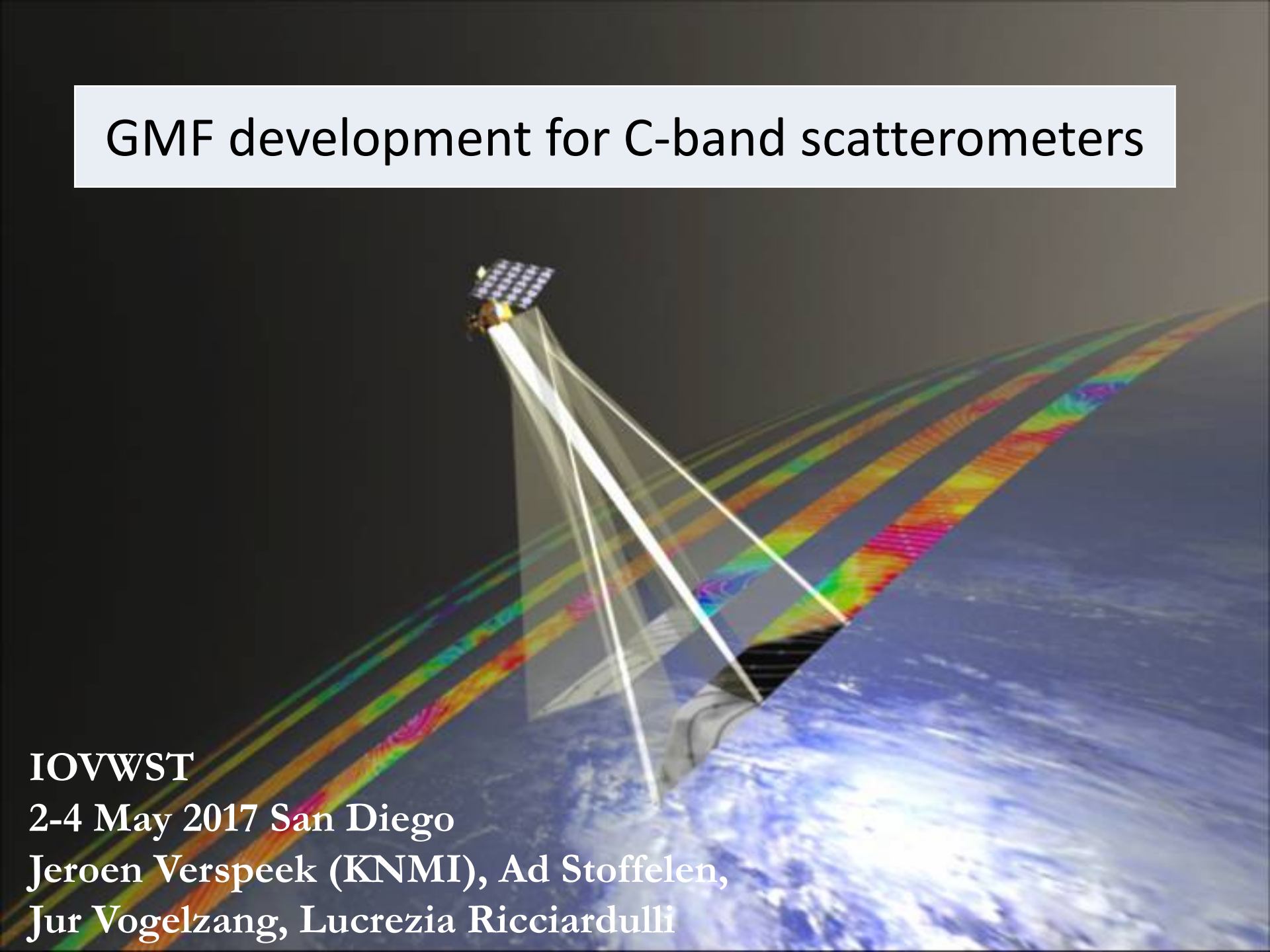
GMF development for C-band scatterometers



IOVWST
2-4 May 2017 San Diego
Jeroen Verspeek (KNMI), Ad Stoffelen,
Jur Vogelzang, Lucrezia Ricciardulli

Outline

- Introduction
- GMF and measurement space
- Development of CMOD7
- Effect on the wind product
- Conclusions

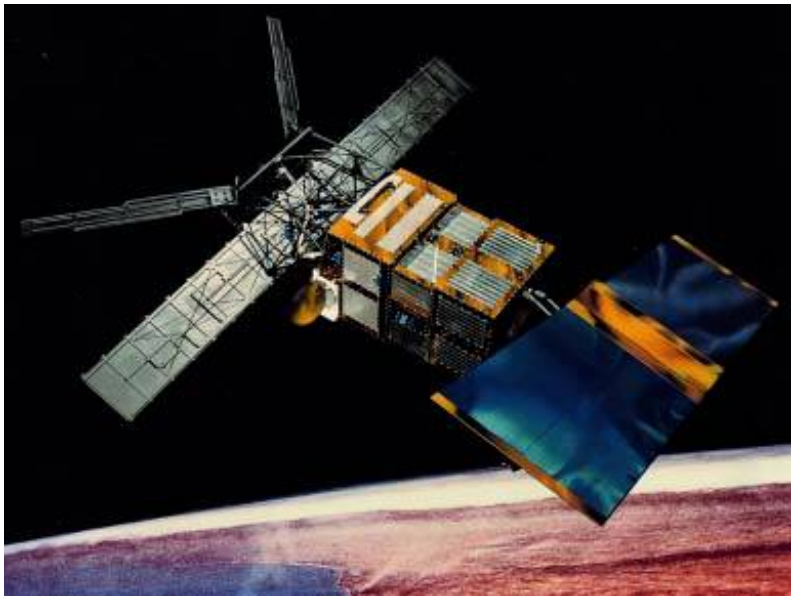
Introduction

- Aim to develop a C-band GMF that can be used for the intercalibration of ERS and ASCAT scatterometers
- Can be used to produce consistent climate data records
- CMOD7 has been developed in several steps as a successor of CMOD5.n
- Developed and validated with stress-equivalent winds rather than real or neutral winds
- Scatterometer wind speed pdfs are made independent of swath position/incidence angle

Introduction ERS/ASCAT scatterometers

- ERA/ASCAT are active radar instruments
- Fixed fan beam, C-band (5 cm), VV-pol
- Fixed geometry, 3 antennas per side
- Polar sun-synchronous orbit

ERS-1/2



ASCAT-A/B/C

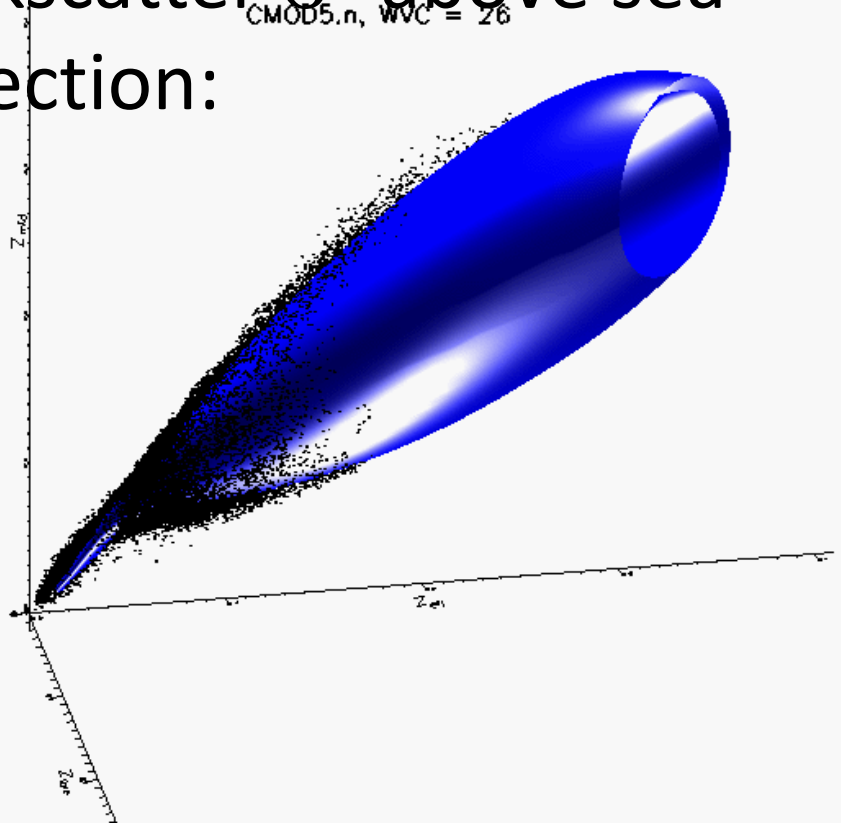
GMF and measurement space

- The Geophysical Model Function (GMF) gives the relation between backscatter σ^0 above sea and wind speed/wind direction:

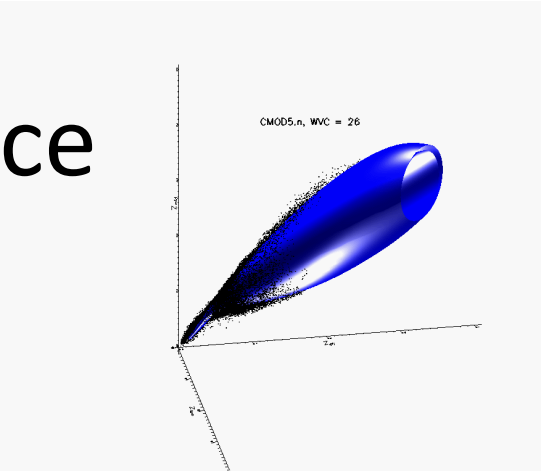
  $\sigma^0 = GMF(V, \theta, \phi)$

- Visualisation in 3D-measurement space

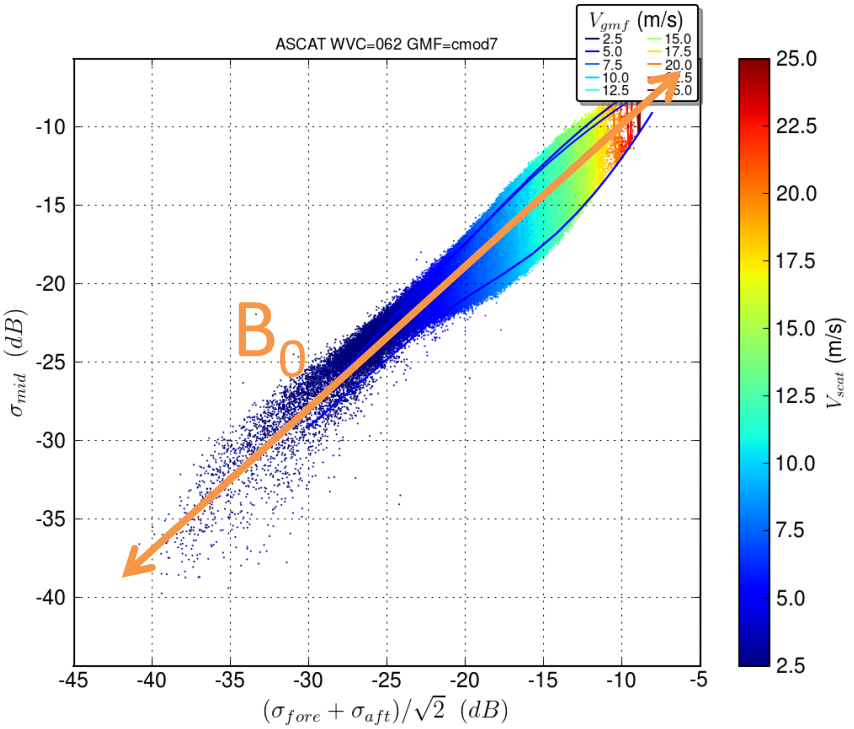
$(x, y, z)=(\sigma^0_{fore}, \sigma^0_{aft}, \sigma^0_{mid})$

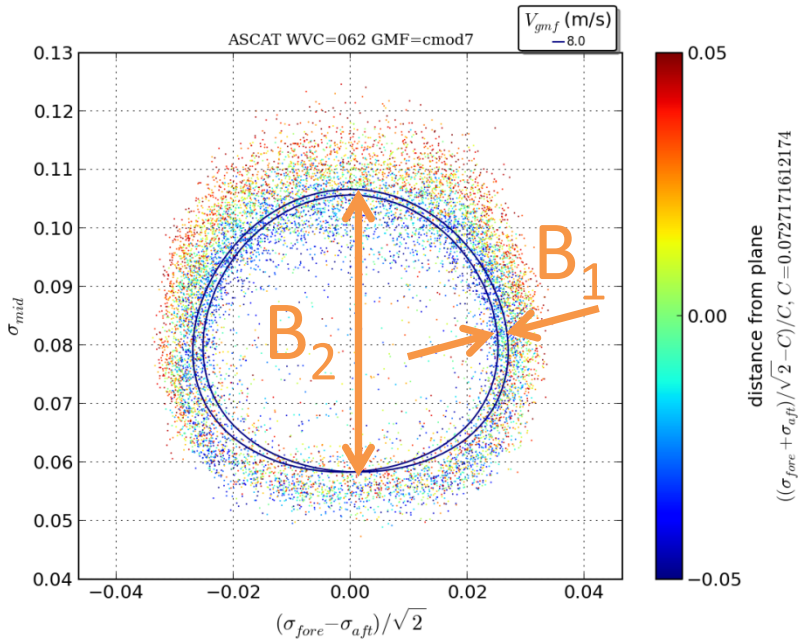


GMF and measurement space



$$\sigma^0 = B_0(V,\theta)[1 + B_1(V,\theta)\cos\varphi + B_2(V,\theta)\cos 2\varphi]^{1.6}$$





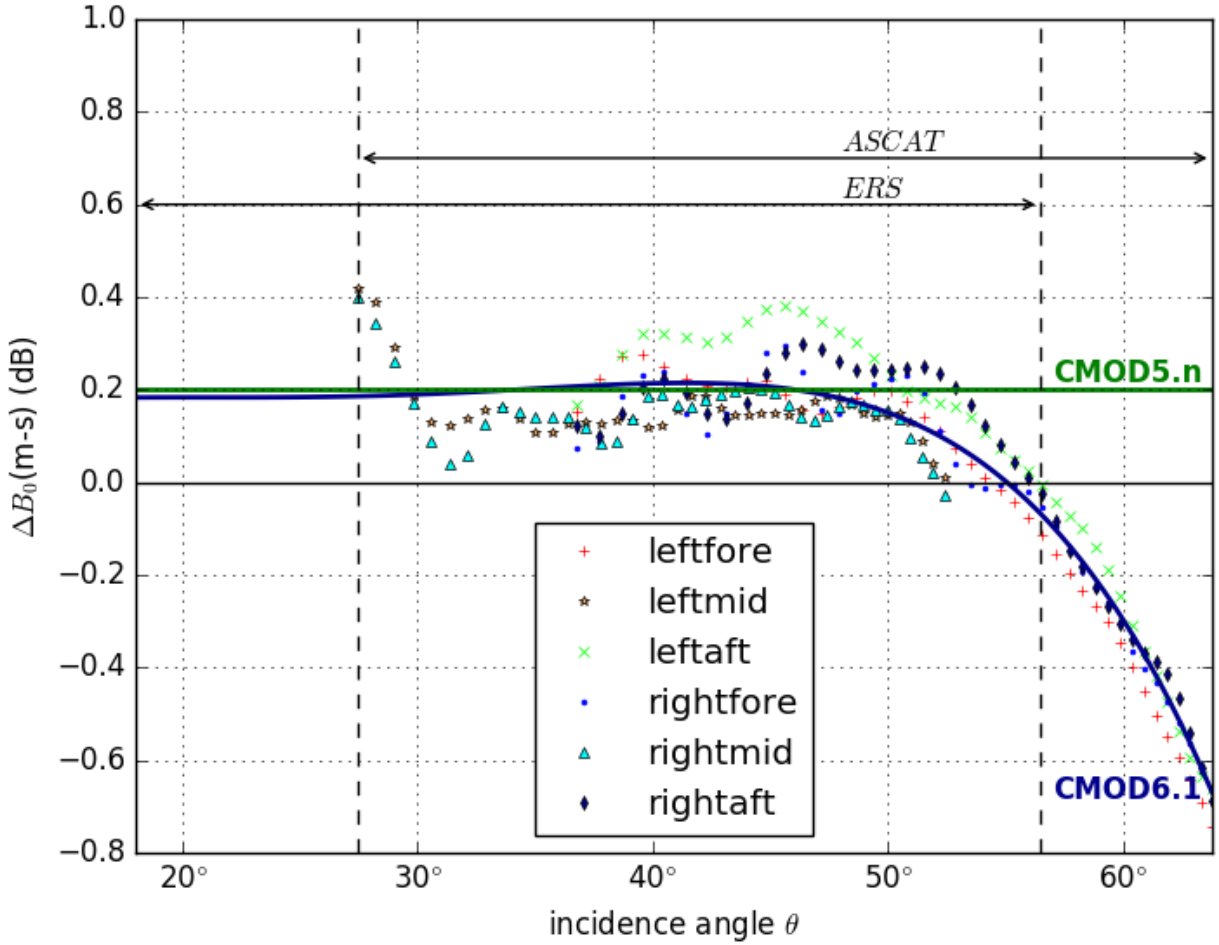
CMOD7 development

CMOD7 has been developed in several steps as a successor of CMOD5.n

- Extend incidence angle range to ERS/ASCAT
- Remove low wind speed artefacts
- Make wind pdfs WVC independent

