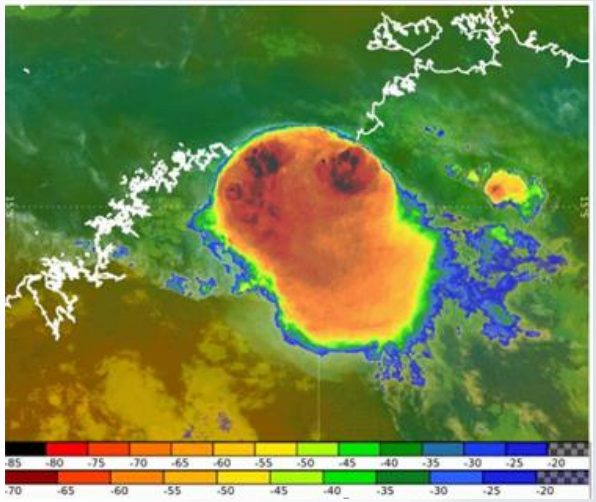
AOMSUC-10

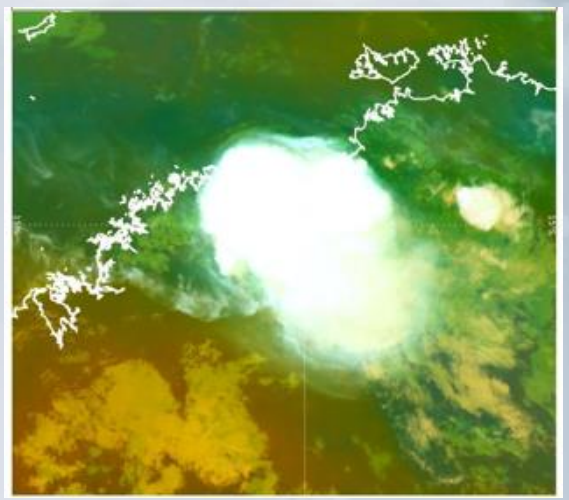
2–7 December 2019
Melbourne, Australia

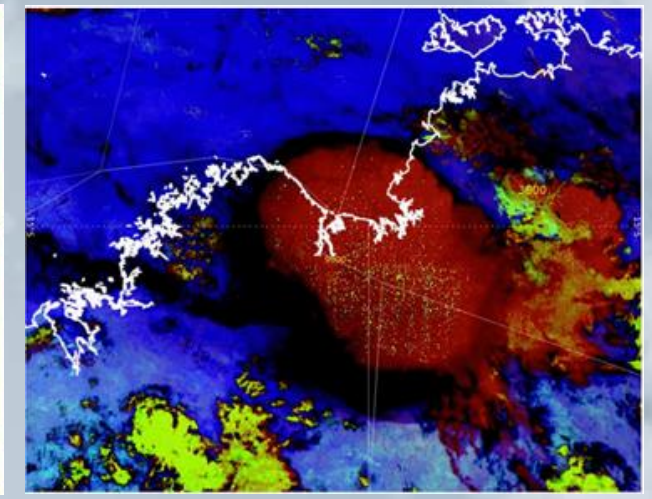
10TH ASIA-OCEANIA METEOROLOGICAL SATELLITE USERS' CONFERENCE

# Introduction to now-casting using satellite data and products

## Thunderstorm examples



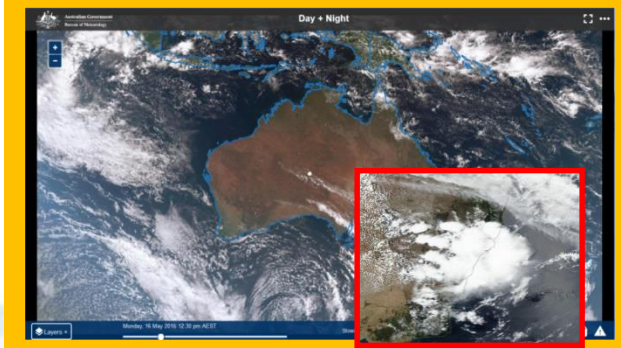


Dean Narramore
Extreme Weather Desk Bureau of Meteorology

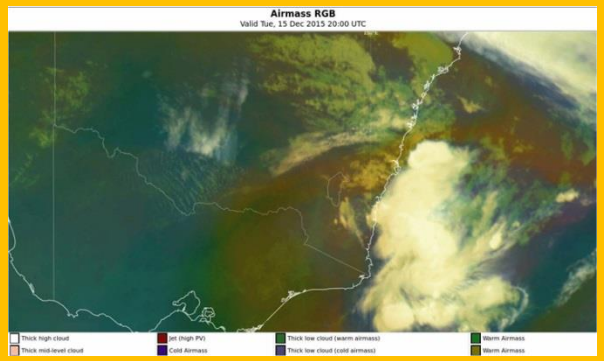
# Content

- Satellite products for monitoring convection. What do you use?
- How useful is satellite data in the lead up to thunderstorm development?
- Examples of using satellite data in identifying thunderstorms and where they might form.
- Can we identify where the first storm will form, using satellite data?
- Satellite surprise.

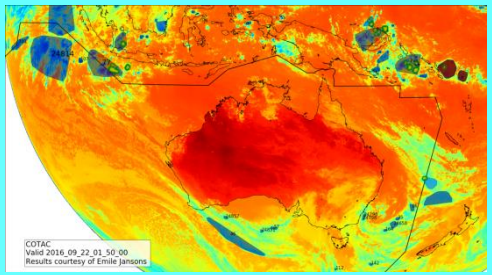
# Using Himawari-8 data to analyse convective development



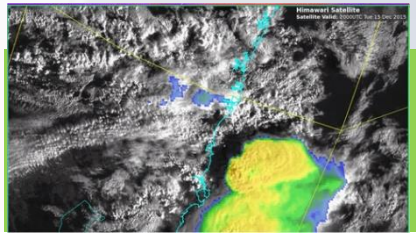

Overview: Visible / Enhanced IR / Sandwich

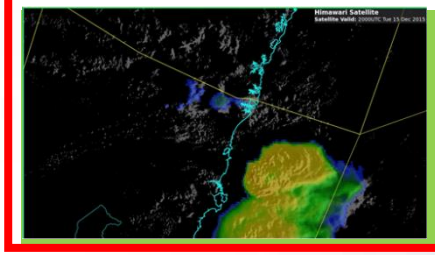



Broadscale setting – Airmass RGB

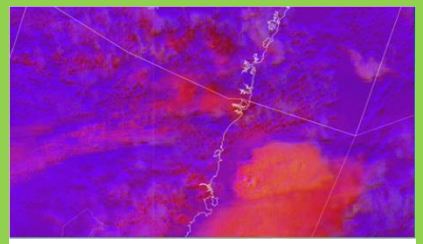



Alerting (machine learning) algorithms (COTAC)

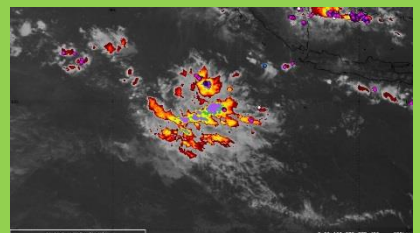




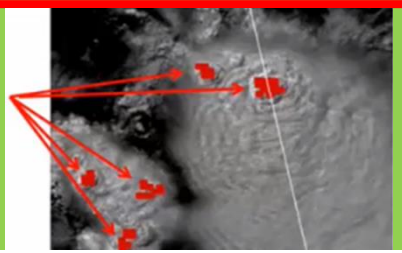
Sandwich product



Day Convective RGB



Monitoring tool (IR-WV)



