TC Harold: *Intensity and structural variations using microwave and scatterometry*

Australian Government
Bureau of Meteorology

Joe Courtney VLAB 29 April 2020

Harold rivals Pam as most intense South Pacific TC

Major impacts on Solomon Is; Vanuatu; Fiji and Tonga

Challenging forecasting for intensity and structure

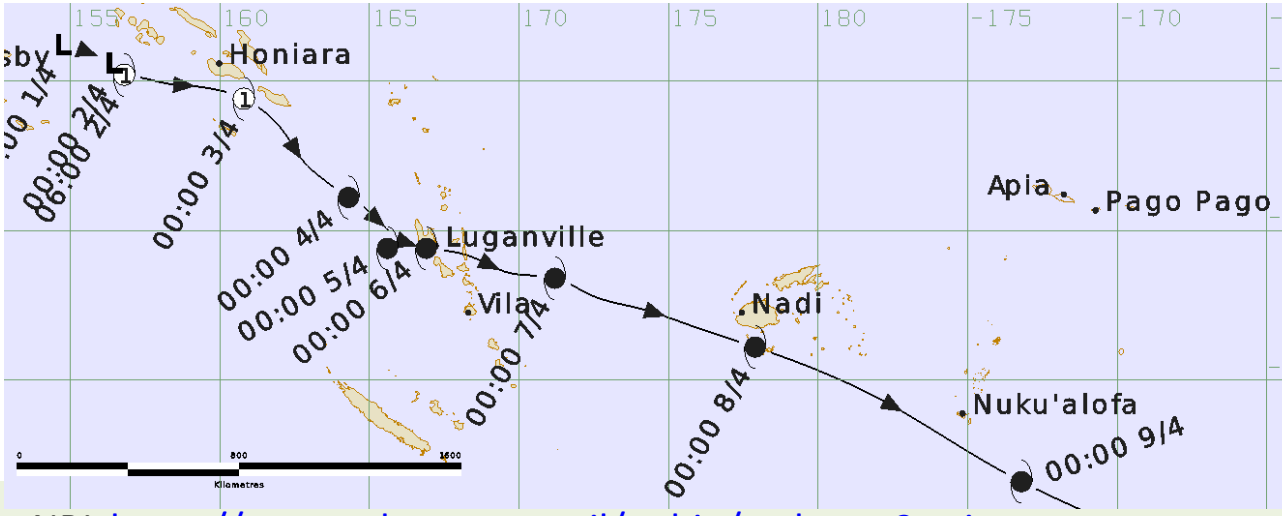
What microwave and scatterometry can provide…

Socrative:

socrative.com

Login as student

Room: TCHAROLD



Acknowledgements: microwave NRL https://www.nrlmry.navy.mil/tc-bin/tc_home2.cgi

CIMSS:mimic realtime http://tropic.ssec.wisc.edu/real-time/mimtc/tc.shtml TPW: http://tropic.ssec.wisc.edu/

Scatterometry NOAA https://manati.star.nesdis.noaa.gov/datasets/ASCATData.php

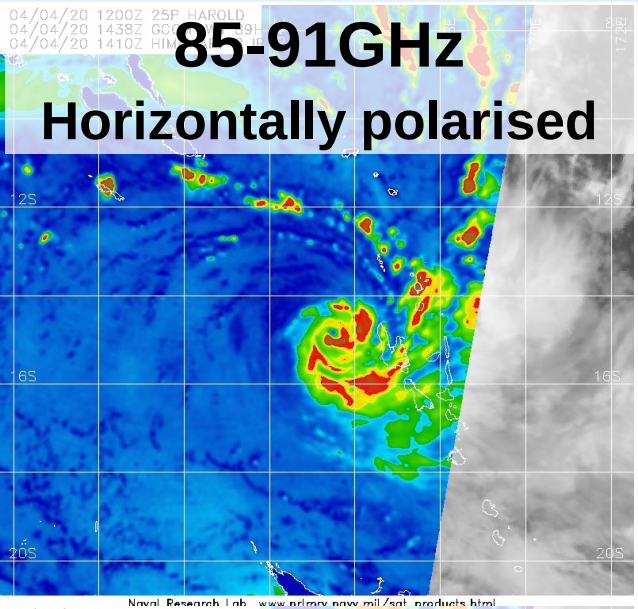
Other imagery: CIRA https://rammb-data.cira.colostate.edu/tc_realtime/

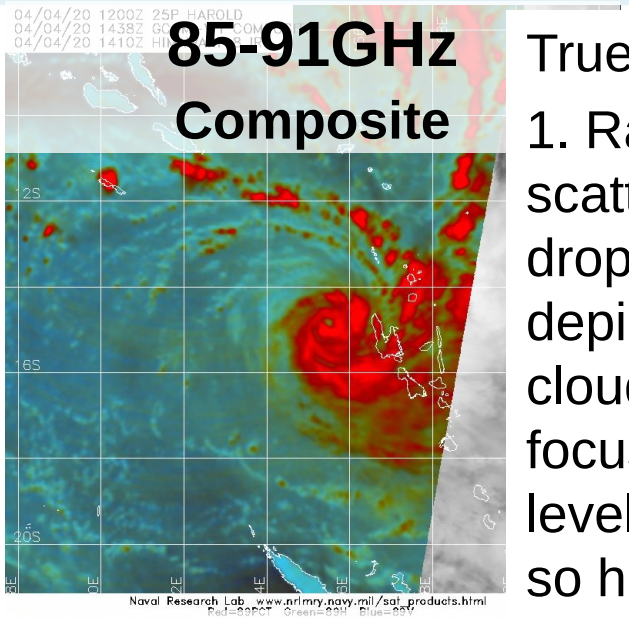
Australian Government
Bureau of Meteorology

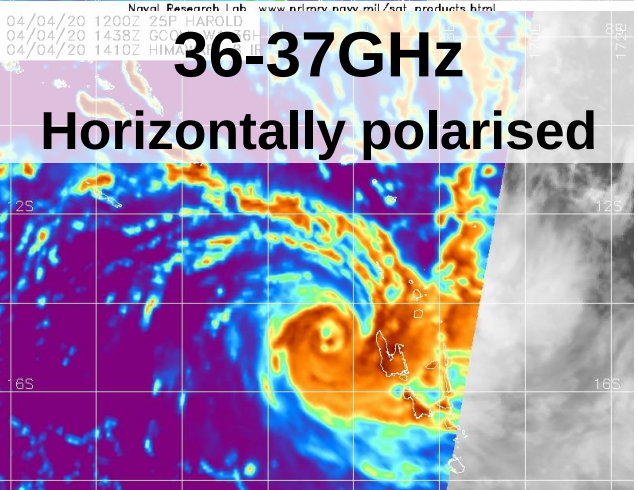
Questions: Microwave review

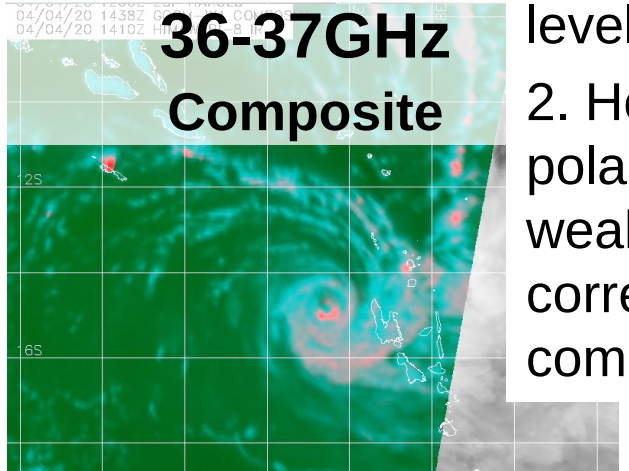
Go to Socrative.com (alternate use chat window)

(Harold 04/1438Z)









True or False

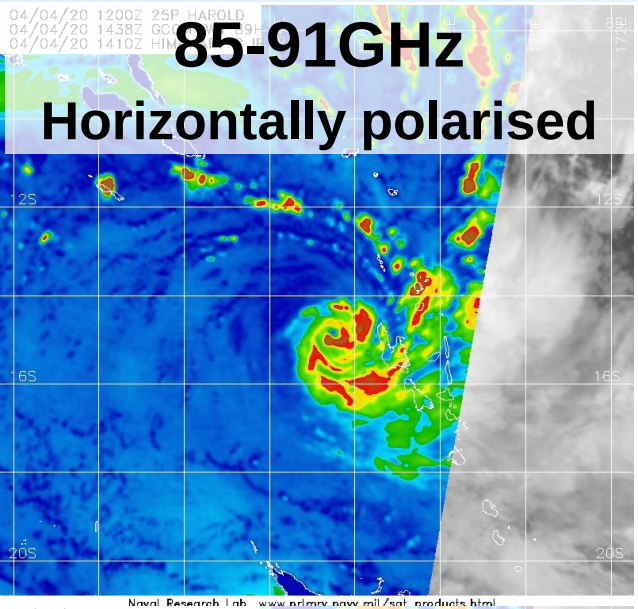
1. Radiation at 37GHz is scattered by large water droplets and ice so can better depict the deep convective clouds whereas at 85-91GHz focuses on cloud liquid water level below the freezing level so helps understand the low-level structure.

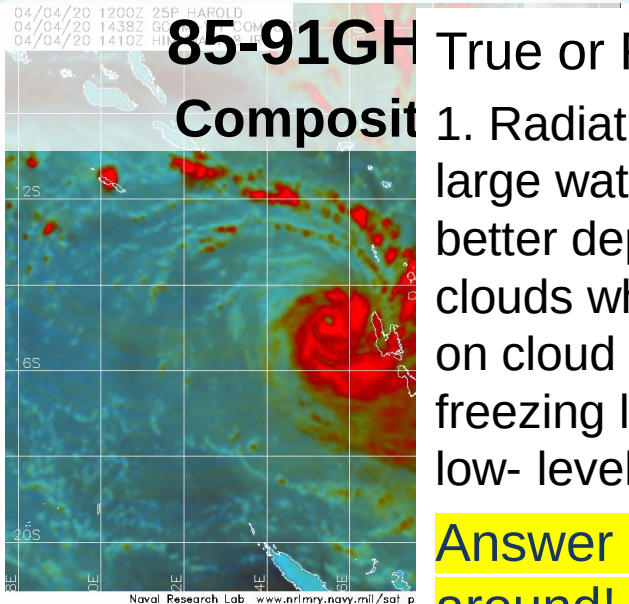
2. Horizontally and Vertically polarised views have weaknesses that can be corrected by viewing the composite view.

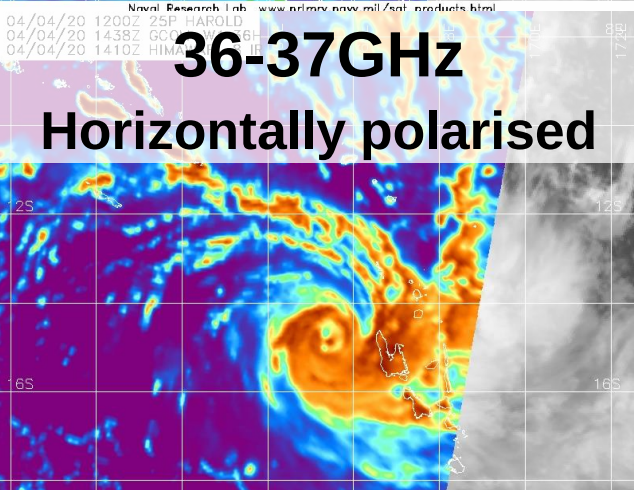
Australian Government
Bureau of Meteorology

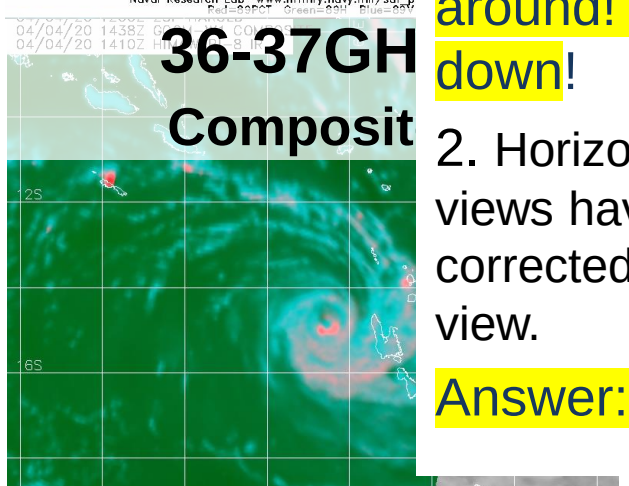
Questions: Microwave review

(Harold 04/1438Z)









True or False

1. Radiation at 37GHz is scattered by large water droplets and ice so can better depict the deep convective clouds whereas at 85-91GHz focuses on cloud liquid water level below the freezing level so helps understand the low- level structure.

Answer **False.** It is the other way around! 37 lower number lower down!

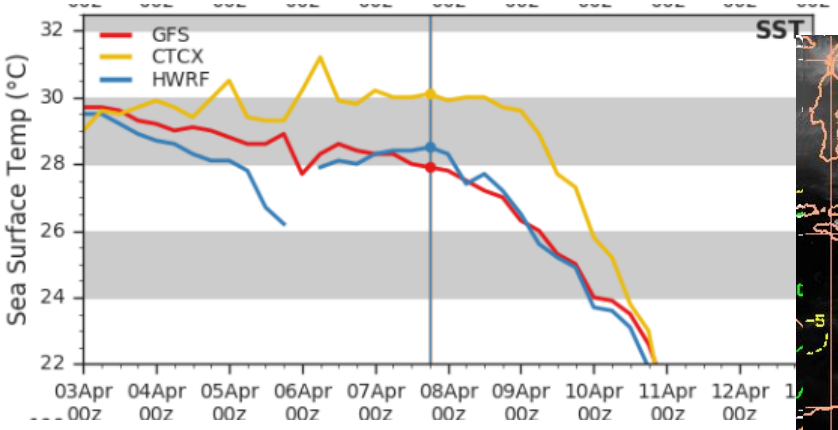
2. Horizontally and Vertically polarised views have weaknesses that can be corrected by viewing the composite view.

