

Towards Homogenization of Scatterometer Wind Retrievals

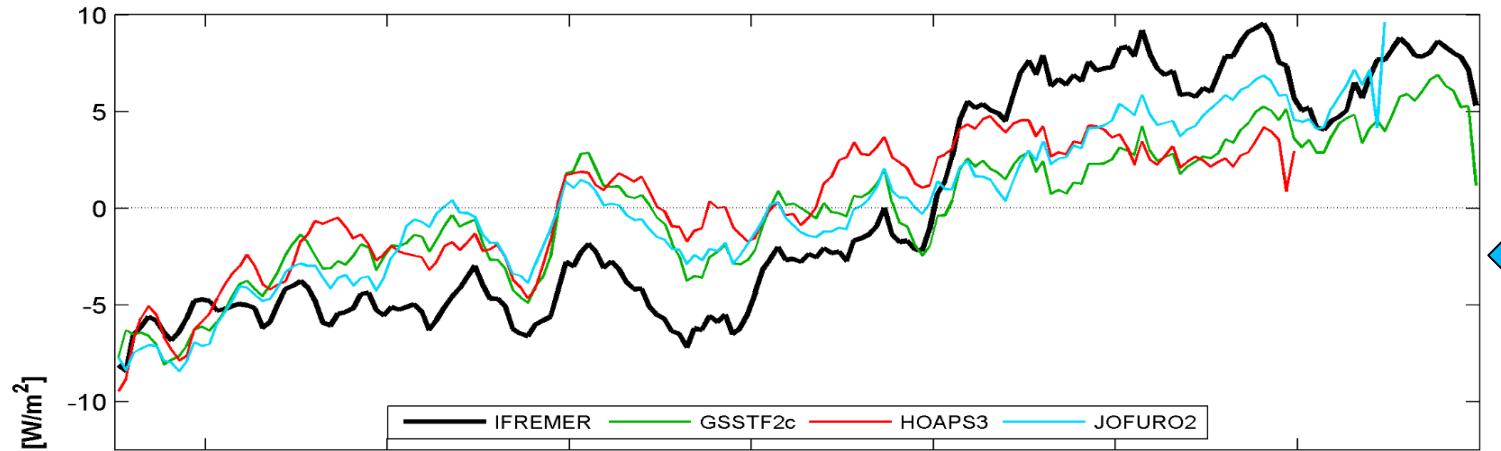
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Objective:

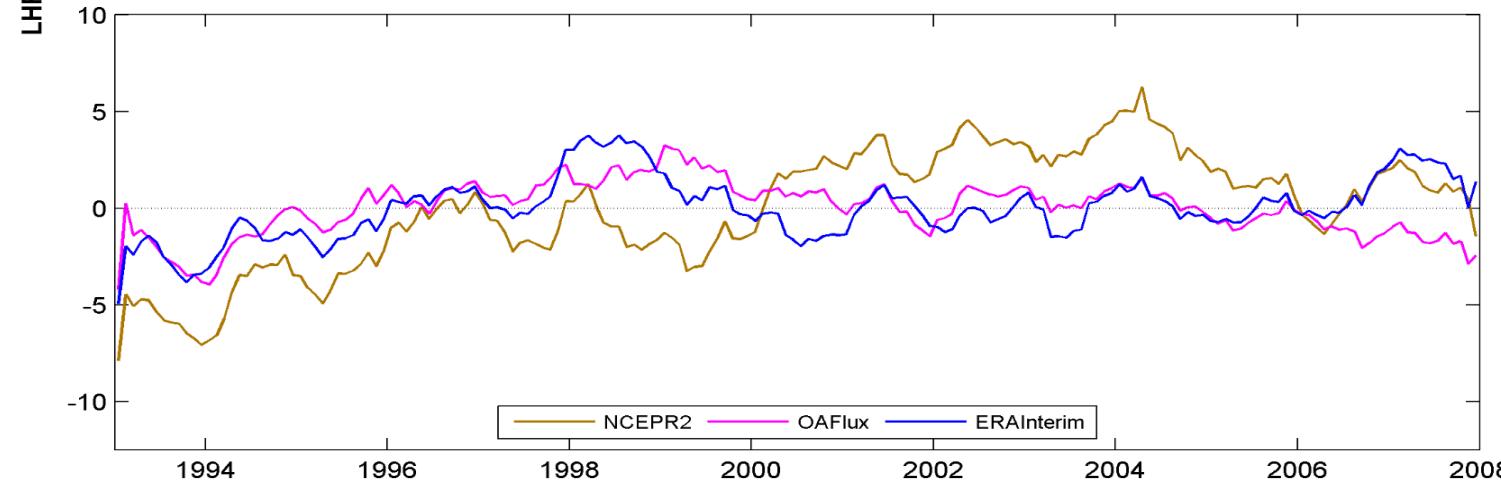
- Determination of long time series (20 years) of surface wind fields from scatterometer retrievals
- Assessment of Consistency based on empirical corrections
- No absolute calibration

Motivation

LHF Anomaly (*Mestas et al, 2014*)

