First Look at NOAA CyGNSS winds in the Tropical Cyclone Environment

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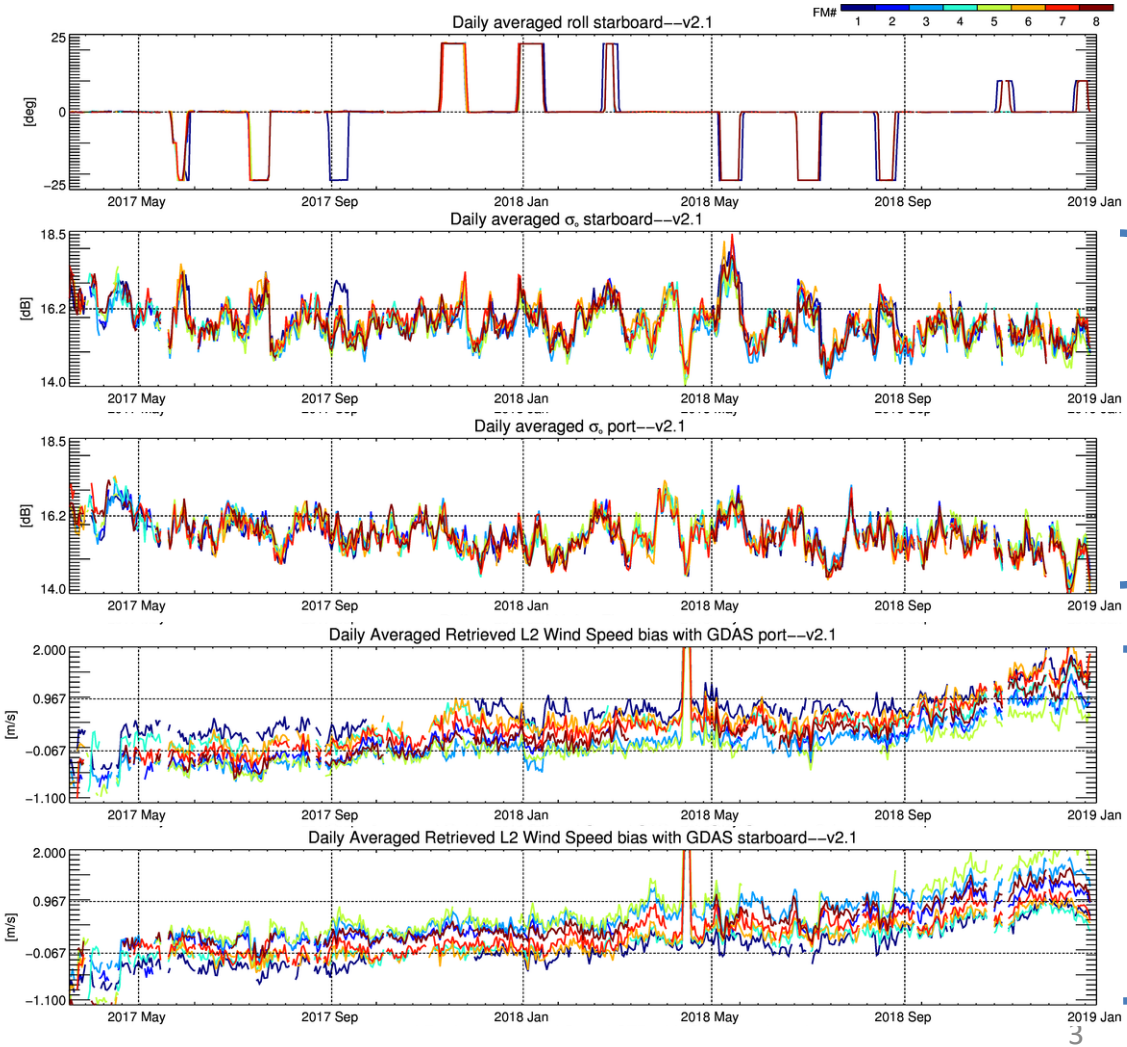
Outline

- Motivation
- brief description of currently used GMF and ‘track-wise’ wind retrieval method
- Wind retrieval performance for 2017/2018 hurricane seasons against
  - Hurricane Weather Research and Forecasting Model (HWRF)
  - Stepped Frequency Microwave Radiometer (SFMR)
- A look at a few case studies
- Summary and Observations

Motivation

1. Dependence on significant wave height first noticed with TDS data[1]
2. Calibration issues



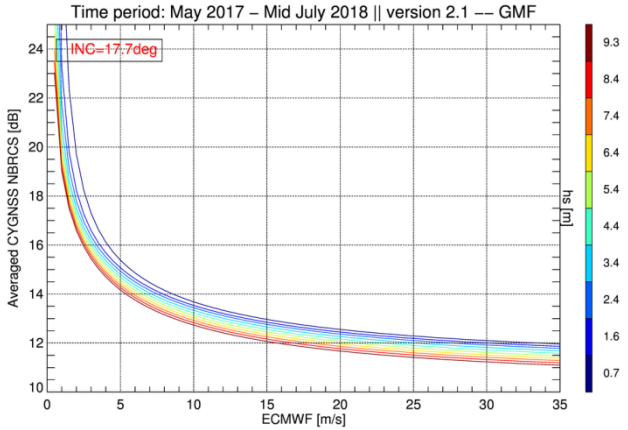
[1]S. Soisuvarn, Z. Jelenak, F. Said, P. S. Chang and A. Egido, "The GNSS Reflectometry Response to the Ocean Surface Winds and Waves," in *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, vol. 9, no. 10, pp. 4678-4699, Oct. 2016. doi: 10.1109/JSTARS.2016.2602703

current NOAA Level 2 GMF using v2.1 from May 2017-July 15th 2018

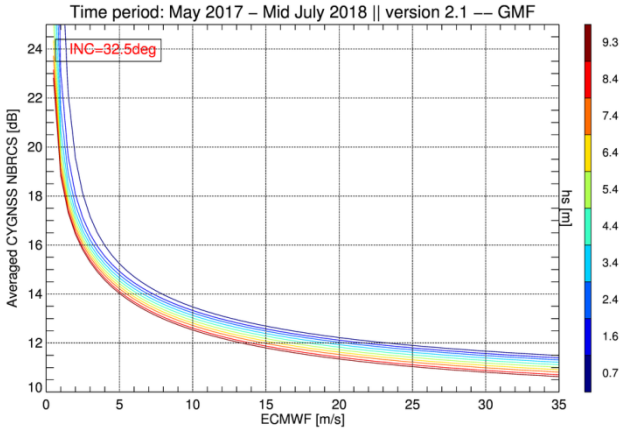
$\sigma^o(u_{10},Hs,\Theta_i)$

0-75m/s | 0-10m | 0-70°

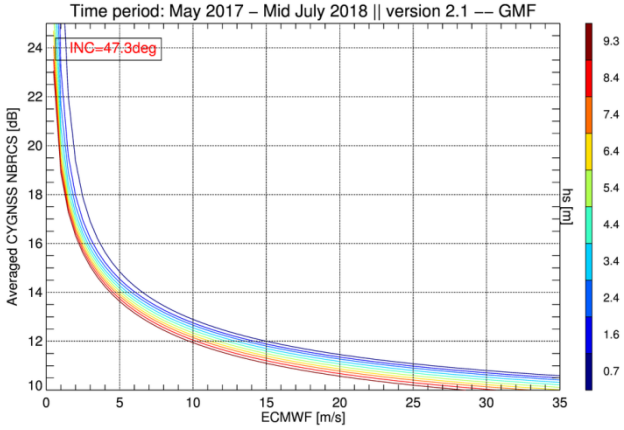
$\sigma^o(\{u_{10},Hs\}|\Theta_i \sim 17.7^o)$

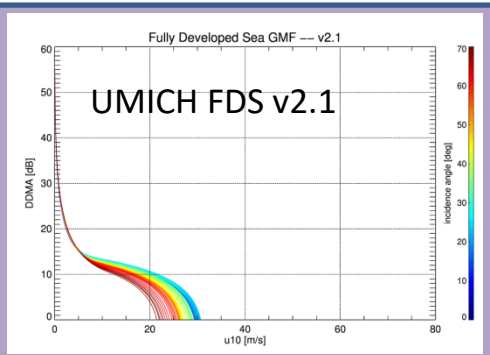


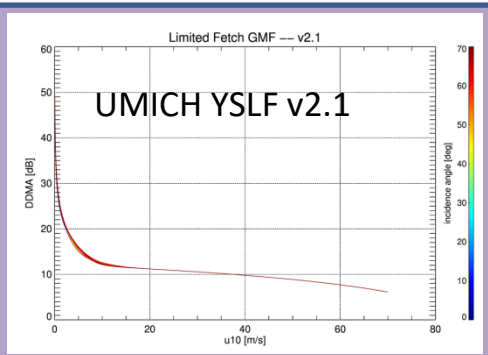
$\sigma^o(\{u_{10},Hs\}|\Theta_i \sim 32.5^o)$



$\sigma^o(\{u_{10},Hs\}|\Theta_i \sim 47.3^o)$





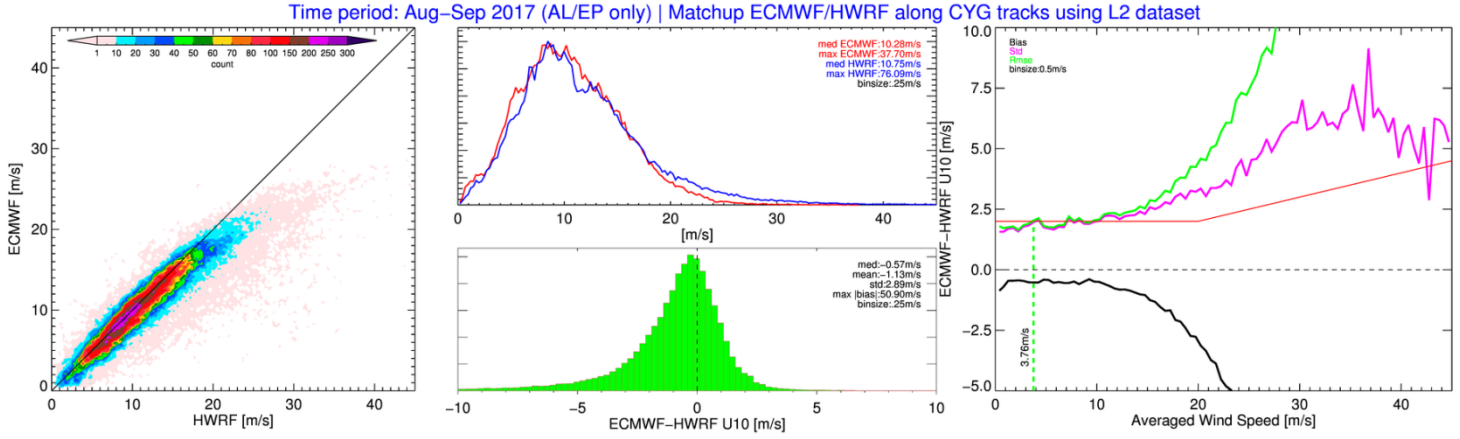


Comparison with HWRF

AL/EP basins (2017)

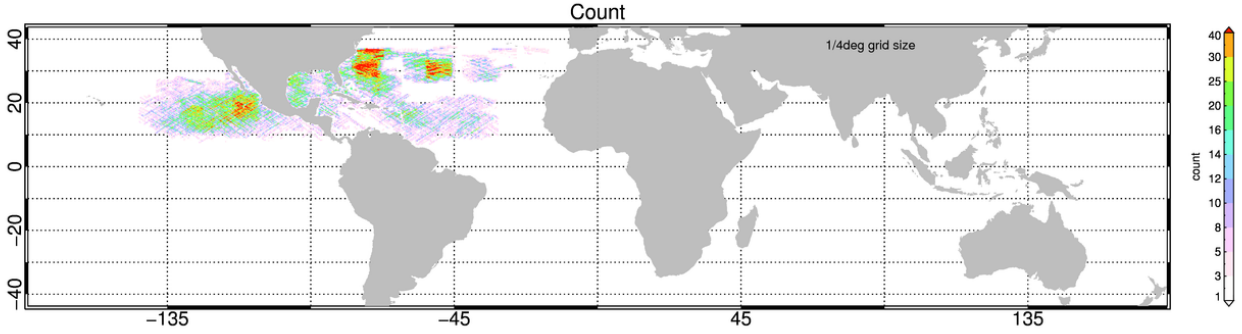
All basins (2018)

