Overview of v1.2 NOAA CyGNSS winds

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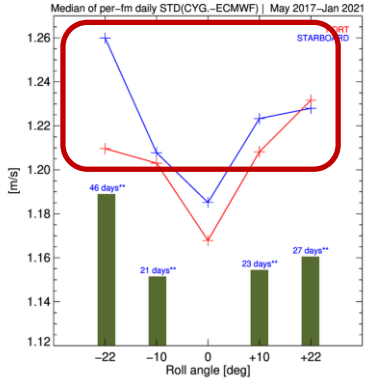
Outline

- v1.2 key improvements
- Performance comparison against NOAA v1.1, including SDR v3.1 (using ECMWF / HWRF)
- Data availability
- Summary
- ‘bonus’ analysis: v3.1 NBRCS incidence angle dependence

v1.2 improvement summary over v1.1

1. v1.1 excludes data with |roll|>5°

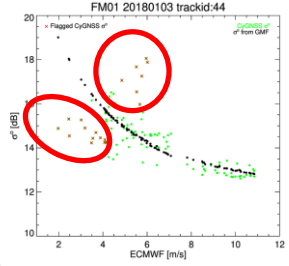
High roll angle data represents ~13% data loss in v1.1



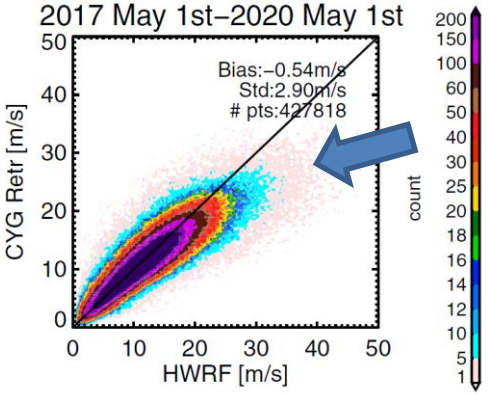
** Vertical bars represent the number of days where ALL eight spacecrafts were simultaneously rolled.

Solution

- Compute and evaluate |pointwise σo bias| (i.e. |σo CYGNSS-σoGMF|) against set threshold
- Threshold is selected based on achieving a balance between acceptable overall performance (stde<1.2m/s) and minimal data loss (1-3%)

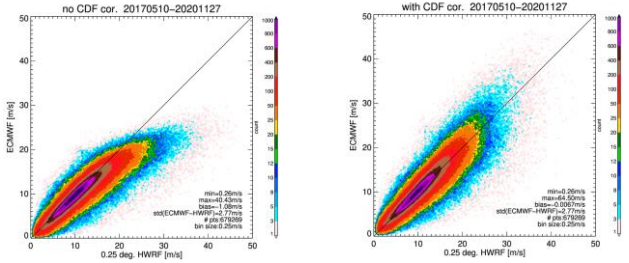


2. v1.1 NOAA CyGNSS winds tend to be underestimated in the higher wind regime

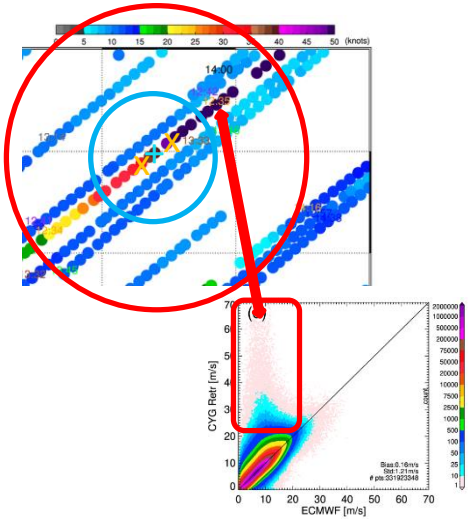


Solution

- collocated 0.25° HWRF/ECMWF winds (within AL/EP basins) are 'CDF matched' in order to apply a high wind correction to ECMWF
- a look-up table is then generated and subsequently used to correct ECMWF winds, which are then used as part of the NOAA track-wise σ_o algorithm



3. Presence of outliers



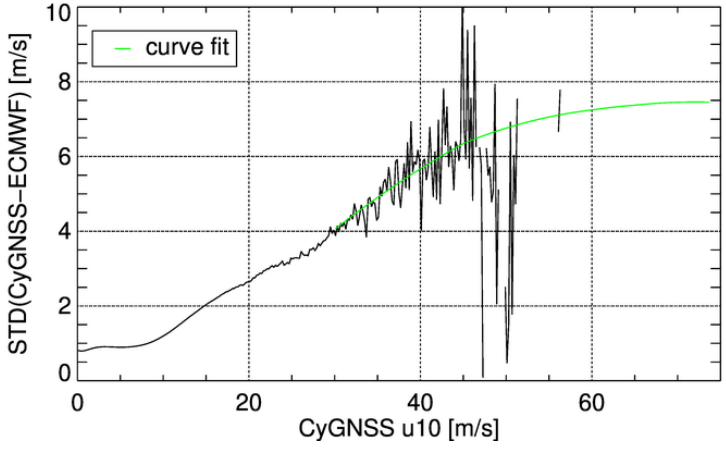
Solution

All *sample_u10* where |*sample_*u_{10}-$u_{10\text{-}mod}$|>6m/s are evaluated where

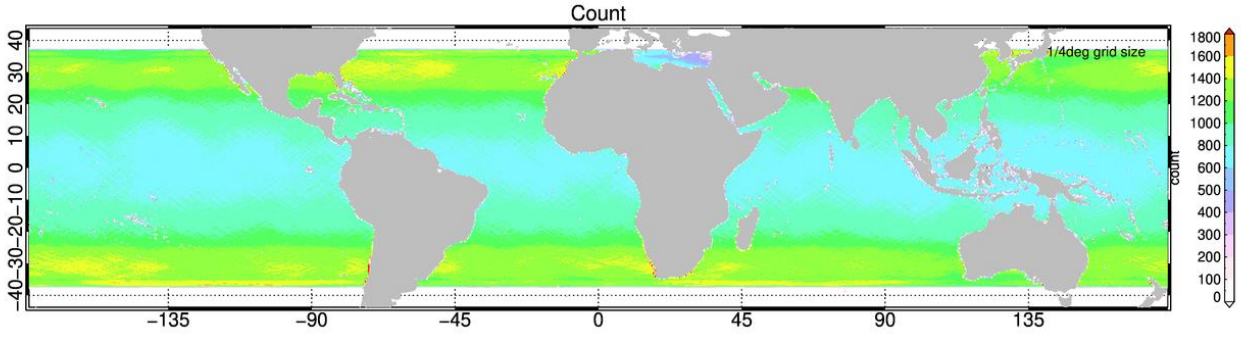
- each sample is collocated with other samples within 80 km and 45 min, **while excluding samples from same track**
- overall median (*overall_med*) is compared against *sample_u10,* where an appropriate threshold is used to flag the data depending on the error (i.e. *sample_u10 - overall_med*)
- collocation criteria are relaxed if no samples are found
- If collocated samples are still not found, then compare direct neighbors along same track with *sample_u10* as a last resort

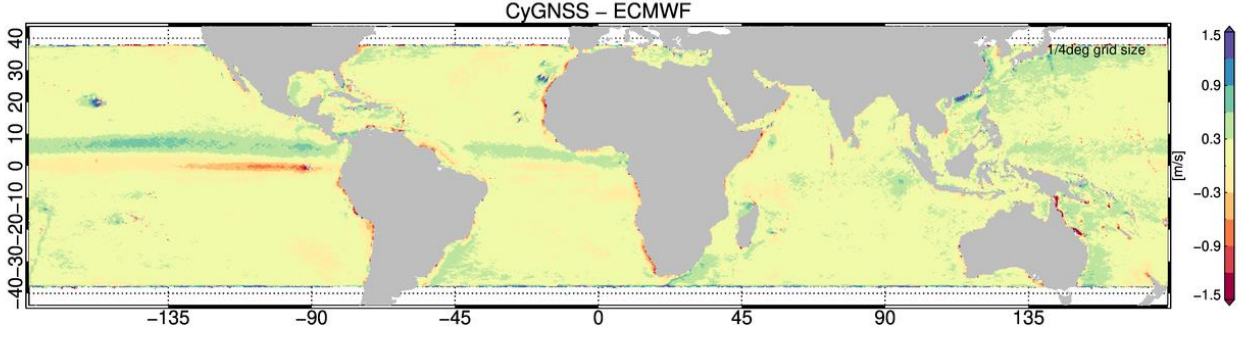
New variable addition to v1.2

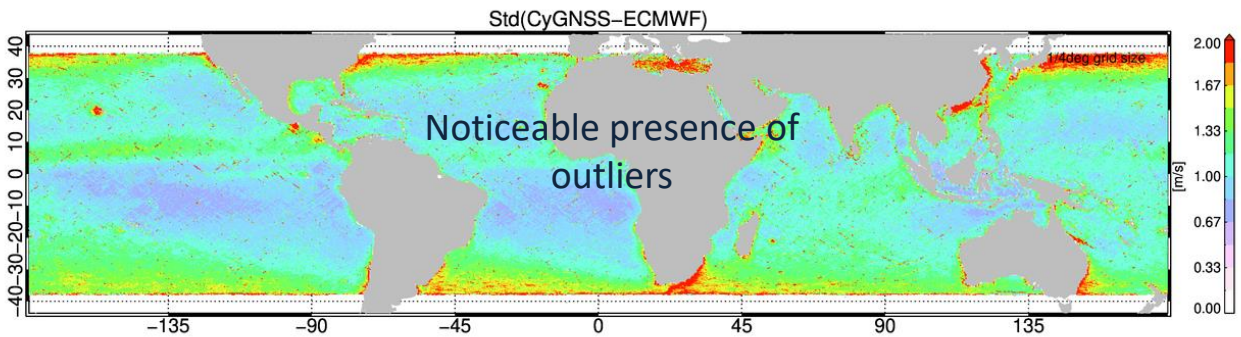
- v1.2 dataset now includes a variable related to the retrieved wind speed uncertainty to facilitate data assimilation experiments
- Variable name: **wind_speed_uncertainty**
- It is derived using the standard deviation of the wind speed error (stde) between CyGNSS and ECMWF
- Collocated data from May 2017 until November 2020 was used to generate this metric