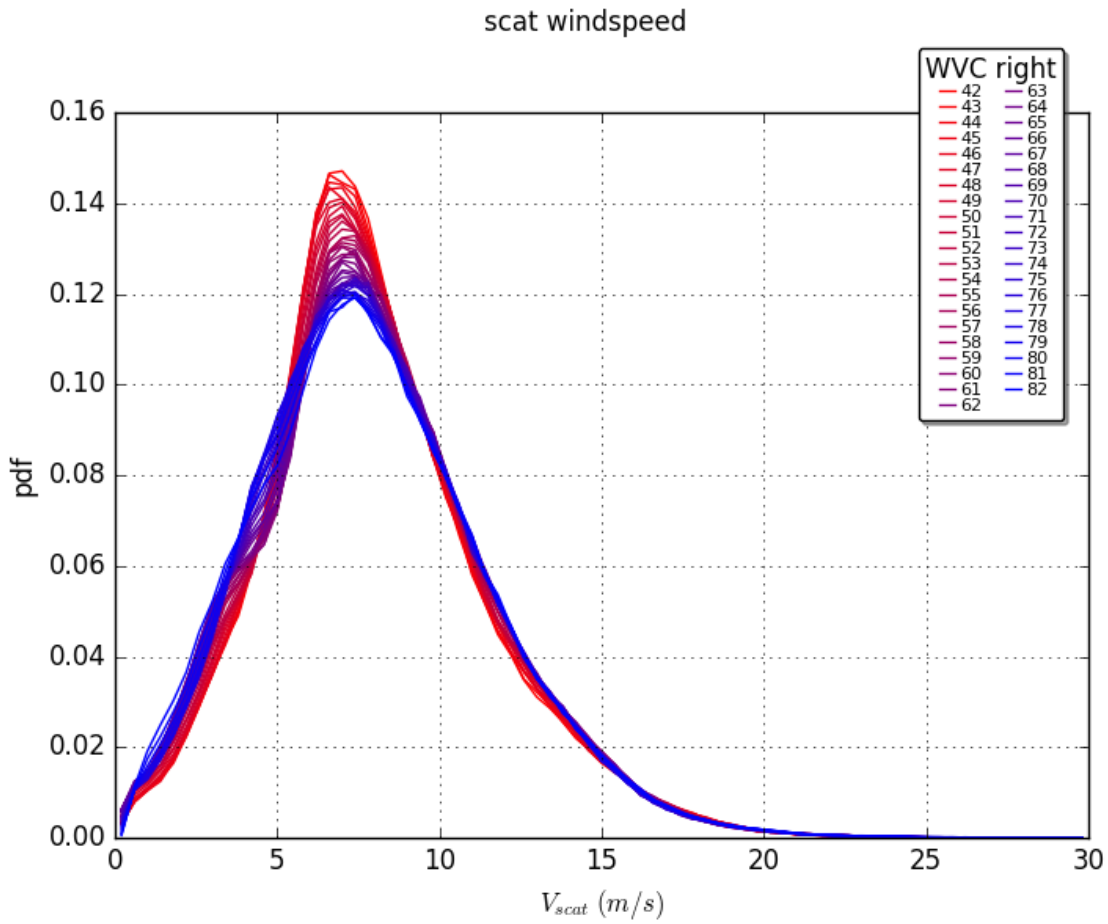
Accomodate ERS/ASCAT incidence angles

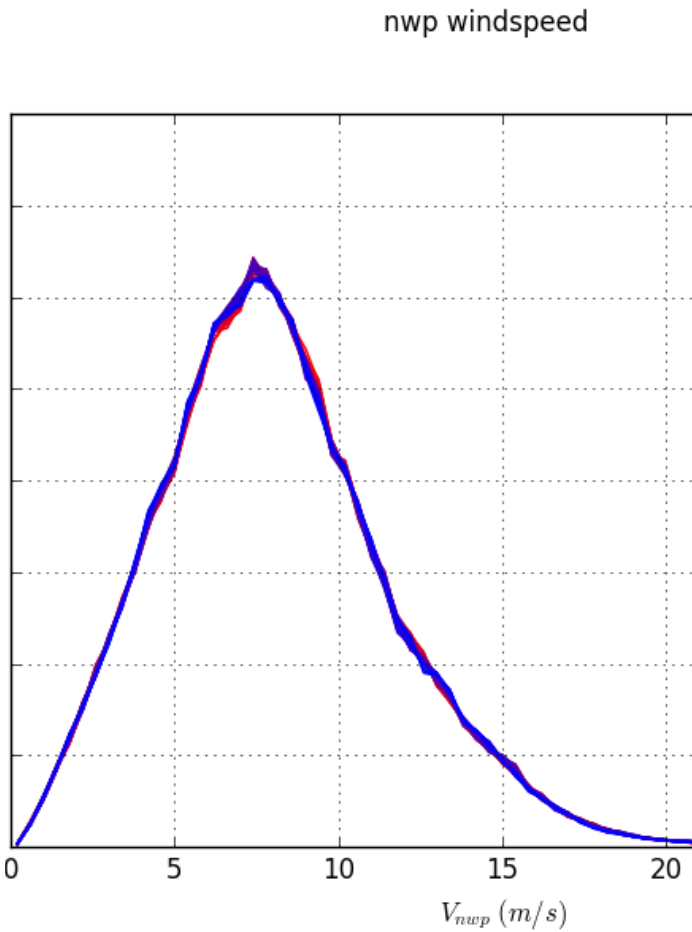
- CMOD5.n based on ERS data only
- ASCAT CMOD5.n NOC residual interpolation -> CMOD6.1
- CMOD6.1 also accomodates the lower ERS incidence angles



wind speed pdf

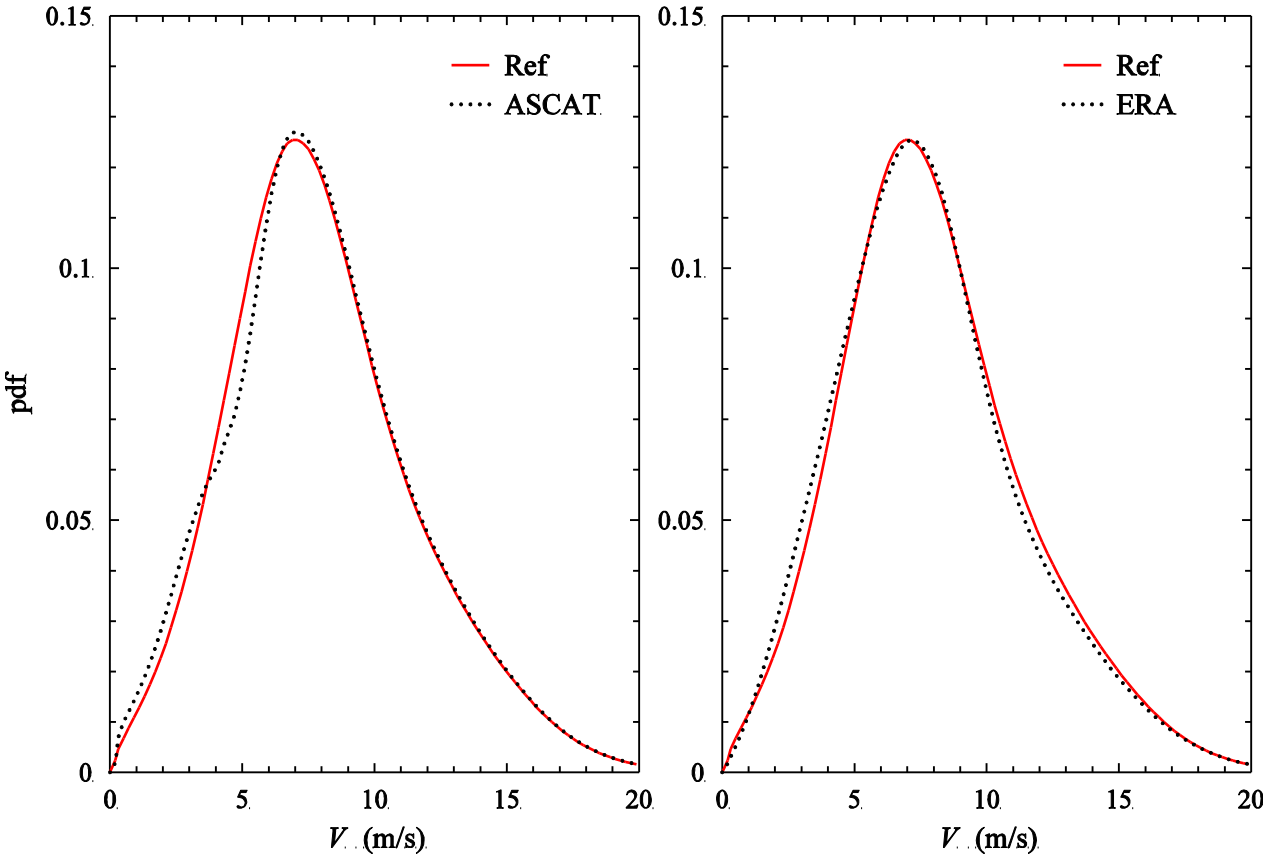
- Scatterometer wind pdf is clearly not WVC independent
- This is largely due to GMF deficiency





