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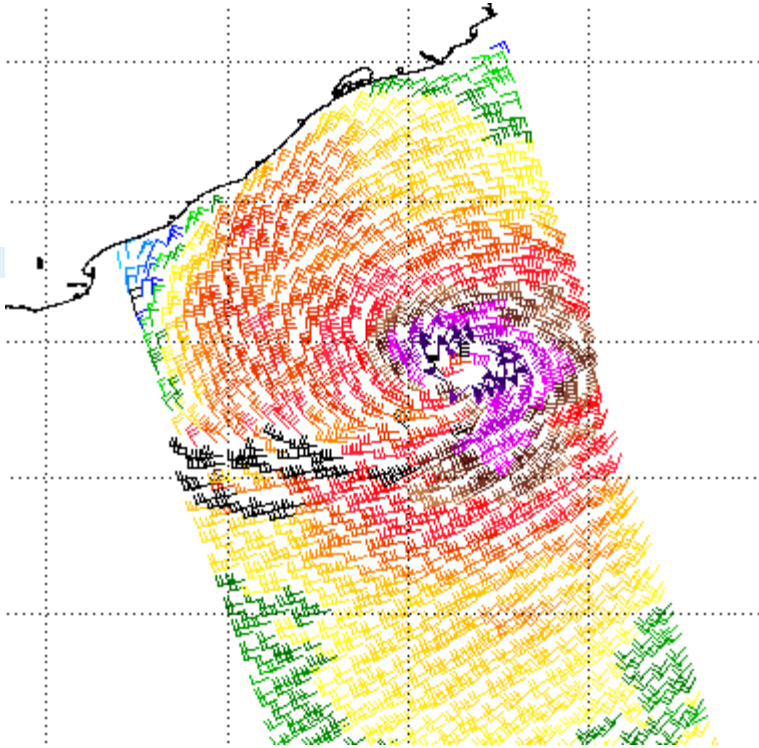
Scatterometry

http://manati.orbit.nesdis.noaa.gov/datasets/ASCATData.php



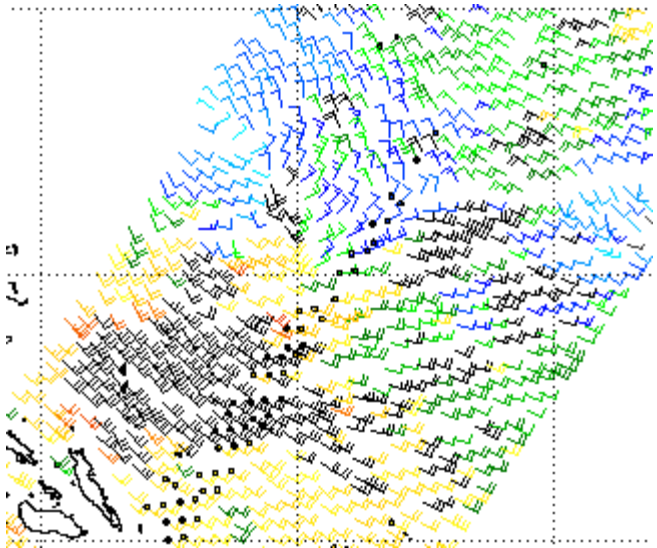
COMET Training package:
https://www.meted.ucar.edu/EUMETSAT/marine_forecasting/navmenu.php?tab=1&page=2-2-0&type=flash

ASCAT: on METOP-A and B satellites

Polar orbiting

see:http://manati.orbit.nesdis.noaa.gov/datasets/ASCATData.php/

Windsat: Very sensitive to heavy rain and so only useful in heavy rain-free areas.



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Scatterometry Theory: Bragg scattering

Small (2-4cm) capillary waves correspond to wind speed

Bragg scattering: energy at similar wavelengths scattered

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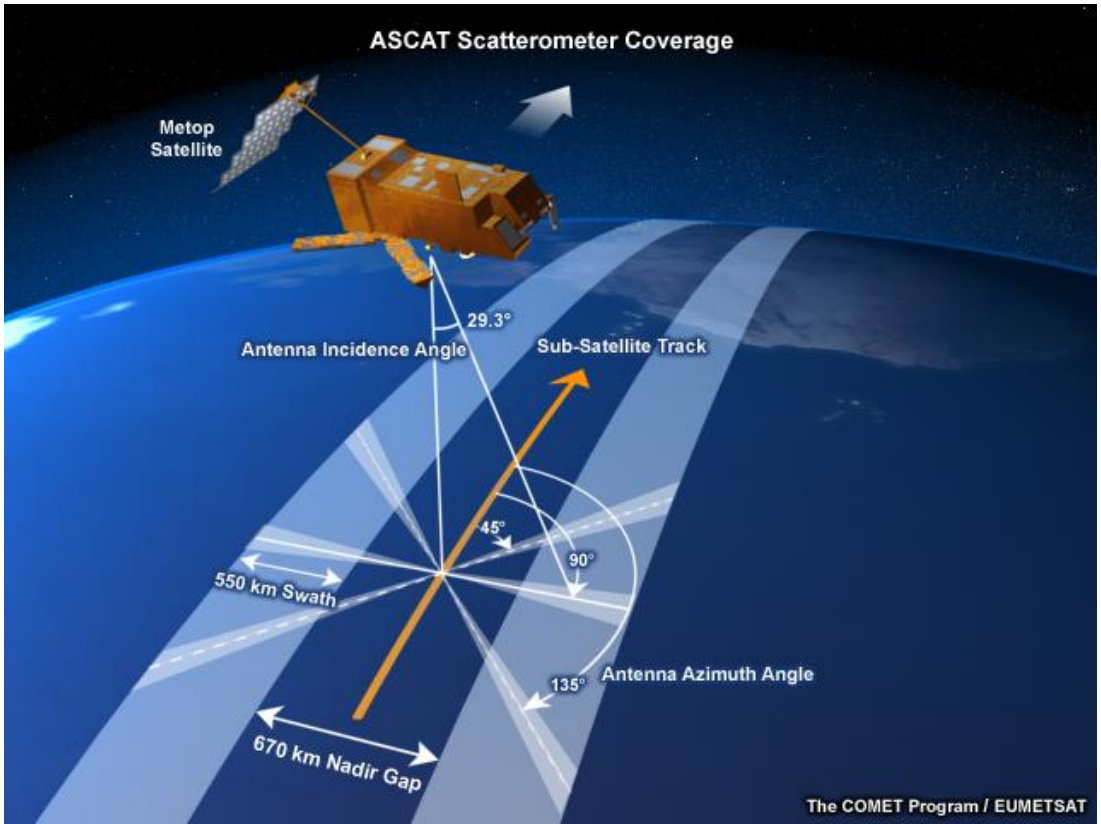
Ascat satellite geometry

Fan-beam: three antennas detecting two swathes ~500km wide separated by ~600km underneath where insufficient energy comes back.



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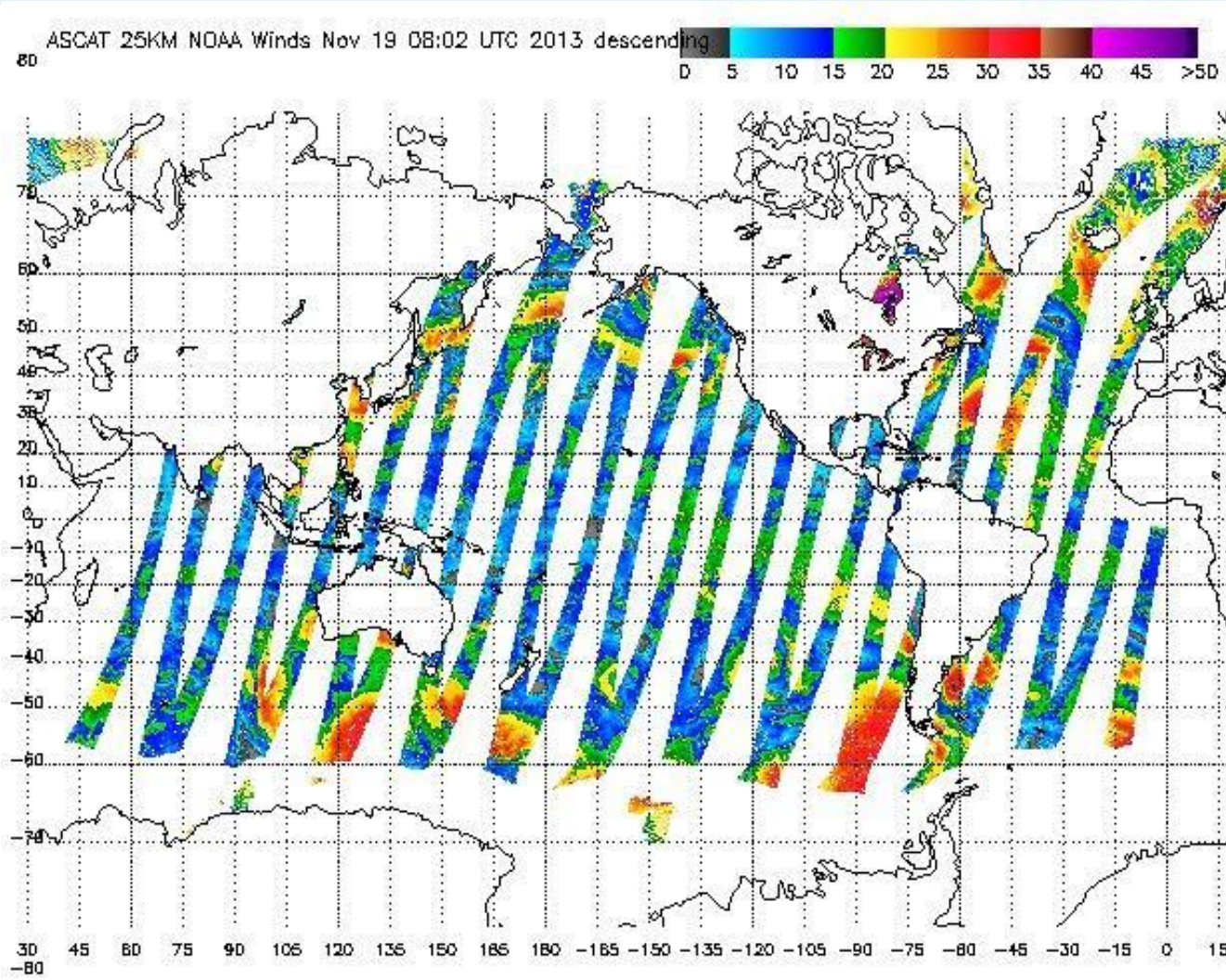
ASCAT coverage

http://manati.star.nesdis.noaa.gov/datasets/ASCATData.php/

Lots of misses in the tropics!



Courtesy: NOAA

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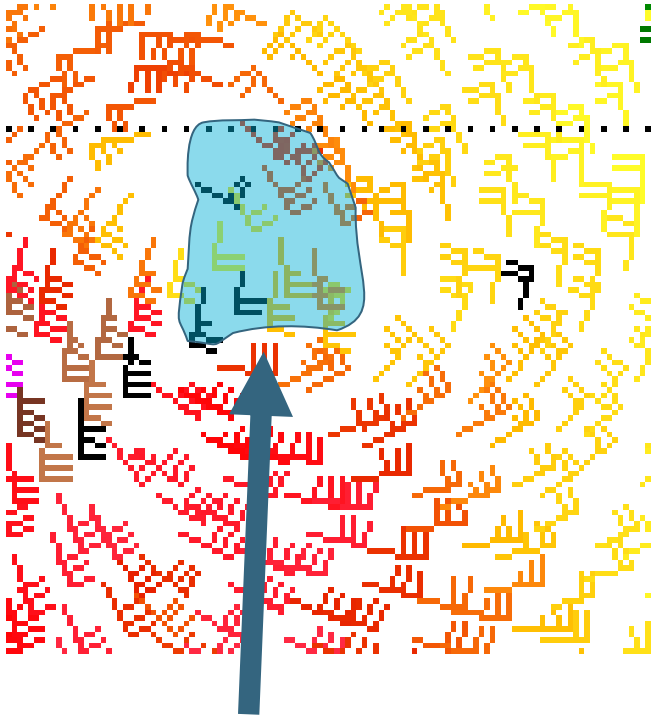
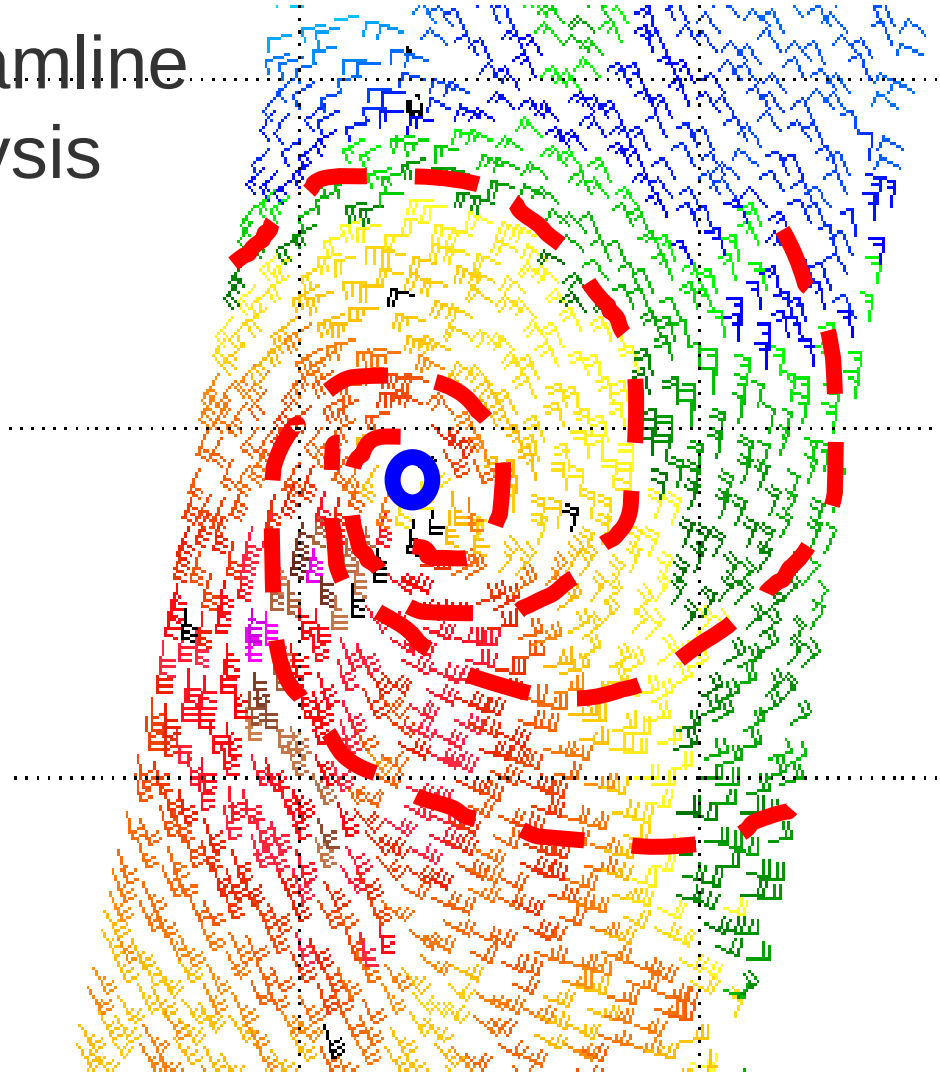
Ascat - positioning



