Intercomparison of C- and Ku-band scatterometer winds

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Outline

- Physical causes of Ku- and C-band wind difference
- ‘Technical’ causes
- ASCAT vs QuikSCAT
- ERS-2 vs QuikSCAT

SST-dependence of wind retrieval

Energy balance of short wind waves

$$\beta B(\vec{k}) - B(\vec{k})[B(\vec{k})/\alpha]^n = 0 \qquad \beta = \beta_w - \beta_\nu$$

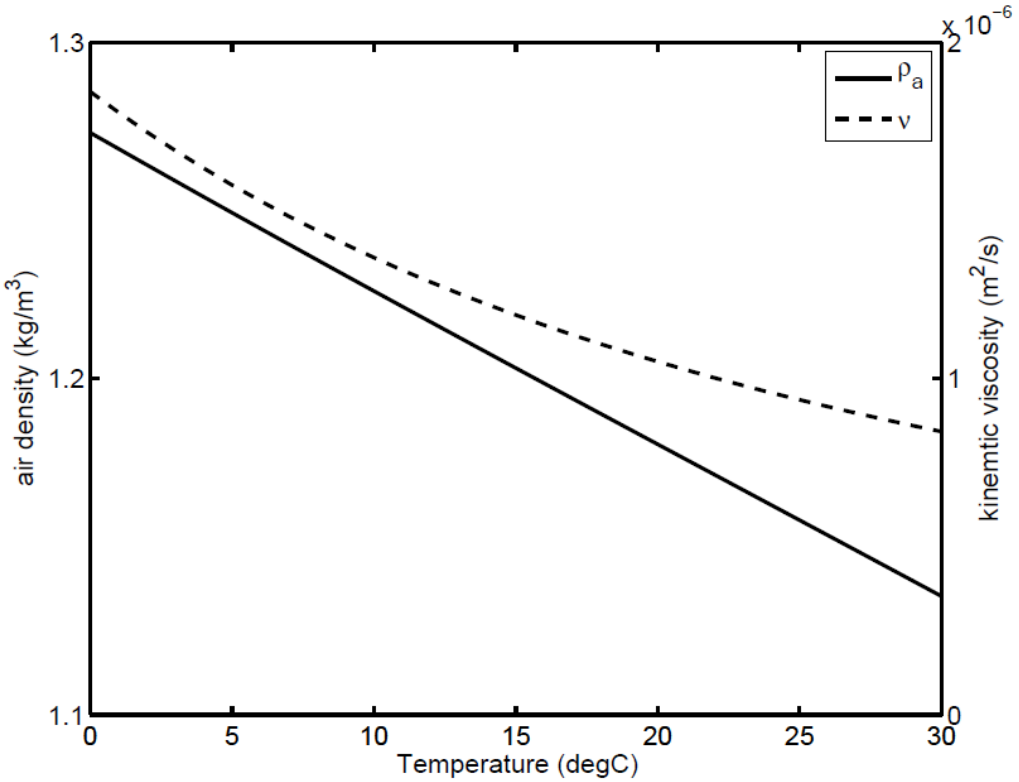
$$\beta_w = 1.5 \frac{\rho_a}{\rho_w} \frac{u_*(W_{\pi/k} - c)}{c^2} |\cos(\varphi)| \cos(\varphi)$$

$$\beta_\nu = 4\nu k^2/\omega$$

Because both, wind growth rate, β_w, and viscous dissipation, β_ν, depend on SST, the radar signal is directly impacted by SST.

β_w weakly depends on radar frequency

β_ν increases with frequency



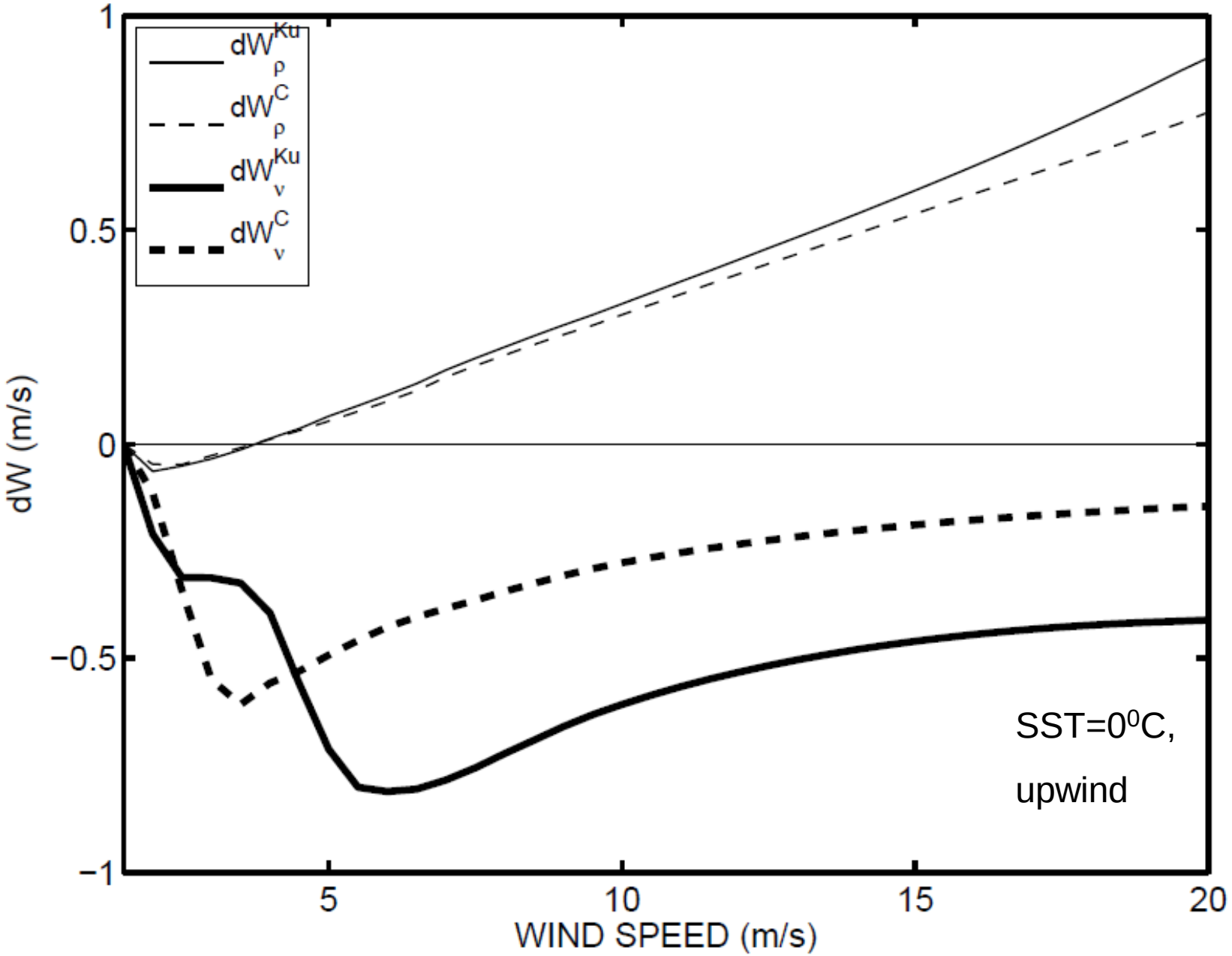
SST-dependence of wind retrieval

Current GMFs don't account for SST. We assume that radar calibration, $d\sigma^o/dW$, refers to To=19^{o}C (global mean SST). The temperature-related wind retrieval error becomes

