Australian Government Bureau of Meteorology | Melbourne VLab Centre Of Excellence | VLab

Australian VLab Centre of Excellence Regional Focus Group meeting 4 July 2019

Bodo Zeschke Australian VLab Centre of Excellence Point of Contact

Content of the Regional Focus Group meeting 4th July 2019

Topics of discussion

A Weather and Forecast discussion (Mr Bodo Zeschke BMTC)

A case study of a recent volcanic eruption, showcasing the application of satellite data and data products (Mr Bodo Zeschke BMTC)

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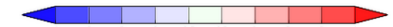
Broadscale Ocean and Atmosphere conditions



SST anomalies – 17-23 Jun 2019

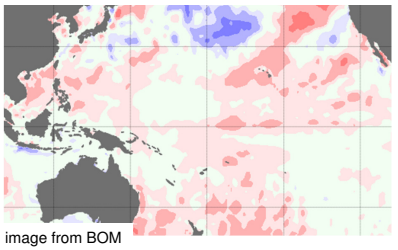


image from BOM

OLR anomalies – 30 days to 1st July 2019

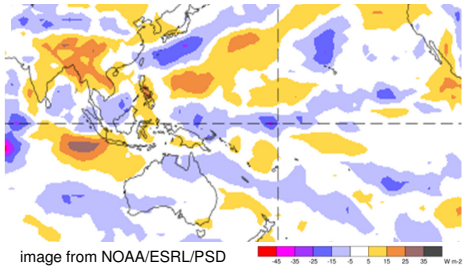


image from NOAA/ESRL/PSD

Southern Oscillation Index (30 day moving)

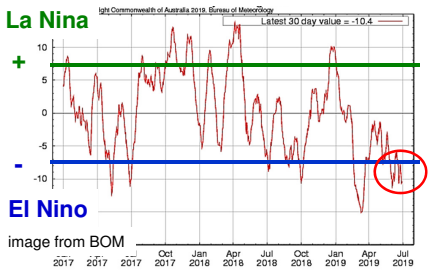


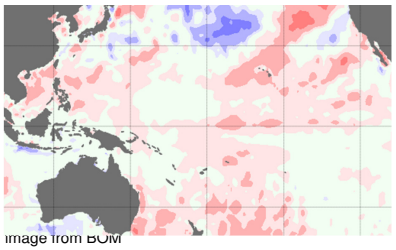
image from BOM

The current situation

- Neutral ENSO conditions. Inactive ENSO
- Surface and subsurface of the equatorial Pacific Ocean remain warmer than average, but have cooled since early 2019.
- Trade winds and SOI (90 day values) remain neutral.

Broadscale Ocean and Atmosphere conditions

SST anomalies – 17-23 Jun 2019



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OLR anomalies – 30 days to 1st July 2019

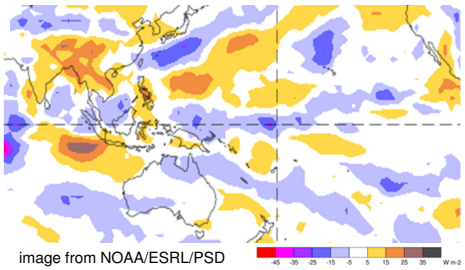


image from NOAA/ESRL/PSD

Climate Model Forecasts (February 2019)

La Nina — El Nino

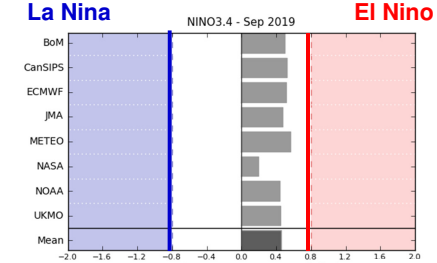
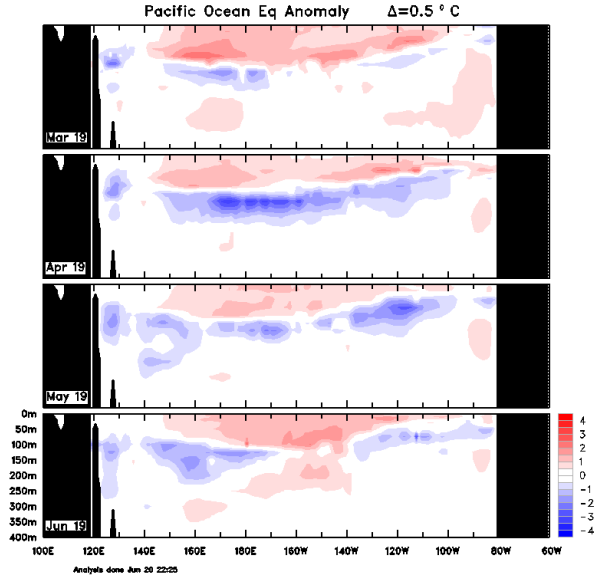


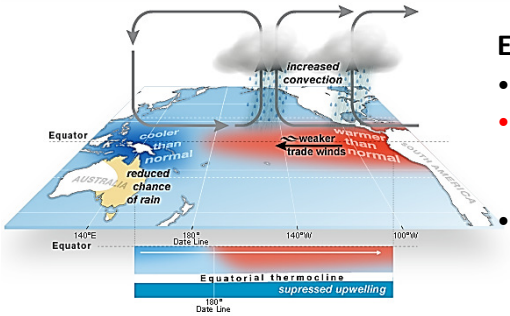
image from BOM

Future Trends

- All models suggest neutral values of NINO3.4 index to persist from August through to the end of the austral/southern spring

Evolution of the equatorial Pacific subsurface temperature anomalies





El Niño–Southern Oscillation (ENSO): **El Niño**

© Commonwealth of Australia 2013.

images from BOM

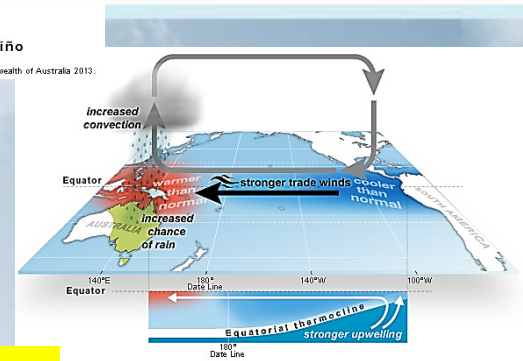
El Nino

- Below average Easterly Trade Winds
- Warm SST anomalies/enhanced convection over central & eastern Pacific Ocean
- Negative SOI – sustained periods below minus 8

La Nina

- Enhanced Easterly Trade Winds
- Warm SST anomalies / enhanced convection over western Pacific & Maritime Continent
- Positive SOI – sustained periods above plus 8

REFERENCE



El Niño–Southern Oscillation (ENSO): **La Niña**

© Commonwealth of Australia 2013.

The state of ENSO (Bureau ENSO Wrap Up http://www.bom.gov.au/climate/enso/#tabs=Outlooks)

- The immediate likelihood of El Niño developing has passed, meaning the *ENSO Outlook* has been reset to INACTIVE.
- While the possibility of El Niño can't be completely ruled out for 2019, the tropical Pacific Ocean is more likely than not to remain in an ENSO-neutral phase over the coming months.
- Oceanic and atmospheric indicators are now largely at ENSO-neutral levels. Tropical Pacific sea surface temperatures have cooled over the past fortnight but remain slightly warmer than average.
- Cloudiness near the Date Line and trade winds have been close to neutral over recent weeks, while the Southern Oscillation Index (SOI) has hovered around El Niño threshold values over the past month.
- With little anomalous warmth in the ocean sub-surface, most climate models indicate the tropical Pacific will continue shifting further away from El Niño thresholds through the winter.

REFERENCE

Indian Ocean Dipole (IOD) / Madden Julian Oscillation (MJO)

Indian Ocean Dipole
(SST anomalies 1 Jul 2019)

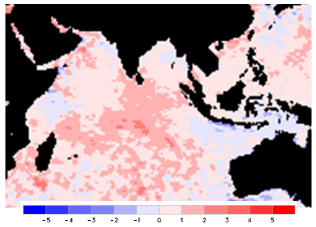


image from BOM

Indian Ocean Dipole

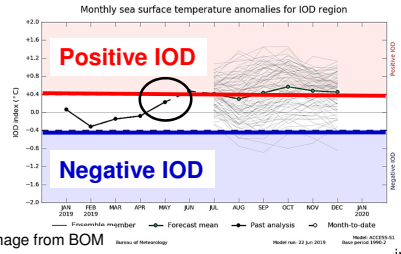
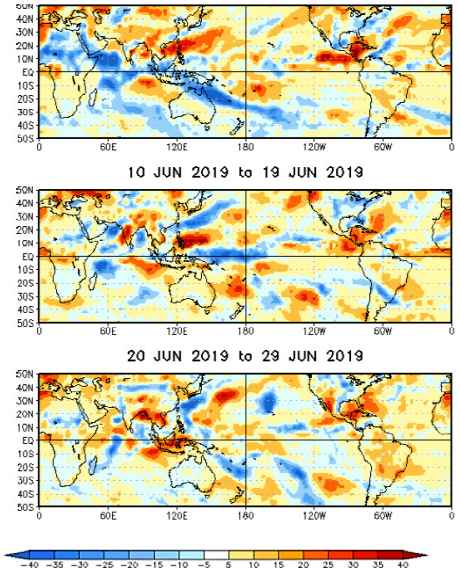


image from BOM

OLR anomalies – weekly to 29 Jun 2019



images from NOAA National Weather Service Climate Prediction Centre

Indian Ocean Dipole (IOD) / Madden Julian Oscillation (MJO)

Indian Ocean Dipole
(SST anomalies 1 Jul 2019)

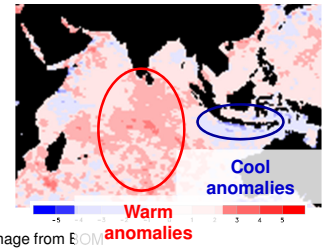
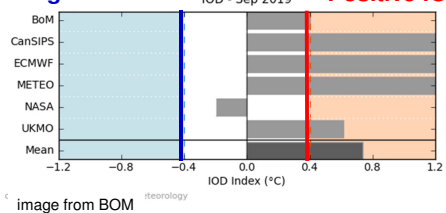


image from BOM

Indian Ocean Dipole



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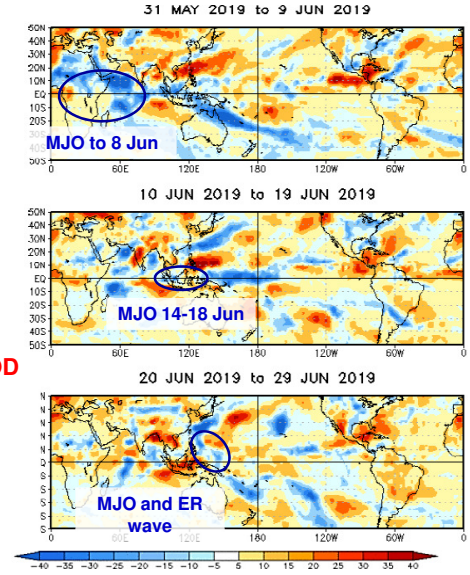
OLR anomalies – weekly to 29 Jun 2019



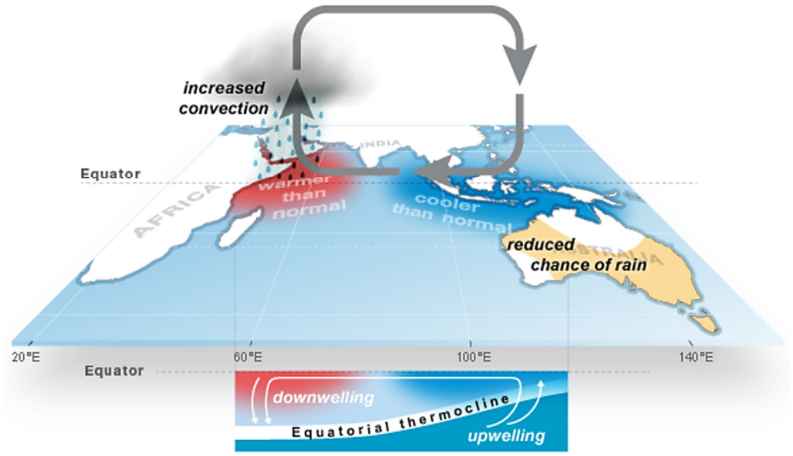
images from NOAA National Weather Service Climate Prediction Centre

The state of the Indian Ocean Dipole (from Indian Ocean Dipole outlooks http://www.bom.gov.au/climate/enso/#tabs=Indian-Ocean)

- The Indian Ocean Dipole (IOD) index has dipped into neutral values during the last week, while the overall pattern remains positive. The latest weekly index value to 23 June is +0.26 °C.
- However, the positive IOD-like SST pattern in the Indian Ocean remains. Surface waters in the central to western Indian Ocean are warmer than average, while in the east, cool anomalies are present south of the Indonesian island of Java, extending eastward to the island of Sumba. The latest fall in the IOD values is simply due to average to cooler than average waters right on the African coastline, most likely generated in association with severe tropical cyclone *Vayu*.
- Five of the six international climate models surveyed by the Bureau indicate positive IOD values are likely to continue through the austral winter and spring, suggesting a positive IOD event may be underway. To be considered a positive IOD event, values above the positive threshold (+0.4 °C) would need to be sustained for at least eight weeks.

REFERENCE

Positive phase of Indian Ocean Dipole (+IOD)

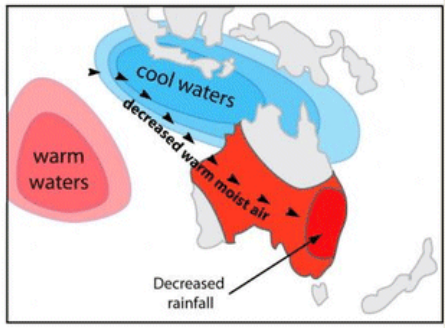


Indian Ocean Dipole (IOD): **Positive phase**

Diagram from Liverpool Plains Land Management Inc.

Positive phase of Indian Ocean Dipole (+IOD)

Usually starts May or June, peaks between August and October and then rapidly decays



Positive phase: warm Indian Ocean water leads to weaker, drier winds and less rainfall.

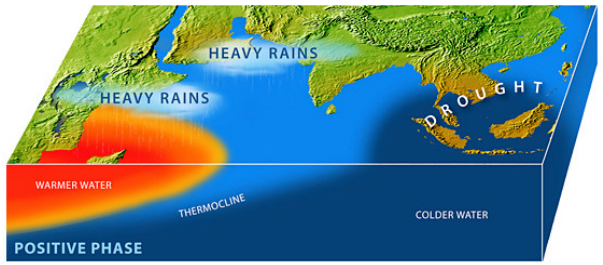


Diagram from the Bureau of Meteorology

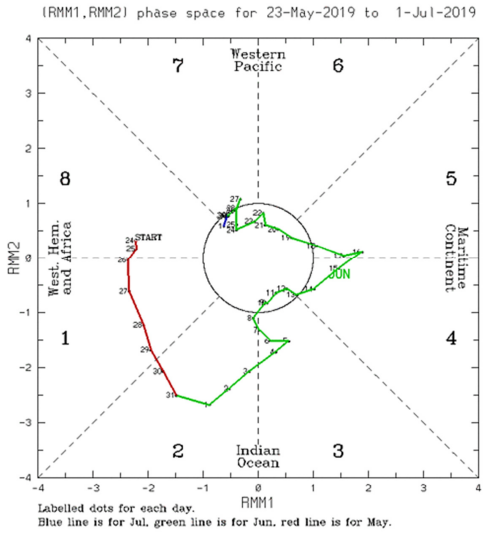
The impact of the Positive phase of the Indian Ocean Dipole

(http://www.bom.gov.au/climate/iod/)

- Westerly winds weaken along the equator allowing warm water to shift towards Africa. Changes in the winds also allow cool water to rise up from the deep ocean in the east. This sets up a temperature difference across the tropical Indian Ocean with cooler than normal water in the east and warmer than normal water in the west.
- Generally this means there is less moisture than normal in the atmosphere to the northwest of Australia. This changes the path of weather systems coming from Australia's west, often resulting in less rainfall and higher than normal temperatures over parts of Australia during winter and spring.