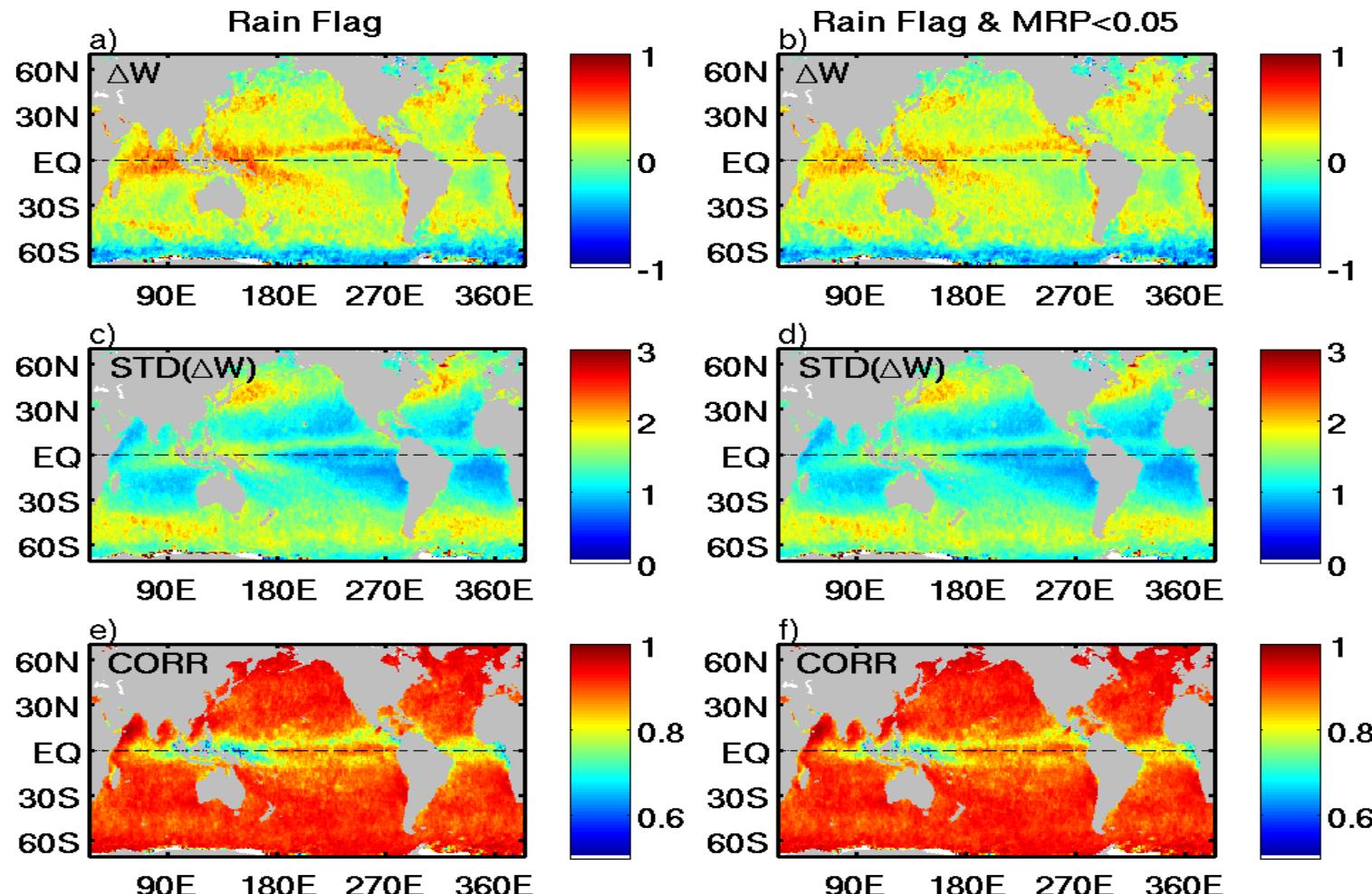


Wind
Consistency
Issue



ASCAT and QuikSCAT Issues

- Bias (top), STD (middle), and Correlation (bottom) of QuikScat-ASCAT wind speed difference.

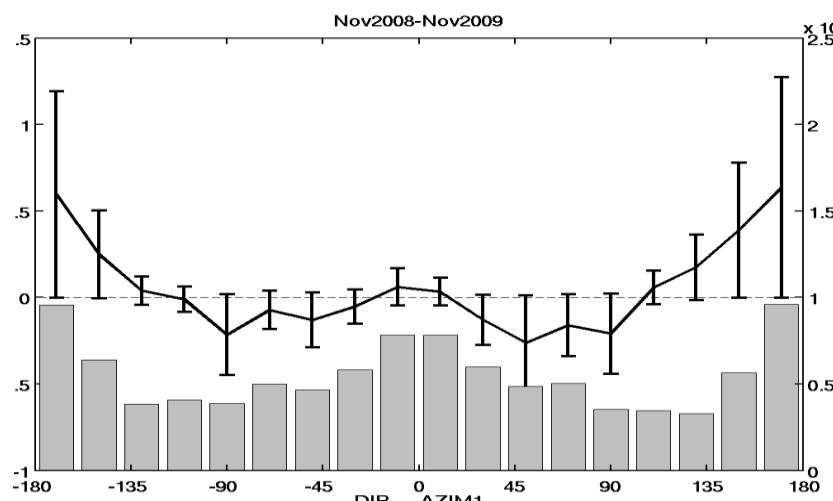


Analysis of ASCAT and QSCAT Differences

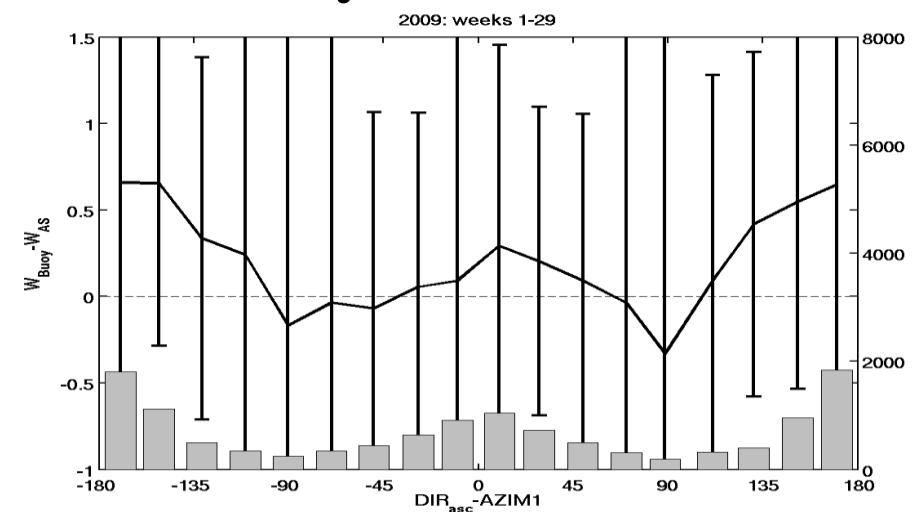
Wind Speed Difference as a function of Wind direction relative to ASCAT mid-beam azimuth (AZIM1)

