

**Technical Interchange Teleconference between NOAA,
BOM and JMA**

**Himawari RGB Quick Guides
and examining RGBs containing
near-infrared imagery
- heading towards more effective use of RGB
composite imagery -**

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- Himawari RGB Quick Guides
 - ✓ Quick guide features
 - ✓ Background
 - ✓ Future plan
- Examining RGBs containing near-infrared imagery
 - based on Himawari RGB Quick Guide contents -
 - ✓ Fire Temperature RGB
 - ✓ Cloud Phase Distinction RGB
- Summary

Himawari RGB Quick Guides

Meteorological Satellite Center (MSC) of JMA

Himawari Natural Color RGB Quick Guide



Main applications: distinction of surface characteristics (snow, vegetation, bare soil), ice/water clouds

Benefits:

- Easy to distinguish between high-level ice clouds and low-level water clouds.
- Easy to identify surface characteristics intuitively (green vegetation, brown bare soil, blue snow/ice).

Limitations:

- Available during daytime only
- The color of high level ice clouds is similar to that of snow/ice covered surface.
- Cyan clouds sometimes contain not only ice clouds but also water clouds with "large" droplets due to small contribution of B03 signal.

Low level clouds including fog drifting to southeastern region of Australia. (21:00 UTC, 17 November 2017)

A ■ : bare ground or desert;
 B ■ : vegetation;
 C ■ : thick low level cloud;
 D ■ : thick high-level cloud;
 E ■ : ocean

Dust plume caused by strong wind can be seen in both visible (bottom) and the RGB (top) images. The RGB first image better discrimination of dust due to clear colored appearance of dust source (e.g. bare soil) in the RGB. Both images are emphasized by gamma correction (1.6).

Dust around Hokkaido (northern Japan). (07:50 UTC, 8 May 2016)

A ■ : bare ground or desert;
 B ■ : dust

RGB recipe with recommended thresholds and related specifications for Natural Color RGB

Color	AHI bands	Central wave length [μm]	Min [%]	Max [%]	Gamma	Physical relation to	Smaller contribution to signal of	Larger contribution to signal of
Red	B05	1.6	0%	99%	1.0	Cloud phase Snow and ice	ice clouds Snow covered land/sea/ice	Water clouds
Green	B04	0.86	0%	102%	0.95	Cloud optical thickness Green vegetation	Thin clouds	Thick clouds Snow covered land Vegetation
Blue	B03	0.64	0%	100%	1.0	Cloud optical thickness	Thin clouds	Thick clouds Snow covered land Sea/ice

Quick Guide features

What is RGB Quick Guide?

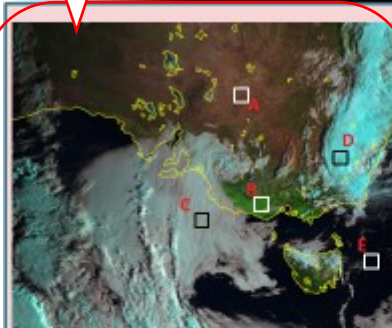
- Simple material which summarizes how to use respective RGB composite imagery.
- Quick Guides are composed of a pair of surface and reverse side (two-slides), therefore you can use them by inserting printed Quick Guides in plastic clear file folders.
- The essential contents allow users to easily use in daily shift work.
- The contents are as follows.
 - ✓ Main application(s), benefits and limitations
 - ✓ Typical cases
 - ✓ Color interpretation
 - ✓ RGB recipe (combinations of imagery assigned to the three primary colors with recommended thresholds) and related specifications
- Himawari Quick Guides for RGB composites which are available on SATAID software (18 types) are in preparation.

Appearance and structure of RGB Quick Guide

Typical case and its explanation.

Surface

Himawari Natural Color RGB Quick Guide



Low level clouds including fog drifting to southeastern region of Australia. (21:00 UTC, 17 November 2017)

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- E : ocean

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Limitations:

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- The color of high level ice clouds is similar to that of snow/ice covered surface.
- Cyan clouds sometimes contain not only ice clouds but also water clouds with "large" droplets due to small contribution of B03 signal



Dust around Hokkaido (northern Japan). 07:50 UTC, 8 May 2016

Main application(s), benefits and limitations.

Typical case and its explanation.

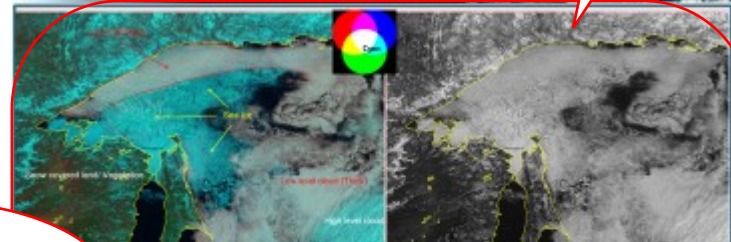
RGB recipe with recommended thresholds and related specifications for Natural Color RGB

Color	AHI bands	Central wave length [μm]	Min [%]	Max [%]	Gamma	Physical relation to	Smaller contribution to signal of	Larger contribution to signal of
Red	B05	1.6	0%	99%	1.0	Cloud phase Snow and ice Cloud optical thickness	ice clouds Snow covered land/sea ice	Water clouds Thick clouds Snow covered land
Green	B04	0.86	0%	102%	0.95	Green vegetation	Thin clouds	Vegetation Thick clouds Snow covered land
Blue	B03	0.64	0%	100%	1.0	Cloud optical thickness	Thin clouds	Thick clouds Snow covered land Sea ice

RGB recipe with recommended thresholds and related specifications.

Reverse

Himawari Natural Color RGB Quick Guide



Low-level cloud with NaturalColor RGB at 23:00 UTC on 15 April 2016 (left).

... lesser contribution to pixels for sea ice, the sea ice area appears in cyan (as a result of contribution from ...). Surface snow cover and high-level cloud with ice crystals are also shown in cyan for the same reason (color interpretation). Distinction between sea ice and low-level cloud can be challenging with conventional imagery (right, Band 3) for inexperienced viewers.



Typhoon Noru with Natural Color RGB display at 02:38 UTC on 4 August 2017

This image illustrates the referential case of Typhoon Noru (13705) approaching southwestern Japan. The detailed structure with whitish low-level clouds (indicated by red arrows) is seen inside the eyewall.

Typical cases and their explanations.

Color interpretation for Natural Color RGB

Color	Interpretation
Cyan	High-level ice clouds
Light Blue	Low-level water clouds
Black	Ocean
Green	Vegetation
Brown	Desert
Blue	Snow/Ice

Color interpretation.

Himawari RGB Quick Guides for WMO Standard RGBs

Night Microphysics

Himawari Night Microphysics RGB Quick Guide

Main application: cloud analysis, especially detection of fog/low clouds at night time

Benefits:

- High contrast between water cloud (fog/low clouds) and cloud free surface
- Efficient tool for nighttime cloud analysis
- Other applications: hot spots

Limitations:

- Available during night time only (full-disk images in magnitude at 40 min)
- It is difficult to distinguish between fog and low clouds only with Night Microphysics RGB. Clouds of high level especially high-level clouds and surface are affected by thermal conditions (latitudinal, seasonal, diurnal etc.)

Legend:

- A: fog/low-level cloud
- B: land and ocean (cloud-free)
- C: thin mid-level cloud
- D: thick mid-level cloud

Example: Fog/low level cloud around East China Sea and Yellow Sea. (22:00 UTC, 27 March 2018)

RGB recipe with recommended thresholds and related specifications for Night Microphysics RGB

Color	Red band	Green band	Blue band	Physical relation to the target	Transfer function to be applied	Large contribution to the color of
Red	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds
Green	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds
Blue	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds

Natural Colors

Himawari Natural Color RGB Quick Guide

Main application: detection of surface characteristics (snow, vegetation, bare soil, freshwater clouds)

Benefits:

- Easy to distinguish between high-level cloud and low-level water clouds
- Easy to identify surface characteristics (mainly green vegetation, brown bare soil, blue ocean)

Limitations:

- Available during daytime only
- The color of high-level cloud is similar to that of snow-covered surface
- Open clouds sometimes contain not only sky cloud but also water cloud with "large" droplets due to small contribution of RGB signal

Legend:

- A: bare ground or desert
- B: vegetation
- C: thick high-level cloud
- D: thin high-level cloud
- E: ocean

Example: Low level clouds including fog drifting in southeastern region of Australia. (23:00 UTC, 17 November 2017)

RGB recipe with recommended thresholds and related specifications for Natural Color RGB

Color	Red band	Green band	Blue band	Physical relation to the target	Transfer function to be applied	Large contribution to the color of
Red	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds
Green	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds
Blue	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds

True Color

Himawari True Color RGB Quick Guide

Main application: detection of atmospheric dust, volcanic ash, high yellow sand and smog

Benefits:

- Color character similar to the visible spectrum of human eyes
- This RGB has been widely used regarding weather forecast and other applications

Limitations:

- Not available during nighttime
- The brightness of the image is not of constant level over the field of view
- Image is distorted by atmospheric refraction
- Image is distorted by color RGB conversion (see Note on Microphysics RGB)
- Microphysics are more suitable
- Low-level refraction is responsible for the characteristic of green component (IR02, 11 μm)

Legend:

- A: cloud
- B: land surface
- C: snow

Example: Smoke caused by forest fire around Siberia. (00:00 UTC, 25 April 2018)

RGB recipe with recommended thresholds and related specifications for True Color RGB

