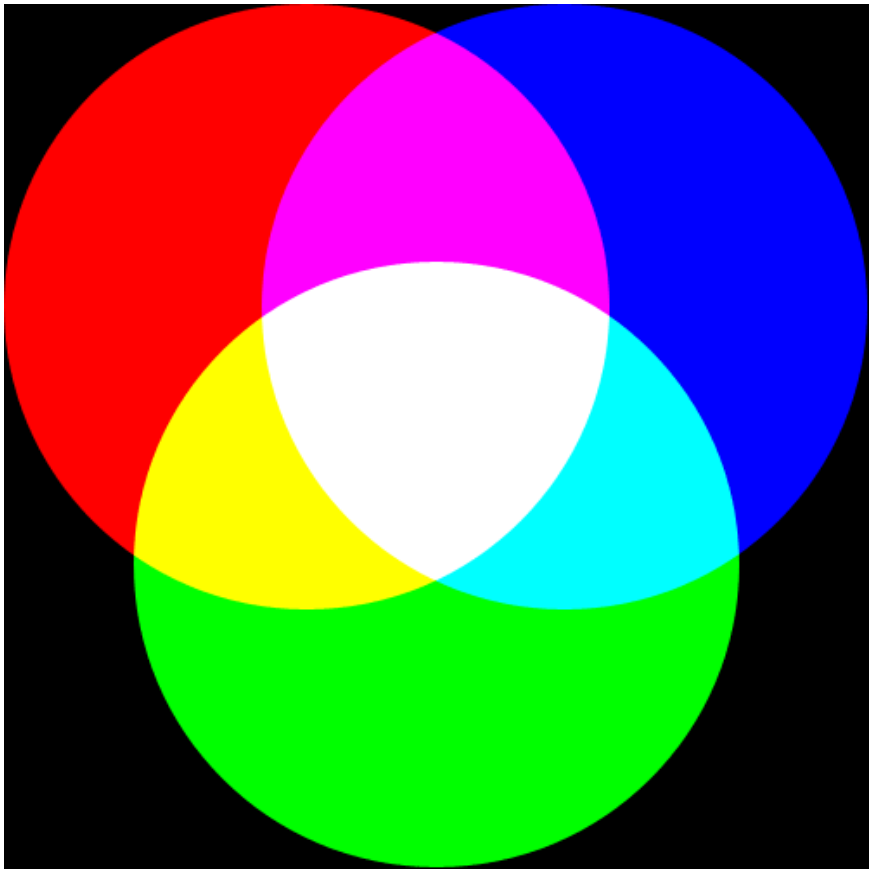
Himawari-8/9 Imager (AHI; Advanced Himawari Imager)



Band		Spatial Resolution	Central Wavelength	Physical Properties	
1	Visible (VIS)	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 (NIR)	1 km	0.86 μm	vegetation, aerosol	Addition of NIR Bands
5		2 km	1.6 μm	cloud phase/particle size	
6			2.3 μm	cloud particle size	
7	Infrared (IR)	2 km	3.9 μm	low cloud, fog, forest fire	
8			6.2 μm	upper-level moisture	Increase of WV Bands
9			6.9 μm	mid- and upper-level moisture	
10			7.3 μm	mid-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	

What's RGB?

- Red (R), green (G) and blue (B), which are the three primary colors of light, constitute color space expressing additive color composite
- RGB compositing is a technique to display a color using this property of the three primary colors of light

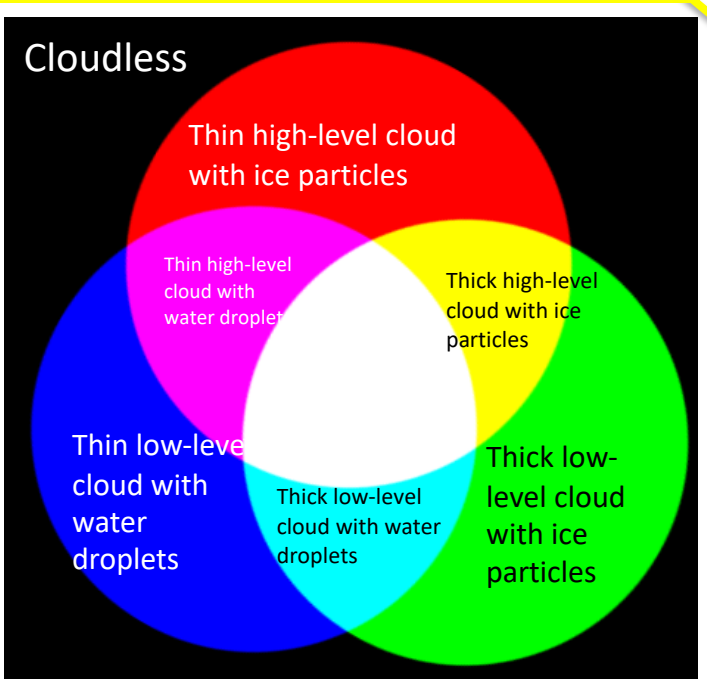


three primary colors RGB

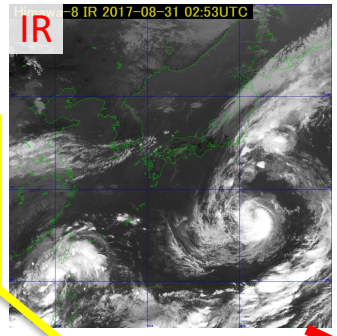
Application to Satellite Imageries

RGB composite

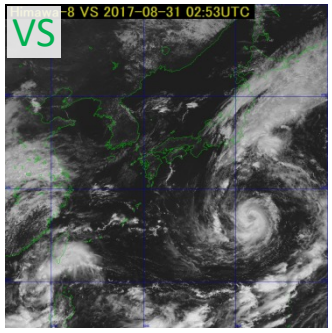
Thick and high cloud (Cb) areas appear yellow!



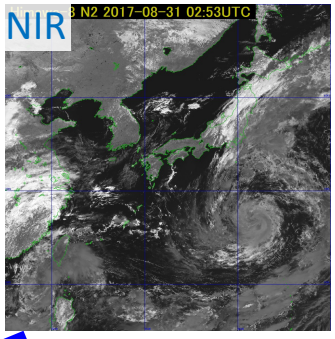
"High" cloud

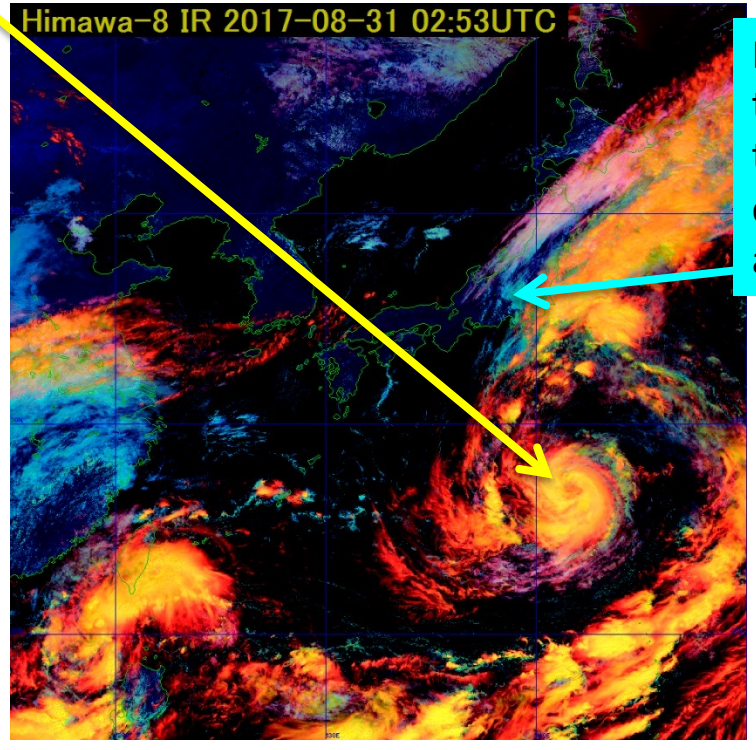


"Thick" cloud



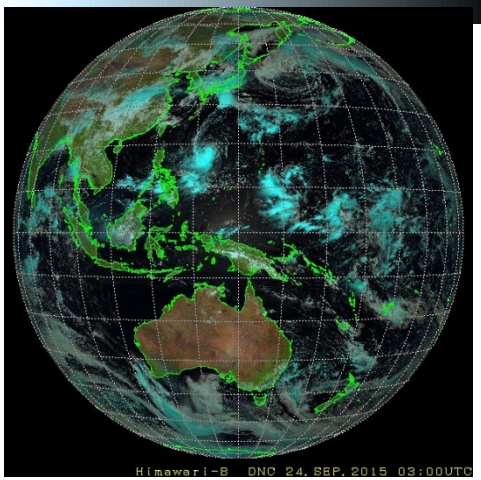
"Ice" cloud



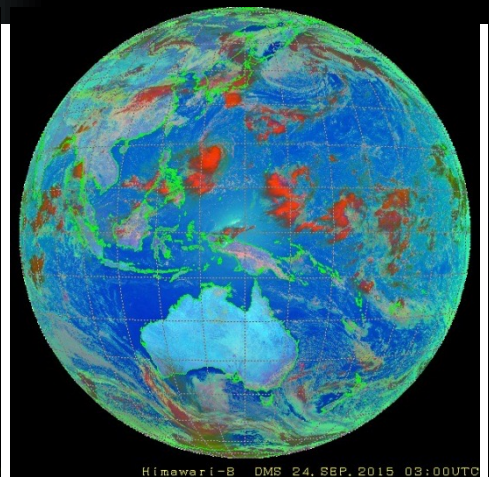


If you want to focus on the low level clouds, look at cyan area.

