

# NOAA's Ultra High Resolution ASCAT Tropical Cyclone Wind Products



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Zorana Jelenak<sup>1,2</sup>, Paul S. Chang<sup>1</sup>, Qi Zhu<sup>1,3</sup>, Faozi Said<sup>1,3</sup>,  
Joseph Sapp<sup>1,3</sup> and Christopher Jackson<sup>1</sup>

**National Environmental  
Satellite, Data, and Information  
Service**

IOVWST – May 29-31, 2024

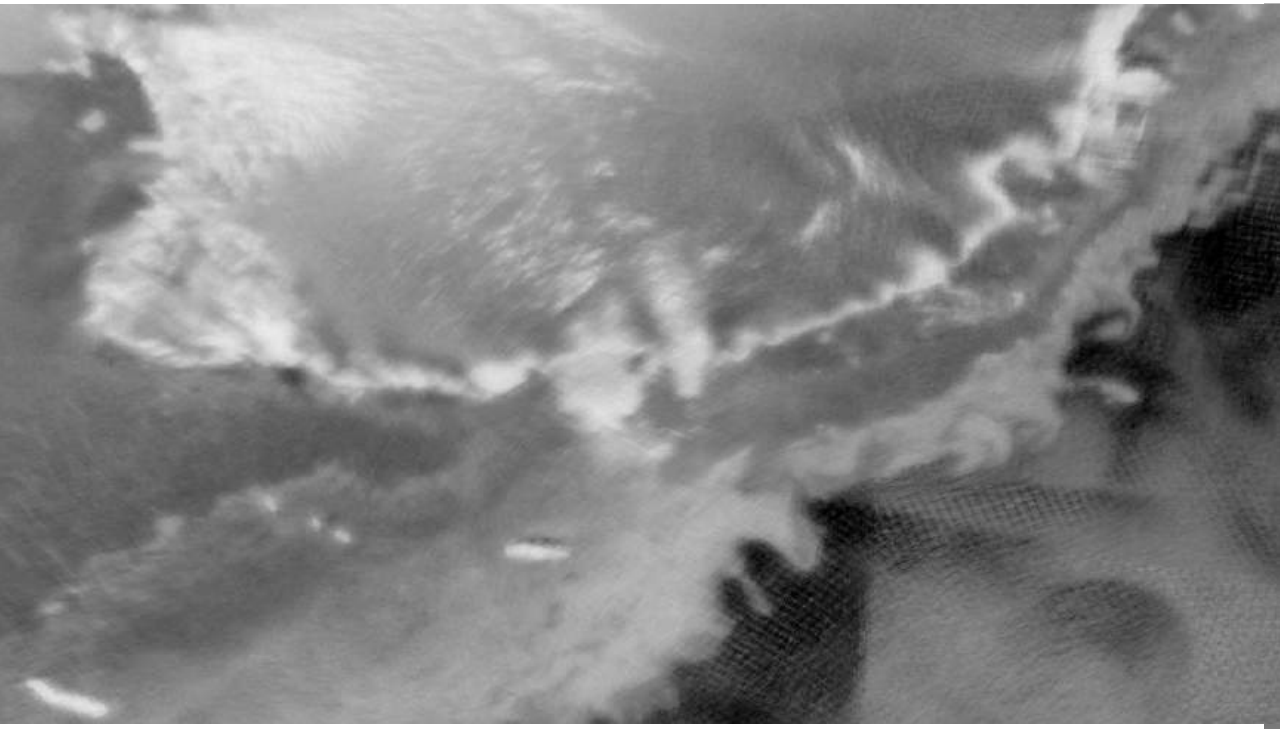
<sup>1</sup>NOAA/NESDIS/STAR

<sup>2</sup>UCAR

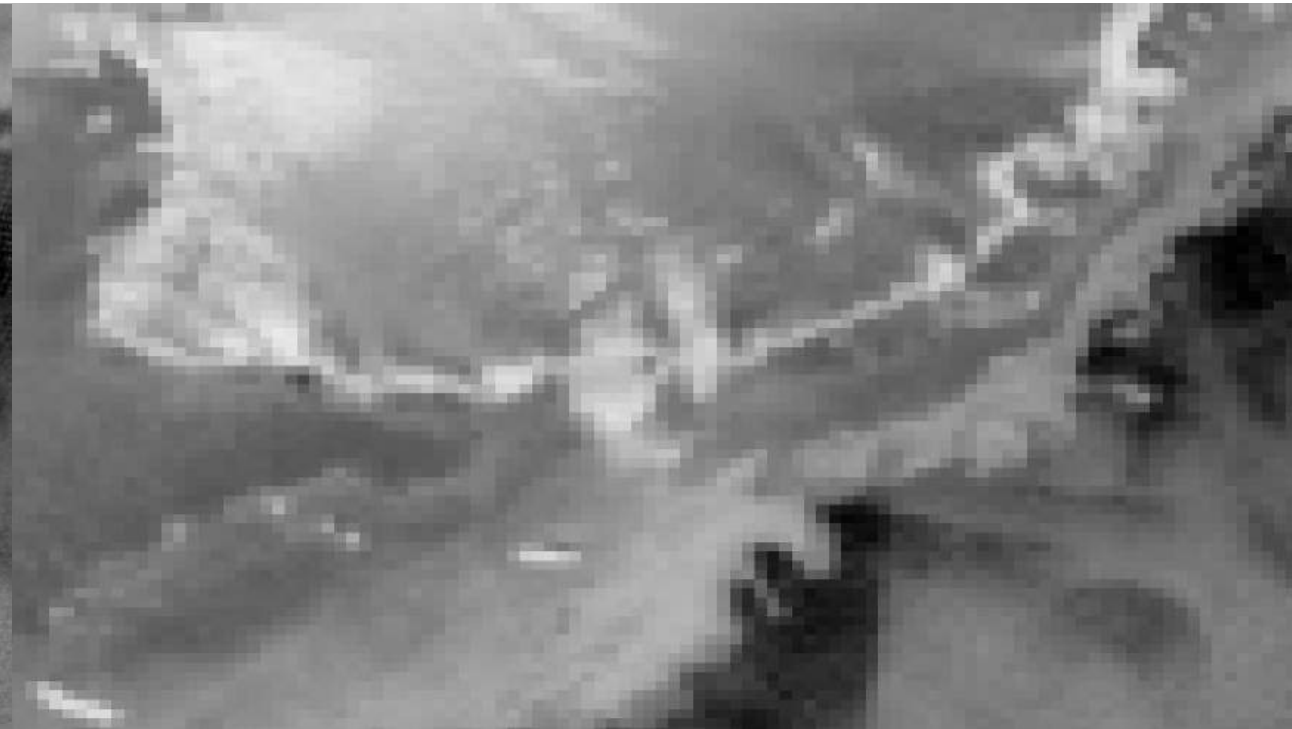
<sup>3</sup>Global Science & Technology, Inc.

# Scatterometer Spatial Resolution Enhancement

(BYU David Long)



AVE (2.225 km pixels)



25 km gridded (grd)

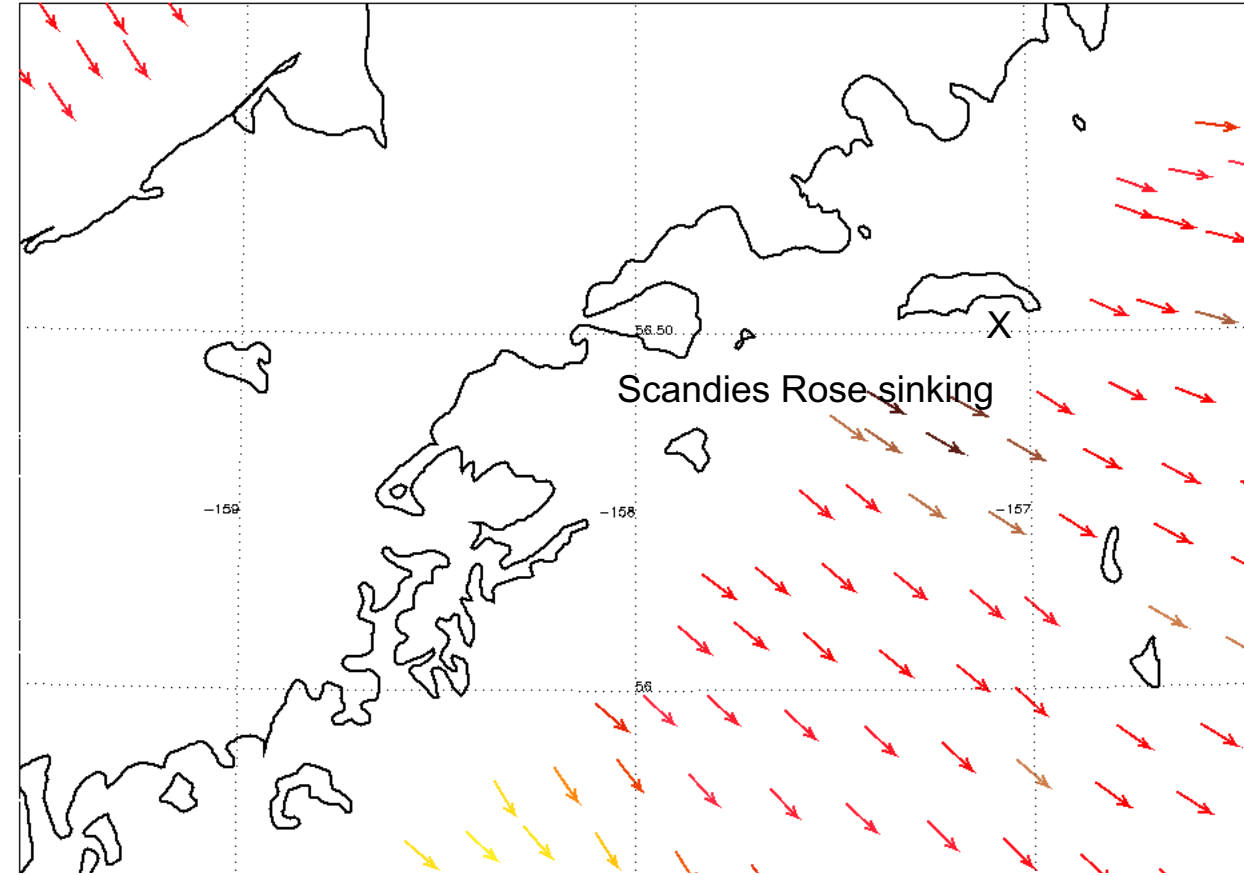
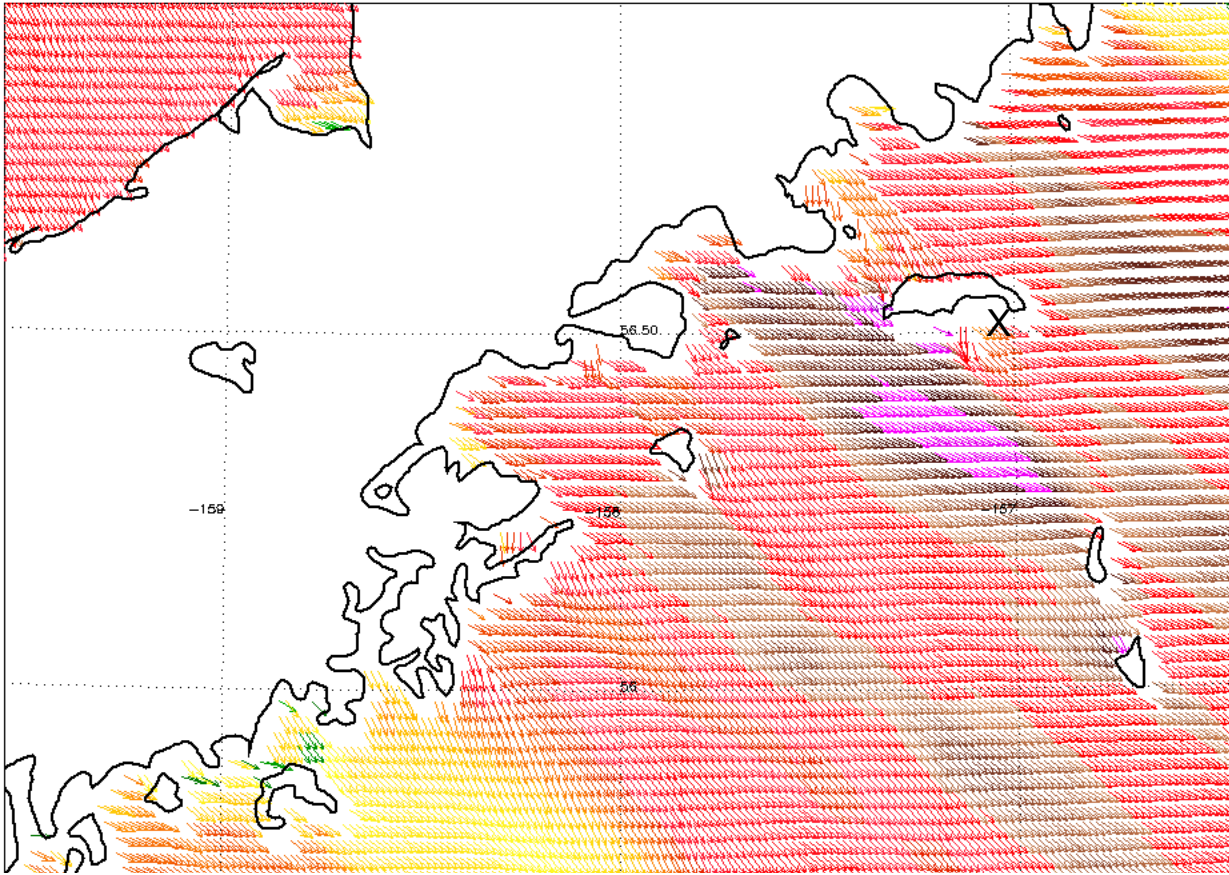


# Motivation – Scandies Rose sinking 2019

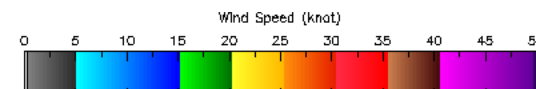
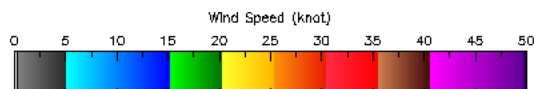


Alaska, ASCAT-B Descending, 20191231, 20:24 UTC, UHR Wind Vector

Alaska, ASCAT-B Descending, 20191231, 20:24 UTC, 12.5km Wind Vector



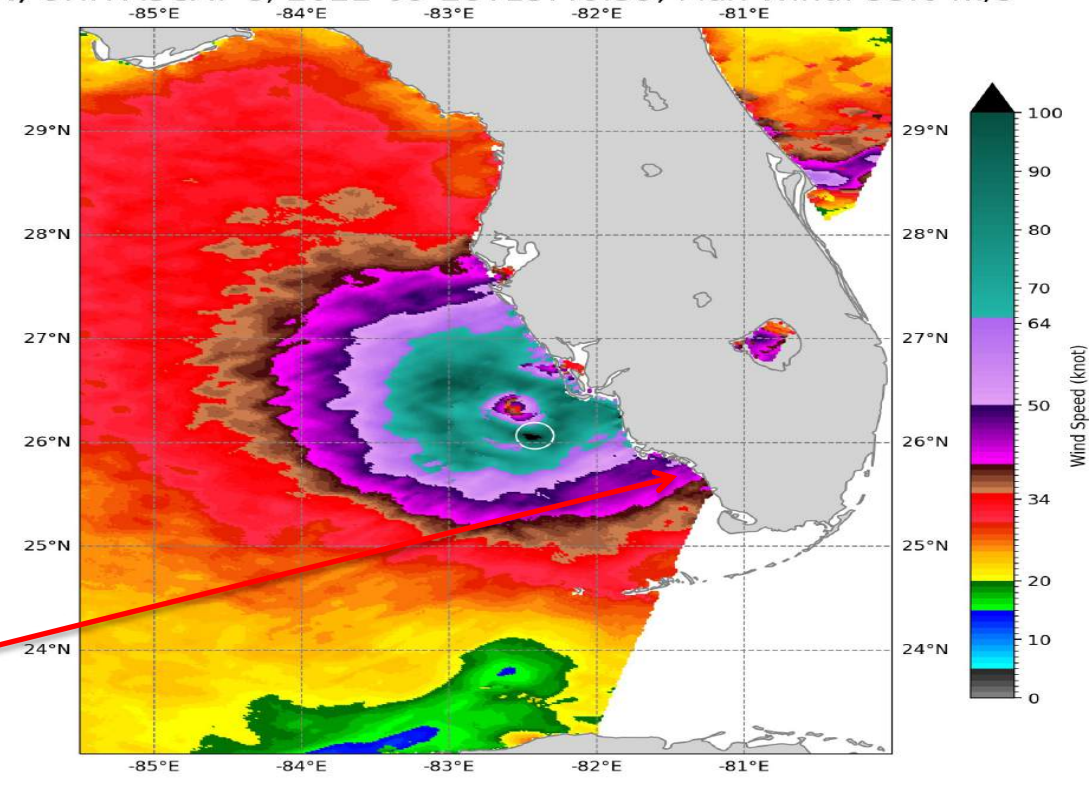
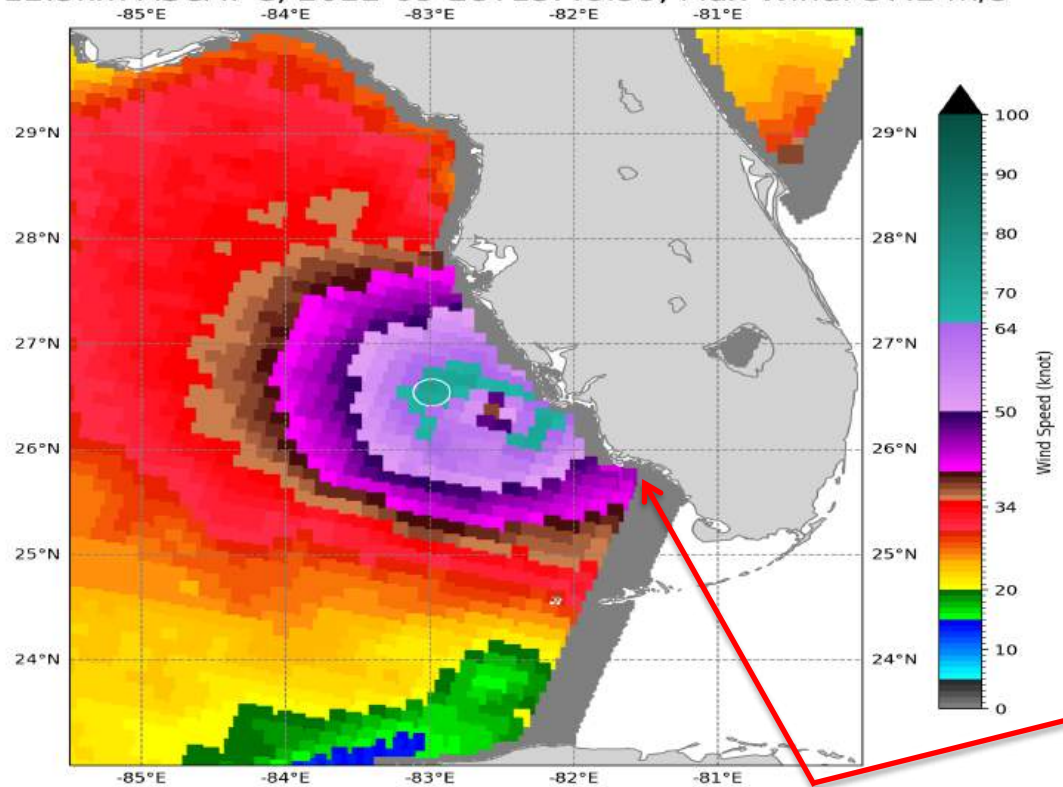
The National Transportation Safety Board said the vessel's inaccurate stability instructions combined with heavy lopsided ice accumulation due to wind and sea conditions, which were more extreme than forecasted during the voyage, caused the vessel to sink near Sutwik Island.



# 12.5km Standard ASCAT vs. UHR ASCAT

IAN, 12.5km ASCAT-C, 2022-09-28T15:48:59, Max Wind: 37.2 m/s

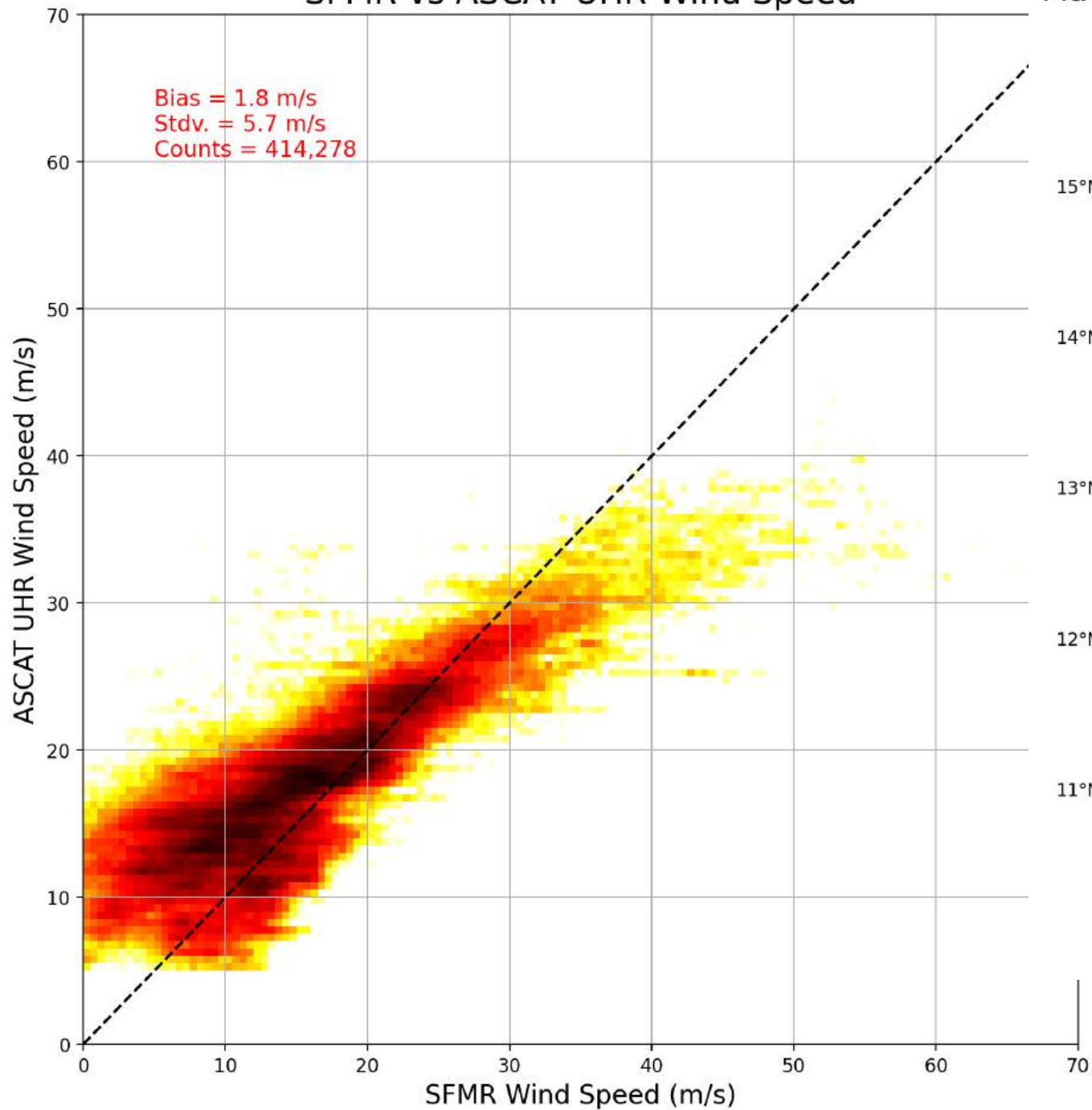
IAN, UHR ASCAT-C, 2022-09-28T15:48:59, Max Wind: 53.6 m/s