wind speed pdf matching

Scatterometer wind speed pdfs are matched to a reference pdf



Reference pdf

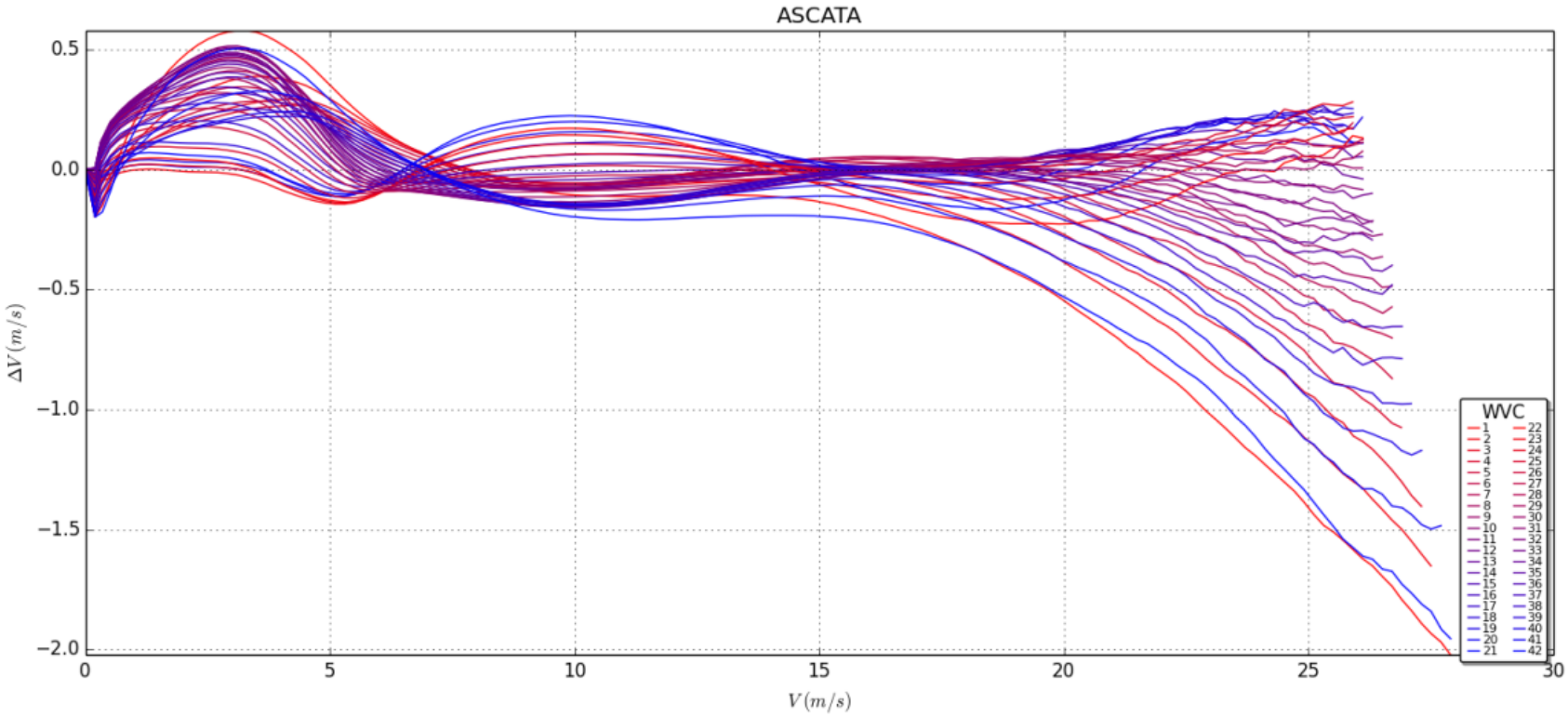
Ascending part : 4th order polynomial

Descending part: average of ASCAT WVC 22-35 (overlapping ERS)

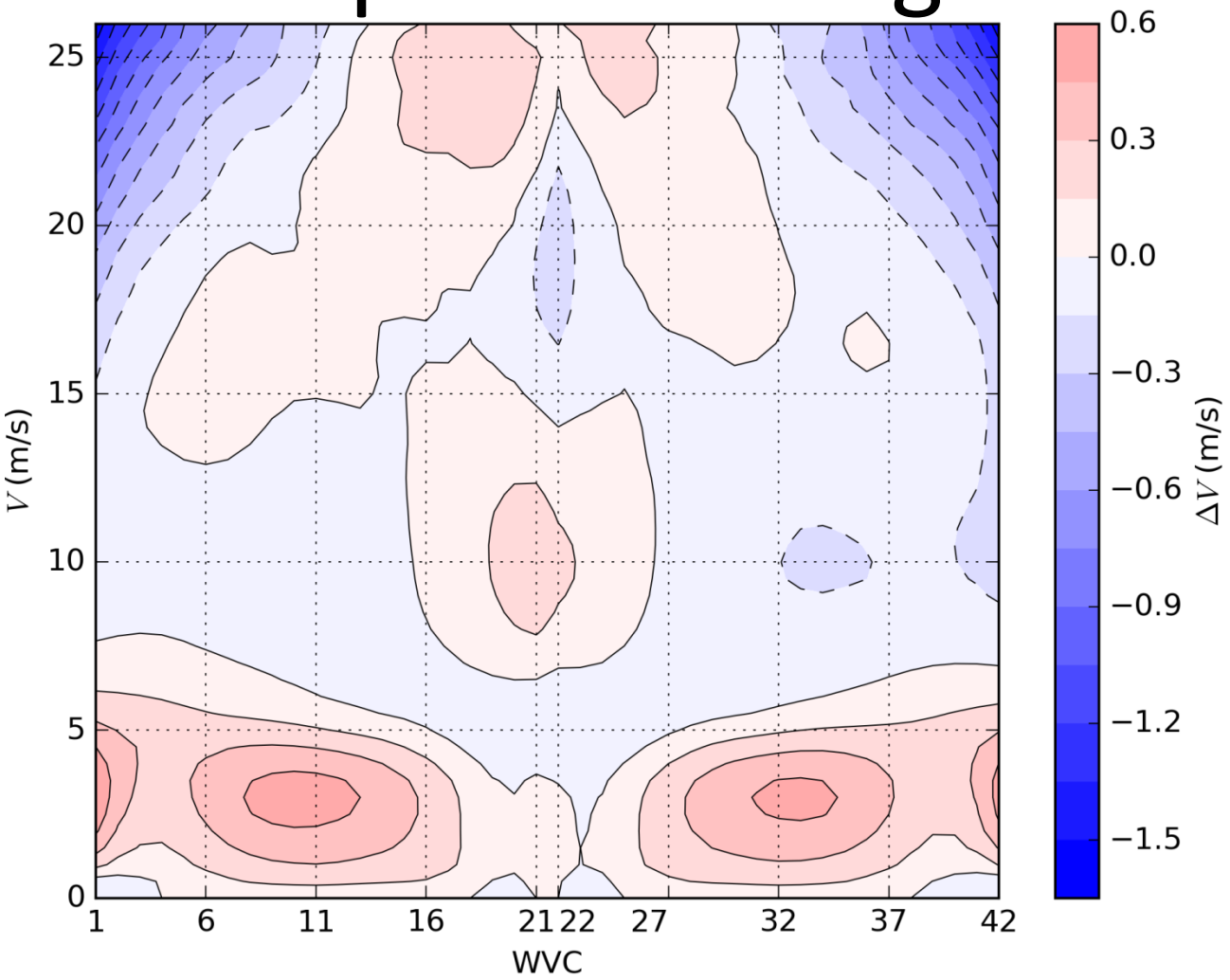
The two parts are coupled at the top, cdfs are also matched

HOC corrections for ASCAT

- Calculate difference between scatterometer pdf and reference pdf as a function of wind speed and WVC
- Seven years of ASCAT-A data used