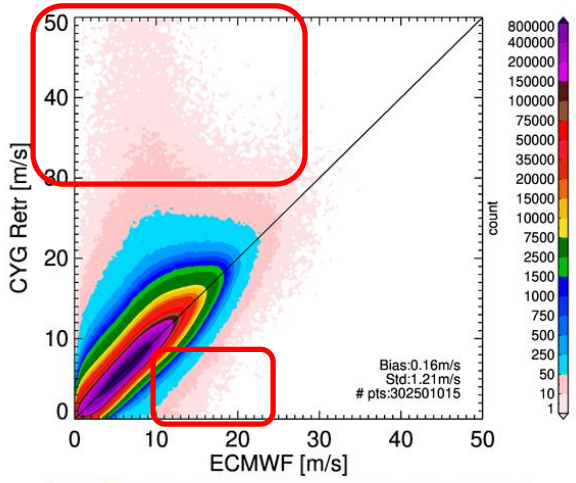


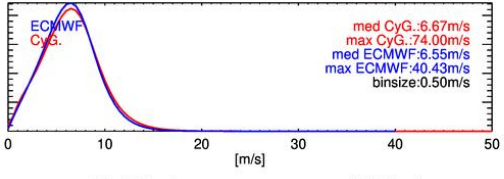
V1.1 CyG vs. ECMWF – 2017 May 01 – 2020 Nov 30

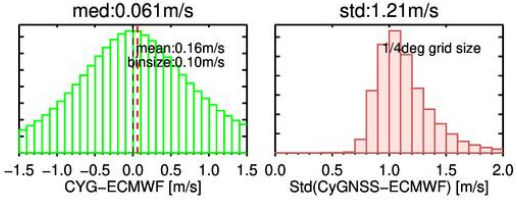


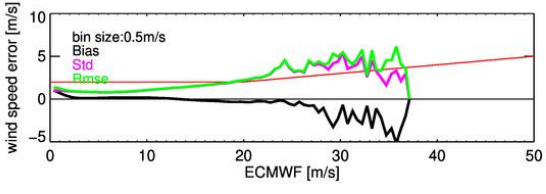




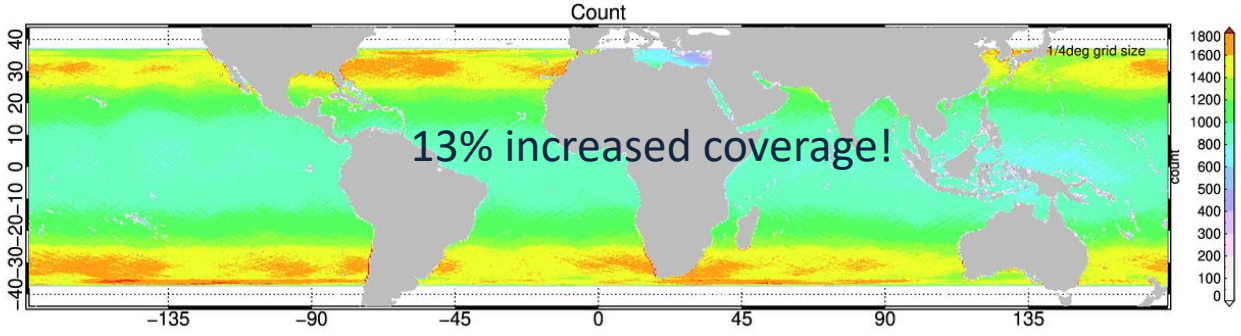


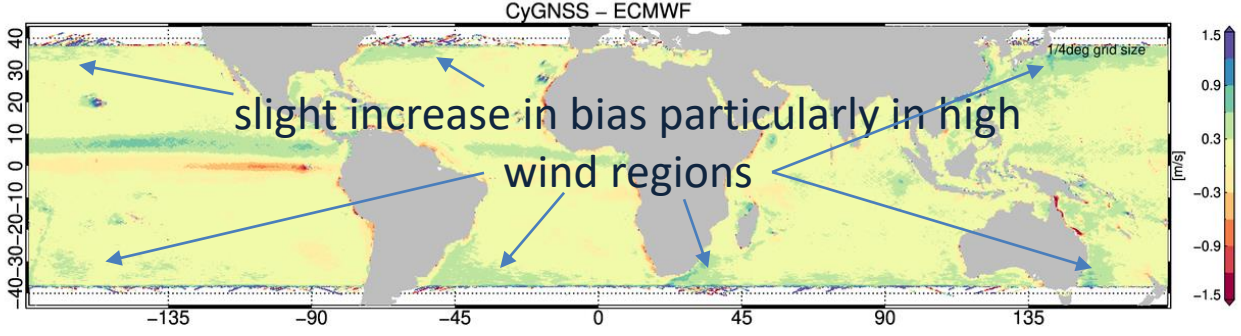


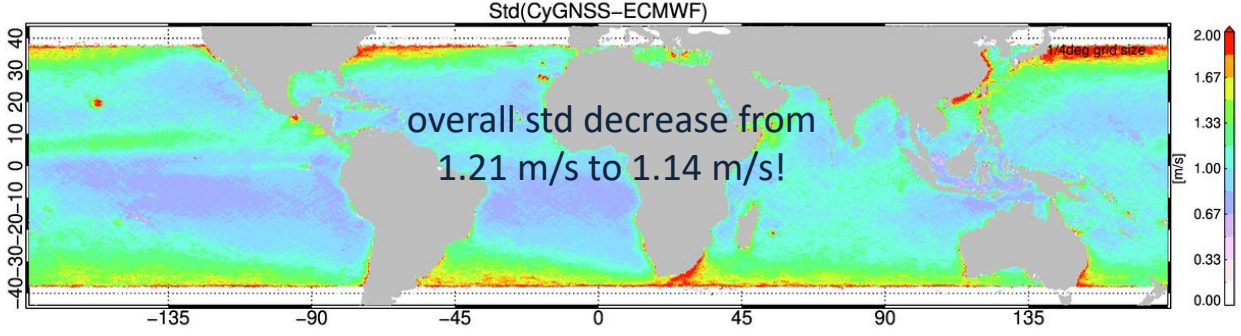


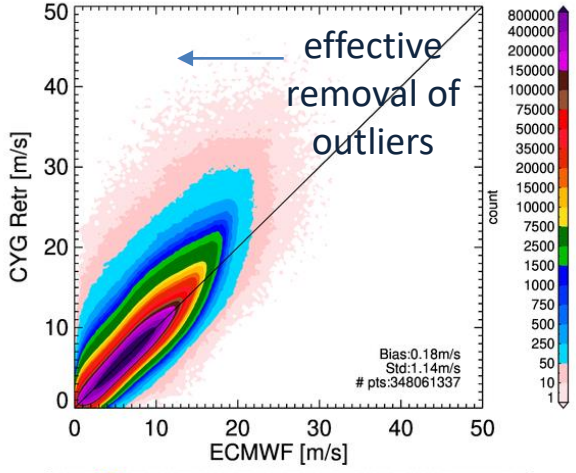


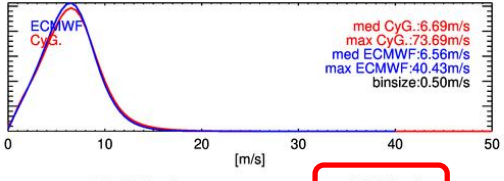
V1.2 CyG vs. ECMWF – 2017 May 01 – 2020 Nov 30

