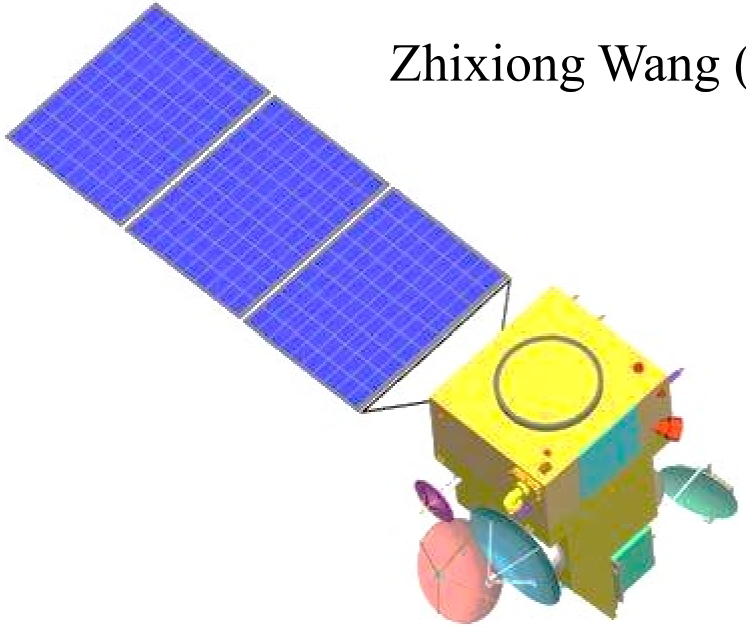
Towards consistent scatterometer wind products:

Intercalibration of HY-2/SCAT and MetOp/ASCAT scatterometer winds



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IOVWST-2022

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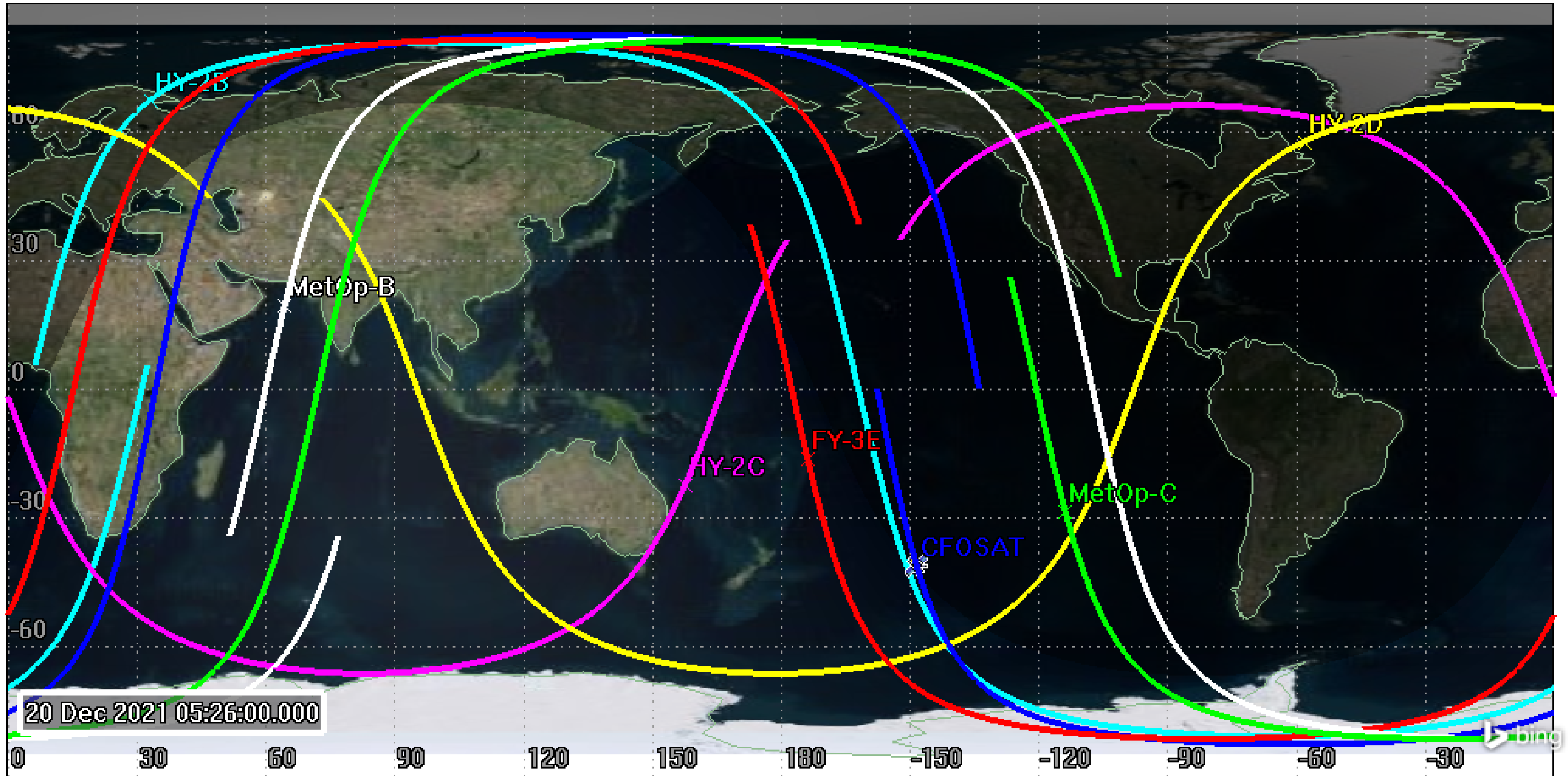
国家卫星海洋应用中心 NSOAS NATIONAL SATELLITE OCEAN APPLICATION SERVICE

Koninklijk Nederlands Meteorologisch Instituut
Ministerie van Infrastructuur en Waterstaat

Outlines

- Operating Satellite Scatterometers
- Intercalibration of Backscatter Measurements among Ku-Band Scatterometers Onboard the Chinese HY-2 Satellite Constellation
- Intercalibration of ASCAT and HSCAT Winds
- Summary

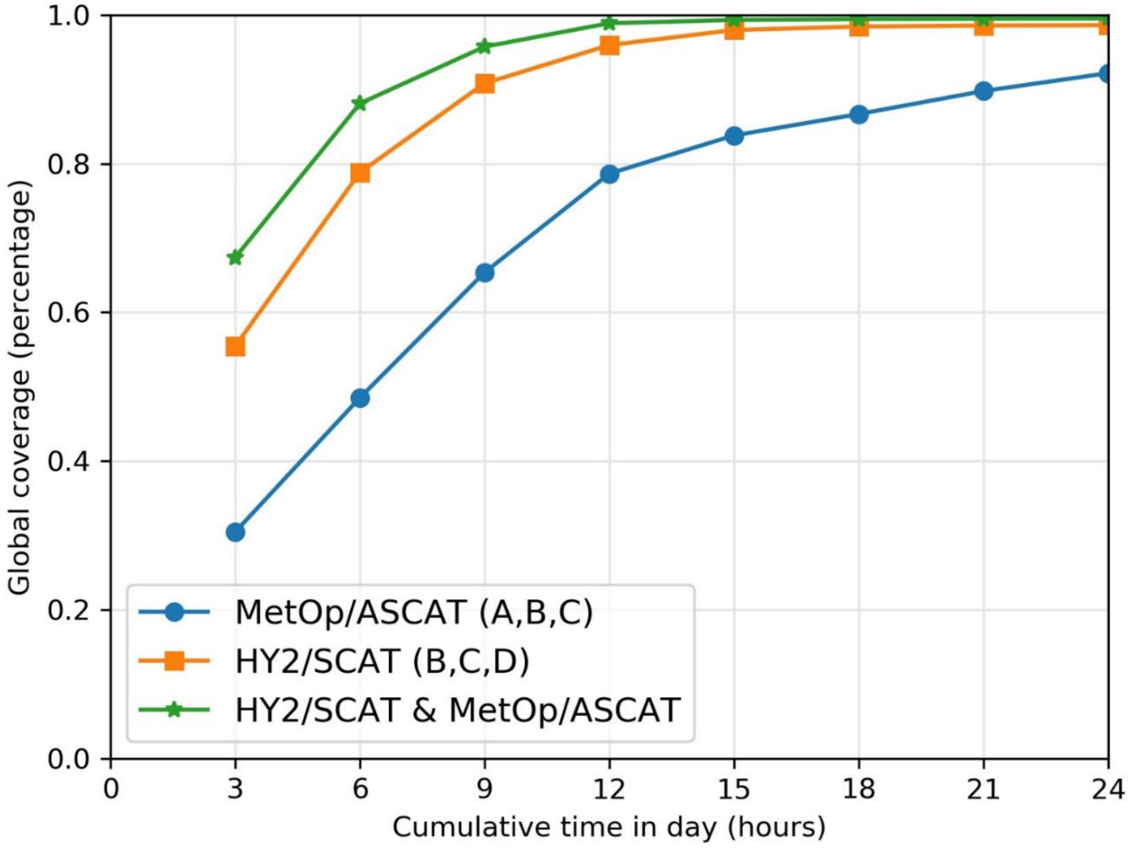
Operating Satellite Scatterometers:



➢ MetOp-B/ASCAT	9:30/21:30
➢ MetOp-C/ASCAT	9:30/21:30
➢ HY-2B/SCAT	6:00/18:00
➢ HY-2C/SCAT	Shifting
➢ HY-2D/SCAT	Shifting
➢ CFOSAT/SCAT	7:00/19:00
➢ FY-3E/WindRAD	6:00/18:00

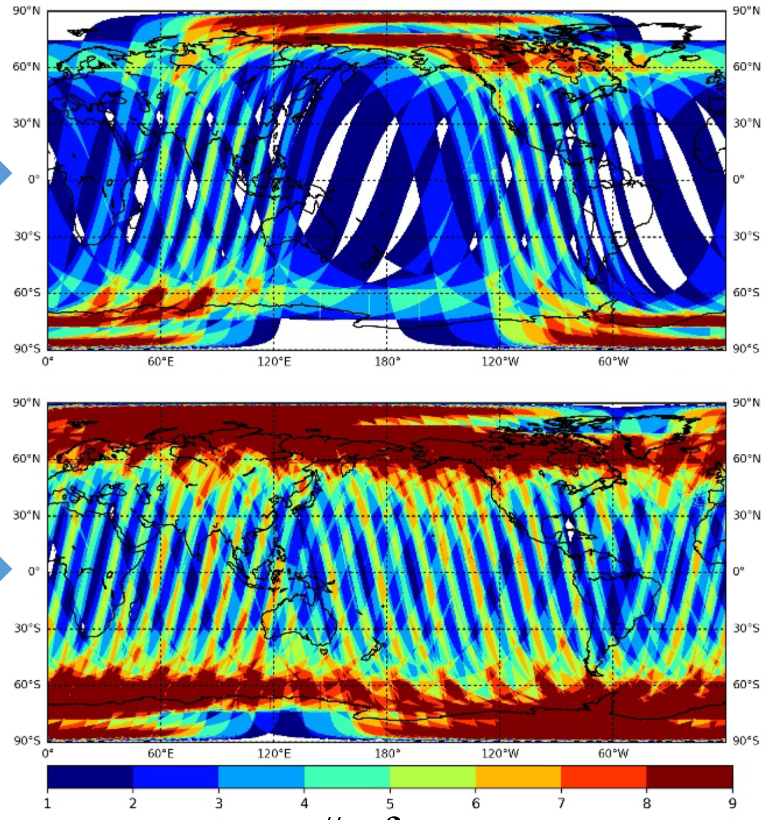
◆It is important to improve the consistency of scatterometer winds

Global Coverage by HY-2/SCAT and MetOp/ASCAT:



0 ~ 6 h

0 ~ 12 h



>90%

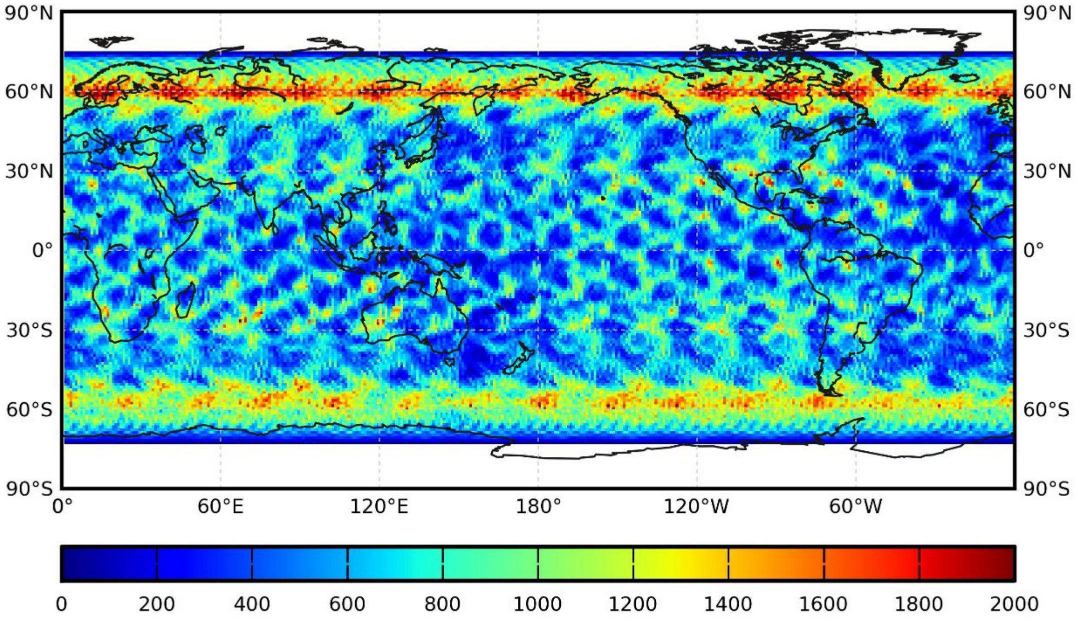
~100%

◆HSCAT and ASCAT global coverage is ~**80%** in every **6h** ; and is **~100%** in every **12h** ;