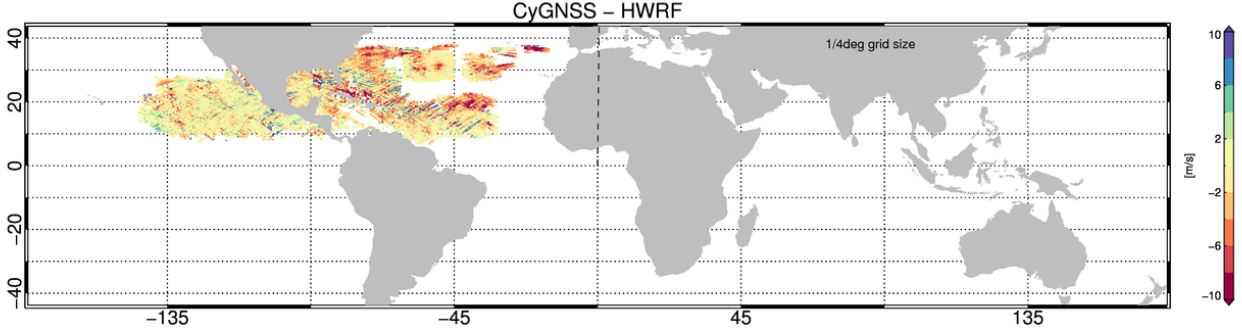
All PRNs included

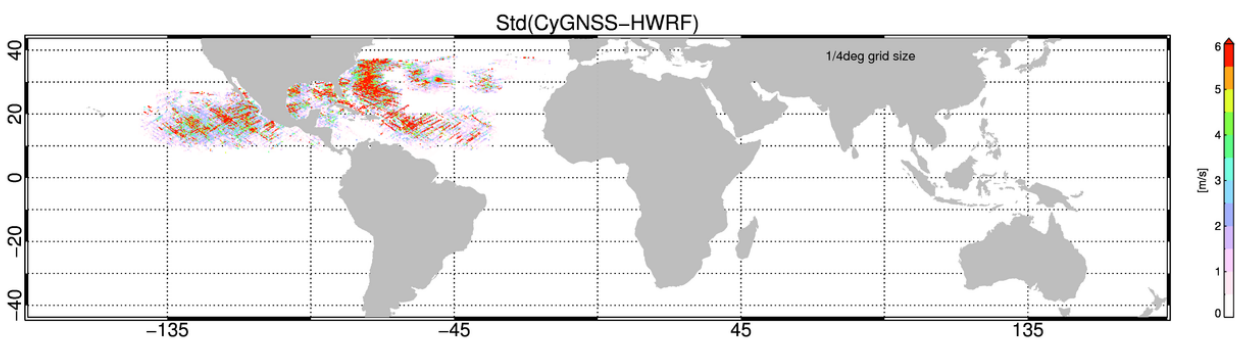


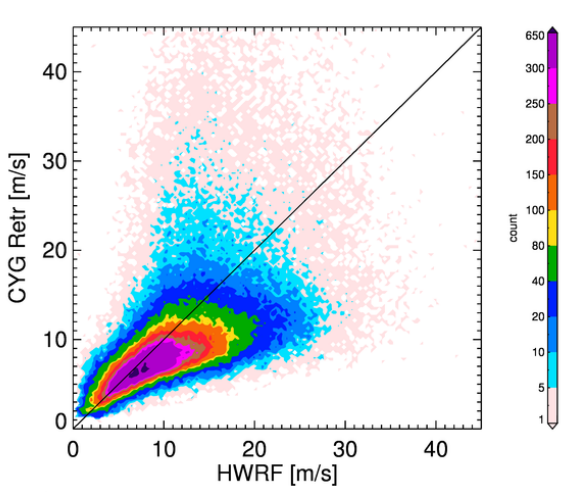
UMICH 2017

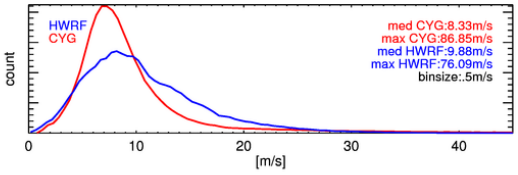
all FMs | All blocks | Time period: Jul 1–Oct 31 2017 | UMICH L2 dataset

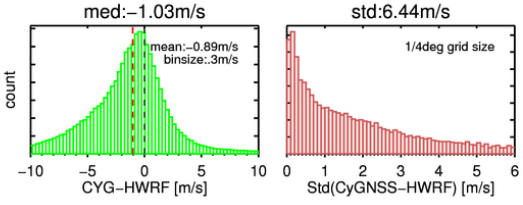


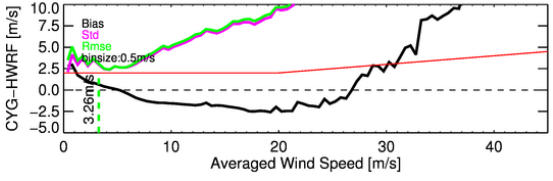






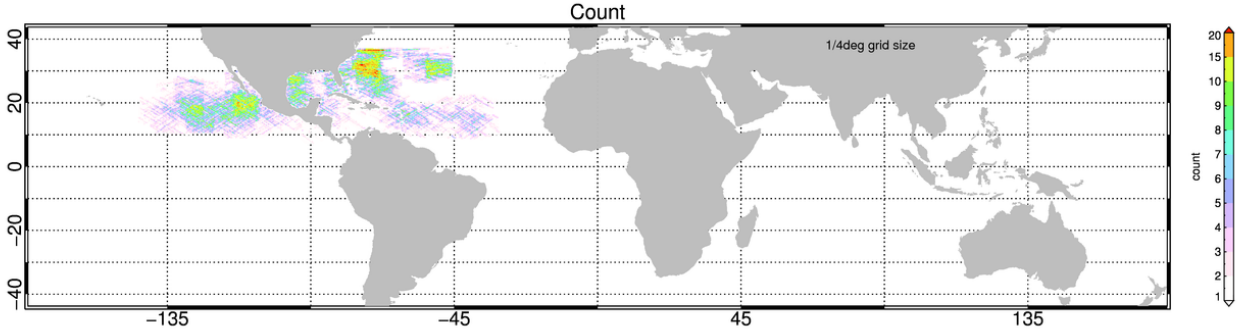


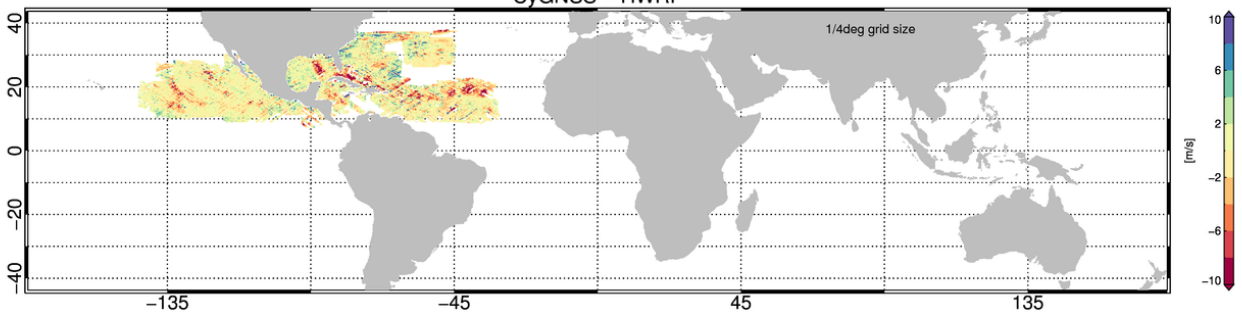


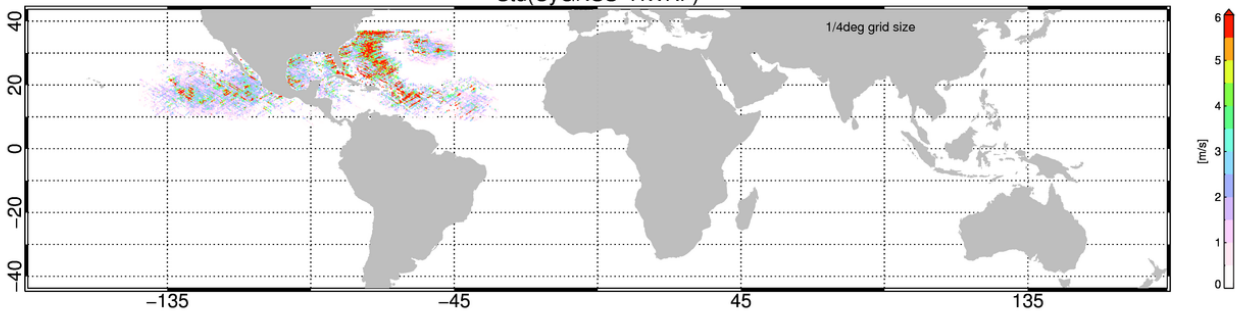


NOAA 2017

all FMs | All blocks | Time period: Jul 1–Oct 31 2017 | NOAA L2 dataset







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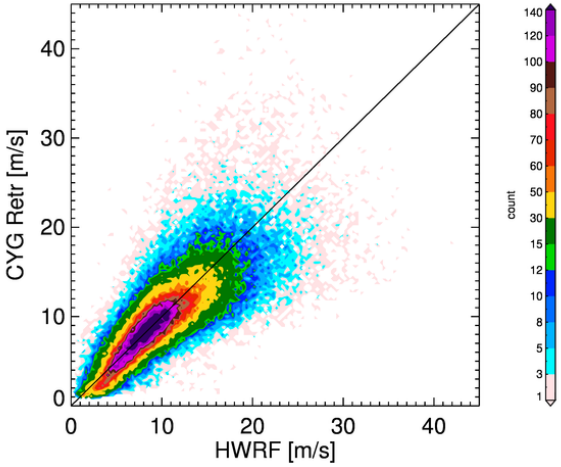
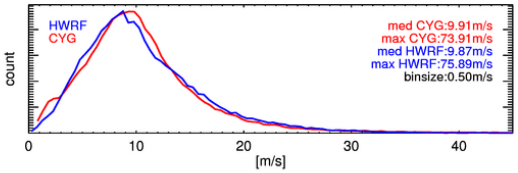
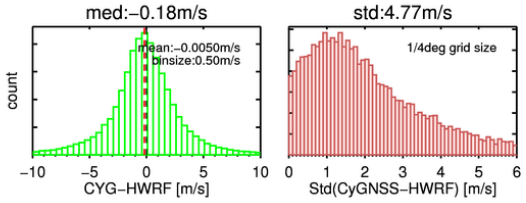
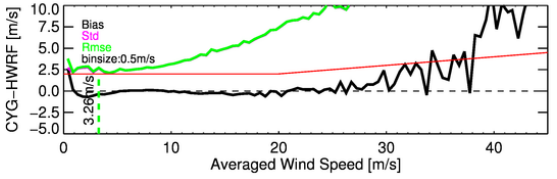


