Applying existing and new RGB products to Himawari-8 data.

Collaborative meeting between BOM, JMA and NOAA, November 2016

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Australian Vlab Centre of Excellence Point of Contact

Contents of this session

Modifications to the **Night Microphysics RGB product**

• Mid-latitude and Tropical versions

Modifications to the **Day Convection RGB** product and its use in combination with the Sandwich Product

• Limitations in applying the Day Convection RGB product for winter storms

Application and potential modifications to the **Dust RGB product**

• Monitoring large and small dust plumes

• Interpretation of the product using histogram analysis (example from the Korea Meteorological Administration)

Forecaster / stakeholder feedback regarding the effective use of these RGB products, including the optimal display of this data with other information for Operational Forecasters.
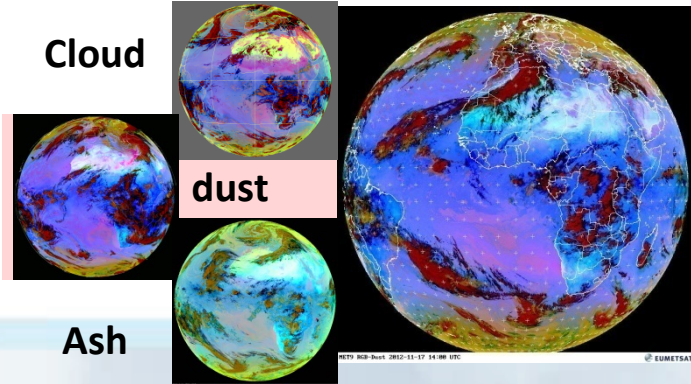
Australian Vlab Centre of Excellence Regional Focus Group meeting resources
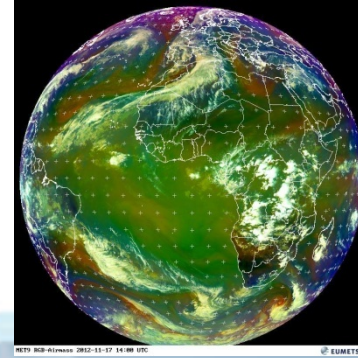
RGB products for Operational Forecasting – WMO/EUMETSAT recommendation

Australian Government
Bureau of Meteorology

Two RGB composites which complement each other
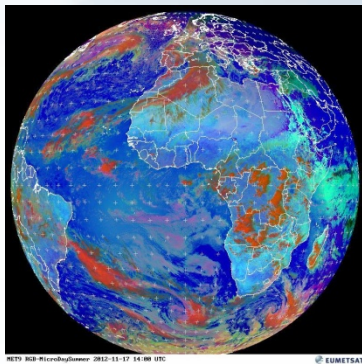
Cloud

dust

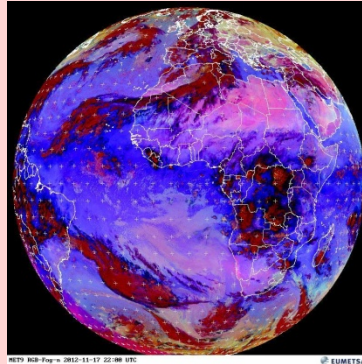**Ash**

24 hour Microphysical RGB

Airmass RGB

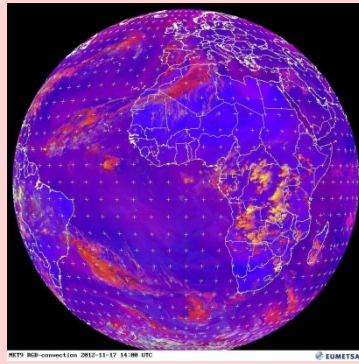from RGB Products Overview (RGB Tutorial) J. Kerkmann EumetSAT

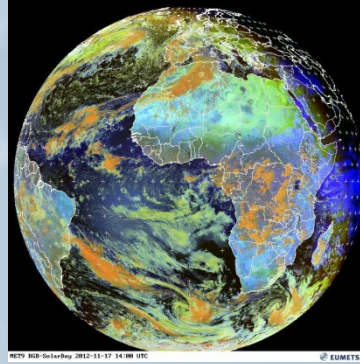## Five application specific RGBs

Day Microphysical RGB

Night Microphysical RGB
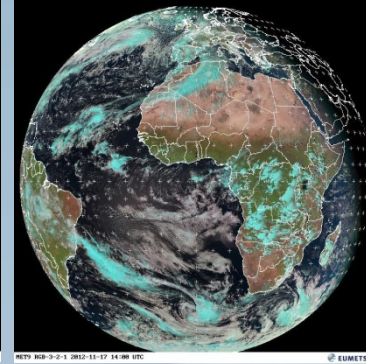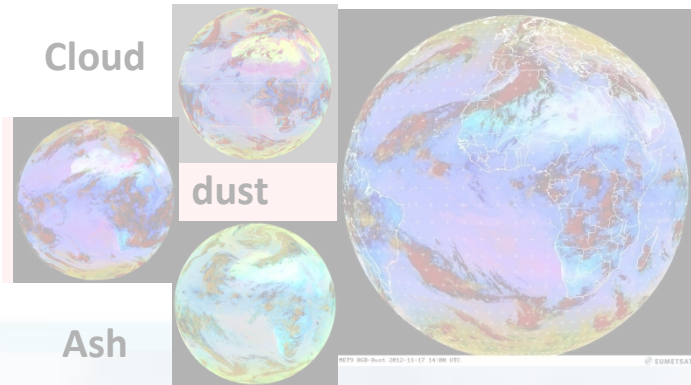
Day Convection RGB

Snow / fog RGB

Natural Colours RGB

RGB products for Operational Forecasting – WMO/EUMETSAT recommendation

Australian Government
Bureau of Meteorology

Two RGB composites which complement each other

Cloud

dust

Ash

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

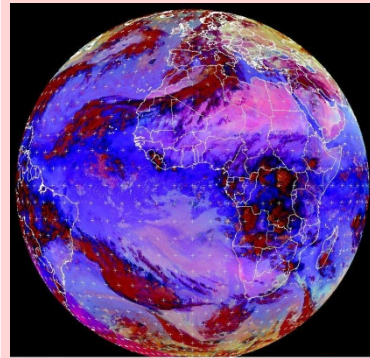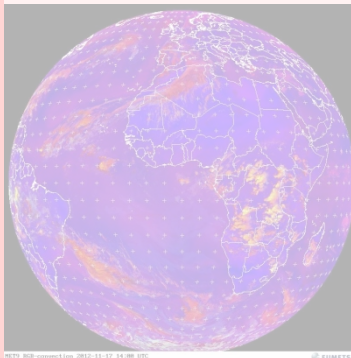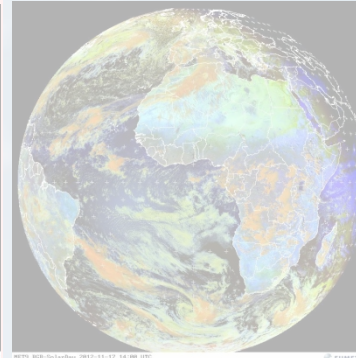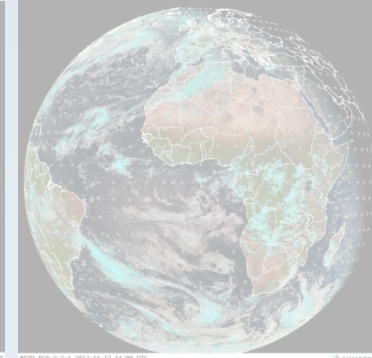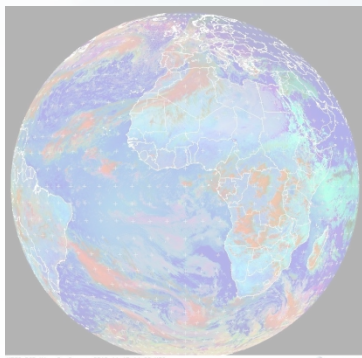# Tuning the Night Microphysics RGB products by Forecasters and stakeholders to suit local conditions

Legend:
- Thick high cloud
- Thin Cirrus
- Thick mid-level cloud
- Thin mid-level cloud
- Low cloud/fog (warm)
- Low cloud/fog (cold)
- Ocean
- Land

Most tuning required in the Red and Green beams

Himawari-8 — images courtesy JMA

Meteosat-10 — images courtesy EUMETSAT

IR12-IR10.8   IR10.8-IR3.9   IR10.8

Night-time Microphysics RGB
Valid Sun, 10 Apr 2016 14:00 UTC

A
C
D
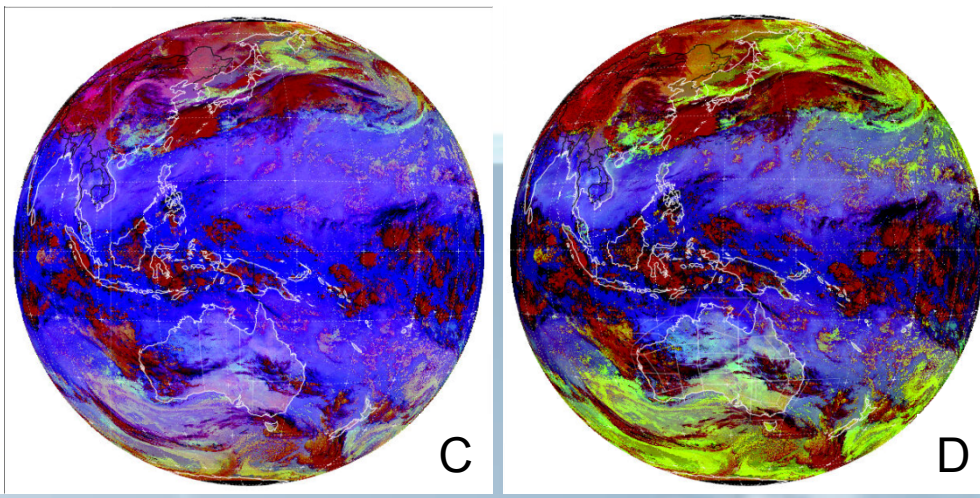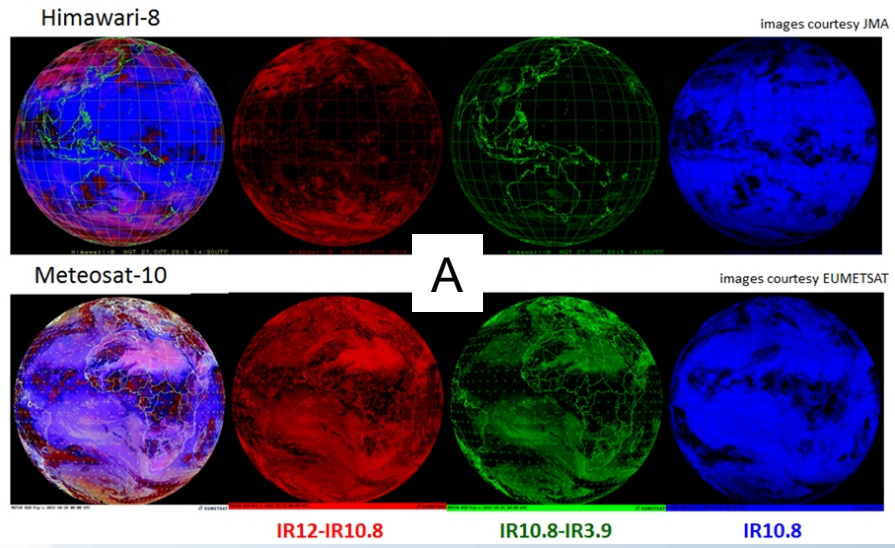
	RED (IR12.0 – IR10.4)	GREEN (IR10.4-NIR3.9)	BLUE (C) (IR10.4)
A: SEVIRI RECIPE	-4 to 2	0 to 10	-30 to 20
B: NCMP-TROP	-4 to 2	0 to 5	0 to 27
C: JMA version 2	-6.7 to 2.6	-3.1 to 5.2	-29.4 to 19.4
D: TROP Hybrid (scaled)	-6.7 to 2.6	-3.1 to 2.6	0.6 to 26.4

Slide 5

Tuning the Night Microphysics RGB products by Forecasters and stakeholders to suit local conditions

From correspondence with Jochen Kerkmann, EUMETSAT, there are two versions of the Night Microphysics as used for the SEVIRI instrument data of the METEOSAT Second Generation satellite: one for Europe (or extra tropics) and one for tropical moist regions, the Night Cloud Microphysics Tropical (NCMP-TROP). The recipes are given in examples A and B in the preceding slide.
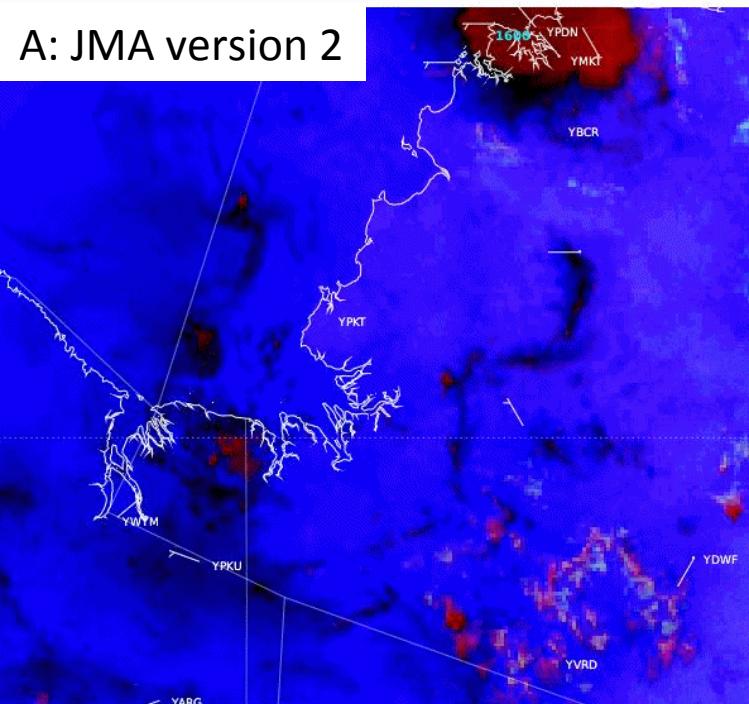
The recipe for the Night Microphysics RGB product as tuned for Himawari-8 by the Japan Meteorological Agency is given in example C.