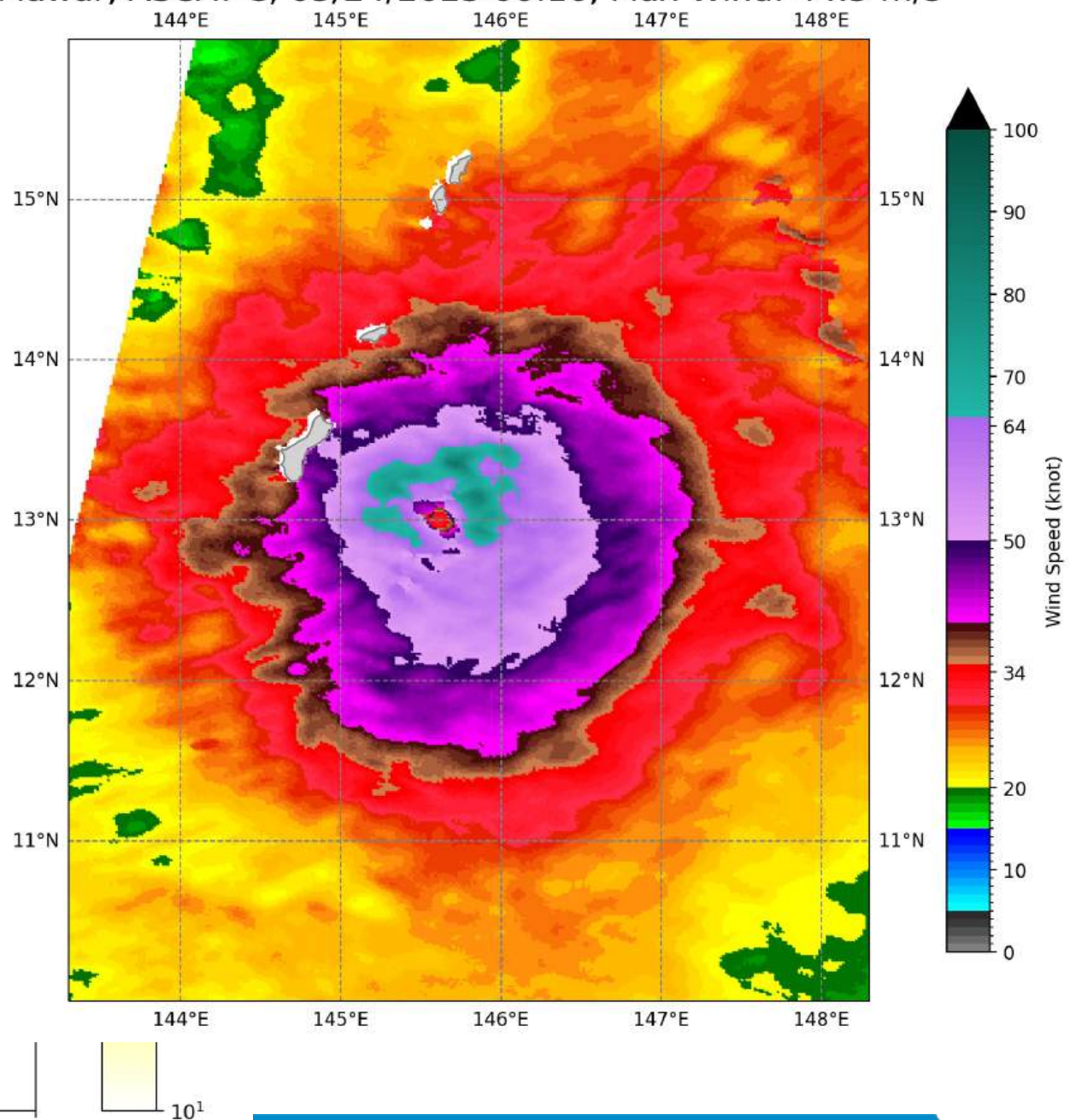
- UHR outer swath extended for 75 km wider than the standard product swath
- UHR wind reported every 1.5 km grid spacing
- UHR winds up to 1 km of the coast vs 5-30 km for the 12.5 km product
- UHR high wind retrievals rescaled utilizing SFMR measurements
- UHR wind direction ambiguity removal initialized by utilizing the 12.5 km directions
- **Reveals finer details in wind field but noisier than the original 12.5 km wind product**



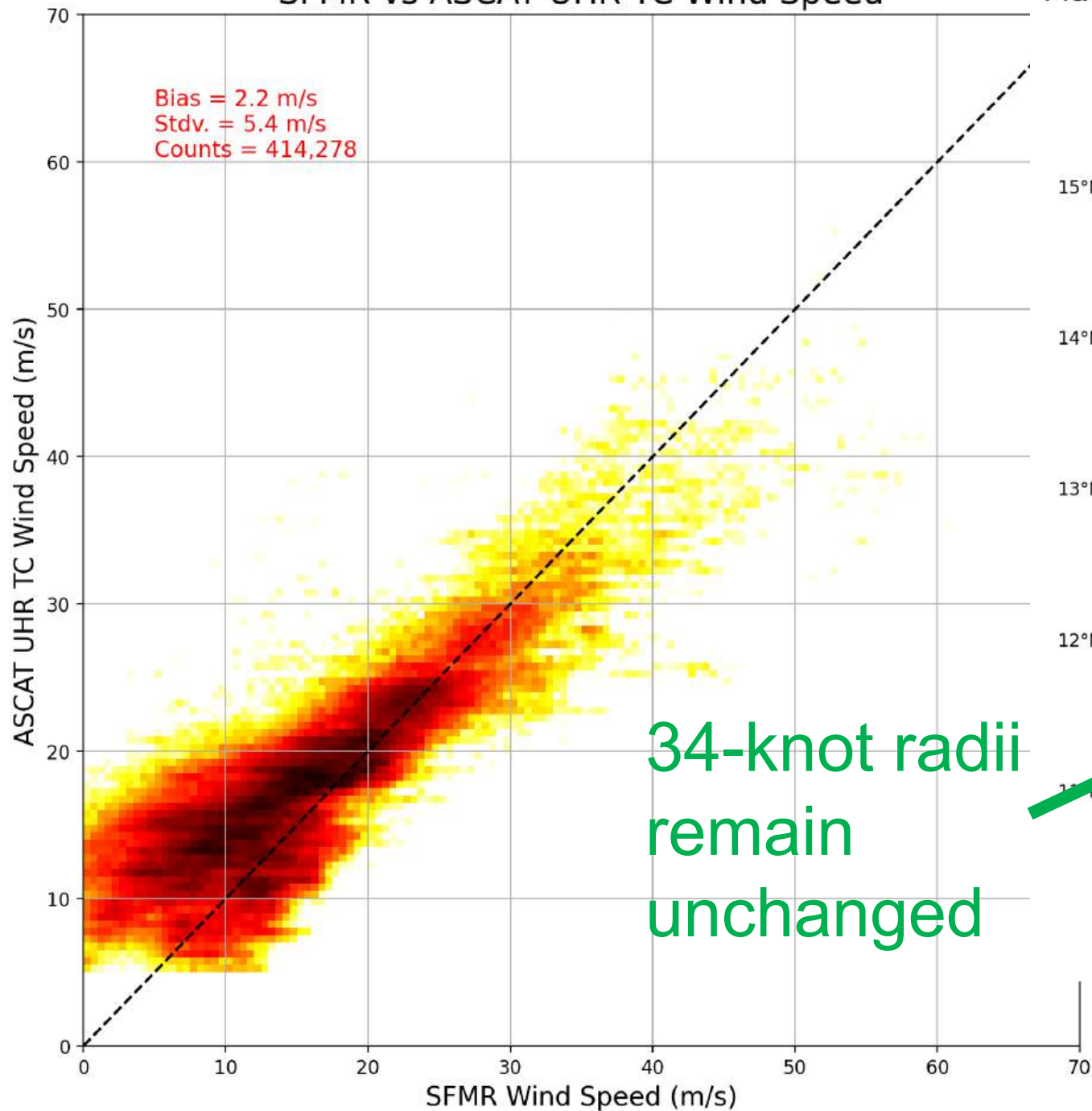
# SFMR vs ASCAT UHR Wind Speed



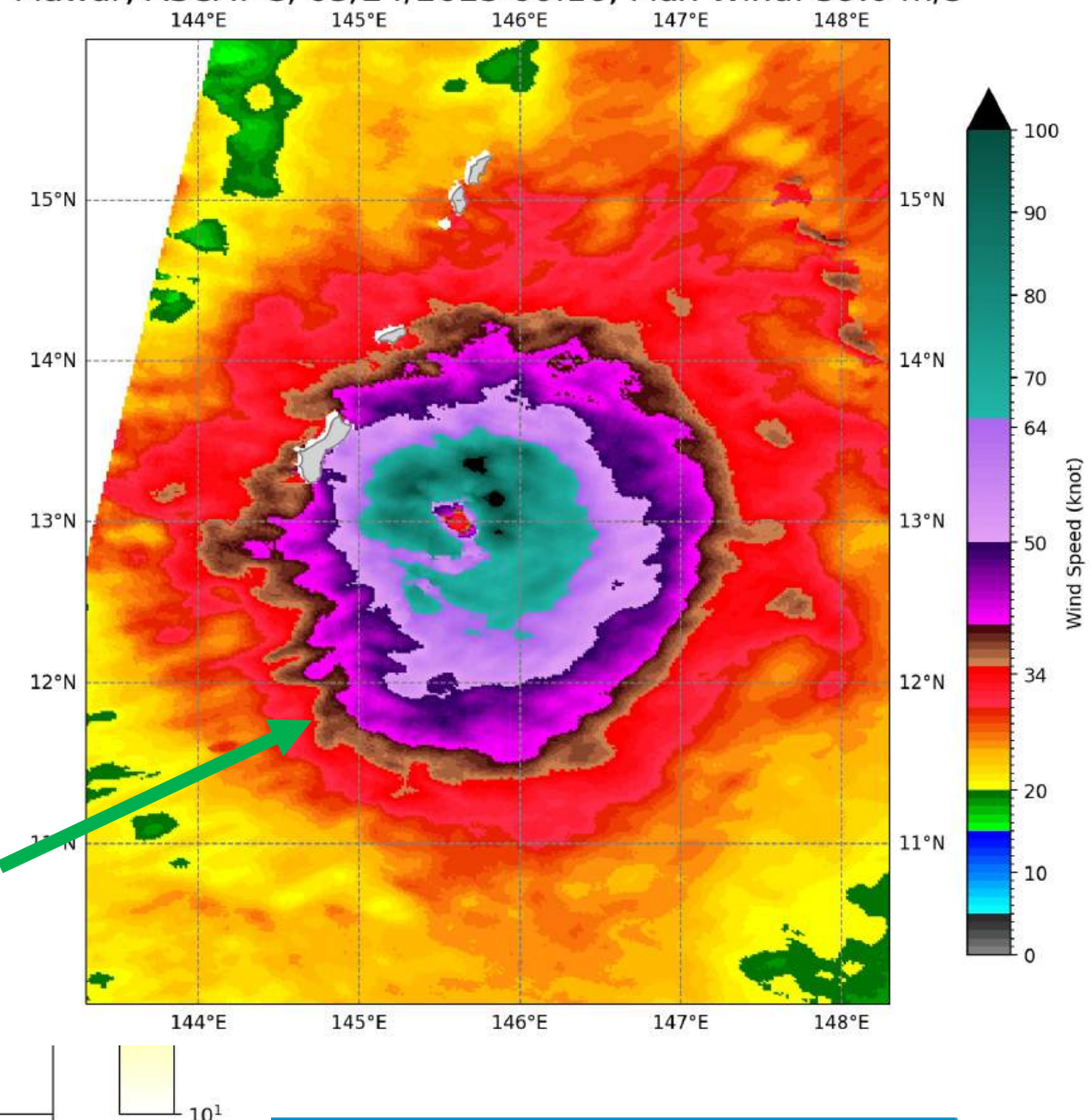
# Mawar, ASCAT-C, 05/24/2023 00:16, Max Wind: 44.5 m/s



