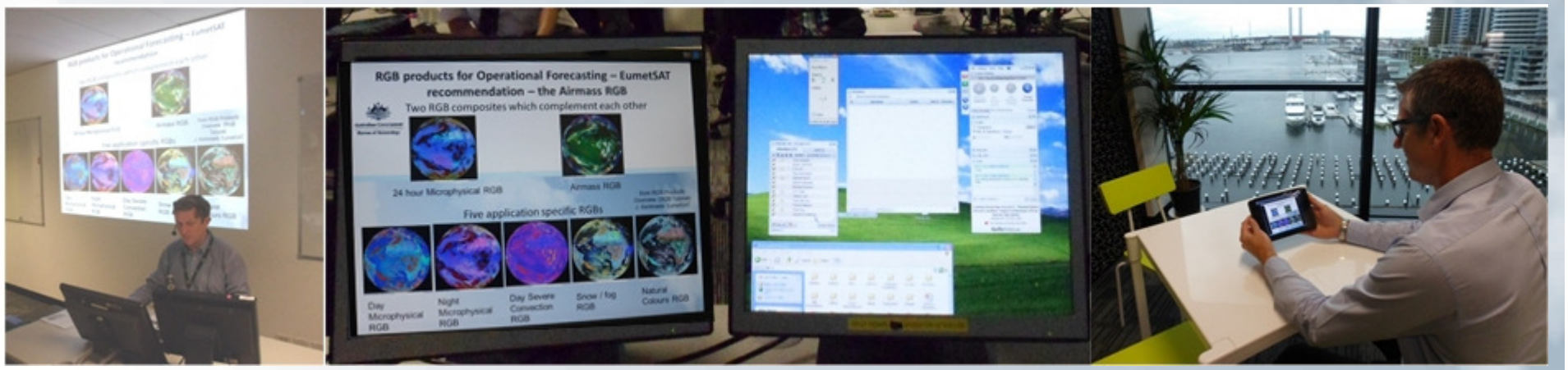
Australian VLab Centre of Excellence

Science Week 2015

Australian Government
Bureau of Meteorology

Himawari-8 derived RGB products applied to the Australasian-Pacific region

(Facilitator: Bodo Zeschke, BMTC)



Australian Government
Bureau of Meteorology

Content

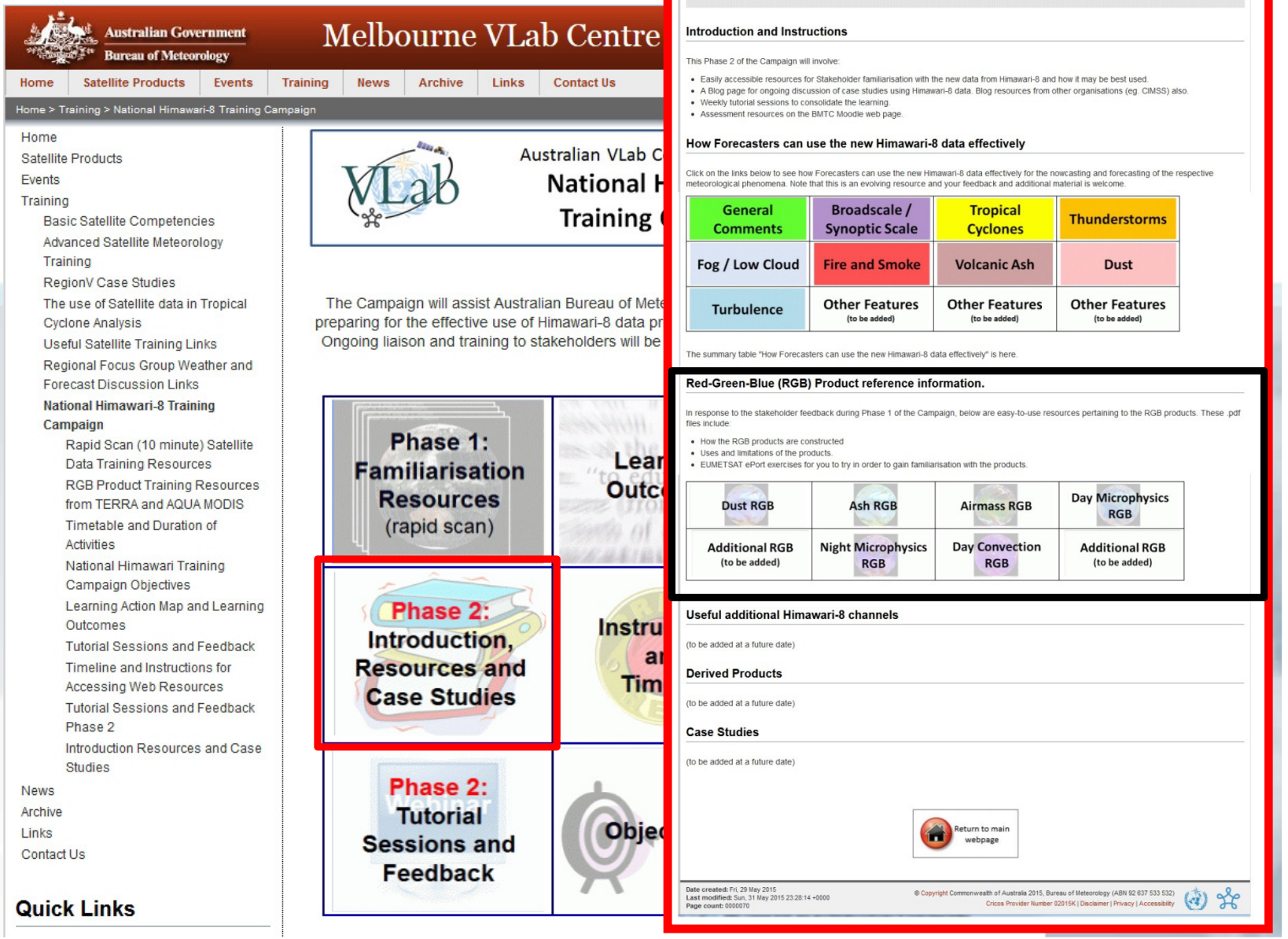
- RGB product resources
- A very brief introduction of RGB products
- WMO/EUMETSAT recommended RGB products
- **Exercise:** Comparing between Himawari-8 and METEOSAT-10 RGB products
- Looking at differences in the imagery in greater detail.
- **Exercise:** Himawari-8 RGB products as applied over different areas of the Australasian and Pacific regions (domains).
- Some RGB product animations

Reminder: National Himawari-8 Training Campaign

http://www.virtuallab.bom.gov.au/training/hw-8-training/

Reminder: National Himawari-8

http://www.virtuallab.bom.gov.au/tra



National Himawari-8 Training Campaign Phase 2

Red-Green-Blue (RGB) Product reference information.

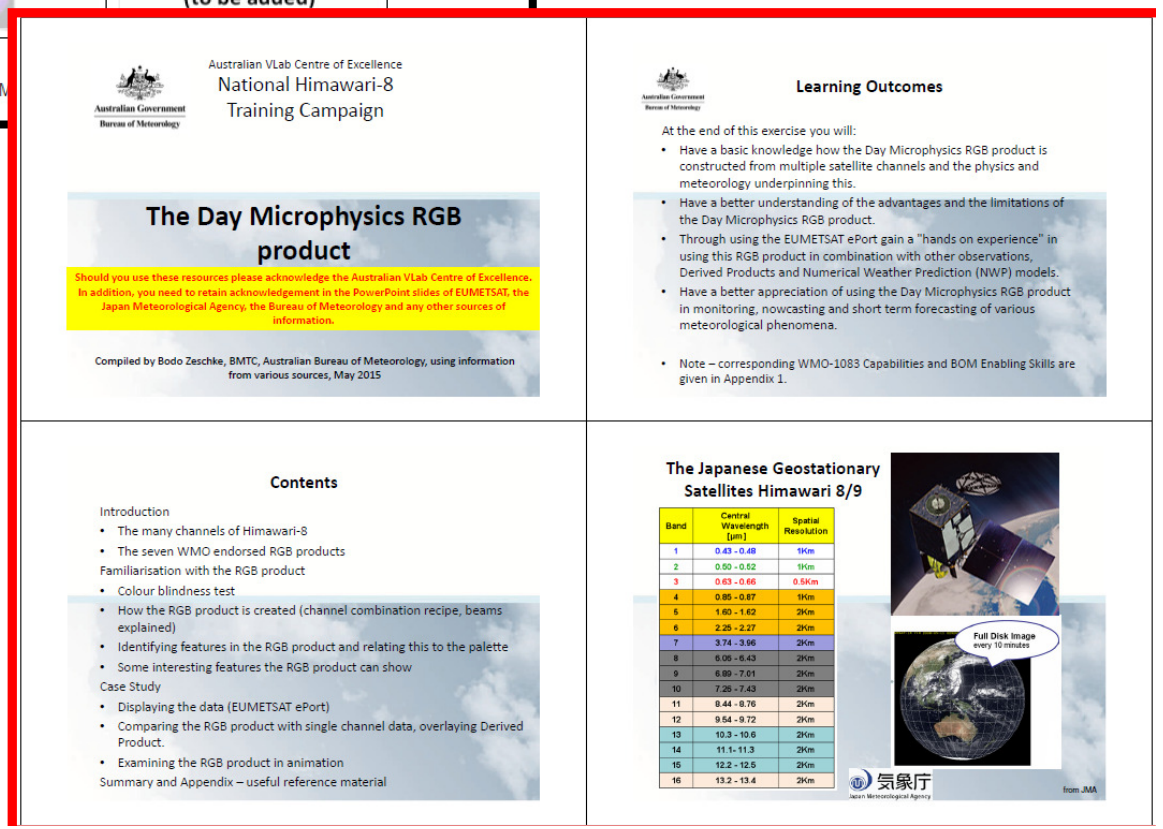
In response to the stakeholder feedback during Phase 1 of the Campaign, below are easy-to-use resources pertaining to the RGB products. These .pdf files include:

- How the RGB products are constructed
- Uses and limitations of the products.
- EUMETSAT ePort exercises for you to try in order to gain familiarisation with the products.

Dust RGB	Ash RGB	Airmass RGB	Day Microphysics RGB
Additional RGB (to be added)	Night Microphysics RGB	Day Convection RGB	Additional RGB (to be added)

A very useful and relevant Himawari-8 RGB Composite Imagery resource from the Japan M

- **RGB product reference .pdf files for easy Forecaster reference.**
- **Most include EUMETSAT ePort exercise.**



Australian VLab Centre of Excellence
National Himawari-8 Training Campaign

The Day Microphysics RGB product

Should you use these resources please acknowledge the Australian VLab Centre of Excellence. In addition, you need to retain acknowledgement in the PowerPoint slides of EUMETSAT, the Japan Meteorological Agency, the Bureau of Meteorology and any other sources of information.

Compiled by Bodo Zeschke, BMTC, Australian Bureau of Meteorology, using information from various sources, May 2015

Learning Outcomes

At the end of this exercise you will:

- Have a basic knowledge how the Day Microphysics RGB product is constructed from multiple satellite channels and the physics and meteorology underpinning this.
- Have a better understanding of the advantages and the limitations of the Day Microphysics RGB product.
- Through using the EUMETSAT ePort gain a "hands on experience" in using this RGB product in combination with other observations, Derived Products and Numerical Weather Prediction (NWP) models.
- Have a better appreciation of using the Day Microphysics RGB product in monitoring, nowcasting and short term forecasting of various meteorological phenomena.
- Note – corresponding WMO-1083 Capabilities and BOM Enabling Skills are given in Appendix 1.

Contents

Introduction
- The many channels of Himawari-8
- The seven WMO endorsed RGB products

Familiarisation with the RGB product
- Colour blindness test
- How the RGB product is created (channel combination recipe, beams explained)
- Identifying features in the RGB product and relating this to the palette
- Some interesting features the RGB product can show

Case Study
- Displaying the data (EUMETSAT ePort)
- Comparing the RGB product with single channel data, overlaying Derived Product.
- Examining the RGB product in animation

Summary and Appendix – useful reference material

The Japanese Geostationary Satellites Himawari 8/9

Band	Central Wavelength [µm]	Spatial Resolution
1	0.43 - 0.48	1Km
2	0.50 - 0.52	1Km
3	0.63 - 0.66	0.5Km
4	0.85 - 0.87	1Km
5	1.60 - 1.62	2Km
6	2.25 - 2.27	2Km
7	3.74 - 3.96	2Km
8	6.06 - 6.43	2Km
9	6.89 - 7.01	2Km
10	7.26 - 7.43	2Km
11	8.44 - 8.76	2Km
12	9.54 - 9.72	2Km
13	10.3 - 10.6	2Km
14	11.1 - 11.3	2Km
15	12.2 - 12.5	2Km
16	13.2 - 13.4	2Km

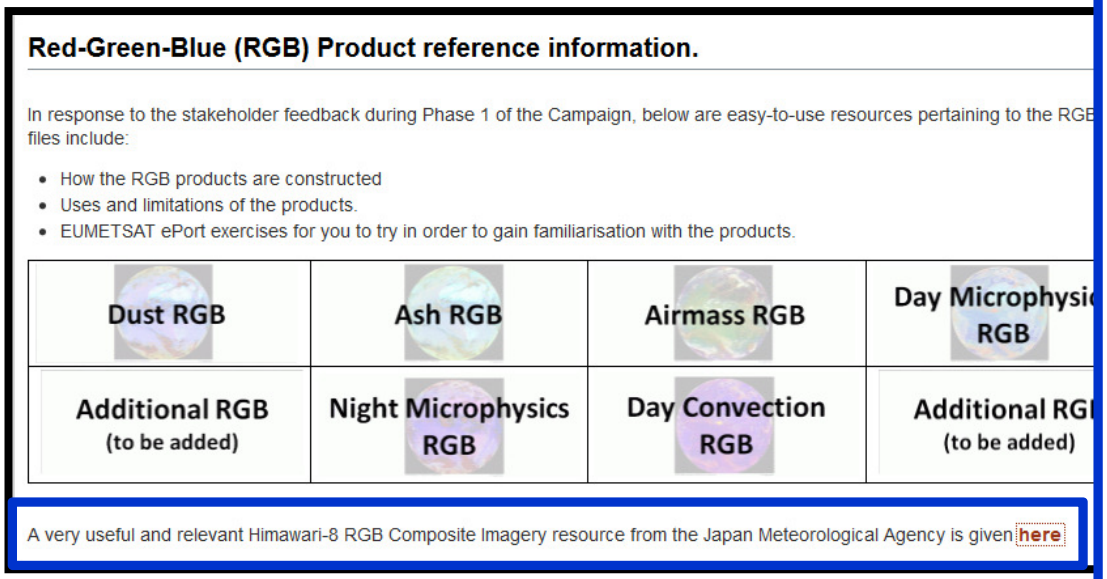
Full Disk Image every 10 minutes

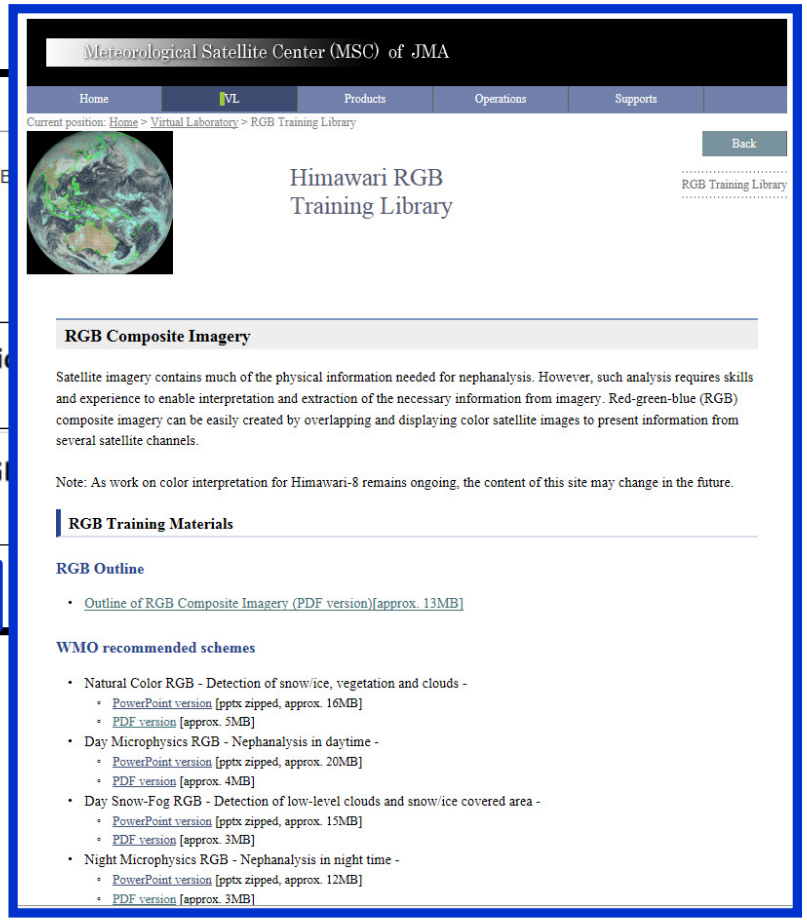
気象庁 Japan Meteorological Agency

from JMA

JMA User's Guide to RGB composite imagery (Himawari RGB Training Library)