Knowing the above recipes we can derive a "first order" approximation of the tropical tuned Night Microphysics RGB product suitable for the Himawari-8 AHI data and this is given in example D.
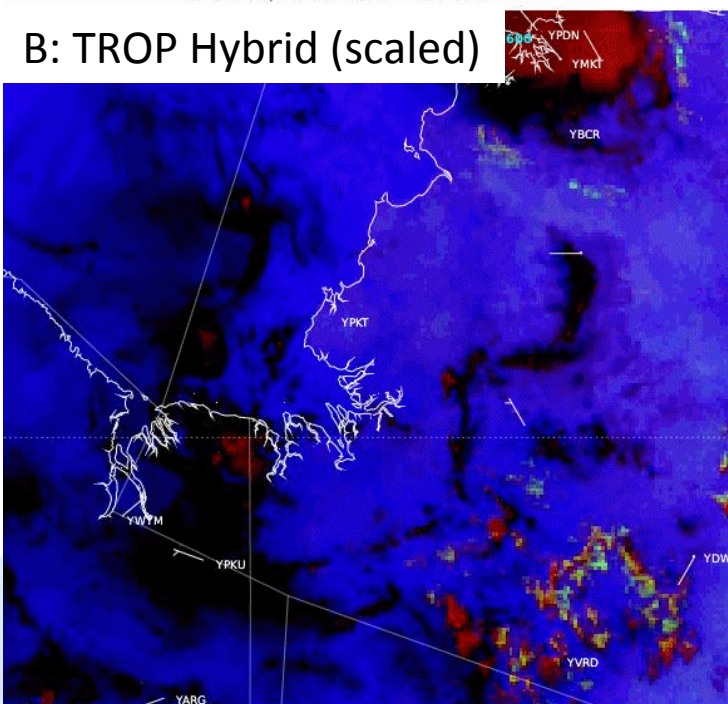
NOTE SLIDE

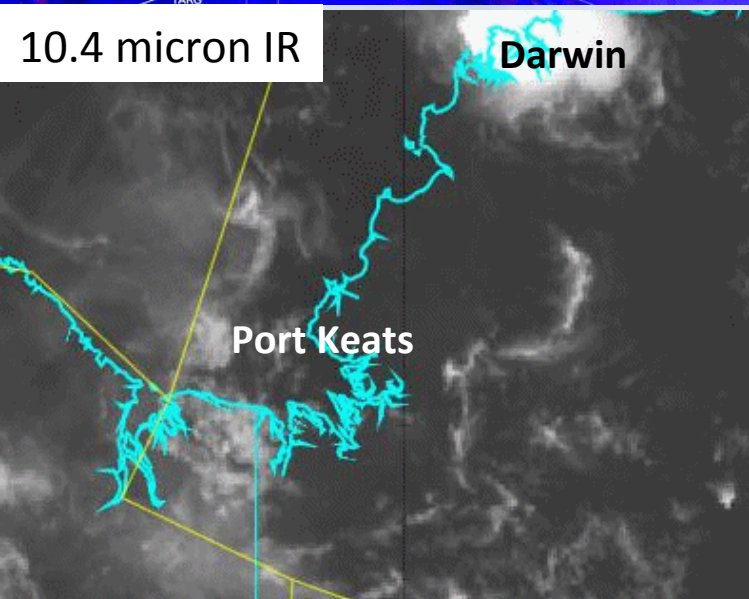**Night-time Microphysics RGB**
Valid Mon, 21 Mar 2016 14:00 UTC

A: JMA version 2

Night-time Microphysics RGB
Valid Mon, 21 Mar 2016 14:00 UTC

B: TROP Hybrid (scaled)

satellite animation courtesy BOM/JMA

Northern Territory,
21st March 2016, 14 – 22UTC

■ (dark red)	Thick high cloud
■ (black)	Thin Cirrus
■ (pink)	Thick mid-level cloud
■ (purple)	Thin mid-level cloud
■ (light blue)	Low cloud/fog (warm)
■ (light green)	Low cloud/fog (cold)
■ (blue)	Ocean
■ (magenta)	Land

10.4 micron IR

Darwin

Port Keats

Wyndham RADAR

Question: What RGB product do you prefer?

radar animation courtesy BOM

What are the advantages in using the RGB product?
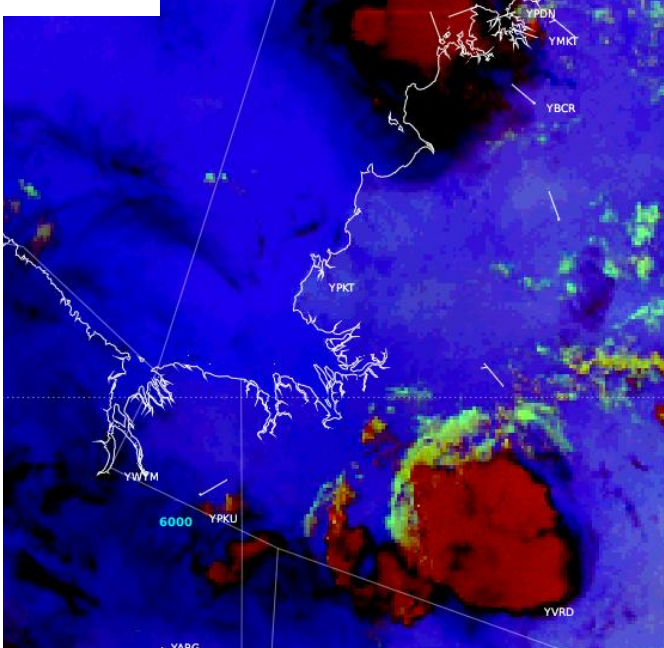
NOTE THESE ARE EMBEDDED ANIMATIONS

Slide 6

17UTC — Night-time Microphysics RGB — Valid Mon, 21 Mar 2016 17:00 UTC

18UTC — Night-time Microphysics RGB — Valid Mon, 21 Mar 2016 18:00 UTC
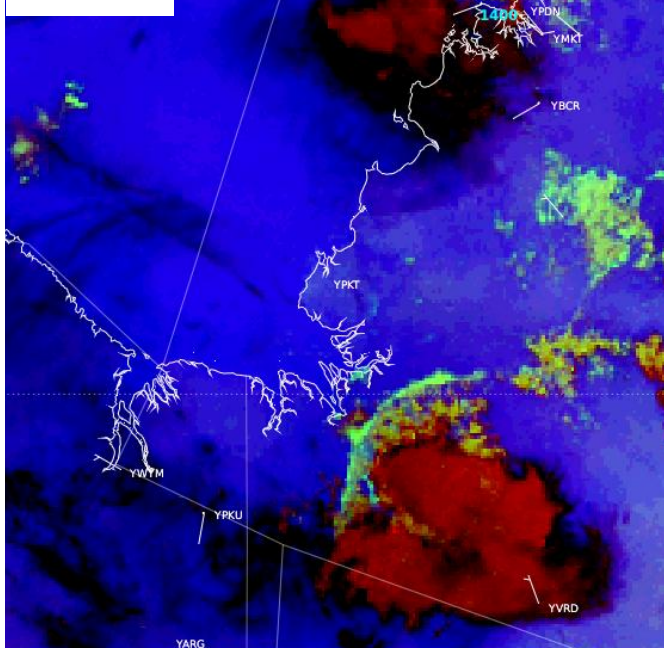
19UTC — Night-time Microphysics RGB — Valid Mon, 21 Mar 2016 19:00 UTC

20UTC — Night-time Microphysics RGB — Valid Mon, 21 Mar 2016 20:00 UTC

satellite animation courtesy BOM/JMA

Northern Territory,
21st March 2016, 17 – 20UTC

	Thick high cloud
	Thin Cirrus
	Thick mid-level cloud
	Thin mid-level cloud
	Low cloud/fog (warm)
	Low cloud/fog (cold)
	Ocean
	Land

Monitoring of the storm outflow / gust front and the development of secondary convection using the Night Microphysics RGB product
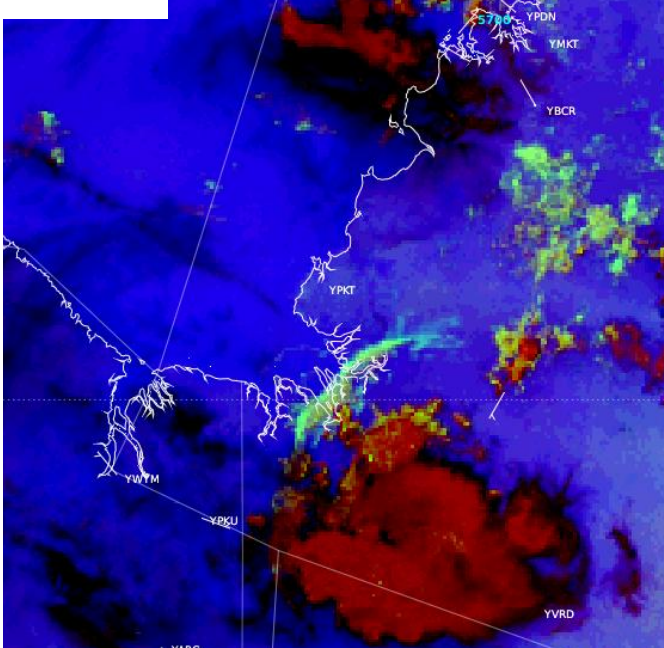
Slide 7

Interpreting the Tropical tuned Night Microphysics RGB product – Central Indonesian region 13UTC 9th April 2016

Night Microphysics RGB

10.4 micron IR

Jakarta

Jakarta

Thick high cloud	Thick mid-level cloud	Low cloud/fog (warm)	Ocean
Thin Cirrus	Thin mid-level cloud	Low cloud/fog (cold)	Land

Question: Any unexpected colours in the RGB product that do not match the EUMETSAT RGB palette?
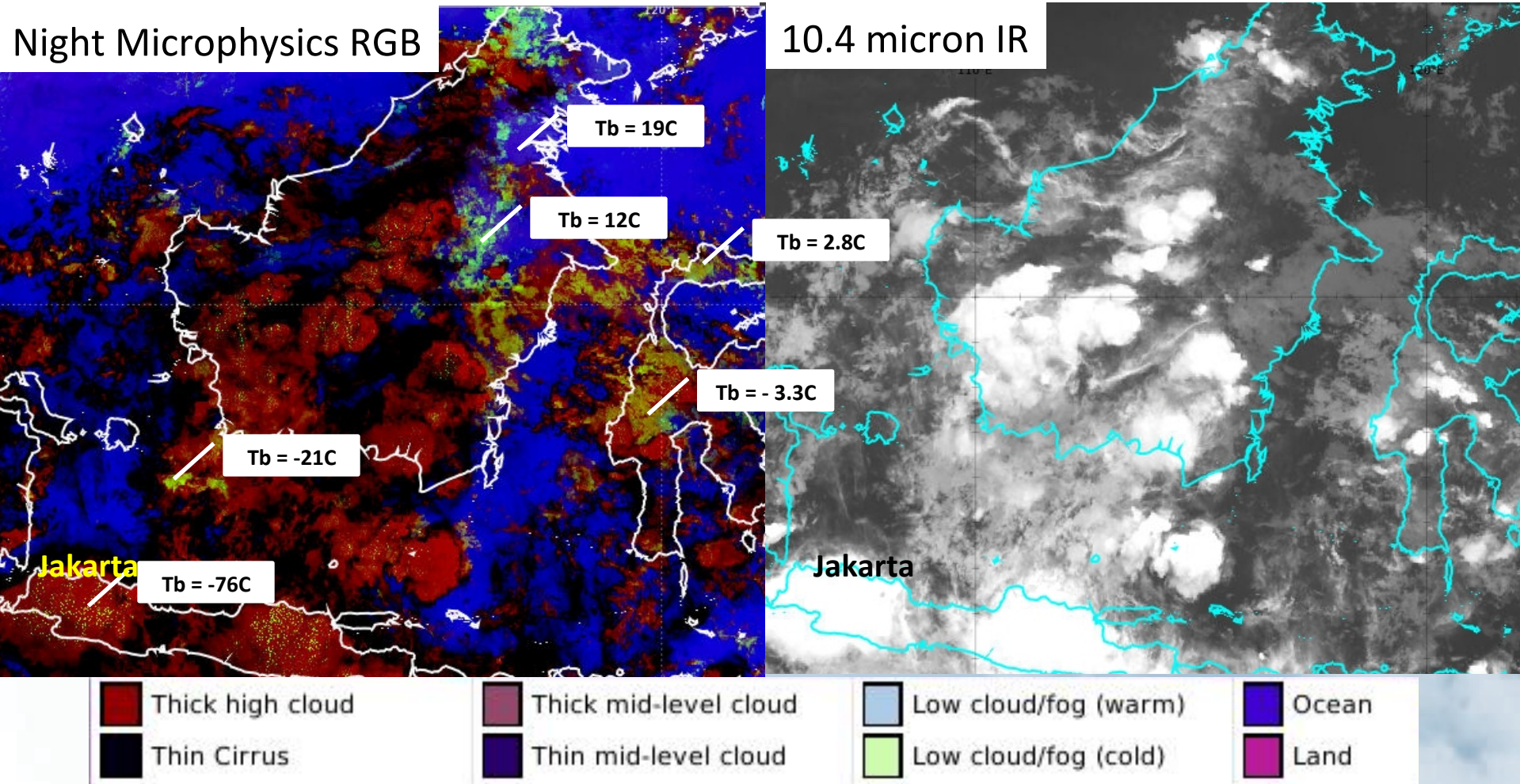
images courtesy BOM/JMA