Answer: **TRUE**

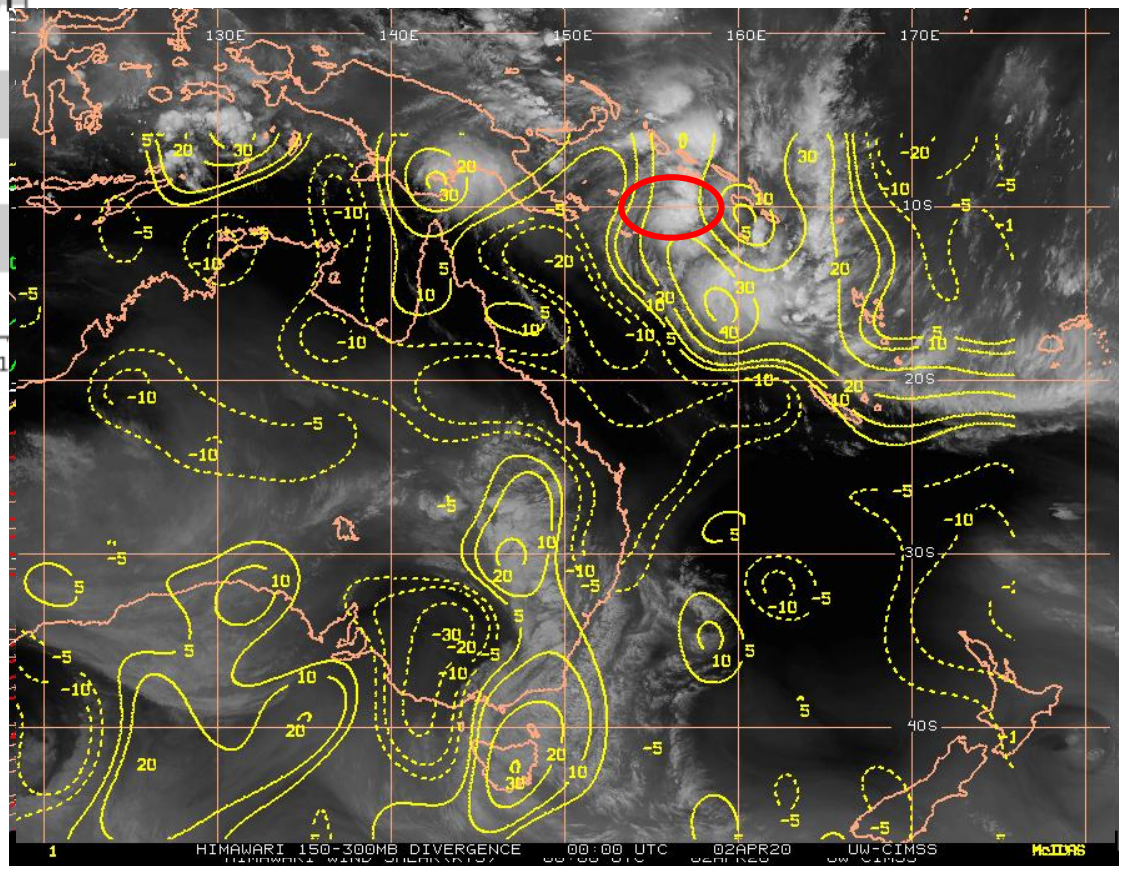
Australian Government
Bureau of Meteorology

Genesis: how quickly will it develop? Consider environmental influences

SST ~30C; Strong upper divergence(CIMSS);



CIRA: https://rammb-data.cira.colostate.edu/tc_realtime/loop.asp?product=diagplot&storm_identifier=sh252020&starting_image=2020sh25_diagplot_202004030000.png



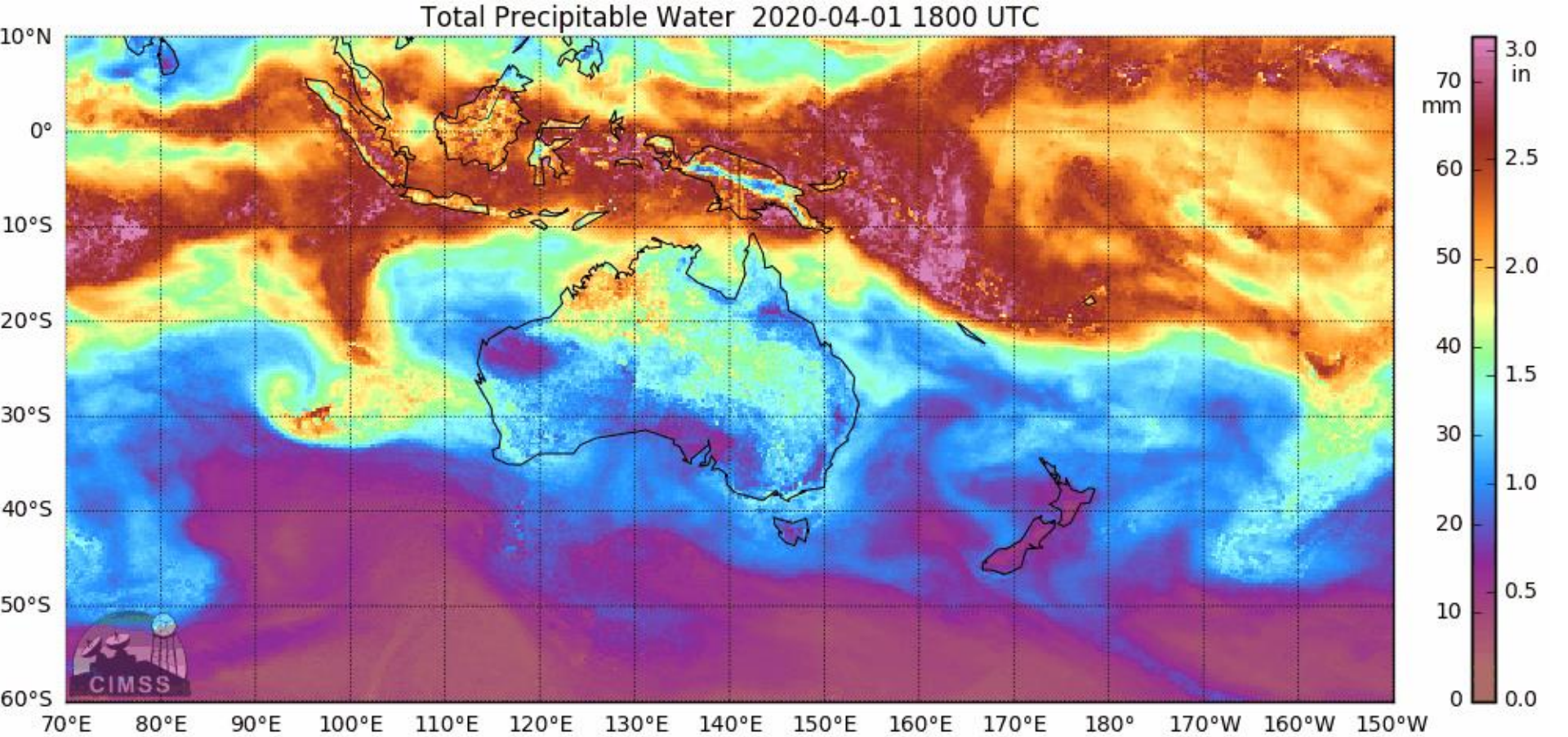
CIMSS http://tropic.ssec.wisc.edu/

Australian Government
Bureau of Meteorology

Genesis: How quickly will it develop?
Moisture: Microwave TPW

TPW (CIMSS) (also WV (CIRA) helpful)

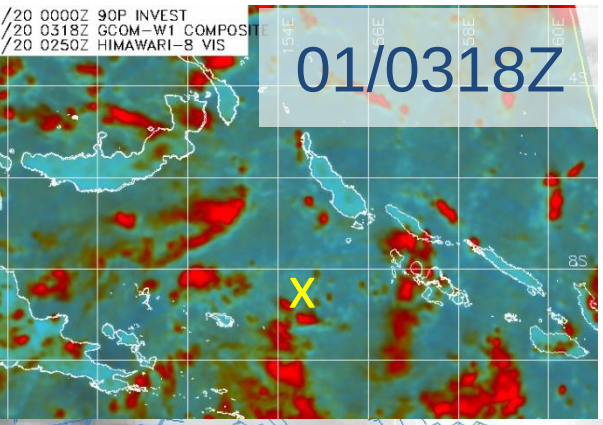
realtime animation: http://tropic.ssec.wisc.edu/real-time/mtpw2/product.php?color_type=tpw_nrl_colors&prod=ausf&timespan=24hrs&anim=html5

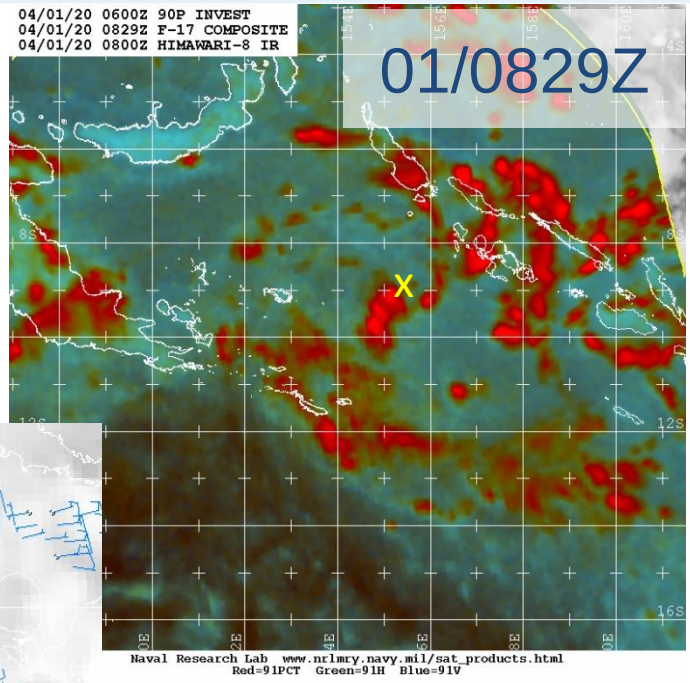


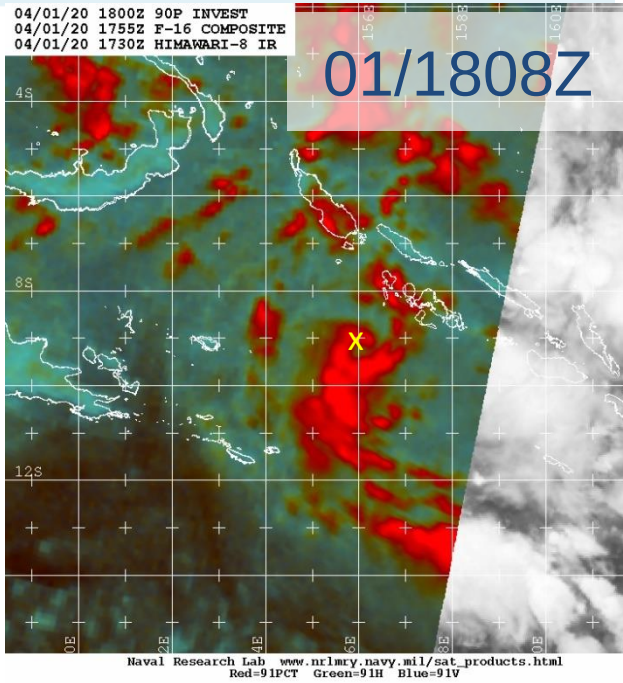
TC Harold genesis 1-2 April 2020

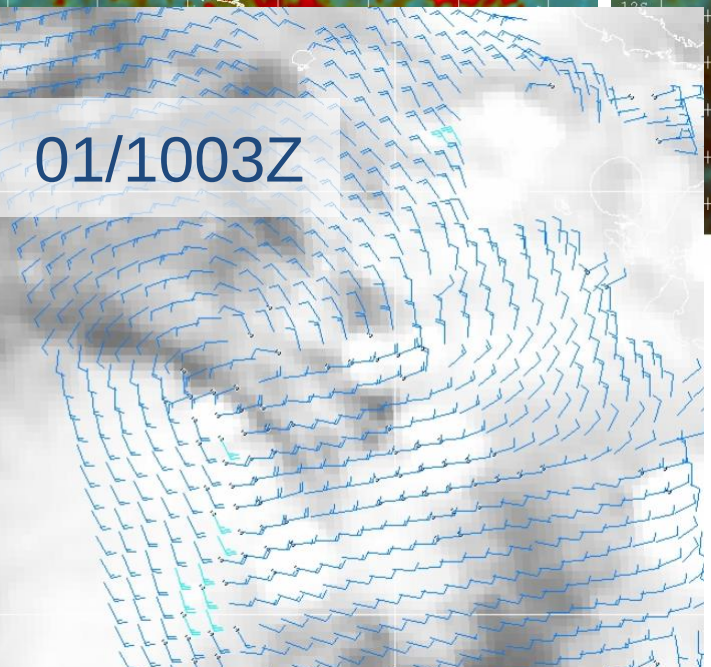
Australian Government
Bureau of Meteorology

Vis/IR is generally better than microwave in early stages to define centre and convection changes until curvature becomes defined! Scatterometry REALLY useful!







