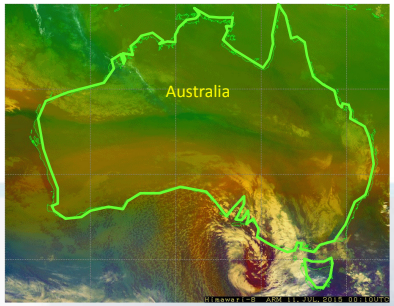
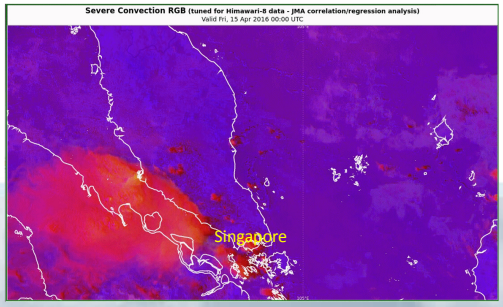
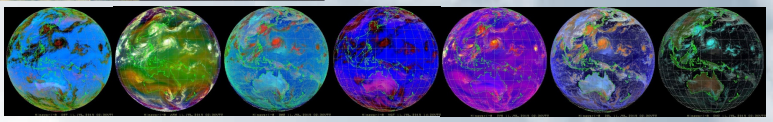
Australian Government
Bureau of Meteorology

Advanced Satellite Meteorology







Session 6: Training in the use of RGB products

Bodo Zeschke
Bureau of Meteorology Training Centre
Australian VLab Centre of Excellence

Advanced Satellite Meteorology Course

Session 1 8th May	Advanced training in the use of visible and infrared satellite imagery.
Session 2 9th May	Advanced training in the use of water vapour satellite imagery.
Session 3 15th May	Training in the use of microwave scatterometer data
Session 4 15th May	Training in the use of cloud drift wind data
Session 5 17th May	Training in the use of rapid scan data.
Session 6 19th May	**Training in the use of RGB products**
Practical sessions (17th and 19th May)	Practical sessions focus upon Rapid Scan and RGB Product data
2 hour exam (26th May)	**Open book exam with resources on latitude**

Australian Government
Bureau of Meteorology

Content of this session

The RGB products as endorsed by WMO as applied to Himawari-8

The Airmass RGB product and how it is constructed

- Interpretation of the RGB product using Himawari-8 examples

The Day Convection RGB product and how it is constructed

- Interpretation of the RGB product using Himawari-8 examples
- Comparing the Day Convection RGB product with the Sandwich Product

Advantages and limitations in using the RGB products, including BOM Forecaster feedback

Accessing RGB reference resources

Australian Government
Bureau of Meteorology

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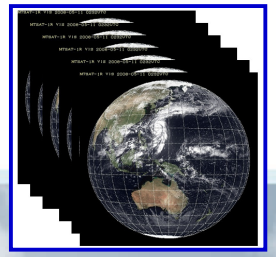
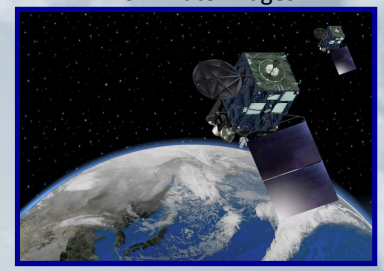
Himawari-8 capabilities

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

16 channels (Bands)



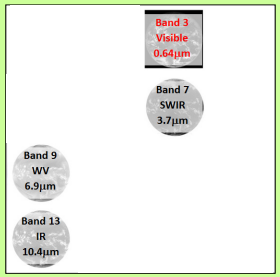
10 minute images



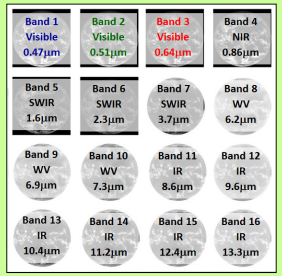
Himawari-8 image courtesy JMA

Himawari-8 data images courtesy JMA

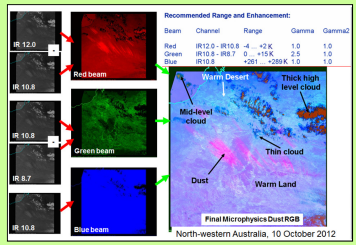
Options in displaying the 16 Himawari-8 channels



Option 1: use some of the channels only, ignore the rest



Option 2: use all of the channels



Option 3: combine channels in a meteorologically and physically meaningful way to produce products of large information content (RGB products)

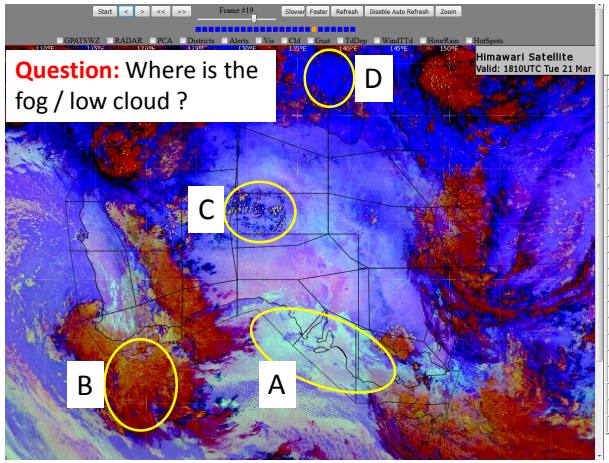
REFERENCE

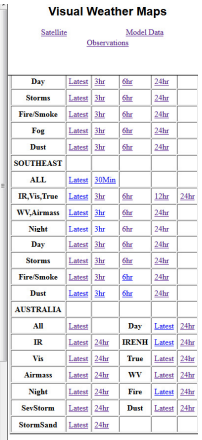
image courtesy JMA/BOM

Review from Basic Satellite Meteorology: The Night Microphysics RGB product

Peter Newham web page at

http://aifs-vic.bom.gov.au/rgn/local/SatLoops/SatelliteHome.html

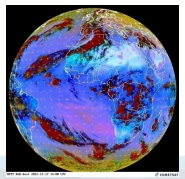




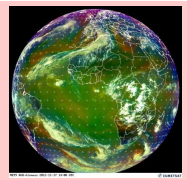
RGB products for Operational Forecasting as recommended by EUMETSAT

Australian Government
Bureau of Meteorology

Two RGB composites which complement each other



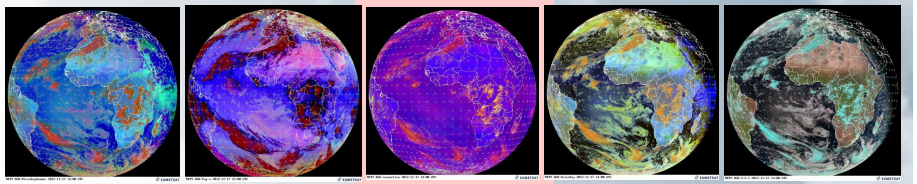
24 hour Microphysical RGB



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

EUMETSAT strategy of using RGB products – two "24-hour products" that are used all the time and five application specific RGB products.

At World Meteorological Organisation (WMO) level: agree on a strict minimum of harmonised RGB composites. The following strategies for the application of RGB products to the forecasting routine were outlined:

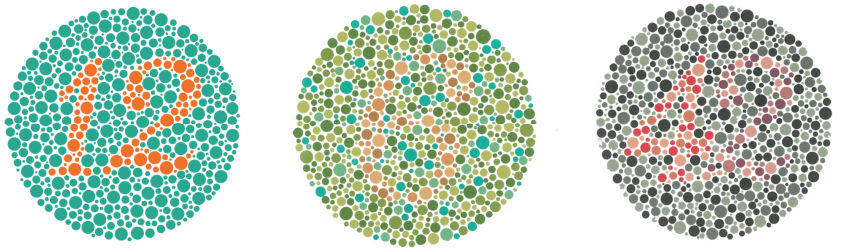
Two RGB composites which complement each other are used all of the time. These are the 24 hour Microphysics RGB and the Airmass RGB.

Five application specific RGB products (Day Microphysics RGB, Night Microphysics RGB, Day Convective Storm RGB, Day Snow-Fog RGB, Natural Colours RGB) are used selectively when appropriate.

REFERENCE

Intermission – Ishihara Vision Colour Deficiency assessment

What number do you see?