Wind Difference

QSCAT – ASCAT



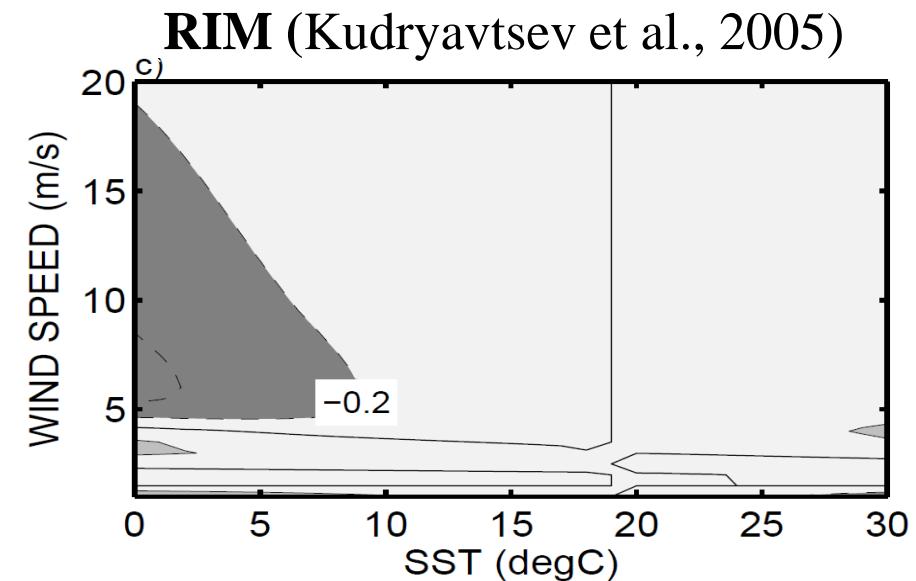
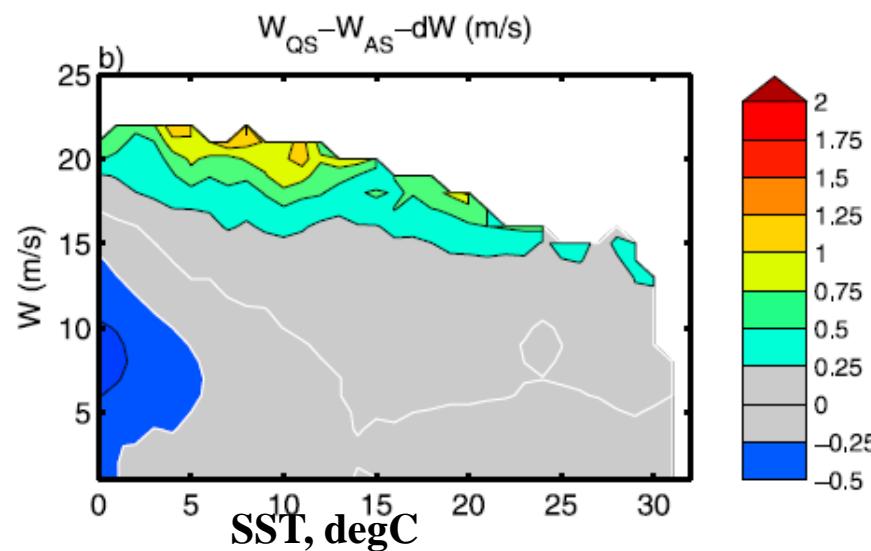
Buoy – ASCAT



Empirical correction (Bentamy et al, 2012)

Analysis of ASCAT and QSCAT Differences

Wind Speed Difference as a function of Sea Surface Temperature



SST-dependent W difference between Ku- and C-band, evaluated using a Radar Imaging Model, is stronger over cold SST<5C and at moderate winds 5m/s<W<10m/s.



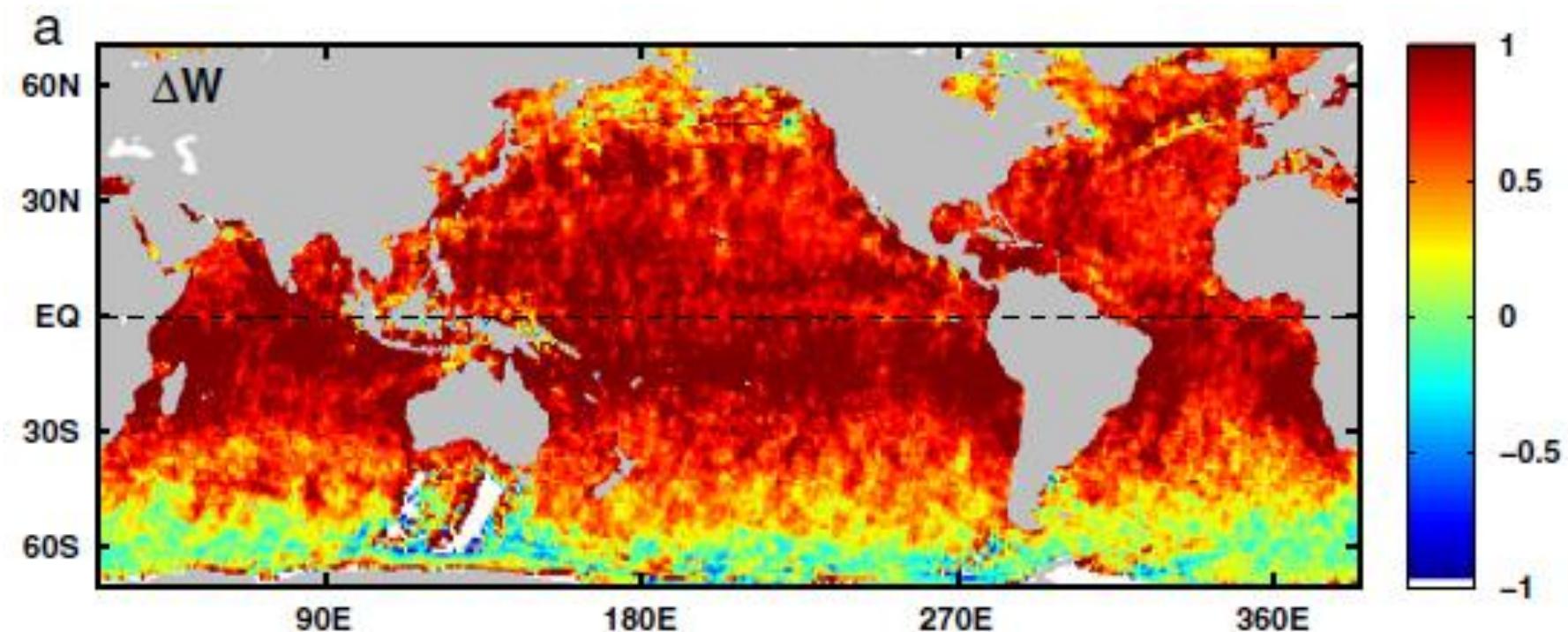
Empirical correction (Grodskey *et al*, 2012)

ERS-2 and QuikSCAT Issues

(Bentamy et al, 2013)

ECT: QS - 6:30am; ERS-2 – 10:30am.