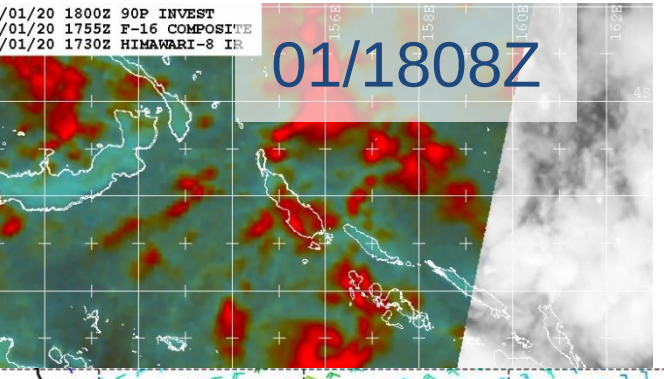


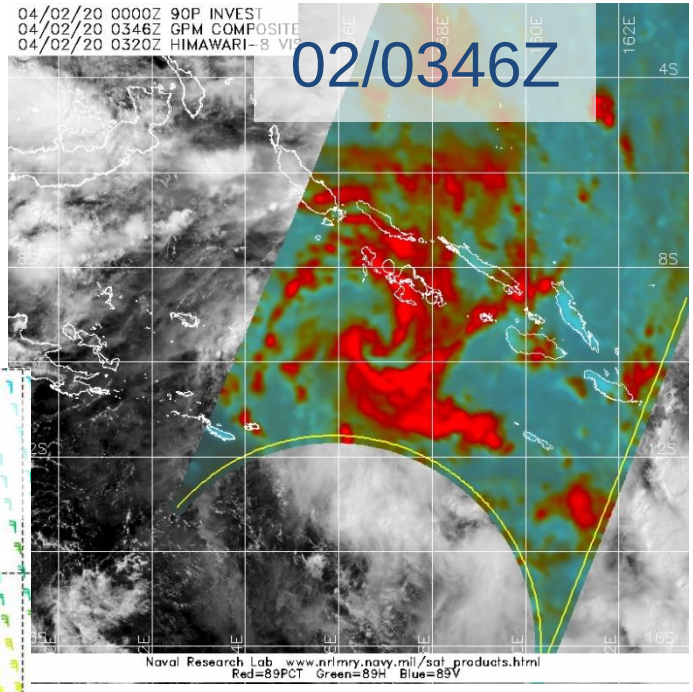
TC Harold named 06Z 2 April 2020

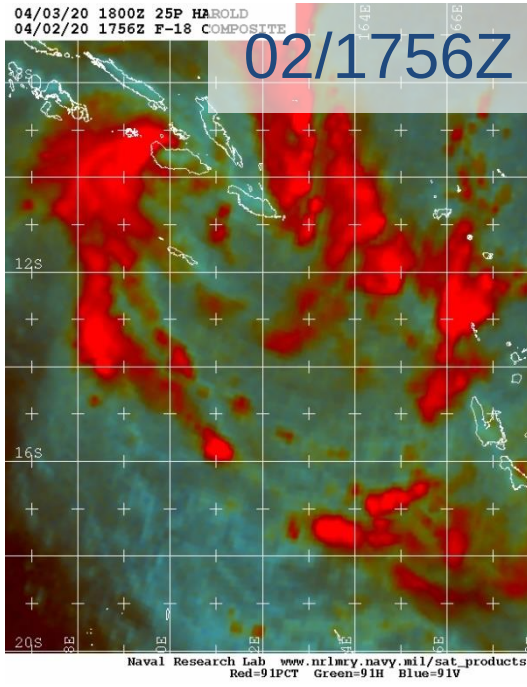
Australian Government
Bureau of Meteorology

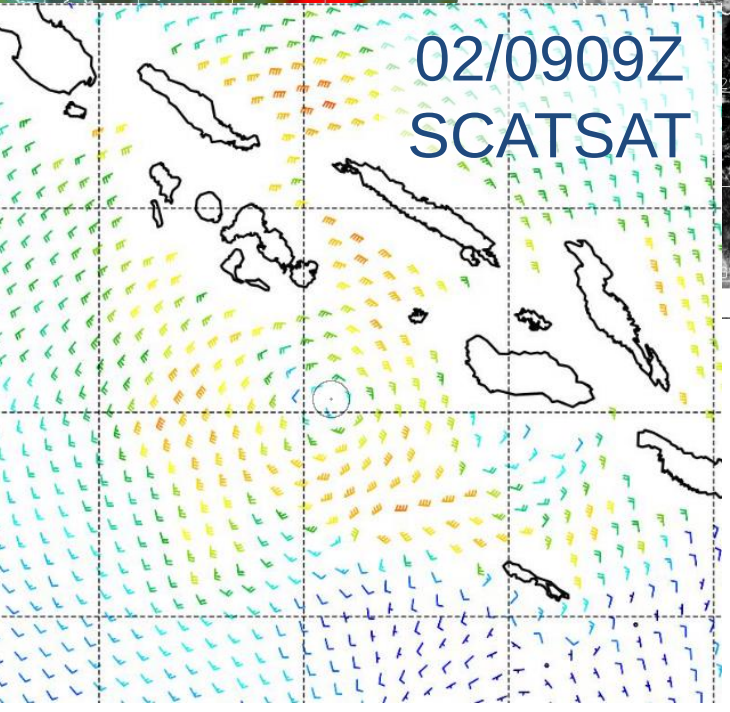
curvature becomes defined but variability

Scatterometry shows 35kn at 09UTC!









Breaking Dvorak constraints. Very tight curvature around centre, with 3h DT average of 0.6 curved band wrap on persistent deep convection. Great SSMI microwave at 0501Z.

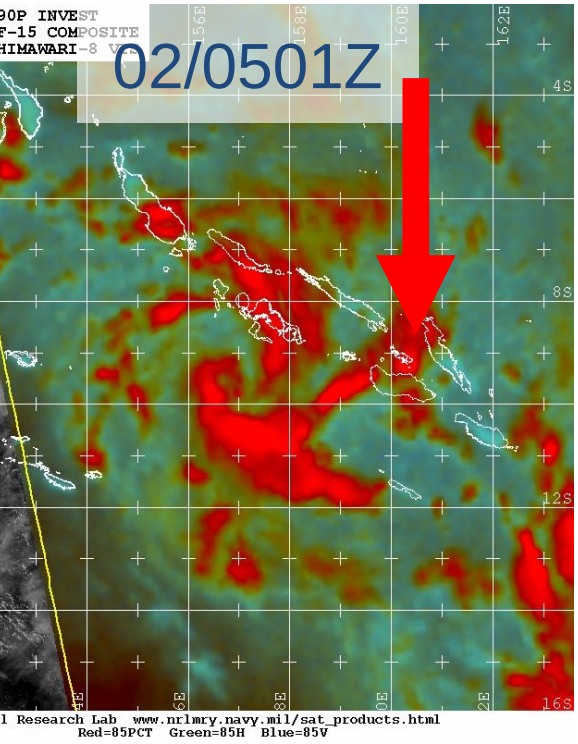
Australian Government
Bureau of Meteorology

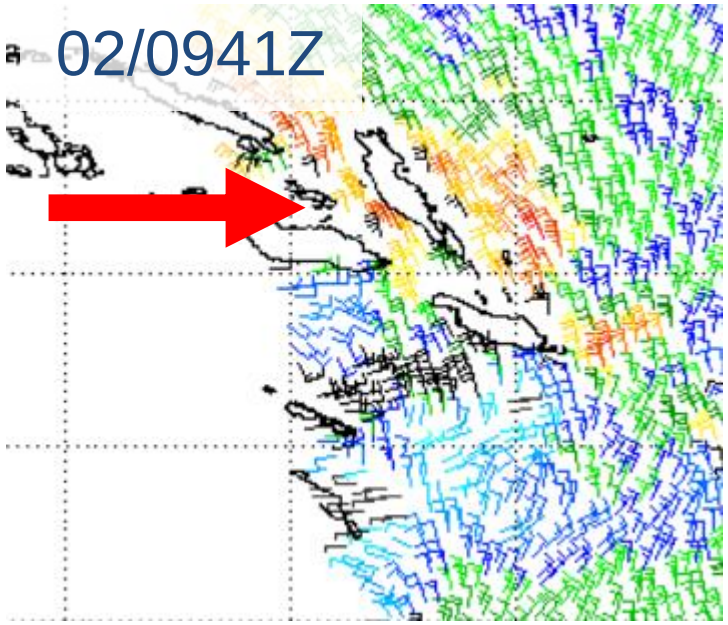
Solomon Is impact

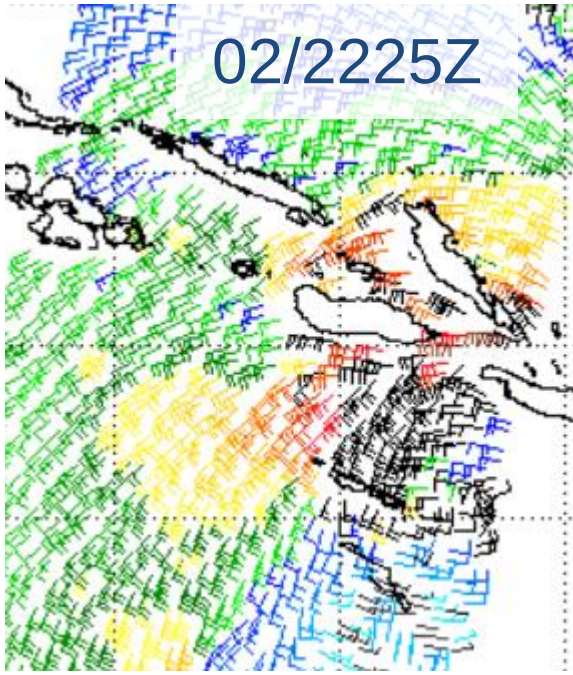
Source: Wikipedia https://en.wikipedia.org/wiki/Cyclone_Harold#Solomon_Islands

27 people washed overboard ferry (MV Taimareho) carrying 738 passengers on 2 April;

57 houses destroyed; 20 damaged roads/bridges washouts;

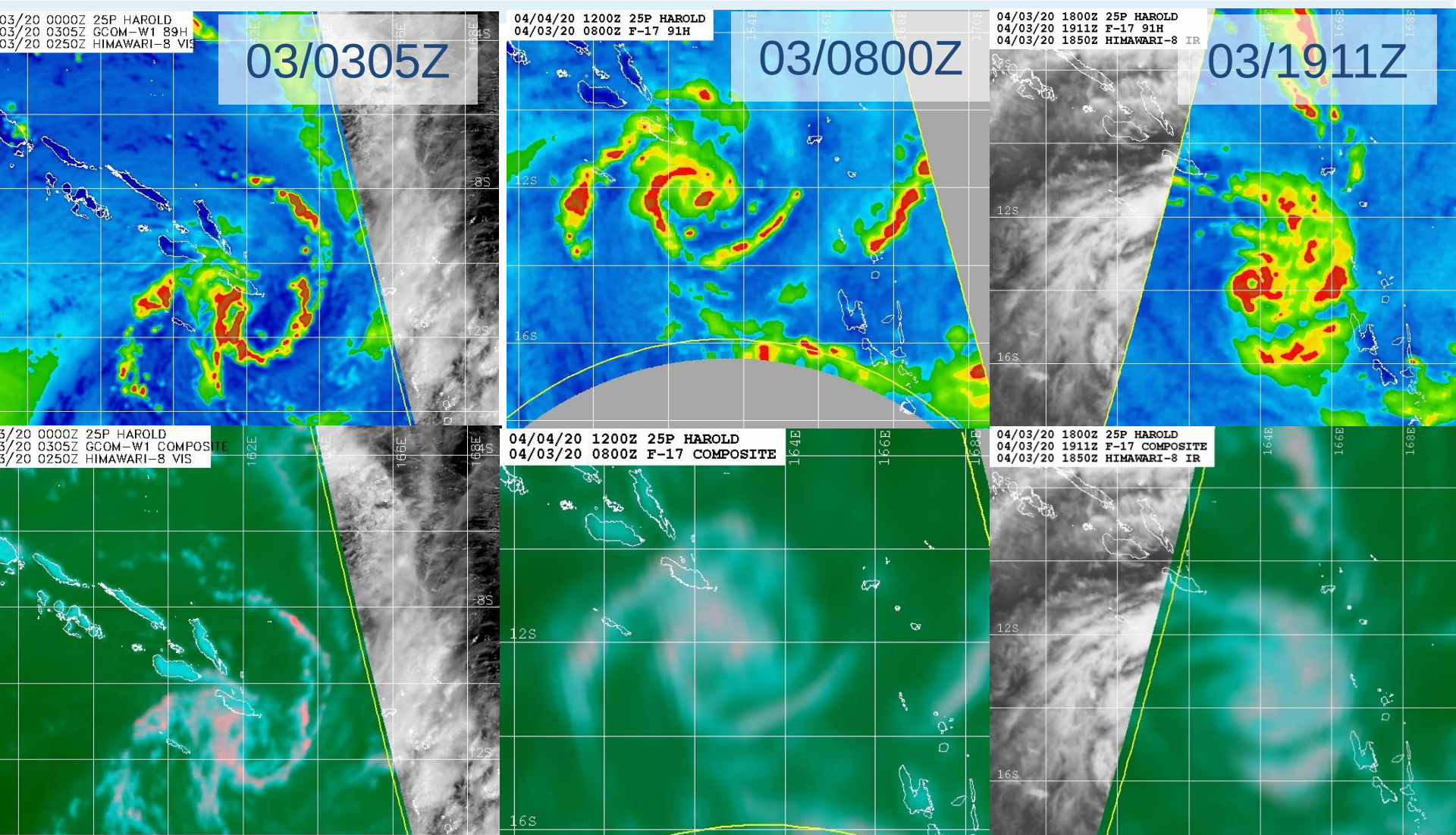






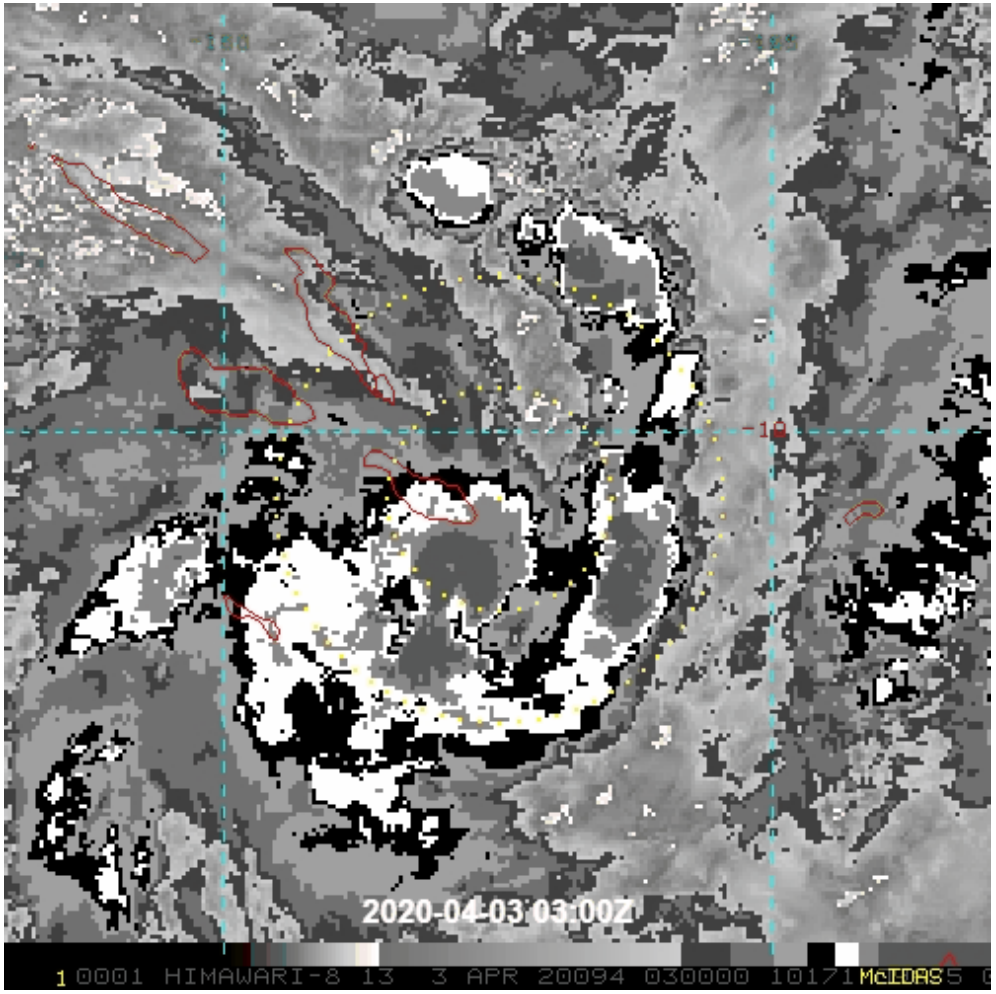
Recognising extreme rapid intensification (ERI)
3 April 2020