A: 12	A: 11	A: 2
B: 19	B: 6	B: 4
C: 11	C: 3	C: 42
D: Nothing. Just a smattering of dots	D: Nothing. Just a smattering of dots	D: Nothing. Just a smattering of dots

images from wikipedia

Australian Government
Bureau of Meteorology

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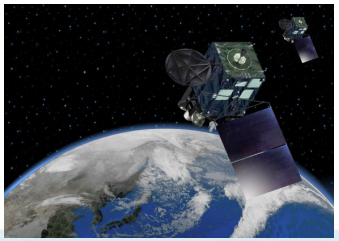
Accessing RGB reference resources

images courtesy JMA / Eumetsat

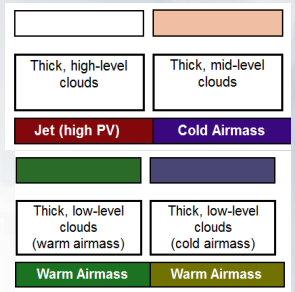
Processing of the Himawari-8 data – the Airmass RGB



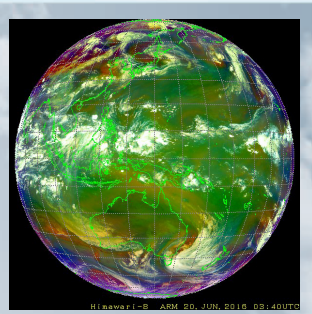
Himawari-8 channels

Airmass RGB	Range	Gamma
6.2 – 7.3 micron	-26.2 to 0.6	1.0
9.6 - 10.4 micron	-43.2 to 6.7	1.0
6.2 micron	243.9 to 208.5	1.0

CHANNEL COMBINATION (BOM/JMA recipe)



Colour interpretation palette



Himawari-8 RGB Composite

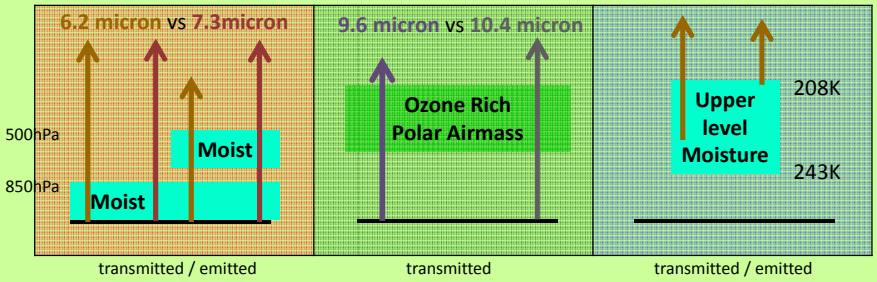
construction courtesy B.Zeschke BOM

REFERENCE

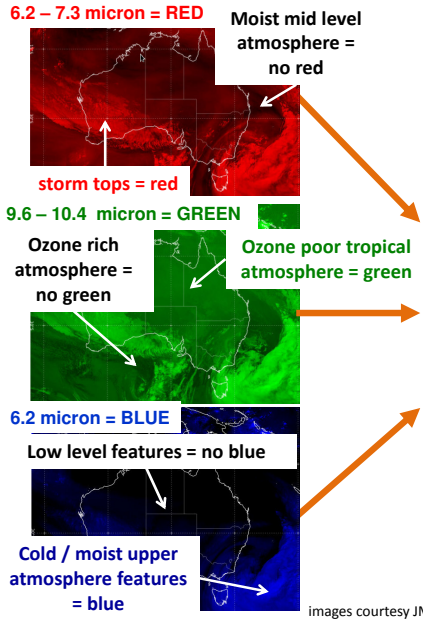
Channel combination recipe of the Airmass RGB

Recommended Range and Enhancement (EUMETSAT scaling)

Beam	Channel	Range	Gamma	Gamma 2
Red	WV6.2 – WV7.3	-25 … 0	1.0	1.0
Green	IR9.7 – IR10.8	-40 … +5	1.0	1.0
Blue	WV6.2	+243 … +208	1.0	1.0



The input beams that make up the Airmass RGB.



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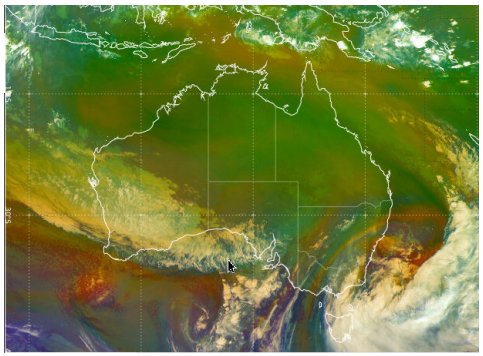


Australia, 20 June 2016 0820UTC, Himawari-8

images courtesy JMA/BOM

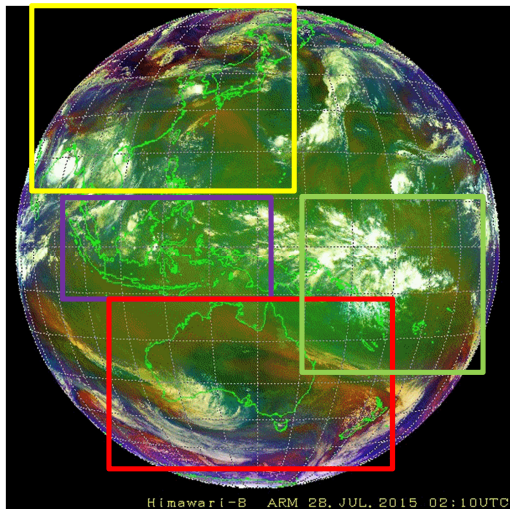
Channel combination recipe of the Airmass RGB

- **In the Red beam:** Due to the difference in the weighting functions for the 6.2 and 7.3 micron radiation, a strong signal in this beam corresponds to radiation emitted by high level clouds. An atmosphere that is moist below ~850hPa and very dry above this will also have a strong red beam component. However, if the atmosphere has moisture in the mid/upper levels of the atmosphere, the 6.2 micron radiation is absorbed more than the 7.3 micron radiation resulting in a weak contribution to the red beam.
- **In the Green beam:** The 9.7 micron channel is strongly absorbed by atmospheric ozone. Therefore an ozone poor tropical atmosphere will have a strong green beam component. An ozone-rich polar atmosphere will have a weak green beam component.
- **In the Blue beam:** The weighting function of the 6.2 micron channel has a maximum in the mid-upper levels of the troposphere (~200-500 hPa). The scaling of the beam ensures that cold and moist upper atmospheric features have a strong blue beam component. Low level and surface features have no contribution in the blue.

REFERENCE

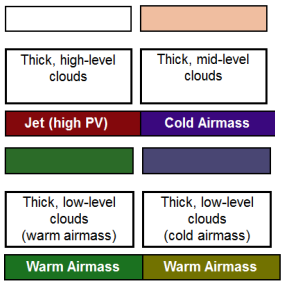
Assess the information content of the Airmass RGB product for the following domains (annotate by ✓or x)

animations courtesy JMA

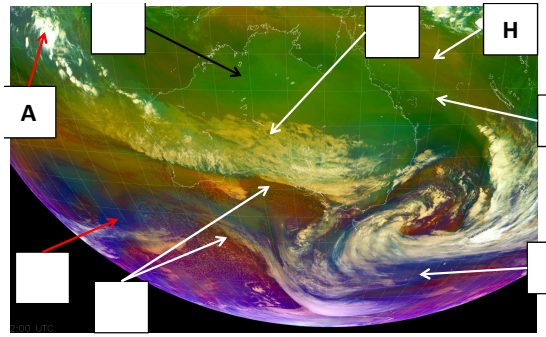


28th July 2015

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



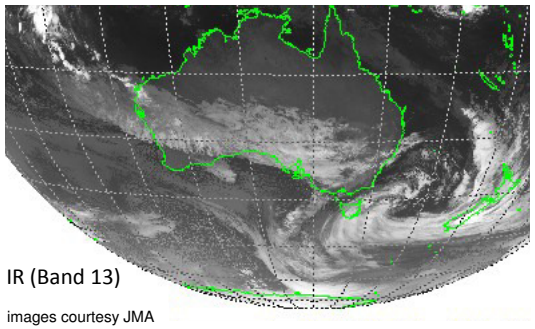
Please start the PowerPoint Slide Show to activate the animations



Exercise 1: The Airmass RGB – Himawari-8 data

Question: identify the features in the full disk image to the letter in the annotated palette

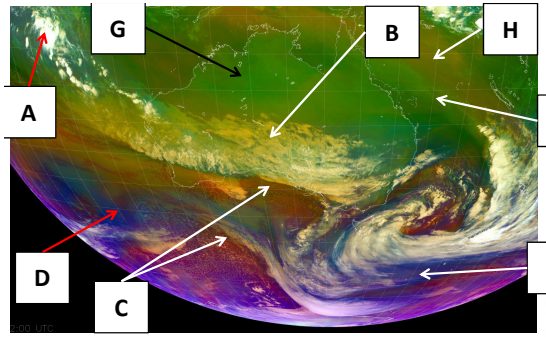
20th June 2016, 22UTC



IR (Band 13)

images courtesy JMA

A	B
Thick, high-level clouds	Thick, mid-level clouds
C Jet (high PV)	D Cold Airmass
E	F
Thick, low-level clouds (warm airmass)	Thick, low-level clouds (cold airmass)
G Warm Airmass	H Warm Airmass



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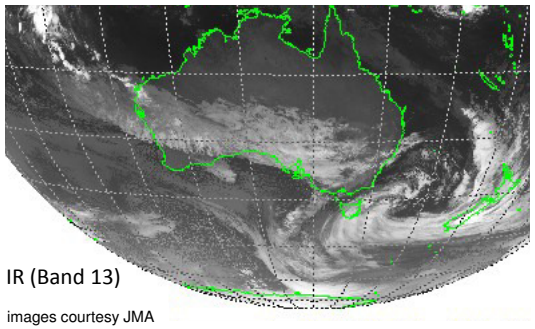