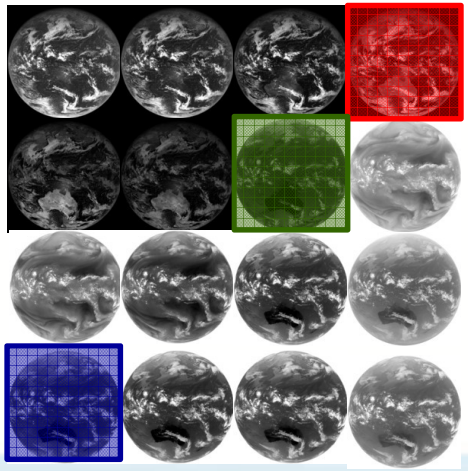
http://www.data.jma.go.jp/mscweb/en/VRL/VLab_RGB/RGBimage.html





images courtesy JMA / Eumetsat

Processing of the Himawari-8 data – the Day Microphysics RGB



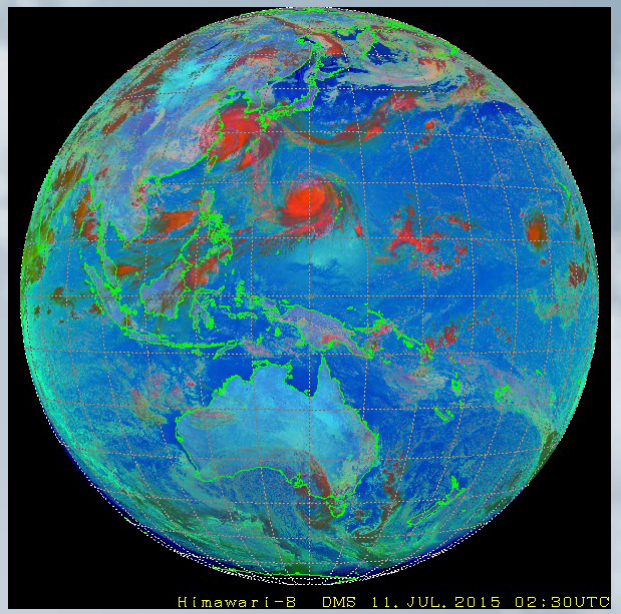
Recommended Range and Enhancement:

Beam	Channel	Range	Gamma
Red	02 (VIS0.8)	0 …+100 %	1.0
Green	04r (IR3.9r)	0 … +60 %	2.5
Blue	09 (IR10.8)	+203 … +323 K	1.0

Channel combination "recipe" (from EUMETSAT)

Himawari-8 channels

Colour interpretation palette



Day Microphysics RGB product

construction courtesy B.Zeschke BOM

Channel combination recipe of the Day
Microphysics RGB

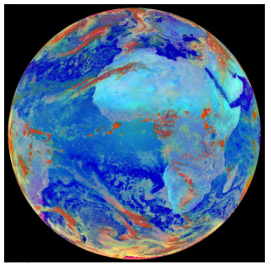
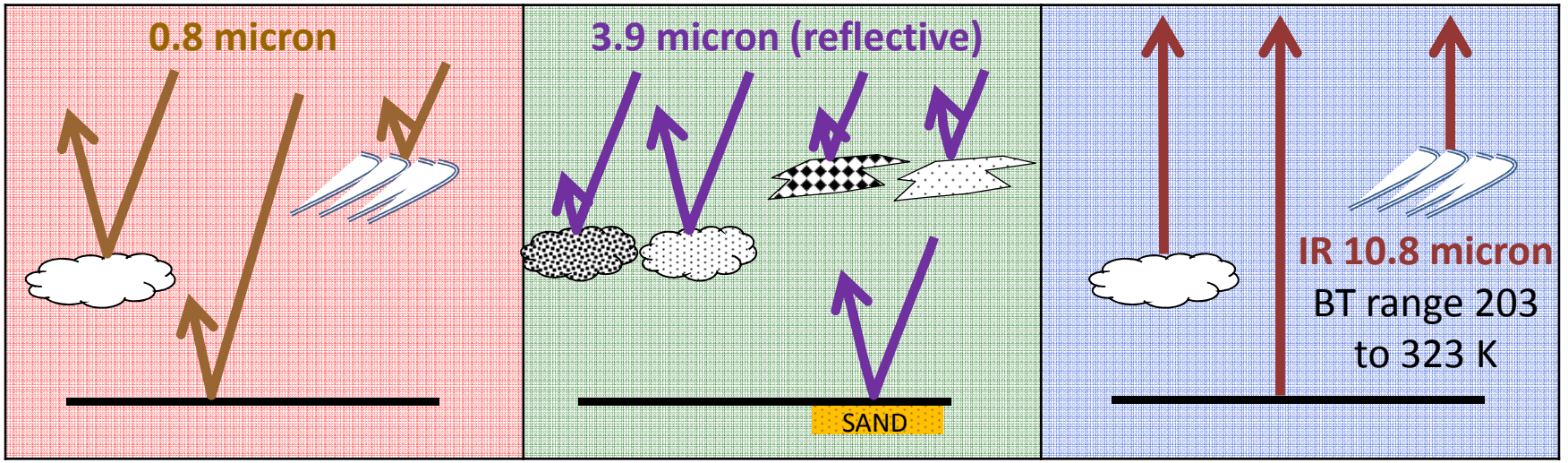


image courtesy
EUMETSAT

Recommended Range and Enhancement

Beam	Channel	Range	Gamma	Gamma 2
Red	**VIS0.8**	0 … 100%	1.0	1.0
Green	**NIR3.9 (r)** **(reflected / solar component)**	0 … 60%	2.5	1.0
Blue	**IR10.8**	+203 … +323 K	1.0	1.0



Channel combination “recipes’ of the Day Microphysics RGB

- **In the RED beam** - The visible reflectance at 0.8 microns approximates the cloud optical depth (thickness) and amount of cloud water and ice. Typically, water cloud is more reflective than ice cloud and thus will have a stronger red beam component. This channel also gives information about the surface of the earth. For example, vegetated land, desert and snow cover are all very reflective
- **In the GREEN beam** - the 3.9 µm shortwave infrared solar reflectance gives a qualitative measure for cloud particle size and phase. Typically smaller water droplets or small ice particles have a higher reflectivity, resulting in a stronger green beam component. A sandy earth surface also has a strong reflectance in this channel.
- **In the BLUE beam** - The 10.8 µm infrared brightness temperature is a function of surface and cloud top temperatures. The scaling for this beam results in a strong blue beam component for warm surfaces, whereas cold cloud tops will not have any contribution in this beam.

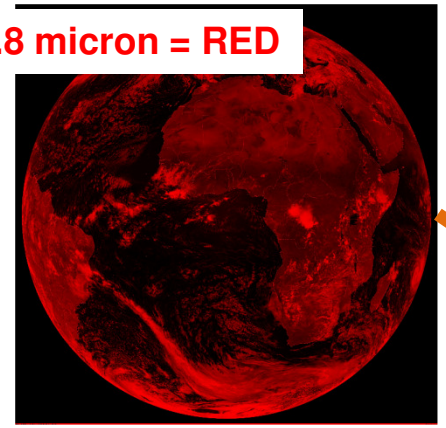
Obtaining the reflective component for the 3.9 micron channel

- For the 3.9 micron channel at daytime the outgoing radiance is due to solar reflection and thermal emission. Thus in order to determine a channel reflectance, it is necessary to subtract the thermal part from the satellite signal.
- To do this, the temperature of the observed object is needed. The usual candidate at hand is the 11 brightness temperature (e.g. VIIRS I5 or M12), since most objects behave approximately as blackbodies in this spectral interval.
- If the satellite observation is given in terms of the brightness temperature, then the corresponding spectral radiance can be derived by convolving the relative spectral response with the Planck function and diving by the equivalent band width. This gives the spectral radiance given the brightness temperature and may be expressed in . In order to get the total radiance over the band one has to multiply with the equivalent band width.

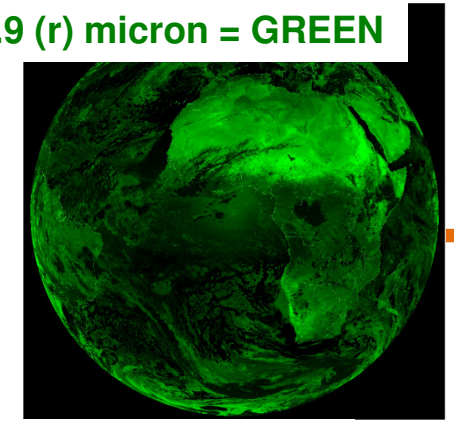
From https://pyspectral.readthedocs.org/en/latest/37_reflectance.html

The input beams that go to make up the Day Microphysics RGB.

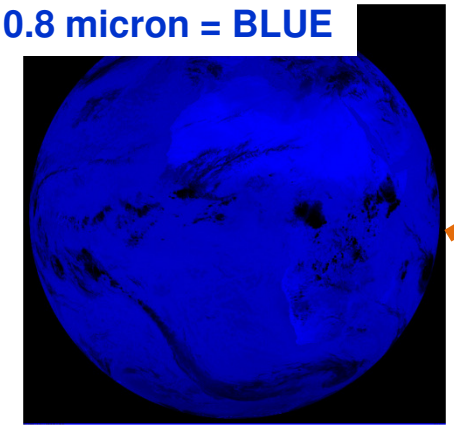
0.8 micron = RED



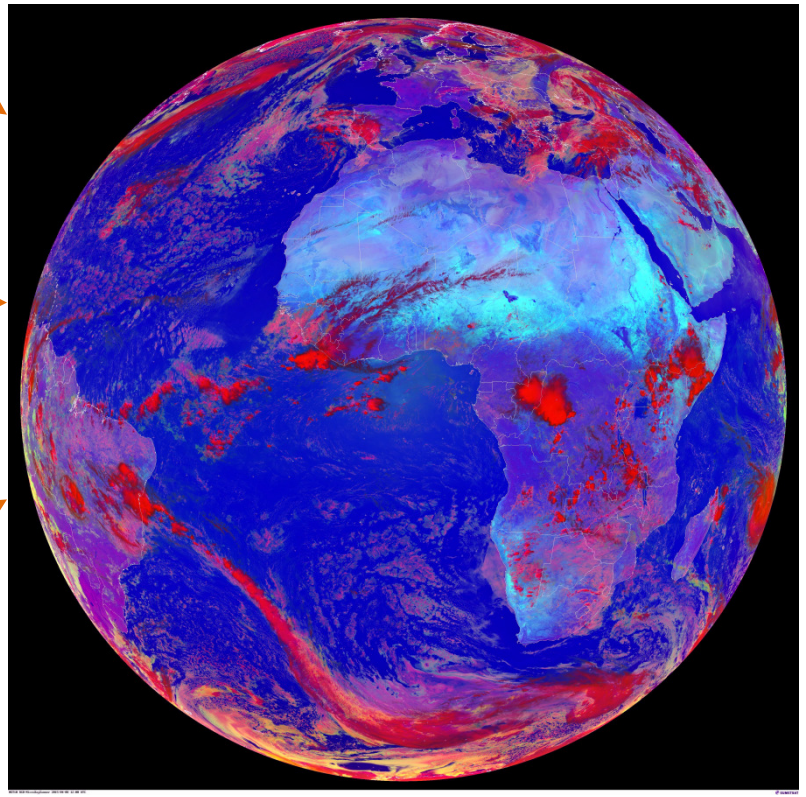
3.9 (r) micron = GREEN



10.8 micron = BLUE



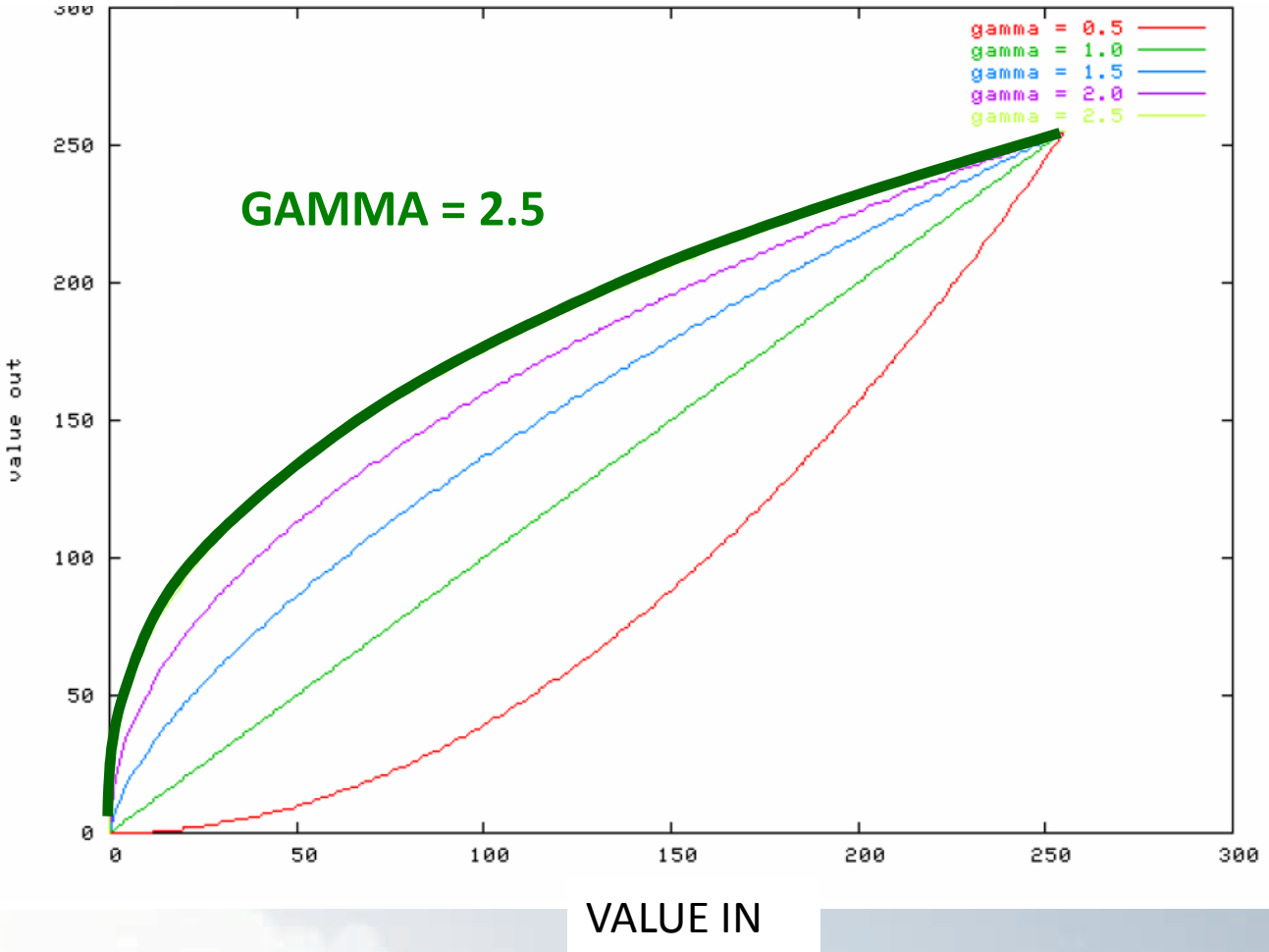
Beam	Channel	Range	Gamma	Gamma 2
Red	VIS0.8	0 … 100%	1.0	1.0
Green	NIR3.9 (r) (reflected / solar component)	0 … 60%	2.5	1.0
Blue	IR10.8	+203 … +323 K	1.0	1.0