REFERENCE

The MJO phase diagram (1st July 2019, http://www.bom.gov.au/climate/mjo/#tabs=MJO-phase)



NOTE SLIDE

The Madden–Julian Oscillation (Issued 2 July 2019, http://www.bom.gov.au/climate/mjo/#tabs=Weekly-note)

- A weak pulse of the Madden–Julian Oscillation (MJO) stalled over the Pacific Ocean during the past week. The MJO interacted with other non-MJO tropical waves (most notably, equatorial Rossby waves) in recent days. The influence of these tropical waves likely contributed to enhanced tropical weather over parts of the western and eastern North Pacific Ocean.
- Most climate models forecast the MJO to be weak or indiscernible for the next few days to a week, before redeveloping over Africa or the northern Indian Ocean and tracking eastwards.
- Depending on the strength and location of the MJO signal, the Indian southwest monsoon could be significantly invigorated in one to two weeks.
- If the MJO pulse strengthens noticeably and moves over the northern Indian Ocean it could positively influence India's 2019 monsoon rainfall which is currently well short of the season-to-date average across nearly all parts of the subcontinent.

REFERENCE

General meteorological activity over the region

OLR anomalies – 30 days to 1st July 2019

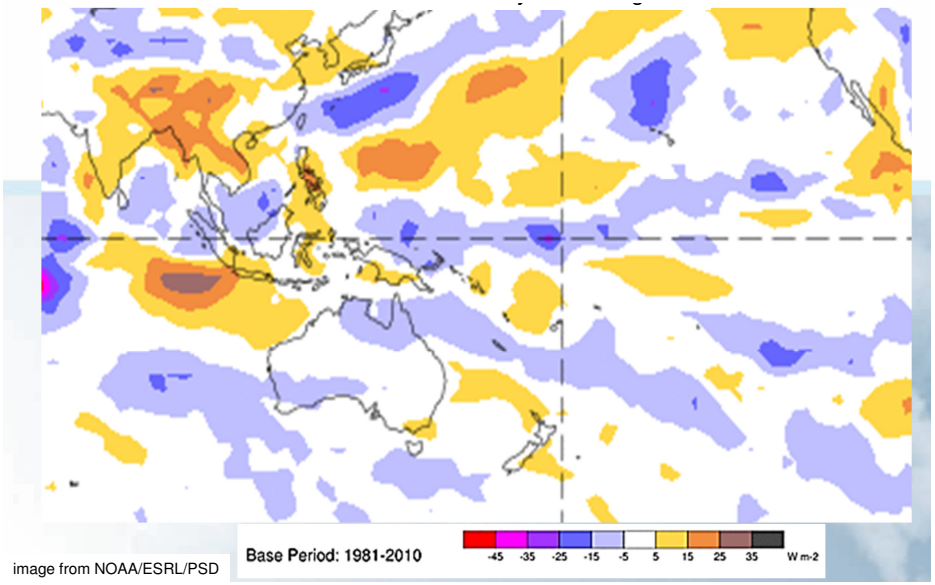


image from NOAA/ESRL/PSD

General meteorological activity over the region

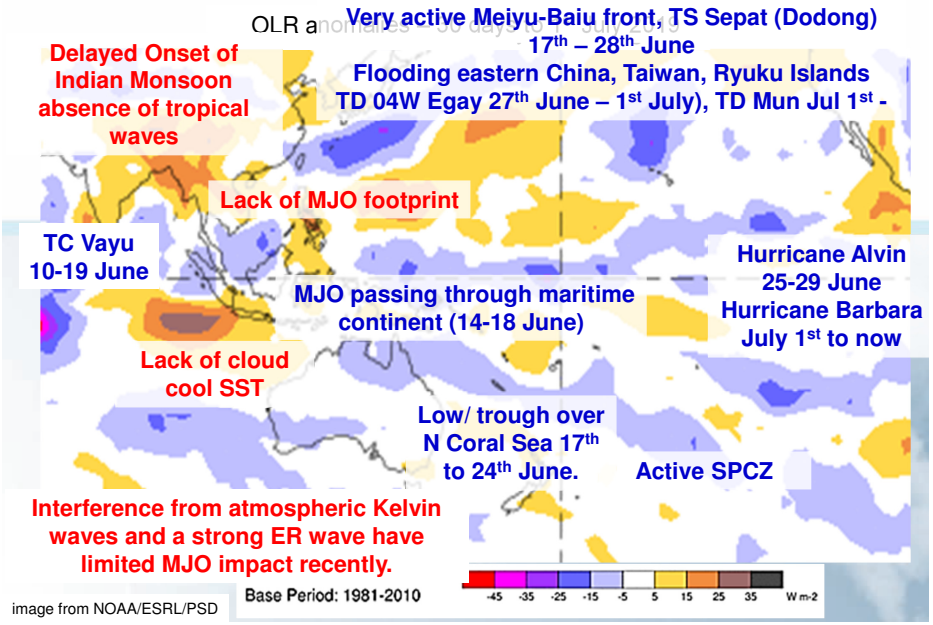


image from NOAA/ESRL/PSD

General meteorological activity over the region (part 1)

- Over the Indian Ocean, the lack of tropical wave activity in recent weeks has contributed to the relatively slow northward progression of the Indian southwest monsoon. The northernmost extent of the monsoon is currently near central parts of the Indian subcontinent. The average position would typically be nearer to the northernmost third of India at this time of year. (from http://www.bom.gov.au/climate/mjo/#tabs=Weekly-note)
- Despite the lack of a significant MJO or other tropical wave activity across the region, heavy rainfall and flooding has been a feature over the northwestern Pacific, particularly parts of eastern China. The Meiyu (or Baiu) front has been active with some parts of eastern China received 150 to 200 mm of rainfall in less than 48 hours, which contributed to local flooding and landslides. Flooding rains have also affected Taiwan and the Ryuku Islands of southern Japan. (from http://www.bom.gov.au/climate/mjo/#tabs=Weekly-note)
- An area of suppressed convection is evident between this equatorial convection and the Meiyu Front extending across Taiwan and south of Japan. http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml#discussion

REFERENCE

General meteorological activity over the region (part 2)

- Sepat, which briefly reached tropical storm strength (equivalent to an Australian category 1 tropical cyclone) in the western North Pacific Ocean generated heavy rainfall over parts of Japan and South Korea before weakening over open waters of the northern Pacific Ocean. This tropical storm developed within a feature called the Meiyu (or Baiu) front, a near-stationary front that forms near eastern China at this time of the year. It combined to generate heavy rains which lead to floods and landslides. A developing tropical low, currently south of Hong Kong, may intensify to tropical cyclone strength in the next day or two. (from http://www.bom.gov.au/climate/mjo/#tabs=Weekly-note)

- In Indonesia, BNPB has reported that anticipation for drought are being monitored in the national level since less to no-rain condition have increased on the several provinces.https://reliefweb.int/report/indonesia/asean-weekly-disaster-update-24-30-jun-2019

REFERENCE

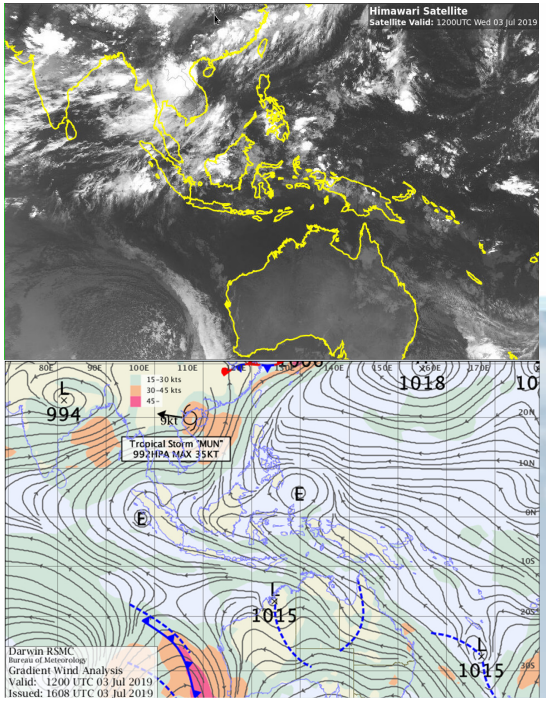


Image courtesy BOM/JMA

Infrared channel satellite image and Gradient Winds ,

12UTC 3rd July 2019

Convection in equatorial regions associated with:

- Active Asian SW monsoon with Tropical Storm Mun
- Monsoon surges over the Bay of Bengal / S China Sea.
- Indian Monsoon continues to advance north
- SPCZ remains relatively weak over the Solomon Islands
- Trade Wind flow over most of SH tropics

Image courtesy BOM

The Darwin RSMC Streamline Analysis Notes for 00Z Wednesday 3rd July 2019 (1):

Overview

- Tropical Storm "Mun" near southern China developed into Category 1 system on Tuesday night.

Tropical Waves

- The Madden-Julian Oscillation (MJO) has returned to the unit circle, after briefly entering Phase 7 (Western Pacific). The model guidance suggests the MJO may emerge in about 3 to 4 days' time in Phase 1 (Africa) or 2 (Indian Ocean).
- An Equatorial Rossby Wave at about 110E is enhancing convection near the equator.

Northern Hemisphere

- Tropical Storm "Mun" near southern China developed into Category 1 system on Tuesday night.

REFERENCE

The Darwin RSMC Streamline Analysis Notes for 00Z Wednesday 3rd July 2019 (2):

Northern Hemisphere (cont)

- On Wednesday afternoon the system was forecast to continue moving northwest impacting China and Vietnam as a Category 1 system during the next 24 to 48 hours, then becoming a tropical depression (low) (Japan Meteorological Agency Tropical Cyclone Information). China Meteorological Administration had warnings current for the system, with wind and heavy rain, as did Vietnam.
- Strong monsoonal flow continues over the Bay of Bengal and South China Sea.
- The Indian Southwest Monsoon continues advancing north. The monsoon remains further south than usual, but in the last week has progressed rapidly north to cover most of the Indian Peninsula. The low which recently developed over north Bay of Bengal has moved inland over India, assisting the monsoon's progression and bringing very heavy rainfall.
- A ridge extends over the Northwest Pacific Ocean, associated with mostly clear conditions.

REFERENCE

The Darwin RSMC Streamline Analysis Notes for 00Z Wednesday 3rd July 2019 (3):

Southern Hemisphere

- The South Pacific Convergence Zone (SPCZ) remains relatively weak over the Solomon Islands.
- Trade flow prevails over most of the southern hemisphere tropics.

REFERENCE

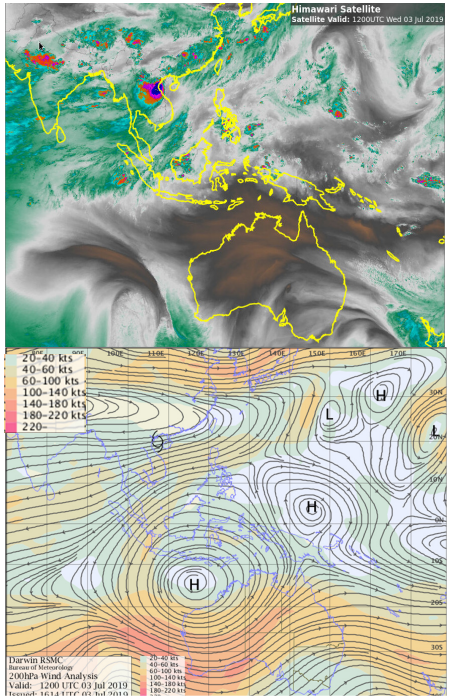
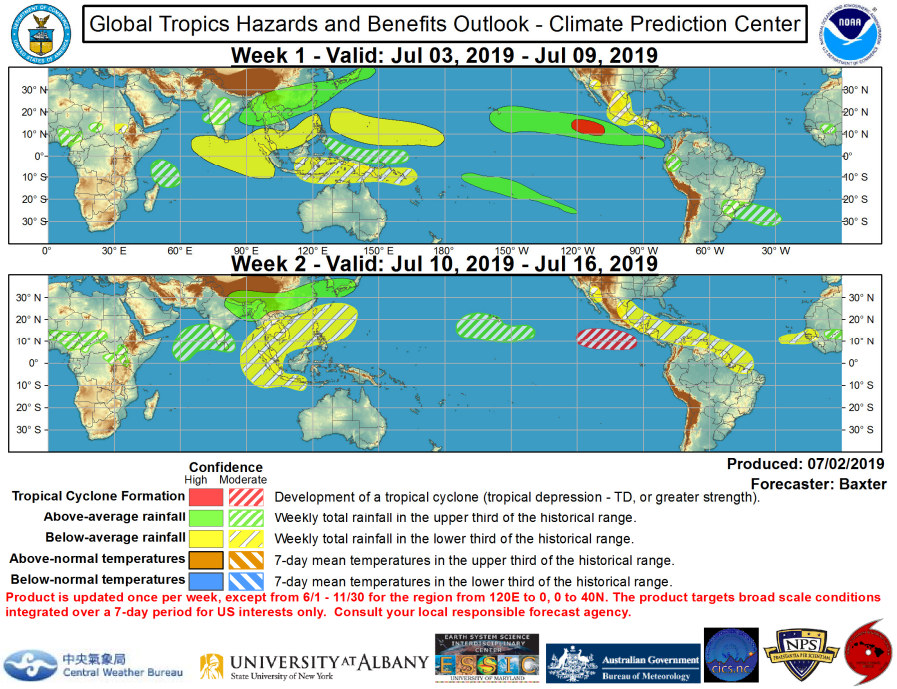


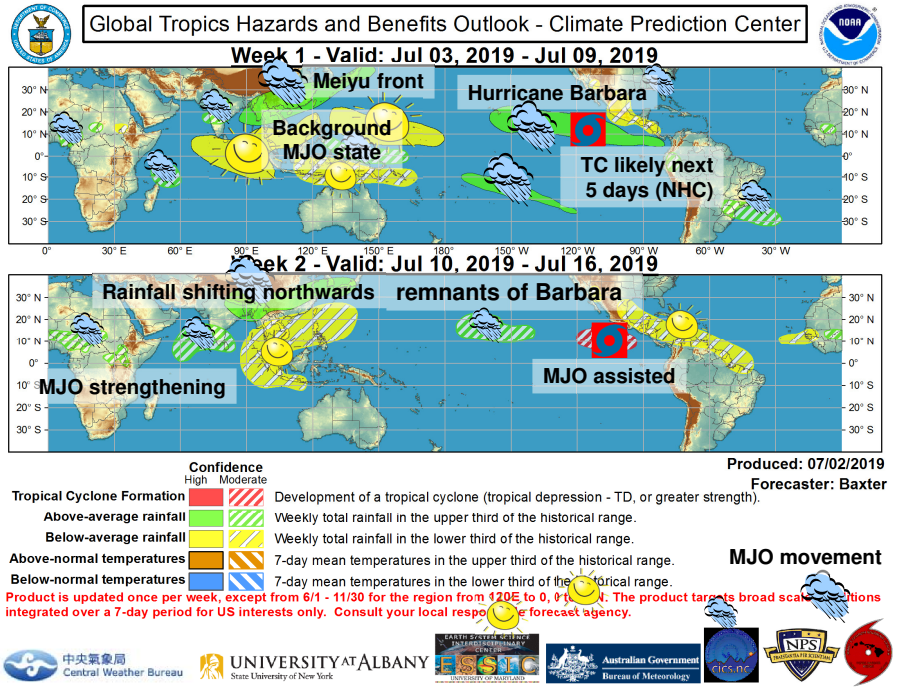
Image courtesy BOM/JMA

Water Vapour channel satellite image and 200hPa Wind analysis, 12UTC 3rd July 2019

- Upper ridge over the Asian Southwest Monsoon.
- Some shear over TS Mun
- Good upper return flow out of the monsoon
- Upper lows over the north central Pacific.
- Upper ridge over northern Australia
- Subtropical Jets to SW Australia and over Japan
- Upper troughs associated with frontal systems / troughs over SH.

Image courtesy BOM





CPC Global Tropics Hazards and Benefits Outlook Discussion (part 1)

Valid: 07.03.19 - 07.16.19

(http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/)

- The MJO was fairly weak over the past several days, but there remain several diagnostic tools that place the MJO enhanced phase over the Pacific. Interference from atmospheric Kelvin waves and a strong equatorial Rossby wave have limited the impact of the background MJO state on observed rainfall anomalies of late. The upper- and lower-level zonal wind fields along with 200-hPa velocity potential retain some MJO footprint, and this is expected to continue for much of the upcoming two weeks. The GEFS and ECMWF ensemble forecasts are in reasonably good agreement on strengthening of the MJO signal over Africa and the western Indian Ocean during Week-2; both also predict more canonical eastward propagation as well.
- Hurricanes Alvin and Barbara formed over the East Pacific during the past week. Alvin dissipated on 29 June, while Barbara is forecast to become a major hurricane on 2 July and track generally westward while weakening to tropical storm strength by this weekend. Its remnants are forecast to pass near or south of Hawaii late in Week-1 and early in Week-2.