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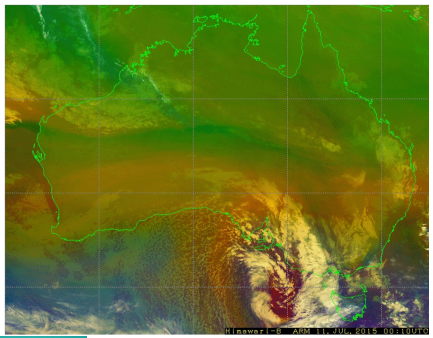
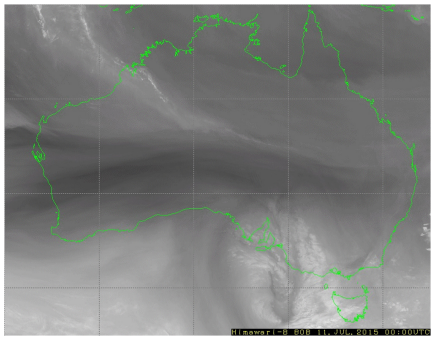




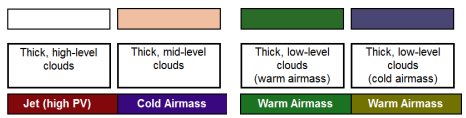
10 frames per second

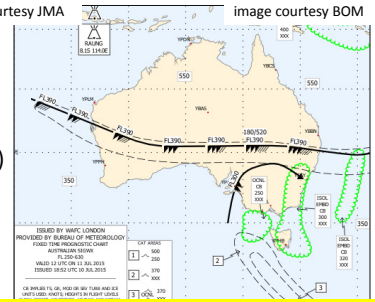
animations courtesy JMA

image courtesy BOM

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

(Airmass RGB Product vs 6.2 micron WV channel)

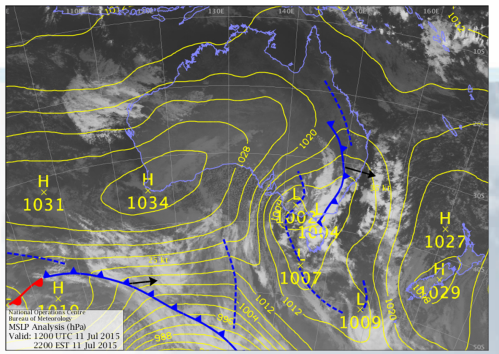




Please start the PowerPoint Slide Show to activate the animations

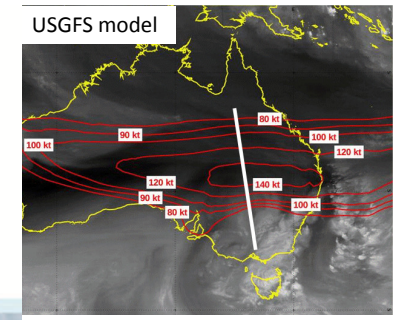
Cold Outbreak SE Australia, 11th July 2015 00-17UTC –

Polar Jet underneath Subtropical Jet?



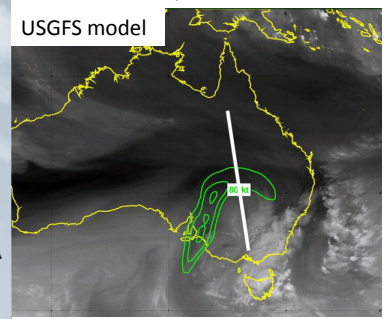
images courtesy BOM/JMA

USGFS model



Isotachs, isentropic level Theta 340K

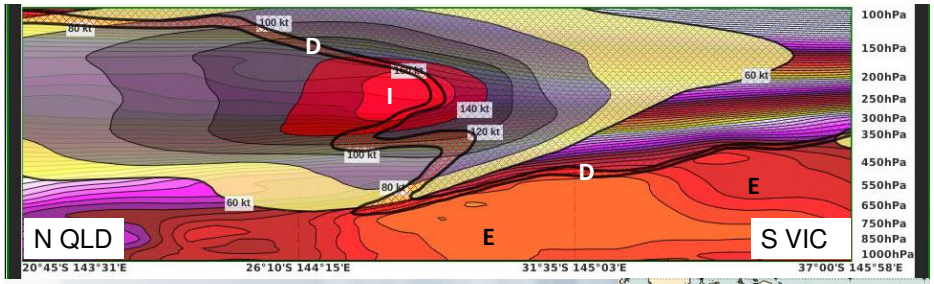
USGFS model



Isotachs, isentropic level Theta 310K

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

images courtesy BOM



USGFS model cross section, 12UTC 11th July 2015

- D = Dynamical Tropopause (PV from -2 to -3 PVU) annotated in bold black lines
- I = Isotachs (knots) show the cross section of the jets
- E = Equivalent Potential Temperature (below the jets)

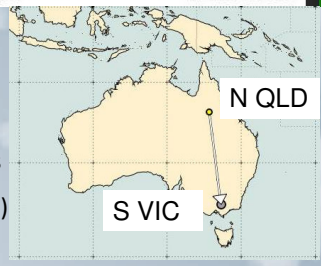
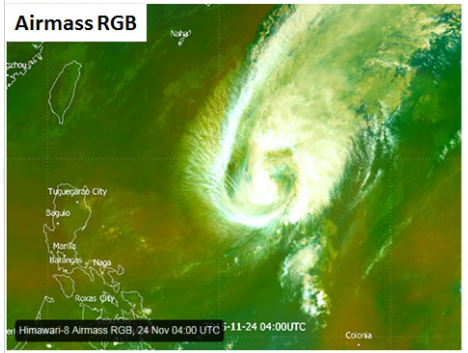


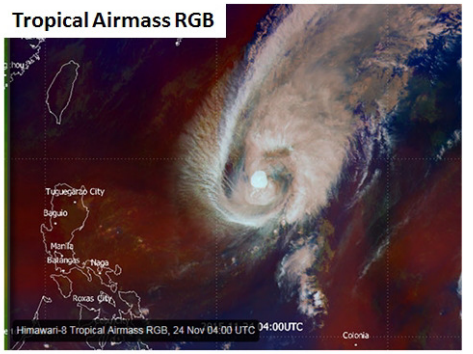
image courtesy BOM

Airmass RGB product – normal vs tropical version

(Typhoon In-fa, 24 November 2015, 04UTC)

image courtesy EUMETSAT





	Red (WV6.2-WV7.3)	Green (IR9.6–IR10.4)	Blue (WV6.2)
Airmass RGB	-25 to 0 K	-40 to +5 K	+243 to +208
Tropical Airmass RGB	-25 to 0 K	-25 to +25 K	+243 to +208

Note: EUMETSAT version of the Airmass RGB given here

Airmass RGB product – normal vs tropical version

(Typhoon In-fa, 24 November 2015, 04UTC)

The standard Airmass RGB shows cold, high-level clouds in a strong white colour, which is a result of selected ranges that over-enhance high, cold clouds, thus not allowing viewers to easily distinguish features like overshooting tops, radial cirrus or gravity waves.

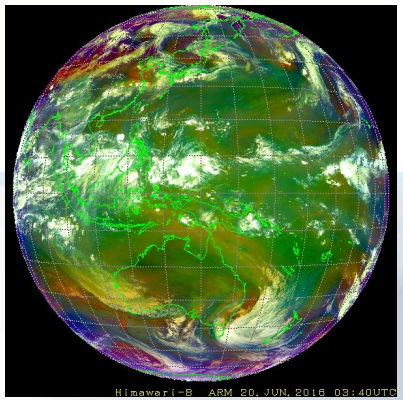
The 'tropical' Airmass RGB alleviates this problem by using ranges more appropriate for cold, high clouds. In particular, for the green range (IR9.6–IR10.4) it uses a range from -25 to +25 K (instead of -40 to +5 K). This makes this RGB very suitable for detecting overshooting tops (white). Also see the large overshooting 'dome' in the centre of typhoon In-fa.

For more information please look at the web link at
http://www.eumetsat.int/website/home/Images/ImageLibrary/DAT_2861499.html

REFERENCE

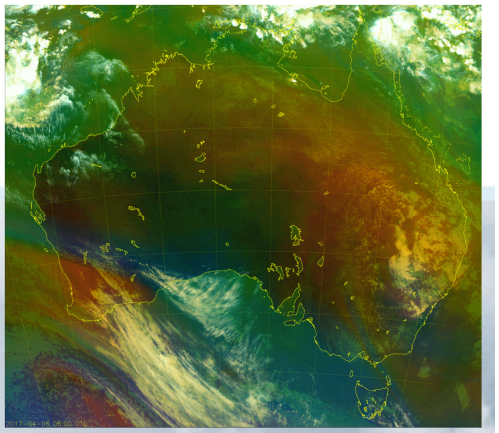
Airmass RGB complications

Image from JMA



Limb cooling effect
enhanced ozone absorption
Himawari-8
20 June 2016
0340UTC

animation from CIRA/JMA



Variations in land surface temperatures (cloud free areas)
Himawari-8 Australian region 6th April 2017

Summary – the Airmass RGB product (1)

from https://www.meted.ucar.edu/satmet/multispectral_topics/rgb/print.htm

The Air Mass RGB is designed and tuned for monitoring the evolution of cyclones, in particular, rapid cyclogenesis, jet streaks, and potential vorticity (PV) anomalies. Since the product relies heavily on infrared channels in the water vapor and ozone absorption regions of the spectrum, it provides information primarily about the middle and upper levels of the troposphere, not so much the lower levels and near-surface conditions.