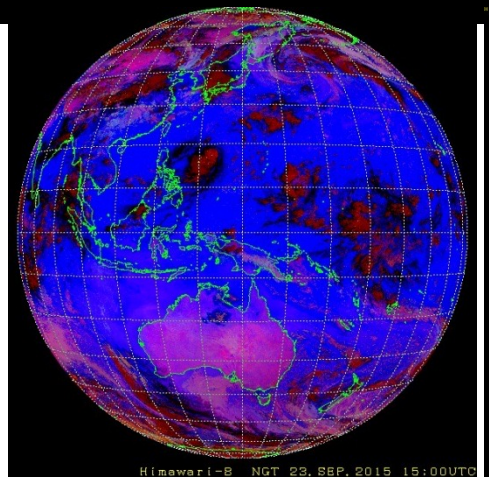
Well-known RGBs from Himawari-8



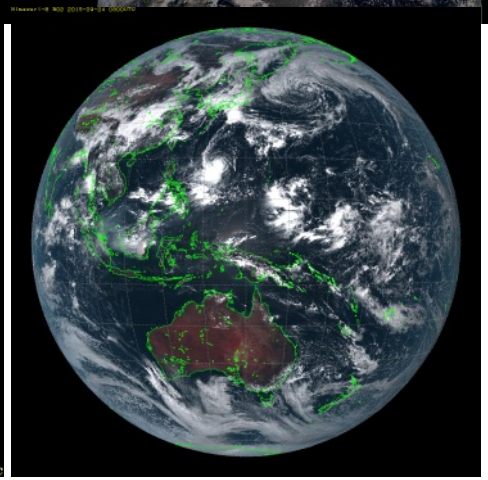
Day Natural Colors



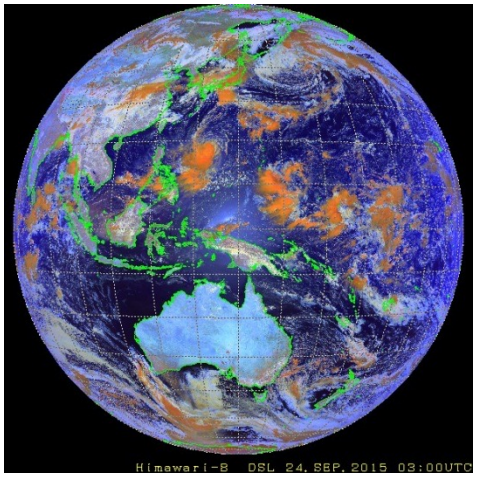
Day Microphysics



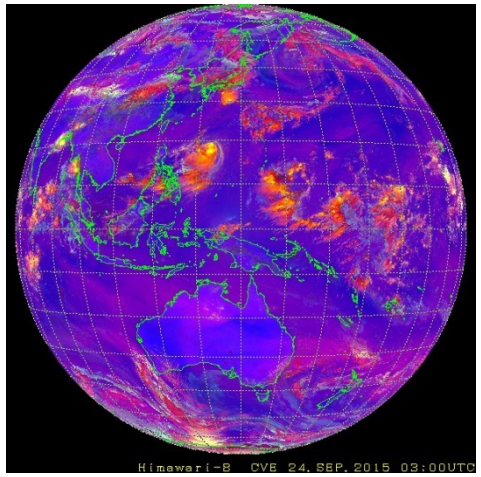
Night Microphysics



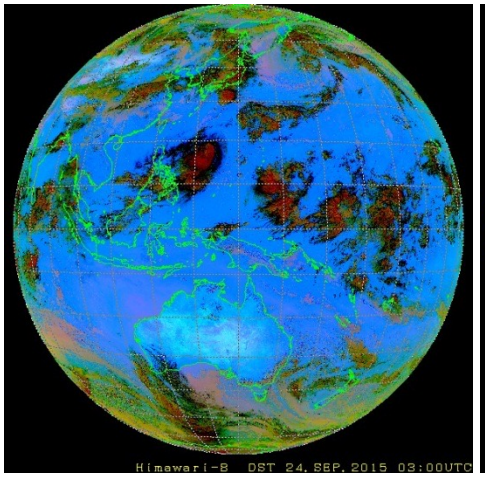
True Color



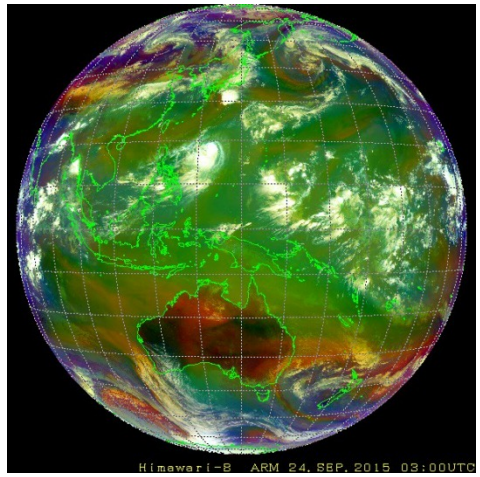
Day Snow-Fog



Day Convective Storm



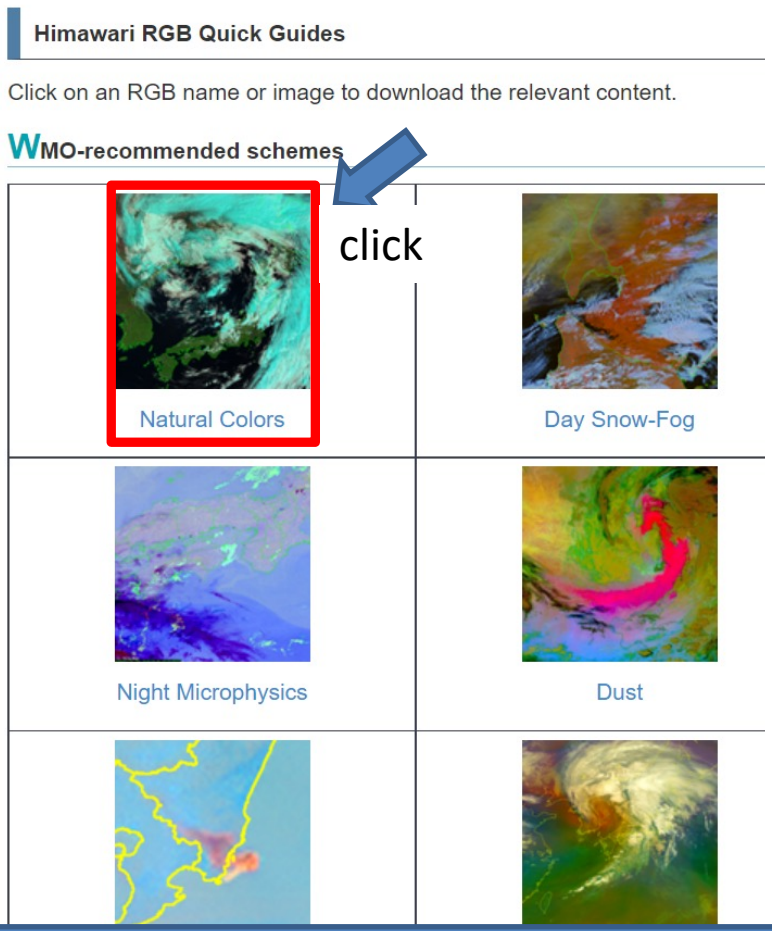
Dust



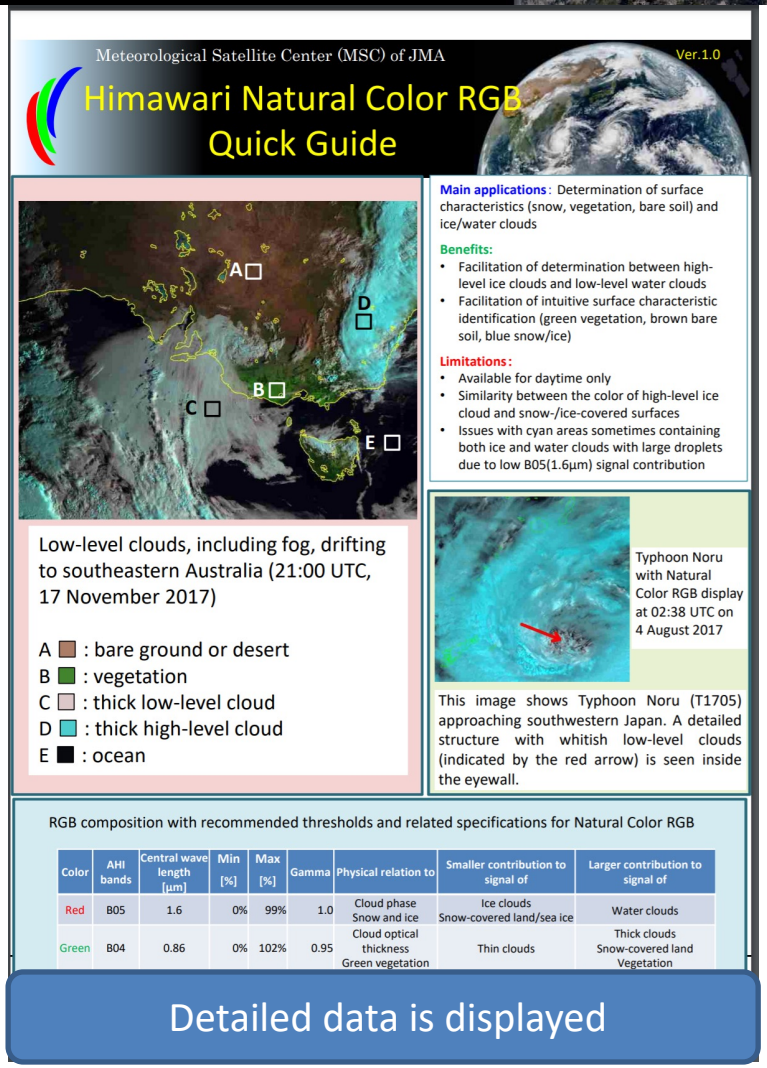
Airmass

https://www.data.jma.go.jp/mscweb/data/himawari/sat_img.php?area=fd_

RGB Quick Guides



RGB Quick Guide Web page in MSC Website

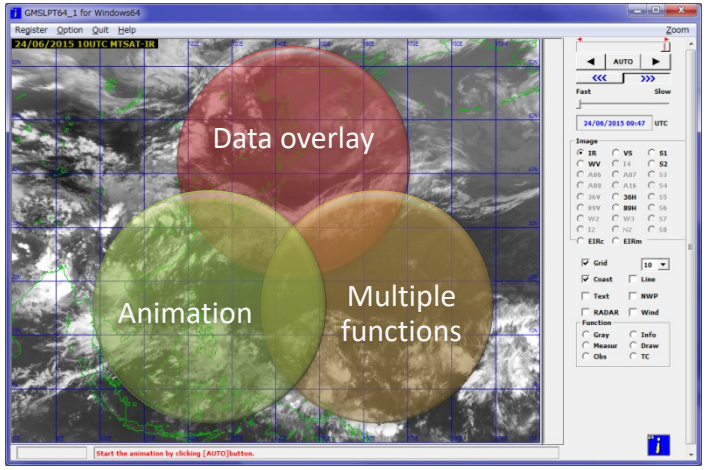


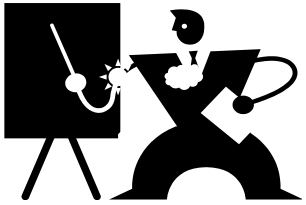
Detailed data is displayed

https://www.jma.go.jp/jma/jma-eng/satellite/VLab/RGB_QG.html

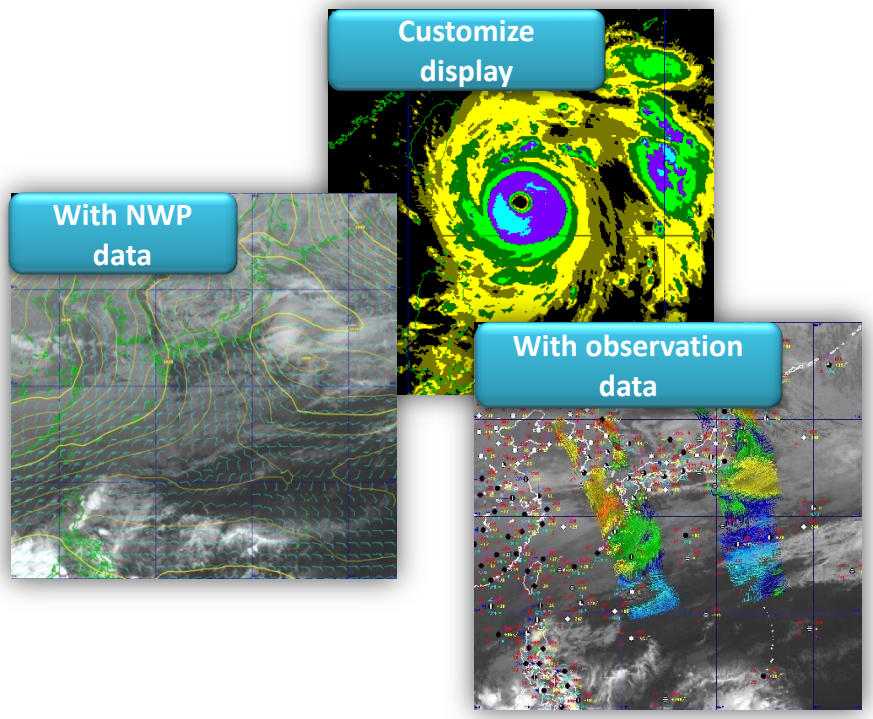
What is SATAID?

SATAID (**SAT**ellite **A**nimation and **I**nteractive **D**iagnosis) is a sophisticated display software visualizing meteorological information **in multiple dimensions (spatial and temporal)**, which assists forecasters to analyze and monitor continually weather parameters and phenomena for better meteorological services.





More efficiently and accurately!