REFERENCE

CPC Global Tropics Hazards and Benefits Outlook Discussion (part 2)

Valid: 07.03.19 - 07.16.19

(http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/)

- NHC currently depicts a 70% chance of tropical cyclone formation during the next five days over the East Pacific; at present this system is forecast to eventually take a more northerly track than Barbara.
- The forecast MJO evolution would support a favorable environment for tropical cyclone formation during Week-2, and so a moderate risk of cyclogenesis is depicted for that period. There is broad support for this from both the GEFS and ECMWF ensemble systems.
  Tropical cyclogenesis is imminent (or already occurred) over the West Pacific basin just east of the Chinese province of Hainan. This system is forecast to cross Hainan on 3 July and affect northern Vietnam shortly thereafter. Elsewhere, the West Pacific is forecast to remain inactive.
- Precipitation forecasts during Week-1 are based largely on the dynamical model consensus among the ECMWF, GEFS, and CFS. Enhanced rainfall remains likely associated with the Meiyu front over parts of southern and eastern Asia.

REFERENCE

CPC Global Tropics Hazards and Benefits Outlook Discussion (part 3)

Valid: 07.03.19 - 07.16.19

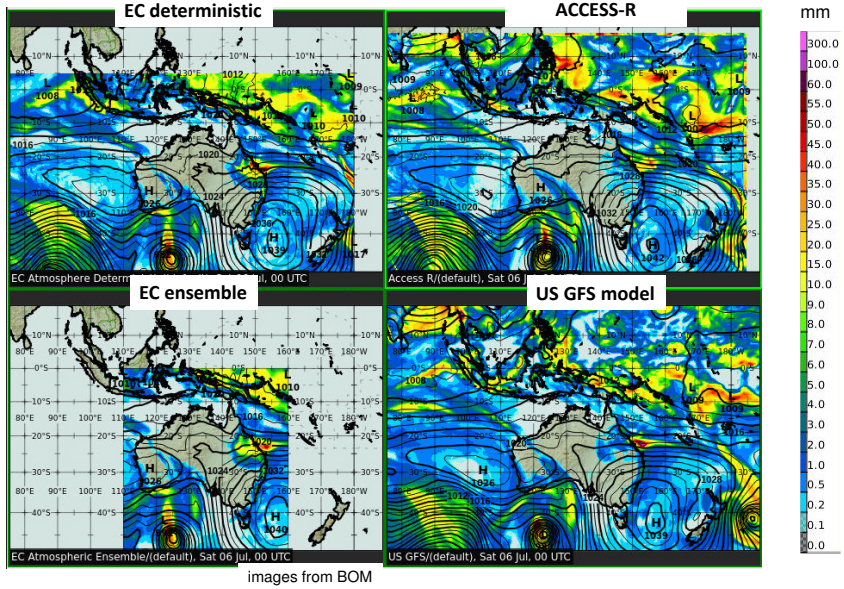
(http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/)

- Above-average rainfall is also more likely over parts of the Indian subcontinent after a slow start to the wet season. Below-average rainfall is more likely over much of the eastern Indian Ocean and Maritime Continent, consistent with the background MJO state. Below-average rainfall is also favored over parts of Central America and the southwestern CONUS.
- During Week-2 a drying trend is expected over the Americas and East Pacific (the elevated tropical cyclogenesis risk notwithstanding).
- Above-average rainfall is favored over the central Pacific basin and the Hawaiian Islands in part associated with the remnants of Barbara. The enhanced rainfall over Asia is forecast to shift northward, while above-average rainfall becomes more likely over parts of the western Indian Ocean.

REFERENCE

Looking ahead: Forecast for 00UTC, Saturday 6th July 2019

(MSLP, 24hr pptn). Model run 00UTC 3rd July 2019



images from BOM

Looking ahead: Forecast for 00UTC, Saturday 6th July 2019

(MSLP, 24hr pptn). Model run 00UTC 3rd July 2019

- Note the slow moving high pressure system, expected over the Tasman Sea, to the east of Australia at 00UTC Saturday.
- The cold front has moved eastwards into the Great Australian Bight.
- Note the tight spacing of isobars between the high and the front, indicating the potential for strong winds offshore from South Australia.
- Also, strong east/southeast winds over the northern Tasman Sea and southern Coral Seas to the east of Australia. These winds are also driving hazardous surf conditions along coastal areas of northern New South Wales and the east coast of Queensland. Note the forecast of significant rainfall along the central Queensland coast.
- Looking to the northern hemisphere, the southwest monsoon is forecast to be still active over the Bay of Bengal
- A general absence of precipitation persists over large parts of Indonesia
- The models indicate that the South Pacific Convergence Zone may become more convectively active towards the weekend.

REFERENCE

Content of the Regional Focus Group meeting 4th July 2019

Topics of discussion

A Weather and Forecast discussion (Mr Bodo Zeschke BMTC)

A case study of a recent volcanic eruption, showcasing the application of satellite data and data products (Mr Bodo Zeschke BMTC)

The Ulawun eruption of 26/27th June 2019

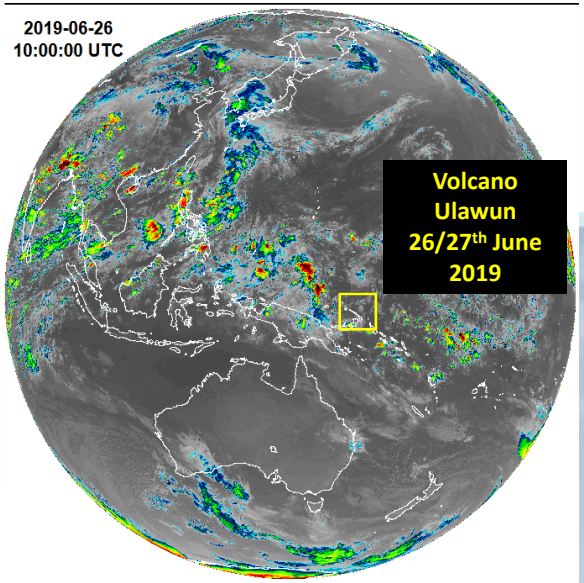
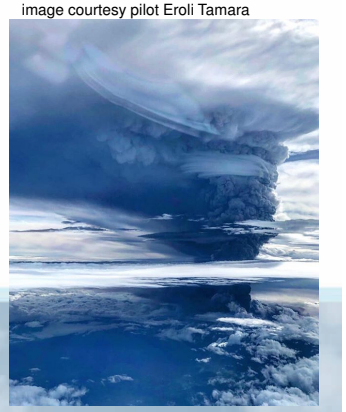


image courtesy RAMMB/CIRA @CSU

image courtesy pilot Eroli Tamara



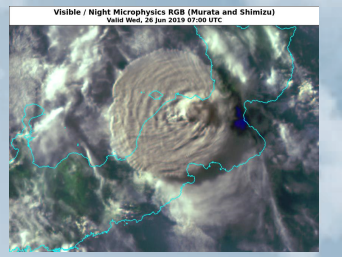


image courtesy JMA/BOM

Background information about Ulawun eruption (part 1)

(from https://watchers.news/2019/06/26/ulawun-volcano-eruption-june-26-2019/)

- A high-level eruption took place at Ulawun volcano, Papua New Guinea on June 26, 2019. The eruption started at about 22:00 UTC on June 25 after a few weeks of increased activity. Nearby villages were evacuated.
- The RVO reported increased seismicity at the volcano and continuous steam/SO_2 emission over the past 24 hours, the Darwin VAAC said in VA Advisory issued 23:47 UTC, June 25. At the time, the eruption was still not observable on satellite imagery.
- Continuous ash emissions to 6.7 km (22 000 feet) were observed extending west from the summit at 01:30 UTC on June 26.
- A high-level eruption was first reported at 01:55 UTC with volcanic ash rising up to 12.8 km (42 000 feet) above sea level and moving SW. The Aviation Color Code was raised to Red.
- Secondary plume to 7.9 km (26 000 feet) a.s.l. was observed at 02:30 UTC.
- Satellite imagery indicated new volcanic emission to approximately 16.7 km (55 000 feet) a.s.l. at 05:50 UTC.

REFERENCE

Background information about Ulawun eruption (part 2)

(from https://watchers.news/2019/06/26/ulawun-volcano-eruption-june-26-2019/)

- Satellite imagery obtained 08:30 UTC indicate an ongoing volcanic ash eruption to approximately 19.2 km (63 000 feet) above sea level extending in all directions, the Darwin VAAC reported 08:33 UTC.
- Volcanic ash to 13.4 km (44 000 feet) a.s.l. continues to drift S and is expected to dissipate within 6 hours.
- "VA to 19.2 km (63 000 feet) a.s.l. which is stratospheric has become detached from the volcano and is moving eastwards," the center reported 11:30 UTC. "Volcanic ash to 16.7 km (55 000 feet) a.s.l. is extending rapidly outwards and bulging more in a southerly direction. The eruption appears to have ceased, with strong hotspot remaining."

REFERENCE

image courtesy pilot Eroli Tamara

The satellite products examined in this case study

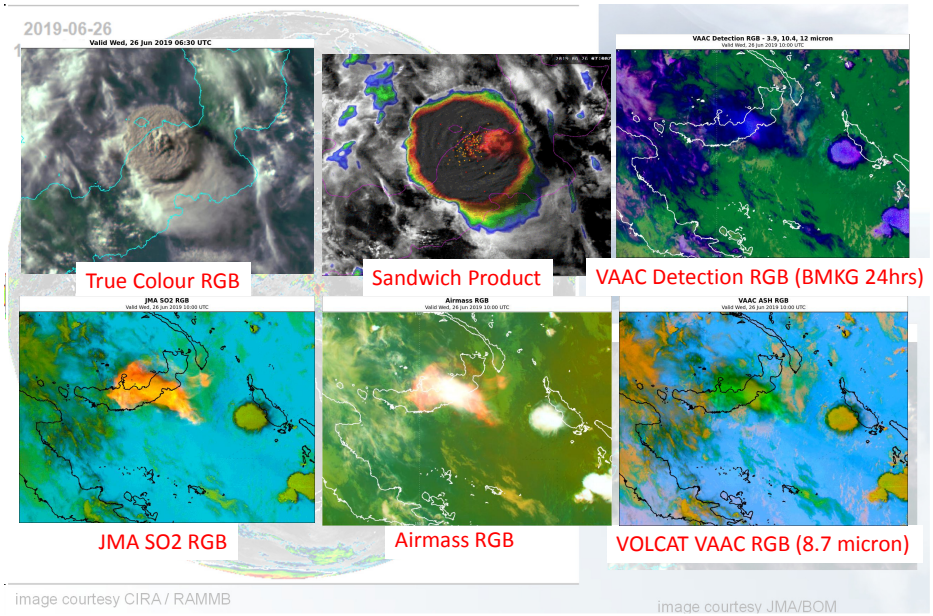


image courtesy CIRA / RAMMB

image courtesy JMA/BOM

The satellite products examined in this case study

Satellite imagery and derived products from the NOAA/CIMSS Volcanic Cloud Monitoring Web Portal

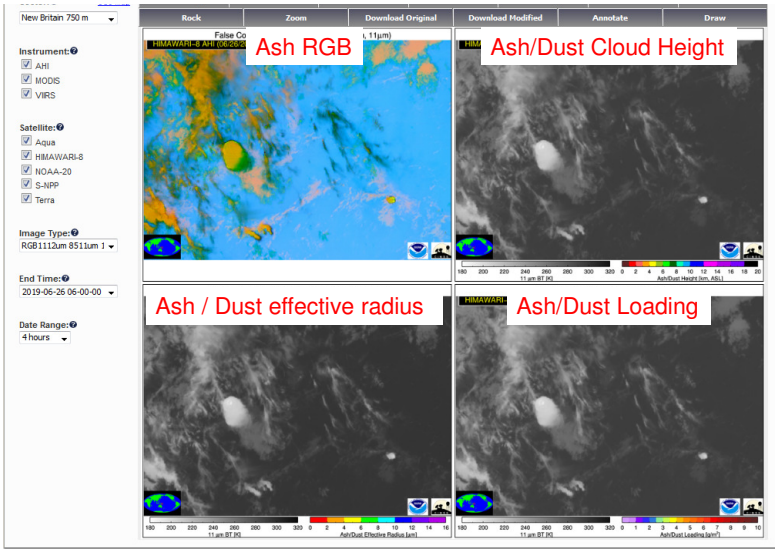


image courtesy pilot Eroli Tamara

True Colour RGB and Sandwich Product

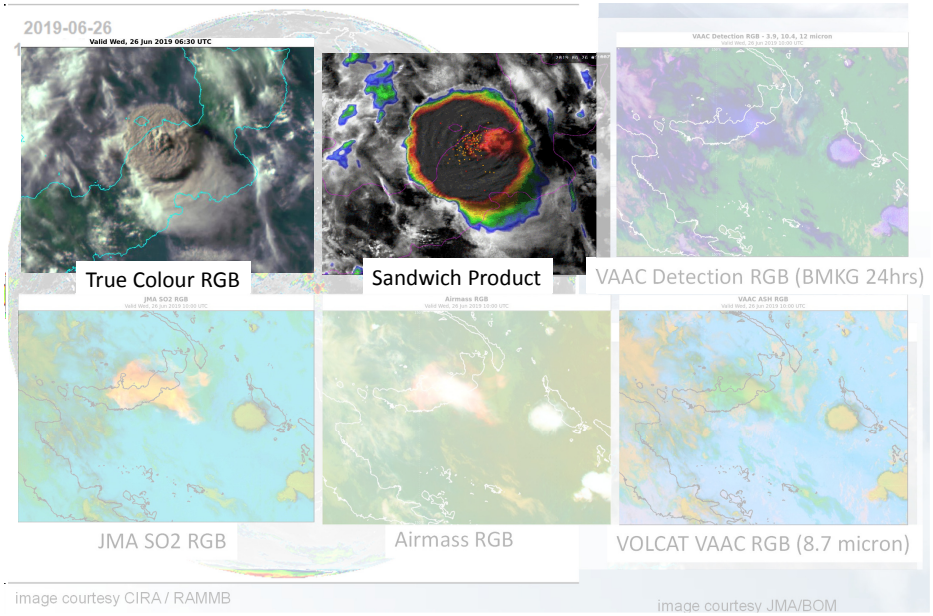
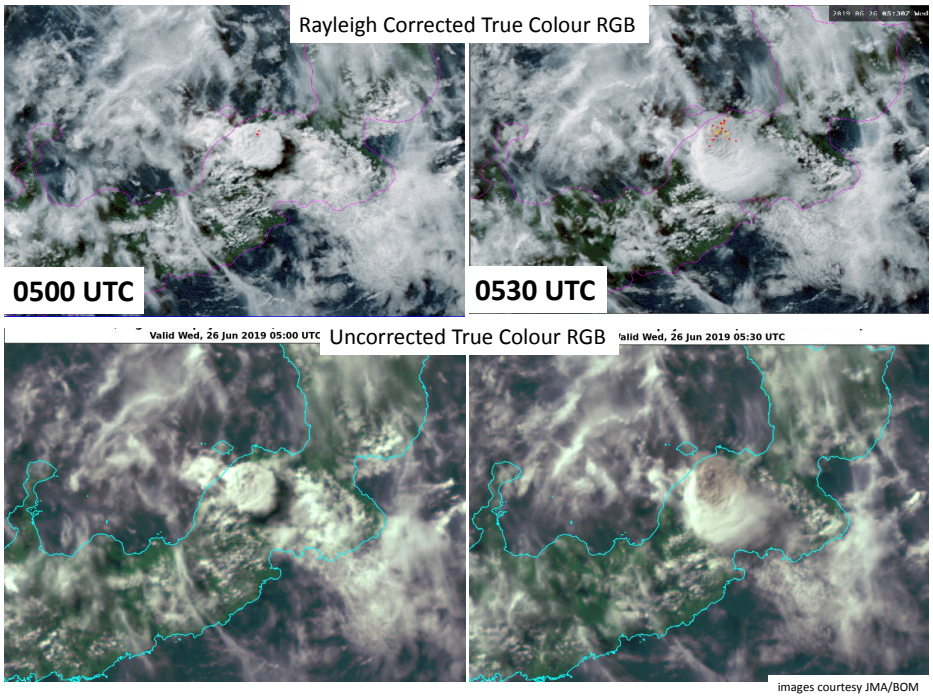
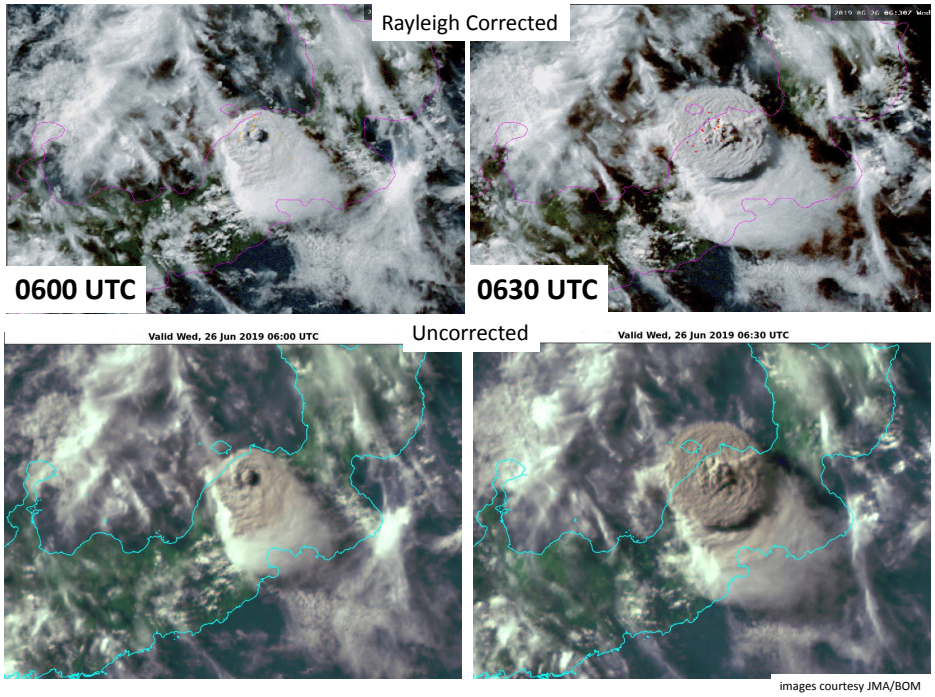