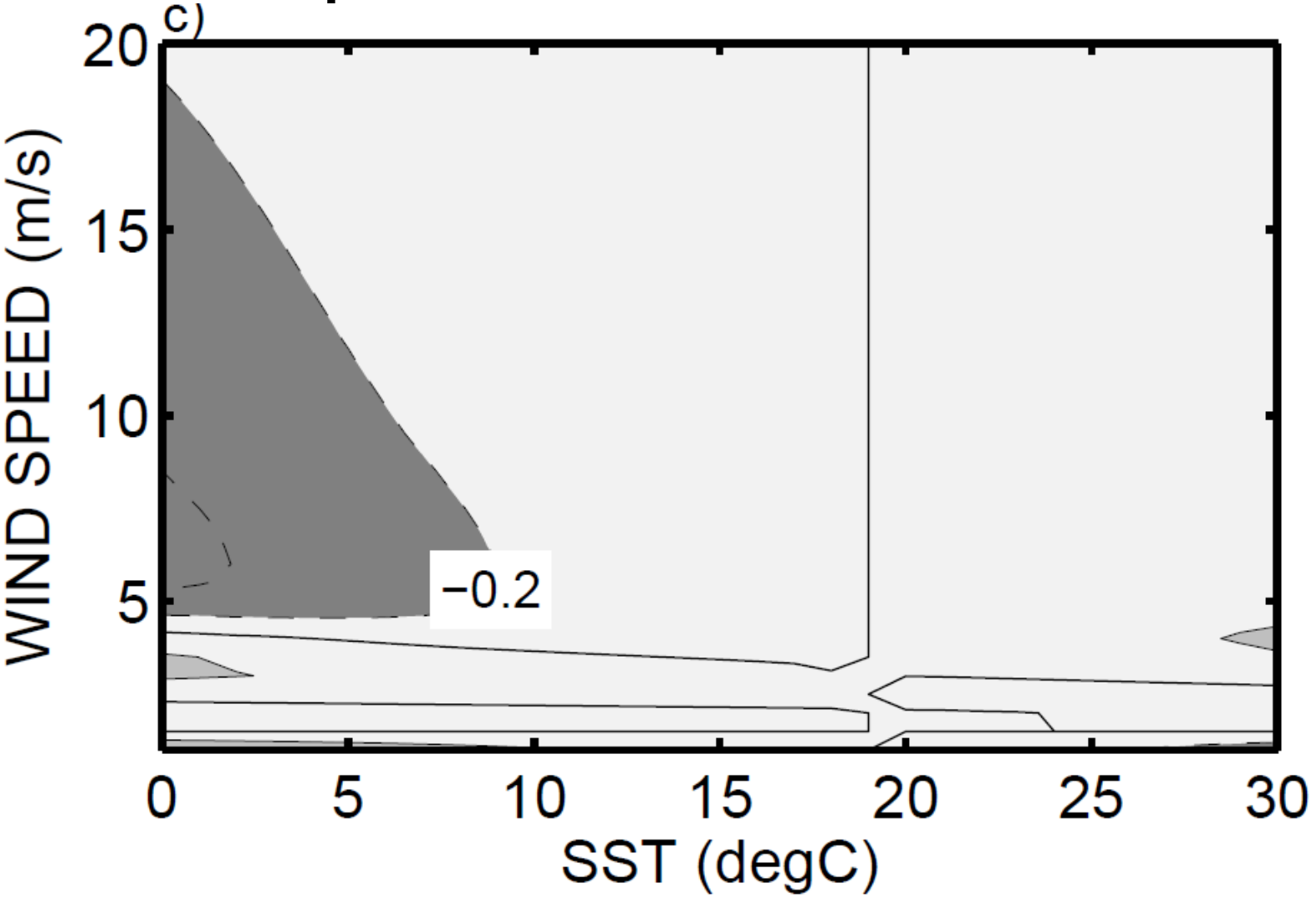
dW_ρ -- Wind error due to change in air-density (ρ_a)

dW_ν -- Wind error due to change in water viscosity (ν) (via viscous dissipation)

