SWIM performance assessment within the tropical cyclone environment

Faozi Said[1,2], Zorana Jelenak[1,3],Paul S. Chang[1]

[1]NOAA/NESDIS/STAR
[2]Global Science & Technology, Inc.
[3]UCAR

National Environmental Satellite, Data, and Information Service

CFOSAT WORKSHOP 2022 – Sep 12-14

The views, opinions, and findings in this report are those of the authors and should not be construed as an official NOAA or U.S. government position or policy.

Motivation

Obtain a better understanding of wind and wave interaction within tropical cyclones (TC)

Outline

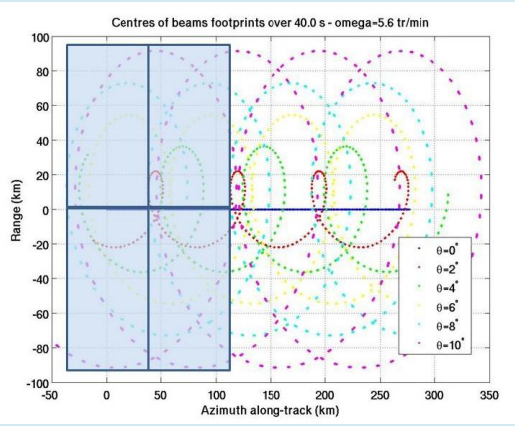
1. Compare spatial distribution and intensity of wind speed and significant waveheight within TCs
2. Use storm composite imagery to assess SWIM significant waveheight performance within TC environment

Composite Storm Analysis Methodology

- Collocate sensor/model data within a preset radius (e.g. 750km) centered around storm center
- Collocated data is gridded and set on a **kilometer grid**
- Storm rotation is taken into consideration (i.e. 'North' of each snapshot corresponds to storm direction)
- Once all snapshots are generated, a storm composite (of average/max wind speed, significant wave height, etc..) image can be created
- For this presentation, *hurricane cat 1-5* snapshots are exclusively used

Selected dataset

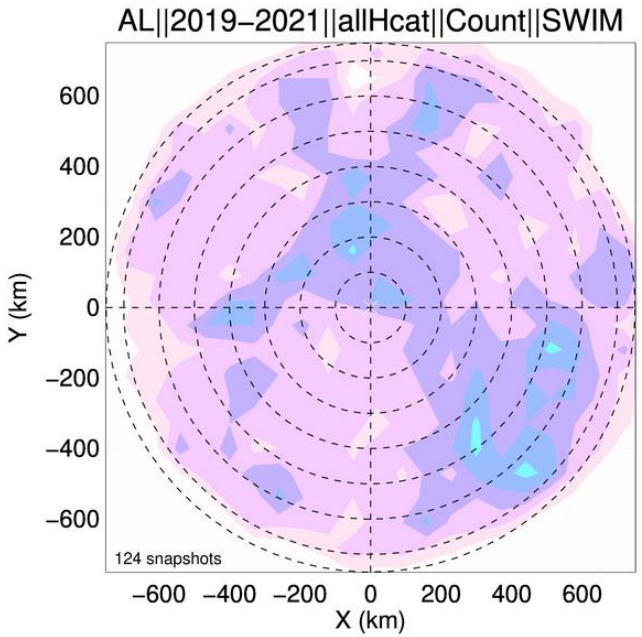
- Selected sensors/models:
  - 0.25° HWRF (i.e. 1-3km HWRF regridded to 0.25°)
  - IFREMER implementation of Wavewatch III
  - SWIM official L2 product (variables used: 'wave_param_combined' and 'wave_param_part_combined')
- Selected hurricane seasons and basin: 2019-2021 || Atlantic, Southern Hemisphere, Western, and Eastern Pacific basins



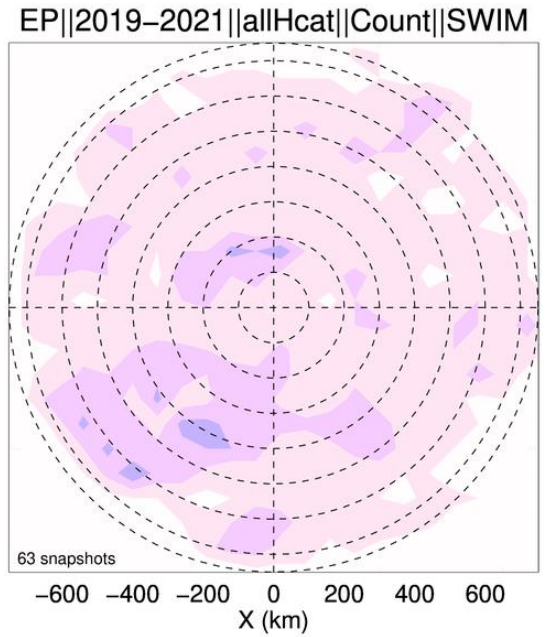
Source: SWIM product user guide (CNES)

HUR. CAT 1-5 | SAMPLE COUNT SWIM

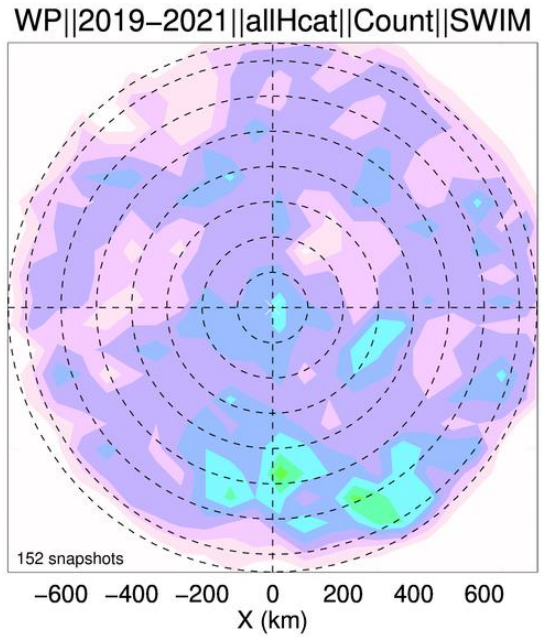
AL



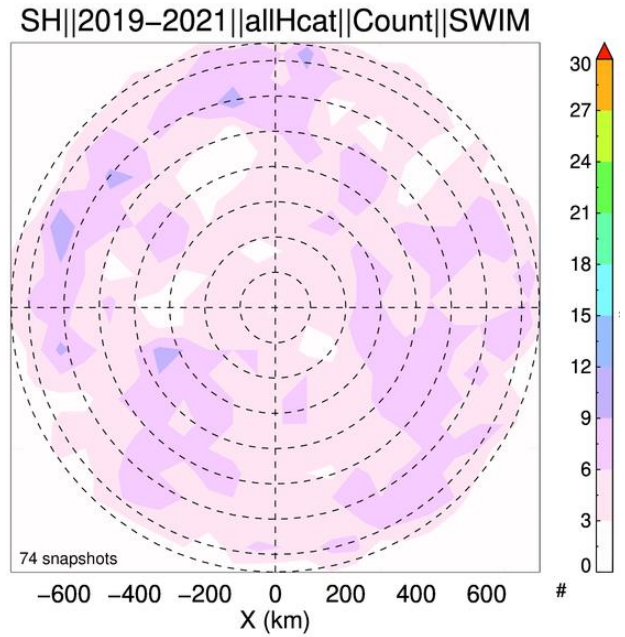
EP



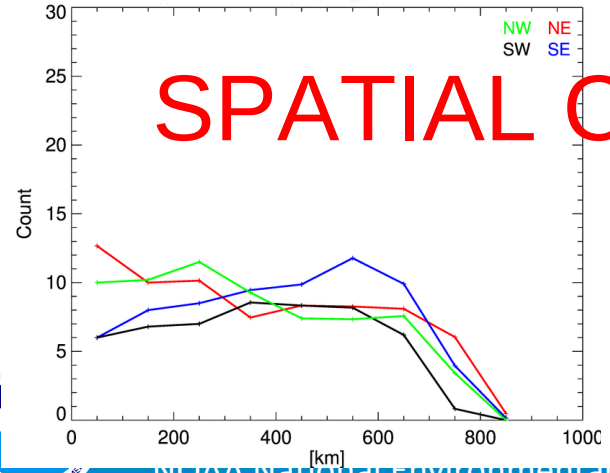
WP

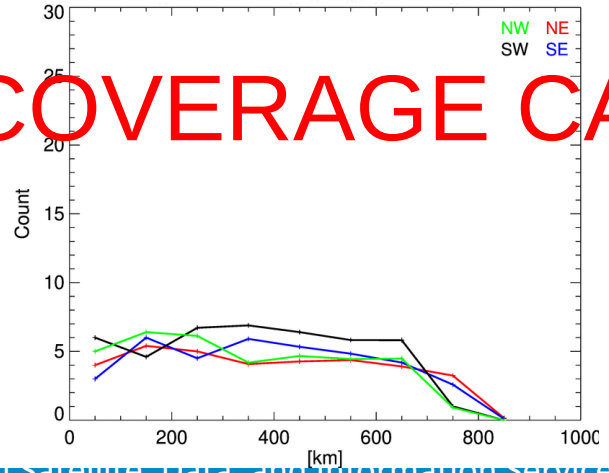


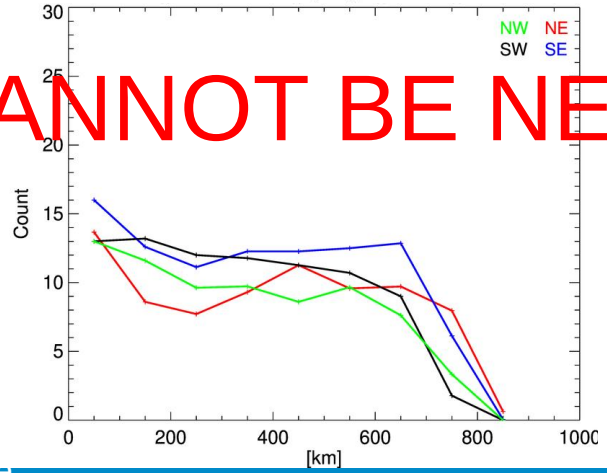
SH

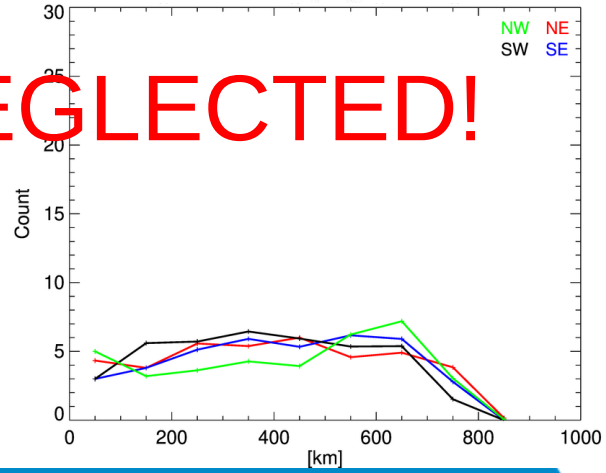


SPATIAL COVERAGE CANNOT BE NEGLECTED!



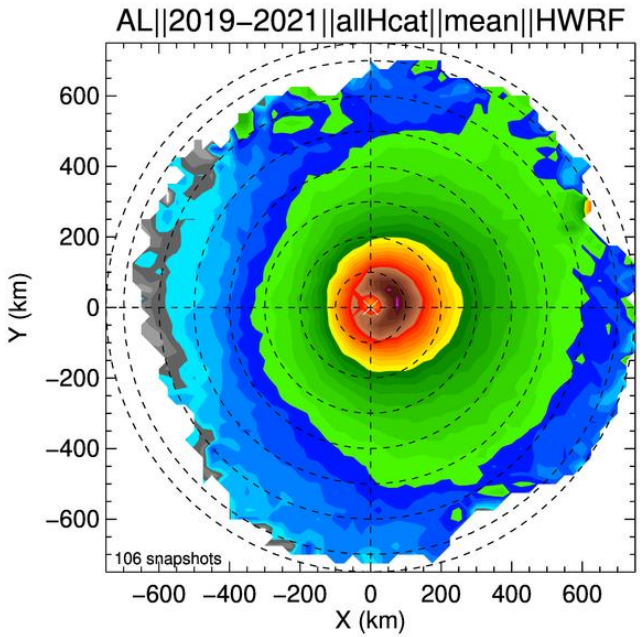




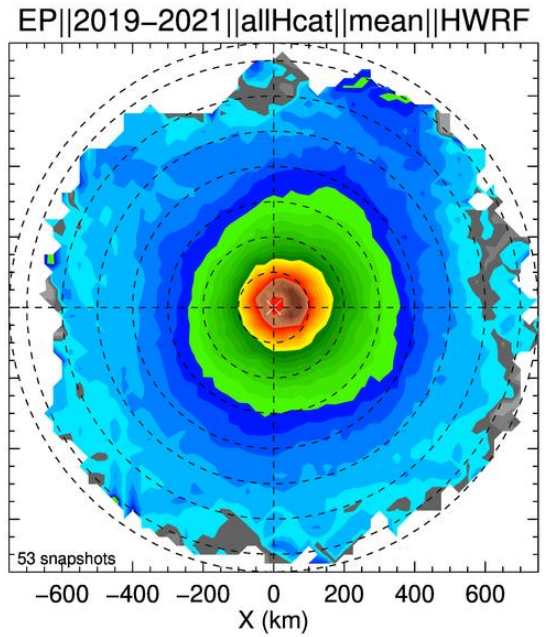


HUR. CAT 1-5 | HWRF WSPD (time collocation)