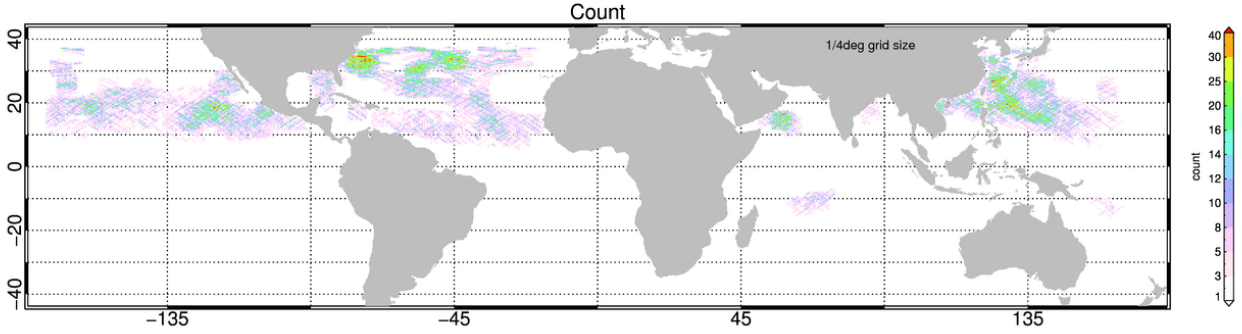


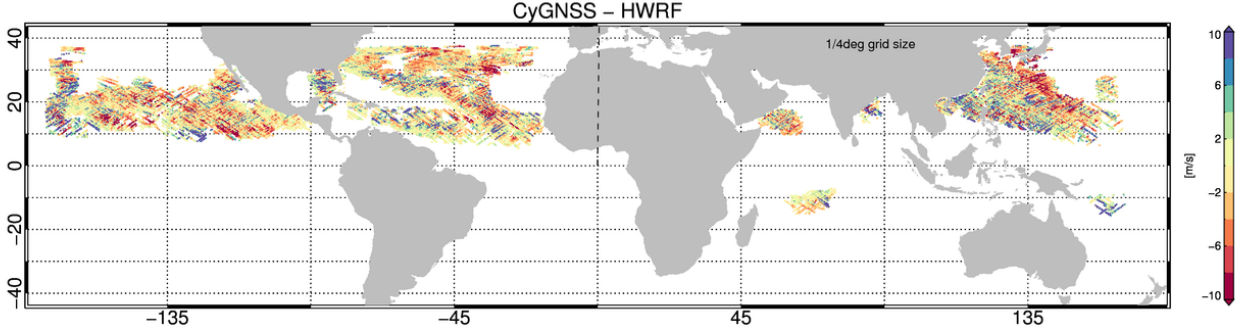


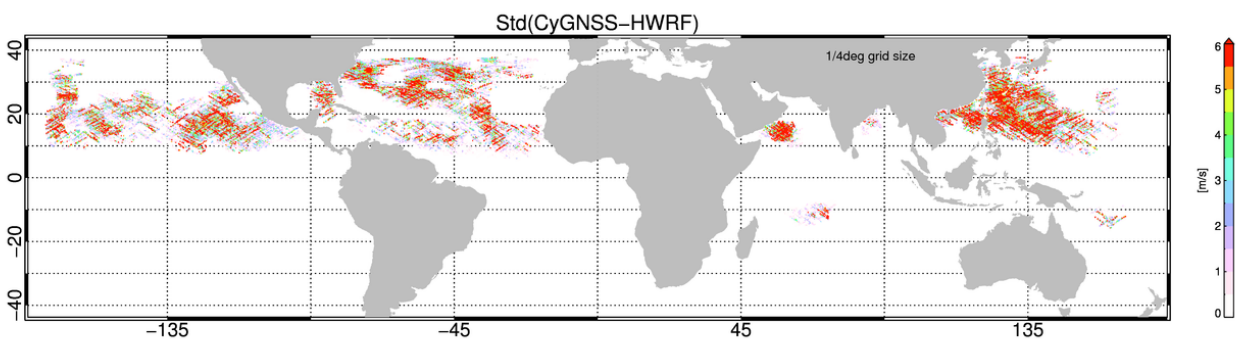


UMICH 2018

all FMs | All blocks | Time period: Jul 1–Oct 31 2018 | UMICH L2 dataset







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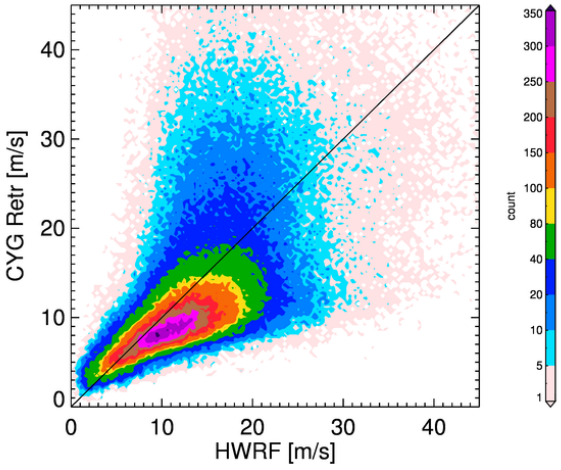
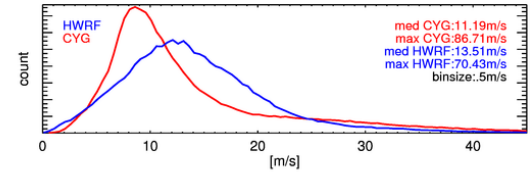
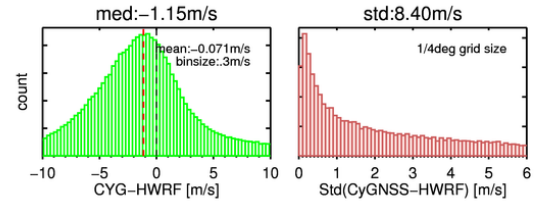
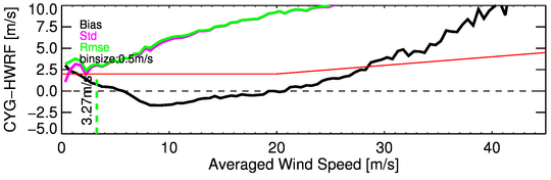


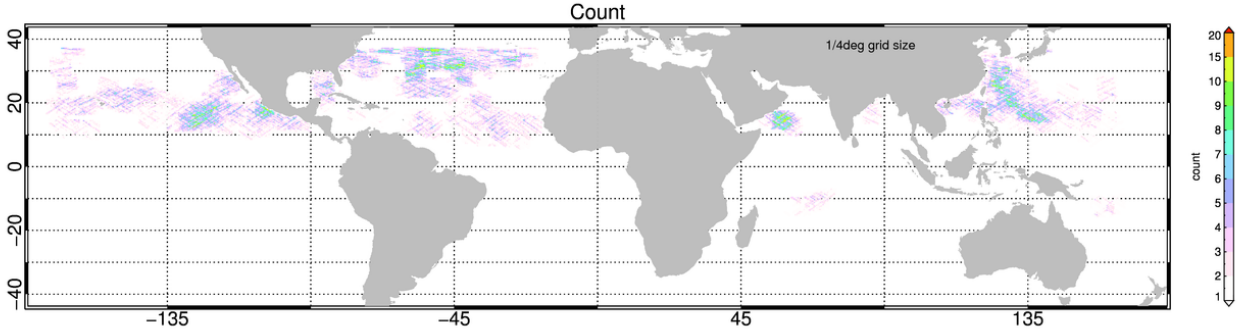


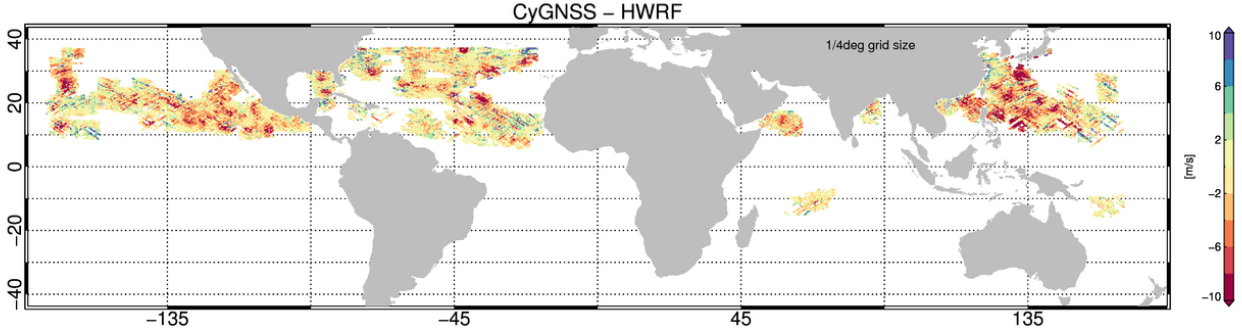


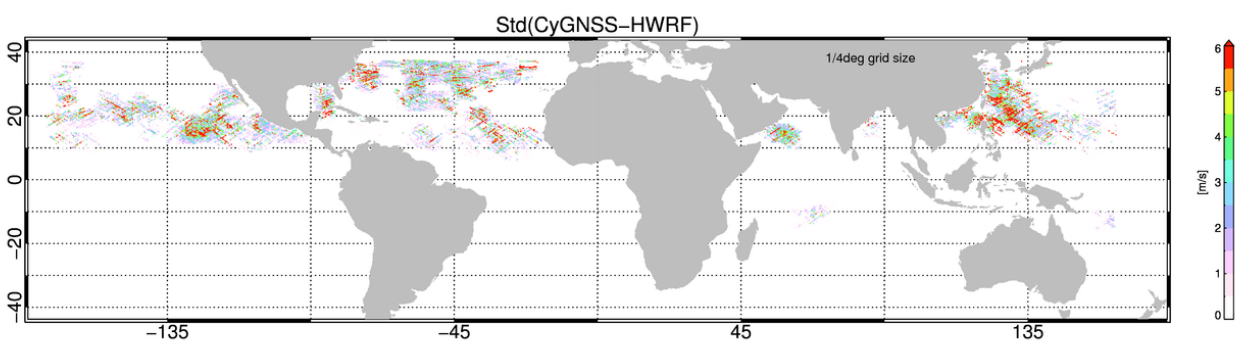


NOAA 2018

all FMs | All blocks | Time period: Jul 1–Oct 31 2018 | NOAA L2 dataset







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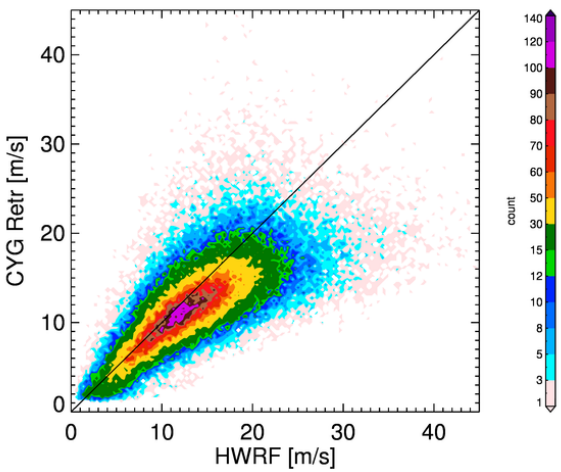
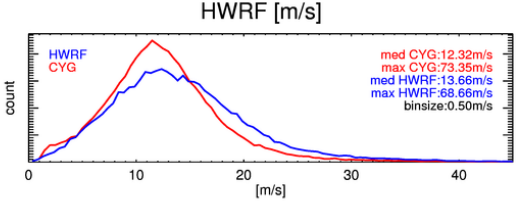
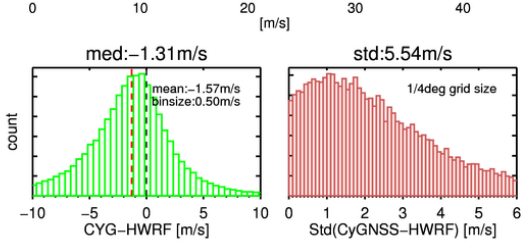
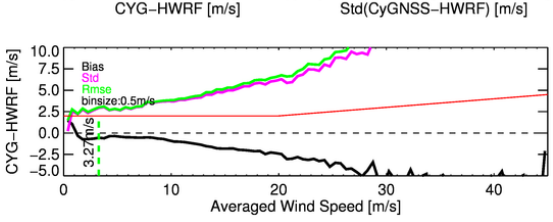




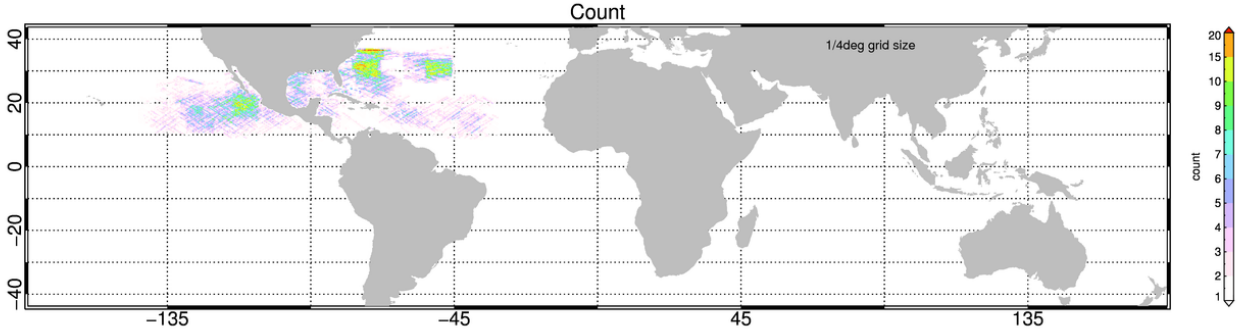


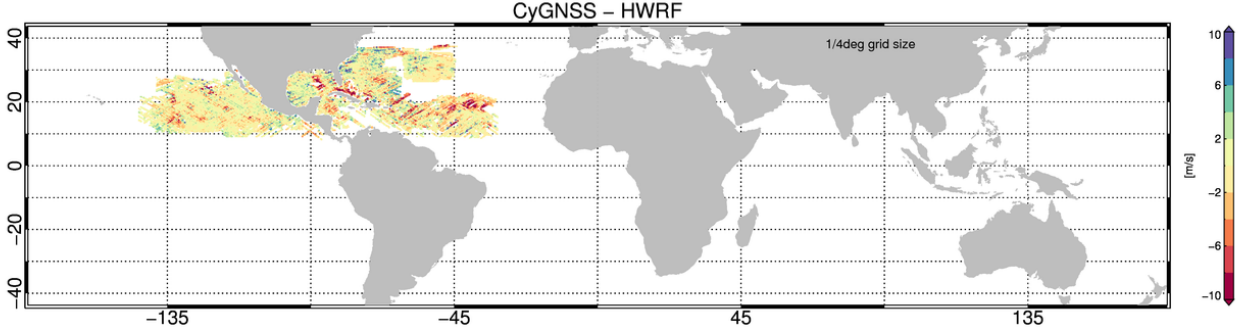


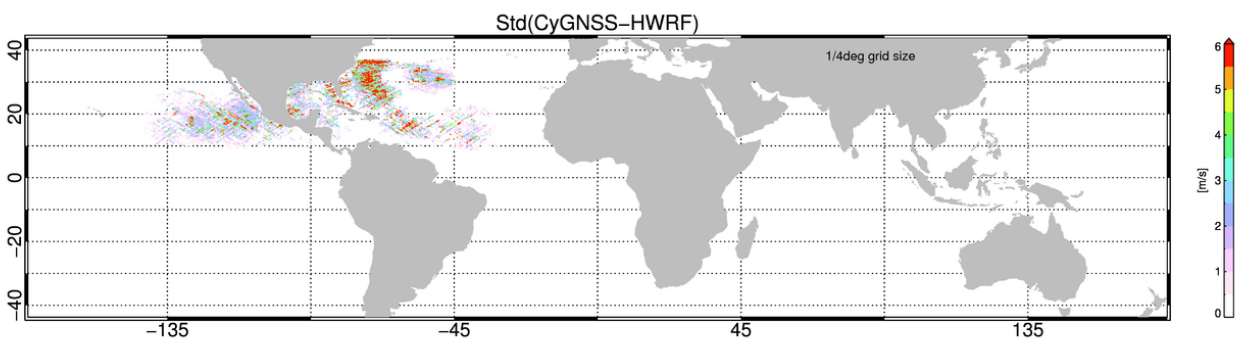
How about retrievals from block IIF?