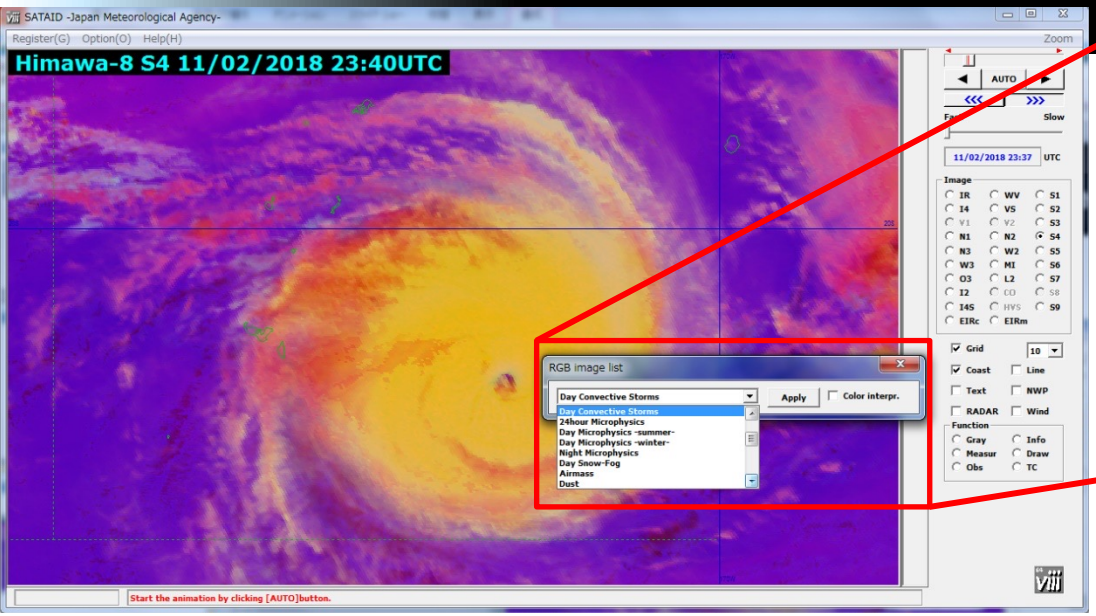


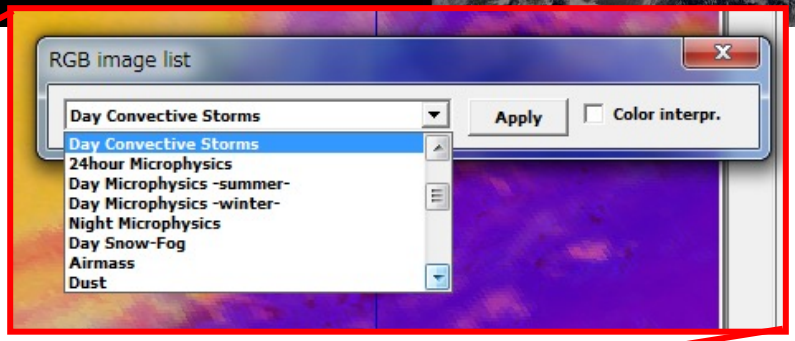
10

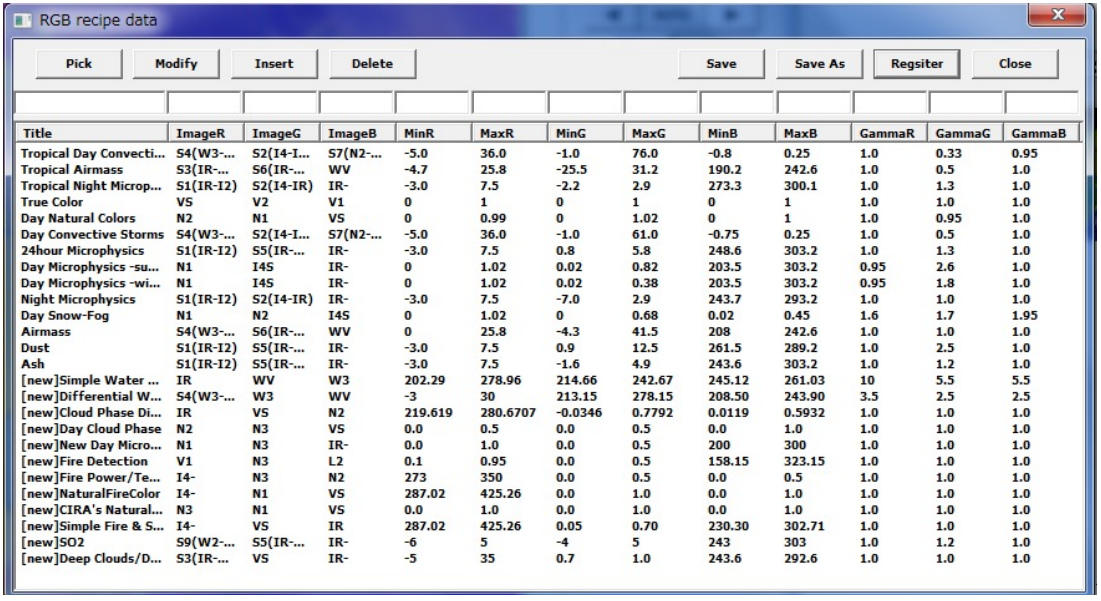
What can we do by using SATAID?

- With SATAID, you can …
  - **Display (and overlay) satellite imagery and NWP data**
    (and various observations i.e. SYNOP, SHIP, TEMP, Radar, Wind Profiler, ASCAT etc. if its format prepared)
  - **Use many functions**
    vertical cross-sectional chart, time-series chart, digital data output to CSV file.....
  - **Save as a file including a package of all data**
    your drawings and comments, which will be useful for trainings and case study archives
  - **Analyze position and intensity of tropical cyclones**

RGB composite imagery on SATAID



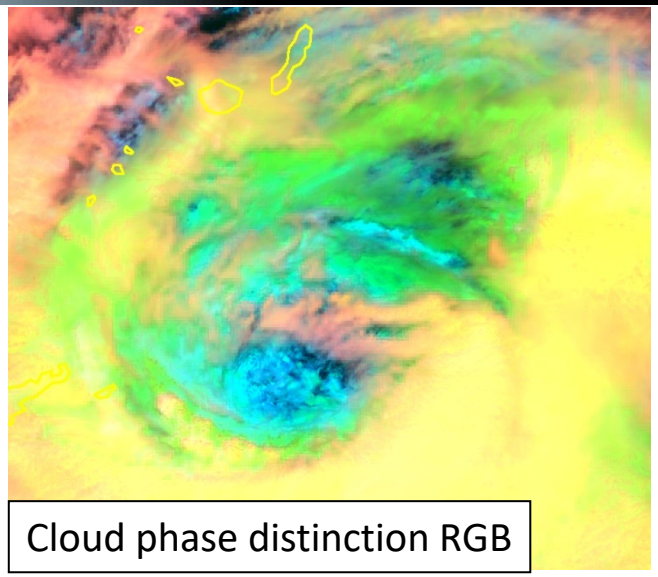




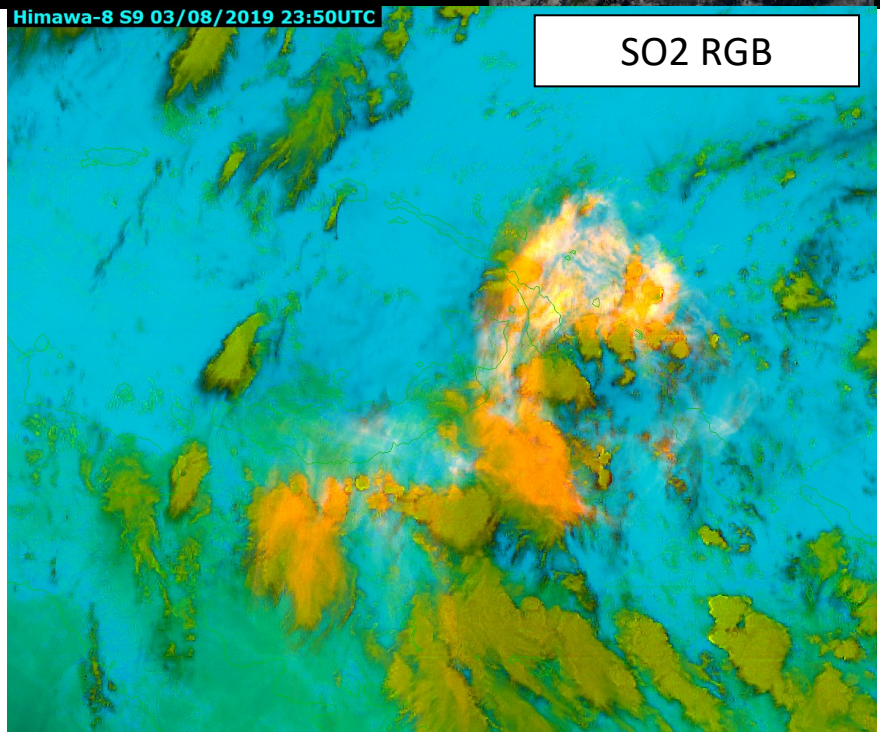
Title	ImageR	ImageG	ImageB	MinR	MaxR	MinG	MaxG	MinB	MaxB	GammaR	GammaG	GammaB
Tropical Day Convecti...	S4(W3-...	S2(I4-I...	S7(N2-...	-5.0	36.0	-1.0	76.0	-0.8	0.25	1.0	0.33	0.95
Tropical Airmass	S3(IR-...	S6(IR-...	WV	-4.7	25.8	-25.5	31.2	190.2	242.6	1.0	0.5	1.0
Tropical Night Microp...	S1(IR-I2)	S2(I4-IR)	IR-	-3.0	7.5	-2.2	2.9	273.3	300.1	1.0	1.3	1.0
True Color	VS	V2	V1	0	1	0	1	0	1	1.0	1.0	1.0
Day Natural Colors	N2	N1	VS	0	0.99	0	1.02	0	1	1.0	0.95	1.0
Day Convective Storms	S4(W3-...	S2(I4-I...	S7(N2-...	-5.0	36.0	-1.0	61.0	-0.75	0.25	1.0	0.5	1.0
24hour Microphysics	S1(IR-I2)	S5(IR-...	IR-	-3.0	7.5	0.8	5.8	248.6	303.2	1.0	1.3	1.0
Day Microphysics -su...	N1	I4S	IR-	0	1.02	0.02	0.82	203.5	303.2	0.95	2.6	1.0
Day Microphysics -wi...	N1	I4S	IR-	0	1.02	0.02	0.38	203.5	303.2	0.95	1.8	1.0
Night Microphysics	S1(IR-I2)	S2(I4-IR)	IR-	-3.0	7.5	-7.0	2.9	243.7	293.2	1.0	1.0	1.0
Day Snow-Fog	N1	N2	I4S	0	1.02	0	0.68	0.02	0.45	1.6	1.7	1.95
Airmass	S4(W3-...	S6(IR-...	WV	0	25.8	-4.3	41.5	208	242.6	1.0	1.0	1.0
Dust	S1(IR-I2)	S5(IR-...	IR-	-3.0	7.5	0.9	12.5	261.5	289.2	1.0	2.5	1.0
Ash	S1(IR-I2)	S5(IR-...	IR-	-3.0	7.5	-1.6	4.9	243.6	303.2	1.0	1.2	1.0
[new]Simple Water ...	IR	WV	W3	202.29	278.96	214.66	242.67	245.12	261.03	10	5.5	5.5
[new]Differential W...	S4(W3-...	W3	WV	-3	30	213.15	278.15	208.50	243.90	3.5	2.5	2.5
[new]Cloud Phase Di...	IR	VS	N2	219.619	280.6707	-0.0346	0.7792	0.0119	0.5932	1.0	1.0	1.0
[new]Day Cloud Phase	N2	N3	VS	0.0	0.5	0.0	0.5	0.0	1.0	1.0	1.0	1.0
[new]New Day Micro...	N1	N3	IR-	0.0	1.0	0.0	0.5	200	300	1.0	1.0	1.0
[new]Fire Detection	V1	N3	L2	0.1	0.95	0.0	0.5	158.15	323.15	1.0	1.0	1.0
[new]Fire Power/Te...	I4-	N3	N2	273	350	0.0	0.5	0.0	0.5	1.0	1.0	1.0
[new]NaturalFireColor	I4-	N1	VS	287.02	425.26	0.0	1.0	0.0	1.0	1.0	1.0	1.0
[new]CIRA's Natural...	N3	N1	VS	0.0	1.0	0.0	1.0	0.0	1.0	1.0	1.0	1.0
[new]Simple Fire & S...	I4-	VS	IR	287.02	425.26	0.05	0.70	230.30	302.71	1.0	1.0	1.0
[new]SO2	S9(W2-...	S5(IR-...	IR-	-6	5	-4	5	243	303	1.0	1.2	1.0
[new]Deep Clouds/D...	S3(IR-...	VS	IR-	-5	35	0.7	1.0	243.6	292.6	1.0	1.0	1.0

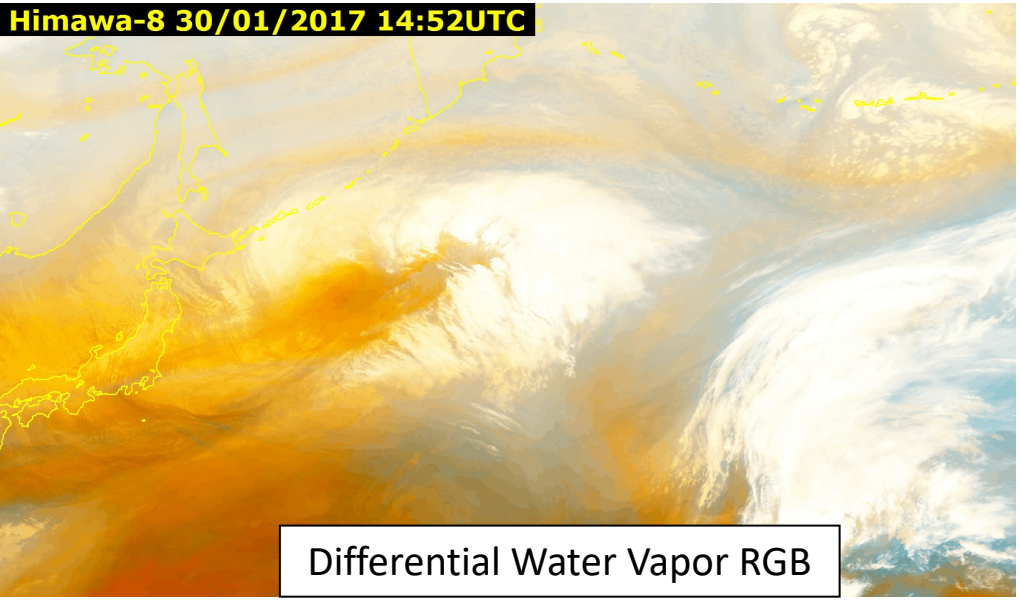
- SATAID can show RGB imagery easily by using RGB image list dropdown menu.
- Select the name of RGB imagery -> Apply
- The RGB list file can edit and you can add new RGB recipe.

JMA original RGB recipes



Cloud phase distinction RGB





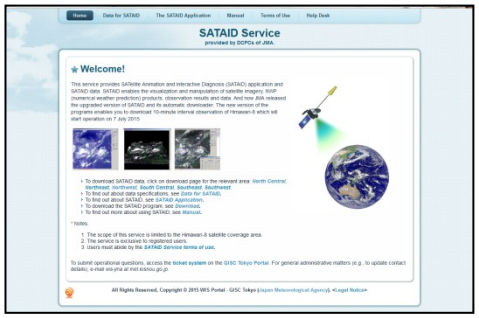
Differential Water Vapor RGB

- RGB list file for SATAID includes some JMA original RGB recipes

How can we get SATAID?