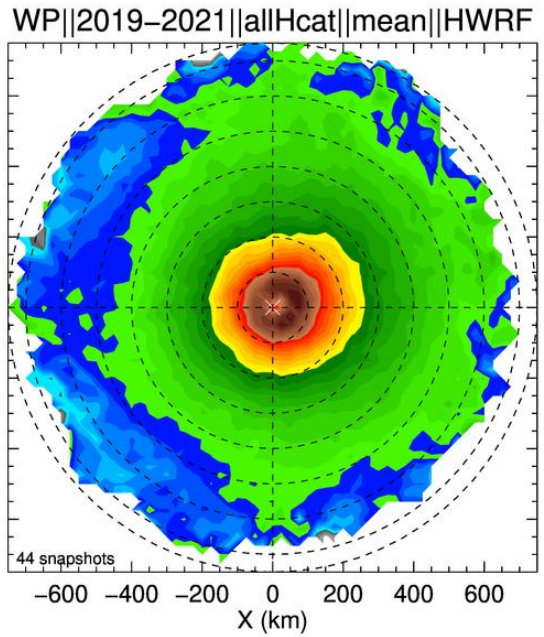
AL



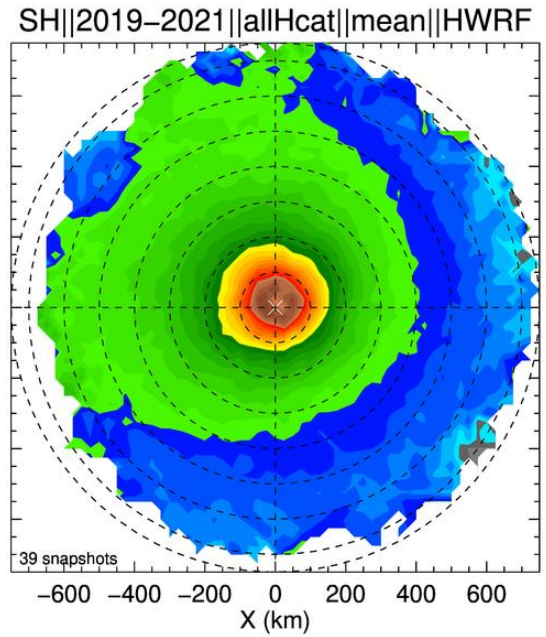
EP

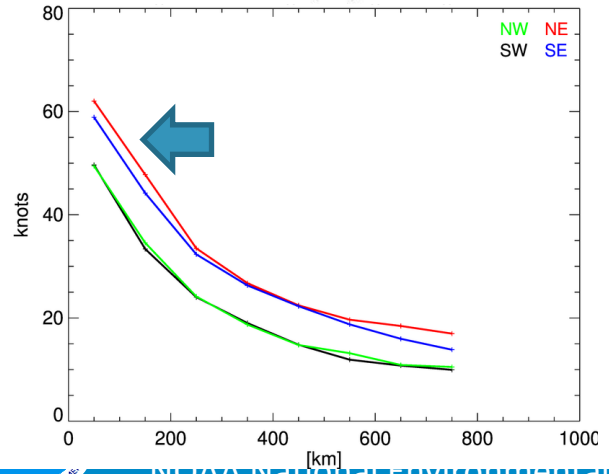


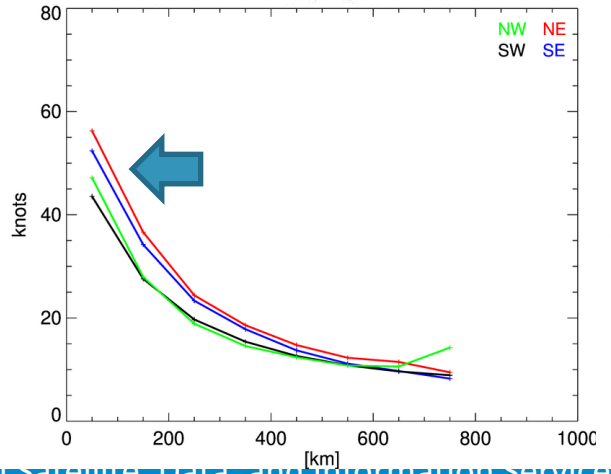
WP

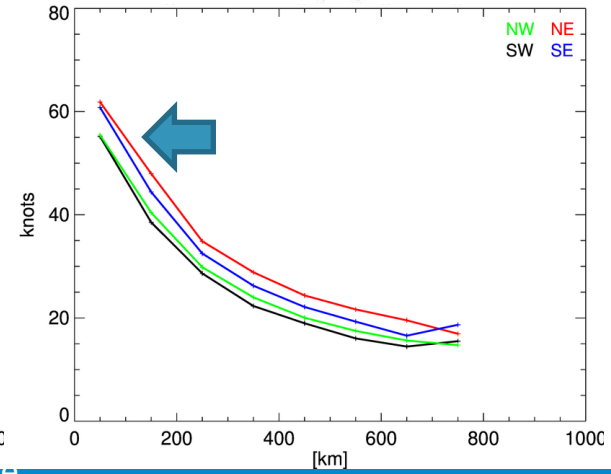


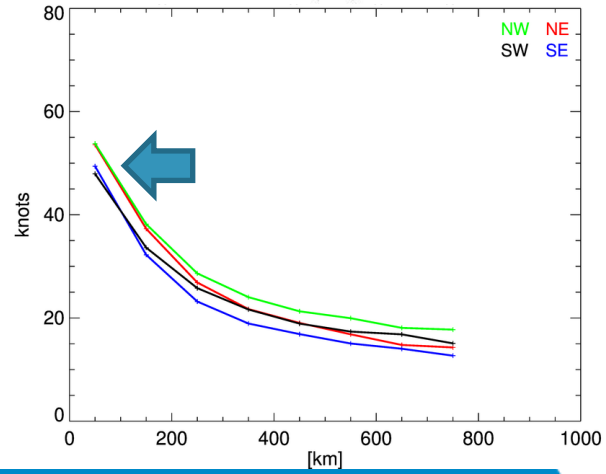
SH





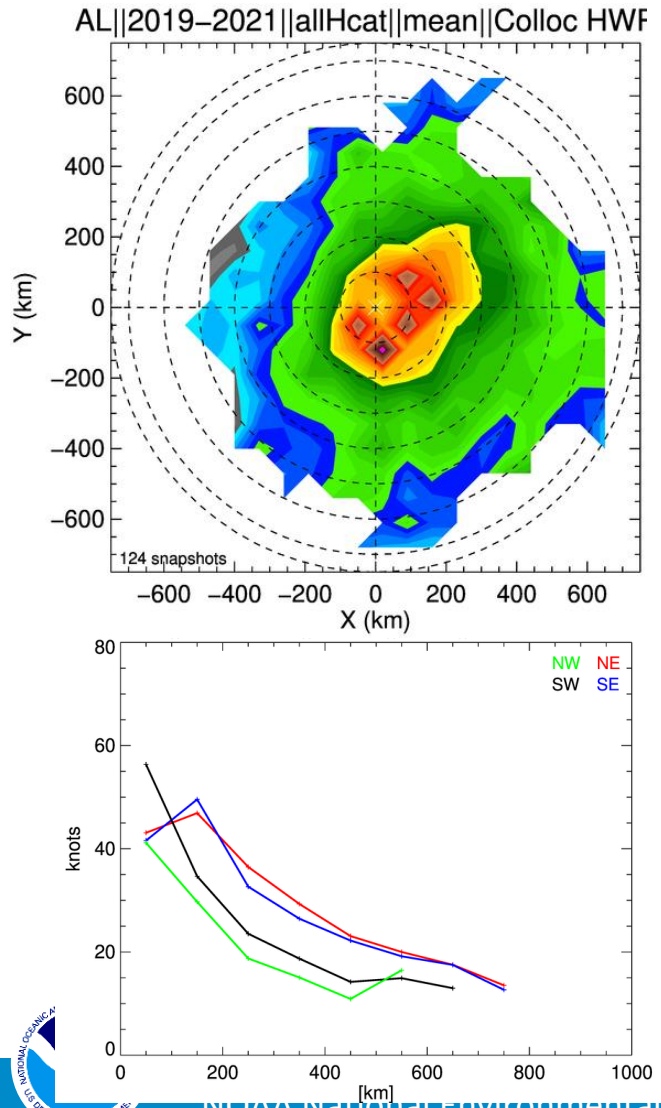




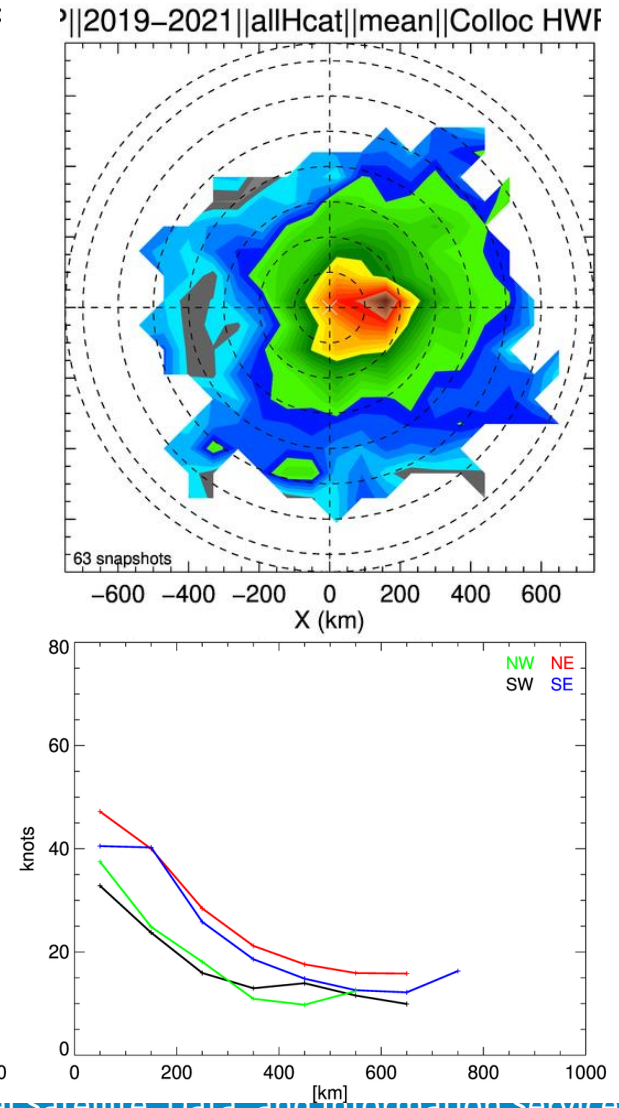


HUR. CAT 1-5 | HWRF WSPD (time/space collocation with SWIM)

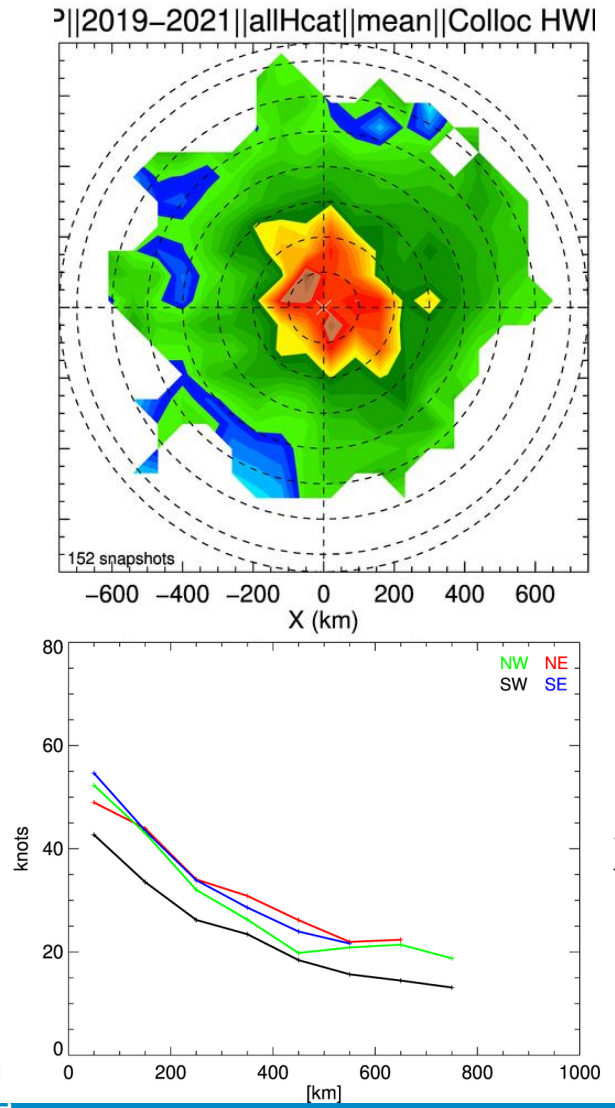
AL



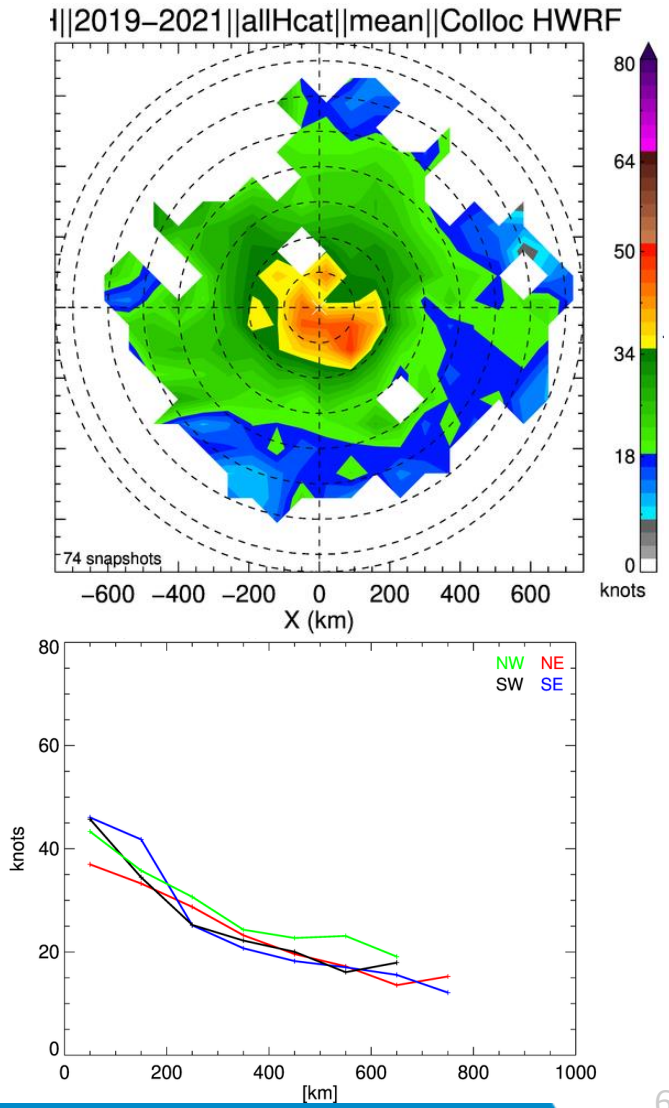
EP



WP

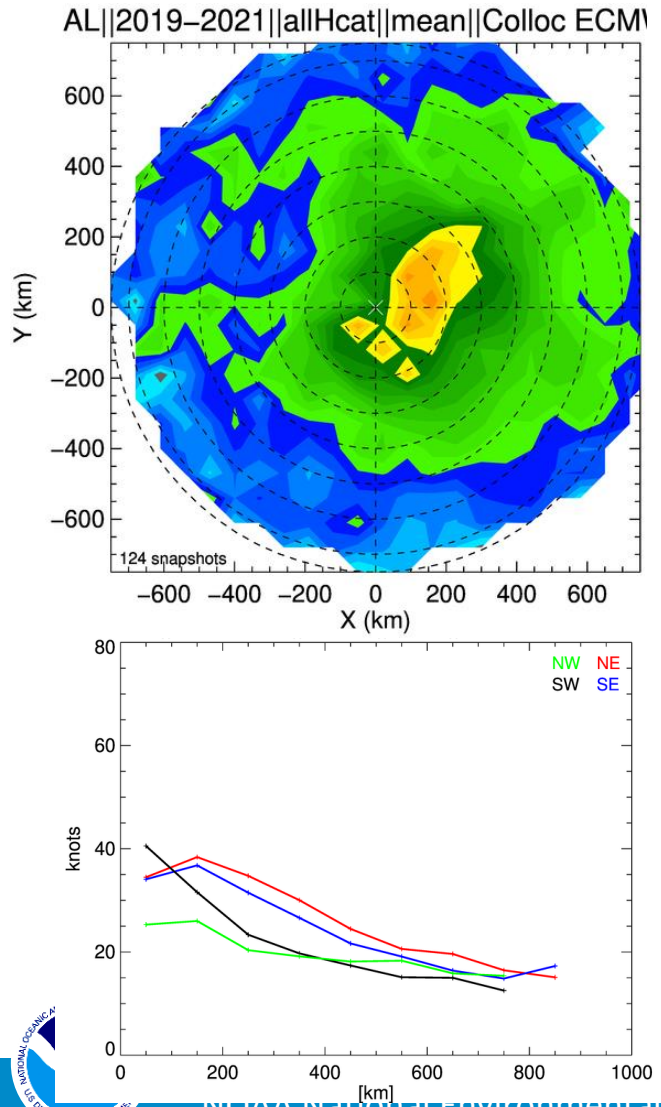


SH

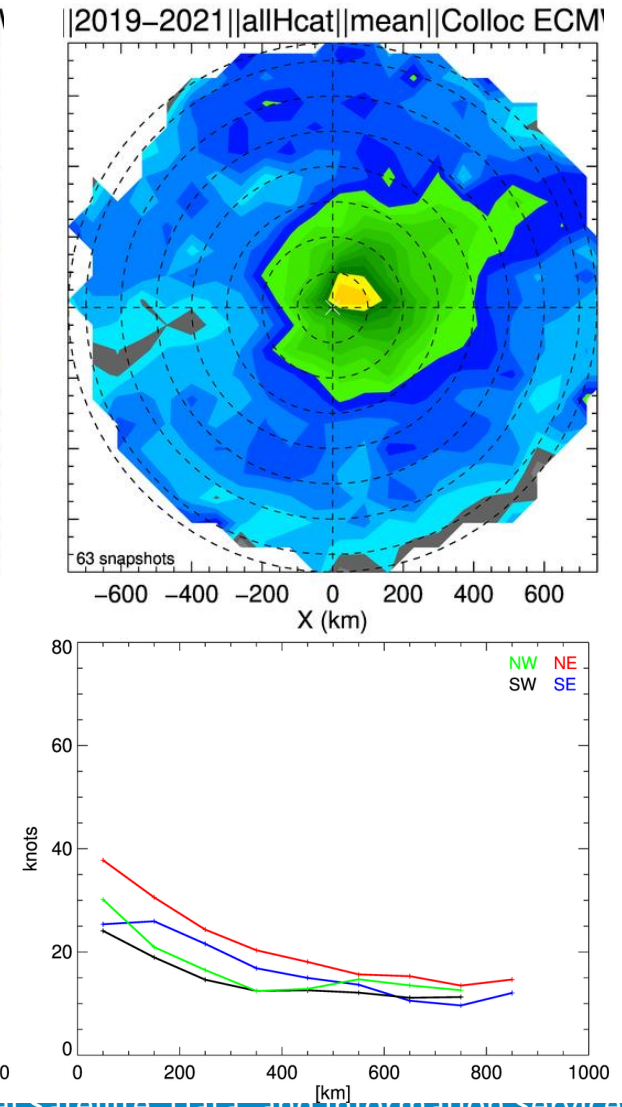


HUR. CAT 1-5 | ECMWF WSPD (time/space collocation with SWIM)

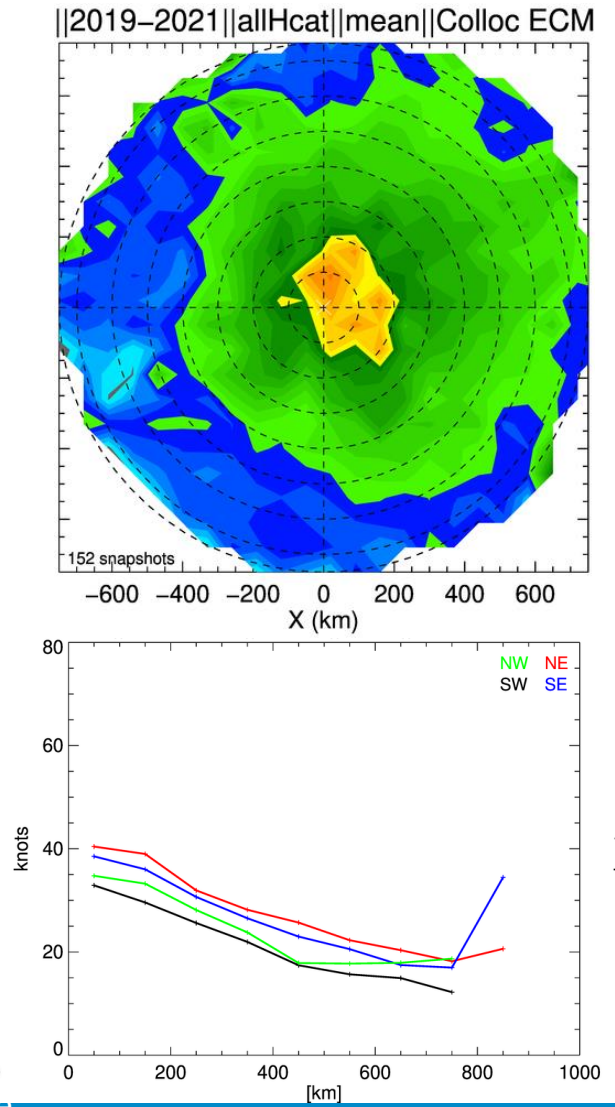
AL



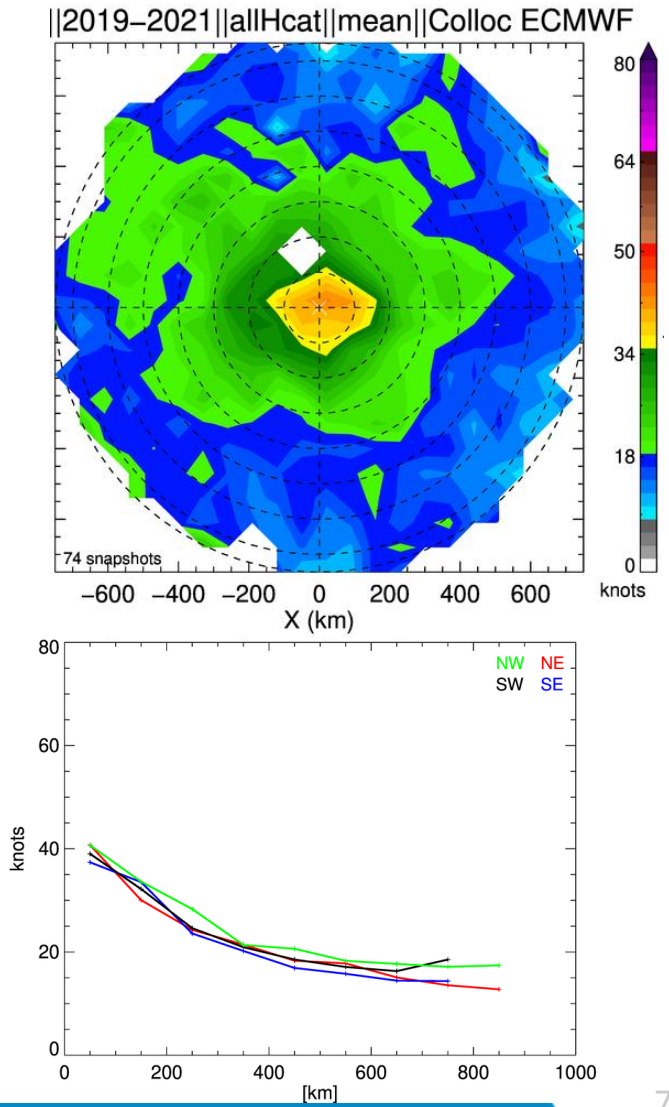
EP



WP

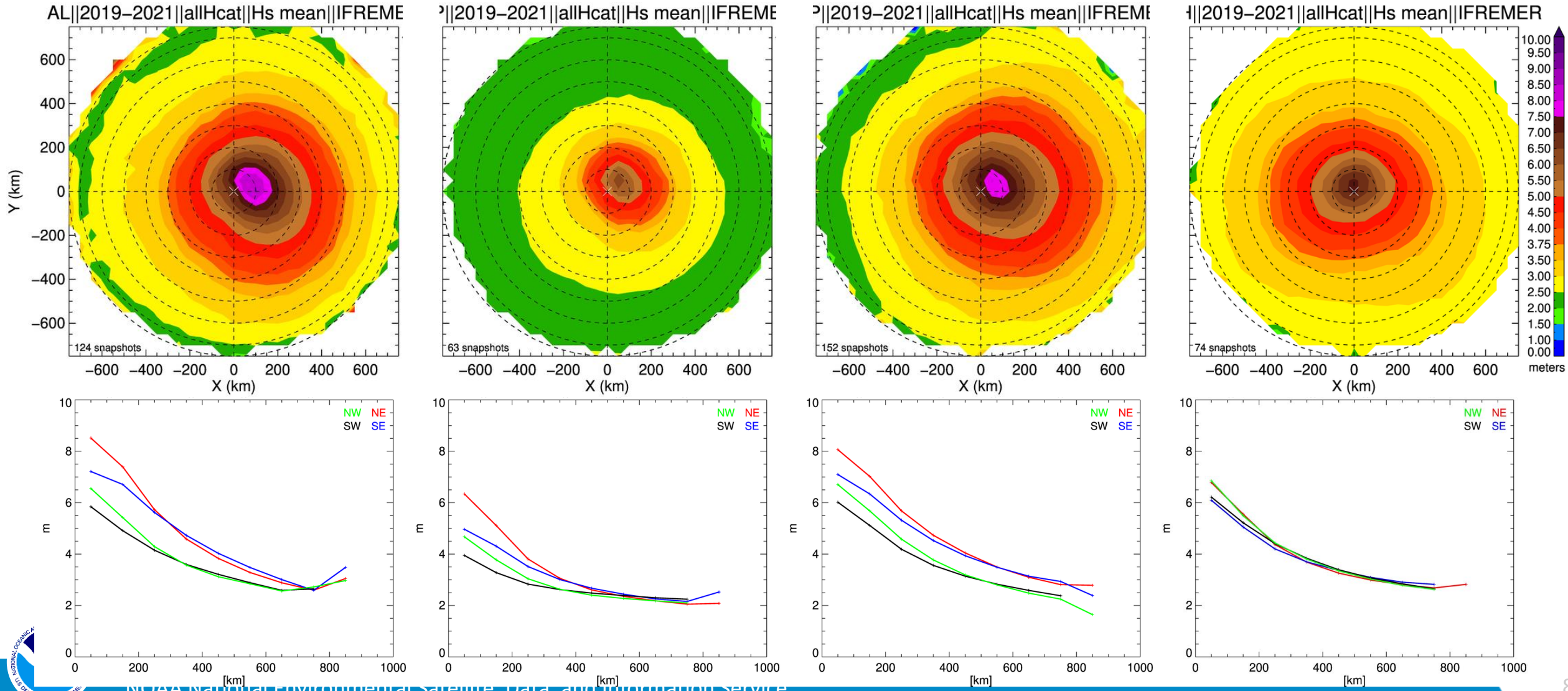


SH



HUR. CAT 1-5 | IFREMER HS (time collocation only)