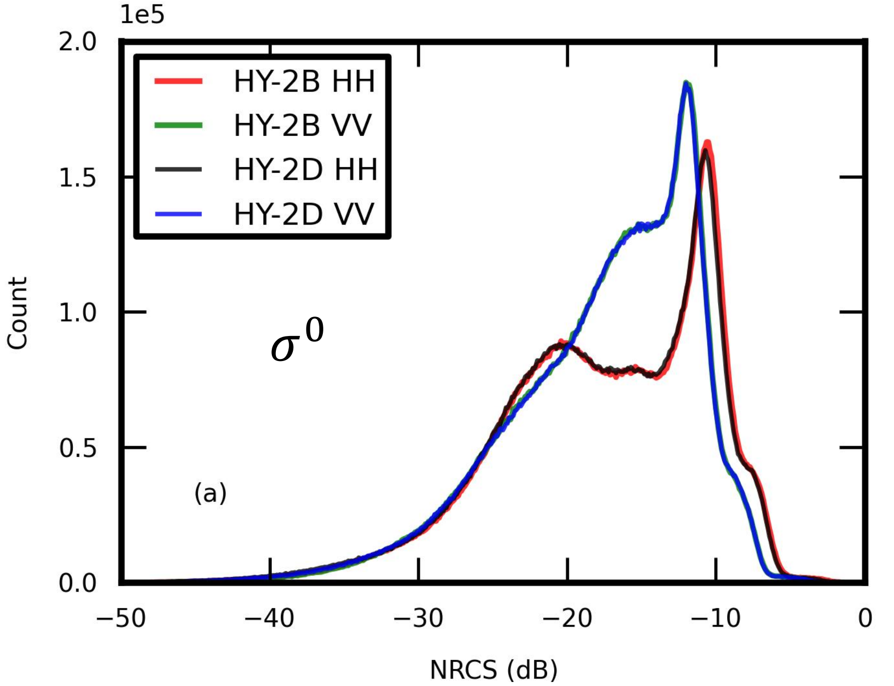
Intercalibration of HSCAT Backscatter Measurements **using CDF Matching Tech.**

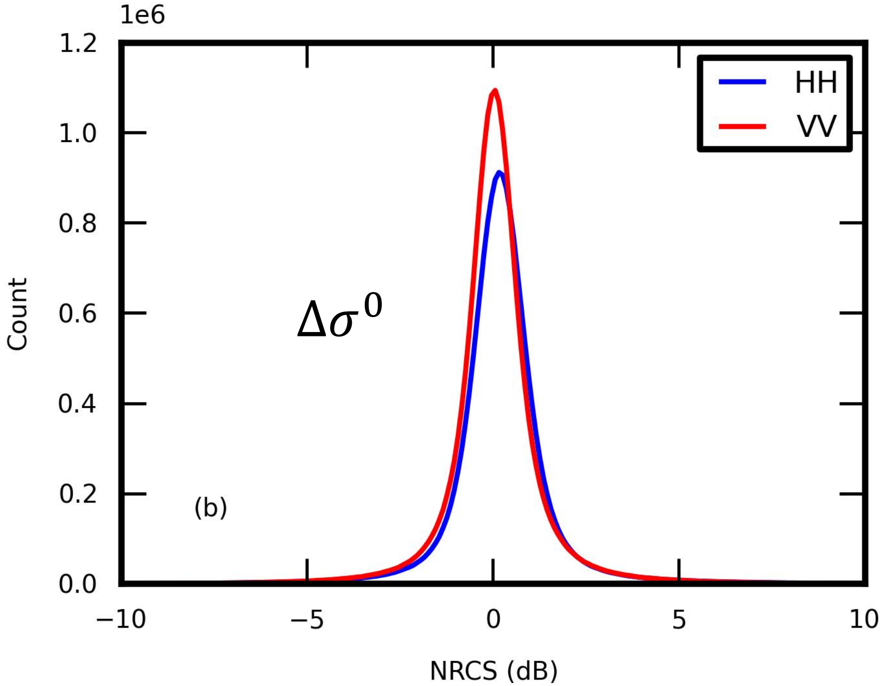
HY2B & HY2C:	**2021/06 ~ 2021/08**
HY2B & HY2D:	
HY2C & HY2D:	

- ✓ **Time diff. < 60 min**
- ✓ **Space diff. < 25 km**
- ✓ **Azimuth diff. < 5 deg**



Global distribution of collocated HY2B&HY2D data





CDF Matching & Intercalibration results

The results showing that the HSCAT sigma0 data are in good agreement, the differences are generally within 0.1 dB.

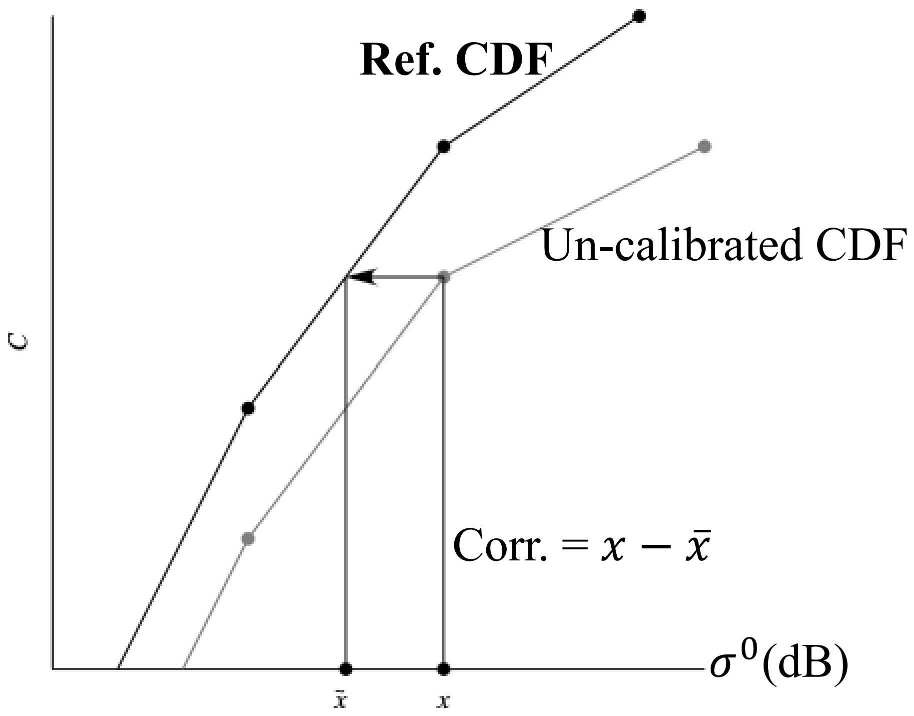
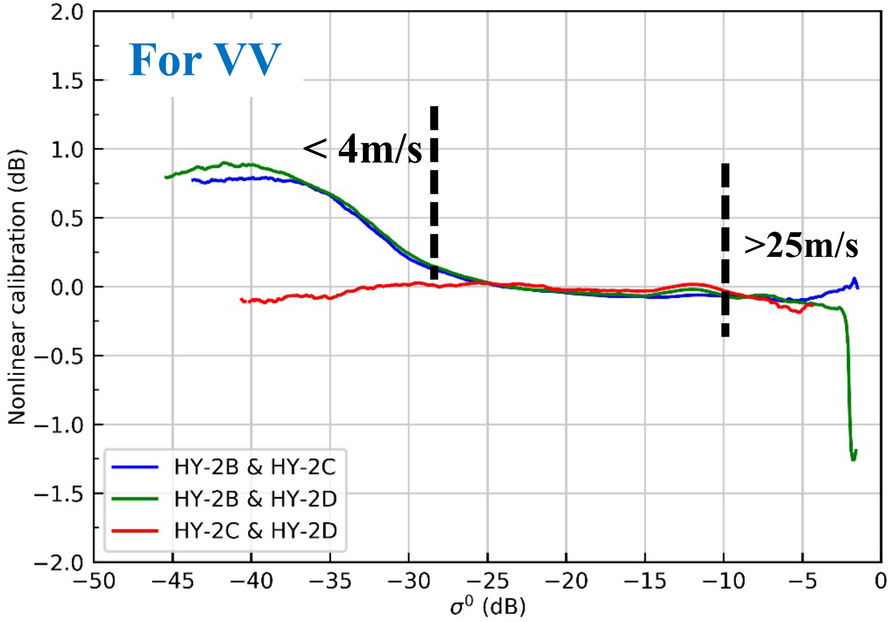
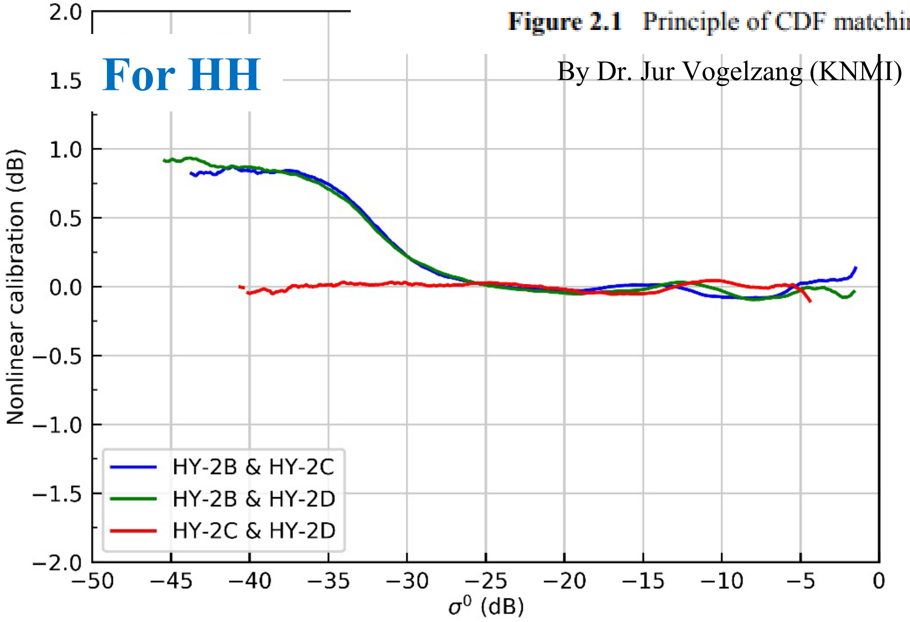


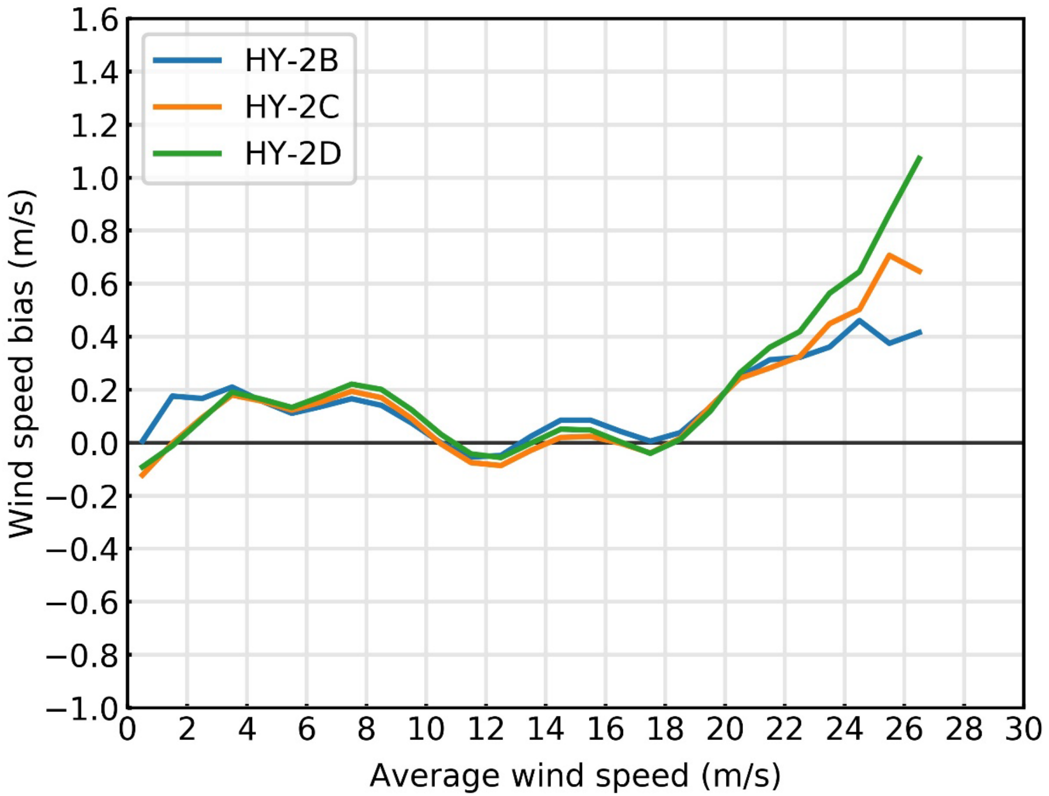
Figure 2.1 Principle of CDF matching.