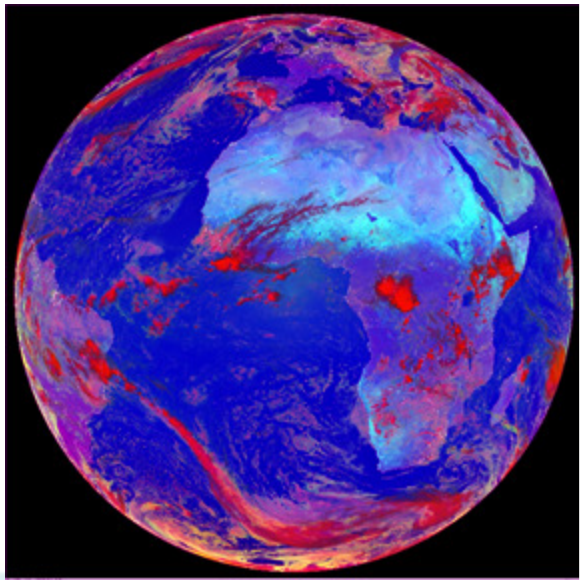


Western Hemisphere 8 April 2015 1200 UTC

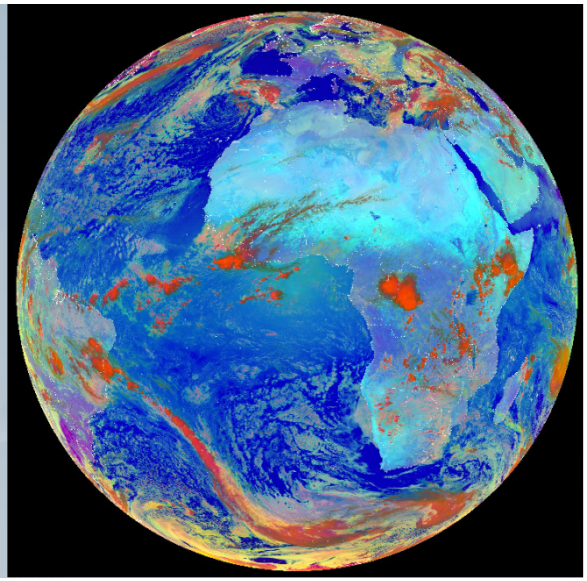
images courtesy EUMETSAT

GAMMA Correction applied





Before GAMMA correction



After GAMMA correction

The GAMMA enhancement. GAMMA=2.5 applied to a Day Microphysics RGB enhancement over the Western Hemisphere. Top, without GAMMA, bottom with GAMMA = 2.5.

images courtesy EUMETSAT

GAMMA Correction applied

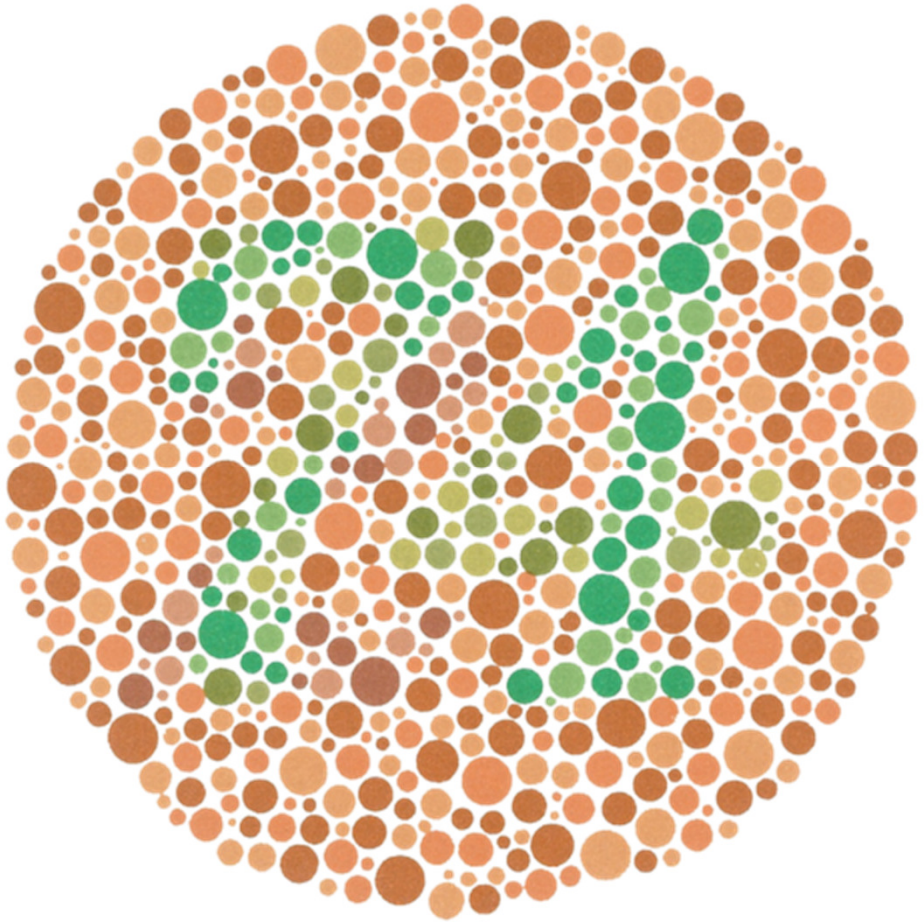
- The Gamma correction changes the linear spreading of a selected range of pixel values over the full intensity scale to a convex (GAMMA < 1) or concave (GAMMA >1) curve.
- The GAMMA correction enhances the contrast of the higher (GAMMA < 1) or lower parts (GAMMA >1) of the pixel values in an image.
- Inspection of the result of applying the GAMMA correction to the green beam of the Day Microphysics RGB shows that a much more "colour balanced" image is produced. Much of the strong red colour overtones are removed.

- For more information please see http://oiswww.eumetsat.int/~idds/html/doc/best_practices.pdf

Intermission

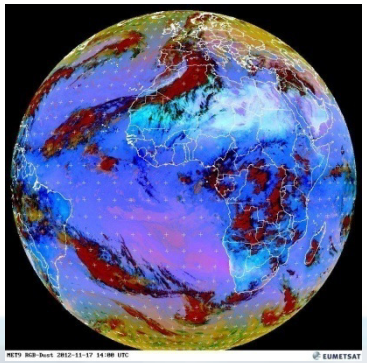
To take full advantage of the RGB products you should be able to see the number "74" in the pattern on the right.

If you cannot see this number, please send an email to b.zeschke@bom.gov.au and I will adapt this training resource accordingly

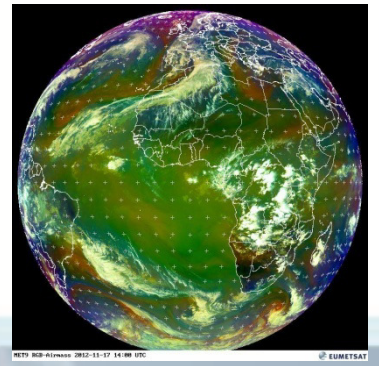


RGB products for Operational Forecasting – EUMETSAT / WMO recommendation

Two RGB composites which complement each other



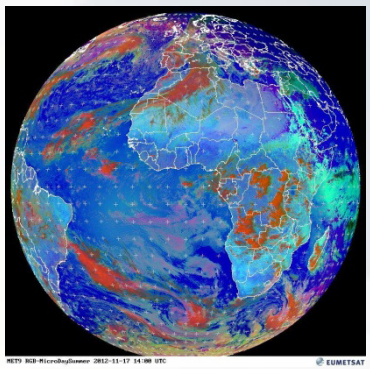
24 hour Microphysical RGB



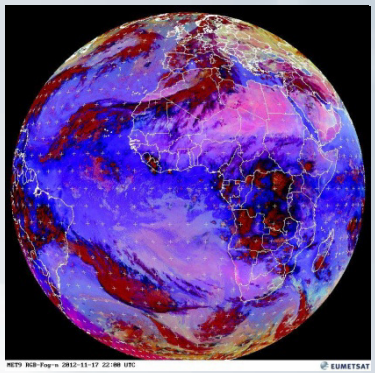
Airmass RGB

from RGB Products Overview (RGB Tutorial) J. Kerkmann EumetSAT

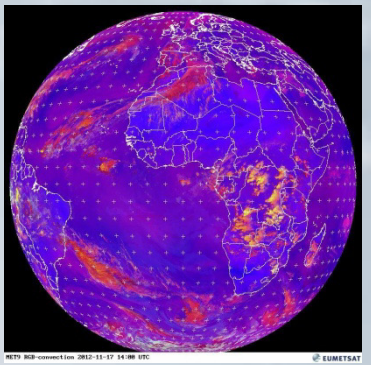
Five application specific RGBs



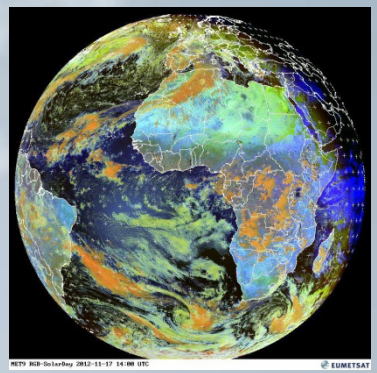
Day Microphysical RGB



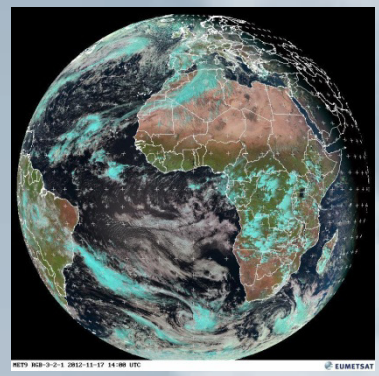
Night Microphysical RGB



Day Convection RGB



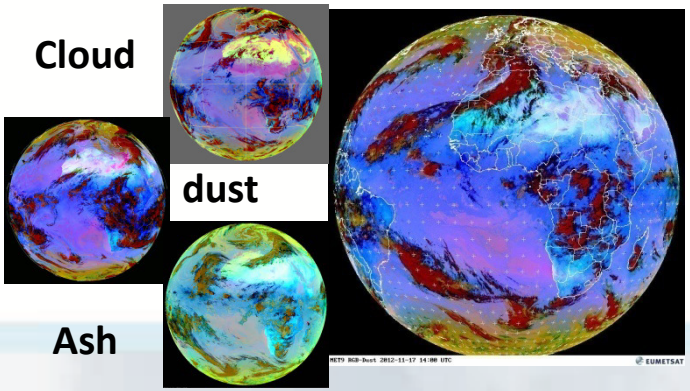
Snow / fog RGB



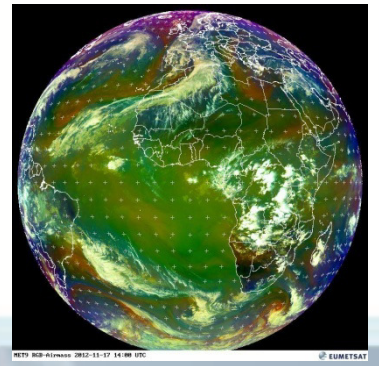
Natural Colours RGB

RGB products for Operational Forecasting – EUMETSAT / WMO recommendation

Two RGB composites which complement each other



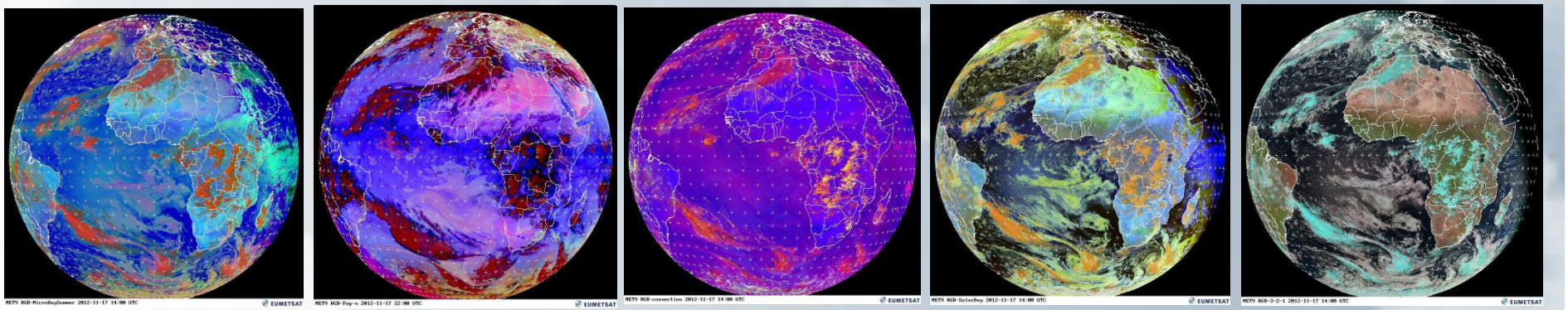
24 hour Microphysical RGB



Airmass RGB

from RGB Products Overview (RGB Tutorial) J. Kerkmann EumetSAT

Five application specific RGBs



Day Microphysical RGB

Night Microphysical RGB

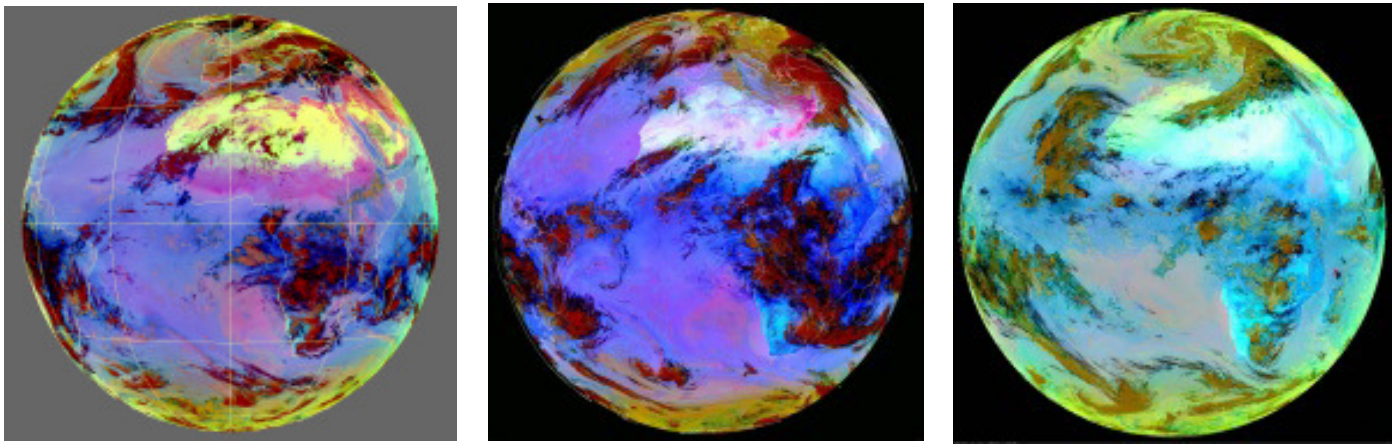
Day Convection RGB

Snow / fog RGB

Natural Colours RGB

For reference: Channel combination recipe for the three classes of 24-hour Microphysics RGB product