Color	Red band	Green band	Blue band	Physical relation to the target	Transfer function to be applied	Large contribution to the color of
Red	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds
Green	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds
Blue	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds

Dust

Himawari Dust RGB Quick Guide

Main application: detection of atmospheric dust during day and night (cloud analysis)

Benefits:

- Since this RGB is composed only of infrared channels, it is applicable to night time
- Therefore, it is useful for monitoring dust plume and for dust plume appearance occurrence
- Available for first look at dust plume by day and night

Limitations:

- Not available during nighttime
- Image is distorted by atmospheric refraction
- Image is distorted by color RGB conversion (see Note on Microphysics RGB)
- Microphysics are more suitable
- Low-level refraction is responsible for the characteristic of green component (IR02, 11 μm)

Legend:

- A: yellow sand (dust)
- B: thick mid-level cloud
- C: thin high-level cloud

Example: Extensive dust cloud (yellow sand) around Bohai Sea, northwestern China and Korean Peninsula with Green Beam: BTLS-uv, version: (2018.03.28, 28 November 2018)

RGB recipe with recommended thresholds and related specifications for Dust RGB

Color	Red band	Green band	Blue band	Physical relation to the target	Transfer function to be applied	Large contribution to the color of
Red	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds
Green	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds
Blue	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds

Day Snow-Fog

Himawari Day Snow-Fog RGB Quick Guide

Main application: identification of coverage with snow/ice and fog/low clouds in day time

Benefits:

- This RGB provides the best color contrast between snow/ice covered surface and water clouds
- It is available to distinguish between cloud and cloud-free land/sea

Limitations:

- It is available during daytime only
- Area of forest (dark forest) may obstruct reflection from snow beneath the forest

Legend:

- A: sea-ice covered land
- B: high-level water cloud
- C: low-level water cloud with small ice particles
- D: sea surface

Example: Sea ice around Sea of Okhotsk, northern Japan and Russia. (02:00 UTC, 4 February 2018)

RGB recipe with recommended thresholds and related specifications for Day Snow-Fog RGB

Color	Red band	Green band	Blue band	Physical relation to the target	Transfer function to be applied	Large contribution to the color of
Red	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds
Green	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds
Blue	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds

Day Microphysics

Himawari Day Microphysics RGB Quick Guide

Main application: market cloud analysis (temperature, cloud optical thickness, cloud particle size and size)

Benefits:

- Added to the above, the RGB is useful to distinguish: Ob. with small cloud particles, water cloud and super-cooled water cloud
- Detection of ash from fire (hot spots), smoke/low level cloud

Limitations:

- It is available during daytime only
- Large number of observations and interpretations may be complicated for novice users
- Upper level cloud may obstruct the view of lower clouds (e.g. super-cooled water cloud) at middle-level clouds

Legend:

- A: thick cloud with large droplets
- B: thick cloud with small ice particles including Ob. cloud with strong updrafts
- C: thin water cloud with (super-cooled) small droplets
- D: high-level ice cloud with small ice particles
- E: sea surface

Example: Typhoon Phobos (T0603) around South China Sea. (08:00 UTC, 1 January 2019)

RGB recipe with recommended thresholds and related specifications for Day Microphysics RGB

Color	Red band	Green band	Blue band	Physical relation to the target	Transfer function to be applied	Large contribution to the color of
Red	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds
Green	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds
Blue	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds

Airmass

Himawari Airmass RGB Quick Guide

Main application: distinguishing air masses (high pressure systems, anticyclones, etc.)

Benefits:

- In addition to discerning patterns, identifying high-level clouds in an air mass (high-level cloud) and low-level clouds in the other (low-level cloud) is useful for forecasting
- Detection of ice-caps in high-level water cloud

Limitations:

- Low-level cloud may obstruct high-level cloud
- Image is distorted by atmospheric refraction
- Image is distorted by color RGB conversion (see Note on Microphysics RGB)
- Microphysics are more suitable
- Low-level refraction is responsible for the characteristic of green component (IR02, 11 μm)

Legend:

- A: air mass (high-level, high-PV air) with descending dry (anticyclonic) air
- B: cold (ice-cap) air mass
- C: warm (ice-free) air mass (high upper tropospheric warming)
- D: warm (ice-free) air mass (low upper tropospheric warming)
- E: high-level (ice-free) cloud

Example: The target area (especially western area) of this image is affected by low-leveling clouds.

RGB recipe with recommended thresholds and related specifications for Airmass RGB

Color	Red band	Green band	Blue band	Physical relation to the target	Transfer function to be applied	Large contribution to the color of
Red	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds
Green	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds
Blue	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds

Ash

Himawari Ash RGB Quick Guide

Main application: detection of volcanic ash and SO₂ during day and night

Benefits:

- Since this RGB is composed only of infrared channels, it is applicable to night time
- Therefore, it is useful for monitoring volcanic plume and SO₂ plume from volcanic eruption occurrence
- Available for first look at volcanic plume by day and night

Limitations:

- Not available during nighttime
- Image is distorted by atmospheric refraction
- Image is distorted by color RGB conversion (see Note on Microphysics RGB)
- Microphysics are more suitable
- Low-level refraction is responsible for the characteristic of green component (IR02, 11 μm)

Legend:

- A: volcanic ash with RGB
- B: volcanic ash with SO₂ gas
- C: volcanic ash with SO₂ gas
- D: volcanic ash with SO₂ gas
- E: volcanic ash with SO₂ gas

Example: Volcanic eruption of Mount Merapi (Mt. Merapi), Japan. (07:00 UTC, 14 May 2018). White circle with broken line indicates volcanic plume. Red triangle indicates the volcano.

RGB recipe with recommended thresholds and related specifications for Ash RGB

Color	Red band	Green band	Blue band	Physical relation to the target	Transfer function to be applied	Large contribution to the color of
Red	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds
Green	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds
Blue	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds

24-hour Microphysics

Himawari 24-hour Microphysics RGB Quick Guide

Main application: cloud identification and night detection of ash and low level cloud

Benefits:

- Since this RGB is composed only of infrared channels, it is applicable to night time
- Therefore, it is useful for monitoring low-level cloud, general cloud and appearance occurrence
- Available for first look at low-level cloud by day and night

Limitations:

- Not available during nighttime
- Image is distorted by atmospheric refraction
- Image is distorted by color RGB conversion (see Note on Microphysics RGB)
- Microphysics are more suitable
- Low-level refraction is responsible for the characteristic of green component (IR02, 11 μm)

Legend:

- A: thick cloud with large droplets
- B: thick cloud with small ice particles including Ob. cloud with strong updrafts
- C: thin water cloud with (super-cooled) small droplets
- D: high-level ice cloud with small ice particles
- E: sea surface

Example: Water clouds and desert area around Southeast Asia, China, India and the surrounding region with Green Beam: BTLS-uv, version: (2018.03.28, 28 May 2018)

RGB recipe with recommended thresholds and related specifications for 24-hour Microphysics RGB

Color	Red band	Green band	Blue band	Physical relation to the target	Transfer function to be applied	Large contribution to the color of
Red	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds
Green	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds
Blue	IR39	IR39	IR39	Cloud optical thickness	Thin clouds	Water clouds

Himawari RGB Quick Guides for well-known RGBs and polar-orbit satellites origin RGBs

Day Convective Storms

Meteorological Satellite Center (MSC) of JMA
Himawari Day Convective Storms RGB
 Quick Guide

Main applications: Identification of high-level cloud top and/or small ice particles which are suggestive of severe storms with strong updrafts.

Benefits:

- CB cloud with strong updrafts and severe weather is colored conspicuous yellowish color in this RGB.

Limitations:

- It is available during daytime only.
- Low-level clouds and surface conditions are not clear in this RGB.
- Yellowish clouds don't always correspond to convective clouds, because high-level low clouds also look yellowish color.

Clouds in motion: Layer Free (CB, UT, 04:10 UTC, 21 March 2013)

Clouds in motion layer free (CB, UT, 04:10 UTC, 21 March 2013). Clouds in motion layer free (CB, UT, 04:10 UTC, 21 March 2013). Clouds in motion layer free (CB, UT, 04:10 UTC, 21 March 2013).

Legend:

- A CB cloud with strong updrafts or high-level cloud with small ice particles.
- B Thick high-level cloud with large ice particles.
- C Thin cirrus cloud.
- D Sea surface.

RGB recipe with recommended thresholds and related specifications for Day Convective Storms RGB

Color	RGB name	Color scale (R/G/B)	Color scale (R/G/B)	Min. (°C)	Max. (°C)	Physical relation to natural color	Large cloud feature in natural color
Red	Red	808	2.3	0%	50%	1.0	Cloud phase and ice clouds
Green	Green	808	2.3	0%	50%	1.0	Cloud phase and ice clouds
Blue	Blue	808	0.47	0%	100%	1.0	Cloud phase and ice clouds

Day Cloud Phase

Meteorological Satellite Center (MSC) of JMA
Himawari Day Cloud Phase RGB
 Quick Guide

Main applications: Analysis of cloud thickness and cloud phase.

Benefits:

- Useful for distinguishing between cirrus clouds and water clouds.
- RGB provides better information on ice and water clouds.
- Suitable for distinguishing water clouds with large particles.

Limitations:

- It is available during daytime only.
- Convective clouds (CB) are not clearly visible in this RGB.
- RGB is sensitive to atmospheric conditions, especially to the amount of water vapor and the amount of aerosols.