By Dr. Jur Vogelzang (KNMI)





Wind speeds show highly consistency!



- ◆ 2021.06 ~ 2021.11,
- ◆ Comparing to ECMWF oper. forecasts, 10m real winds

NSCAT-5 GMF for HY-2/SCAT Winds:

Wind speed dependence

Wind direction modulation

$$\sigma_p^0(V,\phi,\theta,T) = A_{0p}(V,\theta,T_0) * \sum_{i=1}^{N} A_{1p}(V,\theta)\cos(i\phi) * y_p(V,\theta,\Delta T) \qquad (1)$$

SST dependence

HY-2

$$y_p(V,\Delta T) = 1 + B_{1p}(V) * \Delta T + B_{2p}(V) * (\Delta T)^2 \qquad (2)$$

$$\Delta T = T - T_0$$

NSCAT-4 GMF

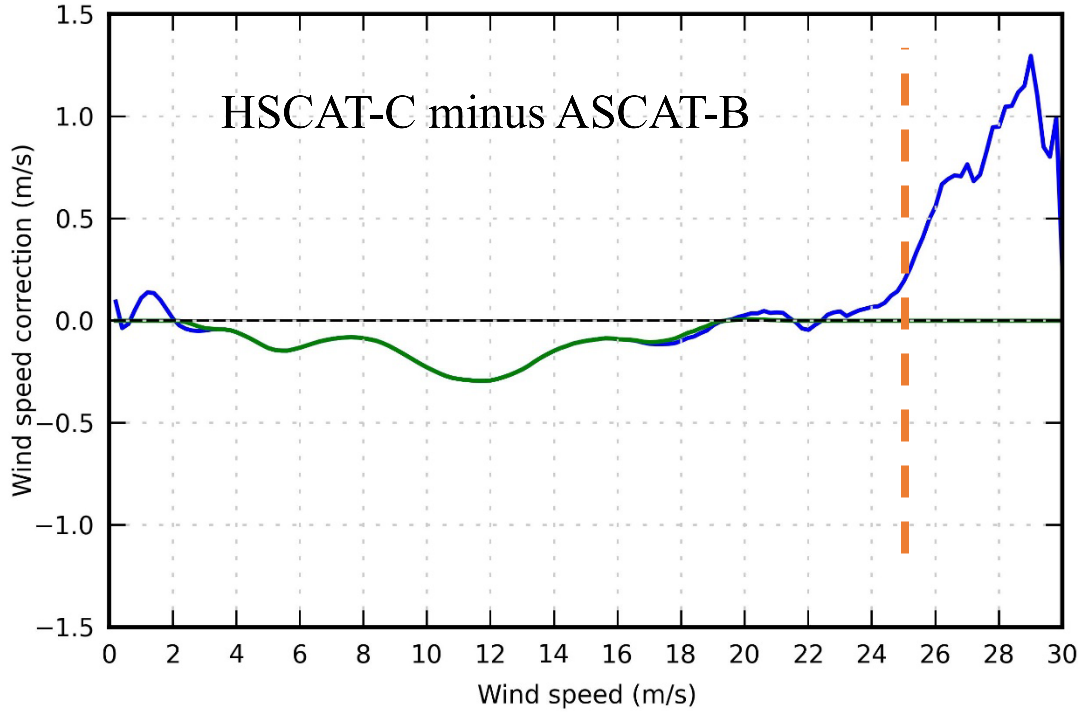
- Improve A_{0p}
- Add SST dependency

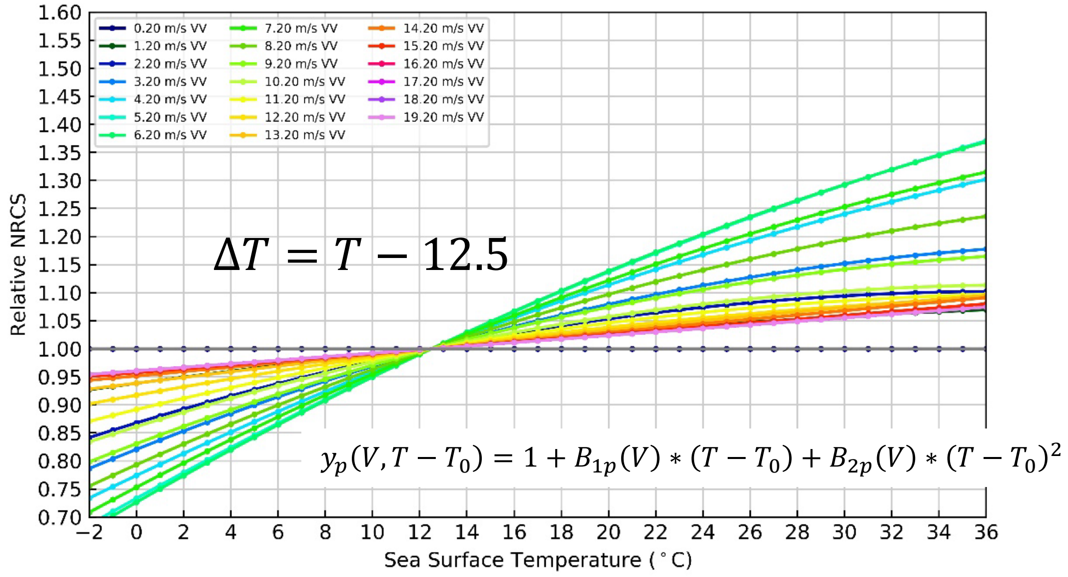
NSCAT-5 GMF

- Based on collocated HY-2C & MetOp-B data

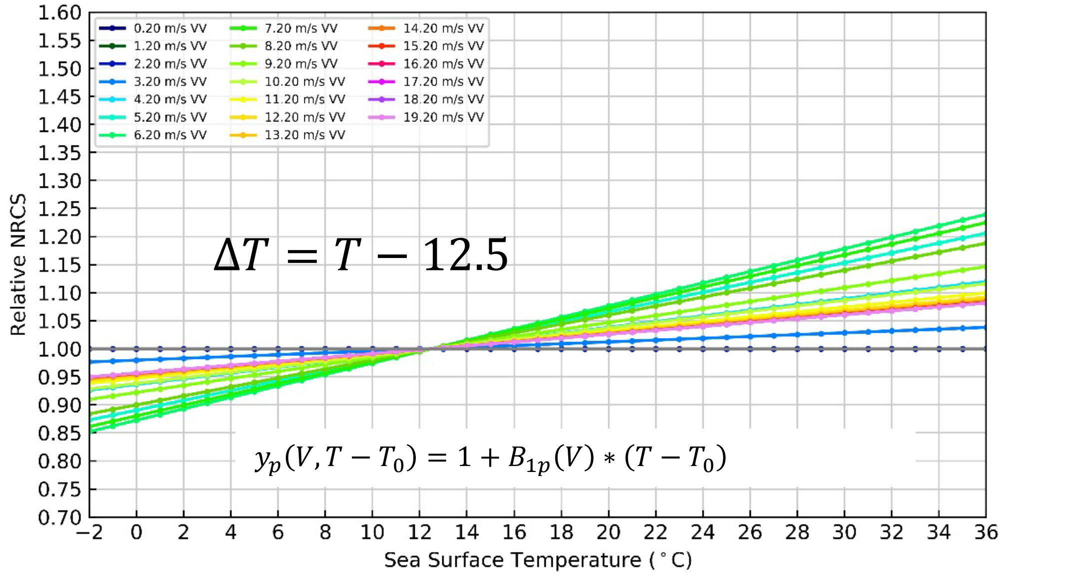
Improve Wind Speed Dependence:

using CDF matching technique => NSCAT-4S

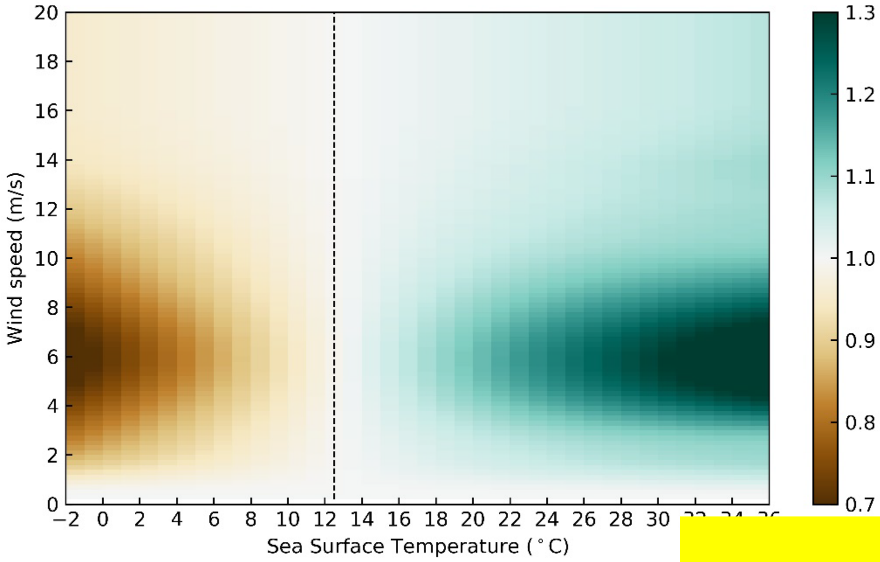


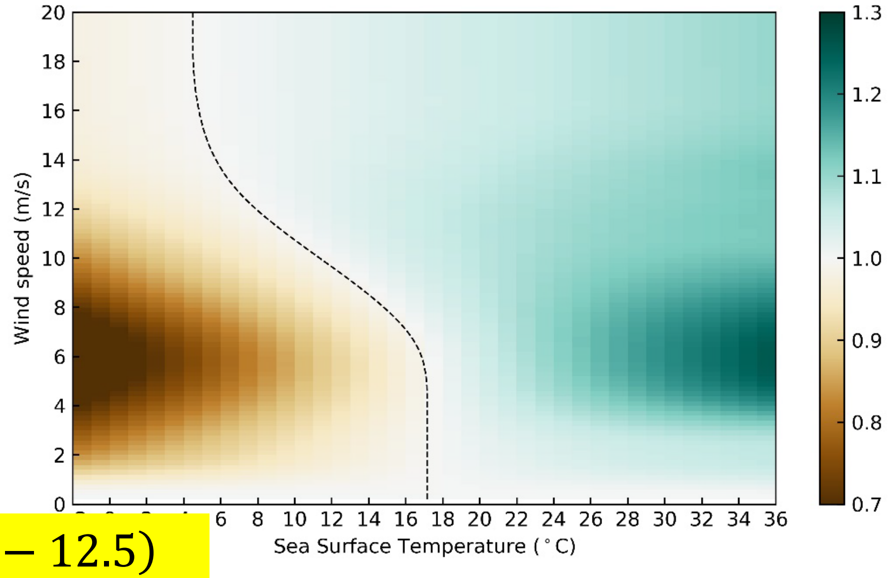


SST+ dependency

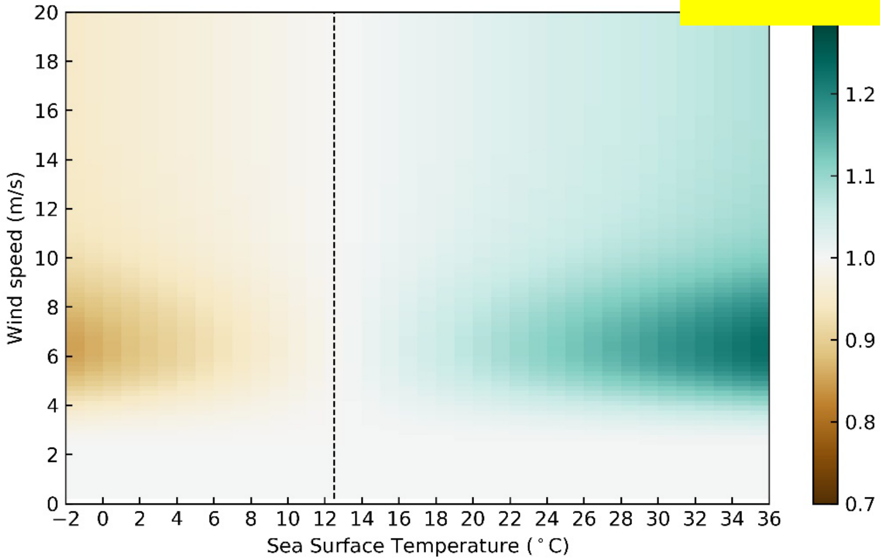


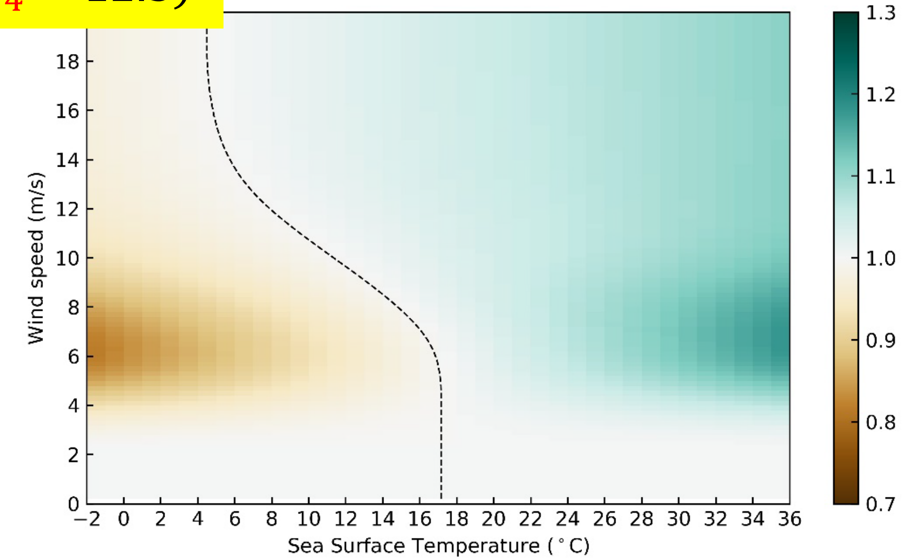
NSCAT-5 GMF





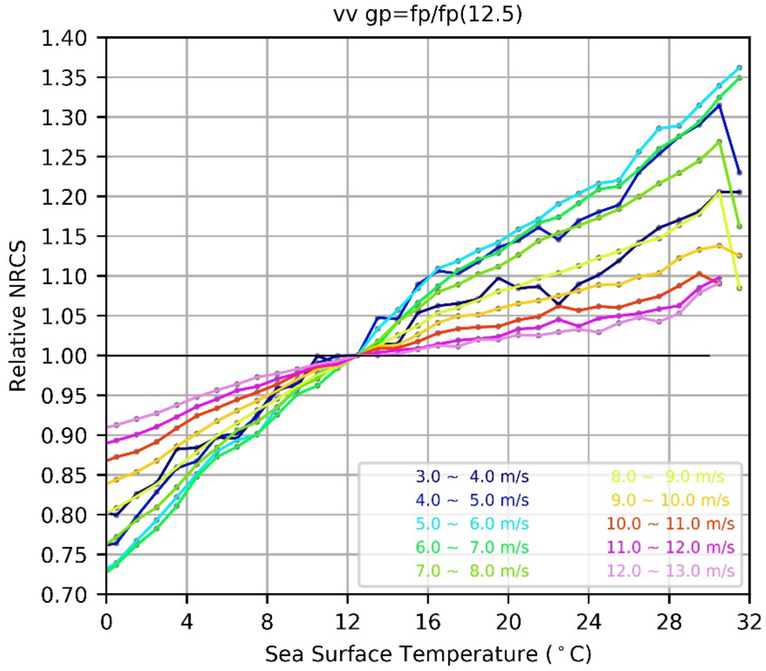
$$\sigma^0_{\mathrm{N5},p}(V,T) = \sigma^0_{\mathrm{N4},p}(V) * \frac{y_p(V, T - 12.5)}{y_p(V, T_{\mathrm{N4}} - 12.5)}$$