Beam	Channel	Range	Gamma	Range	Gamma	Range	Gamma
Red	IR12.0 – IR10.8	-4 ... +2 K	1.0	-4 ... +2 K	1.0	-4 ... +2 K	1.0
Green	IR10.8 – IR8.7	0 ... +6 K	1.2	0 ... +15 K	2.5	-4 ... +5 K	1.0
Blue	IR10.8	+248...+303	1.0	+261...+289	1.0	+243...+303	1.0
		24 hour Cloud Microphysics RGB		24 hour Dust Microphysics RGB		24 hour Ash Microphysics RGB	



from Tri-spectral Window RGB Applications with MSG SEVIRI (24-h Microphysics RGB) J. Kerkmann

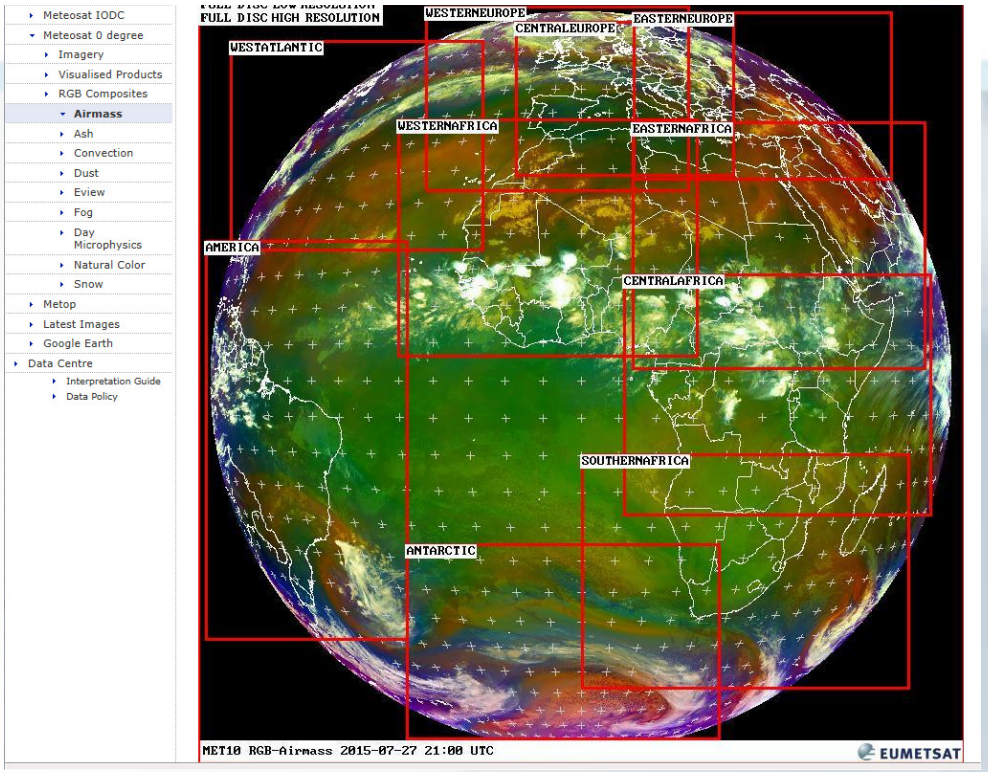
Particular web pages for comparing Himawari-8 with METEOSAT-10 RGB products

Note that JMA are currently adapting the EUMETSAT RGB product recipes to Himawari-8 data. This exercise will give us an overview of which RGB products will require the most tuning.

Eumetsat RGB Composites

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

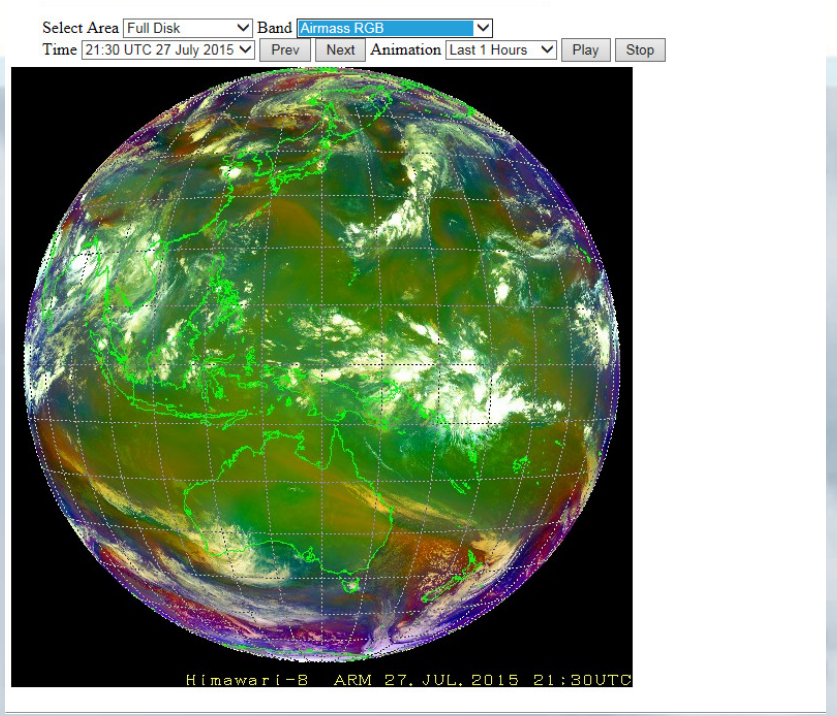
METEOSAT-10



JMA RGB Composites

http://ds.data.jma.go.jp/mscweb/data/himawari/sat_img.php?area=fd_

Himawari-8

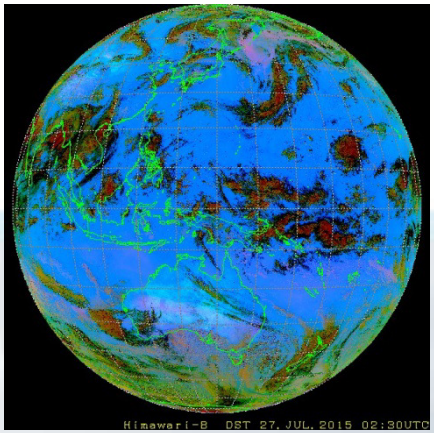


Method of comparing Himawari-8 with METEOSAT-10 RGB products

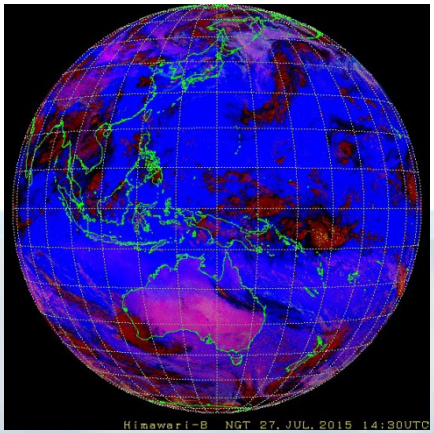
Himawari-8

METEOSAT-10

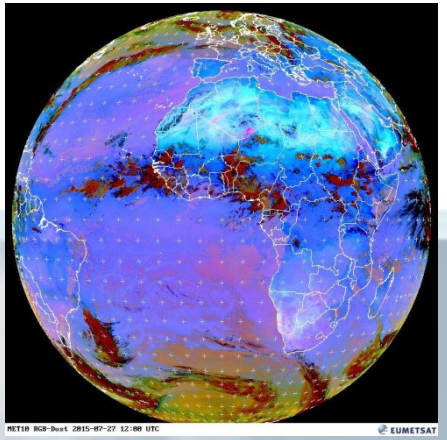
Day Microphysics RGB



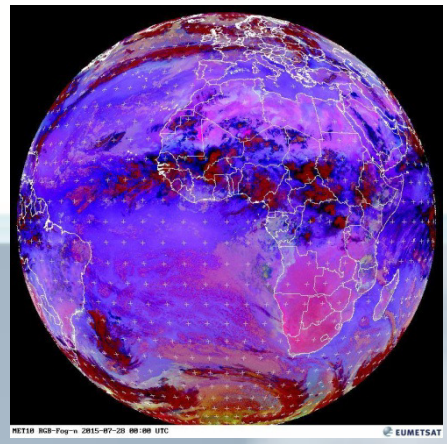
Night Microphysics RGB

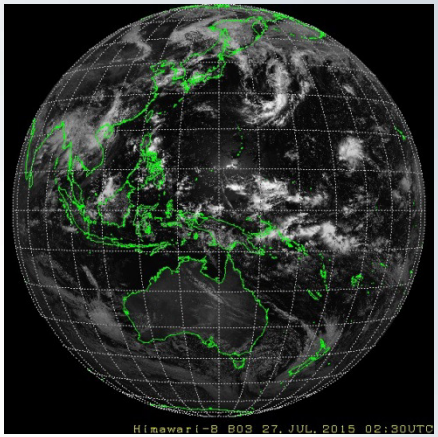


Day Microphysics RGB



Night Microphysics RGB





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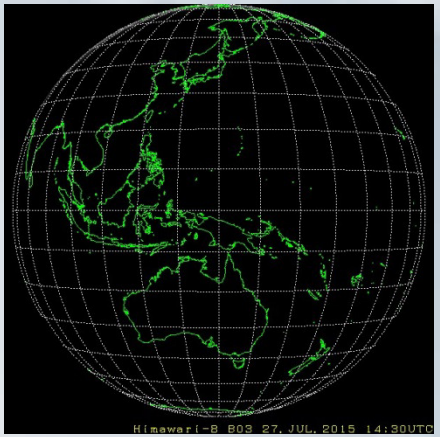
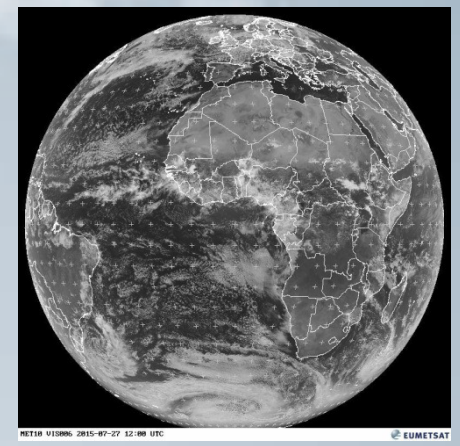
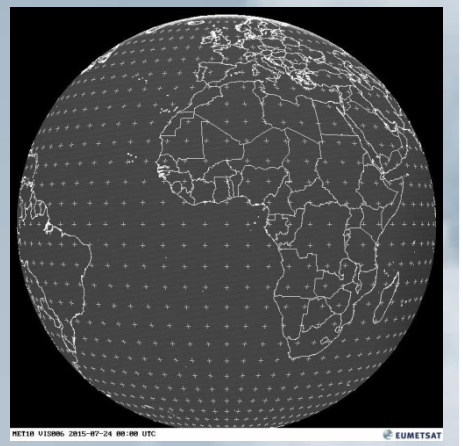


1430UTC visible image channel



1200UTC visible image



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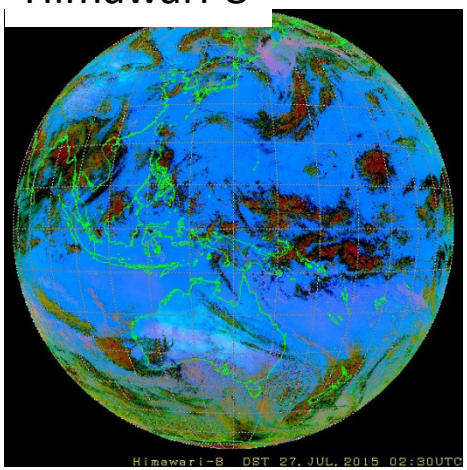
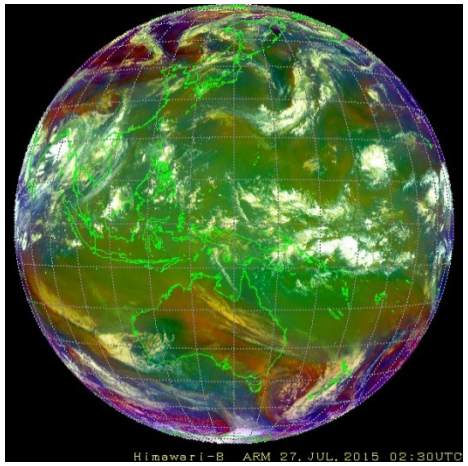
Quiz: RGB products from Himawari-8 and Meteosat 10