Slide 8

Interpreting the Tropical tuned Night Microphysics RGB product – Central Indonesian region 13UTC 9th April 2016

Night Microphysics RGB

10.4 micron IR

Tb = 19C

Tb = 12C

Tb = 2.8C

Tb = - 3.3C

Tb = -21C

Jakarta

Tb = -76C

Jakarta

| | Thick high cloud | | Thick mid-level cloud | | Low cloud/fog (warm) | | Ocean |
| | Thin Cirrus | | Thin mid-level cloud | | Low cloud/fog (cold) | | Land |

Question: What clouds have these "unexpected" colours:
A: high level cloud tops   B: mid level cloud tops   C: low level cloud tops

images courtesy BOM/JMA

Forecaster Display - Adapting the Night Microphysics RGB product to the tropics Courtesy Rebecca Patrick NTRO
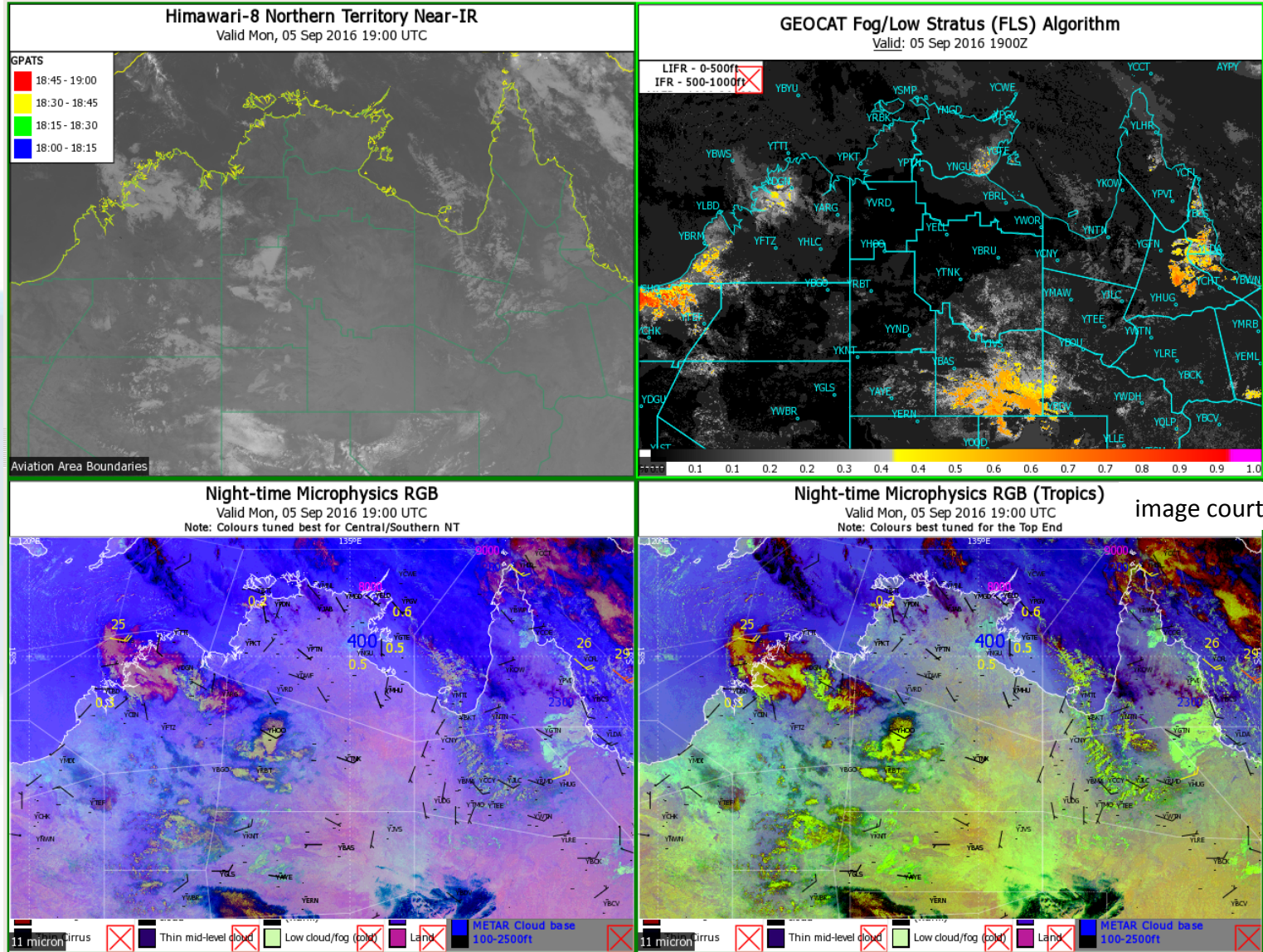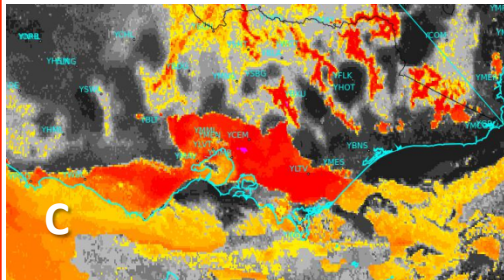

image courtesy BOM/JMA

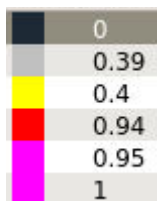# The GEOCAT GOES-R fog/low cloud algorithm

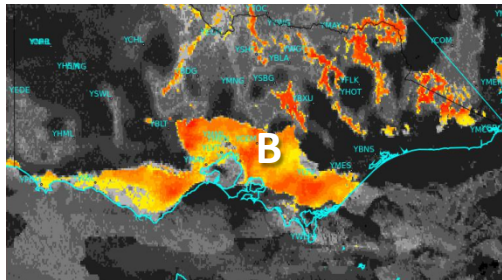Images from BOM
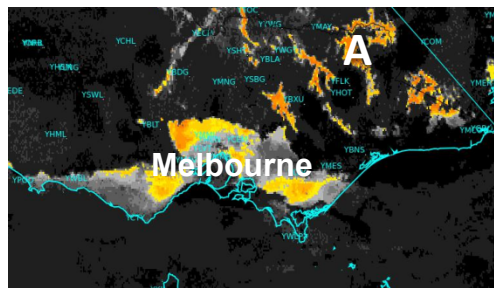
MVFR fog/low cloud Probability (below 3000ft)

IFR fog/low cloud Probability (below 1000ft)

Uses Himawari-8 data
- **0.65, 3.9, 11 micron daytime**
- **3.9, 11 micron at night**

Victoria 15th July 2016 20UTC

LIFR, IFR, MVFR FLC probability

0	
0.39	
0.4	
0.94	
0.95	
1	

LIFR Fog/low cloud Probability (below 500ft)

Melbourne

Algorithm also uses:
- **Modelled relative humidity (NWP profile to find highest RH in the lowest 1000/3000 ft layer)**
- Textural & spectral information
- Difference between cloud radiative temperature and surface temperature
- Cloud object based filtering technique

A: Valley fog/low cloud
B: Stratus
C: Marine Stratocumulus

Key output in Visual Weather:
- **MVFR conditions**
- **IFR conditions**
- **LIFR conditions**

From the Regional Focus Group Weather and Forecast Discussion, 7th July 2016 as presented by B.Zeschke.

NOTE SLIDE

Forecaster Display - Himawari-8 Night-Microphysics RGB product, Melbourne region (19UTC 29th Feb 2016)
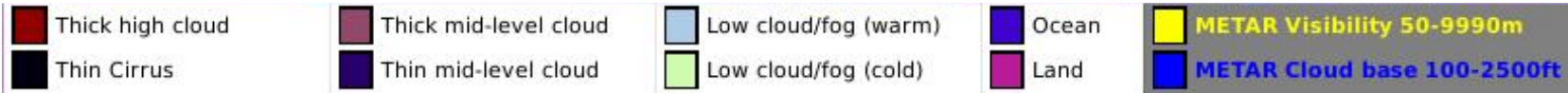
animation courtesy JMA/BOM
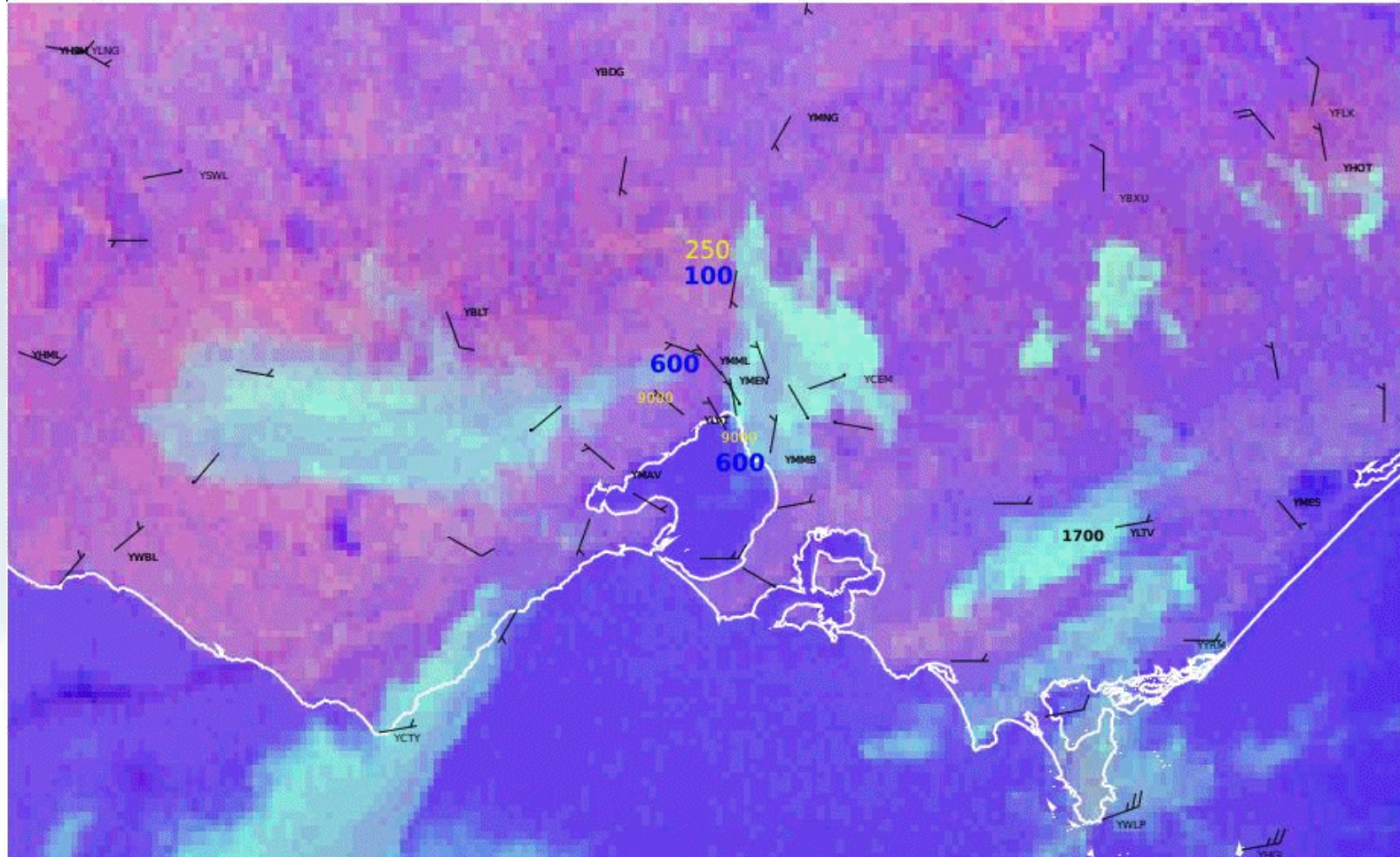
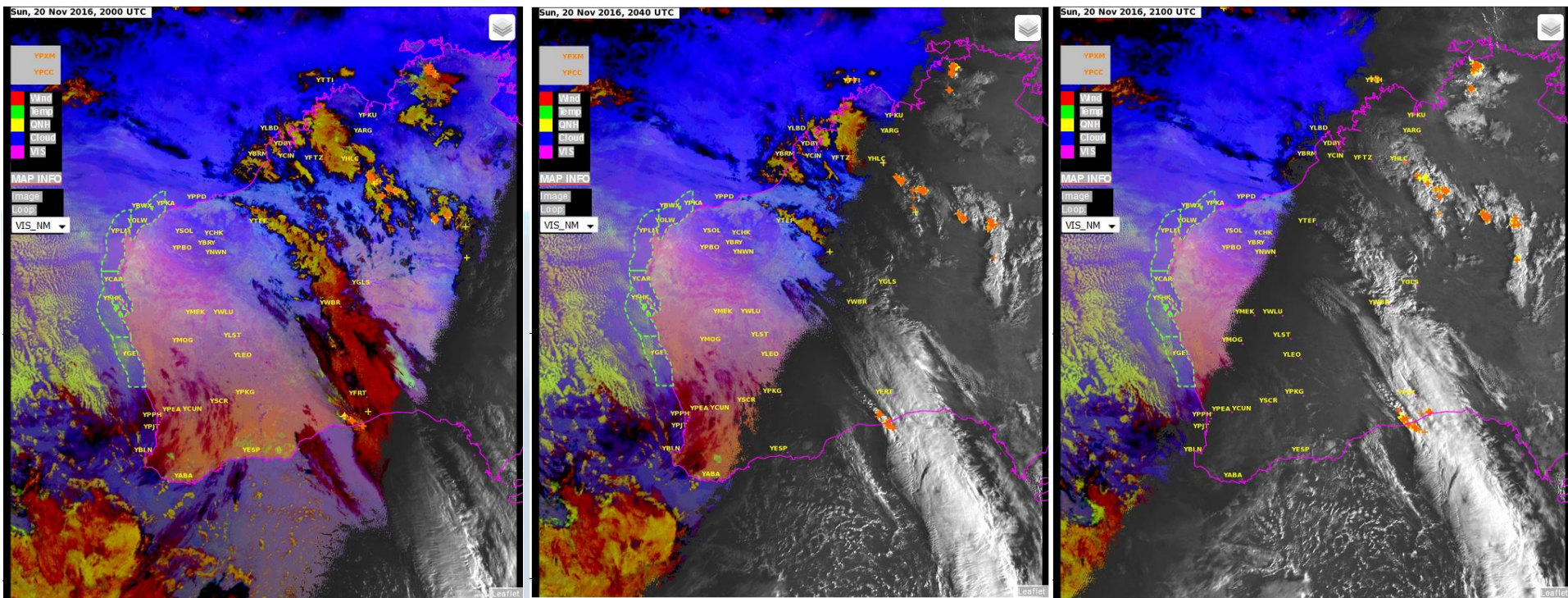# Forecaster Display – the transition of the Night Microphysics RGB into visible imagery (Bureau of Meteorology West Australian Regional Office development led by C.Stuart)