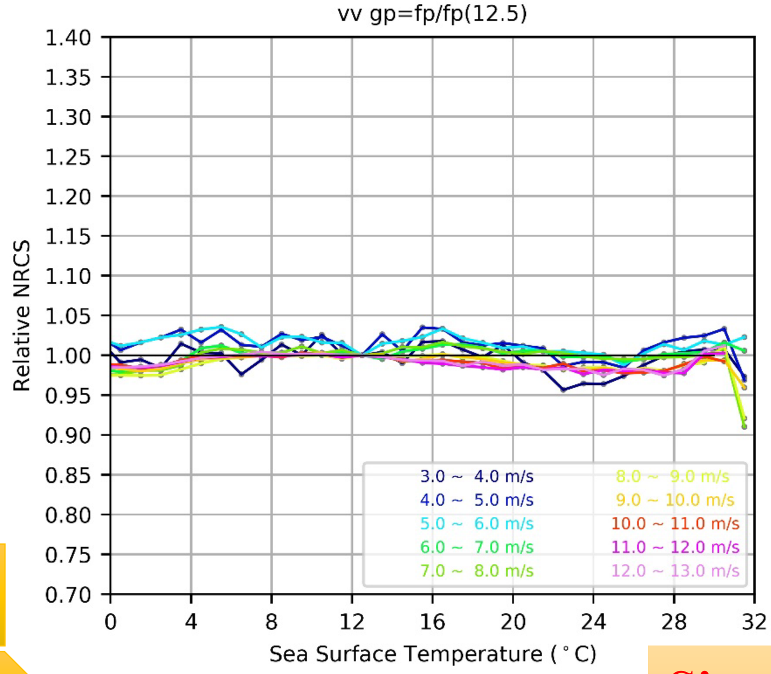




Validation of the NSCAT-5 GMF

VV



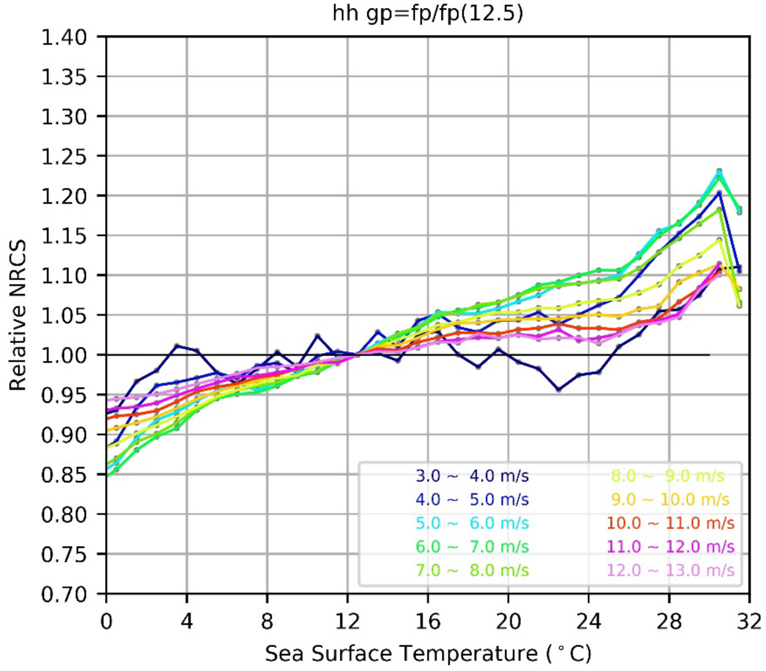


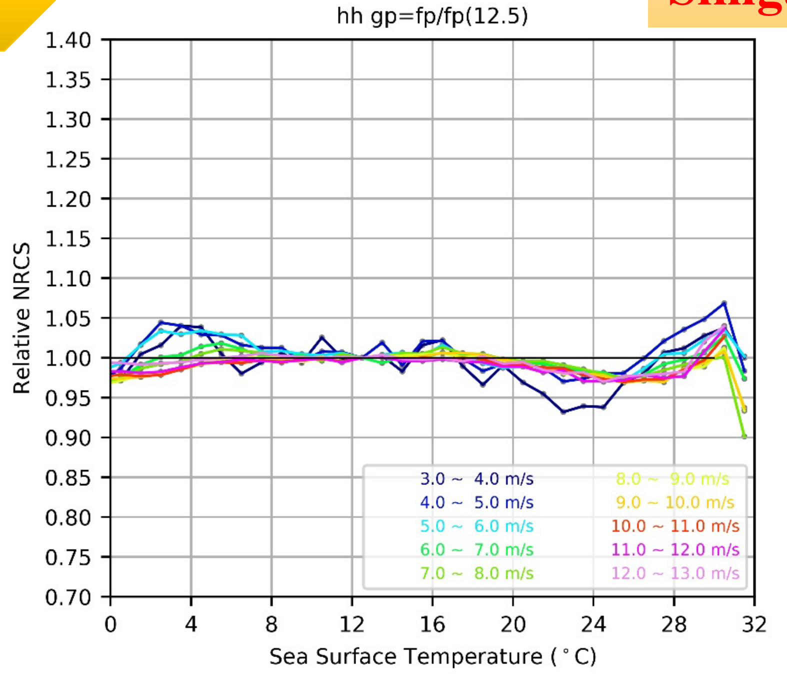
N4

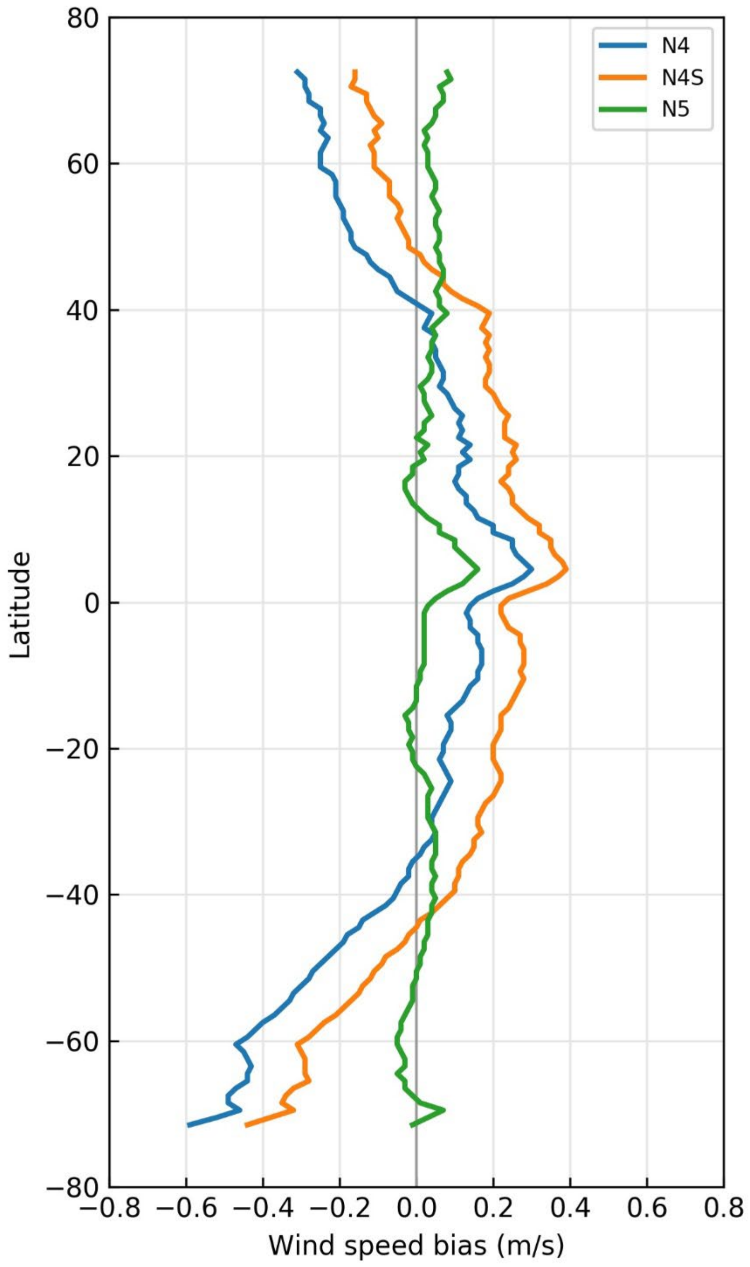
N5

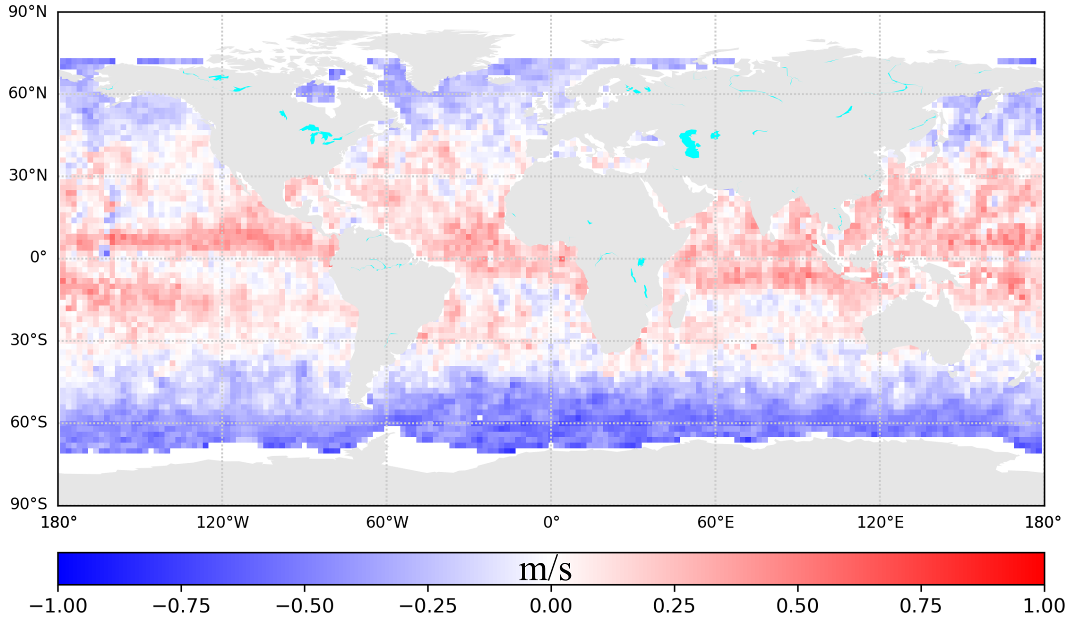
Simga0 as a function of SST

HH



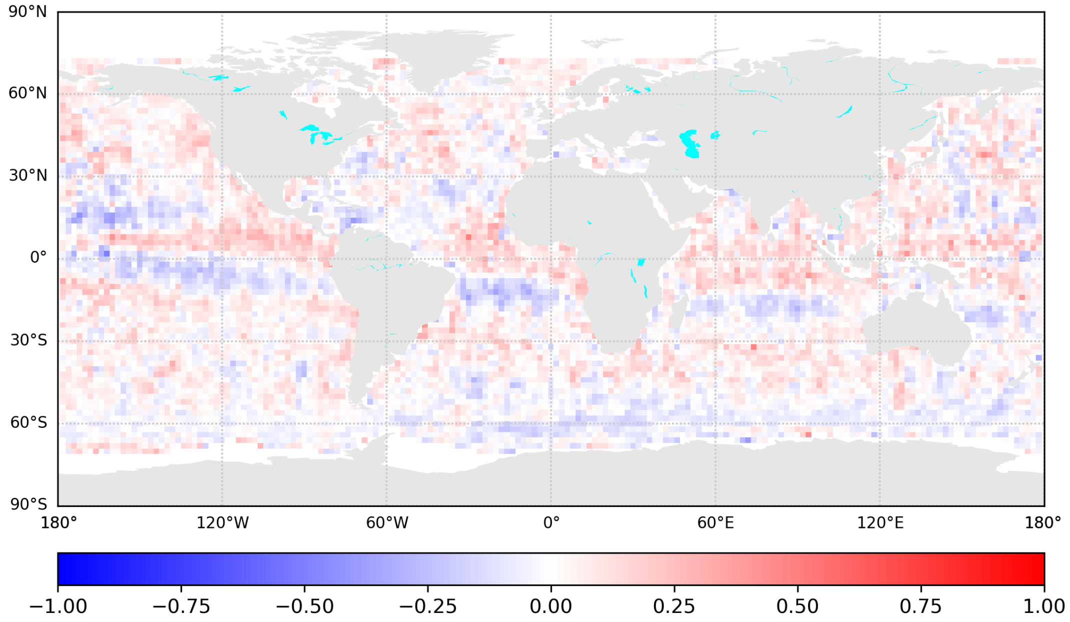




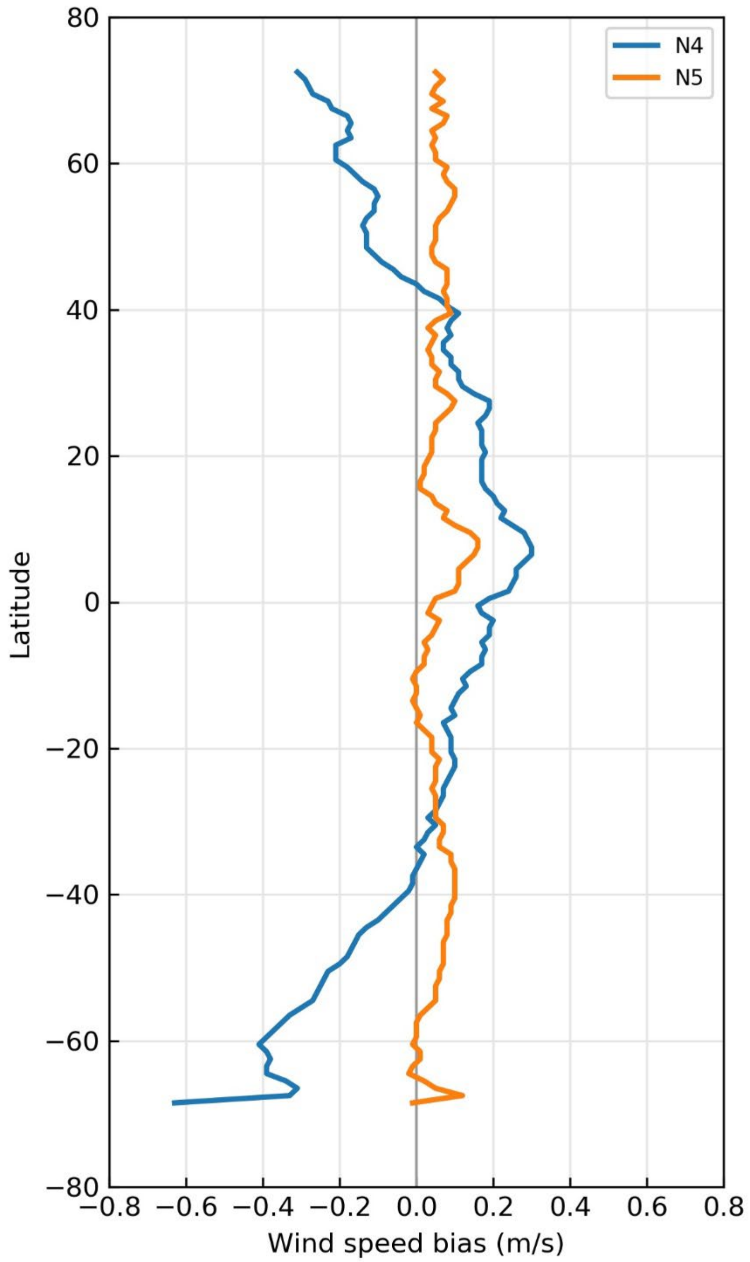


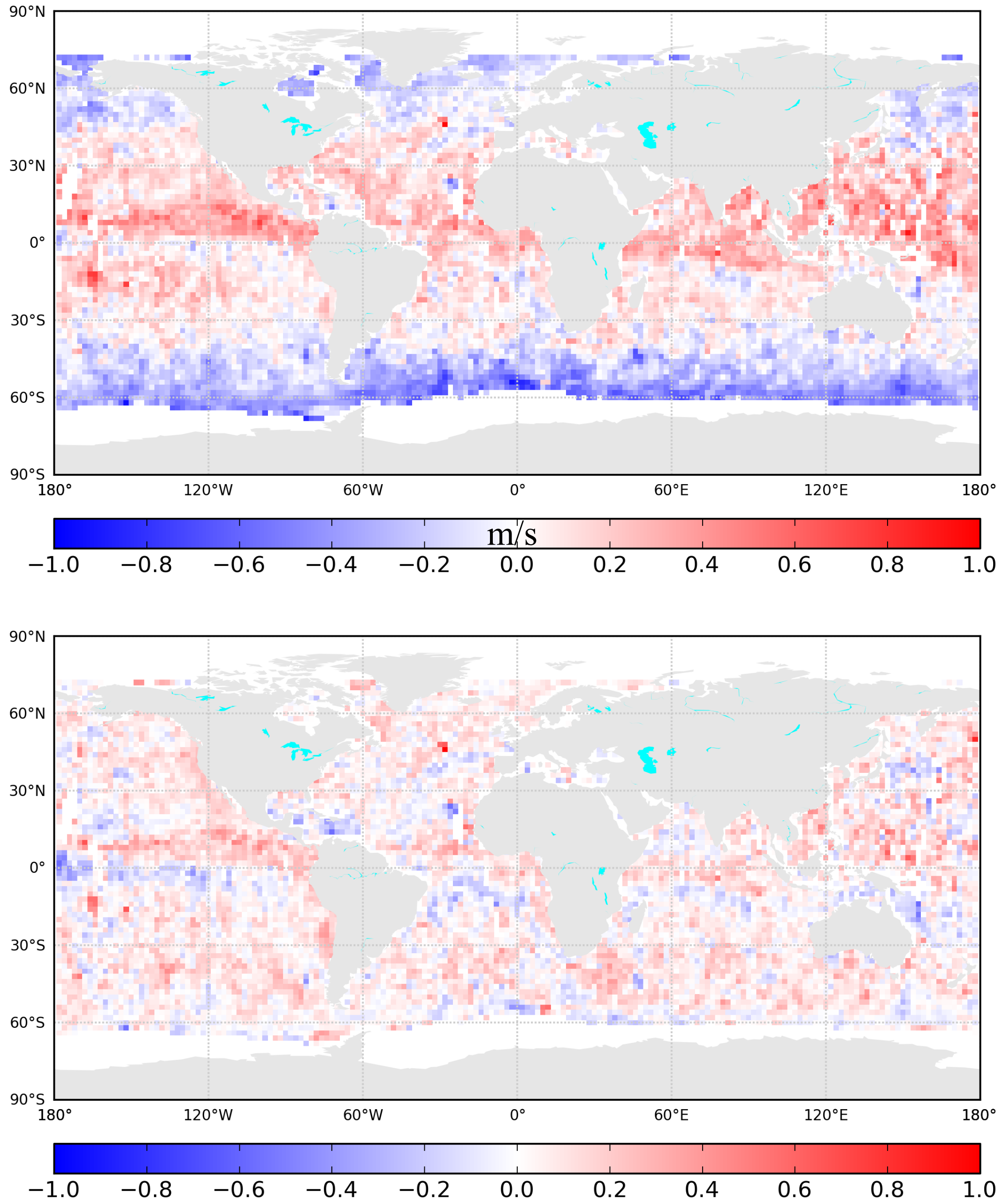
HSCAT-C **N4**

Global distribution of Wind speed biases w.r.t. ASCAT-B



HSCAT-C **N5**

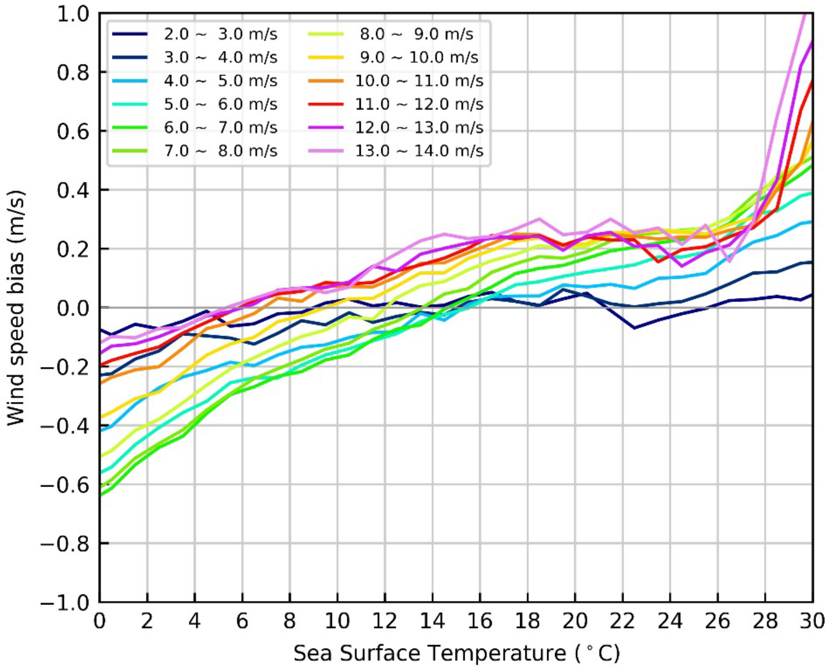




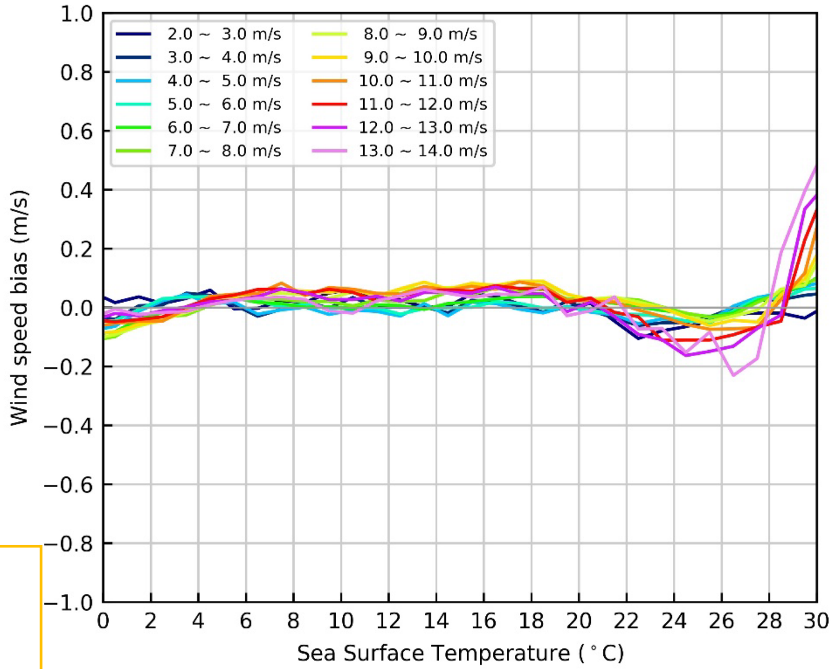
HSCAT-D-N4

Global distribution of Wind speed biases w.r.t. ASCAT-B

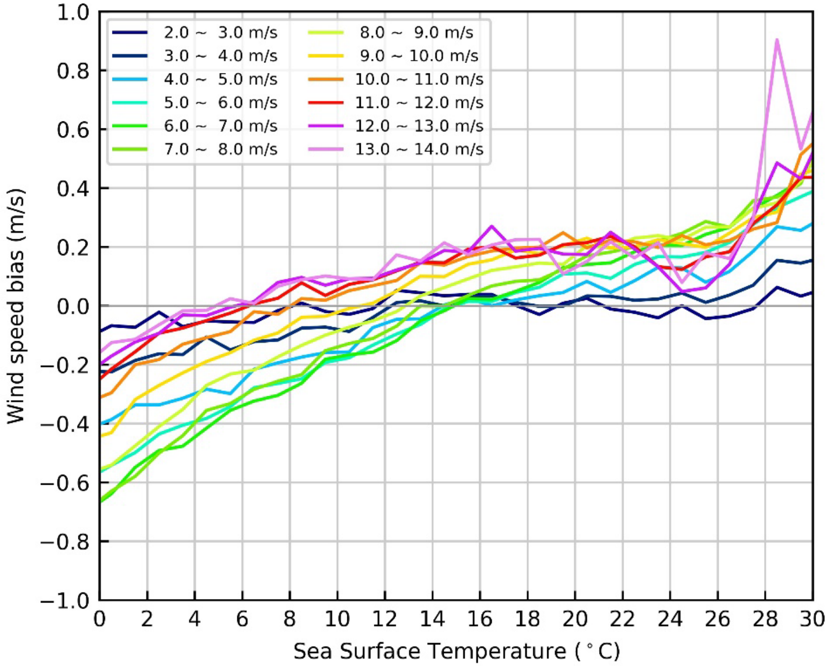
HSCAT-D-N5



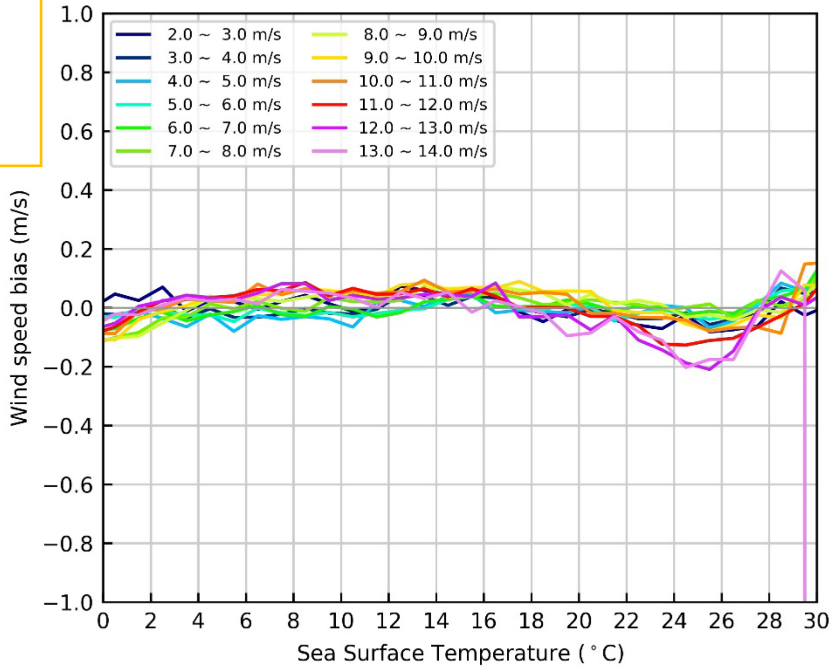
ASCAT-B & HY-2C

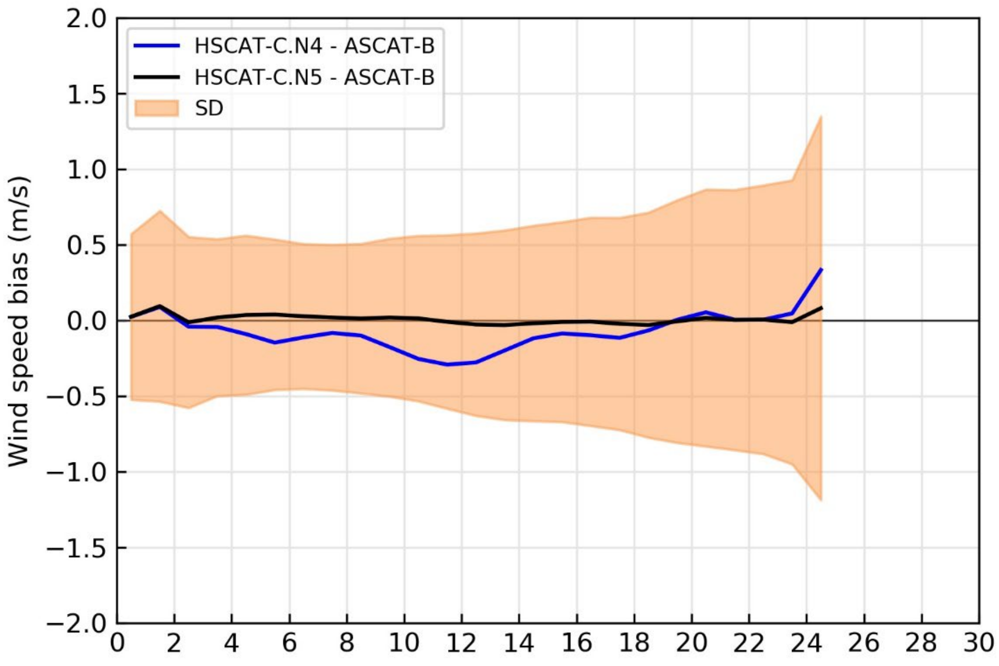


For given wspd range,
Wspd biases as a function of SST



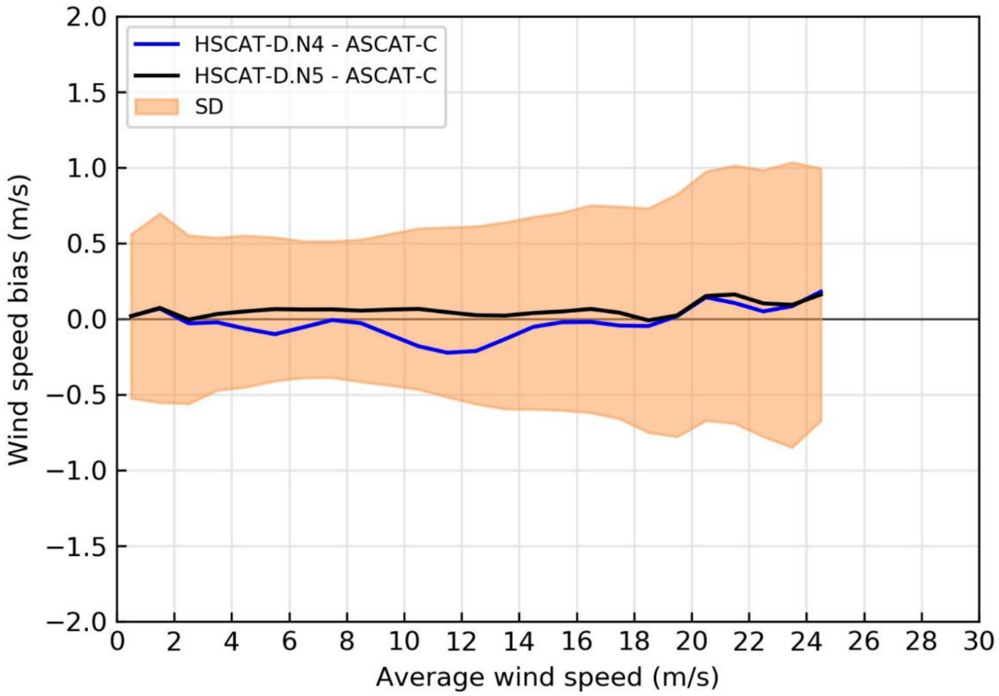
ASCAT-C & HY-2D





HY-**2C** & ASCAT-B

2020.10 ~ 2021.10



HY-**2D** & ASCAT-C

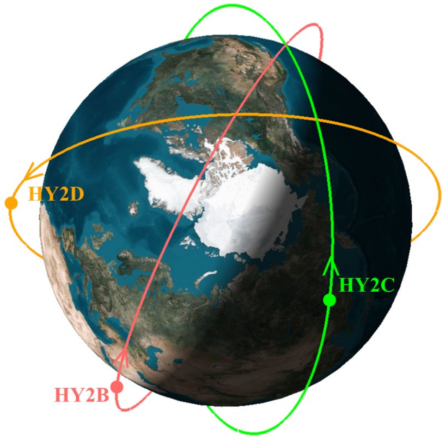