Himawari-8

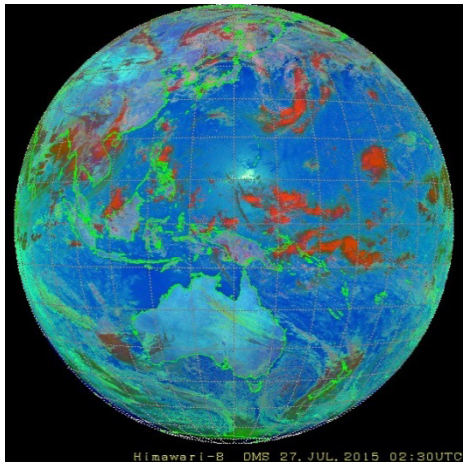
images courtesy JMA



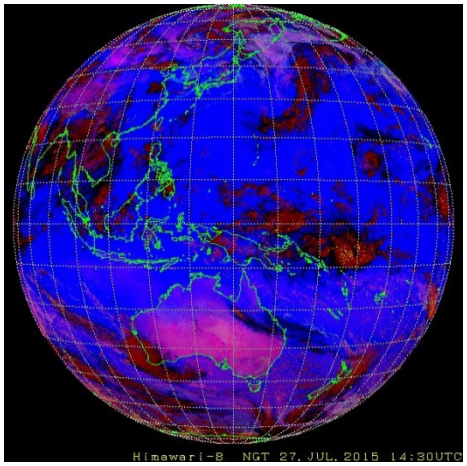
A: Dust RGB



B: Airmass RGB

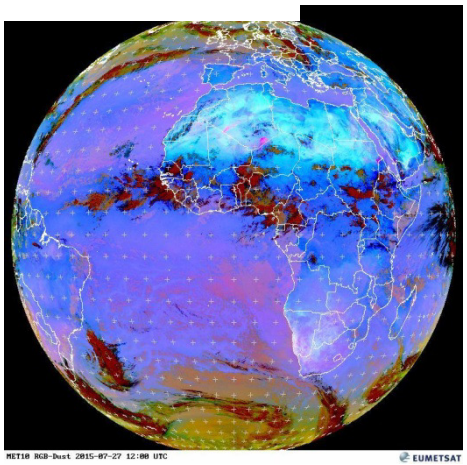


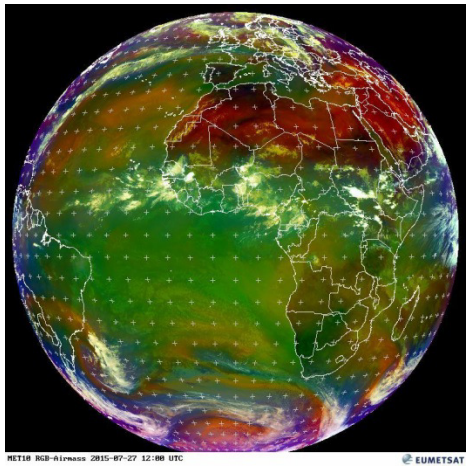
C: Day Microphysics RGB

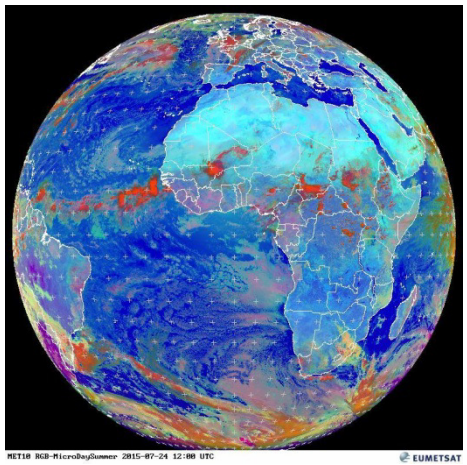


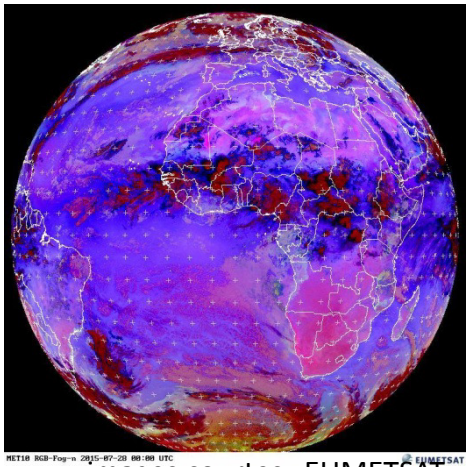
D: Night Microphysics RGB

METEOSAT-10









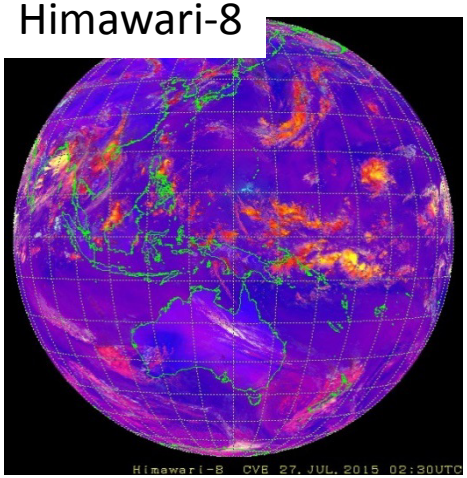
images courtesy EUMETSAT

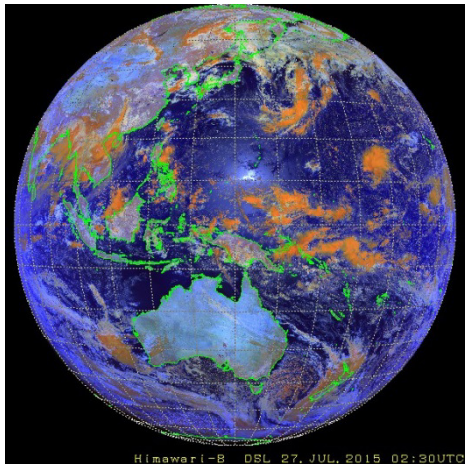
Question: which of these Himawari-8 RGB products require the greatest adjustment?
Rank from 1 (most adjustment) to 4 (least adjustment)

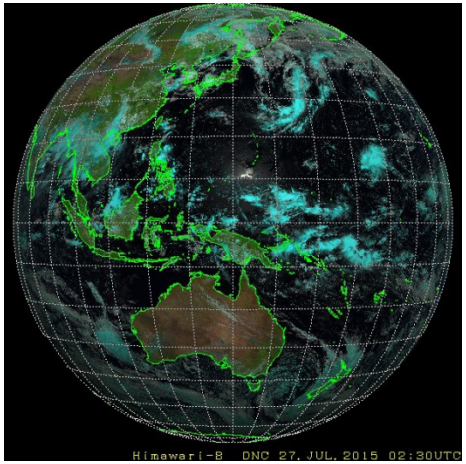
Quiz: RGB products from Himawari-8 and Meteosat 10

images courtesy JMA

Himawari-8







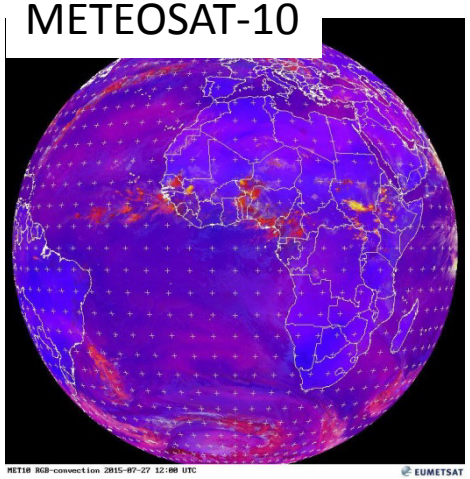
E: Day Convection RGB

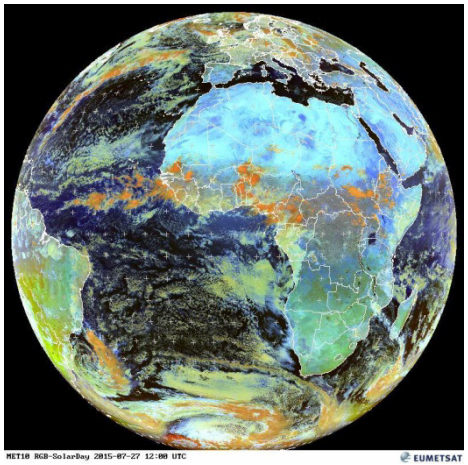
F: Snow/Fog RGB

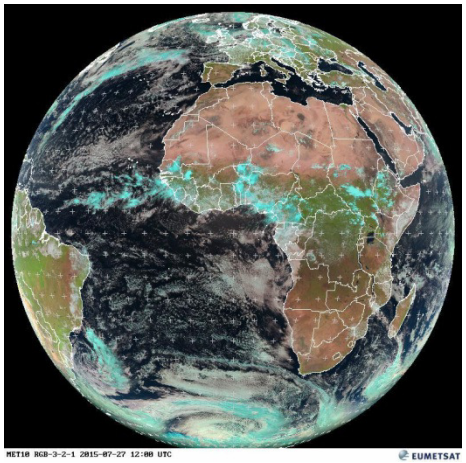
G: Natural Colour RGB

images courtesy EUMETSAT

METEOSAT-10



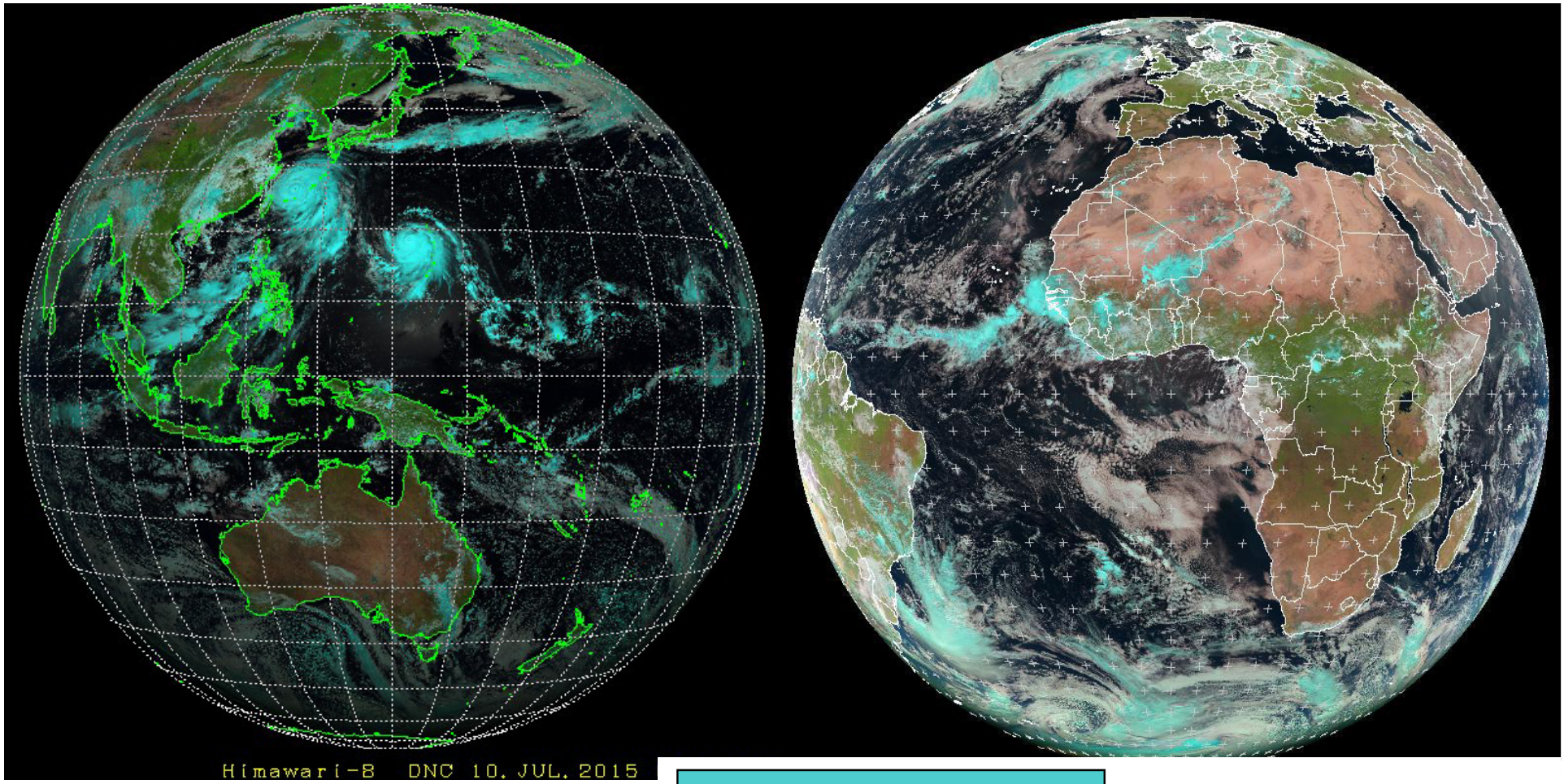




Question: which of these Himawari-8 RGB products require the greatest adjustment?
Rank from 1 (most adjustment) to 4 (least adjustment)

Quiz: Natural Colour RGB product – highlight differences

Himawari-8 vs Meteosat-10, (9th July 2015)



Note that the solar angle correction has not yet been applied to the Himawari-8 image, but this will be applied soon (A.Shimizu JMA, pers. comm.)

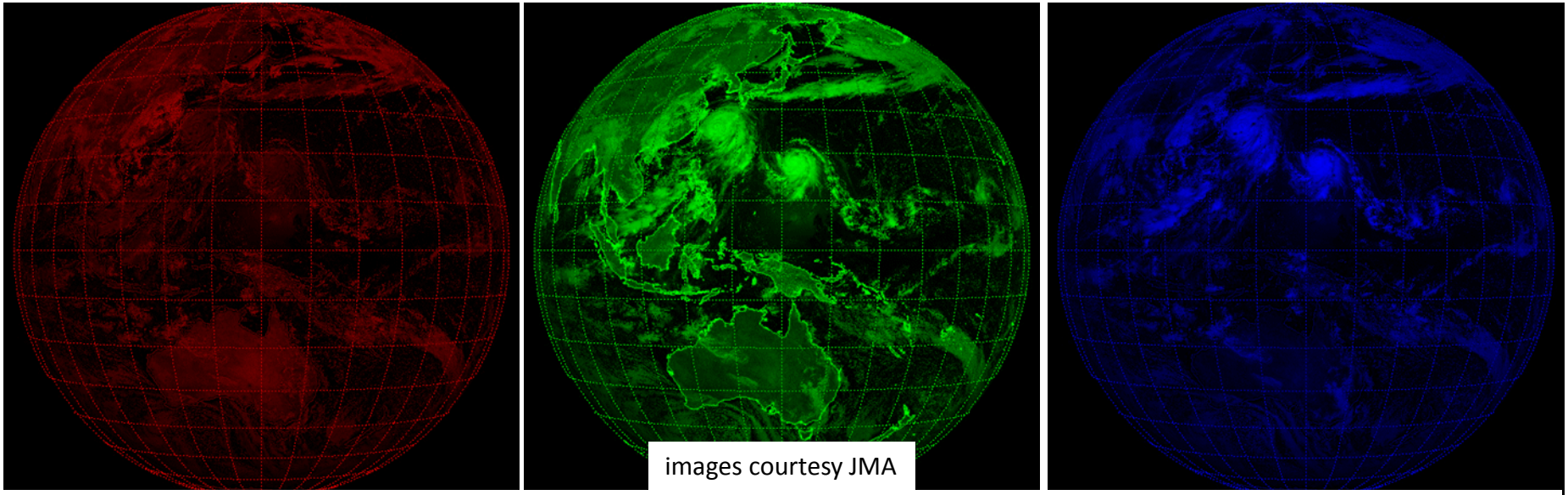
High-level ice clouds

Low-level water clouds

Ocean | Veg. Land | Desert | Snow

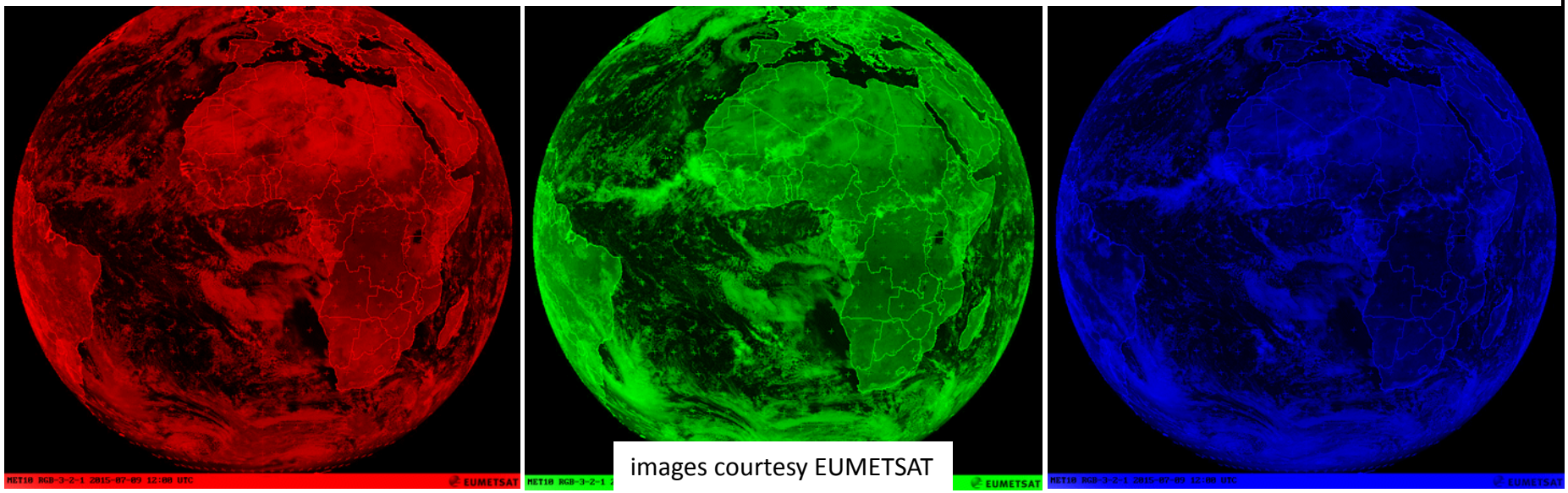
Natural Colour RGB product - decomposed

Himawari-8 (top) vs Meteosat-10 (bottom), (9th July 2015)