WIS Website

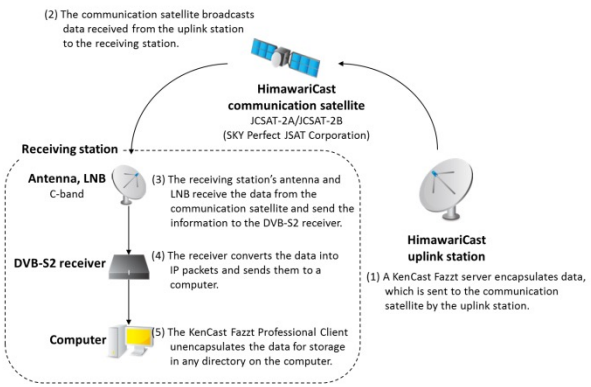
http://www.wis-jma.go.jp/cms/sataid/



- Internet Environment is required
- 5 channels are available every 10 minutes
- ID and Password are required
  (*wis-jma at met.kishou.go.jp*)

Himawari-Cast

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



- Dedicated antenna and computers are required
- 14 channels are available every 10 minutes

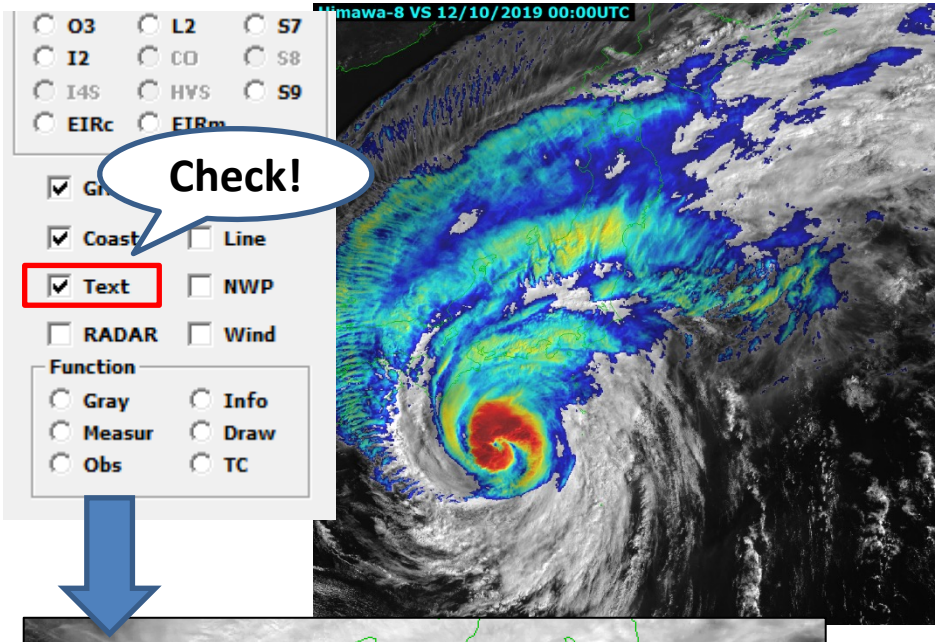
Hands-on training on basic SATAID functions and displaying RGBs / ASWind data

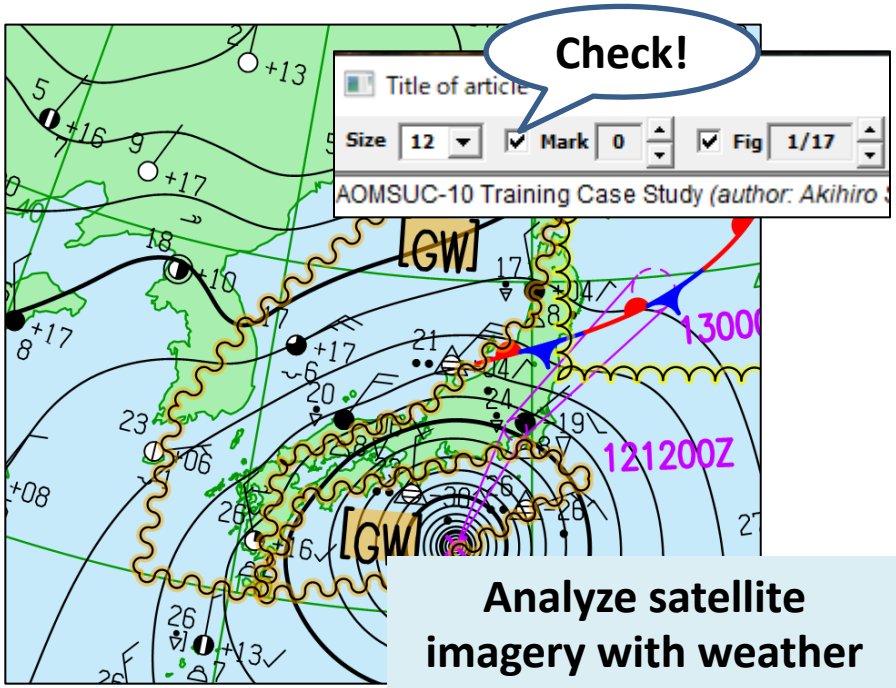
It’s time to practice using main SATAID functions in order to get used to its basic operations!
Then let’s take a look these case studies by SATAID modules.

1. Typhoon Hagibis (T1919) approaching Japan
   - 12 October, 2019 00:00 UTC – 18:30 UTC

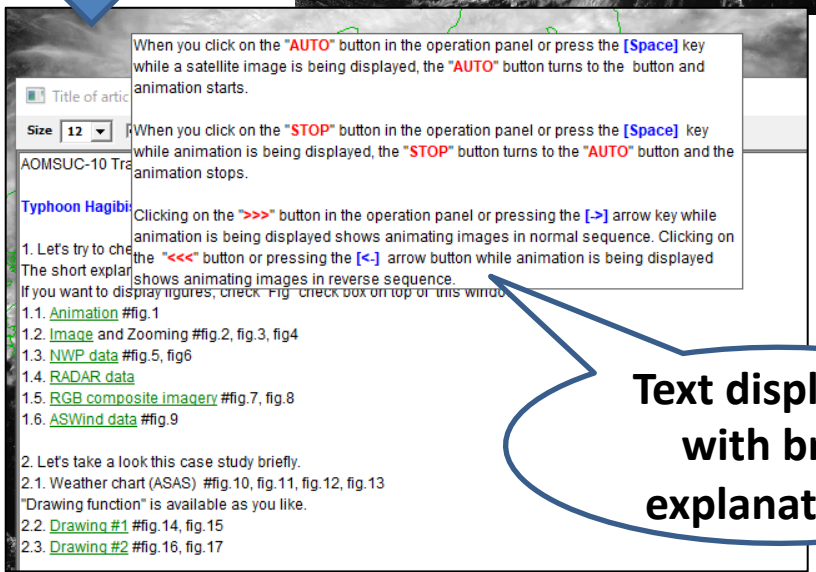
2. Flood in Papua New Guinea
   - 22 September, 2019 00:00 UTC– 23 September, 2019 18:30 UTC

Overview of SATAID case study modules



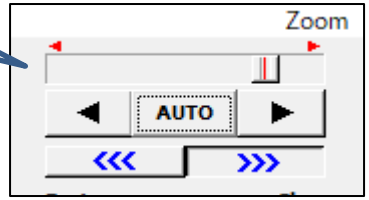


Analyze satellite imagery with weather chart, observation data and so on.

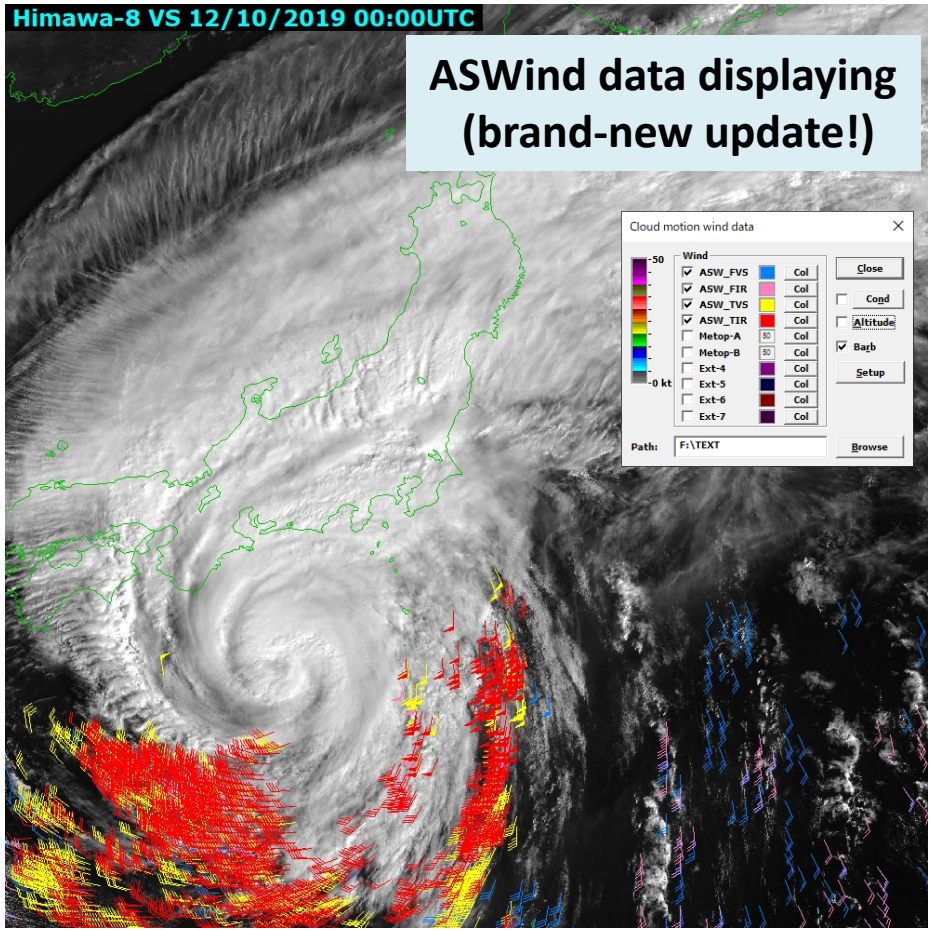


Animation makes easy to analyze satellite imagery.

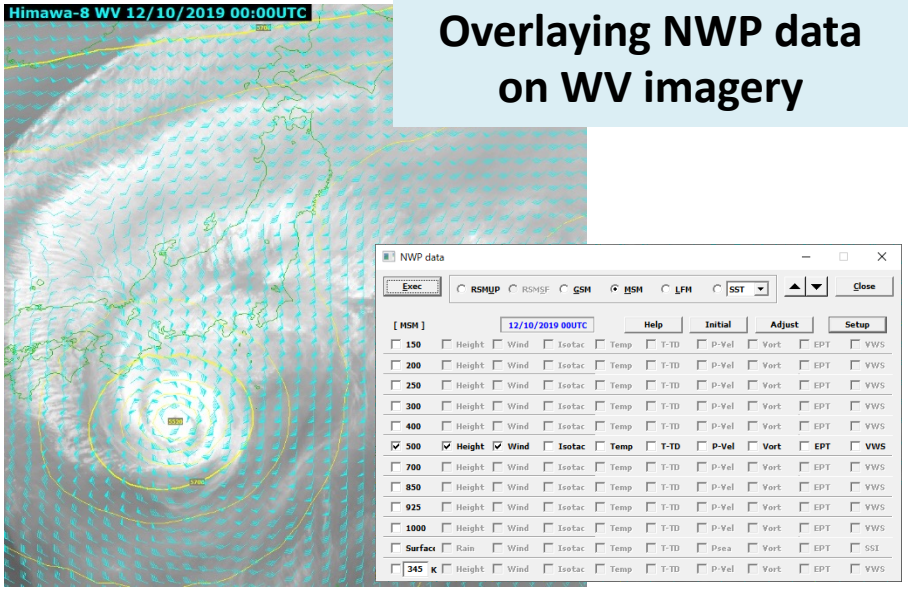
Text displaying with brief explanations.



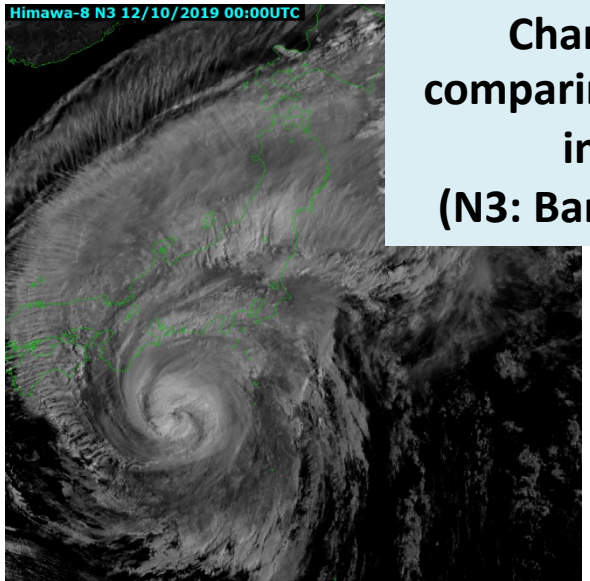
Overview of Case 1
Typhoon Hagibis (T1919) approaching Japan



ASWind data displaying (brand-new update!)