The algorithm displays the Night Microphysics RGB product whenever there is no signal in the visible image

Summary - Bureau Forecaster feedback regarding the use of the Night Microphysics RGB product (1)

This product has been developed recently for a number of reasons:

- Forecasters are familiar with this RGB product as a similar product was constructed using MTSAT data previously.

- The Southern Hemisphere winter season has recently concluded. During this season the fog/low cloud events are most frequent over Australia.

- The imagery loads relatively quickly on the computer as the emissive infrared and short wave infrared channels composing the RGB product are smaller in size than the visible channel.

- The fog/low cloud signal is quite clear and unambiguous most of the time. In many instances fog/low cloud can be monitored in the presence of higher cloud.

- Land surfaces can be seen more clearly in the Himawari-8 data, compared to MTSAT-2 and that can help in discriminating between true fog/low cloud and false signals.

NOTE SLIDE

Summary - Bureau Forecaster feedback regarding the use of the Night Microphysics RGB product (2)

There are some limitations in the use of this product: :

- There are still some cases of false fog/low cloud signal over desert areas.

- When using the night microphysical RGB images it is important to be aware of how temperature effects the images. The blue channel is sensitive to temperature, this means that fog and stratus events may look different depending on the surface temperature. We have seen the RGB colour of the fog/low cloud change between seasons. Even during the overnight period when there are large temperature changes in one night the colours can change dramatically (N.Benger South Australian Regional Office). One way around this is to use multipanel displays showing, for example, the midlatitude and tropical tuned RGB products together with the short wave infrared and the GEOCAT Fog/Low Stratus product

- People who have vision colour deficiency have problems in viewing this imagery. The use of Derived Products (GEOCAT Fog/Low Stratus cloud algorithm) can help overcome this.
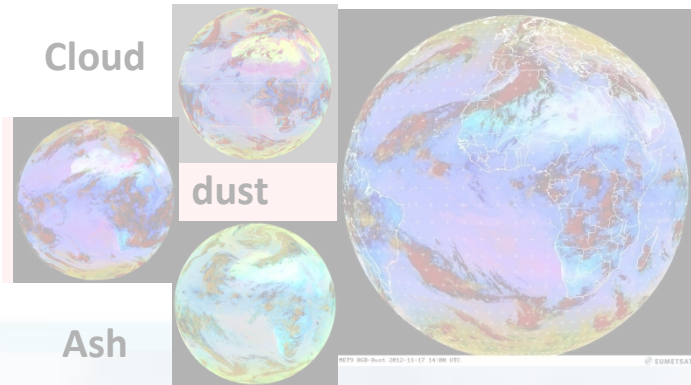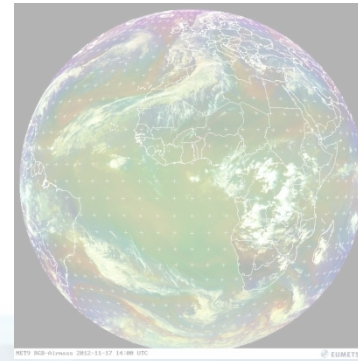
NOTE SLIDE

RGB products for Operational Forecasting – WMO/EUMETSAT recommendation

Australian Government
Bureau of Meteorology

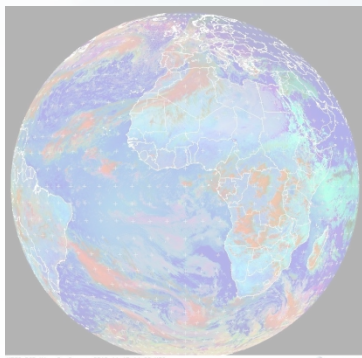Two RGB composites which complement each other
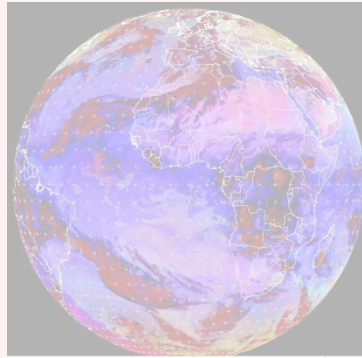
Cloud

dust

Ash

24 hour Microphysical RGB

Airmass RGB

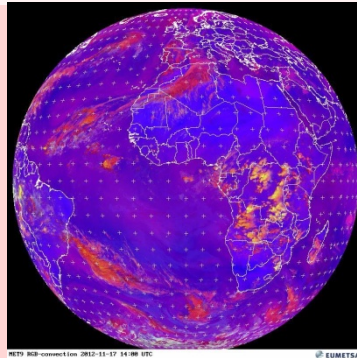from RGB Products
Overview (RGB Tutorial)
J. Kerkmann EumetSAT
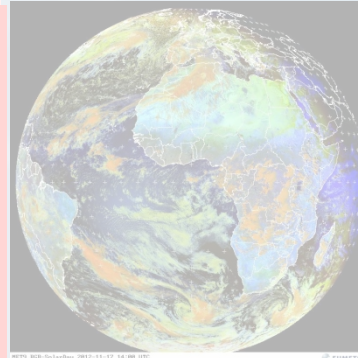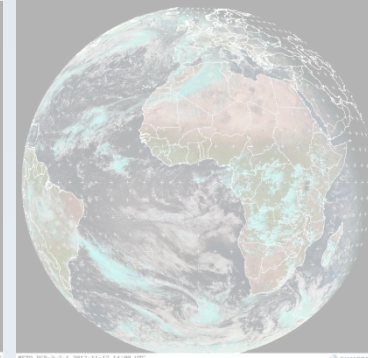
Five application specific RGBs

Day Microphysical RGB

Night Microphysical RGB

Day Convection RGB

Snow / fog RGB

Natural Colours RGB

The Sandwich Product and the Day Convection RGB product
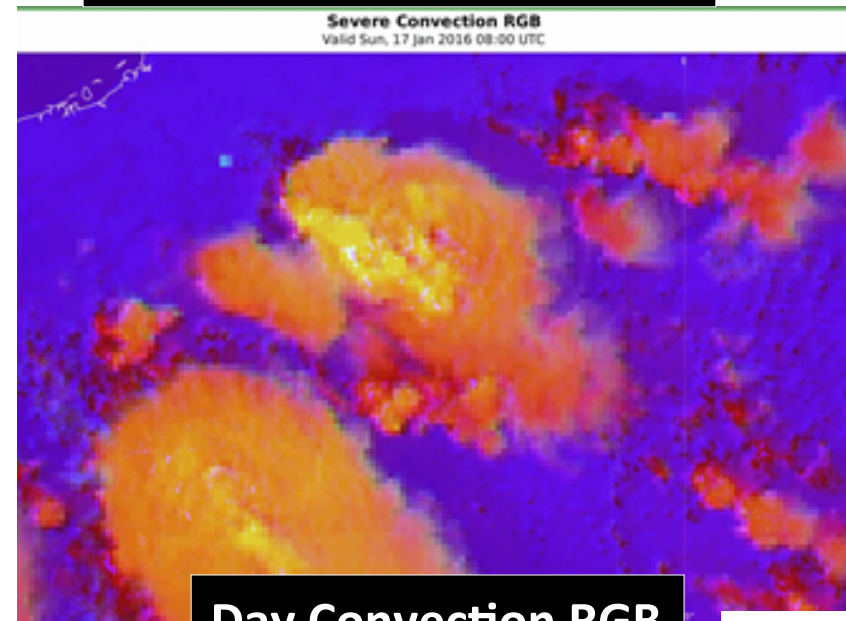
Upper layer: IR10.4 BT image

Bottom layer ("background"):   HRV image

The Sandwich Product (M.Setvak)

Day Convection RGB product

sandwich HRV & IR10.8-BT

Day Convection RGB

The Sandwich Product (M.Setvak CHI)

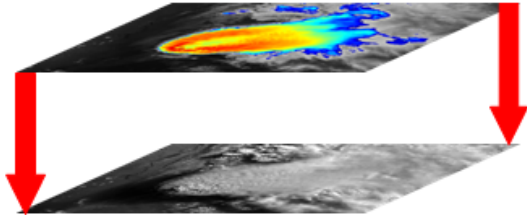http://oiswww.eumetsat.org/WEBOPS/iotm/iotm/20090923_convection/20090923_convection.html

The product consists of two layers: the base one, which is the High Resolution Visible (HRV) image, and the upper layer, containing the color-enhanced IR10.8 image, showing the details of the brightness temperature field. Next, there are several options how to blend these two layers together. The simplest way is to use just the partial transparency of the upper layer, setting the layer opacity somewhere between 40 to 75%

The primary advantage of sandwich products is that they merge the features of the two input images into one single image, thus enabling one to observe the characteristics of both images simultaneously in one single product. In the case of the visible – IR-window sandwich combination (VIS/IR-BT), the visible band brings to the final image the cloud-top "morphology" (shadows and textures), while the color-enhanced IR-window band adds the BT information. Such images often gain almost a 3D appearance, which is absent if the source input images are compared side-by-side. It is much easier to follow the evolution of convective storms (or any other weather phenomenon) in one single sandwich product, rather than in two windows, showing the input bands separately. Finally, the main advantage of the sandwich product is in its animation possibilities, showing the evolution of studied phenomena in one single loop. This makes the sandwich products very attractive for operational applications. As the sandwich products are based on solar bands (visible or near IR), they can't be used at night.
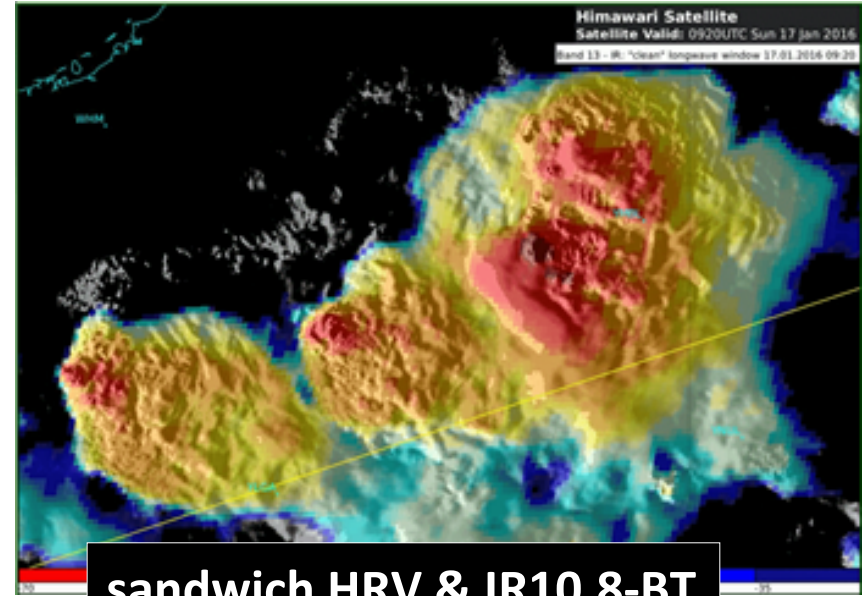
NOTE SLIDE