Clouds in motion: Layer Free (CB, UT, 00:00 UTC, 4 May 2013)

Clouds in motion layer free (CB, UT, 00:00 UTC, 4 May 2013). Clouds in motion layer free (CB, UT, 00:00 UTC, 4 May 2013). Clouds in motion layer free (CB, UT, 00:00 UTC, 4 May 2013).

Legend:

- A Thick ice clouds with small particles.
- B Thick ice clouds with large particles.
- C Thin low-level water clouds with small particles.
- D Thin low-level water clouds with large particles.
- E Sea surface.
- F Land surface.

RGB recipe with recommended thresholds and related specifications for Day Cloud Phase RGB

Color	RGB name	Color scale (R/G/B)	Color scale (R/G/B)	Min. (%)	Max. (%)	Physical relation to natural color	Large cloud feature in natural color
Red	Red	808	2.3	0%	50%	1.0	Cloud phase and ice clouds
Green	Green	808	2.3	0%	50%	1.0	Cloud phase and ice clouds
Blue	Blue	808	0.47	0%	100%	1.0	Cloud phase and ice clouds

Fire Temperature

Meteorological Satellite Center (MSC) of JMA
Himawari Fire Temperature RGB
 Quick Guide

Main applications: Fire hotspot, fire intensity.

Benefits:

- This RGB is helpful for monitoring the hotspot and its intensity by means of its color shade accurately.
- The color components of this RGB provide fire intensity depending on their wavelength.
- This RGB is applicable day and night as regards the hotspot.
- Available to distinguish between ice clouds and water clouds.

Limitations:

- This RGB is not available during daytime except for the hotspot.
- Very dry surface region (e.g. desert) looks reddish color (false fire).

Clouds in motion: Layer Free (CB, UT, 03:20 UTC, 25 April 2013)

Clouds in motion layer free (CB, UT, 03:20 UTC, 25 April 2013). Clouds in motion layer free (CB, UT, 03:20 UTC, 25 April 2013). Clouds in motion layer free (CB, UT, 03:20 UTC, 25 April 2013).

Legend:

- A Fire hotspots (relatively high temperature).
- B Fire hotspots (relatively low temperature).
- C Ice clouds.
- D Ice clouds.
- E Land surface.
- F Sea surface.

RGB recipe with recommended thresholds and related specifications for Fire Temperature RGB

Color	RGB name	Color scale (R/G/B)	Color scale (R/G/B)	Min. (°C)	Max. (°C)	Physical relation to natural color	Large cloud feature in natural color
Red	Red	807	3.9	273.84	393.84	1.0	Temperature Classification
Green	Green	806	2.3	0%	50%	1.0	Temperature Classification
Blue	Blue	805	1.6	0%	50%	1.0	Temperature Classification

Natural Fire Color

Meteorological Satellite Center (MSC) of JMA
Himawari Natural Fire Color RGB
 Quick Guide

Main applications: Fire hotspot, surface features (vegetation, snow/ice cover).

Benefits:

- This RGB is helpful for monitoring the fire hotspot, burnt area and smoke accurately.
- This RGB is similar to Natural Color RGB except for the burnt area (B&C) used in the red component is replaced with the 3.9µm band (B&C).

Limitations:

- Available during daytime only.
- Both water and ice clouds look cyan color unlike original Natural Color RGB.
- The color of high-level ice clouds is similar to that of snow/ice covered surface.

Clouds in motion: Layer Free (CB, UT, 03:20 UTC, 25 April 2013)

Clouds in motion layer free (CB, UT, 03:20 UTC, 25 April 2013). Clouds in motion layer free (CB, UT, 03:20 UTC, 25 April 2013). Clouds in motion layer free (CB, UT, 03:20 UTC, 25 April 2013).

Legend:

- A Fire hotspots.
- B Burnt area.
- C Smoke.
- D Ice clouds.
- E Vegetation.
- F Sea surface.

RGB recipe with recommended thresholds and related specifications for Natural Fire Color RGB

Color	RGB name	Color scale (R/G/B)	Color scale (R/G/B)	Min. (%)	Max. (%)	Physical relation to natural color	Large cloud feature in natural color
Red	Red	806	2.3	0%	100%	3.0	Temperature Classification
Green	Green	804	0.86	0%	100%	1.0	Temperature Classification
Blue	Blue	803	0.84	0%	100%	1.0	Temperature Classification

Himawari RGB Quick Guides for RGBs developed by JMA

Cloud Phase Distinction

Himawari Cloud Phase Distinction RGB Quick Guide

Main application: Analyze cloud thickness, height of cloud top and cloud phase.

Benefits:

- Easy to distinguish between high-level ice clouds and low-level water clouds.
- Easy to identify surface snow/ice.

Limitations:

- Available during daytime only.
- Colors of clouds and surface are affected by thermal conditions (latitude, season, diurnal cycle).

Cloud area with low pressure (polar low) system around Sea of Japan (05:00 UTC, 4 May 2018)

Legend:

- A: Thick high-level clouds with ice particles.
- B: Thin high-level clouds with ice particles (lower "H" corresponds to high-level ice clouds).
- C: Thick low-level water clouds.
- D: Thin low-level water clouds.

RGB recipe with recommended thresholds and related specifications for Cloud Phase Distinction RGB

Color	RGB Recipe	Physical variable to signal of	Larger contribution to signal of
Red	R: 0.13, G: 0.4, B: 0.28	Cloud top temperature	Thin clouds
Green	G: 0.44, B: 0.6	Cloud optical thickness	Thick clouds
Blue	B: 1.0, G: 1.0, B: 0.0	Cloud phase	Snow and ice

Day Deep Clouds

Himawari Day Deep Clouds RGB Quick Guide

Main application: Highlighting thick clouds such as cumulonimbus with overshooting top.

Benefits:

- Useful to distinguish thick cloud (e.g. Cb) with overshooting top.
- This RGB is composed of traditional successor bands of FY4-1B sensor: generation band film, and visible image (VIS) with radiance intensity (bottom), (07:00 UTC, 4 August 2018).
- Color bands of this RGB refer to well-known RGBs such as Day/04-hour stereopyramid RGB.

Limitations:

- Available during daytime only.
- Detailed information about cloud particle size and phase can be obtained from this RGB.
- Thin low-level clouding can not be seen in this RGB.

Legend:

- A: Thin clouds with overshooting top.
- B: Thick clouds.
- C: Thin high clouds.
- D: Sea surface.

RGB recipe with recommended thresholds and related specifications Day Deep Clouds RGB

Color	RGB Recipe	Physical variable to signal of	Larger contribution to signal of
Red	R: 0.13, G: 0.4, B: 0.28	Cloud top temperature	Thin clouds
Green	G: 0.44, B: 0.6	Cloud optical thickness	Thick clouds
Blue	B: 1.0, G: 1.0, B: 0.0	Cloud phase	Sea surface

SO2

Himawari SO2 RGB Quick Guide

Main application: direction of volcanic SO₂ gas during the eruption.

Benefits:

- Since this RGB is composed only of infrared images, it is applicable to the night.
- Basic information (1) provides information about volcanic SO₂ gas direction (observed position) of being emitted.
- Threshold is adjustable according to volcanic SO₂ gas with high temperature anomaly.

Limitations:

- Heavy water concentration of volcanic plume can not be estimated with this RGB.
- To distinguish SO₂ gas from the volcanic plume, compensating a water vapor and low-level clouds is sometimes effective.
- High-level clouds over volcanic plume are difficult to distinguish.
- Low-level clouds over volcanic plume are difficult to distinguish.

Legend:

- A: Volcanic SO₂ gas.
- B: Water vapor and low-level clouds.
- C: High-level clouds.
- D: Low-level clouds.
- E: High-temperature volcanic plume.

RGB recipe with recommended thresholds and related specifications for SO2 RGB

Color	RGB Recipe	Physical variable to signal of	Larger contribution to signal of
Red	R: 0.009, G: 7.5, B: 0.0	SO ₂ gas	High-level clouds
Green	G: 0.103, R: 0.010, B: 0.010	Water vapor and low-level clouds	High-level clouds
Blue	B: 0.112, G: 0.011, B: 0.011	Water vapor and low-level clouds	High-level clouds

Simple Water Vapor

Himawari Simple Water Vapor RGB Quick Guide

Main application: Analysis of atmospheric water vapor distribution for each level and vertical profile.

Benefits:

- The color components of this RGB provide features about different atmospheric levels such as anvil, upper-level clouds, moisture, convective tops and gravity waves (bottom waves).
- Since this RGB is composed only of infrared images, it is applicable to the night.
- Convective initiation can be seen as patchy anvil cloud.

Limitations:

- Color bands features such as low-level clouding can not be seen in this RGB.
- Color bands of high-level clouds, which color is not saturated.
- The color bands are affected by satellite viewing angle or particularly limb area (limb cooling effect).

Legend:

- A: Clouds with high-level top.
- B: Low-level clouds.
- C: Mid-level clouds with humid atmosphere at low-level.
- D: Moisture of high-level.
- E: Moisture of mid/high-level.

RGB recipe with recommended thresholds and related specifications for Simple Water Vapor RGB

Color	RGB Recipe	Physical variable to signal of	Larger contribution to signal of
Red	R: 0.13, G: 0.4, B: 0.28	Cloud top temperature	Thin clouds
Green	G: 0.44, B: 0.6	Cloud optical thickness	Thick clouds
Blue	B: 1.0, G: 1.0, B: 0.0	Cloud phase	Sea surface

Differential Water Vapor

Himawari Differential Water Vapor RGB Quick Guide

Main application: Analysis of atmospheric water vapor distribution for high and low level.