AL



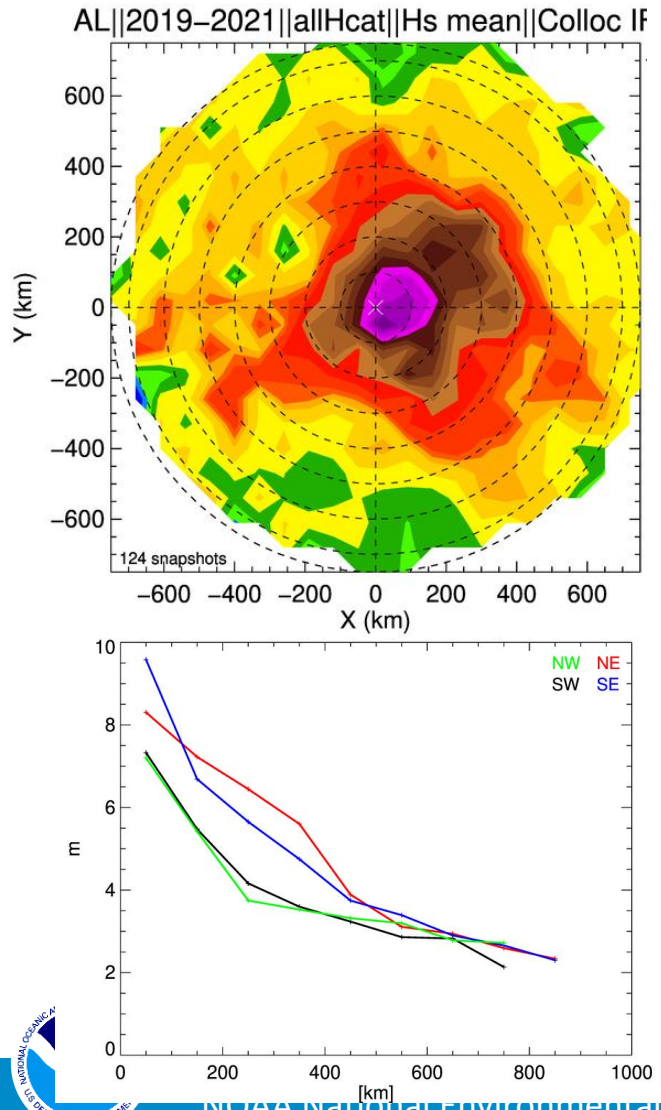
EP

WP

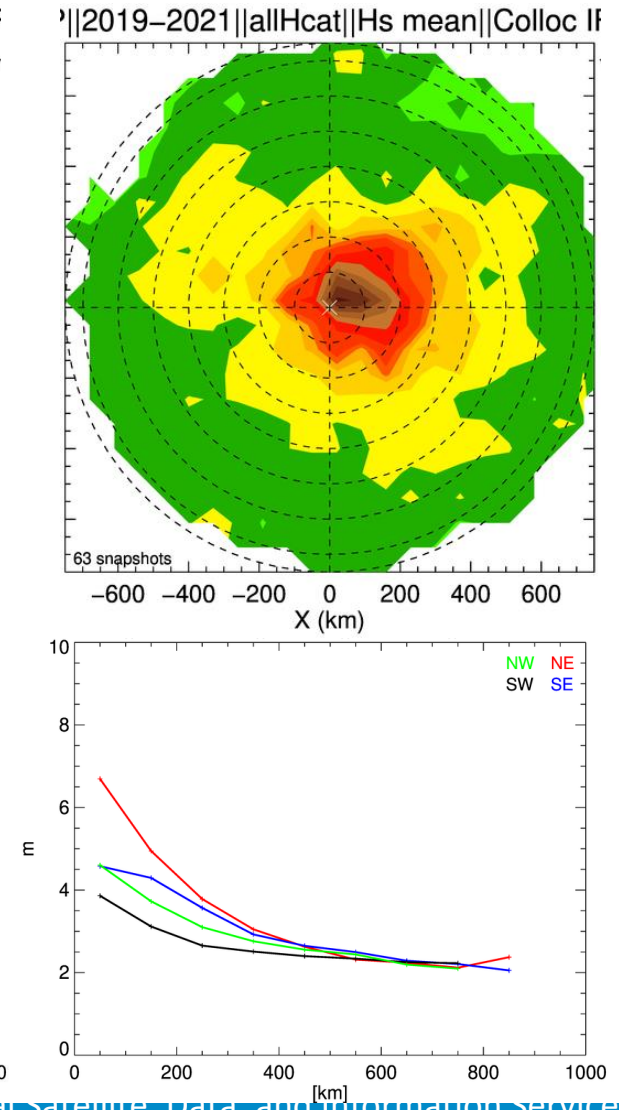
SH

HUR. CAT 1-5 | IFREMER HS (time/space collocation)

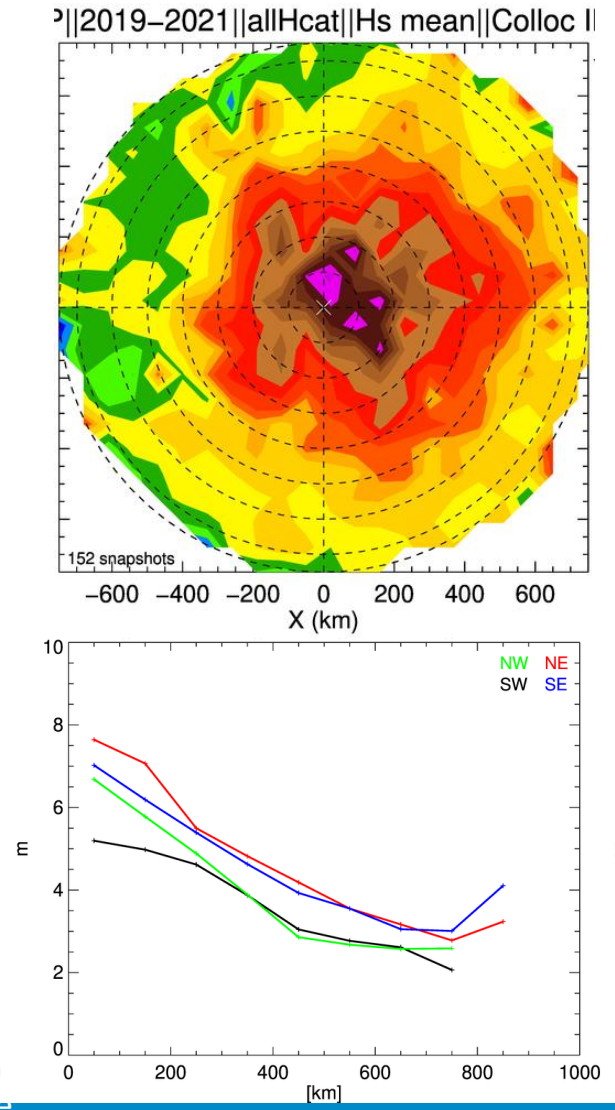
AL



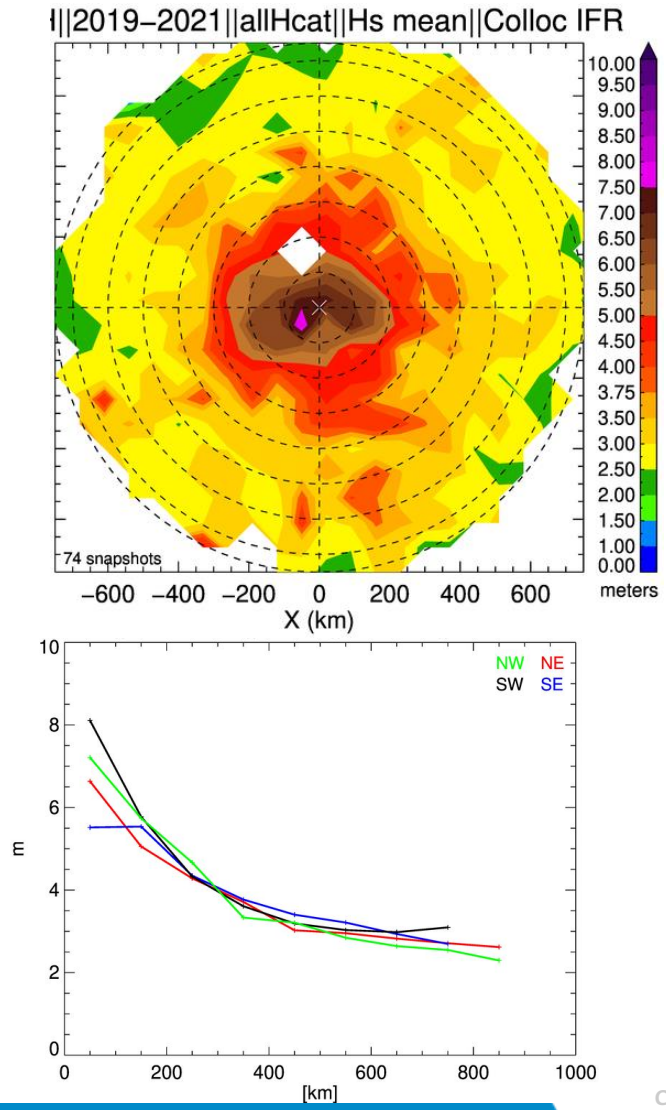
EP



WP

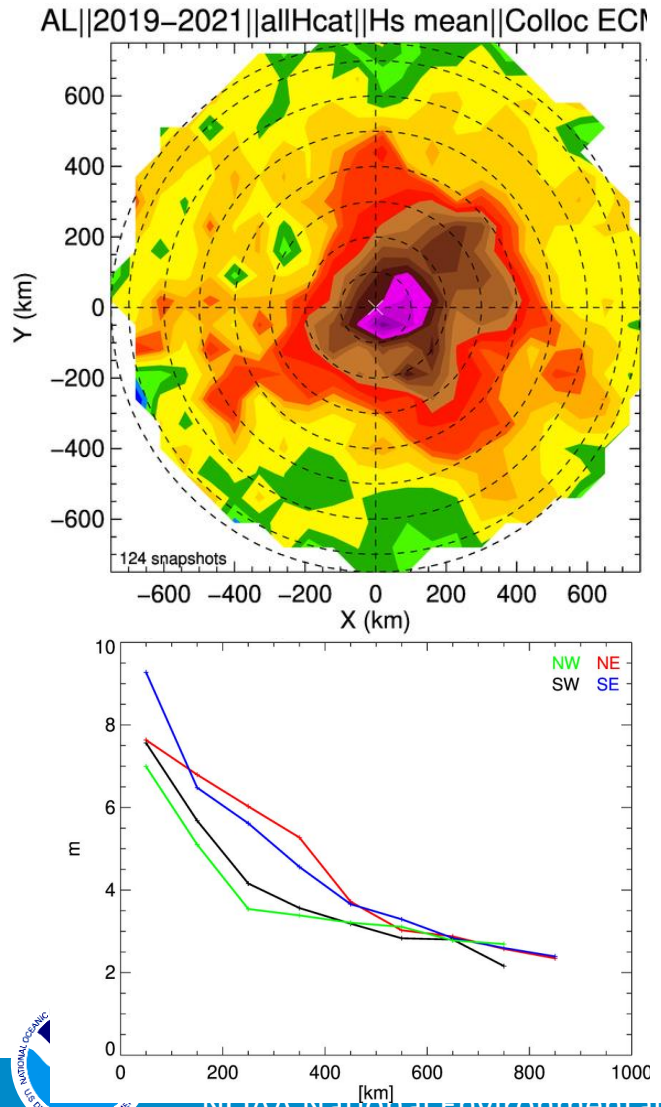


SH

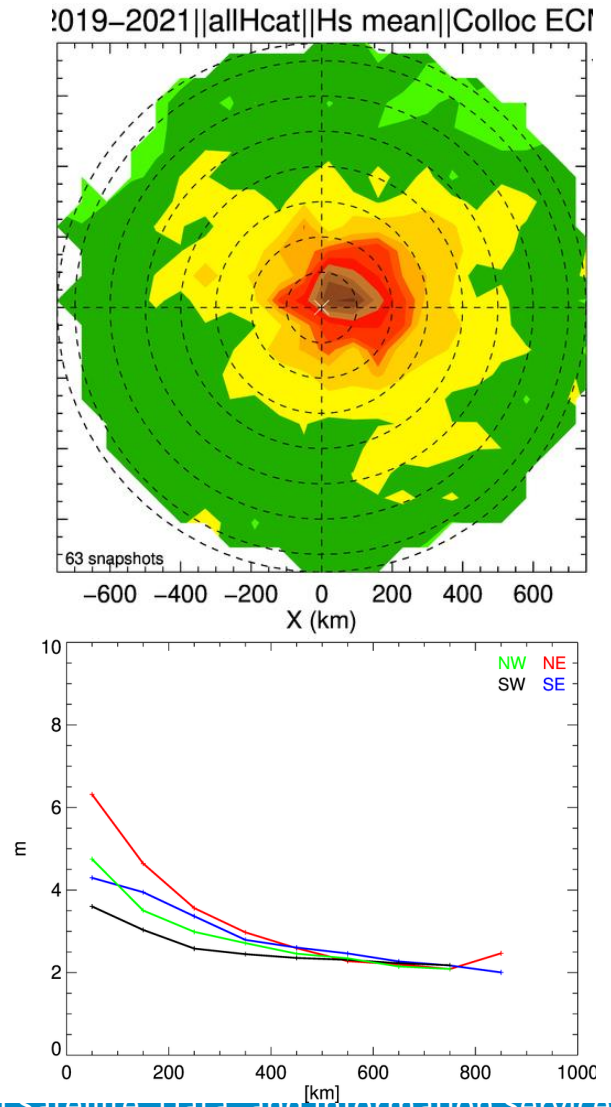


HUR. CAT 1-5 | ECMWF HS (time/space collocation)