The Sandwich Product and the Day Convection RGB product

Upper layer: IR10.4 BT image

Bottom layer ("background"):   HRV image

The Sandwich Product (M.Setvak)

Day Convection RGB product

sandwich HRV & IR10.8-BT

Day Convection RGB

Slide 15

Storm-Top Features identified in high resolution satellite data
Australian Vlab CoE Regional Focus Group meeting of January 2016
http://www.virtuallab.bom.gov.au/archive/regional-focus-group-recordings/

Storms, northwest Australia, 17ᵗʰ January 2016 (Himawari-8 10 minute data)

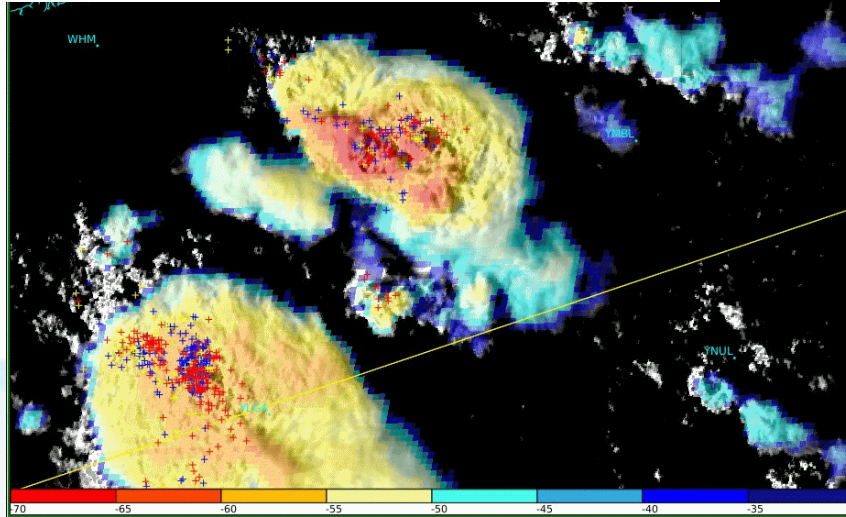Storms, northwest Australia, 17th January 2016 (Himawari-8 10 minute data)

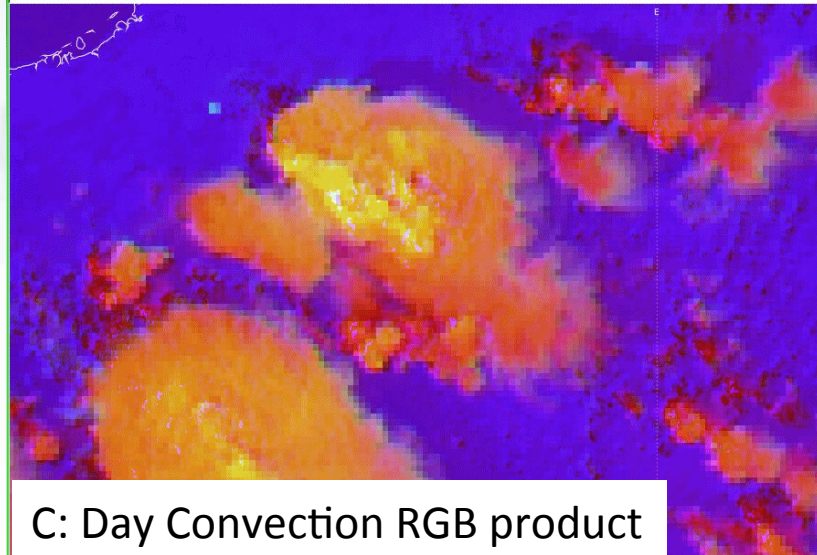lightning data courtesy Global Position and Tracking Systems Pty Ltd (GPATS)

satellite animations courtesy BOM/JMA

A: Sandwich product and lightning

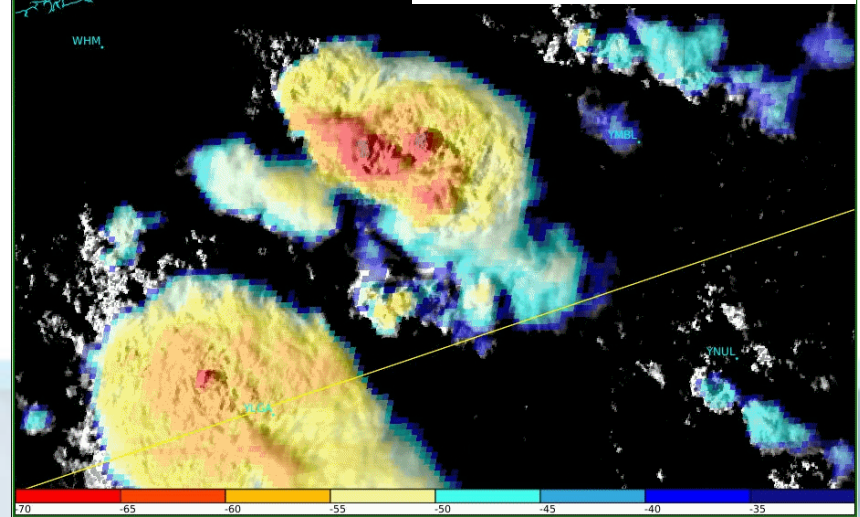B: Sandwich product
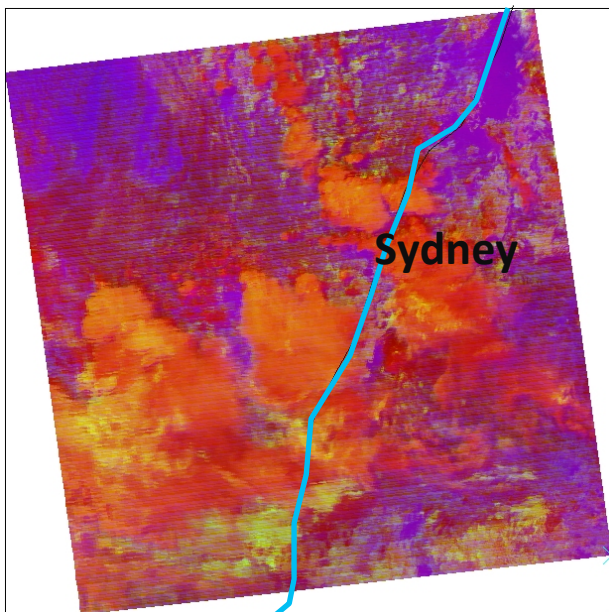
C: Day Convection RGB product
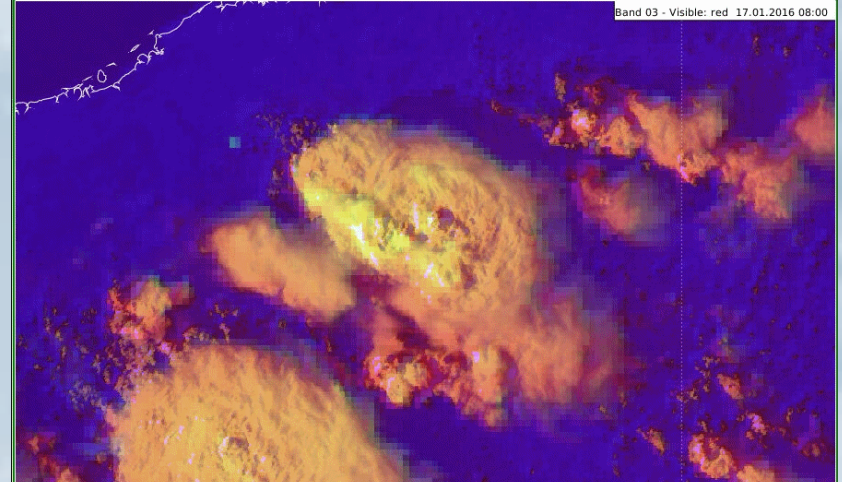
D: HRV/Convection RGB Sandwich Product
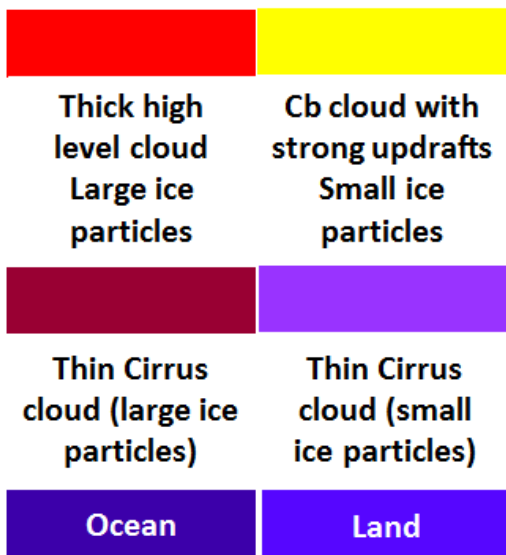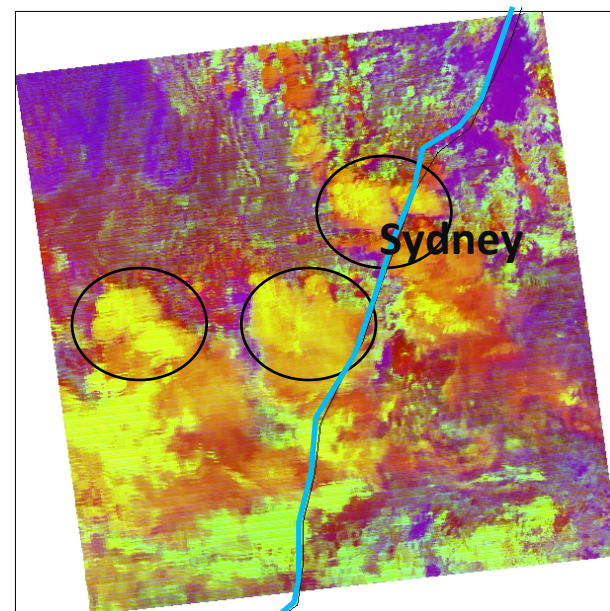
NOTE THESE ARE EMBEDDED ANIMATIONS

Slide 17

Tuning the Day Convective RGB product for a lower tropopause, Severe Storms New South Wales, 24ᵗʰ August 2015

images courtesy NASA FIRMS

Sydney

LHS, Green beam thresholds -5 to +60

RHS, Green beam thresholds -5 to +40. Note that the active stormtops are well captured (black circles), but the mid level water clouds contaminates this signal

Sydney

Thick high level cloud Large ice particles	**Cb cloud with strong updrafts Small ice particles**
Thin Cirrus cloud (large ice particles)	**Thin Cirrus cloud (small ice particles)**
Ocean	**Land**

Enhanced IR image

Sydney

-47C
-31C
-23C
-15C
-7C

cloudtop brightness temperature

image courtesy BOM/JMA
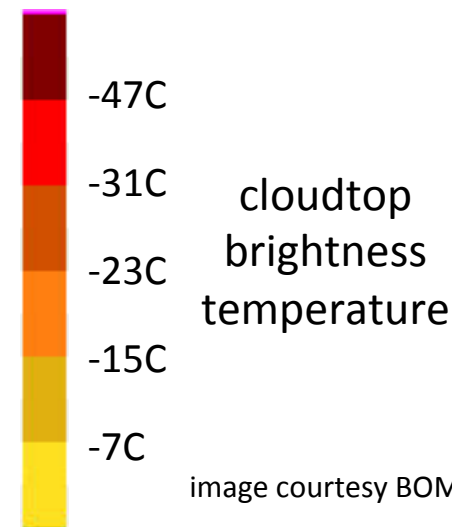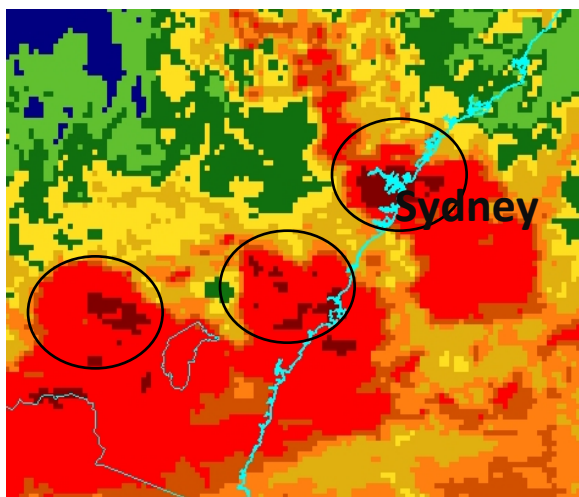
Slide 18