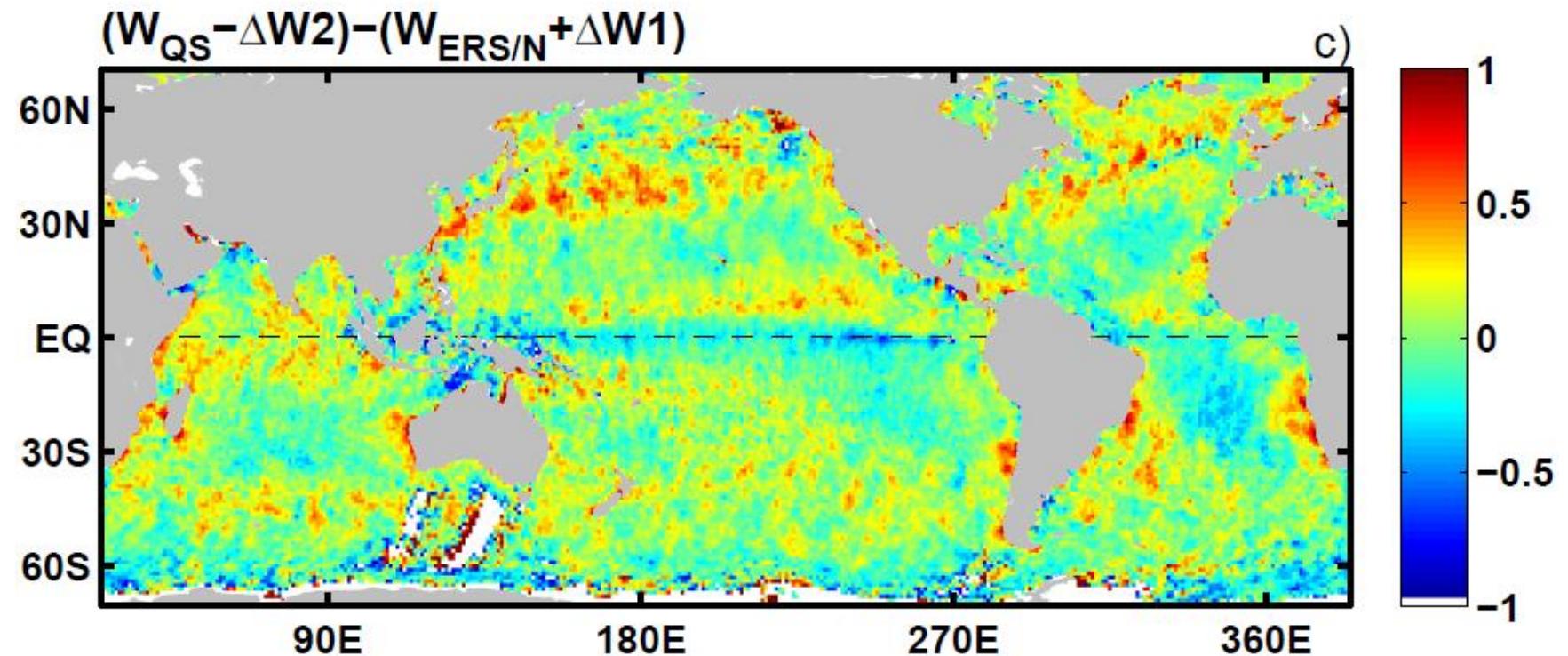
Collocation criteria: <50km, <5hr



QuikSCAT minus ERS-2 collocated wind speed fro JUL1999-JAN2001. No global ERS-2 data after JAN2001.

ERS-2 data are based on CMODIFR2 GMF. CMODIFR2 has been derived by fitting ERS-1 data to in-situ NDBC buoys and used without any adjustments for ERS-2

Collocated ERS-2 and QuikSCAT



QuikSCAT minus ERS/N after applying SST-related correction to QuikSCAT

Towards Scatterometer Homogenization

ERS-1 (Aug 91 – Jun 96)

ERS-2(Apr 95 – Jan 01)

QuikSCAT(Jul 99 – Nov 09)

ASCAT(Apr 07 – Present)

Scatterometer	Period	Cycle	Frequency	GMF	L2b version	WVC	Agency
ERS-1	Aug 1991 – Mar 1992	3 days	C-band (5.3GHz, 5.7 cm)	CMODIFR2	WNF2	50km ²	IFREMER
	Apr 1992 – Dec 1993	35 days					
	Dec 1993 – Apr 1994	3 days					
	Apr 1994 – Mar 1995	168 days					
	Mar 1995 – May 1996	35 days					
	Apr 1995 – Jan 2001	35 days					
ERS-2	Apr 1995 – Jun 2011	35 days	C-band (5.3GHz, 5.7 cm)	CMODIFR2	WNF2	50km ²	IFREMER
	Jul 1999 – Nov 2009	4 days					
QuikSCAT	Oct 2006 – Present	29 days	Ku-band (13.4GHz, 2.2 cm)	Ku_Model	V2	25km ²	JPL
ASCAT	Oct 2006 – Present	29 days	C-band (5.3GHz, 5.7 cm)	CMOD5.n	V1	25km ²	EUMETSAT

Review of Scatterometer Wind Accuracies

NDBC Results

	Wind Speed				Wind Direction		
	Bias (m/s)	STD (m/s)	bs	ρ	Bias (deg)	STD (deg)	ρ^2
ERS-1 WNF	0.42	1.36	1.02	0.92	-4	19	1.84
ERS-2 WNF	0.70	1.41	1.01	0.93	-5	18	1.86
ERS-2 UWI	0.13	1.31	0.99	0.93	-2	38	1.33
QSCAT	-0.01	1.21	0.99	0.94	-4	21	1.85
ASCAT	0.15 (0.10)	1.21 (1.26)	1.00 (1.01)	0.94 (0.94)	0	18	1.90