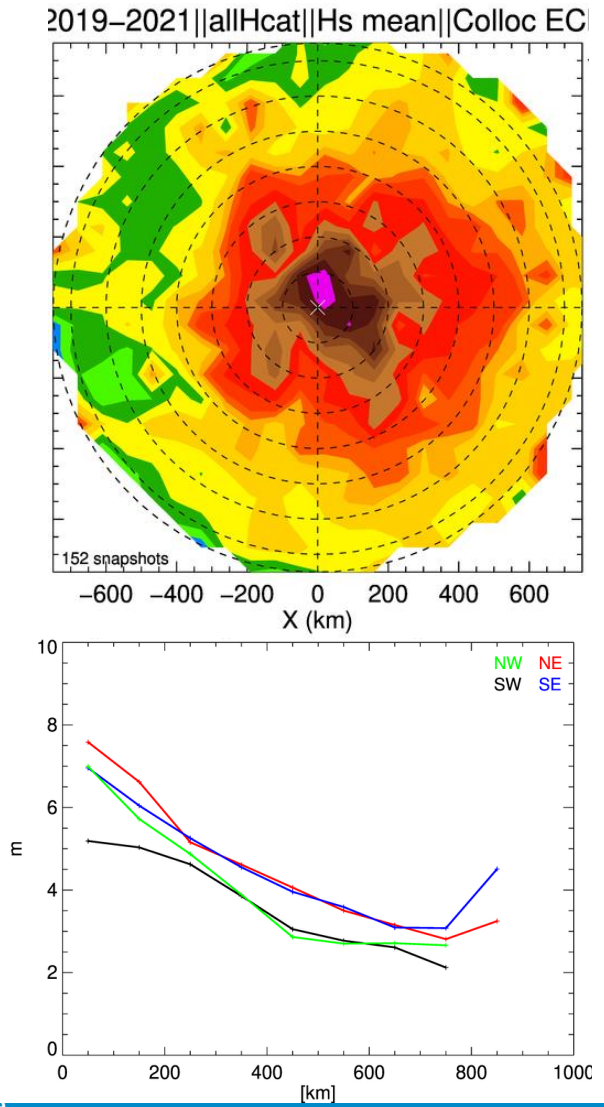
AL



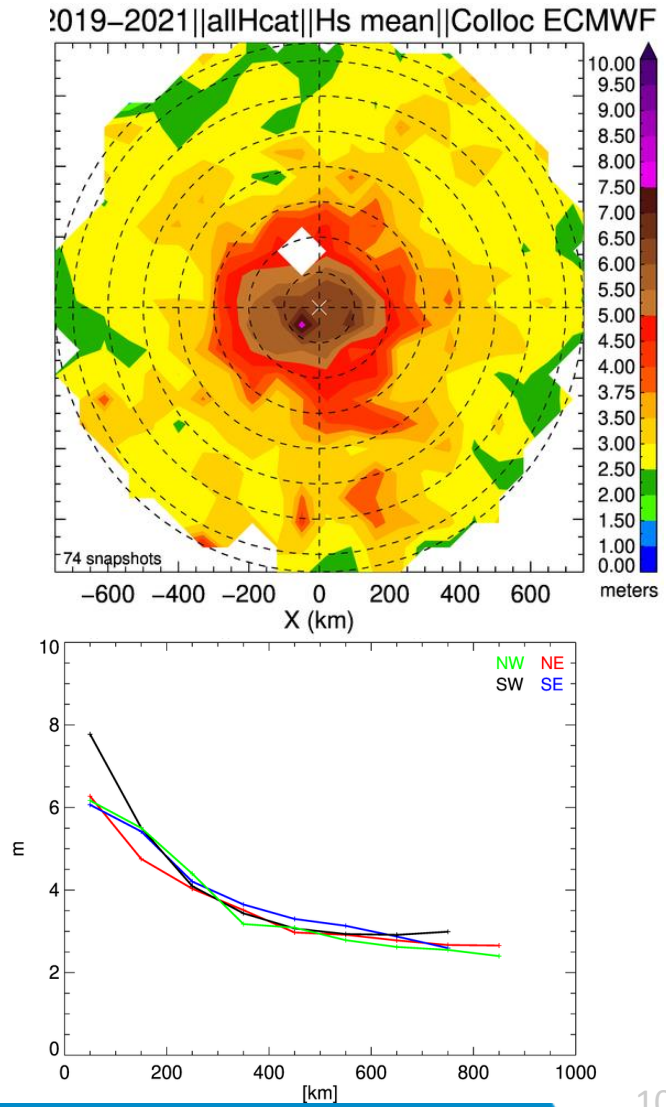
EP



WP

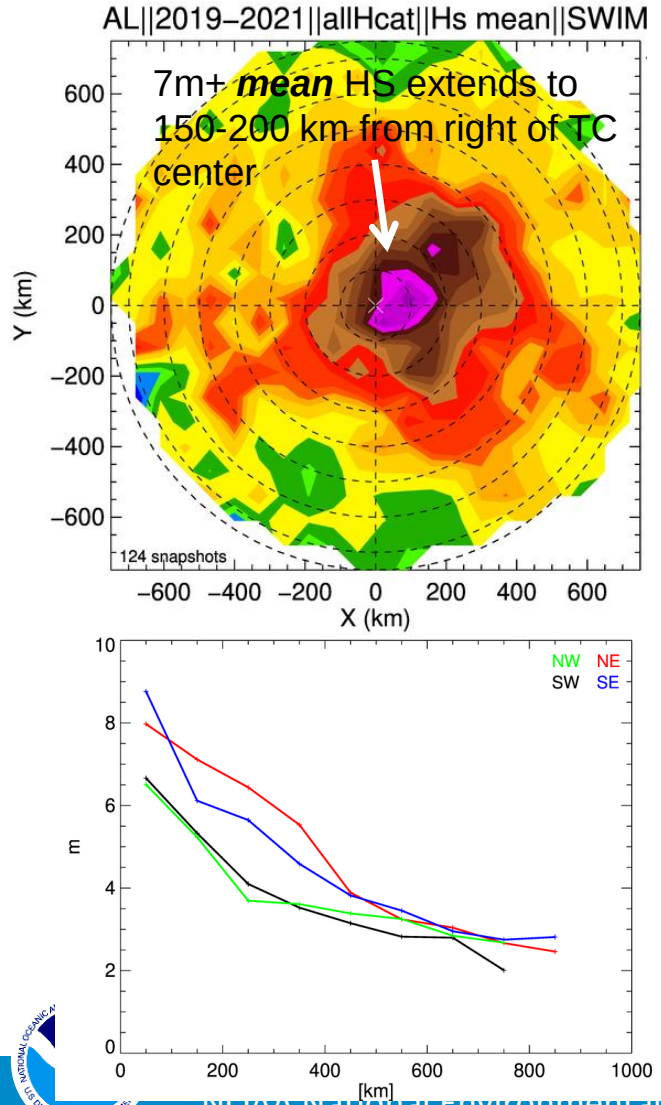


SH

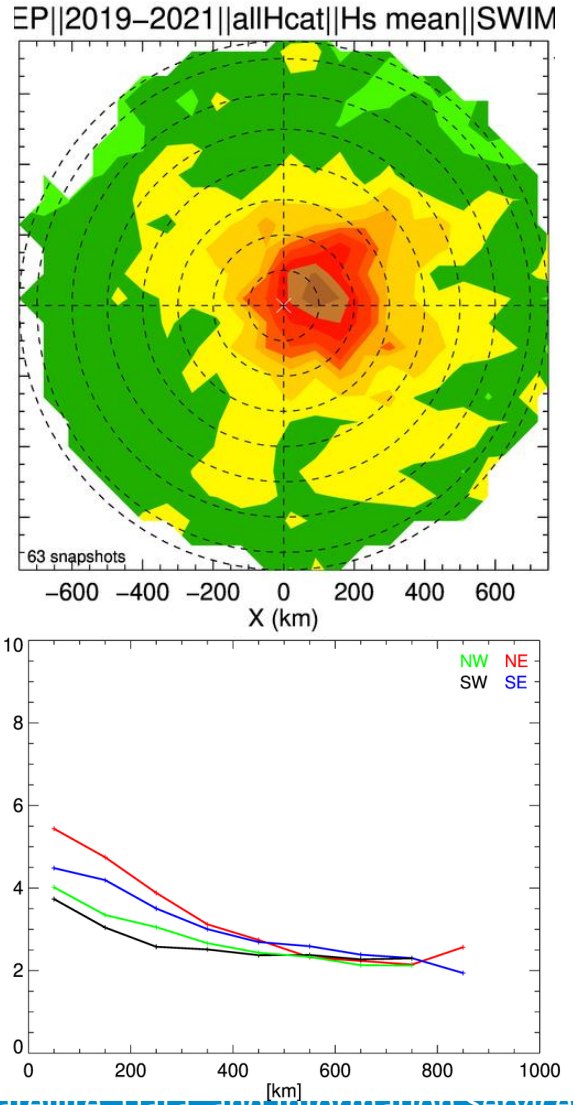


HUR. CAT 1-5 | SWIM HS

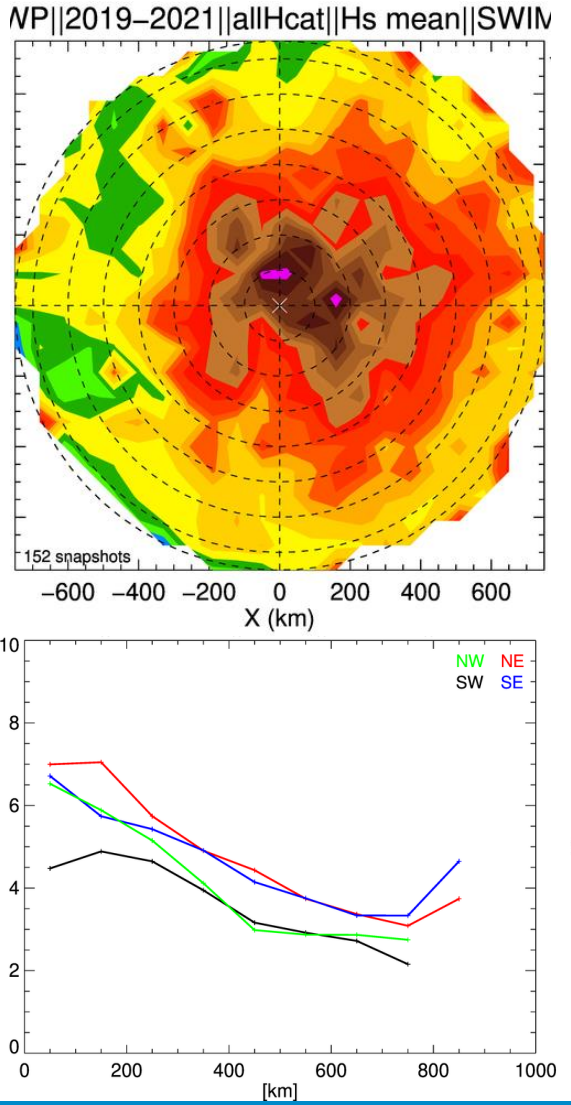
AL



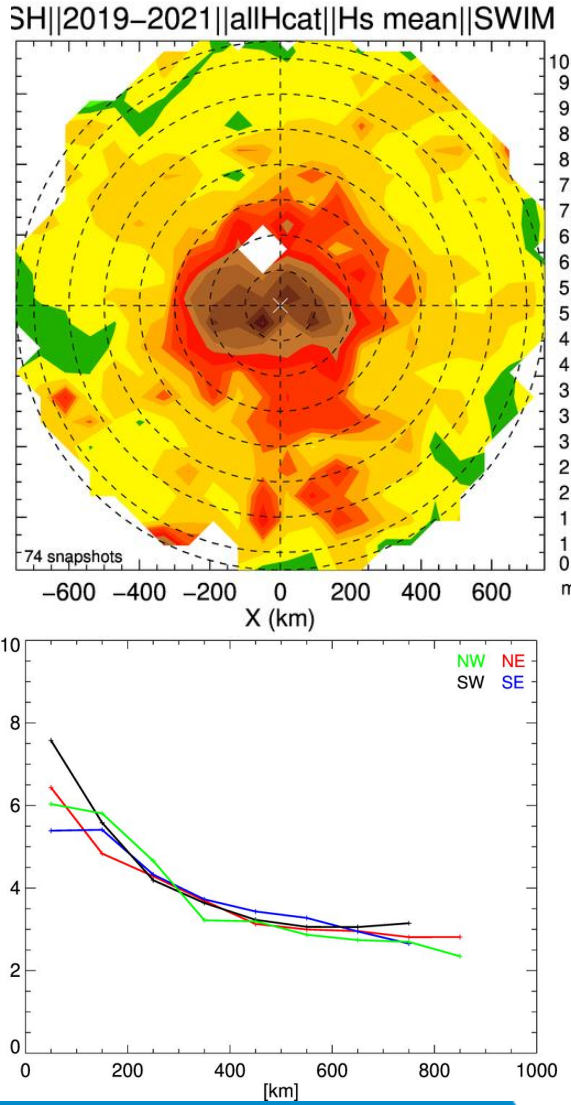
EP



WP

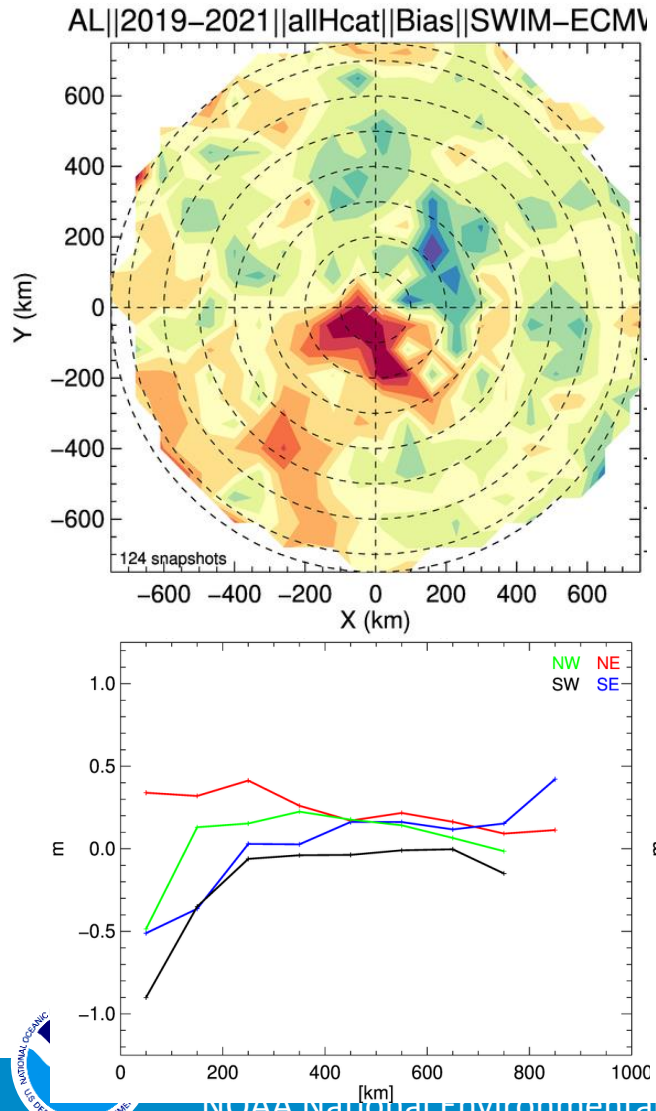


SH

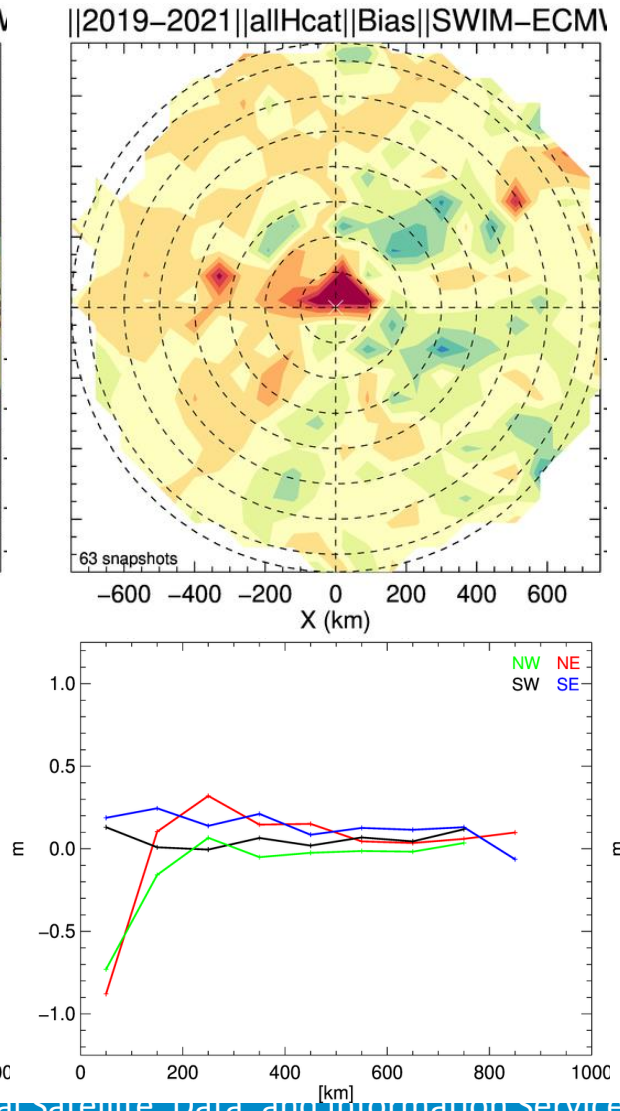


HUR. CAT 1-5 | HS BIAS (SWIM-ECMWF)