Australian Government
Bureau of Meteorology



Australian Government
Bureau of Meteorology

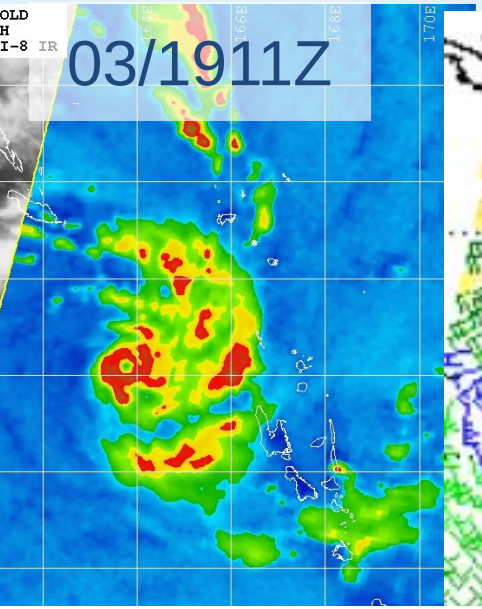
Recognising extreme rapid intensification (ERI)
IR Loop 03-21Z 3 April 2020

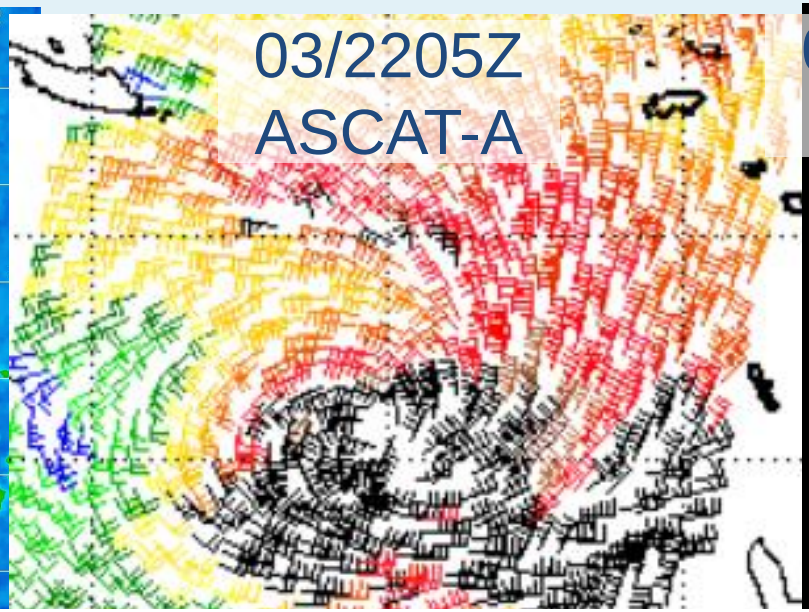


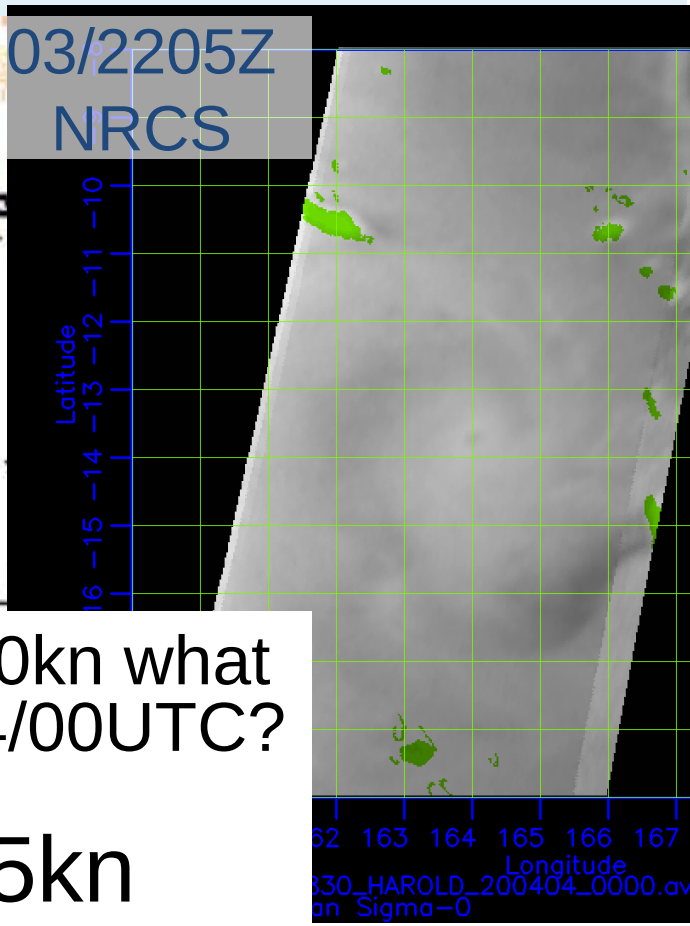
RA: https://rammb-
ta.cira.colostate.edu/tc_realtime/loop.asp?product=4kmsrbdc&storm_identifier=sh252020&starting_image=2020sh25_4
srbdc_202004030300.jpg&ending_image=2020sh25_4kmsrbdc_202004032100.jpg

Recognising extreme rapid intensification
3-4 April 2020
RMW <10nm

Australian Government
Bureau of Meteorology







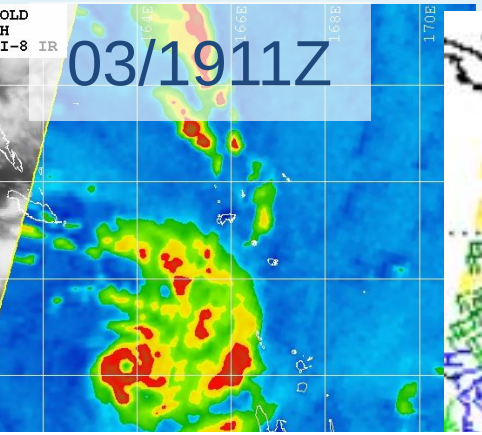
If at 12UTC the intensity estimate was 50kn what do you think the intensity should be at 04/00UTC?

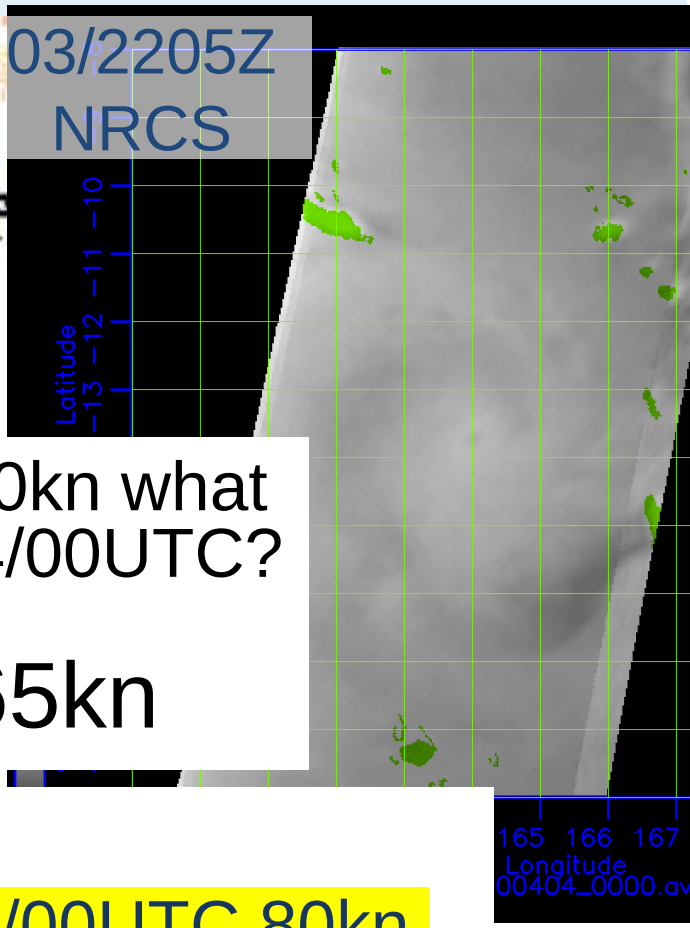
Go to Socrative.com

a. 50kn b. 55-65kn c. >65kn

Recognising extreme rapid intensification
3-4 April 2020
RMW <10nm

Australian Government
Bureau of Meteorology





If at 12UTC the intensity estimate was 50kn what do you think the intensity should be at 04/00UTC?

Go to Socrative.com

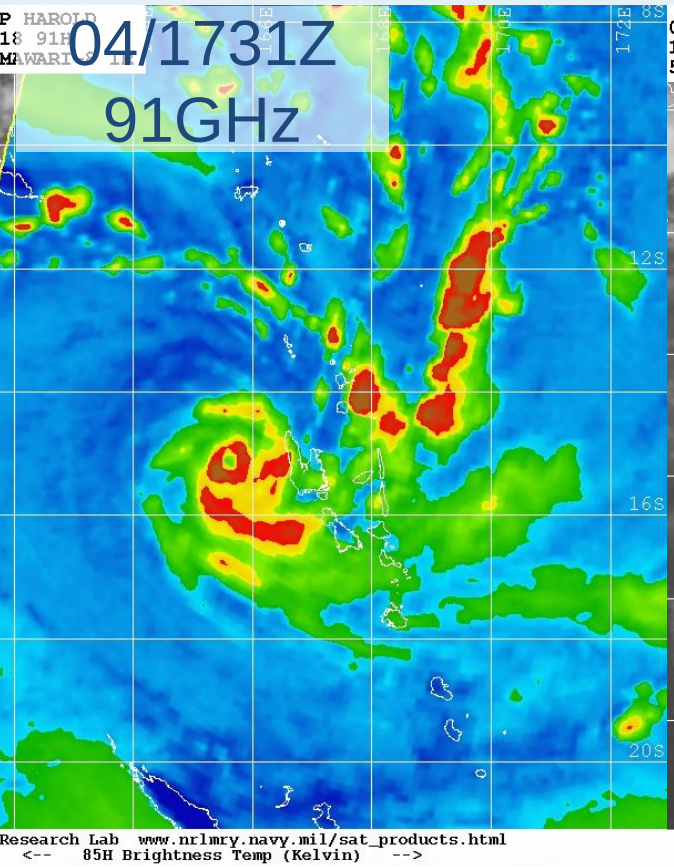
a. 50kn b. 55-65kn c. >65kn

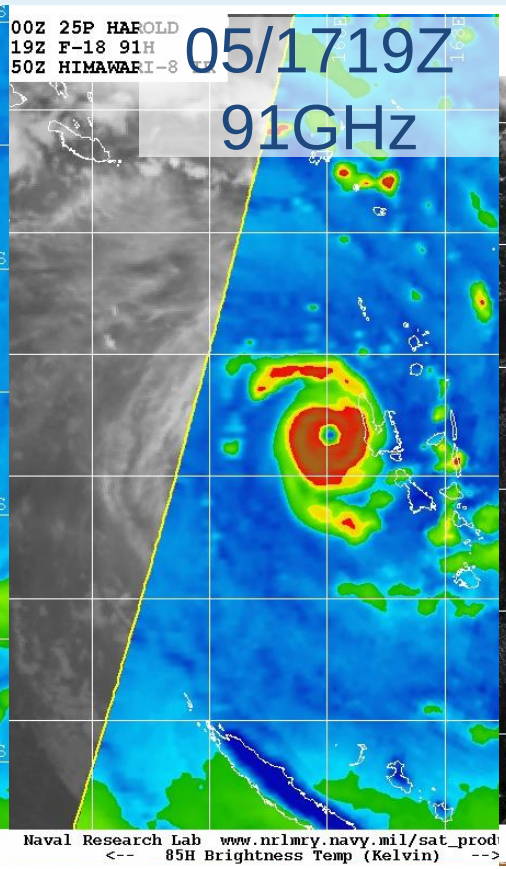
Answer C >65kn

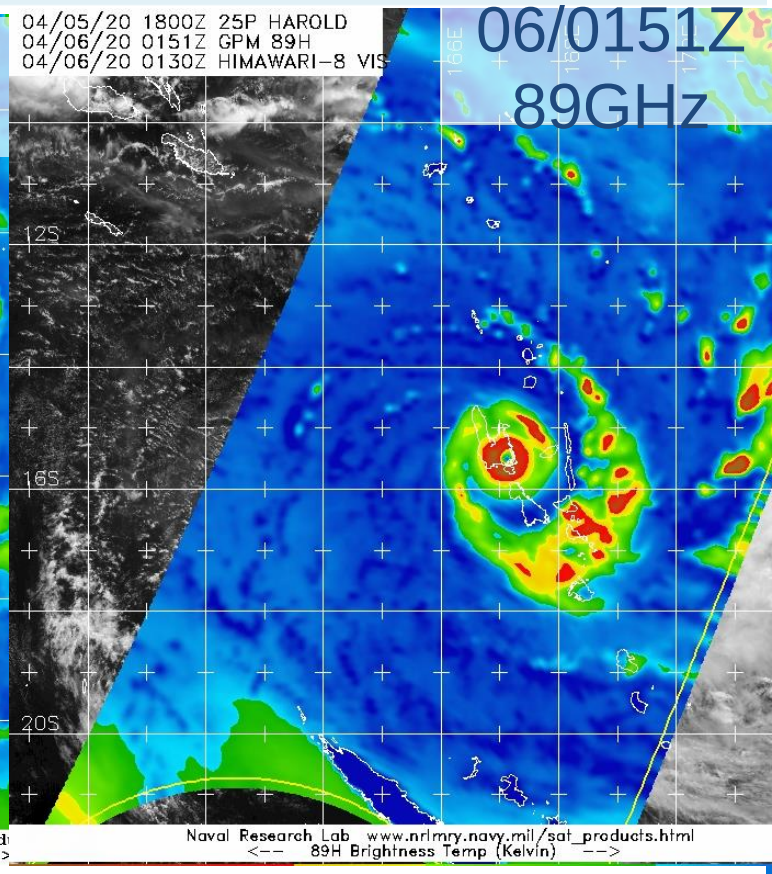
JTWC 03/12UTC 50kn(55kn 1-min) 04/00UTC 80kn (90kn 1-min) or 45kn/24h

Australian Government
Bureau of Meteorology

Intense and slows approaching Vanuatu 4-6 April 2020







JTWC 06/00UTC 105kn (115kn 1-min) but higher?