Benefits:

- The color components of this RGB provide information about lower and upper level atmospheric water vapor and moisture at upper-level moisture layers.
- This RGB can be used to analyze water vapor distribution at different level such as high-level, edge and anvil clouds.
- Since this RGB is composed only of infrared images, it is applicable to the night.

Limitations:

- The color bands are affected by satellite viewing angle or particularly limb area (limb cooling effect).
- Color bands of high-level clouds, which color is not saturated.
- Color bands are affected by satellite viewing angle or particularly limb area (limb cooling effect).

Legend:

- A: Clouds with high-level top.
- B: Moisture of high-level.
- C: Moisture of high-level and moisture at mid-level atmosphere.
- D: Moisture of mid-high-level atmosphere.

RGB recipe with recommended thresholds and related specifications for Differential Water Vapor RGB

Color	RGB Recipe	Physical variable to signal of	Larger contribution to signal of
Red	R: 0.13, G: 0.4, B: 0.28	Cloud top temperature	Thin clouds
Green	G: 0.44, B: 0.6	Cloud optical thickness	Thick clouds
Blue	B: 1.0, G: 1.0, B: 0.0	Cloud phase	Sea surface

Back ground

- Use of RGB composite imagery has become widespread among Himawari image users.
- There were requests from users to make simple, quick-look materials (including color interpretations and AHI band characteristics).
- Other meteorological satellite training centers such as EUMeTrain and SPoRT (NOAA/NASA) have been already providing very useful “RGB Quick Guides”.
- The Japanese language version have been created for JMA’s related staffs beforehand.
- The contents are based on JMA’s “Meteorological Satellite Center Technical Note” written by A. Shimizu (the report will be available on the website in near future.) and existing Quick Guides of EUMeTrain and SPoRT.

Reference: RGB Quick Guide by EUMeTrain

EUMETRAIN
International training project sponsored by EUMETSAT
to support and increase the use of meteorological satellite data

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Home » User Manual » Quick Guides

EUMeTrain Quick Guides

About:

Quick Guides are made in order to help the users of satellite products (in this case Sandwich products and RGBs) to get the most essential information which may be used in daily shift work. A Quick Guide consists of two pages; the first page (fig. 1a) is a short description of the aim of this product, of its benefits and limitations and of the physical background. The second page (fig. 1b) contains examples of images and the interpretations of the characteristic colour and/or the cloud top features showing in the product.

There are currently 12 quick guides developed by EUMeTrain that you can see on this page. Also, at the end of the page there are examples of RGB Quick Guides from NASA SPoRT.

RGB Quick Guides for Meteosat (MSG) users.
Good references for making Himawari version.

Example of a Quick Guide

SEVIRI Ash RGB Quick Guide

Quick description of volcanic ash and SO₂ gas:
This product is used for visual applications. In case of volcanic products:
Conditions: Optically this ash cloud can be well detected and clearly distinguished from ice and water clouds in the Ash RGB images. Optically this ash cloud can also be seen in clouds. However, the volcanic ash becomes rapidly optically thin. These SO₂ gas plumes can be well detected in the volcanic ash image. In some cases, the ash cloud can be detected in the visible channel of the SEVIRI images.

Background:
The table shows which channels (or channel differences) are used in the RGB and the names of the band and channel names which have been used for the image construction in the cloud top view in the RGB. This volcanic ash is registered from the satellite channel in the (0.63-0.67-0.81) channel difference. SO₂ gas is detected due to its absorption band at 7.3 μm.

Colour	(channel [μm])	physically relates to	visual representation	interpretation
Red	0.63-0.67-0.81	Cloud optical thickness	Thin ice clouds	Thin volcanic ash
Green	0.81-0.8 - 0.67	Cloud phase / thin volcanic ash	Ice clouds / thin volcanic ash	SO ₂ gas plume / Water clouds
Blue	0.63-0.7	Temperature	Cloud top	Water clouds

Details:
→ 3 levels with top-to-bottom decrease. (This refers to colour band assignment.)
→ Colour scheme for this volcanic ash, SO₂ gas plume and water clouds (not for the purpose of ash and SO₂ gas).
→ The volcanic ash has good colour contrast against water and SO₂ gas plume. This good colour contrast is due to the fact that the volcanic ash has a high optical depth and water clouds have a low optical depth. This is due to the fact that volcanic ash has a high optical depth and water clouds have a low optical depth. This is due to the fact that volcanic ash has a high optical depth and water clouds have a low optical depth.

Limitations:
→ Low-level volcanic ash and SO₂ gas plume can be missed by high-level clouds.
→ Very dark ash clouds occur in the decreased level in the image.
→ To see the volcanic ash and SO₂ gas plume in detail with other channels, the volcanic ash and SO₂ gas plume should be interpreted with other channels.
→ The volcanic ash and SO₂ gas plume can be easily registered from the satellite image. This is due to the fact that volcanic ash has a high optical depth and water clouds have a low optical depth. This is due to the fact that volcanic ash has a high optical depth and water clouds have a low optical depth.

SEVIRI Ash RGB Quick Guide

Interpretation:

- Cloud top view
- Cloud top view as displayed in the image depending on the temperature and optical thickness
- Thin volcanic ash
- SO₂ gas plume
- Water cloud
- SO₂ gas plume
- Thin volcanic ash
- Water cloud

Legend:
MSG Ash RGB
MSG SO₂ RGB
MSG Water RGB
MSG Cloud RGB

Comments to other products:
In the Ash RGB image you can see the volcanic ash and SO₂ gas plume and the water clouds. In the SO₂ gas plume image you can see the SO₂ gas plume. In the Water RGB image you can see the water clouds. In the Cloud RGB image you can see the water clouds.

http://eumetrain.org/rgb_quick_guides/index.html

Reference: Natural Colour RGB Quick Guide by EUMeTrain

SEVIRI Natural Colour RGB Quick Guide

Primary aim: Display surface characteristics (e.g. snow/vegetation/bare soil). Similar to a True Colour image except for ice, ice clouds and snow.

Secondary aim: Distinguishing ice from water phase (water clouds from ice clouds or from cloud-free snow).

Time period and area of its main application: Daytime, throughout the year. Restrictions during winter for higher latitudes.

Guidelines: The Natural Colour RGB is tuned to provide a satellite image which provides surface vegetation information and which resembles a colour photograph of the Earth. The three daylight channels provide similar colours to a True Colour image of the Earth, except for ice crystals (ice clouds, snow and ice) which are depicted in cyan. This RGB is sensitive to photosynthetically active vegetation while deserts, bare soils and dry vegetation show in a different colour.

Snow on the ground can be distinguished from ice clouds, not so much by its hue than by its structure.



SEVIRI Natural Colour RGB, 15 July 2016, 12:00 UTC

Background

The table below lists the channels used in the Natural Colour RGB. The SEVIRI channel (VIS0.6) scans the Earth in the orange visible spectrum. As this channel is the one nearest to the blue spectrum it is used for the blue colour beam of the Natural Colour RGB. The green colour beam (VIS0.8) is already in the IR spectrum and, therefore, not visible to the human eye. However, plants strongly reflect solar radiation at this wavelength when they are photosynthetically active (see example above). The NIR1.6 channel used for the red colour beam is primarily sensitive to the ice and water phase of clouds. At 1.6 μm , ice clouds usually have a low reflectivity (~30%), while water clouds strongly reflect (~60-70%) the incoming radiation. Therefore, ice clouds are usually darker than water clouds in the NIR1.6 image. Additionally, there is a less pronounced dependency upon cloud particle size at 1.6 μm . Ice clouds with very small ice crystals may be as bright as water clouds, and water clouds with very large droplets may be as dark as ice clouds.

Colour	Channel [μm]	Physically relates to	Smaller contribution to the signal of	Larger contribution to the signal of
Red	NIR1.6	Cloud phase Snow cover	Ice clouds Snow covered land/sea ice	Water clouds
Green	VIS0.8	Cloud optical thickness Green vegetation	Thin clouds	Thick clouds Snow covered land Vegetation
Blue	VIS0.6	Cloud optical thickness Green vegetation	Thin clouds Vegetation	Thick clouds Snow covered land Sea ice

Notation: NIR: near-infrared, VIS: visible; channel number: central wavelength of the channel in micrometer.

Benefits

- Easy to interpret because most of the colours of the image are very similar to a True Colour image of the Earth.
- Reflects surface characteristics like vegetation, rocky soils and deserts.
- Ice clouds can be distinguished from water clouds.
- Snow on the ground, as well as frozen sea ice, can be detected.
- There is a high colour contrast between snow and fog/water clouds.

Limitations

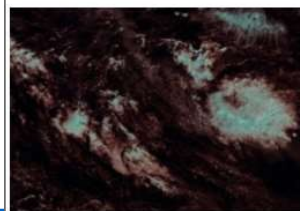
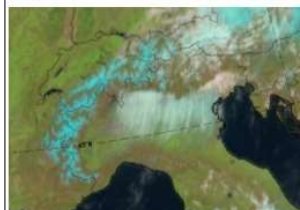
- Available during the day only.
- Pixel colour fades during dawn/dusk when the sun angle is low.
- Not applicable for higher latitudes during winter season.
- Snow-covered land might have similar colour as high clouds with large ice crystals.
- Very small ice crystals in cirrus clouds appear whitish instead of cyan.
- The cyan colour as indication for ice phase clouds can be misleading in the case of large water droplets. The latter absorb shortwave solar radiation at 1.6 μm the same way small ice crystals do.
- Thin cirrus clouds are not seen in the Natural Colour RGB.