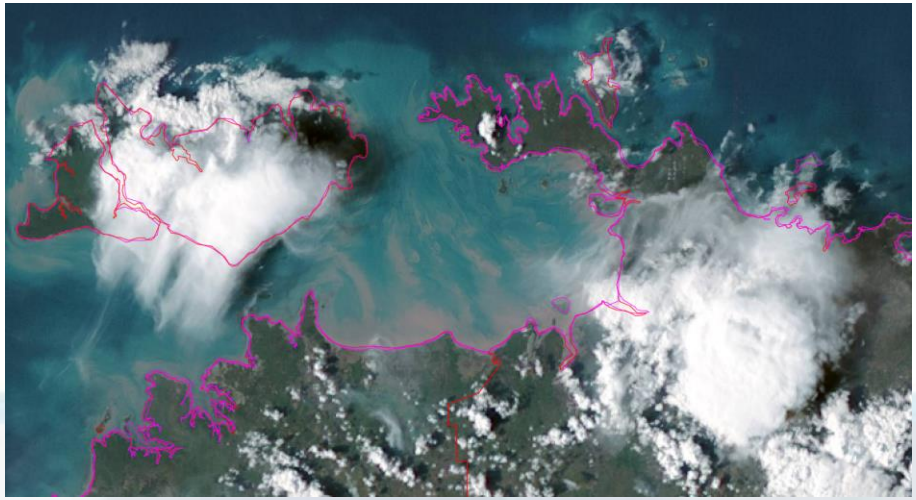
Severe Storm Algorithms

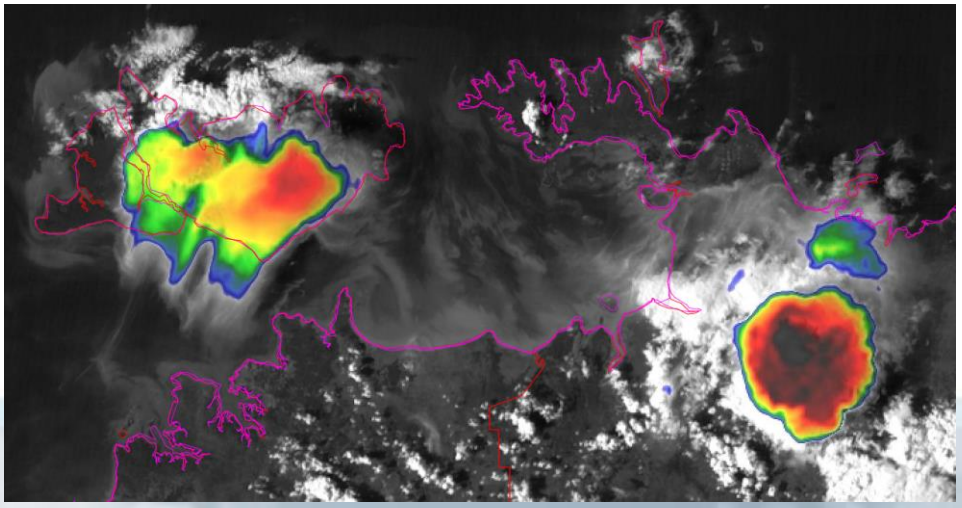
Images courtesy BOM/JMA

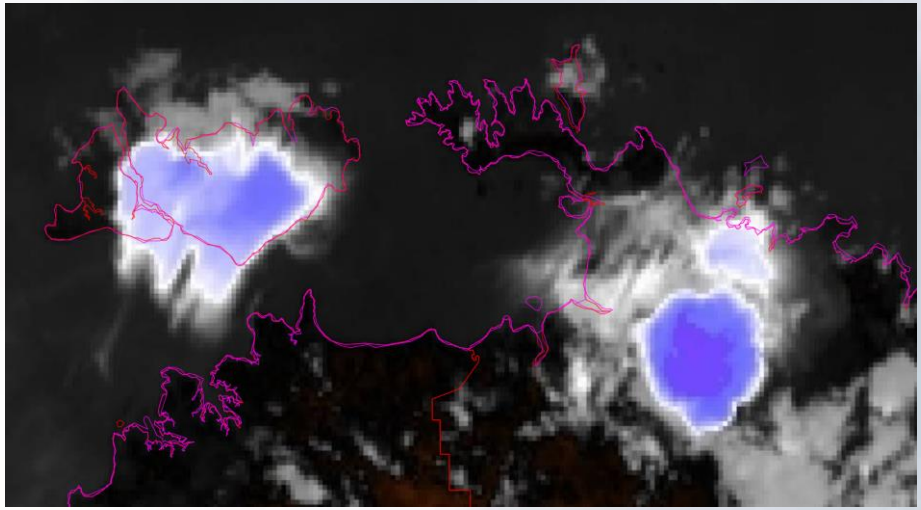
# Socrative Question 1

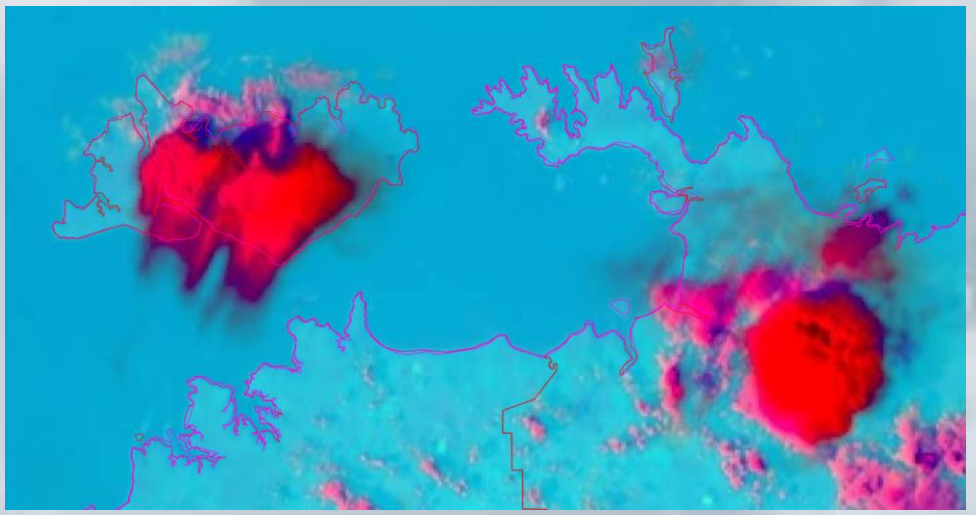
images courtesy JMA/BOM

# One Thunderstorm. Same Time. Multiple channels.







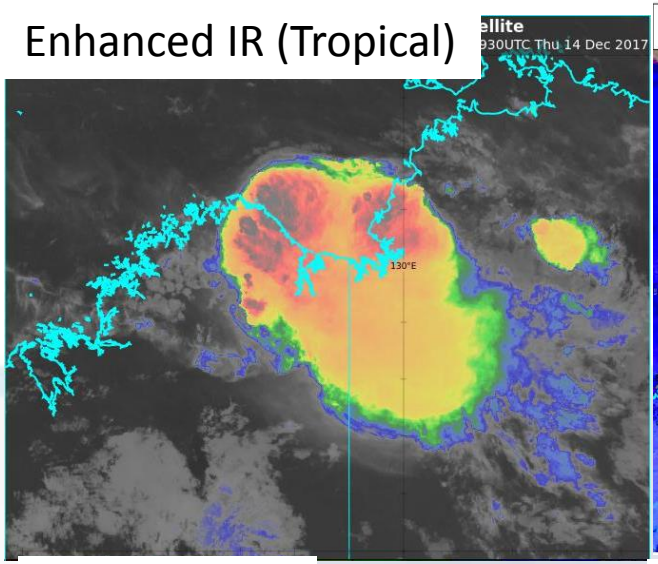


images courtesy JMA/BOM

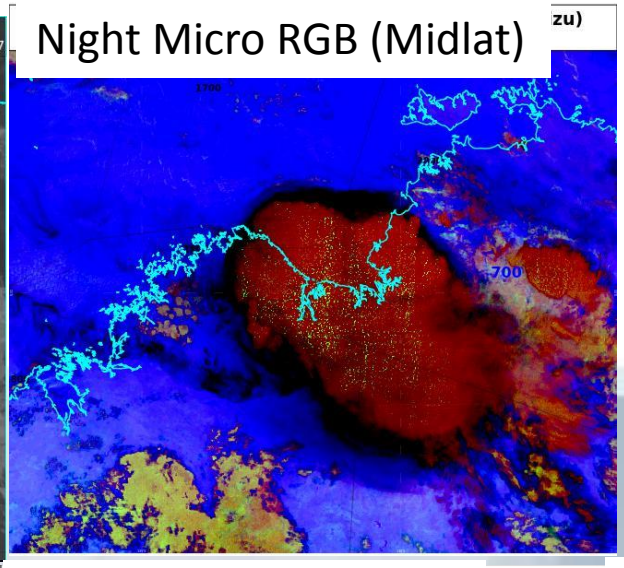
# Another example of multiple channels, one storm, this time at night. RGB products examined during the night time.

(situation at 1930UTC, 14th December)

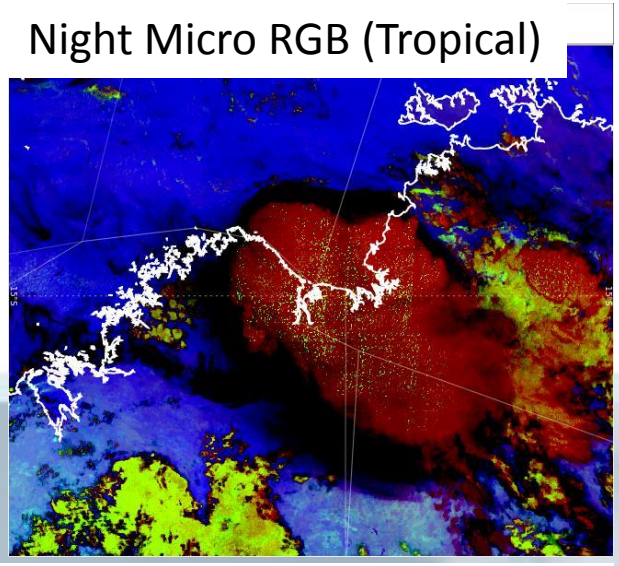
Enhanced IR (Tropical)



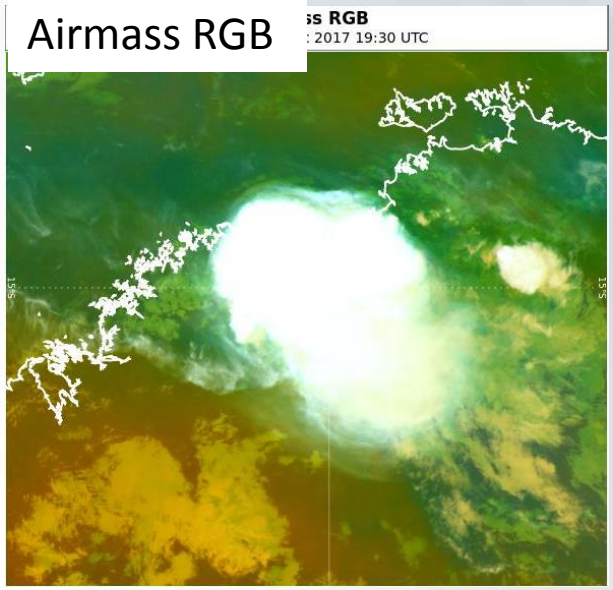

Night Micro RGB (Midlat)



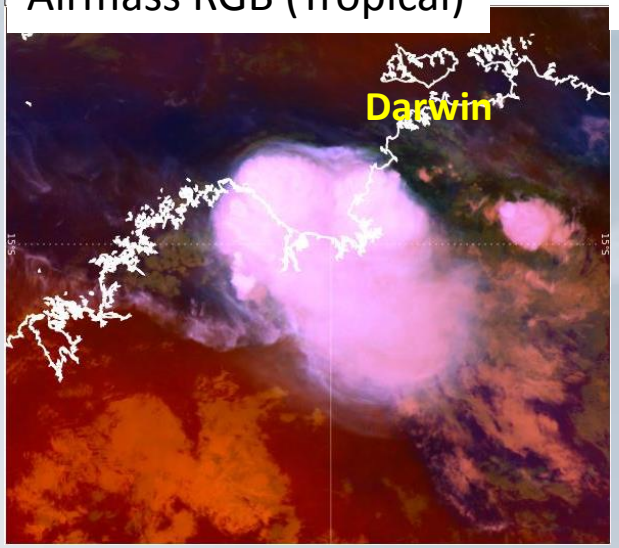

Night Micro RGB (Tropical)



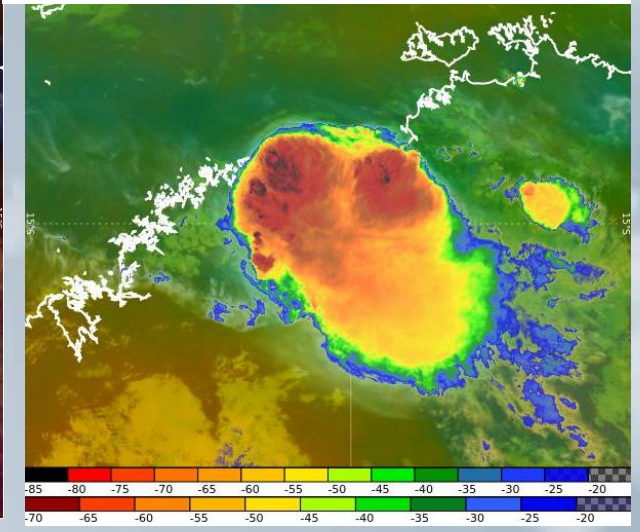
Airmass RGB




Airmass RGB (Tropical)



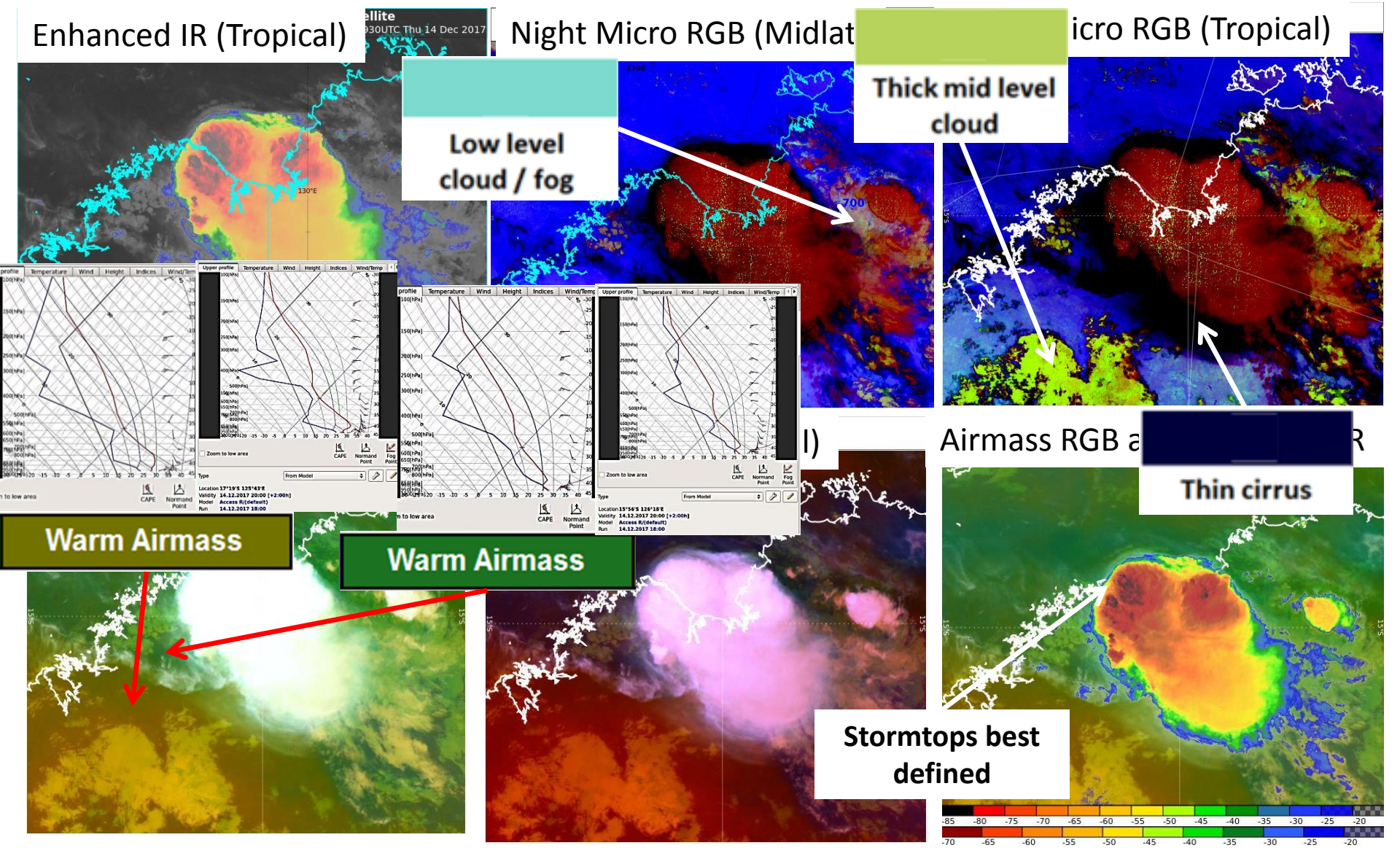

Airmass RGB and enhanced IR



images courtesy JMA/BOM

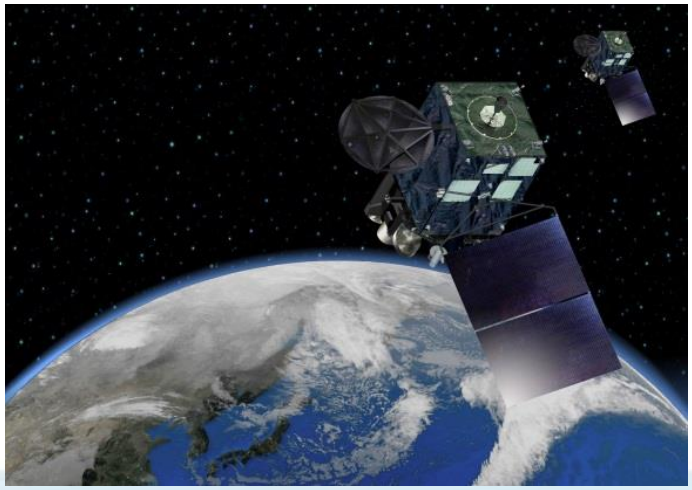
# Summary: RGB products examined during the night time