SST-dependence of wind retrieval

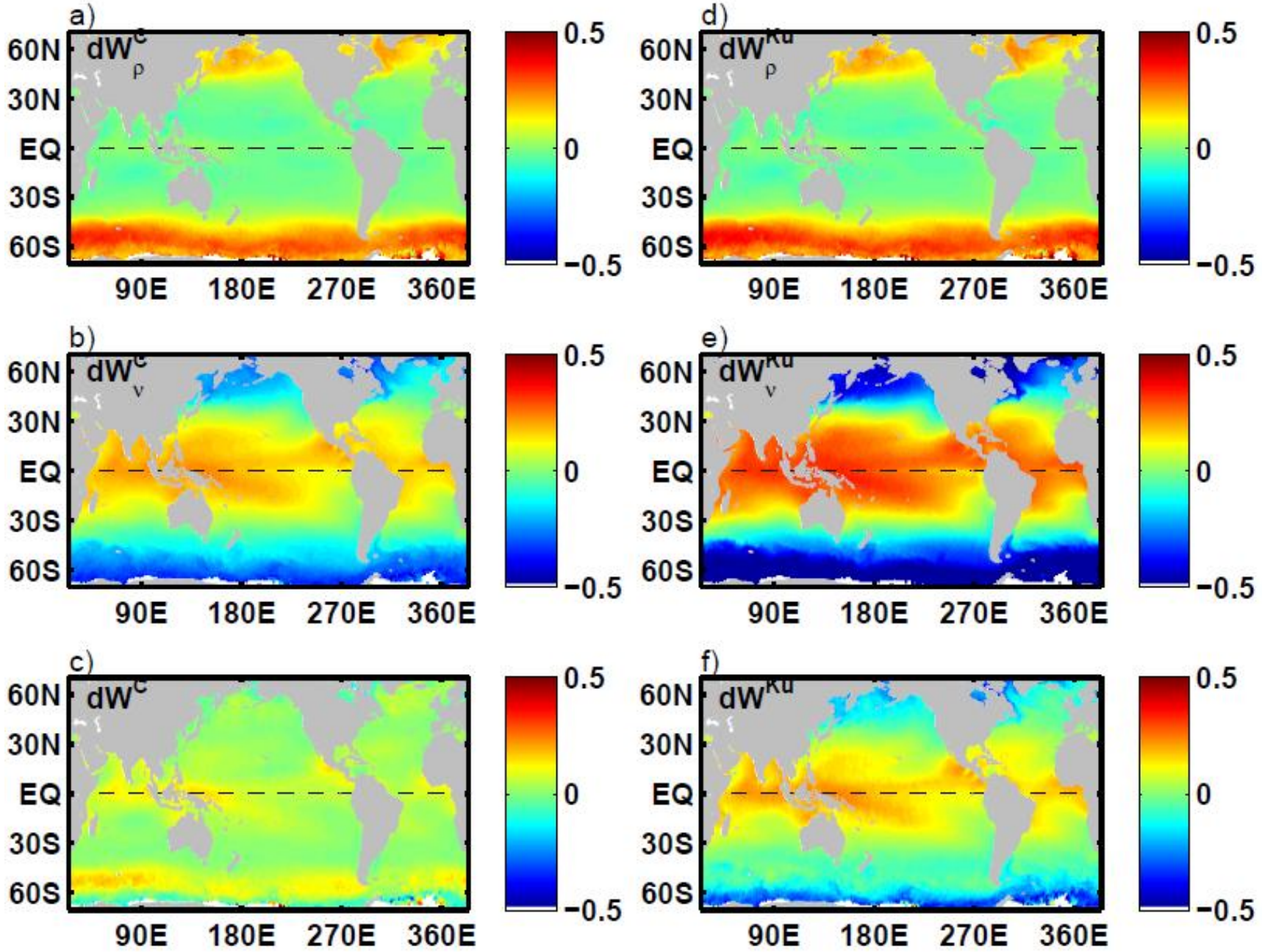


SST-dependence of wind retrieval

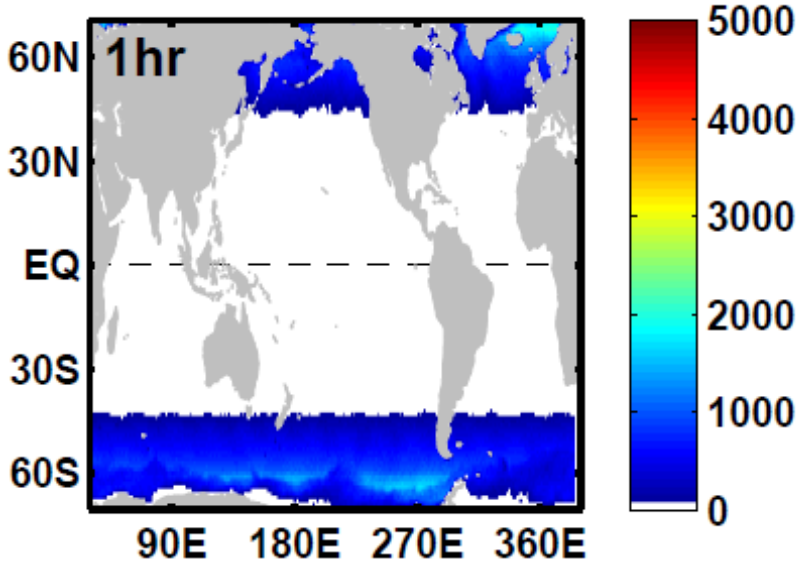


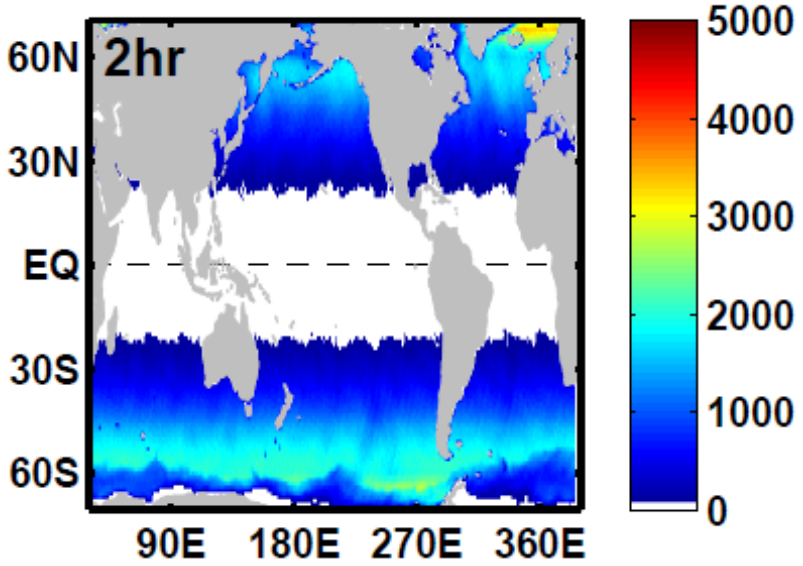
SST-dependent W difference between Ku- and C-band, evaluated using a Radar Imaging Model, is stronger over cold SSS<5C and at moderate winds 5m/s<W<10m/s.

SST-dependence of wind retrieval evaluated from the Radar Imaging Model (**RIM**, Kudryavtsev et al., 2005)