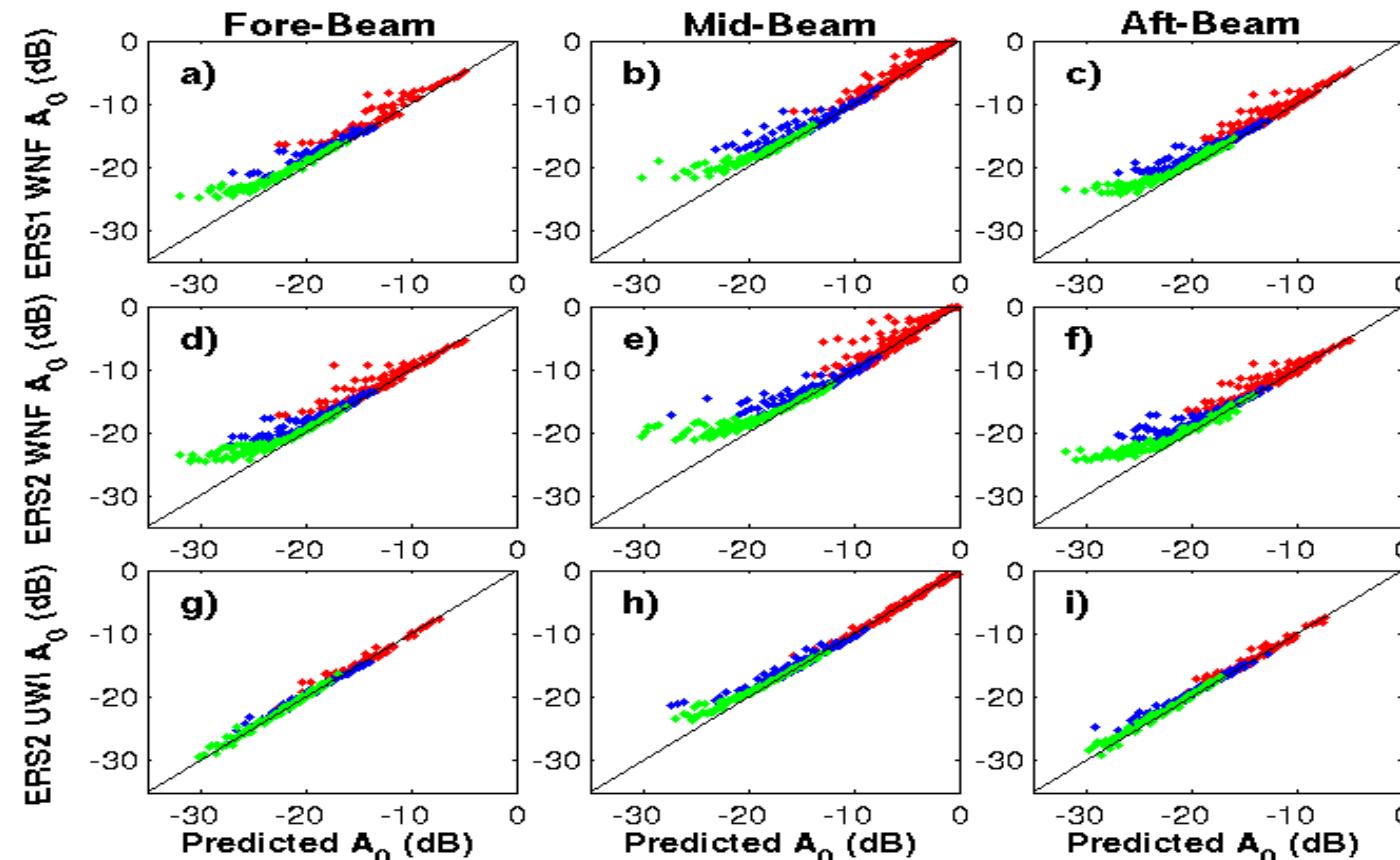
TAO/PIRATA/RAMA Results

	Wind Speed				Wind Direction		
	Bias (m/s)	STD (m/s)	bs	ρ	Bias (deg)	STD (deg)	ρ^2
ERS-1 WNF	0.77	1.23	0.99	0.90	-9	19	1.64
ERS-2 WNF	0.88	1.32	1.01	0.90	-10	20	1.68
ERS-2 UWI	0.46	1.12	0.95	0.90	0	31	1.24
QSCAT	0.19	0.95	0.96	0.91	1	16	1.74
ASCAT	0.45 (0.32)	1.02 (1.01)	0.95 (0.94)	0.91 (0.90)	-3	15	1.78

ERS-1 and ERS-2 Backscatter Coefficient Issues

$$\sigma^\circ = A_0 + A_1 \cos\chi + A_2 \cos 2\chi / A_0 \text{ highly related to wind speed}$$

- Measured $A_0 = F(\sigma_u^\circ, \sigma_d^\circ, \sigma_c^\circ)$
- Predicted $A_0 = \text{CMOD5n}(W_{\text{Buoy}}, \text{Dir}_{\text{Buoy}})$