Advantages:

- Can see important boundaries between air masses, such as tropical and polar, at a glance; these are often invisible on single channel images
- Helps detect the position of jet streams and areas of dry, descending stratospheric air with high PV; these appear in red
- Can detect features commonly seen in water vapor images, such as deformation zones, wave features, and PV anomalies
- The infrared channels make it possible to monitor cloud development at low, middle, and high altitudes

REFERENCE

Summary – the Airmass RGB product (2)

from https://www.meted.ucar.edu/satmet/multispectral_topics/rgb/print.htm

Limitations:

- Air masses are only detectable in areas free of high cloud cover
- Tends to depict conditions in the middle and upper troposphere, but not at the surface
- At the edge of the Earth's disk, air masses can have a magenta color but this does not represent true air mass characteristics, rather limb darkening/cooling due to the large satellite viewing angles

REFERENCE

Bureau forecaster feedback regarding the use of the Airmass RGB product

- The Airmass RGB product loads relatively quickly as the IR channels composing the RGB are smaller in size than the visible channel.
- "I have been looking at this RGB product for some time and one day it all came together. Viewing and animation of the Airmass RGB product I was amazed to see the 3-dimensionality of the atmosphere – the clouds at different levels within the warm and cold airmasses and the flow of the atmosphere revealed.."
- The detection of ozone –rich and high PV intrusions of stratospheric air in the vicinity of jetstreams helps to identify these.
- Tropical Forecasters find this product of limited use.

REFERENCE

Australian Government
Bureau of Meteorology

Content of this session

The RGB products as endorsed by WMO as applied to Himawari-8

The Airmass RGB product and how it is constructed

- Interpretation of the RGB product using Himawari-8 examples

The Day Convection RGB product and how it is constructed

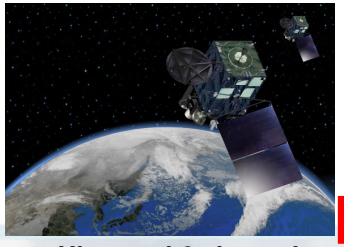
- **Interpretation of the RGB product using Himawari-8 examples**
- **Comparing the Day Convection RGB product with the Sandwich Product**

Advantages and limitations in using the RGB products, including BOM Forecaster feedback

Accessing RGB reference resources

images courtesy JMA

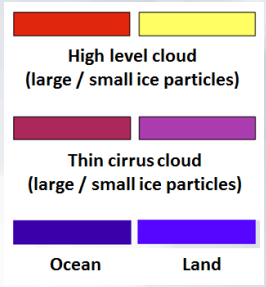
Processing of the Himawari-8 data – the Day Convection RGB



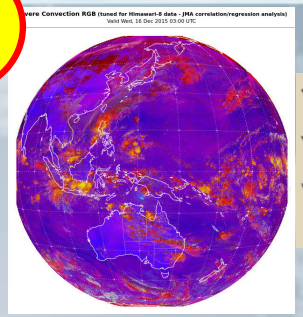
Himawari-8 channels

Day Convection RGB	Range	Gamma
6.2 – 7.3 micron	-35 to 5	1.0
3.9-10.4 micron	-5 to 60	0.5
1.6-0.6 micron	-75 to +20%	1.0

CHANNEL COMBINATION (mid-latitude EUMETSAT recipe)



Colour interpretation palette



Himawari-8 RGB Composite

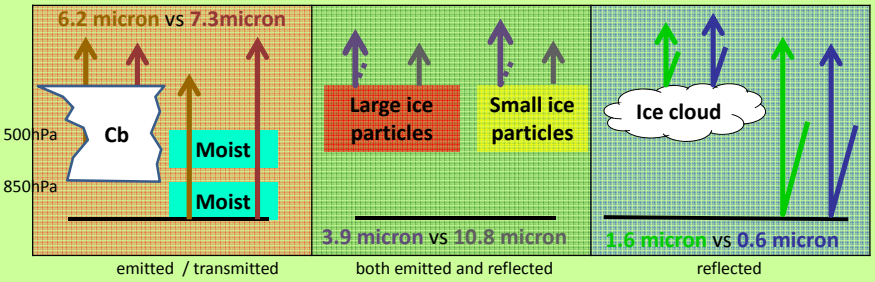
construction courtesy B.Zeschke BOM

Channel combination recipe of the Day Convection RGB

REFERENCE

Recommended Range and Enhancement (EUMETSAT scaling)

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



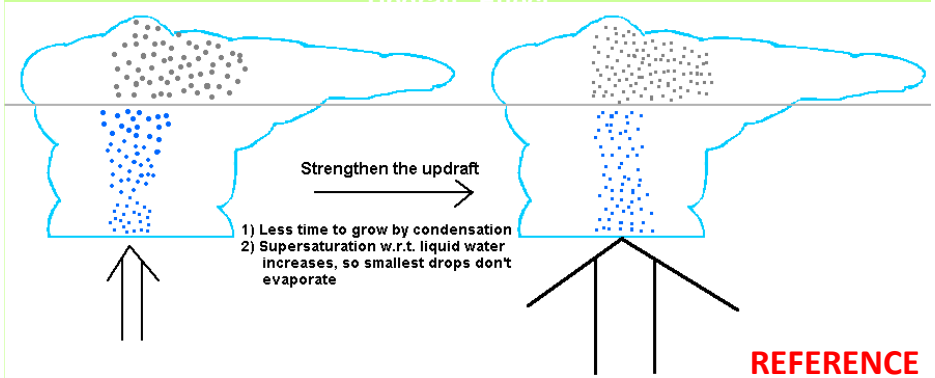
Channel combination recipe of the Day Convection RGB

- **In the RED beam:** Due to the difference in the weighting functions for the 6.2 and 7.3 micron radiation, a strong signal in this beam corresponds to radiation emitted by high level clouds, especially stormtops. If the atmosphere has significant moisture in the mid/upper levels of the atmosphere, the 6.2 micron radiation is absorbed more than the 7.3 micron radiation resulting in a weak contribution to the red beam. If the atmosphere is dry in the mid/upper levels then there will be a reasonable signal in this beam
- **In the Green beam:** The 3.9 micron radiation includes the reflectivity (albedo) component in the Tbb. This is greater for small water droplet clouds and for small ice crystals. Therefore there is a large contribution to the green beam for small ice particles at and above stormtop level. This situation can correspond to strong storm updraft and may therefore indicate storm severity (see next slide).

REFERENCE

- **In the Blue beam**: Ice particles strongly absorb the 1.6 micron radiation. According to the scaling of this beam ice clouds will have little or no signal in this beam. The surface of the earth generally has a strong signal in this beam.

The relation between the strength of the storms updraft and the size of ice crystals at storm top



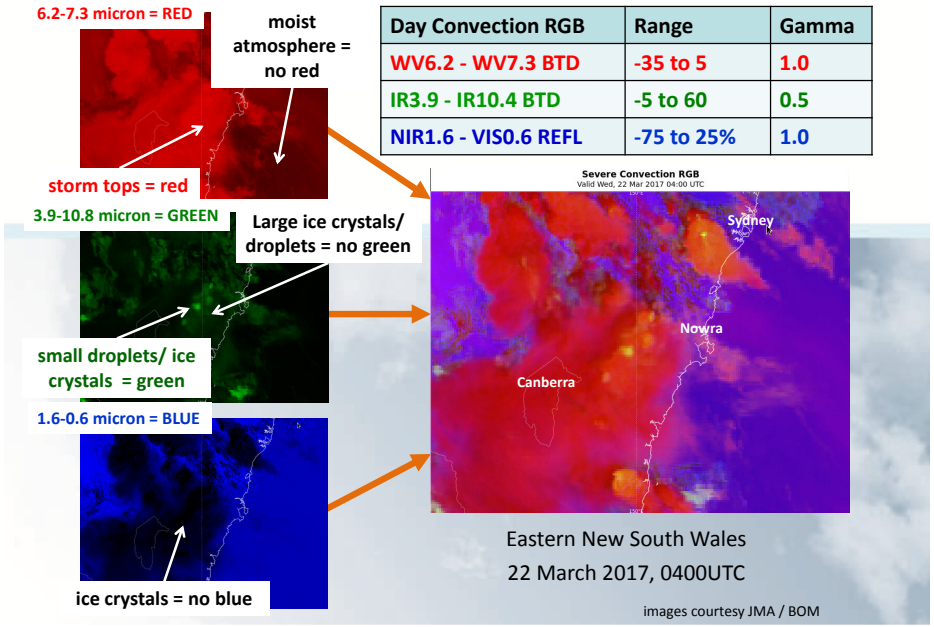
REFERENCE

This idea follows from results from multiple papers by D. Rosenfeld, and Heymsfield et al. (2005)