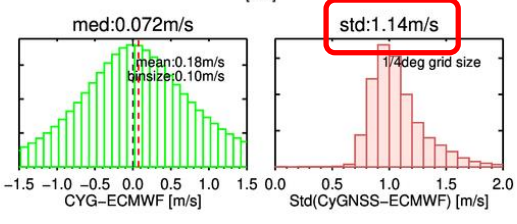


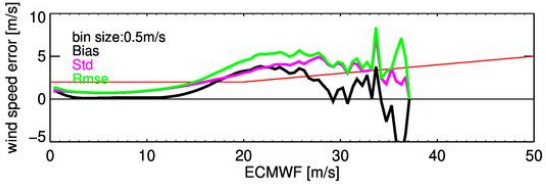




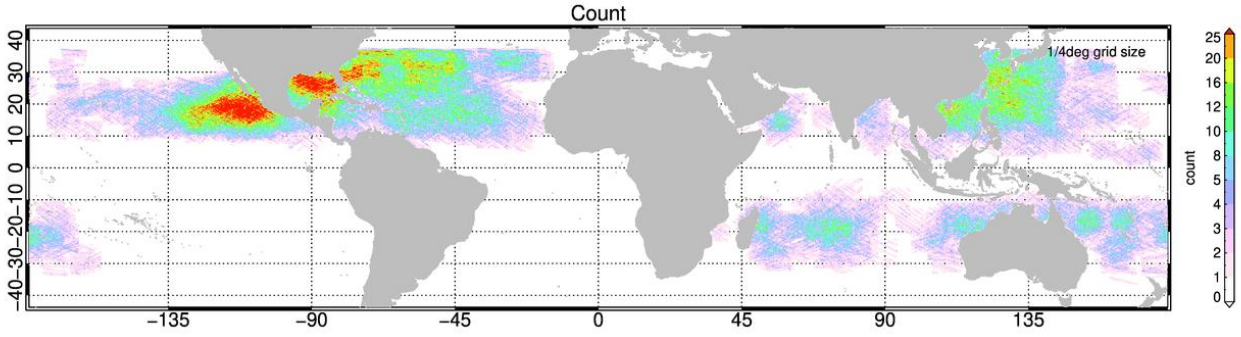


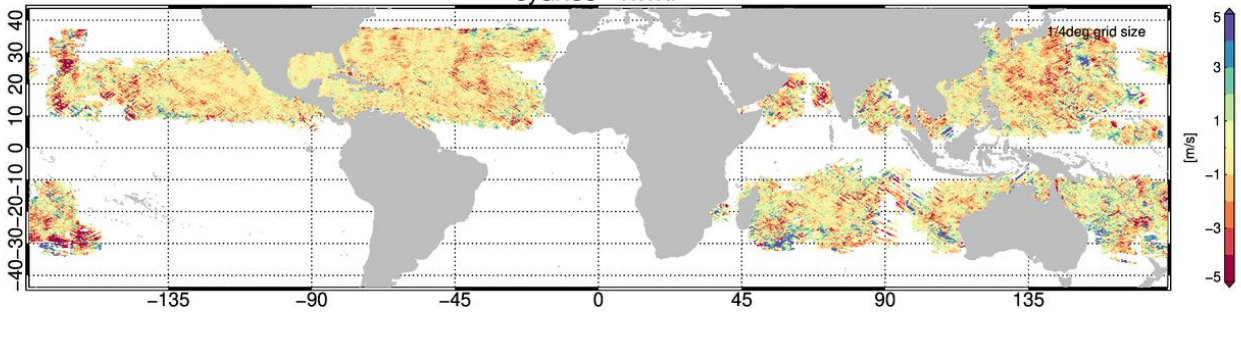


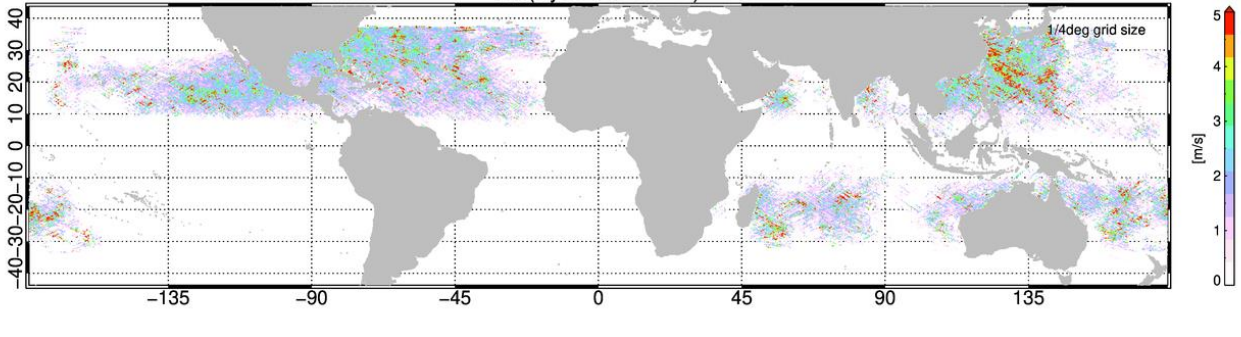


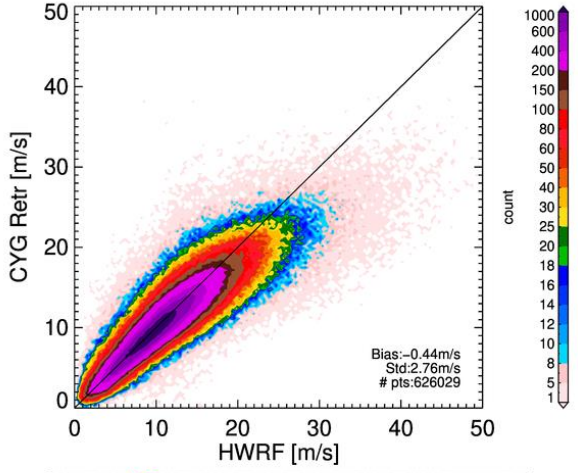


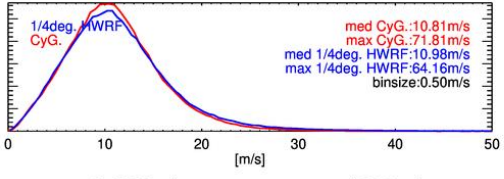
V1.1 CyG vs. HWRF – 2017 May 01 – 2020 Nov 30

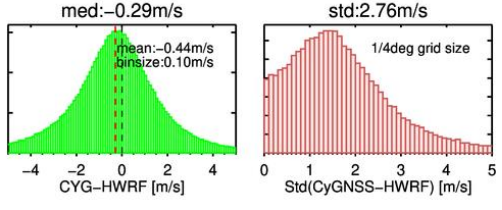


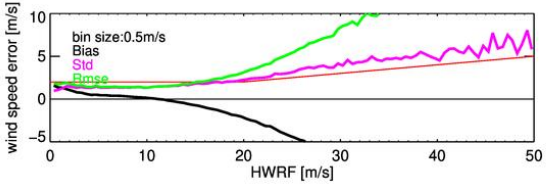




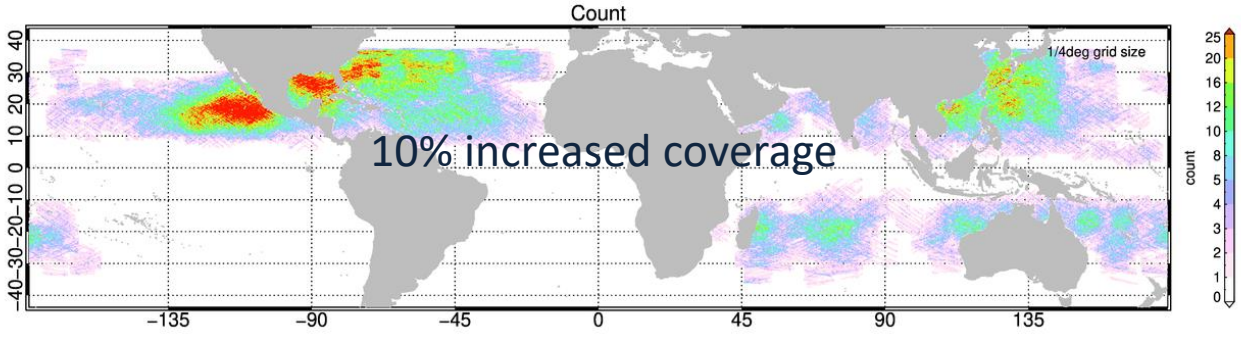


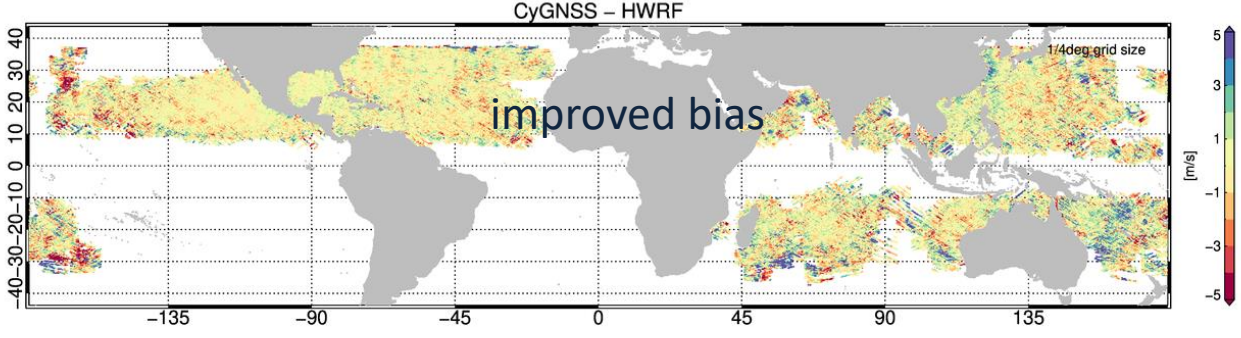


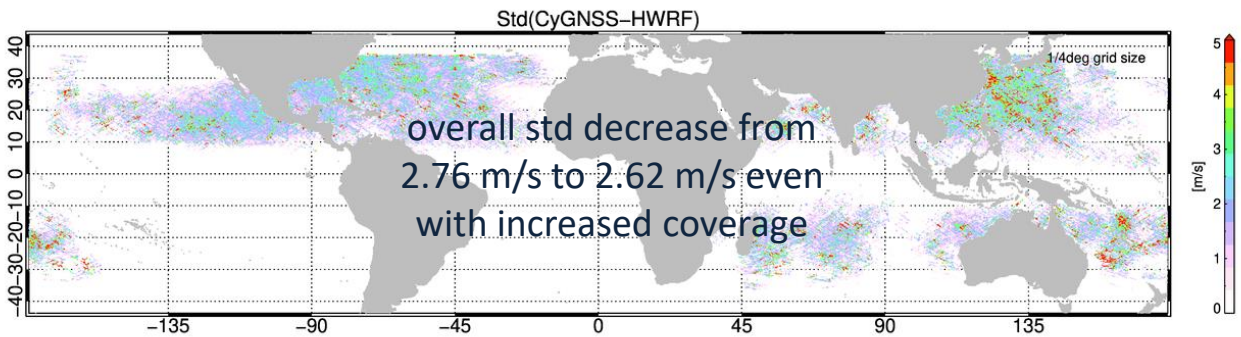


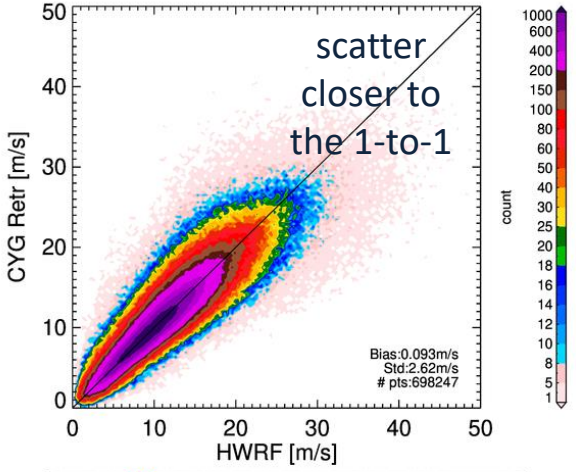


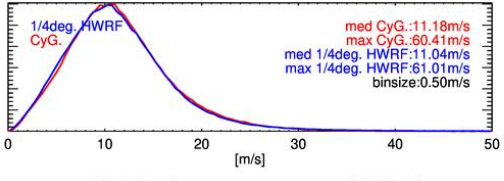
V1.2 CyG vs. HWRF – 2017 May 01 – 2020 Nov 30