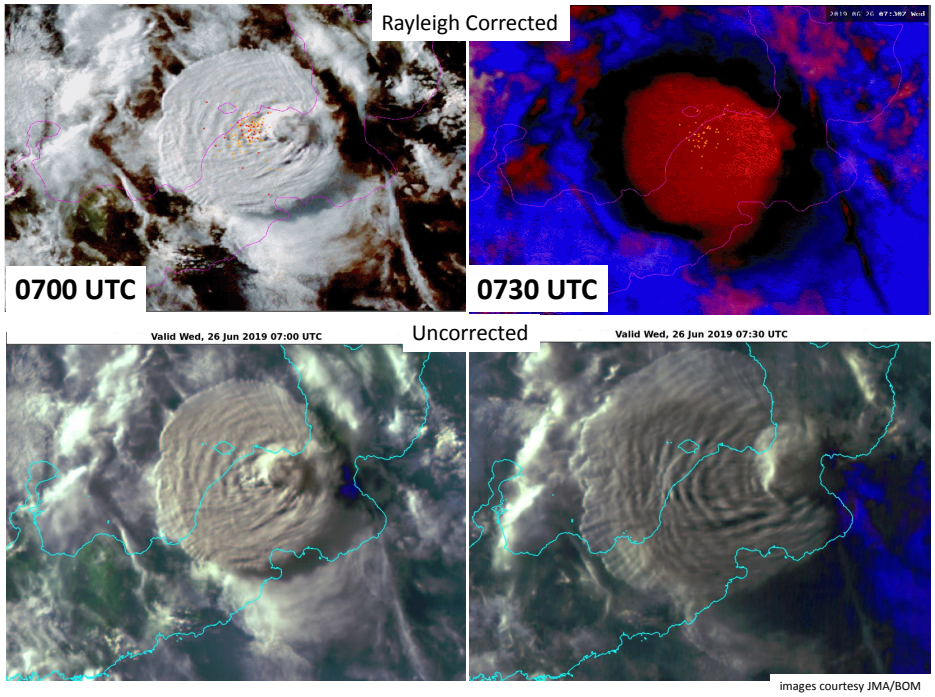
image courtesy CIRA / RAMMB

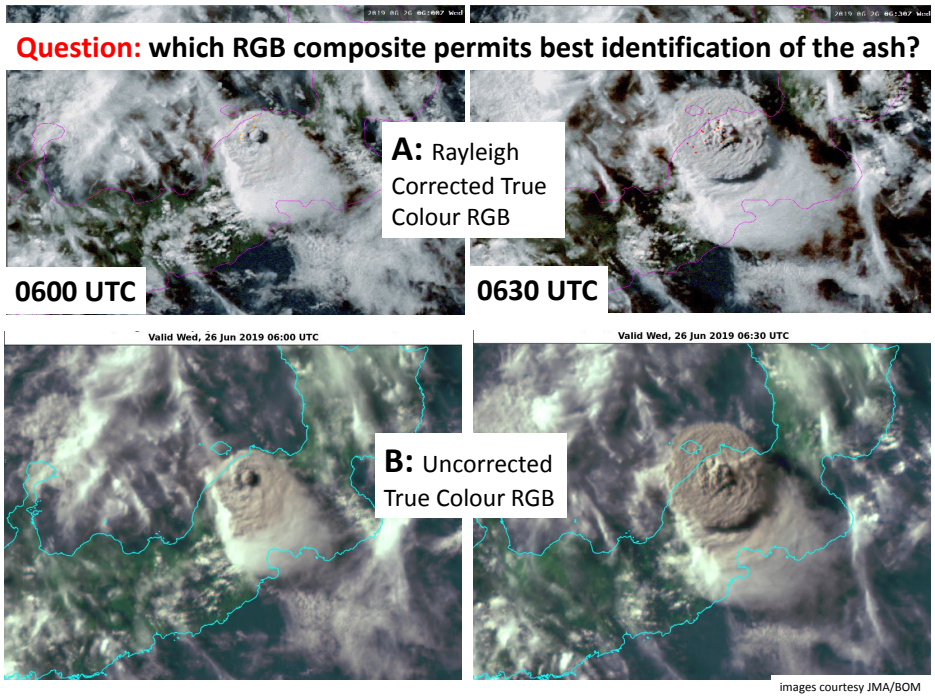
image courtesy JMA/BOM

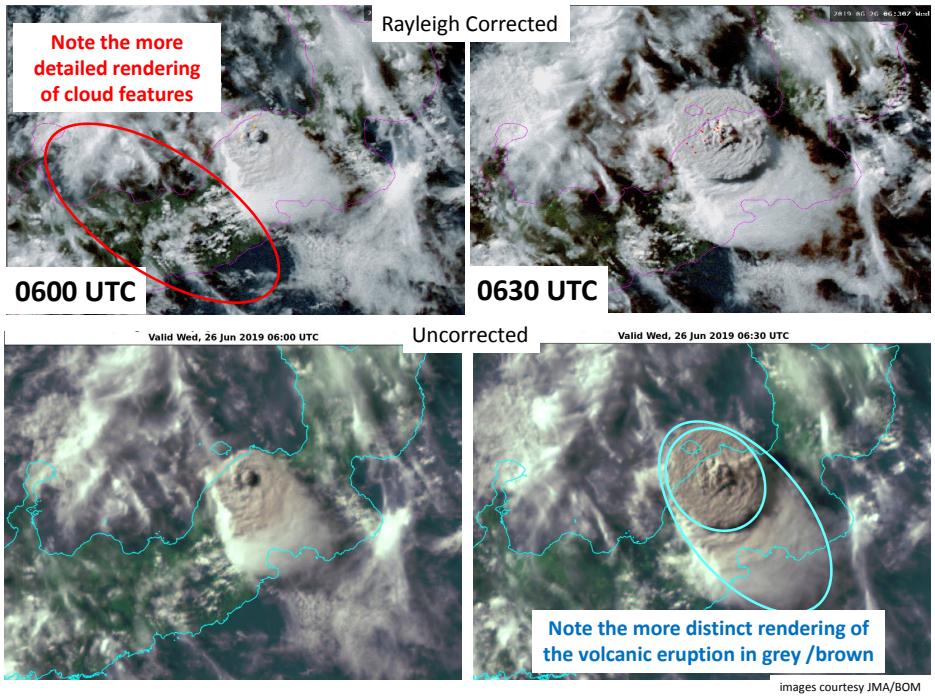


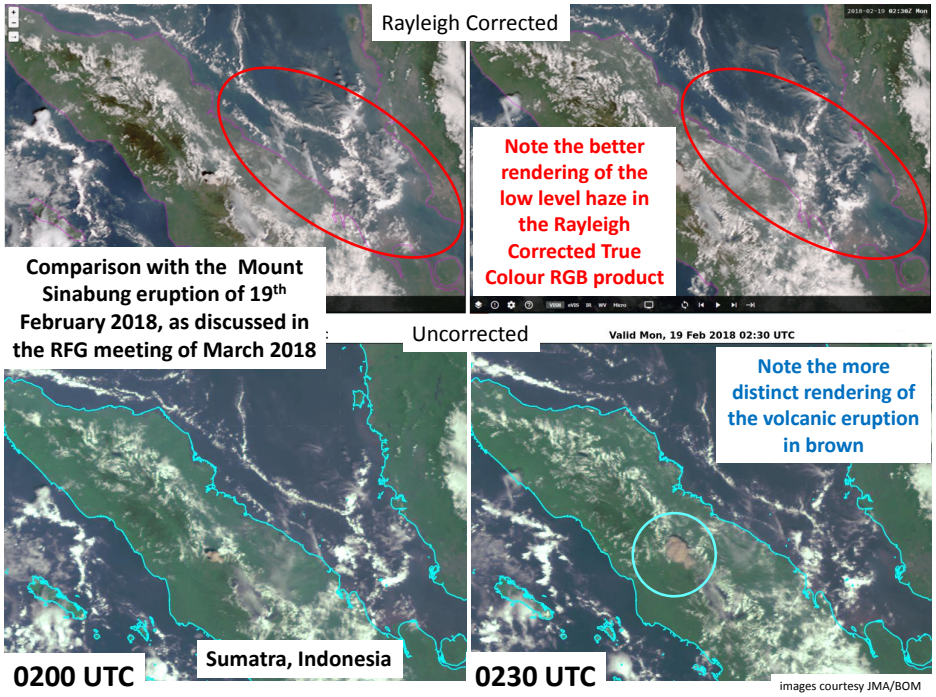
images courtesy JMA/BOM

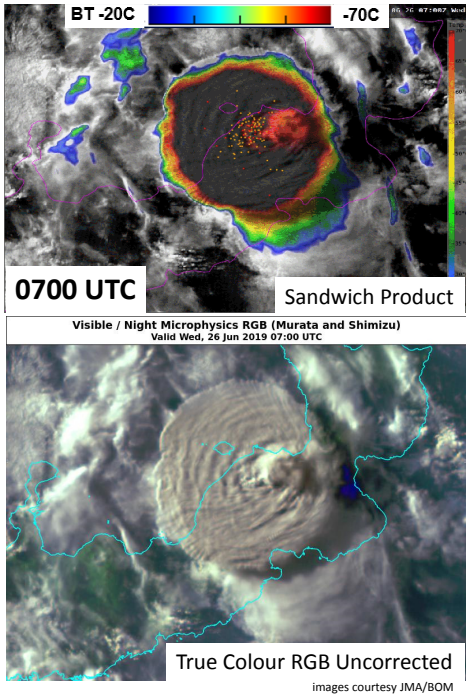

Rayleigh Corrected
0600 UTC
0630 UTC
Uncorrected
Valid Wed, 26 Jun 2019 06:00 UTC
Valid Wed, 26 Jun 2019 06:30 UTC
images courtesy JMA/BOM


Rayleigh Corrected
0700 UTC
0730 UTC
Uncorrected
Valid Wed, 26 Jun 2019 07:00 UTC
Valid Wed, 26 Jun 2019 07:30 UTC
images courtesy JMA/BOM

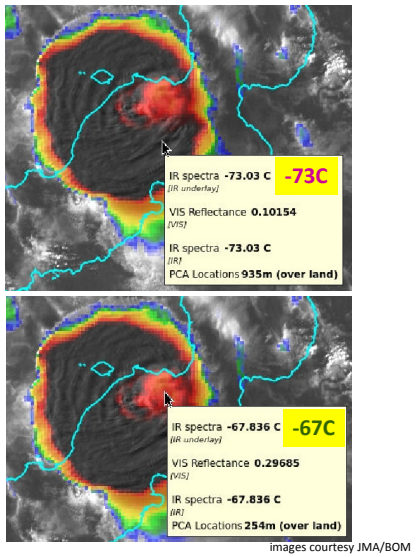

Question: which RGB composite permits best identification of the ash?
A: Rayleigh Corrected True Colour RGB
0600 UTC
0630 UTC
B: Uncorrected True Colour RGB
Valid Wed, 26 Jun 2019 06:00 UTC
Valid Wed, 26 Jun 2019 06:30 UTC
images courtesy JMA/BOM

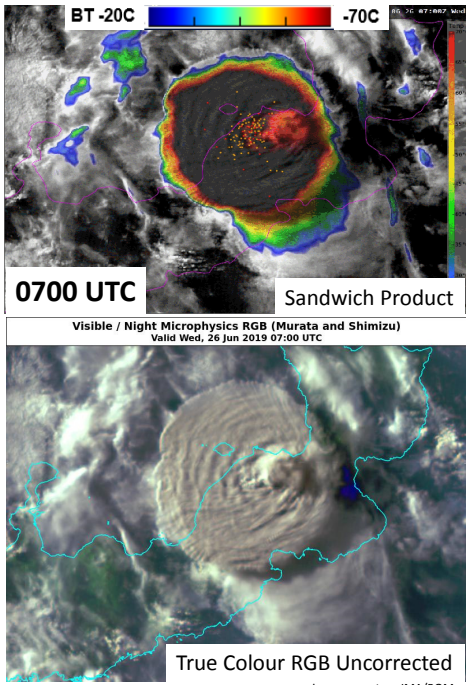

Note the more detailed rendering of cloud features
Rayleigh Corrected
0600 UTC
0630 UTC
Uncorrected
Valid Wed, 26 Jun 2019 06:00 UTC
Valid Wed, 26 Jun 2019 06:30 UTC
Note the more distinct rendering of the volcanic eruption in grey /brown
images courtesy JMA/BOM

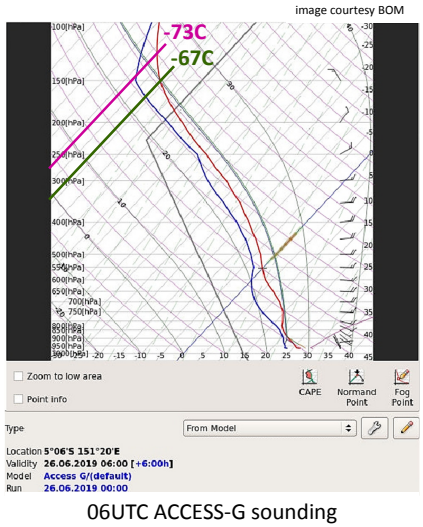




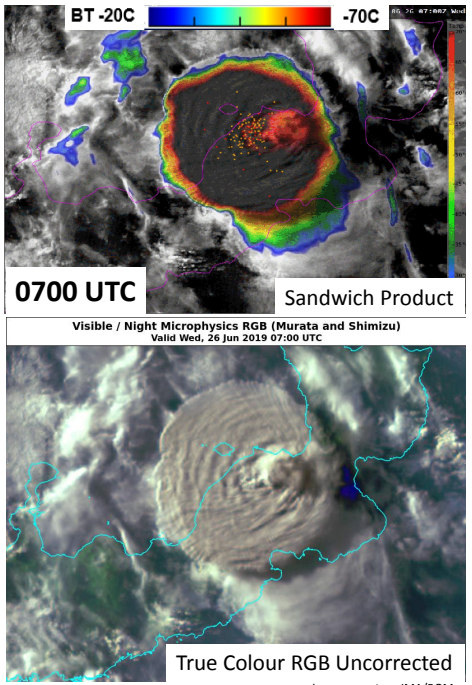
Examination in the Sandwich Product

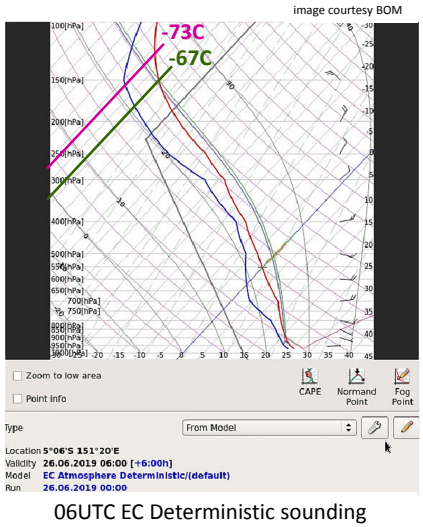






06UTC ACCESS-G sounding



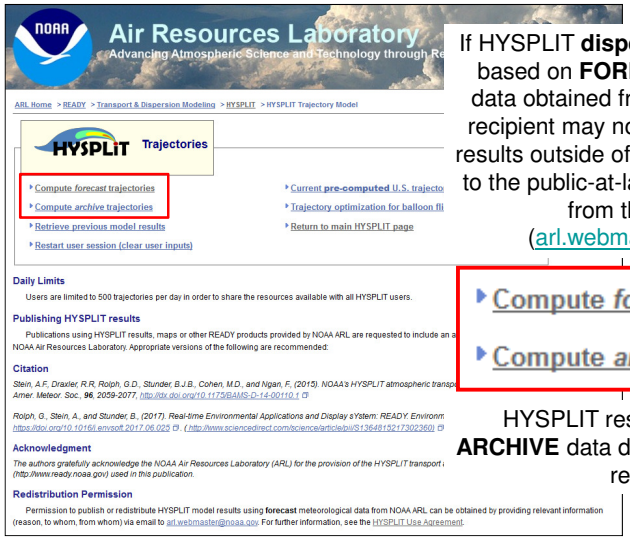


06UTC EC Deterministic sounding

REFERENCE

NOAA HYSPLIT model

https://ready.arl.noaa.gov/HYSPLIT_traj.php



If HYSPLIT **dispersion** model results are based on **FORECAST** meteorological data obtained from the NOAA ARL, the recipient may not redistribute the model results outside of his/her organization, nor to the public-at-large, without permission from the NOAA ARL (arl.webmaster@noaa.gov).

