An introduction to v1.1 NOAA CyGNSS Wind Product and a look at v3.0 Level 1 data

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

[1]NOAA/NESDIS/STAR

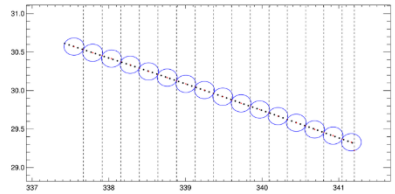
[2]Global Science & Technology, Inc.

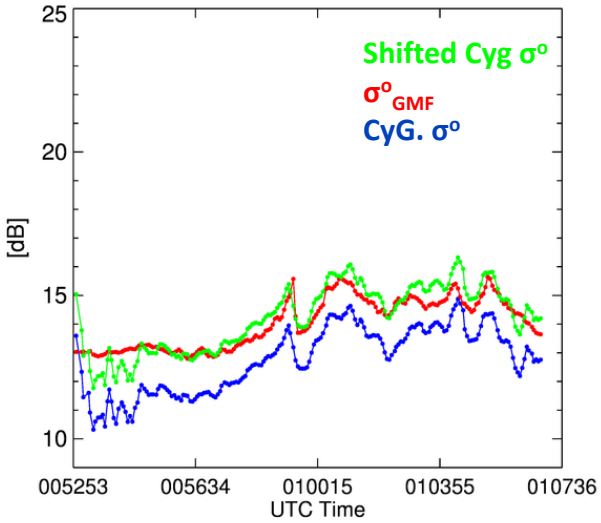
[3]UCAR

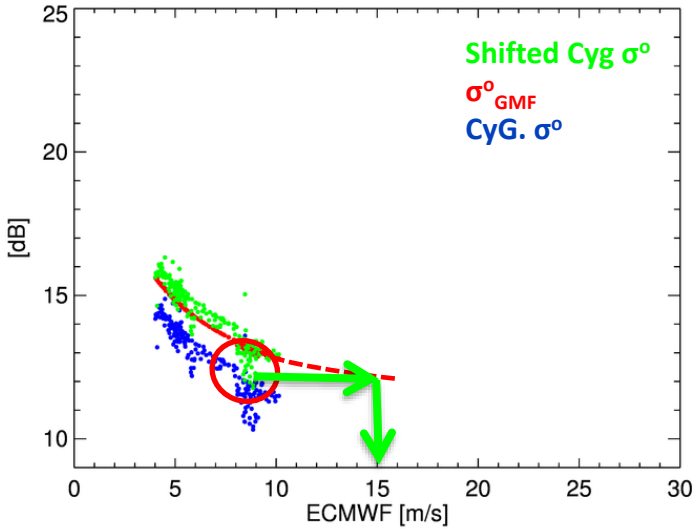
Refresher…

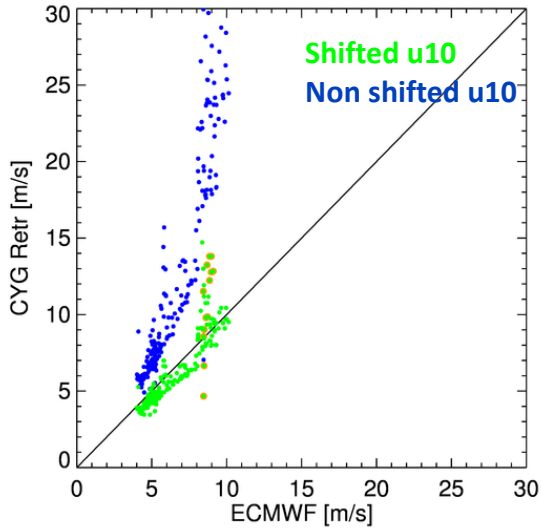
General trackwise bias removal and wind retrieval procedure:

1. For a given track, **grid** σ^o (by averaging sigma0 from all ddms falling within a 25km grid cell) →
2. Generate corresponding σ^o timeseries using the GMF
3. Compute *overall* σ^o bias between the two timeseries
4. Apply this *fixed* bias correction to **all** measured σ^o along the track
5. Pointwise wind retrieval scheme using a priori knowledge of Hs



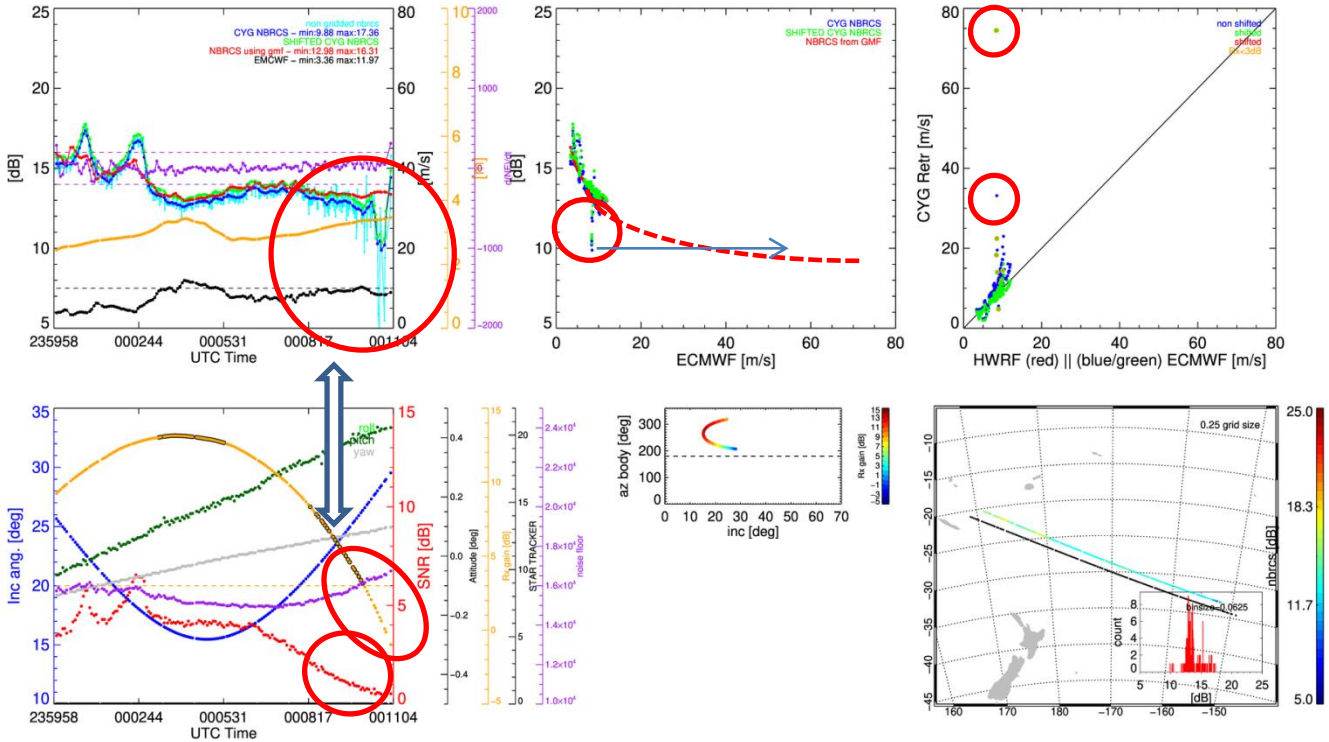






Quality control in v1.0

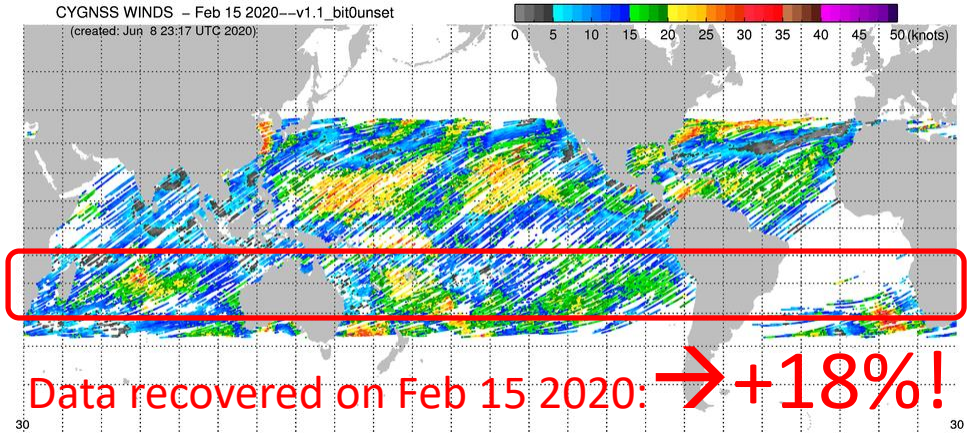
- Low Rx gain combined with Low SNR ranges mostly filtered out
- Algorithm implemented to detect block IIF tracks affected by power flex event
- Roll, Pitch, Yaw > 5 deg
- Track associated to Starboard antenna but showing on the Port side and vice versa
- Star tracker flag data completely flagged out



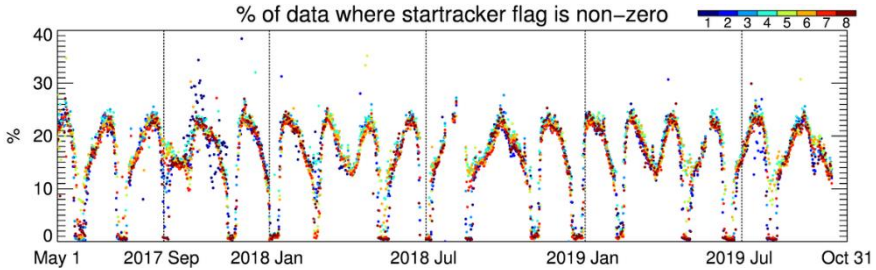
Updated Quality control—1:

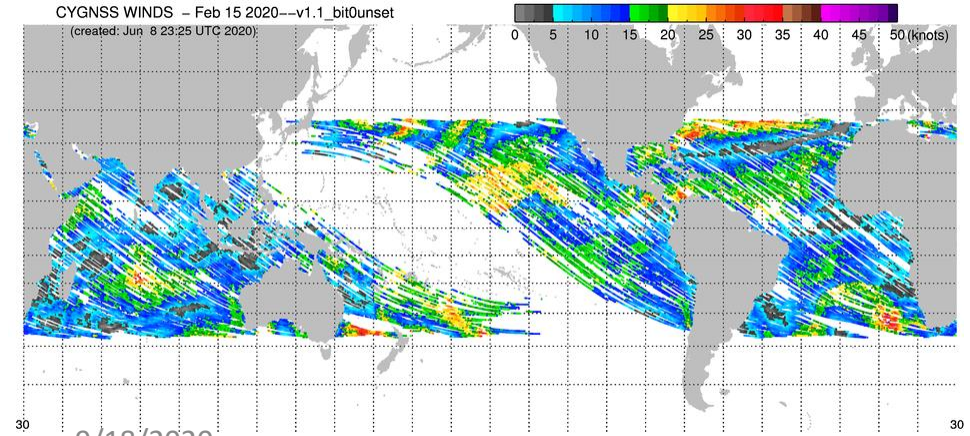
Star tracker flagged data

- Data with Star tracker flag set **now included** and partially flagged (bit 6 of quality flag)



Data recovered on Feb 15 2020: → +18%!





<u>Between May 1st 2017 until Oct 15th 2019:</u>

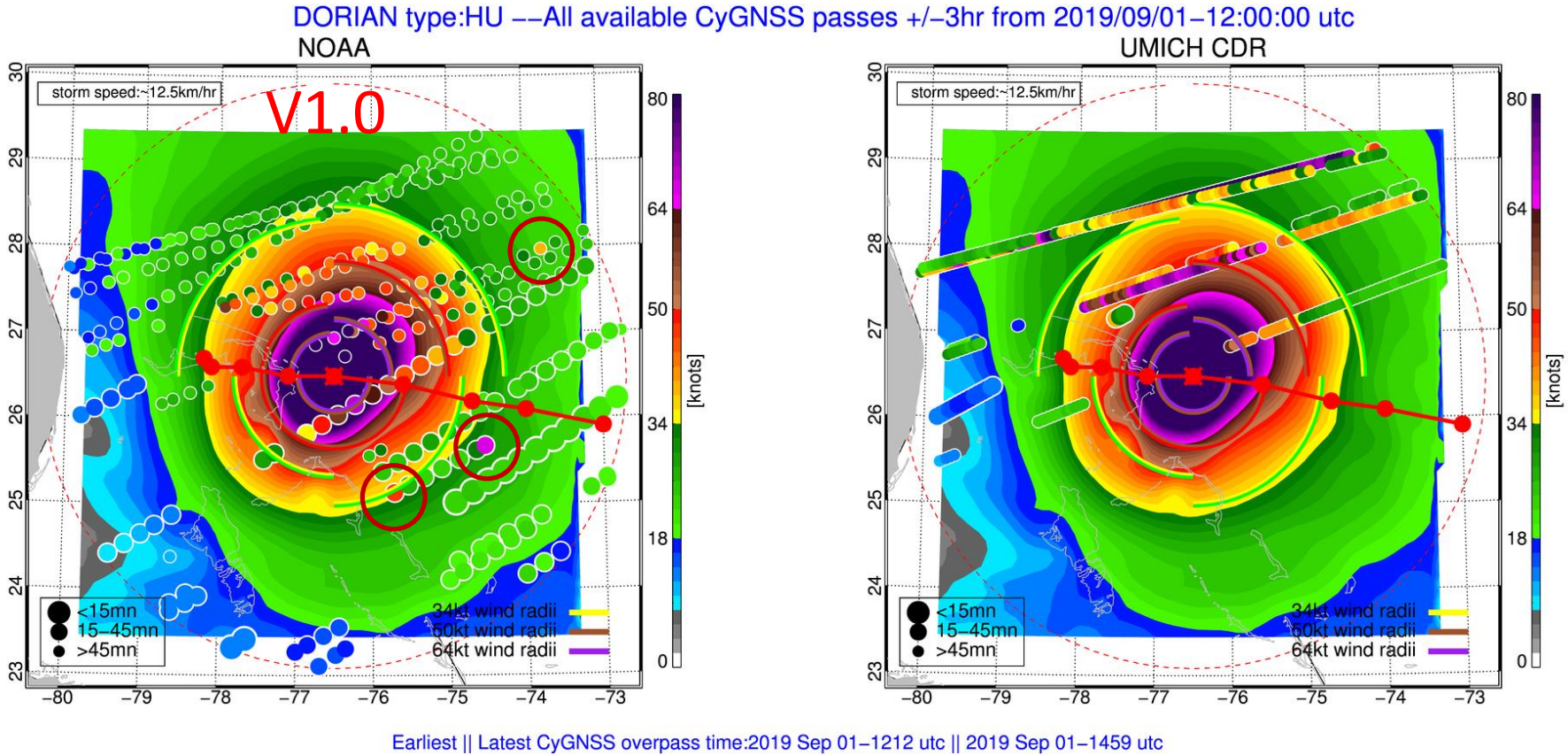
- % of full data set with star tracker flag set: ~17.85