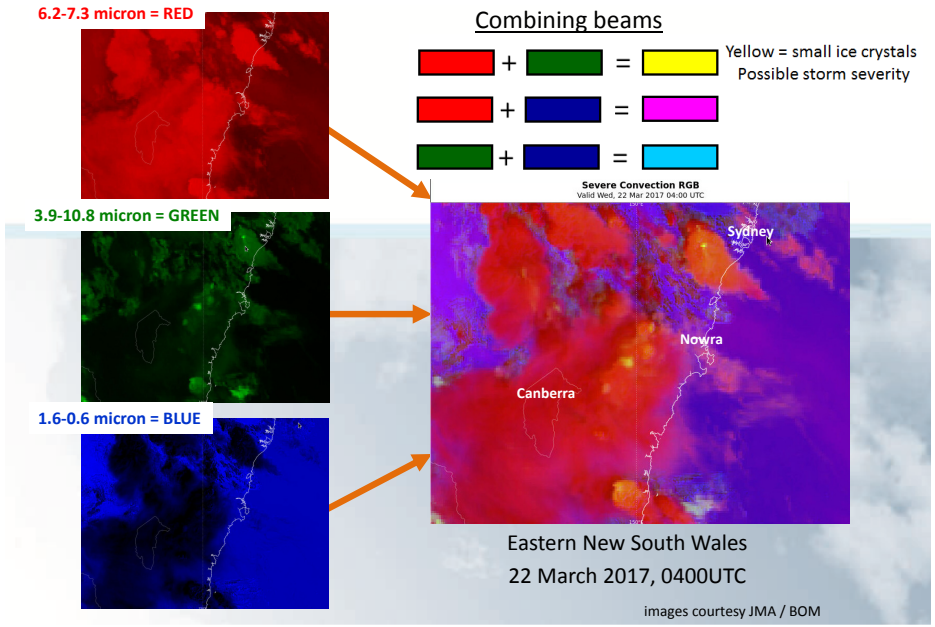
from "UNDERSTANDING CONVECTIVE CLOUDS THROUGH THE EYES OF (MSG): Cloud Particle Size". J.Kerkmann EUMETSAT

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

Day Convection RGB	Range	Gamma
WV6.2 - WV7.3 BTD	-35 to 5	1.0
IR3.9 - IR10.4 BTD	-5 to 60	0.5
NIR1.6 - VIS0.6 REFL	-75 to 25%	1.0

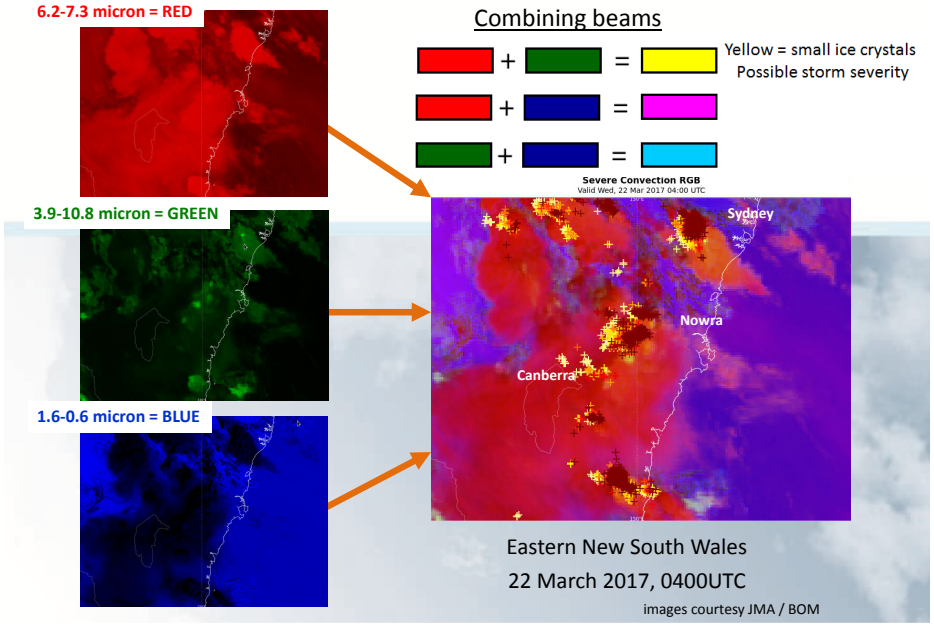


The input beams that go to make up the Day Convection RGB.



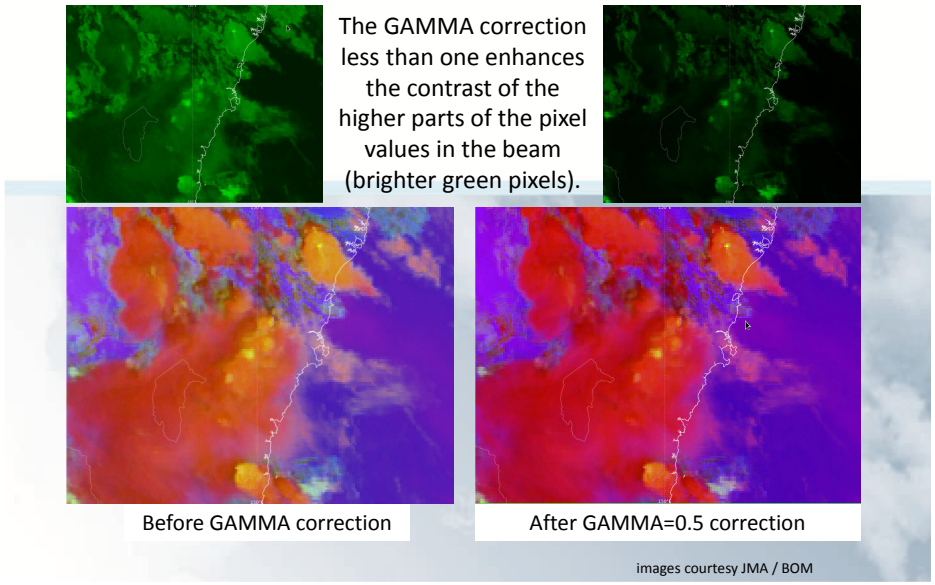
lightning data courtesy WeatherZone

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

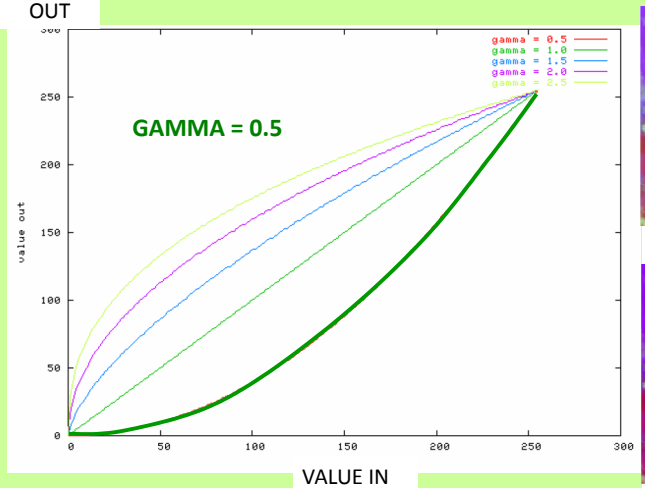


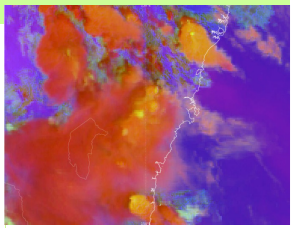
GAMMA Correction of 0.5 applied to the Green Beam

Eastern New South Wales 22 March 2017, 0400UTC

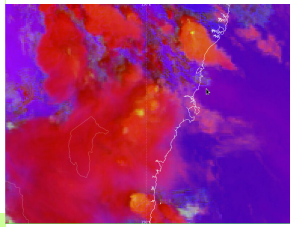


GAMMA Correction applied





Before GAMMA correction



After GAMMA correction

The GAMMA enhancement. GAMMA=0.5 applied to a Day Convective RGB enhancement for the New South Wales case study. Top, without GAMMA, bottom with GAMMA = 0.5.

REFERENCE

images courtesy JMA / BOM

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 Dust RGB shows that a much more "colour balanced" image is produced. Much of the strong red colour overtones are removed.

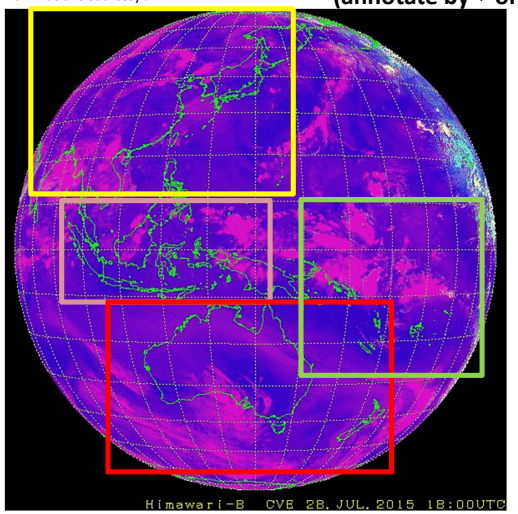
- For more information please see http://oiswww.eumetsat.int/~idds/html/doc/best_practices.pdf