Compute *forecast* trajectories

Compute *archive* trajectories

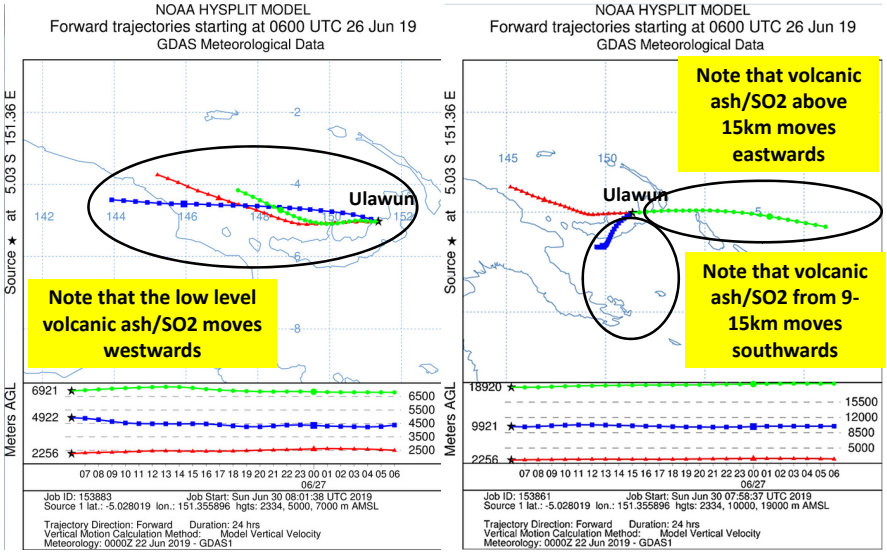
HYSPLIT results produced using **ARCHIVE** data do not need permission to redistribute.

REFERENCE

images courtesy NOAA

NOAA HYSPLIT MODEL data from Archive

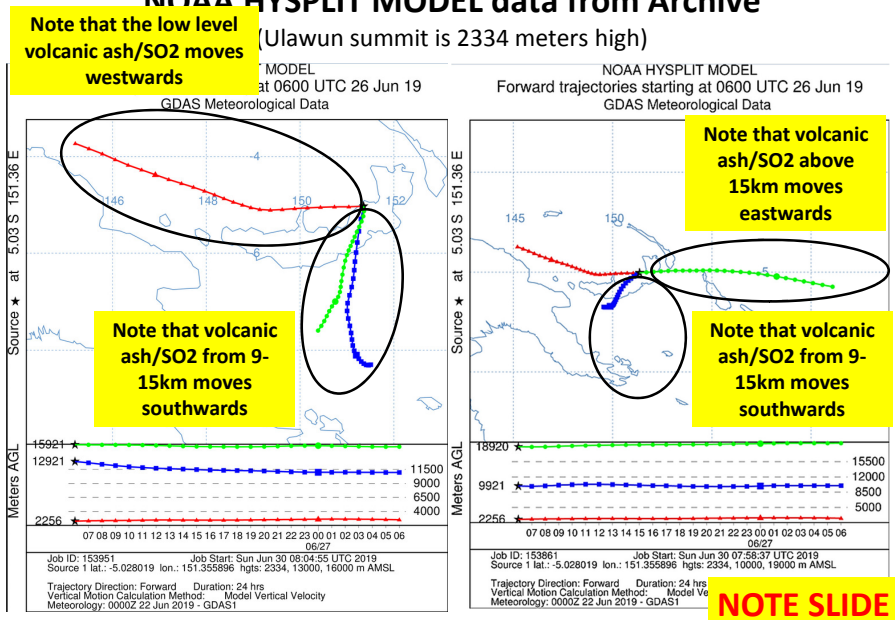
(Ulawun summit is 2334 meters high)



images courtesy NOAA

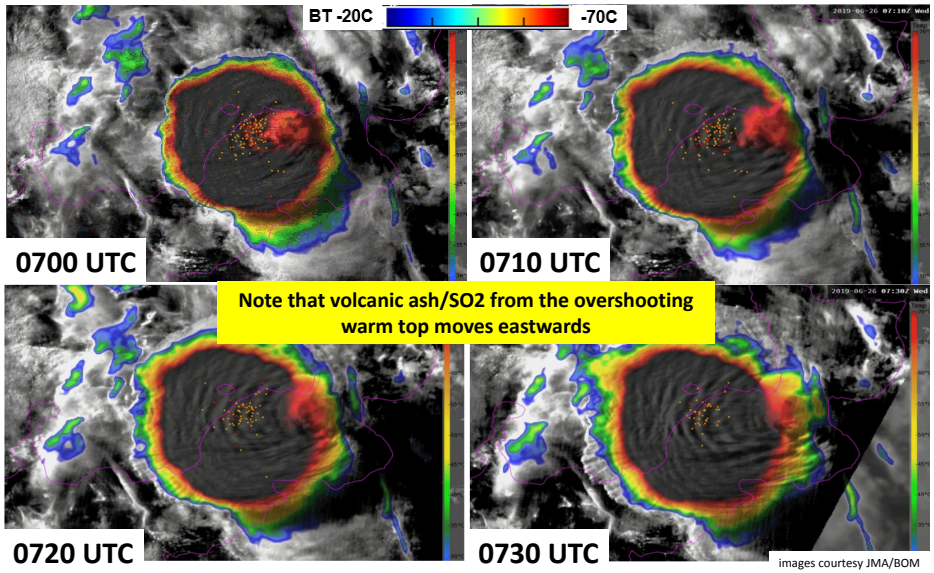
NOAA HYSPLIT MODEL data from Archive

(Ulawun summit is 2334 meters high)



NOTE SLIDE

Examining the evolution of eruption plume of Ulawun using the Sandwich Product



images courtesy JMA/BOM

image courtesy pilot Eroli Tamara

VAAC Detection RGB, Airmass RGB, VOLCAT VAAC RGB

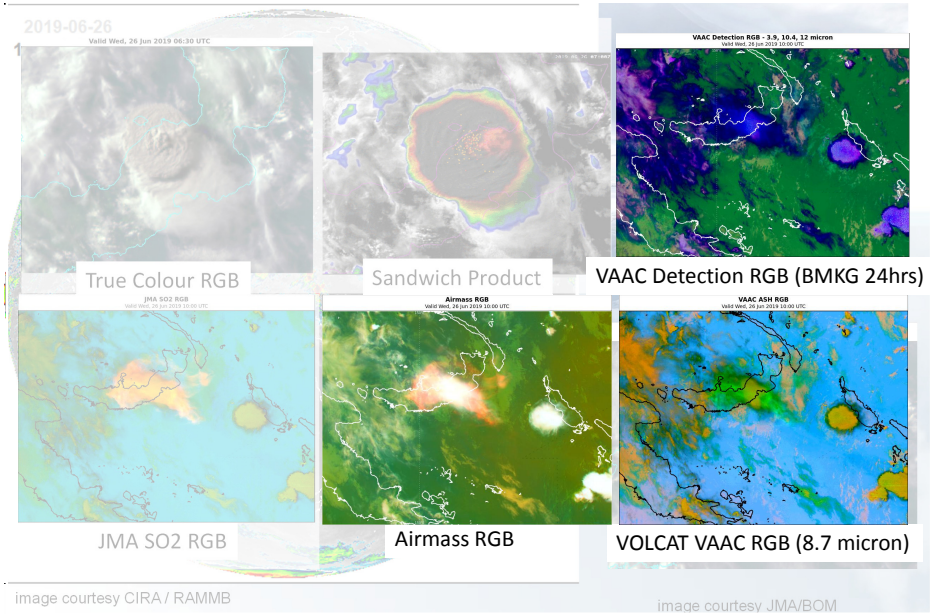


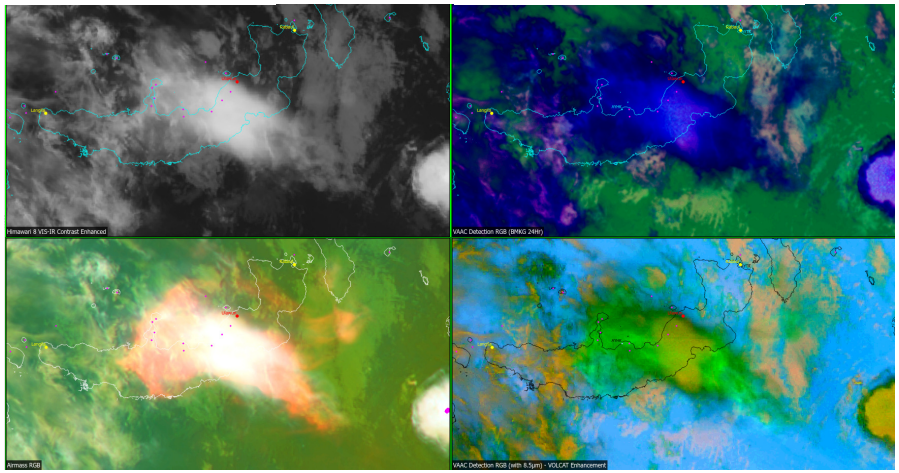
image courtesy CIRA / RAMMB

image courtesy JMA/BOM

Products commonly used at the Darwin Volcanic Ash Advisory Centre (Darwin VAAC) 10UTC

Vis – IR Contrast Enhanced

VAAC Detection RGB (BMKG 24hrs)



Airmass RGB

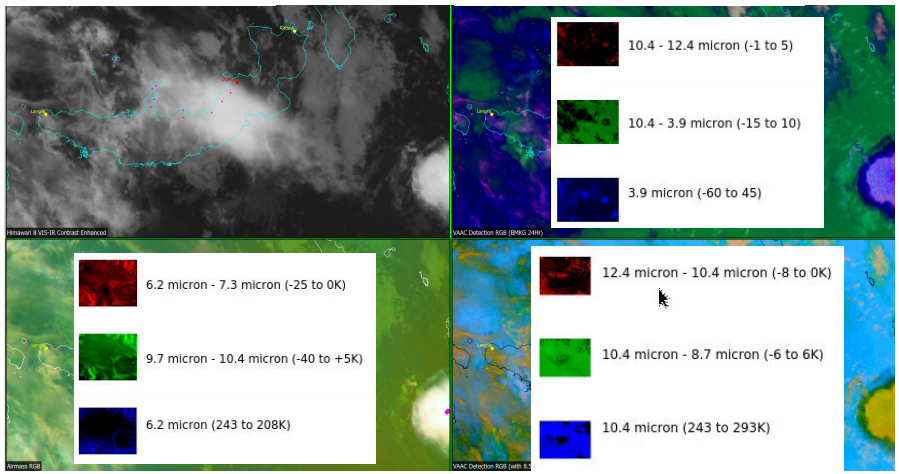
VOLCAT VAAC RGB (8.7 micron)

images courtesy JMA/BOM

The recipes of the various VAAC desk products 10UTC

Vis – IR Contrast Enhanced

VAAC Detection RGB (BMKG 24hrs)



Airmass RGB

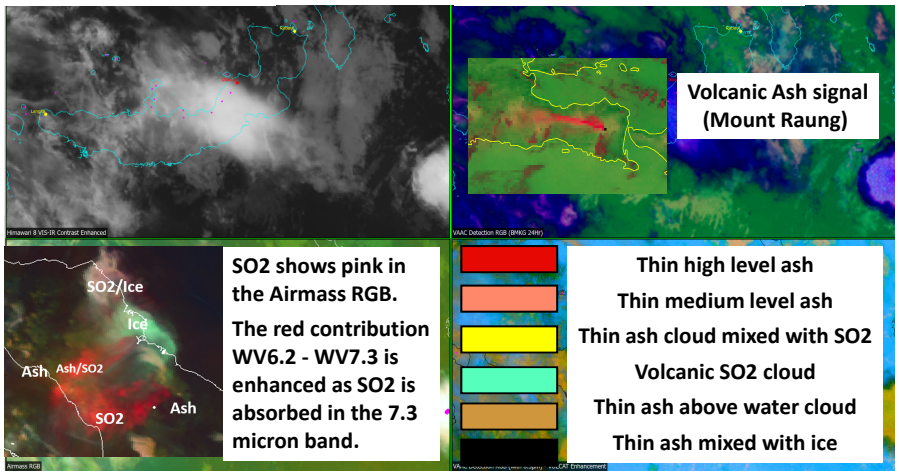
VOLCAT VAAC RGB (8.7 micron)

images courtesy JMA/BOM

The relevant colour palette of the various VAAC desk products 10UTC

Vis – IR Contrast Enhanced

VAAC Detection RGB (BMKG 24hrs)



Airmass RGB

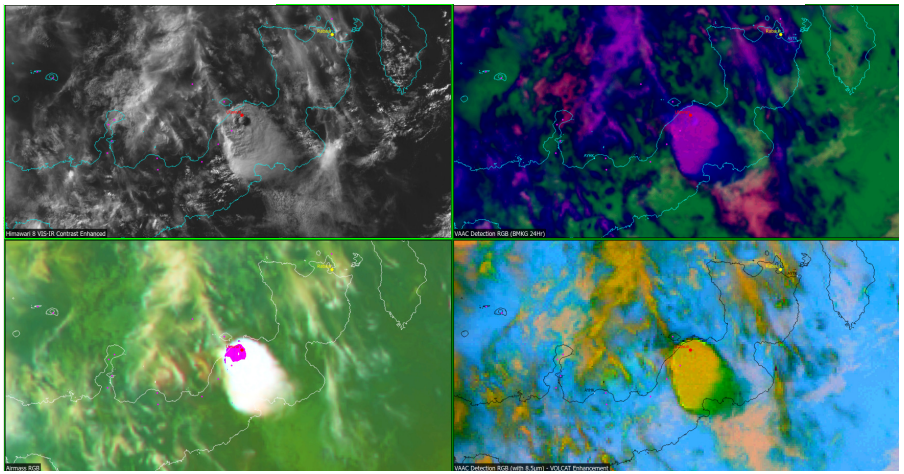
VOLCAT VAAC RGB (8.7 micron)

images courtesy JMA/BOM

Products commonly used at the Darwin Volcanic Ash Advisory Centre (Darwin VAAC) 06UTC

Vis – IR Contrast Enhanced

VAAC Detection RGB (BMKG 24hrs)