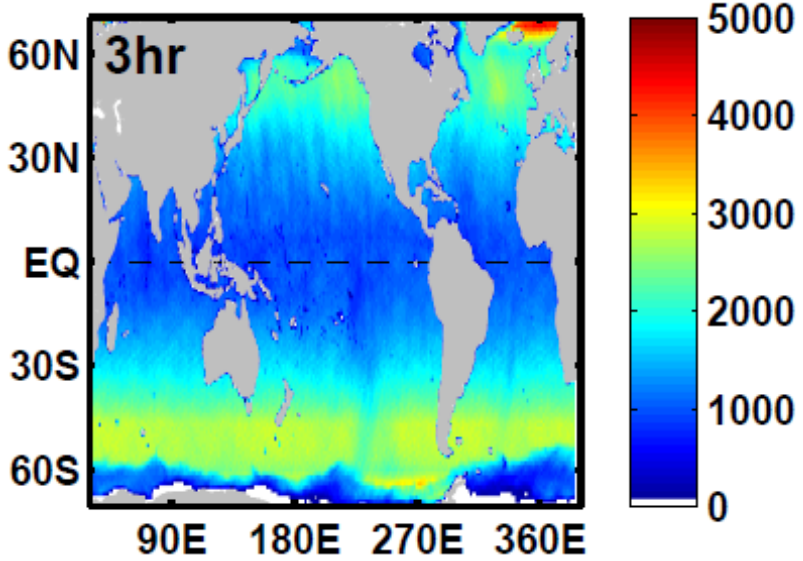


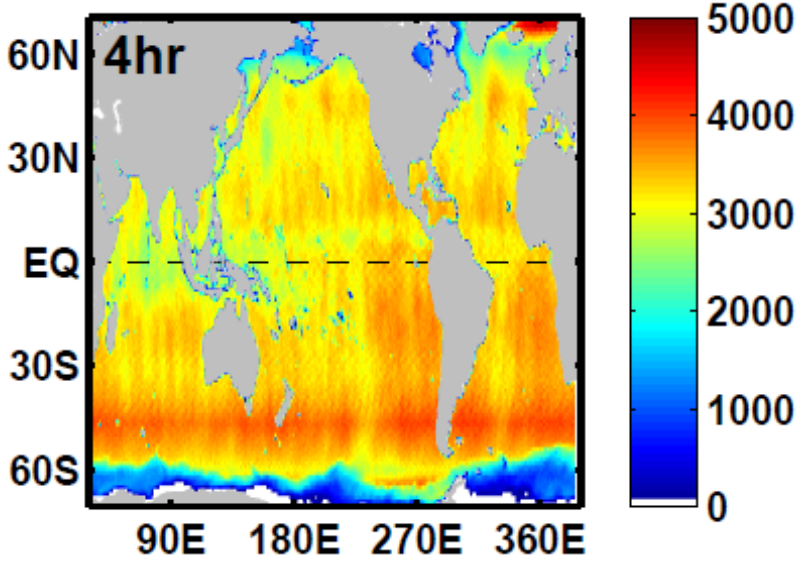
Collocated ASCAT and QuikSCAT





Equator crossing time ascending mode: QuikSCAT- 6:30am, ASCAT – 9.30am

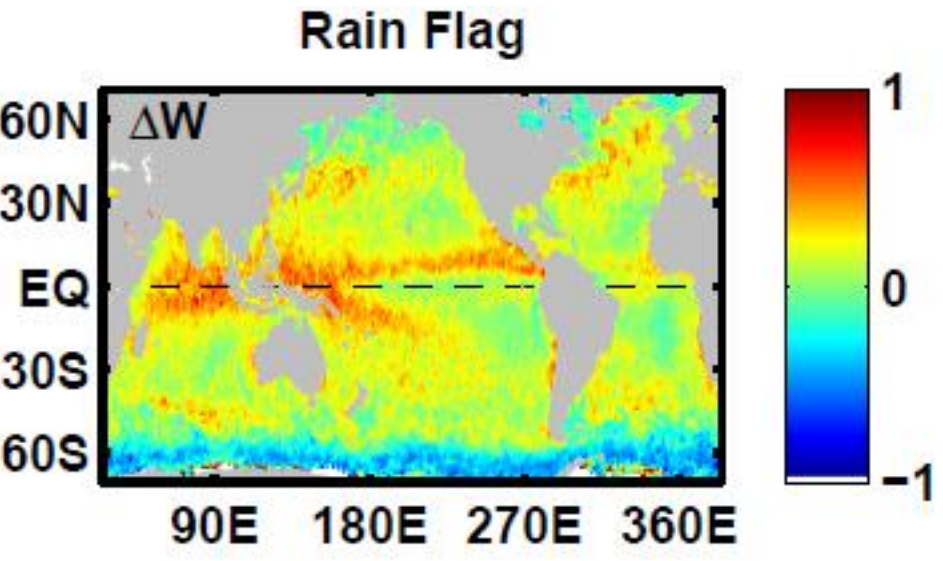


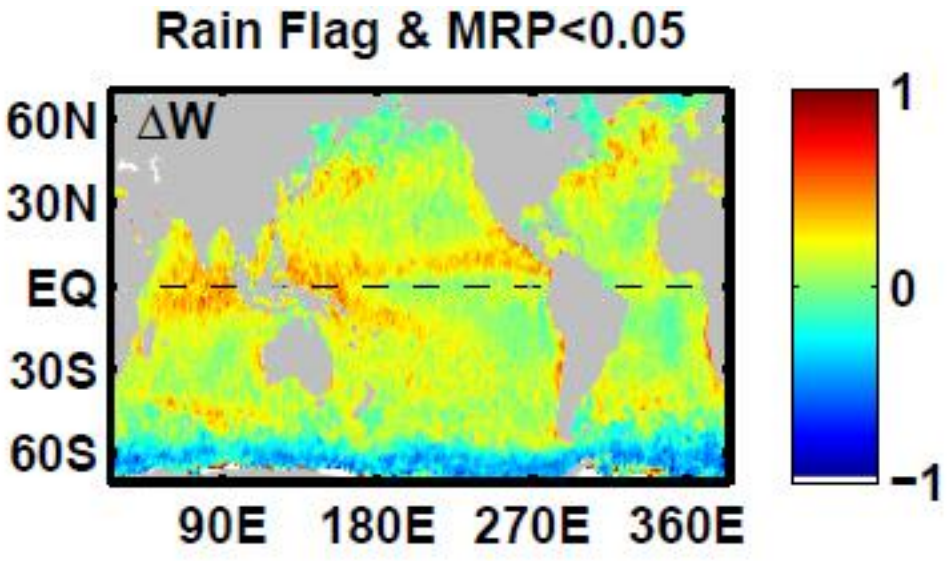


<50km

<4hr

Collocated ASCAT and QuikSCAT

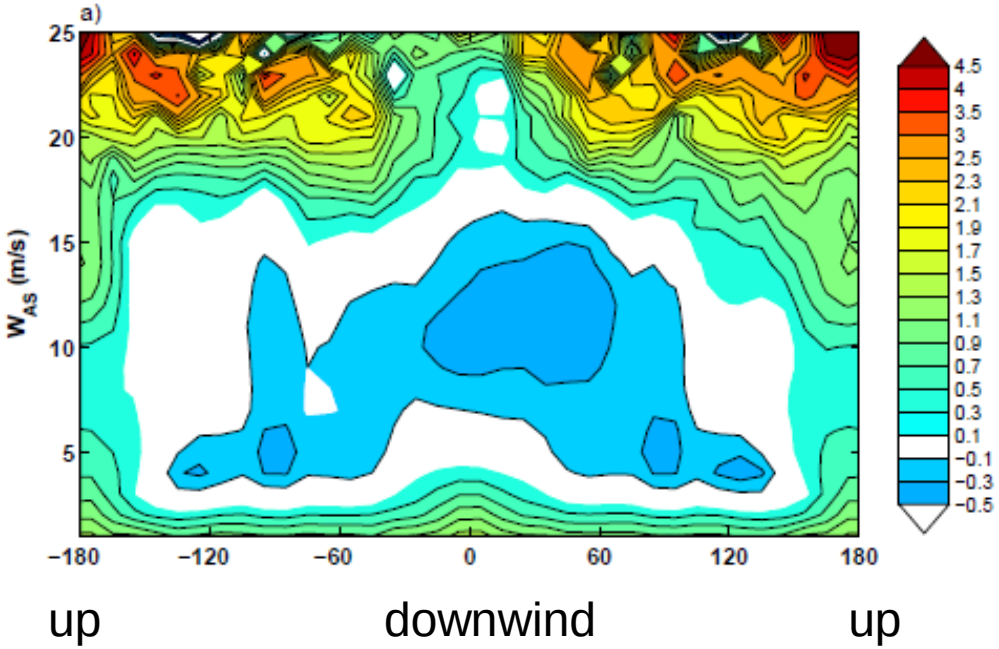




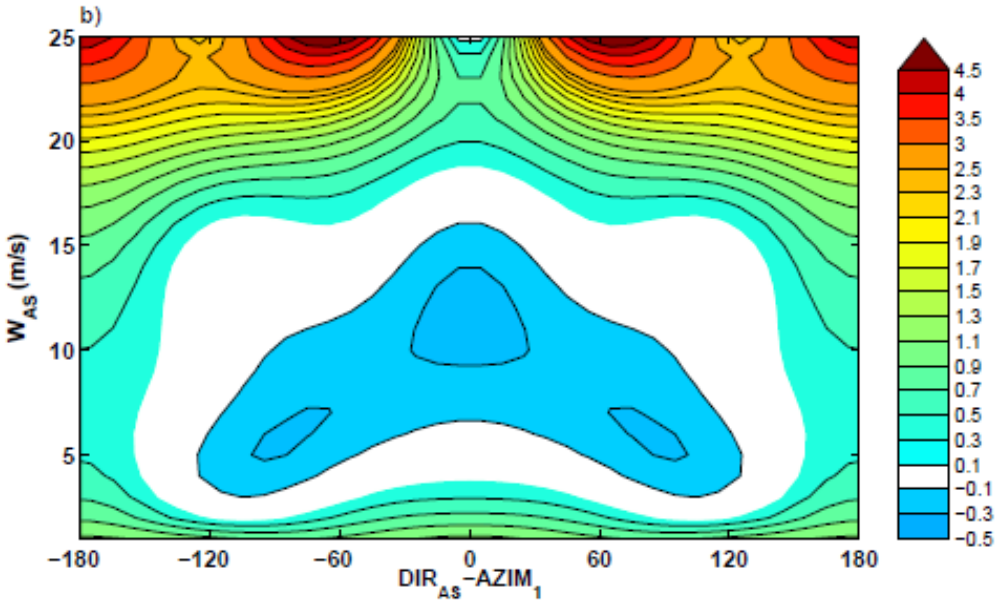
(left) Only rain flag is applied to QuikSCAT, and (right) rain flag and multidimensional rain probability (MPR < 0.05) are both applied.