SEVIRI Natural Colour RGB Quick Guide

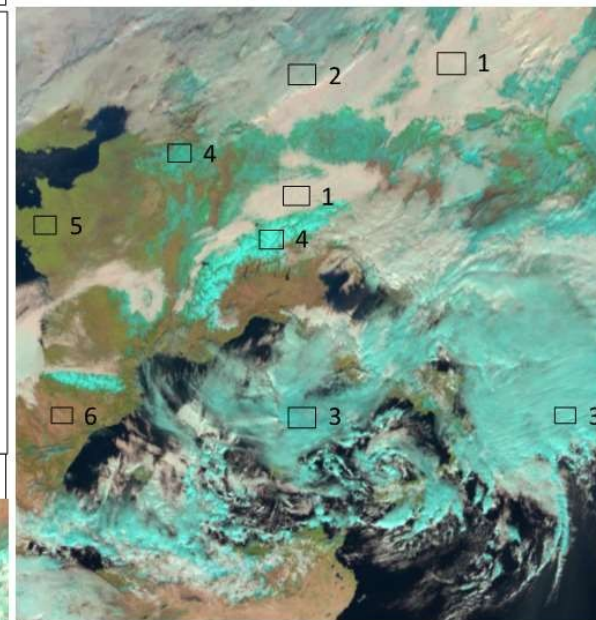
Colour Interpretation

- 1 Water clouds (fog or stratus)
- 2 Mixed phase clouds or clouds with a cirrus veil on top
- 3 Thick ice clouds with large ice crystals in higher levels
- 4 Snow and ice on the ground
- 5 Ground covered by photosynthetically active vegetation
- 6 Sandy deserts, bare soils or arid vegetation
- 7 Sea ice not covered by snow
- 8 Oceans and lakes.

Natural Colour RGB, 17 February 2017, 12:00 UTC



SEVIRI Natural Colour RGB, 18 January 2017, 12:00 UTC



Sea ice and snow covered land (item 4 and 7) can vary in the colour shade depending on the compactness of sea ice and of the snow cover on the ground. Extended snow fields on mountain tops will show brighter cyan colour than snow cover in urban areas or forests.

Limitations

In the case of very small ice particles (e.g. orographic clouds) as shown in the left image over northern Italy on 7 April 2017 at 12:00 UTC, the colour of the ice cloud becomes whitish. The Dust RGB (right image) of the same date shows a compact ice cloud.

If water droplets reach bigger sizes, the Natural Colour RGB will depict them in cyan hues as shown in this example over the Tropical Sea (left image). A comparison to the Cloud Phase RGB (right image) shows that most clouds are water clouds (magenta to yellow), and only the cloud in the upper right image corner is an ice cloud.

[More about RGBs on eumetrain.org](http://www.eumetrain.org)

Reference: RGB Quick Guide by NASA SPoRT



SPoRT Short-term Prediction Research and Transition Center 

SPoRT is a NASA project to transition unique observations and research capabilities to the operational weather community to improve short-term forecasts on a regional scale.

Real-Time Data Core Projects GOES-R PG JPSS PG Transitions Library Organization

NASA SPoRT Training

[Go to SPoRT Training](#)

Training is a key step in the transition of new products and capabilities into an operational environment. To support the user assessment of these products in a "testbed" mode, users are provided training materials to complement their existing, foundational knowledge and resources. This site contains training on remote sensing and modeling products that include:

- Foundational product science (20-30 min.)
- Applications in operations (15 min.)
- Micro-lesson of product impact (8 min.)
- Quick Guides (printable, interactive)

Product training spans a wide range of operational needs (Aviation, Severe Weather, Drought/Flood, etc.) with particular emphasis in areas of:

- Total Lightning (GLM, LMAs, etc.)
- Multispectral (RGB) imagery (GEO & LEO)
- NASA Land Information System suite (soil moisture, percentile, etc.)
- Passive/Active Microwave (GPM/IMERG, etc.)

Latest Training, Applications Library, and Assessment Posts

Featured Training

20 to 400+ sources
(~40 flashes 2km² min⁻¹)

Total Lightning Operational Uses:
Severe Weather
[Read More ->](#)

Applications Library

Product applications training in the form of 1-pager, short videos, and micro-lessons (i.e., < 8 min. audio) created by forecasters in collaboration with SPoRT. Items are available for viewing/download and are searchable by category. NWS users may find these within AWIPS via SPoRT's Integrated Training Tool. Items are reviewed for accuracy and relevance to operational forecasting. Additional examples are welcome from the community. ([Go to Library](#))

Assessments

Feedback from users is gathered via web forms and other means during the evaluation of products in a "testbed" mode. Links to feedback forms as well as resulting summaries of intensive product assessments are available here. Collaboration with end users to Relatively improve products and tools by testing their application in operations is an important step in the product transition process. ([Go to Assessments](#))

Quick Guides

Easy-to-use and short, the Quick Guides are a reference tool to remind forecasters of the more important aspects regarding a product/tool. Often, these are used during operations to quickly recall information from the more robust product training module. A suite of Quick Guides are available for download/print, and some are interactive via a browser or through the user's own display system (e.g. AWIPS, etc.). ([Go to Quick Guides](#))

RGB Quick Guides for GOES users. Some Himawari versions are also available!

Reference: Day Snow-Fog RGB Quick Guide by SPoRT



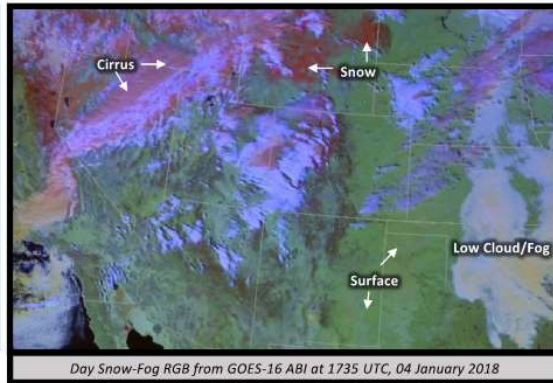
Day Snow-Fog RGB

*interpretation still under investigation

Quick Guide

Why is the Day Snow-Fog RGB Important?

On heritage GOES, it was difficult to distinguish white "reflective" snow from white "reflective" clouds on visible imagery. On the GOES-R series, the reflectance of snow, water, and ice clouds varies across the visible, near infrared, and infrared. The channels which bring out the distinguishing differences are combined in the Day Snow-Fog RGB to show greater contrast between snow and cloud than is generally possible with a single channel.



Day Snow-Fog RGB from GOES-16 ABI at 1735 UTC, 04 January 2018

Day Snow-Fog RGB Recipe

Color	Band / Band Diff. (µm)	Min to Max Gamma	Physically Relates to...	Small contribution to pixel indicates...	Large Contribution to pixel indicates...
Red	0.86 (Ch. 3)	0 to 100 % albedo 1.7	Reflectance of clouds and surfaces	Water, thin cirrus	Thick clouds, snow, sea ice
Green	1.6 (Ch. 5)	0 to 70 % albedo 1.7	Reflectance of clouds and surfaces	Water, snow	Vegetated land, thick water clouds
Blue	3.9 - 10.3 (Ch. 7 - Ch. 13)	0 to 30 °C 1.7	Proxy for 3.9 µm reflected solar radiance	Water, snow	Thick clouds

Impact on Operations

Primary Application

Distinguish snow and clear ground from clouds:

The Near IR 1.6 and IR 3.9 wavelengths are useful for distinguishing non-reflective (dark) snow from reflective (bright) low-level water cloud. Low level cloud layers can be distinguished when thin middle or upper level clouds are present, particularly in an animation.

Cloud phase: Provides information on water versus ice cloud phase.



Limitations

Daytime only application: The 0.86 µm, 1.6 µm, and 3.9 µm bands detect reflected visible solar radiation.

Solar angle: Low solar angles at sunrise and sunset change the color interpretation, as well as limited application for high latitudes during winter.

Cirrus clouds: Limited ability to detect thin cirrus clouds due to low contrast with background features. This can be mitigated somewhat by animation.

Coniferous forest: Areas of coniferous forest mask snow signature beneath the canopy.

Channel difference for blue component: The temperature difference does not capture the reflected solar component as intended by JMA or EUMETSAT, but is an adequate proxy.



Day Snow-Fog RGB

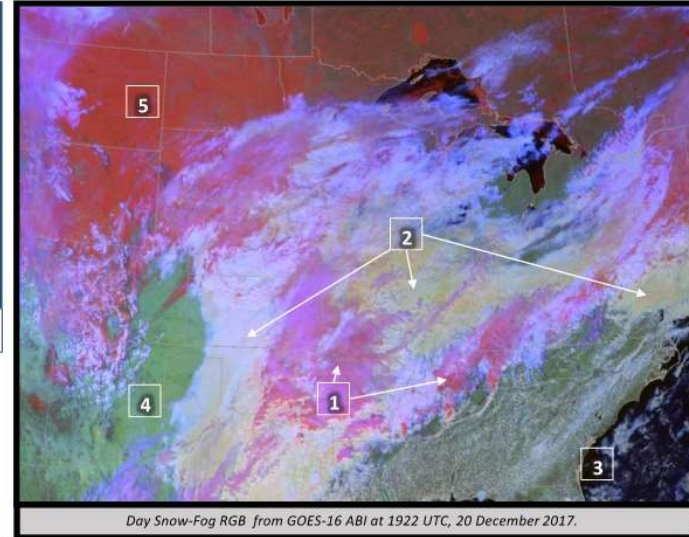
*interpretation still under investigation

Quick Guide

RGB Interpretation

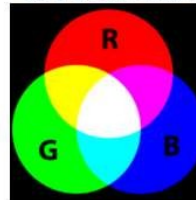
- 1 Ice clouds, cirrus (shades of pink)
- 2 Water clouds, fog (shades of yellow)
- 3 Ocean (black)
- 4 Vegetation (green)
- 5 Snow (red-orange)

Note: colors may vary diurnally, seasonally, and latitudinally



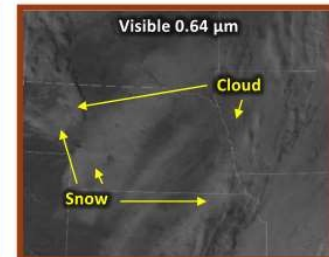
Day Snow-Fog RGB from GOES-16 ABI at 1922 UTC, 20 December 2017.