Wrong direction

Streamline analysis



Southern Hemisphere example

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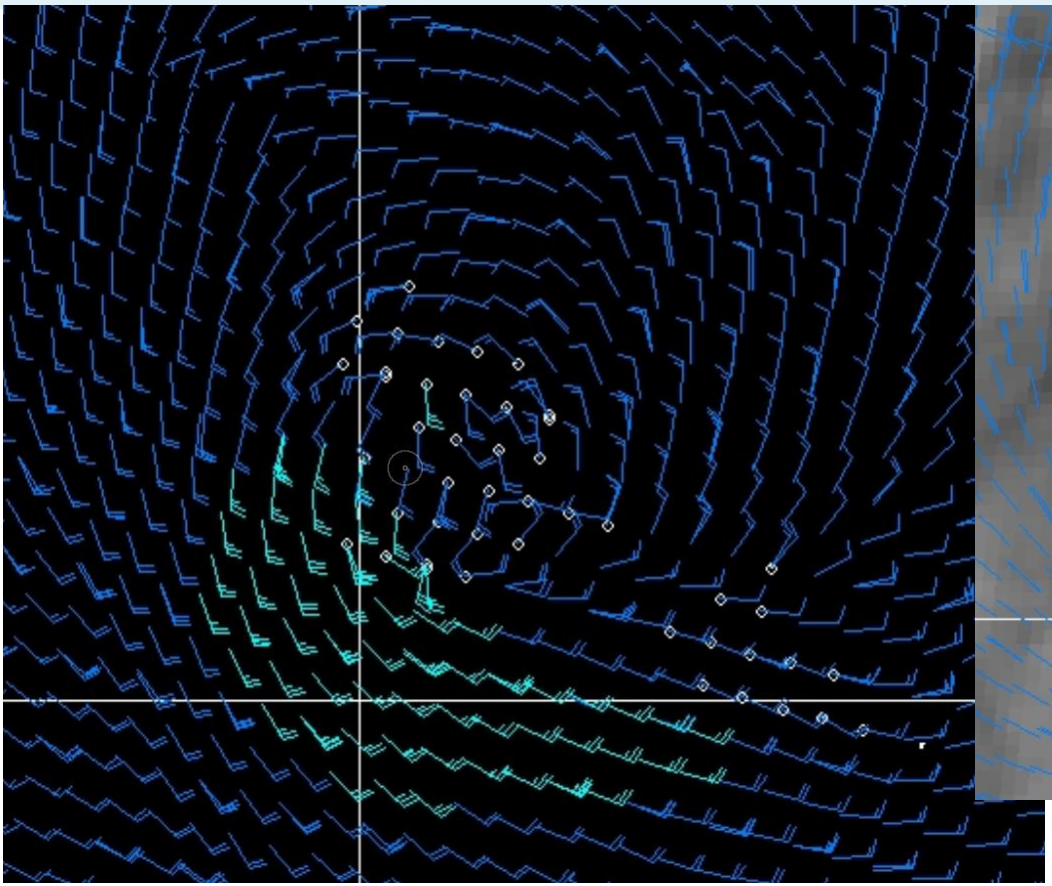
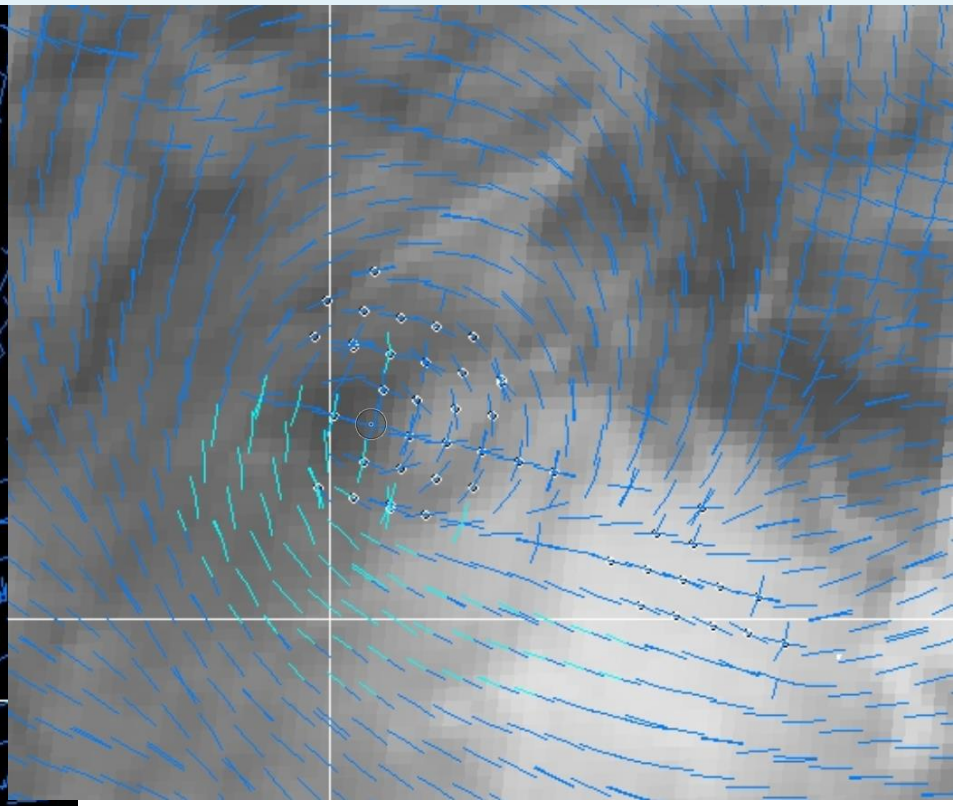
Ascat – positioning

Ambiguity plots for multiple solutions: buddy checking and NWP used





Frances: 30 April 2017

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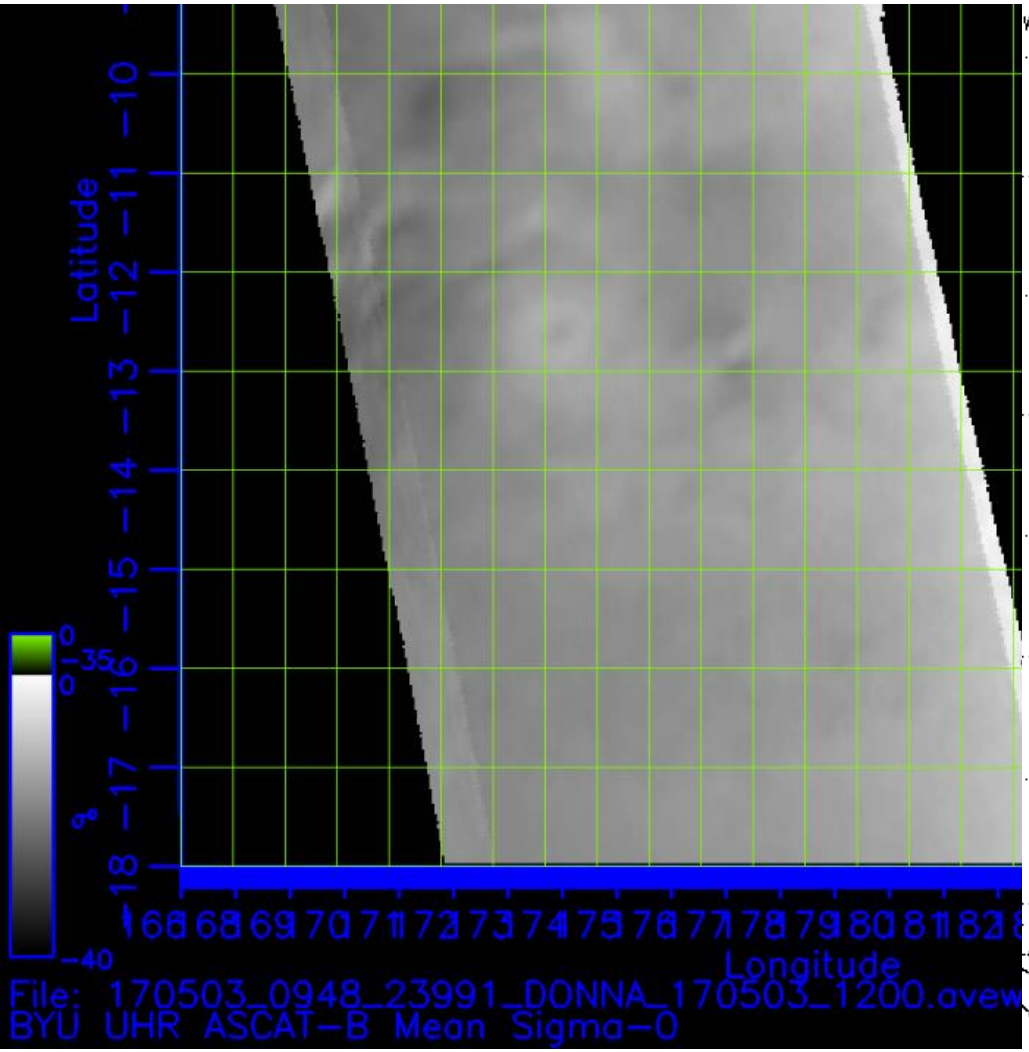
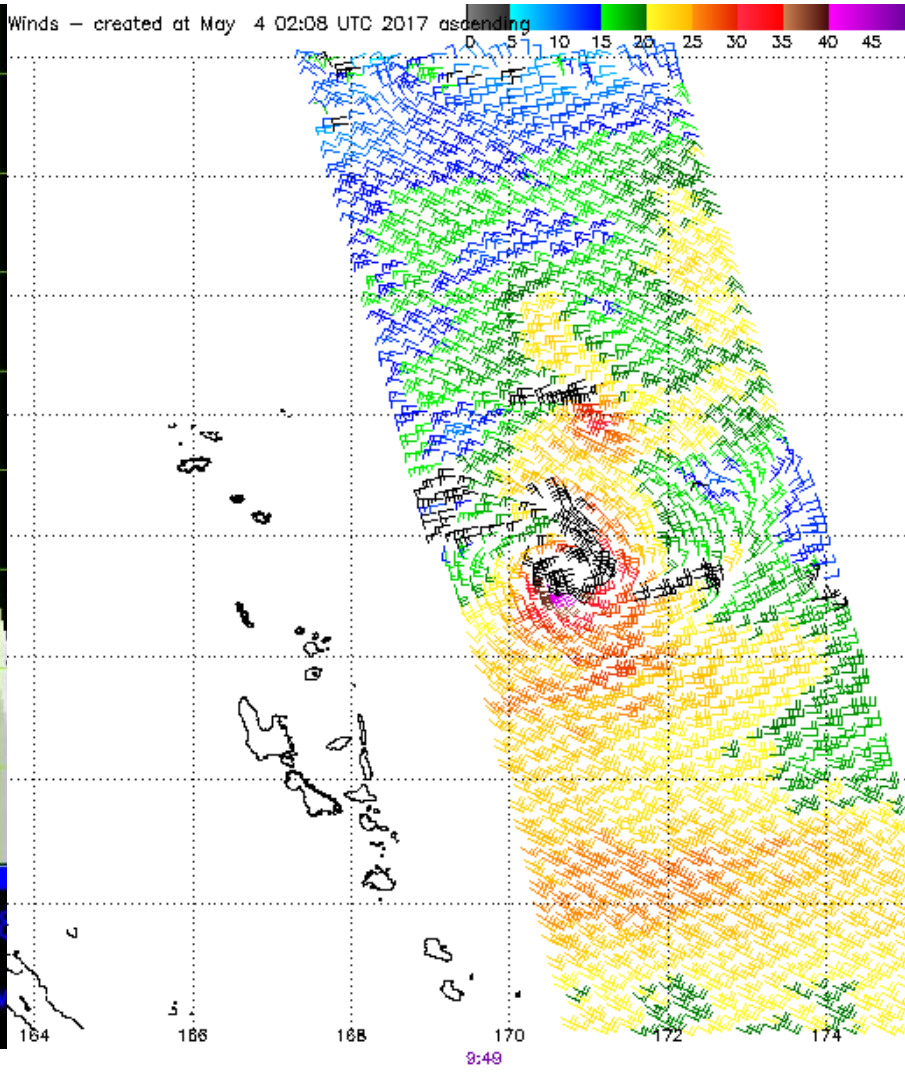
Ascat – positioning NRCS