Collocated data for 20NOV2008 - 19NOV2009. ASCAT data are based on CMOD5.n since November 20, 2008.

Collocated ASCAT and QuikSCAT



up downwind up

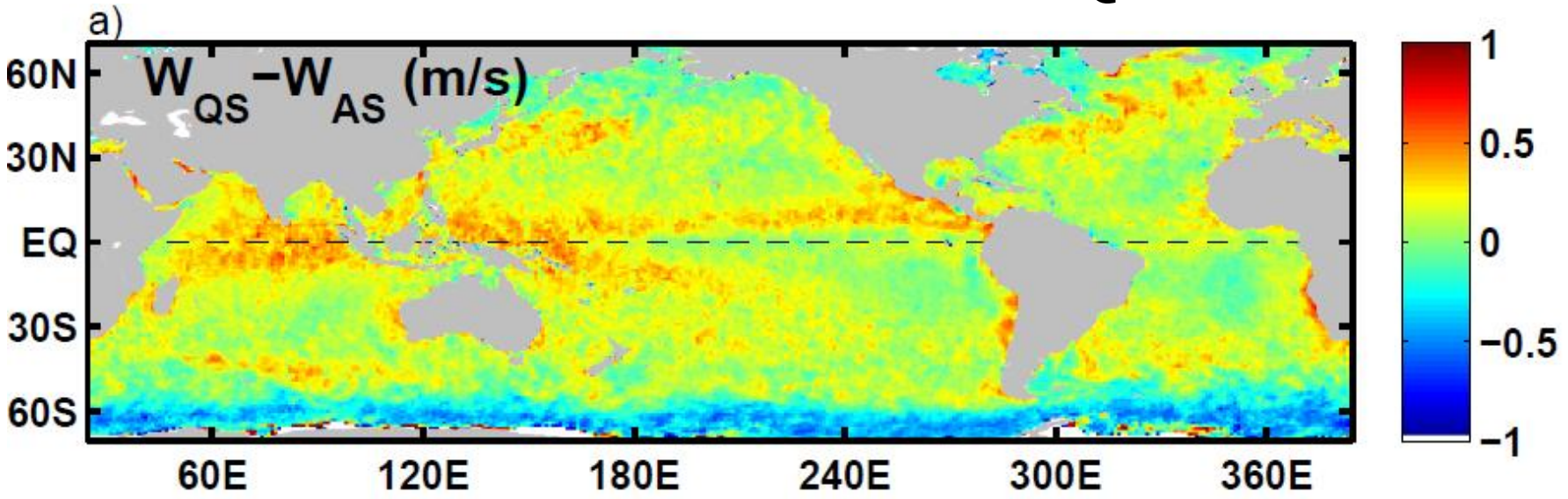


Collocated QuikSCAT-ASCAT wind speed difference (m/s) binned 1 m/s in wind speed and 10° in wind direction relative to the ASCAT mid-beam azimuth DIR_{AS} -$AZIM_1$.

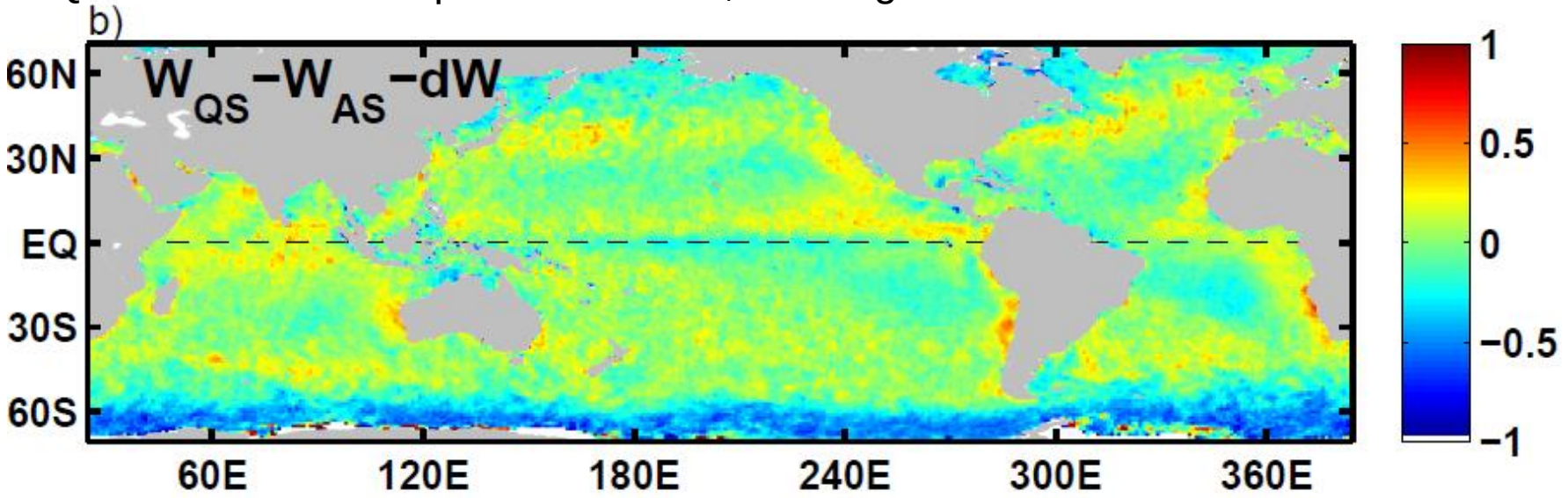
(a) Binned data, in the latitude band 55°S 55°N, thus excluding high latitude areas of negative dW.