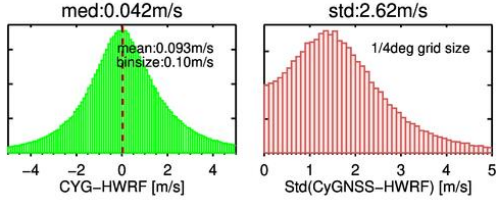


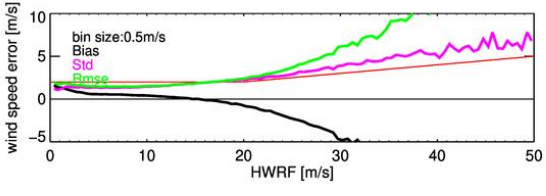






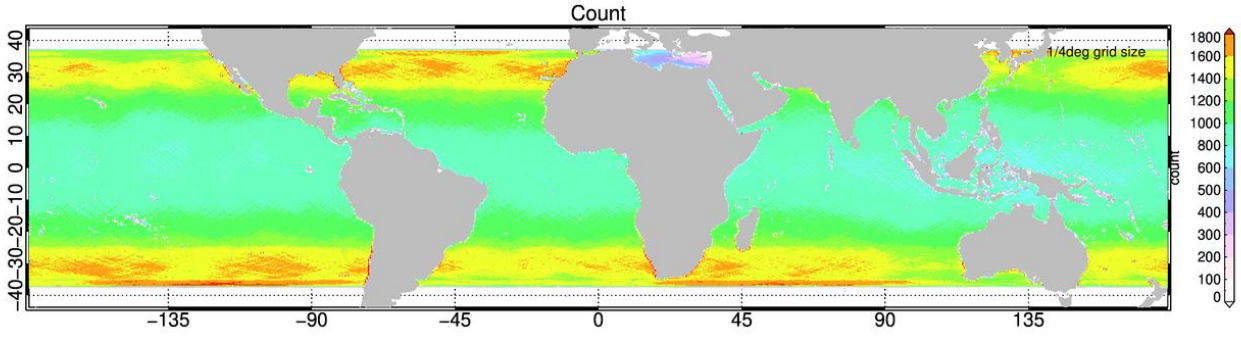


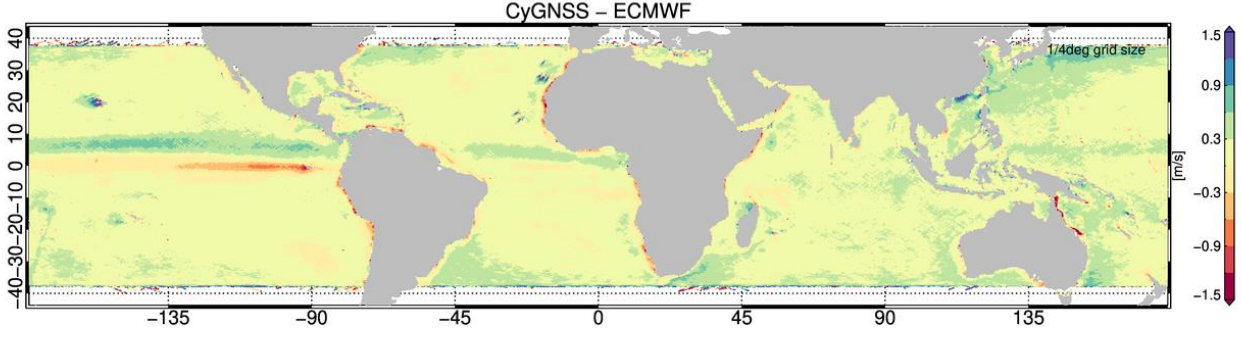


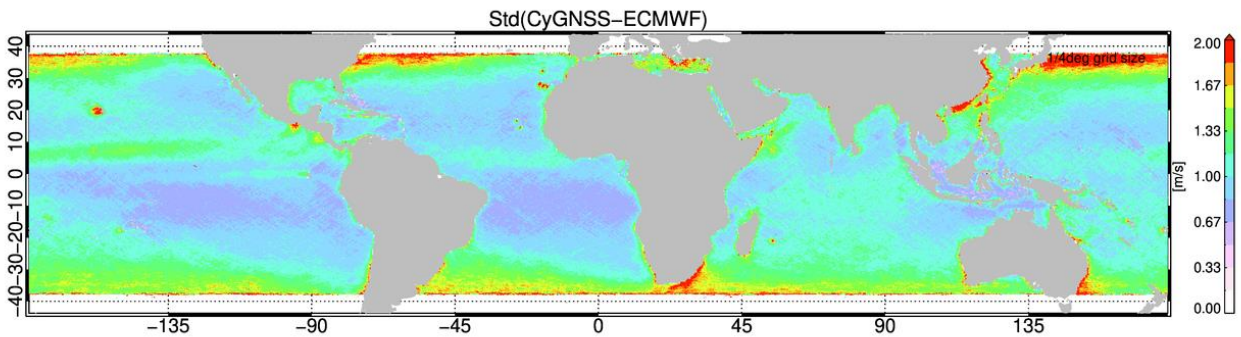


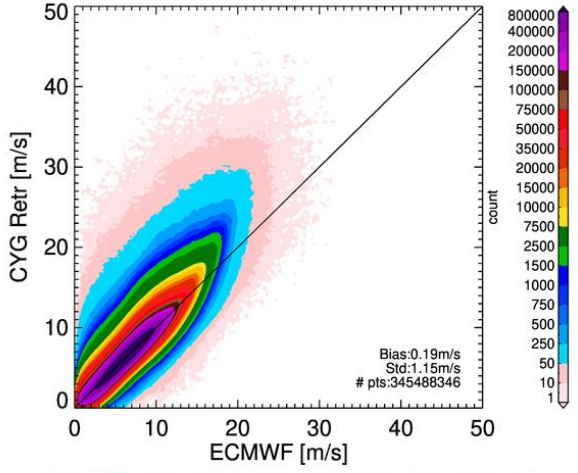
Comparing v1.2 against v3.1 SDR winds

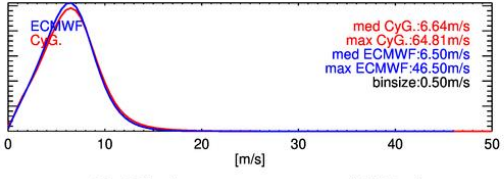
V1.2 CyG vs. ECMWF – 2018 Aug 01 – 2021 Dec 31