RGB Color Guide



Comparison to visible imagery:

The colors of the Day Snow-Fog RGB make it easier to distinguish between low clouds and snow/ice compared to visible imagery, as seen in the images from 11 January 2018 (below). It also provides better identification of the thickness of low-level clouds.



Resources

JMA*

[Day Snow-Fog RGB](#)

EUMeTrain*

[RGB Colour Interpretation Guide \('Snow RGB' formerly 'Day Solar RGB'\)](#)

*Note: color interpretation is slightly different from these products as the 3.9 µm reflected solar component is used for blue

Hyperlinks not available when viewing material in AIR Tool

JMA's Meteorological Satellite Center Technical Note

“Introduction to RGB composite imagery by Himawari-8” (A. Shimizu)

The report will be available on the website in near future.

Introduction to RGB composite imagery by Himawari-8

SHIMIZU Akihiro*

Abstract

The images by multi-spectral imager, AHI (Advanced Himawari Imager) on board Himawari-8, have provided as much of the physical information. The Red-Green-Blue (RGB) composite technique is one of a proper method to utilize plural spectral information. The RGB composite imagery with a focus on the global RGB scheme standards recommended by WMO (World Meteorological Agency) has been widely used among forecasters and researchers. As a future reference, this report introduces basic knowledge about the RGB composite technique which is applied to Himawari-8's imagery including widely-used RGBs and new RGBs developed by Japan Meteorological Agency (JMA).

1. Introduction

Current generation of geostationary satellites, Himawari-8/9 carry an advanced multi-spectral imager called the Advanced Himawari Imager (AHI). In comparison with the former generation (MTSAT-IR/2 (Multi-functional Transport SATellite)) era, the number of observation bands is increased to 16 for Himawari-8/9 from 5 for MTSAT series (Table 1). In the past, the gray scale images or color enhanced (color look-up table) scale images of limited number of respective single images and band differential images have been used. Now it is difficult to manage such a many kinds of “traditional” imagery with physical information for duty users with a severe time restriction.

The RGB composite technique is a method to utilize plural spectral information by assigning the three primary colors of Red-Green-Blue (three color beams) to the three satellite images and applying the color representation based on the additive mixture of colors. With suitable color schemes (combinations of imagery to assign to three primary colors) and thresholds, RGB composite images display surface and atmospheric condition/phenomena to be focused as described below.

In this way, the users are able to obtain the plural information at the same time by means of this RGB composite imagery. In addition, the RGB imagery is friendly to expert user on the gray-scaled satellite imagery because the RGB imagery contains the information such as cloud shapes and textures as well as gray-scaled satellite imagery. Besides duty forecasters, the RGB composite method plays a part in assessing quantitative product outcomes produced by researchers and developers besides routine work by duty forecasters.

Table 1: Observation bands of Himawari-8 and -9, MTSAT-IR and -2 and MSG, and related physical properties for imagery

Band	Himawari-8/9	MTSAT-IR/2	MSG	Physical Properties
1	0.46 μm			Aerosol
2	0.11 μm			Aerosol
3	0.64 μm	0.68 μm	0.635 μm	Low cloud
4	0.86 μm		0.81 μm	Vegetation
5	1.6 μm		1.64 μm	Cloud top
6	2.1 μm			Particle
7	3.9 μm	3.7 μm	3.9 μm	Lower cloud
8	6.2 μm		6.2 μm	Upper level
9	6.9 μm			Mid-top level
10	7.3 μm		7.3 μm	Mid-level
11	8.6 μm		8.7 μm	Cloud top
12	9.6 μm		9.7 μm	Ozone
13	10.4 μm	10.8 μm	10.8 μm	Cloud top information
14	11.2 μm			Cloud top
15	12.4 μm	12.0 μm	12.0 μm	Surface temperature
16	13.3 μm		13.4 μm	Cloud top

The multi-spectral imager, SEVIRI (Spin View and Infrared Imager) on board MSG Second Generation) of European geostatio (has been operating since 2004 by EUM number of channels of SEVIRI (twelve) including broadband (about 0.4 – 1.1 μm) been in advance of other imagers on board meteorological satellites (GEO). By using

MSG users have already accumulated a great deal of know-how on the RGB composite technique. EUMETSAT offered practical MSG's RGB “recipes” and many of them were adopted as WMO standard schemes. Because of this background, JMA introduced the RGB schemes designed by EUMETSAT into RGB composite imagery using Himawari-8 imagery. This will allow Himawari users to use same color interpretation guide of MSG users. Also JMA adopted the RGB schemes of LEO (low earth orbit) meteorological satellites and developed schemes of JMA's own.

2. Basics of RGB composite technique

As mentioned above, the RGB composite imagery is composed of plural images assigned to the three primary colors of Red-Green-Blue. In the RGB color model, the colors are displayed by combinations of respective three colors. To reproduce various colors, the 24-bit (three 8-bit values as integer numbers in the range 0 to 255) computer color model is applied to the RGB composite technique for satellite imagery. Respective Red-Green-Blue images have the values of 256 (= 2⁸) (8-bit) color shades, therefore 256 (= 2⁸) = 16,777,216 (24-bit) colors can be displayed on the RGB composite imagery (Fig. 1).

According to purpose of use, it is required composing RGB imagery to “select single or differential images to assign the three primary colors of Red-Green-Blue” and

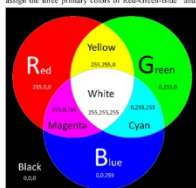


Fig. 1: RGB color model by additive color mixing. The numbers indicate their RGB 4-bit values.

to “adjust thresholds (e.g. brightness temperature (TBR)/reflectivity and gamma value) of respect images”.

2.1. Selection of images to assign the three prime colors

The images of three-color components are determined to focus on the situation of clouds (e.g. lower or upper cloud particle size and phase) and phenomena within single or differential imagery. For example, when RGB composite imagery with higher brightness temperature (TBR) in black color is required, imagery of Band (10-4μm) (note that inverse image of usual grayscale image is applied, i.e. a pixel of higher TBR will be displayed in brighter, and vice versa) will be assigned as blue color component.

Also the color allocation of Red-Green-Blue (i.e. RGB scheme) is important to highlight clouds and phenomena. If same images are applied to RGB composition, there are six combinations for red, green and blue beams. As for an appropriate scheme, warning color such as red and yellow, or natural color such as green vegetation are considered according to a purpose (Fig. 2).

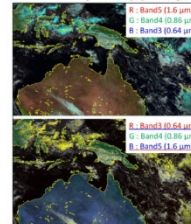


Fig. 2: Comparison of the difference of band assignment to RGB color. The image above (genuine “Natural Color RGB” scheme) is more appropriate to see surface conditions.

Table 17: Color interpretation and RGB values for Dust RGB

Color	Interpretation	RGB Value	HTML
Black	Cold, thick, high-level clouds	140,0,0	#000000
Dark	Thin cirrus clouds	0,0,0	#000000
Contrails		0,0,0	#000000
Thick, mid-level cloud		100,130,50	#640D32
Thin, mid-level cloud		40,130,80	#288350
Low-level cloud (cold atmosphere, high latitude)		180,170,1	#B20B01
Low-level cloud (warm atmosphere, low latitude)		183,90,218	#B730FA
Dust (Yellow sand)/Volcanic ash		255,255,255	#FFFFFF
Clear		190,180,190	#B222B2
Warm desert		170,240,255	#AA00FF
Cold desert		170,240,140	#AA00FF
Warm land		150,150,255	#9900FF
Coastland		150,150,255	#9900FF

Identify thin cirrus clouds and to distinguish water clouds from thick ice clouds as well as 24-hour Microphysics RGB (cloud). The BTD_{10.4μm} assigned to red beam of the RGB helps to distinguish thick and thin clouds (cloud optical thickness) as well as 24-hour Microphysics RGB (cloud) (Table 16). Hence thick clouds show almost zero value and thin clouds show positive value on BTD_{10.4μm} imagery. With respect to dust (and volcanic ash) in the atmosphere, signals from BTD_{13.3μm} become negative values. The BTD_{13.3μm}/BTD_{8.6μm} assigned to green beam of the RGB are helpful to distinguish between water clouds and ice clouds as well as 24-hour Microphysics RGB (cloud). Water clouds show larger positive values and ice clouds show smaller values on BTD_{13.3μm}/BTD_{8.6μm} imagery. Dust and volcanic ash show larger positive values on BTD_{13.3μm}/BTD_{8.6μm} imagery. The contrast of BTD_{13.3μm} differential values

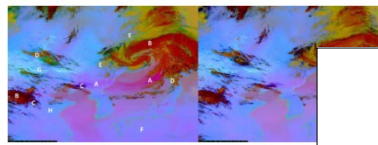


Fig. 18: Comparison of yellow and case around East Asia between Dust RGB with green V (left) and Dust RGB with green beam. BTD_{13.3μm} version (right) (0:20 UTC, 30 April 2017) (A-A: yellow and (dark); B: thick high-level cloud; C: thin cirrus cloud; D: thick mid-level cloud surface; G: warm desert; H: warm land.