(situation at 1930UTC)



images courtesy JMA / Eumetsat

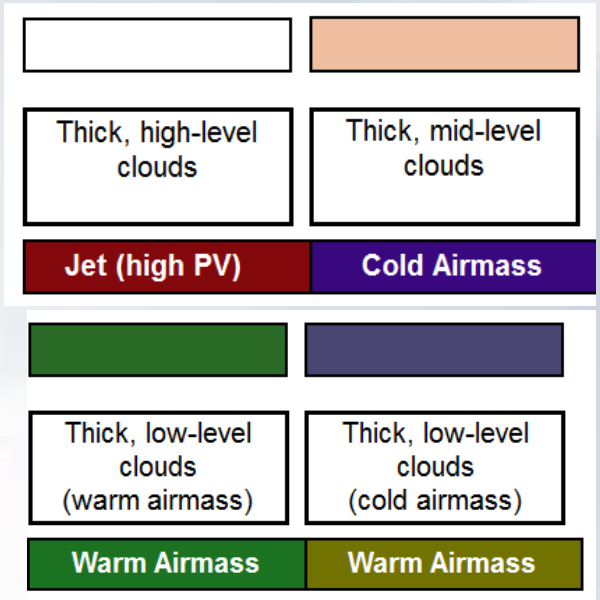
# The Airmass RGB



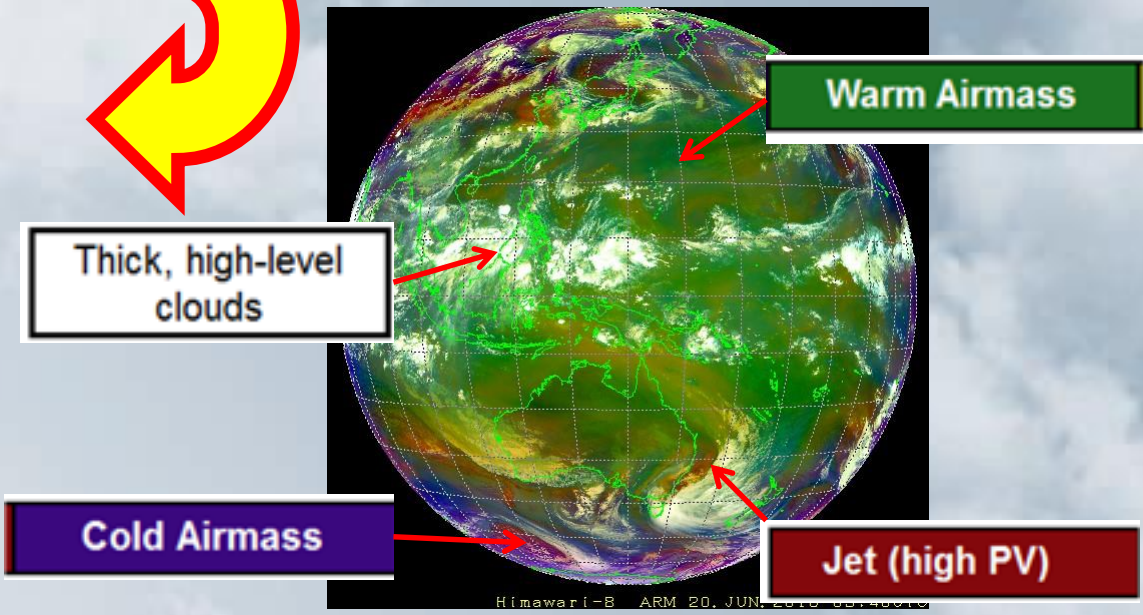
| Airmass RGB | Range | Gamma |
|---|---|---|
| 6.2 – 7.3 micron | -26.2 to 0.6 | 1.0 |
| 9.6 - 10.4 micron | -43.2 to 6.7 | 1.0 |
| 6.2 micron | 243.9 to 208.5 | 1.0 |

**CHANNEL COMBINATION (BOM/JMA recipe)**

## Himawari-8 channels




## Colour interpretation palette




## Himawari-8 RGB Composite

# Socrative Question 2

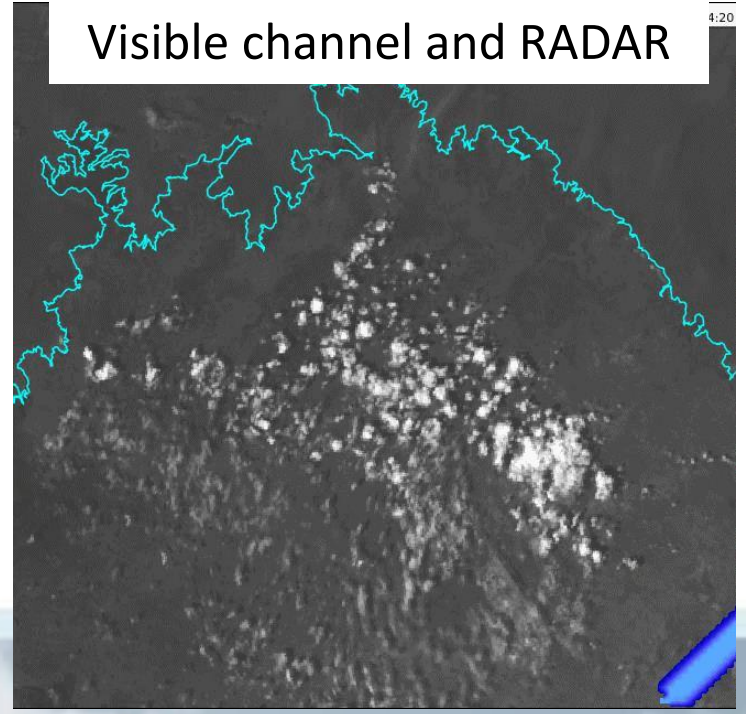
Satellite images courtesy JMA/BOM, Lightning data courtesy WeatherZone

# Kimberley thunderstorms. Early stages: the "clumping" of cumulus cloud in Himawari-8 satellite data

4th November 2019,

**from 04 to 0420UTC**

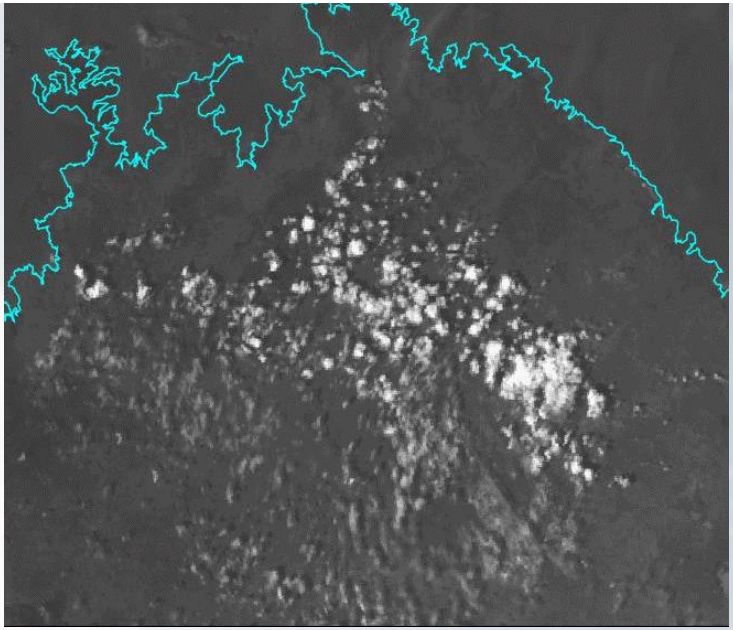
Visible channel and RADAR



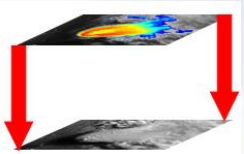
Heavy pptn

Light

Sandwich Product and Lightning

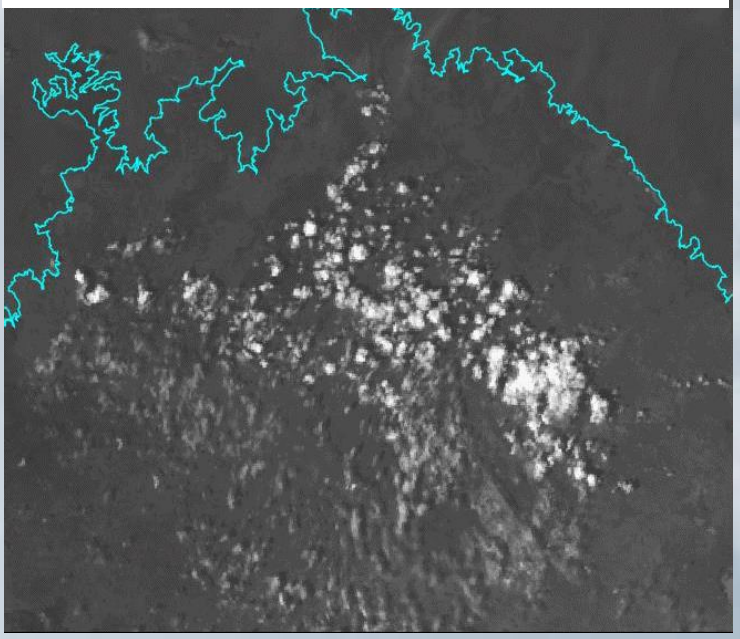


IR10.4 BT



HR Vis

**Sandwich Product (Vis and IR)**



-80C

-20C

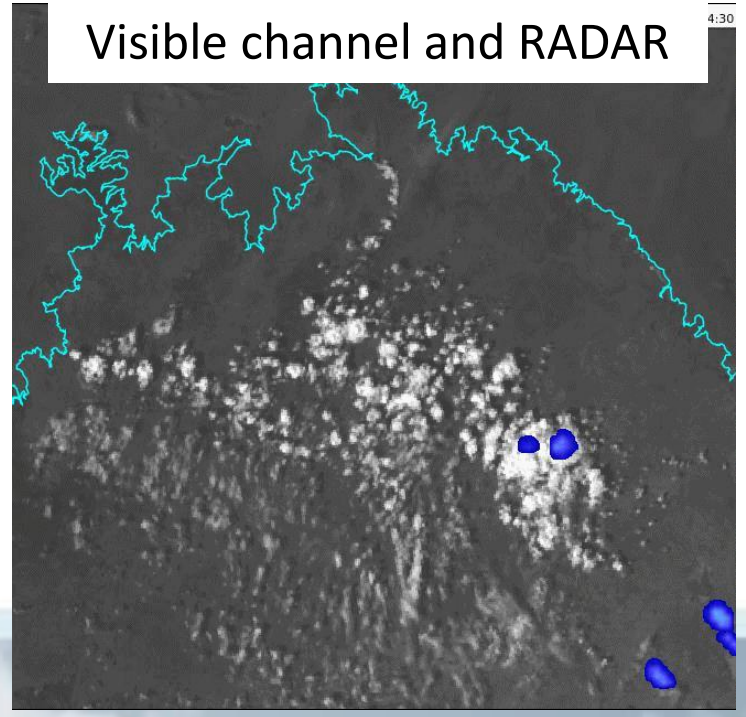
Satellite images courtesy JMA/BOM, Lightning data courtesy WeatherZone