REFERENCE

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

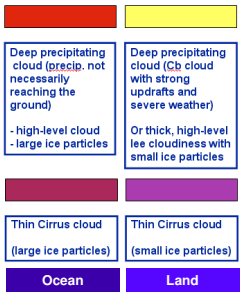
(annotate by ✓or x)

animations courtesy JMA



28th July 2015

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

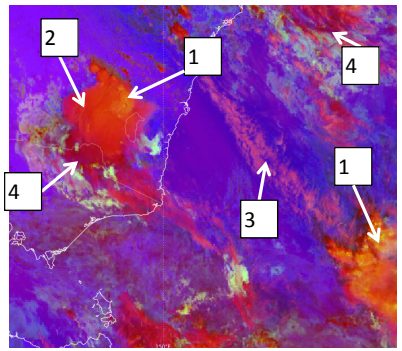


Please start the PowerPoint Slide Show to activate the animations

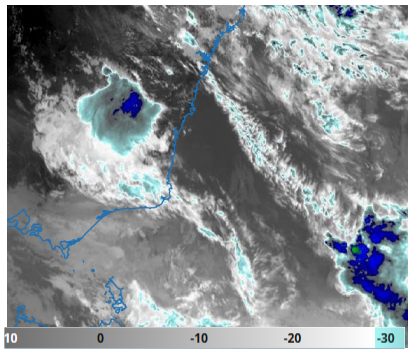
image courtesy JMA/BOM

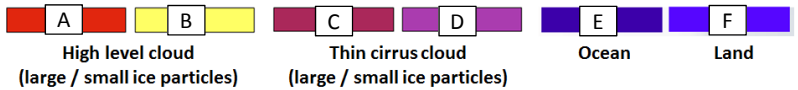
Exercise 2: Day Convection RGB product feature identification

Day Convection RGB, SE Australia 22 March 02UTC



Zehr Enhanced IR, 02UTC





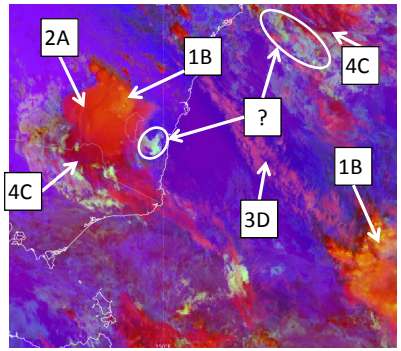
Using the palette and also referring to the enhanced IR imagery:

- Identify various features in the imagery.
- Are there any features that are not well captured by the palette?

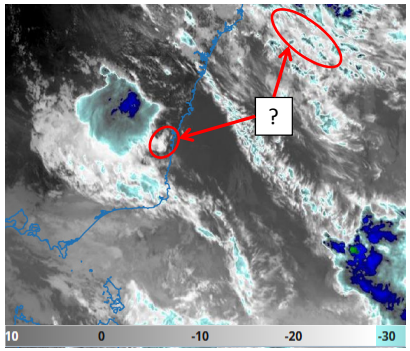
image courtesy JMA/BOM

Exercise 2: Day Convection RGB product feature identification

Day Convection RGB, SE Australia 22 March 02UTC



Zehr Enhanced IR, 02UTC



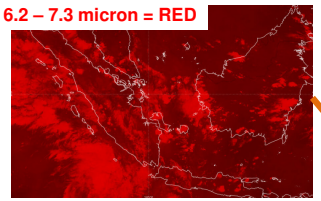
High level cloud (large / small ice particles) | Thin cirrus cloud (large / small ice particles) | Ocean | Land

Using the palette and also referring to the enhanced IR imagery:

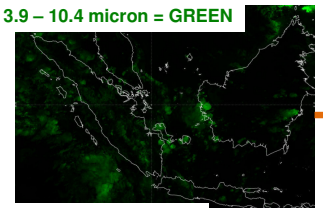
- Identify various features in the imagery.
- Are there any features that are not well captured by the palette?

Tropical tuned Day Convection RGB (EUMETSAT recipe of J.Kerkmann).

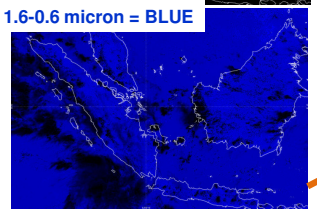
6.2 – 7.3 micron = RED



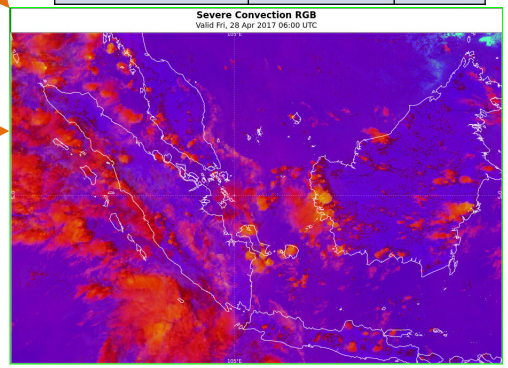
3.9 – 10.4 micron = GREEN



1.6-0.6 micron = BLUE



Day Convection RGB	Range	Gamma
6.2 – 7.3 micron	-35 to 5	1.0
3.9-10.4 micron	-5 to 75	0.5
1.6-0.6 micron	-75 to +20%	1.0



Singapore area, 26 April 2017 0600UTC, Himawari-8 images courtesy BOM/JMA

Additional notes pertaining to the Day Convection RGB product (correspondence with Jochen Kerkmann, EUMETSAT)

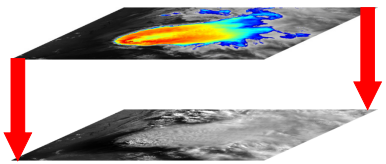
- The green range of the convection RGB should be increased to -5 to +75 K, for tropical conditions (cold cloud tops).
- The convection RGB only sees high level clouds, so it is not useful for monitoring low level features like outflow boundaries.
- The yellow colour of convective clouds is most important for very new storms. That is , in the Day Convection RGB we monitor in particular the colour of the Cb in its very beginning when it glaciates. The later stages, when the anvil grows and small and large ice particles mix, are less interesting. Certainly new convective towers can shoot up through the anvil – which then have to be monitored.

REFERENCE

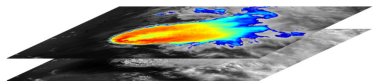
The "Sandwich Product" (Martin Setvak CHMI)

Modification by BOM staff, including Operational Forecasters and B.Zeschke

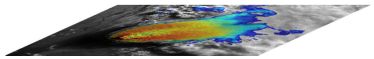
Upper layer: IR10.4 BT image

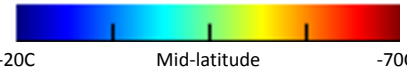


Bottom layer ("background"): HRV image

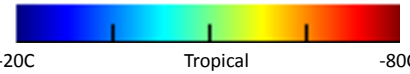


Blending options – applied to the upper layer





scale as adapted from Australian Bureau of Meteorology forecasters



Upper layer opacity set to 50%

Underlying High resolution visible channel:
Contrast 400%
Brightness -170%

adapted from "Satellite Observations of Storm Tops (part 1)" Martin Setvak, Czech Hydrometeorological Institute
http://www.eumetsat.int/website/home/Data/Training/TrainingLibrary/DAT_2042885.html

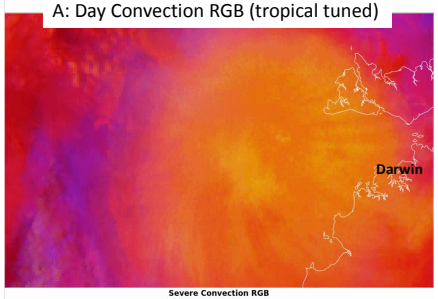
animations courtesy JMA/BOM **Please start the Power Point Slide Show to activate the animation**

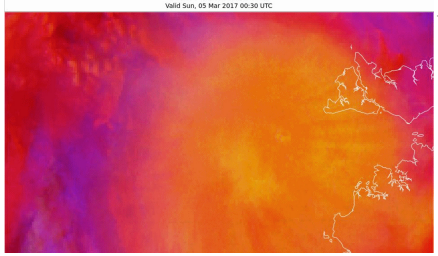
Example - Day Convection RGB / Sandwich product variations

lightning data courtesy GPATS

TC Blanche convection 5th March 2017, 0030 to 0230 UTC

A: Day Convection RGB (tropical tuned)

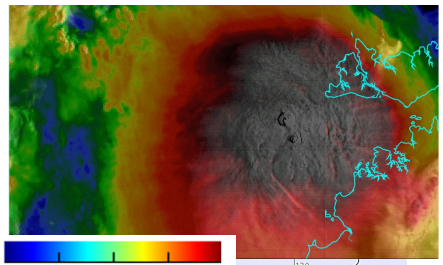


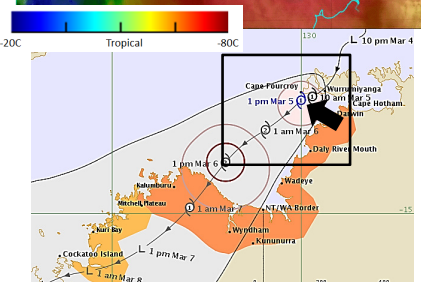


C: Day Convection RGB (tropical tuned and lightning)

B: Enhanced Sandwich Product

Brightness -170%, Contrast 400% for HRVIS. Transparency of enhanced IR as 50%

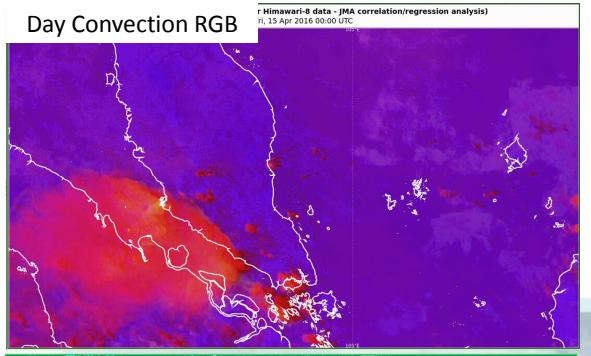


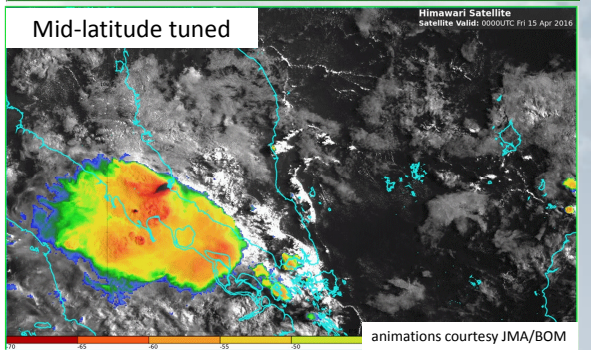


Tropical Cyclone Threat Map

Threat map courtesy BOM

Day Convection RGB





animations courtesy JMA/BOM

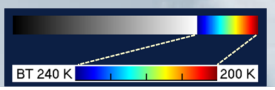
High level cloud
(large / small ice particles)