Airmass RGB

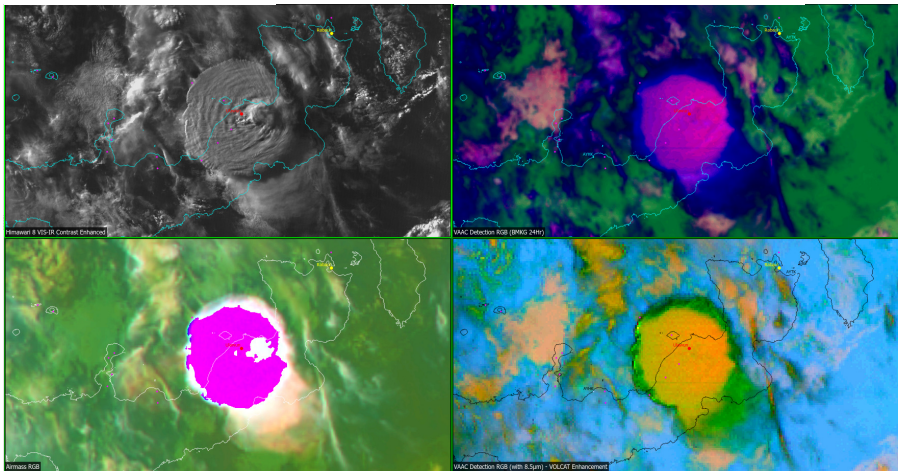
VOLCAT VAAC RGB (8.7 micron)

images courtesy JMA/BOM

Products commonly used at the Darwin Volcanic Ash Advisory Centre (Darwin VAAC) 07UTC

Vis – IR Contrast Enhanced

VAAC Detection RGB (BMKG 24hrs)



Airmass RGB

VOLCAT VAAC RGB (8.7 micron)

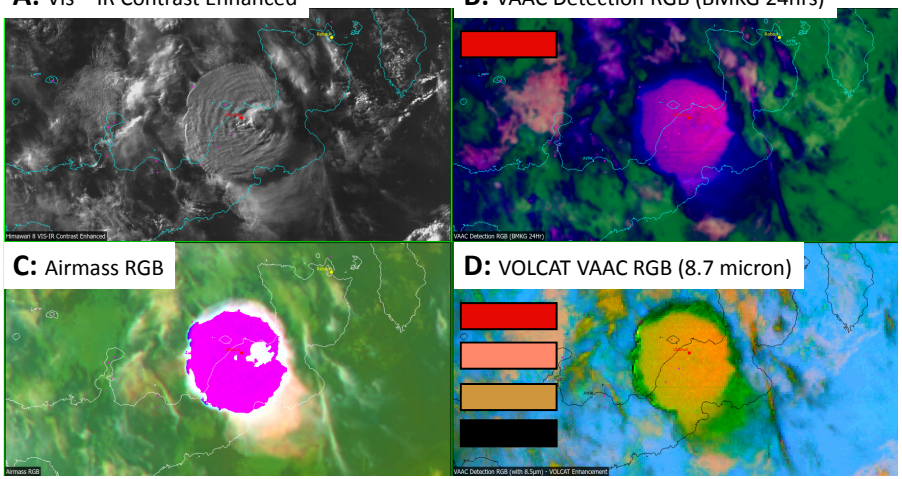
images courtesy JMA/BOM

Question: which RGB composite permits best identification of the ash?

VAAC desk products 07UTC

A: Vis – IR Contrast Enhanced

B: VAAC Detection RGB (BMKG 24hrs)



C: Airmass RGB

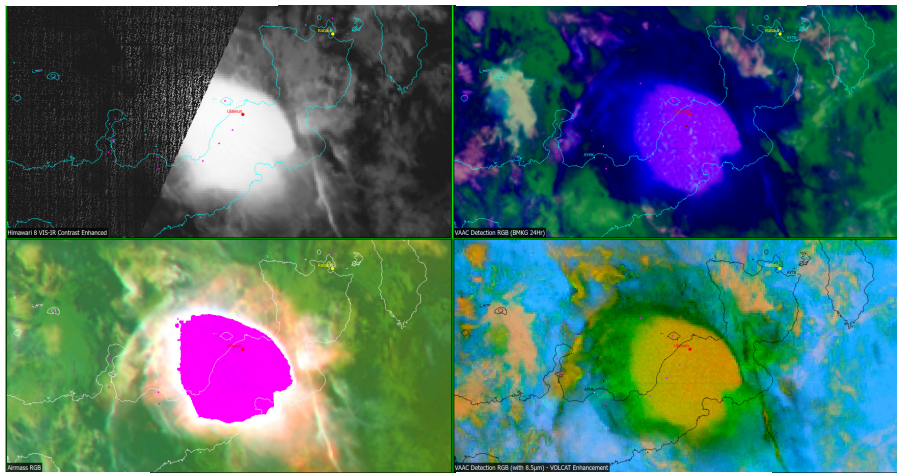
D: VOLCAT VAAC RGB (8.7 micron)

images courtesy JMA/BOM

Products commonly used at the Darwin Volcanic Ash Advisory Centre (Darwin VAAC) 08UTC

Vis – IR Contrast Enhanced

VAAC Detection RGB (BMKG 24hrs)



Airmass RGB

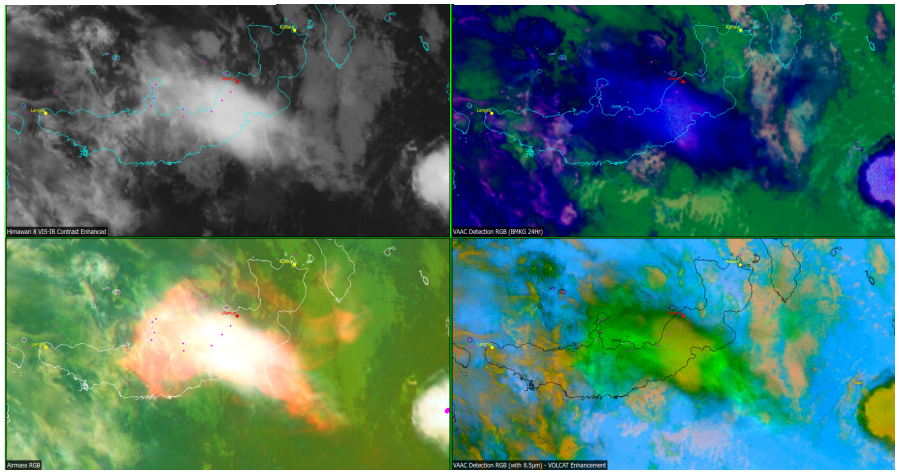
VOLCAT VAAC RGB (8.7 micron)

images courtesy JMA/BOM

Products commonly used at the Darwin Volcanic Ash Advisory Centre (Darwin VAAC) 10UTC

Vis – IR Contrast Enhanced

VAAC Detection RGB (BMKG 24hrs)



Airmass RGB

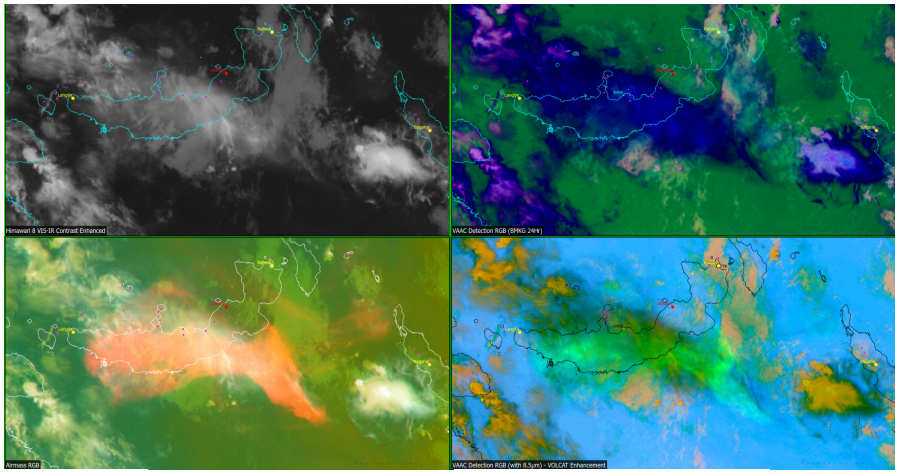
VOLCAT VAAC RGB (8.7 micron)

images courtesy JMA/BOM

Products commonly used at the Darwin Volcanic Ash Advisory Centre (Darwin VAAC) 12UTC

Vis – IR Contrast Enhanced

VAAC Detection RGB (BMKG 24hrs)



Airmass RGB

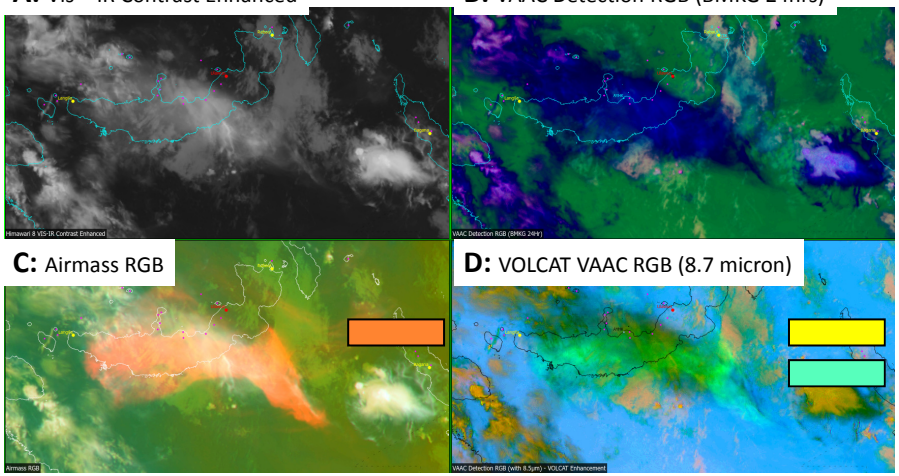
VOLCAT VAAC RGB (8.7 micron)

images courtesy JMA/BOM

Question: which RGB composite permits best identification of the SO2?

A: Vis – IR Contrast Enhanced

B: VAAC Detection RGB (BMKG 24hrs)



C: Airmass RGB

D: VOLCAT VAAC RGB (8.7 micron)

images courtesy JMA/BOM

image courtesy pilot Eroli Tamara

JMA SO2 RGB, Airmass RGB and VOLCAT VAAC RGB

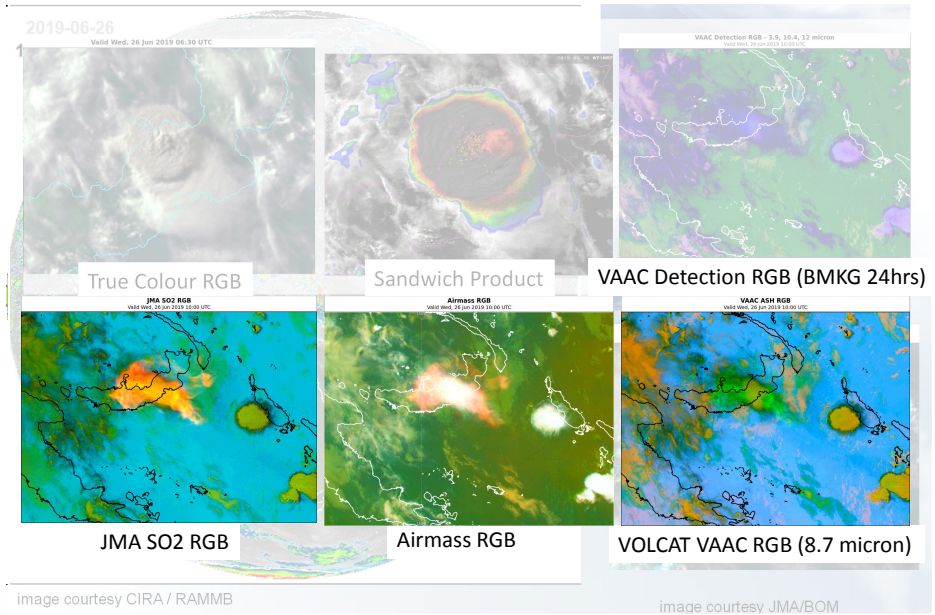
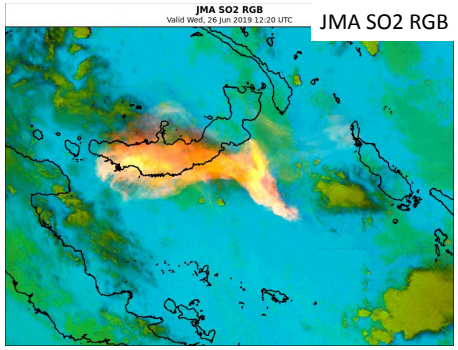


image courtesy CIRA / RAMMB

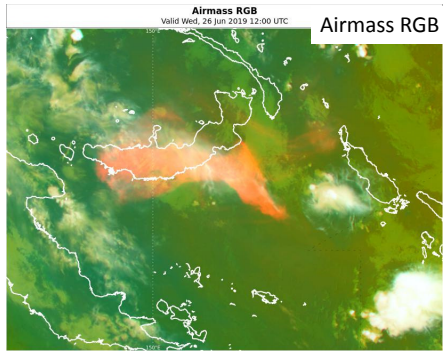
image courtesy JMA/BOM



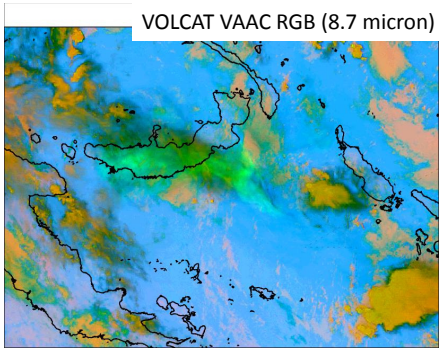
JMA SO2 RGB

Examination of the JMA SO2 RGB product: the Ulawun eruption; 1200UTC 26th June 2019

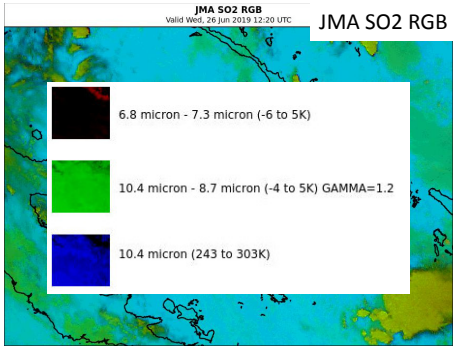
images courtesy JMA/BOM



Airmass RGB



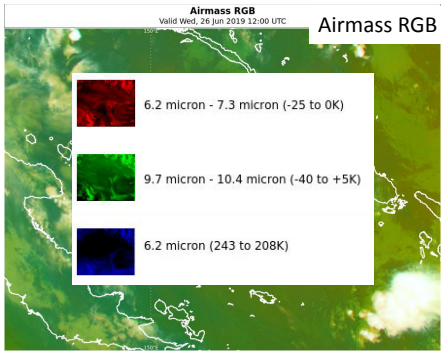
VOLCAT VAAC RGB (8.7 micron)



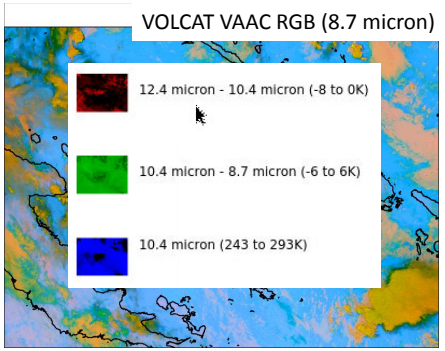
JMA SO2 RGB

The recipes of the various RGB composites: the Ulawun eruption; 1200UTC 26th June 2019

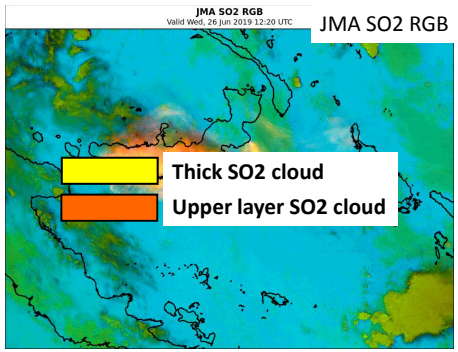
images courtesy JMA/BOM



Airmass RGB



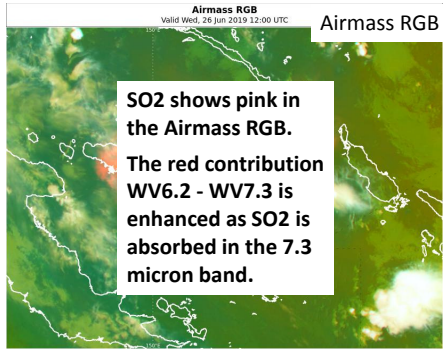
VOLCAT VAAC RGB (8.7 micron)



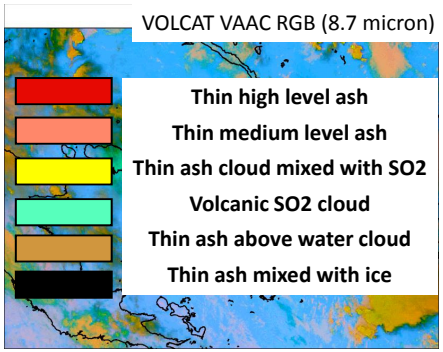
JMA SO2 RGB

The relevant colour palette of the various RGB composites: the Ulawun eruption; 1200UTC 26th June 2019