NRCS – speed only





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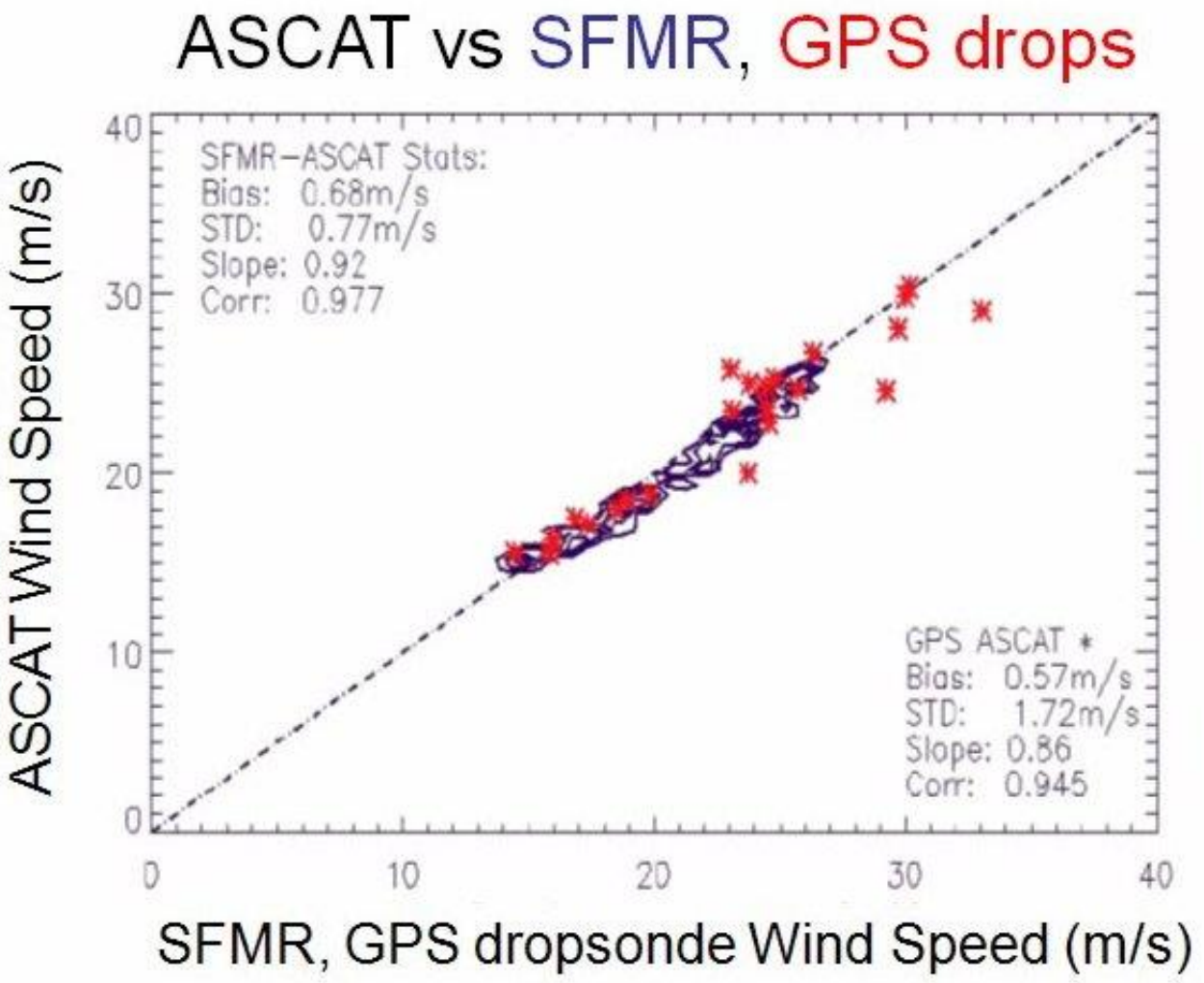
Ascat verification

ASCAT calibrated well but

underestimates >50kn

Esp. in deep convection



Courtesy: Danielson, 2012

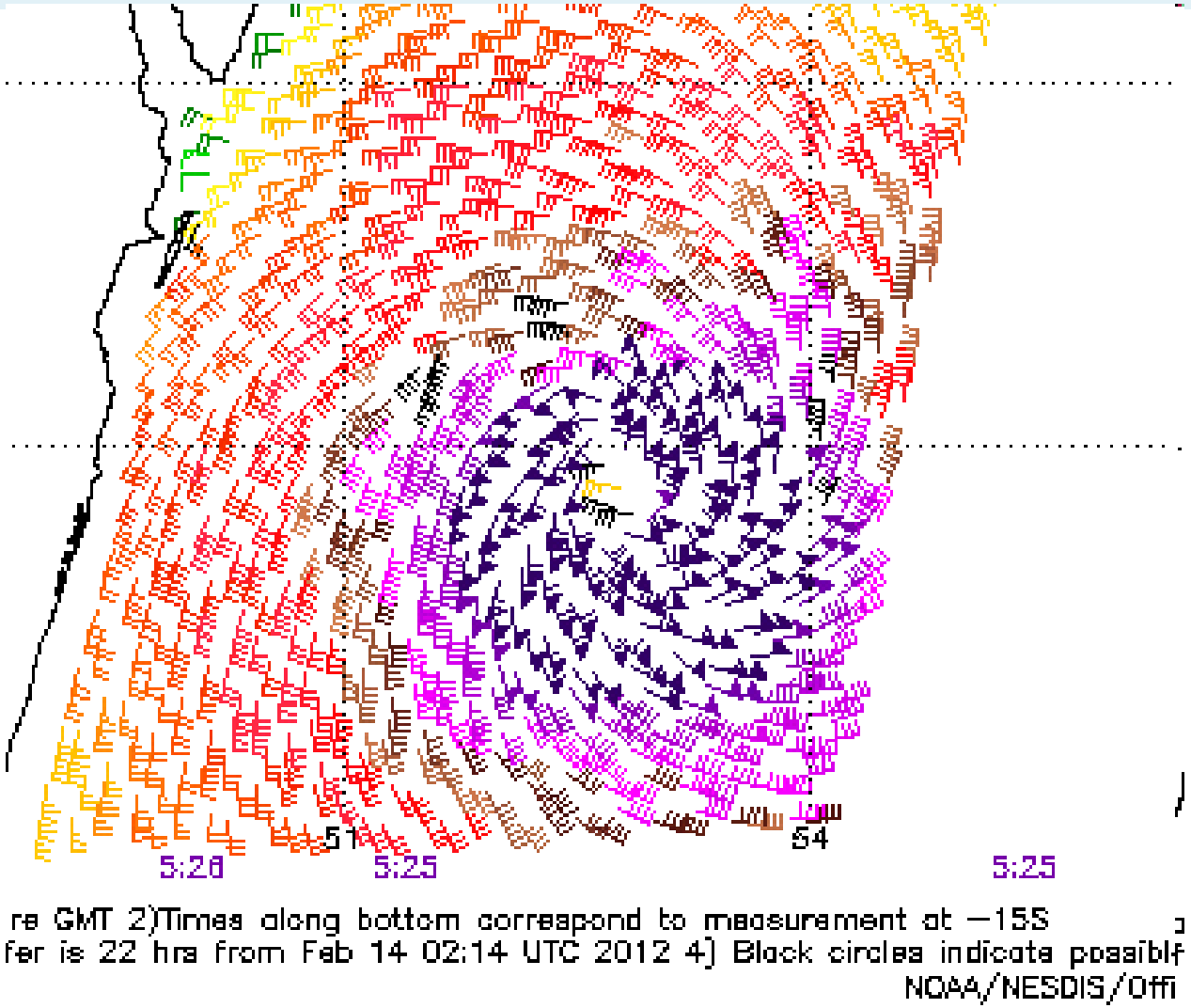
ASCAT cases: Giovanna – what intensity?

a) 50 knots

b) 70 knots

c) 75-90 knots

d) unable to determine



Southern Hemisphere example

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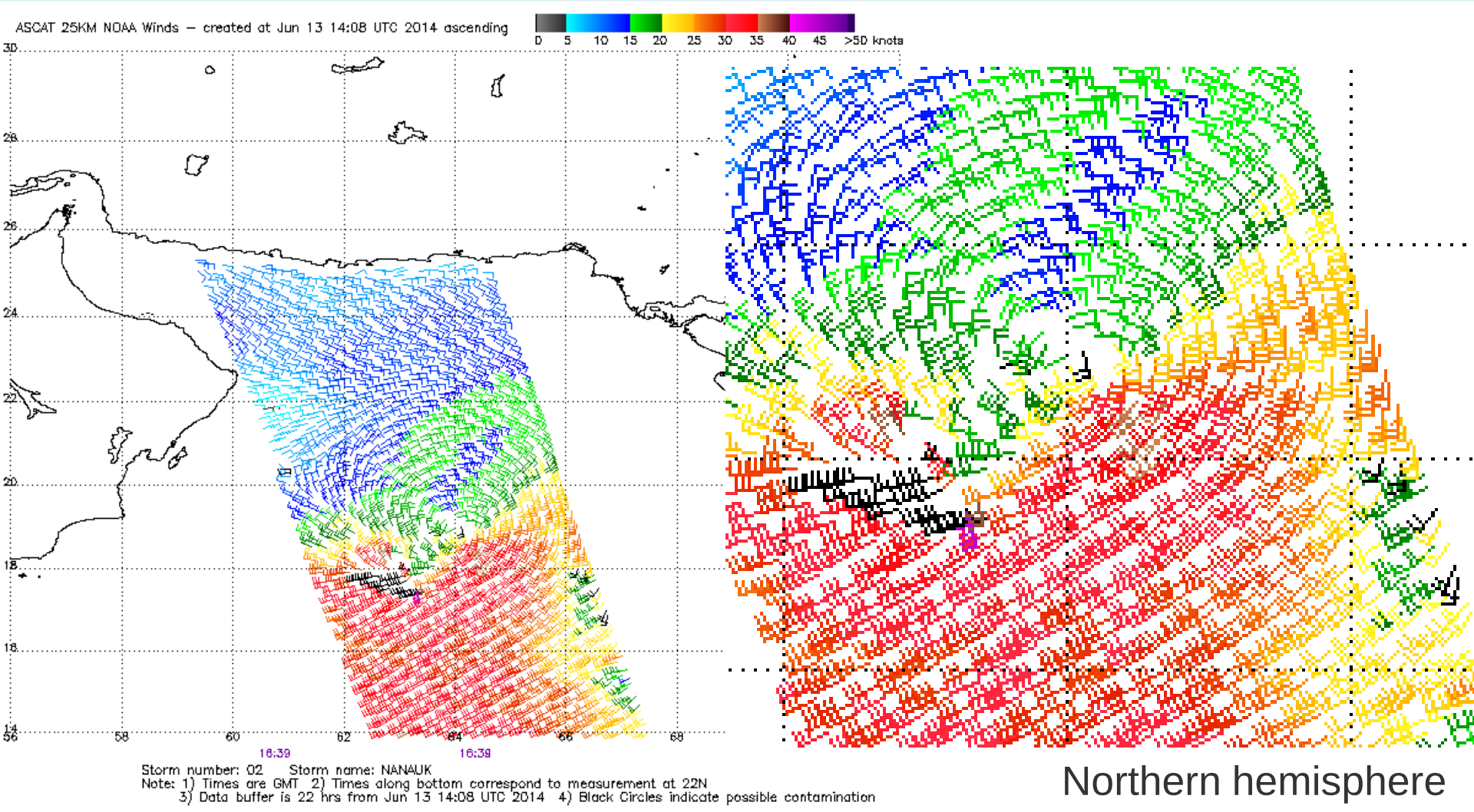
Ascat cases: Nanauk intensity/structure