(b) Data fit by symmetric azimuth harmonics.

Collocated ASCAT and QuikSCAT

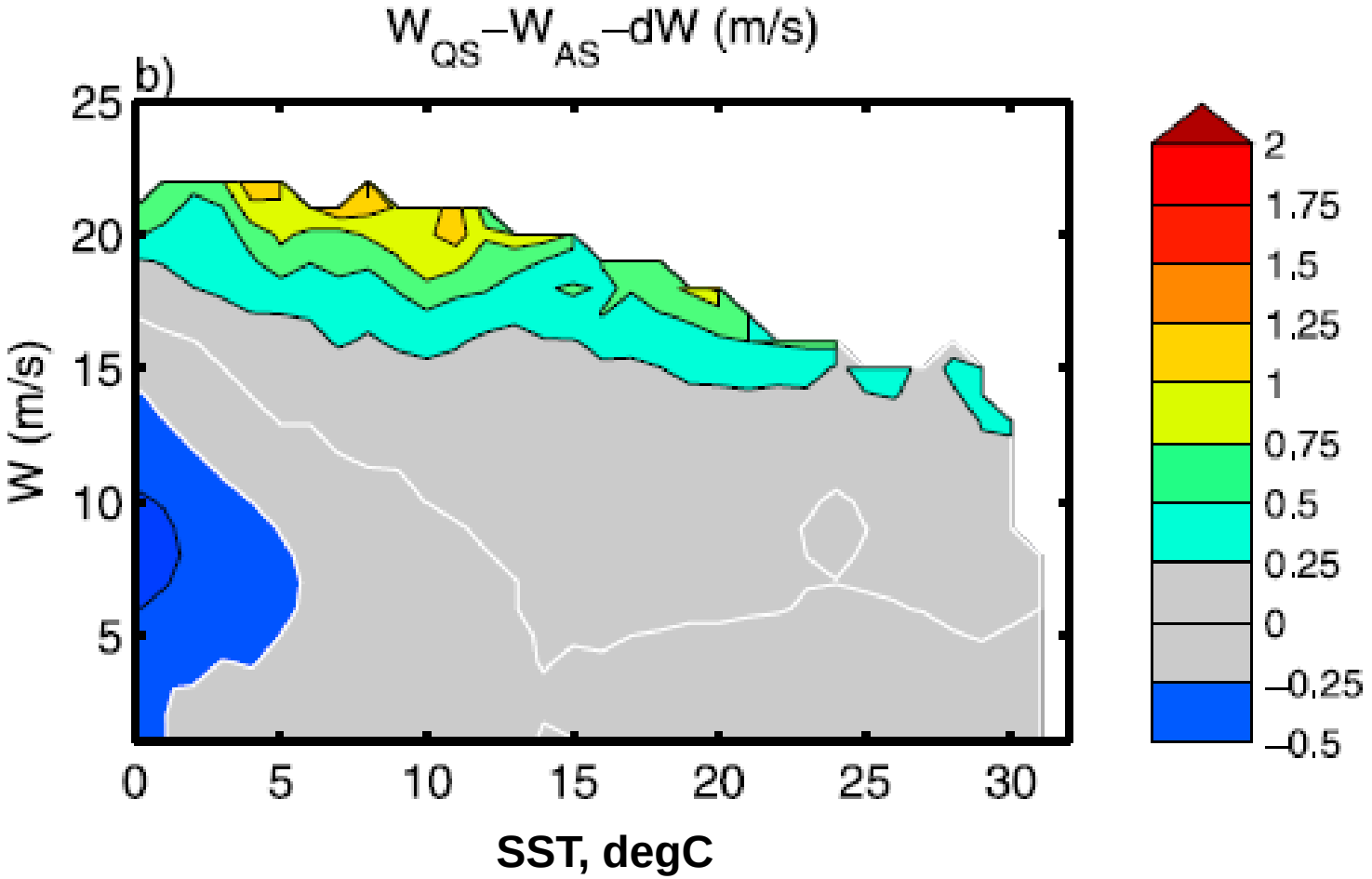


QS minus AS wind speed difference, rain flag and MRP<0.5



QS minus AS wind speed difference, both rain selections + GMF correction