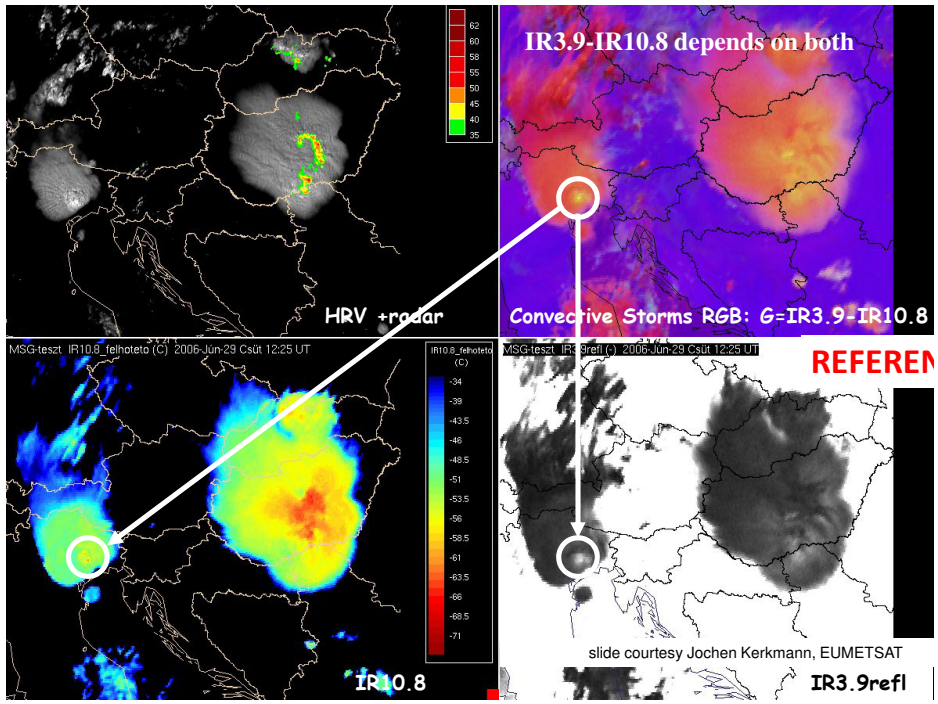
Thin cirrus cloud
(large / small ice particles)

Ocean Land

Comparing Sandwich Product with Day Convection RGB

Question: which product do you prefer, and why?





slide courtesy Jochen Kerkmann, EUMETSAT

Day Convection RGB product use

(correspondence with Jochen Kerkmann, EUMETSAT)

The Day Convection RGB product is most useful in detecting the initial stages of the development of severe thunderstorms with small ice crystals spewing out of their tops.

There is an example of this shown in the illustration below.

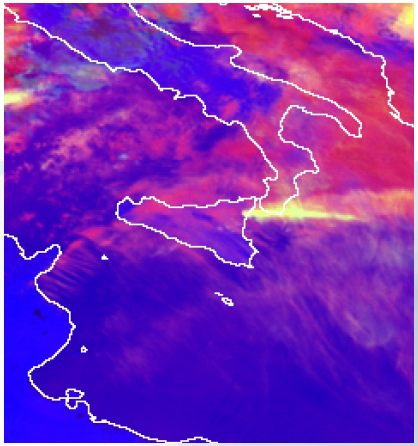
In this example the westernmost storm over Italy was the most severe storm.

On the other hand the enhanced IR image indicated colder cloud top temperatures over the eastern storm over Hungary. See also http://www.eumetsat.int/website/home/Images/ImageLibrary/DAT_IL_06_06_29.html

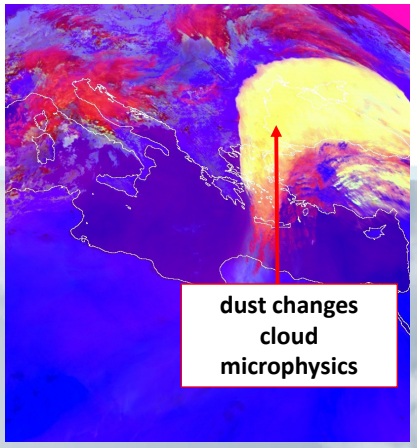
REFERENCE

Limitations in the Day Convection RGB product

RGB Products Overview (RGB Tutorial), J.Kerkmann, Eumetsat 2012



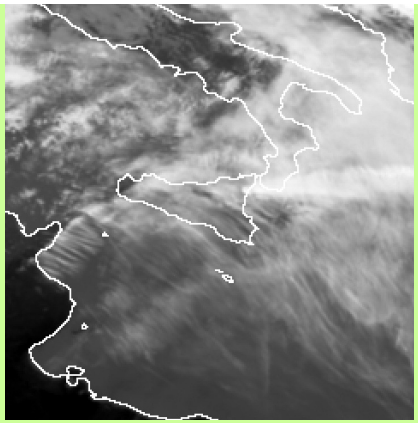
Lee cloudiness – Sicily



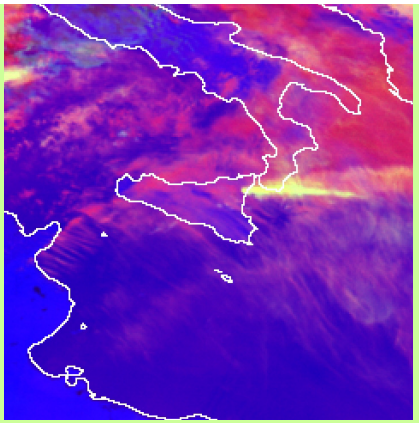
Meteosat-9, 23 March 2008, 12:00 UTC

Limitations in the Day Convection RGB product

Lee cloudiness – Sicily



Infrared image



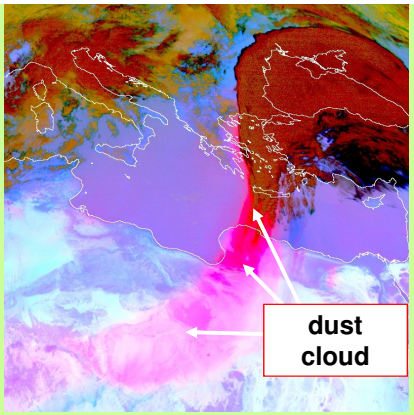
Convection RGB

RGB Products Overview (RGB Tutorial), J.Kerkmann, Eumetsat 2012

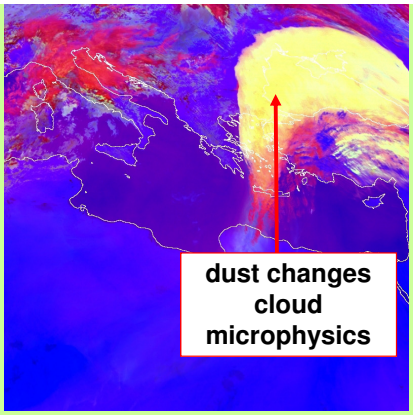
REFERENCE

Limitations in the Day Convection RGB product

Coloured rain - Bulgaria



Dust RGB

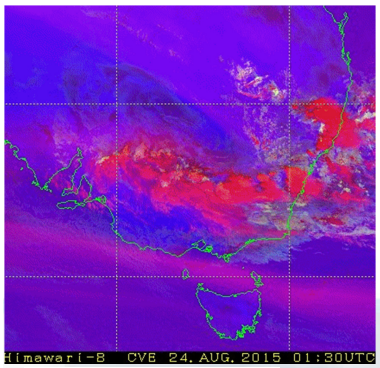


Convection RGB

Meteosat-9, 23 March 2008, 12:00 UTC

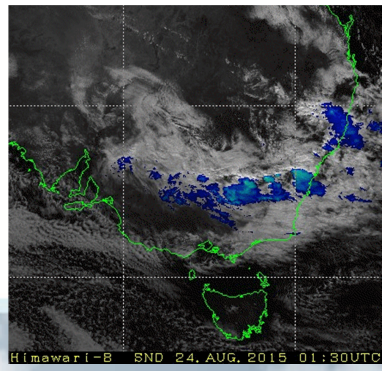
RGB Products Overview (RGB Tutorial), J.Kerkmann, Eumetsat 2012

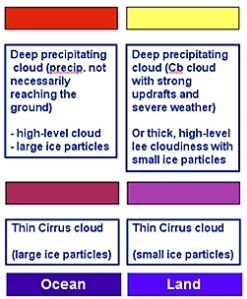
REFERENCE



animations courtesy JMA

Winter-time Severe Storms New South Wales, 24th August 2015





Himawari-8 Day Convection RGB product (top left) and Sandwich product (top right)