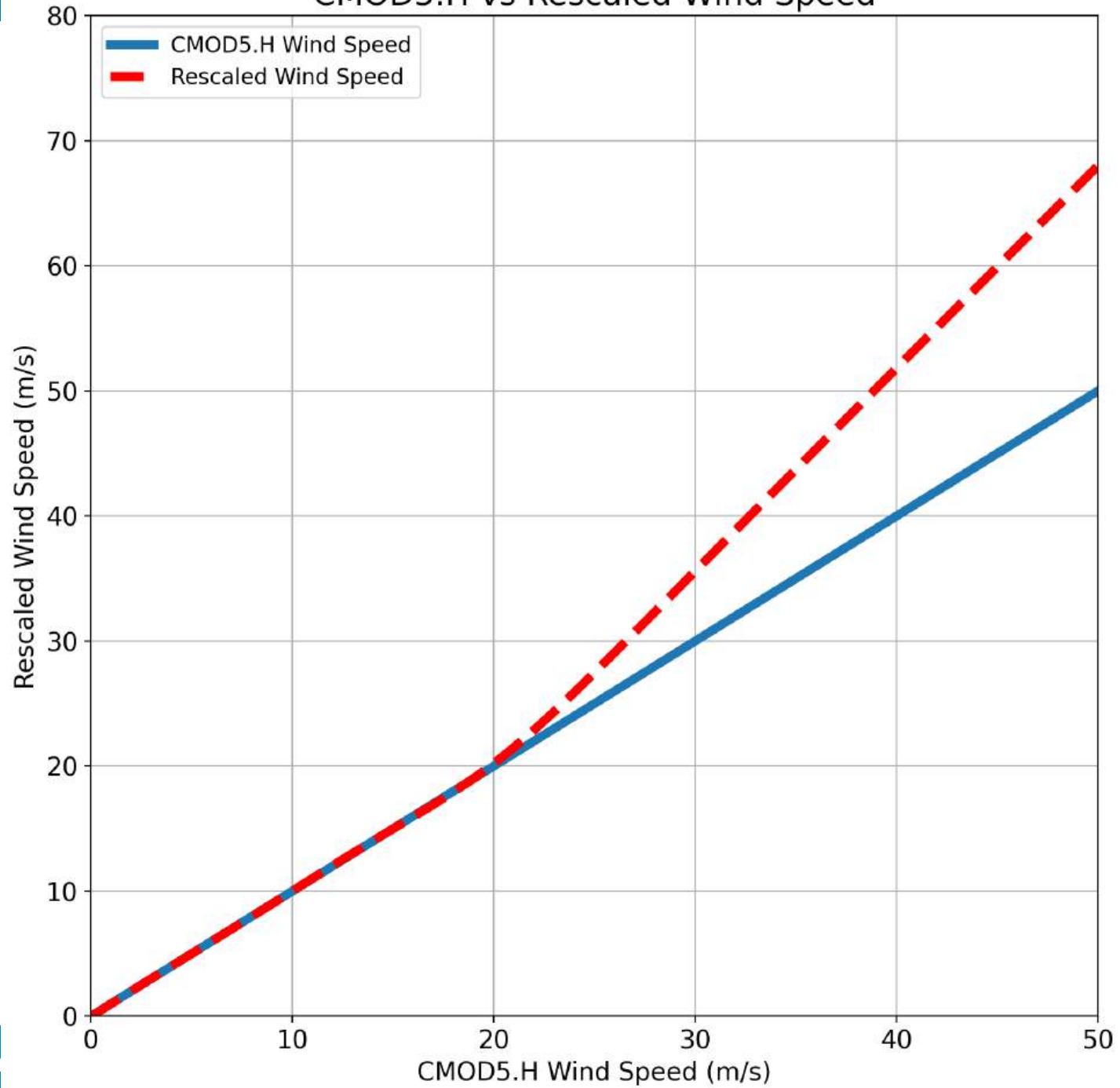
# SFMR vs ASCAT UHR TC Wind Speed



# Mawar, ASCAT-C, 05/24/2023 00:16, Max Wind: 59.0 m/s



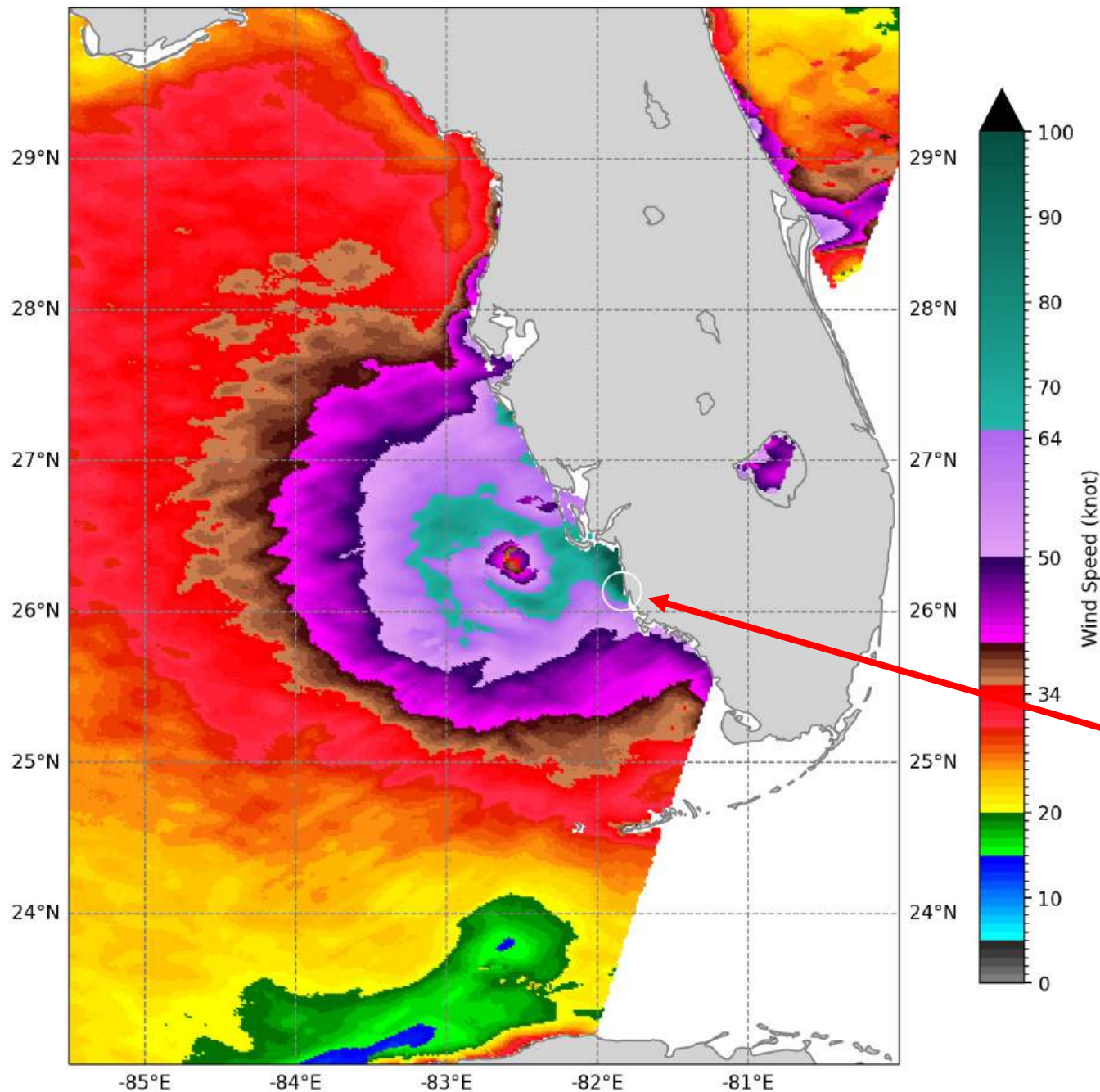
# CMOD5.H vs Rescaled Wind Speed



-85°E -84°E -83°E -82°E -81°E



# UHR Processing Without Coastal Correction

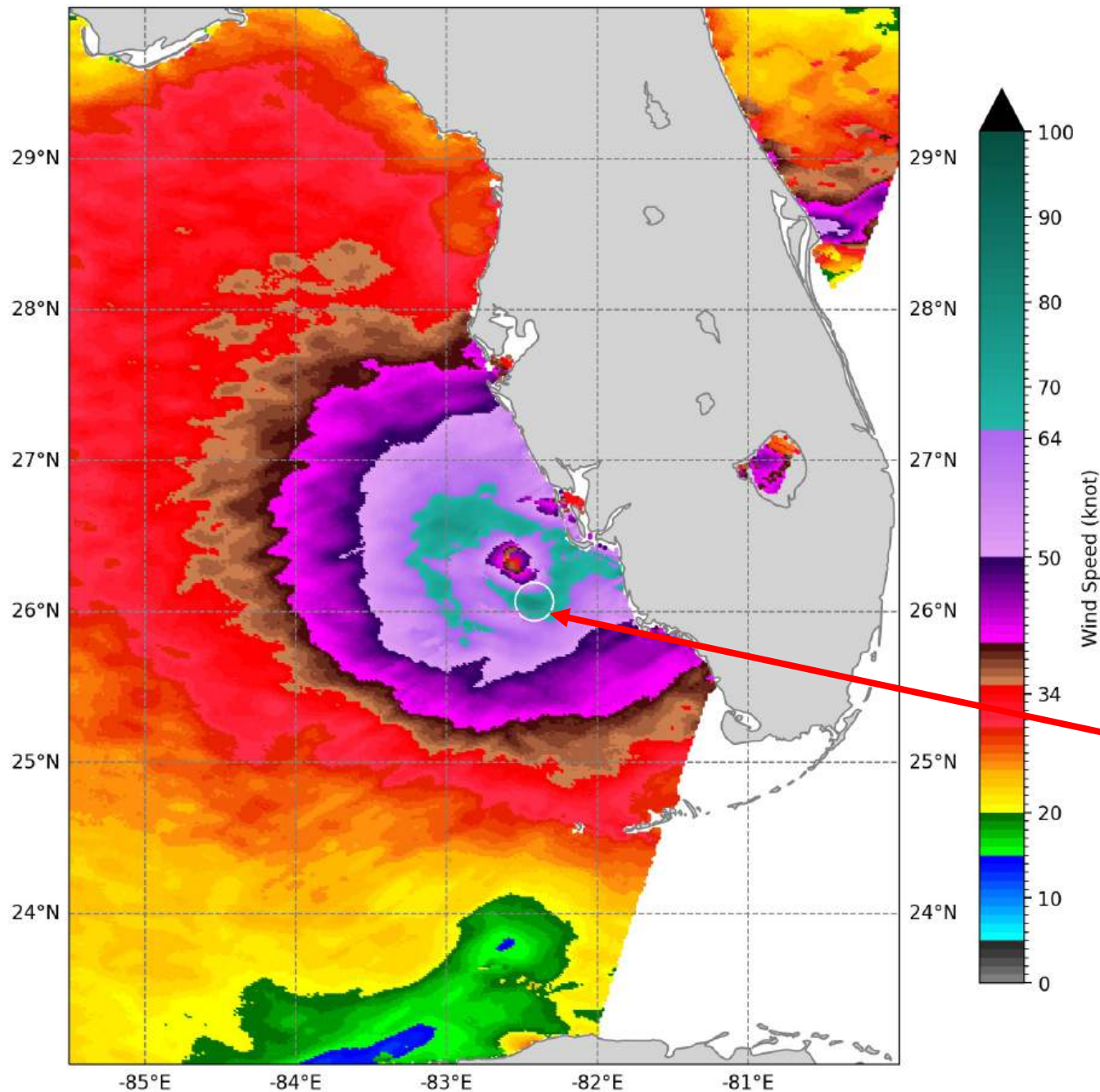


Maximum Wind  
50 m/s

-85°E -84°E -83°E -82°E -81°E

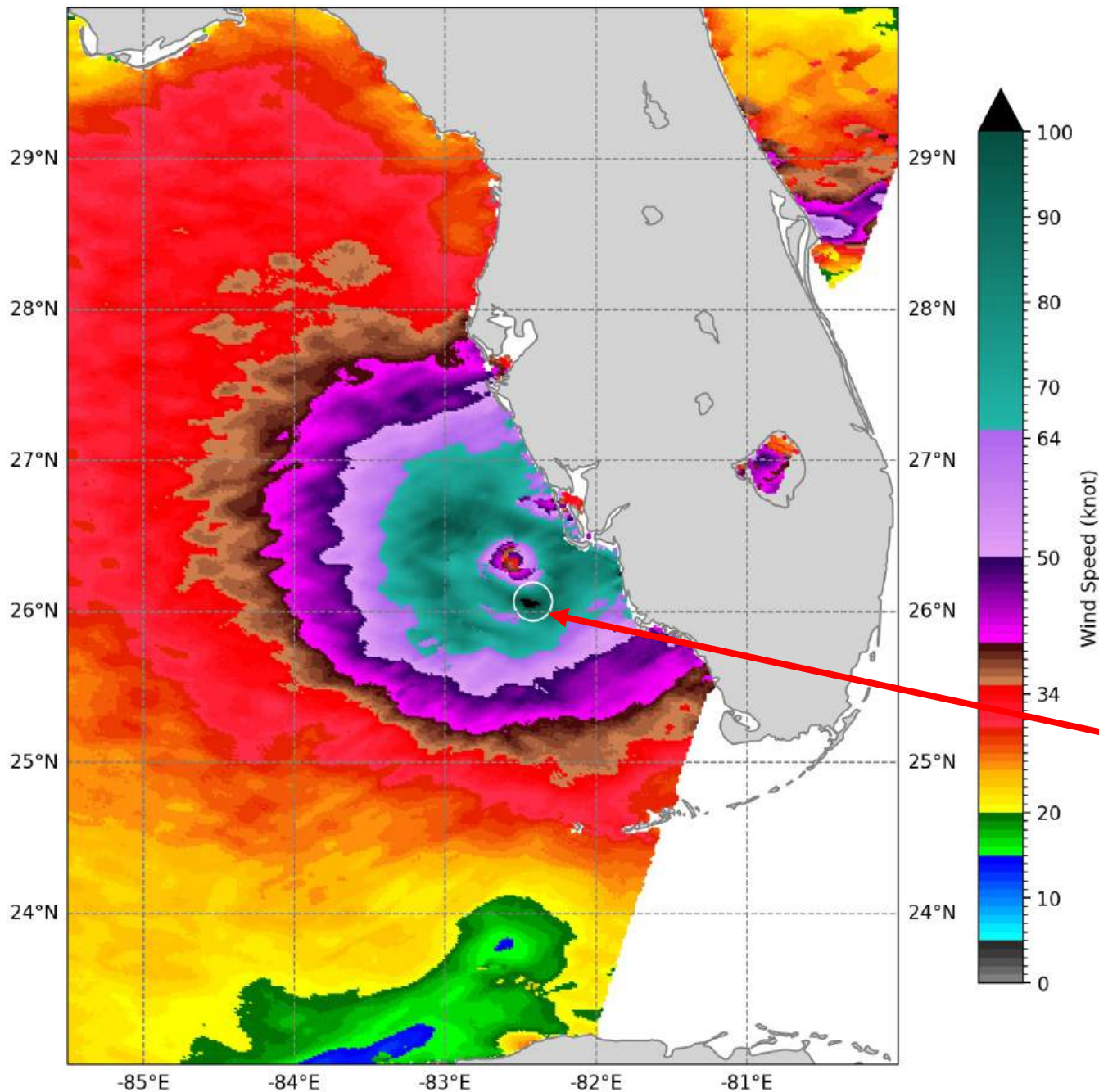


# UHR Processing With Coastal Correction



Maximum Wind  
41.1 m/s

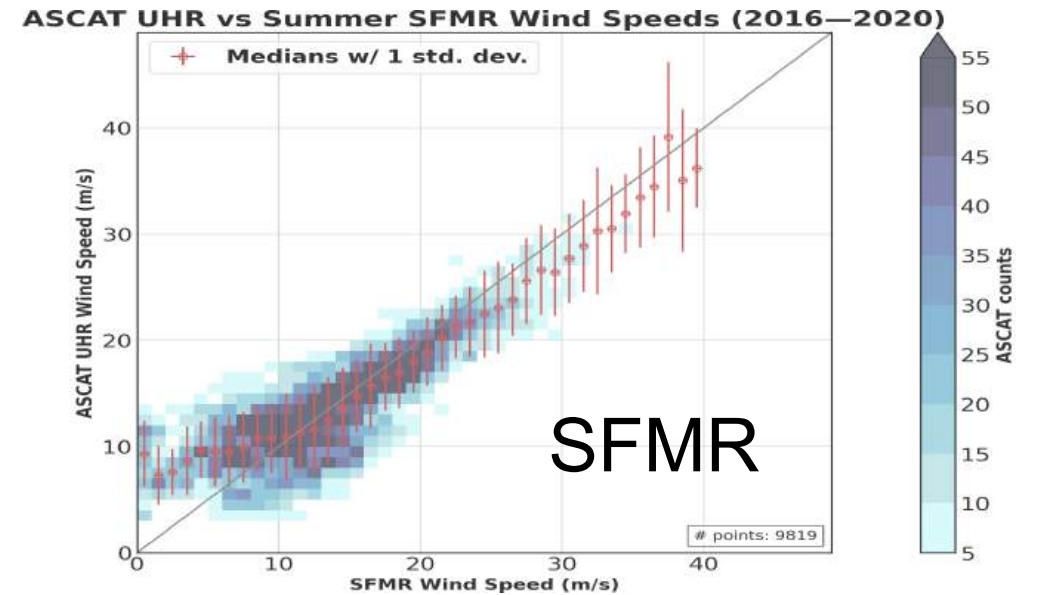
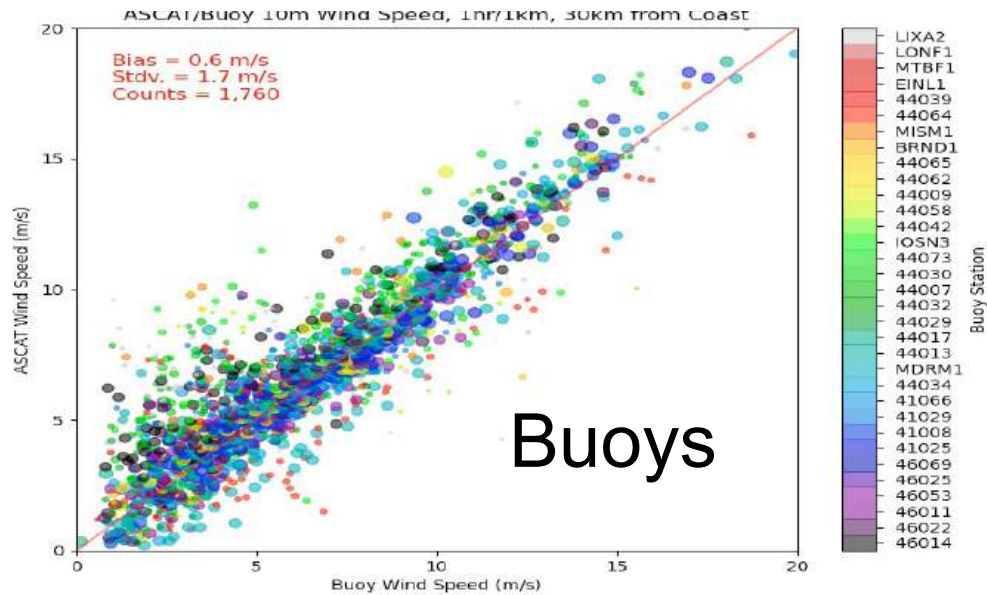
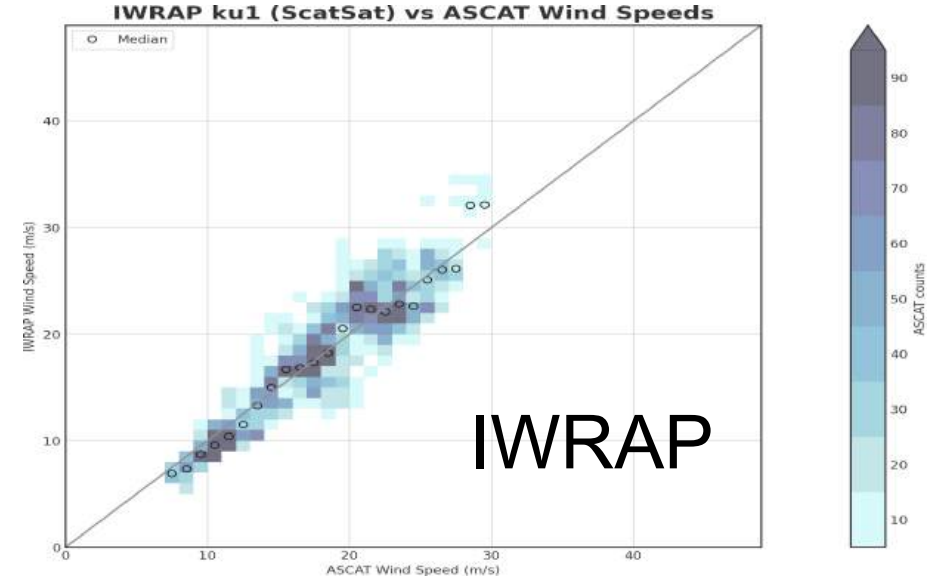
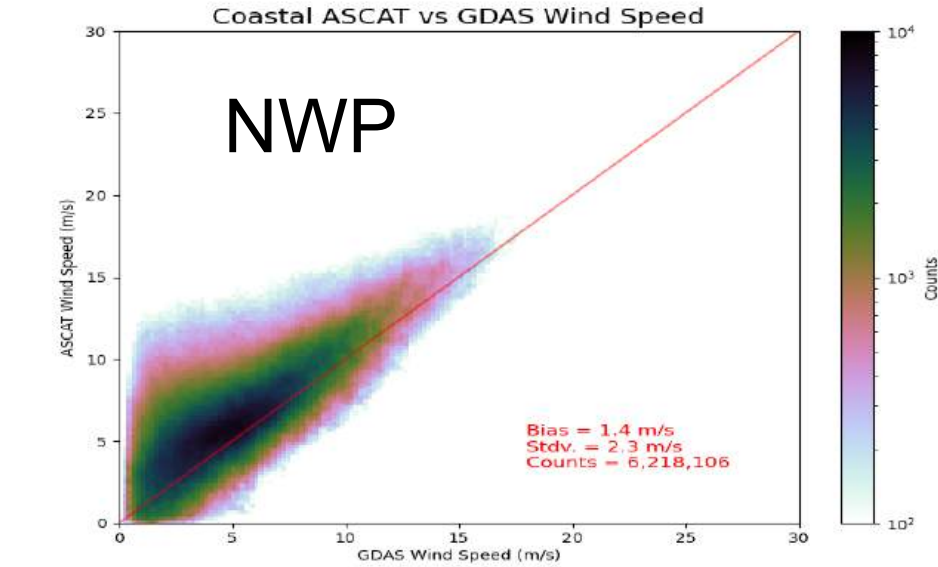
-85°E -84°E -83°E -82°E -81°E



# UHR Processing With Coastal Correction and High Wind GMF

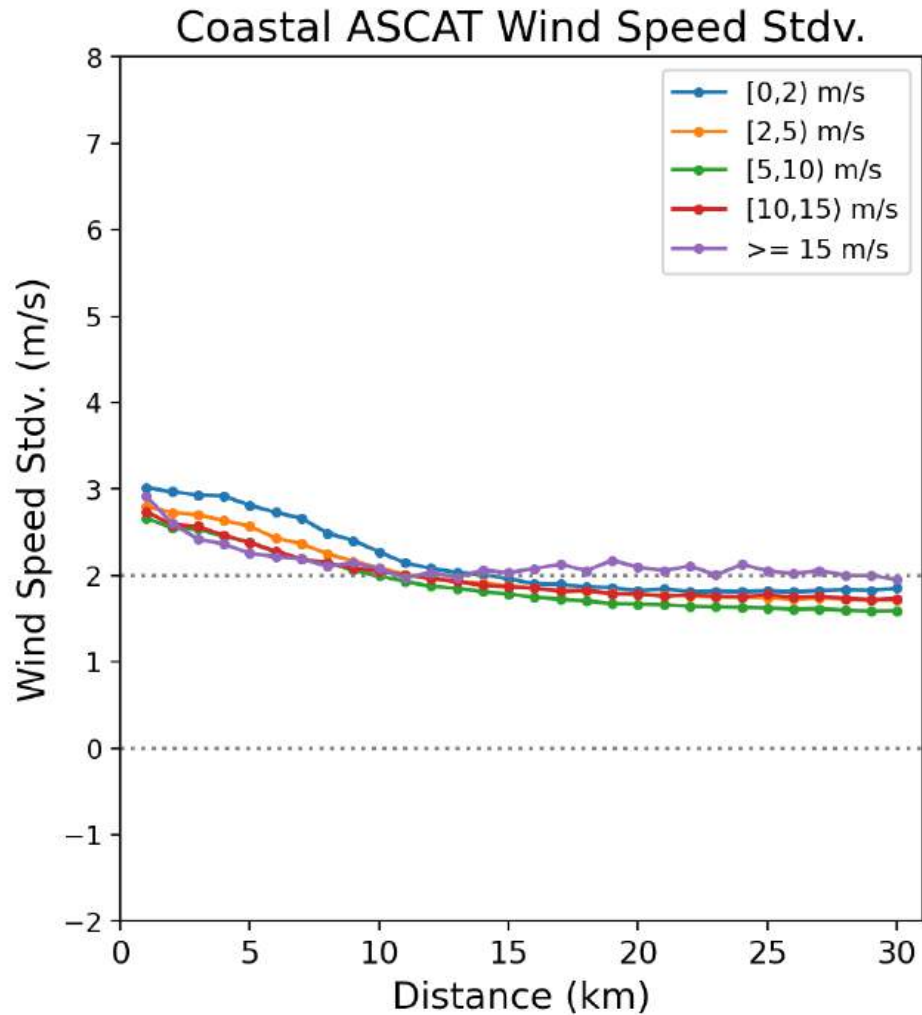
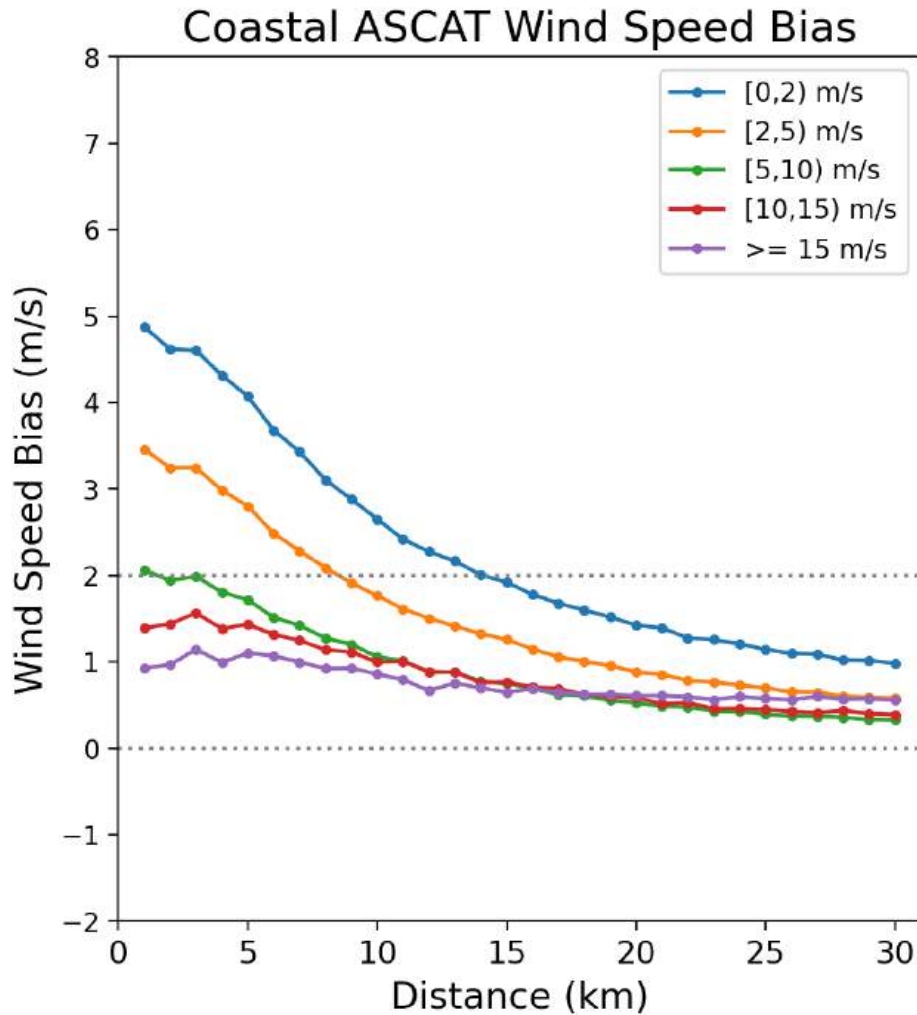
Maximum Wind  
53.6 m/s

# Validation: Model, Buoys, IWRAP, SFMR



S. Soisuvarn, Z. Jelenak, P. S. Chang, Q. Zhu and C. G. Shoup, "[High-Resolution Coastal Winds From the NOAA Near Real-Time ASCAT Processor](#)," in *IEEE Transactions on Geoscience and Remote Sensing*, vol. 61, pp. 1-12, 2023, Art no. 5208612, doi: 10.1109/TGRS.2023.3279764

# Coastal Winds Performance





# Center Fixes

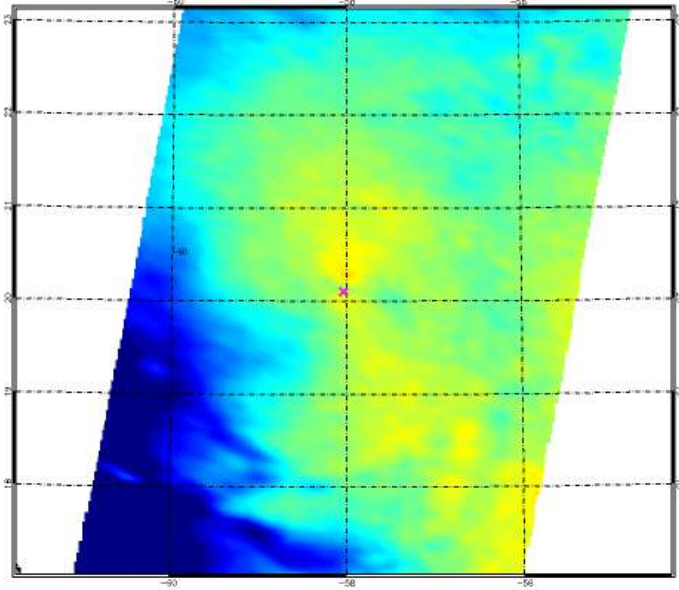




# Example: Hurricane Lee 09/09/2023 – cont.

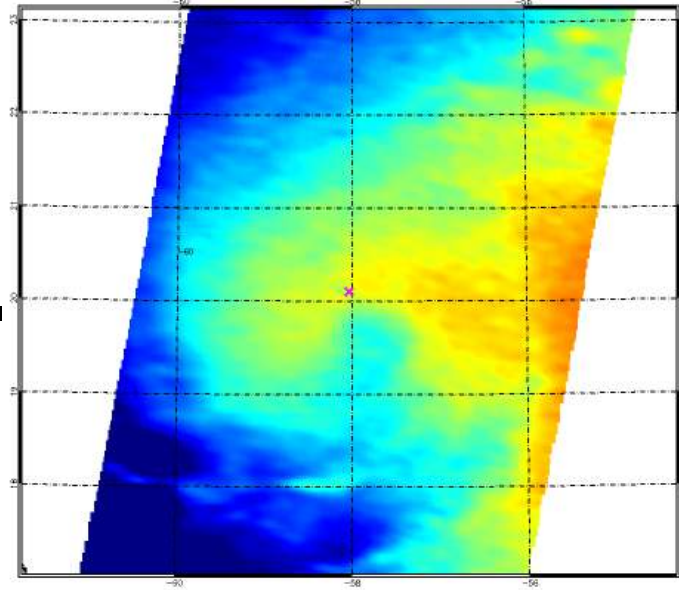
Forward Look  
Sigma0

dB  
-25.0 -22.8 -20.5 -18.2 -16.0 -13.8 -11.5 -9.2 -7.0 -4.8 -2.5  
Hurr. LEE, Fwd Sig0, Time Stamp: 9/9/2023 13:9 UTC

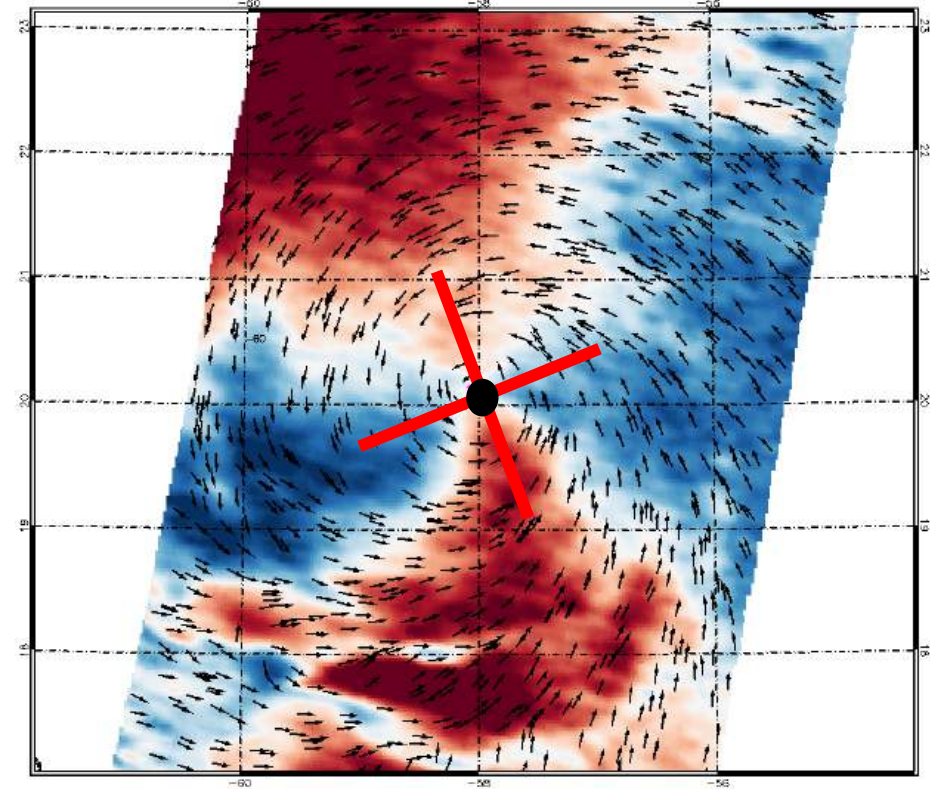


Aft Look  
Sigma0

dB  
-25.0 -22.8 -20.5 -18.2 -16.0 -13.8 -11.5 -9.2 -7.0 -4.8 -2.5  
Hurr. LEE, Aft Sig0, Time Stamp: 9/9/2023 13:9 UTC



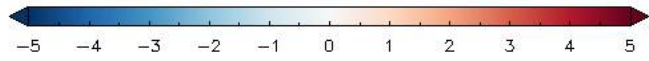
dB  
-5 -4 -3 -2 -1 0 1 2 3 4 5  
Hurr. LEE, (Fwd/Aft) Sig0 ratio, Time Stamp: 9/9/2023 13:9 UTC



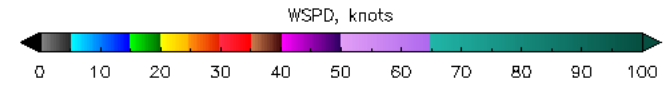
**The intersection of the two red lines is the storm center**