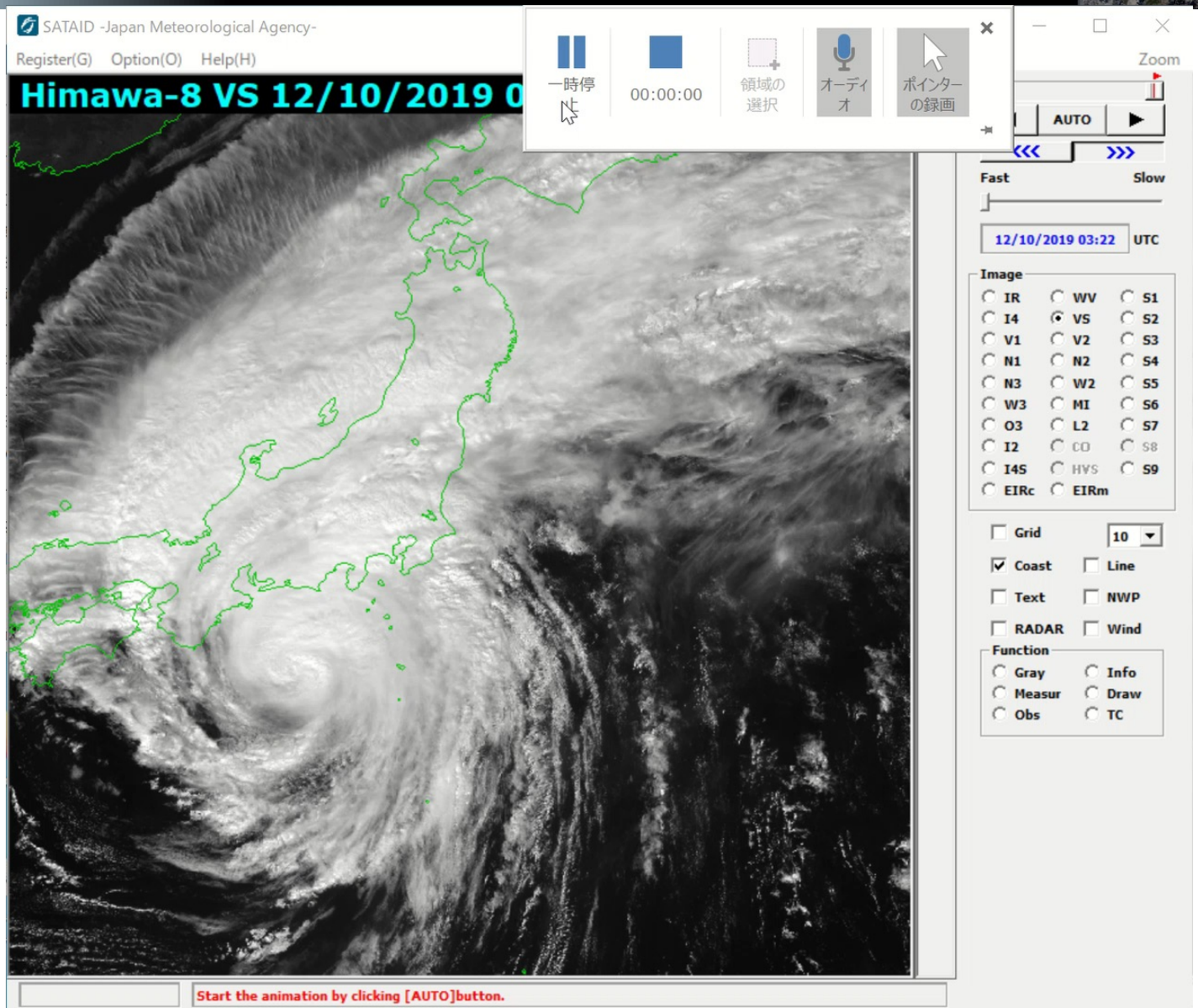
Overlaying NWP data on WV imagery



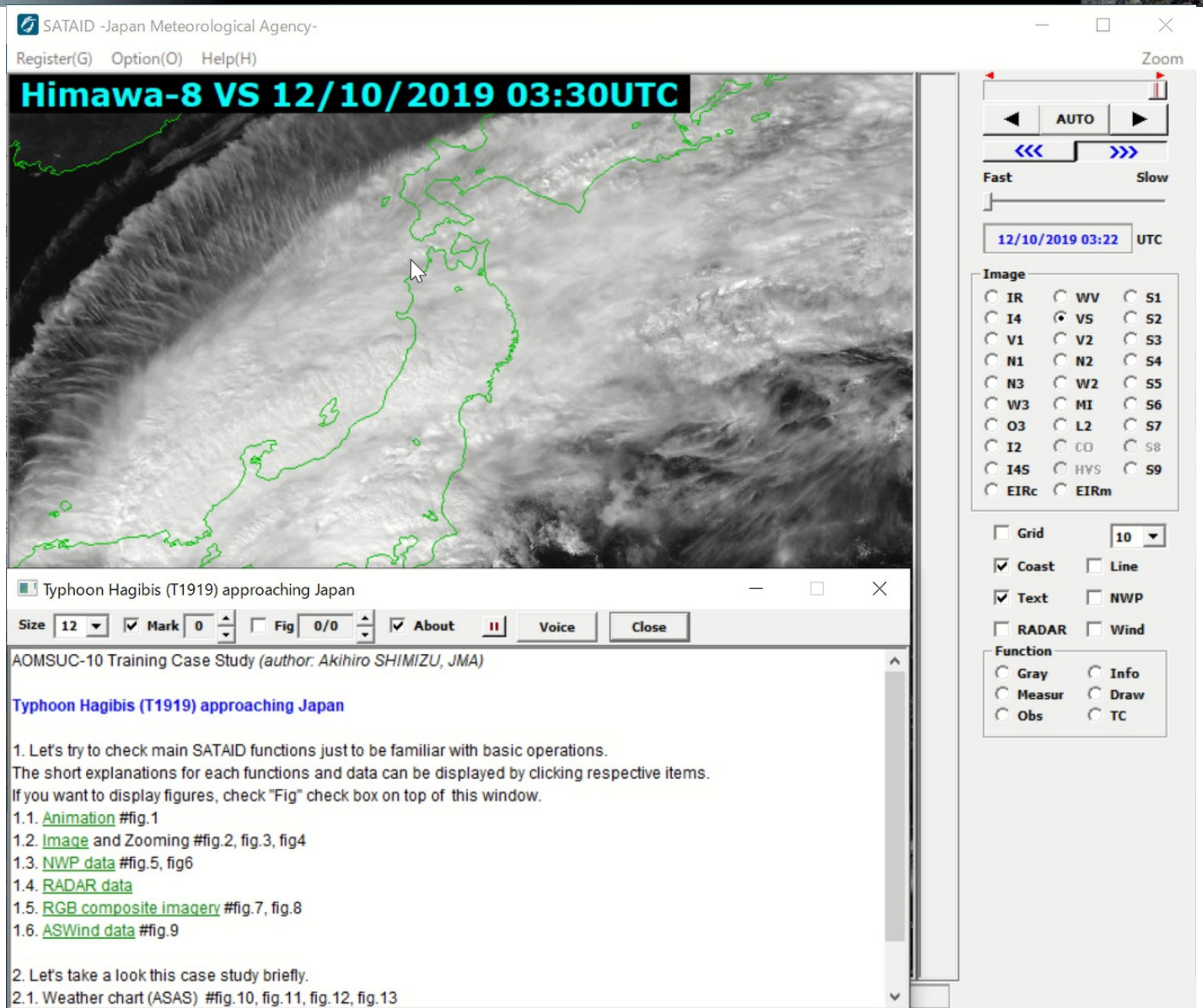
Changing and comparing multi band imagery (N3: Band 6, 2.3 μm)

Let’s have a familiarity with the SATAID basic operations!

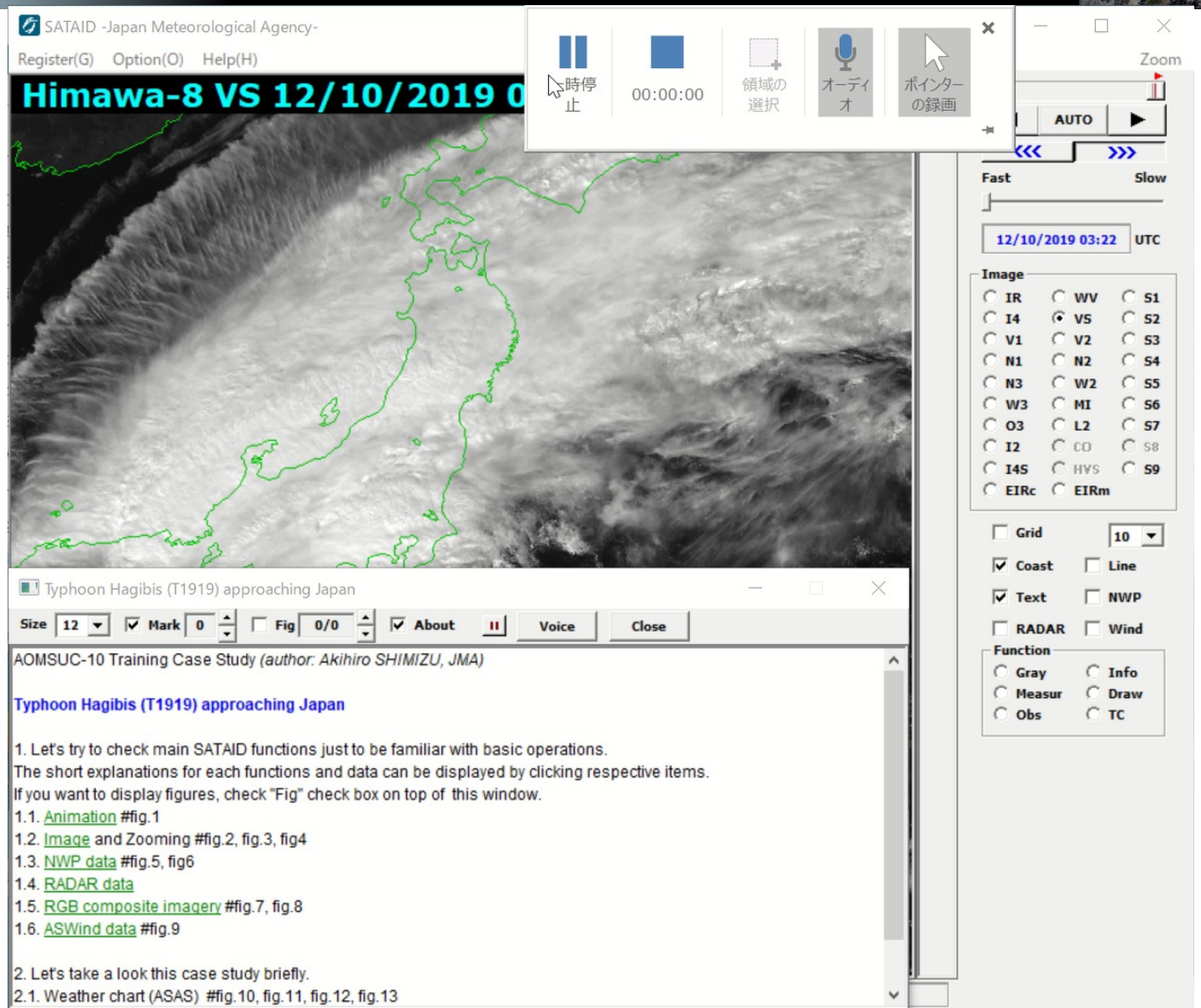
Overview of Case 1
Typhoon Hagibis (T1919) approaching Japan