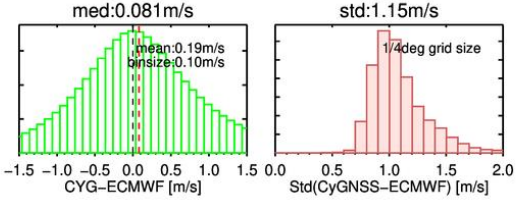


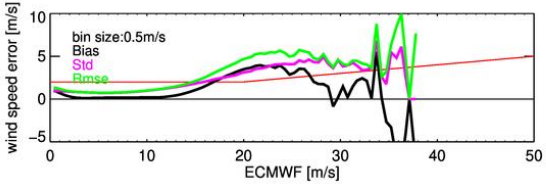






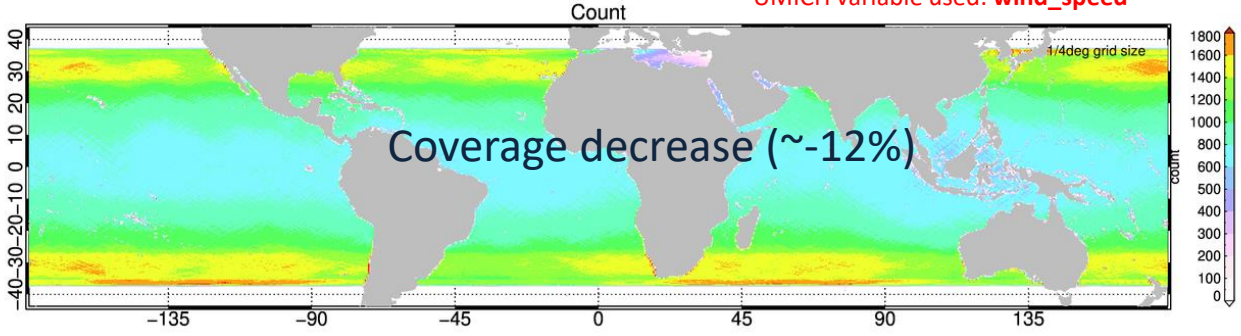


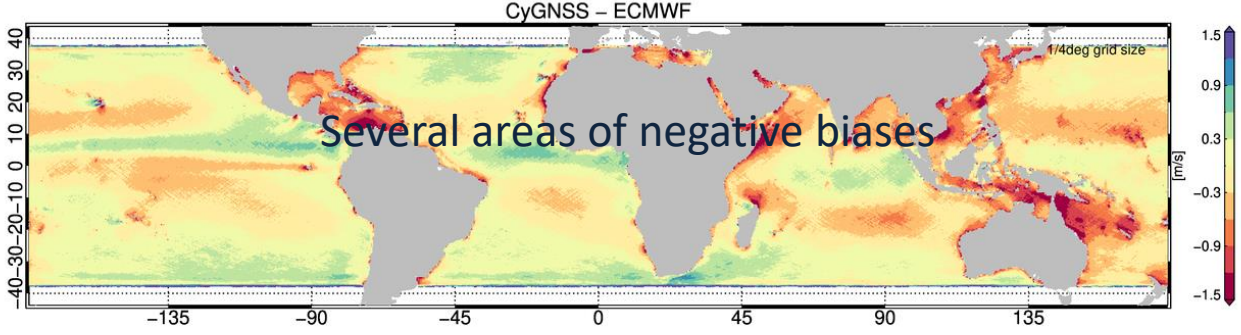


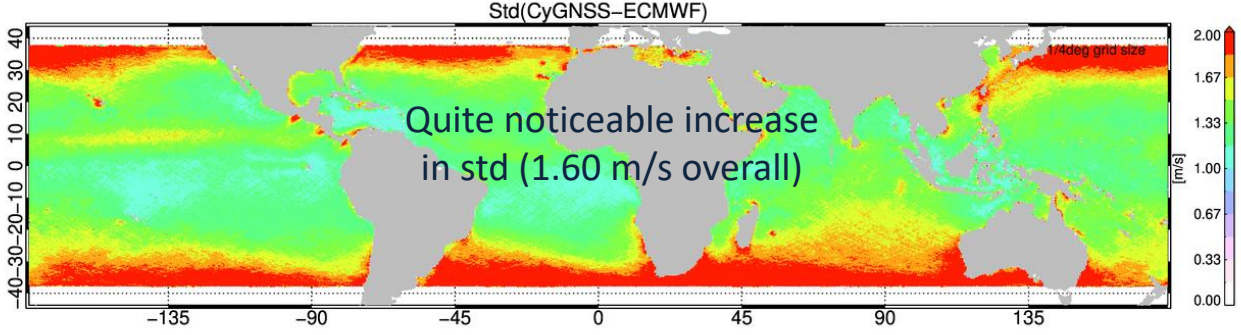


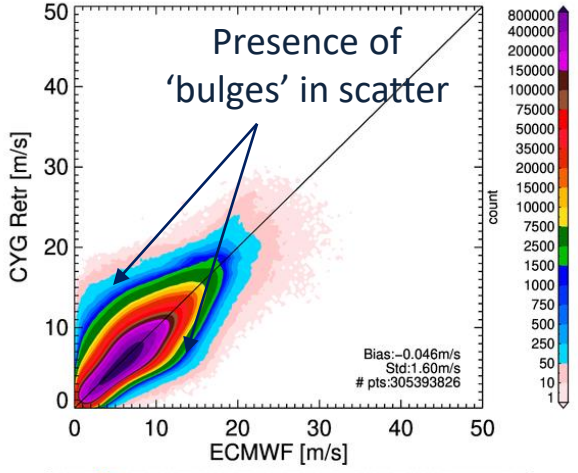
V3.1 SDR CyG vs. ECMWF – 2018 Aug 01 – 2021 Dec 31

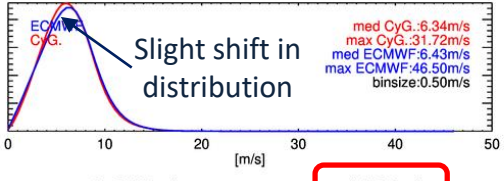
UMICH variable used: **wind_speed**

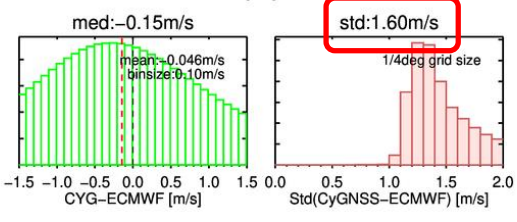


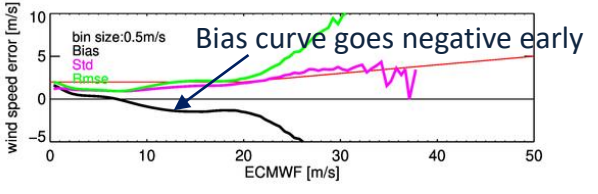




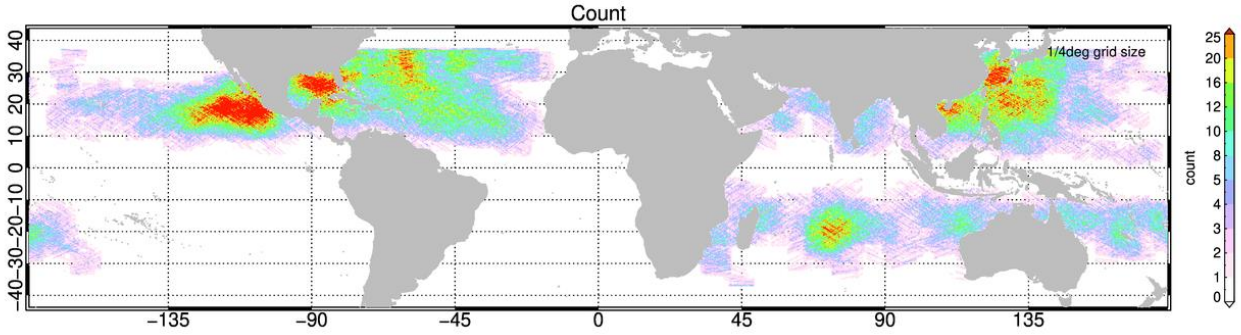


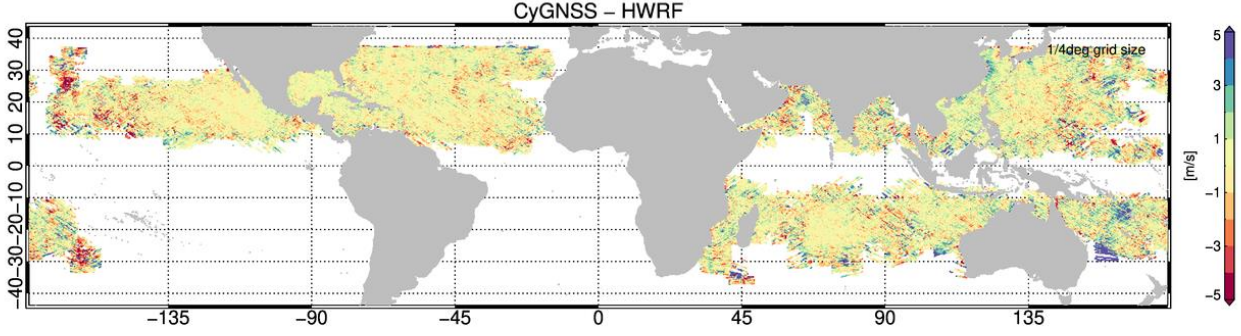


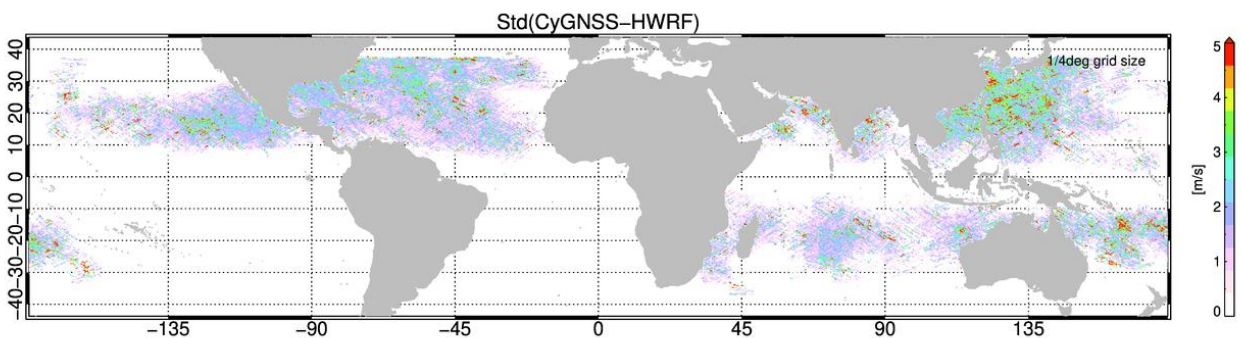


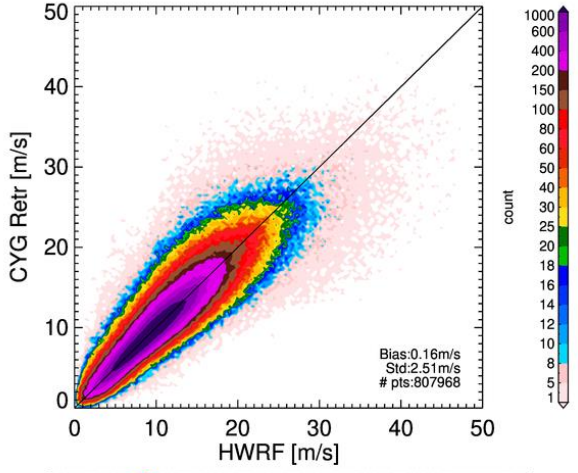


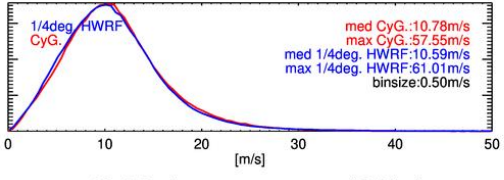
V1.2 CyG vs. HWRF – 2018 Aug 01 – 2021 Dec 31