# Ophelia

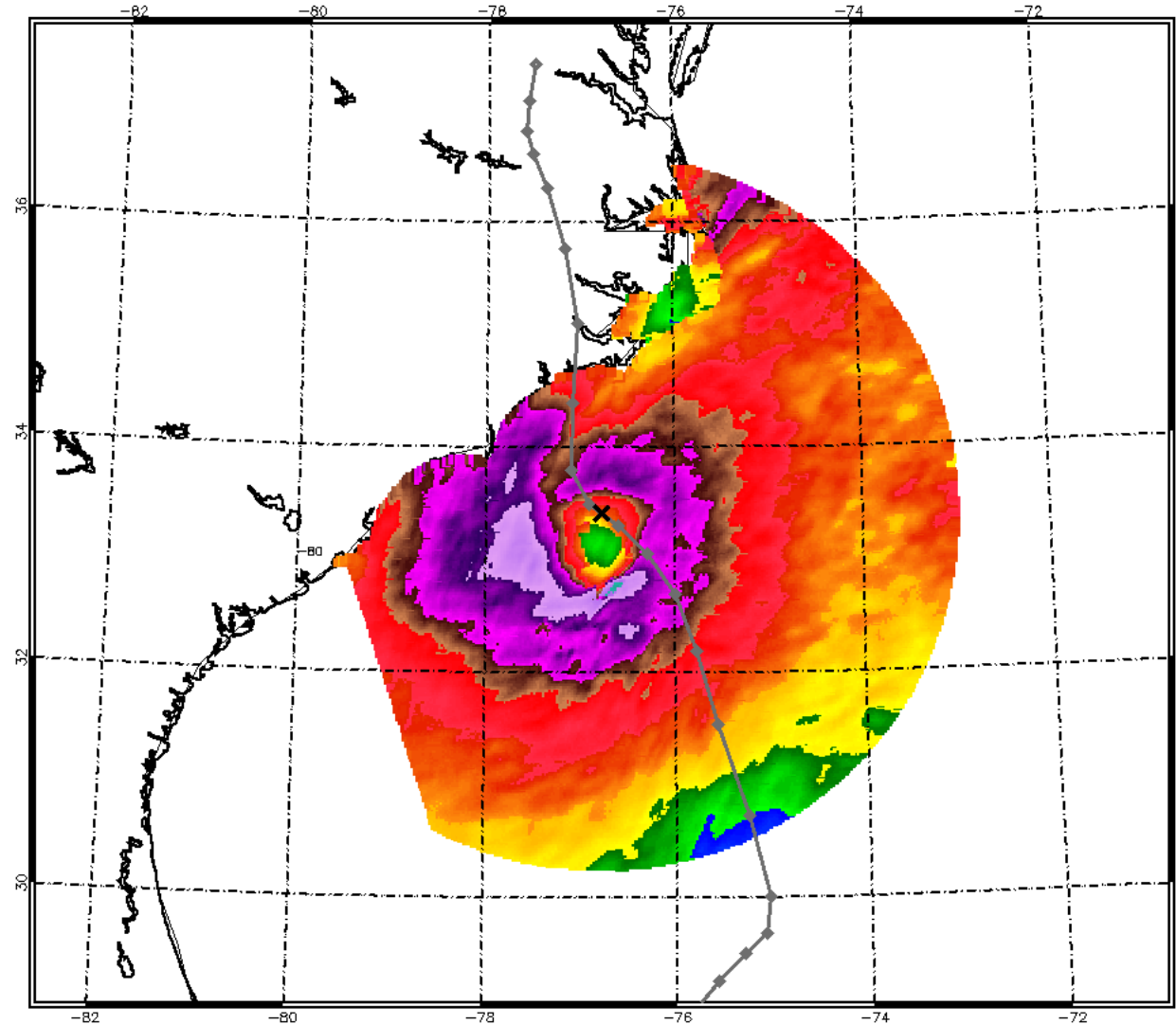
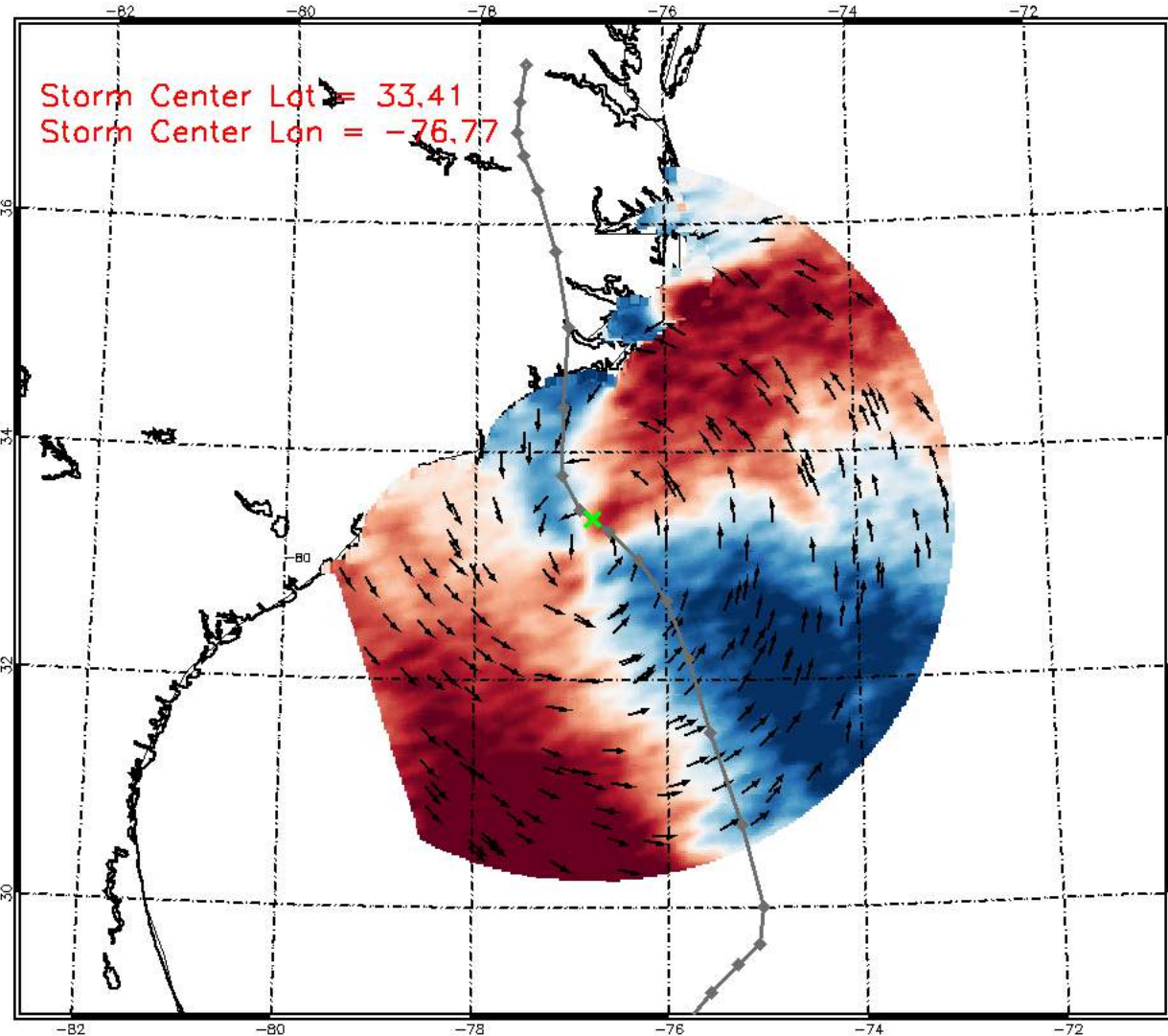


$10 \times \log_{10}(\text{sig0\_fwd}/\text{sig0\_aft})$ , Time Stamp: 9/23/2023 1:43 UTC



OPHELIA\_20230923\_57145\_B\_A, Time Stamp: 9/23/2023 1:43 UTC

Storm Center Lgt = 33.41  
Storm Center Lon = -76.77

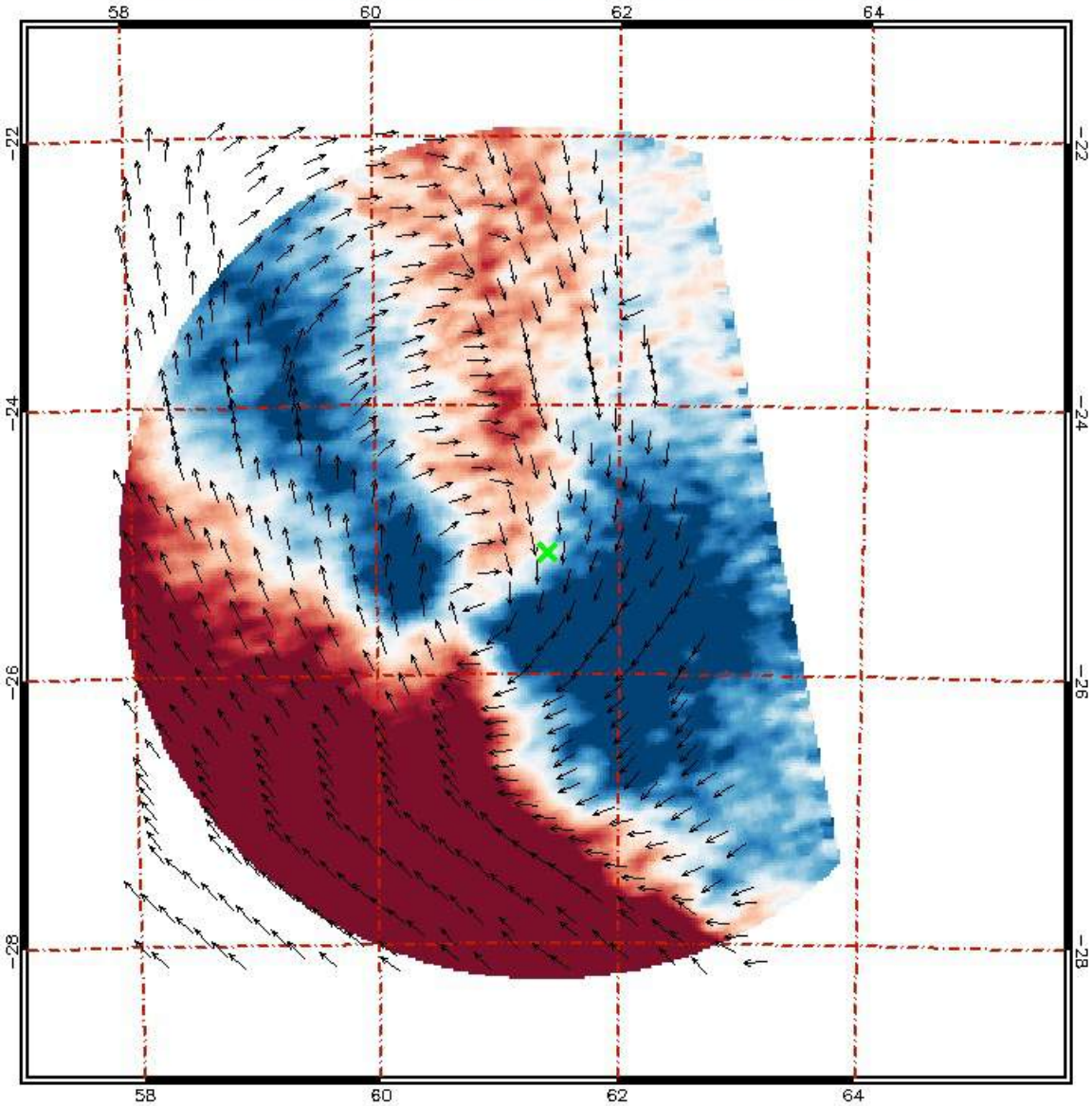


# Belal

Delta Sig0 (FWD - AFT) Time Stamp: 1/20/2024 17:17 UTC

x is obtained from ATCF;  
the time it was reported: 01/20/2024 12:00

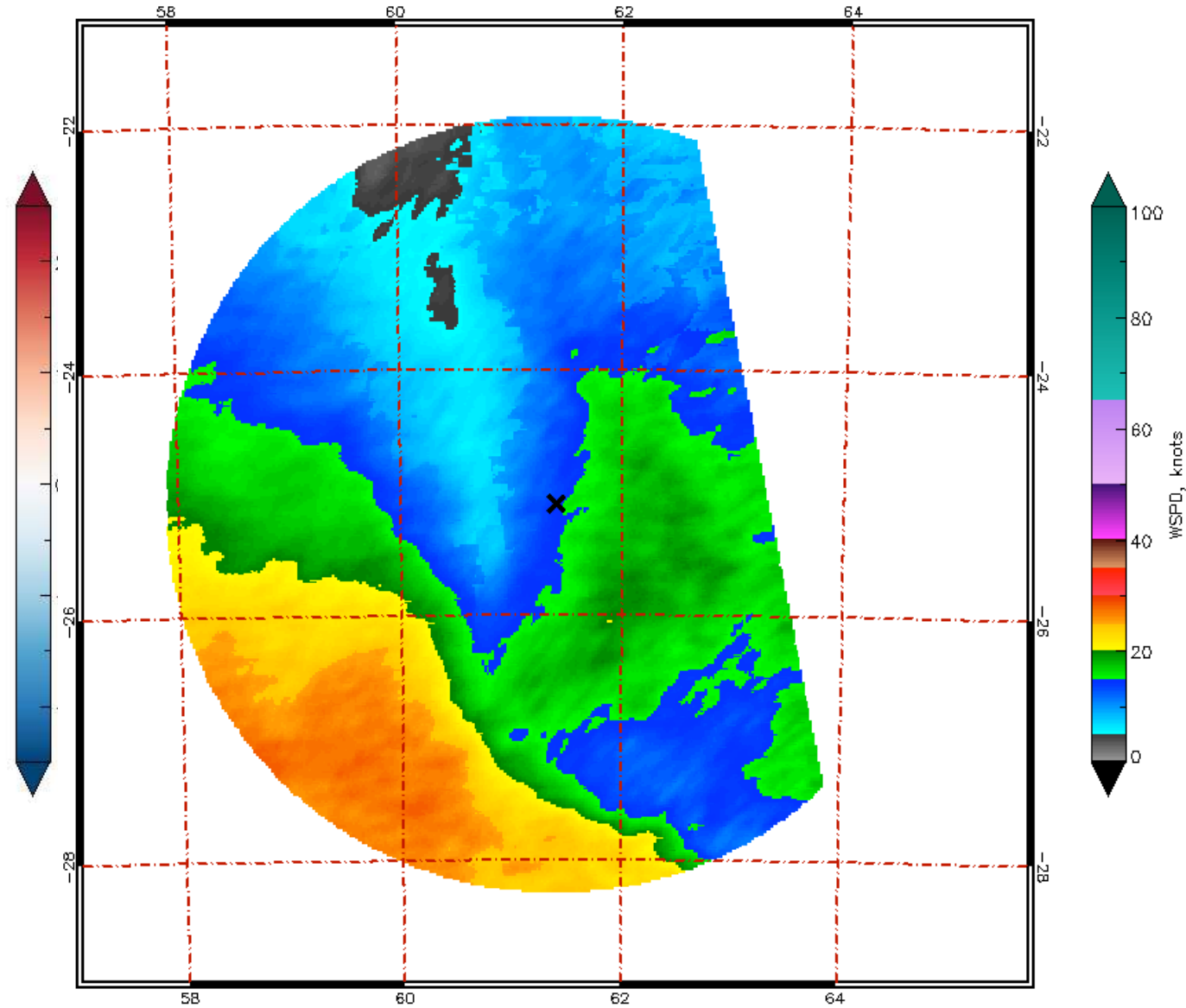
Storm Center Lat=-25.10  
Storm Center Lon=61.40

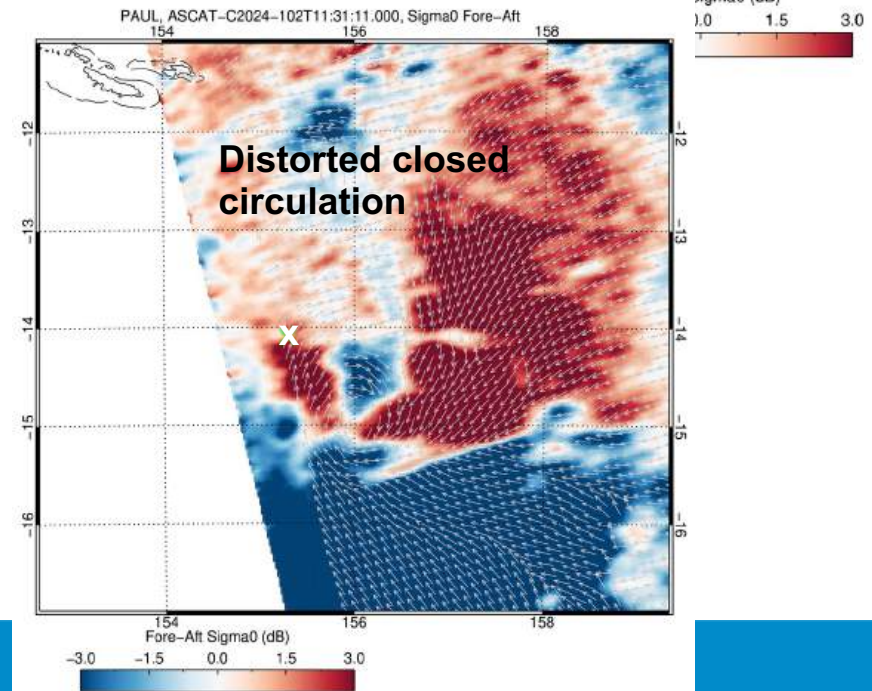
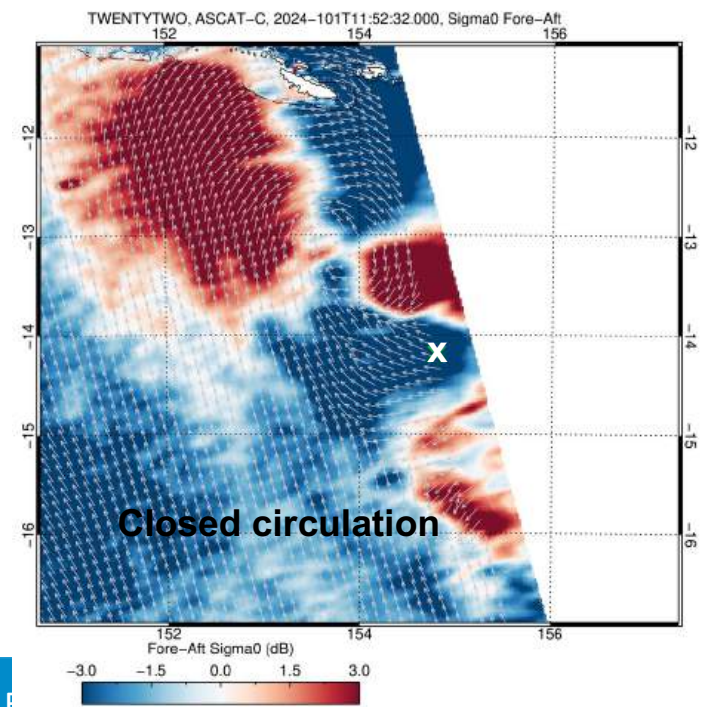
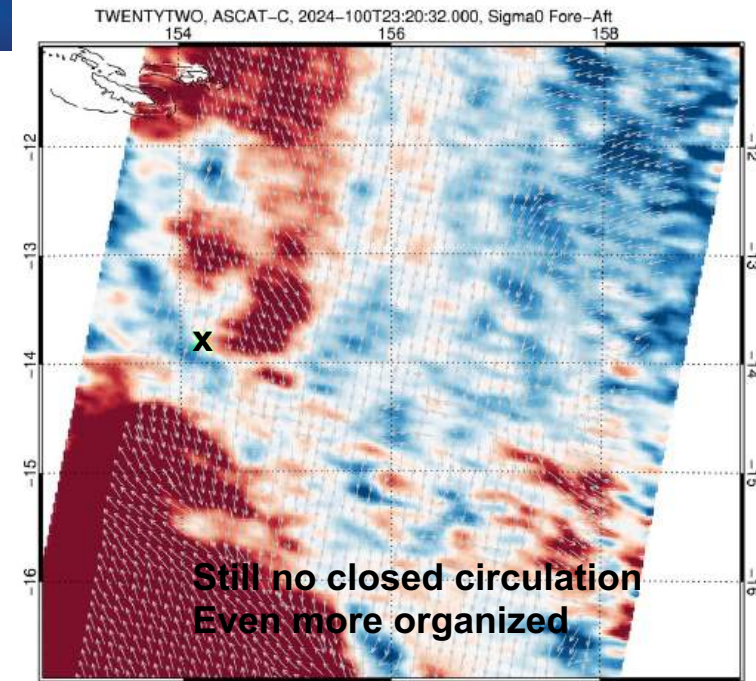
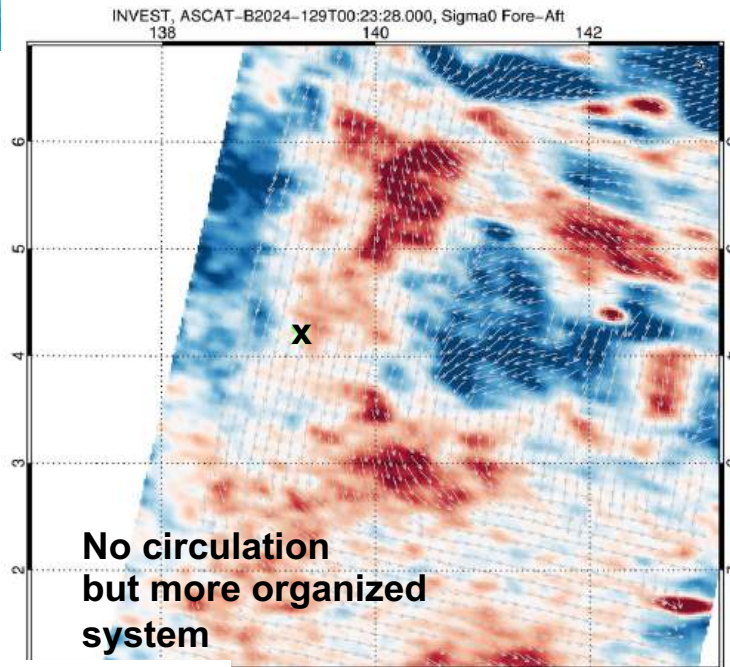
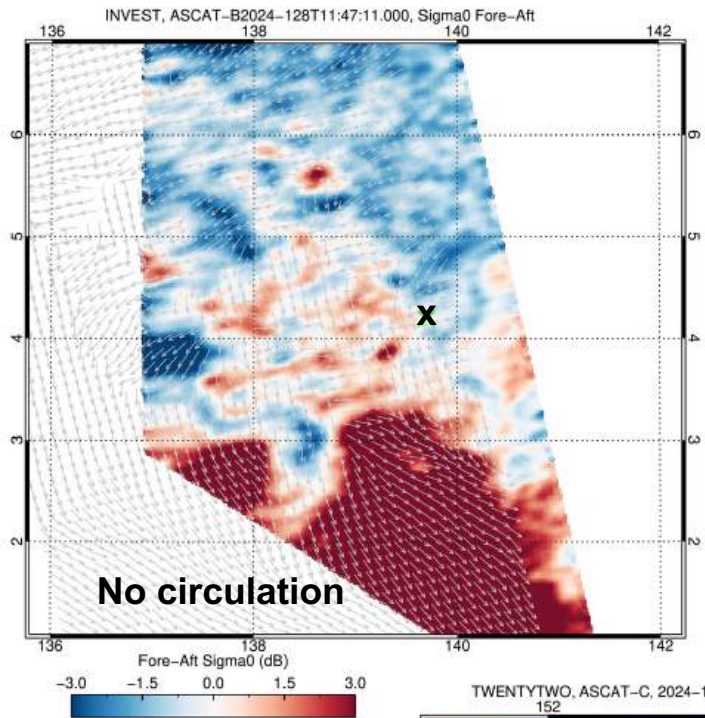