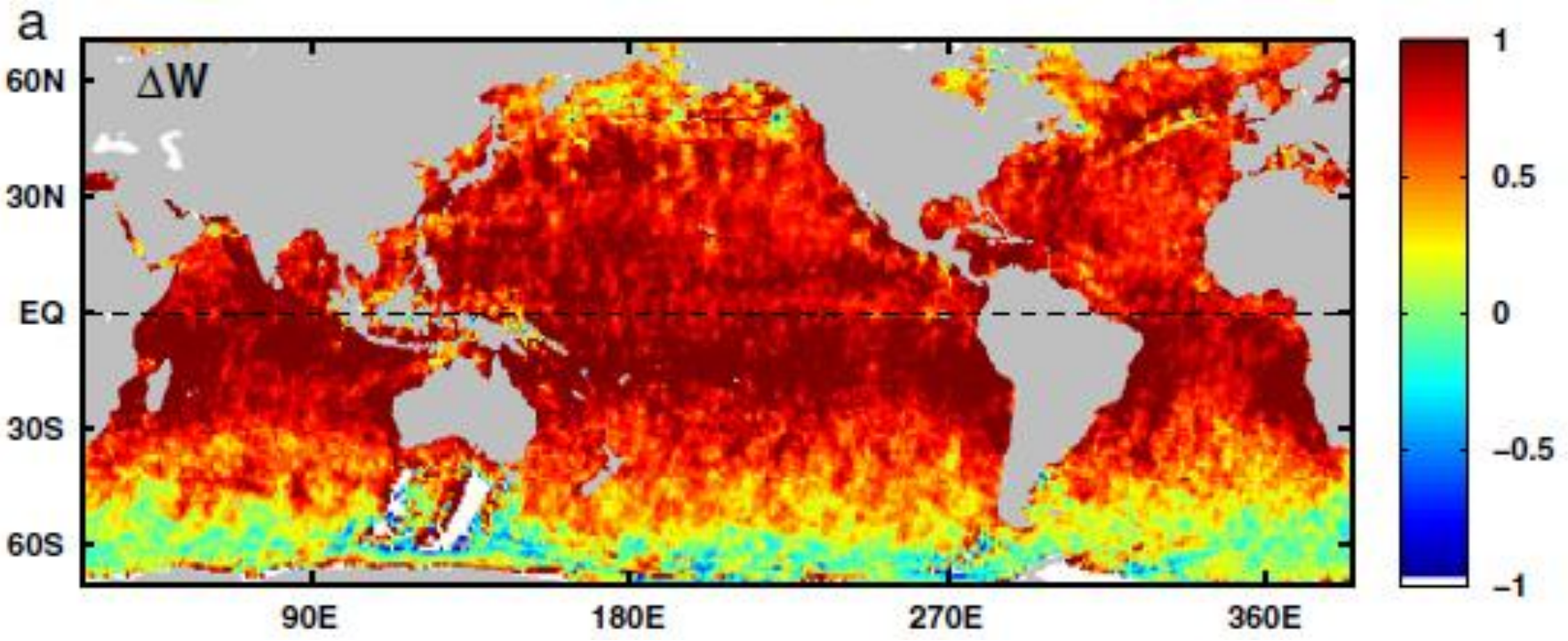
Collocated ASCAT and QuikSCAT



Collocated ERS-2 and QuikSCAT

ECT: QS - 6:30am; ERS-2 – 10:30am.

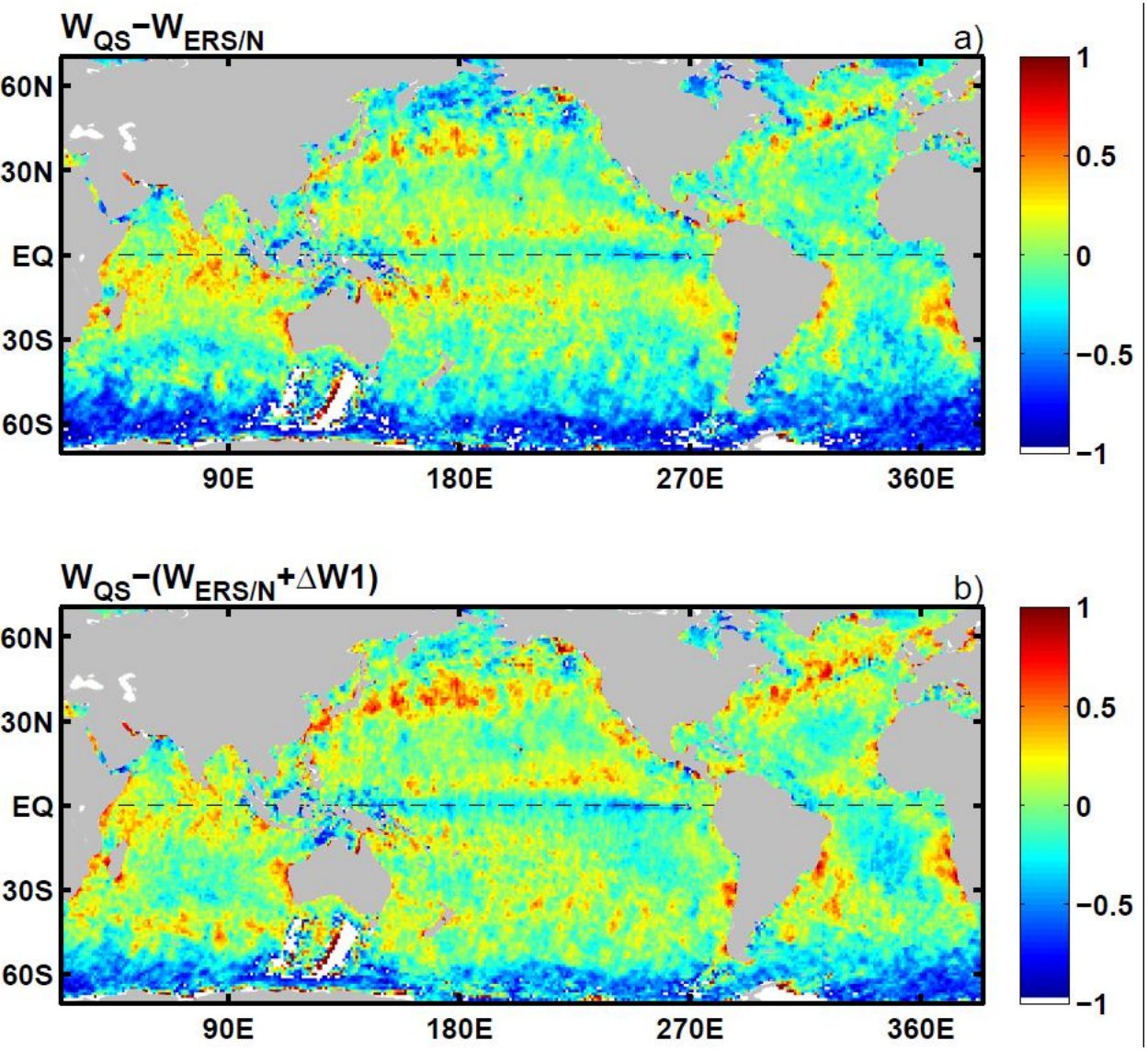
Collocation criteria: <50km, <5hr



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.