NOAA 2017 – BLOCK IIF excluded

all FMs | IIF excluded | Time period: Jul 1–Oct 31 2017 | NOAA L2 dataset







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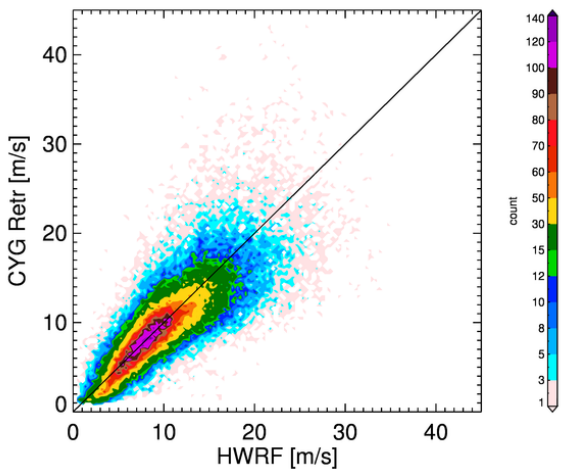
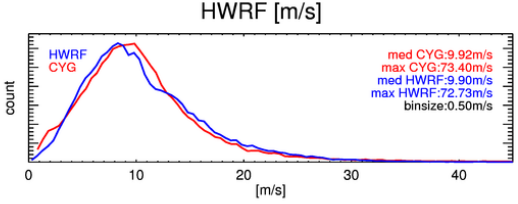
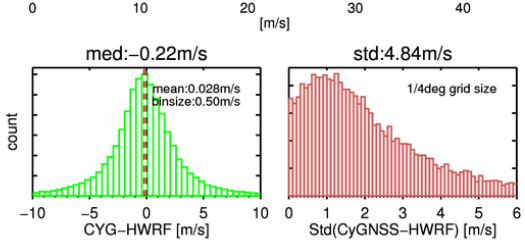
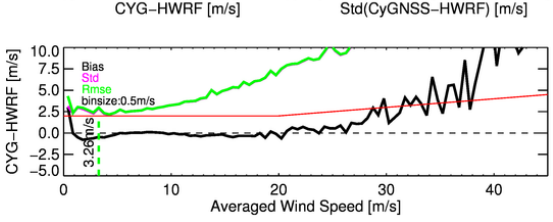


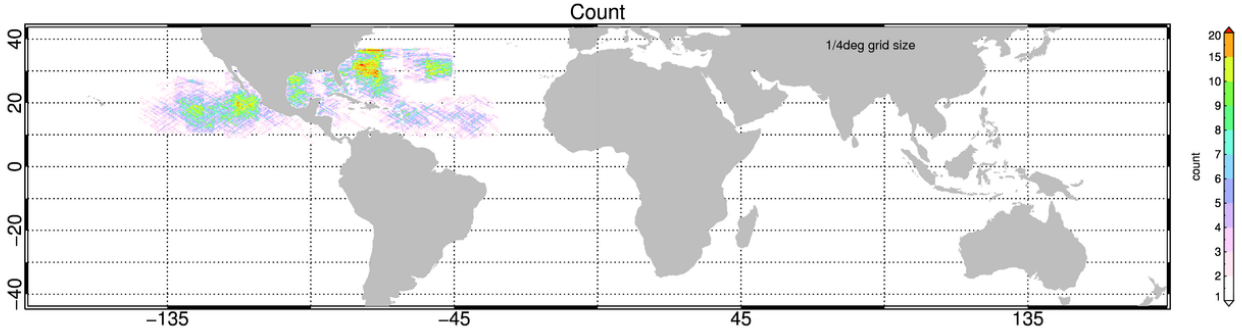


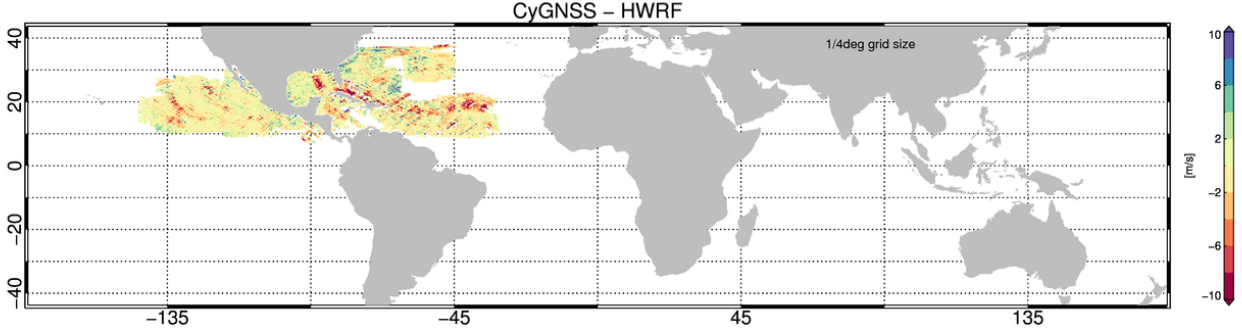


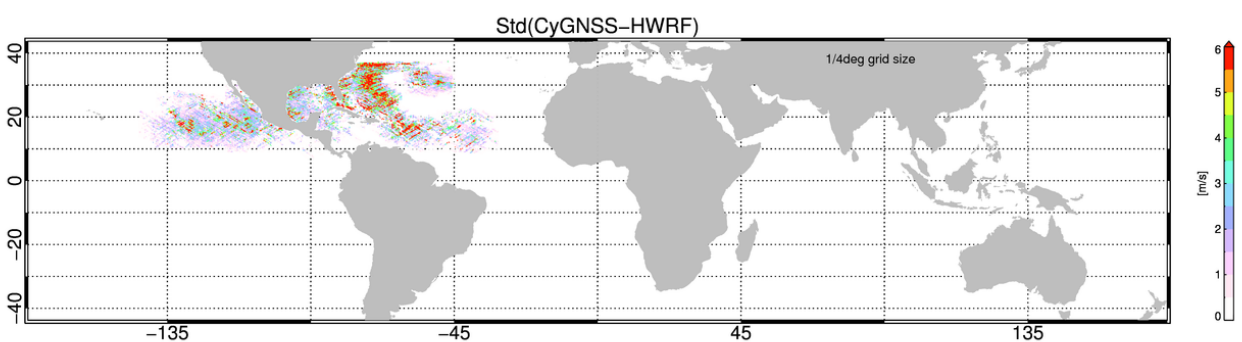


NOAA 2017 – All blocks

all FMs | All blocks | Time period: Jul 1–Oct 31 2017 | NOAA L2 dataset







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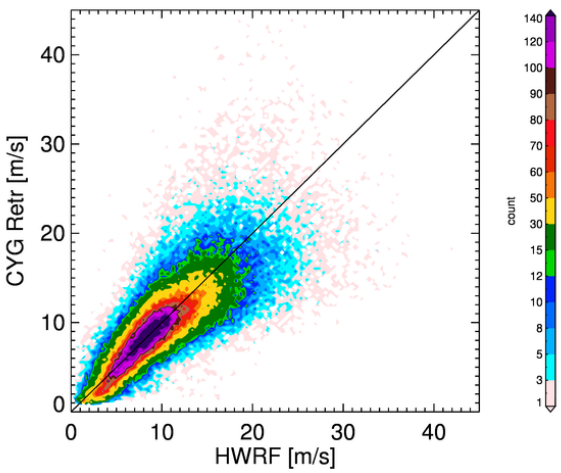
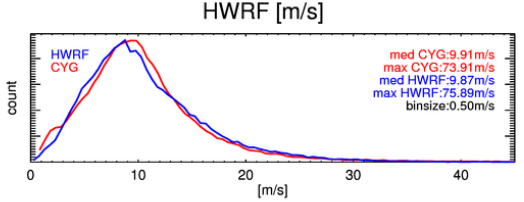
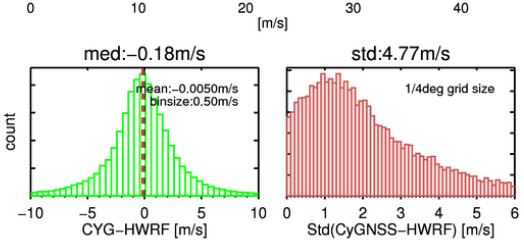
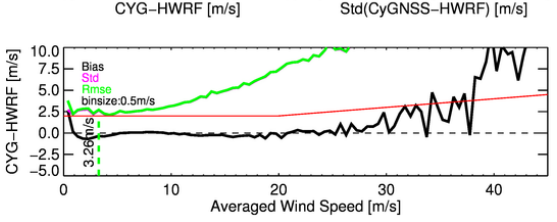


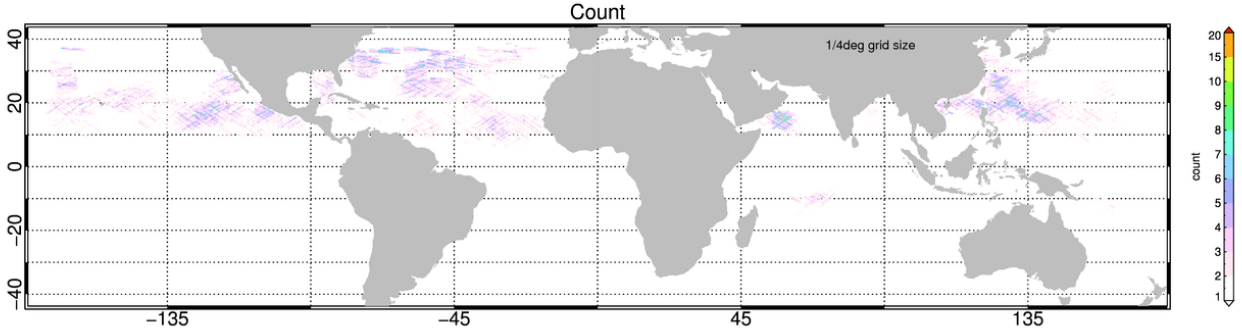


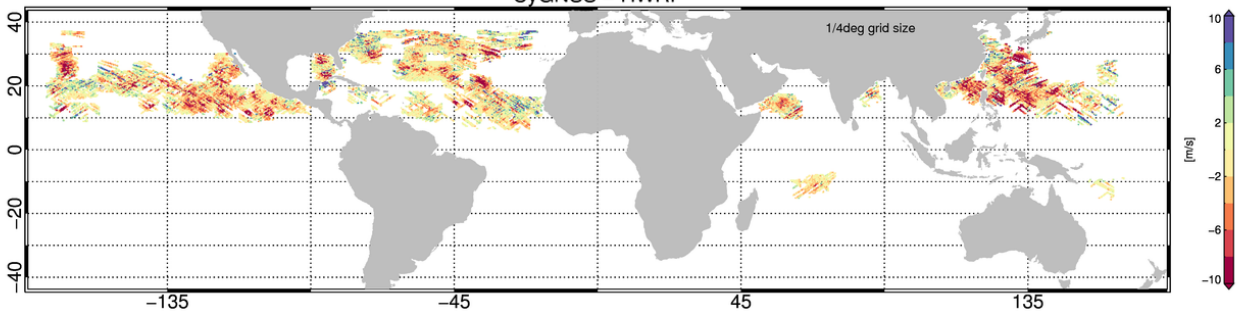


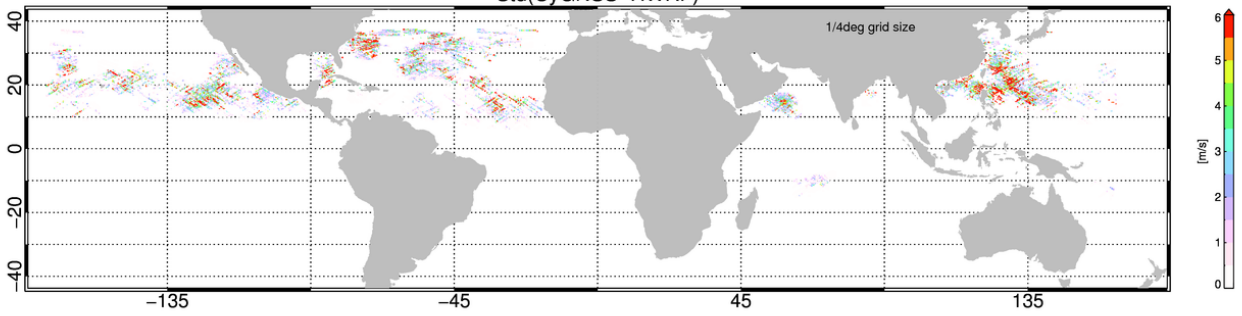


NOAA 2018 – BLOCK IIF excluded

all FMs | IIF excluded | Time period: Jul 1–Oct 31 2018 | NOAA L2 dataset







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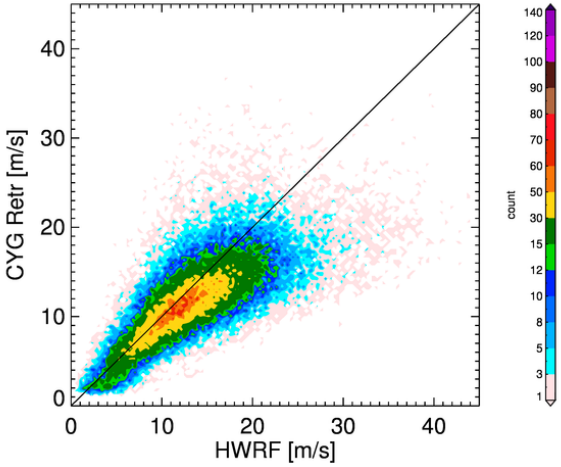
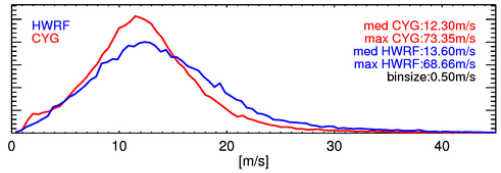
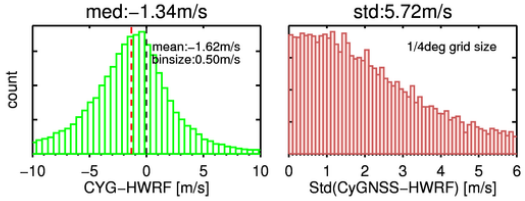
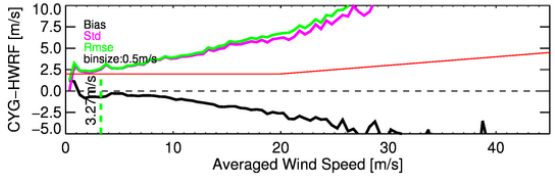