→ Now only flagging about 4.82% of the full data set

Updated Quality control—2:

Addressing unrealistic wind samples and ‘spikes’

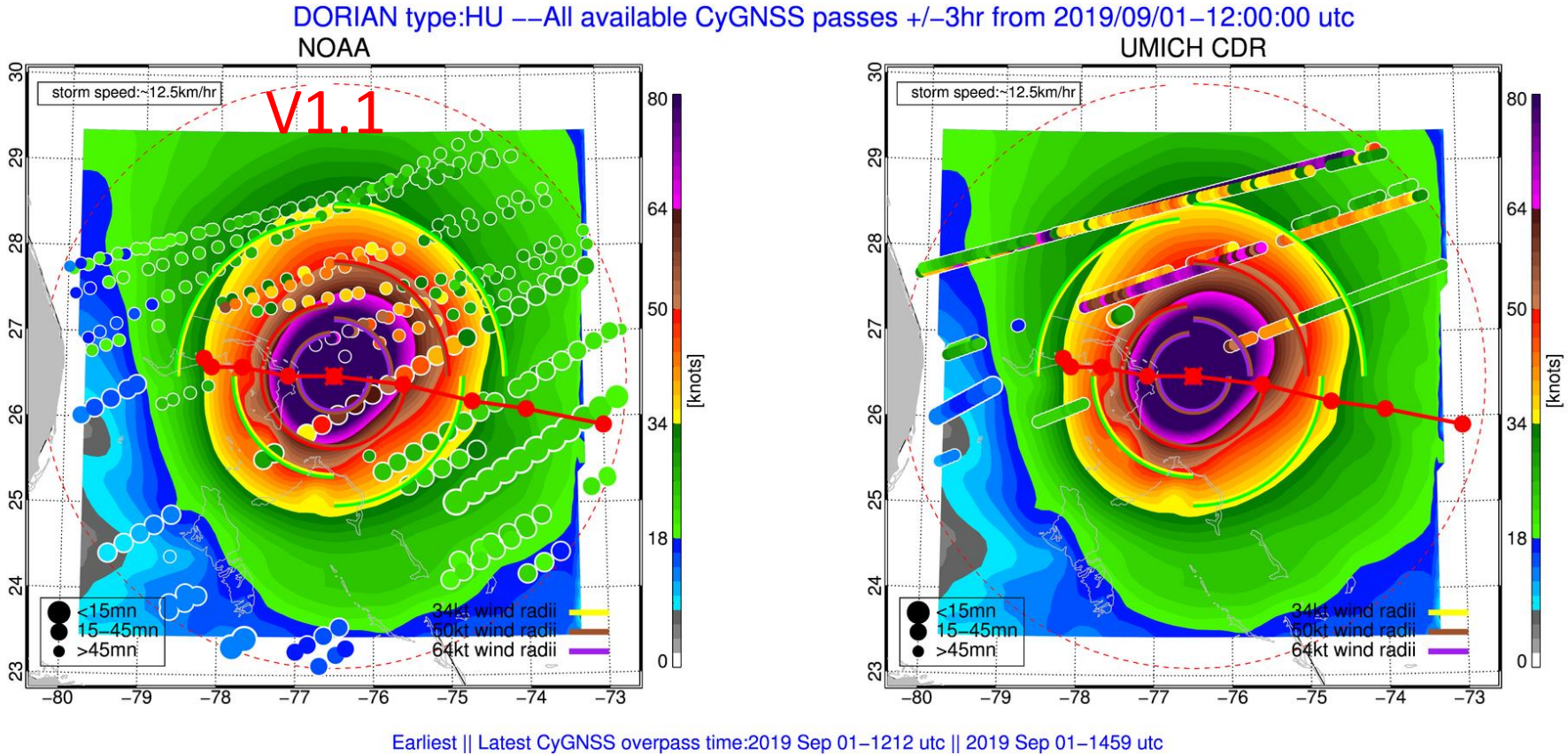
Example 1



Updated Quality control—2:

Addressing unrealistic wind samples and ‘spikes’

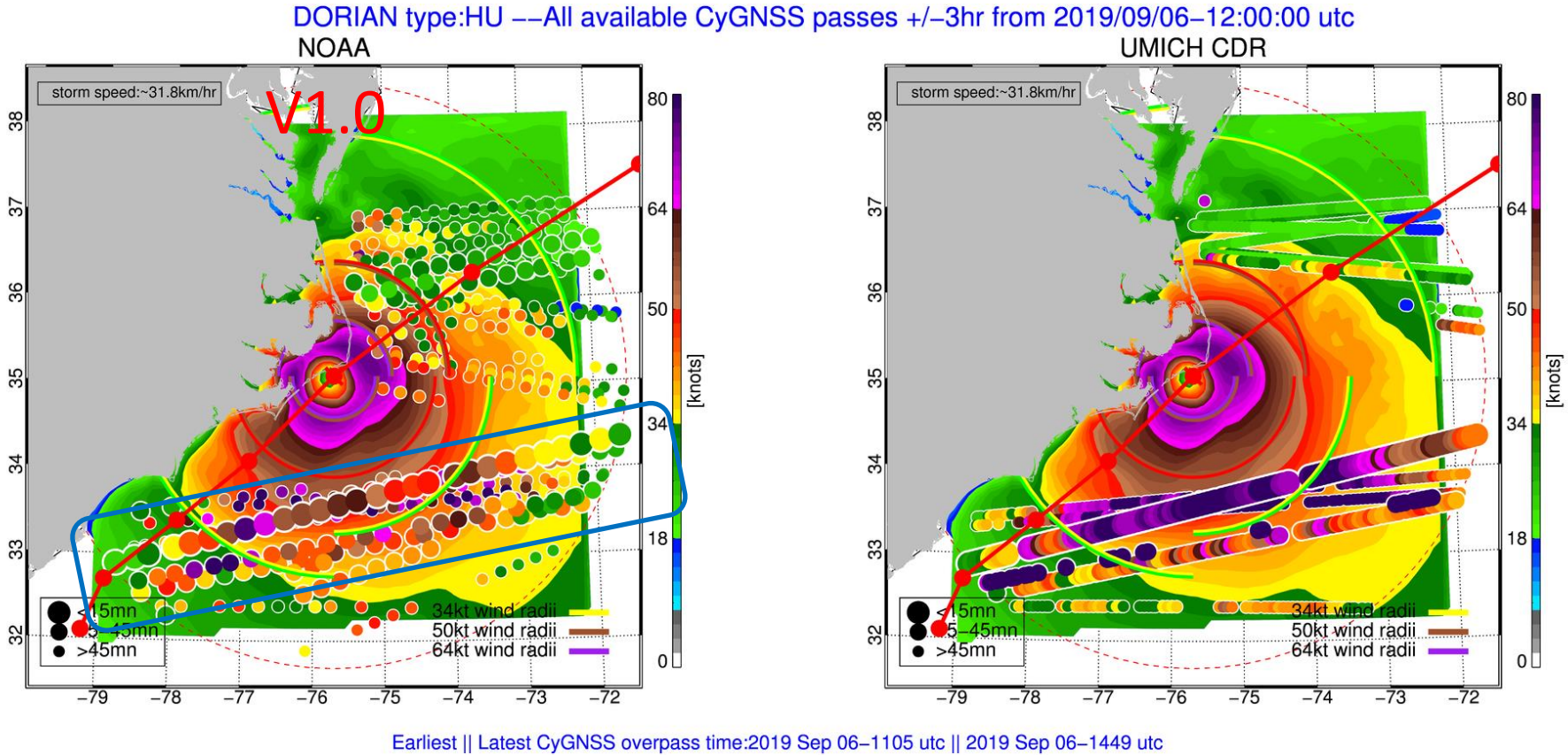
Example 1



Updated Quality control—2:

Addressing unrealistic wind samples and ‘spikes’

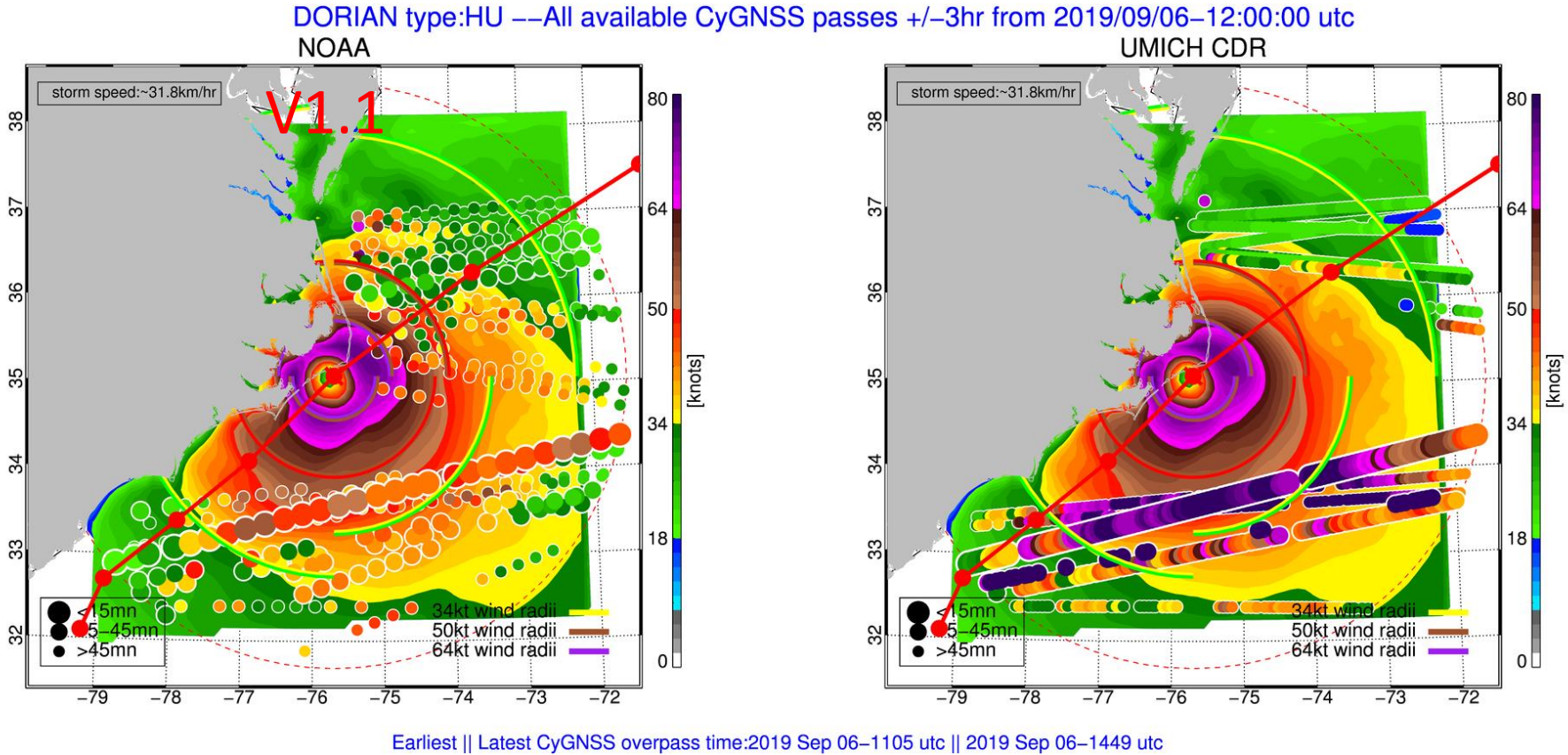
Example 2



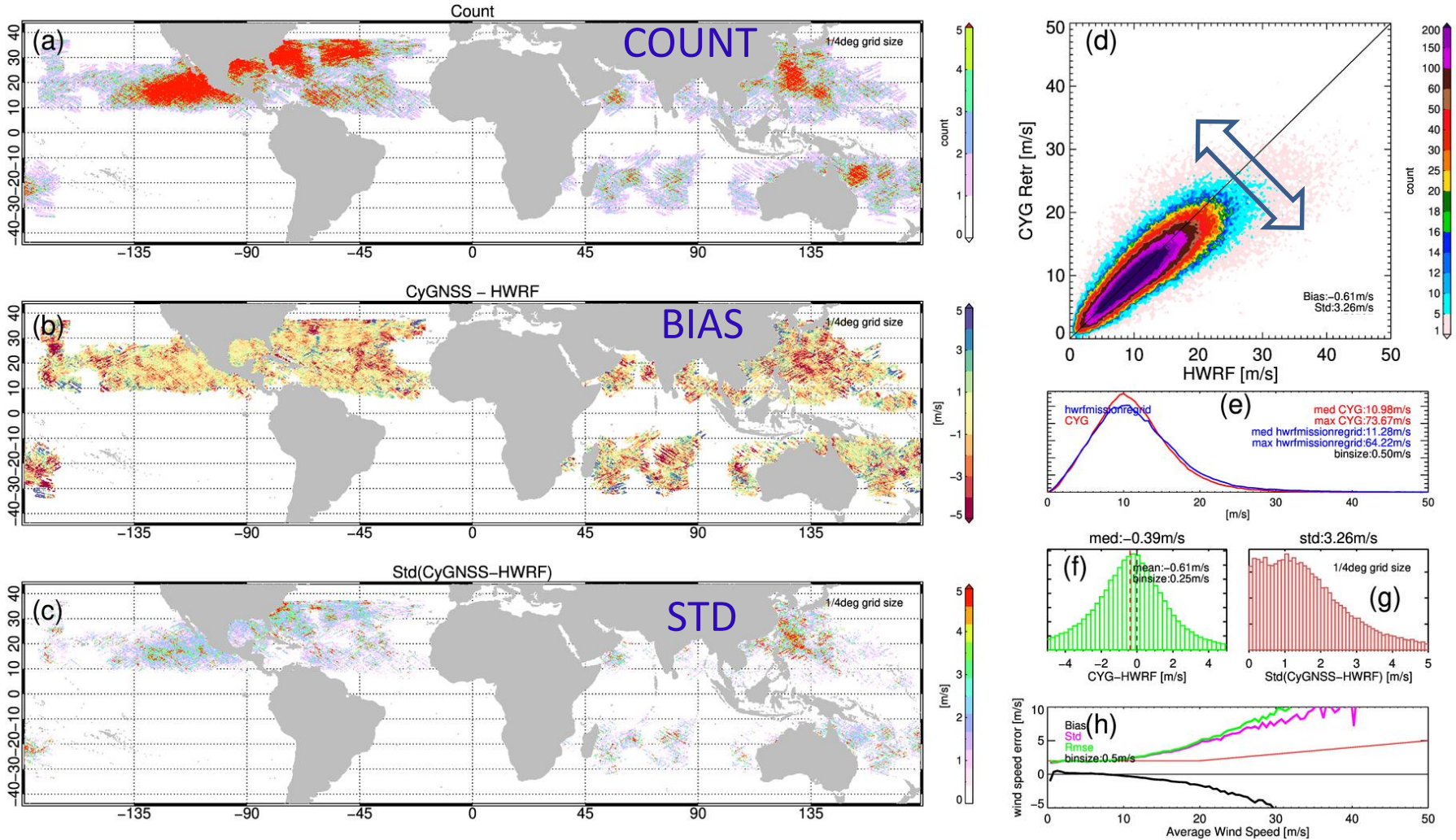
Updated Quality control—2:

Addressing unrealistic wind samples and ‘spikes’

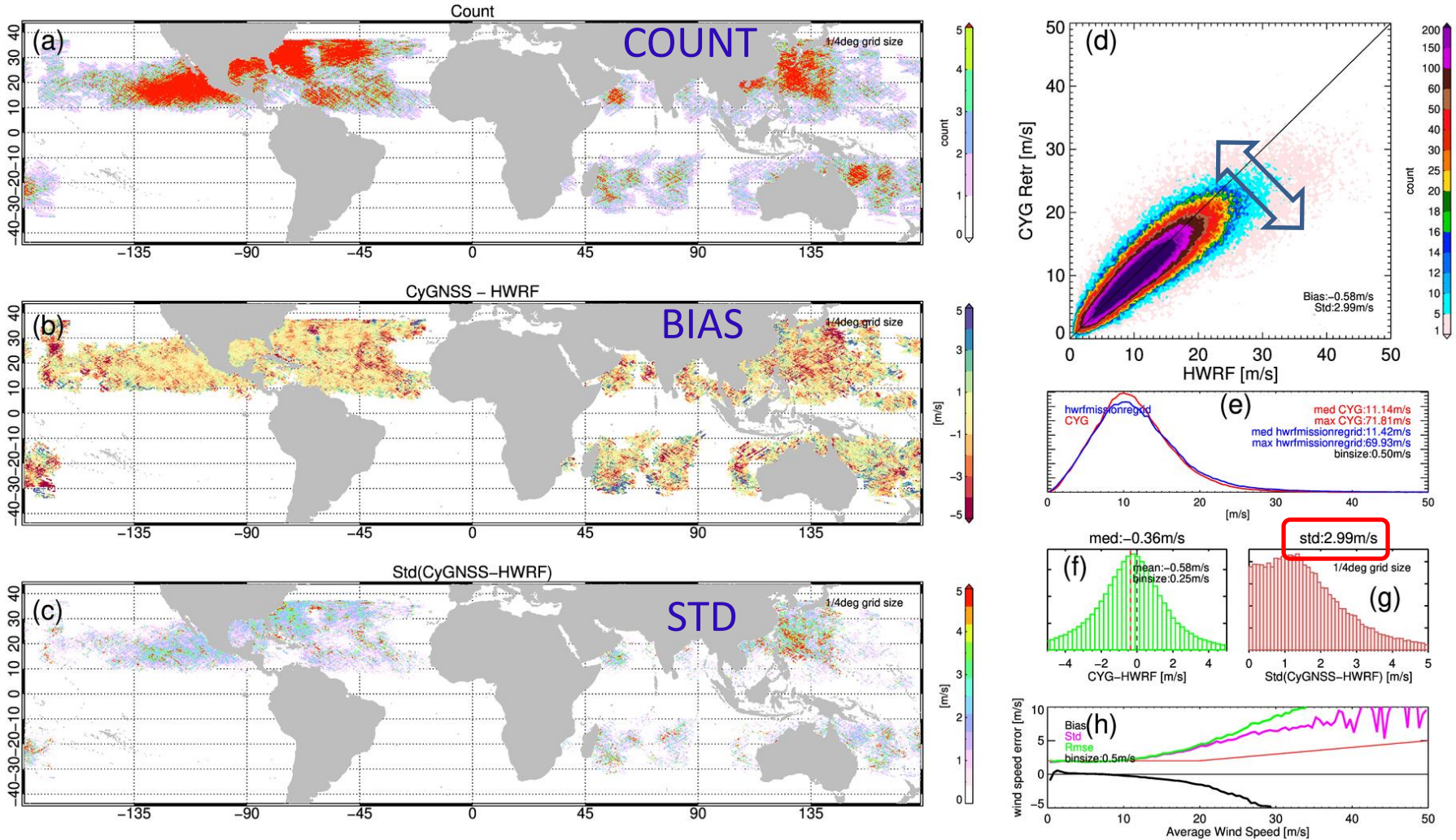
Example 2



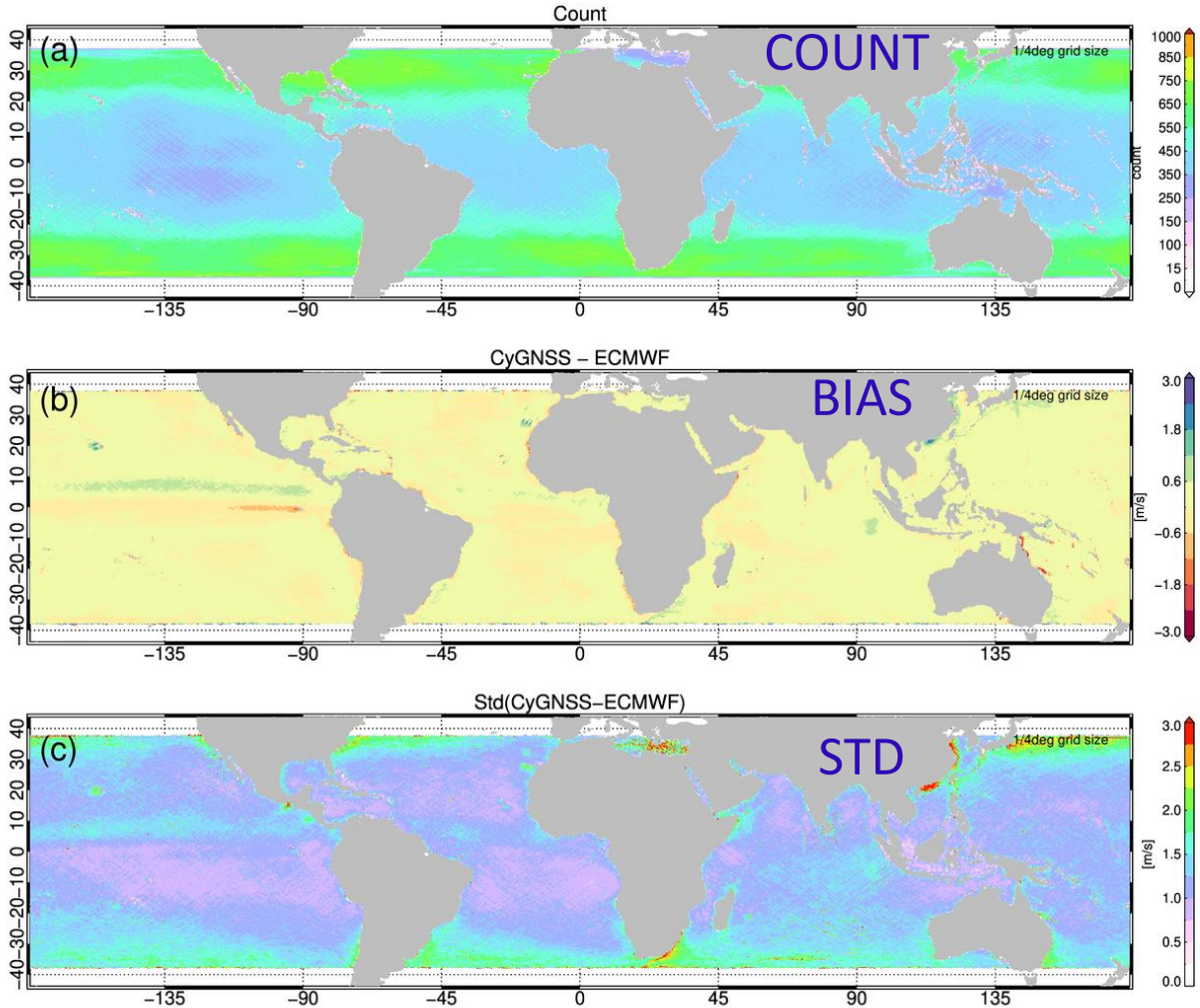
Overall performance against HWRF – v1.0

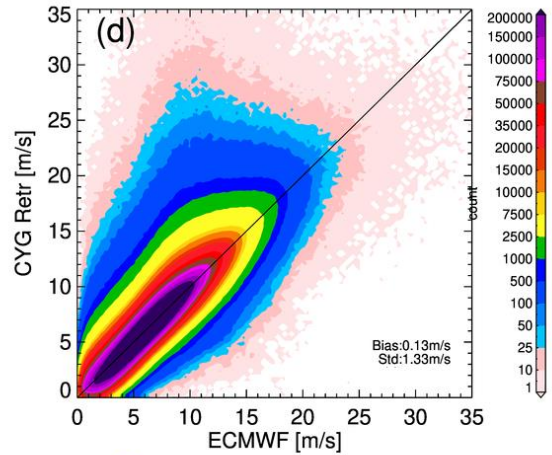


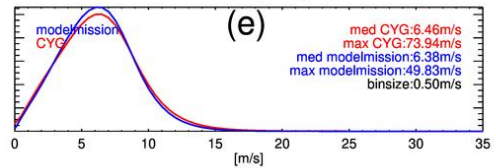
Overall performance against HWRF – v1.1

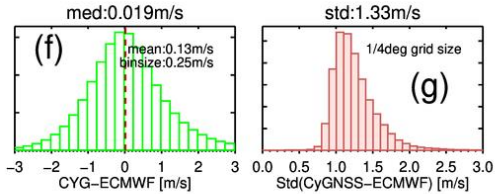


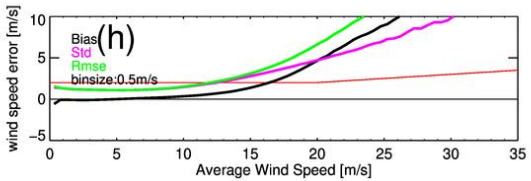
Overall performance against ECMWF – v1.0