# Kimberley thunderstorms: RADAR signals detected

4th November 2019,

**from 0430UTC**

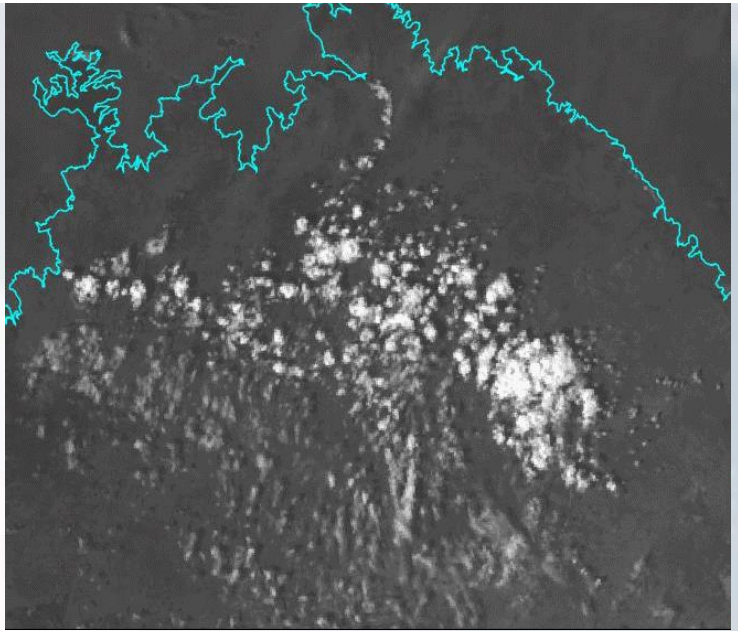
Visible channel and RADAR



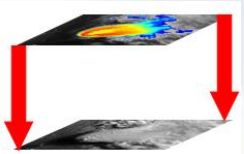
Heavy pptn

Light

Sandwich Product and Lightning

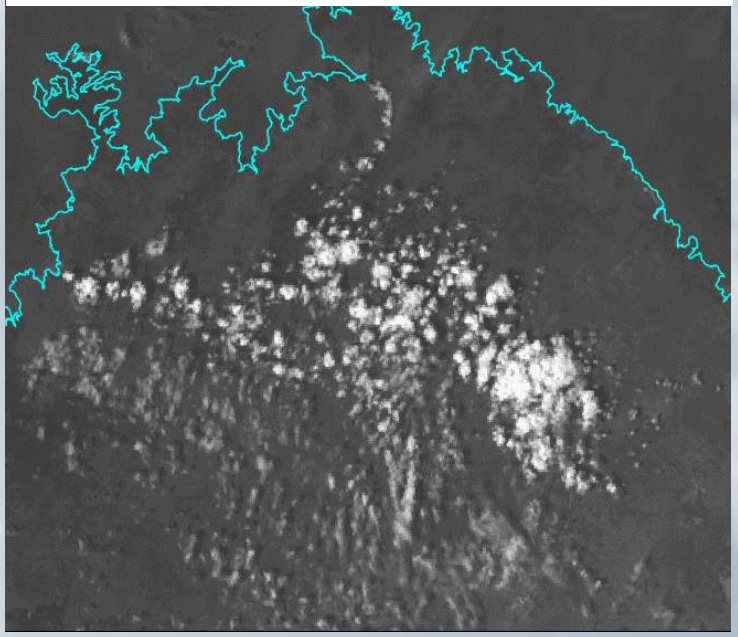


IR10.4 BT



HR Vis

**Sandwich Product (Vis and IR)**



-80C

-20C

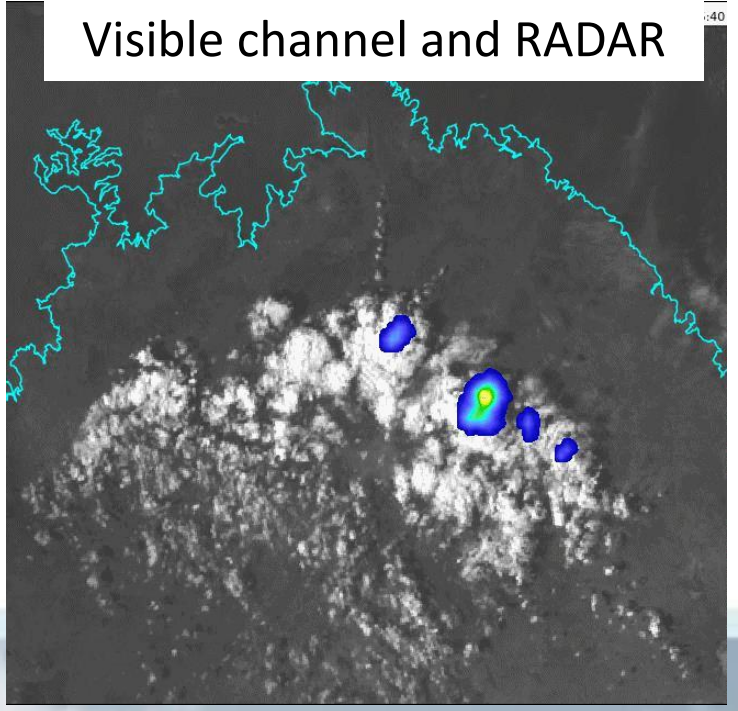
Satellite images courtesy JMA/BOM, Lightning data courtesy WeatherZone

# Kimberley thunderstorms: First Lightning detected

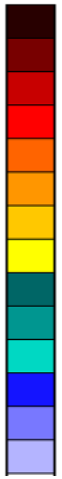
4th November 2019,

**from 0540UTC**

Visible channel and RADAR

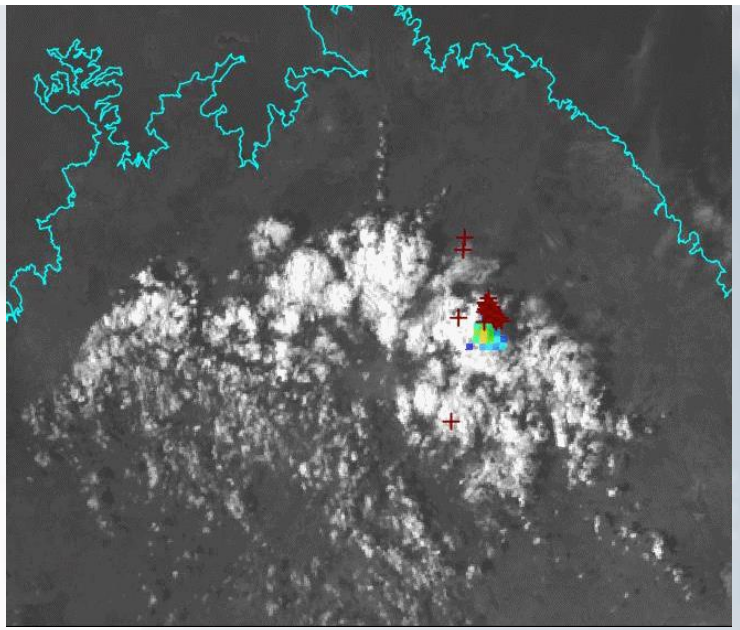


Heavy pptn

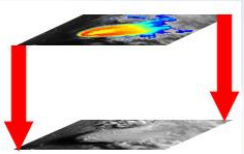


Light

Sandwich Product and Lightning

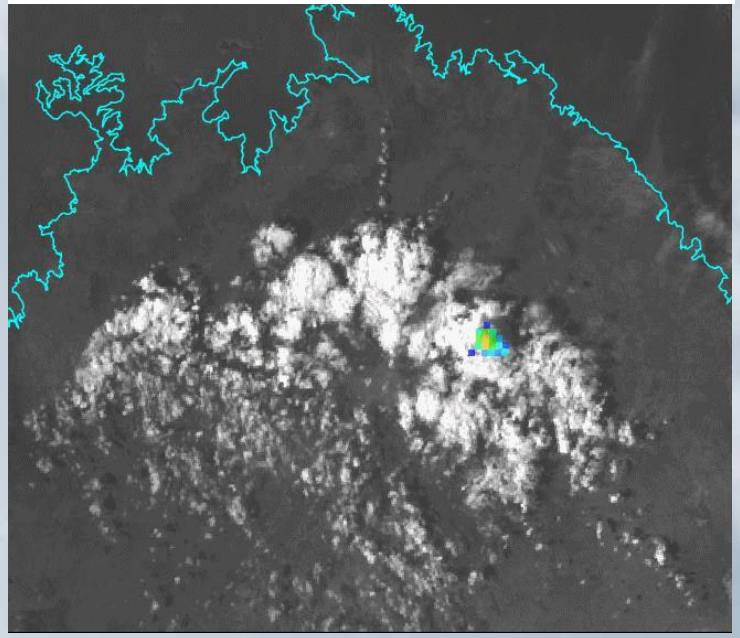


IR10.4 BT



HR Vis

**Sandwich Product (Vis and IR)**

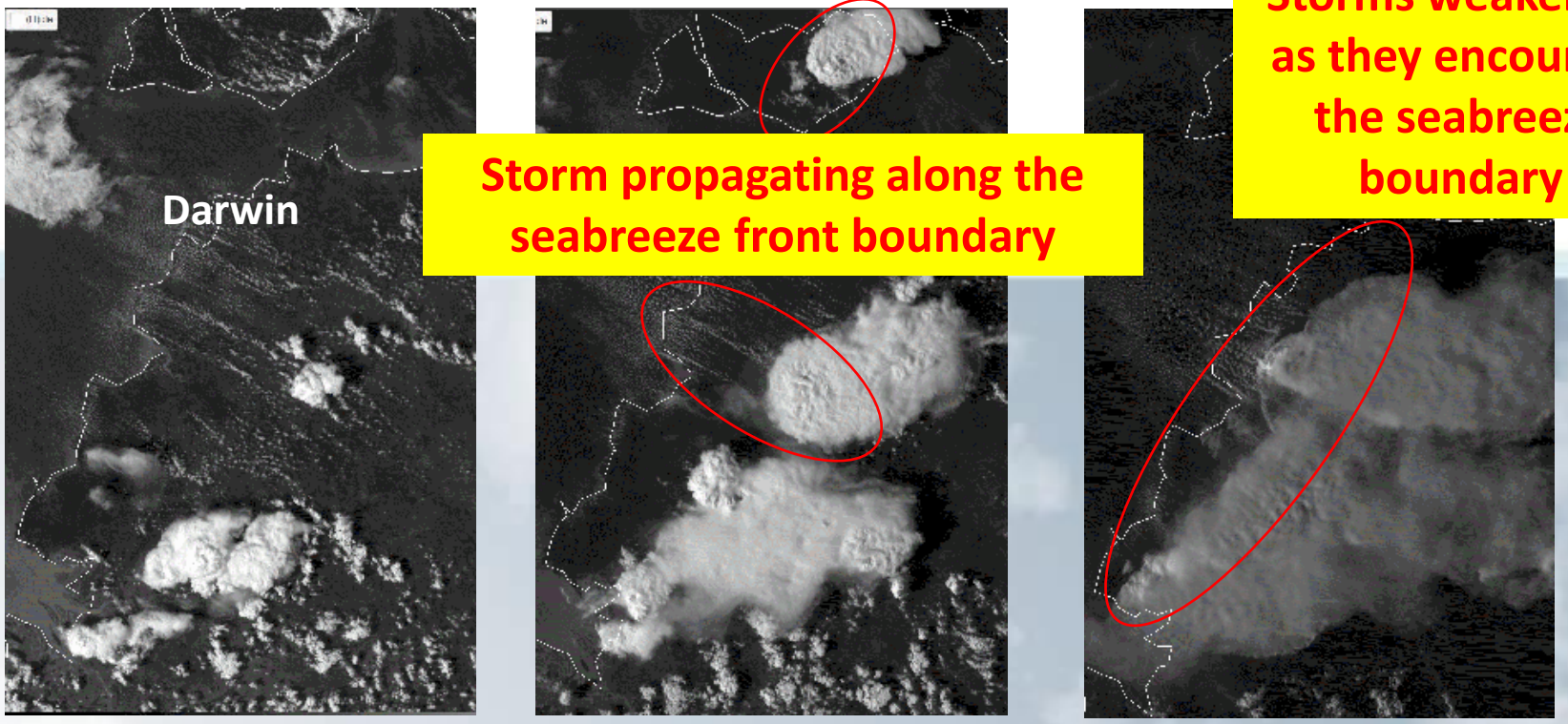


-80C

-20C

# Storm relative animation: western Top End, Australia

10 FPS Rocking animations of storms developing over the northwest Top End, Australia 0400 to 0820UTC 6th December 2018 using the RAMMB/CIRA SLIDER functionality




**Storm propagating into a local convergence area, (a line of Cu)**

satellite animations courtesy JMA / CIRA RAMMB

# System centric vs earth centric animation

1. System (storm) vs earth centric. System centric. Can do System Centric in SLIDER (NT storms example)
2. Can monitor rotation of the storm better, without the additional "translational" component of storm movement.
3. Can monitor the inflow of environmental air (and the source of this) into the storm and also the outflow from the system into the environment, without the additional "translational" component of storm movement.
4. Can resolve the shear associated with the storms development, without the additional "translational" component of storm movement.
5. Can resolve the interaction between storms , without the additional "translational" component of storm movement.