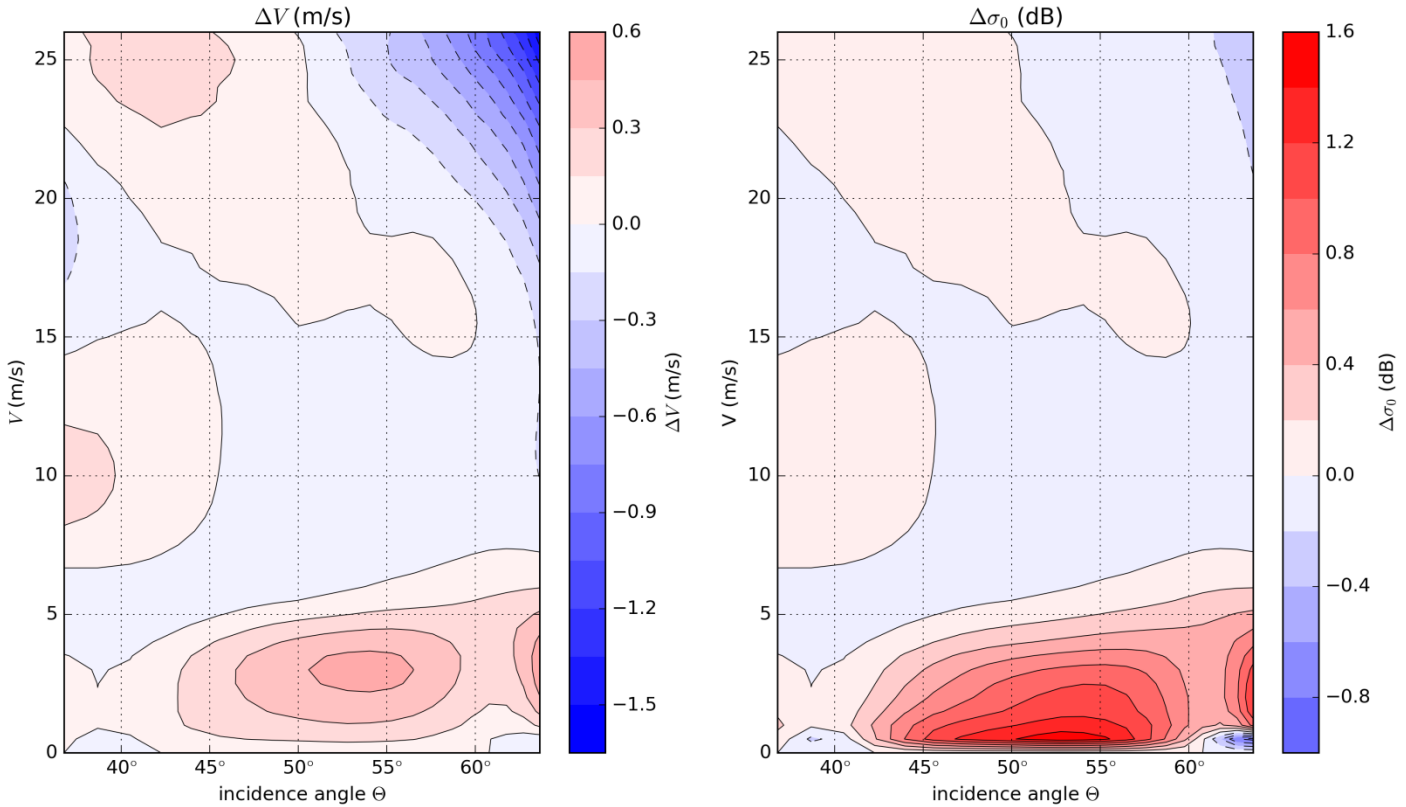


pdf matching



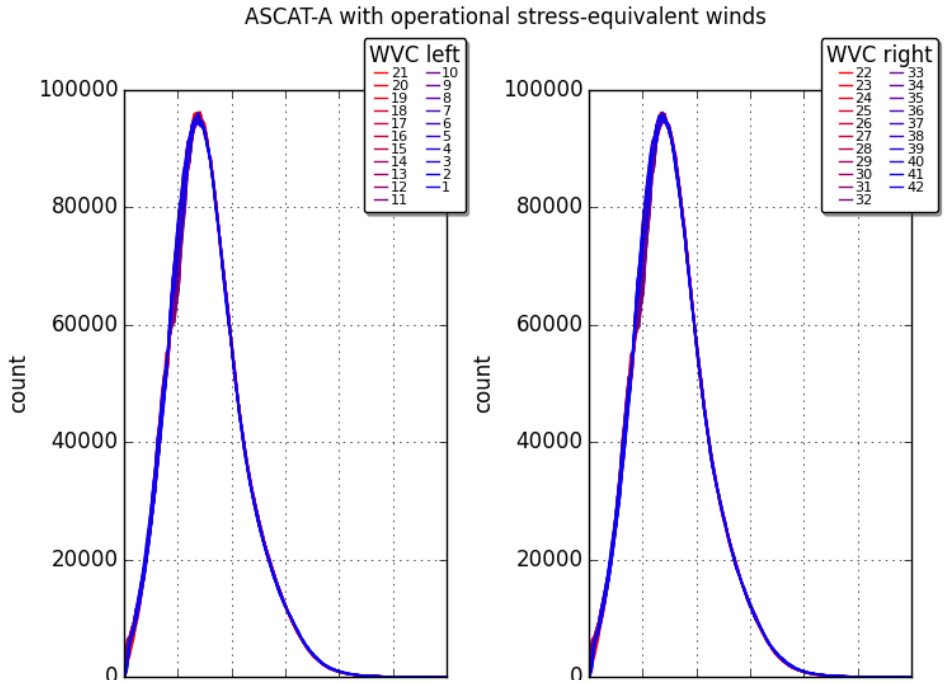
- HOC corrections are averaged over corresponding left and right swath WVC
- WVC is translated to fore/aft incidence angle Θ

pdf matching



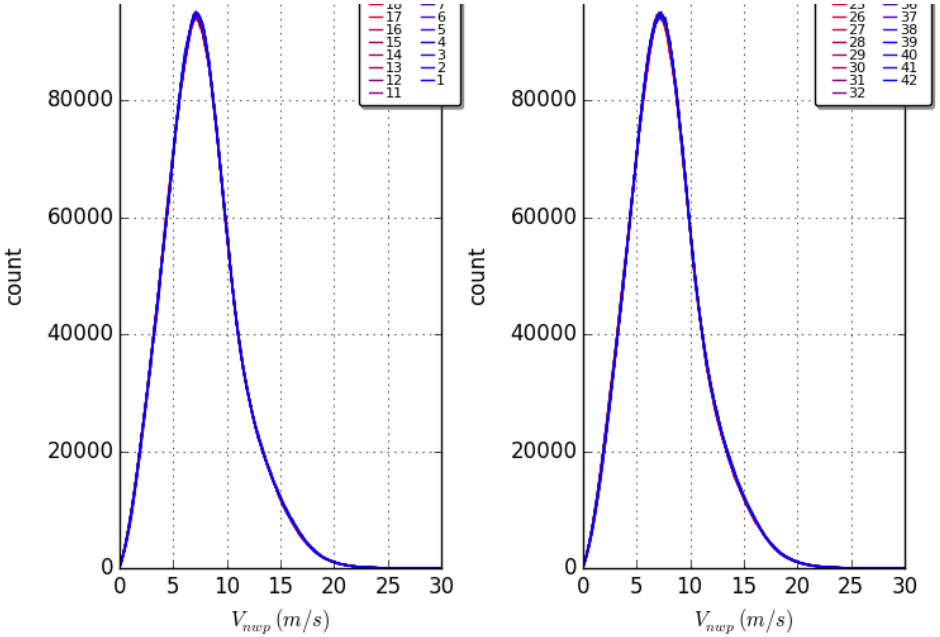
- ΔV is translated into Δσ for every (V, Θ, ϕ) with the GMF
- The Δσ ‘s are incorporated into the GMF
- This leads to a new, corrected GMF
- The procedure is performed for ASCAT and ERS subsequently
- The corrected GMF is WVC independent?