Synthetic Aperture Radar (SAR) 6 April 150kn on NE quadrant! RMS 7nm.

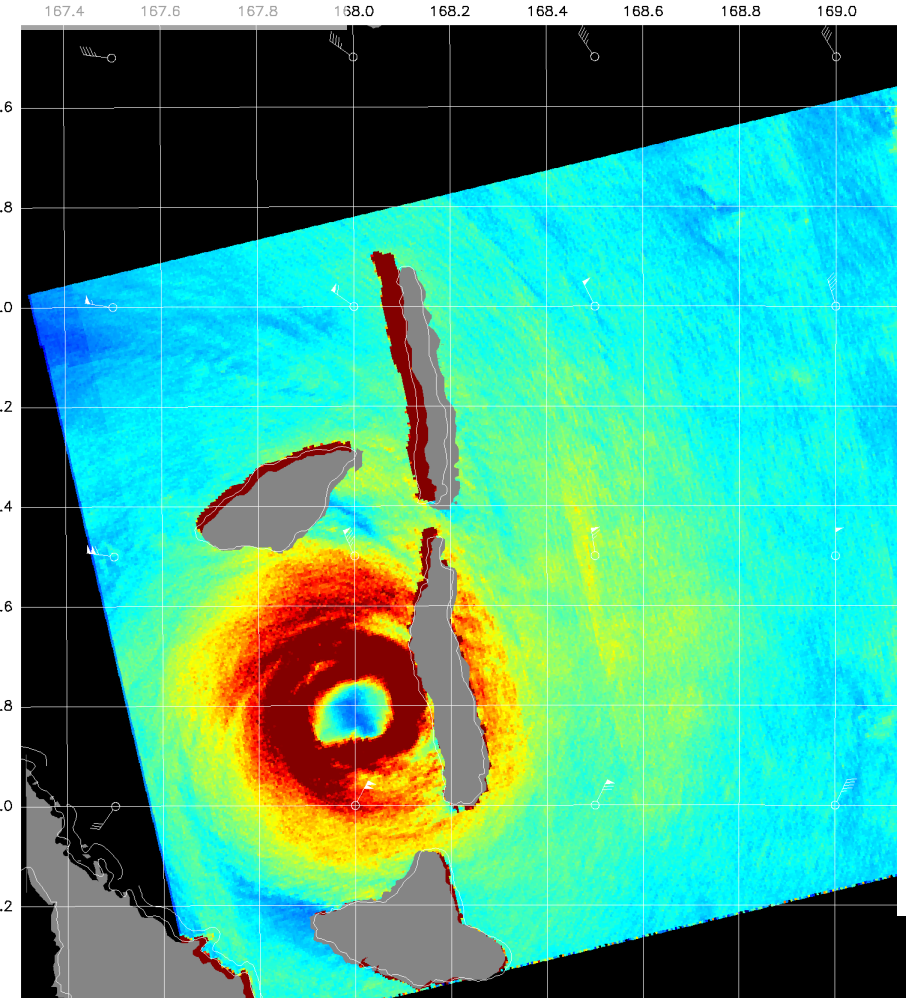
Australian Government
Bureau of Meteorology

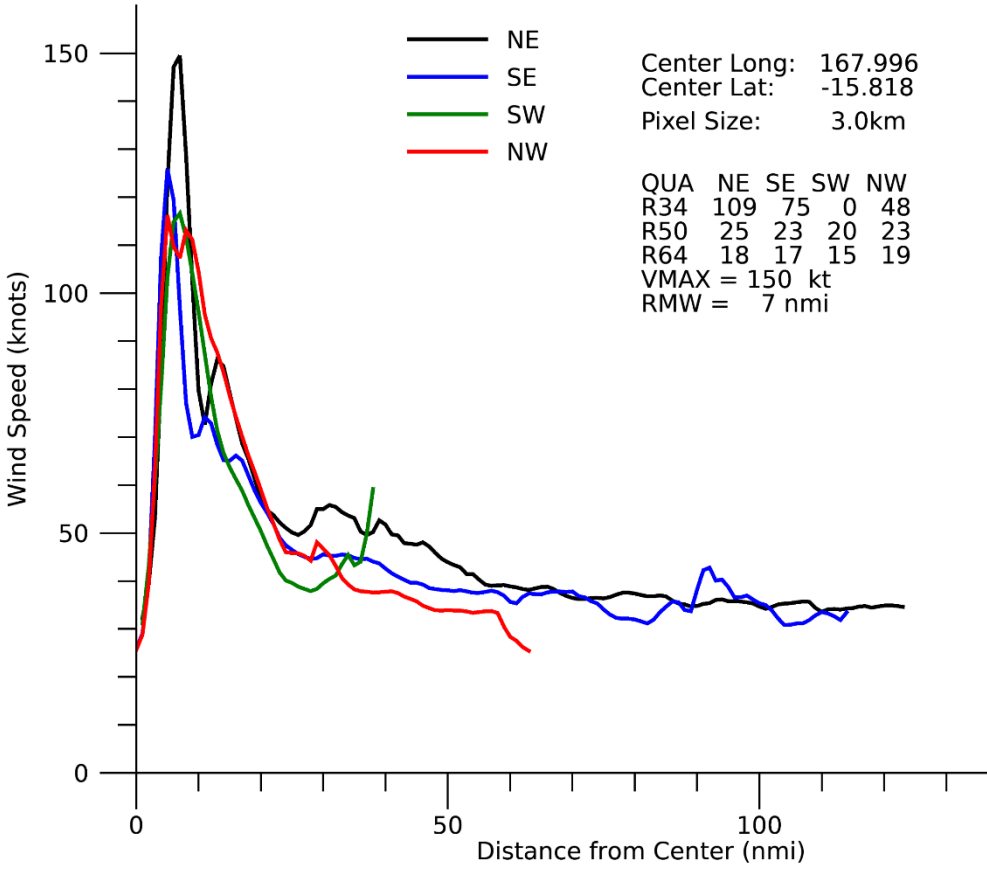
SAR courtesy: Alexis Mouche, IFREMER; and NESDIS/STAR; NRL.

https://www.star.nesdis.noaa.gov/socd/mecb/sar/AKDEMO_products/APL_winds/tropical/?year=2020&storm=SP252020_HAROLD

SAR Wind: S1A_ESA_2020_04_06_07_14_06_0639472446_168.65E_15.46S_VH_C-7_GFS05CDF_wind_level2.nc

06/0714Z



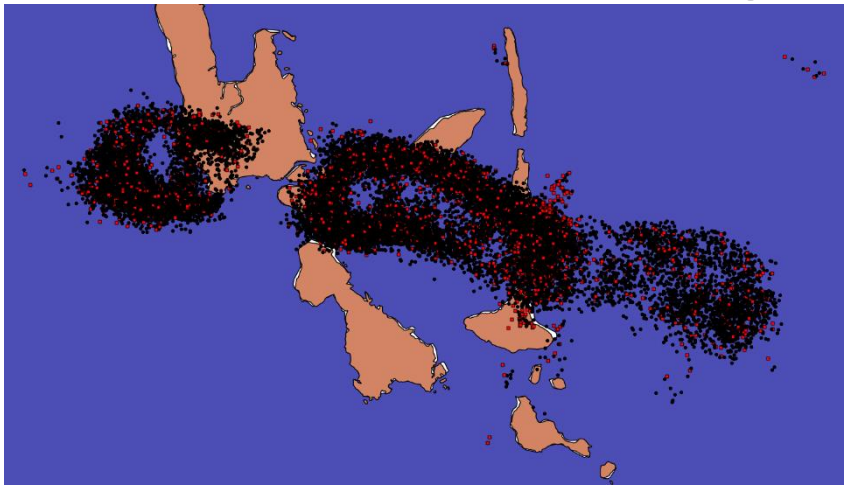


Australian Government
Bureau of Meteorology

Vanuatu impact

Source: Wikipedia https://en.wikipedia.org/wiki/Cyclone_Harold#Vanuatu

Luganville (population 16000 on Espiritu Santu north of Vila) and Pentecost and Malo Islands directly impacted by core;
2 fatalities on Malo Island;
Flooding and defoliation extensive;
COVID-19 restrictions lifted enabling evacuation shelters;



Source: Chris Vagasky 24 hour still map: https://tallgrasswx.files.wordpress.com/2020/04/harold_eel.png
24 hour loop: https://tallgrasswx.files.wordpress.com/2020/04/24-hours-of-lightning.gif?w=750&zoom=2

Australian Government
Bureau of Meteorology

Vanuatu impact : Pentecost and Malo Is

Pentecost Is

Photo: Albert Vireibo; Vanuatu Daily Post

Malo Is

Photo: Alain Simeon; Vanuatu Dept of Agriculture

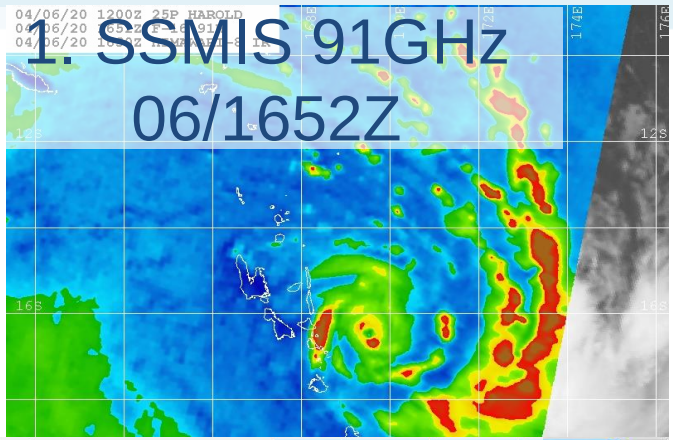
Mr Warri said a group of about 60 people at Londar in south Pentecost was lucky to have survived the cyclone. "They hid under the church and it flew away. All the other houses had flown so the men stood around in a circle and the women and children stood in the middle. "They stood there until the morning in the rain and the wind."

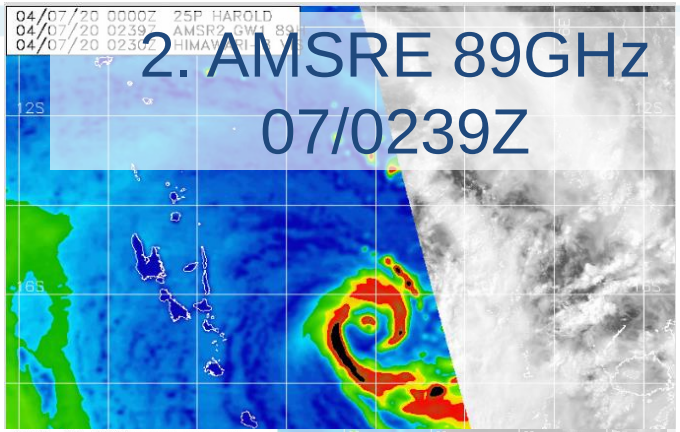
Source: https://www.rnz.co.nz/international/pacific-news/414299/as-if-it-was-bombed-vanuatu-s-pentecost-devastated-by-cyclone-harold

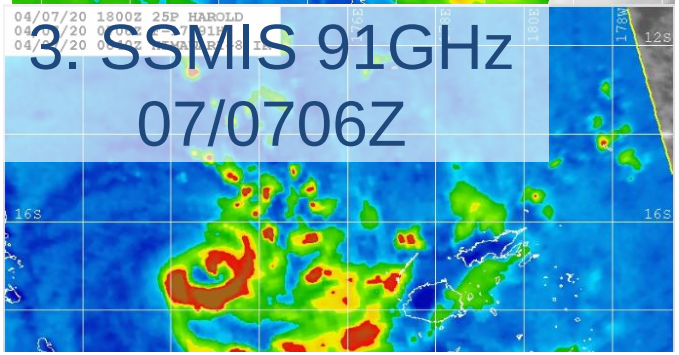
Australian Government
Bureau of Meteorology

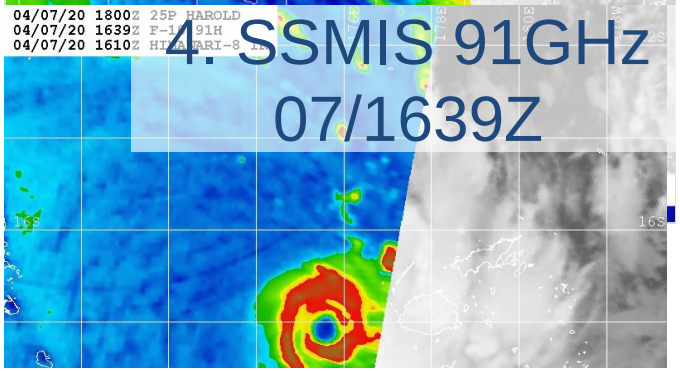
TC Harold eye restructure 6-7 April What is going on?