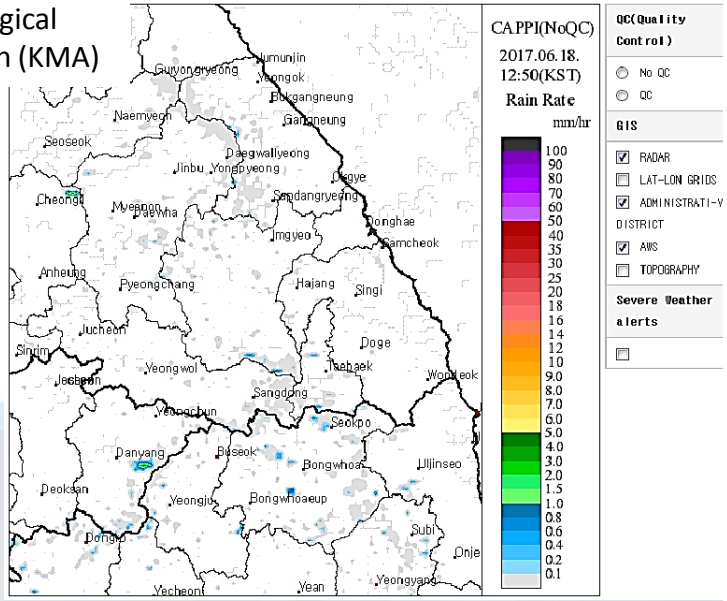
# Socrative Question 3

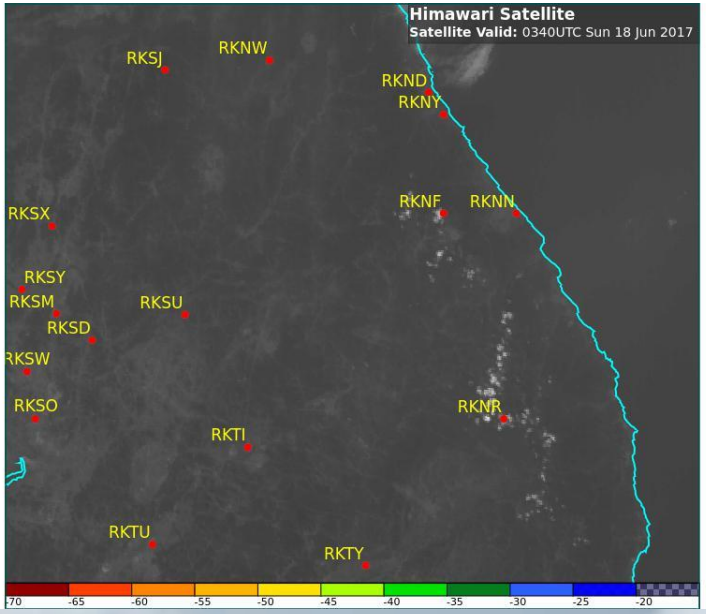
# Korea thunderstorms: cumulus develops in satellite imagery; cumulus clumping:

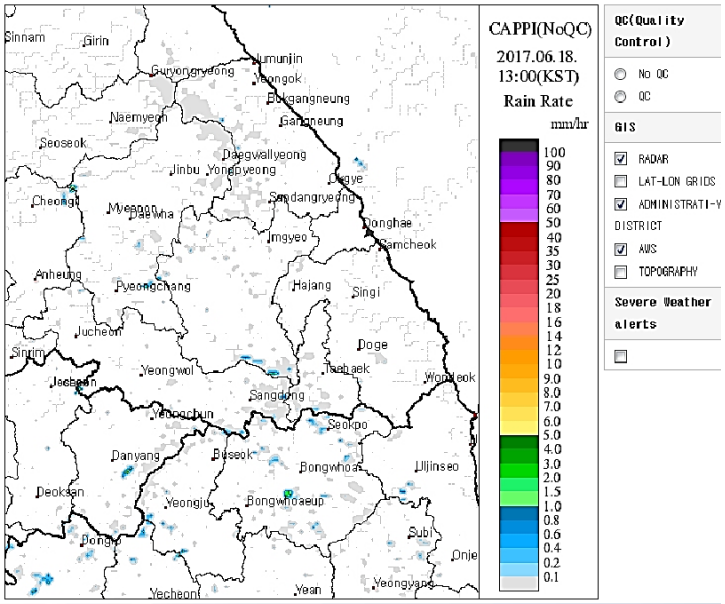
## 0340-0350UTC (1240-1250KST)

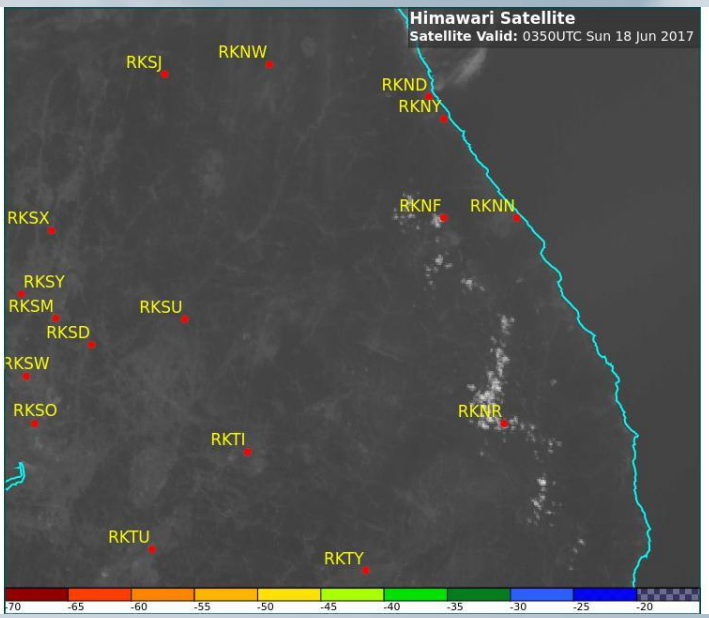
RADAR images courtesy Korea Meteorological Administration (KMA)

satellite images courtesy JMA/BOM



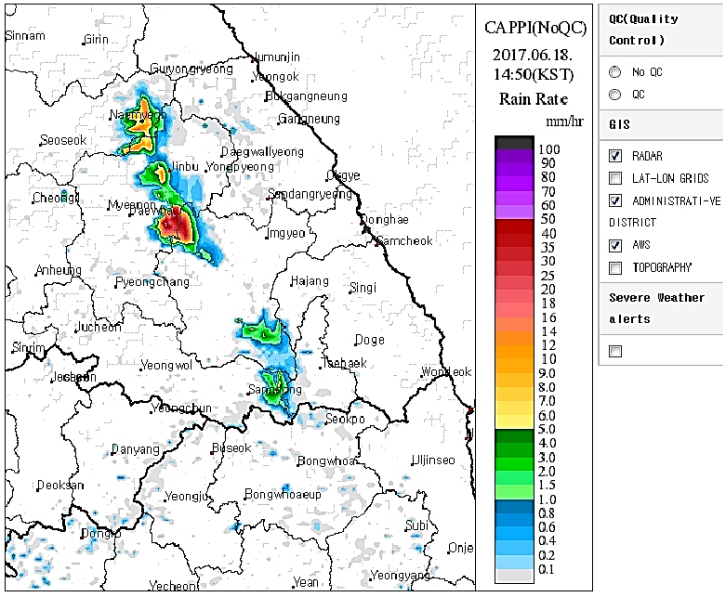



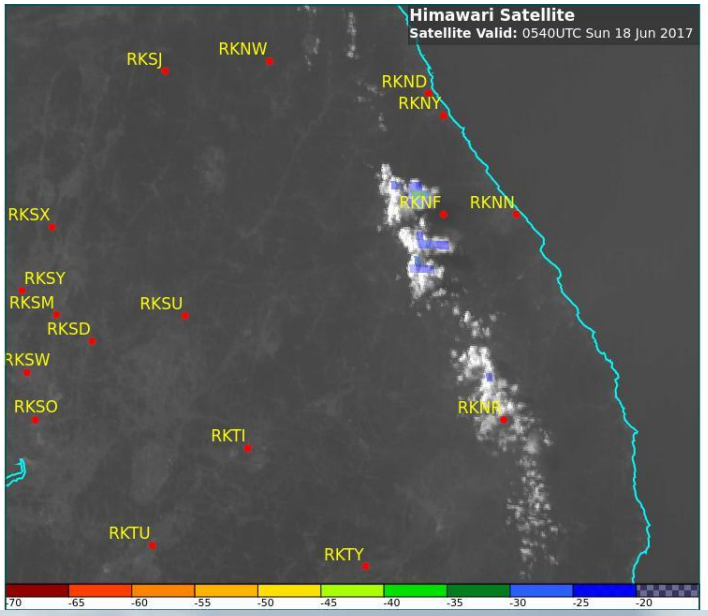



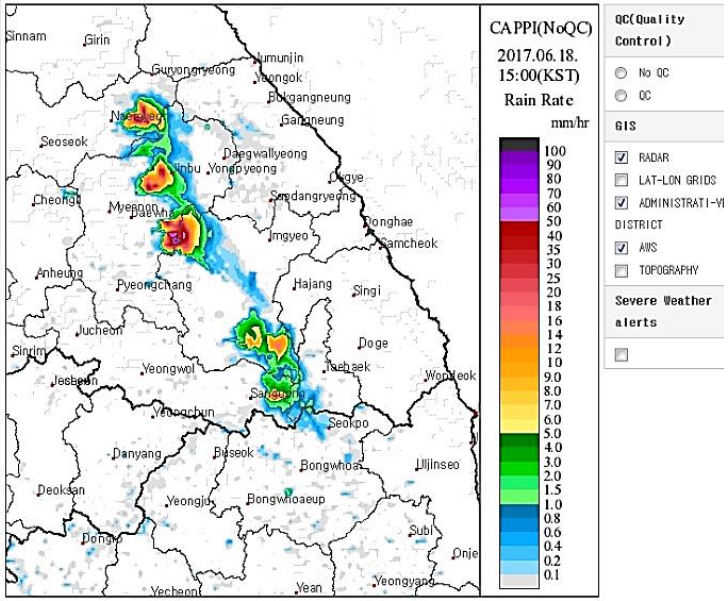
RADAR images courtesy Korea Meteorological Administration (KMA)

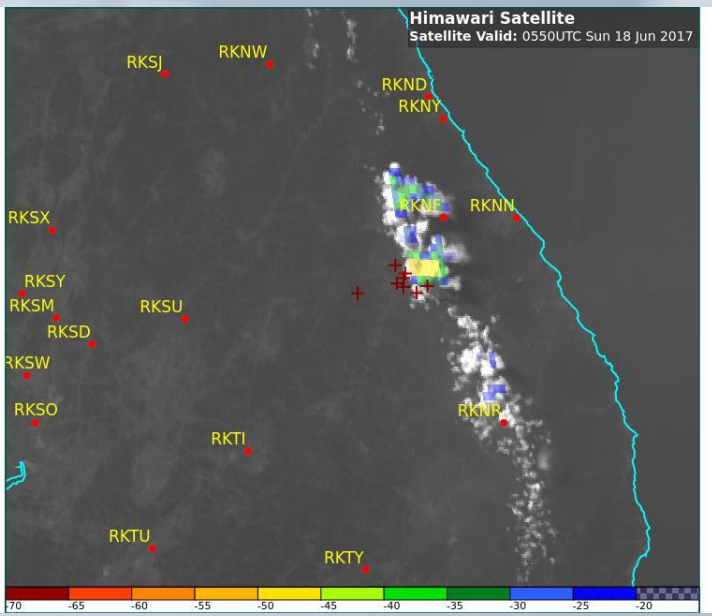
# Korea thunderstorms: first lightning strikes recorded: 0550-0600UTC (1450-1500KST)