Northern hemisphere

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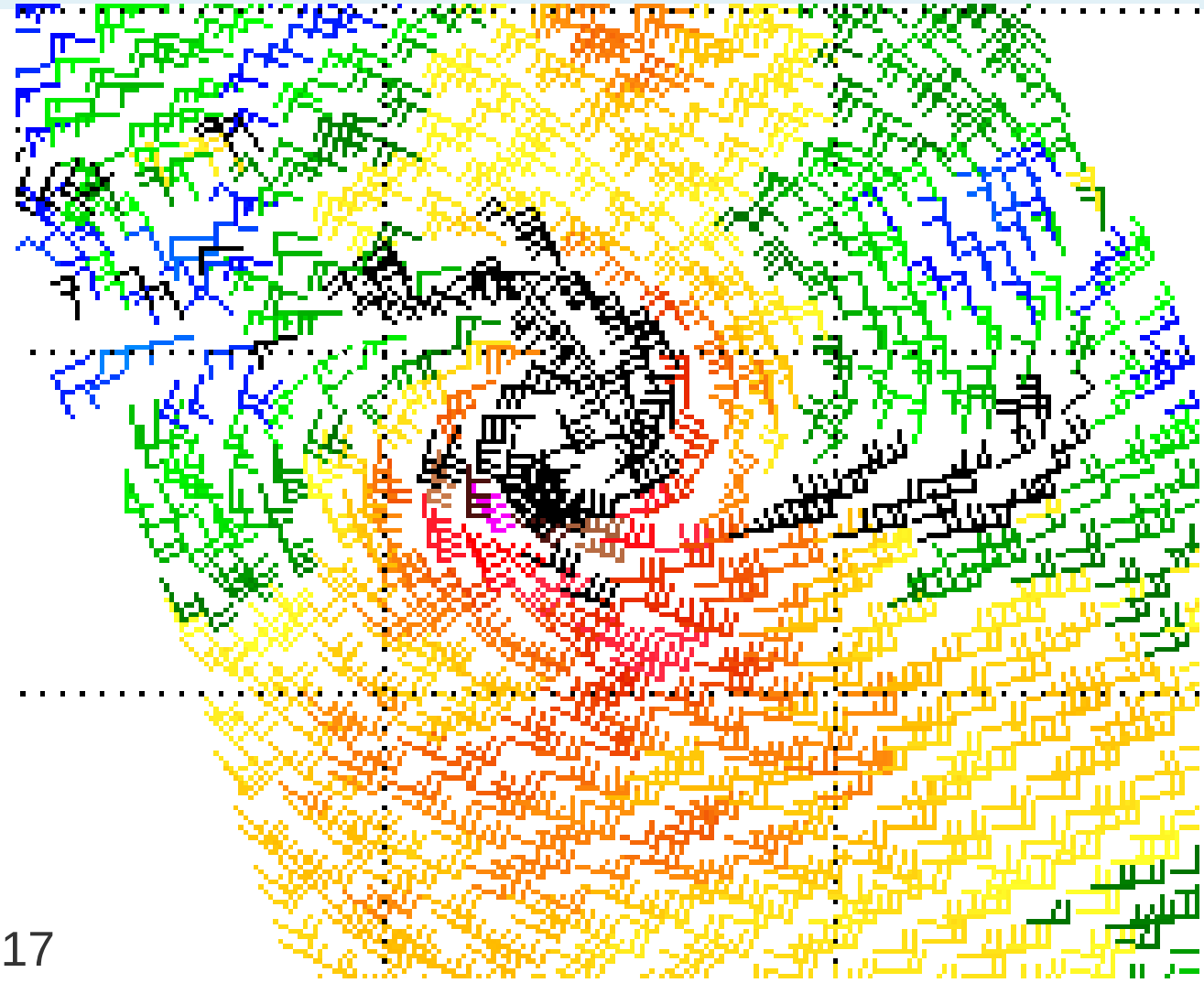
Ascat cases: Donna

What intensity?
What structure?
Anything unusual?



Donna: 10:35Z 3 May 2017

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Scatterometry exercise: Real-time

1. Go to Manati web page
2. For active system, find ASCAT images that provide coverage.
3. What is the time of the images?
4. What can you say about the intensity?
5. What can you say about the structure – radius of gales? Is it asymmetric?
6. Go to Storm and find the latest NRCS image that provides coverage. Is it easy to find the position?

Anything unusual?

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Microwave Imagery Interpretation

Why Microwave?

Satellites and access

Features of 37 and 85 frequencies

How to use both

XX Intensity

COMET microwave training

www.meted.ucar.edu

Acknowledgements: Roger Edson

The Satellites Sensors

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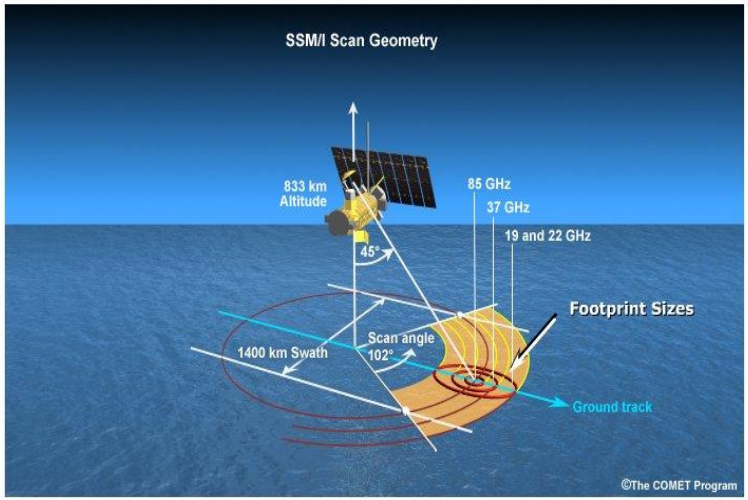
Passive sensing up–radiation from ocean/clouds in 19-24, 37, 85-91GHz ranges

- Polar Orbiting Conical Scanner

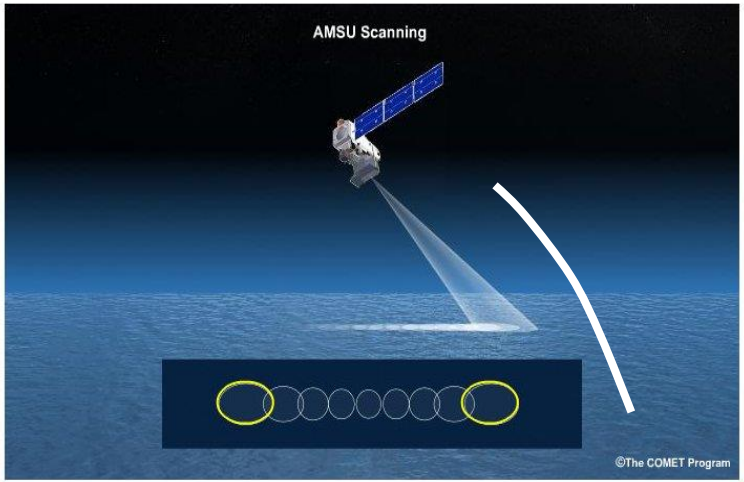
  SSMI, SSMIS, GMI, AMSR2, Windsat (37GHz)

  + more? TMI (TRMM),

- narrow scan widths but maintains footprint resolution across the entire scan
- 85GHz higher res than 37GHz



- Cross track AMSU (85GHz only)
- wider scan swaths but resolution degrades toward the edge of scan



37-85 GHz differences

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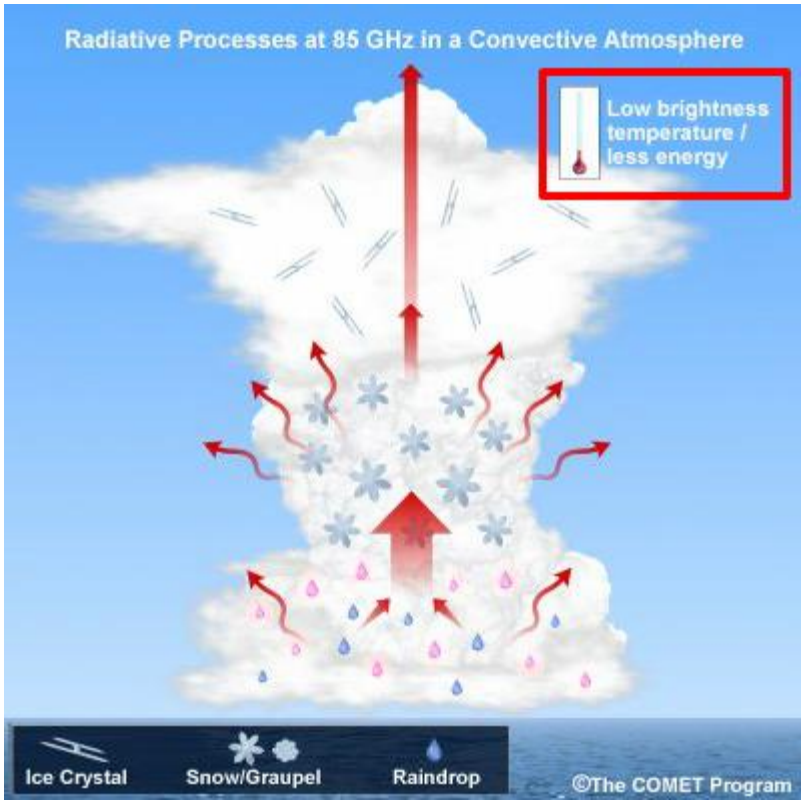
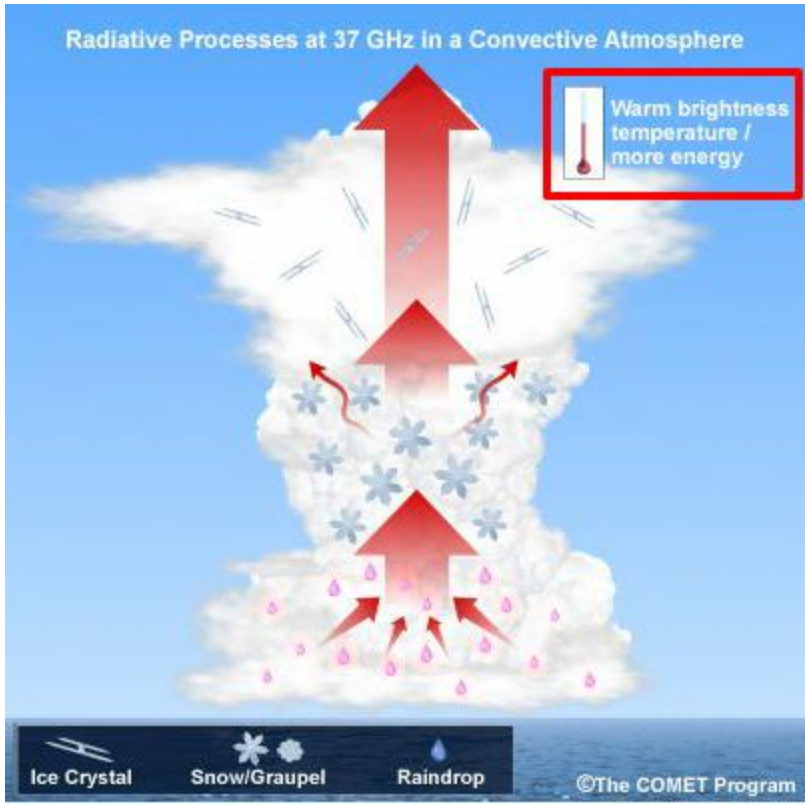
85GHz from ocean is absorbed & scattered by water droplets and further scattered by large water droplets and hail higher up in deep convection leading to low brightness temperatures.



37GHz from ocean is absorbed by cloud/ rain droplets – the radiated energy is NOT affected by large water droplets and hail higher up in deep convection leading to high brightness temperatures.



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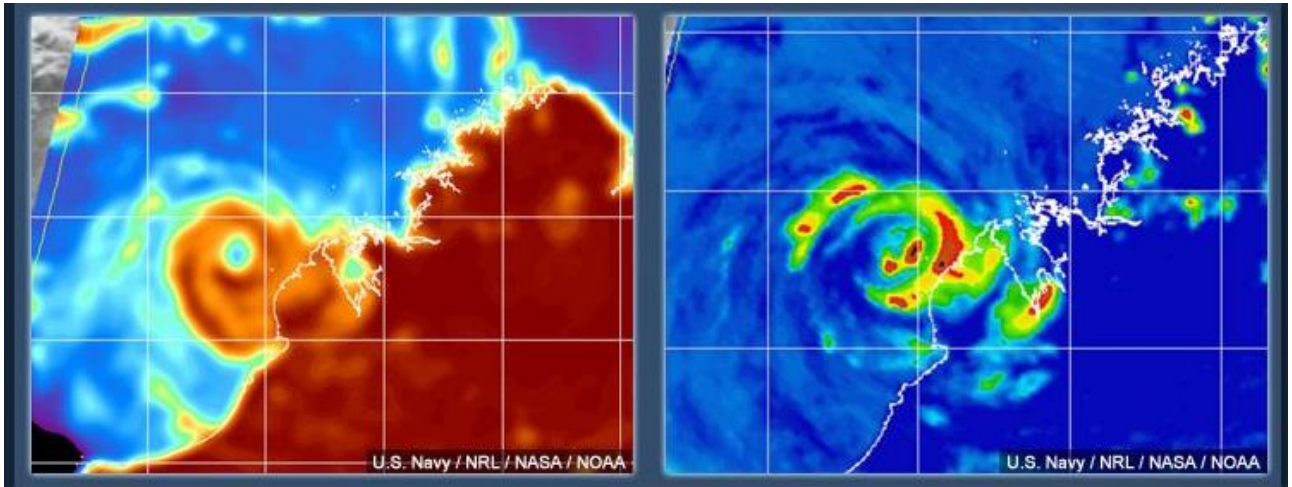
37 Vs 85 GHz – most important slide

- 37 GHz shows region of low-level clouds/rain and so clearly shows low-level circulation but doesn't distinguish deep convection from rain.
- 85-91GHz better shows deep convection but can not always see low-level circulation.