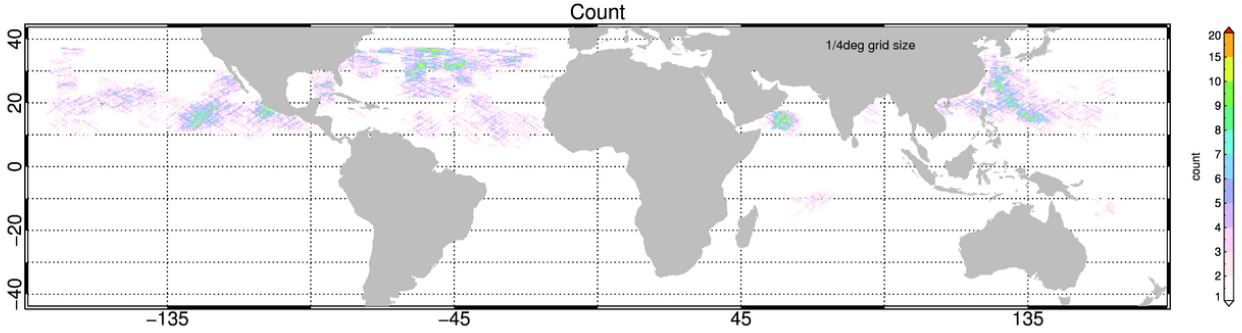


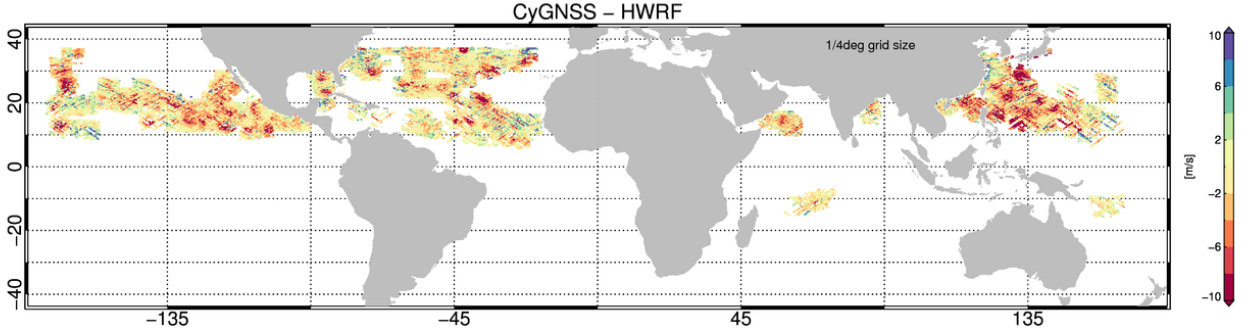


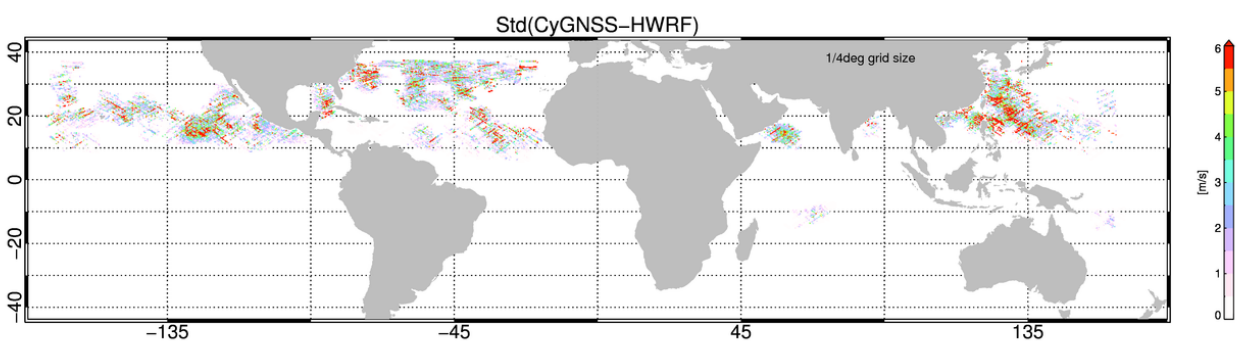


NOAA 2018 – All blocks

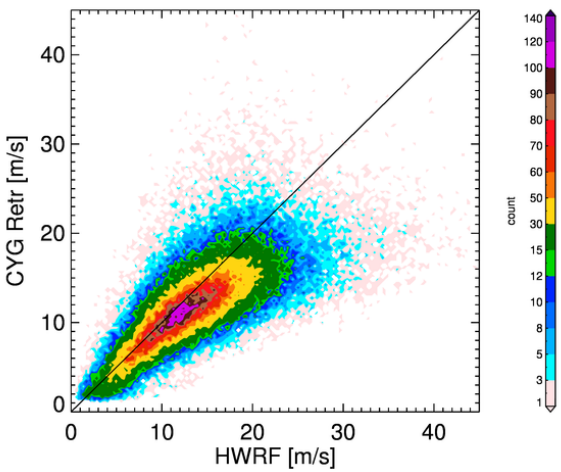
all FMs | All blocks | Time period: Jul 1–Oct 31 2018 | NOAA L2 dataset

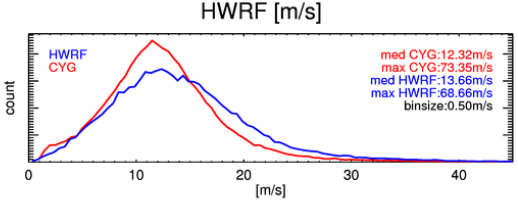


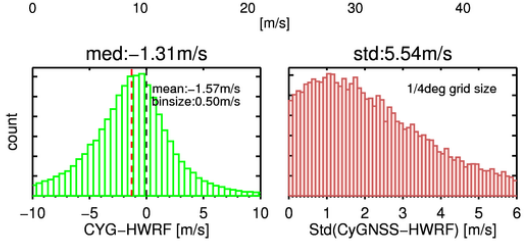


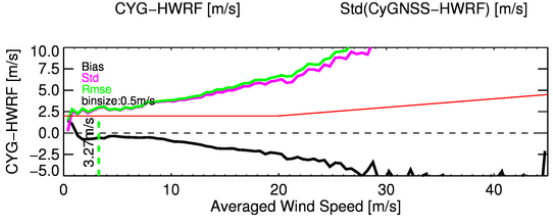


Applied flag:snr > 1 dB and −2<roll<2 deg



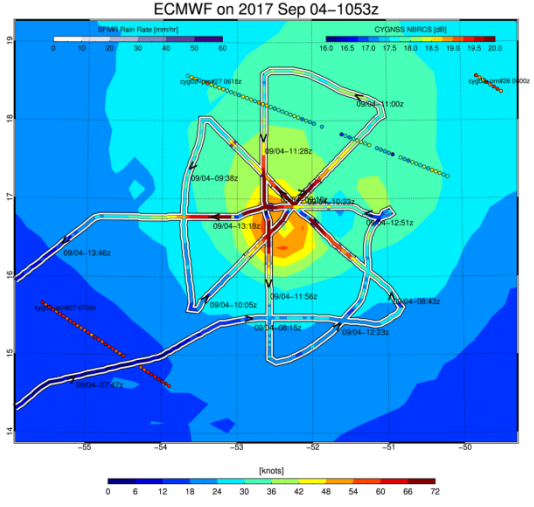






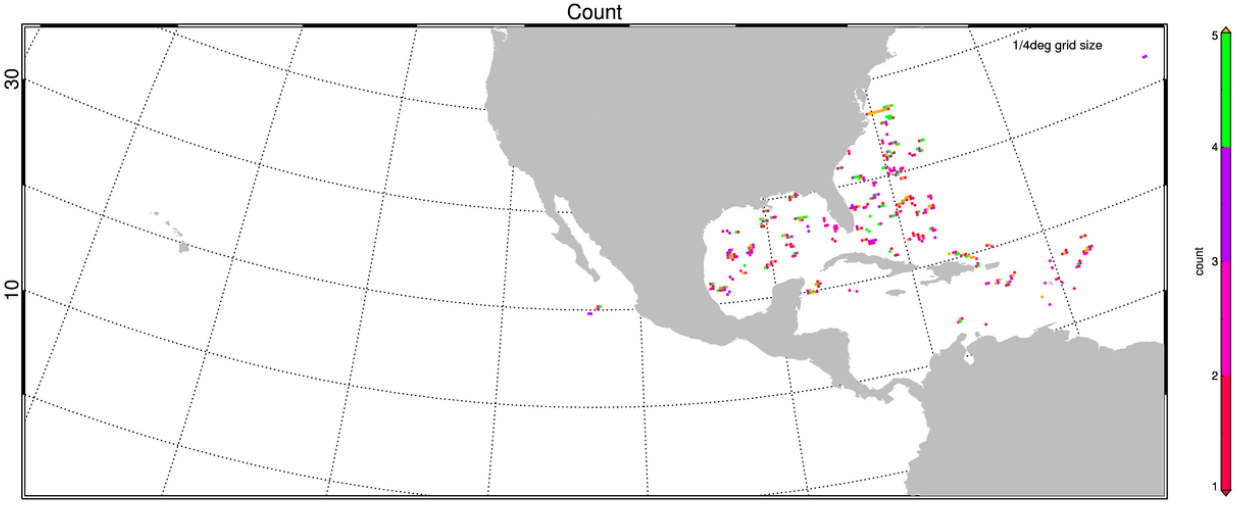
Comparison with SFMR

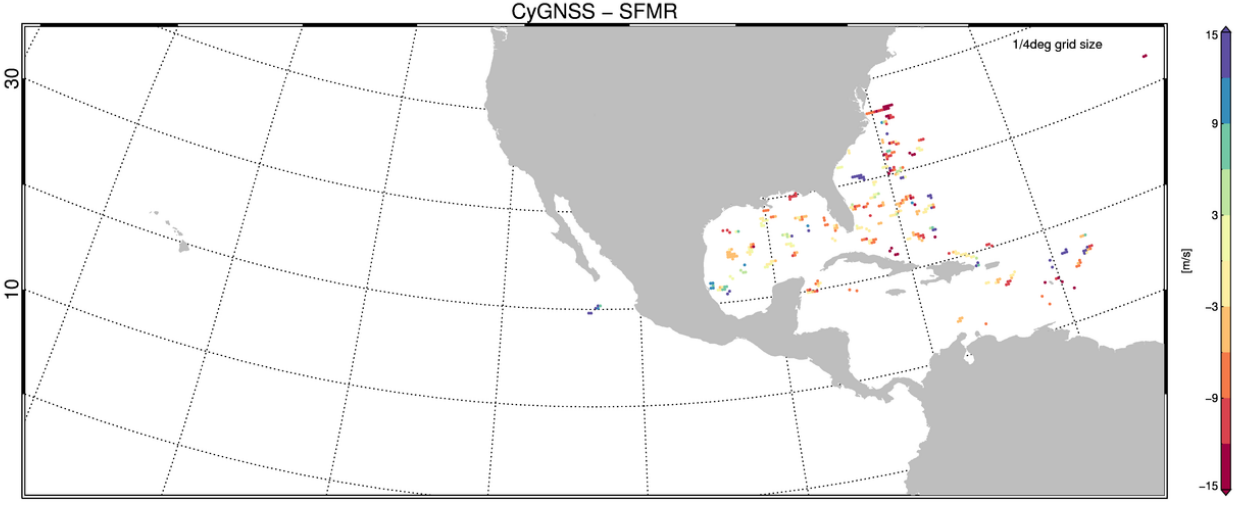
Hurricane Season Years 2017 and 2018



UMICH 2017

all FMs | All blocks | Time period: Jul 1–Oct 31 2017 | UMICH L2 dataset





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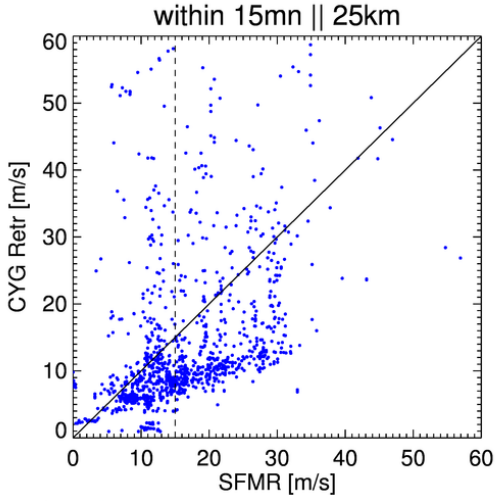
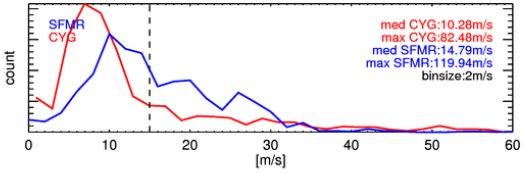
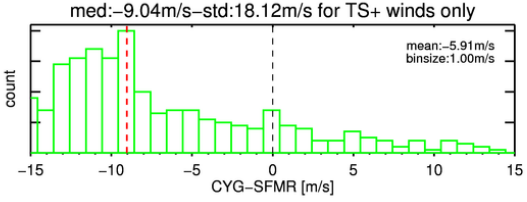
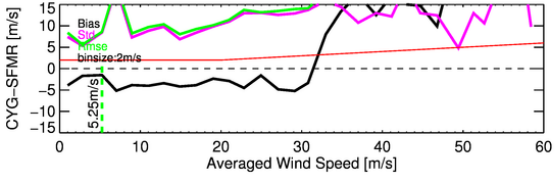