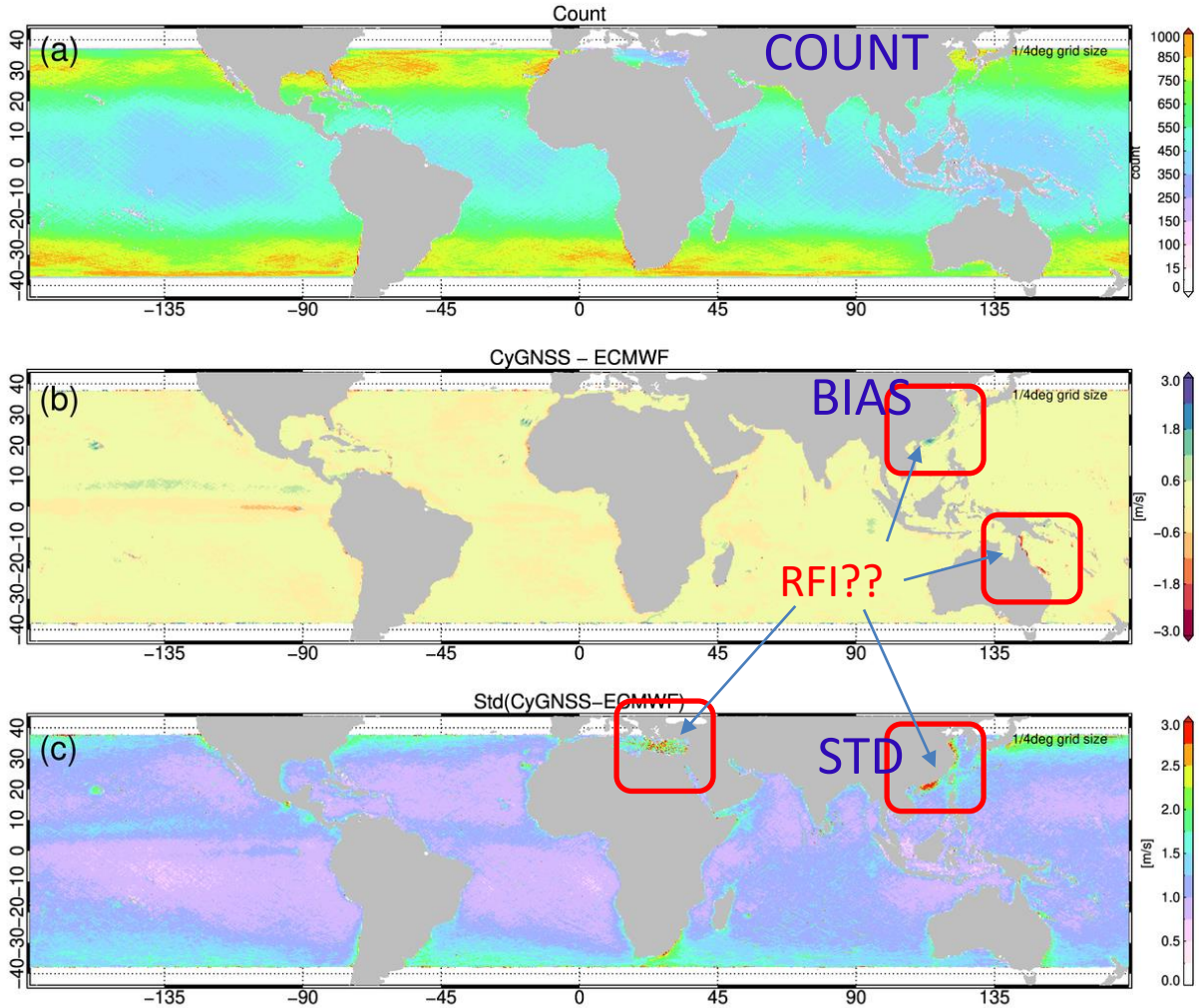


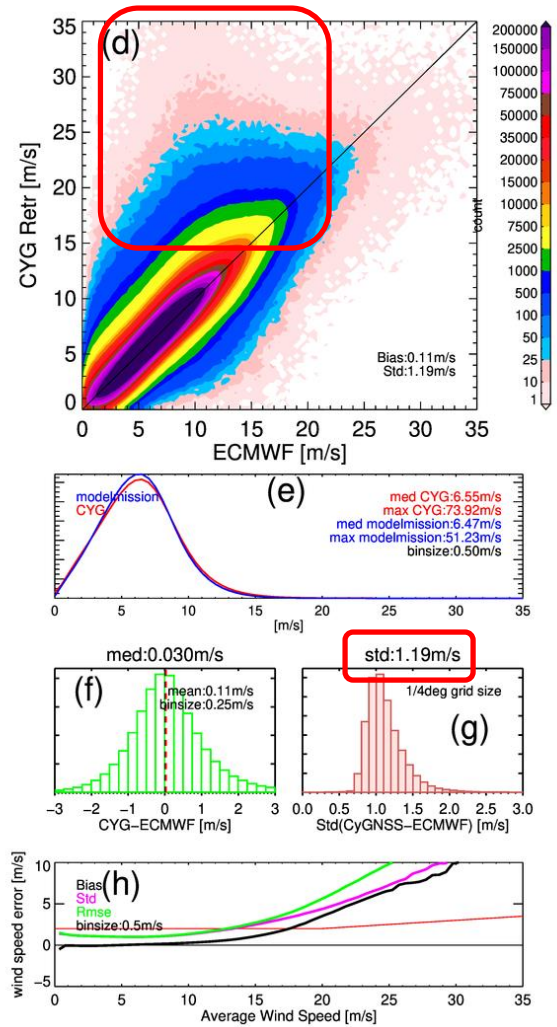






Overall performance against ECMWF – v1.1

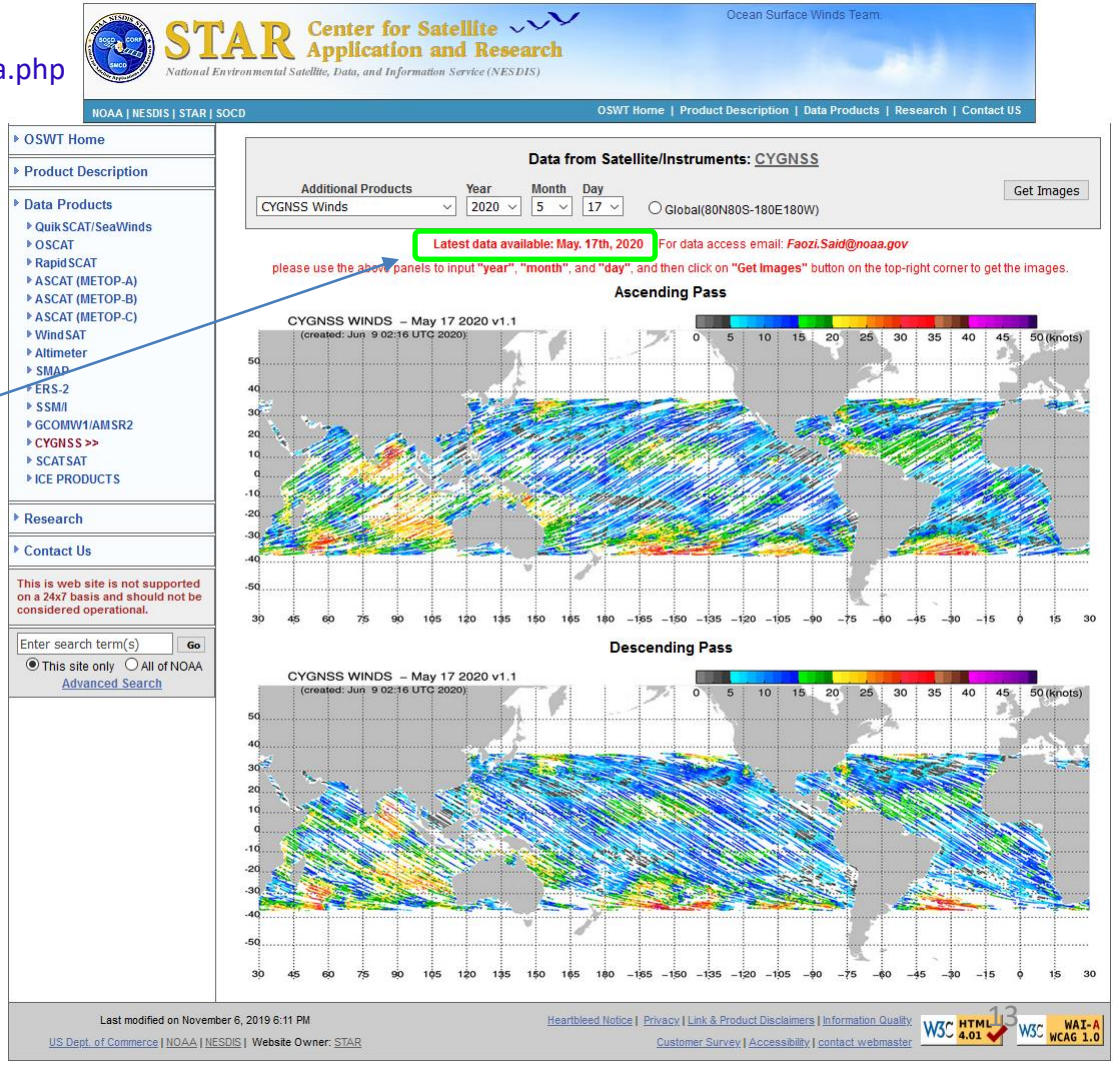




v1.1 data availability

https://manati.star.nesdis.noaa.gov/datasets/CYGNSSData.php

- v1.1 currently available on the manati site for viewing
- Site being populated as we speak (i.e. replacing v1.0 with v1.1)
- May 17 2020 is the most recent date available as of today
- Will transition to 'NRT' towards the end of the week (i.e. whenever a L1 CyGNSS file is made available on the PODAAC, it will shortly be processed using forecast NWP model data and displayed on webpage)
- All v1.1 ncdf data files will be made available to the scientific community within the next 1-2 months

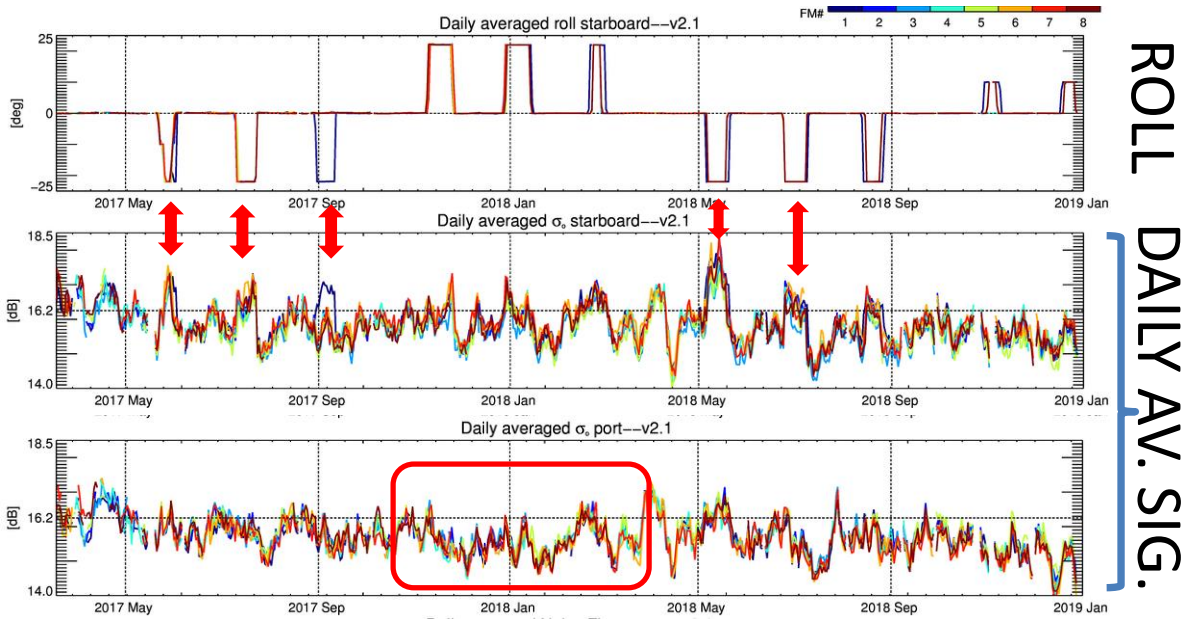


Future works

- With NOAA CYGNSS wind product v1.1 reaching consistency, repeatability and reliability thresholds, defined for operational products, we will begin assessing the possible impact of CYGNSS data on NOAA operations this summer, which will be part of a summer internship project with Charles Powell (UMICH PhD Student)

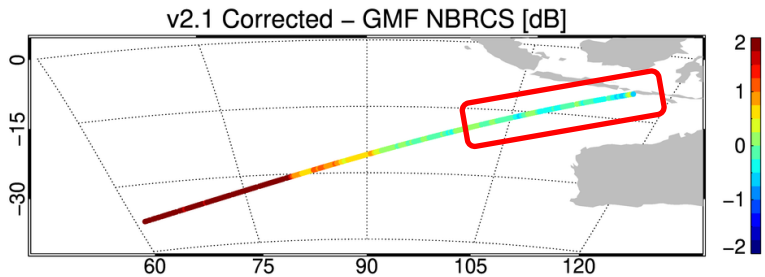
Future works

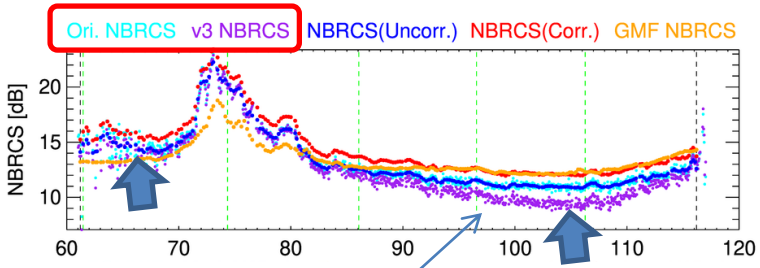
- Recall that Roll, Pitch, Yaw > 5 deg data is currently flagged out. Plan is to figure out how much of the high roll angle data can be recovered



Future works

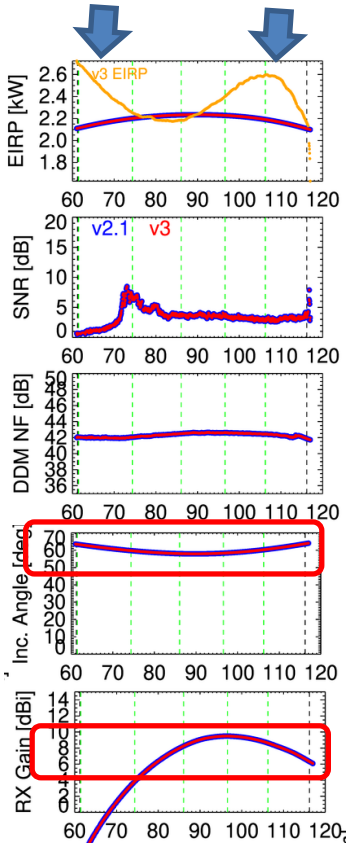
- Carefully inspect v3.0 sigma0 performance





What's going on here?

RFI?
Rx gain?
EIRP?
All of the above?



Originally noticed these sigma0 'drifts' in v2.1..

Bonus Part

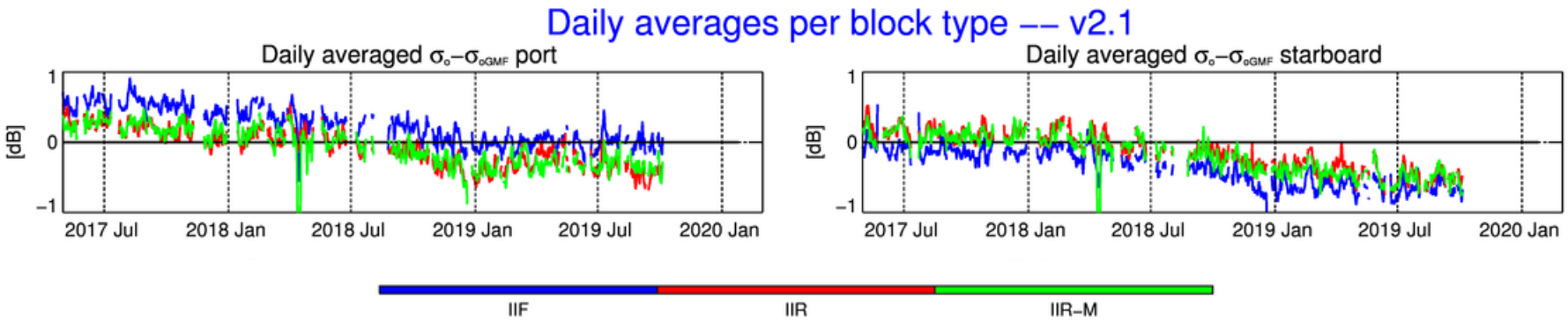
A look at v3.0 (i.e. sand163 and sand180)

Timeseries

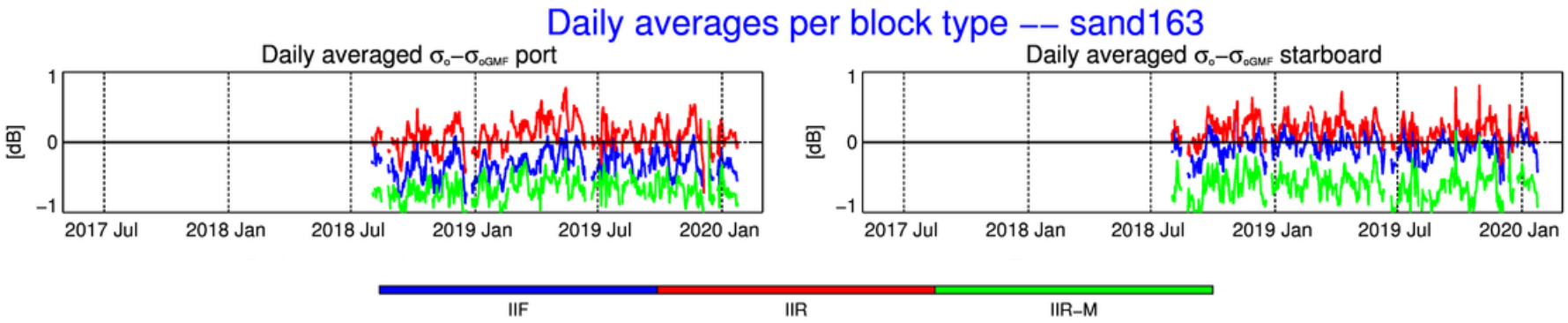
Critical figures helping to detect presence/absence of intersatellite biases and/or sigma0 trends