Use colour enhancement to resolve ambiguity between deep convection and clear ocean surface



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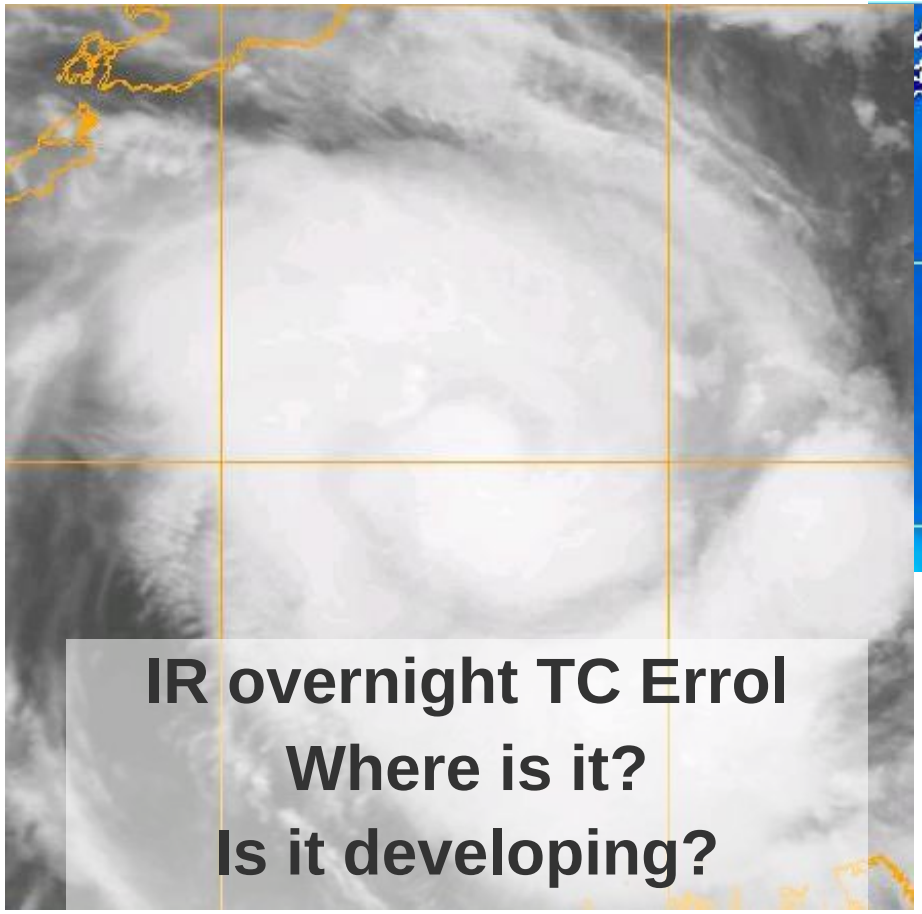
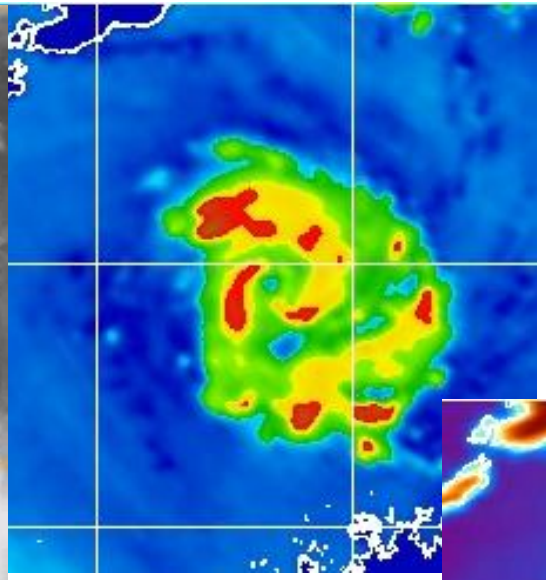
Why the fuss over microwave?

Microwave allows us to see through the high cloud and resolve details of the structure and low level circulation



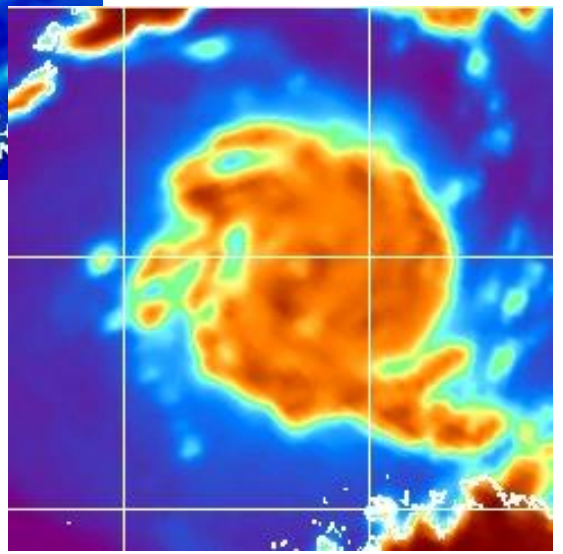
IR overnight TC Errol
Where is it?
Is it developing?



85-91GHz

Deep convection higher up

37GHz low down



Availability: NRL web pages

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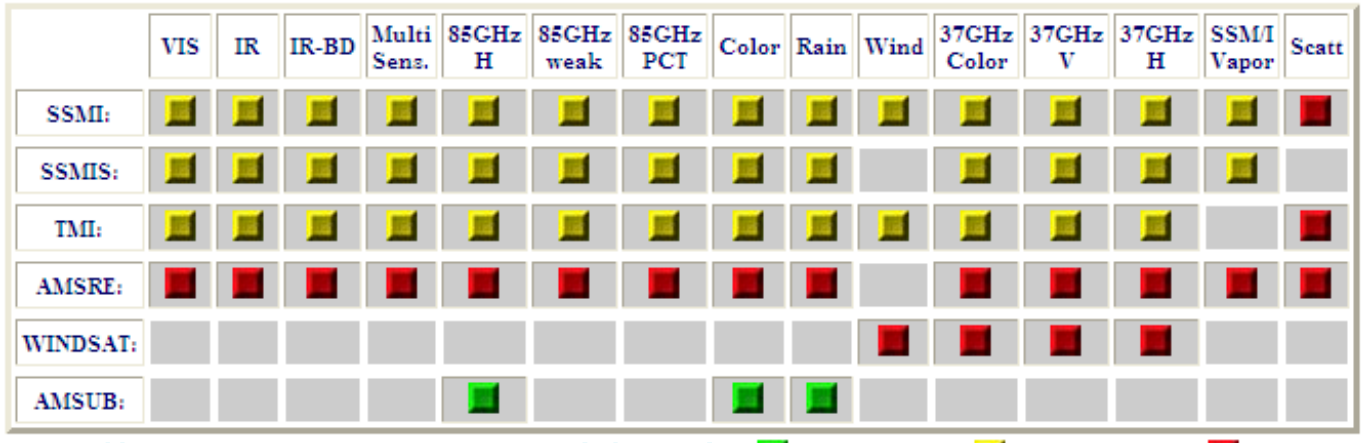
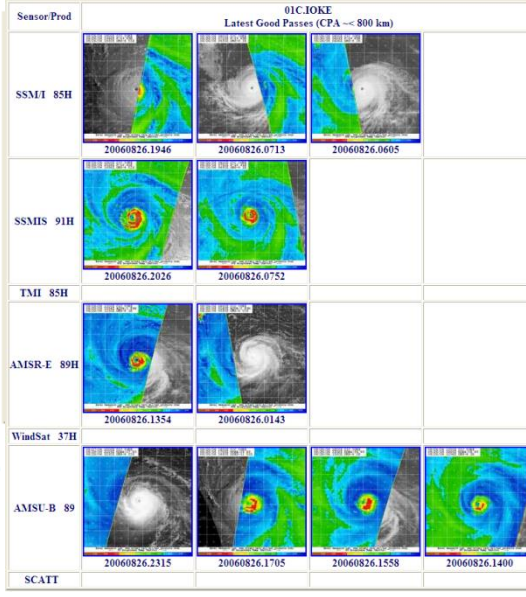
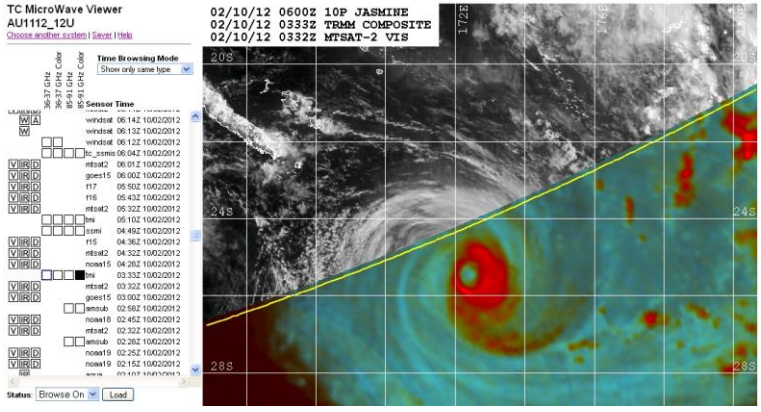




http://www.nrlmry.navy.mil/TC.html

Alternate Page at FNMOC www.fnmoc.navy.mil/tcweb/cgi-bin/tc_home.cgi

BoM Image viewer (web)



Advantages
navigation to get lat/lon;
distance to point;
ease of viewing - fast;
local archive.

Different presentations

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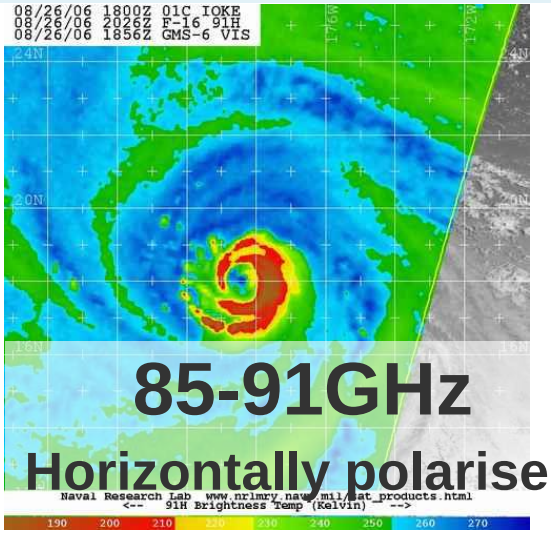
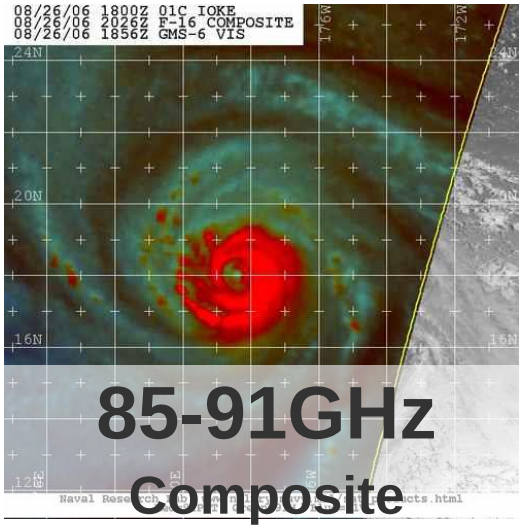
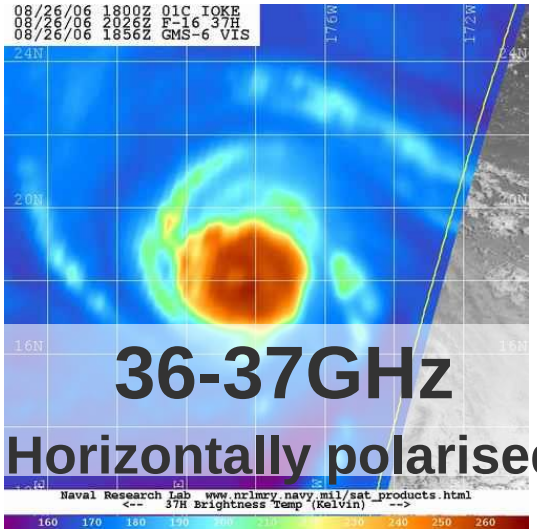
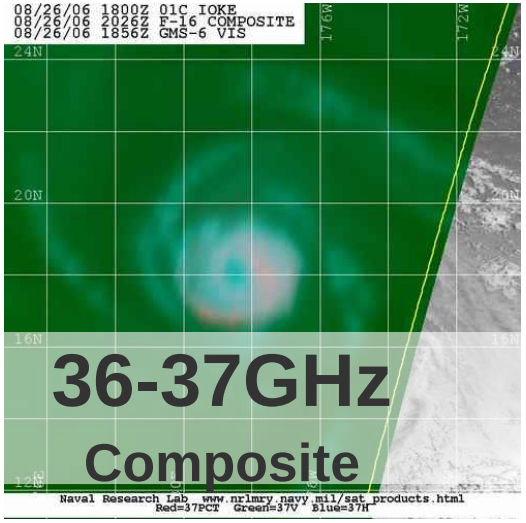


'color' Composite view combines horizontal and vertical polarisation and PCT so can 'correct' for known weaknesses