Forecaster Display – combining a number of products
(feedback from AOMSUC-7)

images courtesy JMA/BOM

Sandwich Product

HRV/Convection RGB Sandwich Product

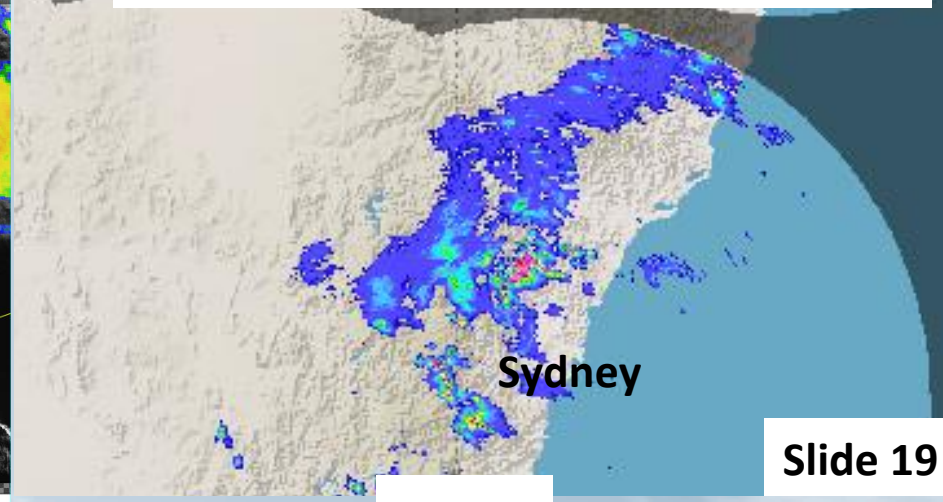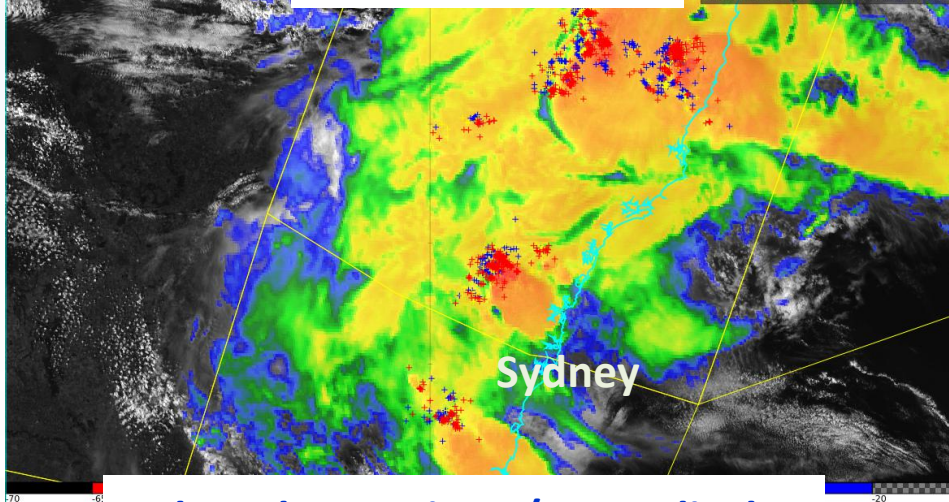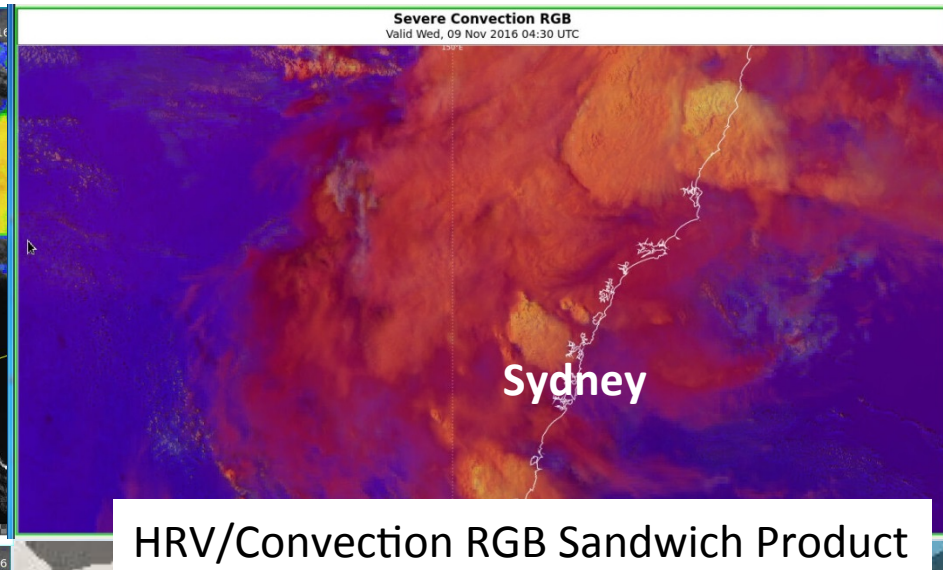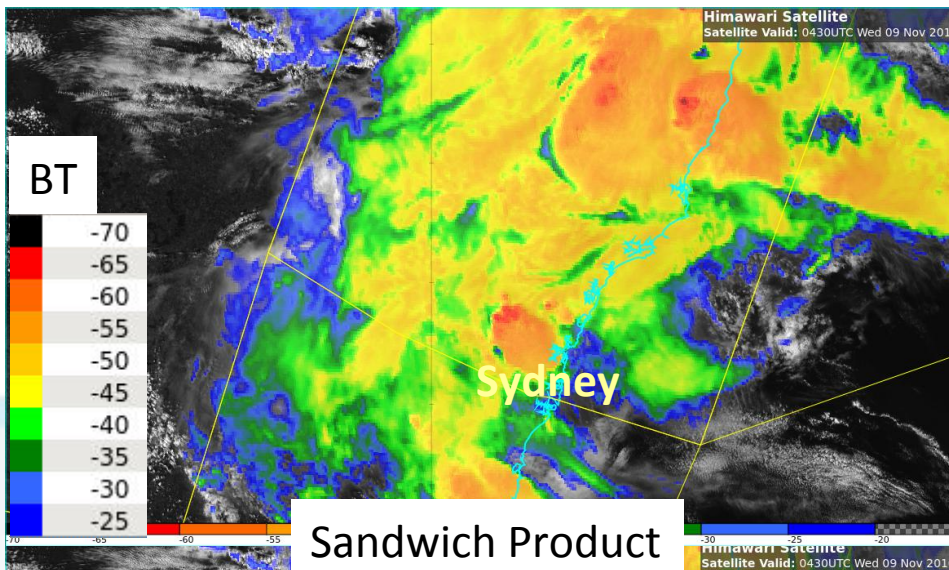Other observations / NWP display

RADAR

Slide 19

Question: what would be useful observations / NWP data to put into the **fourth** panel?

Summary - feedback regarding the use of the Day Convection RGB product and the Sandwich Product (1)

- South Australian Forecasters do not use the Day Convection RGB very much as it is slow to load due to the large size of the reflective channels. Using storm-top enhancements on single channel imagery works similarly and takes far less time to load.

- Queensland Forecasters have found it useful to define particular temperature thresholds in the enhanced infrared channels as important for thunderstorm monitoring. Forecasters look for temperatures colder than -10C to show increased potential. Temperatures colder than -20C usually corresponds to thunderstorms formation.

- Northern Territory (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. Comment from Jochen Kerkmann (EUMETSAT) is that the green range of the convection RGB should be increased to -5 to +75 K, for the cold cloud tops corresponding to tropical conditions.

NOTE SLIDE

Summary - feedback regarding the use of the Day Convection RGB product and the Sandwich Product (2)

Further comments from 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. 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.

- The convection RGB only sees high level clouds, so it is not useful for monitoring low level features like outflow boundaries. Therefore it is useful to combine the Day Convection RGB product with the high resolution visible product to capture all phases of storm formation and development.

- For wintertime convection (not deep), the Day Convection RGB product is not suited well. It is possible to change the range of the Green Beam to -5 to +40 K in order to detect the most active storms, but at the cost of enhancing also other cloud types, in particular mid-level supercooled clouds (for cold water cloud, the signal IR3.9 – IR10.8 gets quite large).
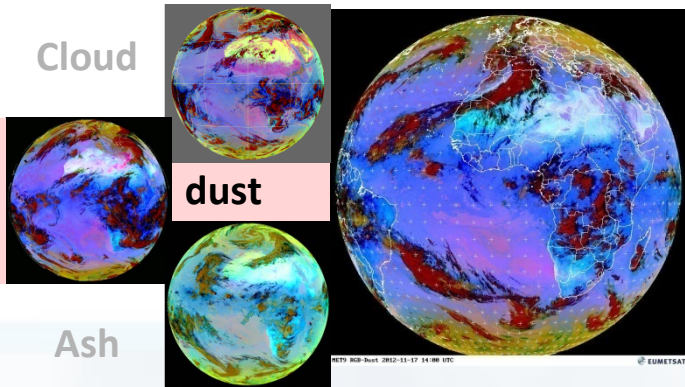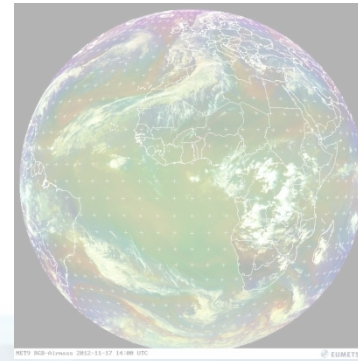
NOTE SLIDE

RGB products for Operational Forecasting – WMO/EUMETSAT recommendation

Two RGB composites which complement each other
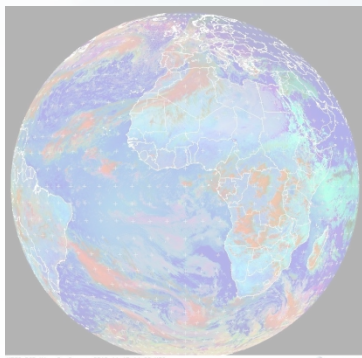
Cloud

dust

Ash
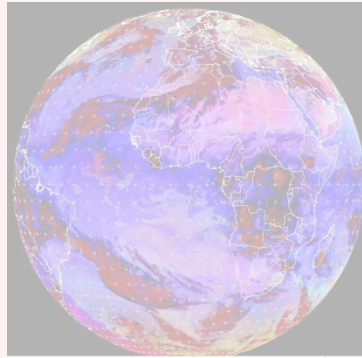
24 hour Microphysical RGB

Airmass RGB

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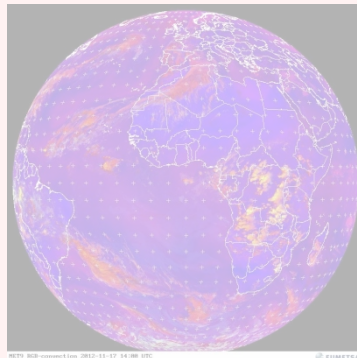Overview (RGB Tutorial)
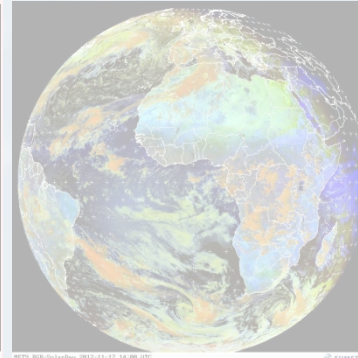J. Kerkmann EumetSAT

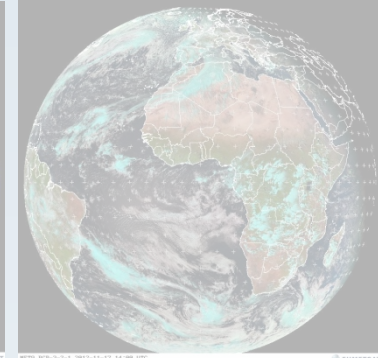## Five application specific RGBs

Day Microphysical RGB

Night Microphysical RGB

Day Convection RGB

Snow / fog RGB

Natural Colours RGB

Processing of the Himawari-8 data – the Dust RGB
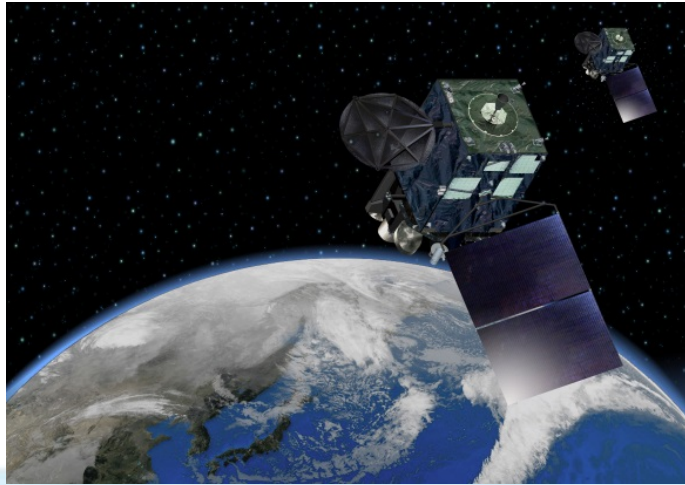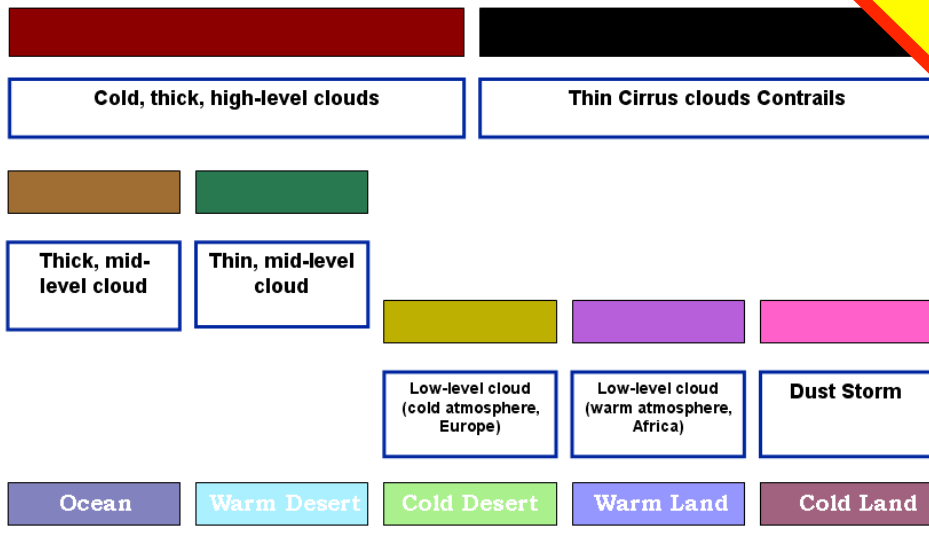
Dust RGB	Range	Gamma
12.0 – 10.4 micron	**-6.7 to 2.6**	**1.0**
11.2 – 8.7 micron	**-0.5 to 20.0**	**2.5**
10.4 micron	**261.2 to 288.7**	**1.0**