ASCAT-A

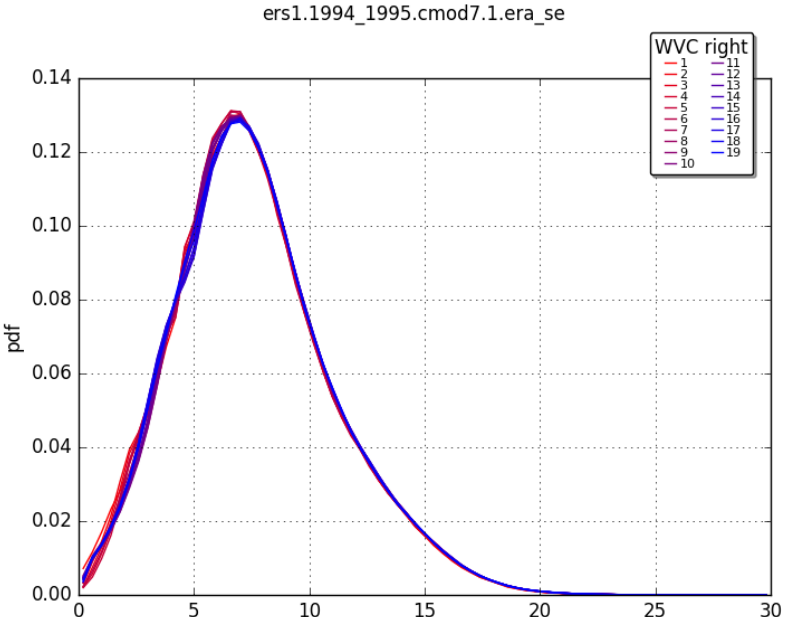


ASCAT wind speed pdfs independent of WVC

ECMWF

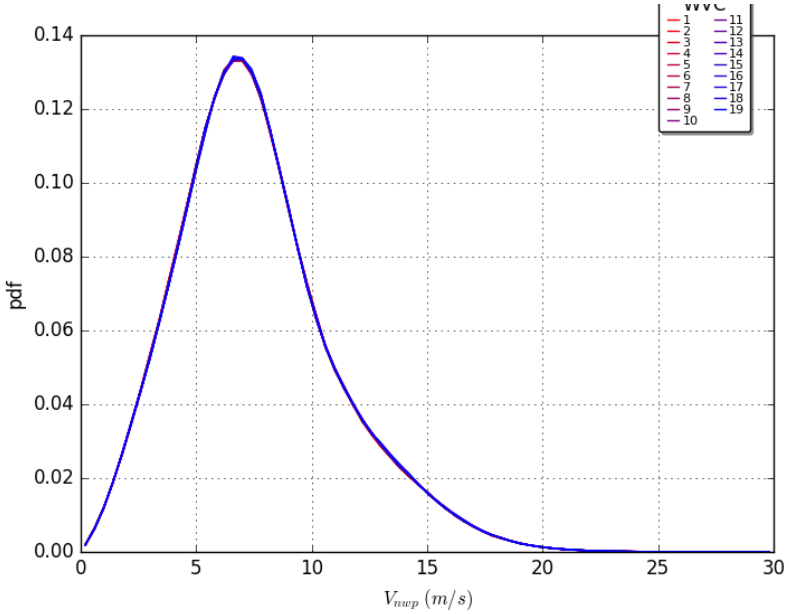


ERS-1

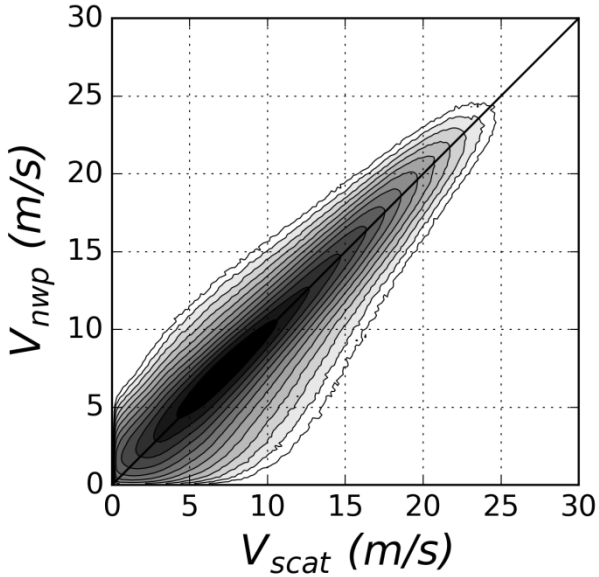


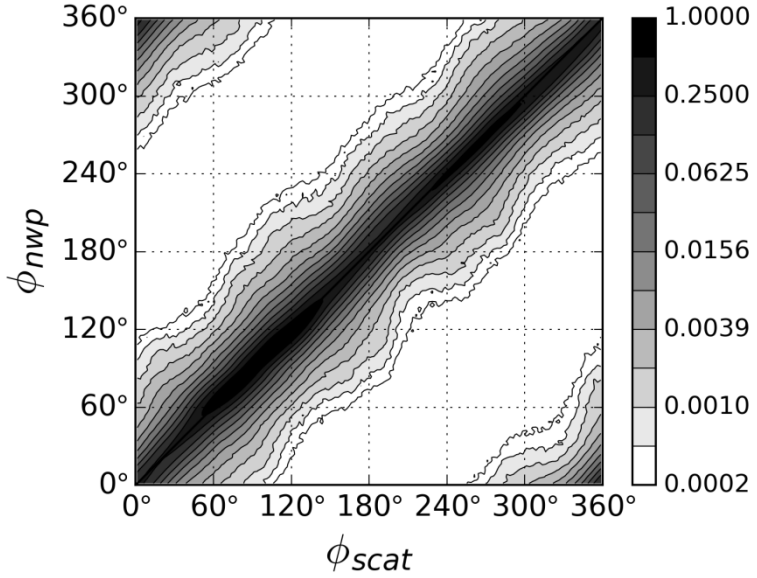
ERS wind speed pdfs independent of WVC

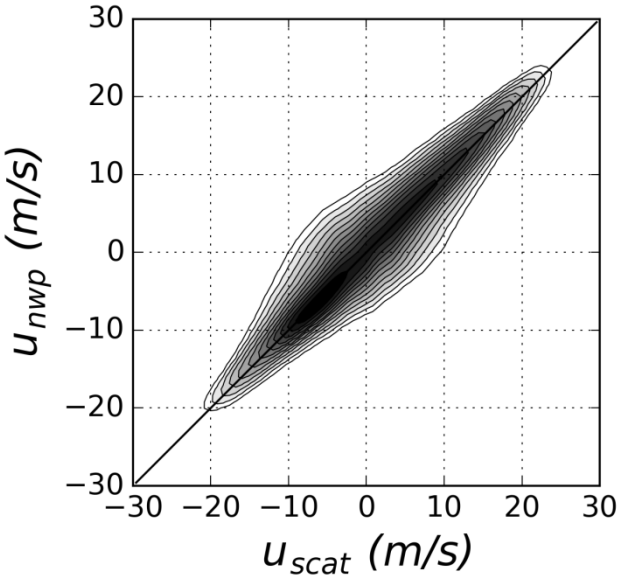
ECMWF

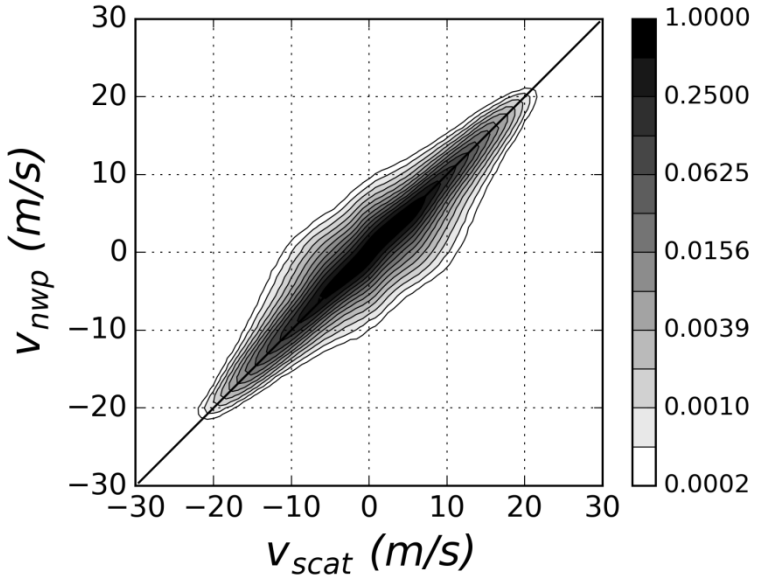


CMOD7 wind product results

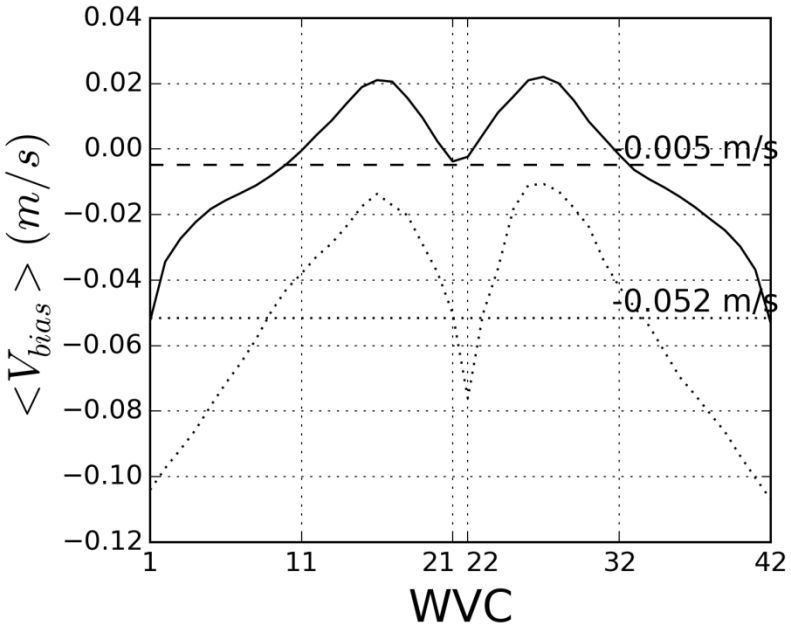


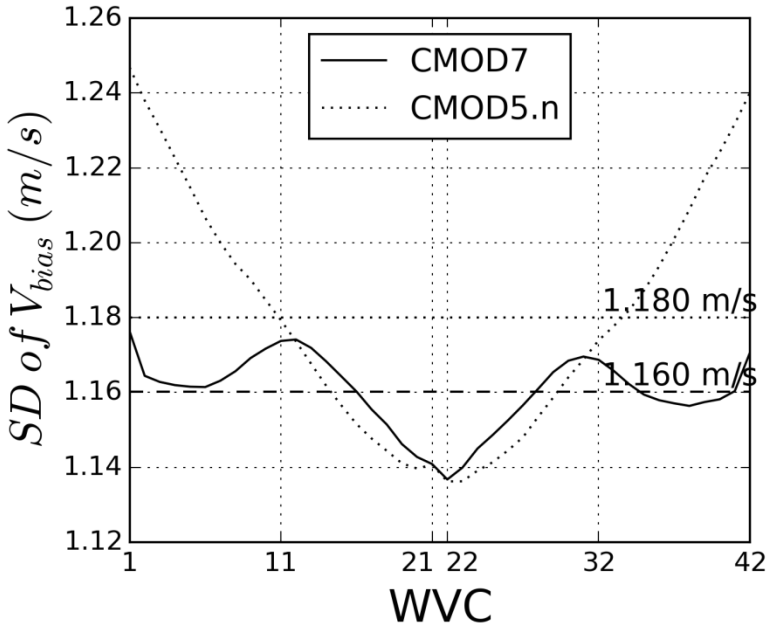


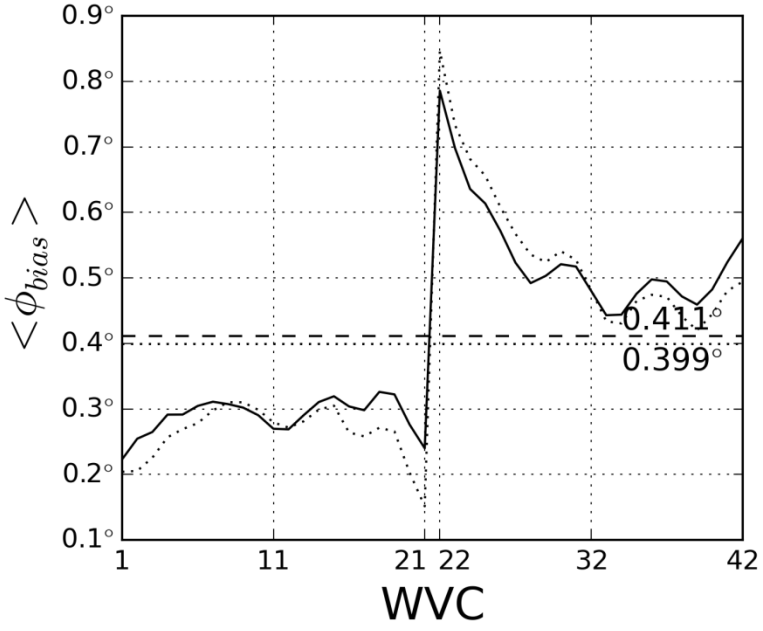


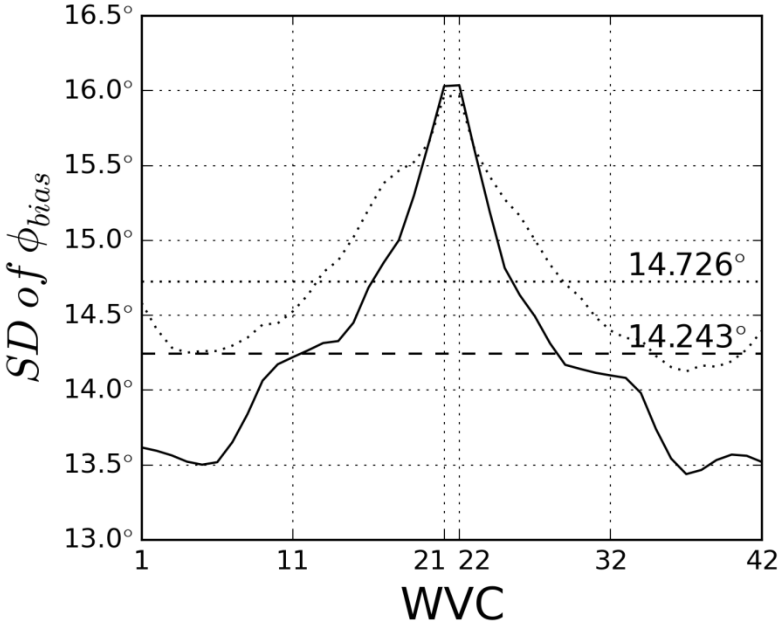


ASCAT-A with operational NWP stress-equivalent winds



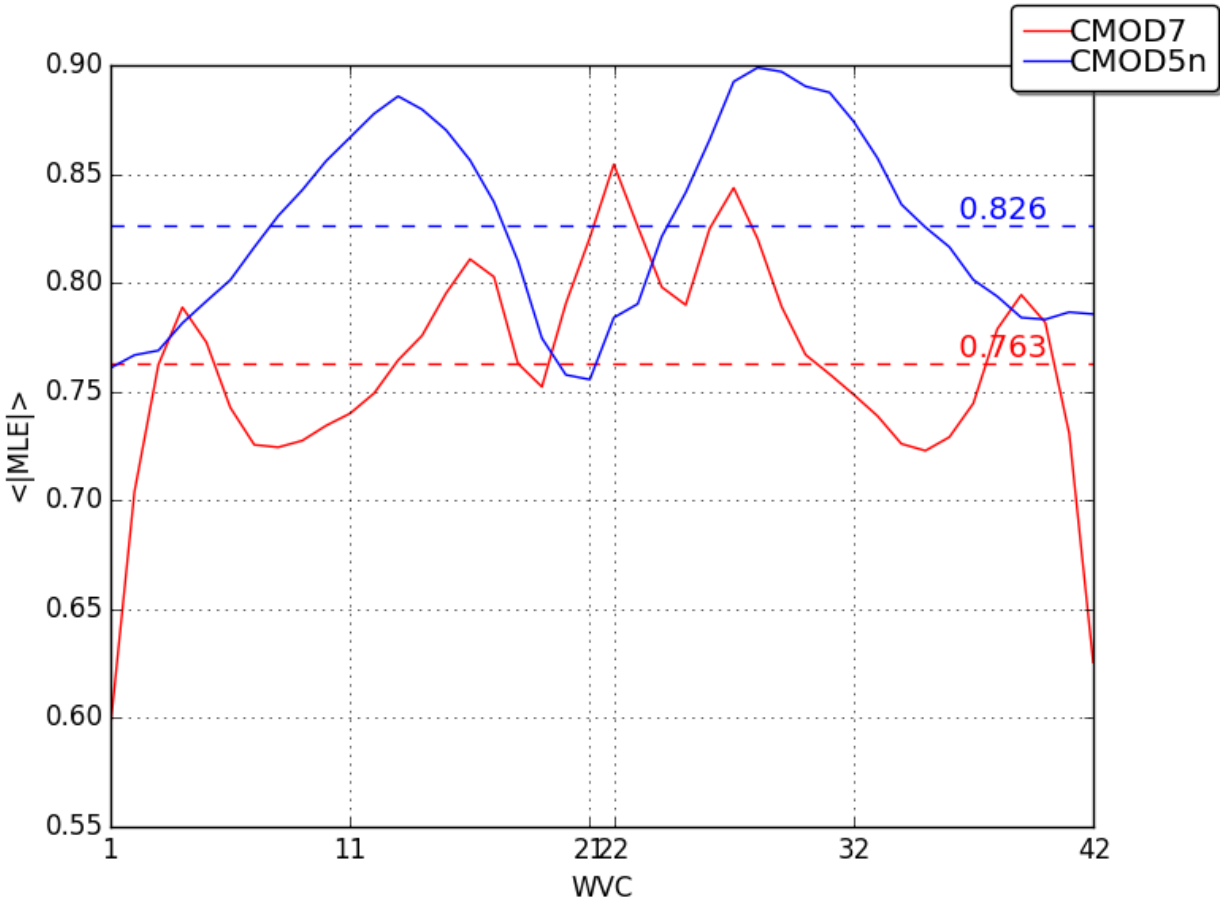




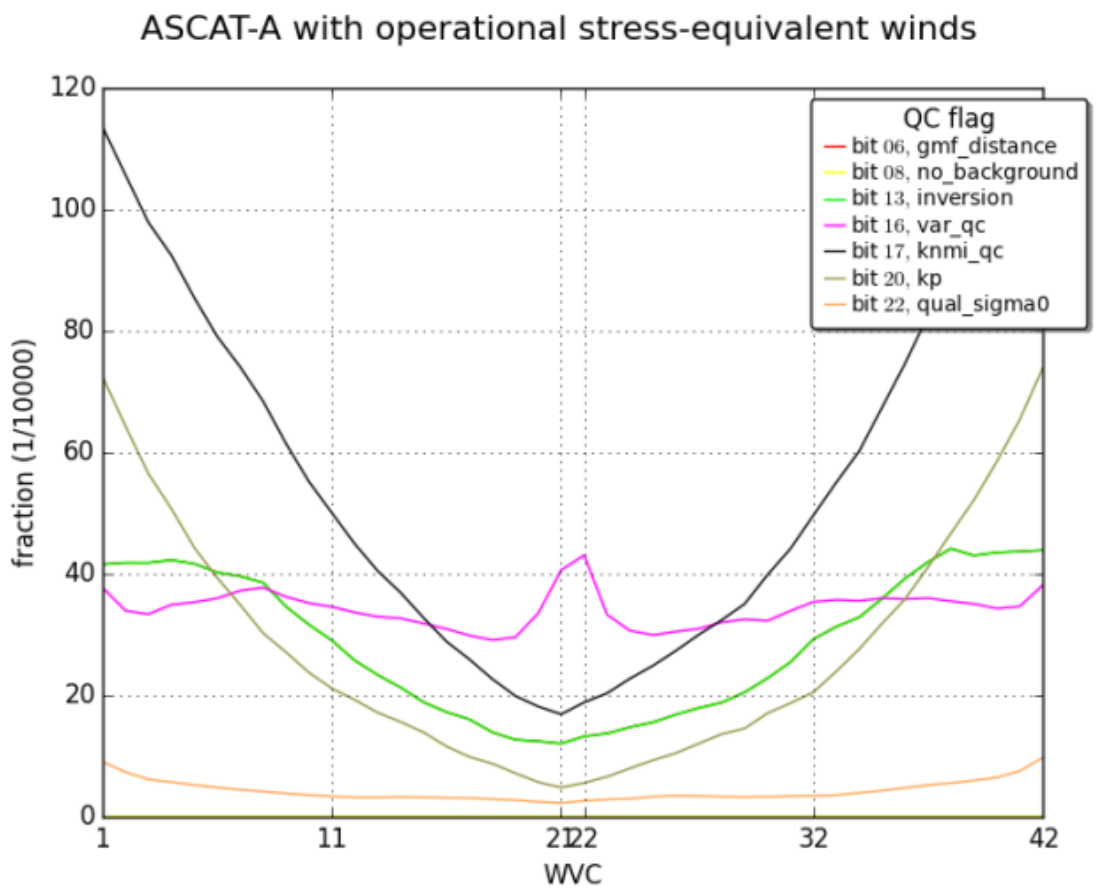


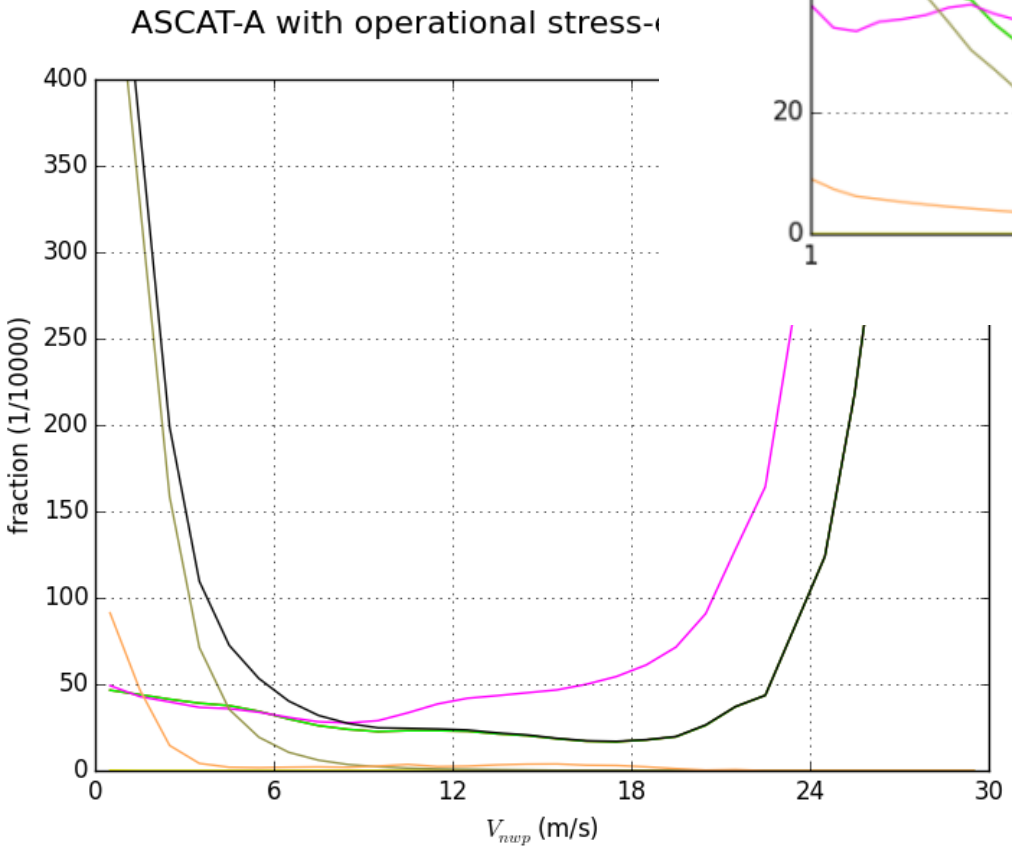
Distance to GMF cone (MLE)

- MLE is the distance of a measurement to the GMF cone surface
- It is an indication of how well the GMF fits the measurement