ASCAT UHR, Time Stamp: 1/20/2024 17:17 UTC, Max WSPD: 28.14 knots

x is obtained from ATCF;  
the time it was reported: 01/20/2024 12:00

Storm Center Lat=-25.10  
Storm Center Lon=61.40

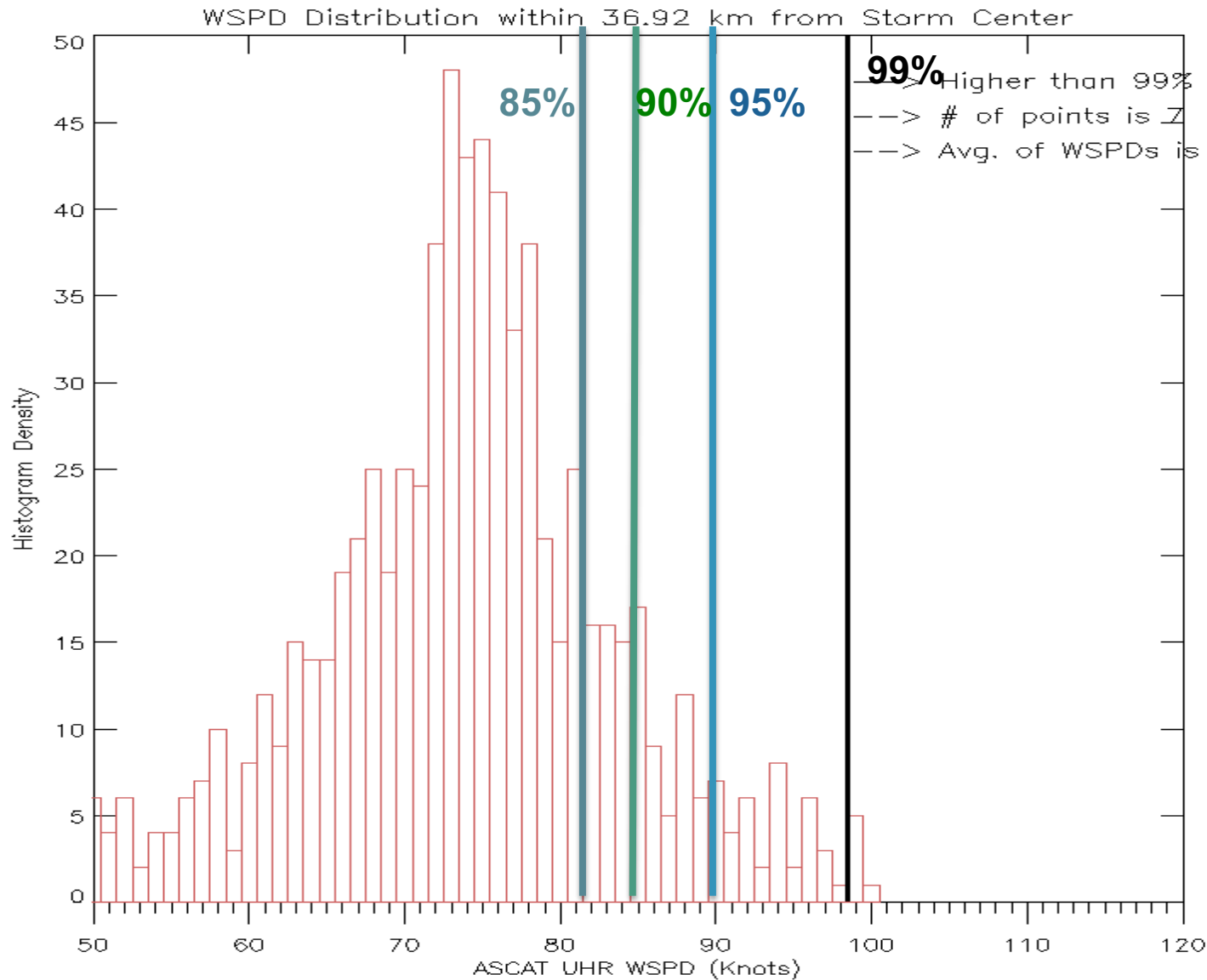






# Max Wind Determination



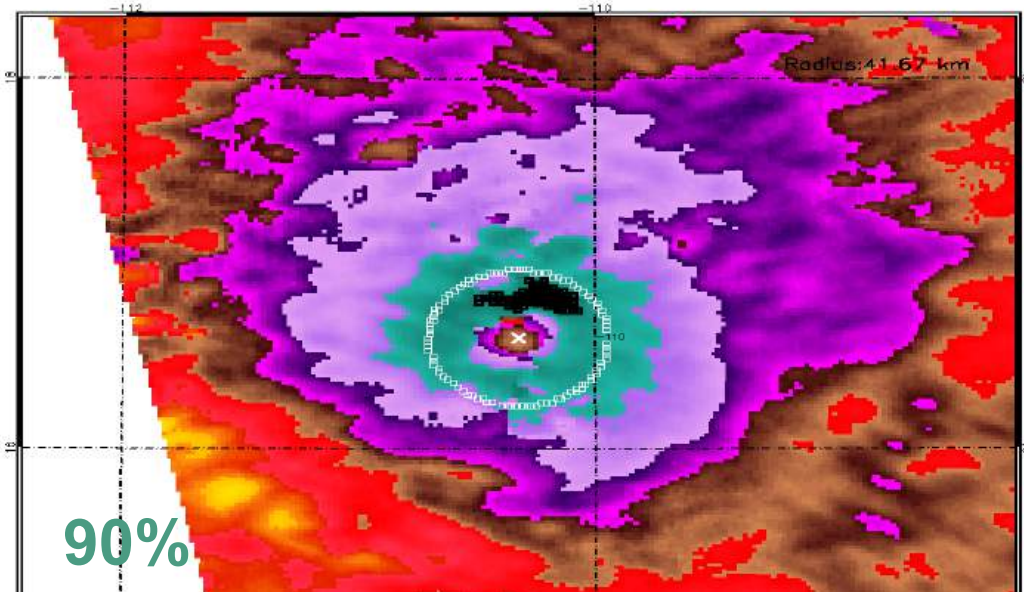
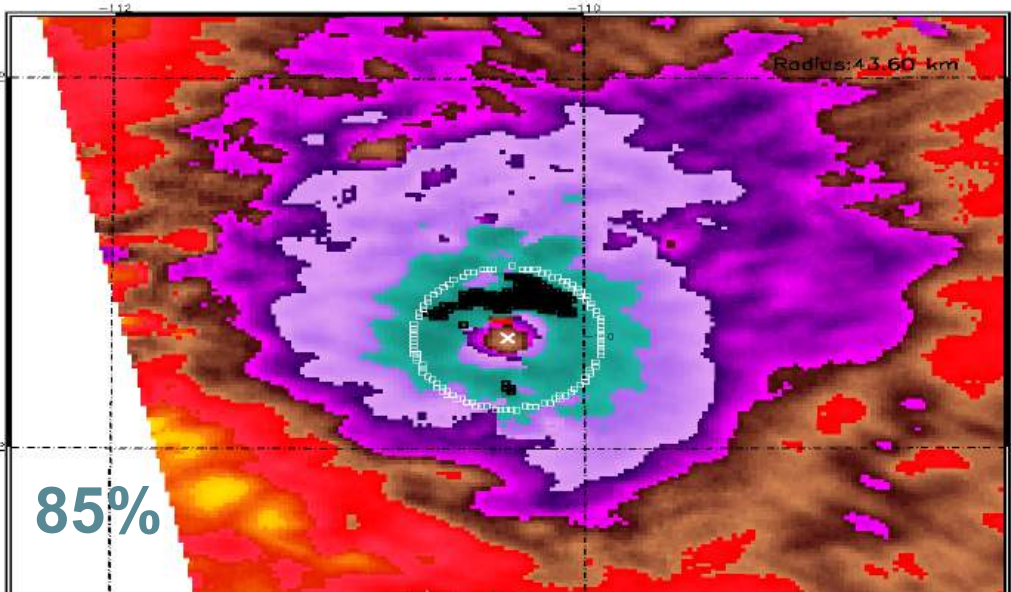


- Determine radius on max winds in all 4 quadrants
- Determine wind speed distribution within the largest radius
- Determine winds within 85, 90, 95 and 99 percentile of the distribution
- Check for consistencies
- Check location within swath

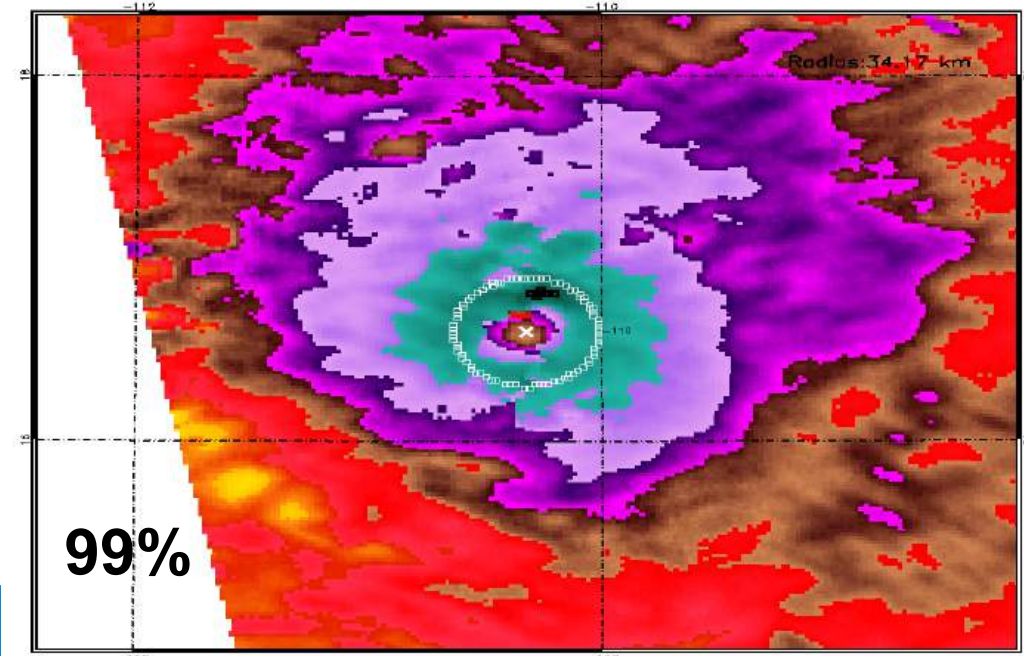
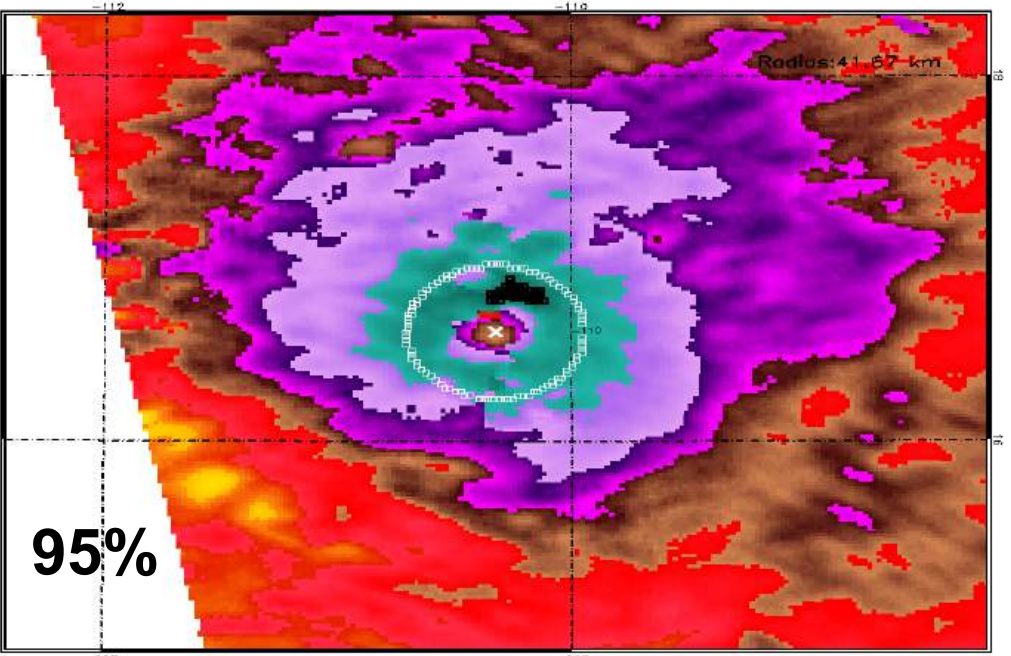
WSPD, knots  
0 10 20 30 40 50 60 70 80 90 100  
Max Wind Speed = 85.67 knots (44.07 m/s)



WSPD, knots  
0 10 20 30 40 50 60 70 80 90 100  
Max Wind Speed = 89.90 knots (46.25 m/s)



Black pixels represent WVCs from which the mean max wind was calculated



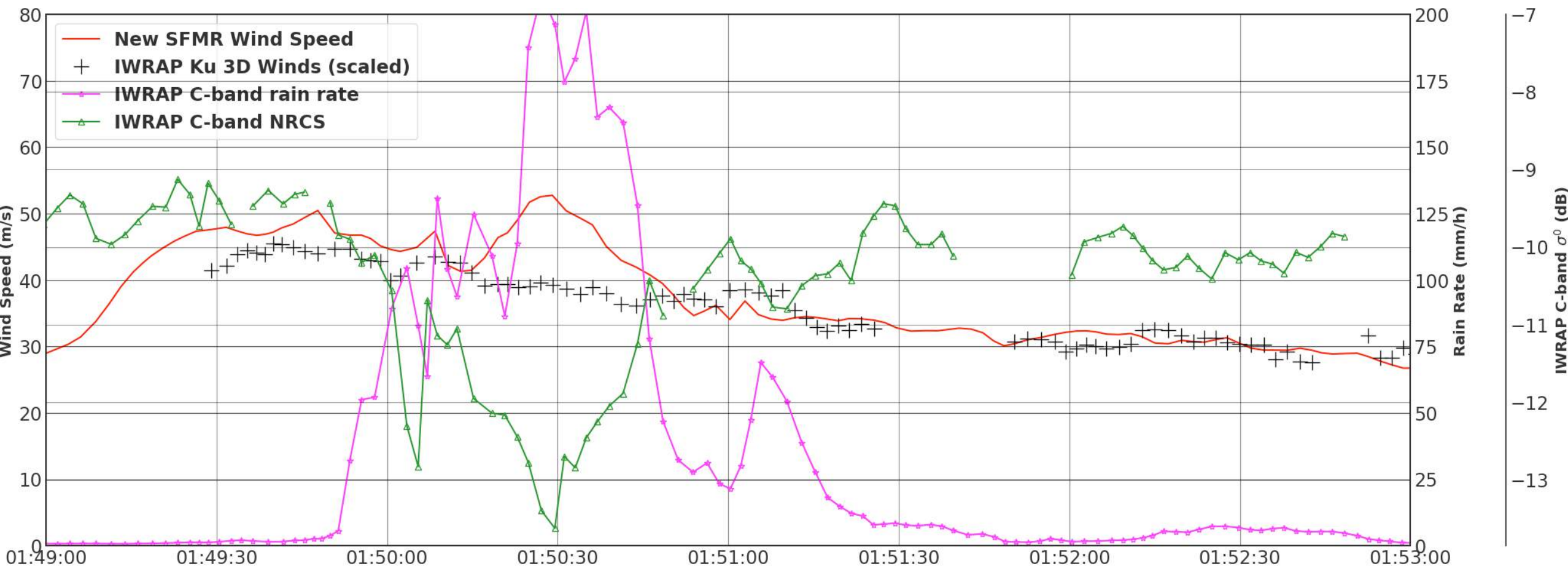
# Maximum Wind

- Maximum wind was calculated as mean of the 85, 90, 95 and 99 percentile of winds within maximum of RMW within four quadrants
  - Using 95% or higher yields cat 3 winds
  - Using lower % results in cat 2 winds
  - Use in combination with other data to determine max

	85% [kts]	90% [kts]	95% [kts]	99% [kts] # number of WVC
ASCAT-B 4:05Z	88.2	90	95	98.89 #7
ASCAT-C 4:58Z	86	90	94	99.25 #7
ASCAT-B 16:36Z	81	83	85.6	88.25 #12
ASCAT-C 17:28Z	86	90	94.4	98.75 #15

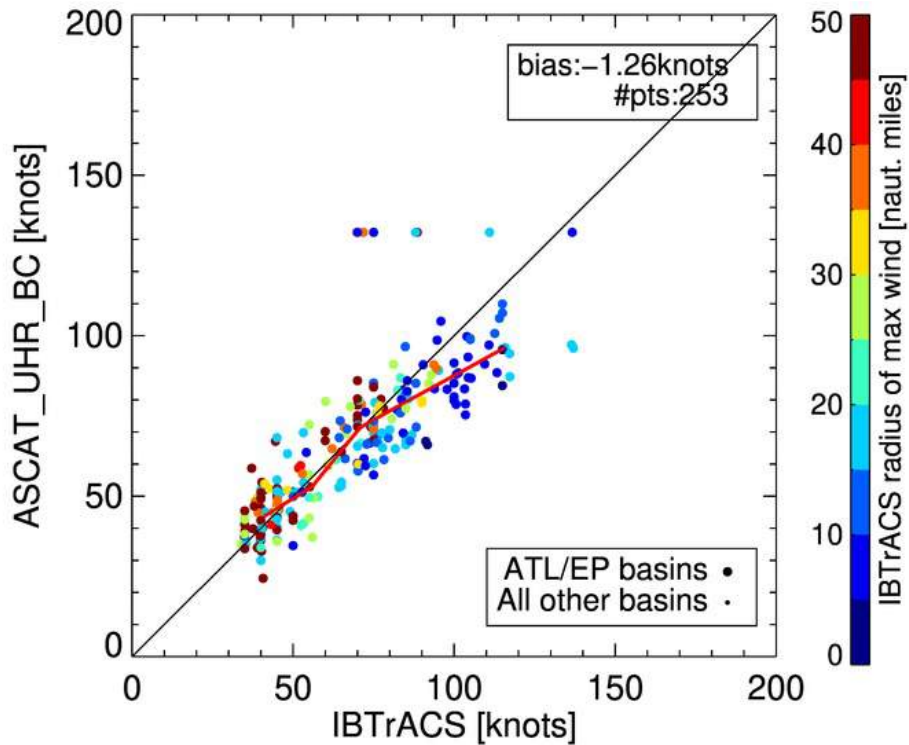


# Important to Remember: C-band is Attenuated in Rain

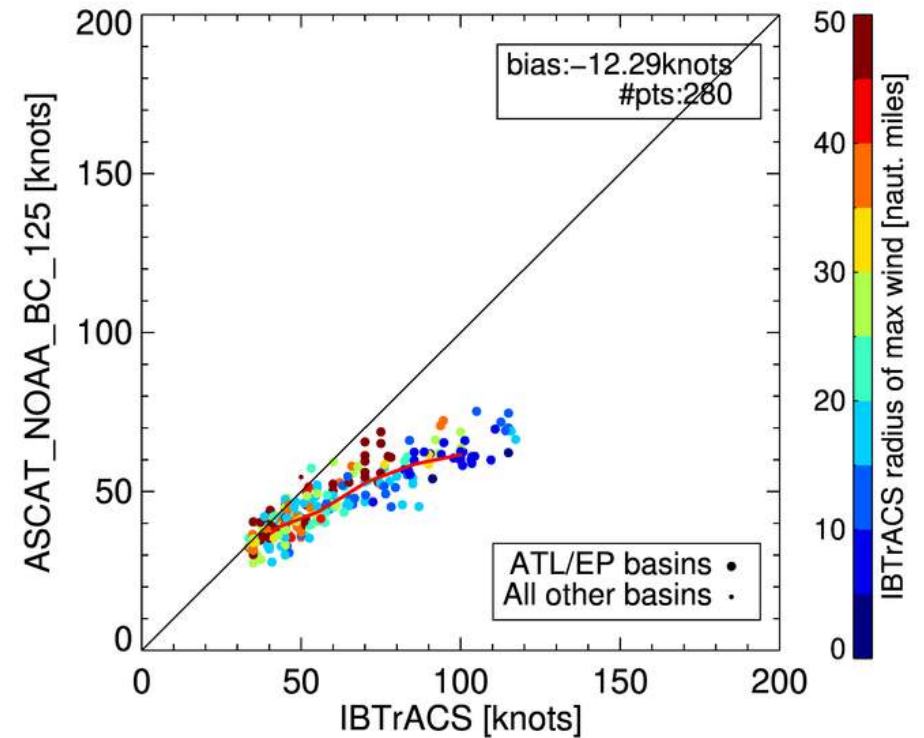


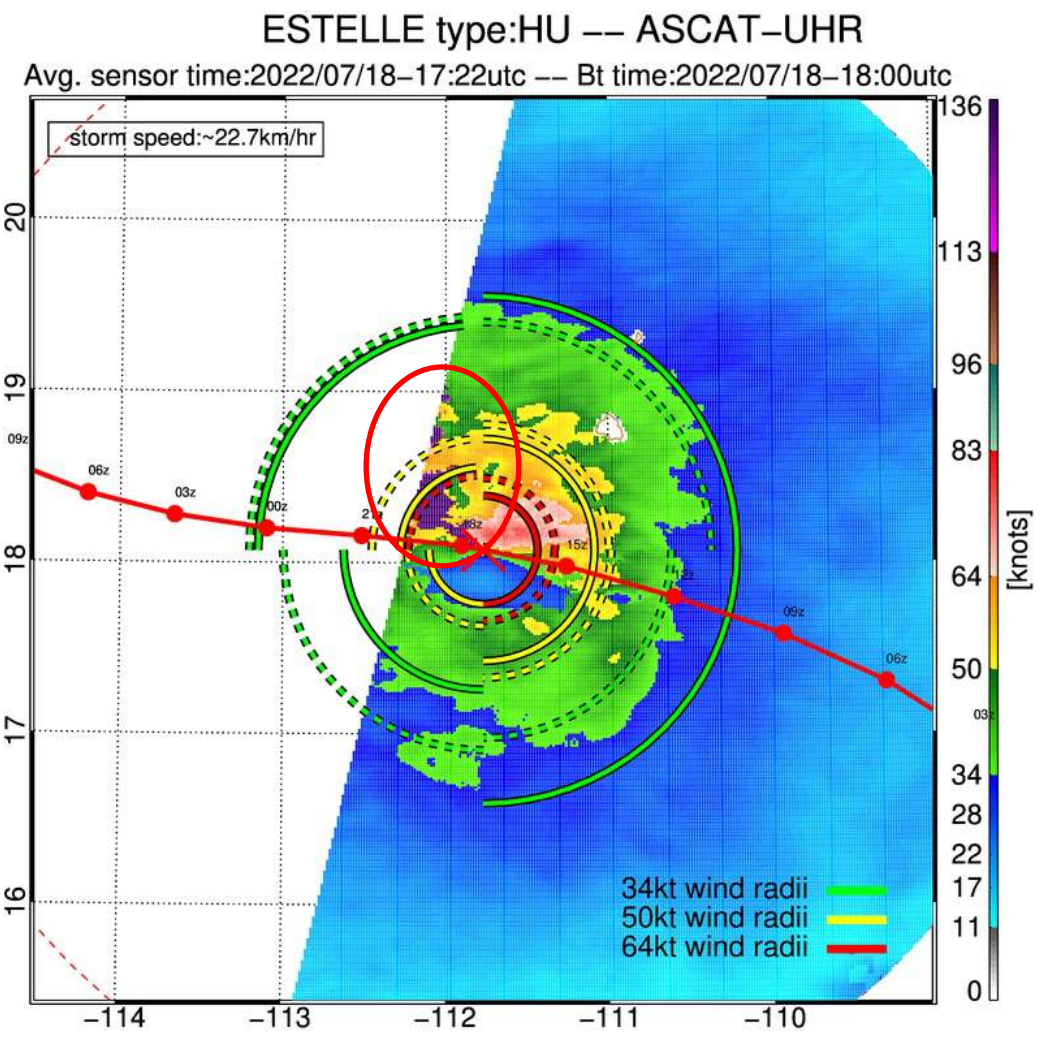
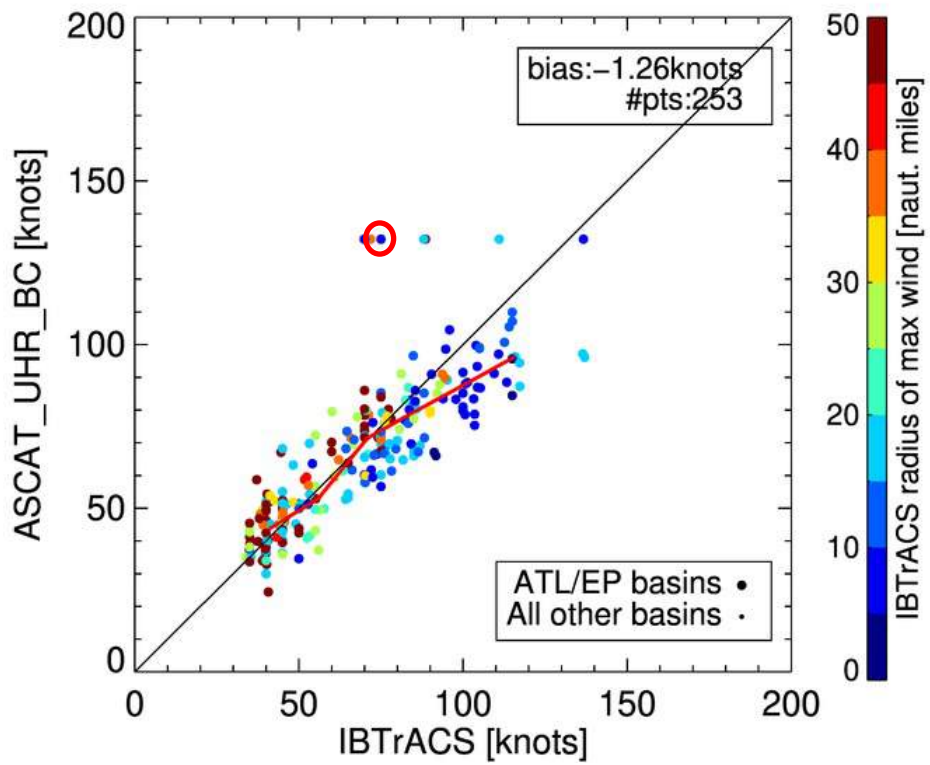
# Max Wind Determination (95%) vs Best Track