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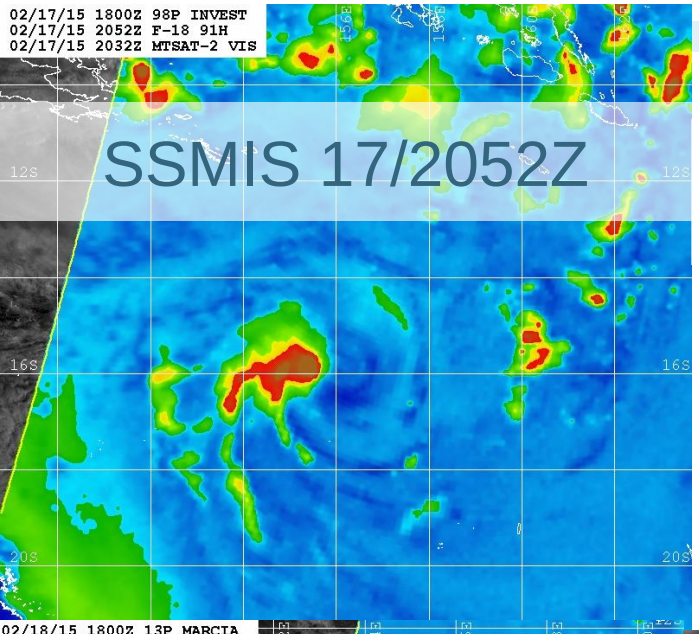
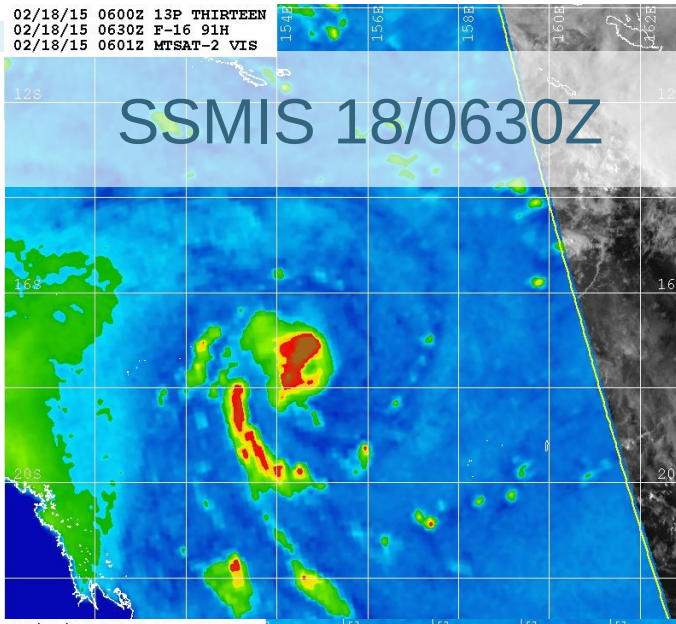
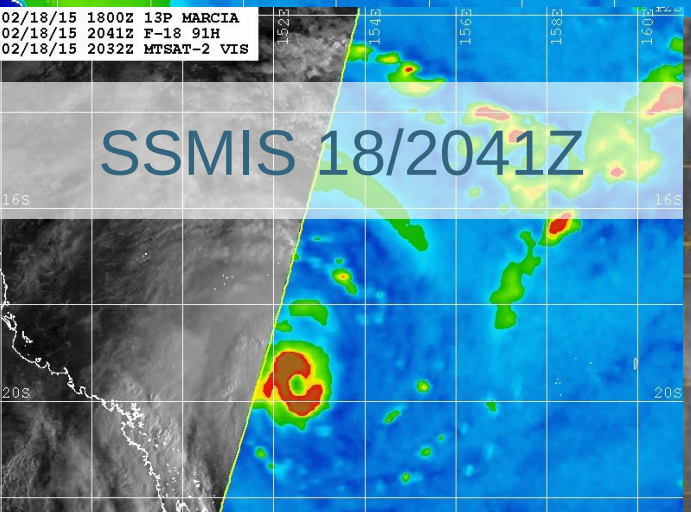
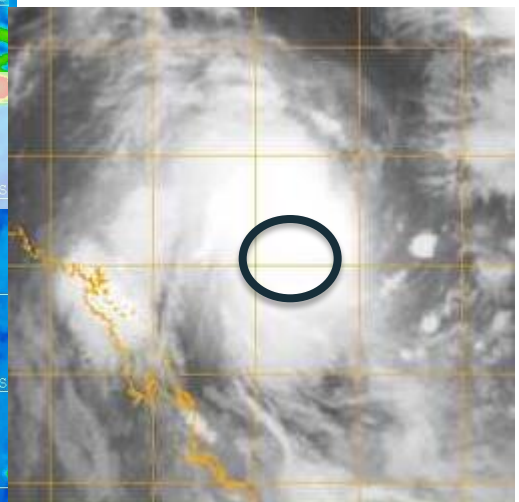
TC Marcia Development

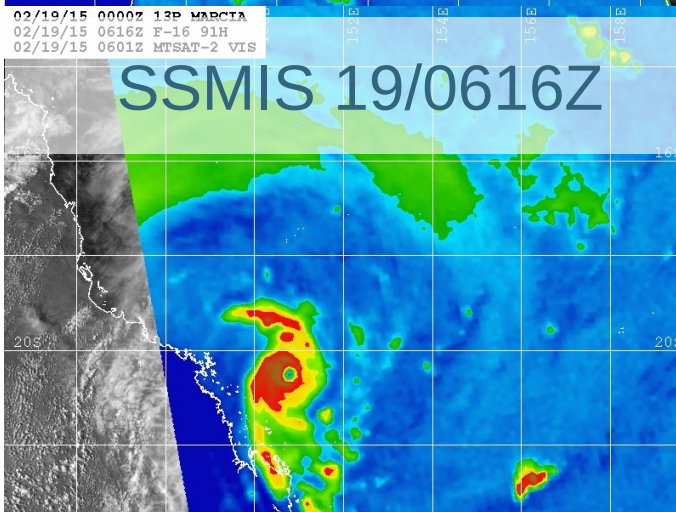


91GHz SSMIS over 34h









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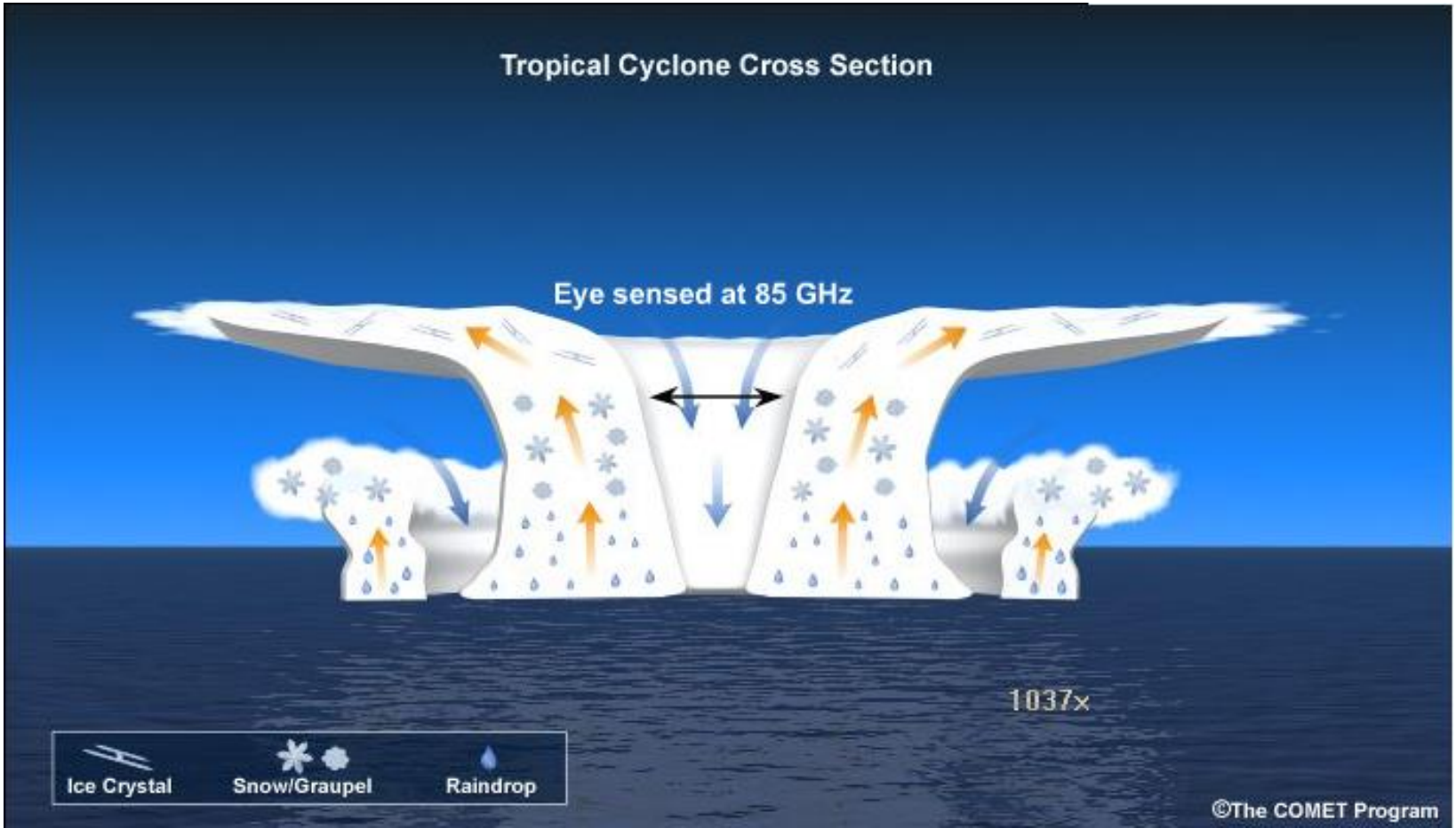
37 Vs 85 GHz

Eye looks bigger on 85 GHz as 85GHz represents conditions higher up.



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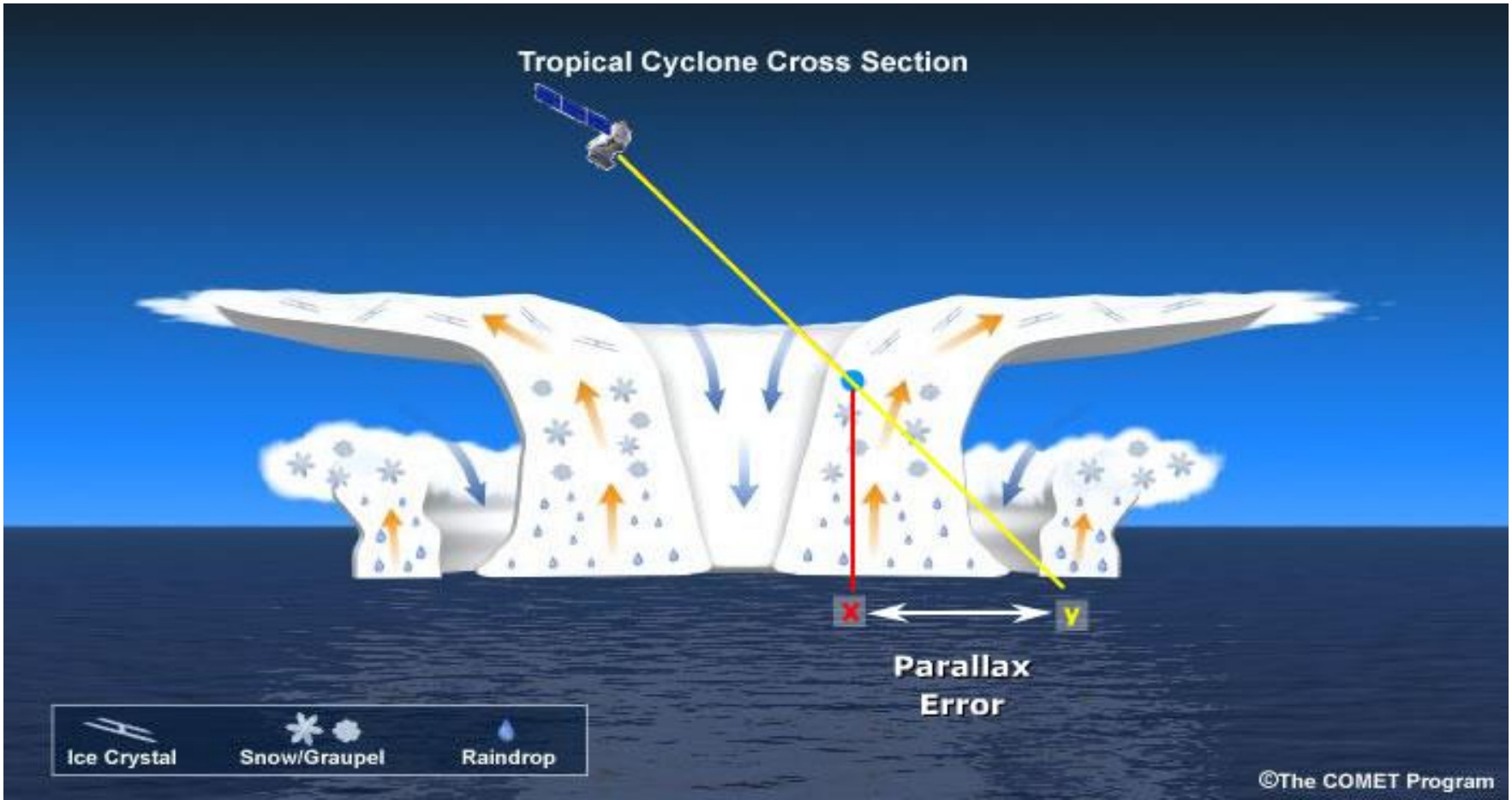
Parallax at 85-91 GHz
Need to correct position