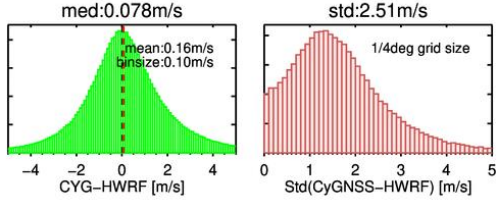


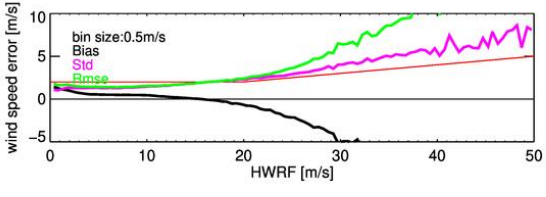






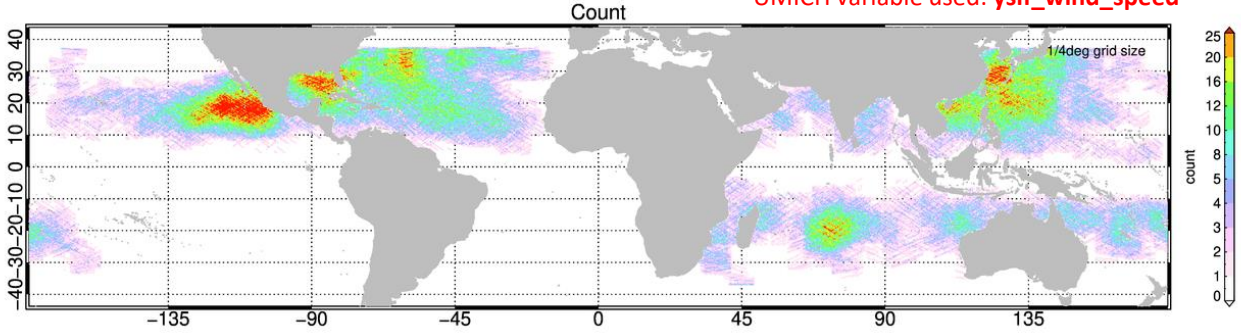


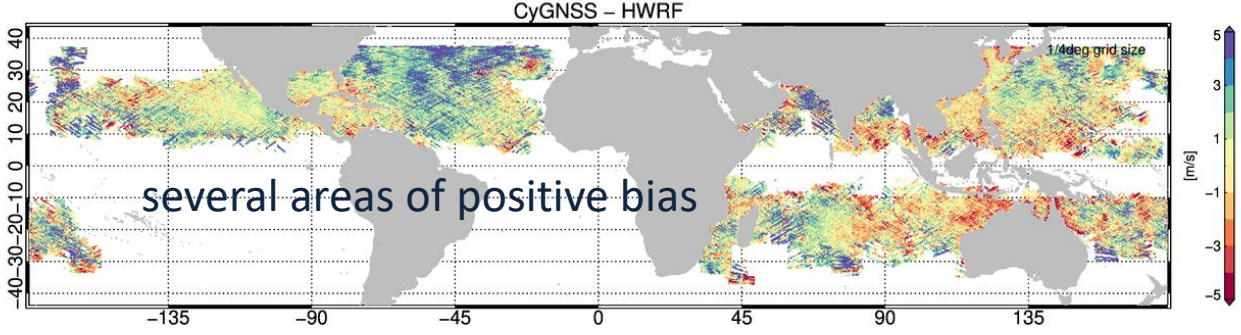


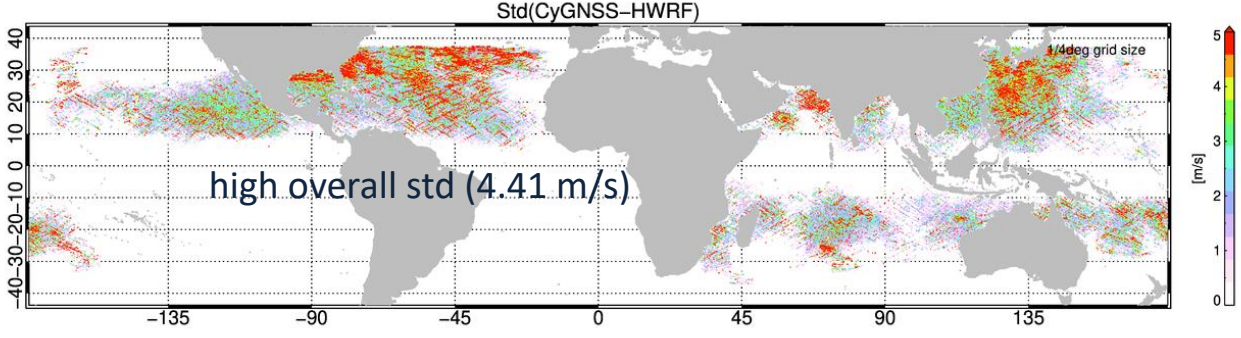


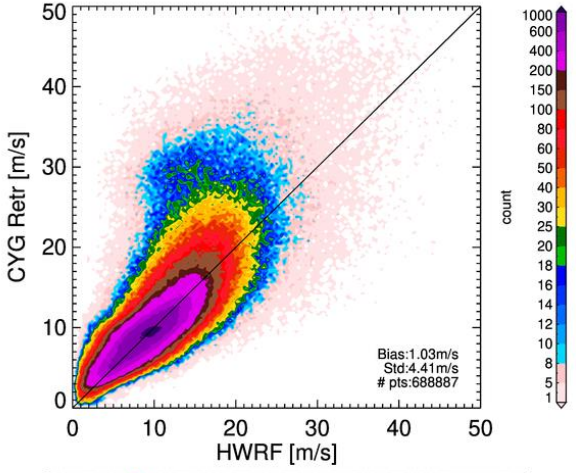
V3.1 SDR CyG vs. HWRF – 2018 Aug 01 – 2021 Dec 31

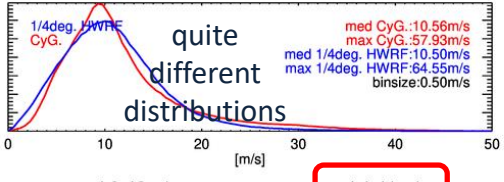
UMICH variable used: **yslf_wind_speed**

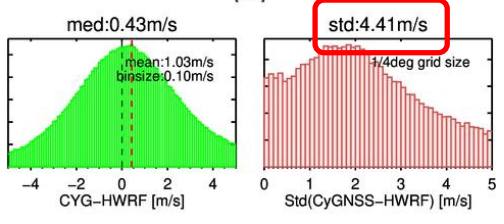


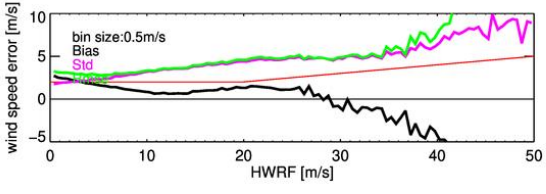












v1.2 data availability and data hosting site

- Data is **currently available** to the public at **https://manati.orbit.nesdis.noaa.gov/cygnss/**. Username and password no longer necessary. It will be available on the PO.DAAC later this year.
- Daily global imagery already available at https://manati.star.nesdis.noaa.gov/datasets/CYGNSSData.php
- File type remains NetCDF
- Filenaming convention remains the same
  - cyg.ddmi.s20170506-000000-e20170506-235959.l2.wind_trackgridsize25km_NOAAv**1.2**_L1a21.d21.nc
- The use of the 'sample_flags' variable remains the same
  - see v1.1 user guide for an example on how to use it: https://podaac-tools.jpl.nasa.gov/drive/files/allData/cygnss/L2/docs/basic_user_guide_noaa_l2_wind_v1.1.pdf
- Only difference with v1.1 data file content is the addition of the 'wind_speed_uncertainty' variable

Index of /cygnss/L2

Name	Last modified	Size	Description
Parent Directory		-	
2017/	2022-02-11 18:14	-	
2018/	2022-02-11 18:38	-	
2019/	2022-02-11 19:06	-	
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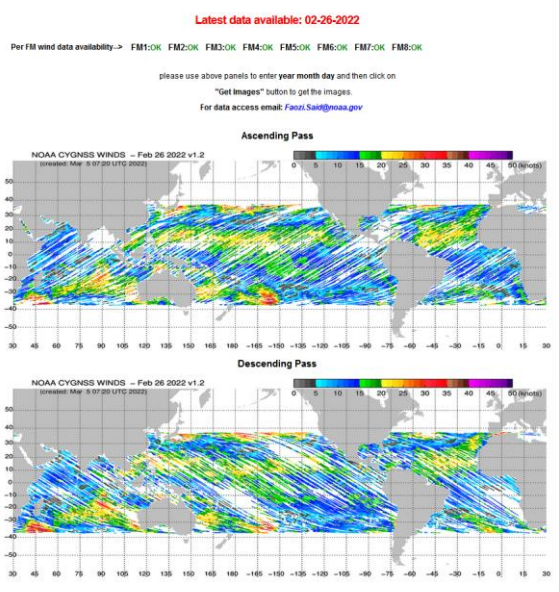


Summary

- Following key improvements included in v1.2 NOAA CyGNSS wind product version:
  1. high roll angle data included with poor quality samples filtered out
  2. high wind correction based on a CDF matching technique applied to ECMWF
  3. updated quality flag more efficient at removing wind speed outliers
  4. inclusion of a wind speed error variable (useful for data assimilation)
- Overall performance against ECMWF shows
  - slight bias increase between v1.1 and v1.2 (0.18 m/s up from 0.16 m/s)
  - decrease in overall stde (1.14 m/s down from 1.21 m/s)
  - removal of outlier wind samples is very noticeable on both stde geographical map and scatterplot
- Overall performance against HWRF shows
  - improved overall bias (before -0.44 m/s - now +0.09 m/s)
  - decrease in overall stde (before 2.76 m/s – now 2.62 m/s)
- +15% increased coverage! No missing days anymore (either due to high roll angle or missing model data)
- Data available at https://manati.orbit.nesdis.noaa.gov/cygnss/
- Will soon be made available on the PO.DAAC

Publication providing details on the NOAA Track-wise algorithm:
F. Said, Z. Jelenak, J. Park, P. S. Chang, "The NOAA track-wise wind retrieval algorithm and product assessment for CyGNSS", Geoscience and Remote Sensing, IEEE Transaction on, July 2021, DOI: 10.1109/TGRS.2021.3087426