satellite images courtesy JMA/BOM



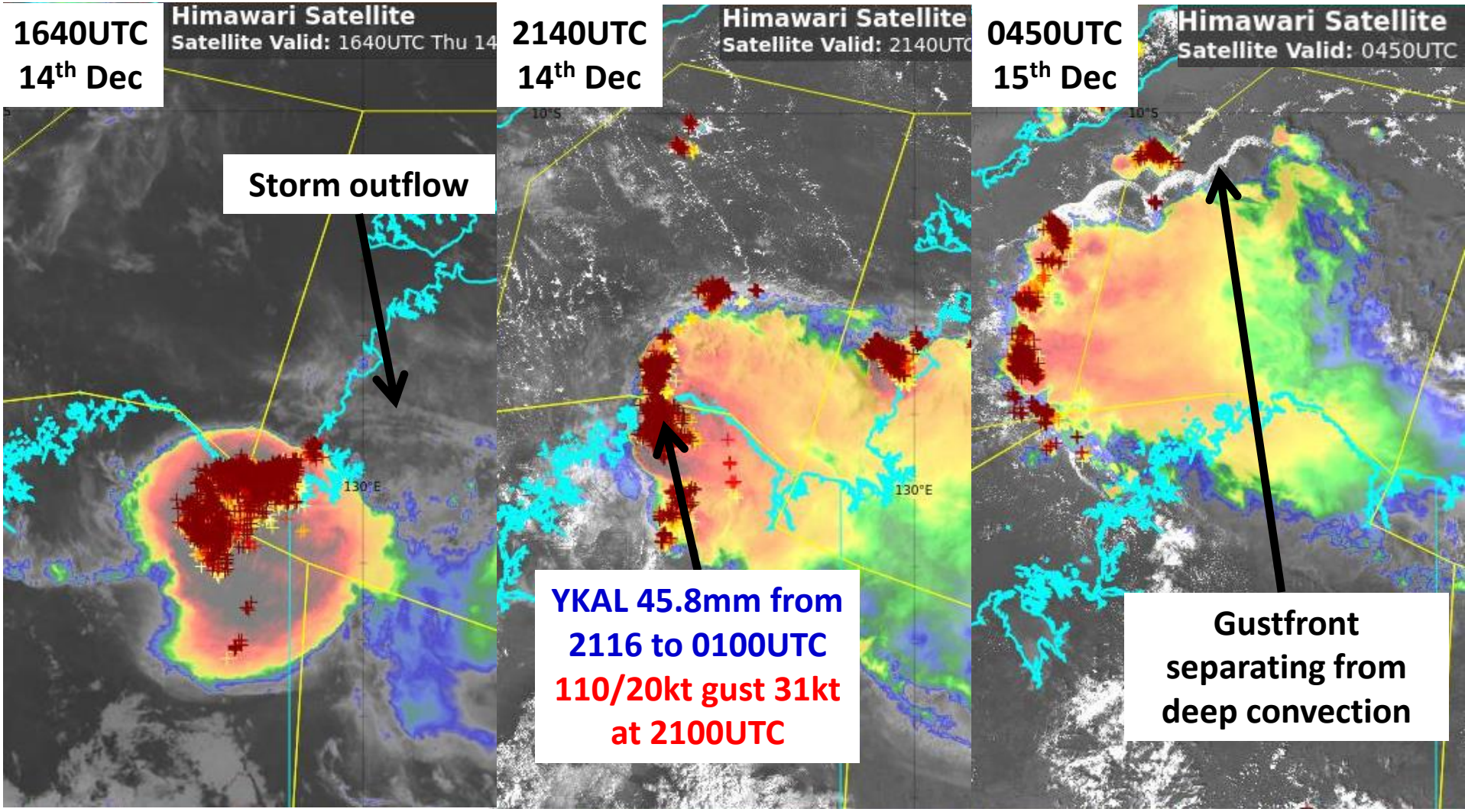



images courtesy JMA/BOM, lightning data from WeatherZone

# Overview of a Thunderstorm event, north Australia

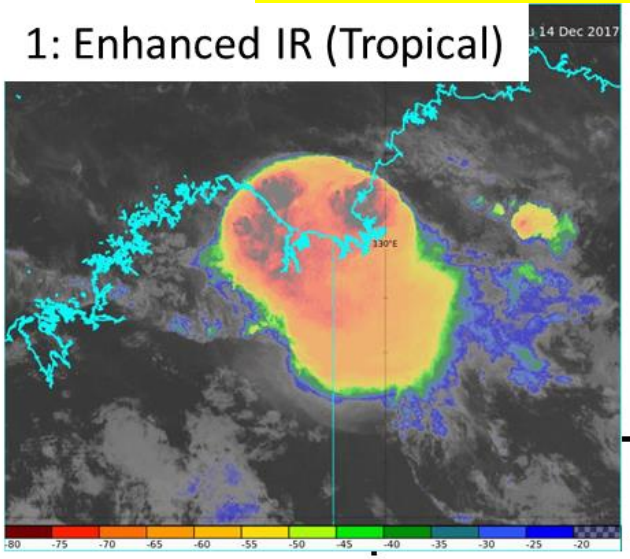
Enhanced Infrared / Sandwich product and 10 minute lightning data
at 1620UTC and 2140UTC, 14th December and 0450UTC 15th December

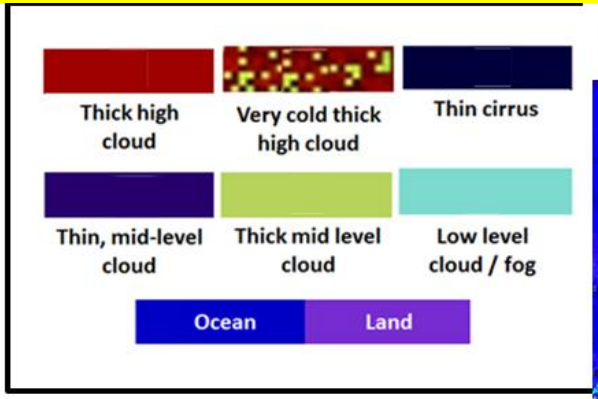


# RGB products examined during night time

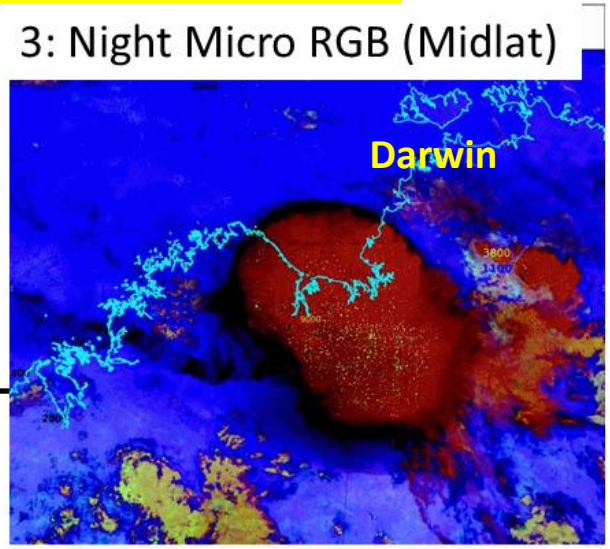
**Question: What RGB composite(s) do you prefer ?**

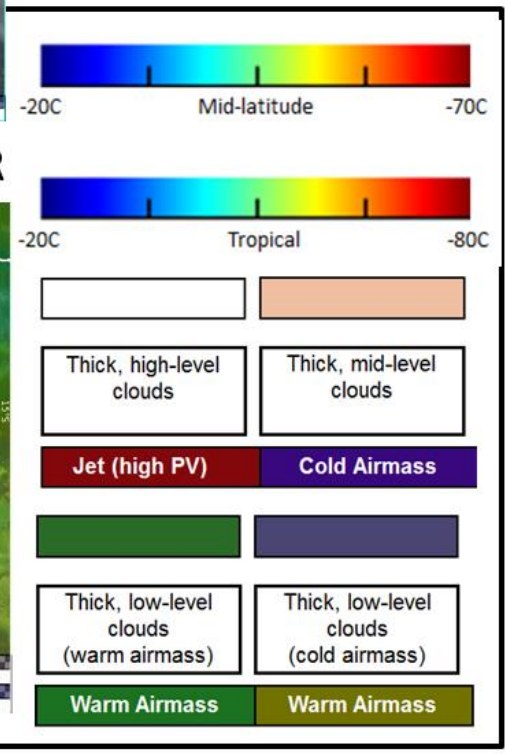
## 1: Enhanced IR (Tropical)



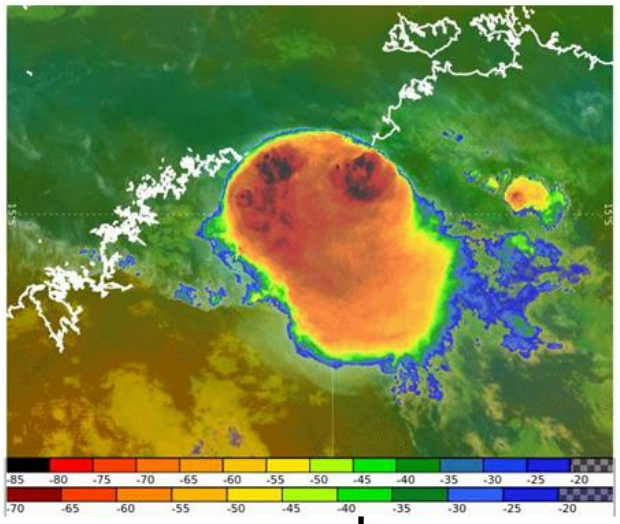




## 3: Night Micro RGB (Midlat)

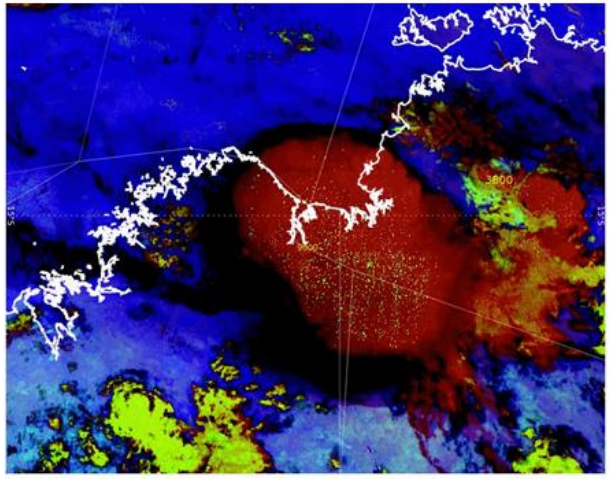



## 2: Airmass RGB & enhanced IR



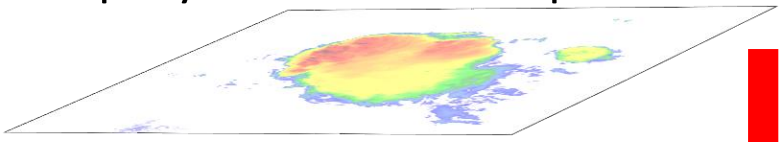

## 4: Night Micro RGB (Tropical)

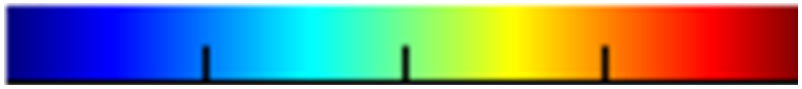


# Example 4: "Airmass RGB Sandwich Product" (HansPeter Roesli)

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

Top layer: IR10.4 BT tropical scale

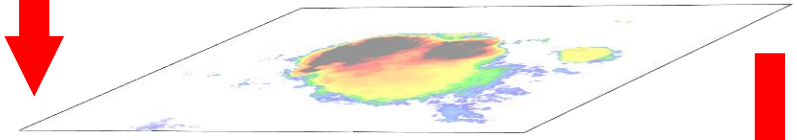


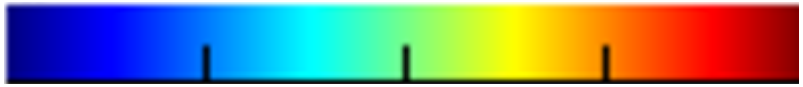


-20C Tropical -80C

scale as adapted from Australian Bureau of Meteorology forecasters

Mid layer: IR10.4 BT midlat scale

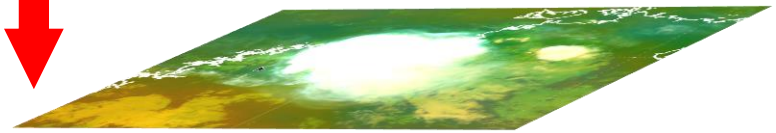




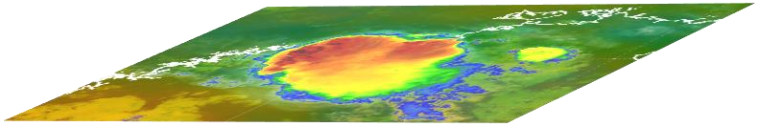
-20C Mid-latitude -70C

Upper and mid layer opacity set to 50%

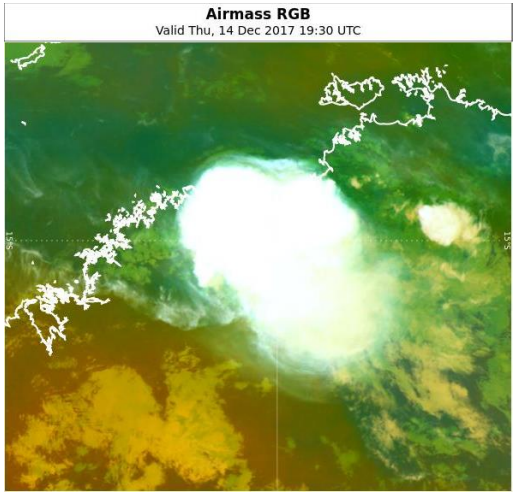
Bottom layer (“background”): Airmass RGB (midlat tuned)