2021.06 ~ 2021.10

Table. Wind comparisons between ASCAT and HSCAT

Scatterometer winds	Number	Wind speed		U component		V component		Direction RMSE
		Bias(m/s)	SD(m/s)	Bias(m/s)	SD(m/s)	Bias(m/s)	SD(m/s)	
ASCAT-B & HSCAT-C-N4	7 609 185	-0.14	0.61	-0.09	1.07	+0.05	1.11	11.1°
ASCAT-B & HSCAT-C-N4S	6 925 777	-0.00	0.60	-0.07	1.06	+0.05	1.12	11.2°
ASCAT-B & HSCAT-C-N5	7 658 750	+0.01	0.54	+0.01	1.02	+0.04	1.09	11.0°
ASCAT-C & HSCAT-C-N4	8 063 139	-0.11	0.60	-0.09	1.06	0.06	1.11	10.9°
ASCAT-C & HSCAT-C-N4S	6 982 340	0.03	0.60	-0.06	1.05	0.05	1.12	10.9°
ASCAT-C & HSCAT-C-N5	7 757 247	0.04	0.54	0.01	1.02	0.04	1.08	10.7°
ASCAT-C & HSCAT-D-N4	3167545	-0.08	0.59	-0.10	0.98	0.03	1.06	10.2°
ASCAT-C & HSCAT-D-N5	3108028	0.05	0.53	-0.02	0.94	0.01	1.04	10.1°

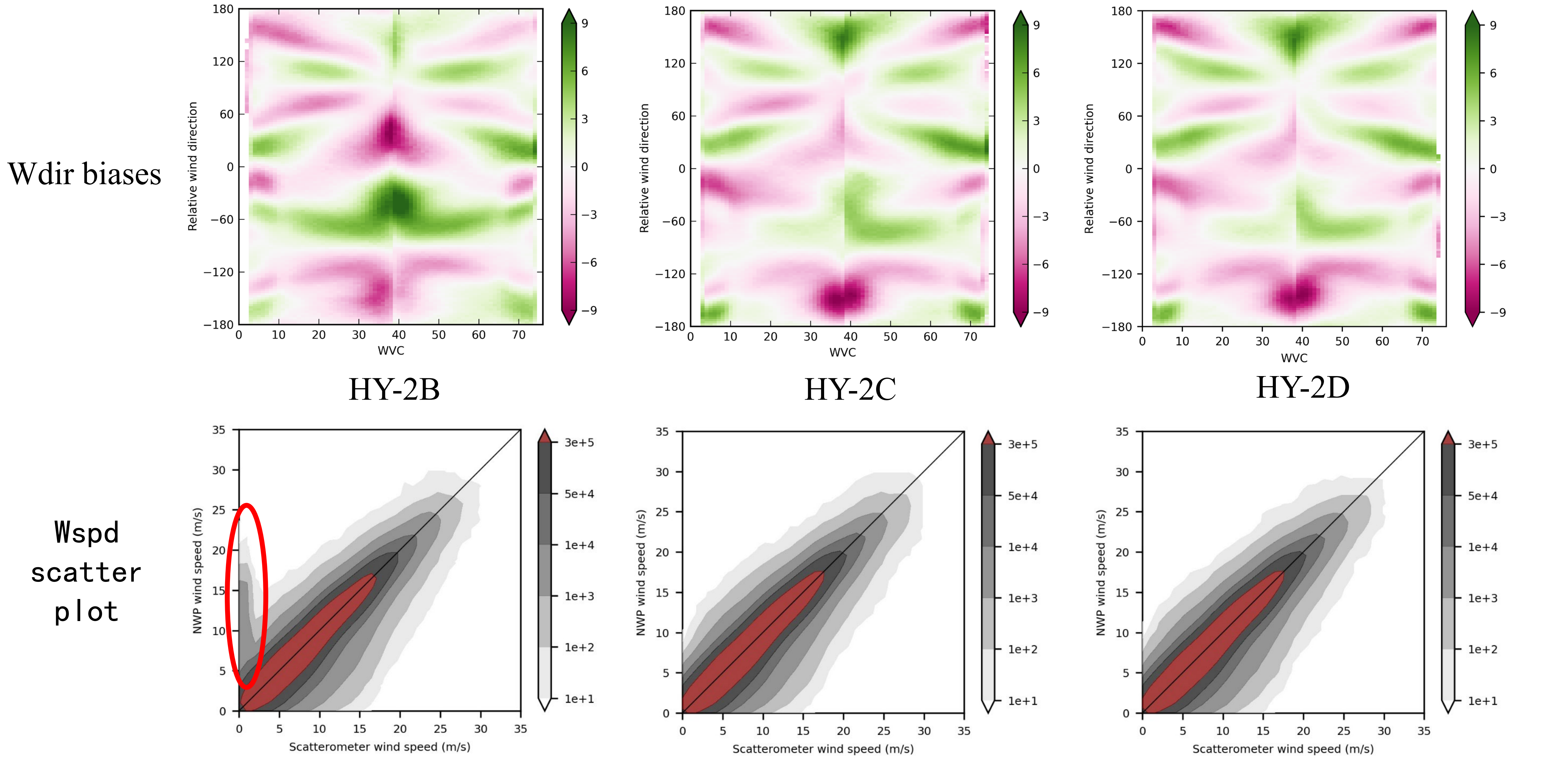
Summary

- The HY-2 series scatterometer constellation is operating now, including HY-2B,HY-2C,HY-2D!
- A very good intercalibration can be achieved among HSCAT measurements by using the CDF matching technique. Due to direct comparison, the accuracy is about 0.1 dB.