Separated by GPS block type

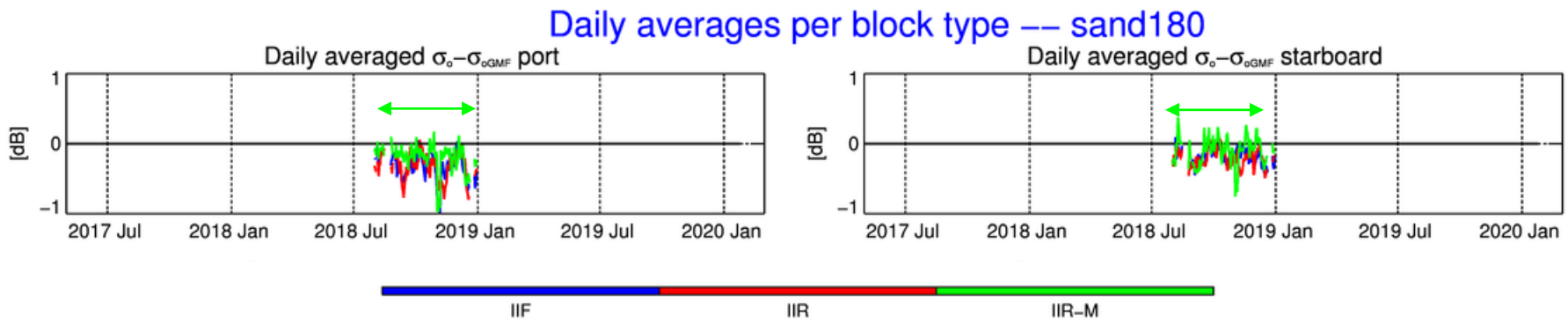
v2.1


Daily averages per block type -- v2.1
Daily averaged σo−σoGMF port
Daily averaged σo−σoGMF starboard
[dB]
1
0
−1
2017 Jul
2018 Jan
2018 Jul
2019 Jan
2019 Jul
2020 Jan
IIF
IIR
IIR−M

sand163

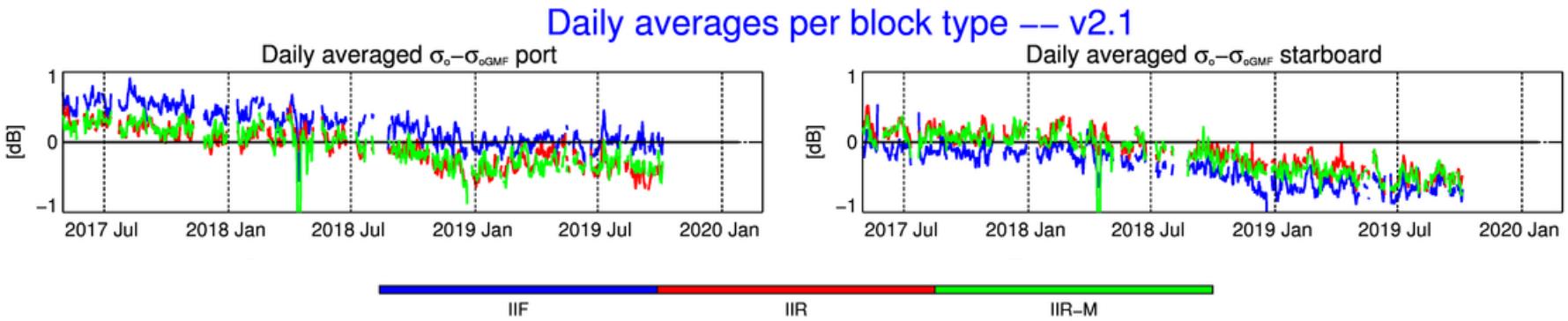

Daily averages per block type -- sand163
Daily averaged σo−σoGMF port
Daily averaged σo−σoGMF starboard
[dB]
1
0
−1
2017 Jul
2018 Jan
2018 Jul
2019 Jan
2019 Jul
2020 Jan
IIF
IIR
IIR−M

sand180

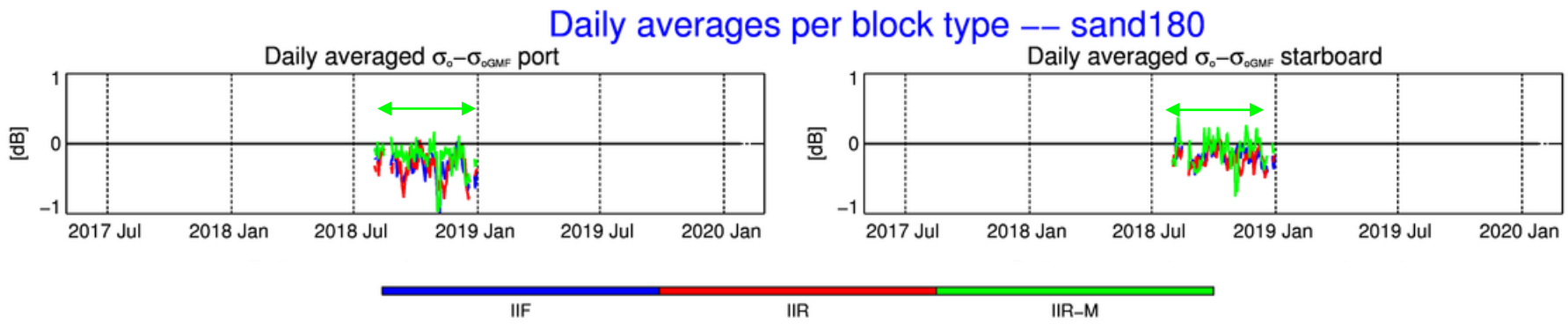


→apparent improvement in terms of sigma0 trend
→definite decrease in inter GPS block sigmao biases compared to 2.1

v2.1


Daily averages per block type -- v2.1
Daily averaged σo−σoGMF port
Daily averaged σo−σoGMF starboard
[dB]
1
0
−1
2017 Jul
2018 Jan
2018 Jul
2019 Jan
2019 Jul
2020 Jan
IIF
IIR
IIR−M

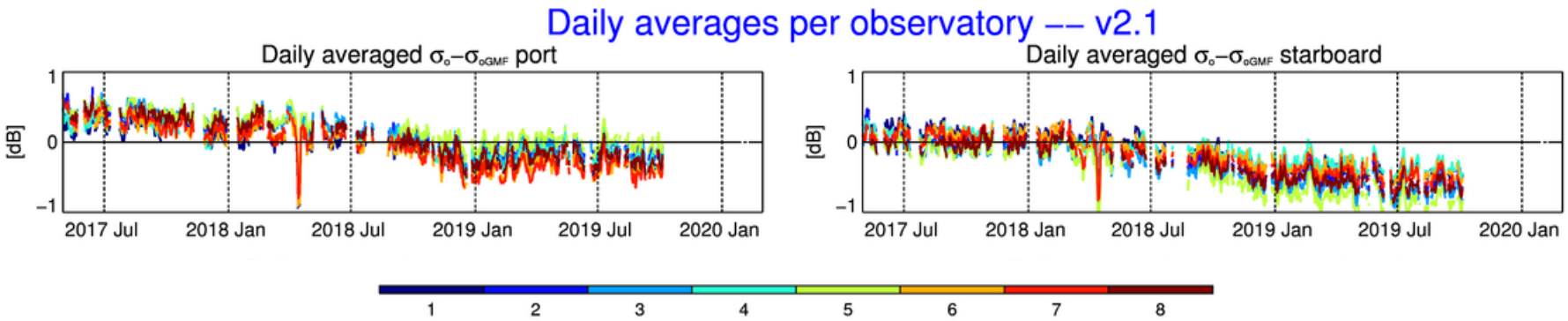
sand180



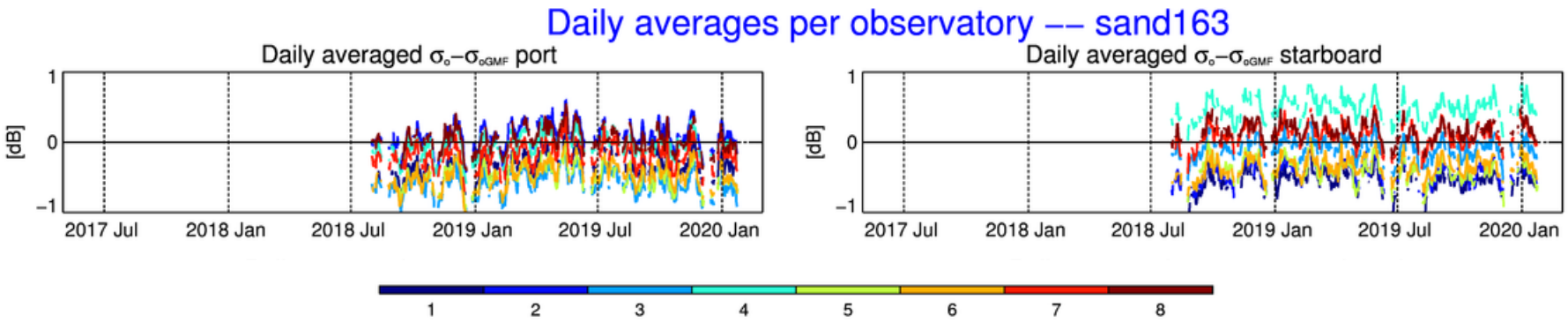
→apparent improvement in terms of sigma0 trend
→definite decrease in inter GPS block sigmao biases compared to 2.1

Separated by observatory

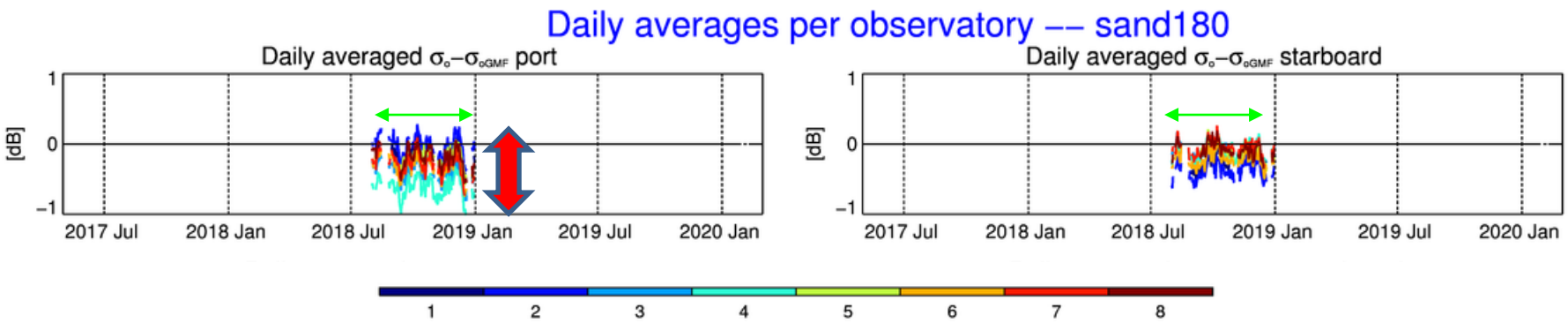
v2.1


Daily averages per observatory -- v2.1
Daily averaged σo−σoGMF port
Daily averaged σo−σoGMF starboard
[dB]
1
0
−1
2017 Jul
2018 Jan
2018 Jul
2019 Jan
2019 Jul
2020 Jan
1
2
3
4
5
6
7
8

sand163


Daily averages per observatory -- sand163
Daily averaged σo−σoGMF port
Daily averaged σo−σoGMF starboard
[dB]
1
0
−1
2017 Jul
2018 Jan
2018 Jul
2019 Jan
2019 Jul
2020 Jan
1
2
3
4
5
6
7
8

sand180

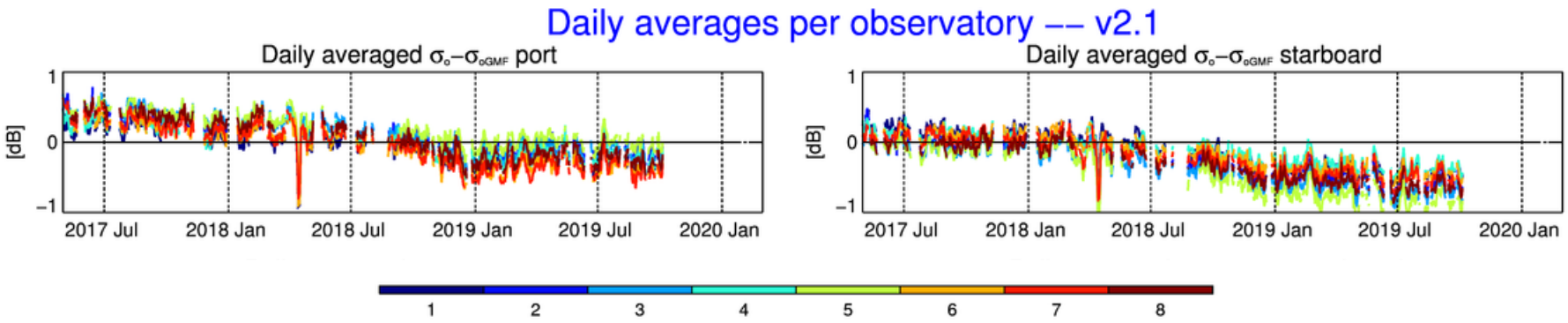


→apparent improvement in terms of sigma0 trend

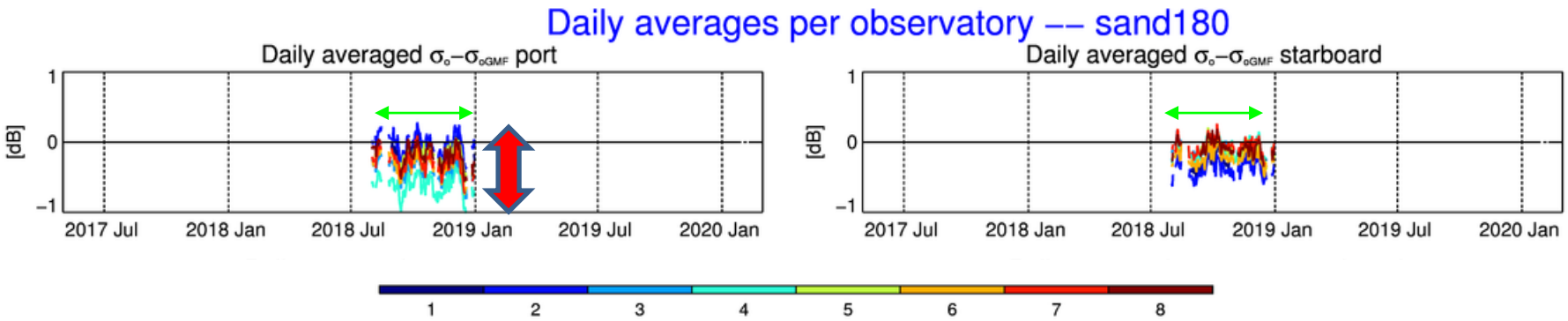
→larger intersatellite sigmao biases compared to 2.1