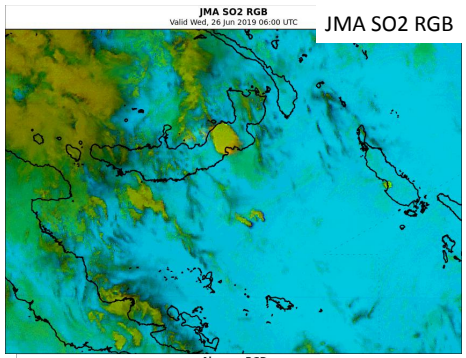
images courtesy JMA/BOM



Airmass RGB



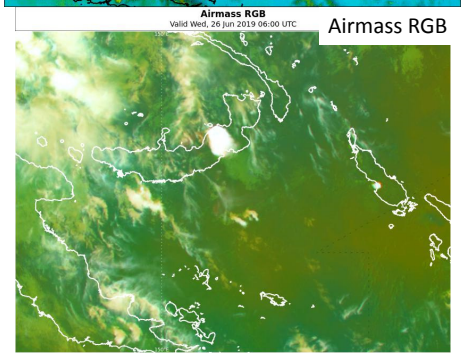
VOLCAT VAAC RGB (8.7 micron)



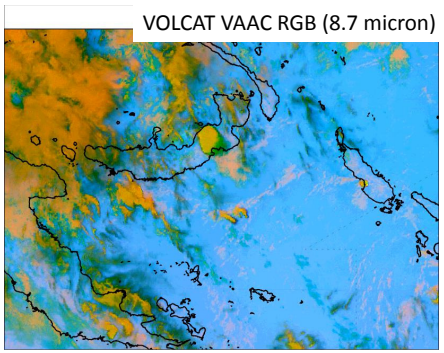
JMA SO2 RGB

Examination of the JMA SO2 RGB product: the Ulawun eruption; 0600UTC 26th June 2019

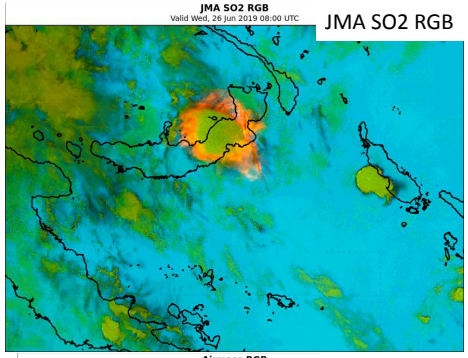
satellite images courtesy JMA/BOM



Airmass RGB



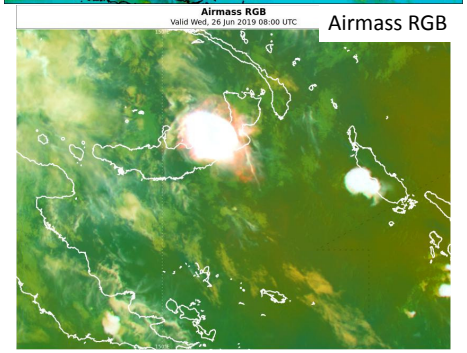
VOLCAT VAAC RGB (8.7 micron)



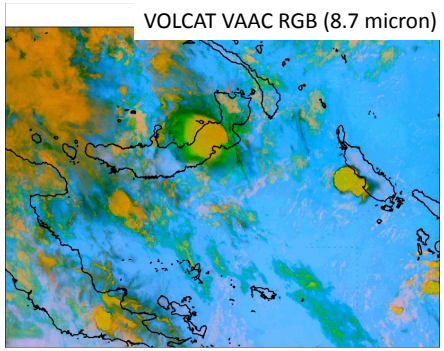
JMA SO2 RGB

Examination of the JMA SO2 RGB product: the Ulawun eruption; 0800UTC 26th June 2019

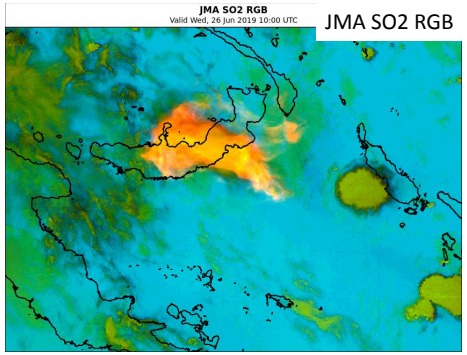
satellite images courtesy JMA/BOM



Airmass RGB



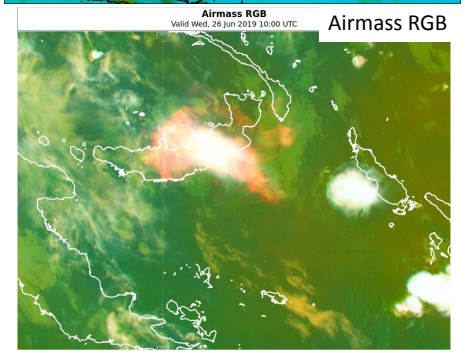
VOLCAT VAAC RGB (8.7 micron)



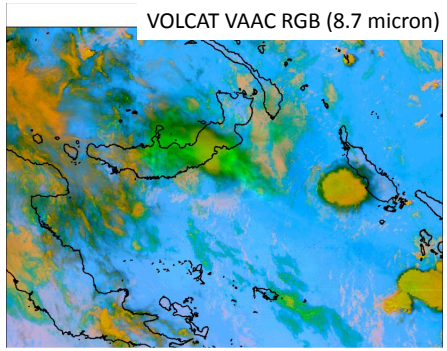
JMA SO2 RGB

Examination of the JMA SO2 RGB product: the Ulawun eruption; 1000UTC 26th June 2019

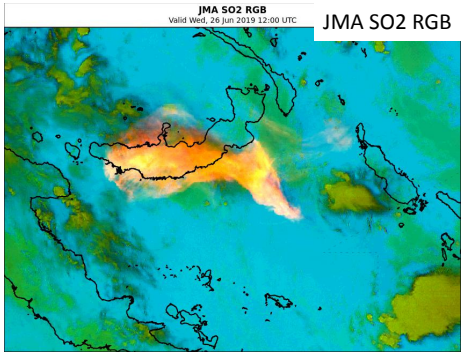
satellite images courtesy JMA/BOM



Airmass RGB



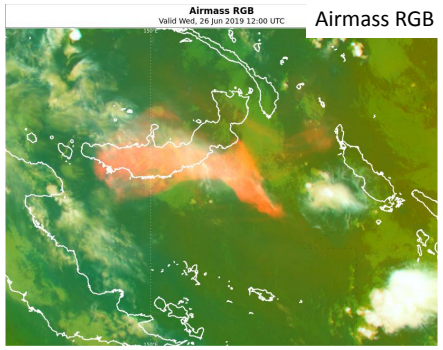
VOLCAT VAAC RGB (8.7 micron)



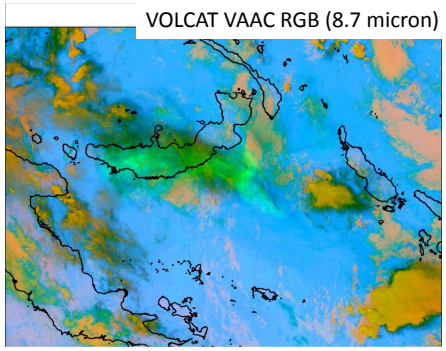
JMA SO2 RGB

Examination of the JMA SO2 RGB product: the Ulawun eruption; 1200UTC 26th June 2019

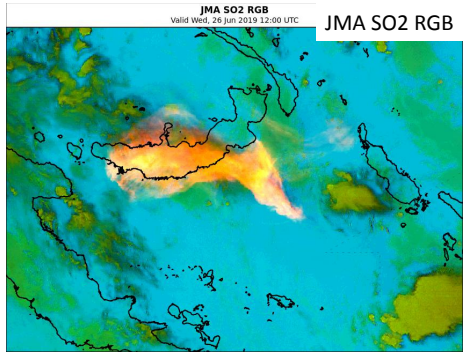
satellite images courtesy JMA/BOM



Airmass RGB



VOLCAT VAAC RGB (8.7 micron)



JMA SO2 RGB

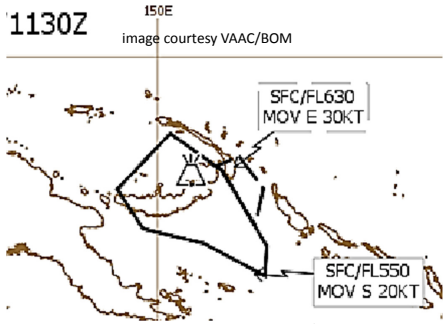
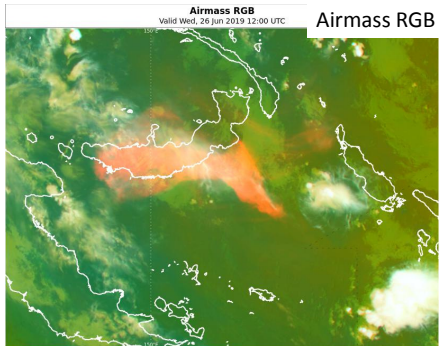
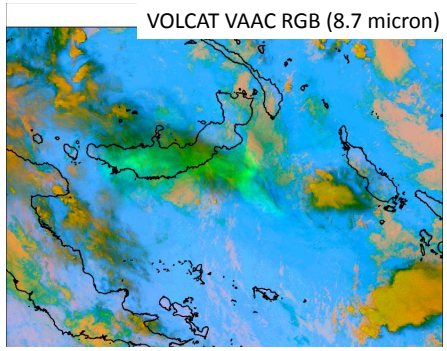


image courtesy VAAC/BOM

satellite images courtesy JMA/BOM

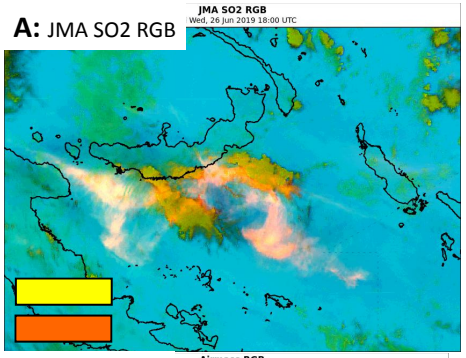


Airmass RGB



VOLCAT VAAC RGB (8.7 micron)

A: JMA SO2 RGB

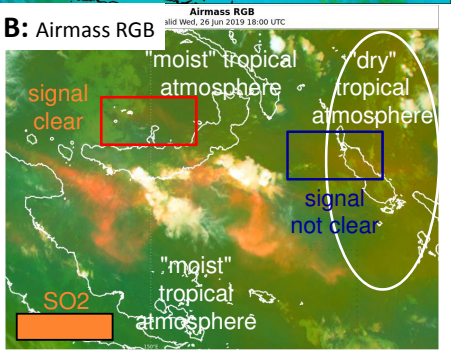


Question: which RGB composite permits best identification of the SO2?

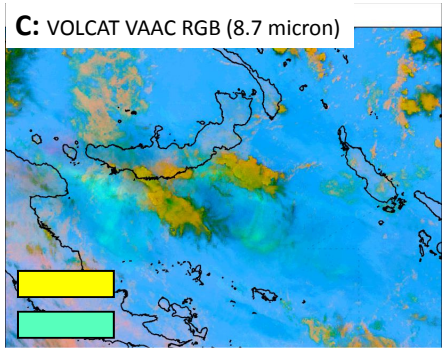
Examination of the JMA SO2 RGB product: the Ulawun eruption; 1800UTC 26th June 2019

satellite images courtesy JMA/BOM

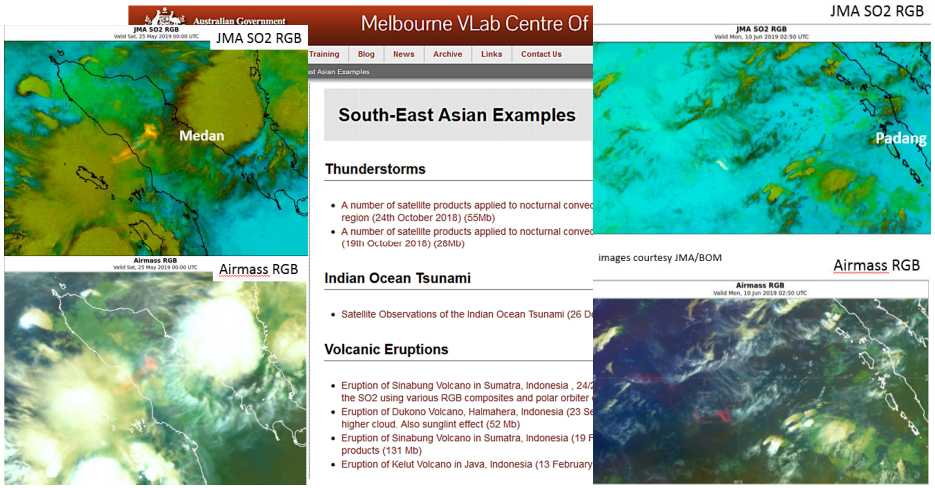
B: Airmass RGB



C: VOLCAT VAAC RGB (8.7 micron)

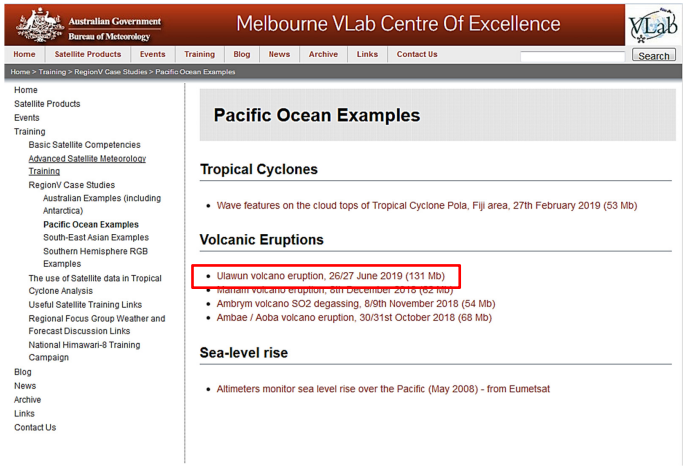


Other examples comparing the Airmass and the JMA SO2 RGB composites (Sinabung eruptions of May / June 2019)



http://www.virtuallab.bom.gov.au/training/regionv-case-studies/south-east-asian-examples/

Comparing RGB products across Himawari-8 and GOES-17 platforms (Ulawun eruption 26/27 June 2019)

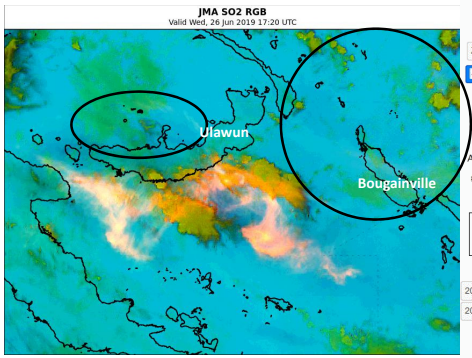


http://www.virtuallab.bom.gov.au/training/regionv-case-studies/pacific-ocean-examples/

Comparing the JMA SO2 RGB composite utilising Himawari-8 and GOES-17 data:

the Ulawun eruption; 1720UTC 26th June 2019

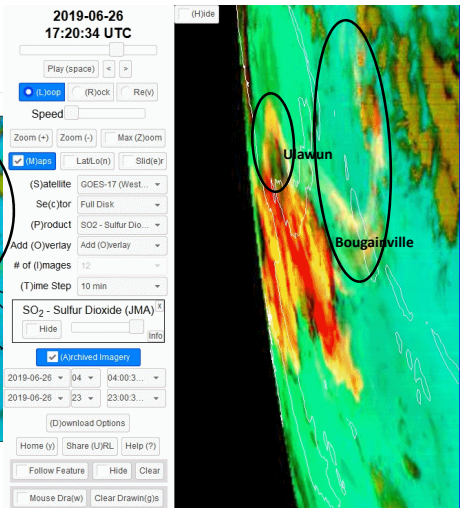
Additional information provided by the GOES-17 satellite due to the limb effect