ASCAT UHR



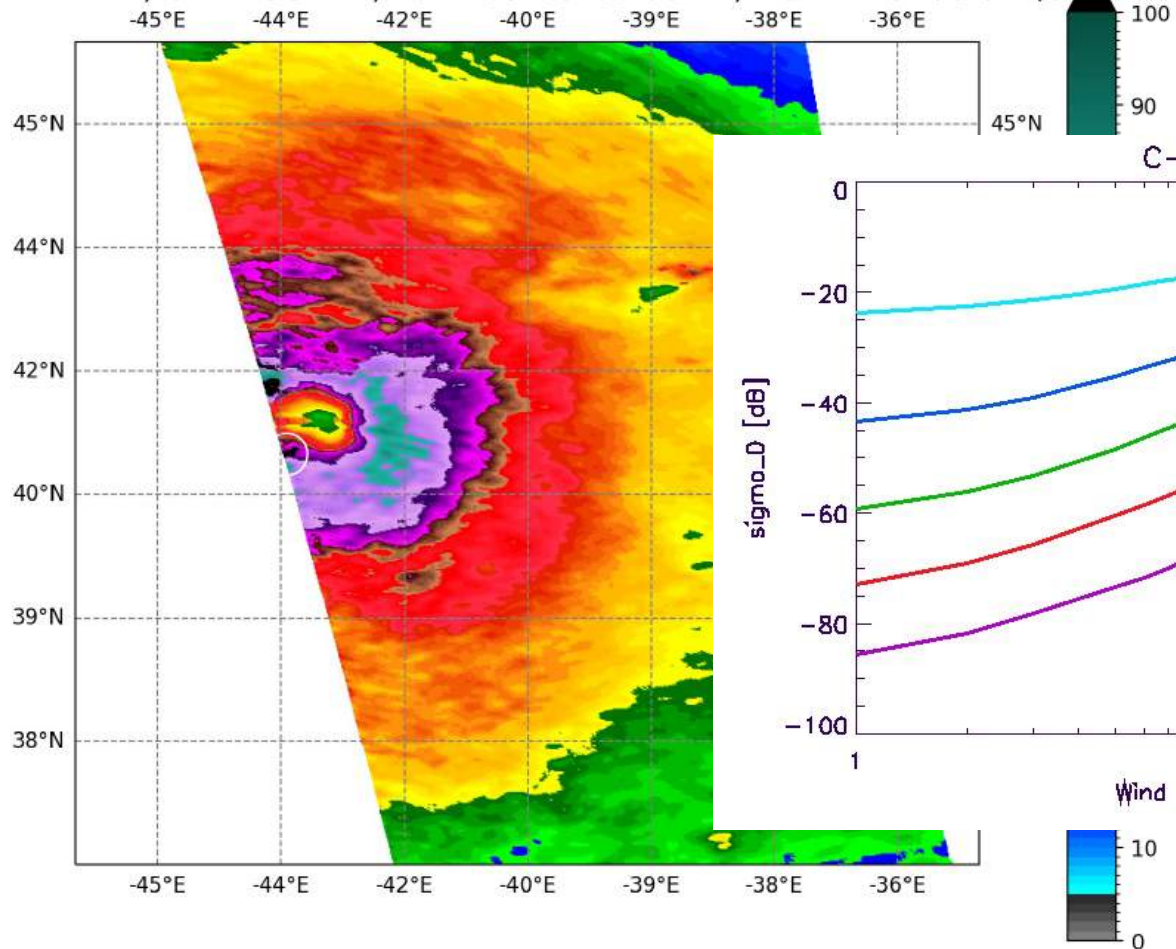
ASCAT NOAA 12.5



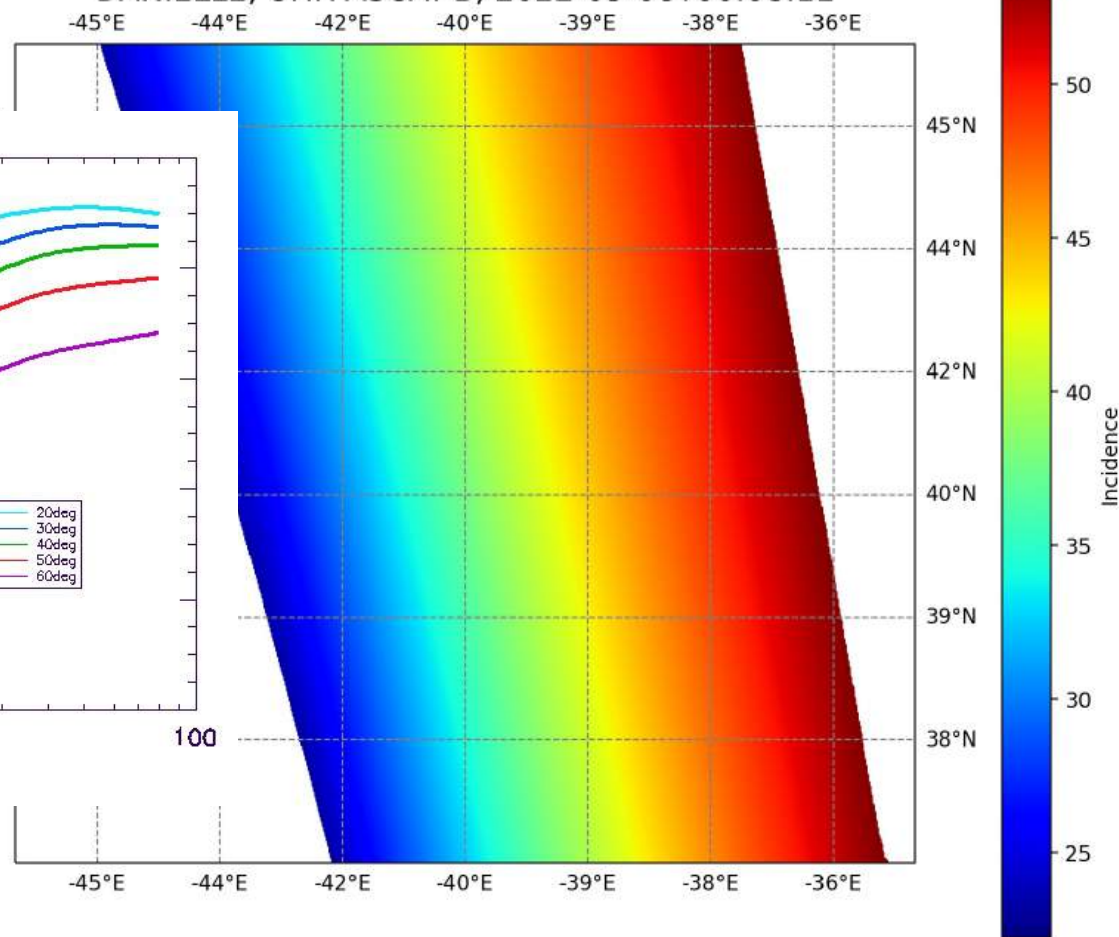


# Edge Issues

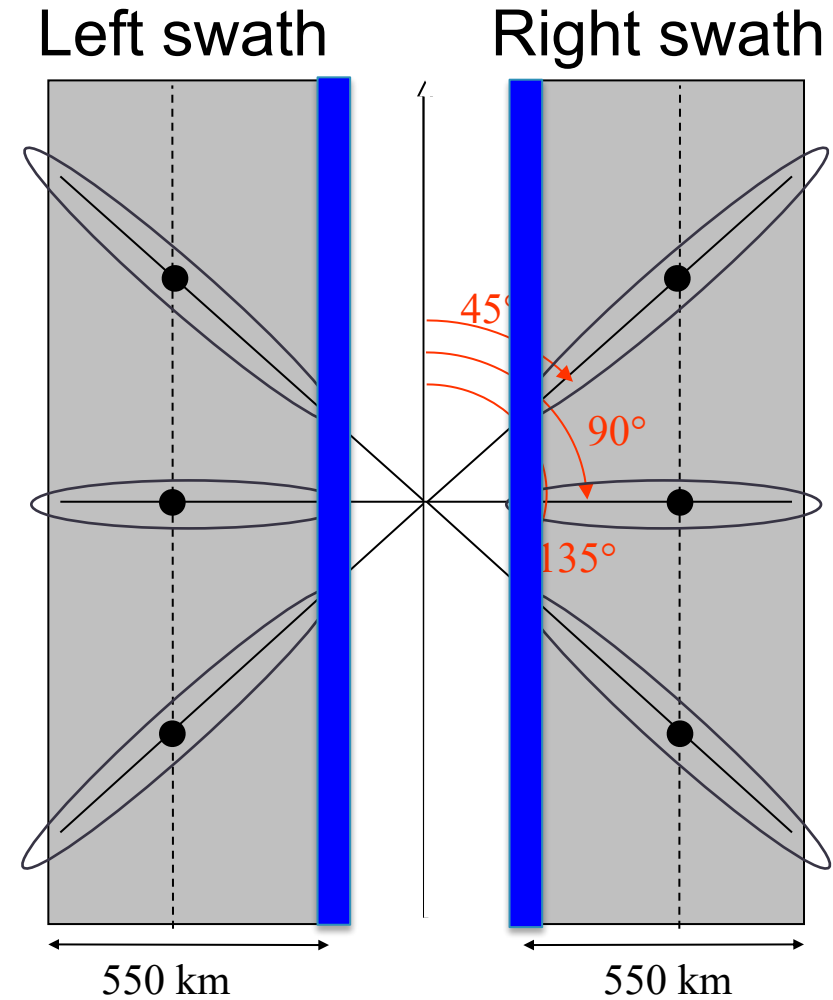
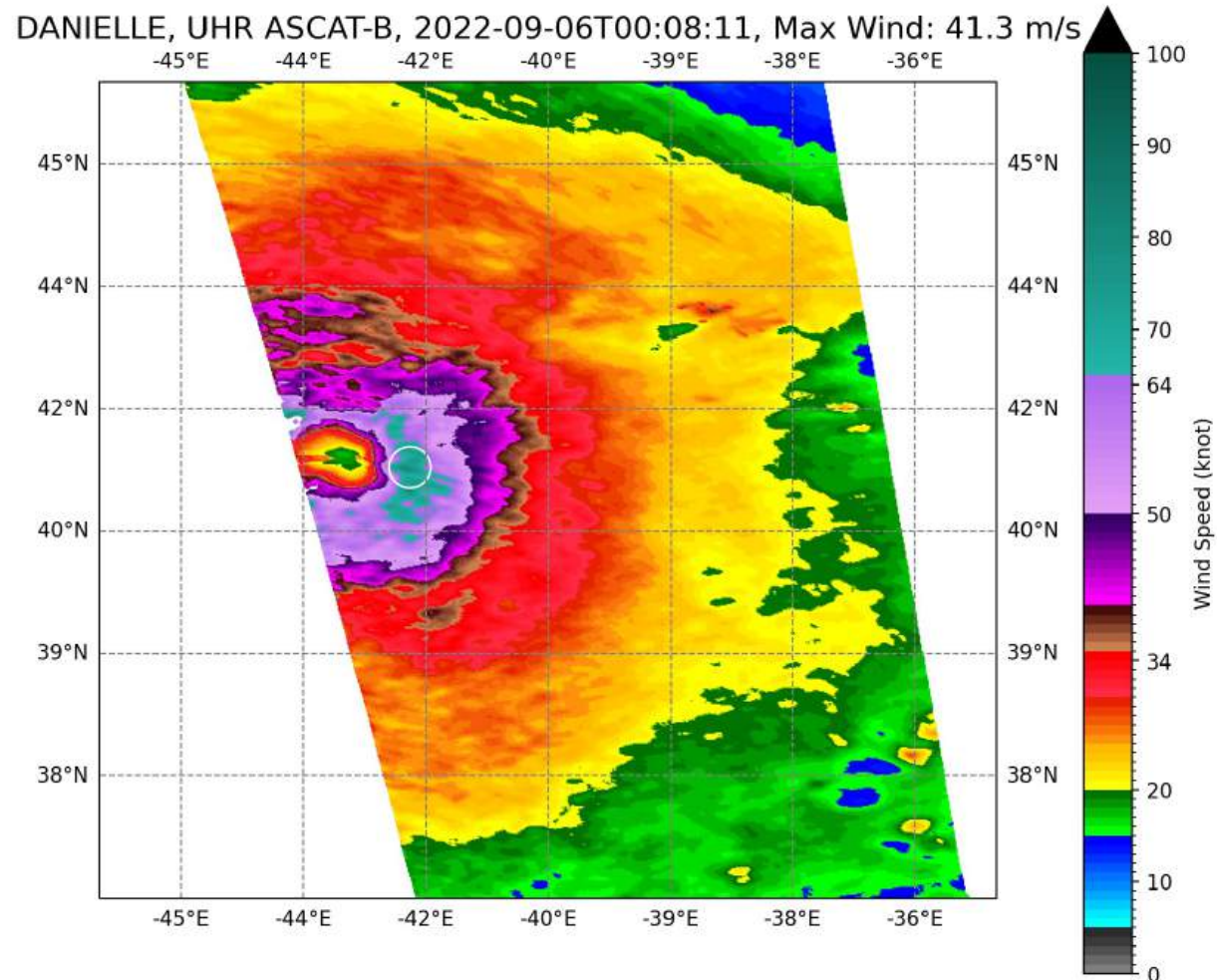
DANIELLE, UHR ASCAT-B, 2022-09-06T00:08:11, Max Wind: 68.0 m/s



DANIELLE, UHR ASCAT-B, 2022-09-06T00:08:11



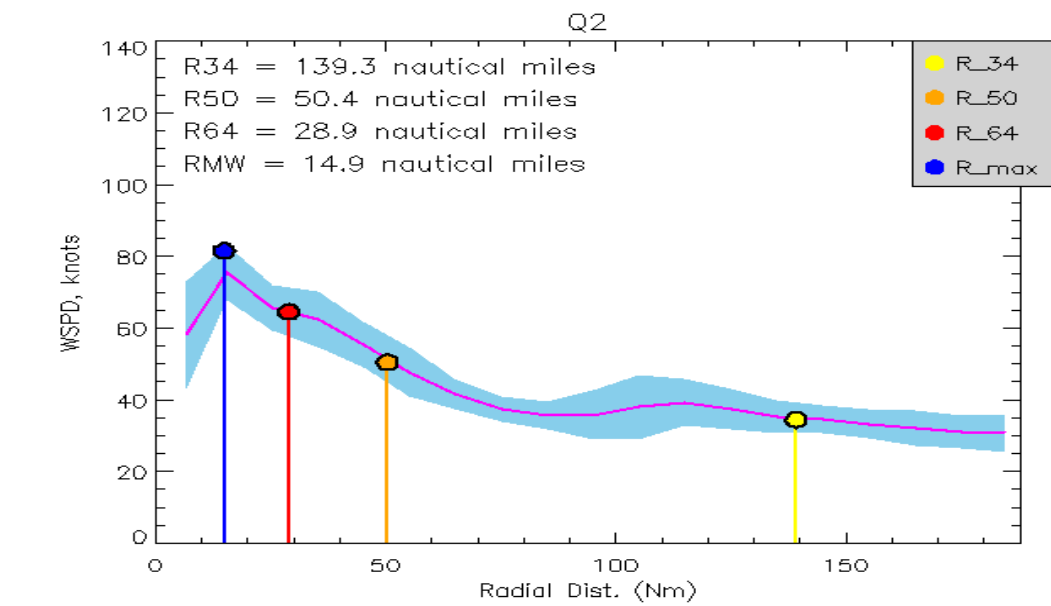
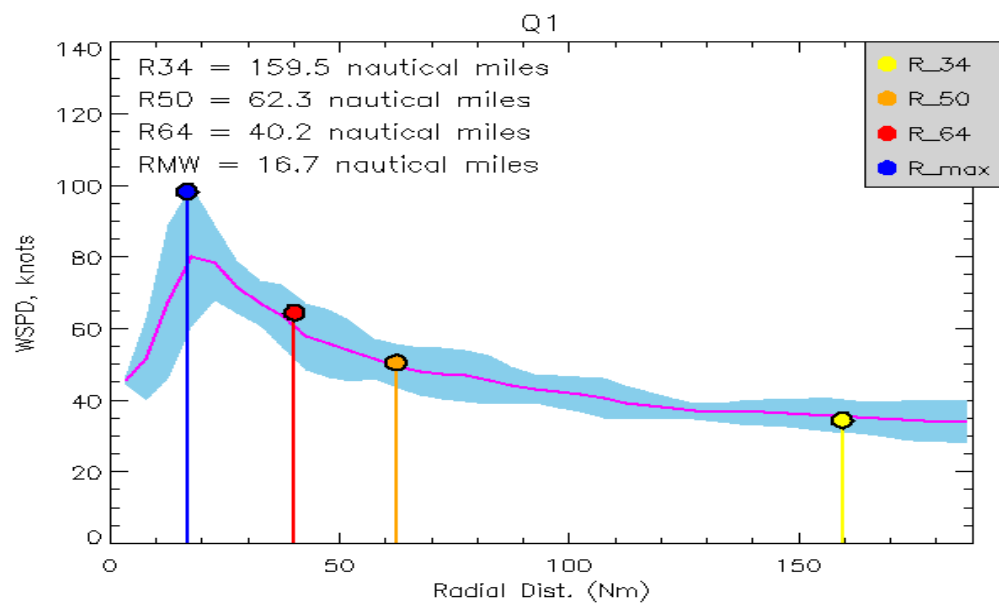
# All winds above 30m/s with Mid Beam Incidence angle $<25^\circ$ should be omitted from Max Wind and Wind Radii Estimations



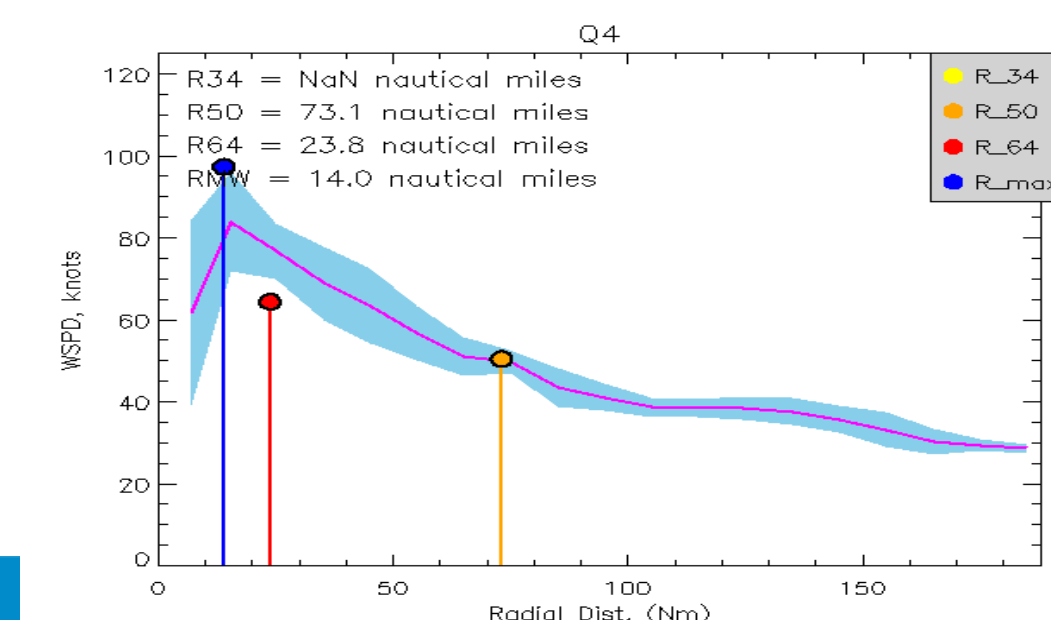
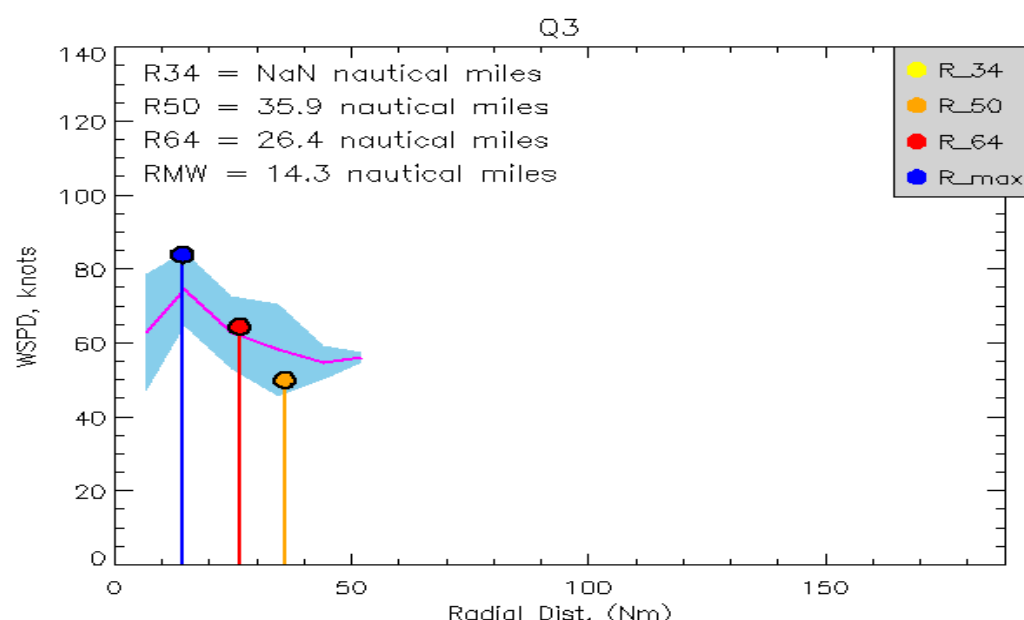
# Wind Radii Determination



# New UHR Products – In Testing/Validation Phase



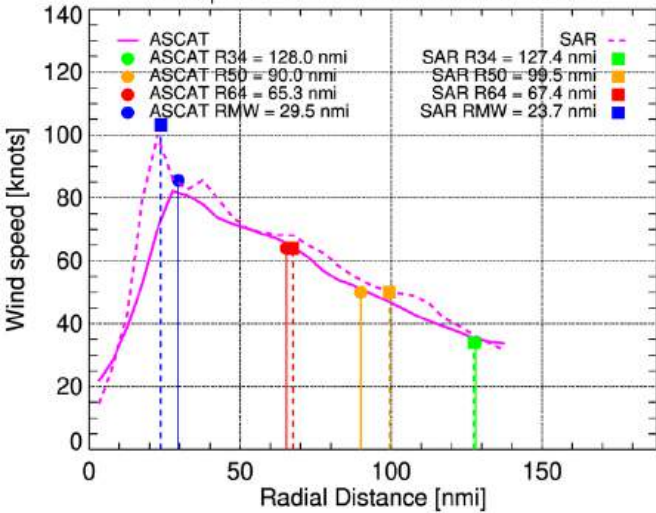
## Analyzed Wind Radii @4:05z 08/18/2023



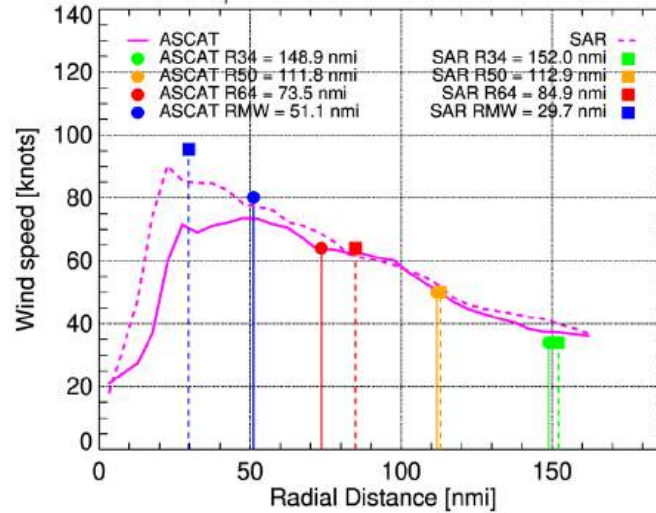
# LEE case study

SAR time:2023/09/12-10:13 | ASCAT time:2023/09/12-14:34 (4hr+ time diff.)