→different sigma0 biases between star/port given the same observatory

v2.1


Daily averages per observatory -- v2.1
Daily averaged σo−σoGMF port
Daily averaged σo−σoGMF starboard
[dB]
1
0
−1
2017 Jul
2018 Jan
2018 Jul
2019 Jan
2019 Jul
2020 Jan
1
2
3
4
5
6
7
8

sand180



→apparent improvement in terms of sigma0 trend

→larger intersatellite sigmao biases compared to 2.1

→different sigma0 biases between star/port given the same observatory

Bin averaged Sigma0 vs incidence angle
separated by antenna and observatory

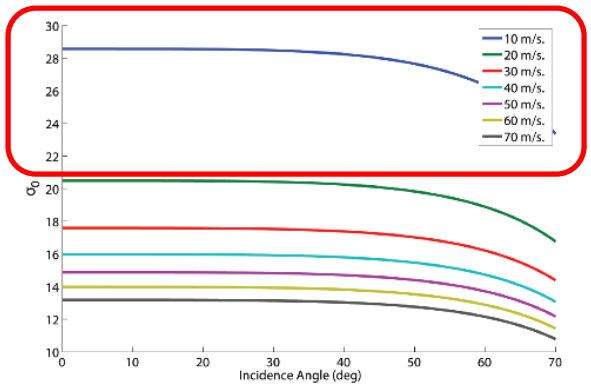
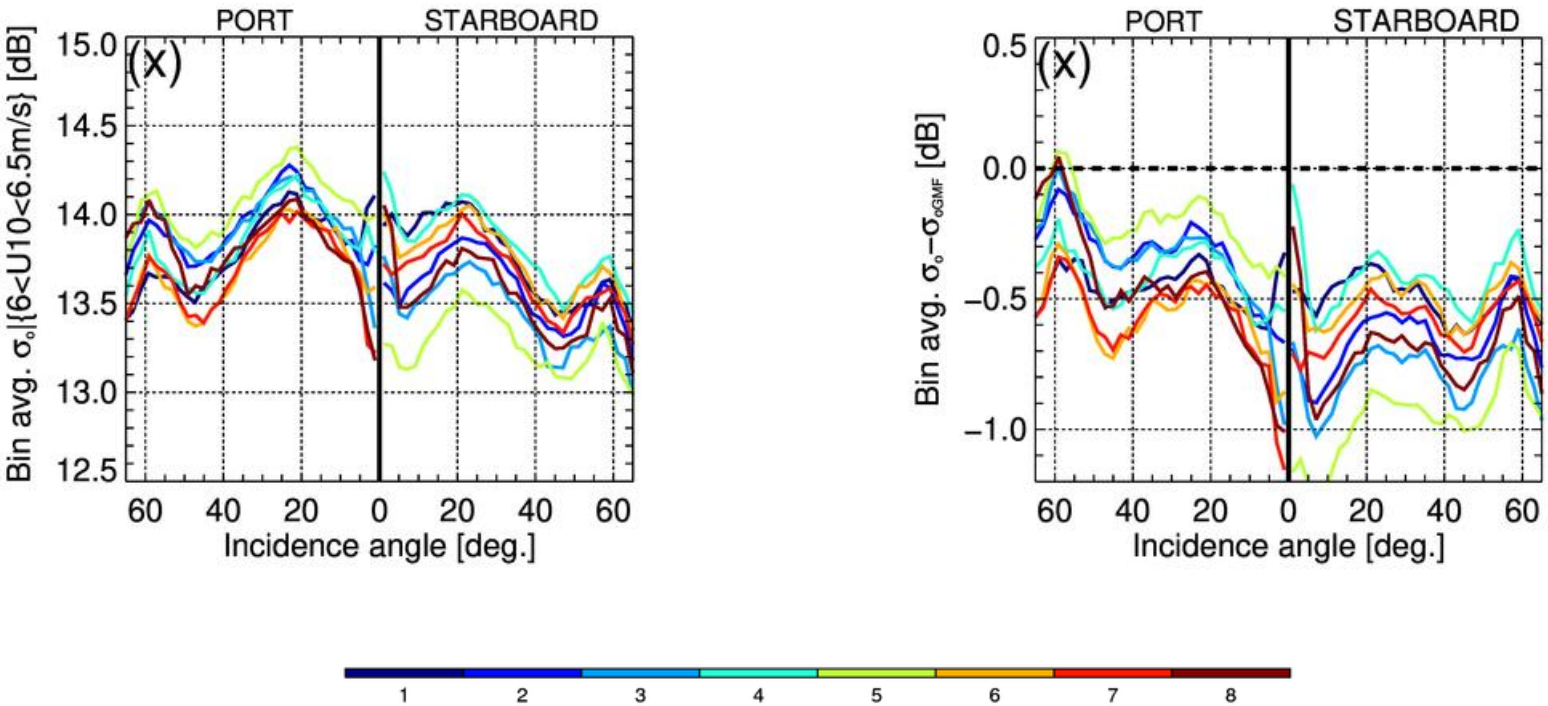
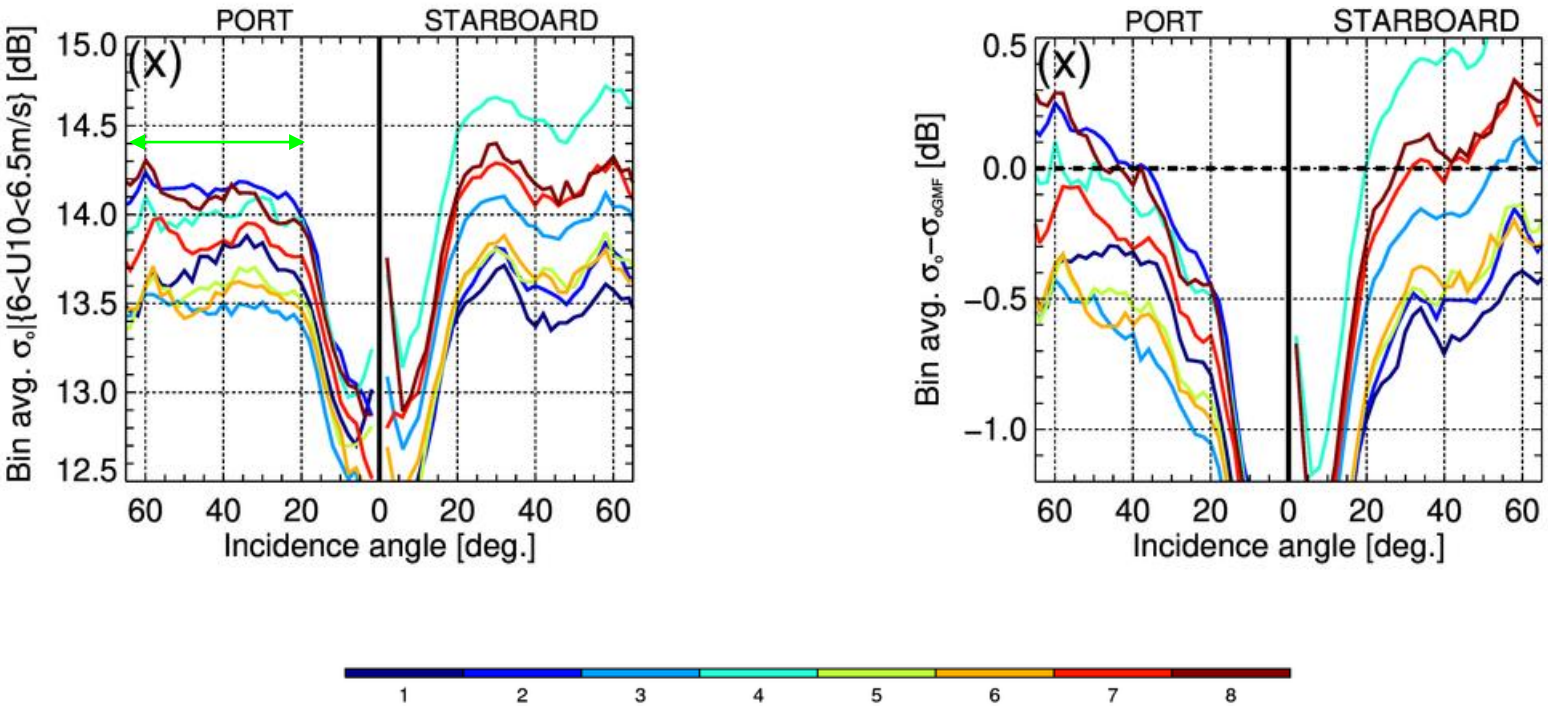


Figure 9.14. Curves of $\sigma_0(\bar{r}_{gr})$ versus incidence angle, for different wind speed values.

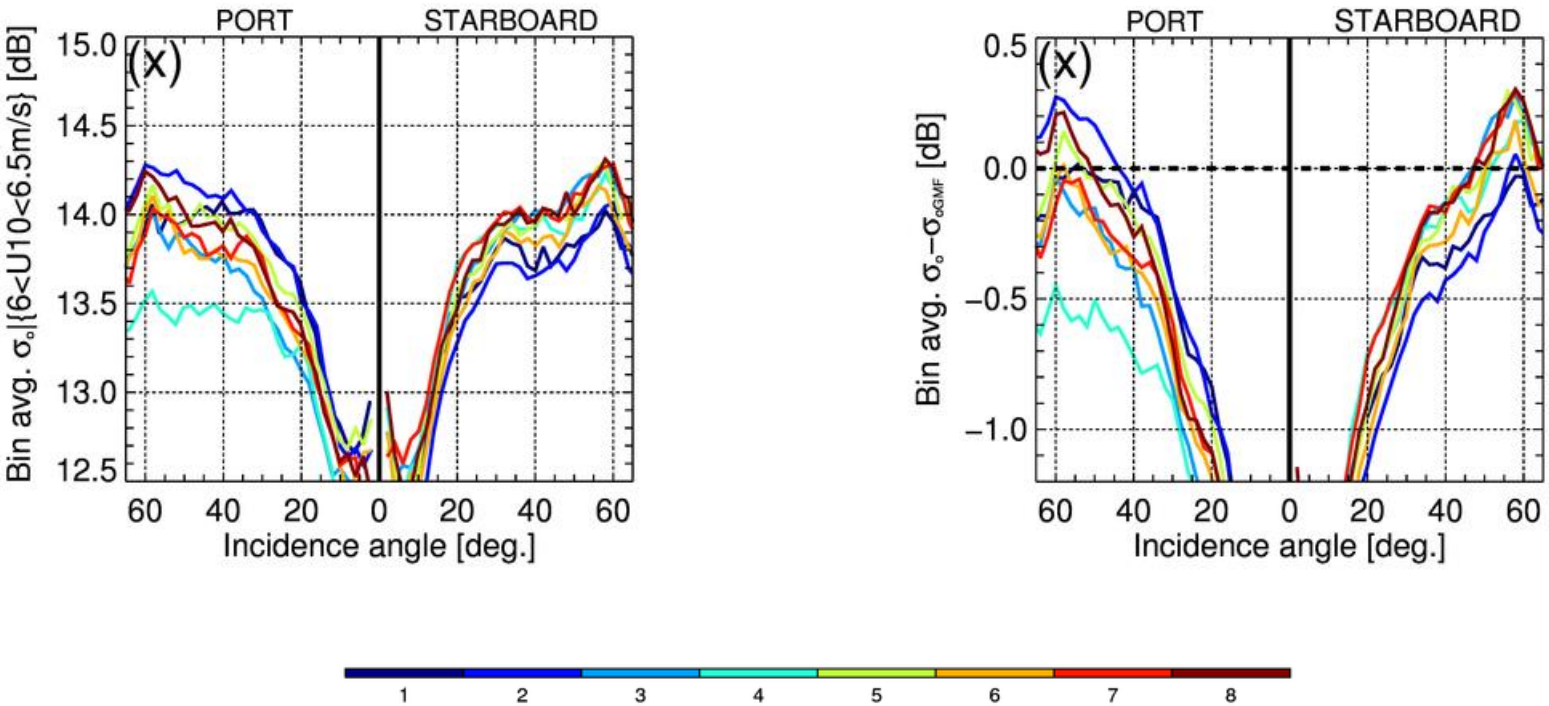
v2.1


PORT
STARBOARD
(x)
Bin avg. σo|{6<U10<6.5m/s} [dB]
15.0
14.5
14.0
13.5
13.0
12.5
60 40 20 0 20 40 60
Incidence angle [deg.]
PORT
STARBOARD
(x)
Bin avg. σo−σoGMF [dB]
0.5
0.0
−0.5
−1.0
60 40 20 0 20 40 60
Incidence angle [deg.]
1 2 3 4 5 6 7 8

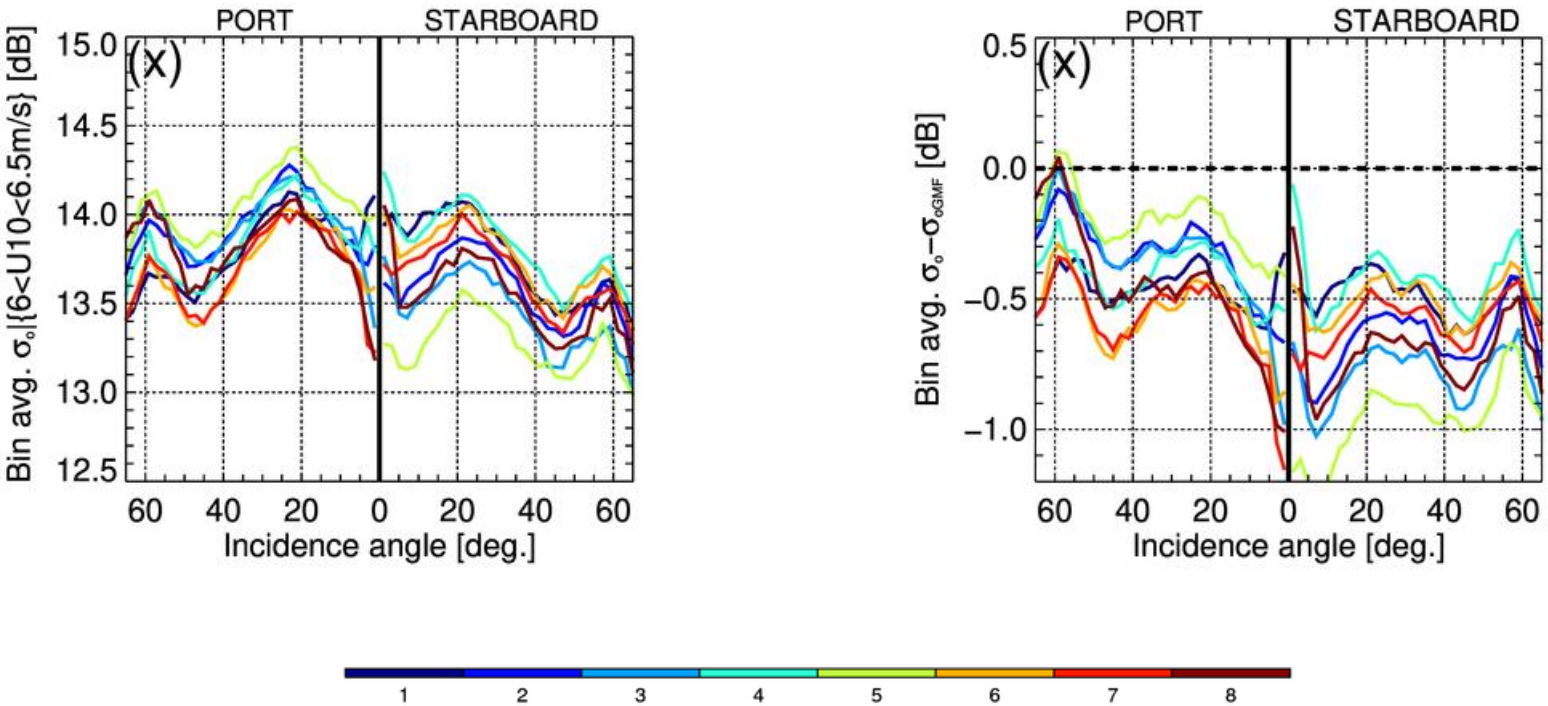
sand163


PORT
STARBOARD
(x)
Bin avg. σo|{6<U10<6.5m/s} [dB]
15.0
14.5
14.0
13.5
13.0
12.5
60 40 20 0 20 40 60
Incidence angle [deg.]
PORT
STARBOARD
(x)
Bin avg. σo−σoGMF [dB]
0.5
0.0
−0.5
−1.0
60 40 20 0 20 40 60
Incidence angle [deg.]
1 2 3 4 5 6 7 8