images courtesy JMA

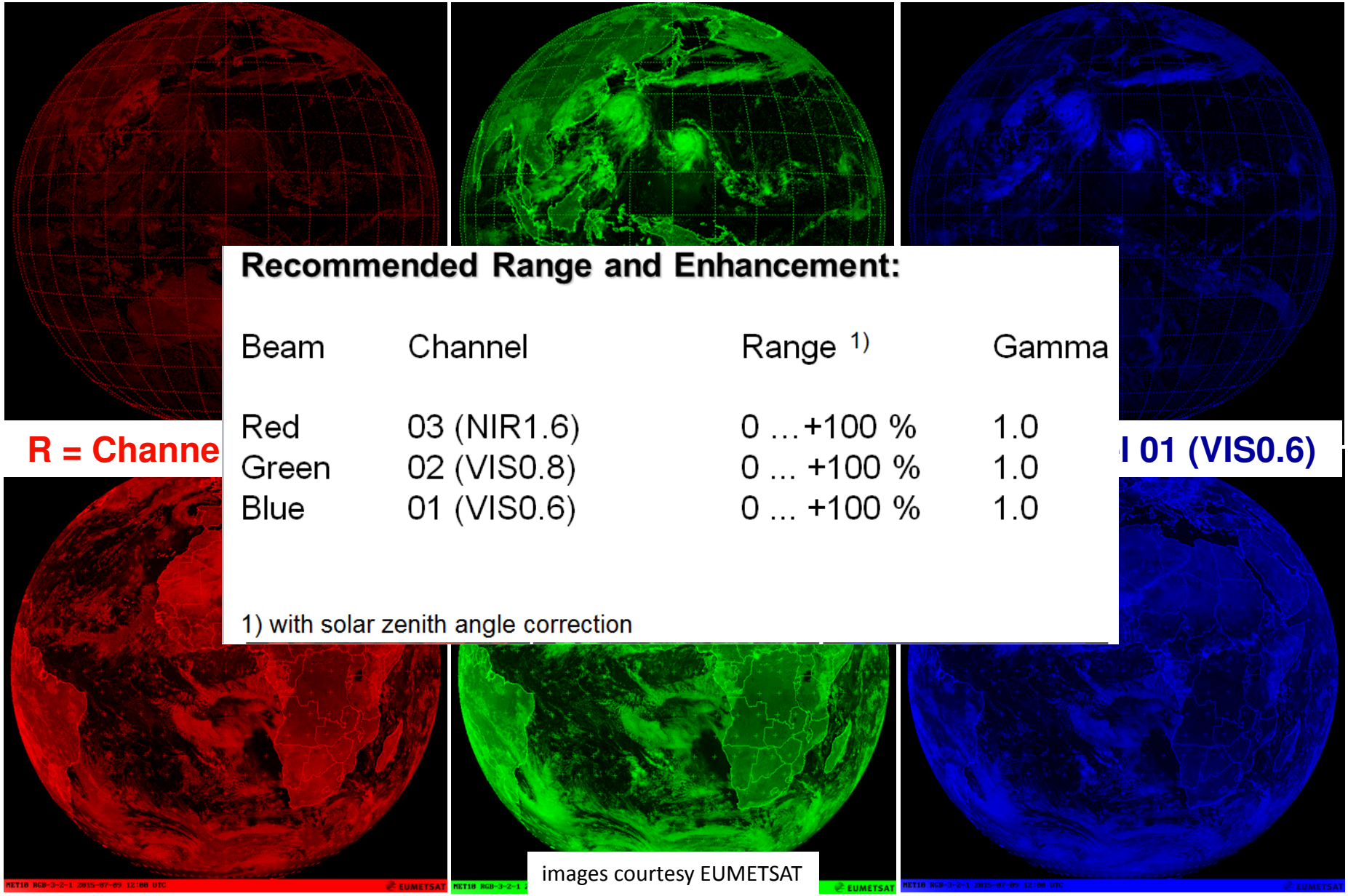
R = Channel 03 (NIR1.6) **G = Channel 02 (VIS0.8)** **B = Channel 01 (VIS0.6)**



images courtesy EUMETSAT

Natural Colour RGB product - decomposed

Himawari-8 (top) vs Meteosat-10 (bottom), (9th July 2015)



Recommended Range and Enhancement:

Beam	Channel	Range [1)]	Gamma
Red	03 (NIR1.6)	0 …+100 %	1.0
Green	02 (VIS0.8)	0 … +100 %	1.0
Blue	01 (VIS0.6)	0 … +100 %	1.0

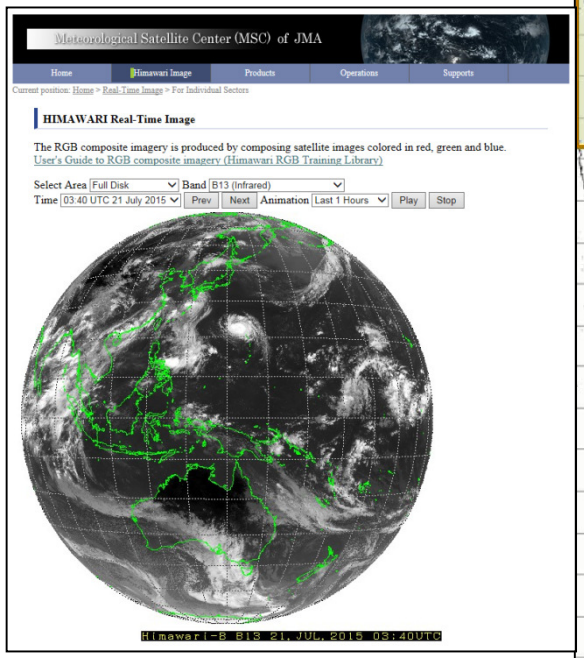
1) with solar zenith angle correction

R = Channe

l 01 (VIS0.6)

images courtesy EUMETSAT

Examining Himawari-8 RGB products across different domains



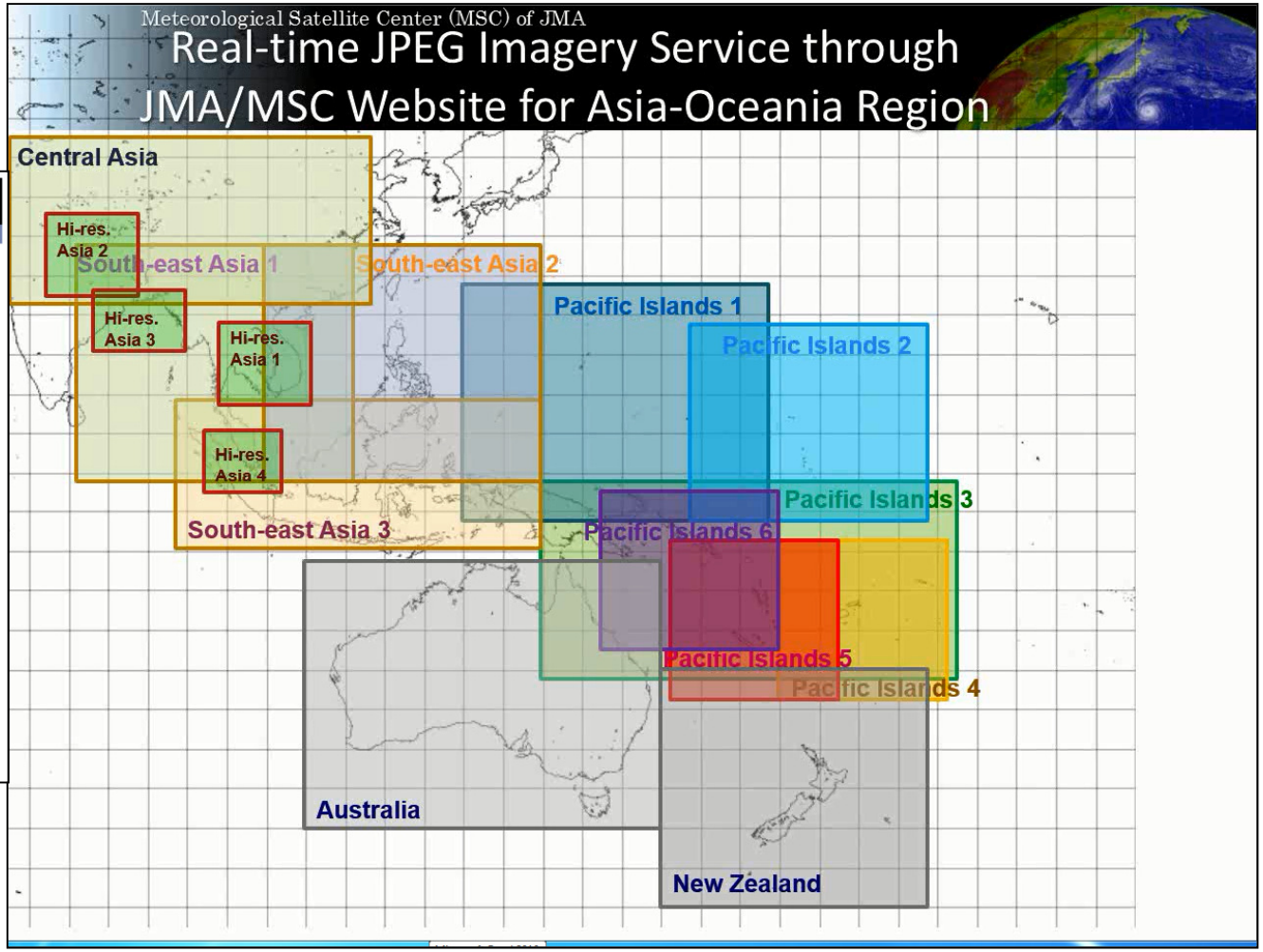
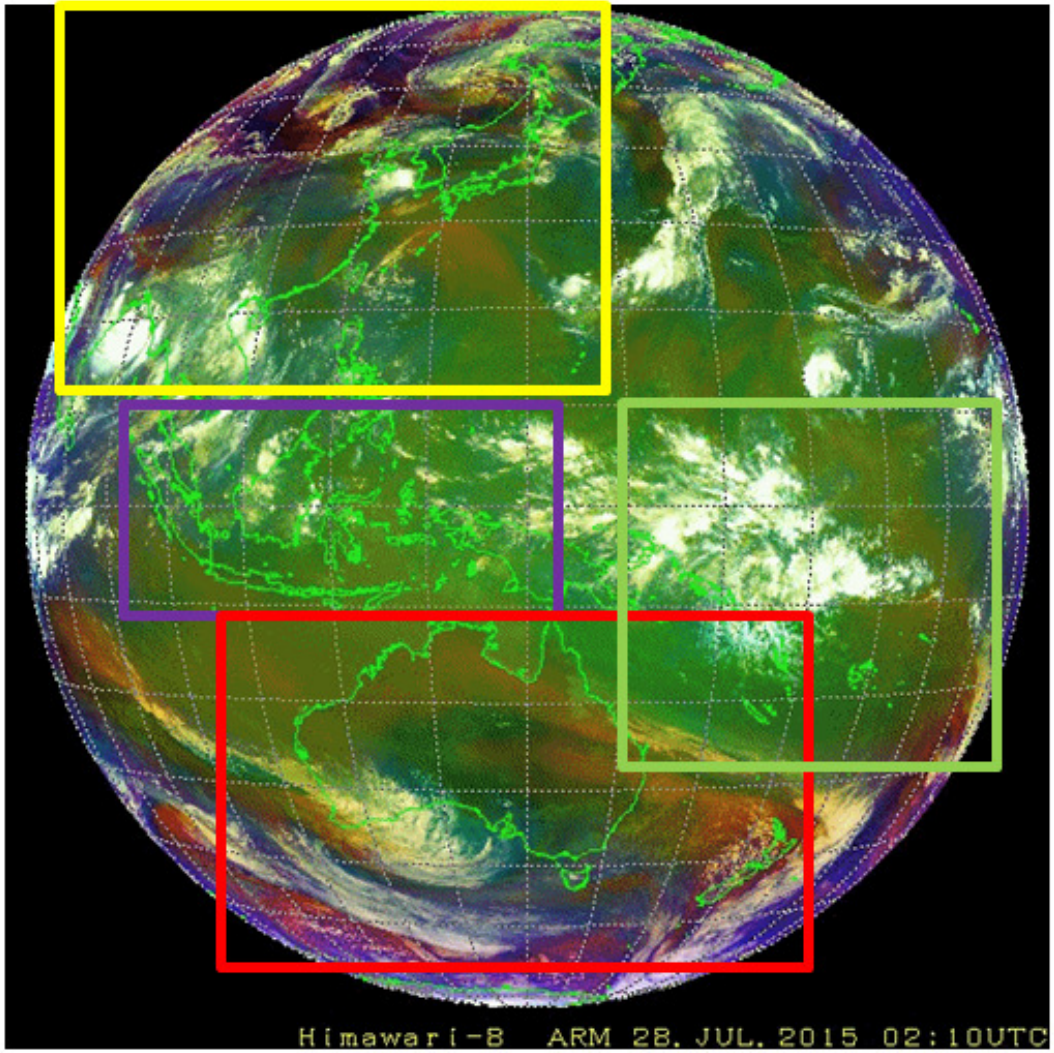


image from the presentation "Introduction of JMA VLab Support Site on RGB Composite Imagery", Mr.A.Shimizu (JMA)

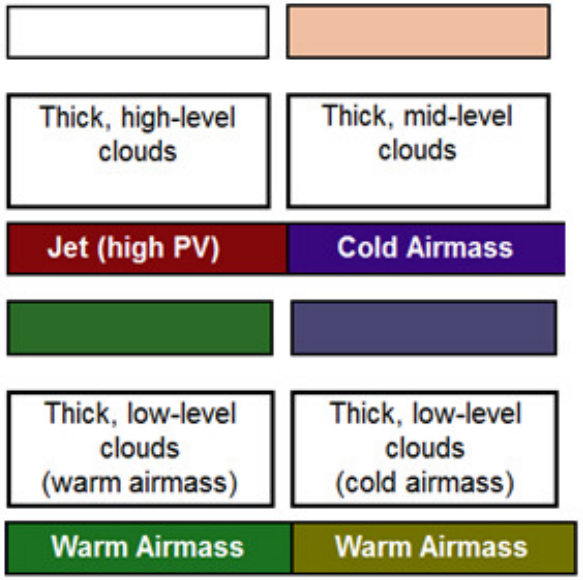
Animation 1: Assess the information content of the Airmass RGB product for the following domains (annotate by ✓or x)

animations courtesy JMA



28th July 2015

- Australia-New Zealand Region
- Indonesian region
- Southwest Pacific
- East Asia