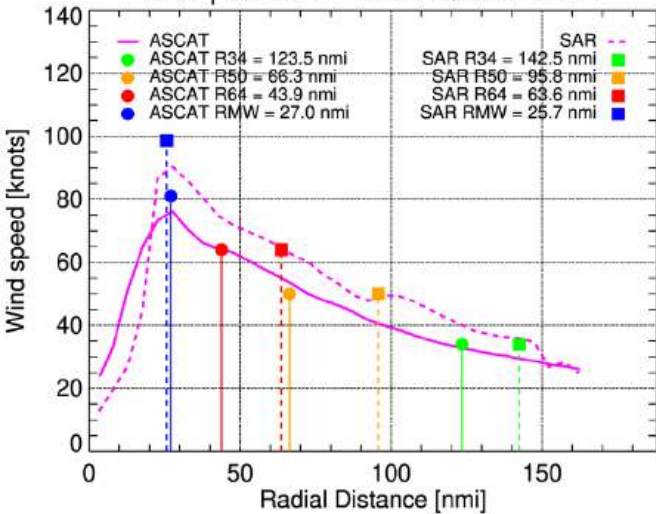
LEE | NORTH WEST QUADRANT



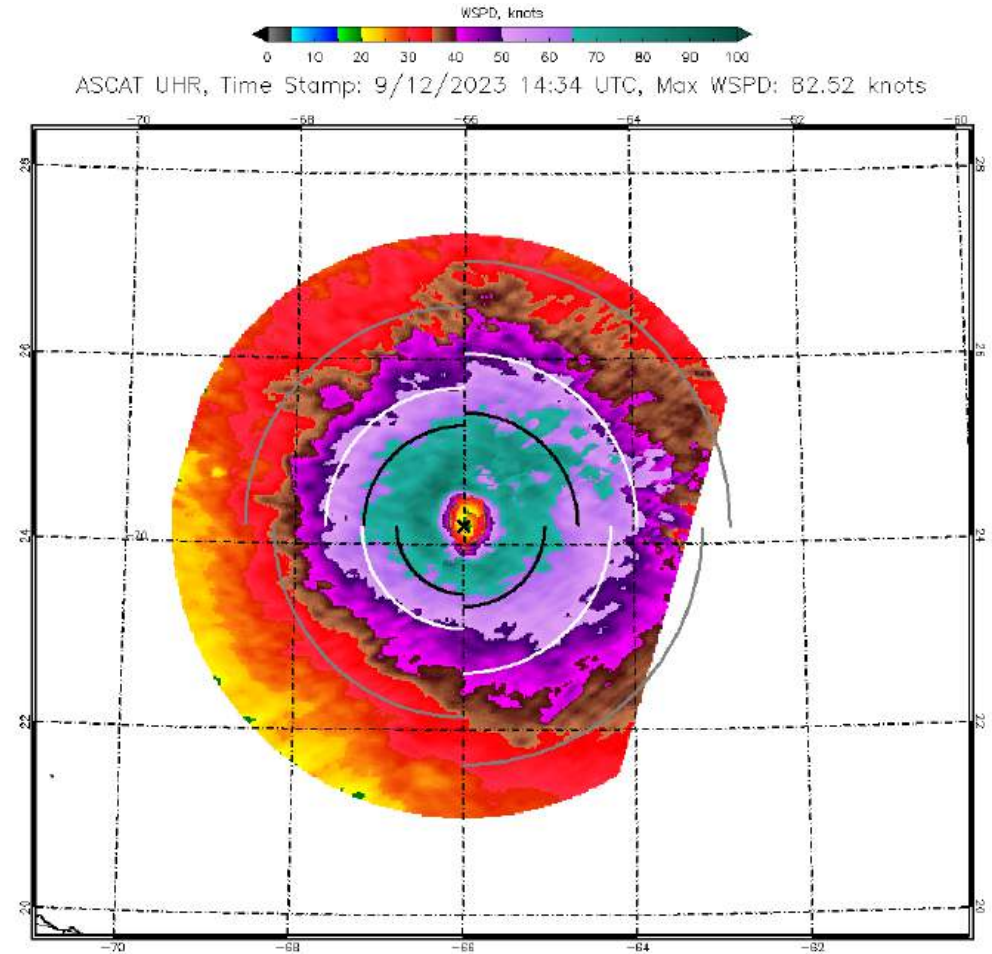
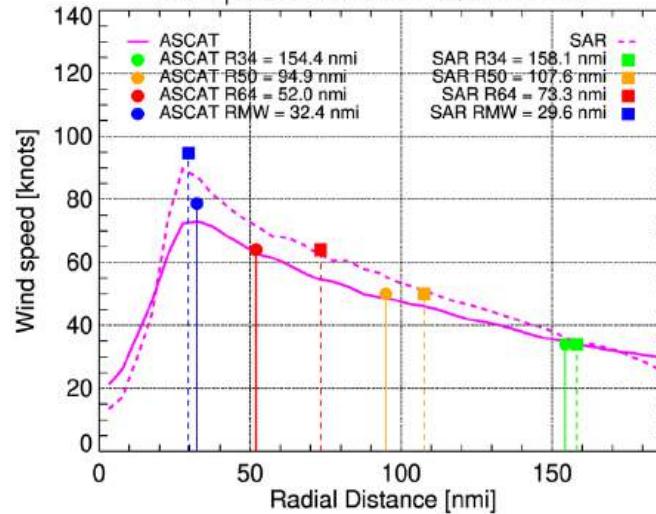
LEE | NORTH EAST QUADRANT



LEE | SOUTH WEST QUADRANT



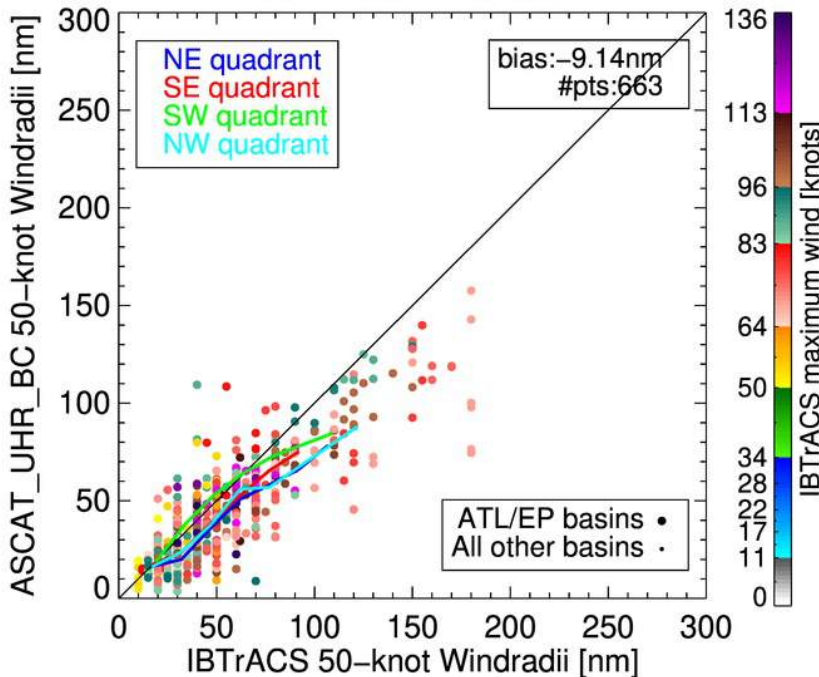
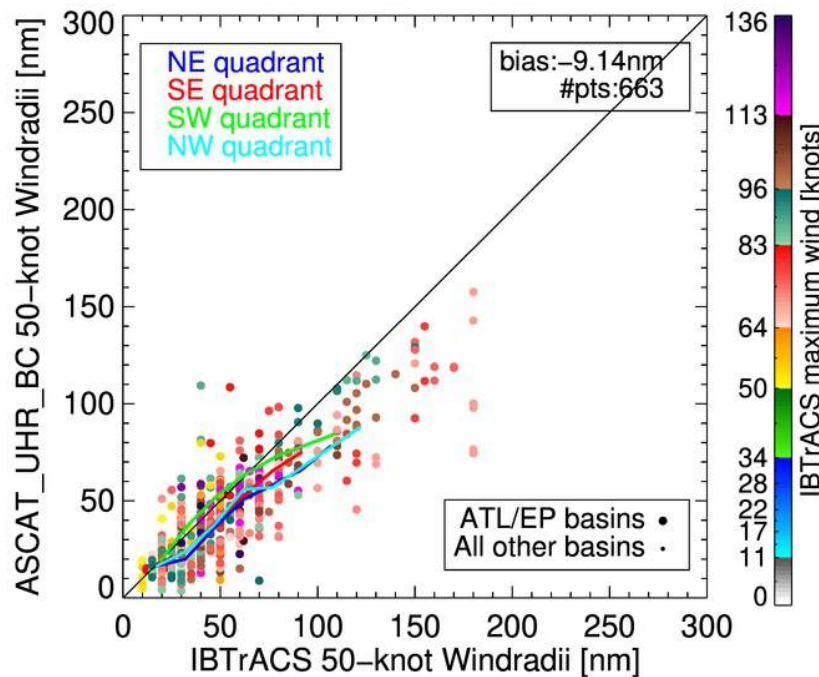
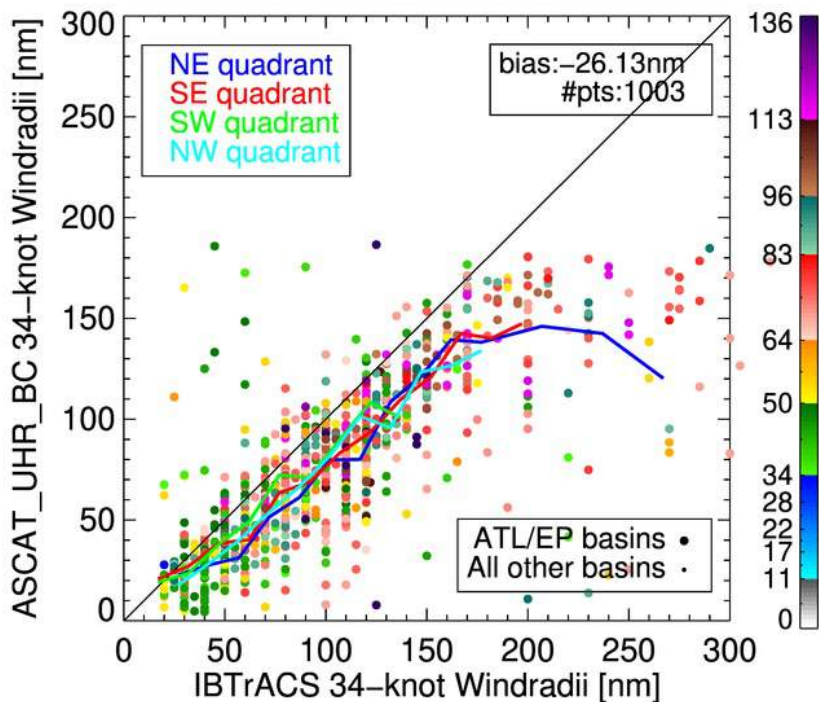
LEE | SOUTH EAST QUADRANT



# 34kts

# 50kts

# 64kts



STAR Center for Satellite Applications and Research  
National Environmental Satellite, Data, and Information Service (NESDIS)  
Ocean Surface Winds Team

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Data from Satellite/Instruments: Advanced Scatterometer (ASCAT METOP-B)

Go To ASCAT-B Main Page Go To ASCAT-C Storm Web Page

### ASCATB Storm Web Page

2024 Season Storms

25km Winds NRCS Images Ultra-High Winds Ambiguity Winds

All Active

Year Atlantic

East Pacific

Central Pacific

West Pacific

- 90W.INVEST
- 91W.INVEST
- 92W.INVEST
- 93W.INVEST
- 94W.INVEST

Indian Ocean

- 98B.INVEST

Southern Hem.

- 04S.ALVARO
- 05S.BELAL
- 05S.FIVE
- 06S.ANGGREK
- 06S.INVEST
- 06S.SIX
- 07P.KIRRIILY
- 07P.SEVEN
- 08S.CANDICE
- 09S.NINE
- 10P.NAT
- 10P.TEN
- 11P.ELEVEN

20S.GAMANE

GAMANE UHR ASCAT-B Surface Winds  
2024-03-30 18:12:47

Wind Speed (knot)

100  
85  
65  
45  
30  
20  
15  
10  
5  
0

12°S  
13.5°S  
15°S  
16.5°S  
18°S  
19.5°S  
21°S

48°E 49.5°E 51°E 52.5°E 54°E 55.5°E 57°E 58.5°E

GAMANE\_20240330\_20041\_S\_Aur

- Data available in NRT
- [https://manati.star.nesdis.noaa.gov/UHR\\_ASCAT/](https://manati.star.nesdis.noaa.gov/UHR_ASCAT/)
- Images
- <https://manati.star.nesdis.noaa.gov/datasets/ASCATCStorm.php>

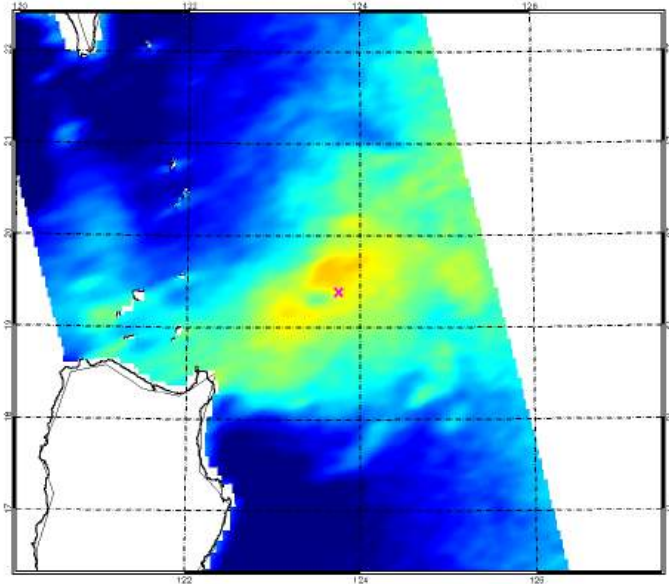
- UHR winds reveal finer spatial structures and higher wind speeds
  - UHR ASCAT = “coarse resolution SAR”
- High wind performance with respect to IWRAP Ku and C-band measurements valid up to 45 m/s
- Validation with SFMR shows a correlation of 0.9 and a 2.67 m/s low bias (We believe this is a SFMR problem not ASCAT)
- For closed circulation and storm center detection Fore-Aft Sigma0 imagery should be considered
  - UHR wind direction too noisy
- UHR ASCAT maximum wind should be considered together with ASCAT 12.5km wind directions and rain flag
- Capable of retrieving 34, 50 and 64 knot wind radii

# Backup slides



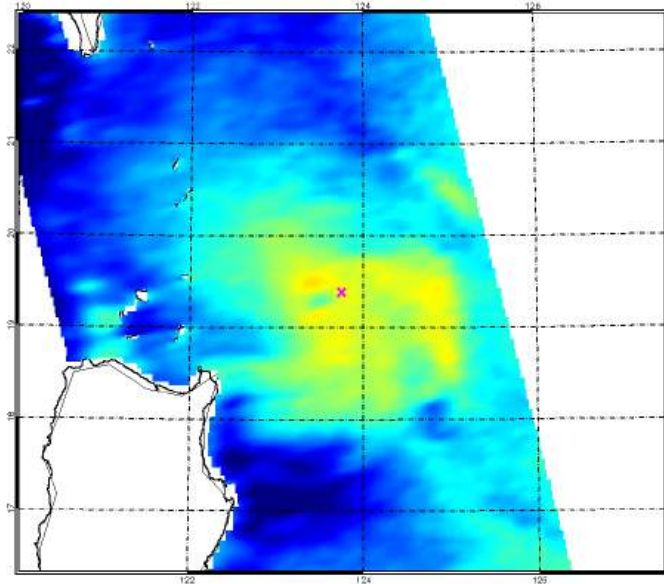
### Forward Look Sigma0

dB  
-25.0 -22.8 -20.5 -18.2 -16.0 -13.8 -11.5 -9.2 -7.0 -4.8 -2.5  
Hurr. SAOLA, Fwd Sig0, Time Stamp: 8/25/2023 12:41 UTC

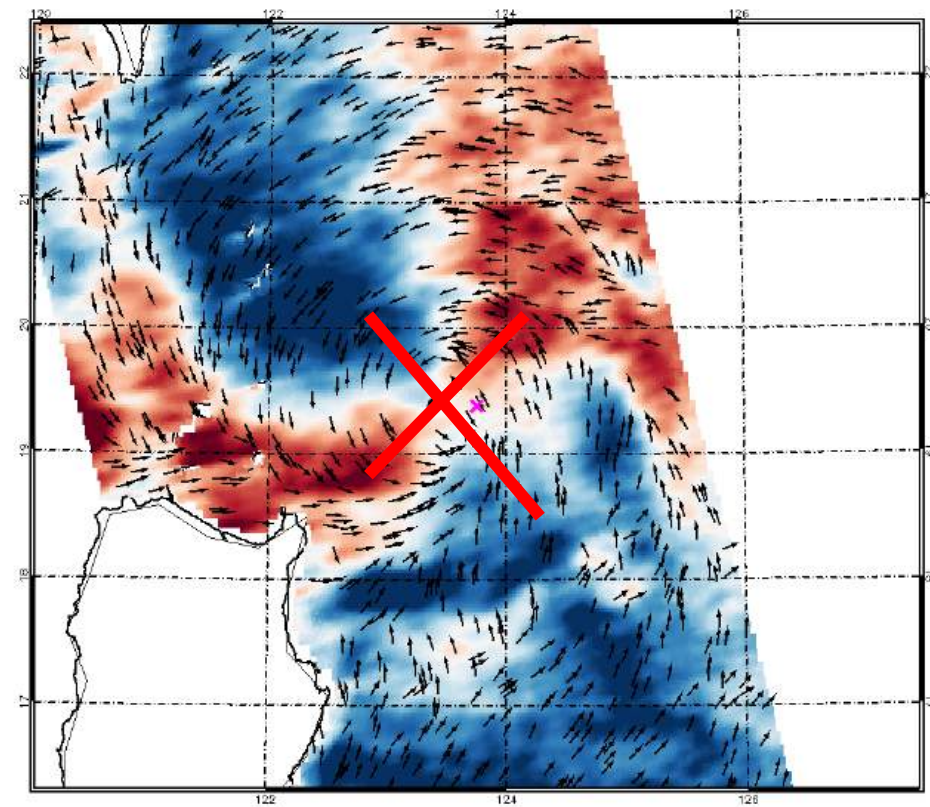


### Aft Look Sigma0

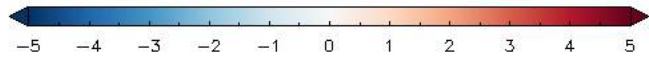
dB  
-25.0 -22.8 -20.5 -18.2 -16.0 -13.8 -11.5 -9.2 -7.0 -4.8 -2.5  
Hurr. SAOLA, Aft Sig0, Time Stamp: 8/25/2023 12:41 UTC



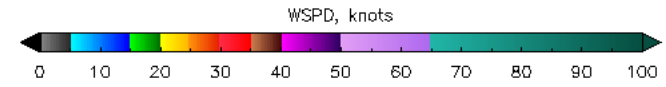
dB  
-5 -4 -3 -2 -1 0 1 2 3 4 5  
Hurr. SAOLA, (Fwd/Aft) Sig0 ratio, Time Stamp: 8/25/2023 12:41 UTC



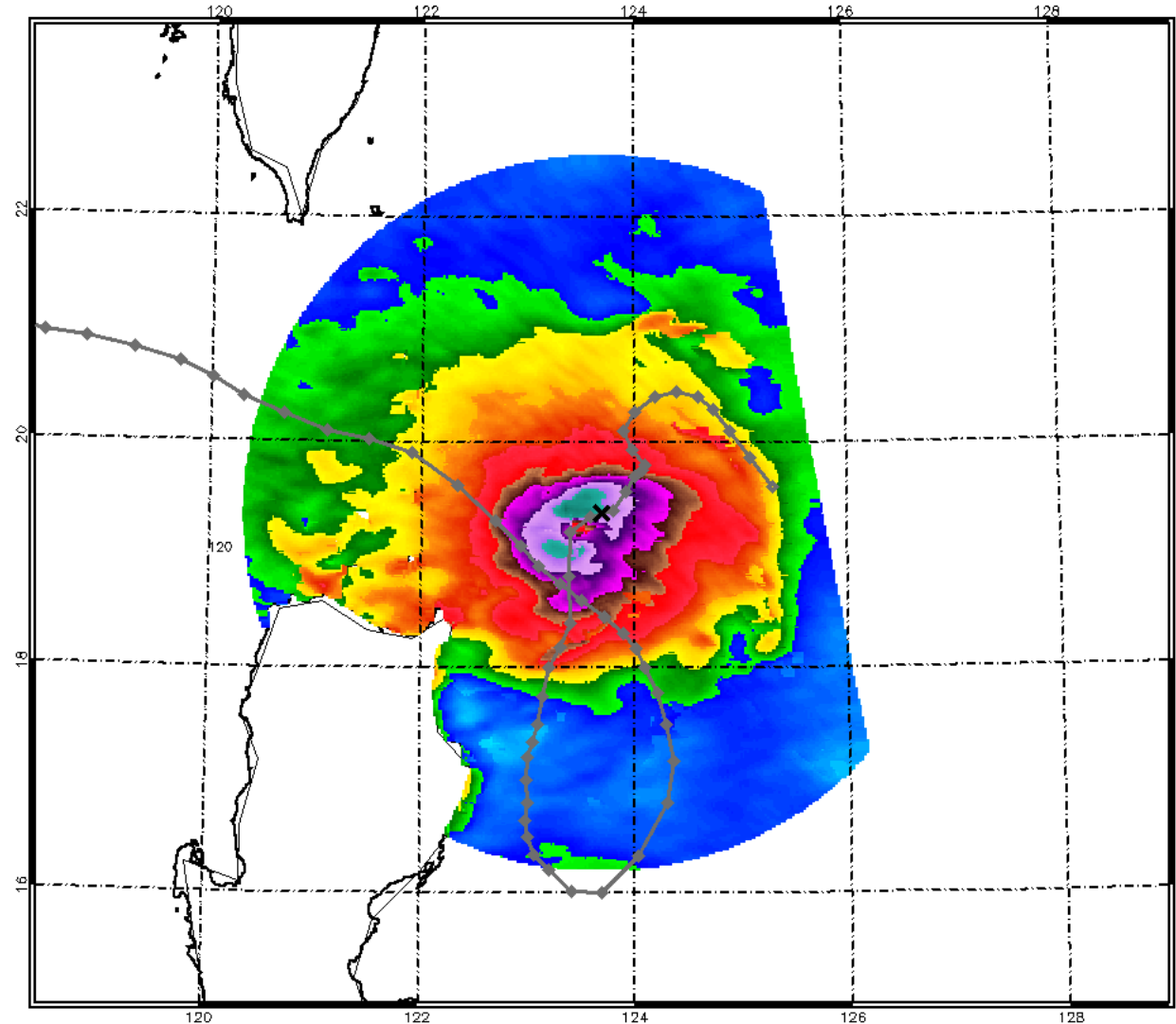
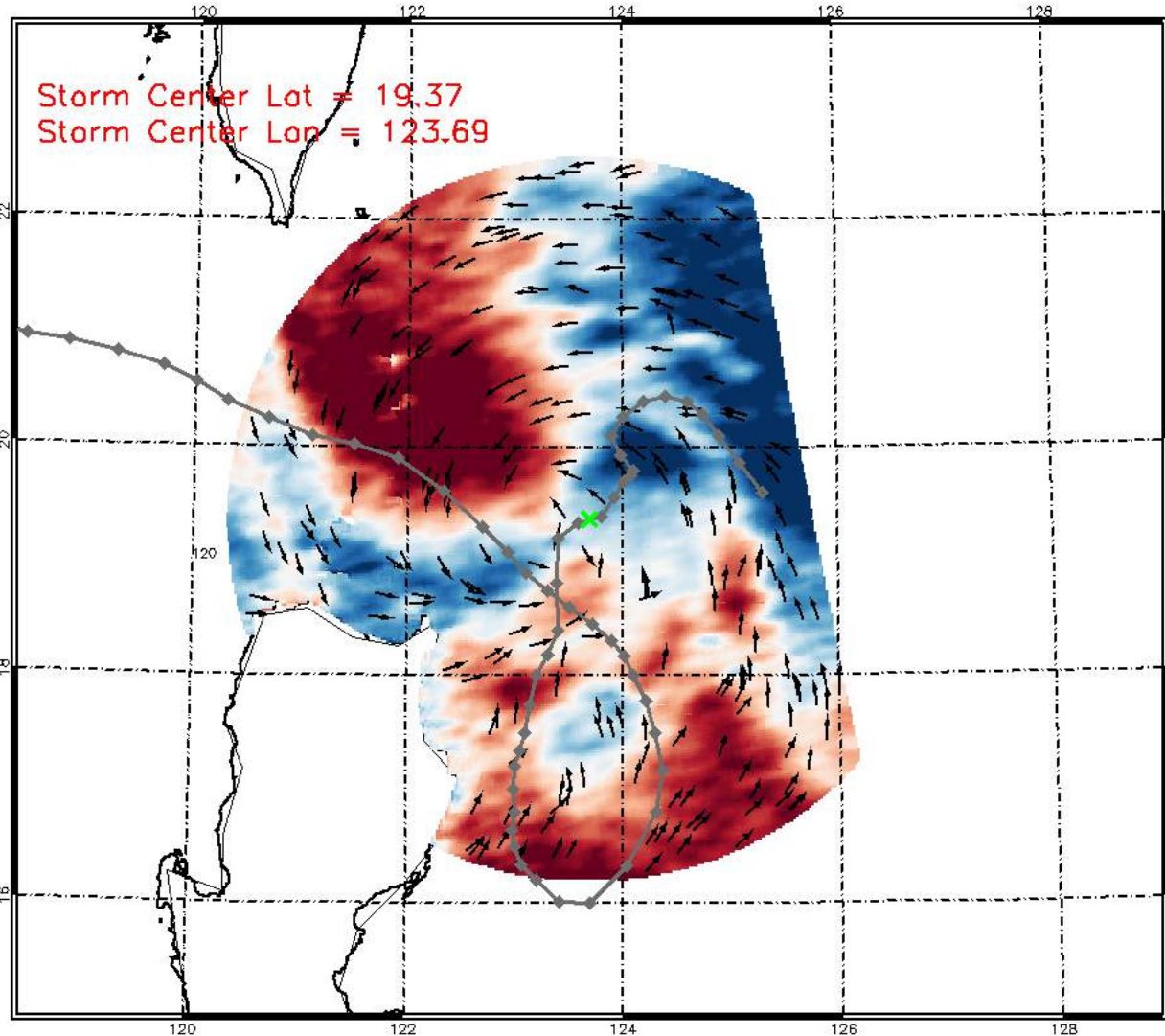
# Saola