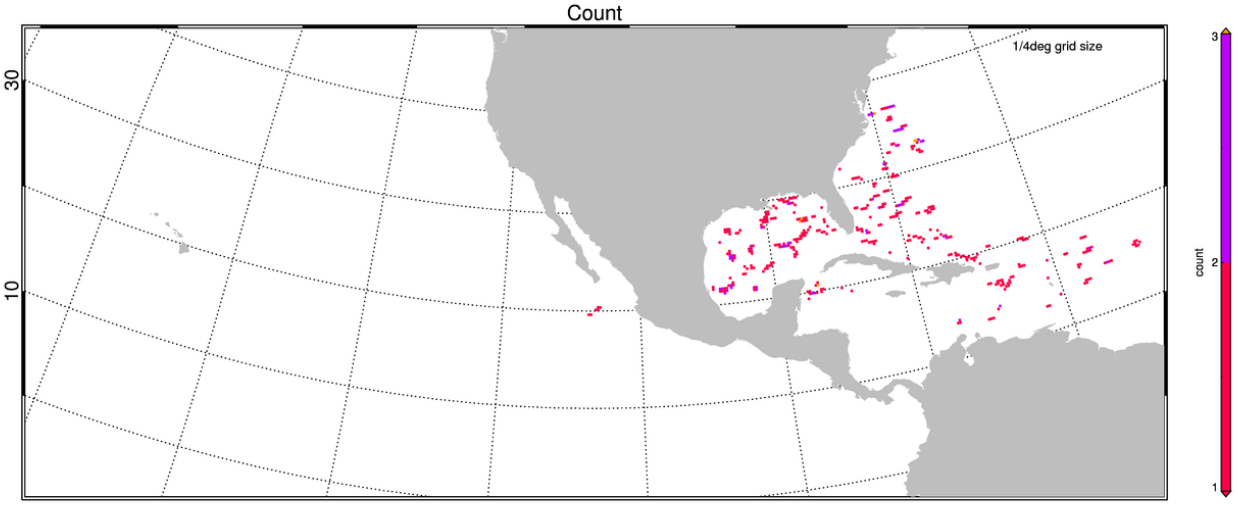


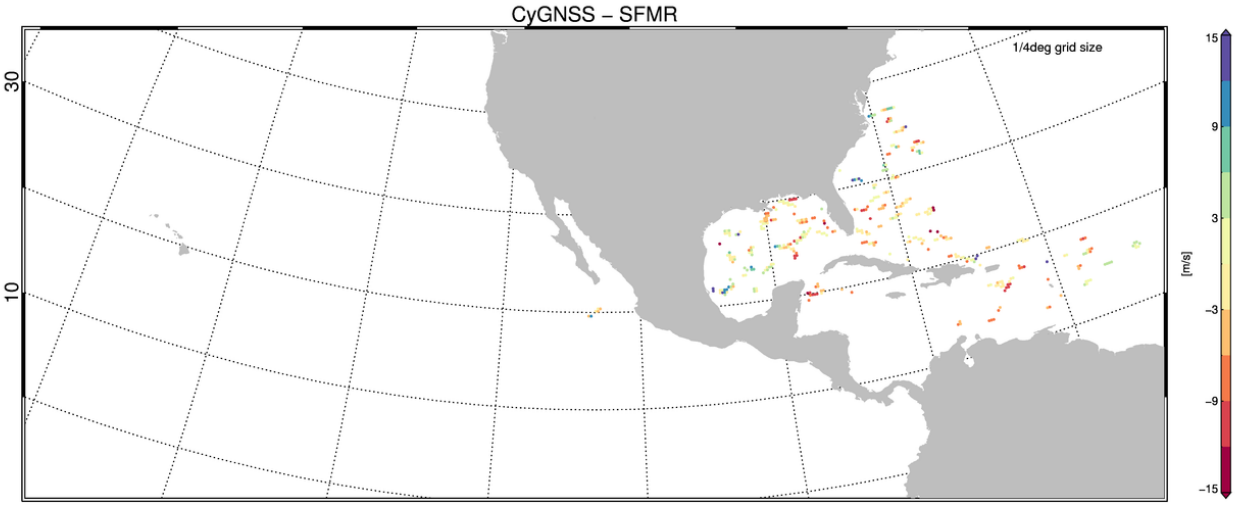




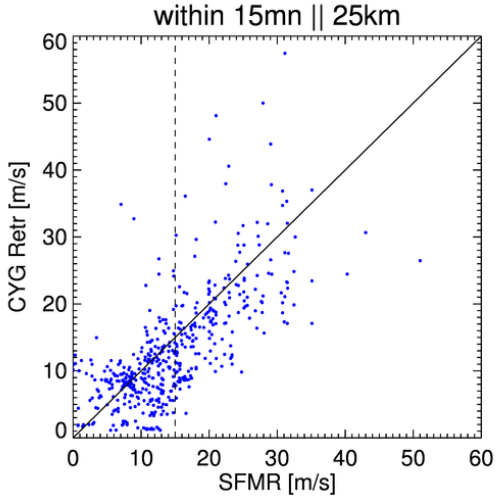
NOAA 2017

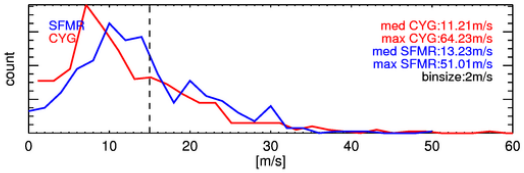
all FMs | All blocks | Time period: Jul 1–Oct 31 2017 | NOAA L2 dataset

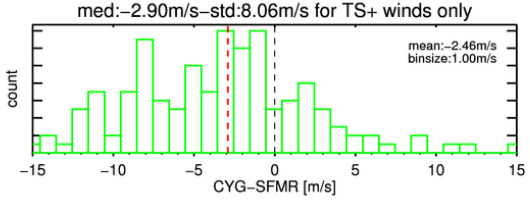


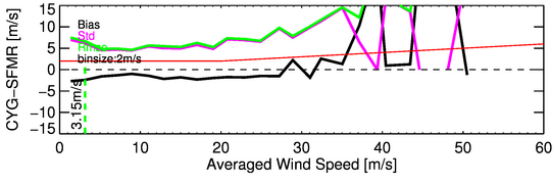


Applied flag:snr > 1 dB and −2<roll<2 deg



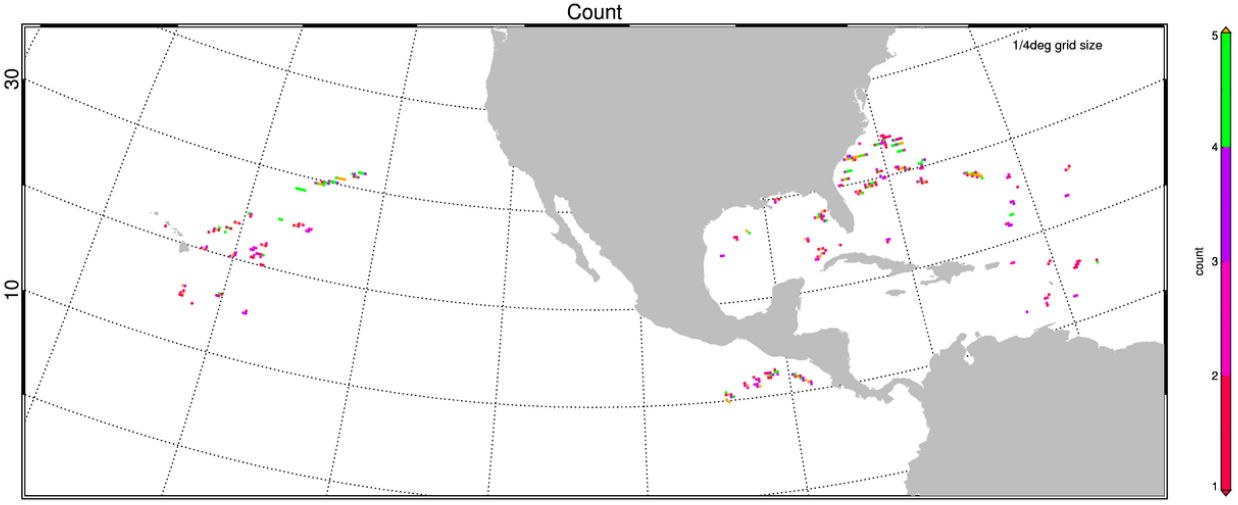


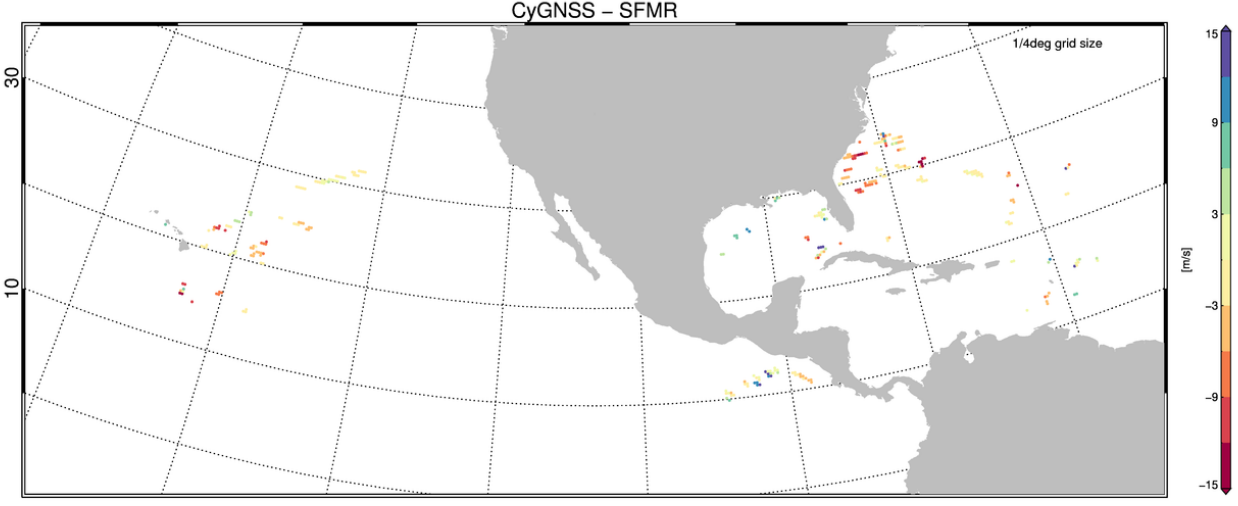




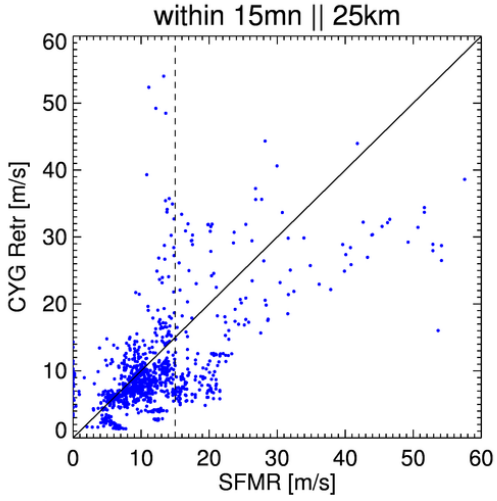
UMICH 2018

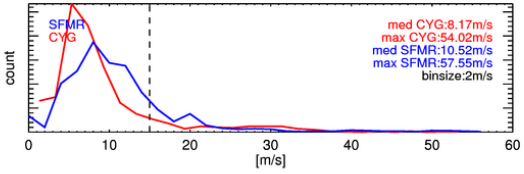
all FMs | All blocks | Time period: Jul 1–Oct 31 2018 | UMICH L2 dataset