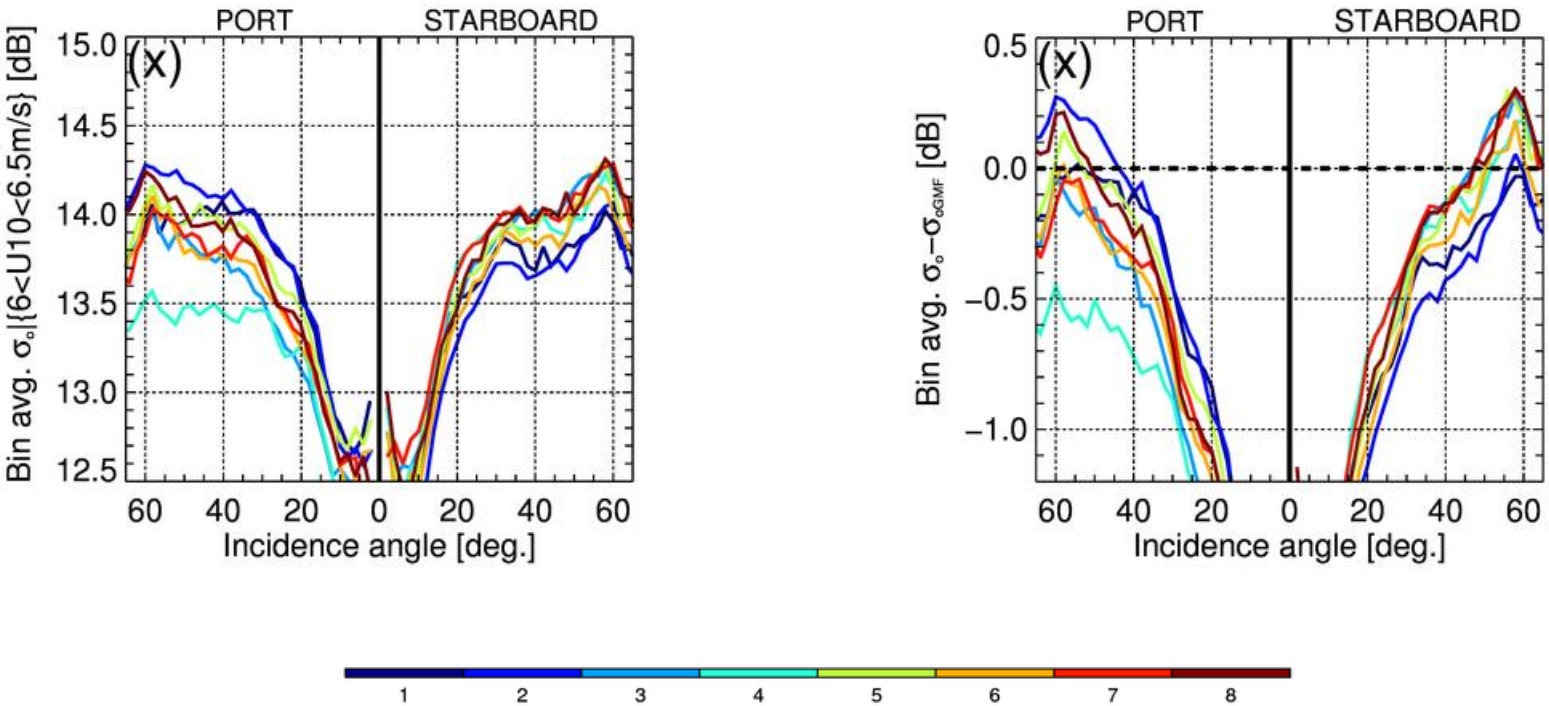
sand180


PORT
STARBOARD
(x)
Bin avg. σo|{6<U10<6.5m/s} [dB]
15.0
14.5
14.0
13.5
13.0
12.5
60 40 20 0 20 40 60
Incidence angle [deg.]
PORT
STARBOARD
(x)
Bin avg. σo−σoGMF [dB]
0.5
0.0
−0.5
−1.0
60 40 20 0 20 40 60
Incidence angle [deg.]
1 2 3 4 5 6 7 8

v2.1


PORT
STARBOARD
(x)
Bin avg. σo|{6<U10<6.5m/s} [dB]
15.0
14.5
14.0
13.5
13.0
12.5
60 40 20 0 20 40 60
Incidence angle [deg.]
PORT
STARBOARD
(x)
Bin avg. σo−σoGMF [dB]
0.5
0.0
−0.5
−1.0
60 40 20 0 20 40 60
Incidence angle [deg.]
1 2 3 4 5 6 7 8

sand180


PORT
STARBOARD
(x)
Bin avg. σo|{6<U10<6.5m/s} [dB]
15.0
14.5
14.0
13.5
13.0
12.5
60 40 20 0 20 40 60
Incidence angle [deg.]
PORT
STARBOARD
(x)
Bin avg. σo−σoGMF [dB]
0.5
0.0
−0.5
−1.0
60 40 20 0 20 40 60
Incidence angle [deg.]
1 2 3 4 5 6 7 8