Bonus analysis:
v3.1 NBRCS vs incidence angle dependence

separated by FM, receiver antenna, GPS block type
Selected time periods:
2018 Aug -2021 Dec
2018 Aug – Mid Feb 2020 (BEFORE FLEX POWER EVENT)
Mid Feb 2020 – 2021 Dec (AFTER FLEX POWER EVENT)

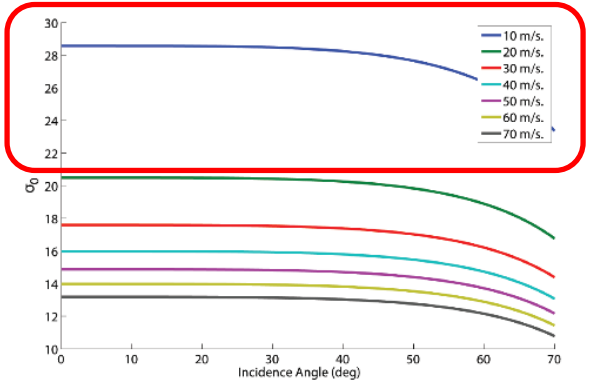
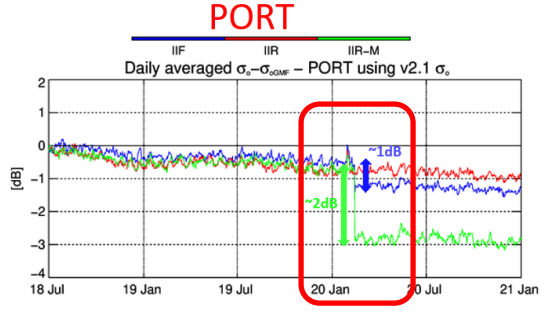
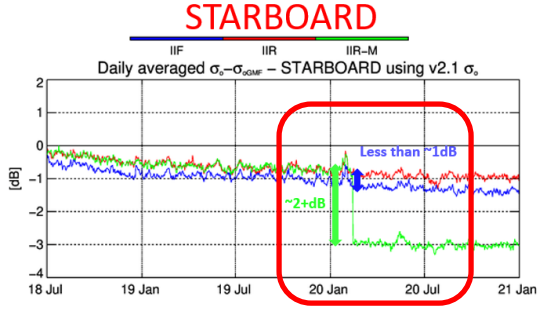


Figure 9.14. Curves of $\sigma_0(\bar{r}_{SP})$ versus incidence angle, for different wind speed values.

source: C. Ruf *et al.*, *CYGNSS Handbook*. Ann Arbor, MI, USA: Michigan Publishing, Apr. 2016.



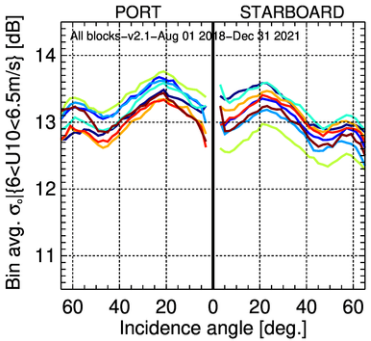


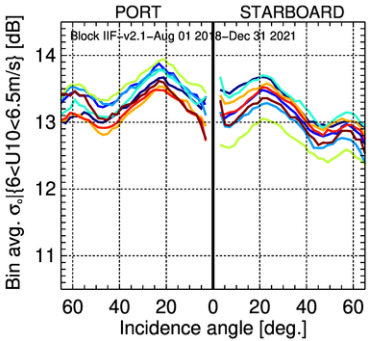
Bin averaged NBRCS vs incidence angle separated by block,antenna,FM

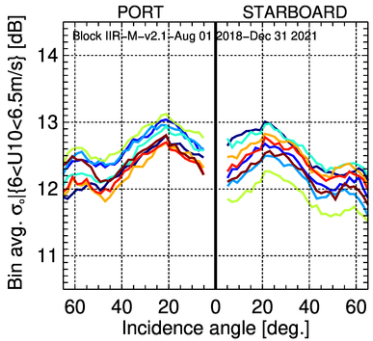
Comparing v2.1,sand265,v3.1 -- Time period:20180801-20201231 (except sand265)

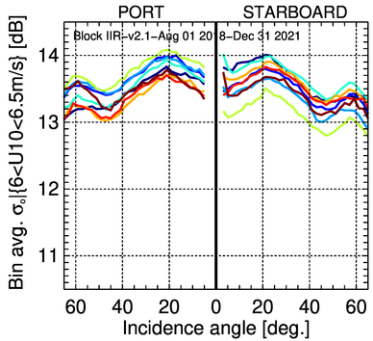
All blocks | IIF | IIR-M | IIR

v2.1

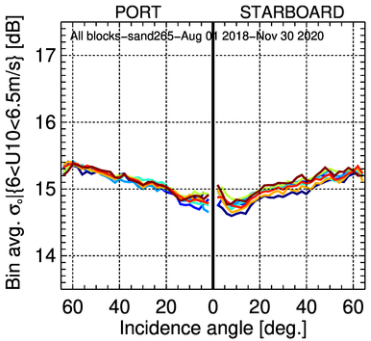


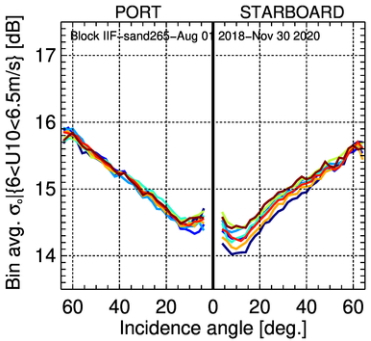


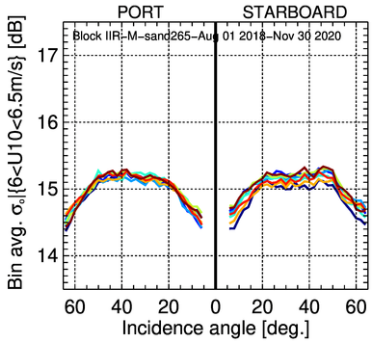


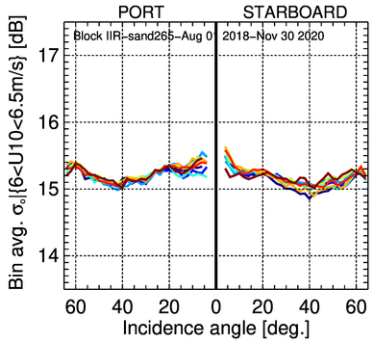


sand 265

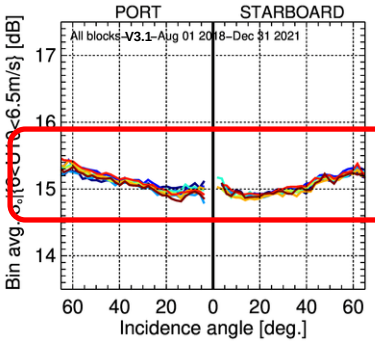


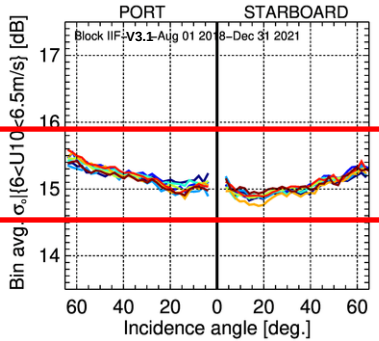


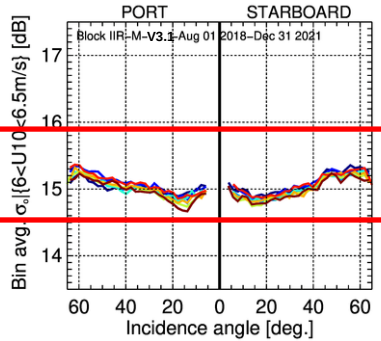


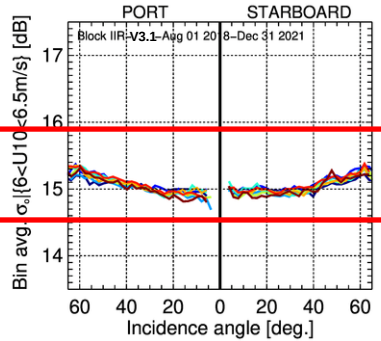


v3.1







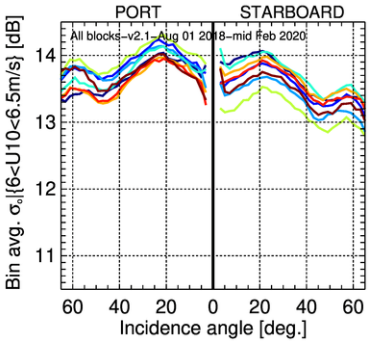


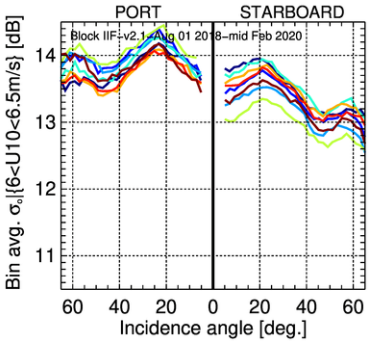
Bin averaged NBRCS vs incidence angle separated by block,antenna,FM

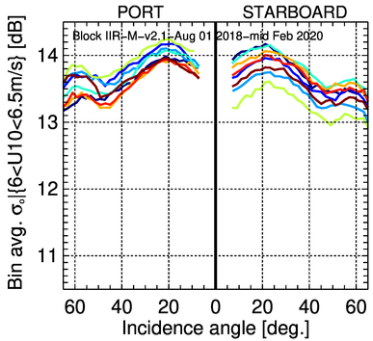
Comparing v2.1,sand265,v3.1 -- Time period:20180801-20200215