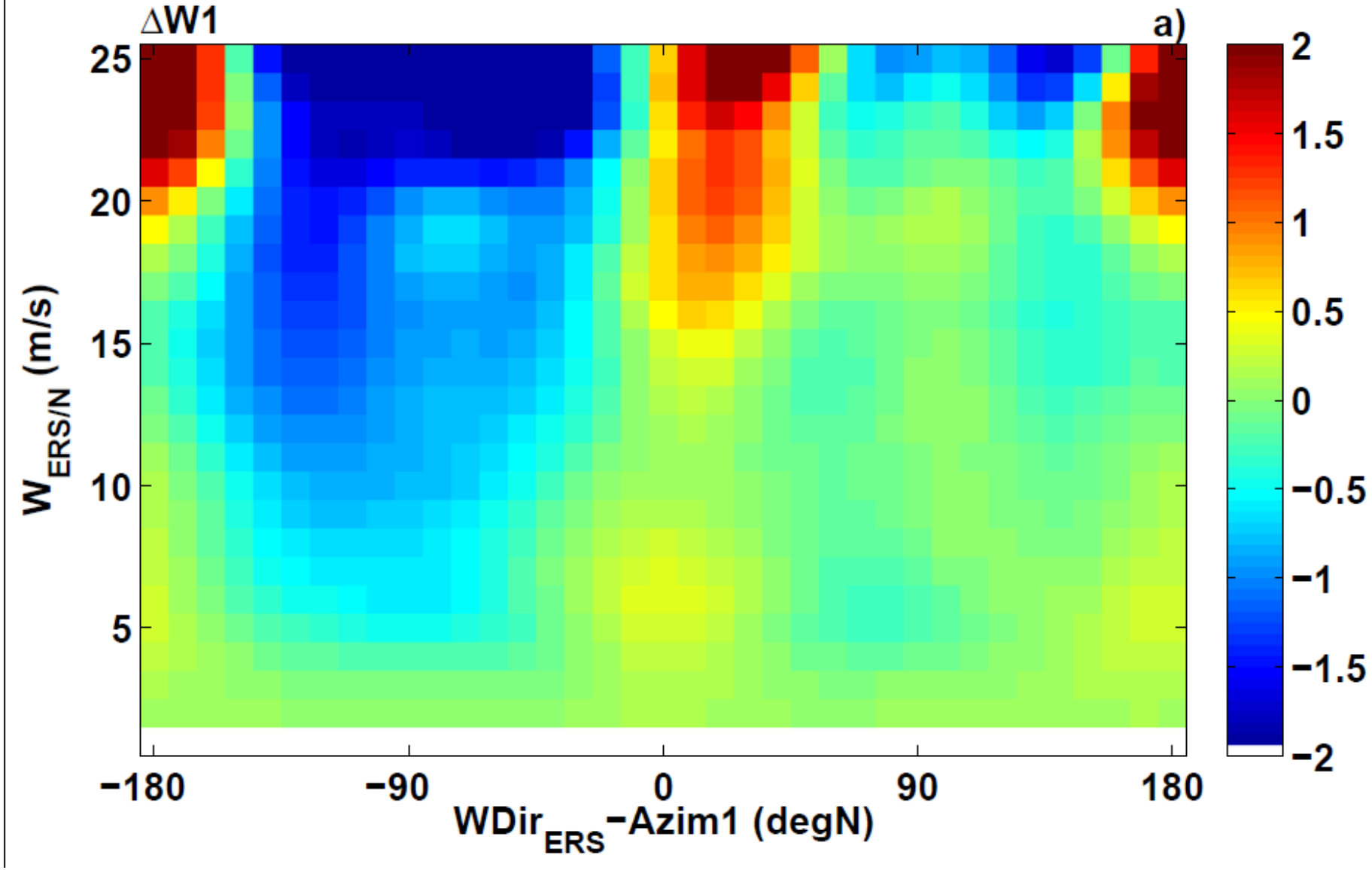
Collocated ERS-2 and QuikSCAT



Partial reprocessing of ERS-2 using CMOD5.n and assuming wind direction unchanged. Resulting winds (ERS/N) are available for collocated data only.

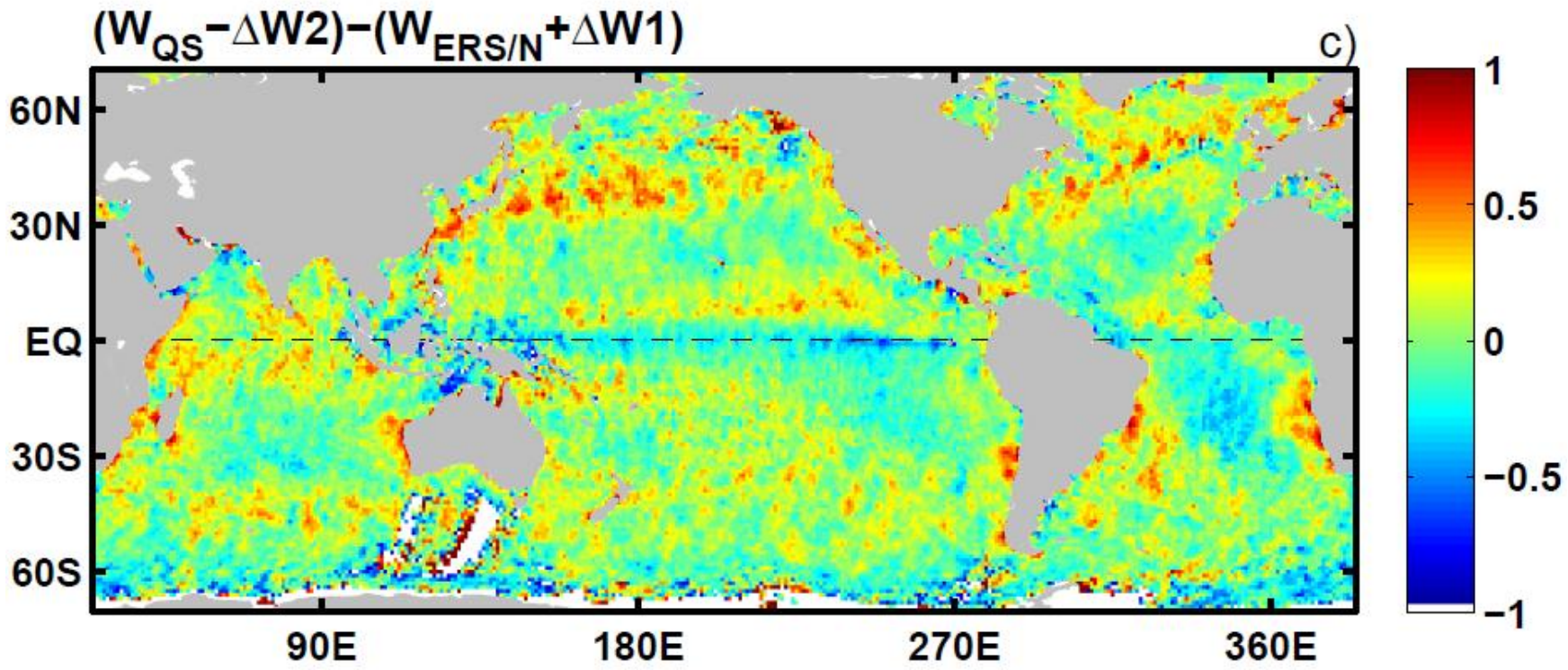
Applying GMF-related correction to ERS/N

Collocated ERS-2 and QuikSCAT



Wind speed difference is not symmetric in azimuth (versus ERS-2 mid beam) suggesting biases in ERS-2 fore- and aft-beam calibration

Collocated ERS-2 and QuikSCAT



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

Conclusions

1. Ku-band wind speed (W) is higher (by 0.5 m/s) than C-band in major precipitation zones (ITCZ, storm tracks).
2. Ku-band W is lower than C-band (by 0.5 m/s) at high latitudes (SST<5C) and moderate winds 5-15m/s.
3. Outside the two regions above, the difference between collocated Ku- and C-band winds is parameterized as a function of W and wind direction relative to the mid-beam azimuth (GMF-related correction for C-band, then applied globally).
4. Agreement between ERS-2 and QuikSCAT winds is greatly improved after applying CMOD5.n (in comparison with CMODIFR2). ERS-2 needs complete reprocessing. There are indirect indications of inconsistency in ERS-2 beams calibration.