Refer ERC VLAB at: http://www.virtuallab.bom.gov.au/archive/regional-focus-group-recordings/









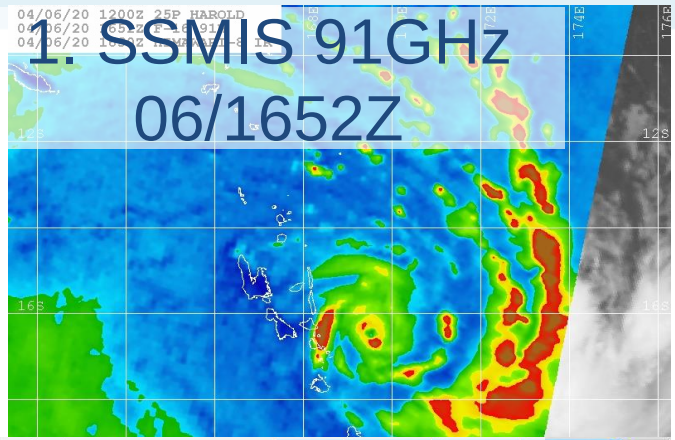
What is the best intensity description? Go to Socrative

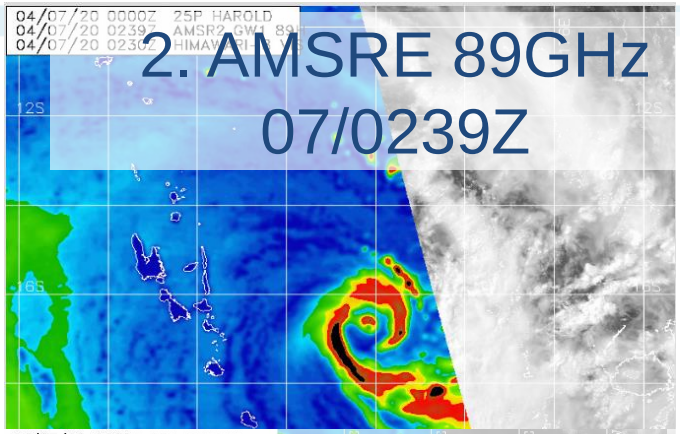
a. from peak at 1. weakens to 2. and 3. then increases at 4.
b. intensity steady from 1. to 2. then weakens to 3. and increases to 4.
c. intensifies from 1. to 2. then weakens to 3. and increases to 4.
d. from peak at 1. weakens to 2. then increases to 3. and 4.

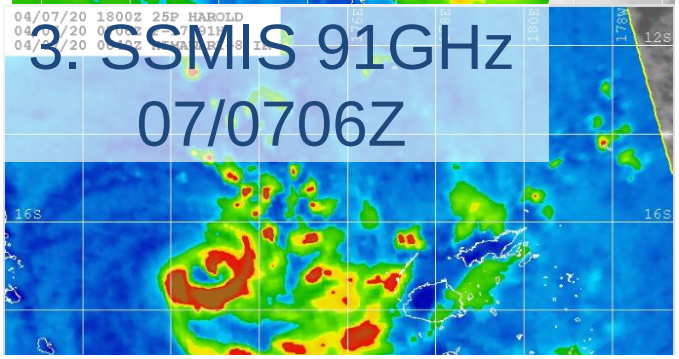
Australian Government
Bureau of Meteorology

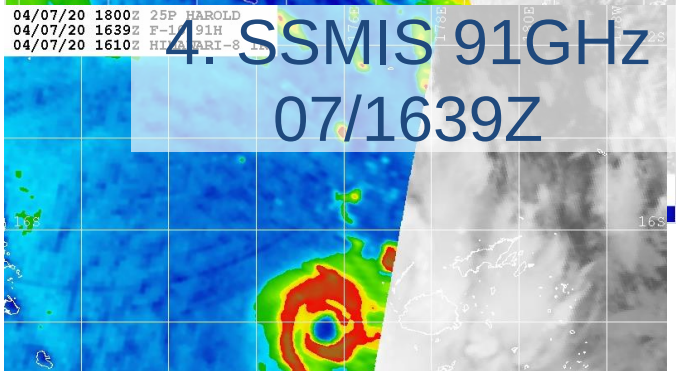
TC Harold eye restructure 6-7 April What is going on?

Refer ERC VLAB at: http://www.virtuallab.bom.gov.au/archive/regional-focus-group-recordings/









What is the best intensity description? Go to Socrative

a. from peak at 1. weakens to 2. and 3. then increases at 4.

b. intensity steady from 1. to 2. then weakens to 3. and increases to 4.

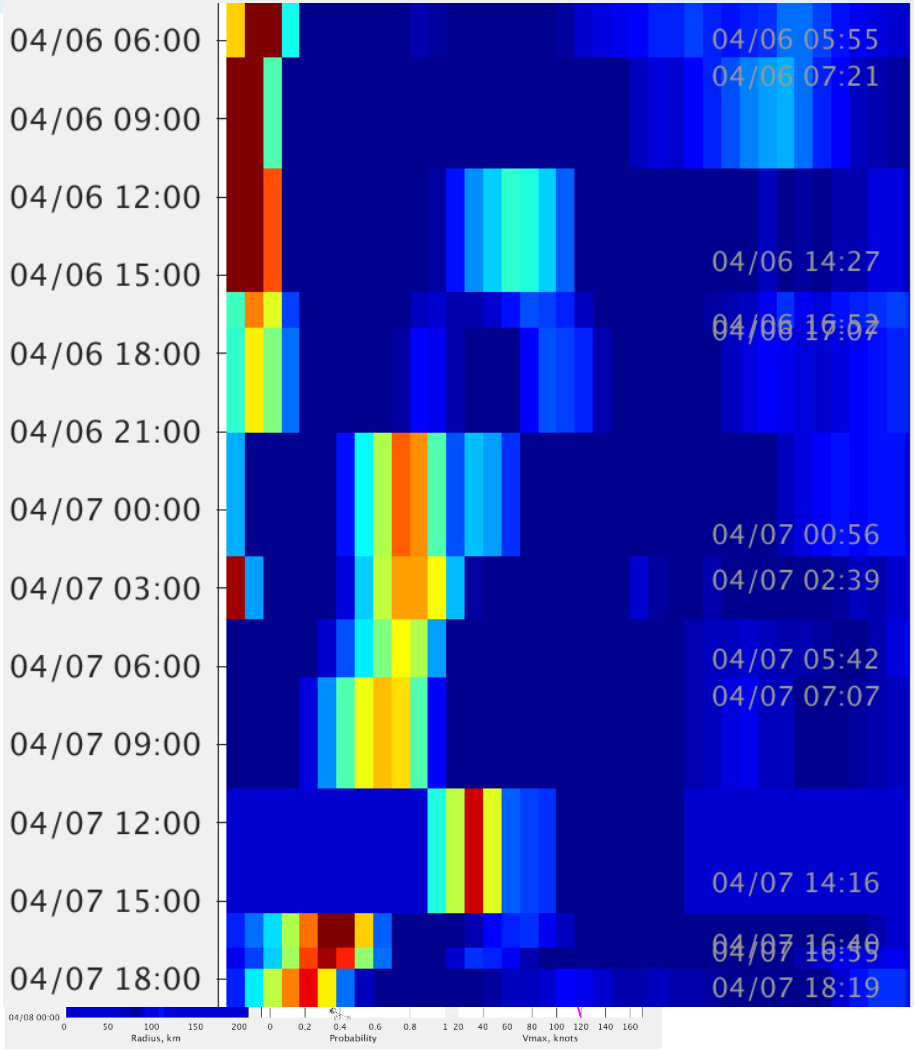
c. intensifies from 1. to 2. then weakens to 3. and increases to 4.

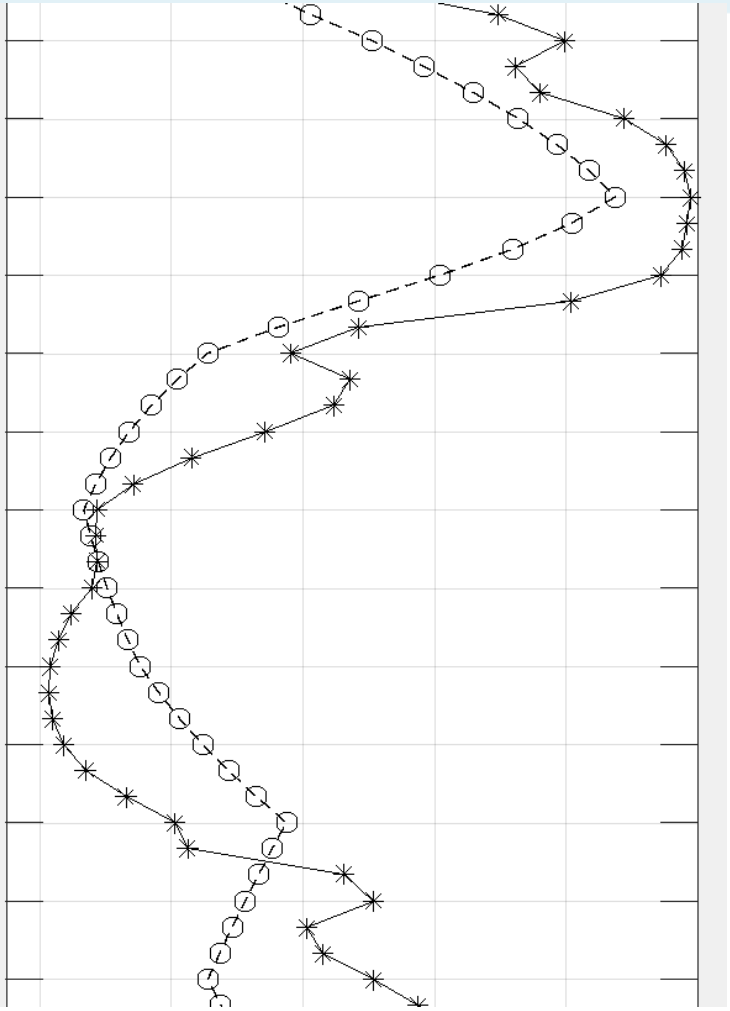
d. from peak at 1. weakens to 2. then increases to 3. and 4.

M-PERC guidance (CIMSS) 6-7 April

Australian Government
Bureau of Meteorology

realtime: http://tropic.ssec.wisc.edu/real-time/archerOnline/web/index_erc.shtml



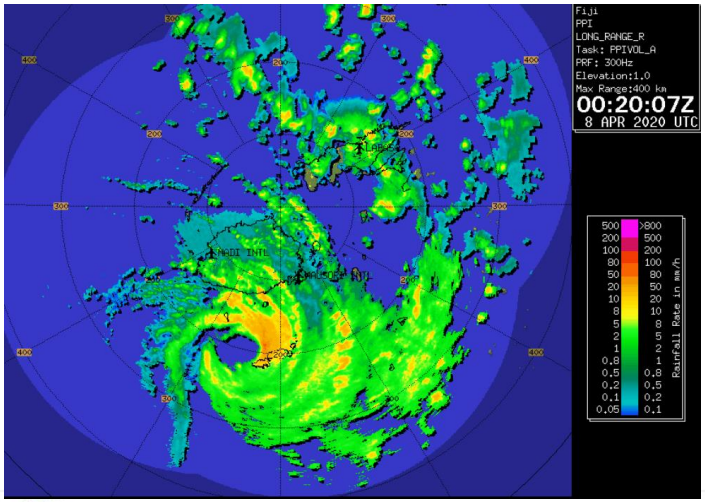


Australian Government
Bureau of Meteorology

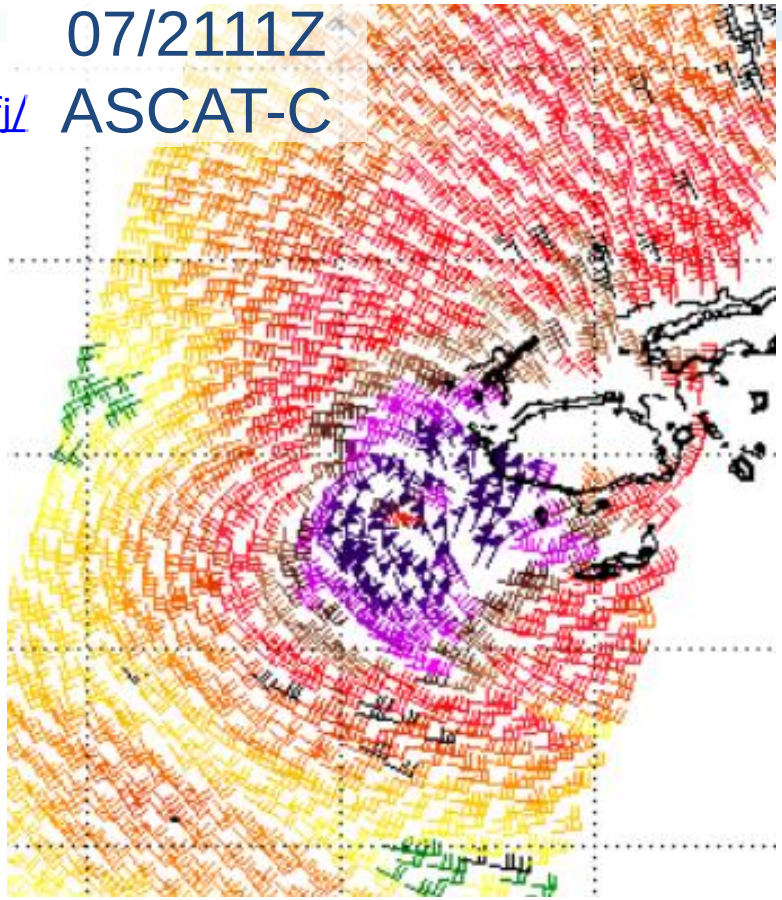
Fiji impact 8 April expansion of 48kn winds on ASCAT