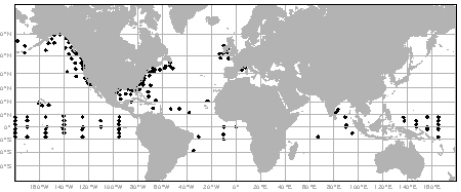


QC rejections





Triple collocation



of buoy, scatterometer and NWP model wind

				Buoys		*Scatterometer*		*ECMWF*	
Scatterometer	Grid (km)	GMF	Background	σ_u (m/s)	σ_v (m/s)	σ_u (m/s)	σ_v (m/s)	σ_u (m/s)	σ_v (m/s)
ASCAT-A	25.0	CMOD5n	operational	1.17	1.26	0.54	0.71	1.30	1.36
ASCAT-A	25.0	CMOD7	operational	1.15	1.25	0.49	0.60	1.32	1.37
ASCAT-B	25.0	CMOD5n	operational	1.17	1.24	0.49	0.67	1.29	1.35
ASCAT-B	25.0	CMOD7	operational	1.15	1.22	0.43	0.54	1.30	1.36
ASCAT-A	12.5	CMOD7	operational	1.08	1.16	0.61	0.75	1.40	1.45
ASCAT-B	12.5	CMOD7	operational	1.10	1.14	0.56	0.73	1.40	1.45
ASCAT-A	25.0	CMOD7	ERA-interim	1.14	1.23	0.44	0.56	1.53	1.59
ERS-1	25.0	CMOD5n	ERA-interim	1.38	1.42	0.68	0.94	1.38	1.51
ERS-1	25.0	CMOD7	ERA-interim	1.36	1.32	0.62	0.88	1.39	1.51

Conclusions