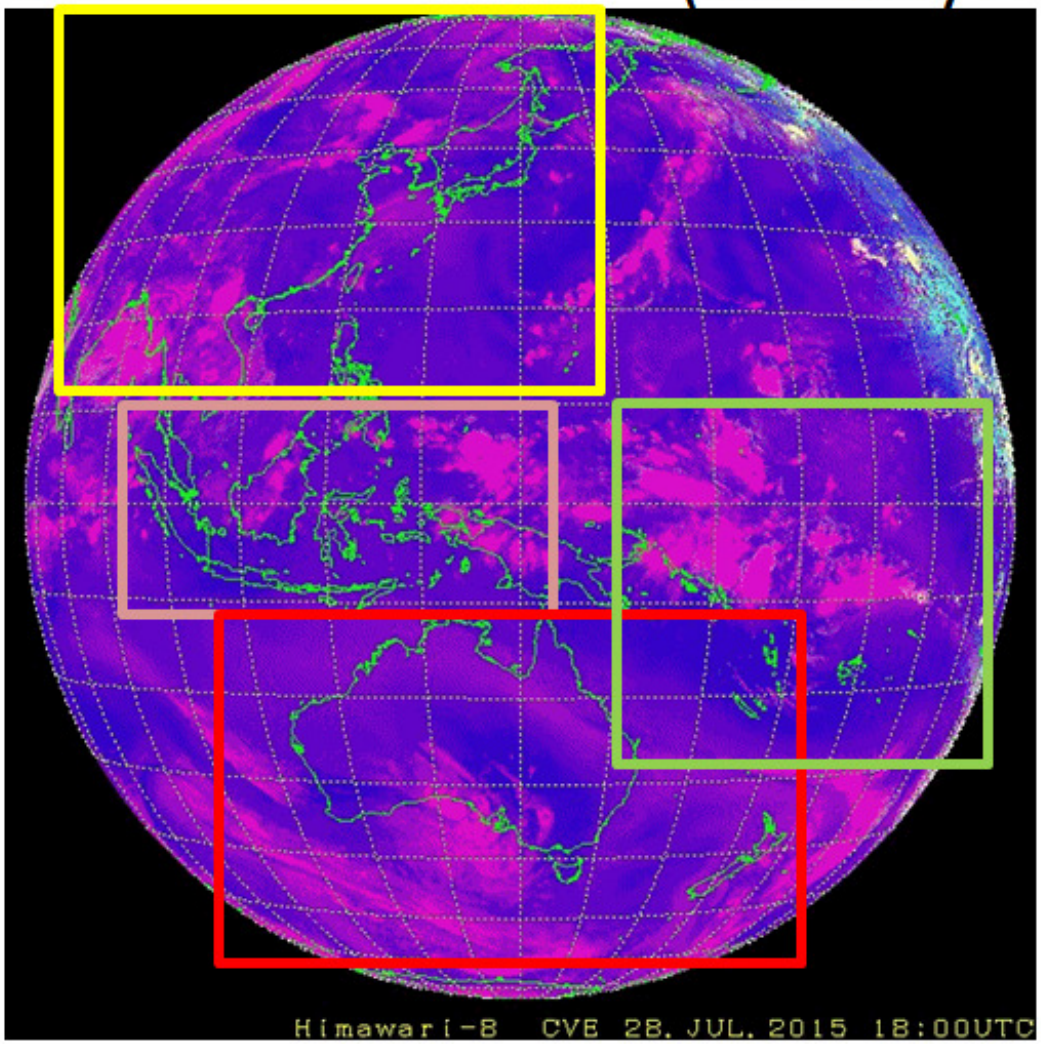


Please start Animation 1

Animation 2: Assess the information content of the Day Convection RGB product for the following domains

(annotate by ✓or x)

animations courtesy JMA



28th July 2015

- Australia-New Zealand Region (winter)
- Indonesian region
- Southwest Pacific
- East Asia (summer)

Ocean	Land
Deep precipitating cloud (precip. not necessarily reaching the ground) - high-level cloud - large ice particles	Deep precipitating cloud (Cb cloud with strong updrafts and severe weather) Or thick, high-level lee cloudiness with small ice particles
Thin Cirrus cloud (large ice particles)	Thin Cirrus cloud (small ice particles)

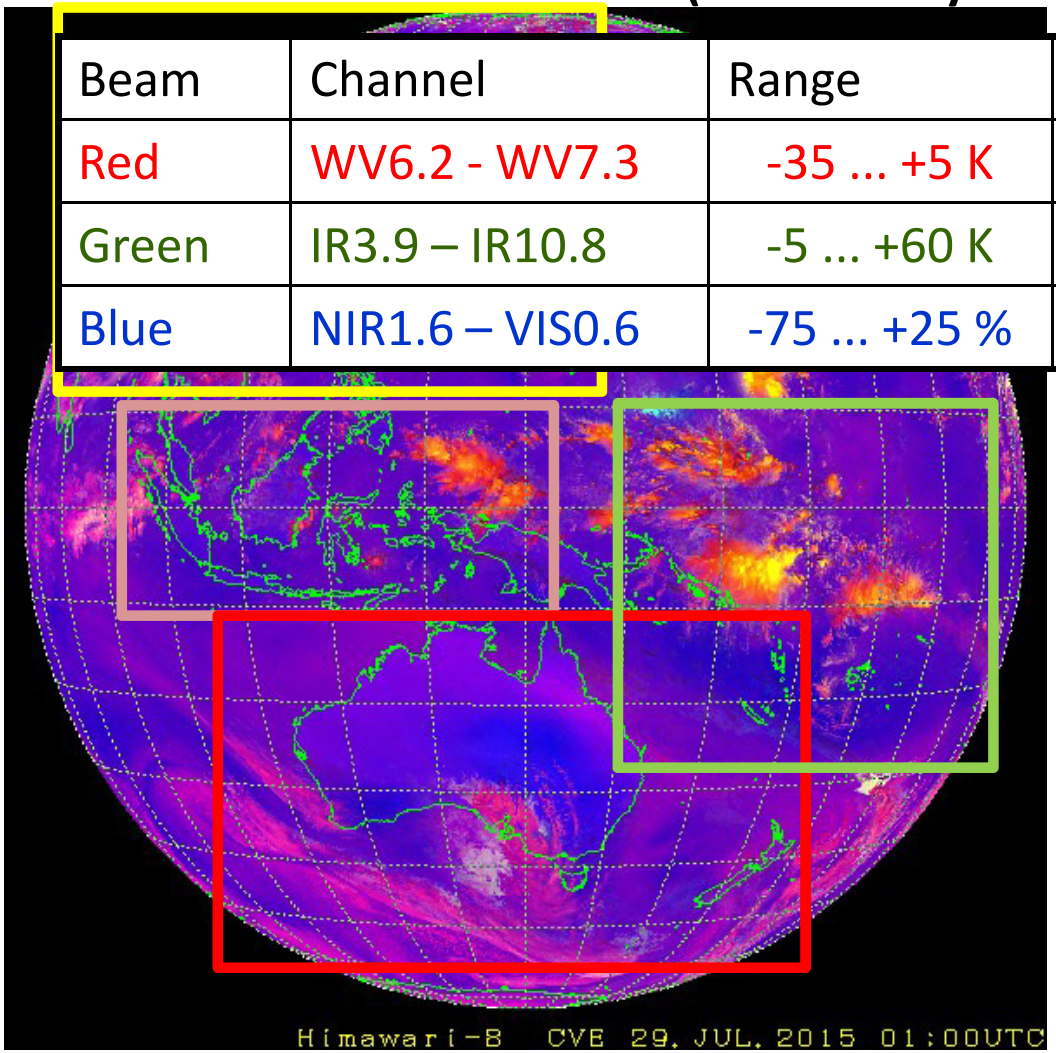
Please start Animation 2

Animation 2: Assess the information content of the Day Convection RGB product for the following domains

(annotate by ✓or x)

Beam	Channel	Range	Gamma	Gamma 2
Red	WV6.2 - WV7.3	-35 … +5 K	1.0	1.0
Green	IR3.9 – IR10.8	-5 … +60 K	0.5	1.0
Blue	NIR1.6 – VIS0.6	-75 … +25 %	1.0	1.0

d

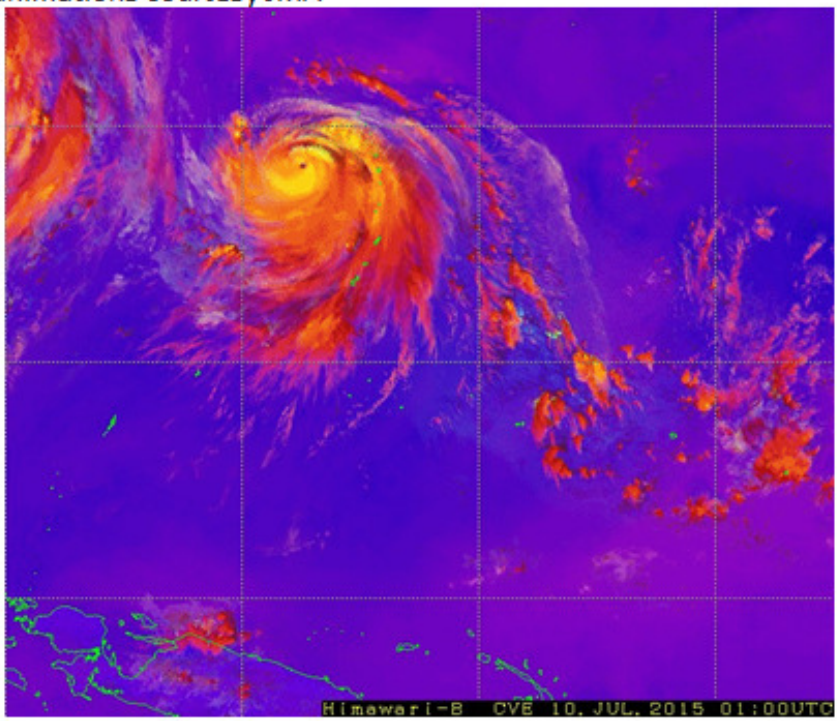


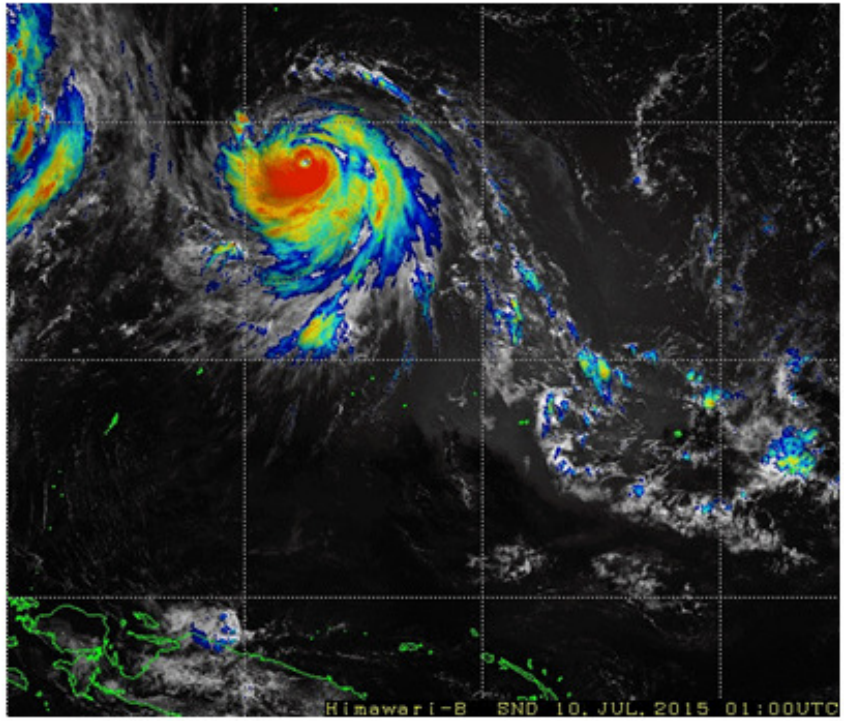
28th July 2015

- East Asia (summer)

Deep precipitating cloud (precip. not necessarily reaching the ground) - high-level cloud - large ice particles	Deep precipitating cloud (Cb cloud with strong updrafts and severe weather) Or thick, high-level lee cloudiness with small ice particles
Thin Cirrus cloud (large ice particles)	Thin Cirrus cloud (small ice particles)
Ocean	Land

animations courtesy JMA





Animation 3: Typhoon Nangka

10th July 2015

(Day Convection RGB Product / Sandwich Product)

Deep precipitating cloud (precip. not necessarily reaching the ground) - high-level cloud - large ice particles	Deep precipitating cloud (Cb cloud with strong updrafts and severe weather) Or thick, high-level lee cloudiness with small ice particles	Thin Cirrus cloud (large ice particles)	Thin Cirrus cloud (small ice particles)

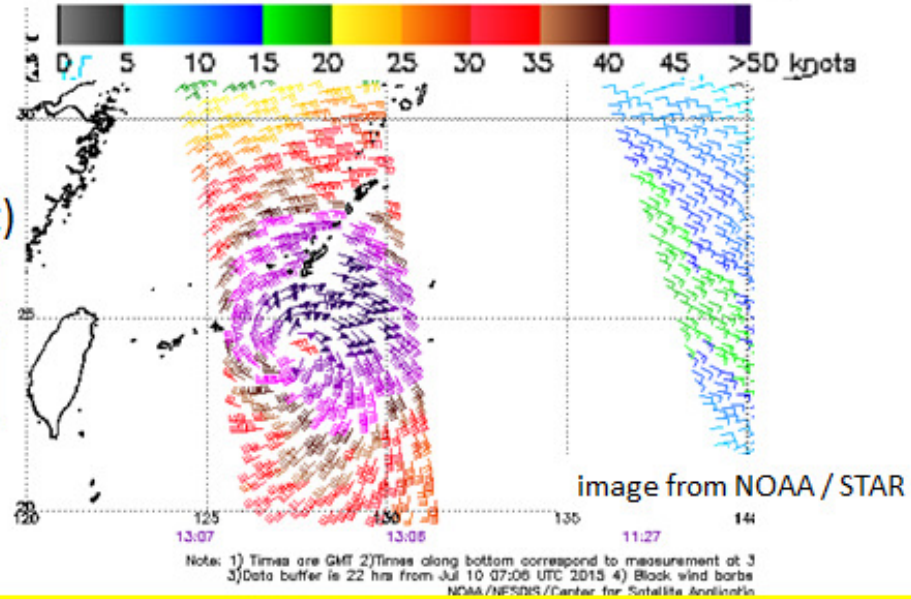


image from NOAA / STAR

Please start Animation 3

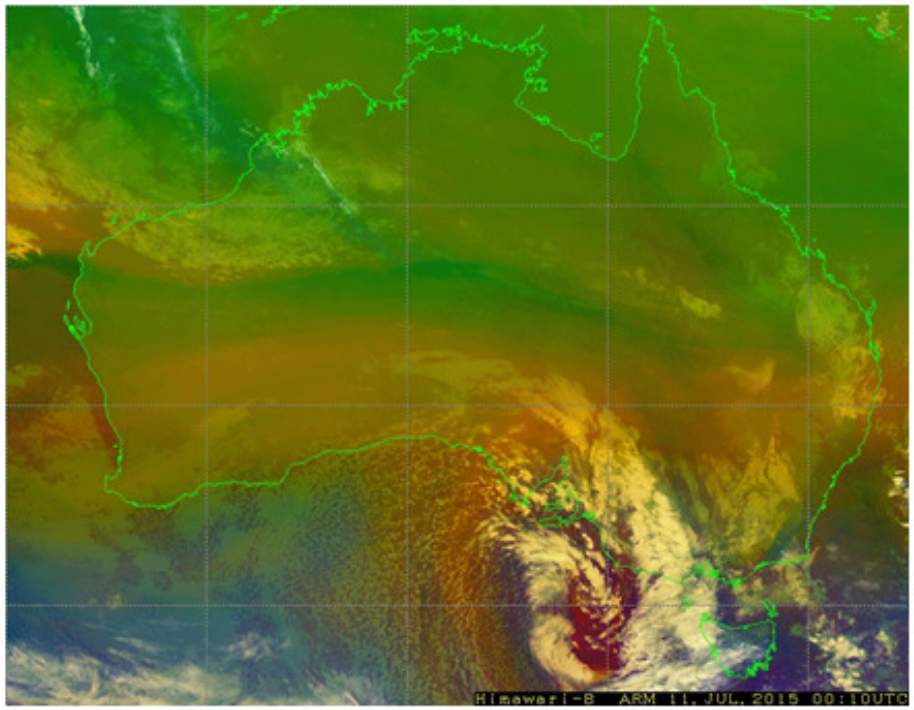
Notes on Severe Storm RGB product

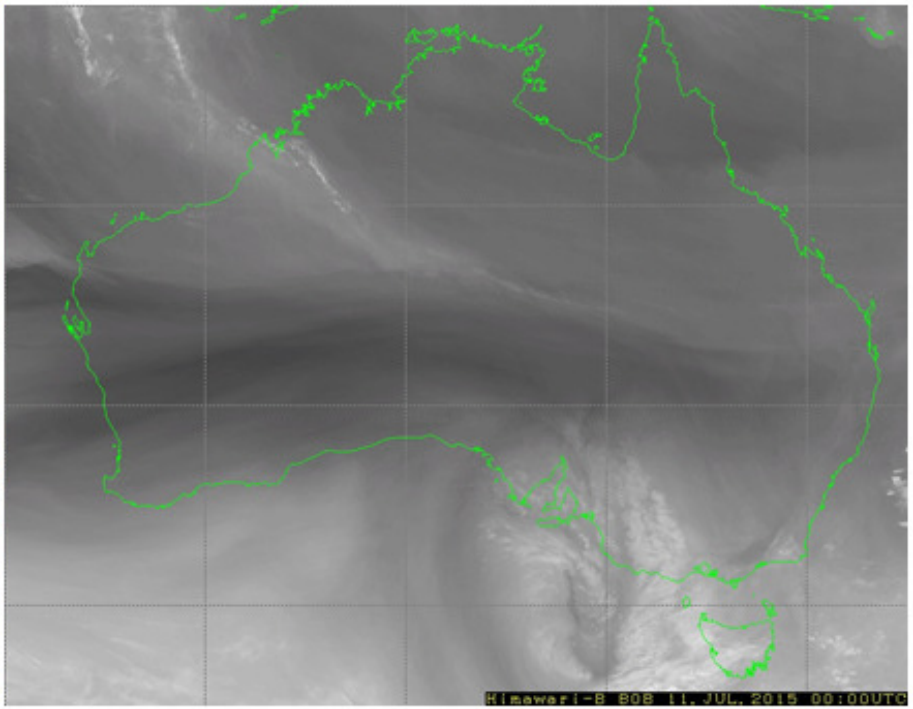
(J.Kerkmann pers. comm. July 20-015)

- As regards small / large ice in tropical cyclones, this is a very good question that has not been understood/answered yet. In the outer bands the small ice areas may be interpreted like in convective storms, but in the central part close to the eye, e.g. the CDO area, it is not clear how and why small ice particles are formed there. The updraft mechanism in TC centres is different from convective storms, but I am not an expert on this.