Passed over Kadavu Is group

Fiji Met radar courtesy https://www.met.gov.fj/



07/2111Z ASCAT-C



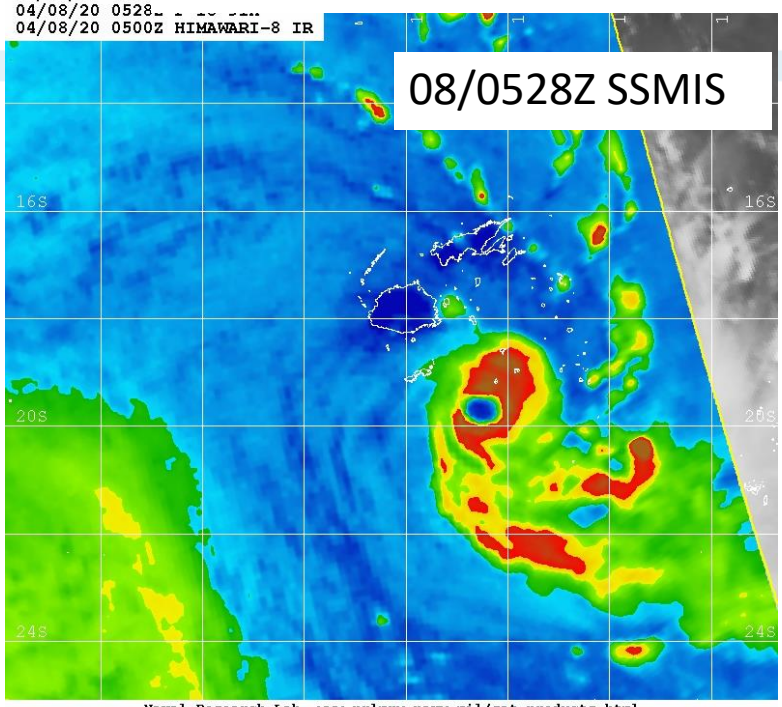
Atishwar Navtarang @atishwarchand · Apr 8

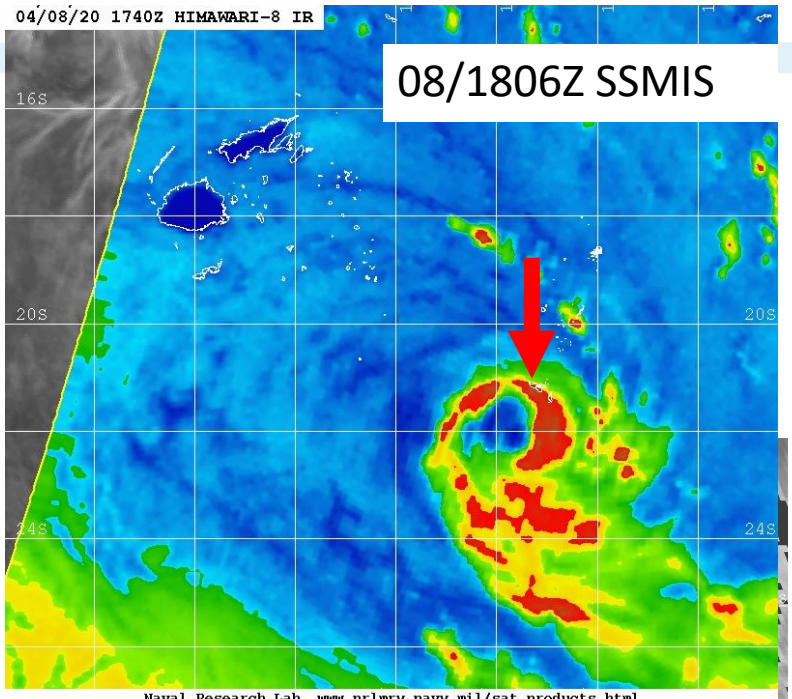
#TCHarold in #Kadavu. Kadavu experienced brunt Category 4 Tropical Cyclone Harold.
Hope people of #Kadavu are safe. #TeamFiji

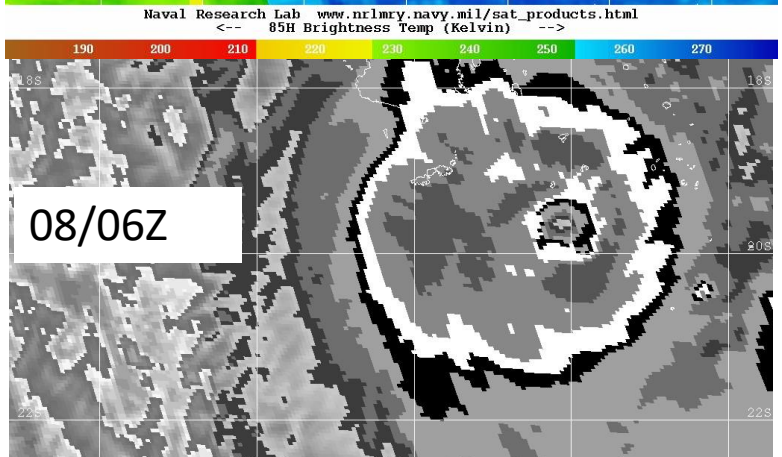
Twitter Atishwar Navtarang
https://twitter.com/atishwarchand/status/1247808560479657986?ref_src=twsrc%5Etfw%7Ctwcamp%5Etweetembed%7Ctwterm%5E1247808560479657986%7Ctwgr%5E&ref_url=https%3A%2F%2Fwww.windy.com%2Farticles%2Ftropical-cyclone-harold-is-expected-to-cross-vanuatu-11723

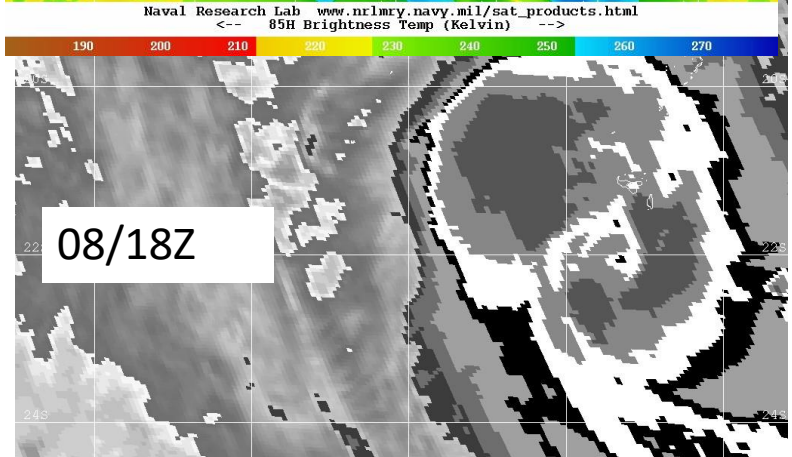
Approaching Tonga: IR (eye weakening) microwave expansion of RMW

Australian Government
Bureau of Meteorology









Tonga impact : high waves and tides
But No lives lost

Australian Government
Bureau of Meteorology

Sources: https://matangitonga.to/2020/04/10/no-lives-losttc-Harold

https://twitter.com/TongaPolice/status/1248073108109443072?ref_src=twsrc%5Etfw%7Ctwcamp%5Etweetembed%7Ctwterm%5E1248073108109443072%7Ctwgr%5E&ref_url=https%3A%2F%2Fwww.windy.com%2Farticles%2Ftropical-cyclone-harold-is-expected-to-cross-vanuatu-11723

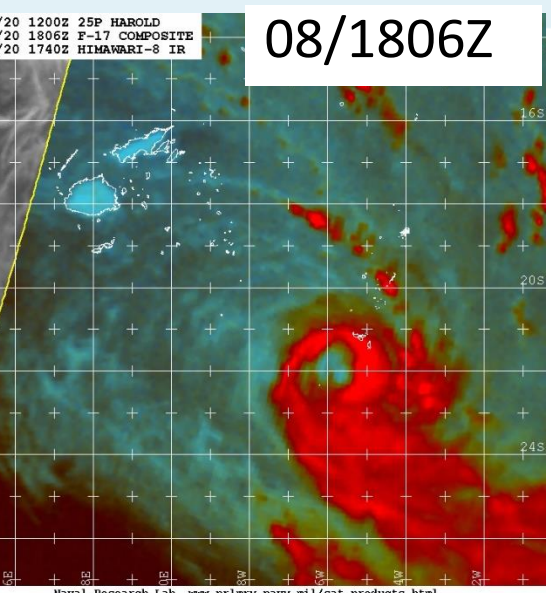
'Ofa Fa'anunu, Dir. TMS: "*the storm surges of over 2.4 to 2.7m had done more damage than the wind…the sea was running inland about one metre above its usual highest level, which was quite devastating… The winds weren't that strong but the rain was very heavy so it made it seem worse, the gusts were Cat. 2-3. We had anticipated the extreme high tides and tried to give warnings with NEMA officials to explain and tell people to expect tsunami like waves,"*

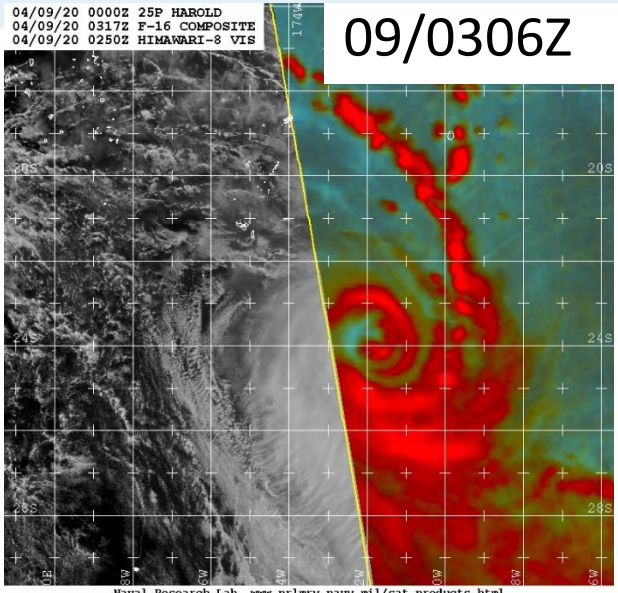
'Eua wharf destroyed; significant coastal erosion

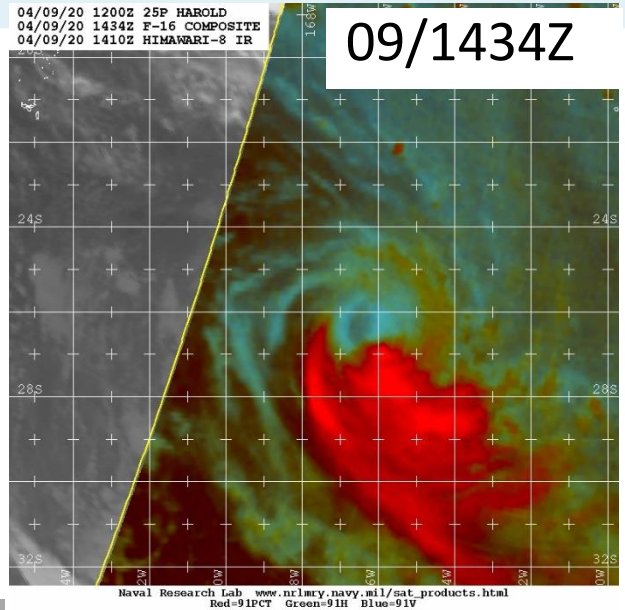
Australian Government
Bureau of Meteorology

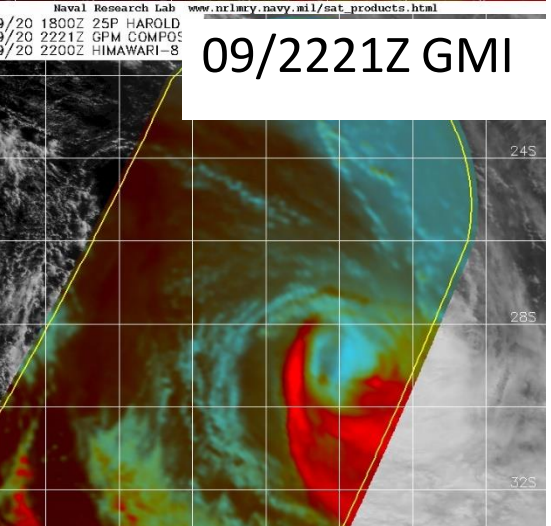
Post Tonga transformation: rapid convective weakening

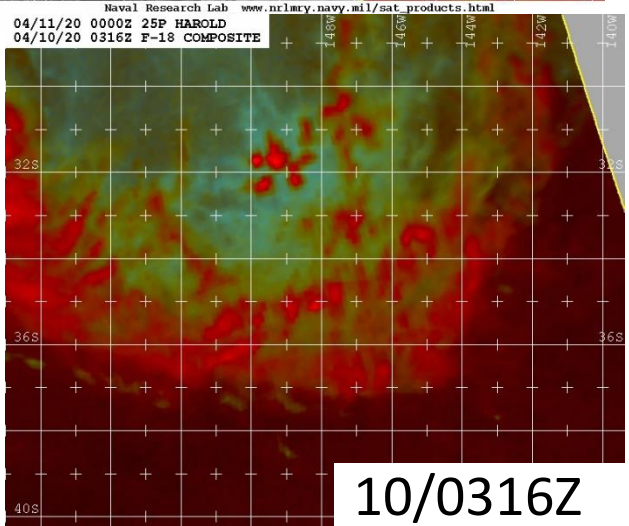
Images: courtesy NRL: https://www.nrlmry.navy.mil/TC.html