Note: Not to scale



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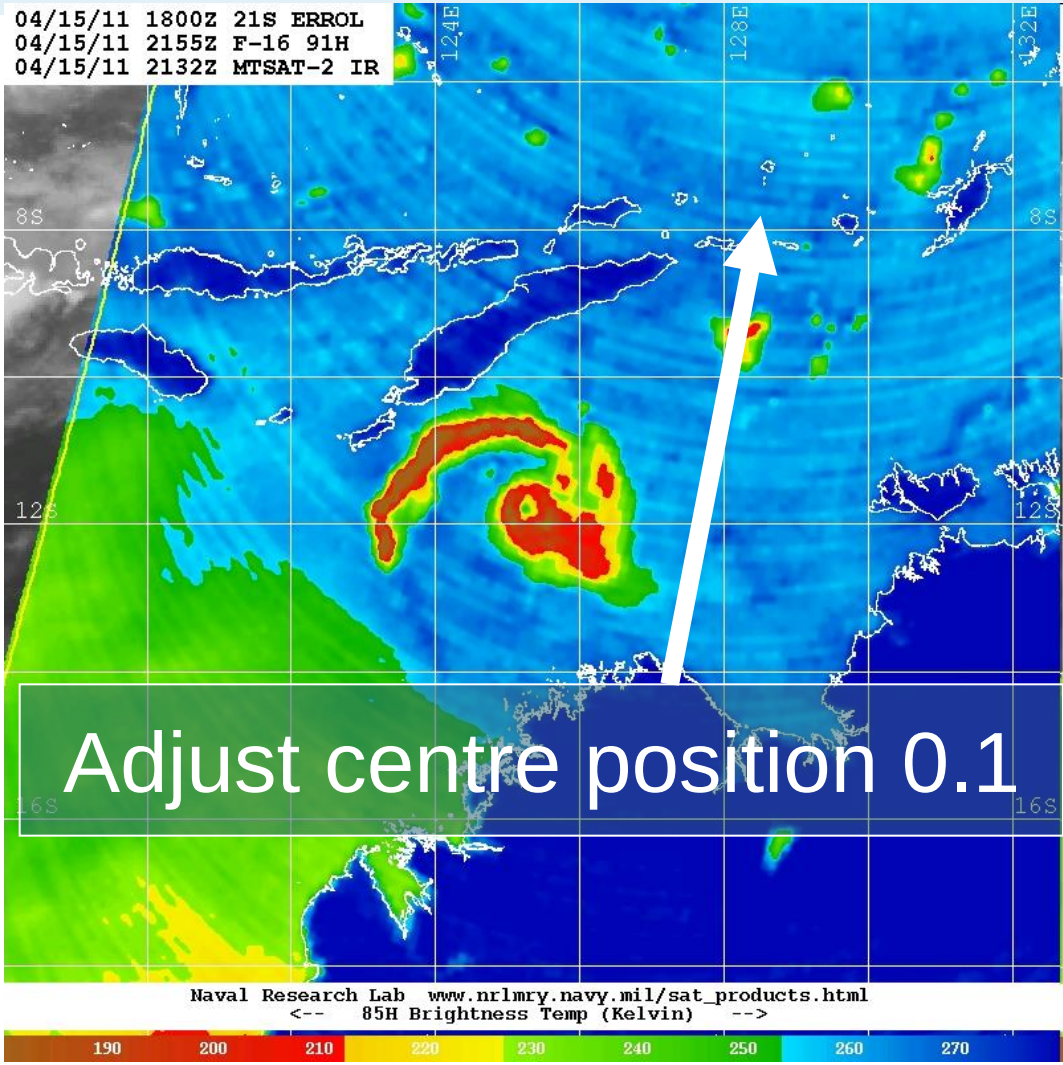
Parallax for 85-91GHz

Which direction is the satellite travelling?

Which way is the parallax correction?



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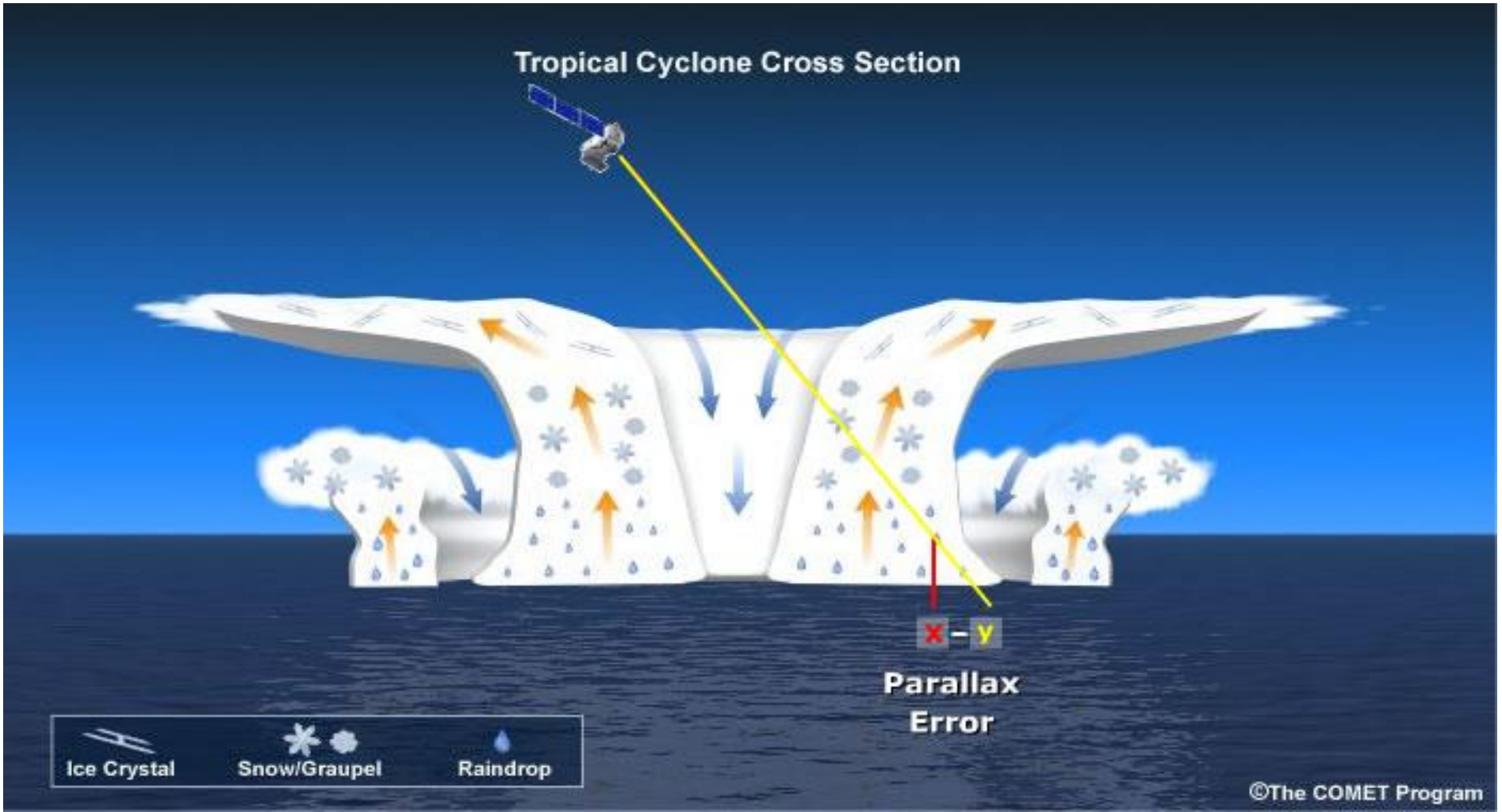
Parallax at 37 GHz



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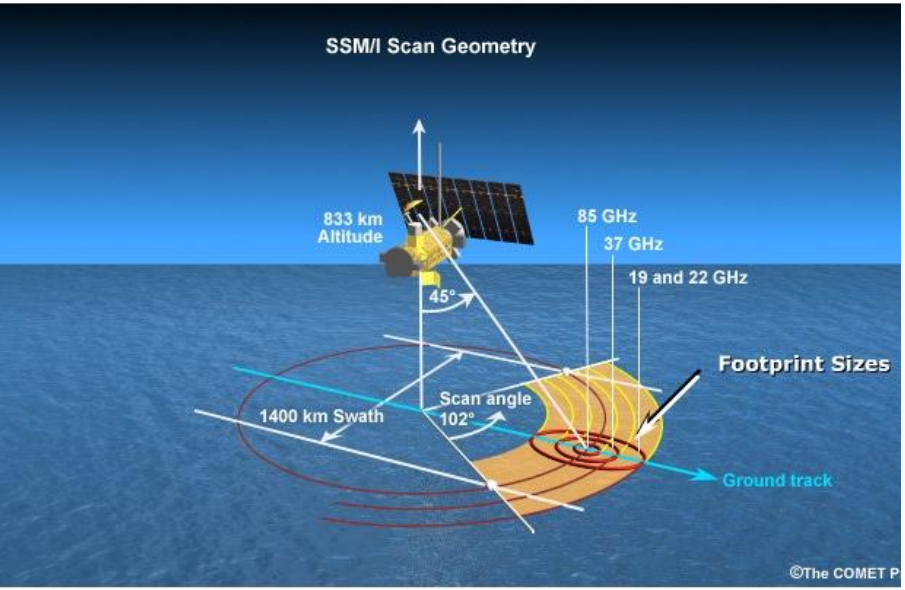
37 Vs 85 GHz – Eye size & Parallax

Parallax error:

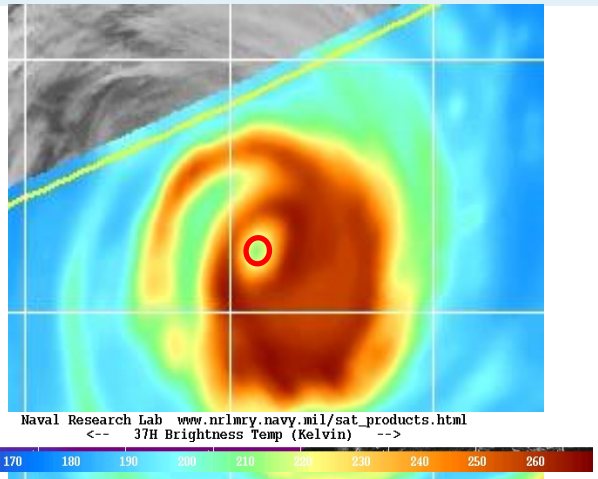
37 GHz - 5 km or less

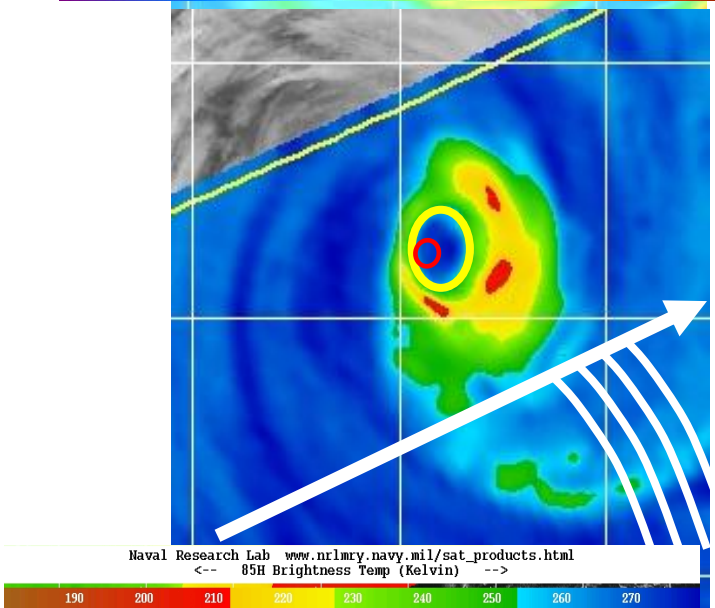
85-91 GHz - 10-20 km



Correction back towards satellite

motion is parallel to edge; use 85 windscreen wiper effect to determine direction