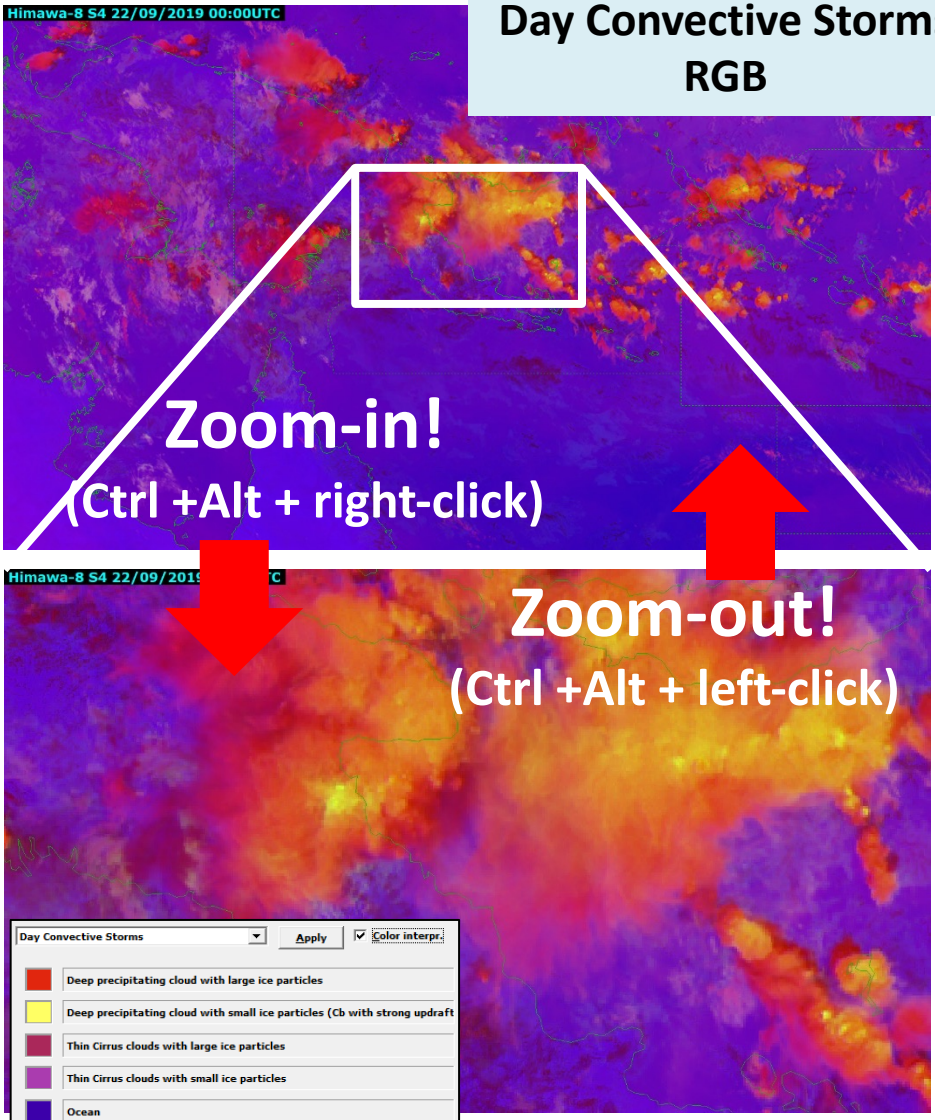
Overview of Case 1
Typhoon Hagibis (T1919) approaching Japan



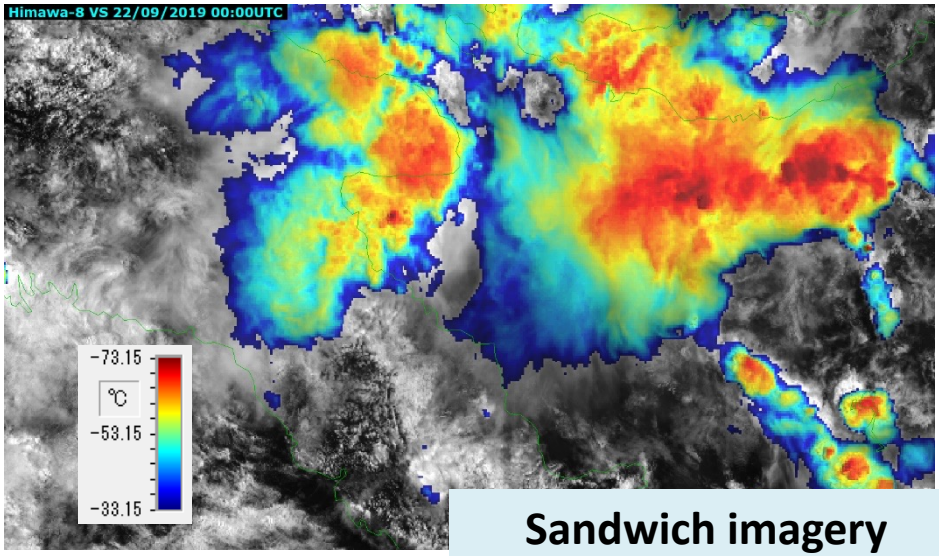
Overview of Case 1
Typhoon Hagibis (T1919) approaching Japan



Overview of Case 2
Flood in Papua New Guinea

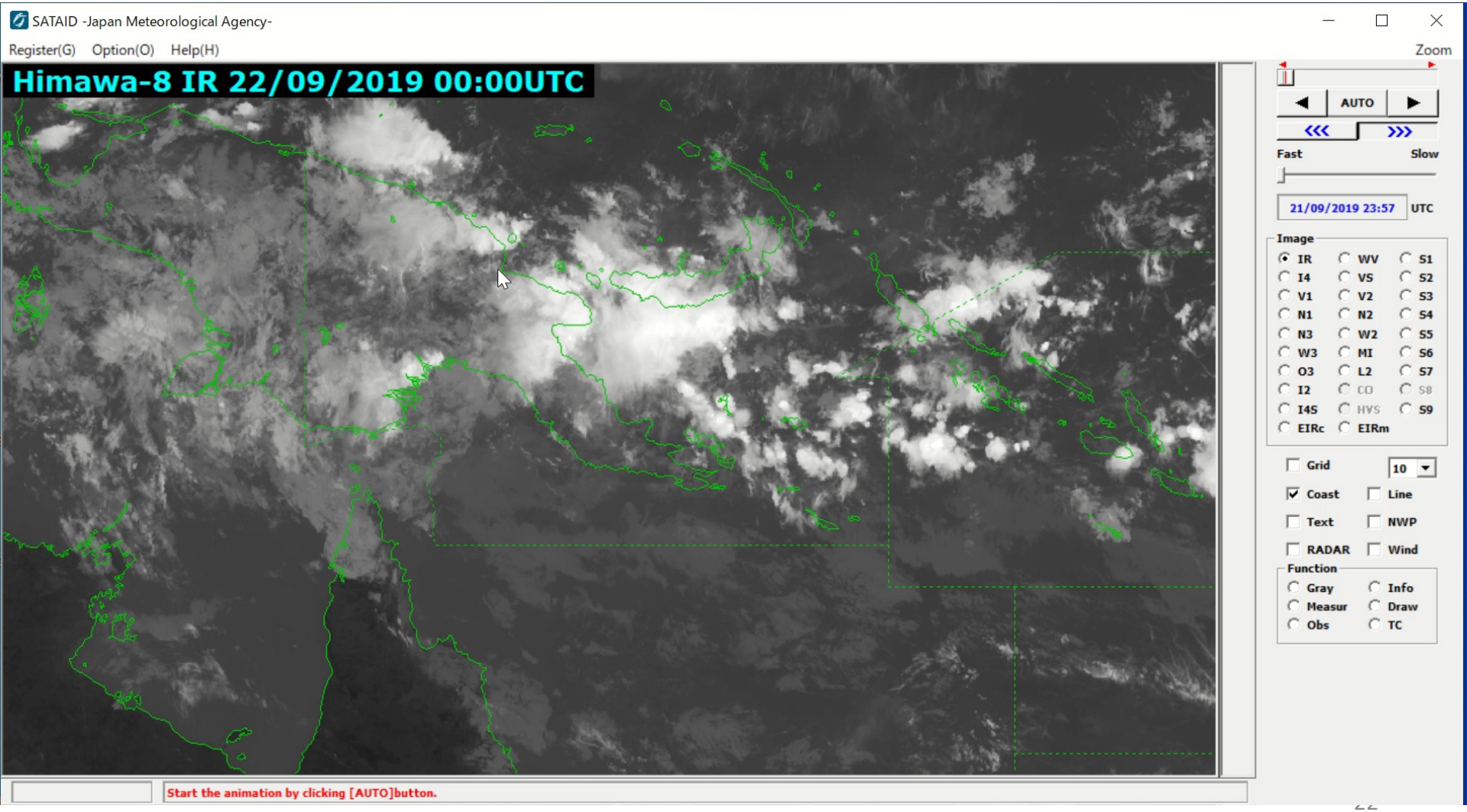


Focus on Cb clouds which brought heavy rain and flood.



Sandwich imagery

Overview of Case 2
Flood in Papua New Guinea



Summary

- Himawari-8, 9 Overview

Himawari-8, 9 make Full Disk observations every 10 minutes and Region observations every 2 and a half minutes. From them, RGB composites can be made and these are useful for disaster prevention and so on.

- RGB Composite

By progress of Himawari's observation, it has become possible to observe many bands. RGB Composites were developed to get important information easily.

- SATAID

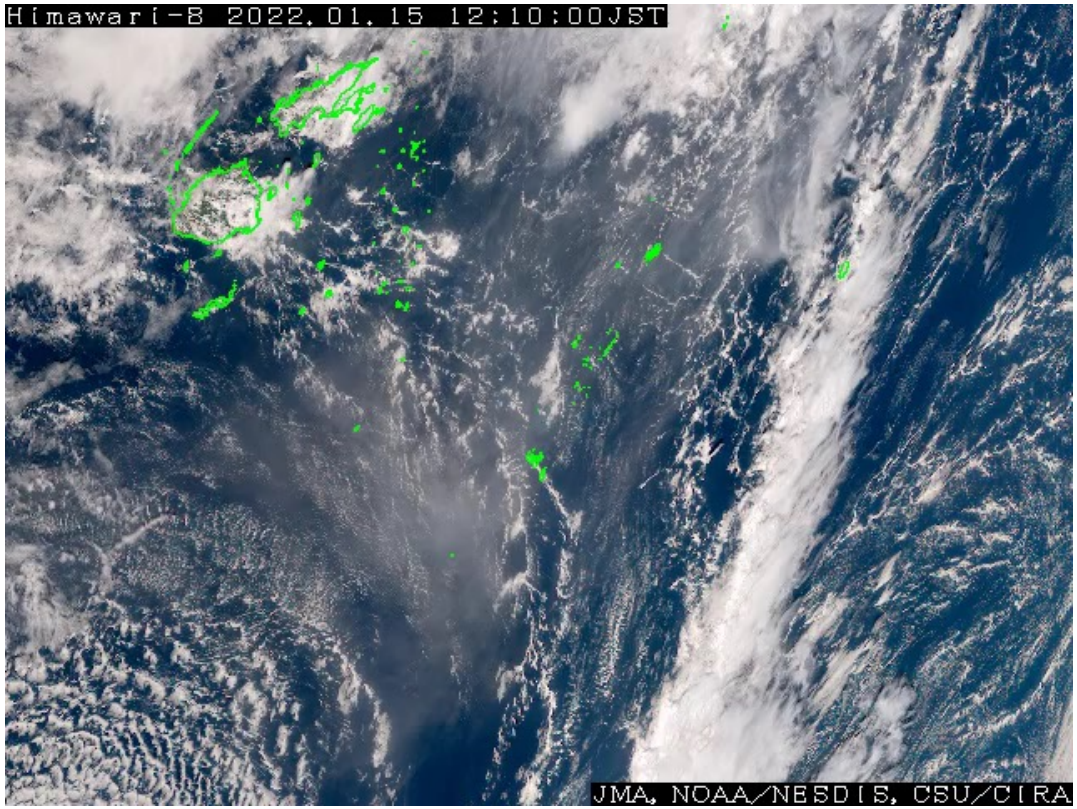
JMA is developing SATAID that can display satellite imagery, other observations (ex.in-situ, radar), and NWP datasets at the same time.

Summary

- SATAID can display RGB composite imagery by simple operation.
- SATAID can show WMO standard RGB recipes and JMA original recipes.
- We challenged hands-on practical training of RGB case studies by using SATAID.