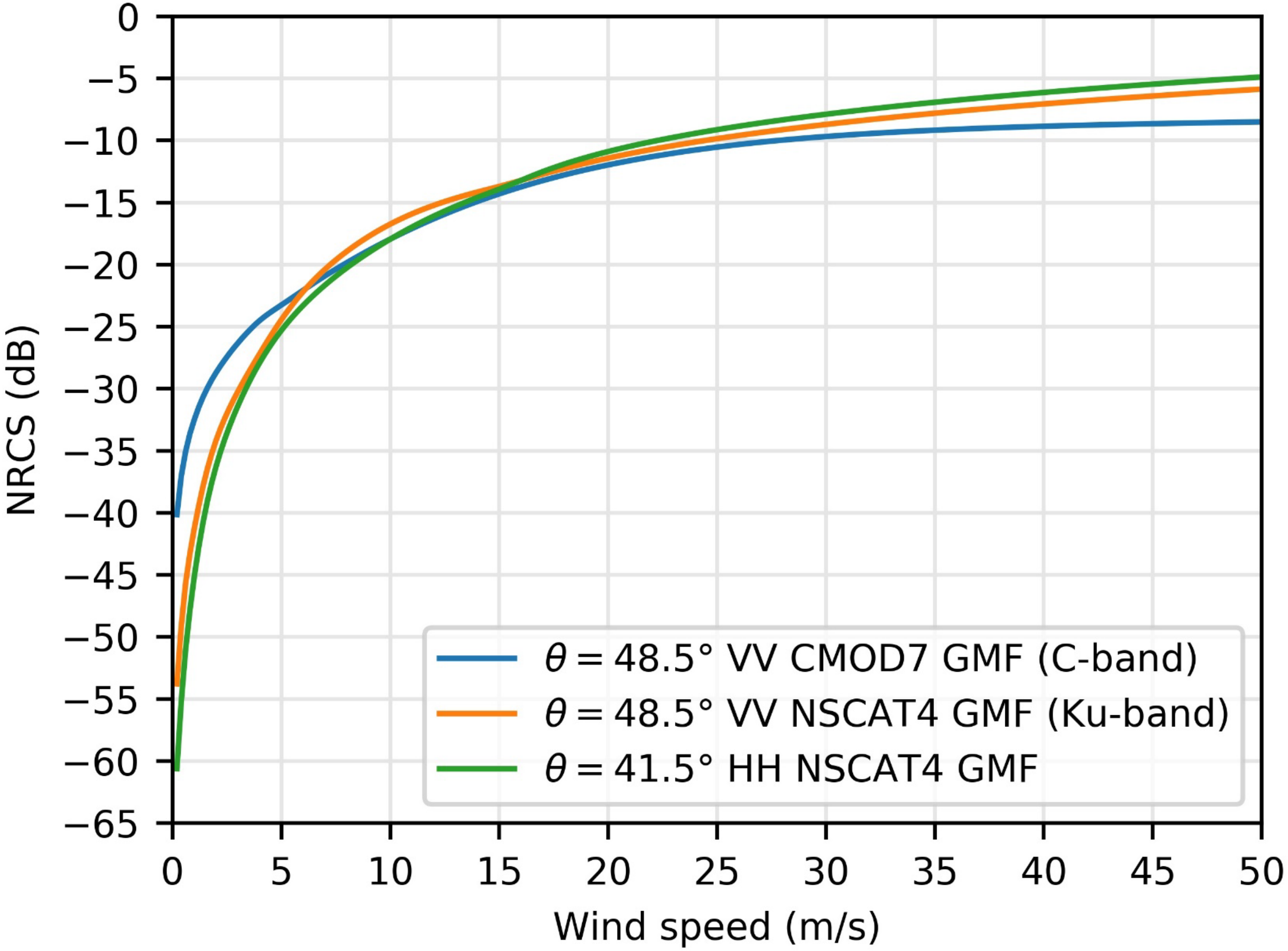


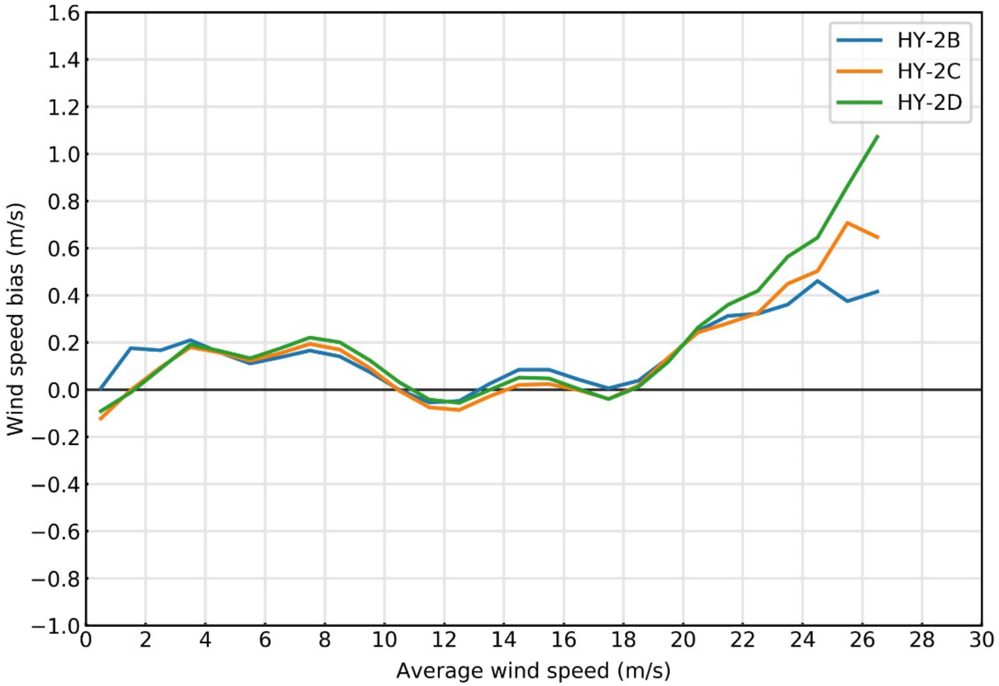
- The NSCAT-5 GMF has been specially built for HSCAT wind retrieval. It successfully removed the SST-dependent retrieval biases, and significantly improved the consistency of winds between ASCAT and HSCAT.

感谢各位！
欢迎批评指导！



Wdir biases
Relative wind direction
WVC
HY-2B
HY-2C
HY-2D
Wspd scatter plot
NWP wind speed (m/s)
Scatterometer wind speed (m/s)
3e+5
5e+4
1e+4
1e+3
1e+2
1e+1


0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−50
−55
−60
−65
NRCS (dB)
0
5
10
15
20
25
30
35
40
45
50
Wind speed (m/s)
$\theta = 48.5°$ VV CMOD7 GMF (C-band)
$\theta = 48.5°$ VV NSCAT4 GMF (Ku-band)
$\theta = 41.5°$ HH NSCAT4 GMF

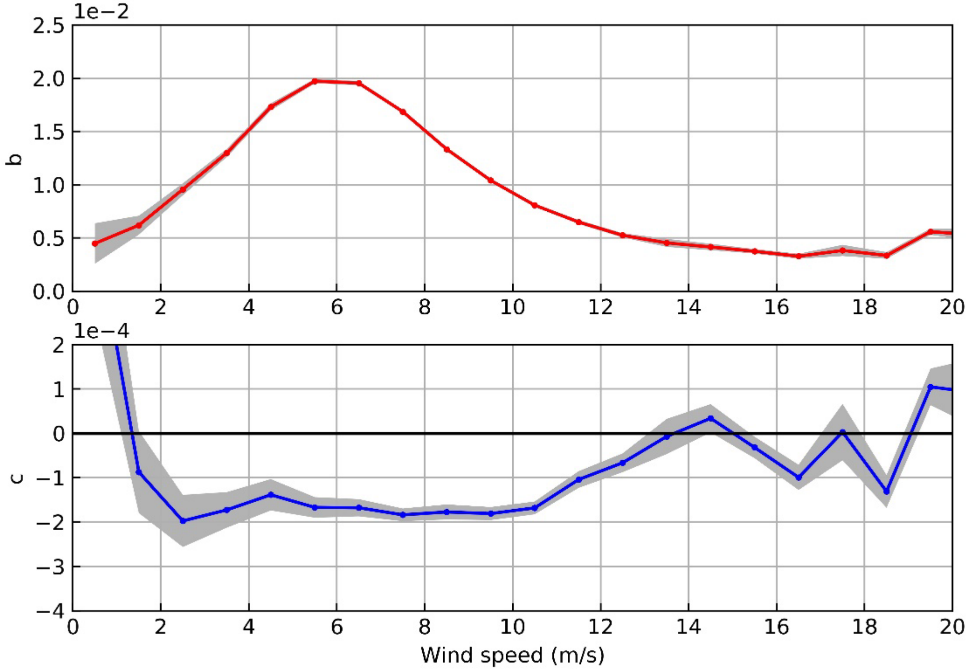


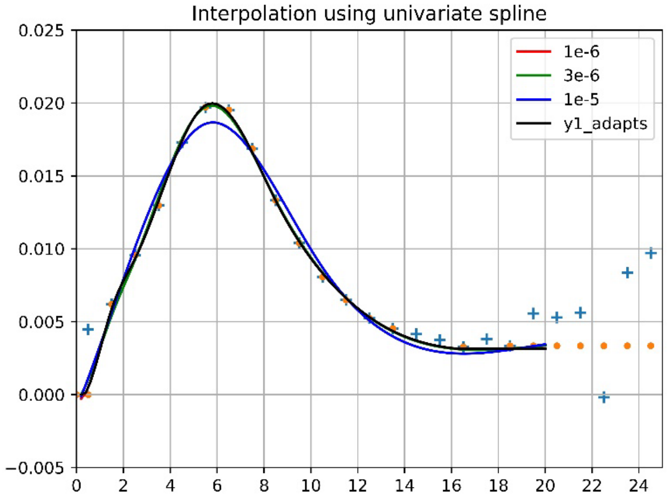
- 2021.06 ~ 2021.11
- ECMWF oper. forecasts, 10m real winds

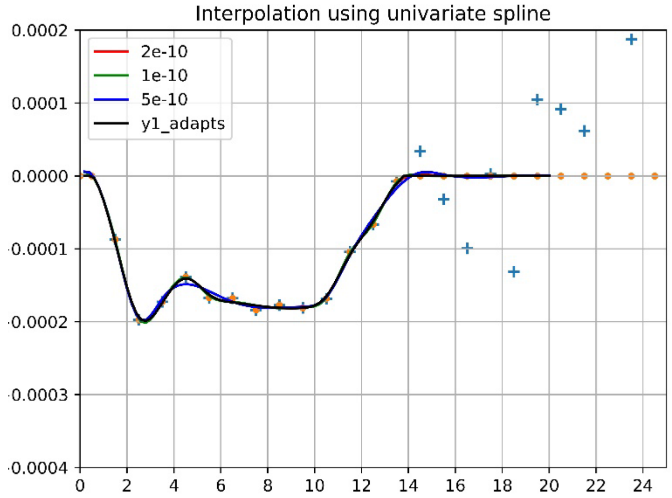
Scatterometer winds	QC ratio	Wind speed		U component		V component		Direction RMSE
		Bias(m/s)	SD(m/s)	Bias(m/s)	SD(m/s)	Bias(m/s)	SD(m/s)	
HSCAT-B N4	5.8%	0.11	1.15	-0.10	1.24	0.02	1.19	10.3°
HSCAT-C N4	6.2%	0.10	1.12	-0.14	1.26	0.02	1.23	10.6°
HSCAT-D N4	8.2%	0.12	1.12	-0.15	1.21	0.01	1.20	10.0°

模型参数拟合

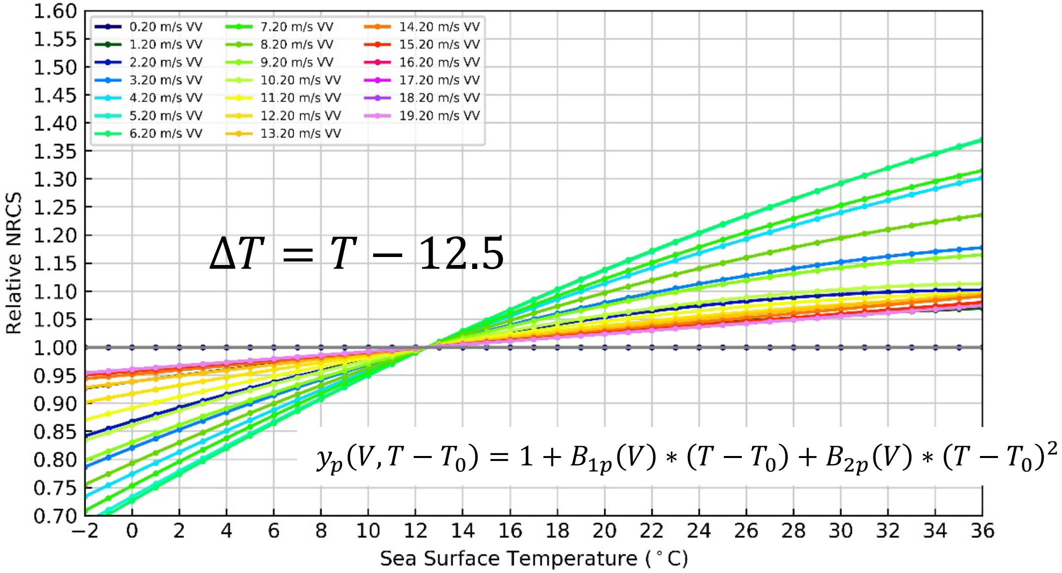
$$y = 1 + b * \Delta T + c * (\Delta T)^2$$