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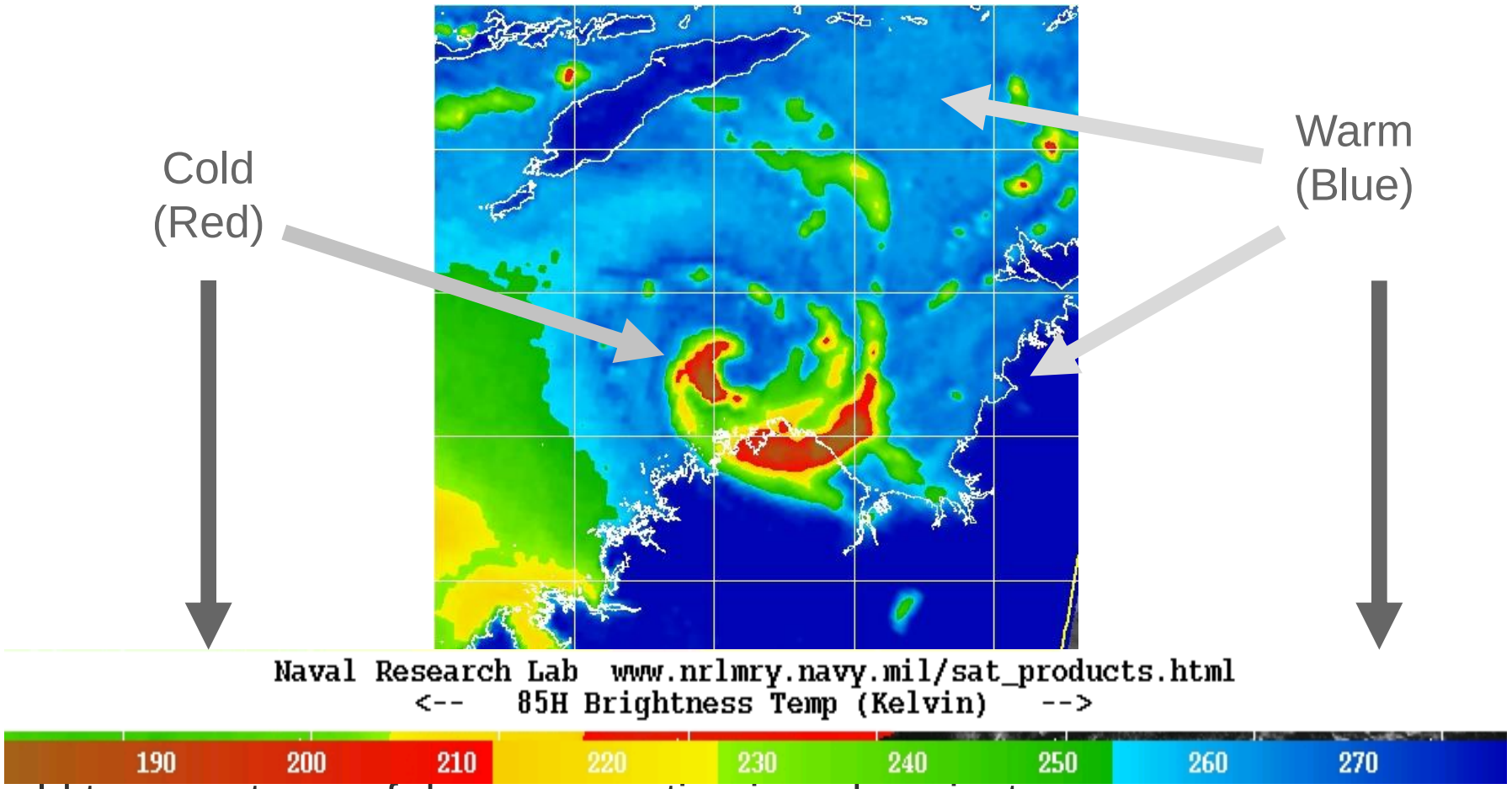
85 GHz



cold temperatures of deep convection in red against a warmer ocean background (and land) in blue.

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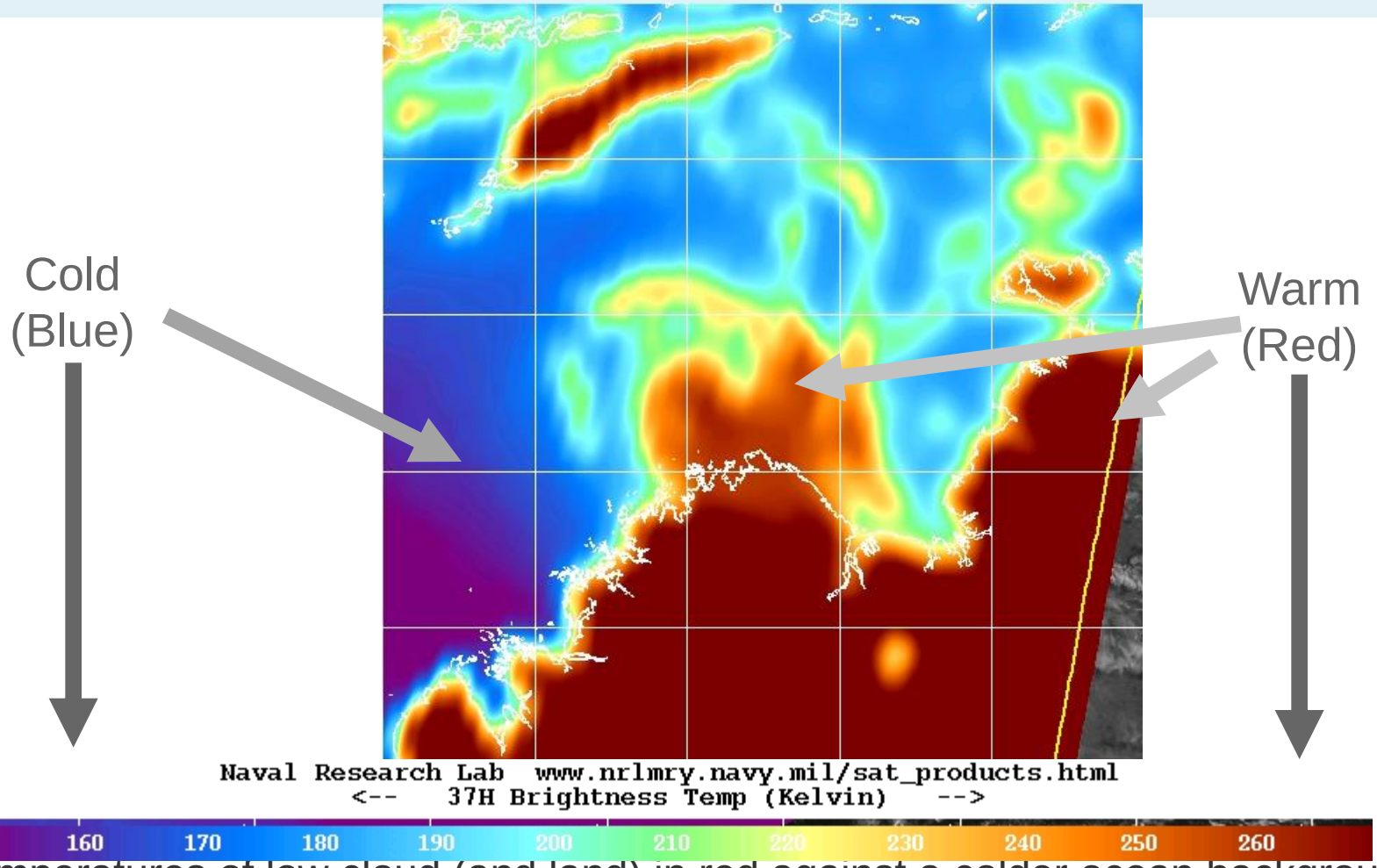
37 GHz



warm temperatures of low cloud (and land) in red against a colder ocean background in blue.

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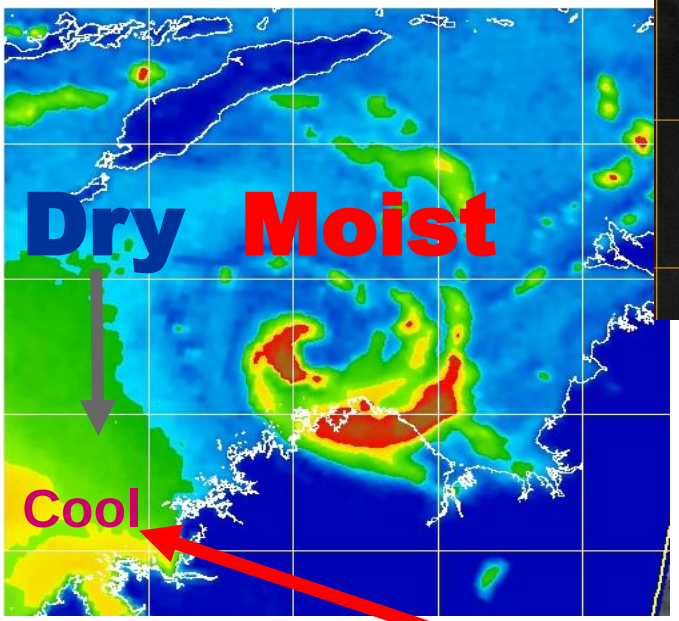
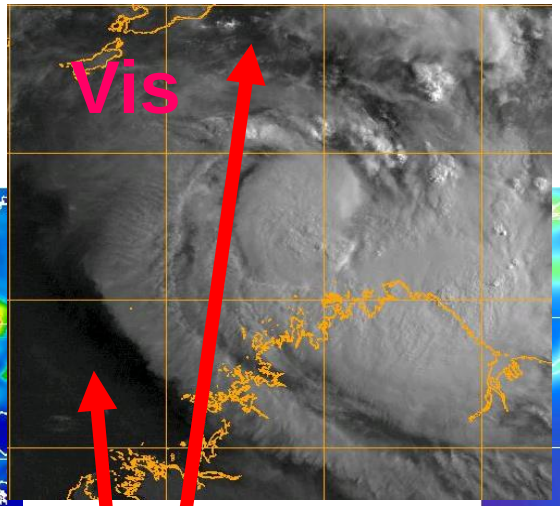
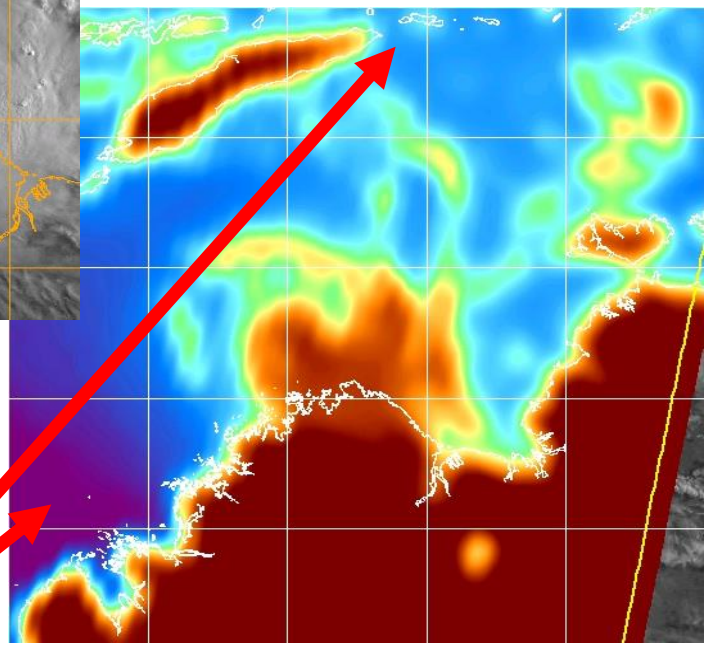
Viewing Interpretation--*Oceans*

*Oceans Appears Cool in 85GHz

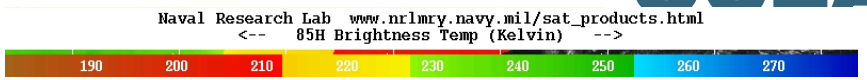




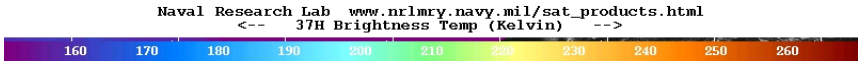
*Oceans Appears Cold in 37GHz



OCEAN



Cold Cool Warm



Cold Warm

85-91GHz

Australian Government
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At 85 GHz, energy emitted from the ocean surface is rapidly depleted in lower to middle portions of convective clouds due to scattering by water drops and large ice particles

Advantages:

Can penetrate cirrus and reveal internal storm structure such as eyes and convective bands;

Distinguishes deep convection from lightly raining cloud features;

Offers higher spatial resolution than at 37GHz;

Limitations:

Can not always see low-level circulation;

Cold ocean may look like deep convection – needs colour enhancement to resolve ambiguity ocean and cloud;

Parallax errors when viewing deep convection (10-20km);

Not available on Windsat;

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Bureau of Meteorology

37GHz

At 37 GHz, abundant energy emitted by water droplets lower in the convective cloud is largely unaffected by ice particles higher in the cloud

Advantages:

Can penetrate cirrus and reveal detail within the storm core missed by 85GHz such as eyes;

Shows regions of low level clouds/rain;

Small parallax error compared to 85GHz;

Limitations:

As deep convection not distinguished well from low clouds then inner core may be poorly defined;

Lower spatial resolution than on 85GHz;

Some scattering in very intense convection resulting in false signal

– needs colour enhancement to resolve this detail;

Not available on AMSU-B;

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Summary

- There are different techniques used to find the centre: use all available and the best;
- Microwave images:
  - 37GHz low level – generally best for positioning
  - 85-91GHz highlights convection in mid-levels
  - Use 'color' composite views to help distinguish ocean/low cloud from higher cloud.

Q Microwave is most useful for determining the centre when …

Q Microwave is least useful for determining the centre when …

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Exercises: Donna

Where would you put the centre?
What imagers were most useful?
What other information would help?

Positions at:

1. 0730UTC 6 May 2017
2. 03UTC 8 May 2017
3. 03UTC 9 May 2017
4. 1327UTC 4 May 2017
5. 0706UTC 5 May 2017
6. 03UTC 3 May 2017
7. 12UTC 3 May 2017
8. 18UTC 3 May 2017
9. 00UTC 2 May 2017