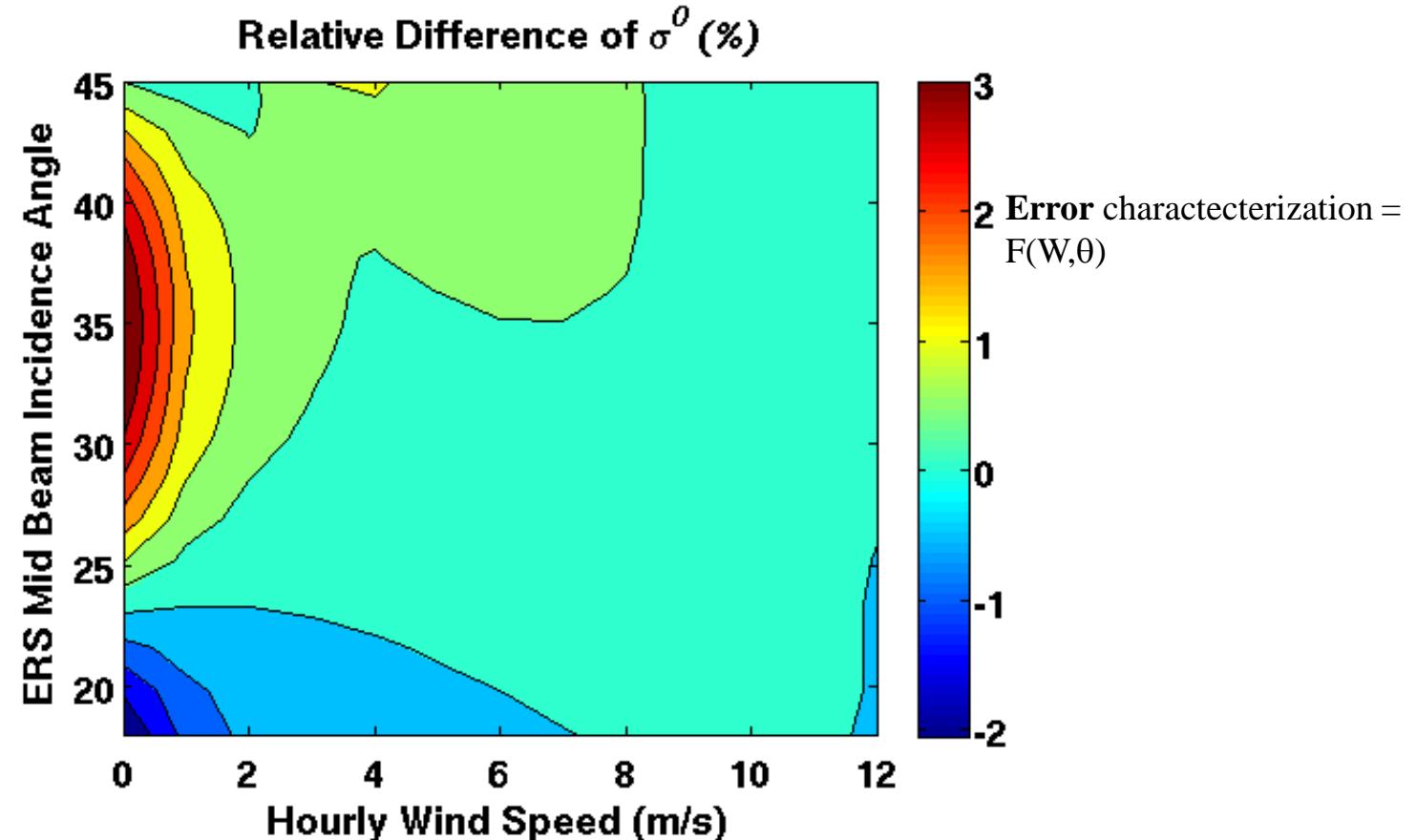


$$\begin{aligned}\theta_1 &= 18^\circ \\ \theta_1 &= 27^\circ \\ \theta_1 &= 45^\circ\end{aligned}$$

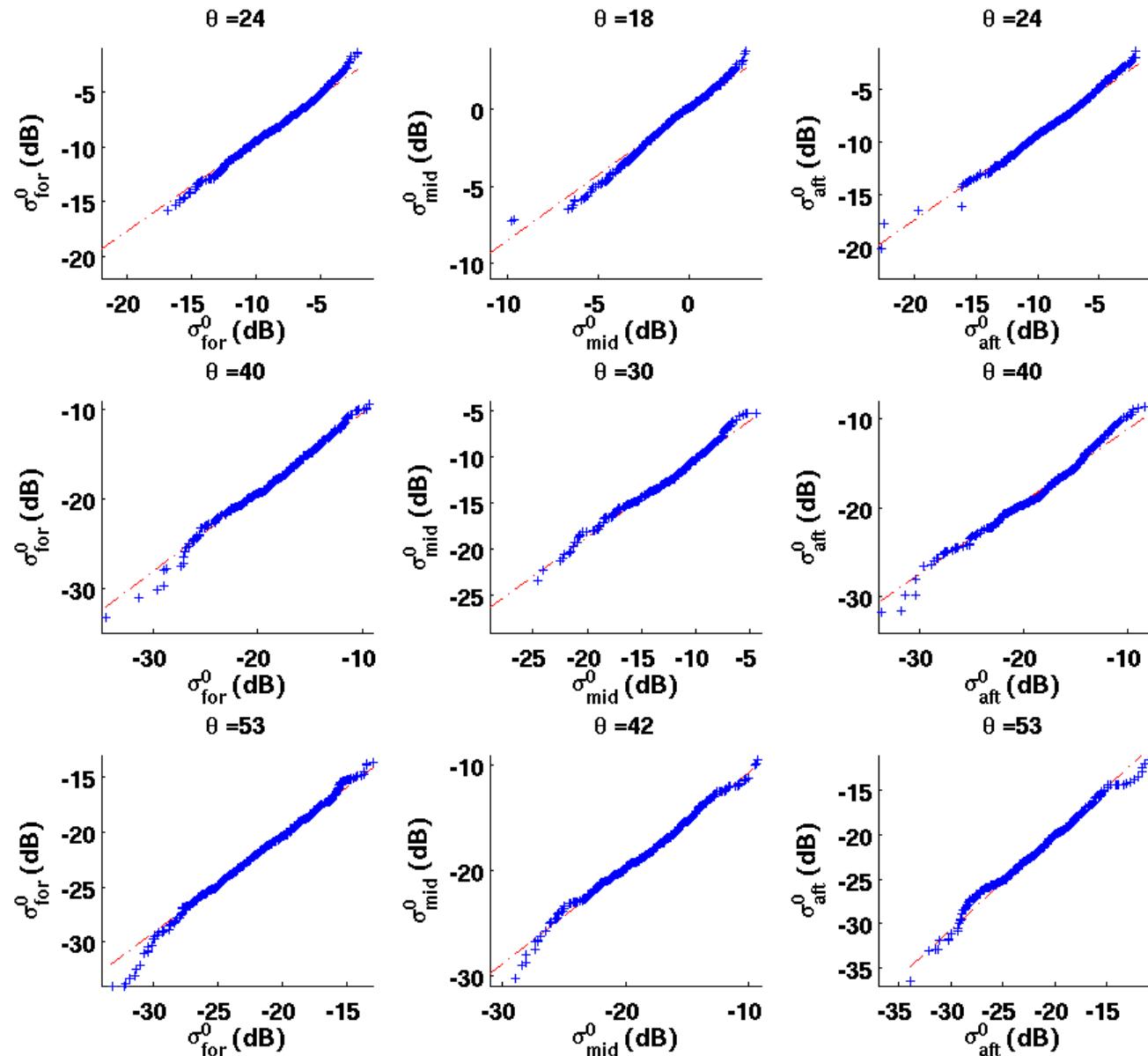
Calibration Issue

- Using buoy winds for ERS-1 and ERS-2 Backscatter Coefficient Corrections
- Space and Time Averaging Issue :
 - 1992 – 1999: Buoy winds are hourly averages of 8-mn measurements.

Error relied on difference between Mean σ_0 (calculated from 10mn-winds) and σ_0 (calculated from hourly-averaged winds).