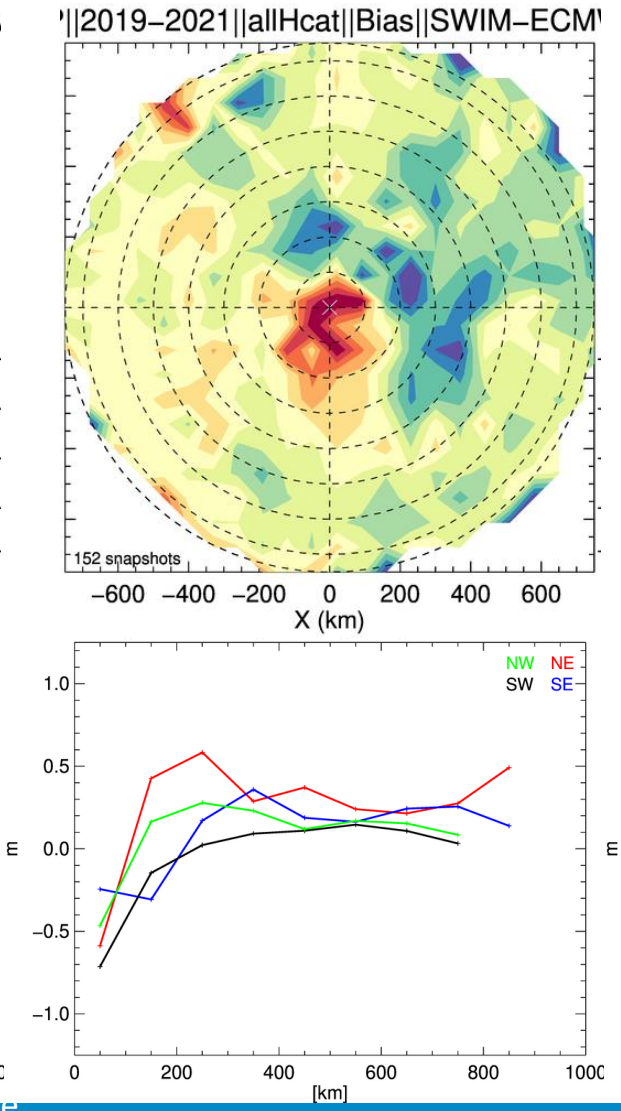
AL



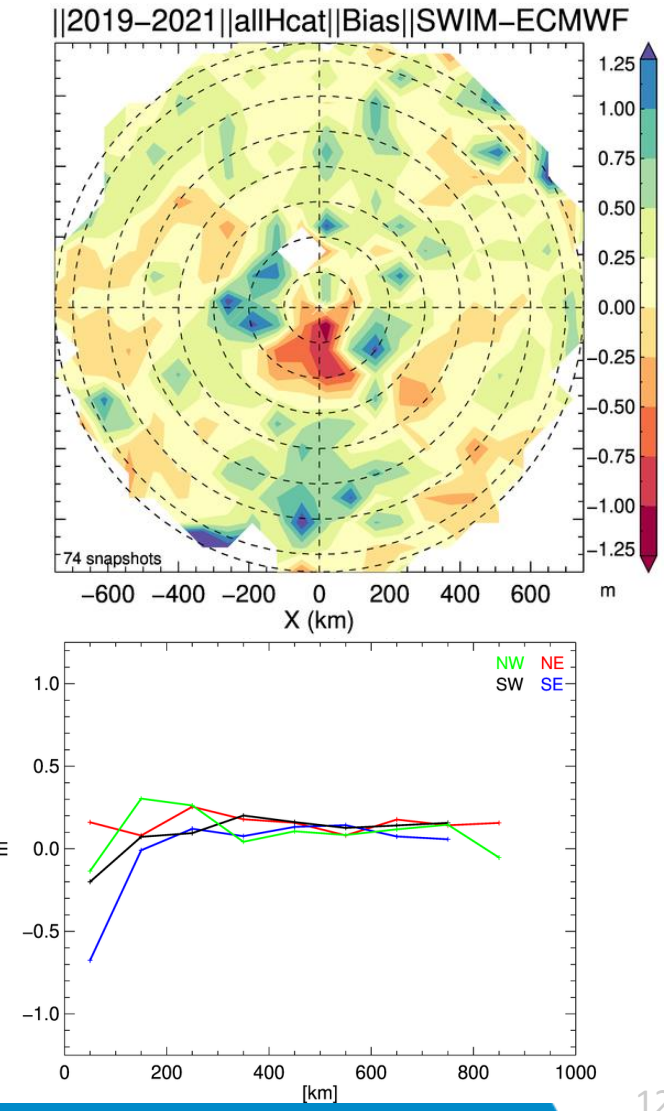
EP



WP

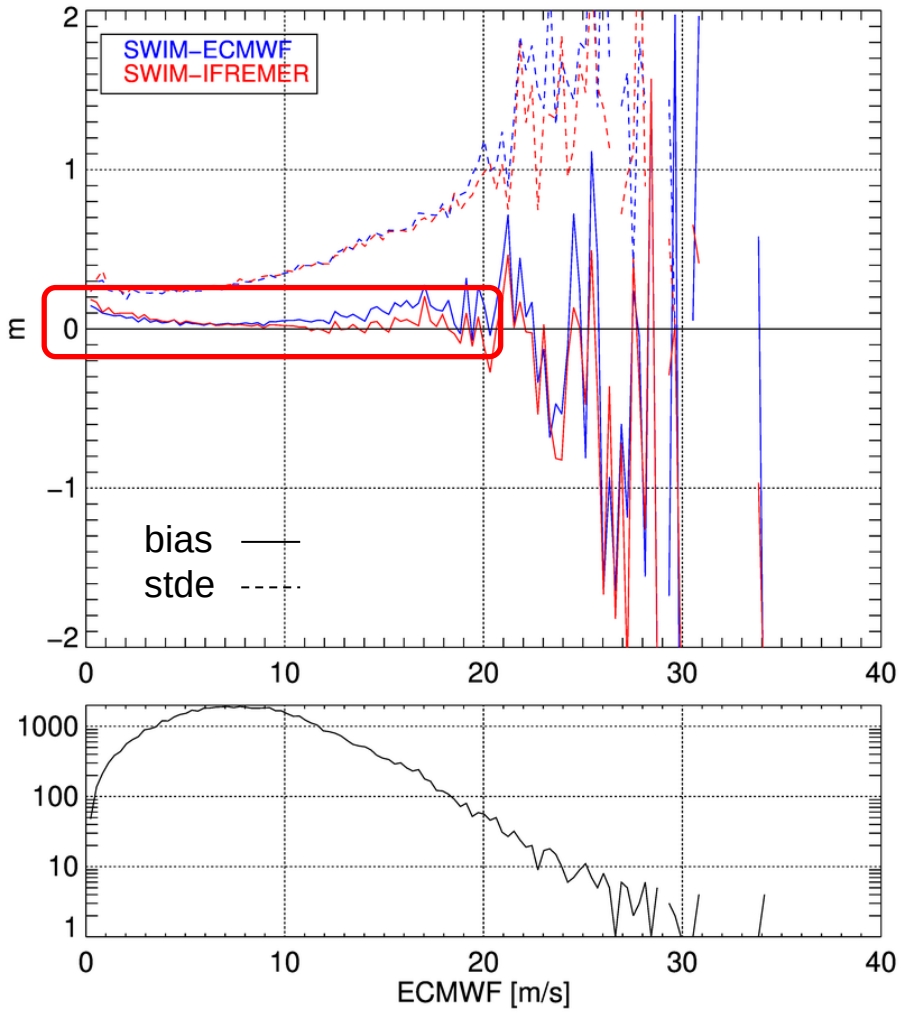


SH

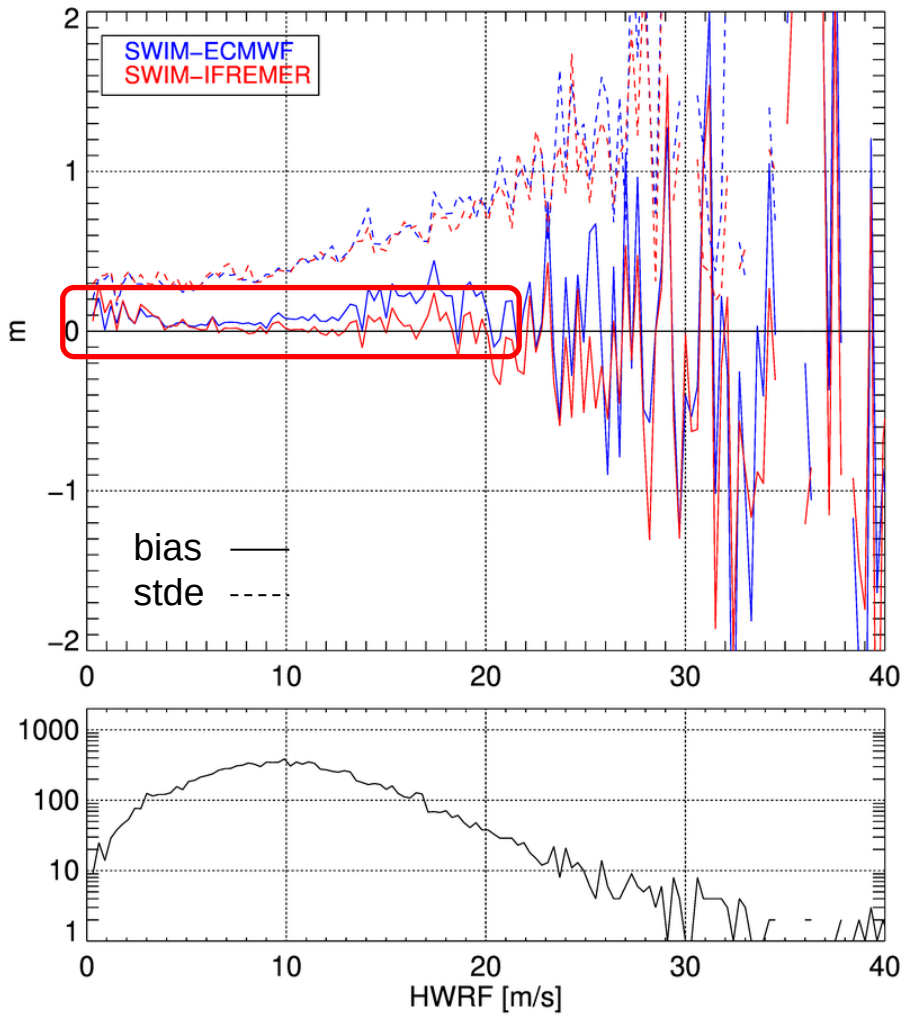


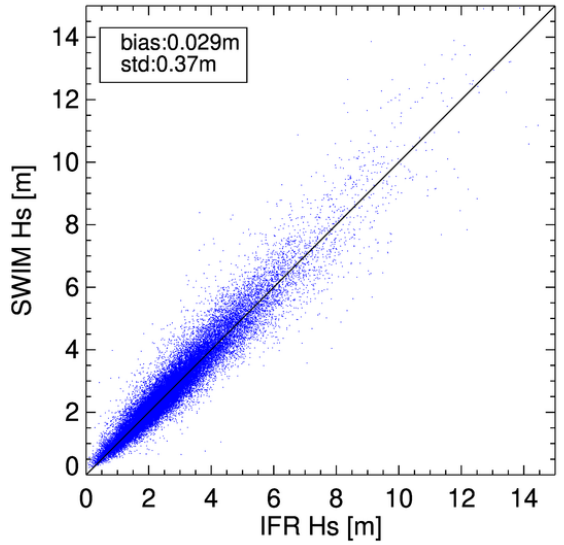
Overall Hs statistics within TC environment (all basins combined)

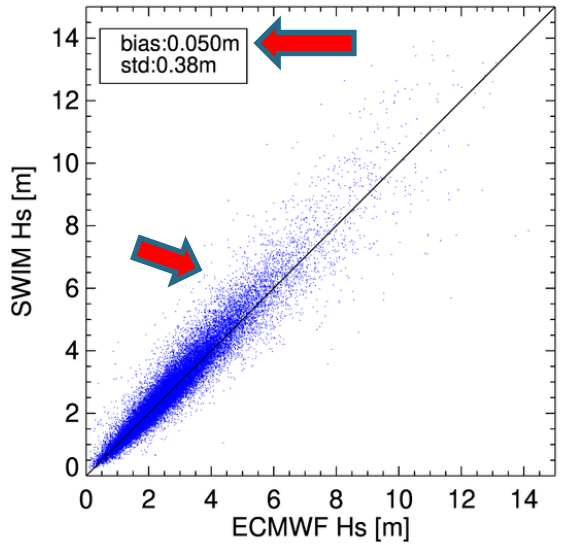
Hs bias and std vs. ECMWF wind



Hs bias and std vs. HWRF wind

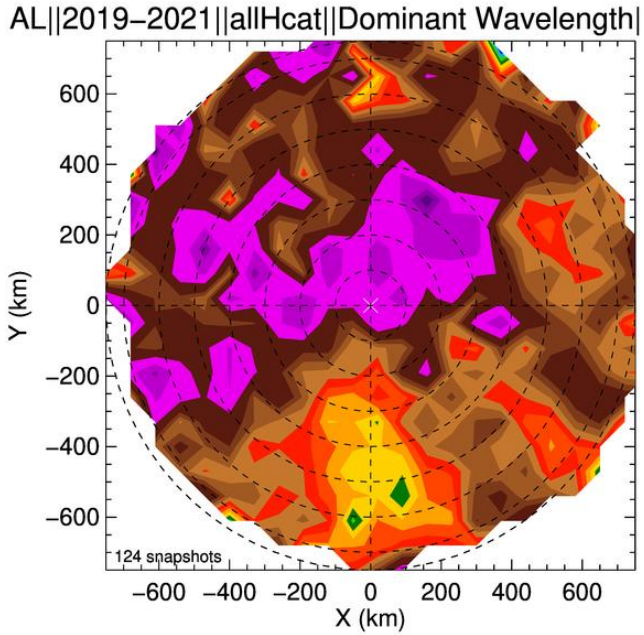


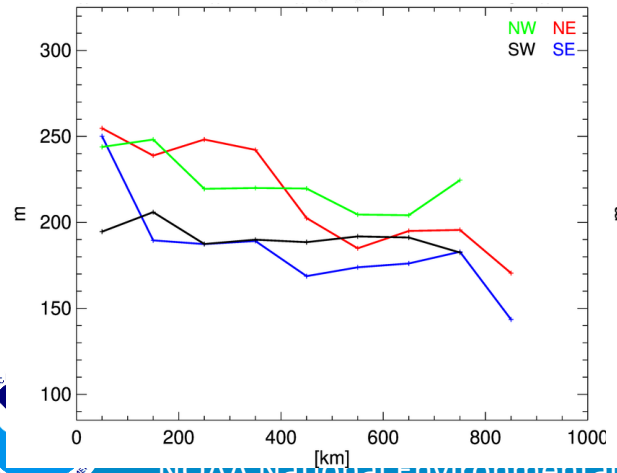




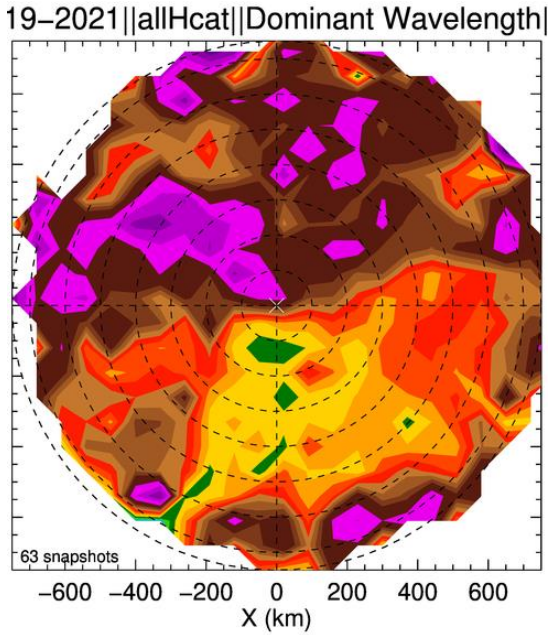
HUR. CAT 1-5 | SWIM dominant wavelength

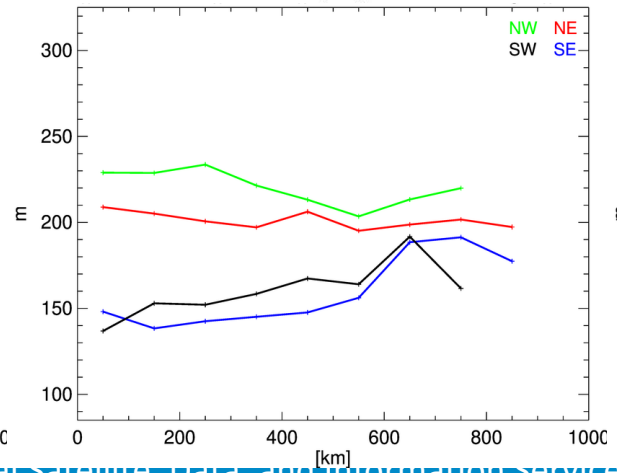
AL



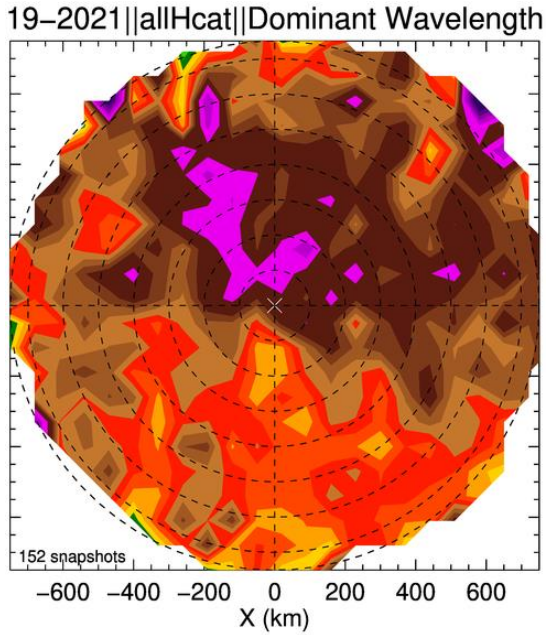


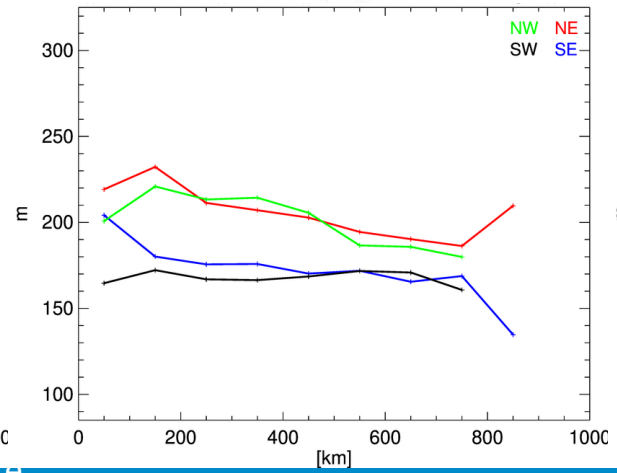
EP



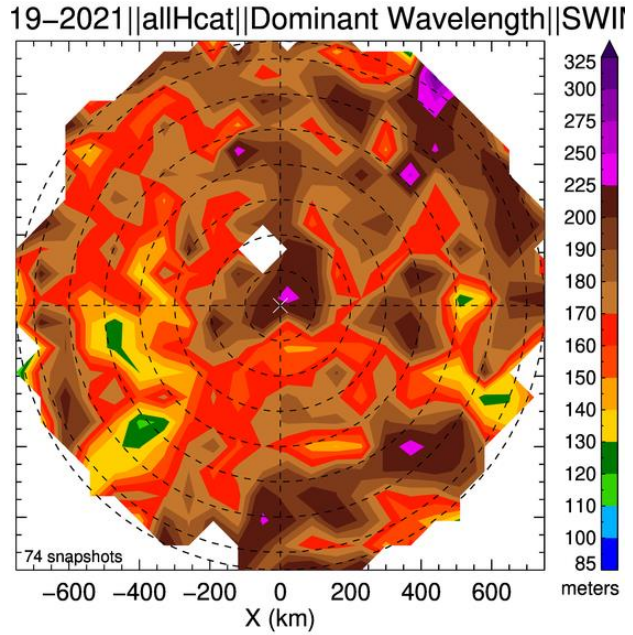


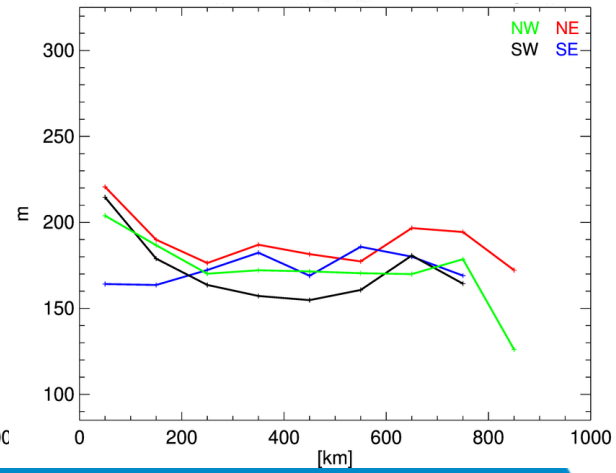
WP





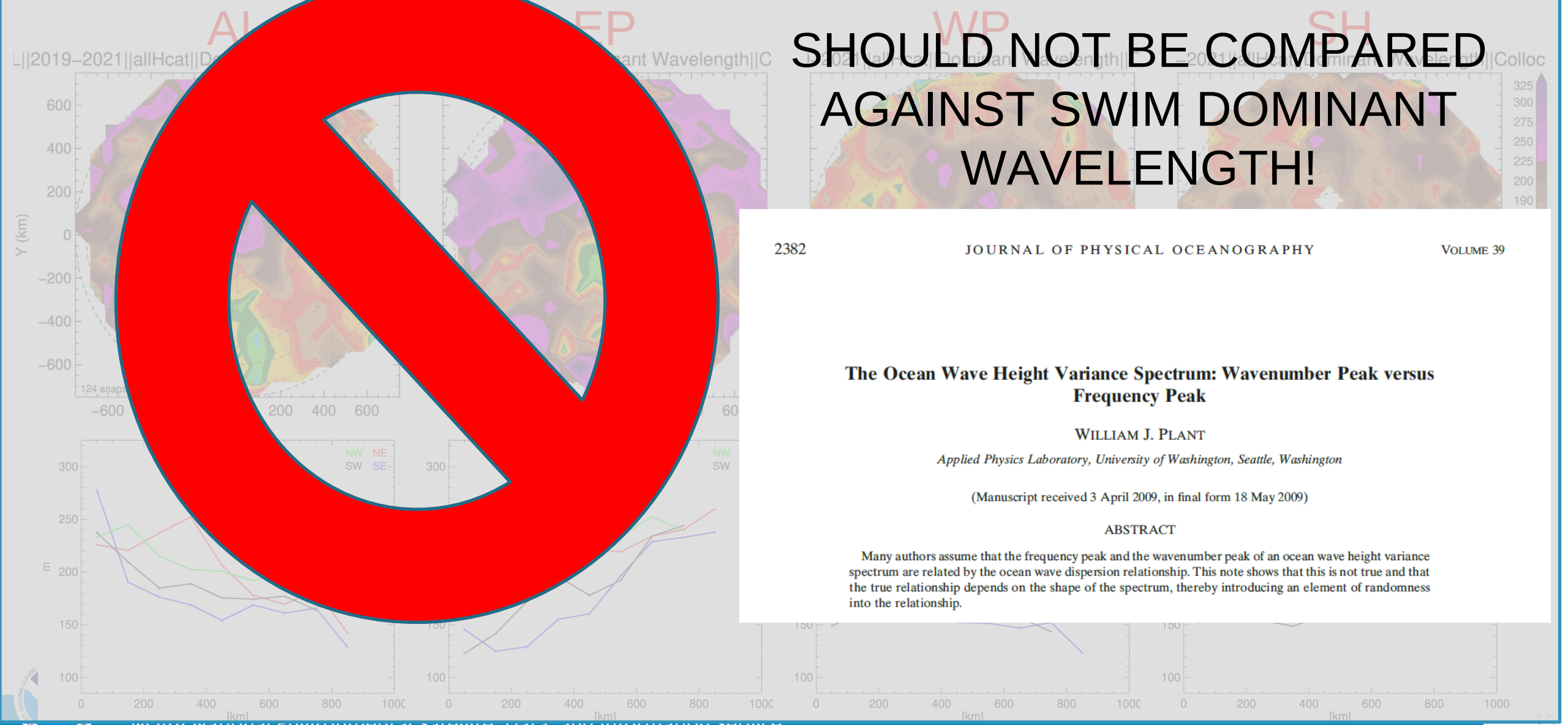
SH





HUR. CAT 1-5 | IFREMER dominant wavelength (derived from fp)

SHOULD NOT BE COMPARED AGAINST SWIM DOMINANT WAVELENGTH!