CHANNEL COMBINATION (JMA recipe)

Himawari-8 channels

24hr DUST Microphysics RGB
Valid Fri, 19 Feb 2016 05:00 UTC

Cold, thick, high-level clouds

Thin Cirrus clouds Contrails

Thick, mid-level cloud

Thin, mid-level cloud

Low-level cloud (cold atmosphere, Europe)

Low-level cloud (warm atmosphere, Africa)

Dust Storm

Ocean | Warm Desert | Cold Desert | Warm Land | Cold Land
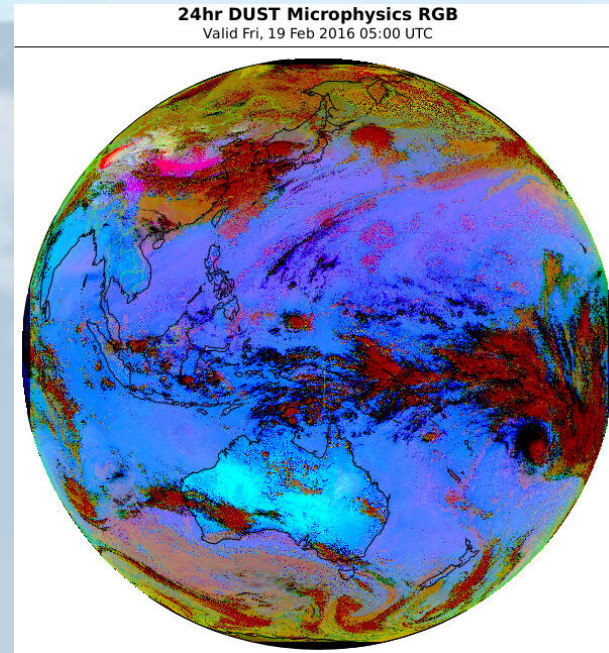
Himawari-8 RGB Composite

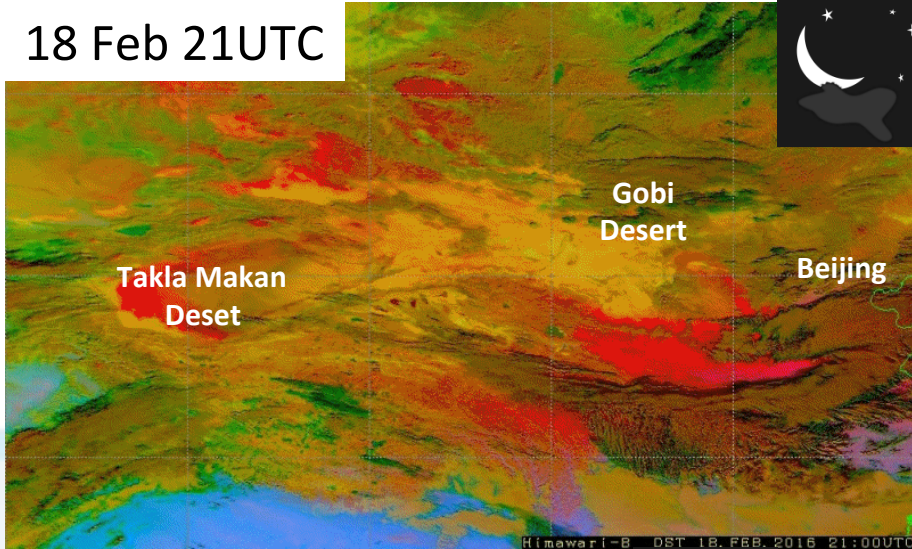**Colour interpretation palette**

China dust storm, Dust RGB, 18-19 Feb 2016
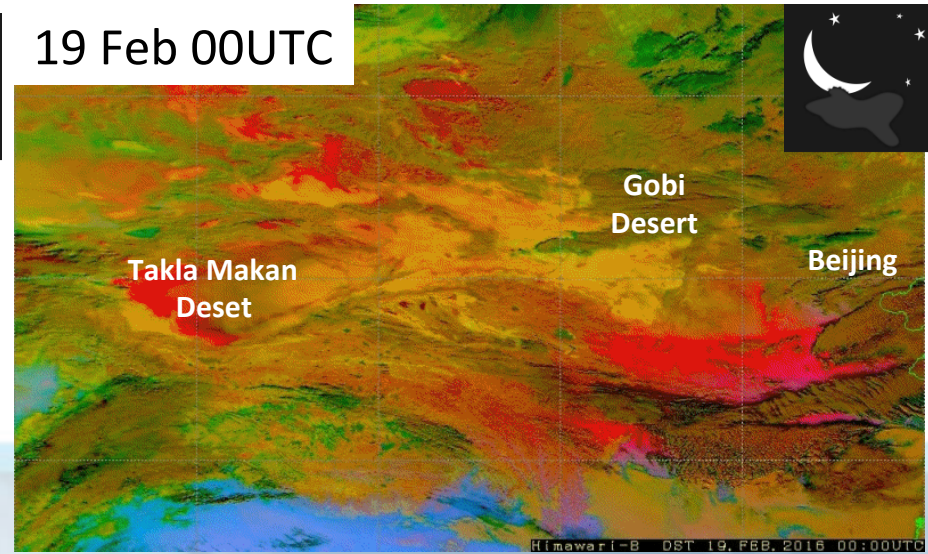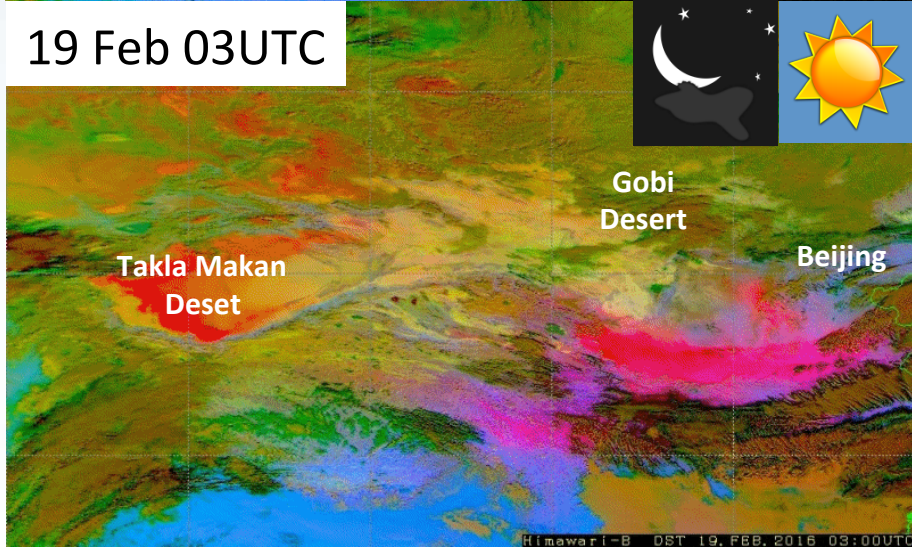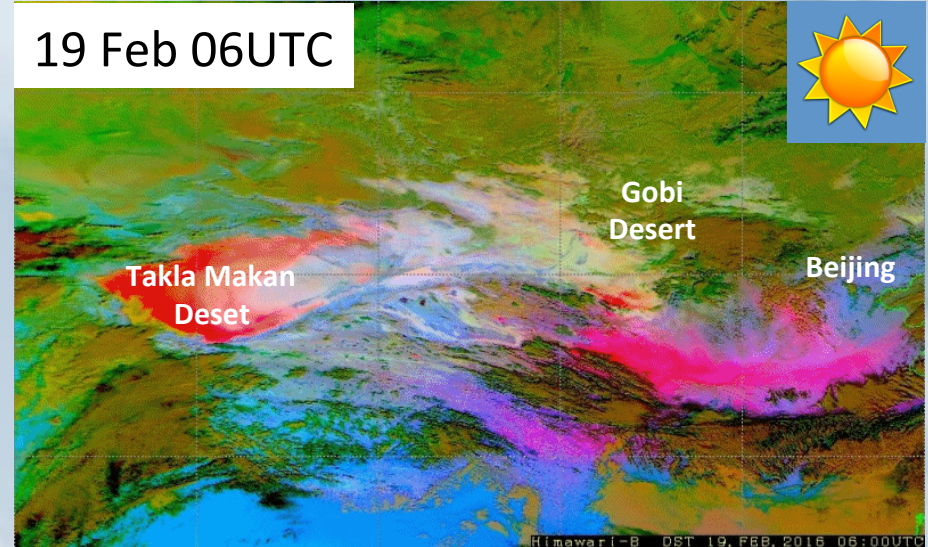
Images forwarded by Jochen Kerkmann, EUMETSAT, 19th February

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Comparing various products for a weak dust plume

(northwestern Australia, 4 March 2016) Himawari-8 images courtesy BOM/JMA
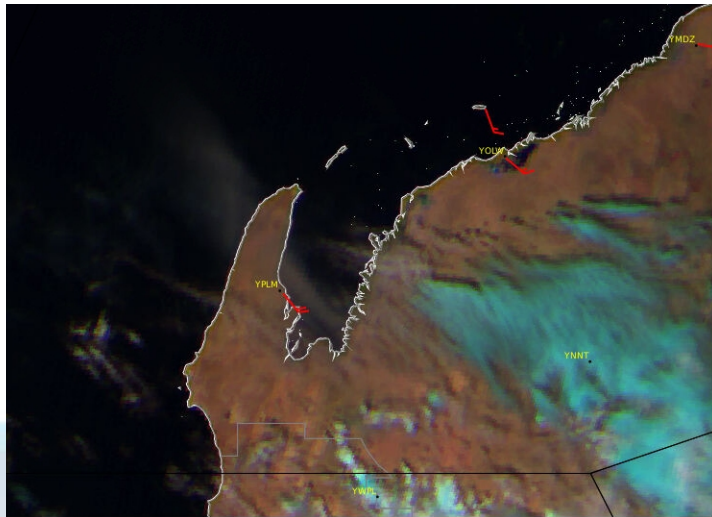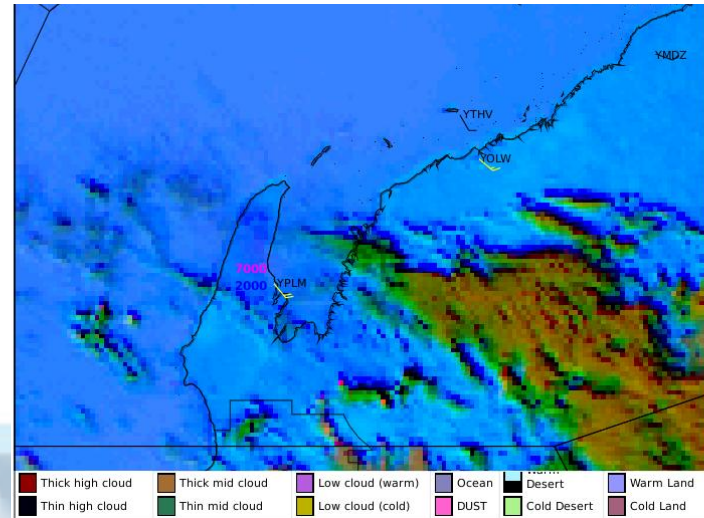

Natural Colour RGB (0300UTC)

Dust Microphysics RGB (0300UTC)

Soumi NPP VIIRS True Colour image (~0450UTC)

MODIS True Colour image (0305UTC)

Comparing various products for a weak dust plume
(northwestern Australia, 4 March 2016)Himawari-8 images courtesy BOM/JMA