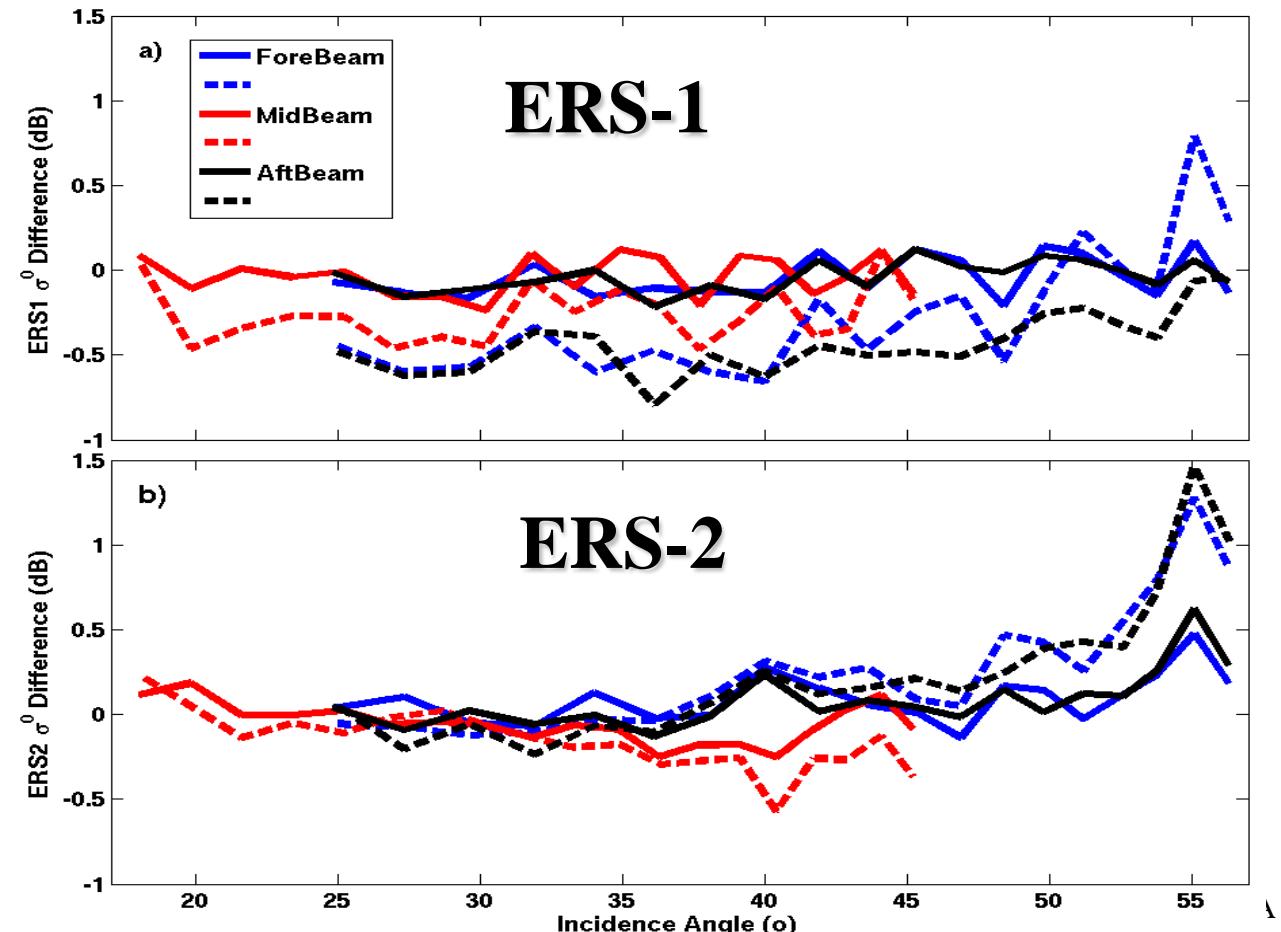


Comparison of Measured and Predicted Backscatter Coefficient → Determination of σ^0 Correction Method



Procedure

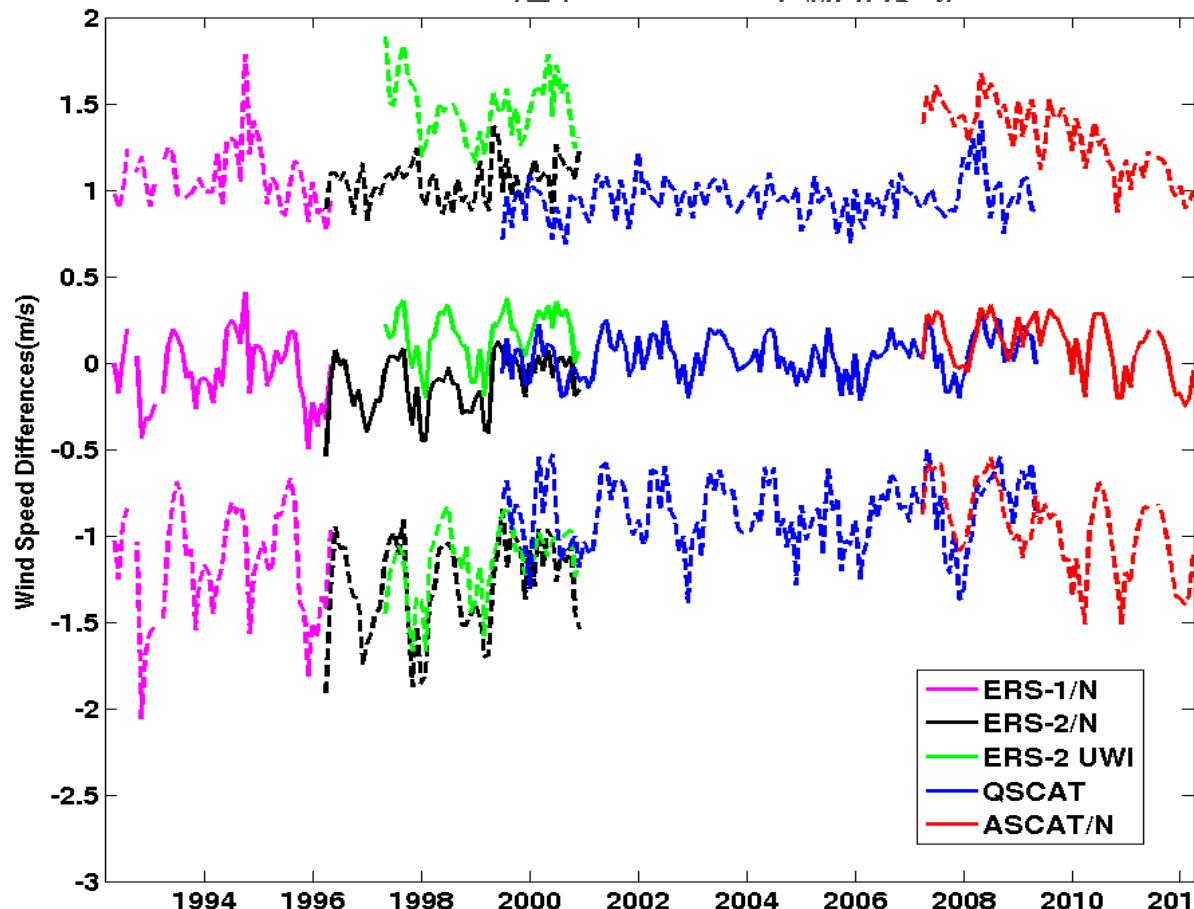
- Two collocated for ERS-1/buoy and ERS-2/Buoy datasets are selected for Calibration and validation, respectively.
- ERS-1 and ERS-2 correction: RMA regression : $\sigma_m^0 - \sigma_e^0 = b_s \sigma_m^0 + a_s$
Where b_s and $a_s = F(\theta)$
- Validation of the corrected backscatter coefficients
- Error analysis and characterization