The Ocean Wave Height Variance Spectrum: Wavenumber Peak versus Frequency Peak

WILLIAM J. PLANT

Applied Physics Laboratory, University of Washington, Seattle, Washington

(Manuscript received 3 April 2009, in final form 18 May 2009)

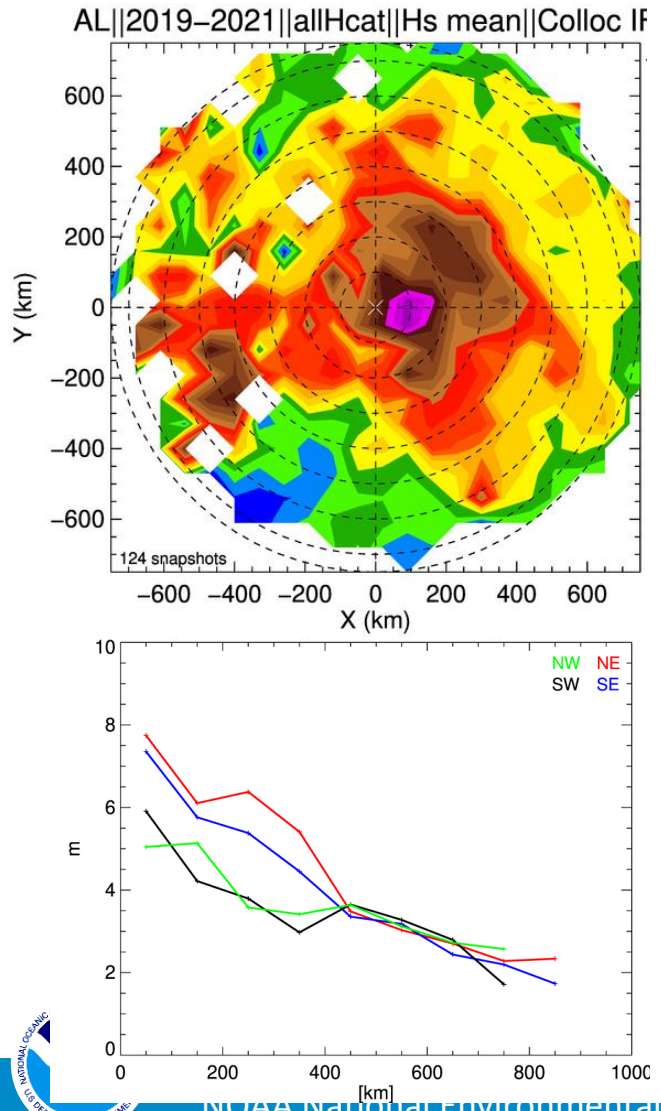
ABSTRACT

Many authors assume that the frequency peak and the wavenumber peak of an ocean wave height variance spectrum are related by the ocean wave dispersion relationship. This note shows that this is not true and that the true relationship depends on the shape of the spectrum, thereby introducing an element of randomness into the relationship.

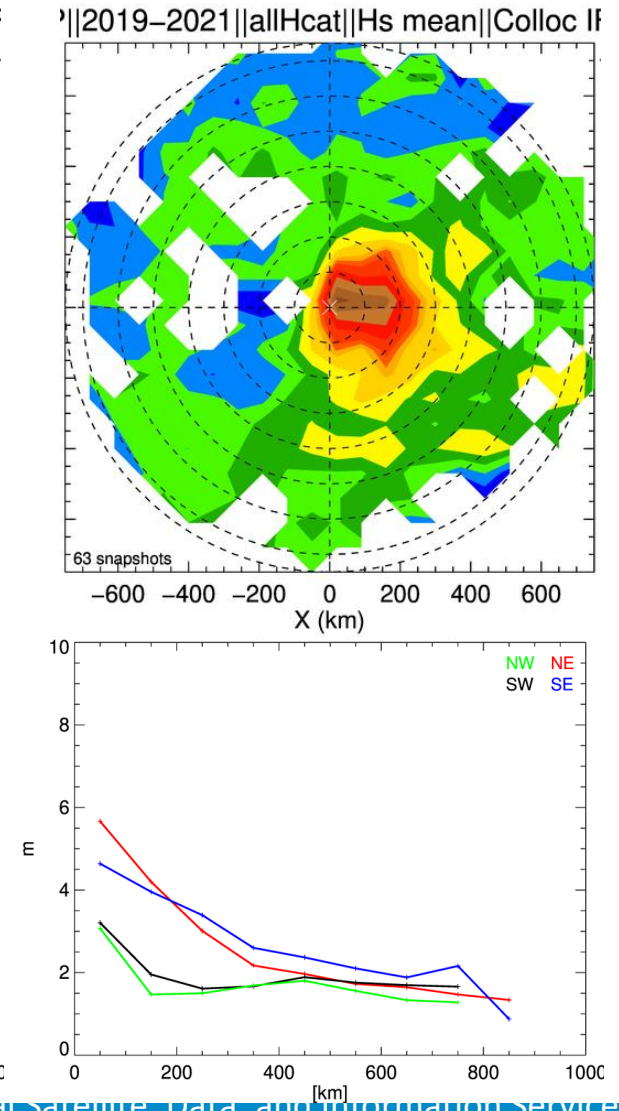
A look at HS from the first two spectrum partitions referred to as “PHS0” and “PHS1”

HUR. CAT 1-5 | IFREMER PHS0 (time/space collocation)