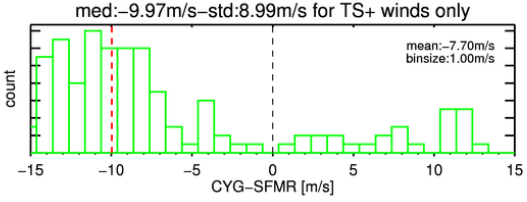


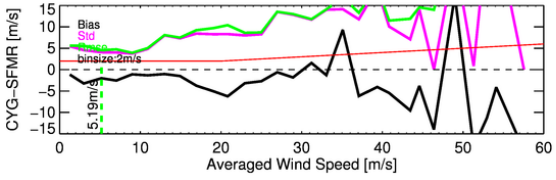


Applied flag:yslf_sample_flags bit 0 unset and range_corr_gain > 3



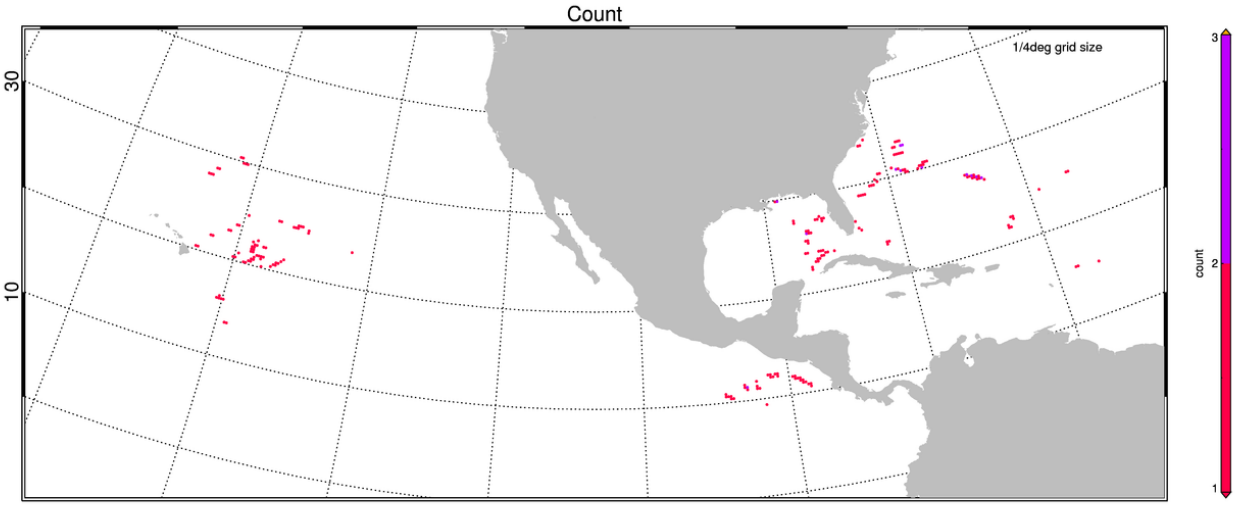


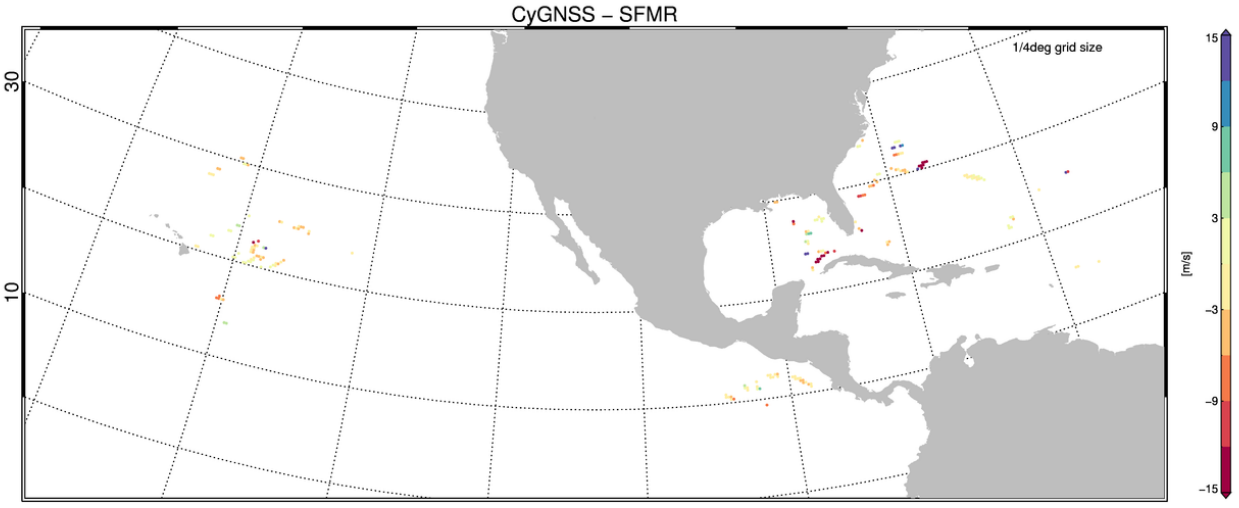




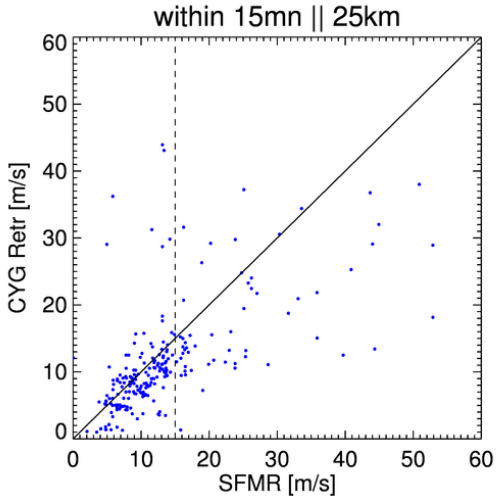
NOAA 2018

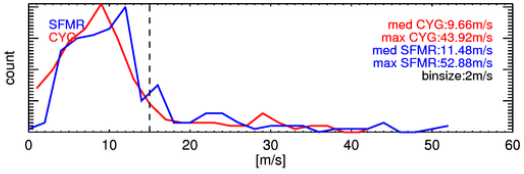
all FMs | All blocks | Time period: Jul 1–Oct 31 2018 | NOAA L2 dataset