Himawari-8

Thick SO2 cloud
Upper layer SO2 cloud

image courtesy JMA/BOM



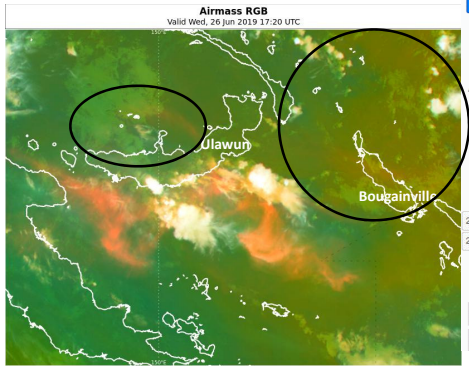
GOES-17 as displayed in RAMMB/CIRA SLIDER

image courtesy RAMMB/CIRA @ CSU

Comparing the Airmass RGB composite utilising Himawari-8 data with the JMA SO2 RGB composite utilising GOES-17 data:

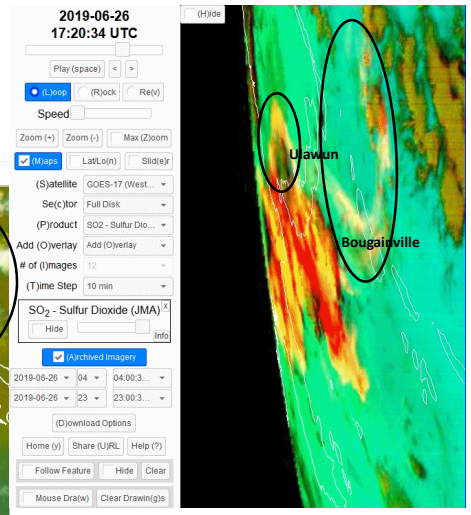
the Ulawun eruption;
1720UTC 26th June 2019

Additional information provided by the GOES-17 satellite due to the limb effect



Himawari-8

image courtesy JMA/BOM



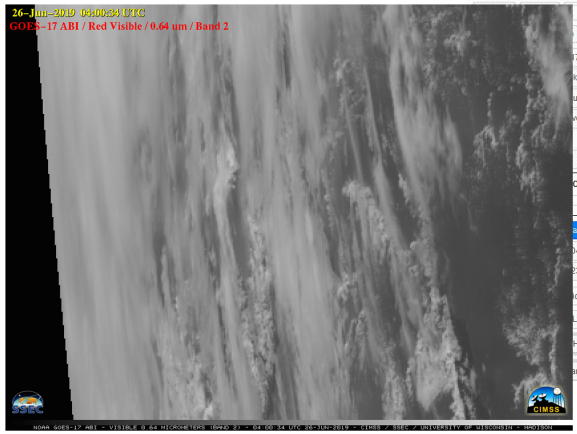
GOES-17

image cc **RESERVE**

Animation 1: The GOES-17 visible (Band 2) data compared to the JMA SO2 RGB composite

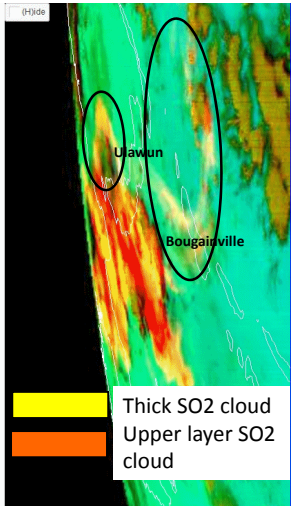
the Ulawun eruption;
26th June 2019

Please start the Power Point Slide Show to activate the animation



GOES-17 ABI / Red Visible / 0.64 micron 0400 – 0740UTC

animation courtesy Scott Bachmeier SSEC Wisconsin



GOES-17 JMA SO2 RGB at 1720UTC as displayed in RAMMB/CIRA SLIDER

image courtesy RAMMB/CIRA @ CSU

Comparing the JMA SO2 RGB composite utilising GOES-17 data with the Probability of Ash from the Bureau's DEPS model :

the Ulawun eruption;
1700/1720UTC 26th June 2019

Additional information provided by the GOES-17 satellite due to the limb effect

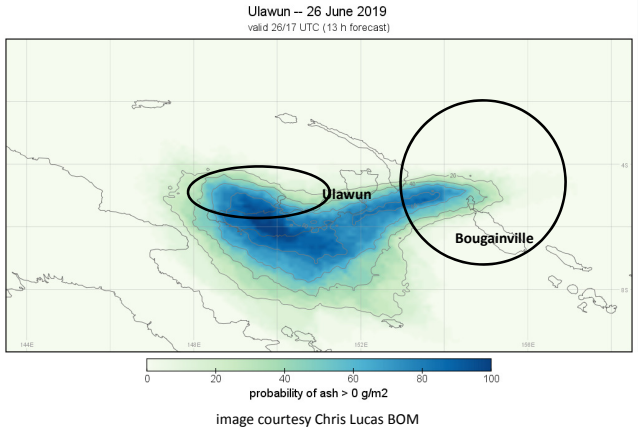
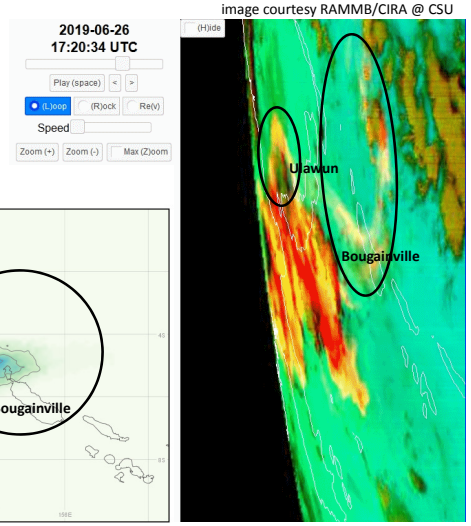


image courtesy Chris Lucas BOM

image courtesy RAMMB/CIRA @ CSU



GOES-17 as displayed in RAMMB/CIRA SLIDER

Information about the Bureau's Dispersion Ensemble Prediction System (DEPS) model output (part 1)

Information courtesy Chris Lucas BOM

- Contours/colours show the probability of ash load > 0 g/m2, essentially an ash/no-ash forecast, made by DEPS for 26/17 UTC from a run performed at 26/04 UTC and initialized in the model from 0130 UTC.
- We do show the eastward extension of the plume out to north of Bougainville at this time.
- Looking in more detail at the model, I can confidently say that this is the stratospheric portion of the eruption…which was clearly observed in the early phases of the final eruption.
- Our model run is a bit slow in translating this feature…not surprising. We initialise it too strongly -- I initialized the whole plume for 4 hours and the stratospheric portion of the eruption did not last that long, so we have put too much mass up there…
- In DEPS, we have maybe 1 or 2 members pushing it that far east (a slight green colouring on plot), most are much slower.

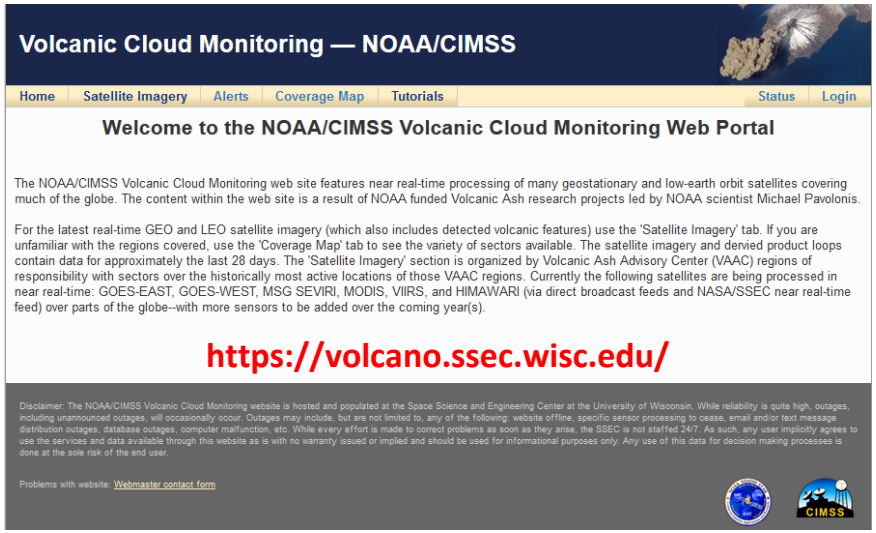
REFERENCE

Information about the Bureau's Dispersion Ensemble Prediction System (DEPS) model output (part 2)

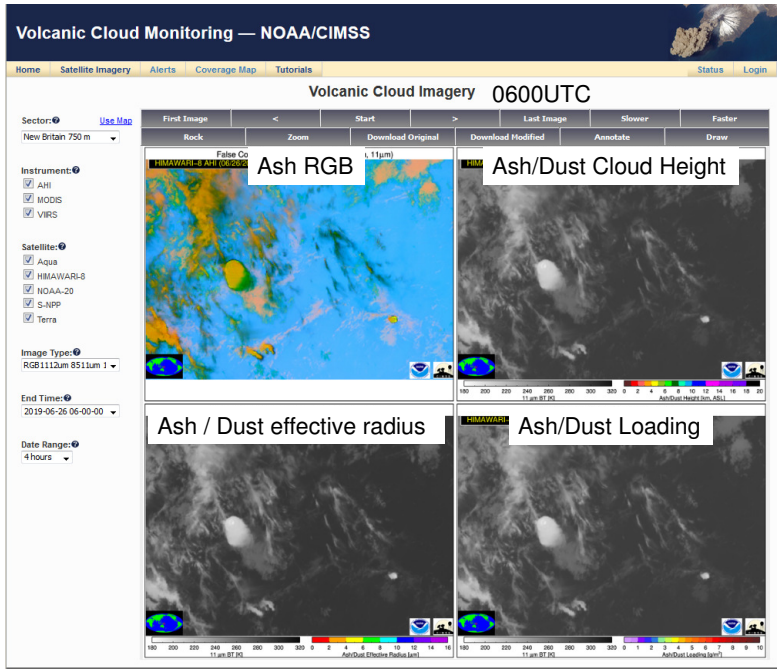
Information courtesy Chris Lucas BOM

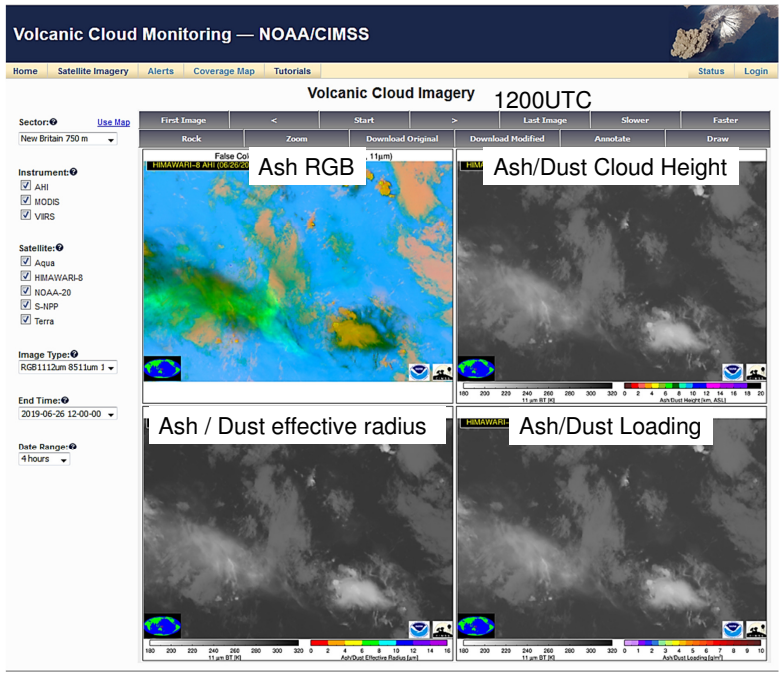
- The apparent skill in DEPS comes from both the inherent 'goodness' of the (mostly) ACCESS-based wind/met fields as well as a careful and appropriate initialization of the volcanic source in the simulation.
- There is considerably more information that is available from these runs, including the use of different mass load thresholds, and some information about the distribution of mass with height (i.e. in pre-specified layers). There are also numerous intermediate times where we can do the validation. This has the potential to provide considerably more information to inform warnings/advisories/forecasts for volcanic ash than is currently available.

REFERENCE



The NOAA/CIMSS Volcanic Cloud Monitoring web site features near real-time processing of many geostationary and low-earth orbit satellites covering much of the globe. The content within the web site is a result of NOAA funded Volcanic Ash research projects led by NOAA scientist Michael Pavolonis.





Explanation of the products on the NOAA/CIMSS Volcanic Cloud Monitoring web site (part 1) (https://volcano.ssec.wisc.edu/)

The NOAA/CIMSS Volcanic Cloud Monitoring web site features near real-time processing of many geostationary and low-earth orbit satellites covering much of the globe. The content within the web site is a result of NOAA funded Volcanic Ash research projects led by NOAA scientist Michael Pavolonis.

- **Sample ash height retrieval image with 11 um brightness temperature underlay.**
  When an ash cloud is detected, the radiometrically retrieved heights [kilometers above sea level] are plotted in color with the 11 um brightness temperature [K] plotting in grayscale as an image underlay. A pixel with valid retrieved height is indicative of a pixel included in a detected ash cloud object. If no ash cloud is detected the image will simply show 11 um brightness temperature in grayscale.

REFERENCE

Explanation of the products on the NOAA/CIMSS Volcanic Cloud Monitoring web site (part 2)
(https://volcano.ssec.wisc.edu/tutorials/)

- **Sample ash mass retrieval image with 11 um brightness temperature underlay.**
  When an ash cloud is detected, the retrieved mass loading [grams per square meter] are plotted in color with the 11 um brightness temperature [K] plotting in grayscale as an image underlay. A pixel with valid retrieved mass loading is indicitive of a pixel included in a detected ash cloud object.

- **Sample ash effective radius retrieval image with 11 um brightness temperature underlay.**
  When an ash cloud is detected, the retrieved particle effective radius [microns] are plotted in color with the 11 um brightness temperature [K] plotting in grayscale as an image underlay. A pixel with valid retrieved effective radius is indicitive of a pixel included in a detected ash cloud object.

REFERENCE

Explanation of the products on the NOAA/CIMSS Volcanic Cloud Monitoring web site (part 3)
(https://volcano.ssec.wisc.edu/tutorials/)

- **With what latency are alerts produced?**
  The data latency varies depending upon sensor and method for data acquistition. Each alert contains a production date/time stamp, which allows a user to infer latency. In general, data latency is 5-30 minutes for geostationary satellites, 20-40 minutes for direct broadcast polar satellites, and 1-4 hours for MODIS data obtained via NASA LANCE Rapid Response Near Real Time feed.

REFERENCE

Feedback from VAAC Darwin Forecasters and BOM staff pertaining to the products on the NOAA/CIMSS Volcanic Cloud Monitoring Web Portal (part 1)

- VAAC Darwin receives email alerts from this web site.
- These products are experimental products by Mike Pavolonis. The output needs tuning so Mike would appreciate feedback.
- A great resource
- Generally picks major eruptions
- For other eruptions – 50% right, 50% overforecasting
- Ash plume height needs to be taken with a grain of salt. Use the IR temperature / sounding method. For optically thin cloud this method gives a height that is too low.
- Feedback from Chris Lucas pertaining to the performance of these products for the Ulawun eruption; "The main reason is that the initial eruption cloud is optically thick…for the retrievals to work properly (as well as ash detection based on the 11-12 micron channel difference), the ash cloud must be semi-transparent to upwelling surface radiance…the optical depth must be less than about 4.

REFERENCE

Feedback from VAAC Darwin Forecasters and BOM staff pertaining to the products on the NOAA/CIMSS Volcanic Cloud Monitoring Web Portal (part 2)

Feedback from Chris Lucas (continued)

- So if there is too much ash, none of the IR radiation from the surface gets through, and the ash cannot be seen…only the blackbody temperature of the cloud is detected. This channel differencing ('reverse absorption' by ash) effect is maximized where the optical depth is at about 2-3; so if the ash is too thin or too thick, then no signal is detected.
- The lack of quantitative retrievals is unfortunately fairly common in the biggest eruptions, particularly in the early stages. As the cloud disperses and thins out, you often get retrievals later on in the event. The retrievals also tend to drop out when ash loads get below about 1 g/m2. This didn't really happen in Ulawun, which suggests that perhaps the ash was removed quickly. Ice-rich ash clouds are also a problem, where the ash apparently acts as ice nuclei and becomes covered in ice. These have some likely spectral signals of their own, including an exceptionally strong positive 11-12 brightness temperature difference, and during the day some signatures in the near-IR parts of the spectrum.

REFERENCE

Summary of the Regional Focus Group meeting, 4th July 2019

A Weather and Forecast discussion (Mr Bodo Zeschke BMTC)

A case study of a recent volcanic eruption, showcasing the application of satellite data and data products (Mr Bodo Zeschke BMTC)

The next Regional Focus Group meeting is scheduled to be held during late July 2019

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