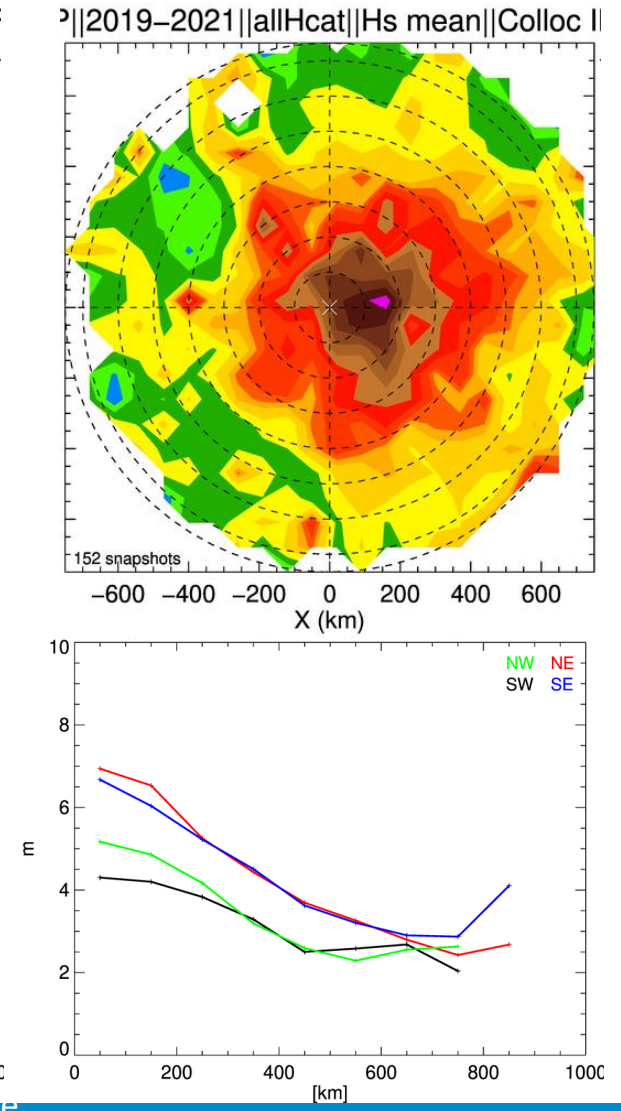
AL



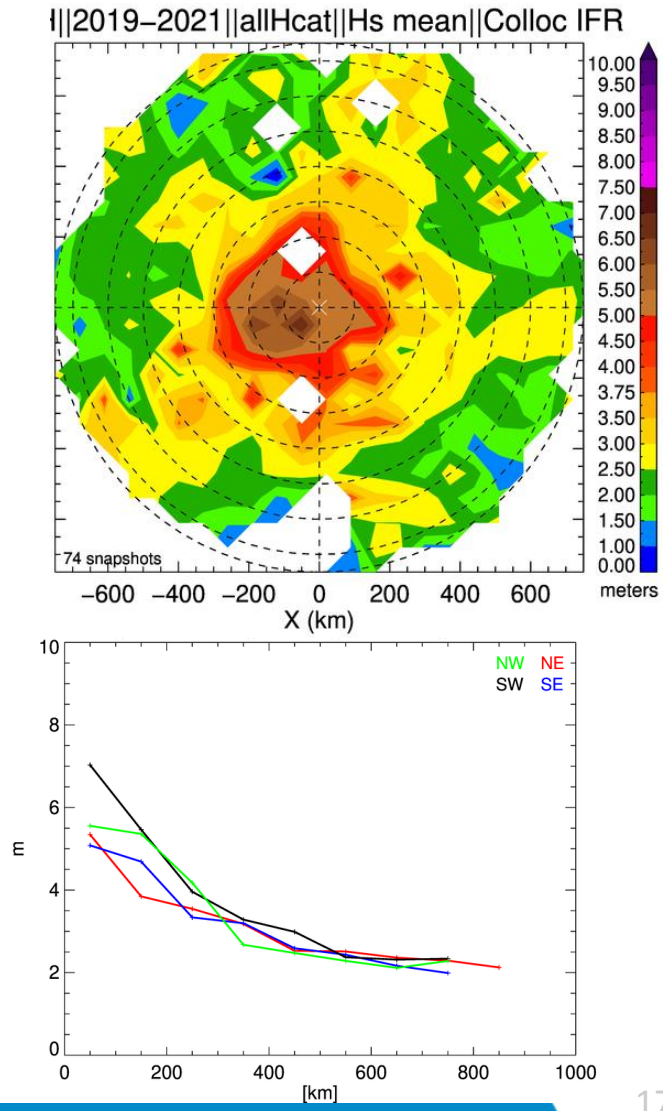
EP



WP

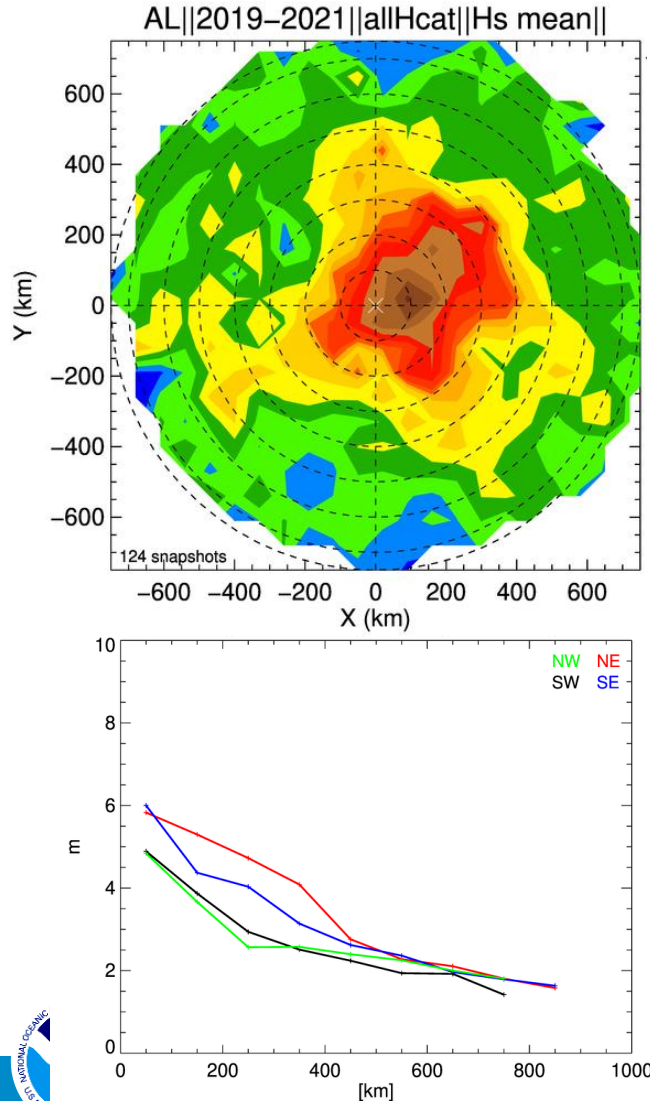


SH

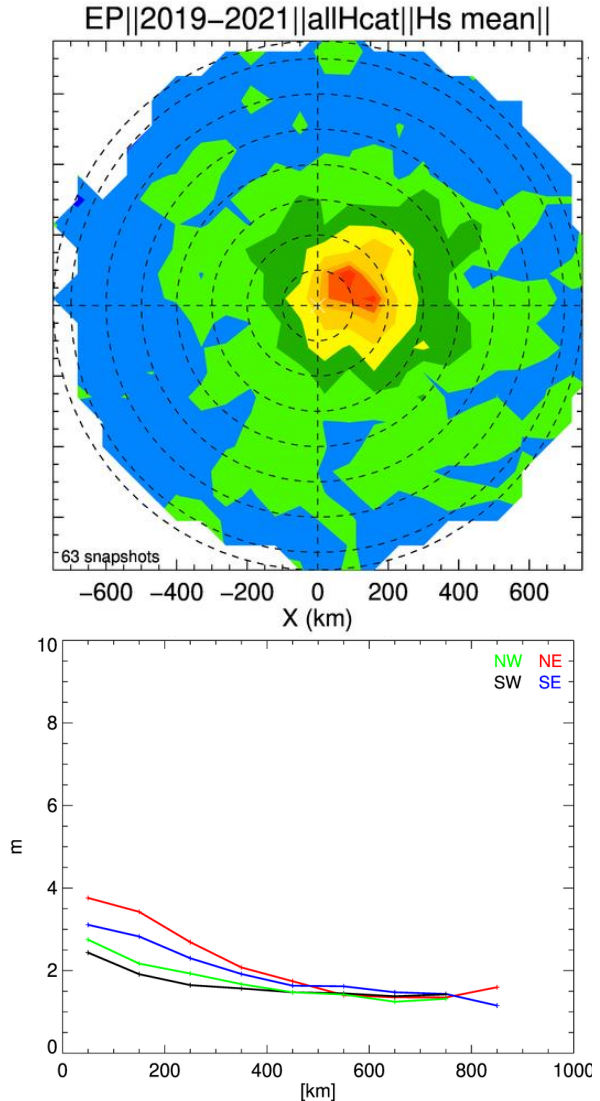


HUR. CAT 1-5 | SWIM PHS0

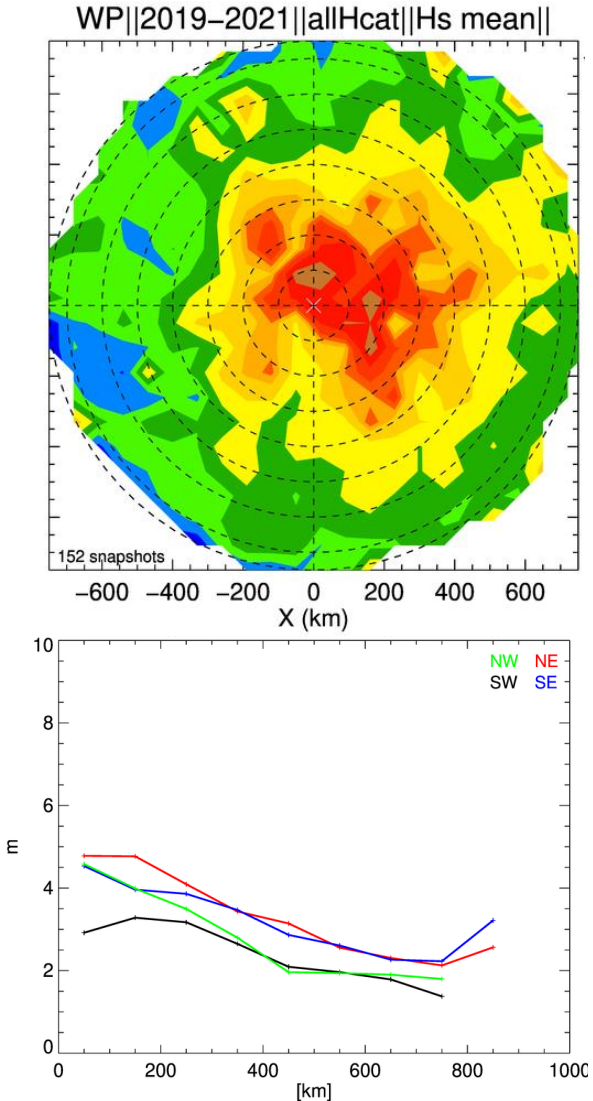
AL



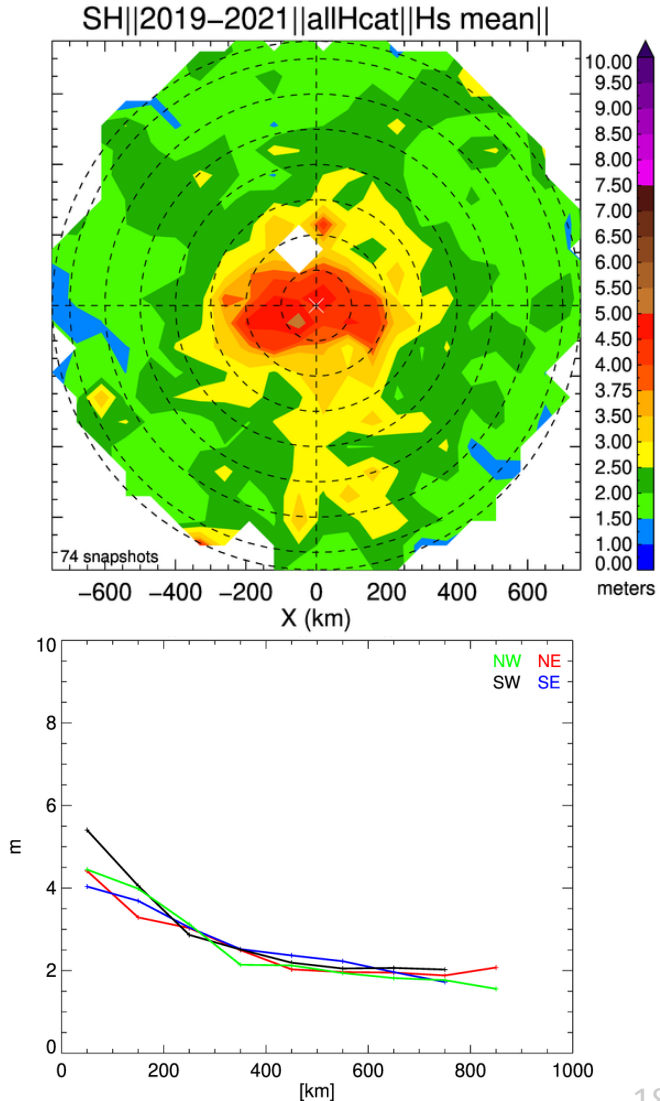
EP



WP

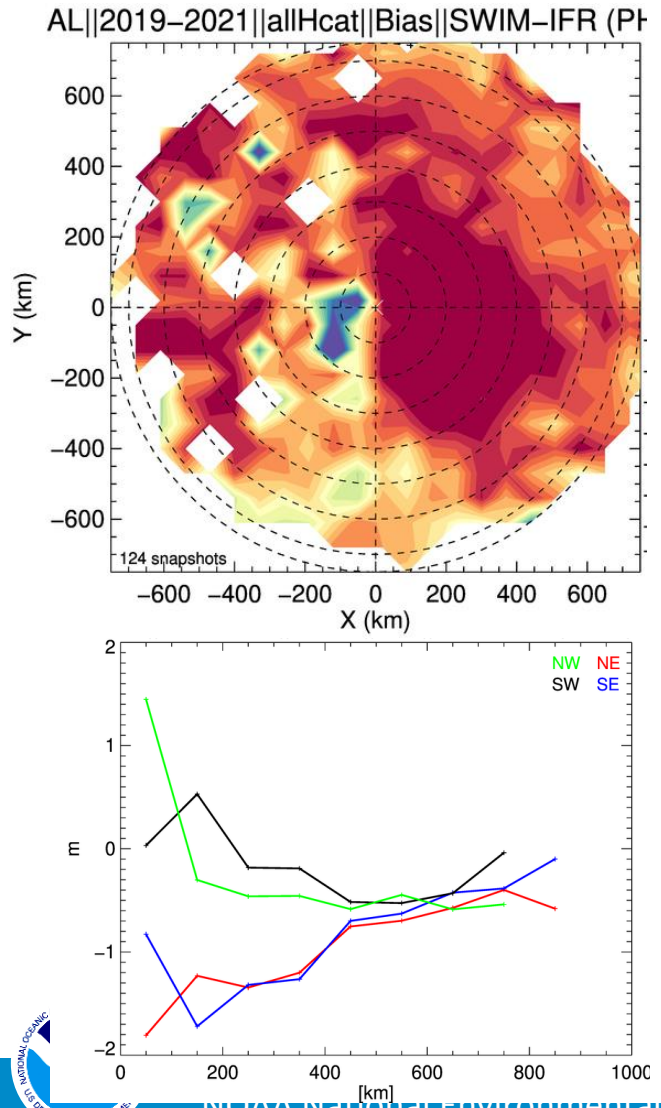


SH

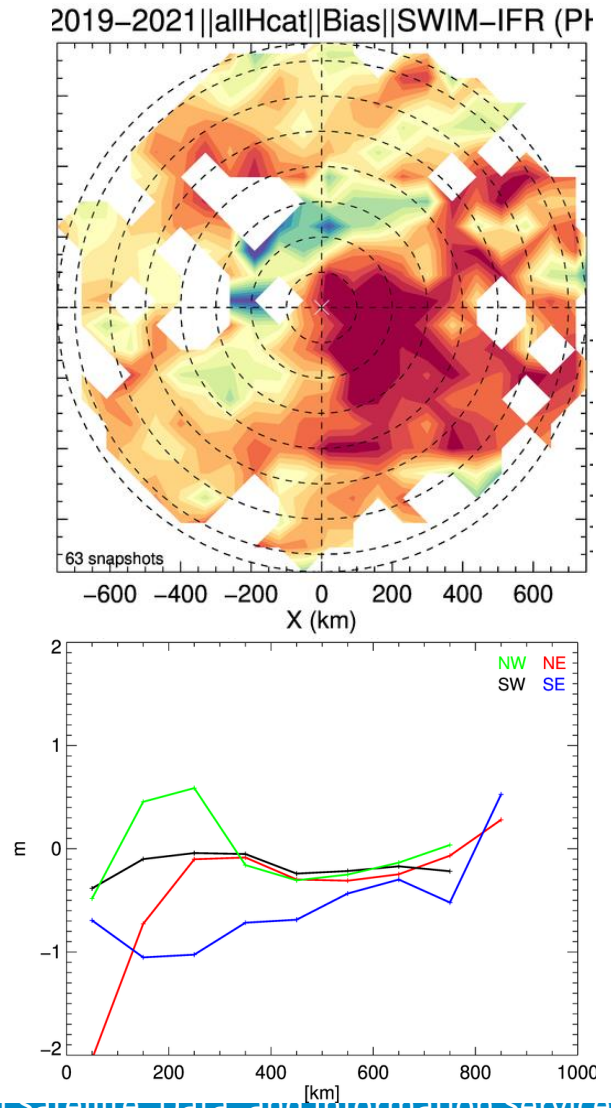


HUR. CAT 1-5 | PHS0 Bias SWIM-IFREMER

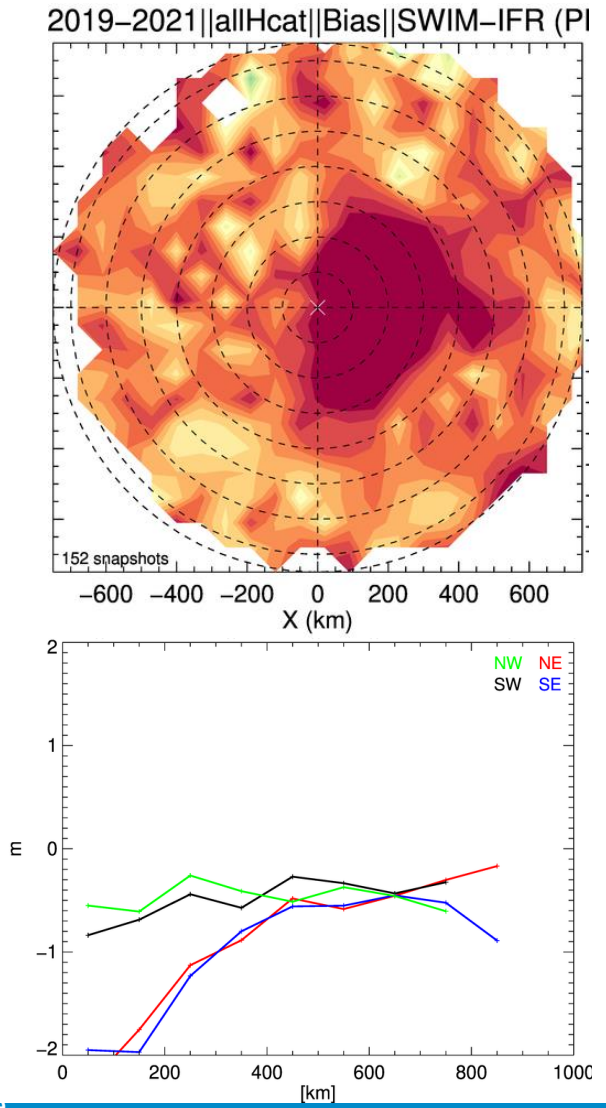
AL



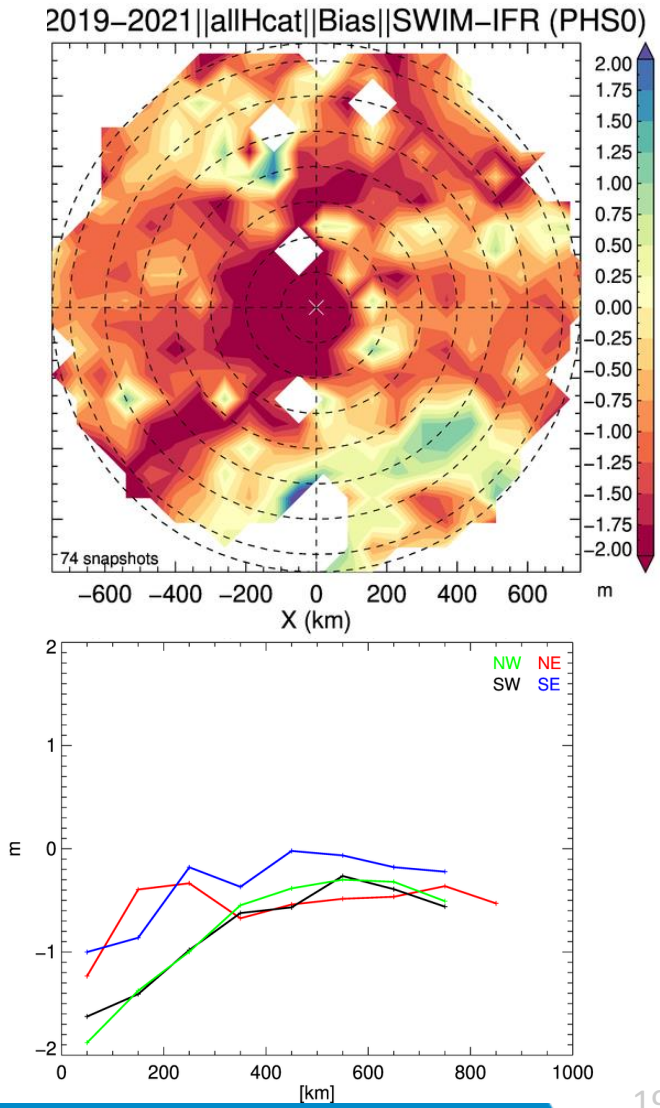
EP



WP

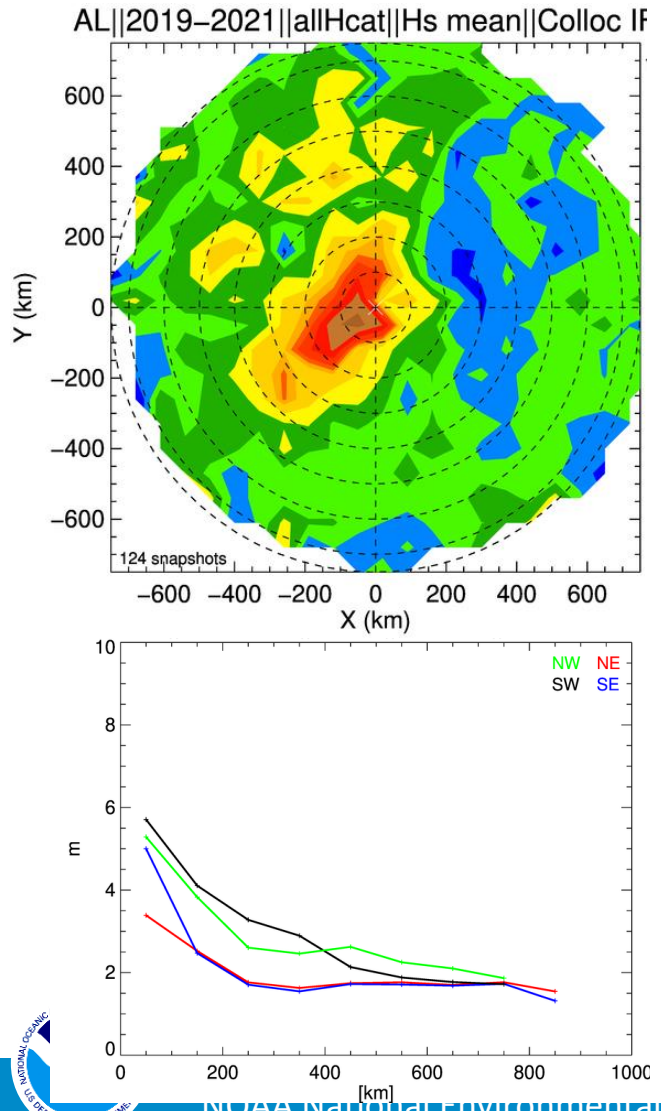


SH

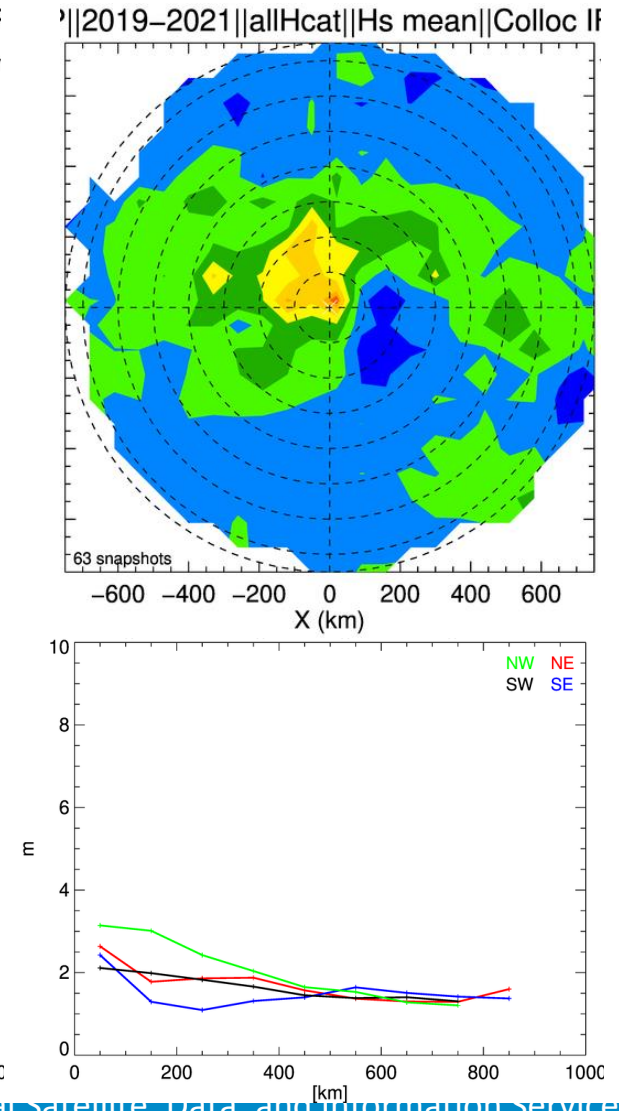


HUR. CAT 1-5 | IFREMER PHS1 (time/space collocation)