Table 29: Band components and related specifications for Day Cloud Phase RGB

Color	Add Bands	Central wave length(μm)	Physically related to	Smaller contribution to the total of	Larger contribution to the total of
Red	R05	1.6	Cloud phase	Ice clouds	Water clouds
Green	G06	2.3	Cloud phase and size	Ice clouds with large ice crystals	Thin water clouds with small droplets
Blue	B03	0.64	Cloud optical thickness	Thin clouds	Thick clouds (overcast/land/sea ice)

Table 30: Color interpretation and RGB values for Day Cloud Phase RGB

Color	Interpretation	RGB Value	HTML
Ice clouds with small particles		70,242,255	#46F0FF
Ice clouds with large particles		45,85,200	#2D0064
Water clouds with small particles		255,237,140	#FFED99
Water clouds with large particles		181,151,203	#B399C7

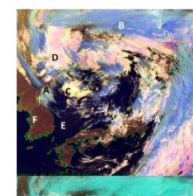


Fig. 31: Comparison of case of cloud around Sea of Japan between Day Cloud Phase RGB (upper) and Natural Color RGB (lower) (0000 UTC, 4 May 2015). A: Thick ice clouds with small particles; B: Thick ice clouds with large particles; C: Thick low level water clouds with small particles; D: Sea surface; E: Land surface.

*Satellite Application and Analysis Division, Data Processing Department, Meteorological Satellite Cent

Reference: HimawariCast Newsletter

Ash RGB based on Himawari observation imagery

Volcanic eruptions generally release toxic sulfur dioxide (SO₂) and airborne ash, which negatively impacts aviation safety.

The specific thresholds of Ash RGB data for volcanic ash and gas detection during daytime and nighttime periods make this information useful for ongoing monitoring of volcanic eruptions. The scheme (consisting of combinations of imagery assigned to the three primary colors) of this RGB set is common to 24-hour Microphysics RGB and Dust RGB (Table 5), which were featured in newsletters No. 10 and No. 11, respectively.

As with 24-hour Microphysics RGB and Dust RGB, detection of volcanic ash containing silicon is facilitated by brightness temperature difference (BTD) imagery produced from Band 13 and Band 15 (BTD₍₁₃₋₁₅₎) with assignment to the red of the RGB. Aeolian dust identification is also facilitated by BTD₍₁₃₋₁₅₎ as with 24-hour Microphysics RGB and Dust RGB.

Difference imagery produced from Band 11 and Band 13 (BTD₍₁₁₋₁₃₎) is assigned to the green of the RGB, facilitating discrimination of volcanic SO₂ because of absorption by this gas in Band 11. Differentiation between water clouds and ice clouds is also facilitated by BTD₍₁₁₋₁₃₎. This imagery further supports volcanic ash detection, although not as well as BTD₍₁₃₋₁₅₎.

The inverted Band 13, which is assigned to the blue of the RGB, shows surface and cloud-top temperatures (with warm-colored pixels increasing the contribution of blue to RGB imagery) in the same way as

24-hour Microphysics RGB, Dust RGB and Night Microphysics RGB.

Against this background, volcanic ash is displayed in a reddish (produced by high contribution of red) or pinkish hue. Greenish and yellowish hues may appear in volcanic plumes containing volcanic SO₂, with yellowish hues indicating a mixture of gas and ash. Color interpretation for Ash RGB is shown in Figure 8.

The Ash RGB imagery in Figure 9 shows the eruption of Mt. Raikoke in the Kuril Islands at 09:00 UTC on 22 June 2019 (inside the dashed white line). The plume contains ash and a distinct presence of volcanic SO₂ (B and C).

Figure 10 shows Japan. Similarly, SO₂ (C). Its darkened by ice crystals in the plume.

Figure 11 shows Indonesia. Hard ash are seen, but are observed in the thick clouds (D) indicates that the large amounts of ash also been seen at a

As shown in RGB are highly latitude and diurnal the high-latitude greenish shades, a 11 generally has

Table 5 Band components and related specifications

Color	AHI Bands	Central wave length (μm)	Physical relation to	Smaller c to si
Red	B13 – B15	10.4 – 12.4	Cloud optical thickness Volcanic ash	Thin ic
Green	B11 – B13	8.6 – 10.4	Cloud phase	Thin ic Volca
Blue	B13 (inverse)	10.4	Cloud top temperature Temperature of surface	Cold Cold

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Figure 8 Ash RGB interpretation in SATAID

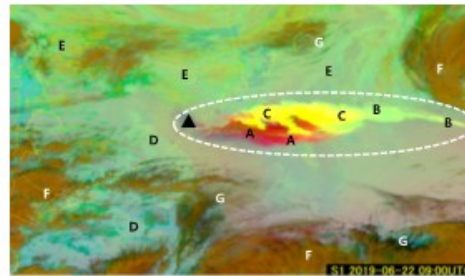


Figure 9 Eruption of Mt. Raikoke in the Kuril Islands (09:00 UTC, 22 June 2019). The white dashed line marks the volcanic plume, and the black triangle marks the volcano.

A: volcanic ash; B: volcanic SO₂; C: volcanic ash with SO₂; D: thick low-level clouds; E: thick mid-level clouds; F: thick (high-level) clouds; G: thin cirrus clouds

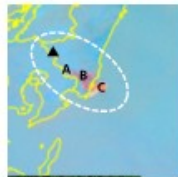


Figure 10 Eruption of Mt. Kirishima, Japan (07:00 UTC, 14 May 2018). The white dashed line marks the volcanic plume, and the black triangle indicates the volcano.

A: volcanic ash; B: volcanic ash with ice crystals; C: volcanic ash with SO₂

HimawariCast Newsletter No. 12, 10 October 2019

- HimawariCast Newsletters have been established in consideration of the current situation to enable sharing of important information and expertise on satellite imagery analysis.
- Their contents include important information relating to the operation of HimawariCast receiving systems, examples of satellite imagery analysis techniques and tips on using JMA's SATAID display and analysis program.

There are serialized article on RGB composites!

Future plan

- Currently, the details of the contents are being examined.
- There is a plan to publish the Himawari RGB Quick Guides on the Meteorological Satellite Center/JMA website.
- The detailed report related to the RGB composite introduction will be also published on the website.
- Additional quick guide for other useful imagery products (e.g. sandwich product) will be considered in the future.

Examining RGBs containing near-infrared imagery

- based on Himawari RGB Quick Guide contents -

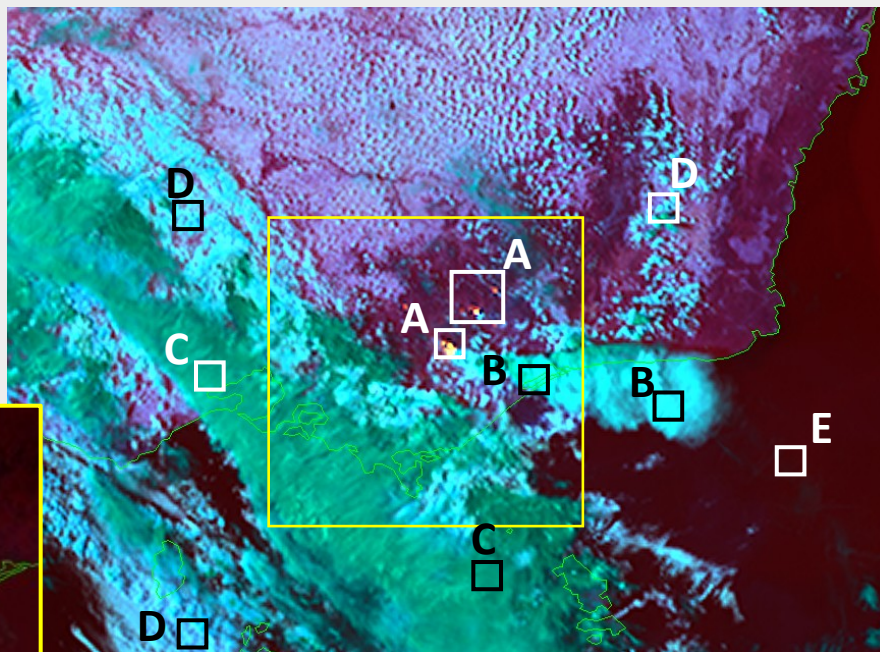
Fire Temperature RGB
Cloud Phase Distinction RGB

Fire Temperature RGB

(Right) Large scale fires in Victoria, Australia.
(05:30 UTC, 3 March 2019)

Cloud marked "B" corresponds to fire cloud (including pyrocumulus cloud) caused by bush fire (marked "A").