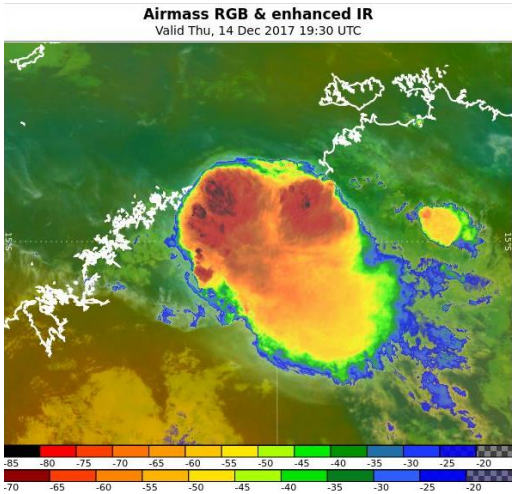
**Blending options – applied to the upper layer**



**Before**

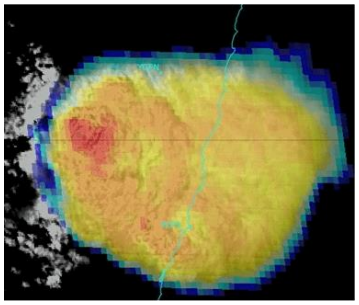



**After**

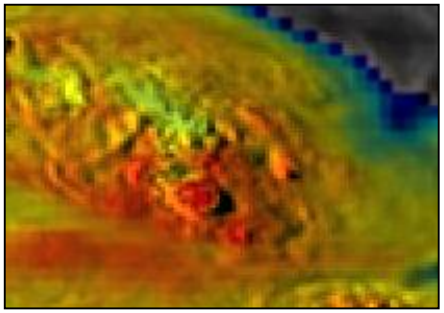


# Socrative Question 4

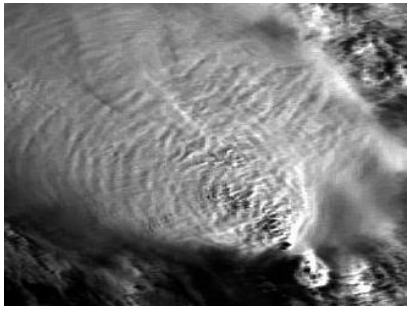
# Storm-Top Features



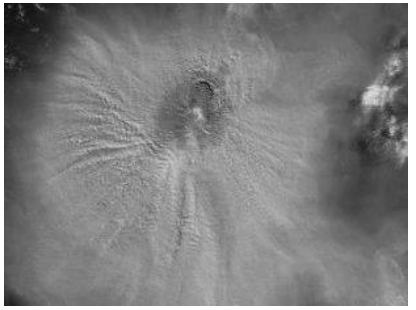
Overshooting top



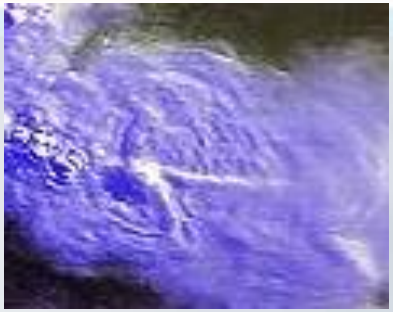
Pancake formation



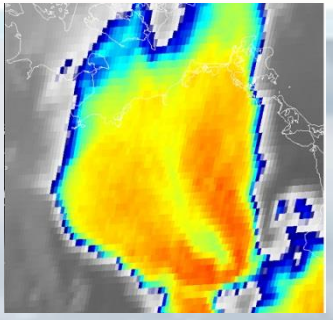
Gravity waves



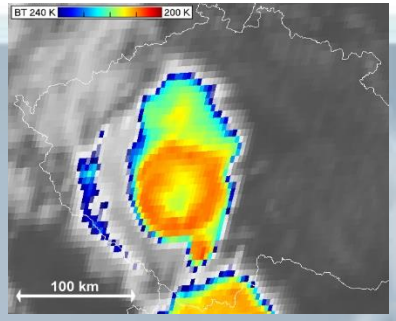
Radial cirrus



Ship wake

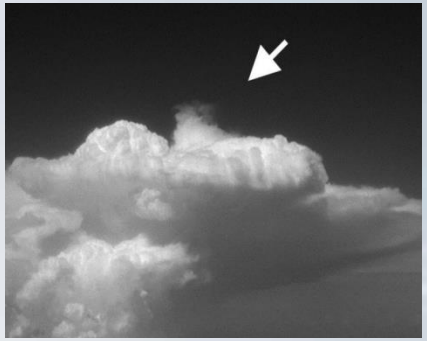


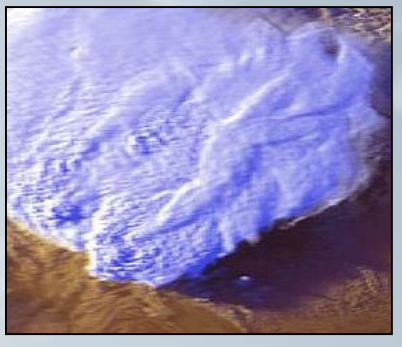
Cold U-shaped storm




Cold ring shaped storm

Jumping cirrus





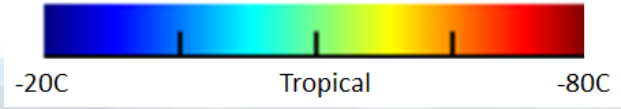
Above anvil cirrus plume

satellite data courtesy BOM/JMA, lightning data from Weather Zone

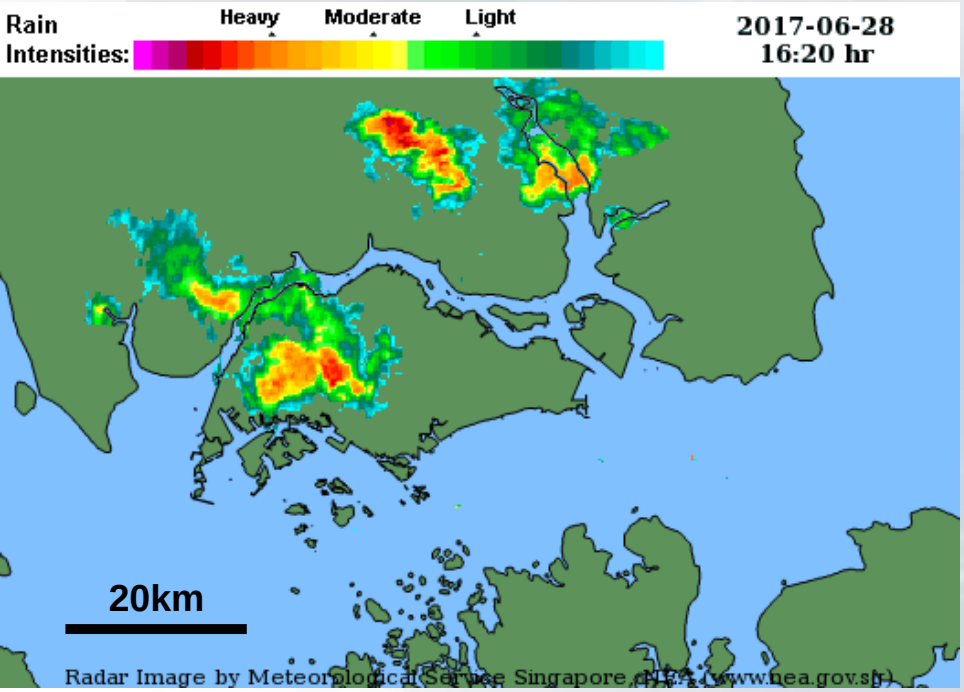
# Singapore thunderstorm event, 28th June 2017

at the time 16:20 LST, 0810UTC

Comparing RADAR, Himawari-8 satellite and lightning data.

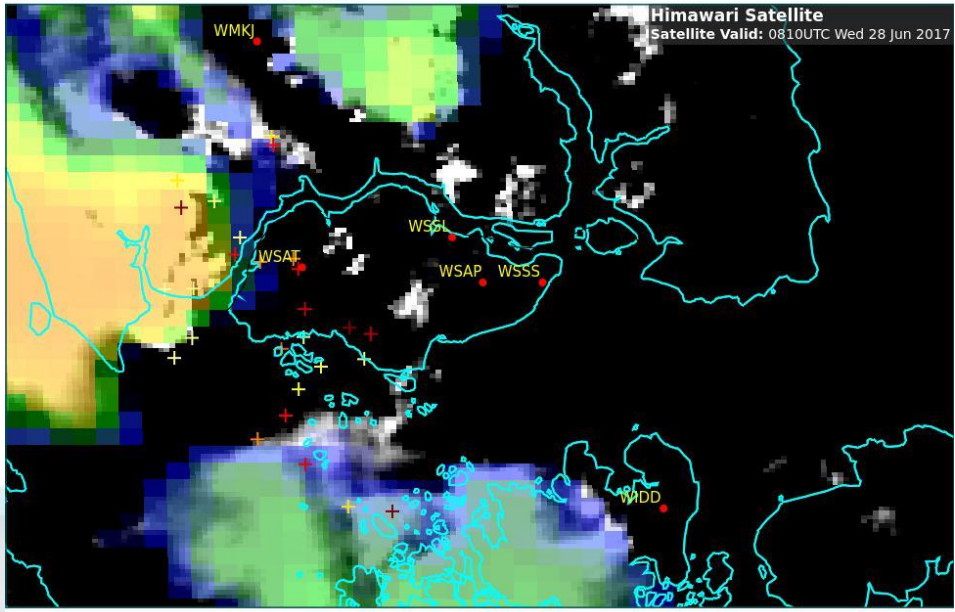



RADAR data courtesy NEA Singapore

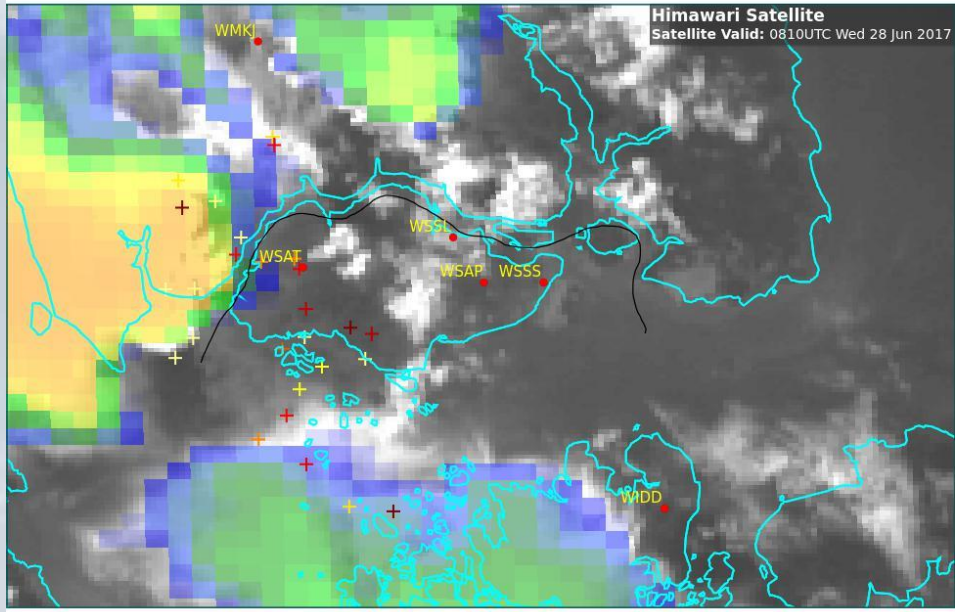



## Modified Tropical Sandwich Product

(vis brightness -170, contrast 400)