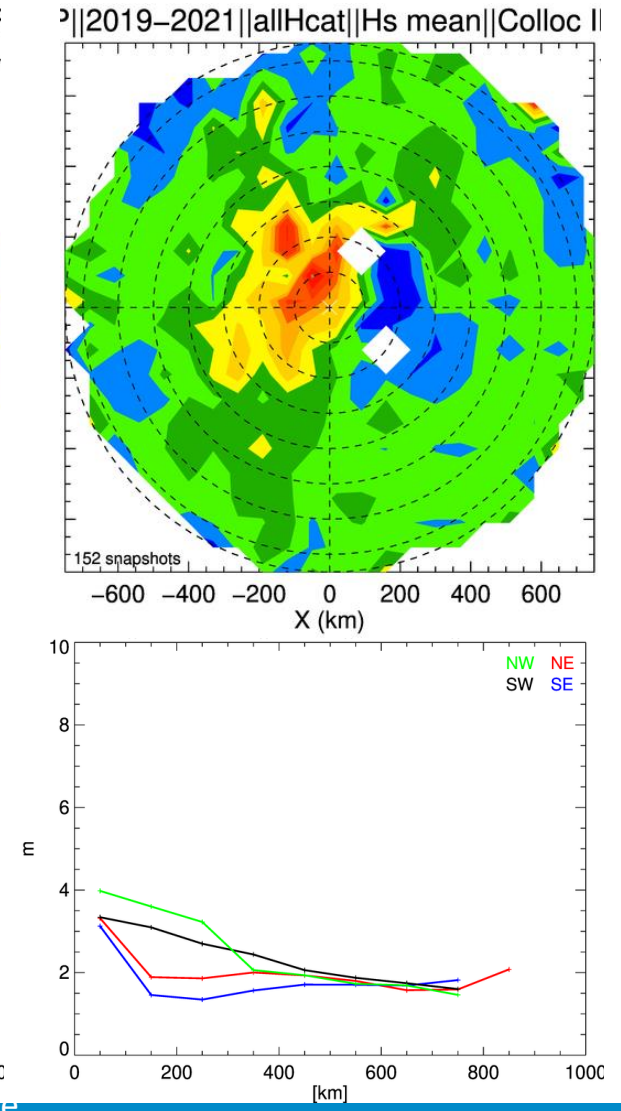
AL



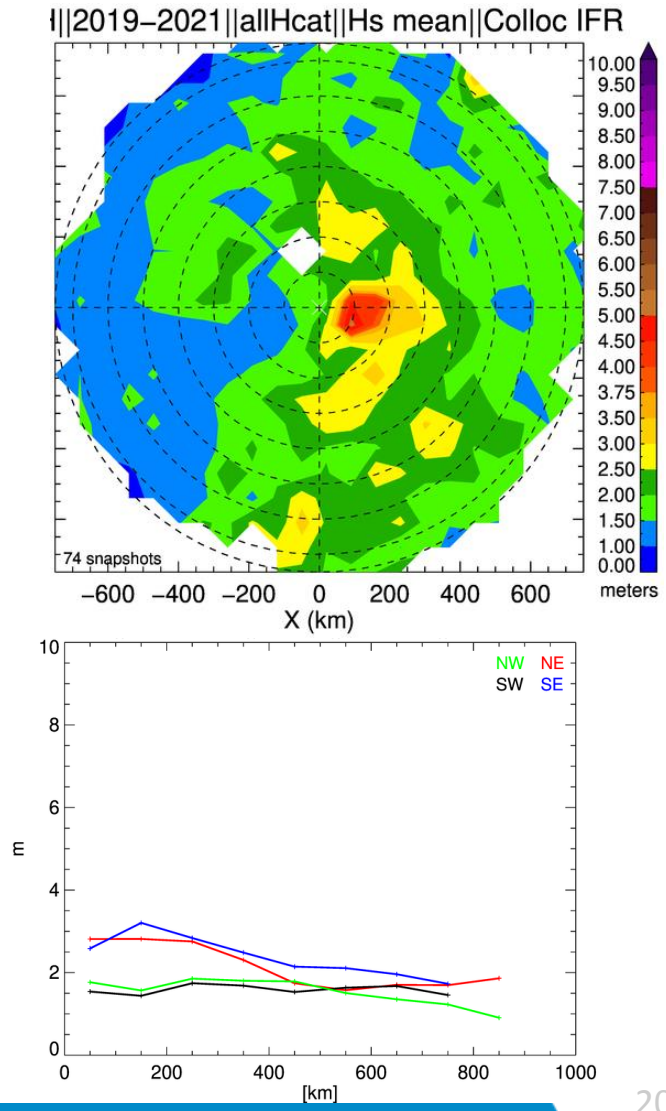
EP



WP

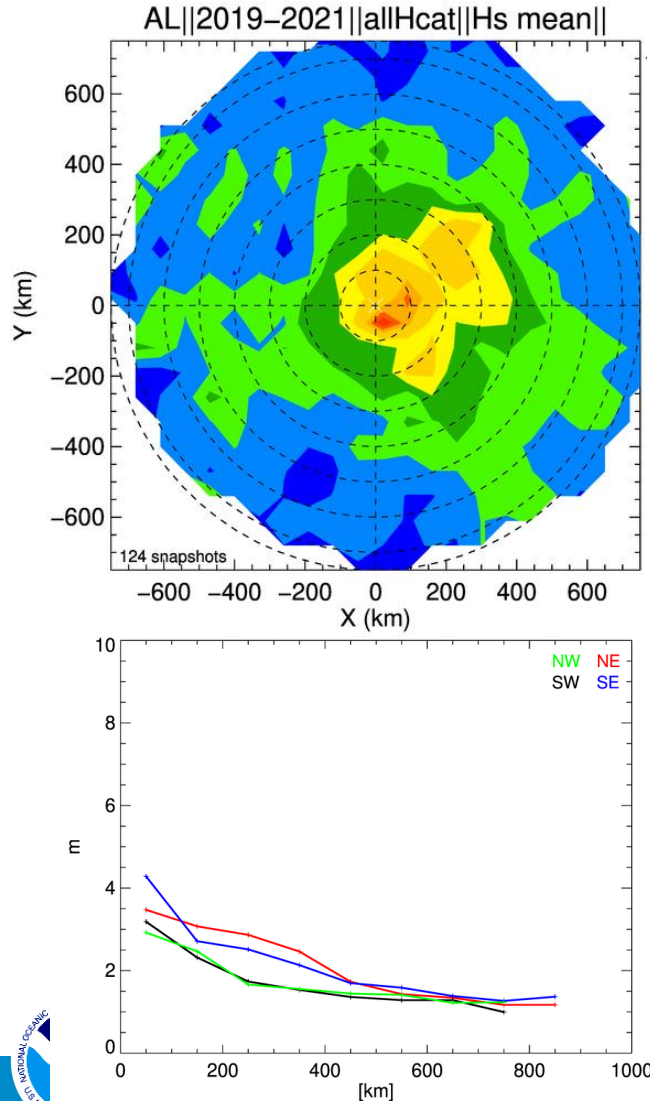


SH

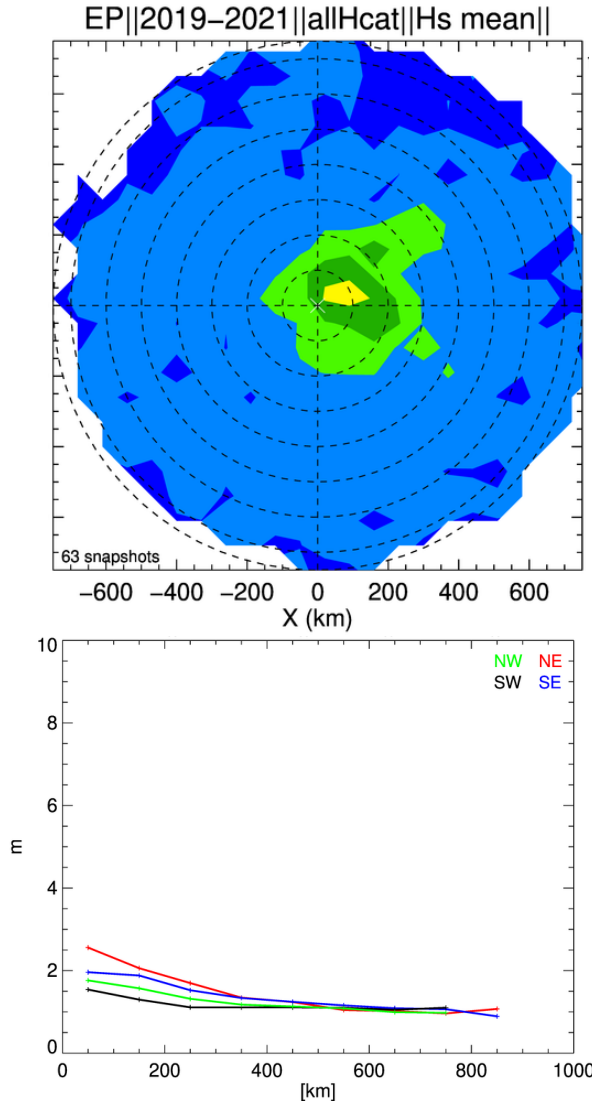


HUR. CAT 1-5 | SWIM PHS1

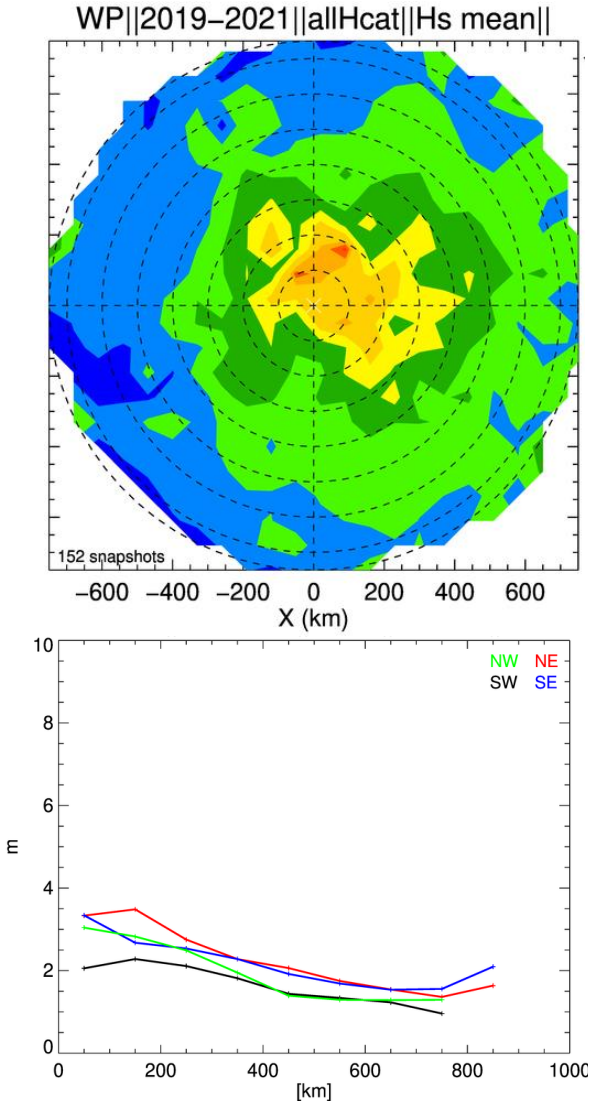
AL



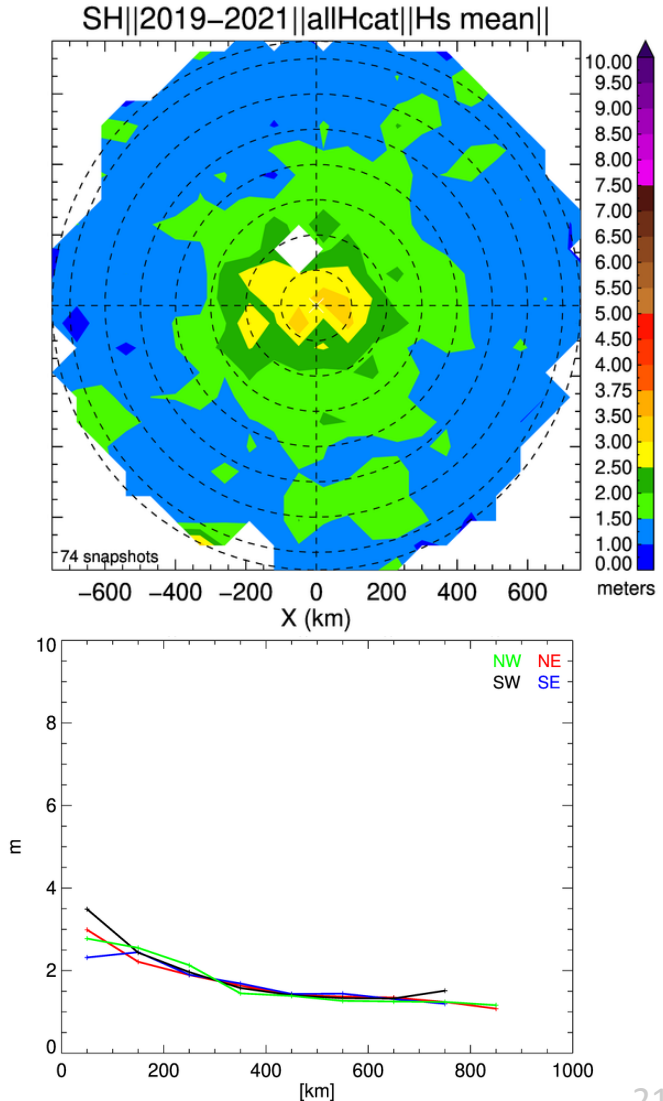
EP



WP

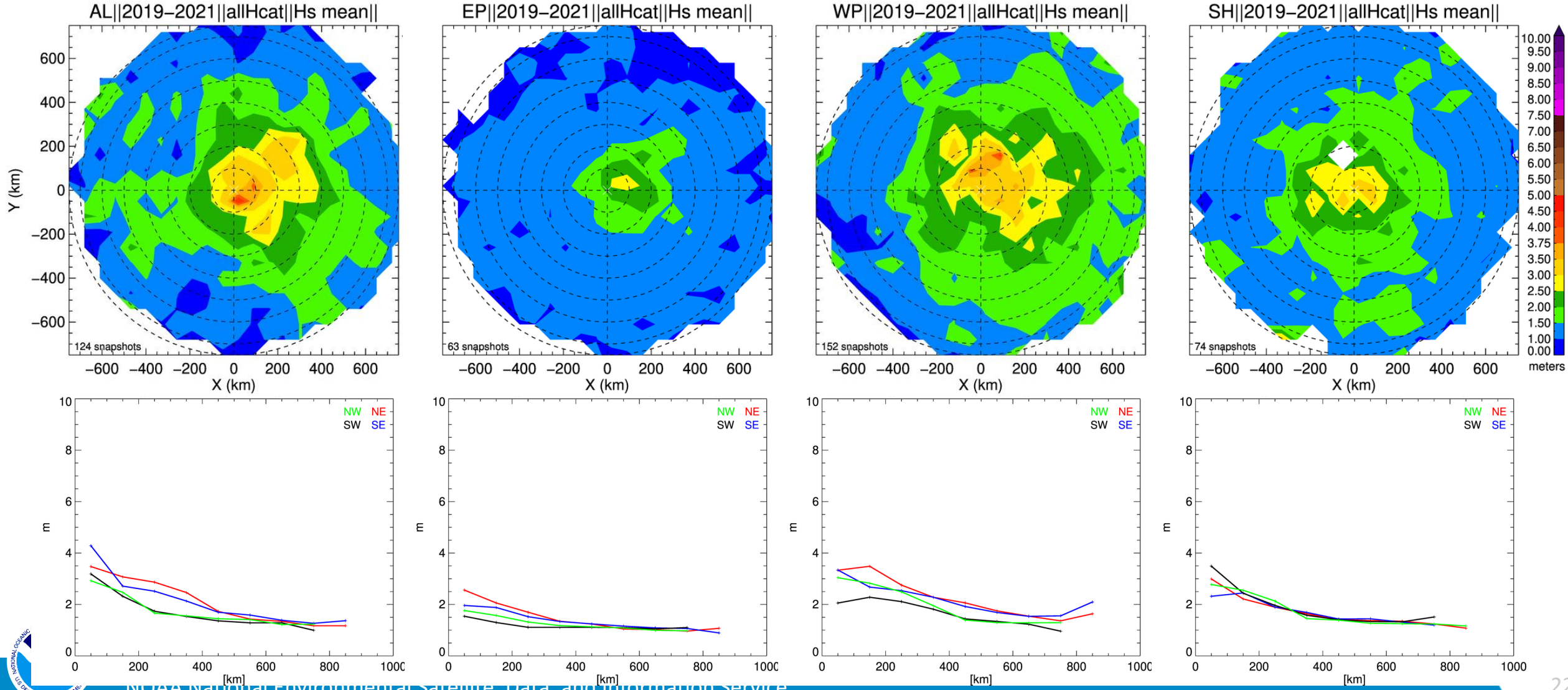


SH



HUR. CAT 1-5 | SWIM PHS1

AL



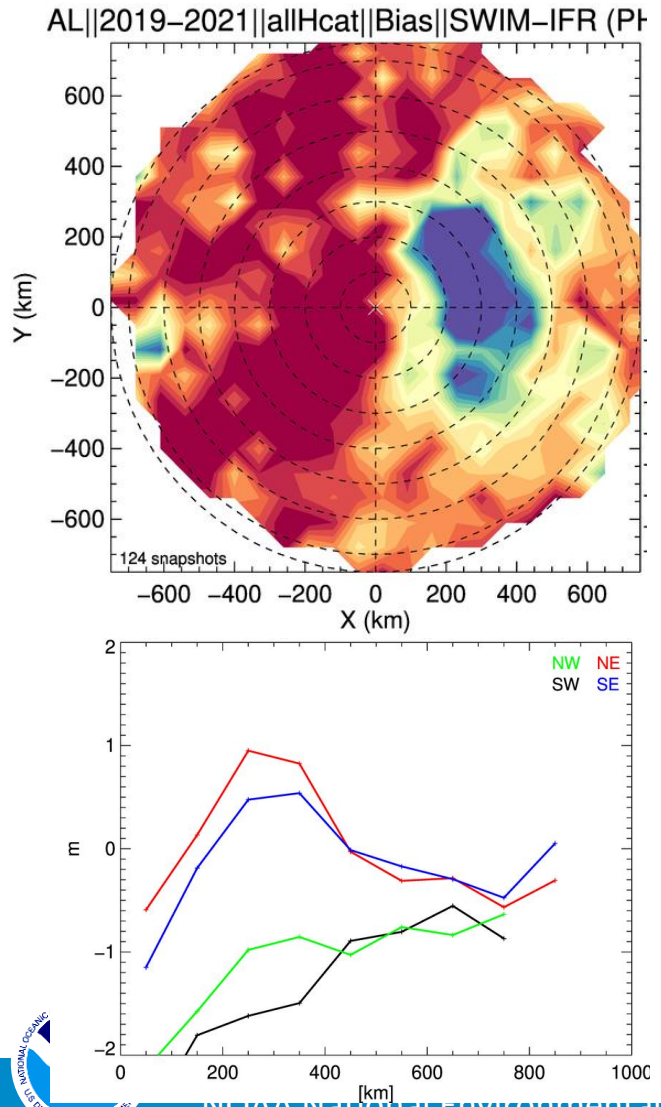
EP

WP

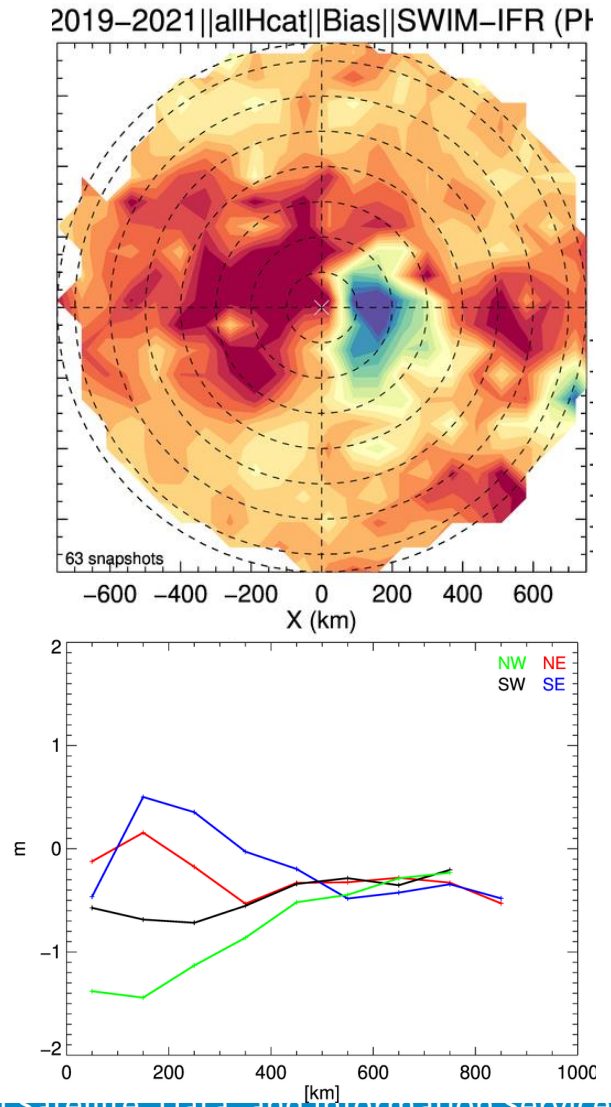
SH

HUR. CAT 1-5 | PHS1 Bias SWIM-IFREMER

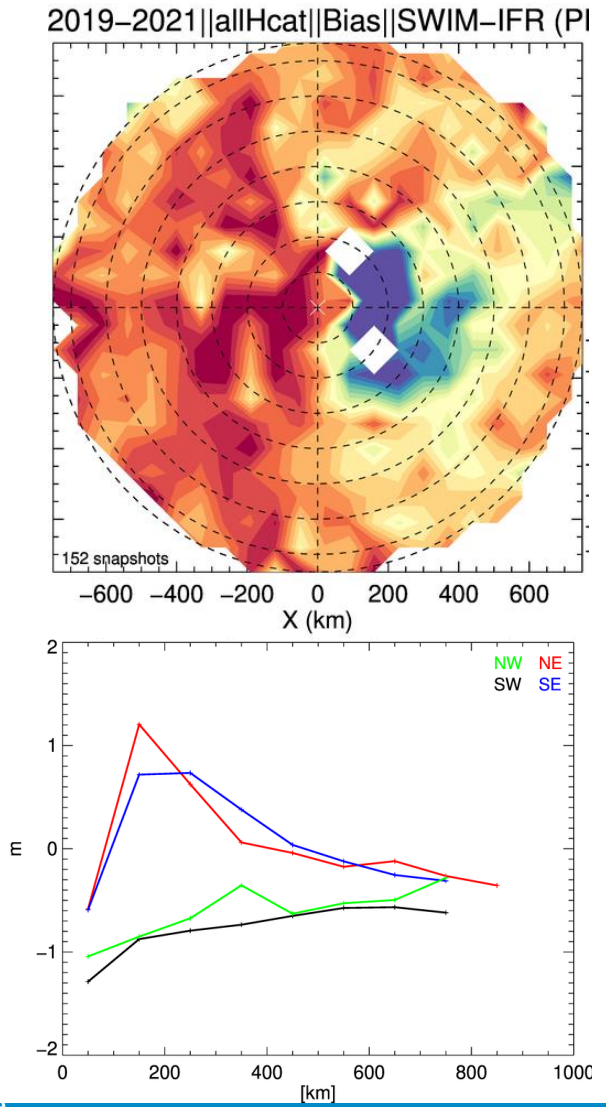
AL



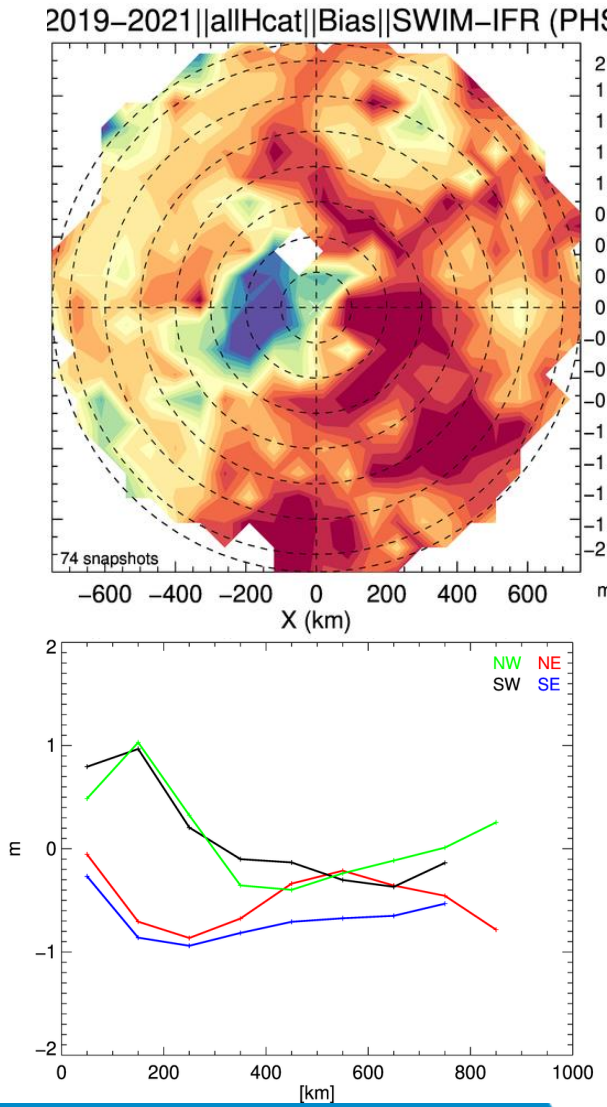
EP



WP



SH



Summary

- Even though SWIM resolution is quite coarse and spatial coverage is fairly limited, SWIM Hs spatial distribution around TC center compares well with IFREMER model
- This is important especially knowing that certain 'wave sensitive' missions depend on modeled Hs for their retrieval (e.g. CyGNSS, SMAP).
- confirmed Hs asymmetry around TC where strongest Hs is found on the right hand side of TC within Northern Hemisphere and left hand side within Southern Hemisphere
- 7m+ ***mean*** HS extends to 150-200 km from right of TC center (AL basin)
- presence of small positive bias between SWIM and ECMWF Hs given either ECMWF or HWRF winds between 0 and 20 m/s
- Quite large discrepancies between IFREMER and SWIM HS from first and second partitions (especially the latter)

Possible future work

- compare SWIM data with Kaia measurements including MFWAM, NOAA WW3, Hs from Altimeter data
- Include in future analysis SWIM data produced by OceanDataLab/IFREMER

Ka-/Ku-band Interferometric Altimeter (KaIA) :

- KaIA is a nadir-looking Ka-/Ku-band interferometric radar altimeter installed on the NOAA WP-3D aircraft since the 2020 hurricane season
- Capable of centimetric altimetry (500 MHz bandwidth)
- Can retrieve significant wave height (SWH), mean-squared slope (MSS), relative ocean height, low-to-moderate wind speeds
- Implements a real-time tracker and re-tracker to provide altimetry products
- Records the raw complex return from the surface
- Ku-band channel added in winter 2021 (far right):
  - Adds rain retrieval, rain correction, and ice freeboard measurement capability

Source: AMS 35th conf 2022, Joe Sapp et.al.