Himawari-8 Band 3 (0300UTC)
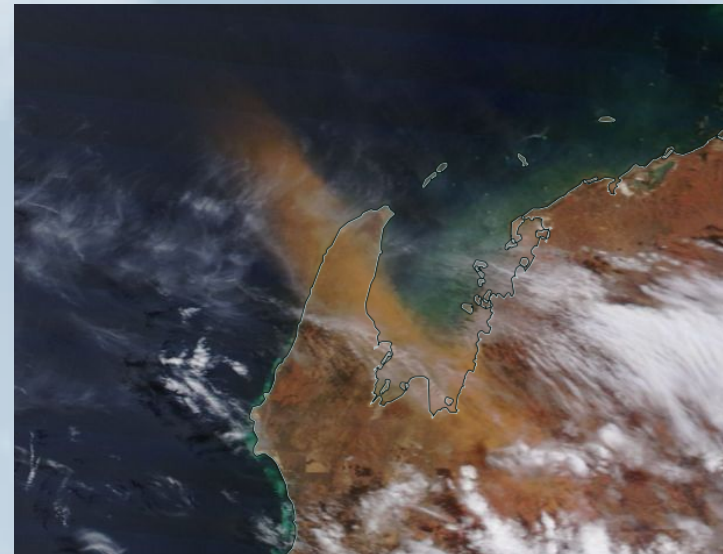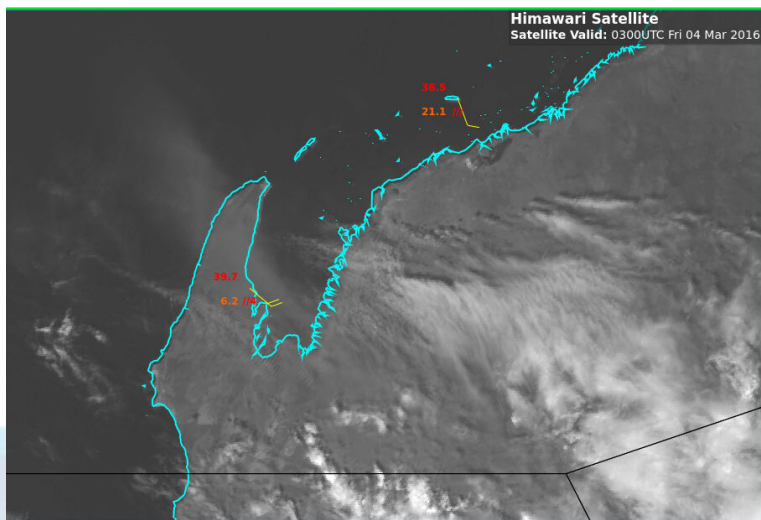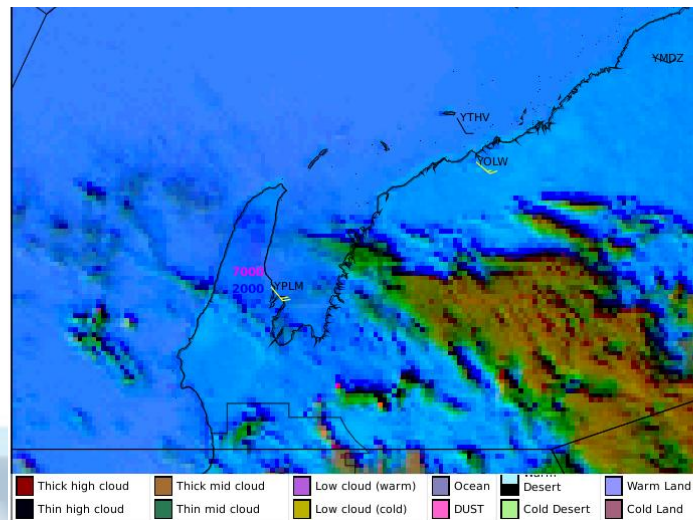

Dust Microphysics RGB (0300UTC)
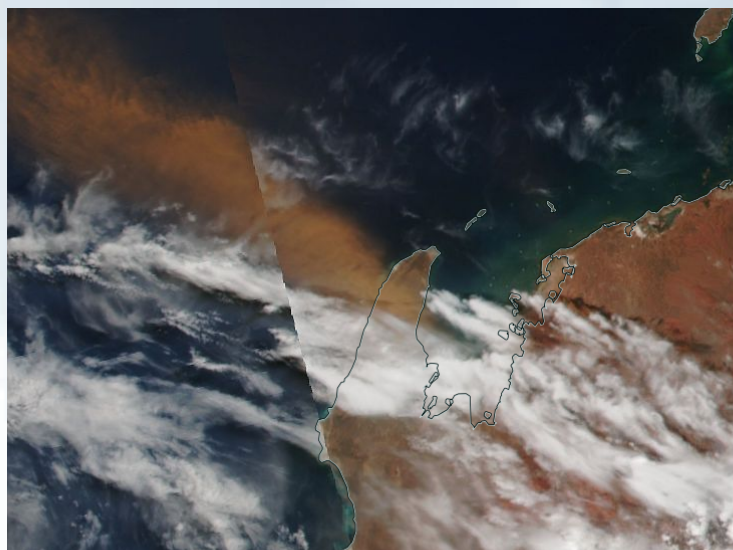
Soumi NPP VIIRS True Colour image (~0450UTC)
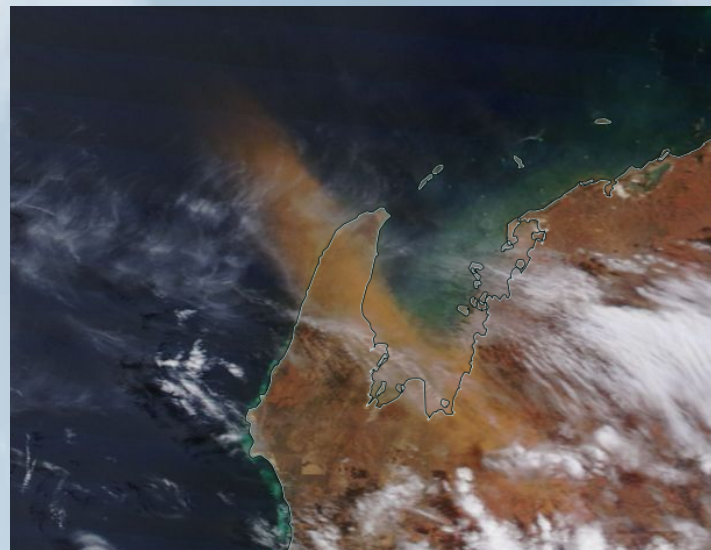
MODIS True Colour image (0305UTC)

Some work conducted by the Korea Meteorological Administration

RED : IR12.3-IR10.4
Range: -4 ~ 2K

GREEN : IR10.4-IR8.6
Range : 0 ~ 15K

BLUE : IR10.4
Range: 261 ~ 289K

Dust =RED+BLUE

From "Dust Detection Method using Various Satellite Products" Australian Vlab Centre of Excellence presentation of August 2016 by Dr Hyesook Park

Summary - feedback regarding the use of the Dust RGB product

- Tropical Forecasters in the Bureau do not use the Dust RGB much, as they have had limited success in using this product. For example, a Wes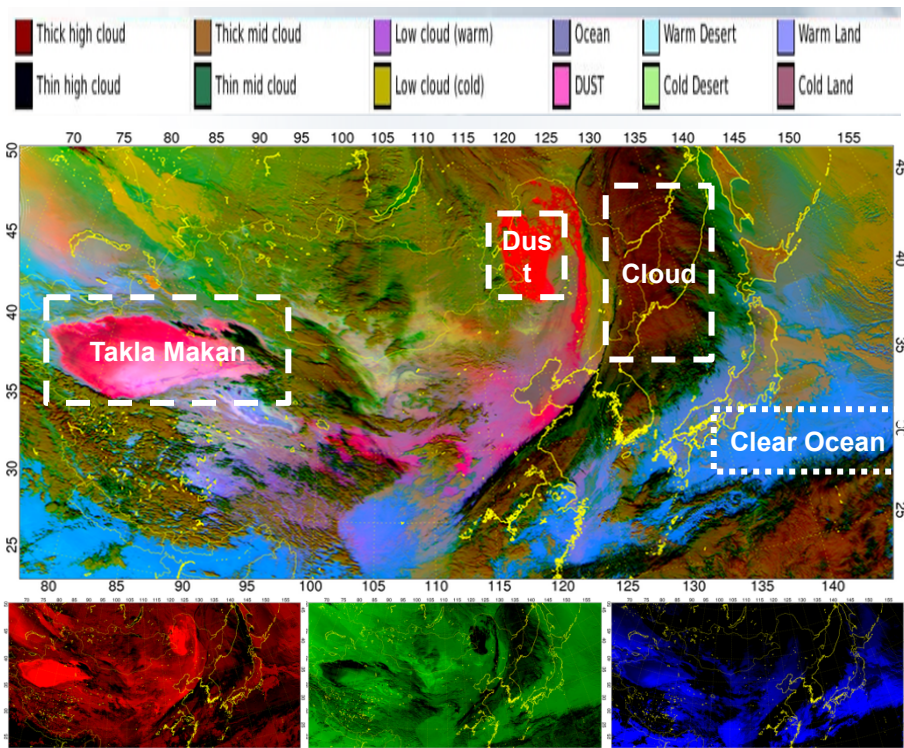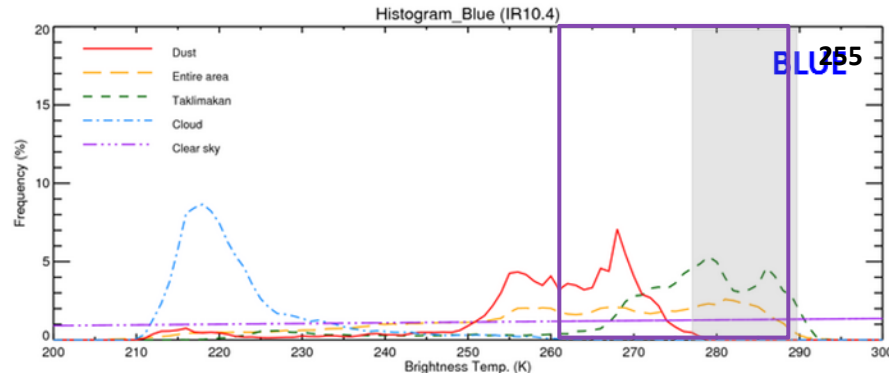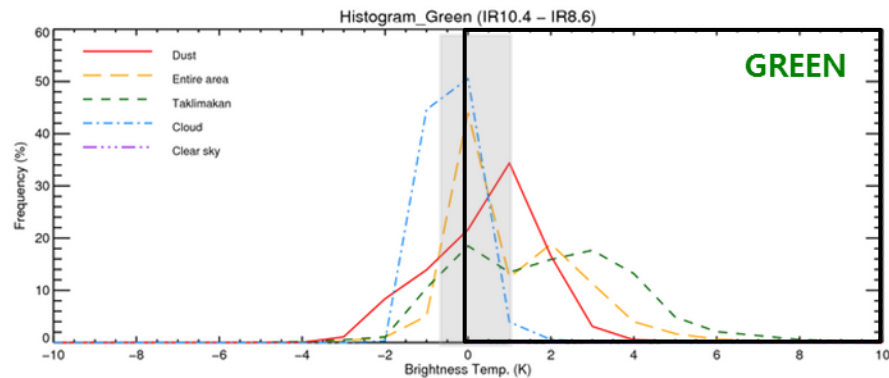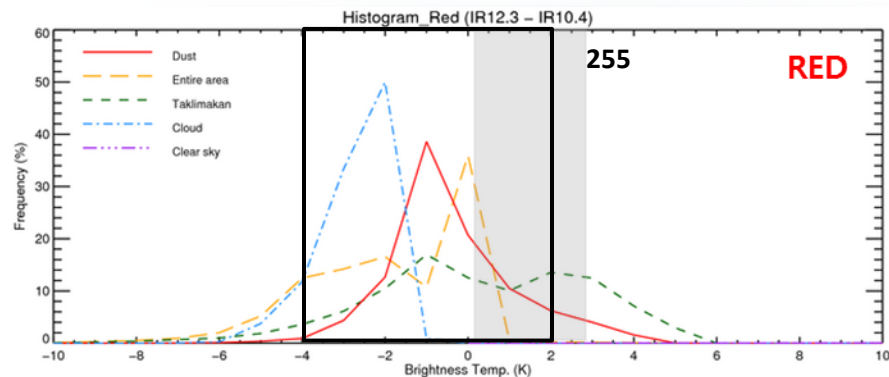t Australian Forecaster sent me an example of a dust plume near Learmonth which did not show up in the Dust RGB product but did shows up well in the Natural Colour RGB product.

- Mid latitude, South Australian Forecasters have noted that a number of dust reports at stations do not show up in the Dust RGB product. They have found the visible imagery more useful for detecting and monitoring this dust, particularly very small dust plumes. On the other hand, the thick dust observed near Adelaide on the 3 December 2015 could be seen in the RGB product.

- Jochen Kerkmann (EUMETSAT) has noted that the range of the Green Beam is best from 1.0 to 10.9. The recipe should be using the 10.4 micron channel instead of the 11.2 micron channel (email of 4th November 2016).

- It is also noted that very cold, snow covered surfaces (eg Siberia in winter) will have a similar signal to dust at night.

NOTE SLIDE

Summary

- Mid-latitude and Tropical versions of the Night Microphysics RGB product have been presented

- Have introduced modifications to the Day Convection RGB product and its use in combination with the Sandwich Product, including limitations in applying the RGB product for winter storms.

- Have introduced the application of the Dust RGB product and potential modifications to this product, including the monitoring of large and small dust plumes, also the interpretation of the product using histogram analysis.

- Forecaster / stakeholder feedback regarding the effective use of the Day Convection, Night Microphysics and Dust RGB products has been presented, including the optimal display of this data with other information for Operational Forecasters.

- Australian VLab Centre of Excellence Regional Focus Group meeting recordings have a lot of information pertaining to the application of Himawari-8 RGB products to case studies in the Australasian-Pacific region.