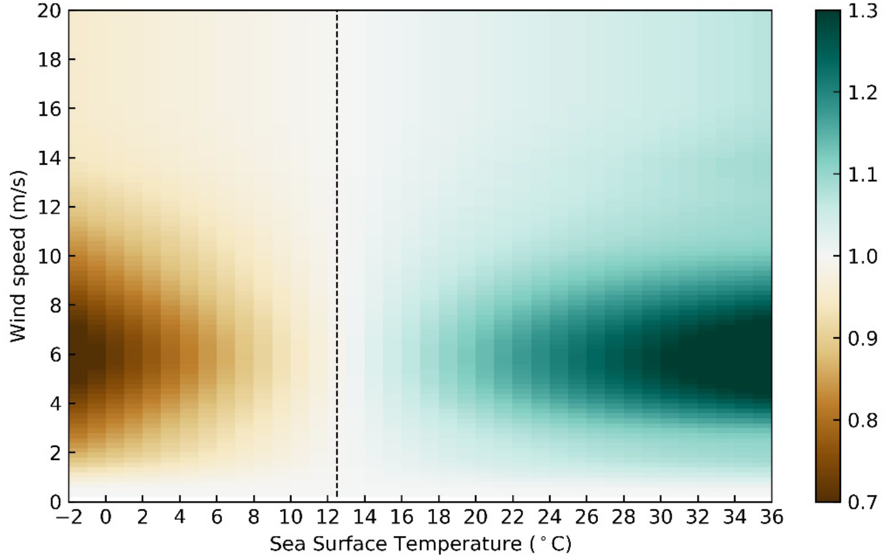






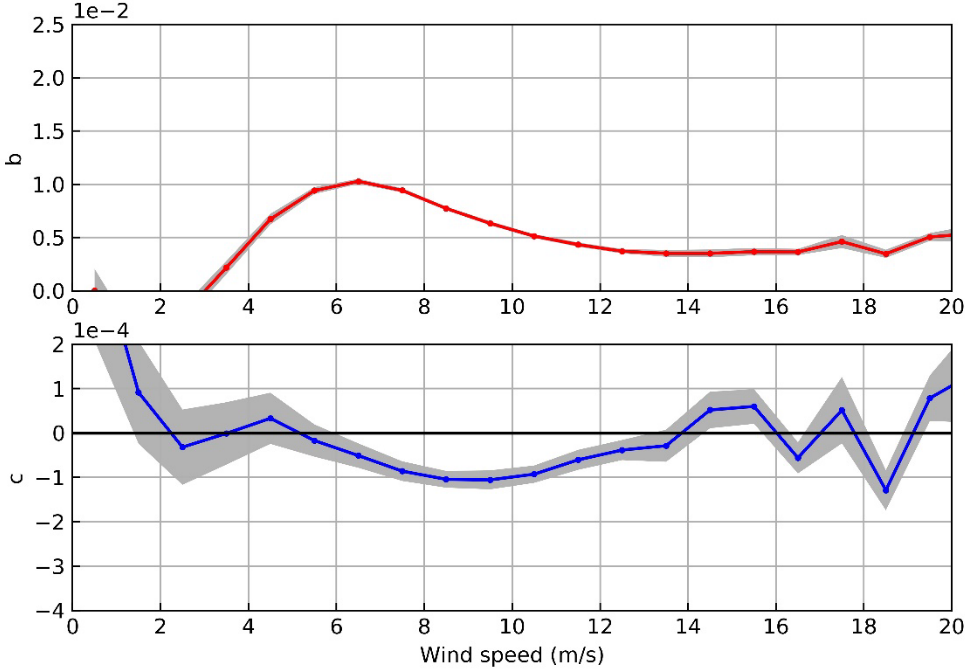
SST Corrections for VV

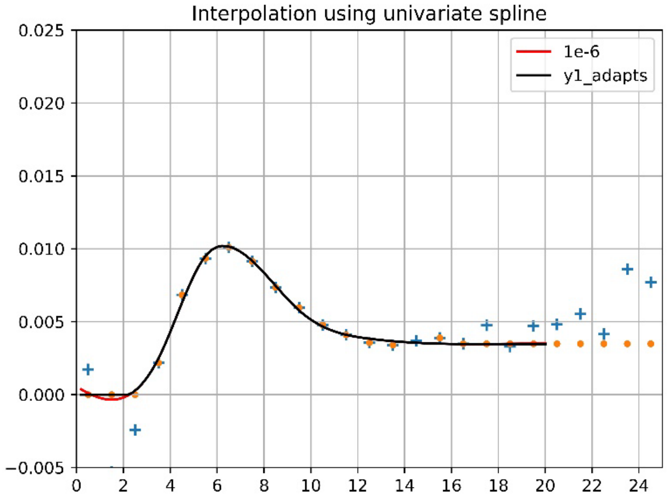




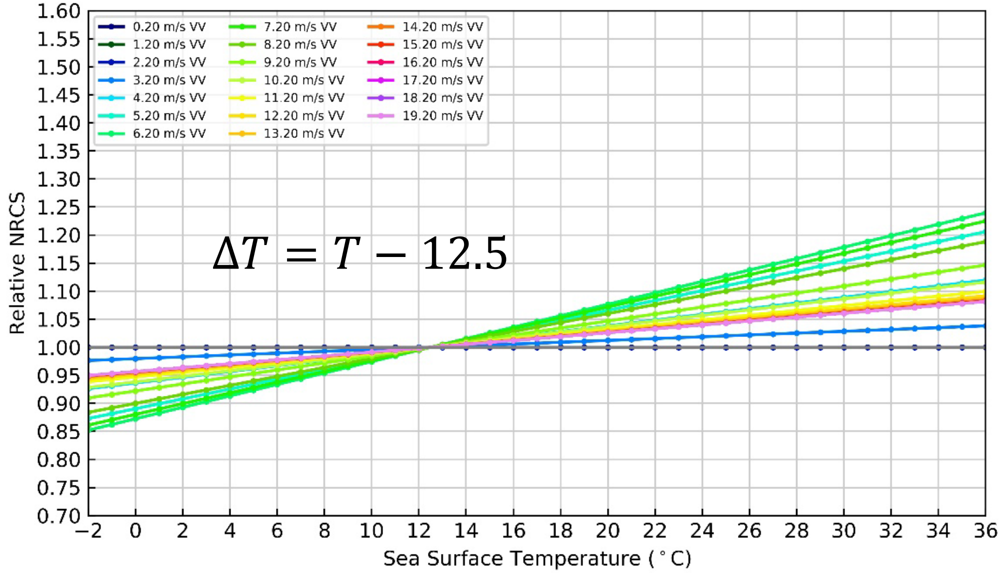
模型参数拟合

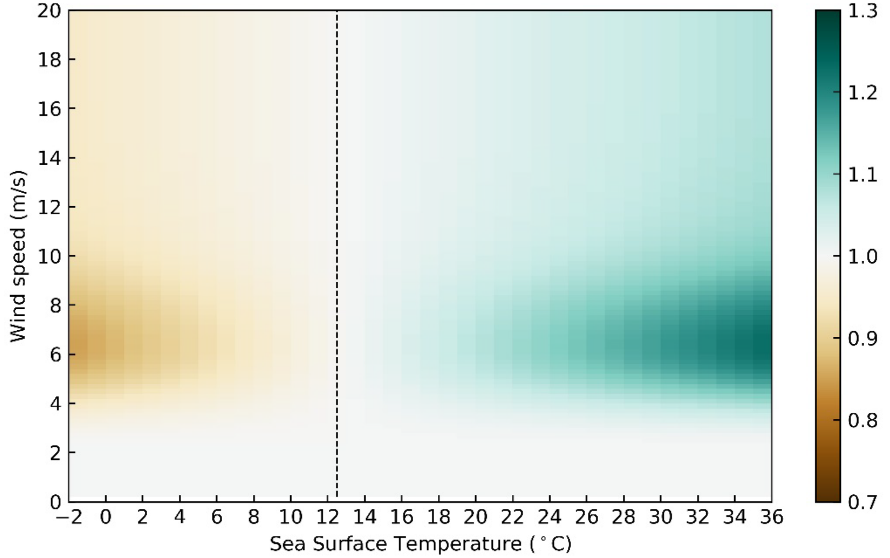
$$y = 1 + b * \Delta T + c * (\Delta T)^2$$



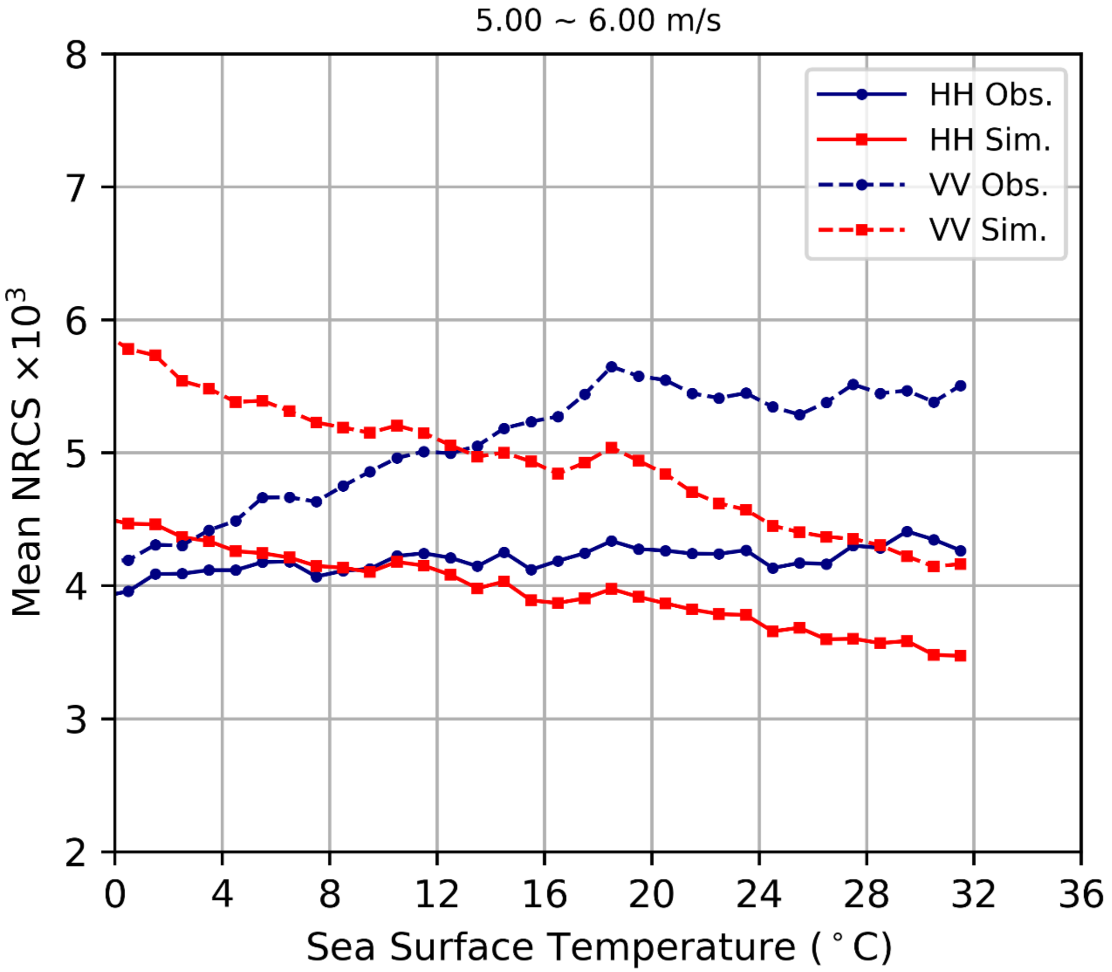


SST Corrections for HH





Derivation of SST Dependence:



$$\sigma^0_{p,\mathrm{Obs}}(V,T) = \sigma^0_p(V,T_0) * y_p(V,T - T_0) \qquad (2)$$

$$\sigma^0_{p,\mathrm{sim}}(V,T) = \sigma^0_p(V,T_0) * y_p(V,T_{\mathrm{N4}} - T_0) \qquad (3)$$

$$f_p(V,T) = \frac{\sigma^0_{p,\mathrm{obs}}(V,T)}{\sigma^0_{p,\mathrm{sim}}(V,T)} = \frac{\cancel{\sigma^0_p(V,T_0)} * y_p(V,T - T_0)}{\cancel{\sigma^0_p(V,T_0)} * y_p(V,T_{\mathrm{N4}} - T_0)} \qquad (4)$$

$$g_p(V,T) = \frac{f_p(V,T)}{f_p(V,T_0)} = \frac{y_p(V,T - T_0) * \cancel{y_p(V,T_{\mathrm{N4}} - T_0)}}{\cancel{y_p(V,T_{\mathrm{N4}} - T_0)} * \cancel{y_p(V,T_0 - T_0)}} \qquad (5)$$