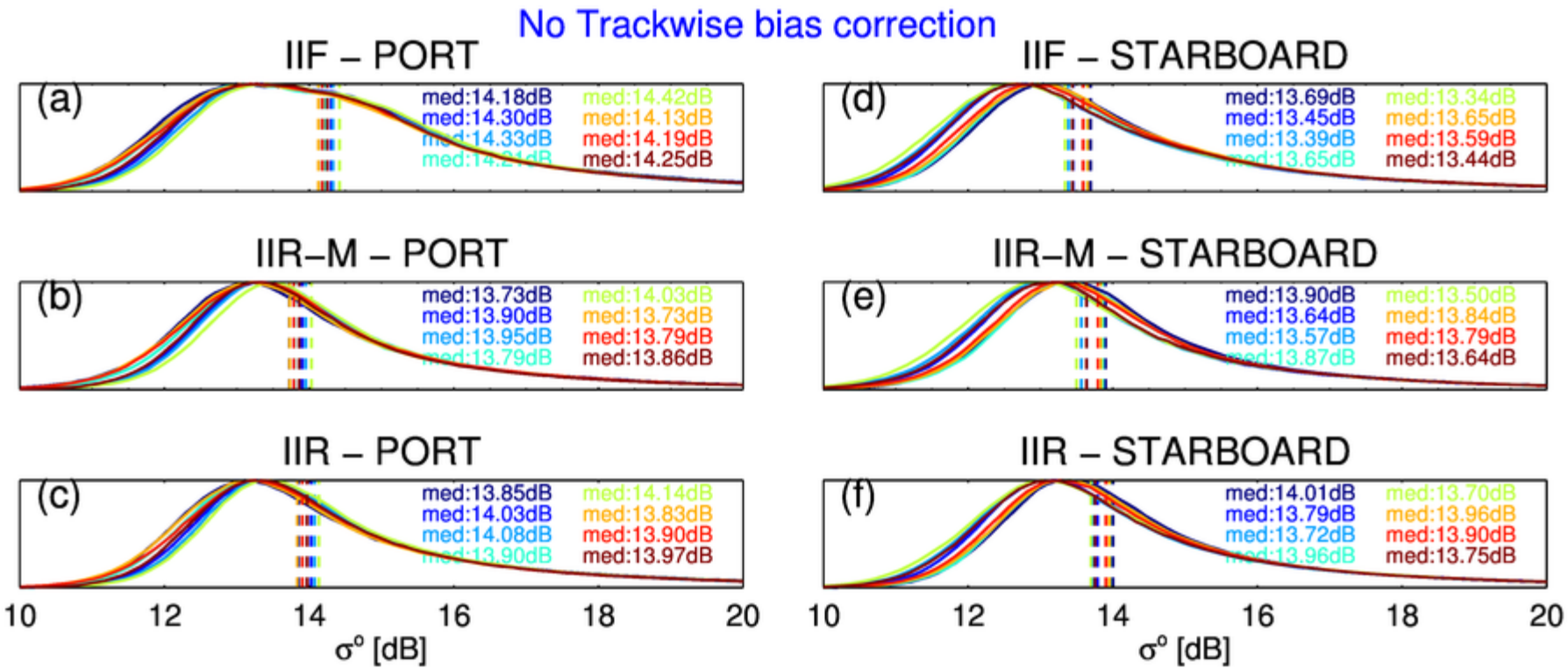
σ_o distribution

separated by antenna,

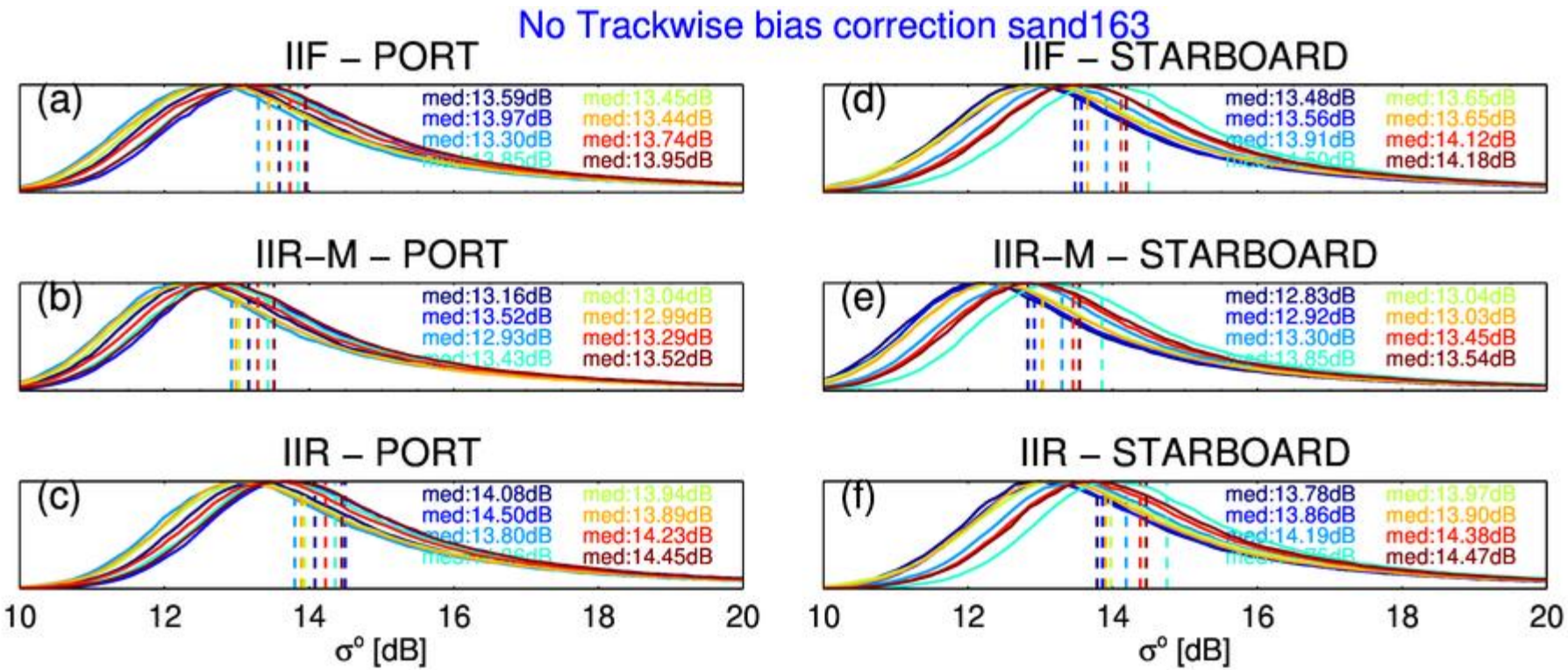
observatory,

and GPS block type

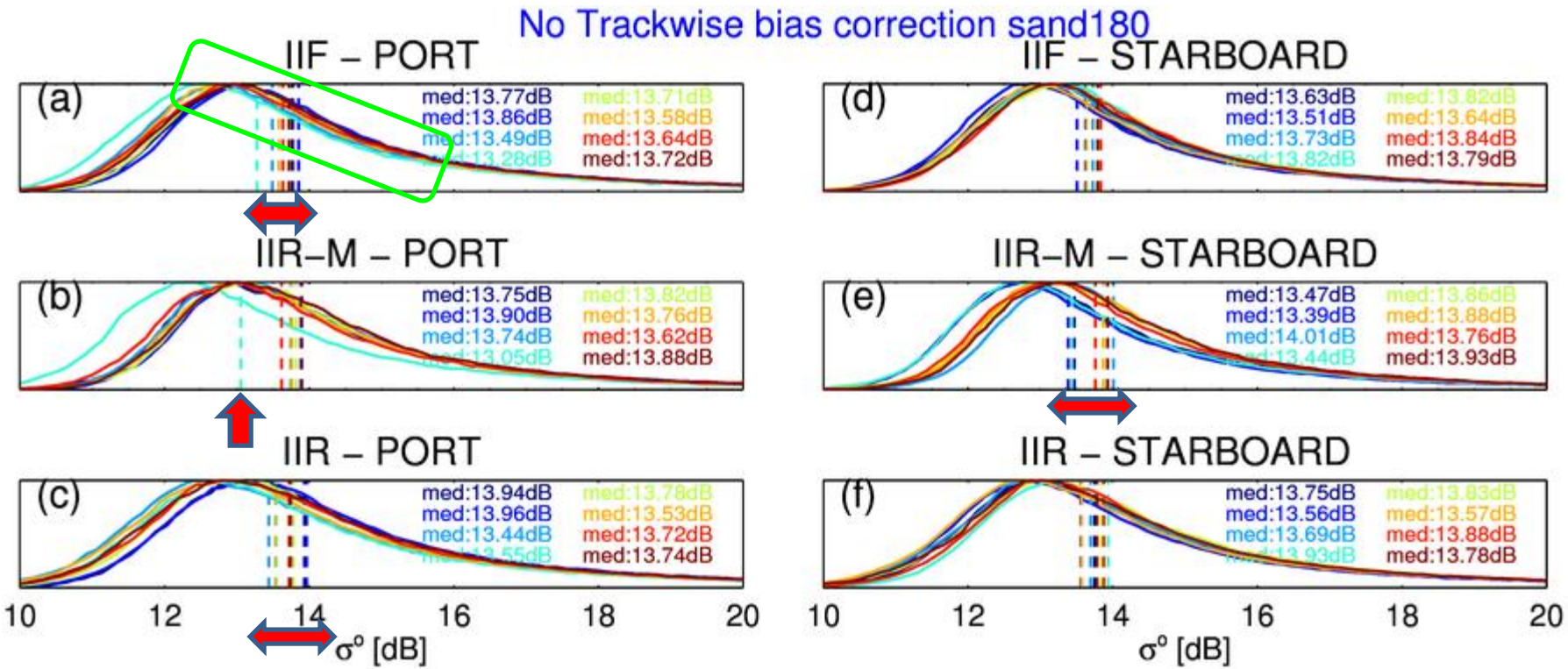
v2.1


No Trackwise bias correction
IIF – PORT
(a)
med:14.18dB
med:14.30dB
med:14.33dB
med:14.21dB
med:14.42dB
med:14.13dB
med:14.19dB
med:14.25dB
IIF – STARBOARD
(d)
med:13.69dB
med:13.45dB
med:13.39dB
med:13.65dB
med:13.34dB
med:13.65dB
med:13.59dB
med:13.44dB
IIR–M – PORT
(b)
med:13.73dB
med:13.90dB
med:13.95dB
med:13.79dB
med:14.03dB
med:13.73dB
med:13.79dB
med:13.86dB
IIR–M – STARBOARD
(e)
med:13.90dB
med:13.64dB
med:13.57dB
med:13.87dB
med:13.50dB
med:13.84dB
med:13.79dB
med:13.64dB
IIR – PORT
(c)
med:13.85dB
med:14.03dB
med:14.08dB
med:13.90dB
med:14.14dB
med:13.83dB
med:13.90dB
med:13.97dB
IIR – STARBOARD
(f)
med:14.01dB
med:13.79dB
med:13.72dB
med:13.96dB
med:13.70dB
med:13.96dB
med:13.90dB
med:13.75dB
10
12
14
16
18
20
σ° [dB]

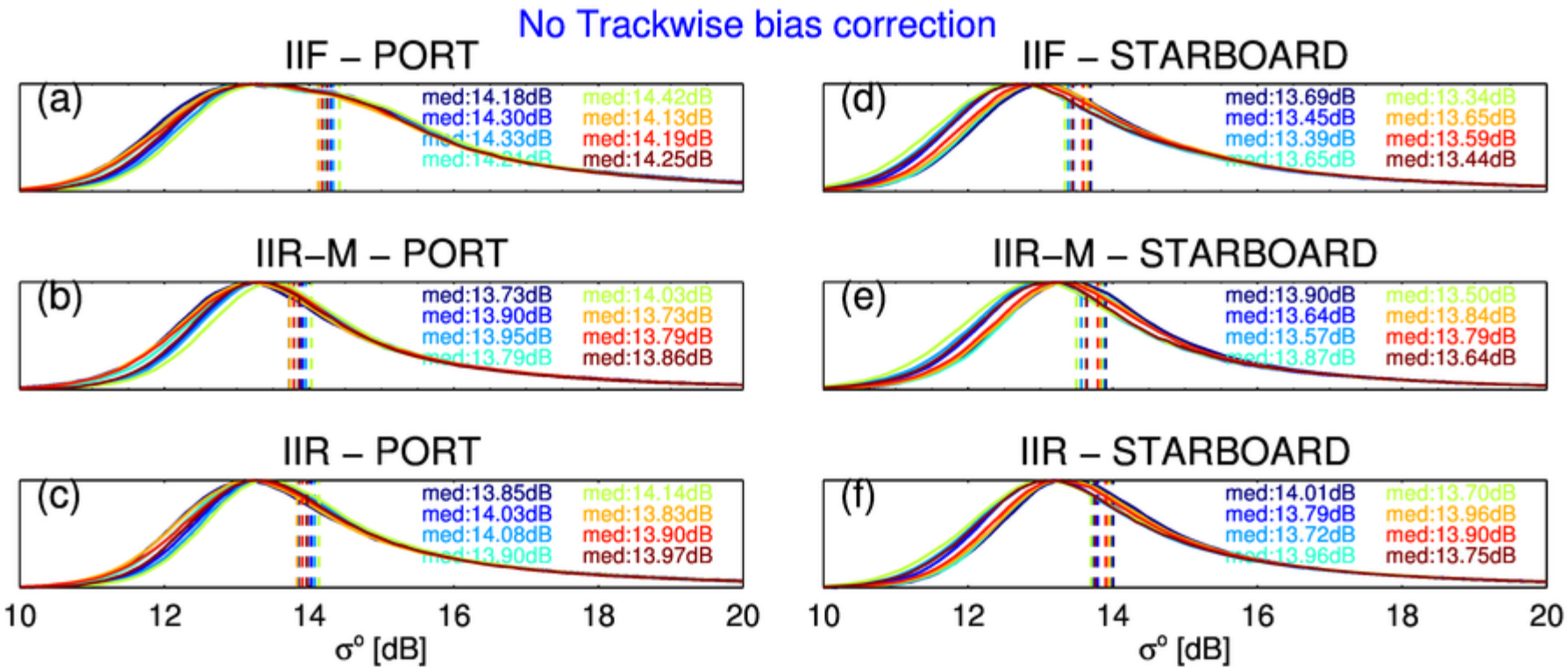
sand163


No Trackwise bias correction sand163
IIF – PORT
(a)
med:13.59dB
med:13.97dB
med:13.30dB
med:13.45dB
med:13.44dB
med:13.74dB
med:13.95dB
IIF – STARBOARD
(d)
med:13.48dB
med:13.56dB
med:13.91dB
med:13.65dB
med:13.65dB
med:14.12dB
med:14.18dB
IIR–M – PORT
(b)
med:13.16dB
med:13.52dB
med:12.93dB
med:13.04dB
med:12.99dB
med:13.29dB
med:13.52dB
IIR–M – STARBOARD
(e)
med:12.83dB
med:12.92dB
med:13.30dB
med:13.04dB
med:13.03dB
med:13.45dB
med:13.54dB
IIR – PORT
(c)
med:14.08dB
med:14.50dB
med:13.80dB
med:13.94dB
med:13.89dB
med:14.23dB
med:14.45dB
IIR – STARBOARD
(f)
med:13.78dB
med:13.86dB
med:14.19dB
med:13.97dB
med:13.90dB
med:14.38dB
med:14.47dB
10
12
14
16
18
20
σ° [dB]

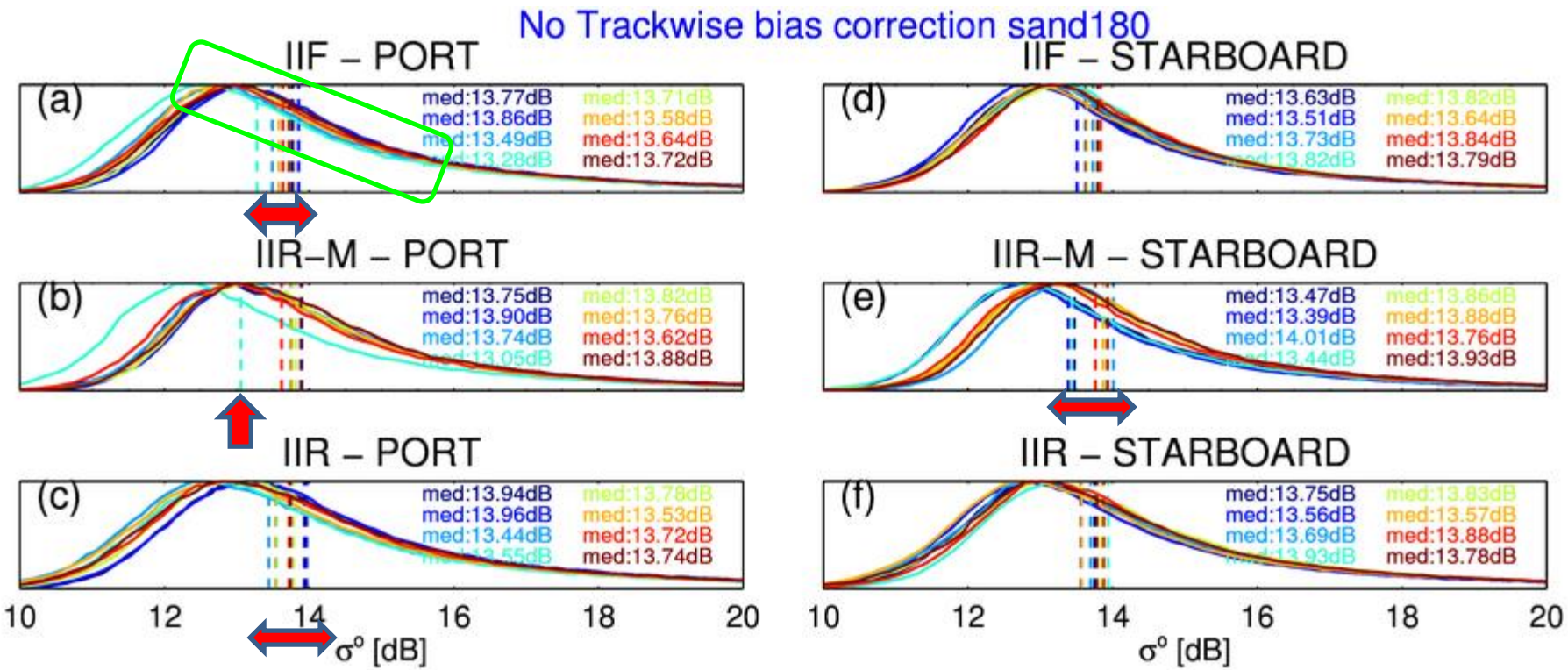
sand180


No Trackwise bias correction sand180
IIF – PORT
(a)
med:13.77dB
med:13.86dB
med:13.49dB
med:13.28dB
med:13.71dB
med:13.58dB
med:13.64dB
med:13.72dB
IIF – STARBOARD
(d)
med:13.63dB
med:13.51dB
med:13.73dB
med:13.82dB
med:13.82dB
med:13.64dB
med:13.84dB
med:13.79dB
IIR–M – PORT
(b)
med:13.75dB
med:13.90dB
med:13.74dB
med:13.05dB
med:13.82dB
med:13.76dB
med:13.62dB
med:13.88dB
IIR–M – STARBOARD
(e)
med:13.47dB
med:13.39dB
med:14.01dB
med:13.44dB
med:13.86dB
med:13.88dB
med:13.76dB
med:13.93dB
IIR – PORT
(c)
med:13.94dB
med:13.96dB
med:13.44dB
med:13.55dB
med:13.78dB
med:13.53dB
med:13.72dB
med:13.74dB
IIR – STARBOARD
(f)
med:13.75dB
med:13.56dB
med:13.69dB
med:13.93dB
med:13.83dB
med:13.57dB
med:13.88dB
med:13.78dB
10
12
14
16
18
20
σ° [dB]

v2.1


No Trackwise bias correction
IIF – PORT
(a)
med:14.18dB
med:14.30dB
med:14.33dB
med:14.21dB
med:14.42dB
med:14.13dB
med:14.19dB
med:14.25dB
IIF – STARBOARD
(d)
med:13.69dB
med:13.45dB
med:13.39dB
med:13.65dB
med:13.34dB
med:13.65dB
med:13.59dB
med:13.44dB
IIR–M – PORT
(b)
med:13.73dB
med:13.90dB
med:13.95dB
med:13.79dB
med:14.03dB
med:13.73dB
med:13.79dB
med:13.86dB
IIR–M – STARBOARD
(e)
med:13.90dB
med:13.64dB
med:13.57dB
med:13.87dB
med:13.50dB
med:13.84dB
med:13.79dB
med:13.64dB
IIR – PORT
(c)
med:13.85dB
med:14.03dB
med:14.08dB
med:13.90dB
med:14.14dB
med:13.83dB
med:13.90dB
med:13.97dB
IIR – STARBOARD
(f)
med:14.01dB
med:13.79dB
med:13.72dB
med:13.96dB
med:13.70dB
med:13.96dB
med:13.90dB
med:13.75dB
10
12
14
16
18
20
σ° [dB]

sand180


No Trackwise bias correction sand180
IIF – PORT
(a)
med:13.77dB
med:13.86dB
med:13.49dB
med:13.28dB
med:13.71dB
med:13.58dB
med:13.64dB
med:13.72dB
IIF – STARBOARD
(d)
med:13.63dB
med:13.51dB
med:13.73dB
med:13.82dB
med:13.82dB
med:13.64dB
med:13.84dB
med:13.79dB
IIR–M – PORT
(b)
med:13.75dB
med:13.90dB
med:13.74dB
med:13.05dB
med:13.82dB
med:13.76dB
med:13.62dB
med:13.88dB
IIR–M – STARBOARD
(e)
med:13.47dB
med:13.39dB
med:14.01dB
med:13.44dB
med:13.86dB
med:13.88dB
med:13.76dB
med:13.93dB
IIR – PORT
(c)
med:13.94dB
med:13.96dB
med:13.44dB
med:13.55dB
med:13.78dB
med:13.53dB
med:13.72dB
med:13.74dB
IIR – STARBOARD
(f)
med:13.75dB
med:13.56dB
med:13.69dB
med:13.93dB
med:13.83dB
med:13.57dB
med:13.88dB
med:13.78dB
10
12
14
16
18
20
σ° [dB]