(Bottom) Fire hotspots before daylight time
(20:00 UTC, 2 March 2019)



- A ■ ■ : fire hotspots;
- B ■ : fire clouds (pyrocumulus cloud) with ice droplets;
- C ■ : ice clouds;
- D ■ : water clouds;
- E ■ : sea surface

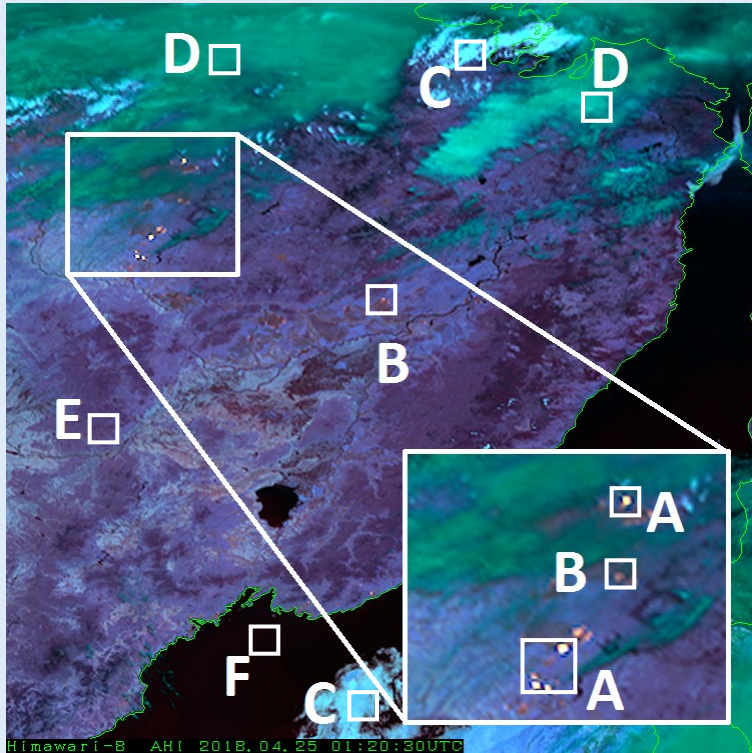
RGB recipe with recommended thresholds and related specifications for Fire Temperature RGB

Color	AHI bands	Central wave length [μm]	Min [K/%]	Max [K/%]	Gamma	Physical relation to	Smaller contribution to signal of	Larger contribution to signal of
Red	B07	3.9	273.0K	350.0K	1.0	Temperature Cloud phase	Thick water clouds	Fire hotspots (with lower temperature)
Green	B06	2.3	0%	50%	1.0	Temperature Cloud phase and size	Thin ice clouds with large ice particles	Fire hotspots (with mid temperature) Thick water clouds with small droplets
Blue	B05	1.6	0%	50%	1.0	Temperature Cloud phase	Thin ice clouds	Fire hotspots (with higher temperature) Thick water clouds

Color interpretation for Fire Temperature RGB

Color	Interpretation
■	Low temperature hotspots
■	Medium temperature hotspots
■	High temperature hotspots
■	Water clouds
■	Ice clouds

Fire Temperature RGB



Forest fire in the vicinity of Siberia, Russia. (01:20 UTC, 25 April 2018)

- A ■ : fire hotspots (relatively high temperature);
- B ■ : fire hotspots (relatively low temperature);
- C ■ : water clouds;
- D ■ : ice clouds;
- E ■ : land surface;
- F ■ : sea surface

Main applications: Fire hotspot, fire intensity

Benefits:

- This RGB is helpful for monitoring fire hotspot and its intensity by means of its color shade successively.
- The color components of this RGB provide fire intensity depending on their wavelength.
- This RGB is applicable day and night as regards fire hotspot.
- Available to distinguish between ice clouds and water clouds.

Limitations:

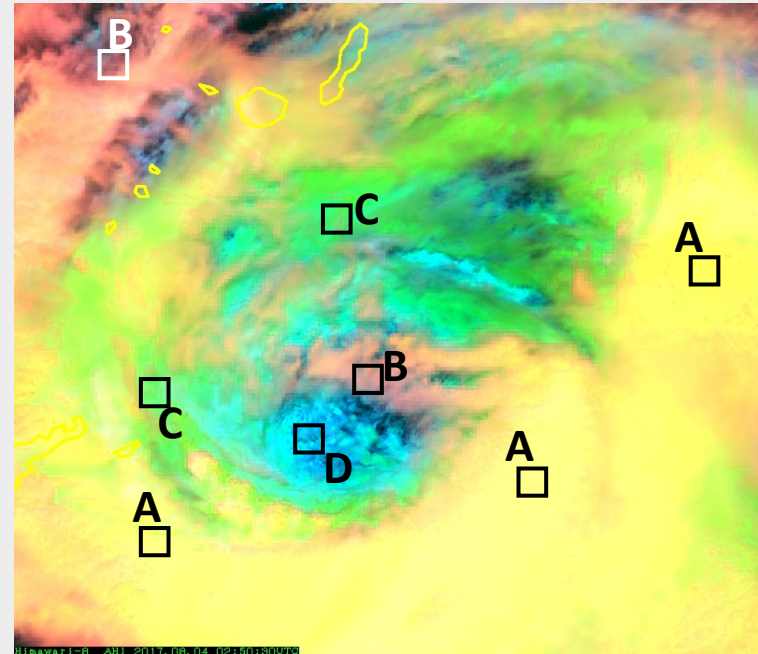
- This RGB is not available during daytime except for fire hotspot.
- Very dry surface region (e.g. desert) looks reddish color (false fire).

Cloud Phase Distinction RGB

Typhoon (Noru) by Cloud Phase Distinction RGB.
(02:50UTC, 4 August 2017)

The detailed structure consisting of blueish low level clouds (marked "D") can be seen inside eyewall.

- A ■ : thick high-level clouds with ice particles;
- B ■ : thin high-level clouds with ice particles;
- C ■ : thick low level ice clouds;
- D ■ : thick low level water clouds



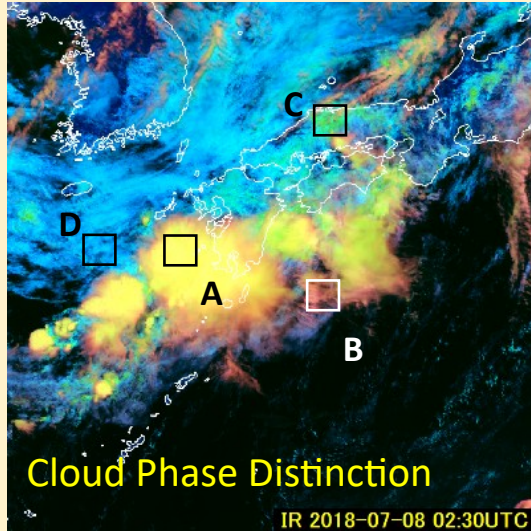
Color interpretation for
Cloud Phase Distinction RGB

Color	Interpretation
■	Thick high level clouds with ice particles, Cb
■	Thin high level clouds with ice particles
■	Thick low level ice clouds Snow/ice covered area
■	Thick low level water clouds

RGB recipe with recommended thresholds and related specifications for Cloud Phase Distinction RGB

Color	AHI bands	Central wave length [μm]	Min [K/%]	Max [K/%]	Gamma	Physical relation to	Smaller contribution to signal of	Larger contribution to signal of
Red	B13	10.4	219.6K	280.7K	1.0	Cloud top temperature	Warm clouds	Cold clouds
Green	B03	0.64	0%	85%	1.0	Cloud optical thickness	Thin clouds	Thick clouds Snow covered land Sea ice
Blue	B05	1.6	1%	50%	1.0	Cloud phase Snow and ice	Ice clouds	Water clouds

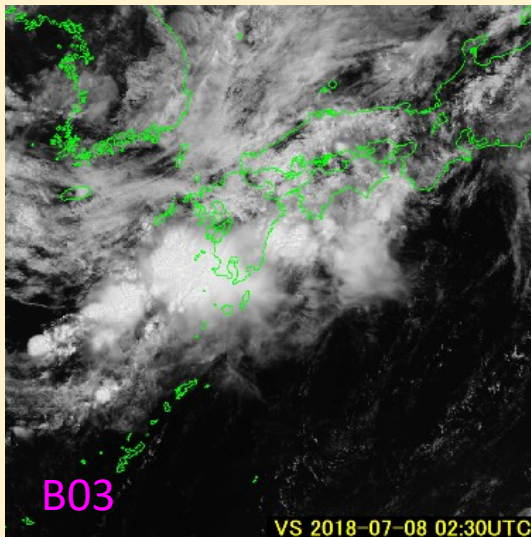
Cloud Phase Distinction RGB



Cloud area corresponding to Baiu (Mei-yu) stationary front above Western Japan. (02:30 UTC, 8 July 2018)

Cloud analysis only by using visible image (bottom) requires to estimate from cloud shapes and patterns. Meanwhile, thick clouds (Cbs) and low-level clouds can be distinguished easily by Day Cloud Phase RGB (top) at a glance.

- A ■ : thick high-level clouds with ice particles;
B ■ : thin high-level clouds with ice particles;
C ■ : thick low level ice clouds;
D ■ : thick low level water clouds



Main applications: Analysis cloud thickness, height of cloud top and cloud phase

Benefits:

- Easy to distinguish between high-level ice clouds and low-level water clouds.
- Easy to identify surface snow/ice.

Limitations:

- Available during daytime only
- Colors of clouds and surface are affected by thermal conditions (latitudinal, seasonal, diurnal etc.).

Summary

- JMA is planning to provide RGB Quick Guides to Himawari imagery users on JMA/MSC website.
- The detailed report related to the RGB composite introduction will be also published on the website.
- The RGB composites which are not so familiar to users (e.g. RGBs developed by JMA) are also useful.
- As examples of such RGBs, “Fire Temperature RGB” and “Cloud Phase Distinction RGB” were introduced by using Himawari RGB Quick Guide contents.



Thank you !

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Samples of Himawari RGB Quick Guides

- [24hourMicrophysics](#)
- [Airmass](#)
- [Natural Color](#)
- [Cloud Phase Distinction](#)
- [Fire Temperature](#)
- [Day Deep Clouds](#)