Procedure (*Cont*)

ERS-1 and ERS-2 wind retrievals (1992 – 2001):

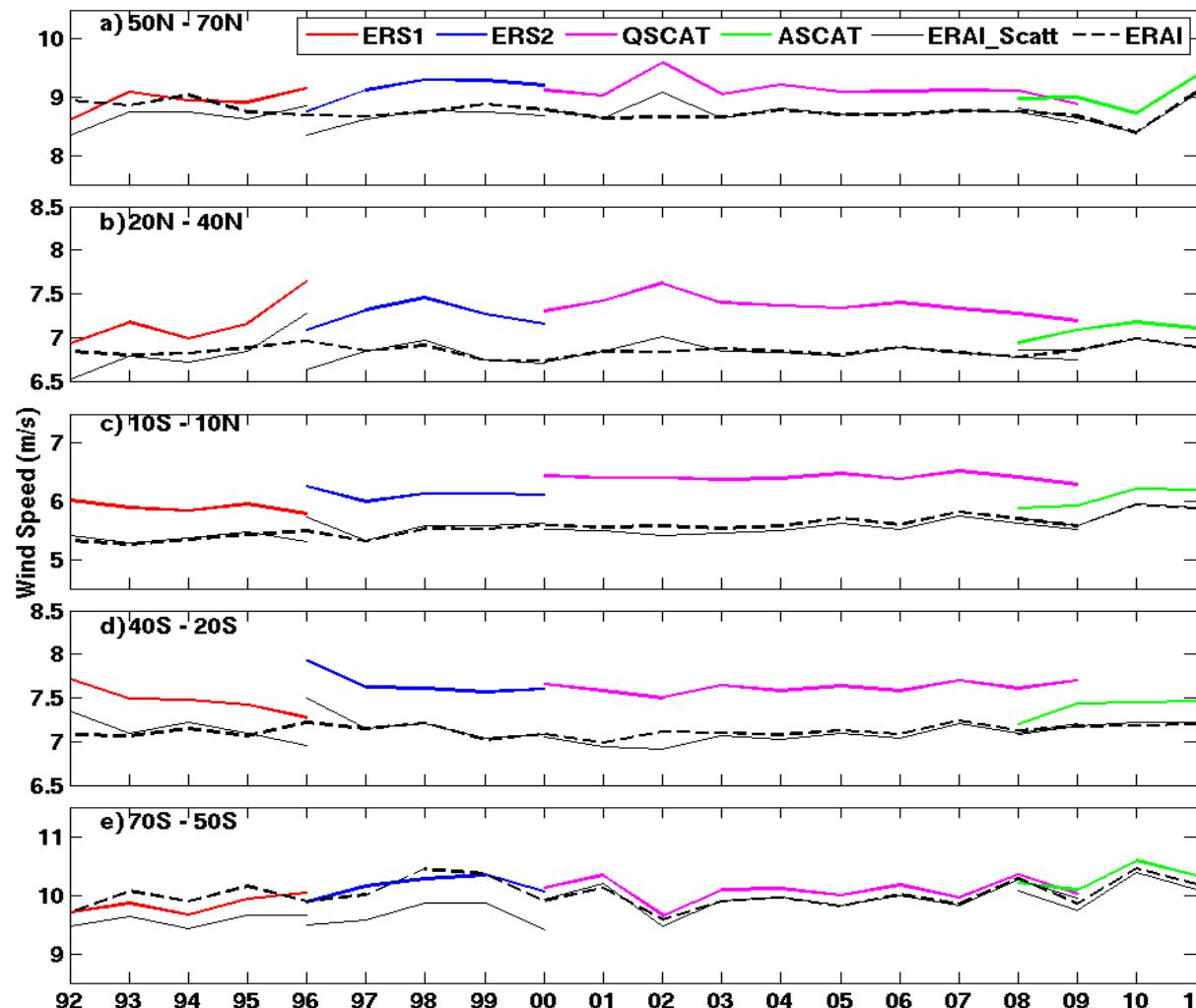
$$J(W, \chi) = \sum_{i=1}^3 [\sigma_i^0 - \sigma_{i, \text{CMODE}}^0 (W, \chi)]^2$$



	Wind Speed			
	Bias (m/s)	STD (m/s)	bs	ρ
ERS-1 WNF	0.42 (-0.06)	1.36 (1.10)	1.02 (1.00)	0.92 (0.94)
ERS-2 WNF	0.70 (-0.15)	1.41 (1.09)	1.01 (1.02)	0.93 (0.95)
ERS-2 UWI	0.13	1.31	0.99	0.93
QSCAT	-0.01	1.21	0.99	0.94
ASCAT	0.15 (0.10)	1.21 (1.26)	1.00 (1.01)	0.94 (0.94)

Time series of monthly differences between NDBC buoy and scatterometer wind speeds. Full and dashed lines indicate running bias and bias \pm STD, respectively.

Long time series from ERS-1, ERS-2, QuikSCAT, ASCAT, and ERA Interim



Annual mean speed estimated from available monthly averaged collocated scatterometer (ERS-1/N, ERS-2/N, QSCAT, ASCAT/N) and ERA Interim data. They are calculated for the period March 1992 – March 2011, and for latitudinal oceanic zones: a) $50^{\circ}\text{N} - 70^{\circ}\text{N}$; b) $20^{\circ}\text{N} - 40^{\circ}\text{N}$; c) $10^{\circ}\text{S} - 10^{\circ}\text{N}$; d) $40^{\circ}\text{S} - 20^{\circ}\text{S}$; and e) $70^{\circ}\text{S} - 50^{\circ}\text{S}$. ERAI_Scatt (thin black line) indicate ERA Interim data collocated with scatterometer retrievals, whereas ERAI (dashed black line) indicates annual winds calculated from 6-hourly analyses.

Summary

- Consistency of 20 years of Scatterometer Wind Retrievals
- Procedure mainly based on the use moored measurements
- Empirical correction of ERS-1 and ERS-2 backscatter coefficients
- Validation: Better comparison to predicated σ_0 as well as to ERS-2 UWI
- New ERS-1 and ERS-2 wind speed retrievals are calculated based on GMOD5.n
- Validation:
 - Better Statistics derived from moored collocated data
 - No systematic bias
 - Main changes relied on wind distributions
- Further investigations:
 - Inversion methods, ambiguity, radar characteristics
 - Using newly ERS-1/2 data from ongoing ESA projects (e.g. Scirocco)
- Calculation of global surface wind analyses and of turbulent fluxes for the period : 1992 – 2012 (ESA OHF Project)