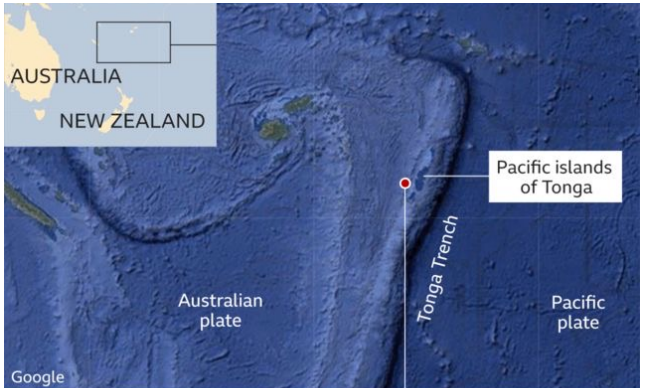
Case1 : Huge Volcanic eruption in Tonga

Overview

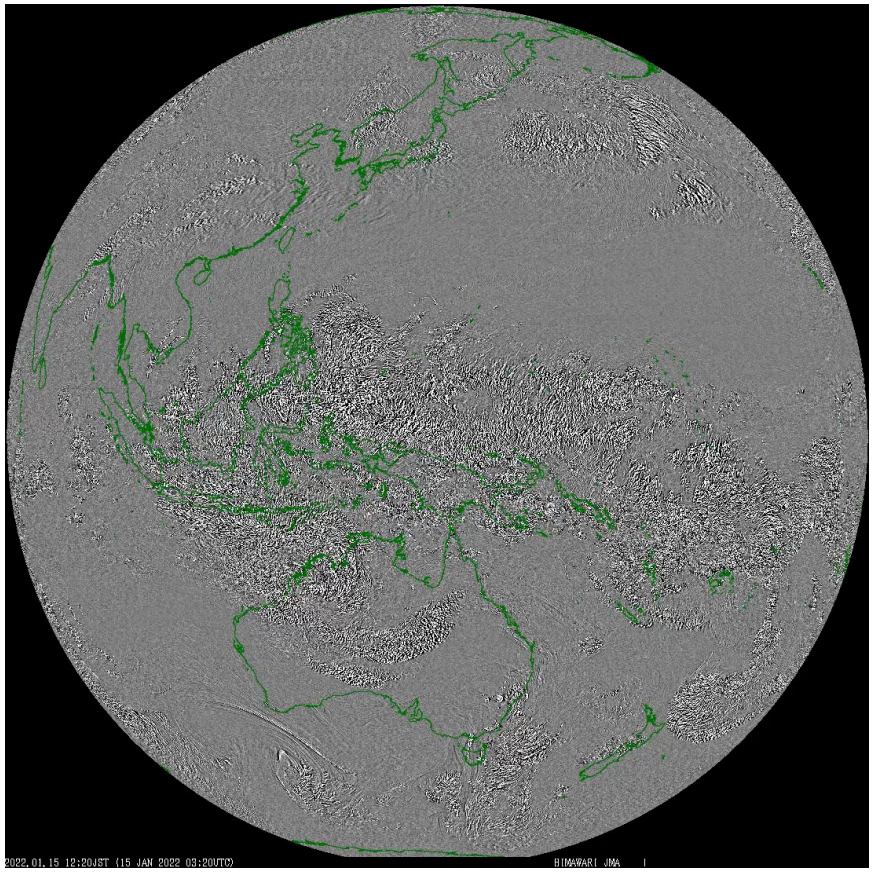


On 15th January 2022 at about 04UTC, a huge eruption occurred at Hunga Tonga-Hunga Ha'apai volcano, a submarine volcano in Tonga. Tsunamis (tidal changes) were observed at distant locations as a result of this eruption.

The left video is True Color Reproduction Image of Himawari-8 at the time of the eruption. (Band 13 at night time)



Atmospheric waves confirmed by Himawari-8

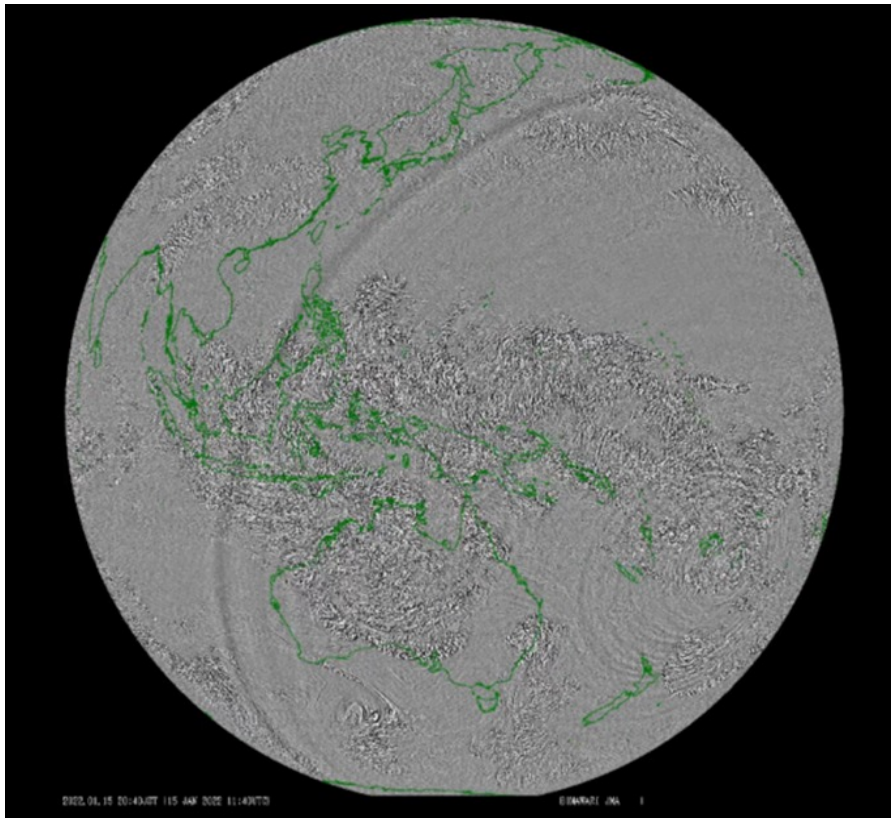


The video is the second time derivatives of 10-min interval images of Himawari-8 band 10.
(03UTC 15th January – 00UTC 17th January)

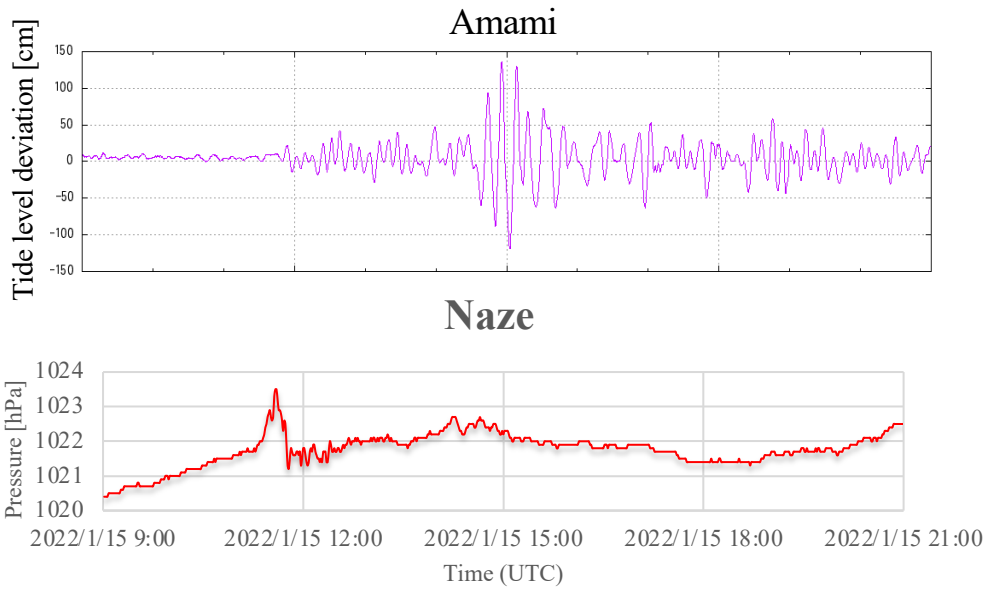
change in atmospheric density due to air shock
⇒ change in water vapor density
⇒ change in brightness temperature of band 10

Visualization of the second time derivatives make it easier to see changes.

Confirmed atmospheric waves and pressure changes



The second time derivatives image of B10 (11:40UTC 15th January)



Tide level deviation (top) and pressure (bottom) at Amami-Oshima Island, Japan

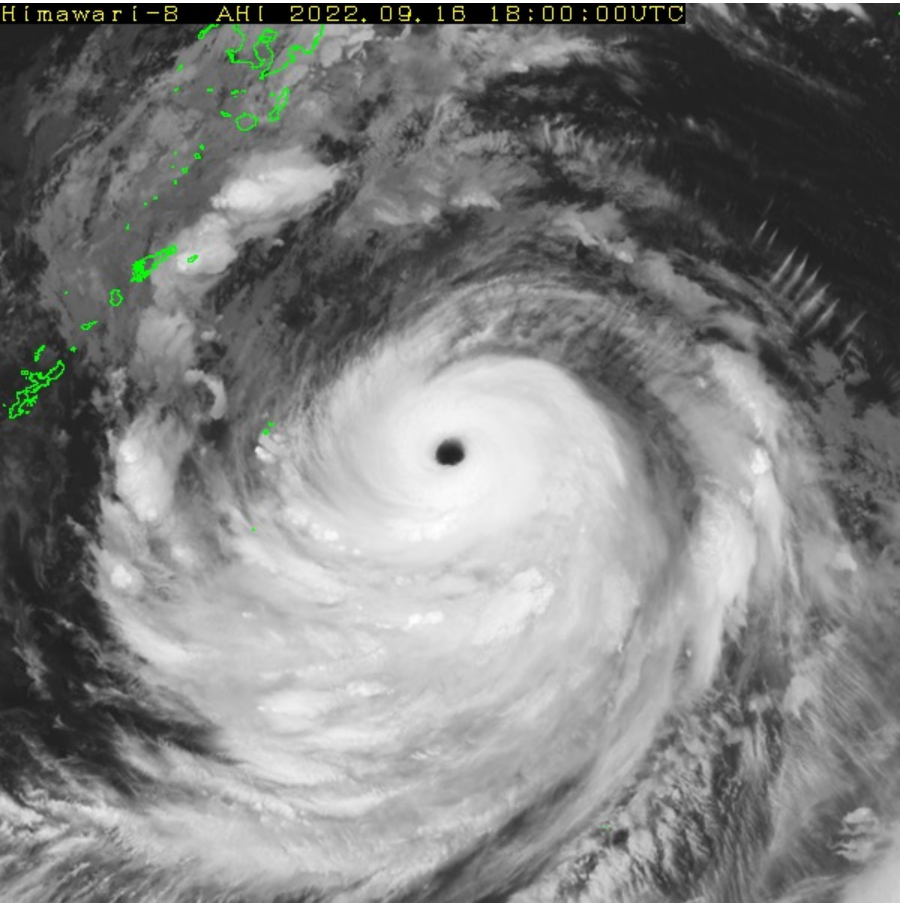
Time of atmospheric wave passage and time of atmospheric pressure spike almost coincide.

Summary

- The spread of the volcanic plume at the time of the eruption can be seen in detail from Himawari-8.
- The atmospheric wave generated by the eruption can be visualized by using water vapor images.
- It may also be necessary to understand such a phenomenon for a large-scale eruption such as this one.

Case2 : Typhoon Nanmadol (T2214)

Overview



Typhoon Nanmadol formed on 13th September at 18UTC over the sea south of Japan.

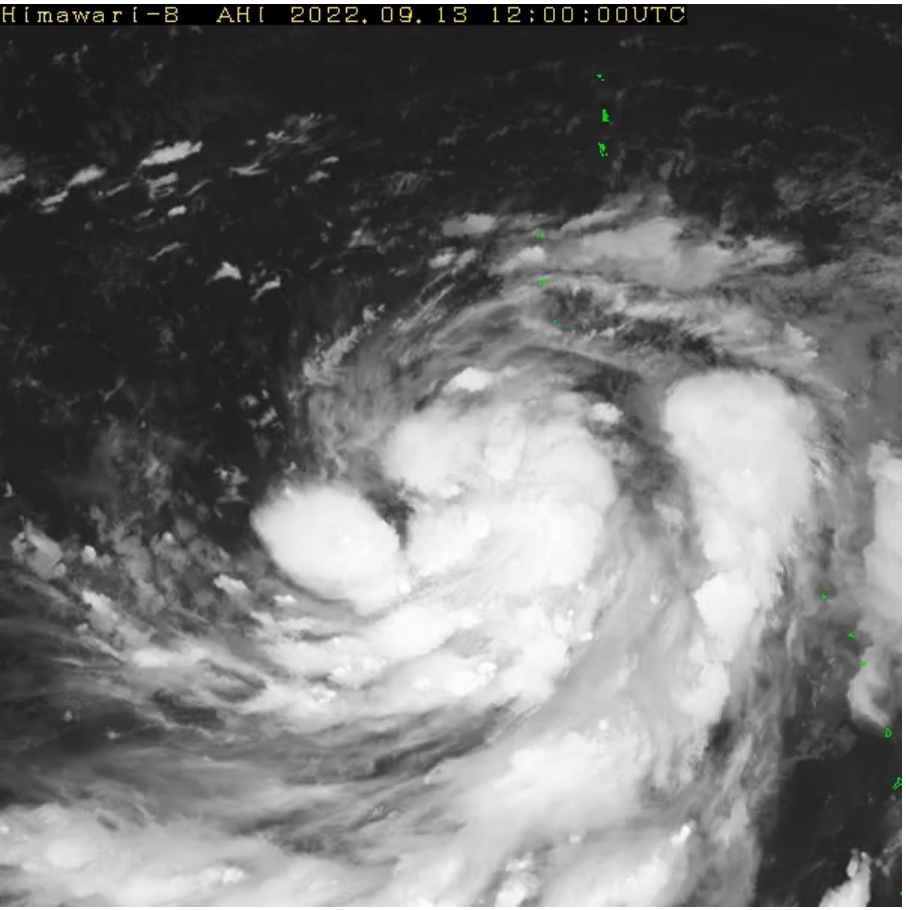
This typhoon developed rapidly from the 16th to the 17th.
(16th 00UTC 950hPa -> 16th 18UTC 910hPa !)

10UTC 18th :
This typhoon made Landfall near Kagoshima city.
(At this time, The central atmospheric pressure is 935hPa.)

00UTC 20th : This typhoon became an extratropical cyclone.

The left image is the image of the peak period 16th at 18UTC.
At this time, the central atmospheric pressure was 910hPa and maximum wind speed was 55m/s.