10xLog10(sig0\_fwd/sig0\_aft), Time Stamp: 8/25/2023 13:28 UTC



SAOLA\_20230825\_56740\_B\_A, Time Stamp: 8/25/2023 13:28 UTC

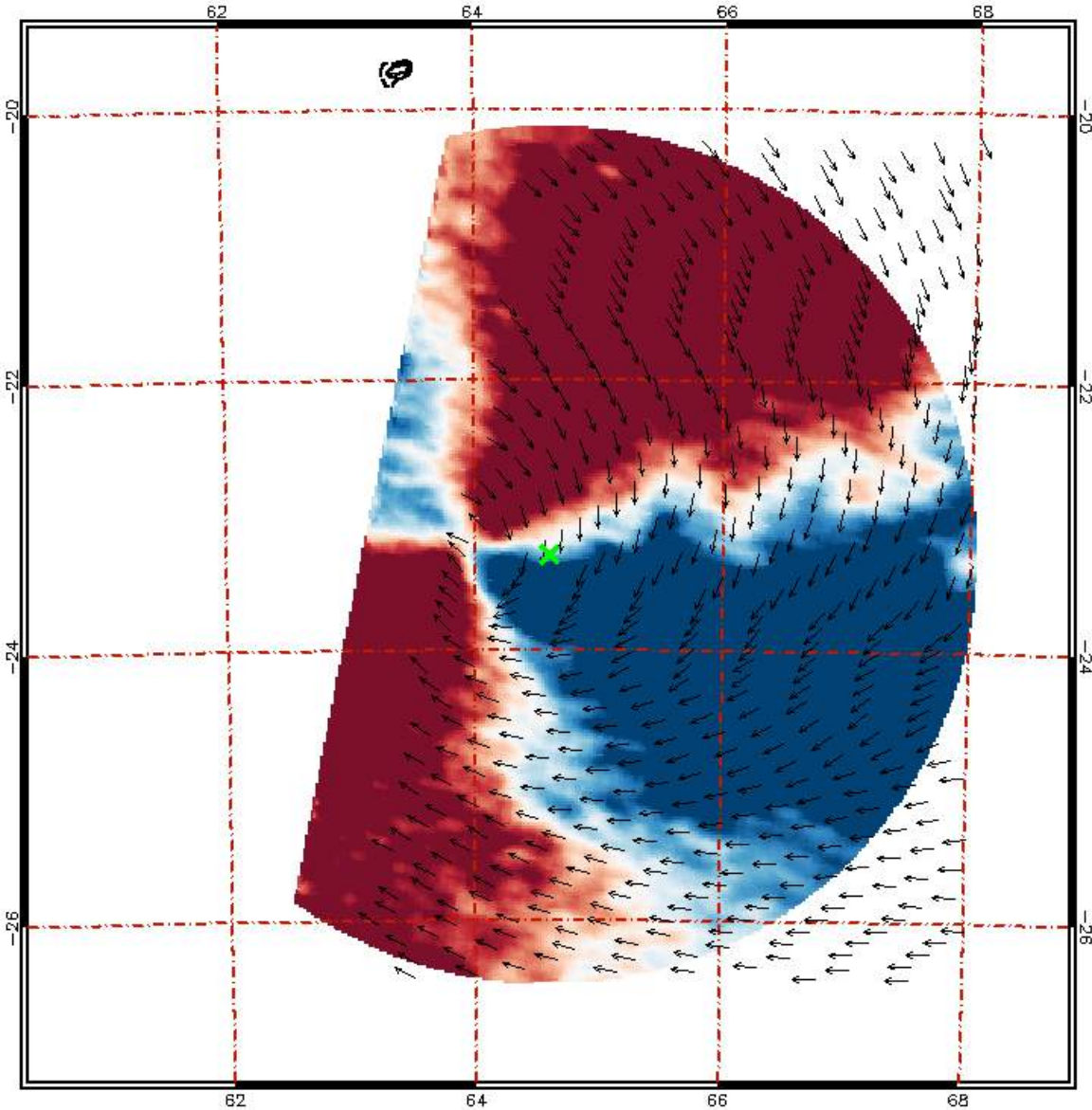


# Anggrek

Delta Sig0 (FWD - AFT) Time Stamp: 1/19/2024 5:10 UTC

x is obtained from ATCF;  
the time it was reported: 01/19/2024 00:00

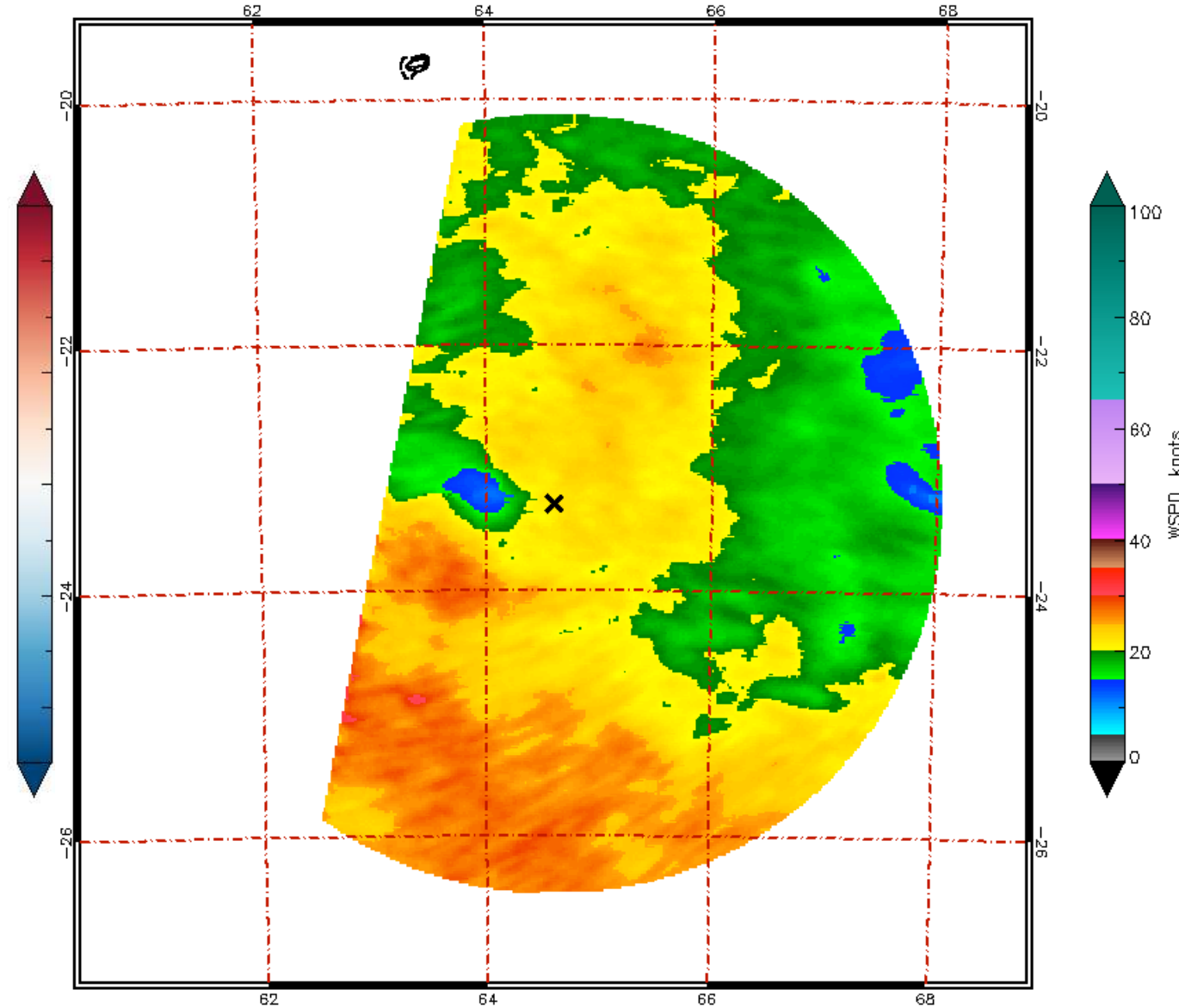
Storm Center Lat=-23.30  
Storm Center Lon=64.60



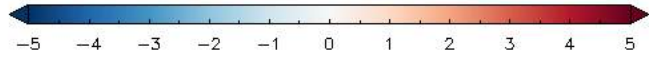
ASCAT UHR, Time Stamp: 1/19/2024 5:10 UTC, Max WSPD: 32.01 knots

x is obtained from ATCF;  
the time it was reported: 01/19/2024 00:00

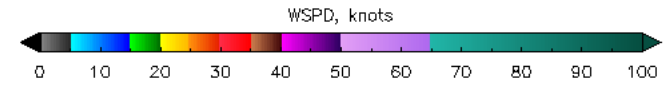
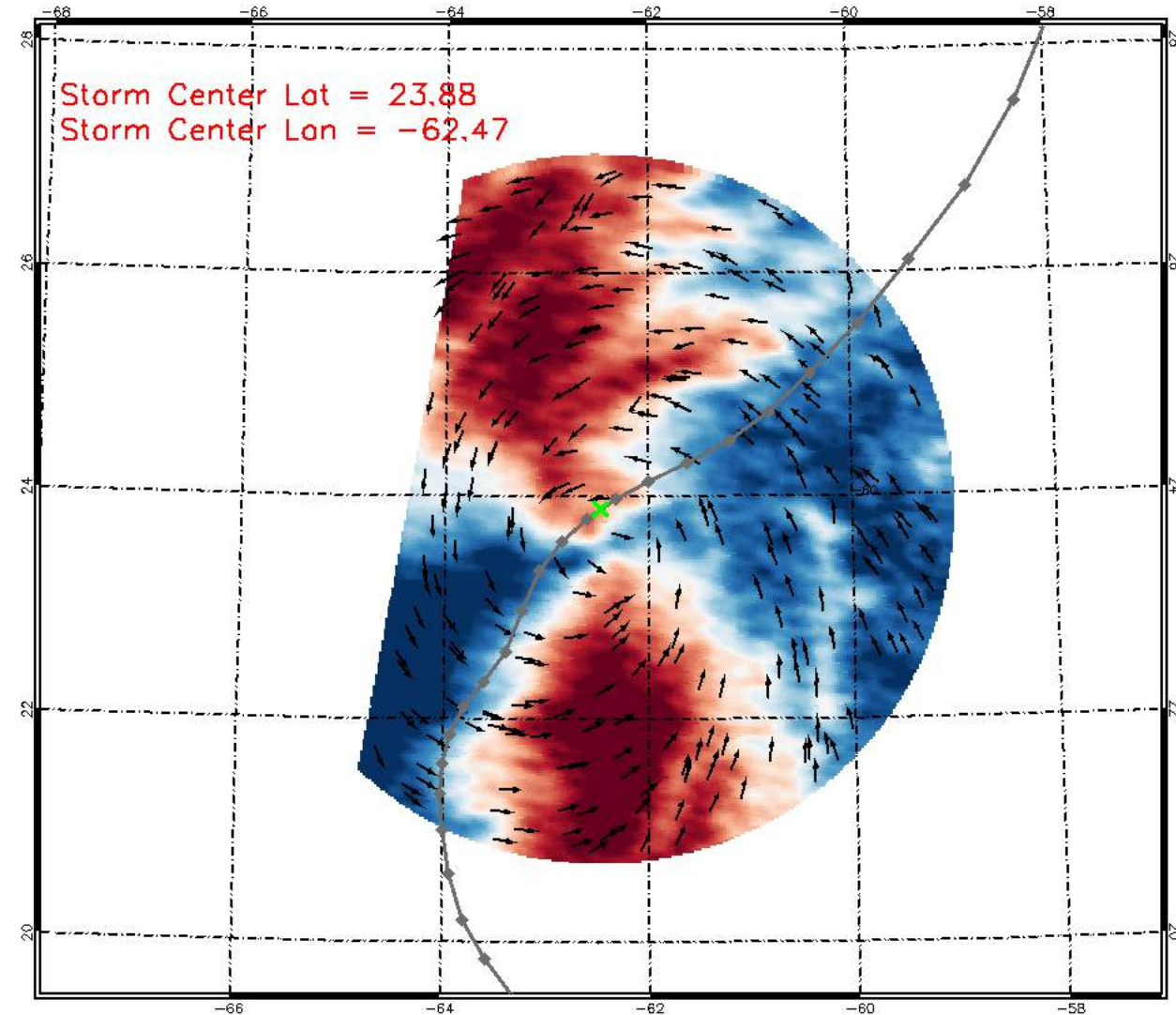
Storm Center Lat=-23.30  
Storm Center Lon=64.60



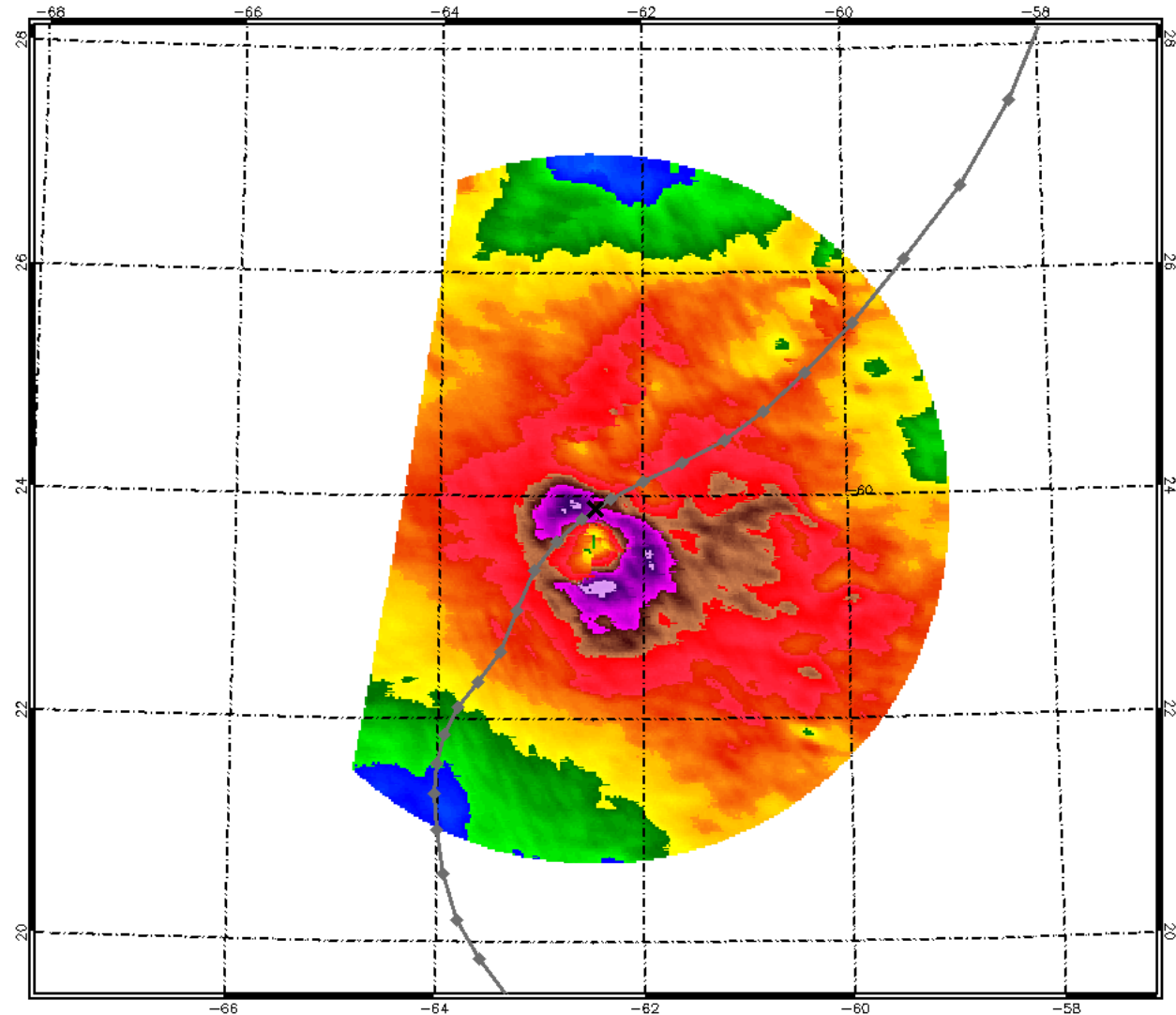
# Tammy



$10 \times \log_{10}(\text{sig0\_fwd}/\text{sig0\_aft})$ , Time Stamp: 10/24/2023 13:24 UTC



TAMMY\_20231024\_57593\_B\_D, Time Stamp: 10/24/2023 13:24 UTC

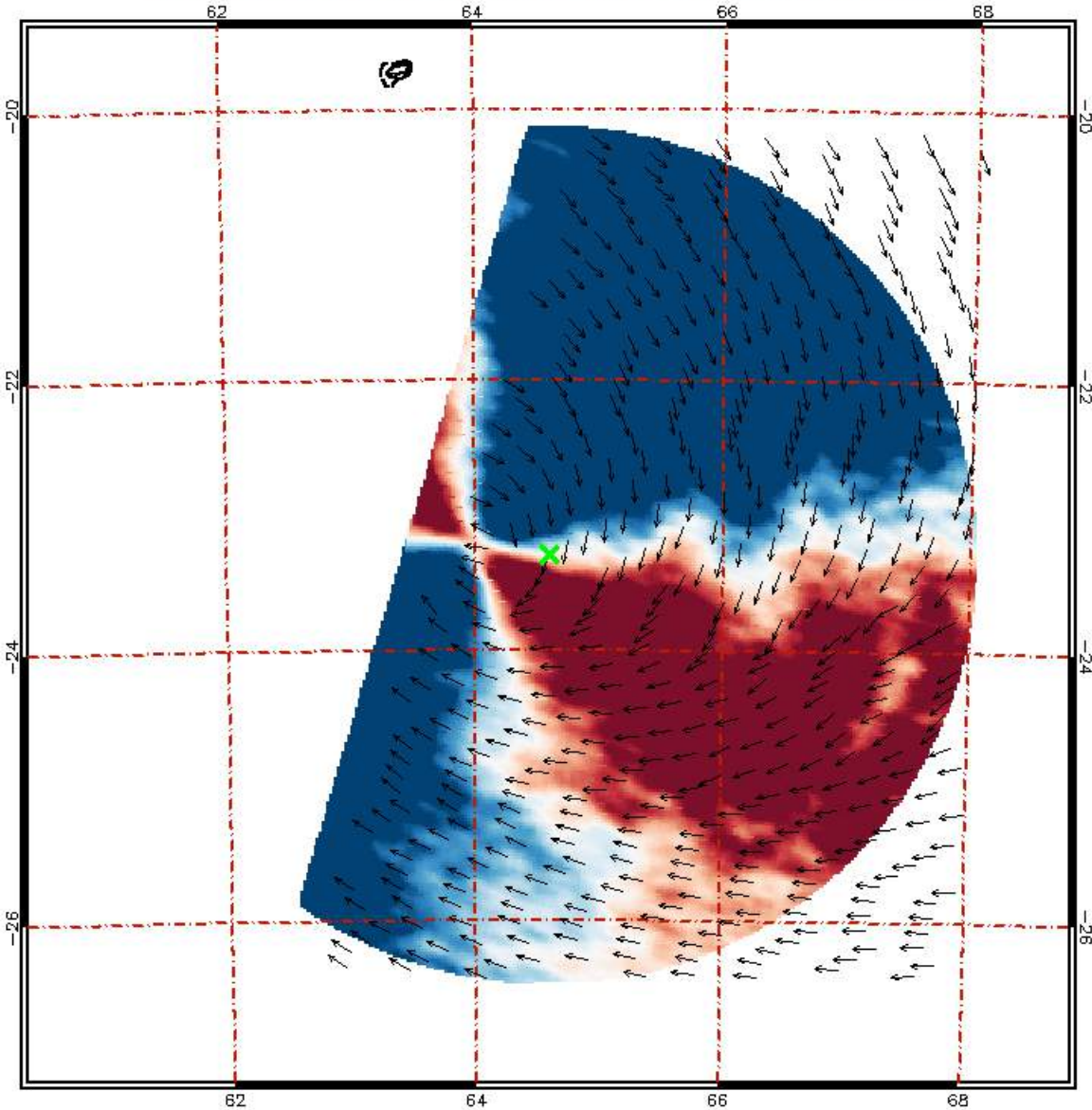


# Belal

Delta Sig0 (FWD - AFT) Time Stamp: 1/19/2024 4:24 UTC

x is obtained from ATCF;  
the time it was reported: 01/19/2024 00:00

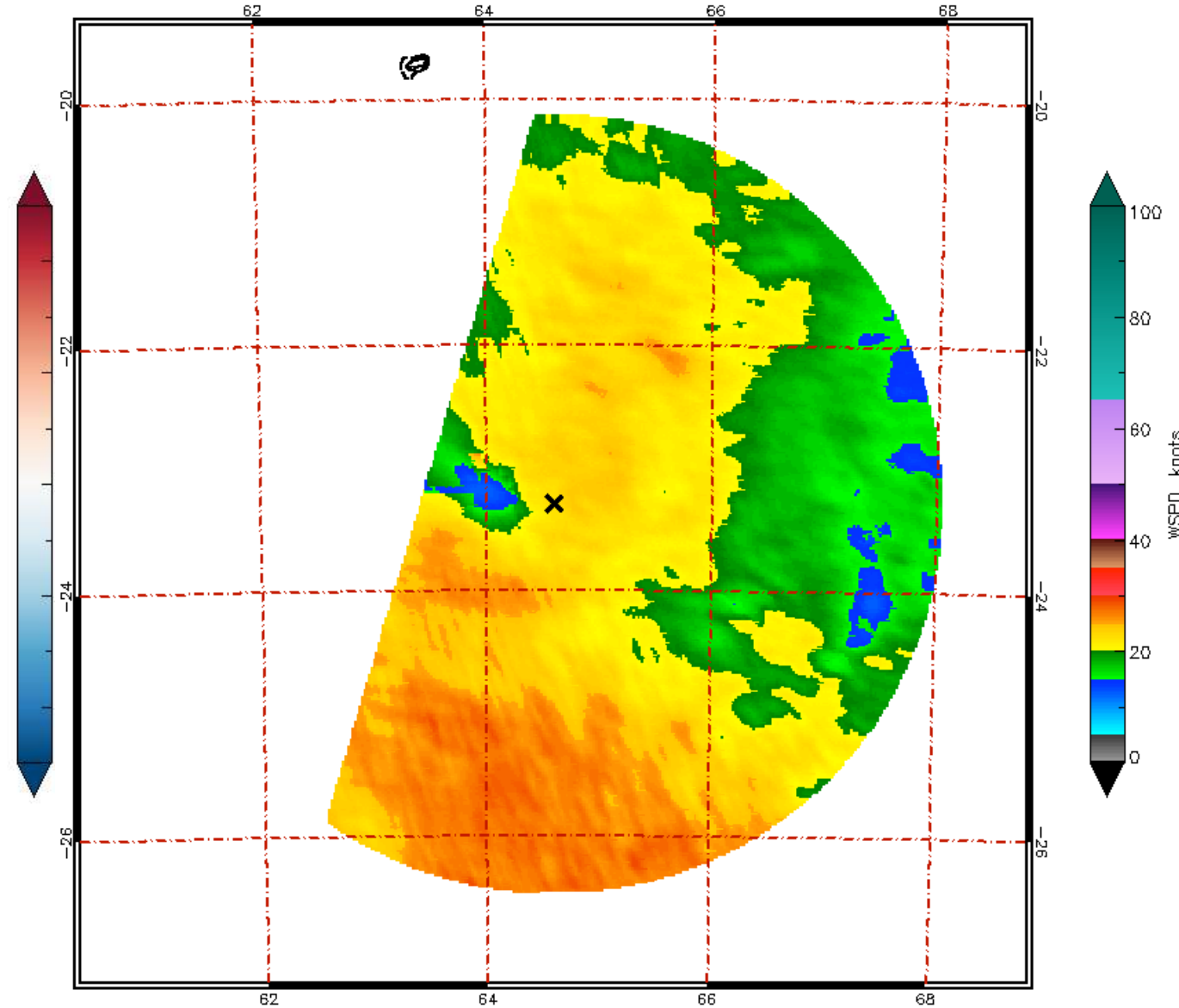
Storm Center Lat=-23.30  
Storm Center Lon=64.60



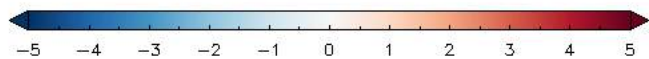
ASCAT UHR, Time Stamp: 1/19/2024 4:24 UTC, Max WSPD: 28.88 knots

x is obtained from ATCF;  
the time it was reported: 01/19/2024 00:00

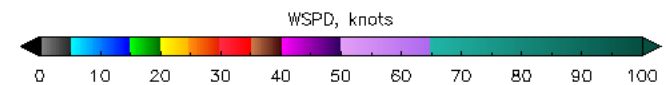
Storm Center Lat=-23.30  
Storm Center Lon=64.60



# Saola



$10 \times \log_{10}(\text{sig0\_fwd}/\text{sig0\_aft})$ , Time Stamp: 8/26/2023 1:57 UTC



SAOLA\_20230826\_56748\_B\_D, Time Stamp: 8/26/2023 1:57 UTC