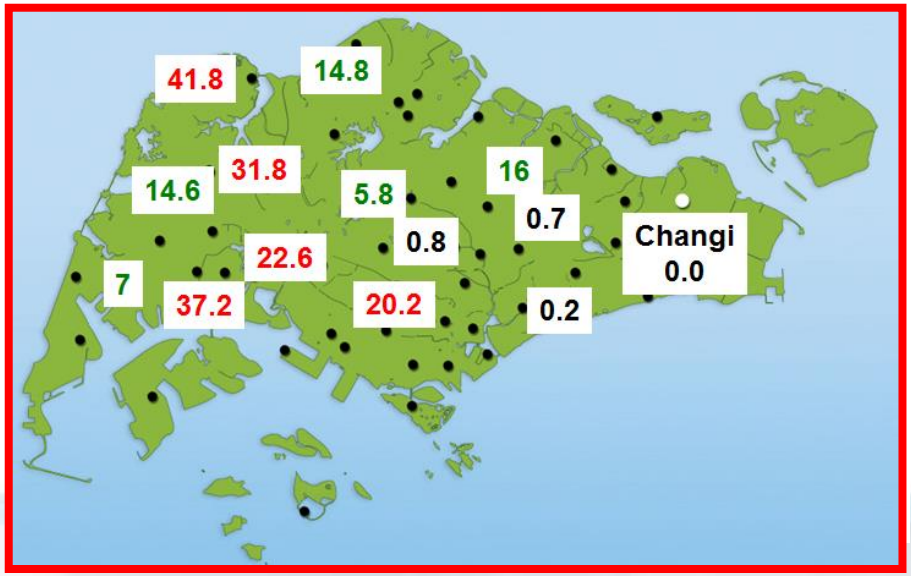



## Tropical Sandwich Product

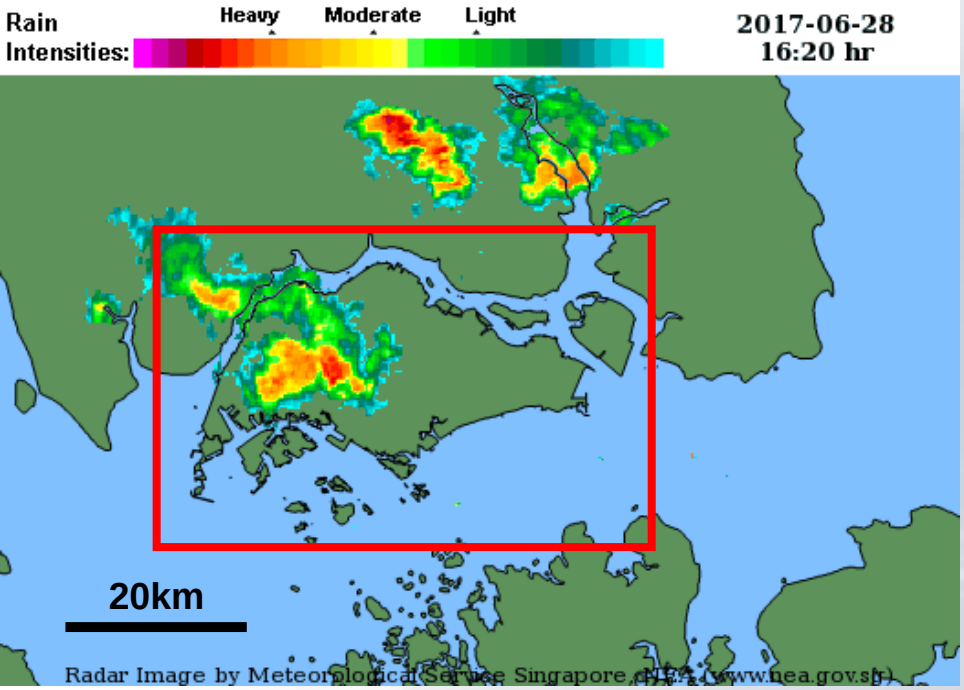


satellite data courtesy BOM/JMA, lightning data from Weather Zone

## 24 hour precipitation (mm)

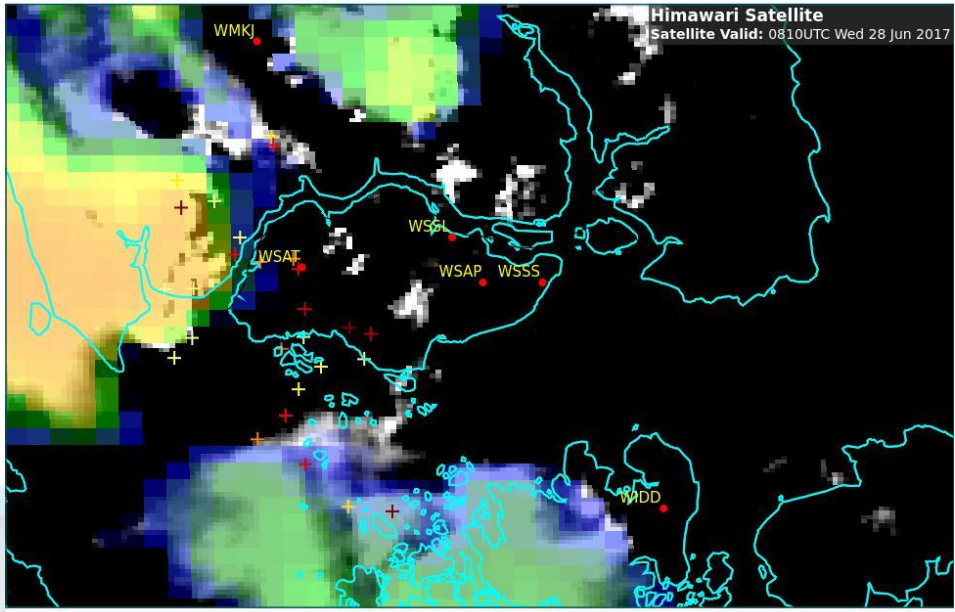



RADAR and precipitation data courtesy NEA Singapore

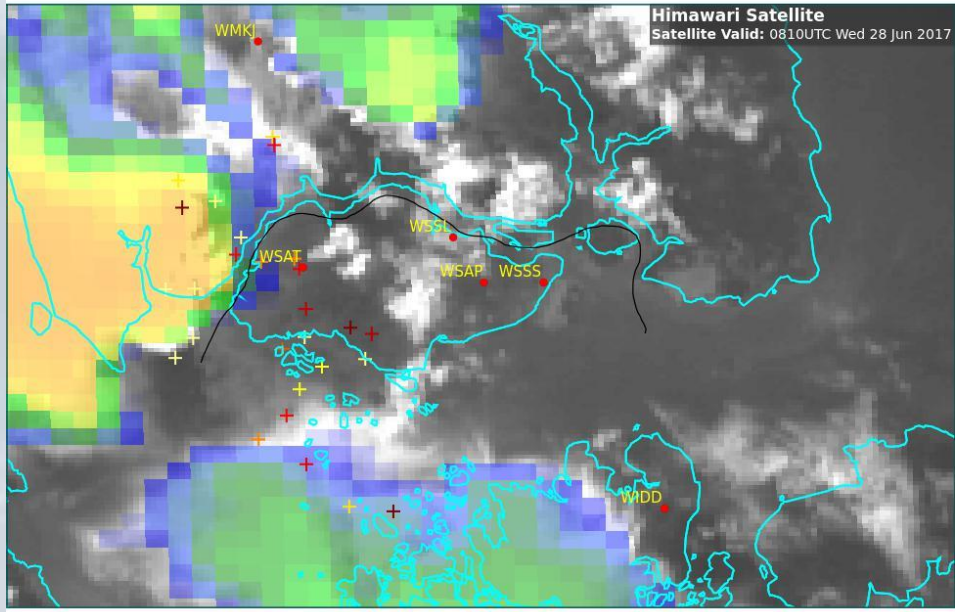



## Modified Tropical Sandwich Product

(vis brightness -170, contrast 400)




## Tropical Sandwich Product



# Explaining the Parallax error

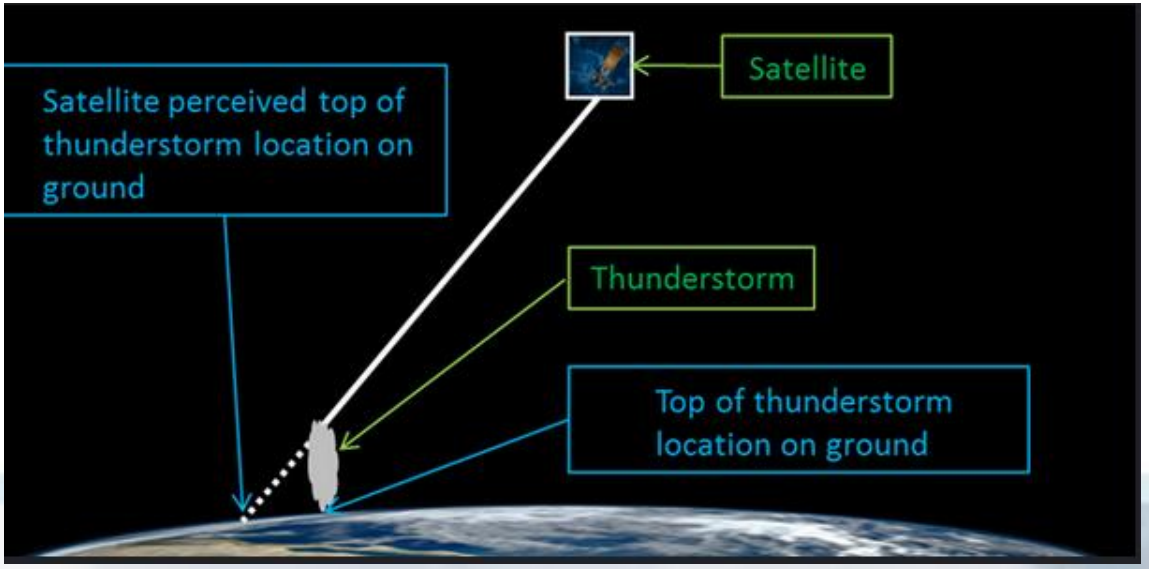
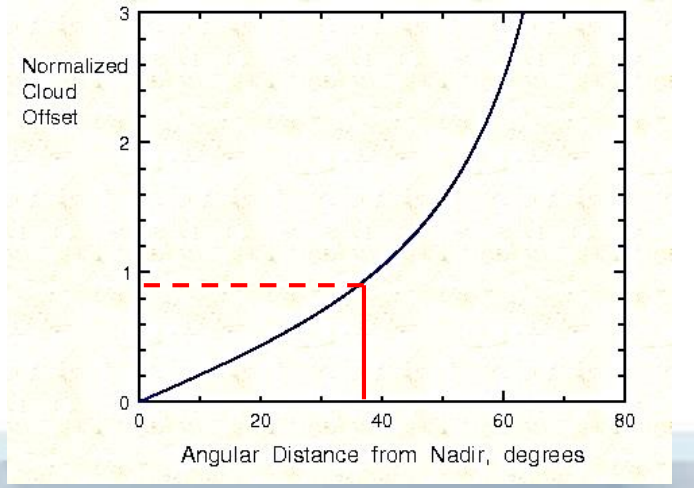



image modified from Satellite Liaison Blog submission by B.Line




from http://www-das.uwyo.edu/~geerts/cwx/notes/chap02/parallax.html

| | |
|---|---|
| Singapore location | 1.35° N, 103.82° E |
| Himawari-8 sub-satellite | 0, 140.7E |
| Distance from sub-satellite point | ~37 degrees |
| Normalise cloud offset | ~ 0.8 to 0.9 |
| Stormtop height | ~14km (Tbb ~-65C) |
| Offset | ~12 km away from (to west) of sub-satellite point |

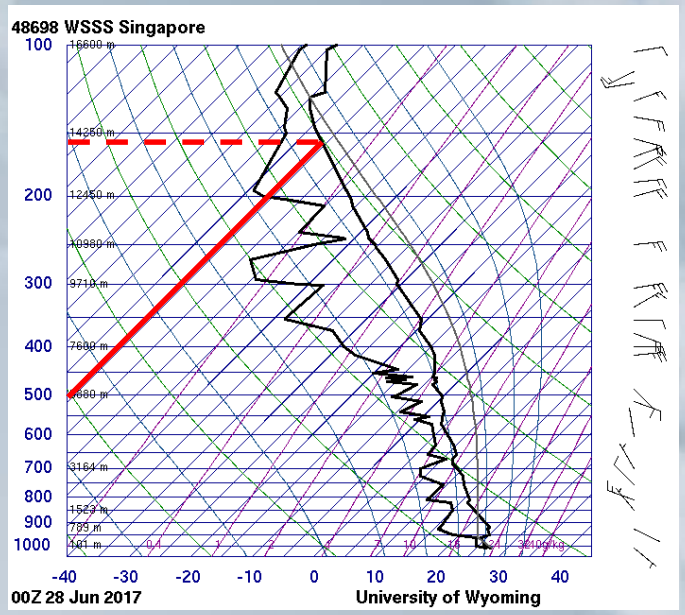



image from University of Wyoming

Australian Government
Bureau of Meteorology

# Summary

- So many possibilities when looking at satellite data and all the channels.
- Visible satellite images are a powerful tool in identifying where thunderstorms will form in real time.
- Sandwich products are useful in identifying storm details especially storm tops and were the strongest updraughts are occurring.
- Animations are awesome
- RGB can tell us so much



# The End

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Extreme Weather Desk Bureau of Meteorology
Australia