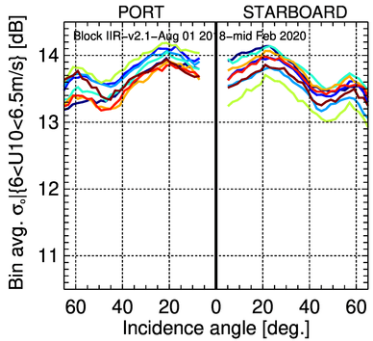
All blocks | IIF | IIR-M | IIR

v2.1

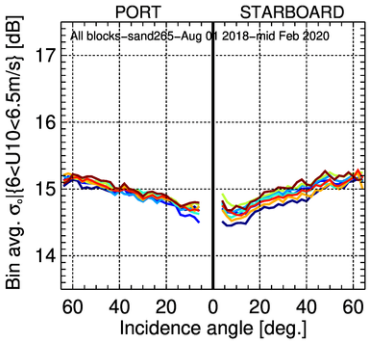


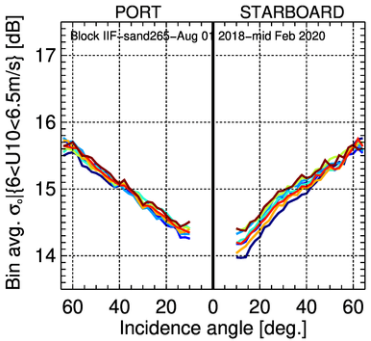


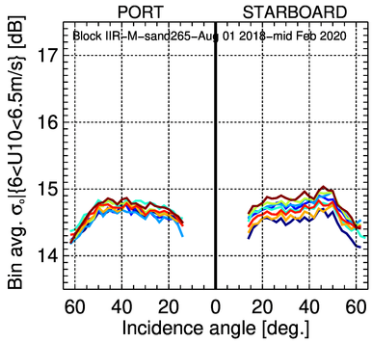


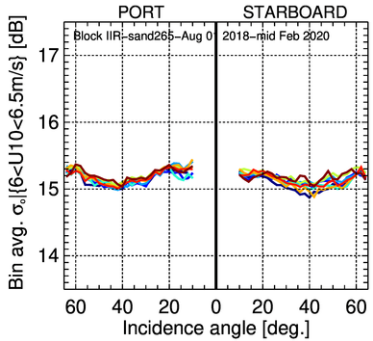


sand 265

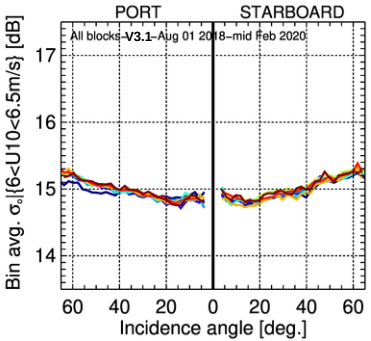


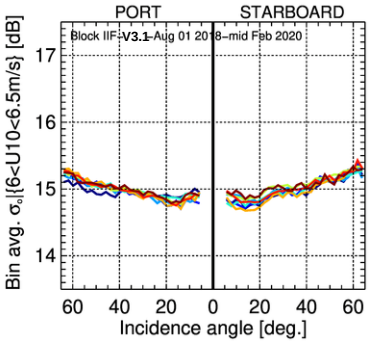


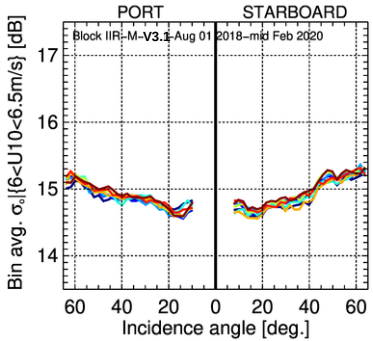


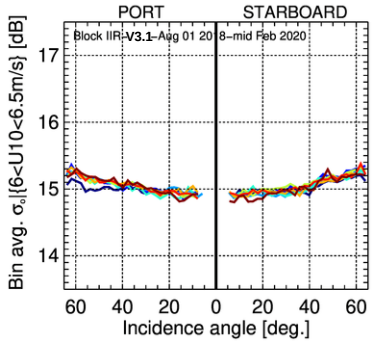


v3.1









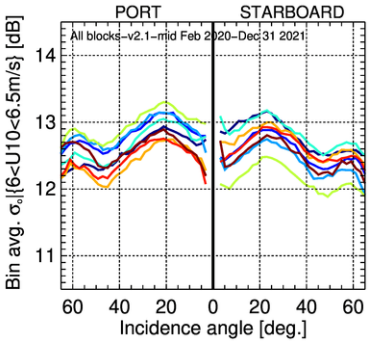
BEFORE FLEX EVENT

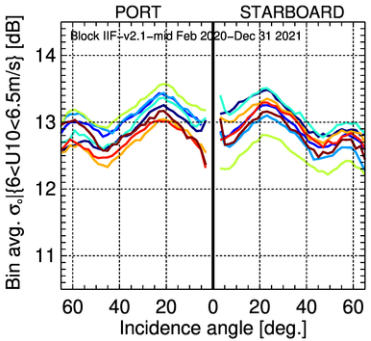
Bin averaged NBRCS vs incidence angle separated by block,antenna,FM

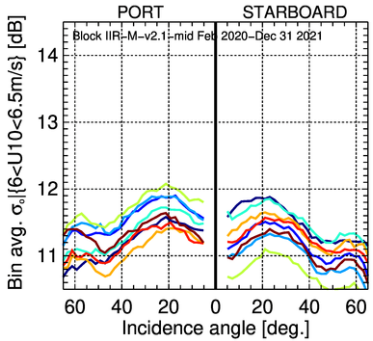
Comparing v2.1,sand265,v3.1 -- Time period:20200215-20201130 (except sand265)

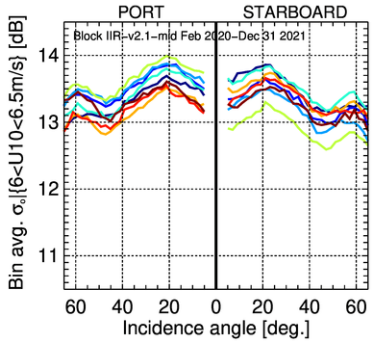
All blocks | IIF | IIR-M | IIR

v2.1

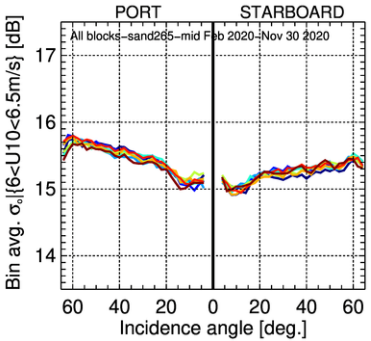


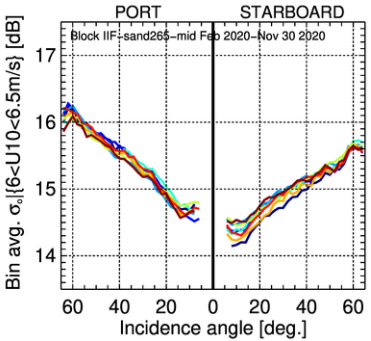


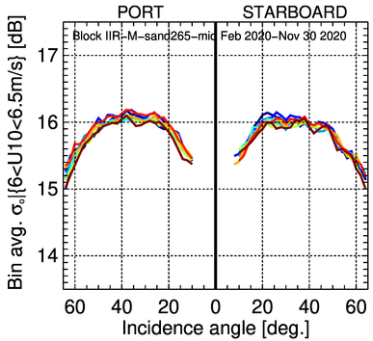


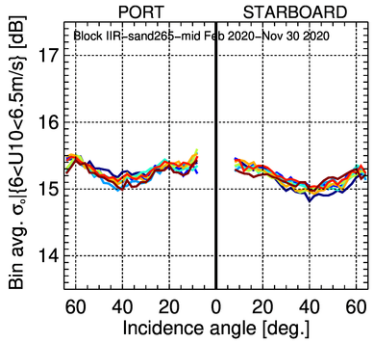


sand 265

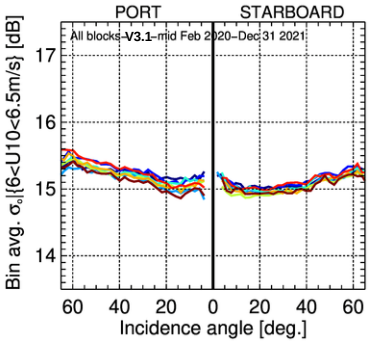


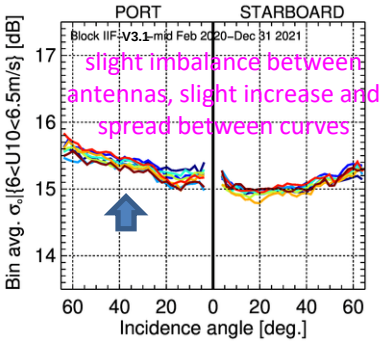


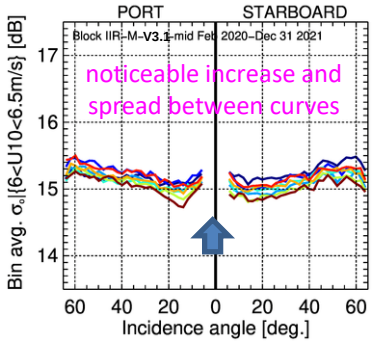


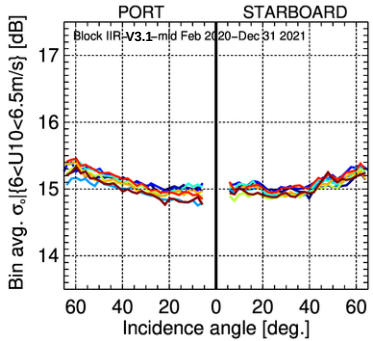


v3.1









AFTER FLEX EVENT