- I looked at a number of Atlantic hurricane cases (all hurricanes in MSG view between 2004 and 2010), and there are moments when blobs of small ice particles appear close to the centre of the storms - often followed by increasing strength of the hurricane, as defined by the category of the SS scale. One has to pay attention that yellow in the convection RGB not always comes from small ice but can simply be caused by very low temperatures.

- A problem with MSG looking at hurricanes over the Atlantic is that after about 18 UTC, the hurricanes are in the sunglint area of MSG (during JUL-AUG-SEP period), which strongly affects the IR3.9 channel and makes images useless (clouds become totally yellow in convection RGB). Note that sunglint is not only for the ocean surface but also from smooth high level clouds!!





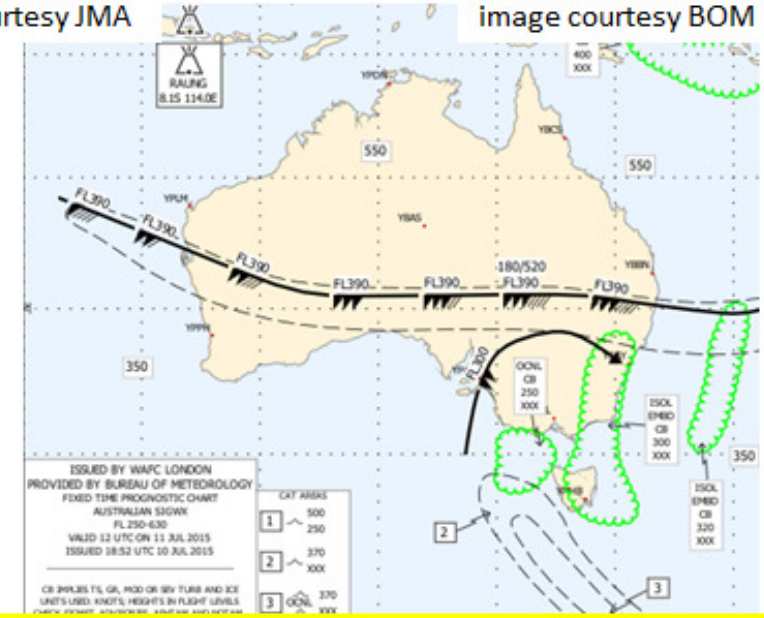
animations courtesy JMA

image courtesy BOM

Animation 4: Cold Outbreak SE Australia, 11th July 2015 00-17UTC

(Airmass RGB Product)

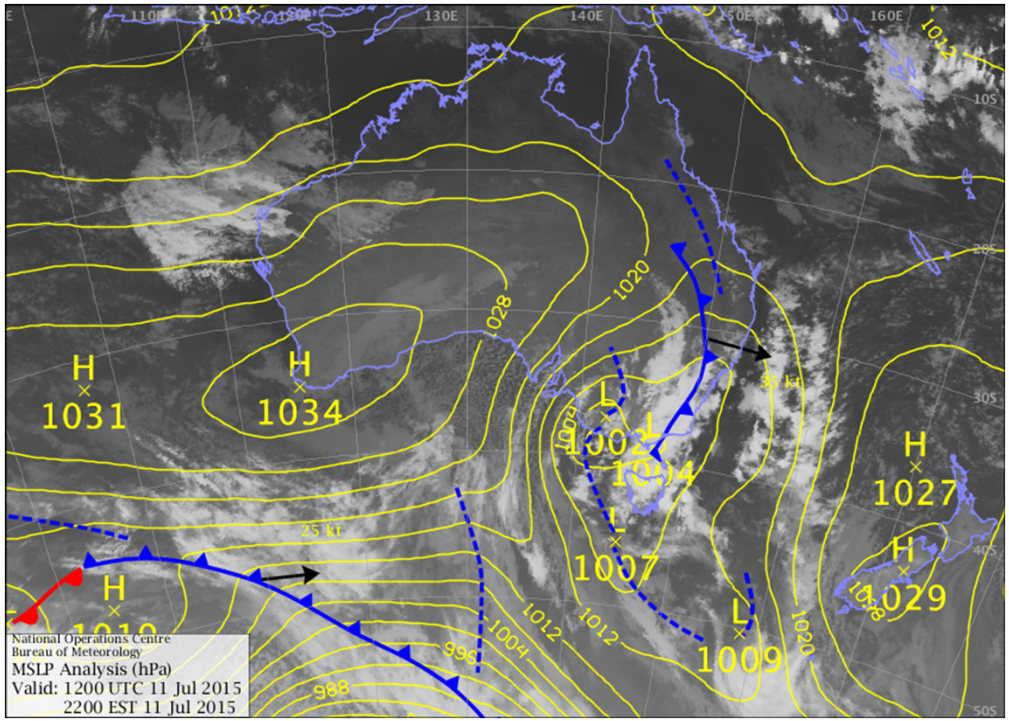
Thick, high-level clouds	Thick, mid-level clouds	Thick, low-level clouds (warm airmass)	Thick, low-level clouds (cold airmass)
Jet (high PV)	Cold Airmass	Warm Airmass	Warm Airmass



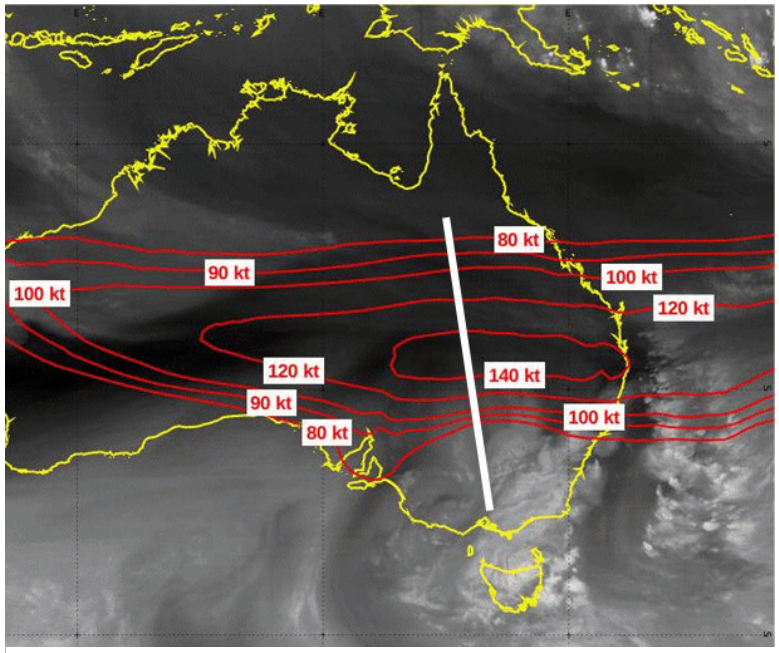
Please start Animation 4

Cold Outbreak SE Australia, 11th July 2015 00-17UTC –

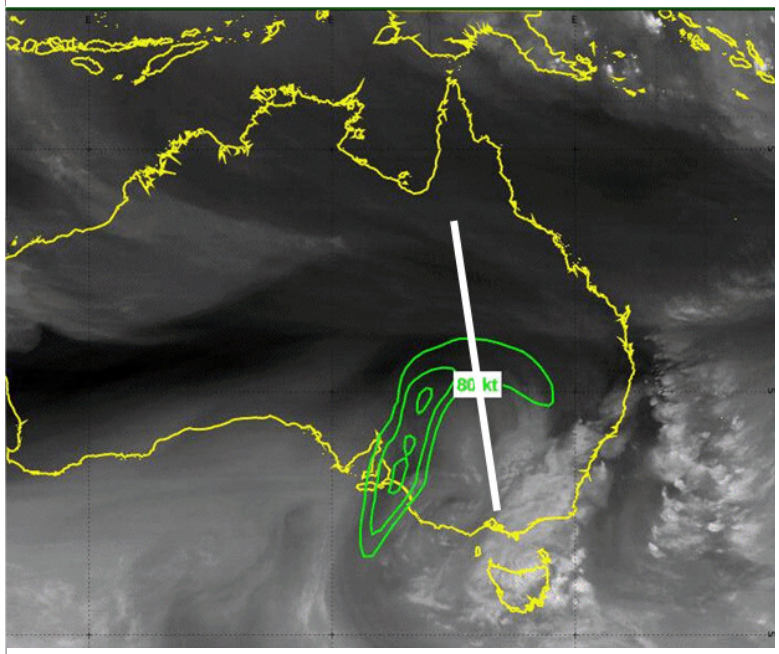
Polar Jet underneath Subtropical Jet?



images courtesy BOM/JMA

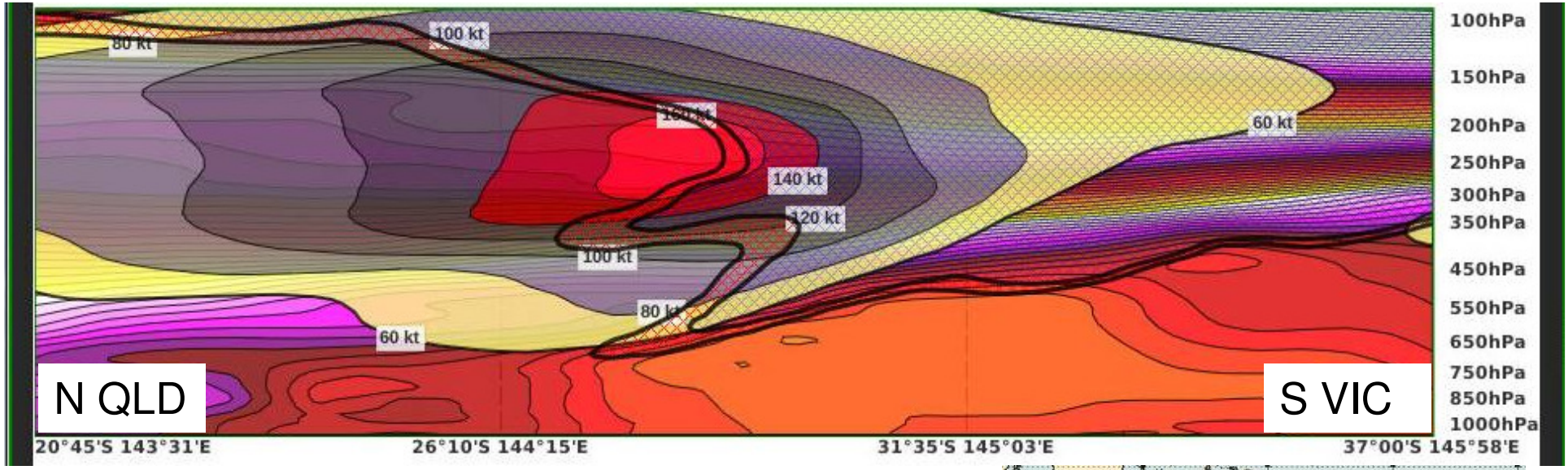


Isotachs, isentropic level Theta 340K

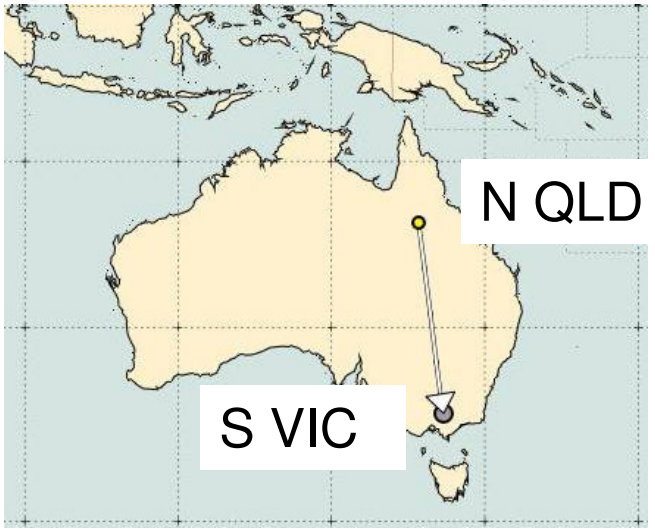


Isotachs, isentropic level Theta 310K

Cold Outbreak SE Australia, 11th July 2015 – Polar Jet underneath Subtropical Jet?



images courtesy BOM

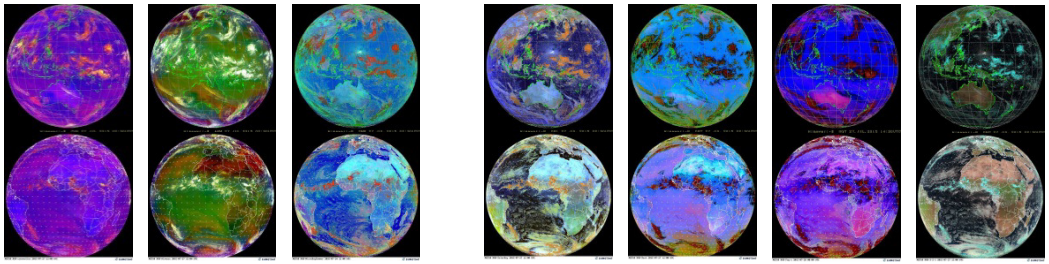


- Equivalent Potential Temperature
- Dynamical Tropopause (PV between -2 and -3PVU) annotated in bold black lines
- Isotachs (knots)

Australian Government
Bureau of Meteorology

Summary

- Have given a very brief introduction of RGB products and resources
- We have performed a "visual comparison" of Himawari-8 and METEOSAT-10 RGB products



- We have examined the Airmass RGB product and the Day Convection RGB product over different regions in the Australasia-Pacific region.
- Have shown some Himawari-8 product animations and compared these to existing satellite data and NWP.