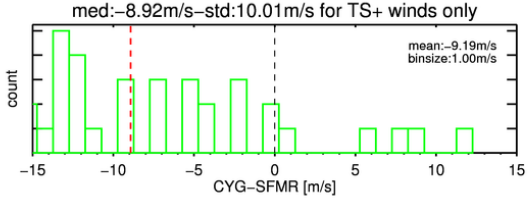


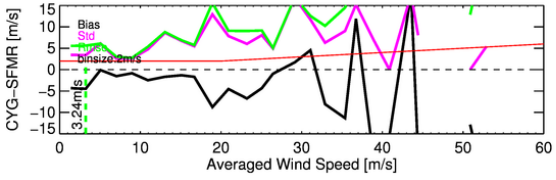


Applied flag:snr > 1 dB and −2<roll<2 deg



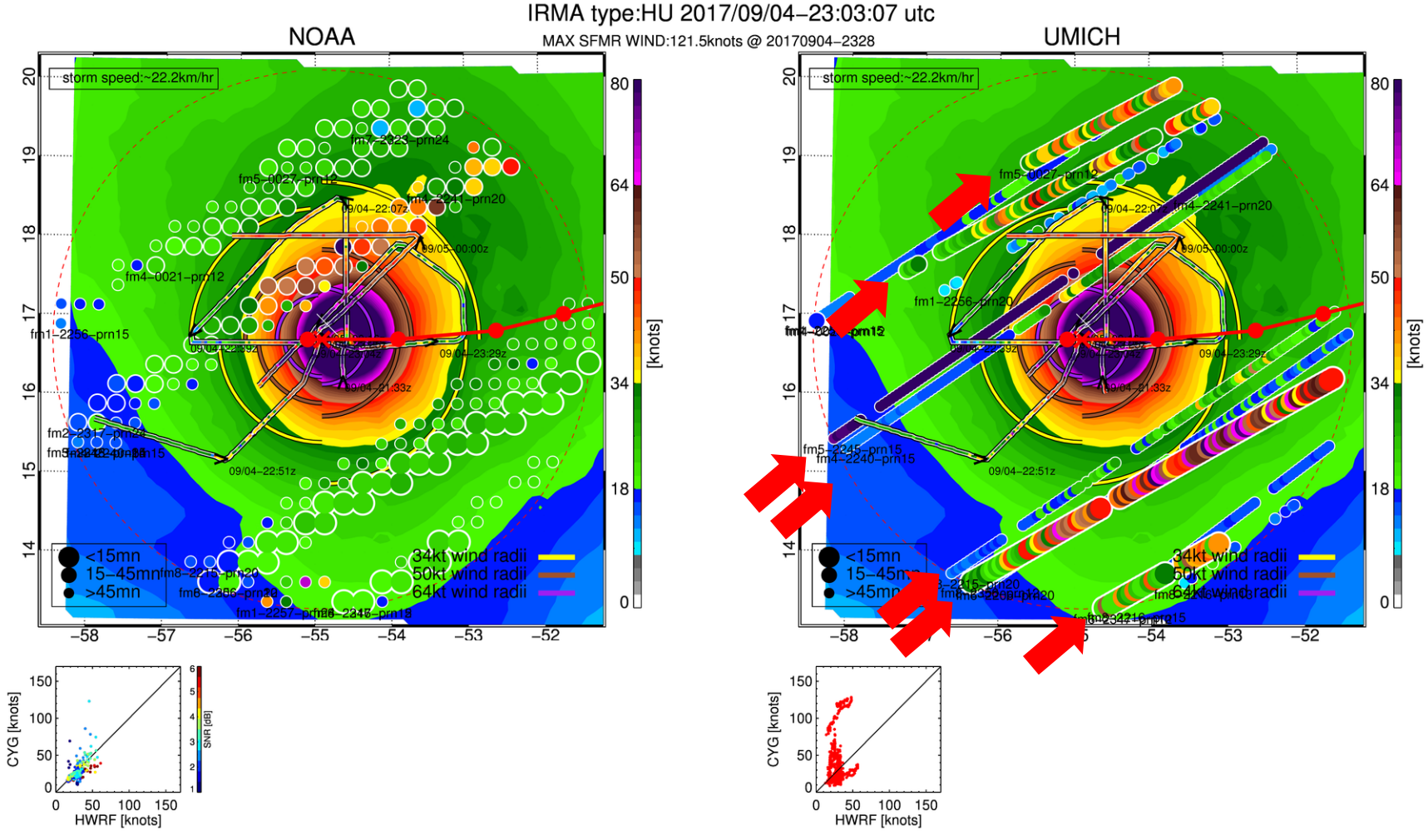




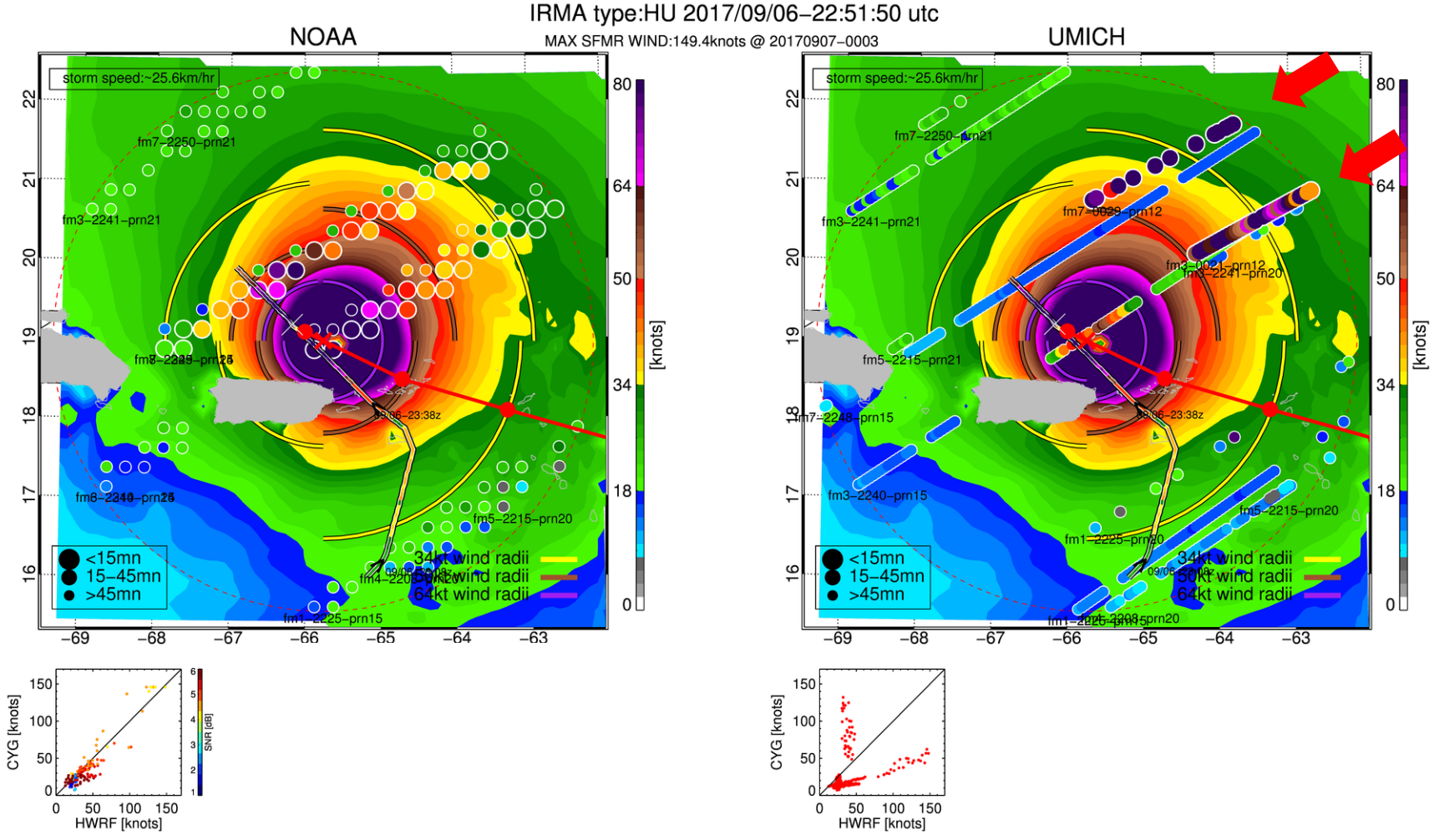


Selected Tropical Cyclone case studies

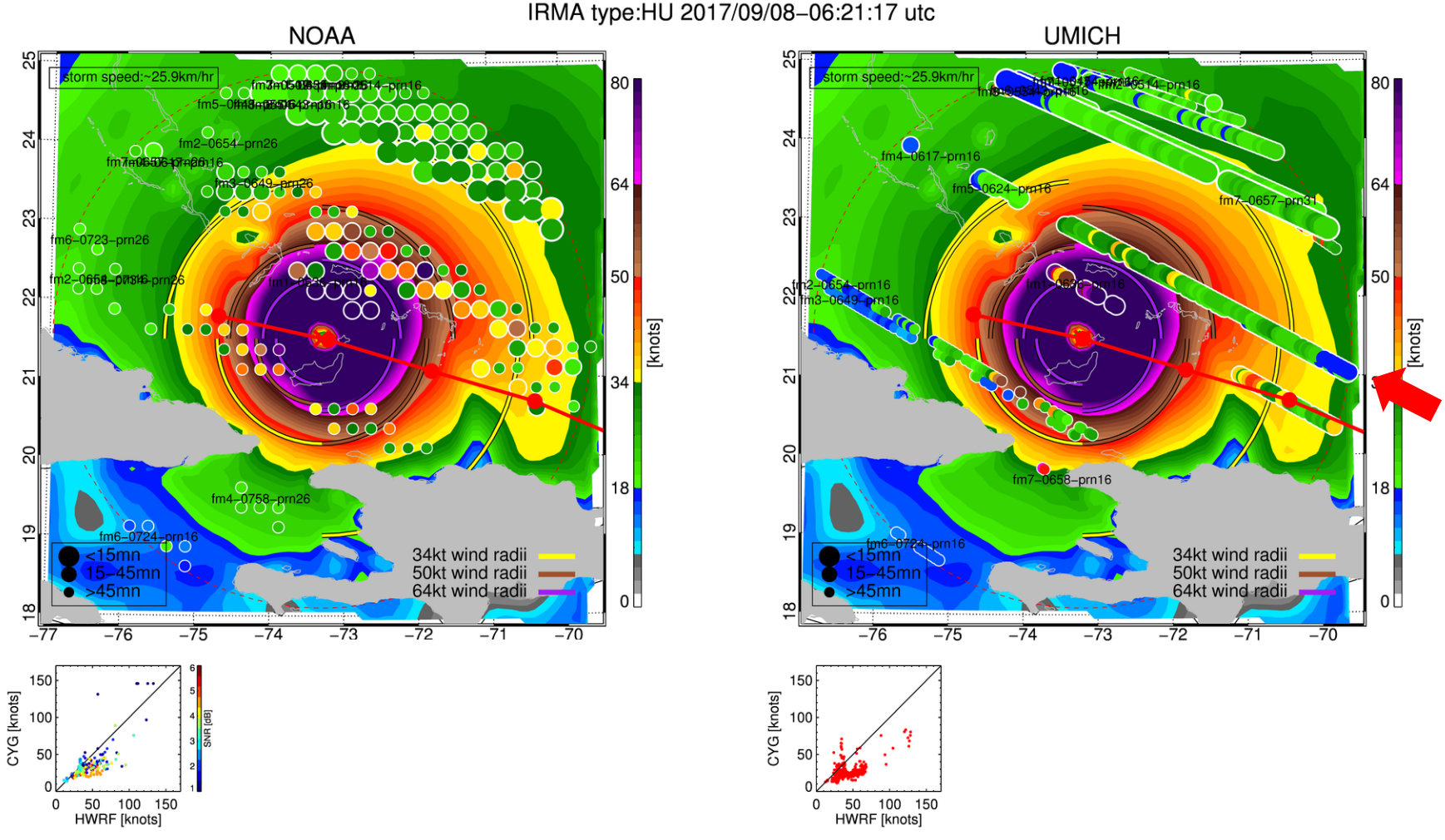
IRMA CASE 1


IRMA type:HU 2017/09/04-23:03:07 utc
MAX SFMR WIND:121.5knots @ 20170904-2328
NOAA
UMICH
storm speed:~22.2km/hr
<15mn
15-45mn
>45mn
34kt wind radii
50kt wind radii
64kt wind radii
[knots]
CYG [knots]
HWRF [knots]
SNR [dB]

IRMA CASE 2


IRMA type:HU 2017/09/06-22:51:50 utc
NOAA
MAX SFMR WIND:149.4knots @ 20170907-0003
UMICH
storm speed:~25.6km/hr
fm7-2250-prn21
fm3-2241-prn21
fm5-2215-prn20
fm1-2225-prn15
fm7-0039-prn12
fm3-0021-prn12
fm3-2241-prn20
fm5-2215-prn21
fm7-2248-prn15
fm3-2240-prn15
fm1-2225-prn20
<15mn
15-45mn
>45mn
34kt wind radii
50kt wind radii
64kt wind radii
[knots]
CYG [knots]
HWRF [knots]
SNR [dB]

IRMA CASE 3


IRMA type:HU 2017/09/08-06:21:17 utc
NOAA
UMICH
storm speed:~25.9km/hr
fm2-0654-prn26
fm3-0649-prn26
fm6-0723-prn26
fm4-0758-prn26
fm6-0724-prn16
fm4-0617-prn16
fm5-0624-prn16
fm7-0657-prn31
fm7-0658-prn16
<15mn
15-45mn
>45mn
34kt wind radii
50kt wind radii
64kt wind radii
[knots]
CYG [knots]
HWRF [knots]
SNR [dB]

Summary

- Trackwise w.r algorithm
  - implements a $\sigma^{o\ bias}$ removal on a track-by-track basis
  - makes use of a GMF dependent on incidence angle, wind speed and significant waveheight
- improves performance in Tropical Cyclone environment
- Storm structure is more apparent on a case by case basis
- Performance is similar regardless of GPS block type

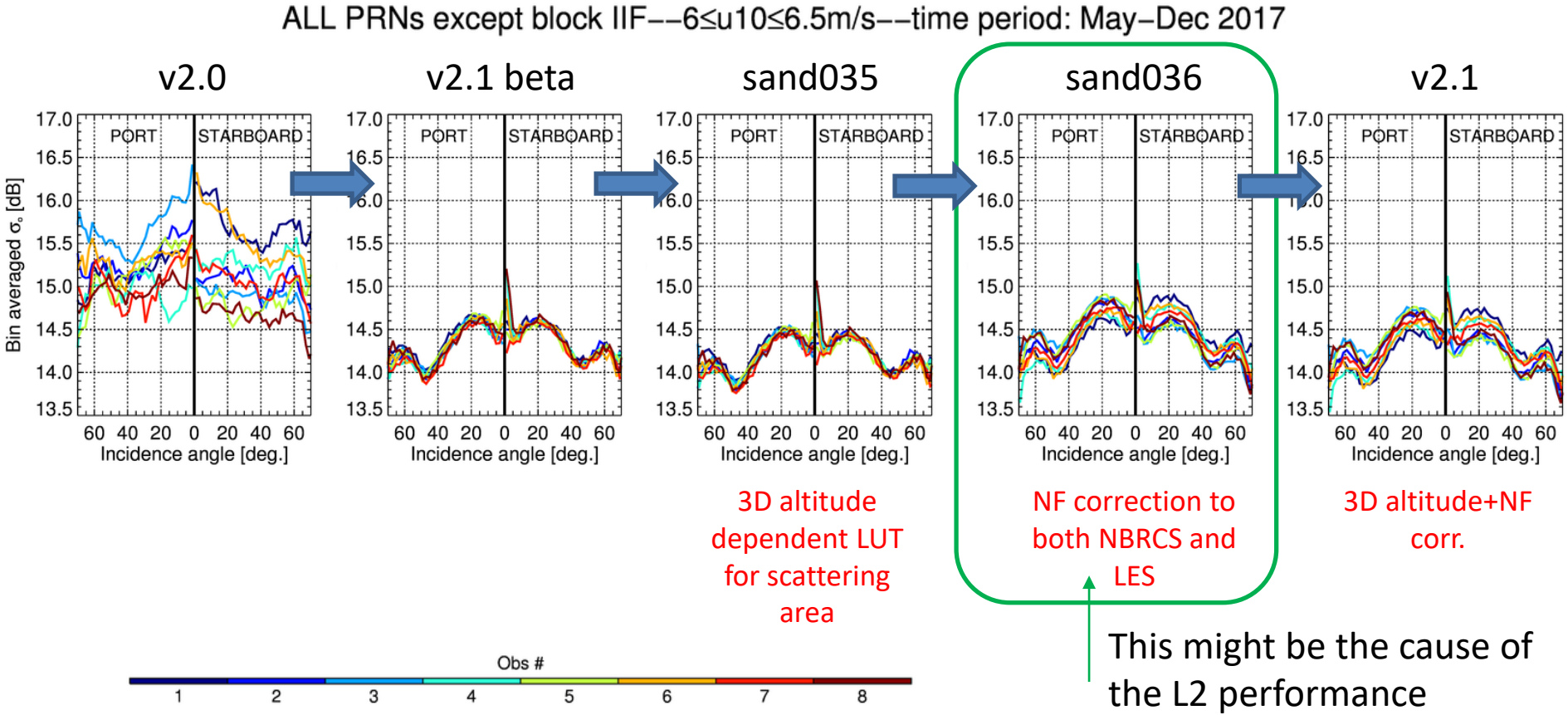
Future work

- Refine GMF
- Improve the gridding algorithm
- Improve aspects of the track-wise bias removal
- Test it with upcoming CyGNSS v3.0 L1 data
- Compare with winds from other scatterometers/radiometer instruments

C'è una speranza, dopo tutto!

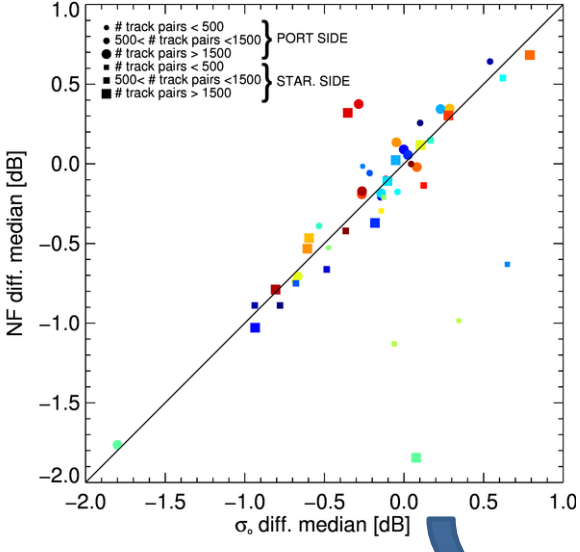
Additional slides

Bin averaged Sigma0 vs incidence angle **separated by antenna and observatory**

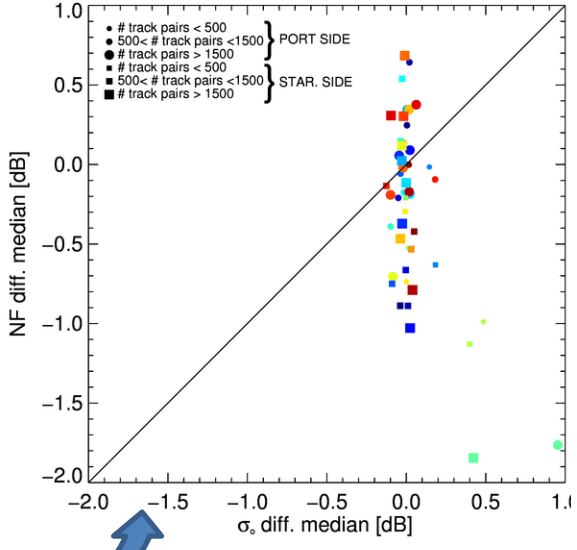


This might be the cause of the L2 performance degradation previously noted

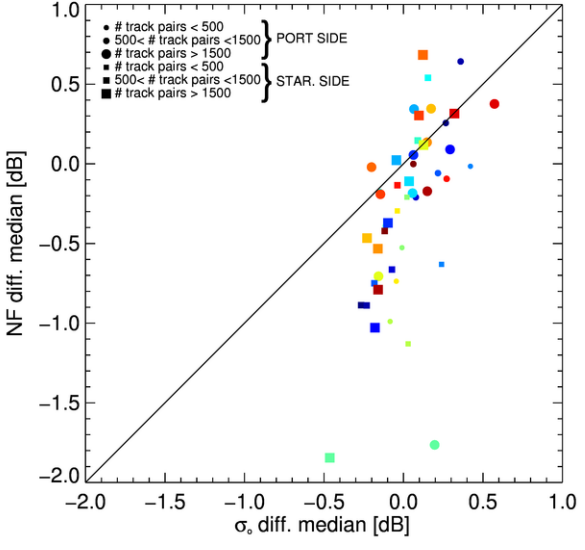
v2.0

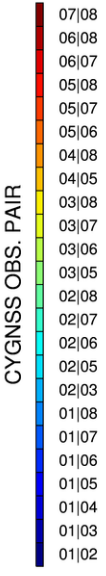


v2.1 beta



v2.1





D/A conversion from Rx power cal. was removed