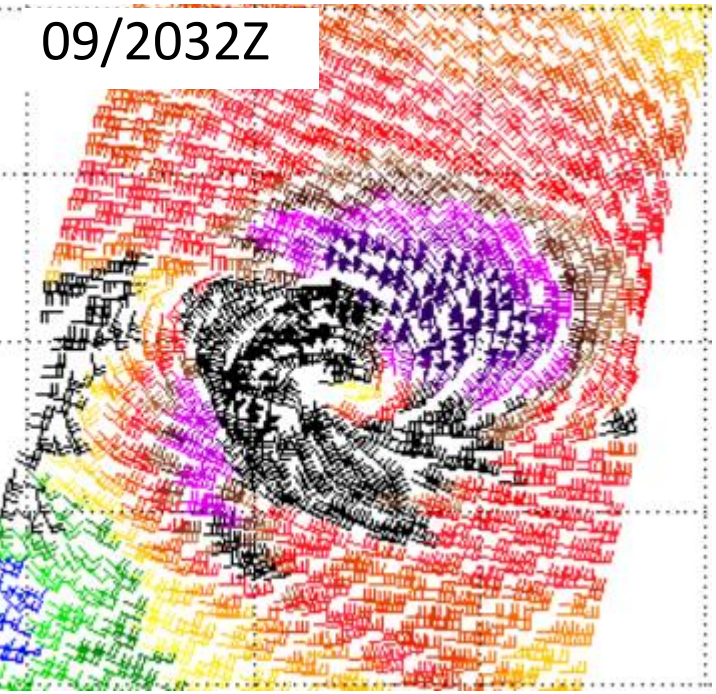




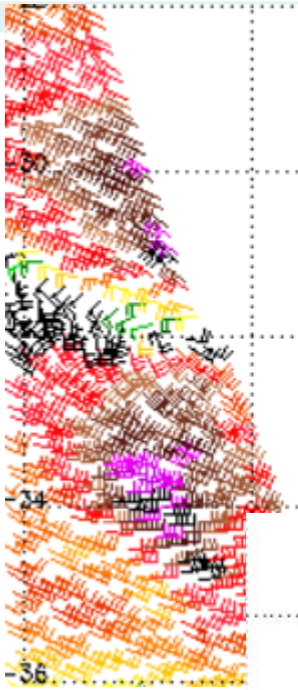
No longer tropical at 10/00Z

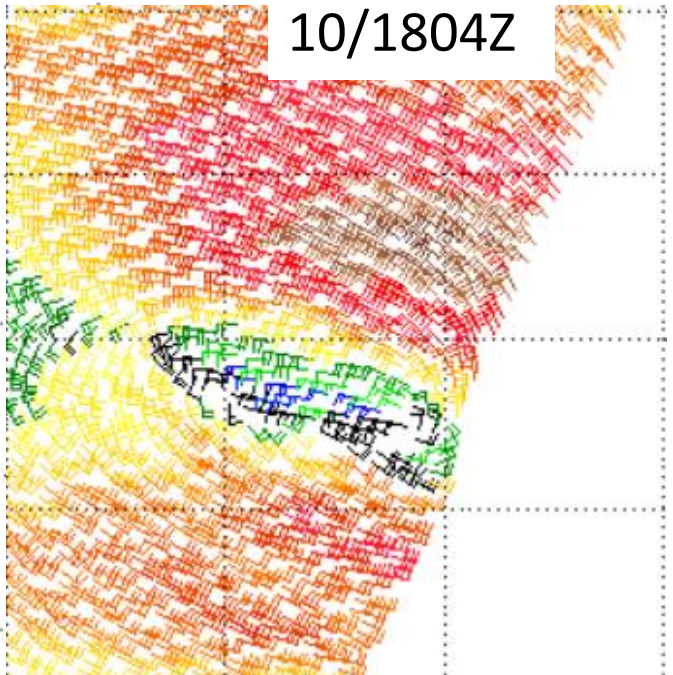
Australian Government
Bureau of Meteorology

ASCAT winds higher than Vis/IR (Dvorak) translation and synoptic SE flow



R48 NE ~120nm



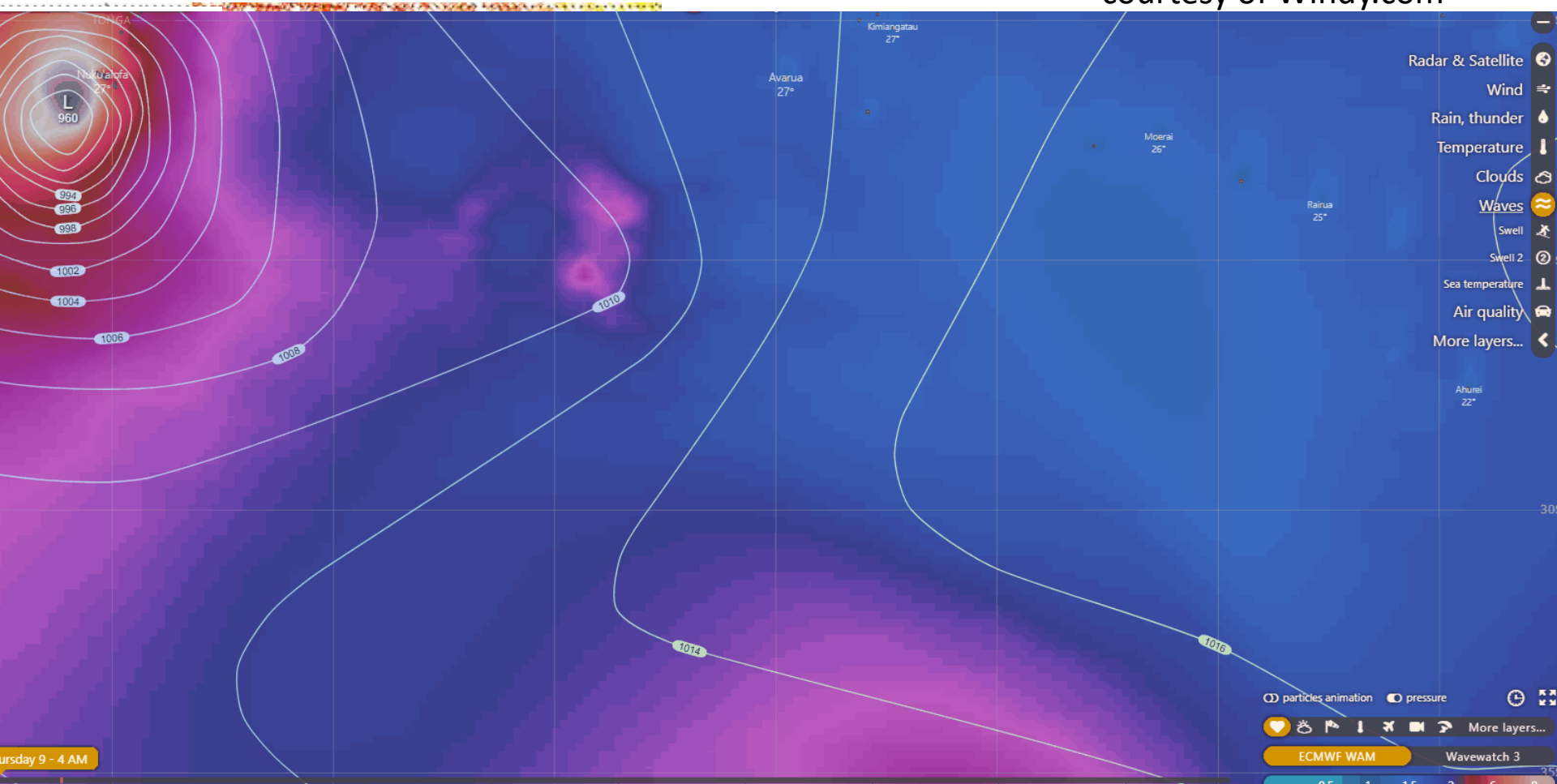


Australian Government
Bureau of Meteorology

Harold wind and waves
enhanced fetch
fast moving (30kn) linear track

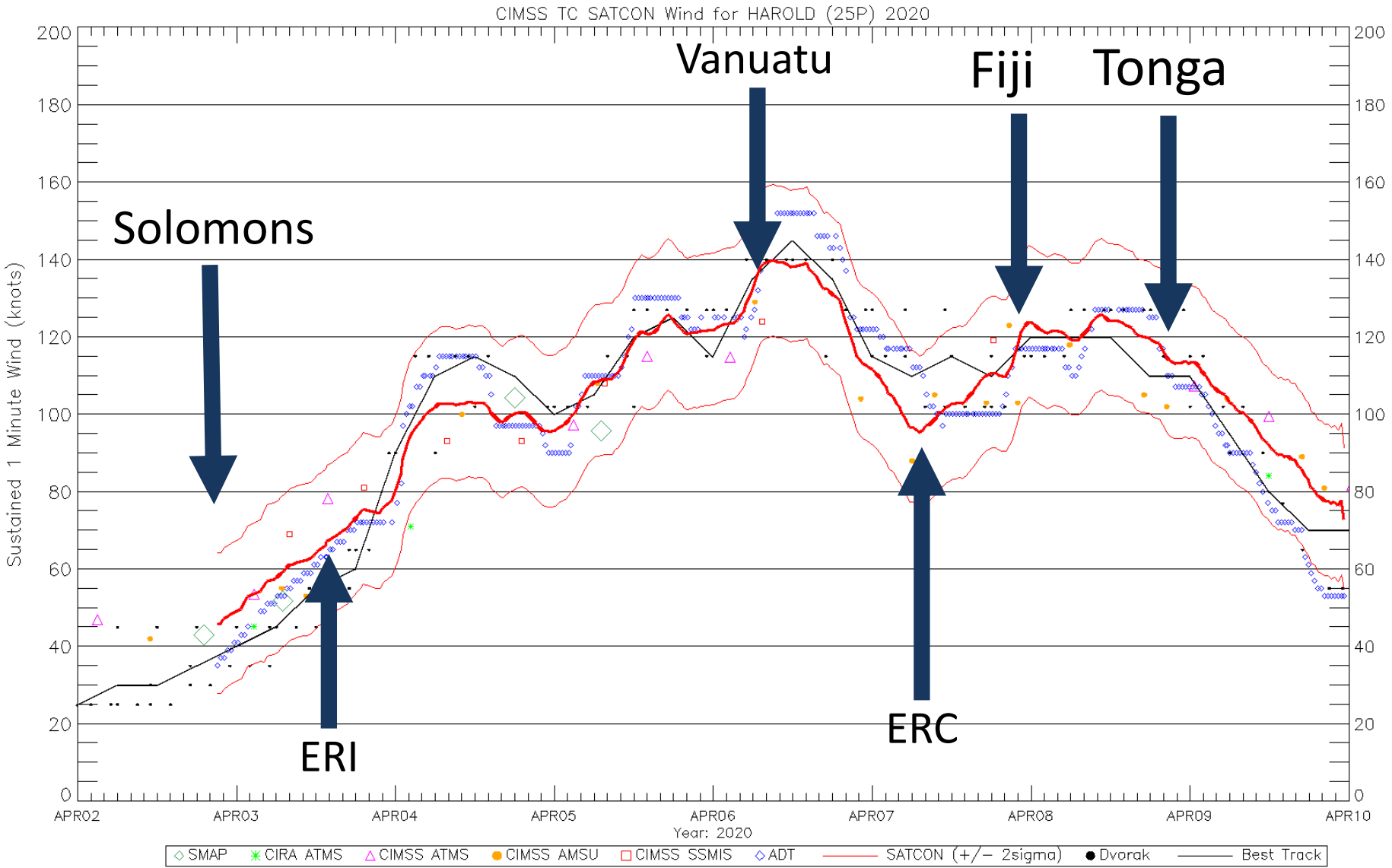
EC waves >10m

courtesy of Windy.com



SATCON Harold 6 days as Cat 3+

Australian Government
Bureau of Meteorology



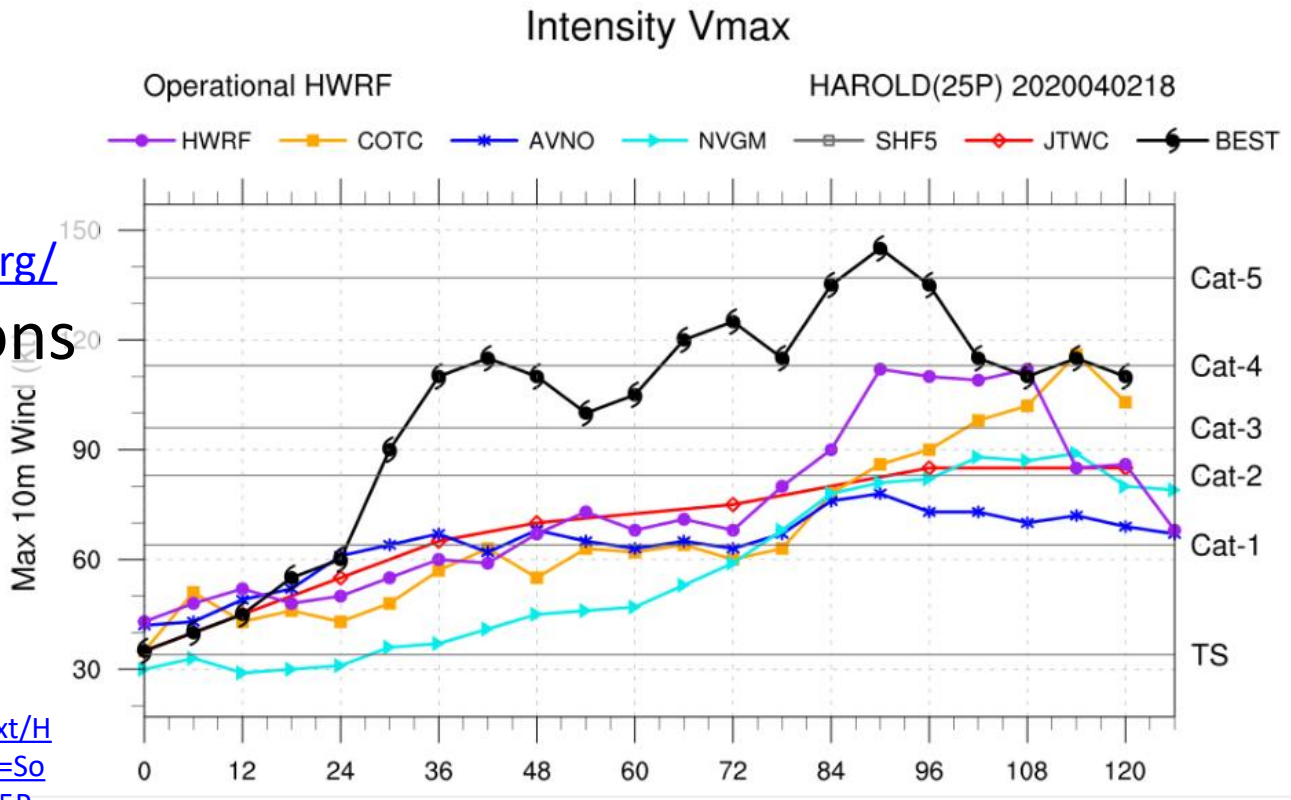
Australian Government
Bureau of Meteorology

Summary: the Harold challenge

In addition to conventional Vis/IR/WV imagery, microwave and scatterometry are essential tools to analyse genesis, RI, ERC and weakening phases

Questions?

Donations:
http://www.vanuaturedcross.org/
+ Tonga/Fiji/Solomons



Graphic: HWRF
https://www.emc.ncep.noaa.gov/gc_wmb/vxt/HWRF/tcall.php?selectYear=2020&selectBasin=Southern+Hemisphere&selectStorm=HAROLD25P

Australian Government
Bureau of Meteorology

TC Harold 91 GHz SSMIS series 2-8 April 2020