- CMOD7 is an important step for ERS and ASCAT scatterometer intercalibration
- It is useful to generate climate data records
- Higher order corrections are successfully used to make the wind pdfs independent of WVC
- CMOD7 wind statistics show overall good results, and are in many respects an improvement over CMOD5n
- Improvements are for both ASCAT and ERS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谢谢
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σας ευχαριστώ
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감사합니다
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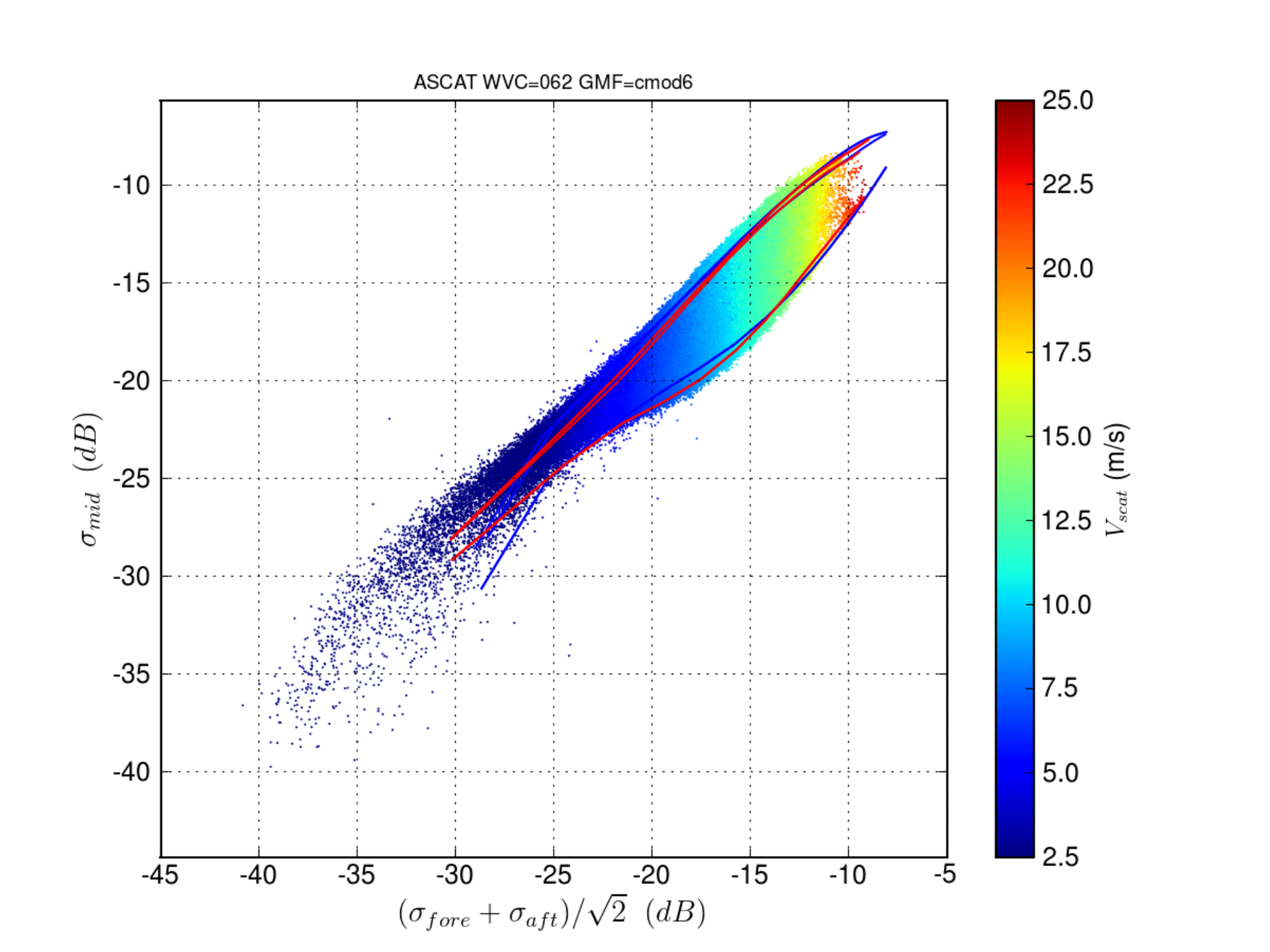
তোমাকে ধন্যবাদ


ASCAT WVC=062 GMF=cmod6
-10
-15
-20
-25
-30
-35
-40
σ_{mid} (dB)
-45
-40
-35
-30
-25
-20
-15
-10
-5
$(\sigma_{fore} + \sigma_{aft})/\sqrt{2}$ (dB)
25.0
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
V_{scat} (m/s)

Cone cross-sections (CMOD6-C2013)