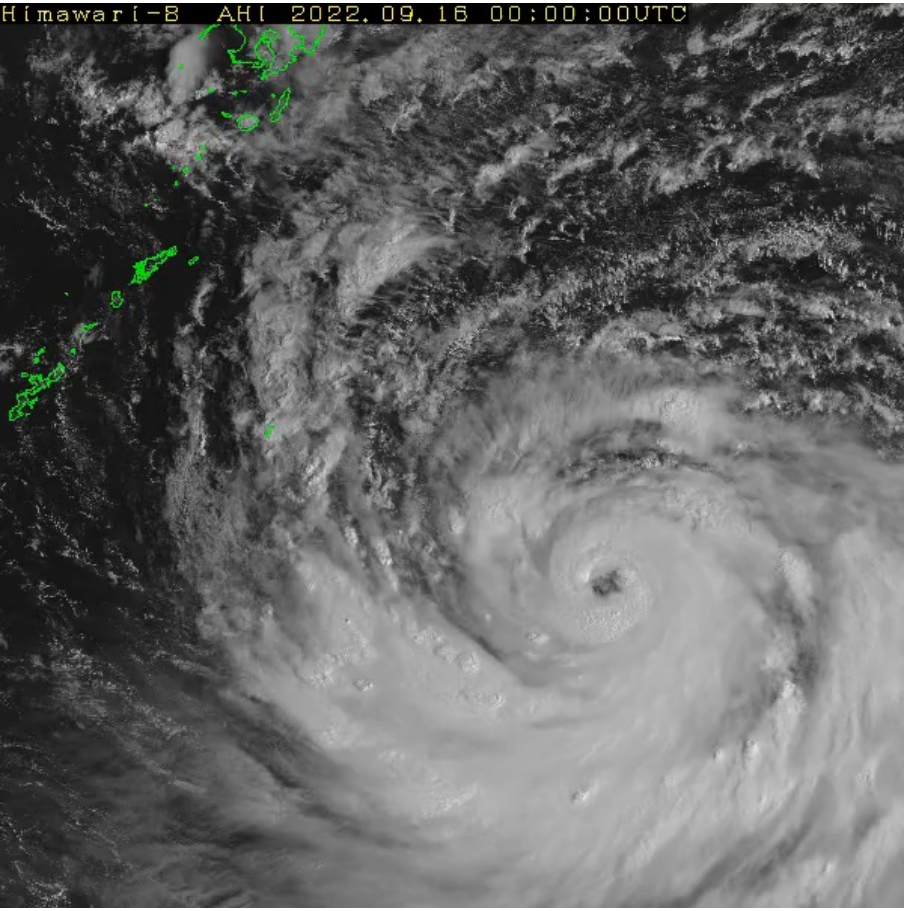
Formed stage



The video is an observation image of Himawari-8
before and after the typhoon formed.
(12UTC 13th September – 06UTC 14th September)
Infrared images at night time, visible images during day time.

A band of convective clouds is gradually formed,
and it can be confirmed that the swirling state becomes clear.

Rapid developed stage



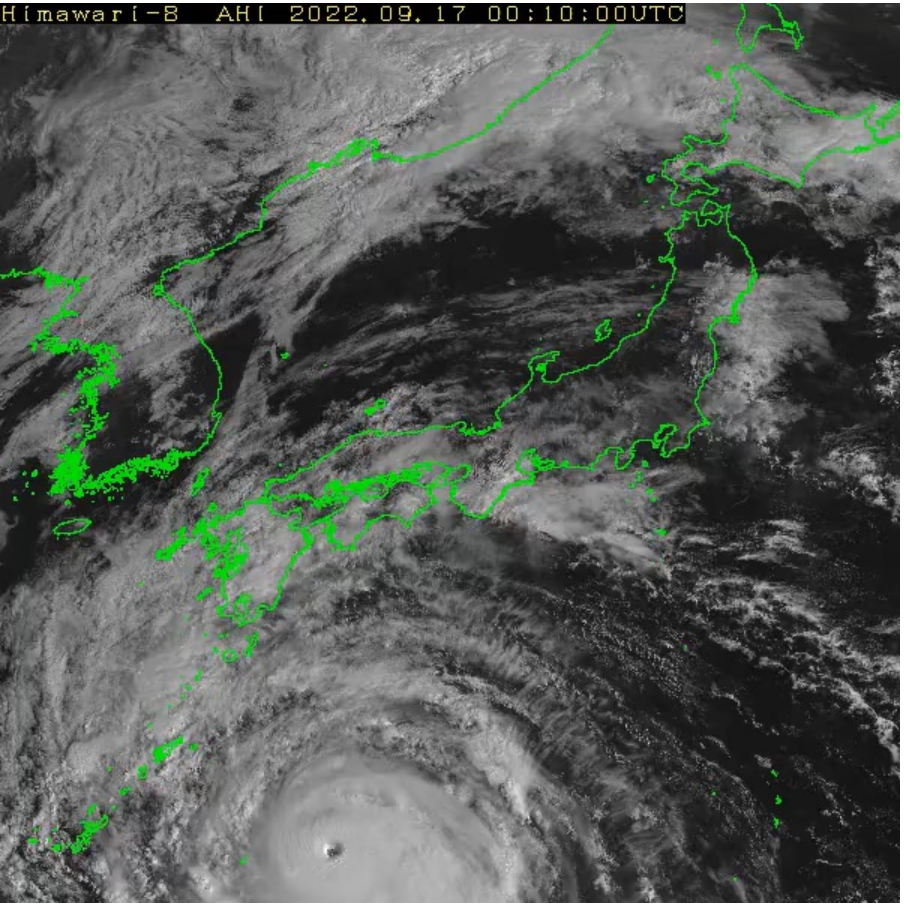
The video is an observation image of Himawari-8.
(00UTC 16th September – 00UTC 17th September)
Infrared images at night time, visible images during day time.

The central atmospheric pressure was 950hPa at 00UTC 16th.
18 hours later, 910hPa at 18UTC 16th.
The typhoon developed rapidly in 18 hours.

As it developed, the eye of typhoon Nanmadol
changed from ragged eye to distinct small eye.

Infrared images of Himawari-8 show that
the eyewall is cold and strongly developed.

From landfall to decline



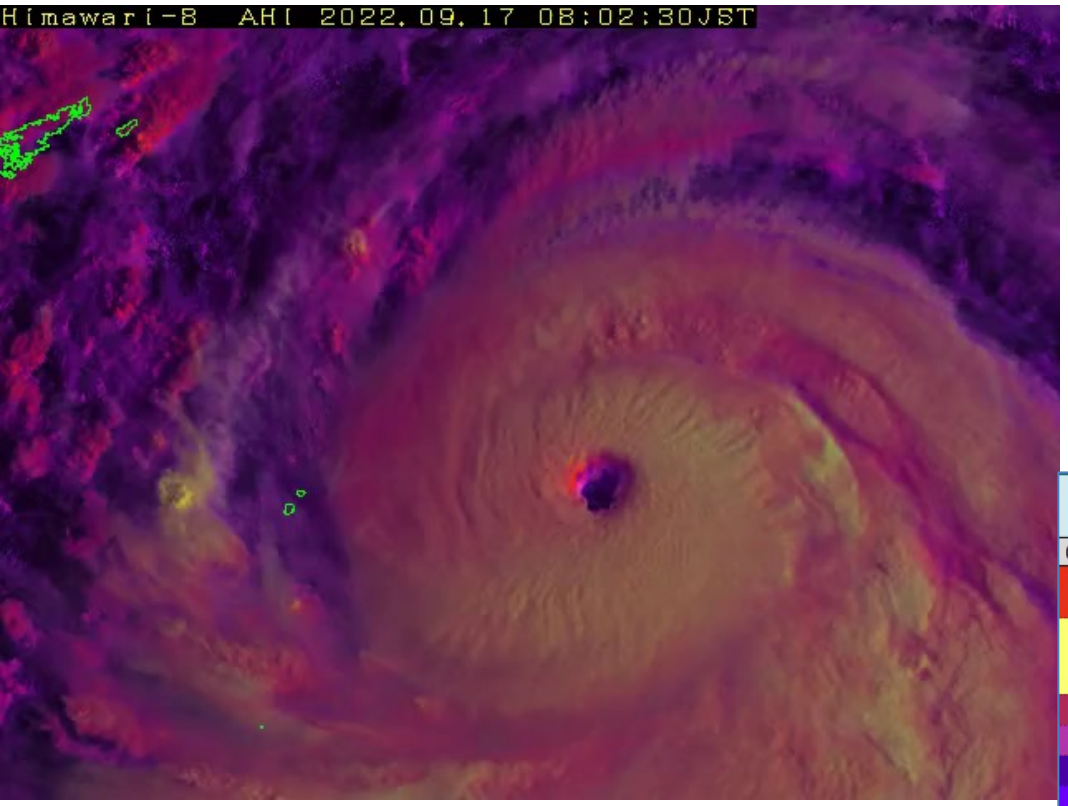
The video is an observation image of Himawari-8.
(00UTC 17th September – 23UTC 19th September)

19UTC 18th :
Typhoon Nanmadol made landfall near Kagoshima city.
(935hPa at this time, this is the lowest in the 2000s.)

The total rainfall exceeded 1000 mm,
and there were points where the maximum wind speed exceeded 50 m/s.

After landfall, the shape of the typhoon gradually collapsed and rapidly declined.
This typhoon became an extratropical cyclone at 00UTC 20th.

RGB Composite imagery



This video is Day Convective Storms RGB + visible image.
(23UTC 16th Sep. – 08UTC 17th Sep.)

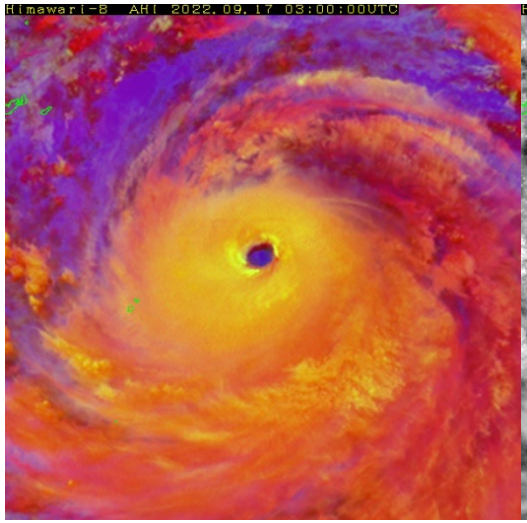
Using the technique described in the next slide, While preserving the hue of the RGB composite image keep high resolution.

It becomes easier to distinguish yellow cloud areas with strong updrafts.

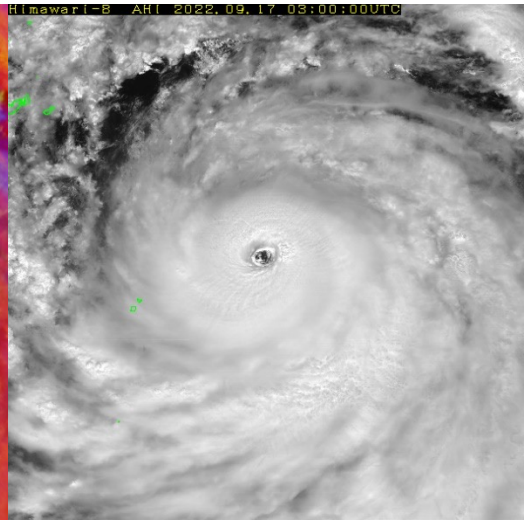
Color interpretation for Day Convective Storms RGB

Color	Interpretation
	Deep precipitating cloud (precipitation is not necessarily reaching the ground) - high-level cloud, large ice particles
	Deep precipitating cloud (Cb cloud with strong updrafts and severe weather)* - high-level cloud, small ice particles *or thick, high-level lee cloudiness with small ice particles
	Thin cirrus cloud (large ice particles)
	Thin cirrus cloud (small ice particles)
	Ocean
	Land

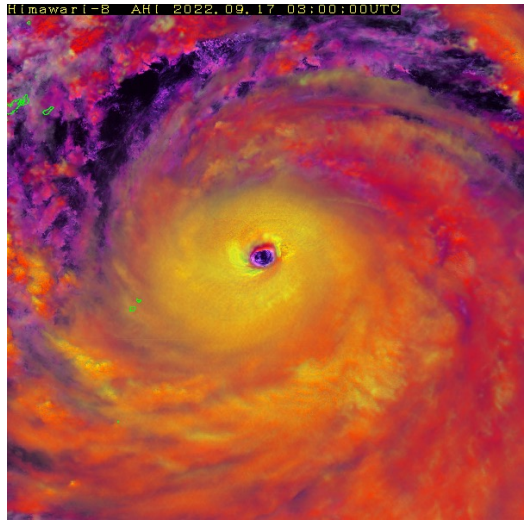
RGB Composite imagery



Day Convective Storms RGB
About 2km resolution



B03
About 500m resolution



High resolution +
Day Convective Storms RGB

Day Convective Storms RGB and B03
(red,green,blue) -> (hue, saturation, brightness)

(hue, saturation, brightness(B03))

(hue, saturation, brightness(B03)) -> (red, green, blue)
high-resolution image while preserving the color of
the Day Convective Storms RGB composite image.

Thank you
for your participation!