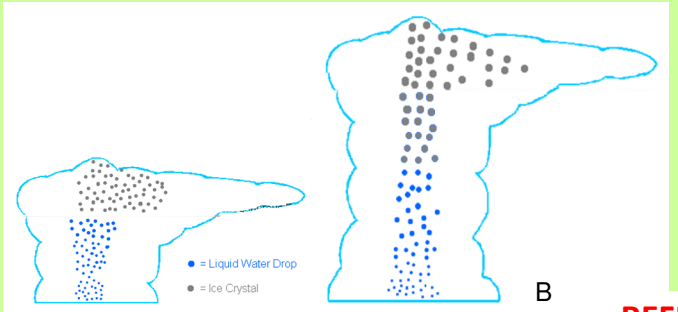
Impact of the storms:

- Large hailstones
- Damaging winds (above 90km/hr)
- Heavy rainfall (170+mm in 24hours for some locations)
- Tornado near Dubbo (NSW)

Please start the Power Point Slide Show to activate the animation

Limitations in the Day Convection RGB product

„Higher tropopause“ Effect



A B

REFERENCE

A	Small ice crystals – highly reflective. STRONG signal in 3.9 micron channel	Cold cloud tops. WEAK signal at 10.8 microns	T3.9-T10.8 = **LARGE**
B	Larger ice crystals – less reflective MODERATE signal at 3.9 microns	Very cold cloud tops. VERY WEAK signal at 10.8 microns	T3.9-T10.8 = **LARGE**

Modified from UNDERSTANDING CONVECTIVE CLOUDS THROUGH THE EYES OF (MSG): Cloud Particle Size. J.Kerkmann EUMETSAT

The Day Convection RGB – summary (1)

from https://www.meted.ucar.edu/satmet/multispectral_topics/rgb/print.htm

Advantages:

- Compared to many satellite images, this RGB highlights the youngest and most intense cells, showing overshooting thunderstorm tops, which can help distinguish new convection from dissipating convective activity.

Limitations:

- Daytime only, requires solar reflectance information
- Not effective for observing or discriminating types of weather other than convection
- Yellow is indicative of small ice particles. Small ice particles can form in non-severe Cb clouds:
  - in Cb clouds with cold (high) cloud base (short time from cloud base to spontaneous freezing level)
  - Pileus cloud on top of developing thunderstorms. These thunderstorms need not necessarily be severe.

REFERENCE

Also from UNDERSTANDING CONVECTIVE CLOUDS THROUGH THE EYES OF (MSG): Cloud Particle Size. J.Kerkmann EUMETSAT

The Day Convection RGB – summary (2)

Limitations (cont):

- Yellow is indicative of small ice particles. Small ice particles can occur in areas where there are no cumulonimbus clouds:
  - in mountain wave clouds
  - in highly “polluted” clouds

REFERENCE

From UNDERSTANDING CONVECTIVE CLOUDS THROUGH THE EYES OF (MSG): Cloud Particle Size. J.Kerkmann EUMETSAT

Bureau forecaster feedback regarding the use of the Day Convection RGB product

Tropical Forecasters have found that the Day Convection RGB shows the yellow stormtop enhancement for many storms. There is a perception that this product has too many "false alarms" and requires tuning.

The inclusion of the high resolution visible channel means that this product takes longer to load into the visualisation software on the computer

Using storm-top enhancements on single channel imagery works similarly and takes far less time to load.

From communication with EUMETSAT staff I have been told that the Day Convection RGB product is most useful in detecting the initial stages of the development of severe thunderstorms with small ice crystals spewing out of their tops. I have shown an example of this for the north Italian storm previously. See also http://www.eumetsat.int/website/home/Images/ImageLibrary/DAT_IL_06_06_29.html

REFERENCE

Australian Government
Bureau of Meteorology

Content of this session

The RGB products as endorsed by WMO as applied to Himawari-8

The Airmass RGB product and how it is constructed

- Interpretation of the RGB product using Himawari-8 examples

The Day Convection RGB product and how it is constructed

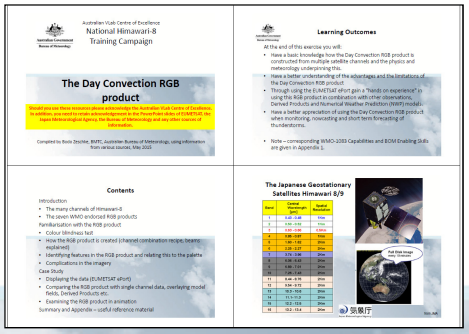
- Interpretation of the RGB product using Himawari-8 examples
- Comparing the Day Convection RGB product with the Sandwich Product

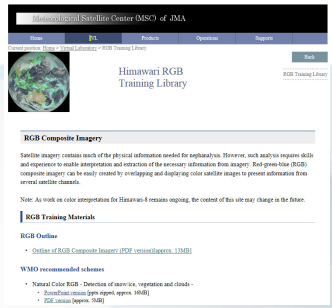
Advantages and limitations in using the RGB products, including BOM Forecaster feedback

Accessing RGB reference resources

Accessing RGB resources (1)

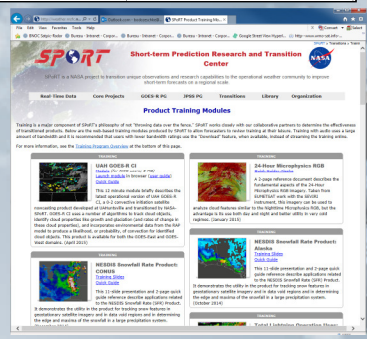
Australian VLab Centre of Excellence web page
http://www.virtuallab.bom.gov.au/training/hw-8-training/introduction-resources-and-case-studies/





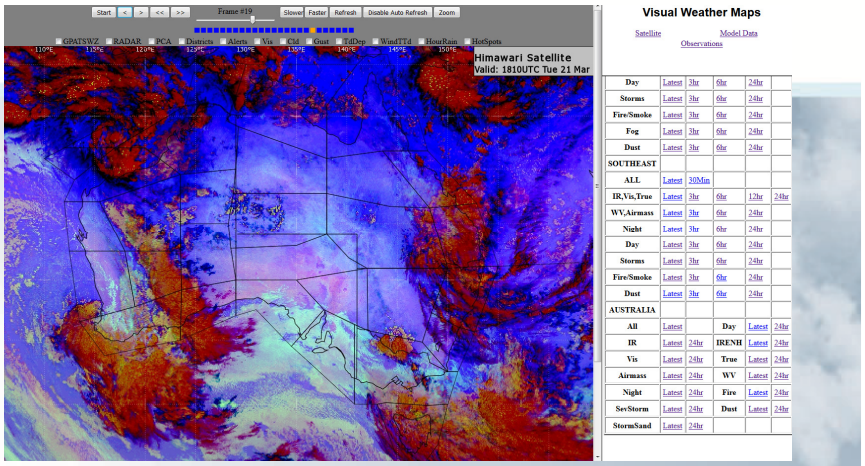
JMA User's Guide to RGB composite imagery (Himawari RGB Training Library)
http://www.data.jma.go.jp/mscweb/en/VRL/VLab_RGB/RGBimage.html

NASA Short-term Prediction Research and Transition Center (SPORT) Training
http://weather.msfc.nasa.gov/sport/training/



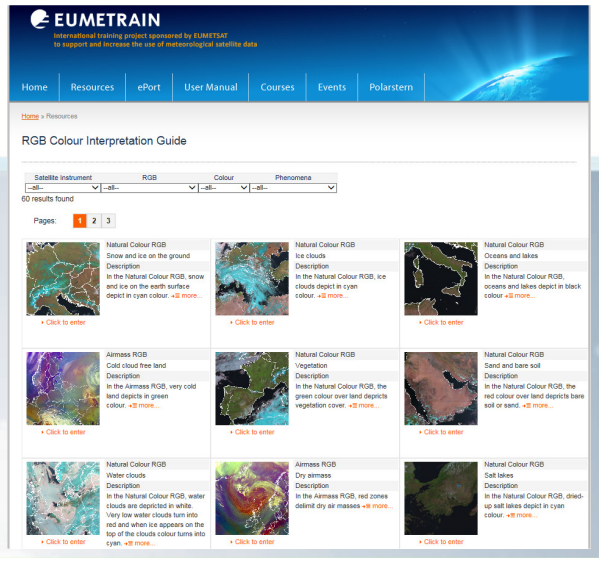
Accessing RGB resources (2)

Peter Newham web page as adapted from software developed by Tom Whittaker (CIMSS, University of Wisconsin Madison) at
http://aifs-vic.bom.gov.au/rgn/local/SatLoops/SatelliteHome.html



Very useful website for reference – the EUMETRAIN RGB Colour Interpretation Guide

http://www.eumetrain.org/RGBguide/rgbs.html



Australian Government
Bureau of Meteorology

Summary

- RGB products as endorsed by WMO
- How the products have adapted for Himawari-8 use over the Australasian-Pacific hemisphere
- Have examined the Airmass and the Severe Convection RGB products as well as the Sandwich Product in detail, including practical exercises examining each.
- Have presented advantages and disadvantages in using the products and Forecast Feedback when necessary.
- Have shown resources for RGB product information.