# NOC and cone analyses

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Scirocco MTR, Frascati June 3rd 2015

# Outline

- NOC on test datasets
- NOC open issues
- Cone analyses: status

# NOC on test DATASETS

## Comparing ocean calibration results from:

1) ASCAT A over 2014

2) ASCAT B over 2014

3) ERS2 from ASPS2.0 over tandem phase (part of 1997)

4) ERS2 from KNMI reprocessed ERA40 over 1997

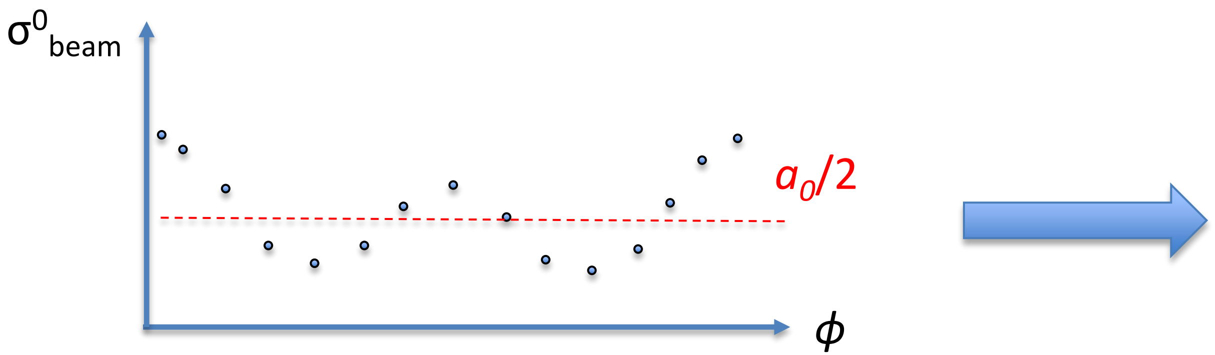
Motivation: To test local installation of AWDP OC, and obtain preliminary ocean calibration coeffs for reprocessed ASPS 2.0 files – in order to confirm RMA's results.

# NOC at a glance

$$\sigma^0(v,\phi) = B_0(v)\left[1 + B_1(v)\cos\phi + B_2(v)\cos 2\phi\right]^{1.6}$$

Statistical distribution of backscatter (sigma_naught, z-space) for fixed wind speed

[fixed beam, BINNING as a function of (NWP) azimuth]




$B_{0,beam}^{SIM}(v,WVC)$

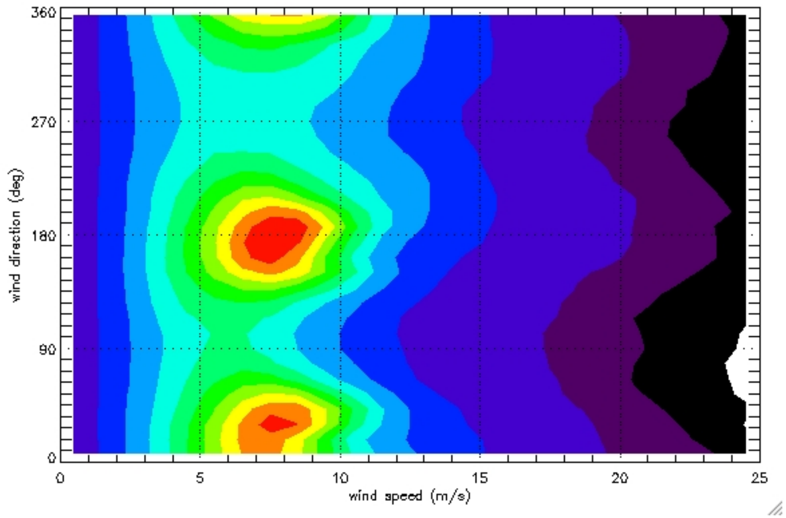
$B_{0,beam}^{OBS}(v,WVC)$

Mean isotropic backscatter

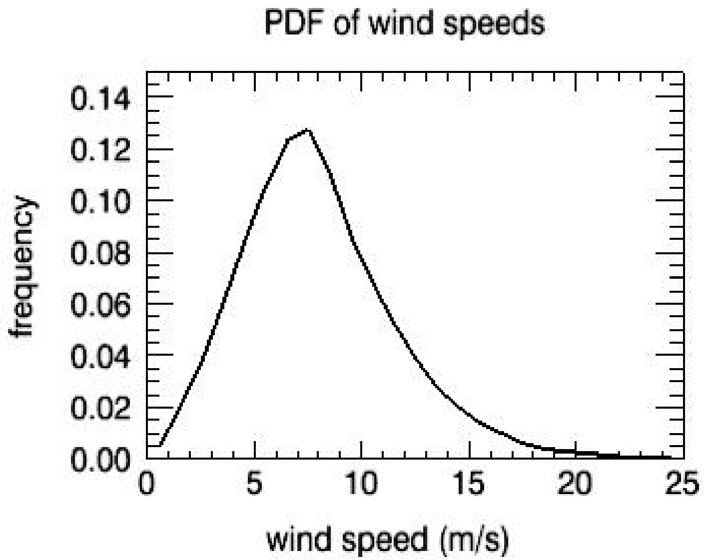
$$z(v,\phi) = \frac{1}{2}a_0(v) + a_1(v)\cos\phi + a_2(v)\cos 2\phi$$

# Weighted averages

$$< w(v,\phi) \cdot z(v,\phi) >_{\phi} = \int w(v,\phi) \cdot N(\phi|v) \cdot z(v,\phi) d\phi = \frac{1}{2} a_0(v)$$



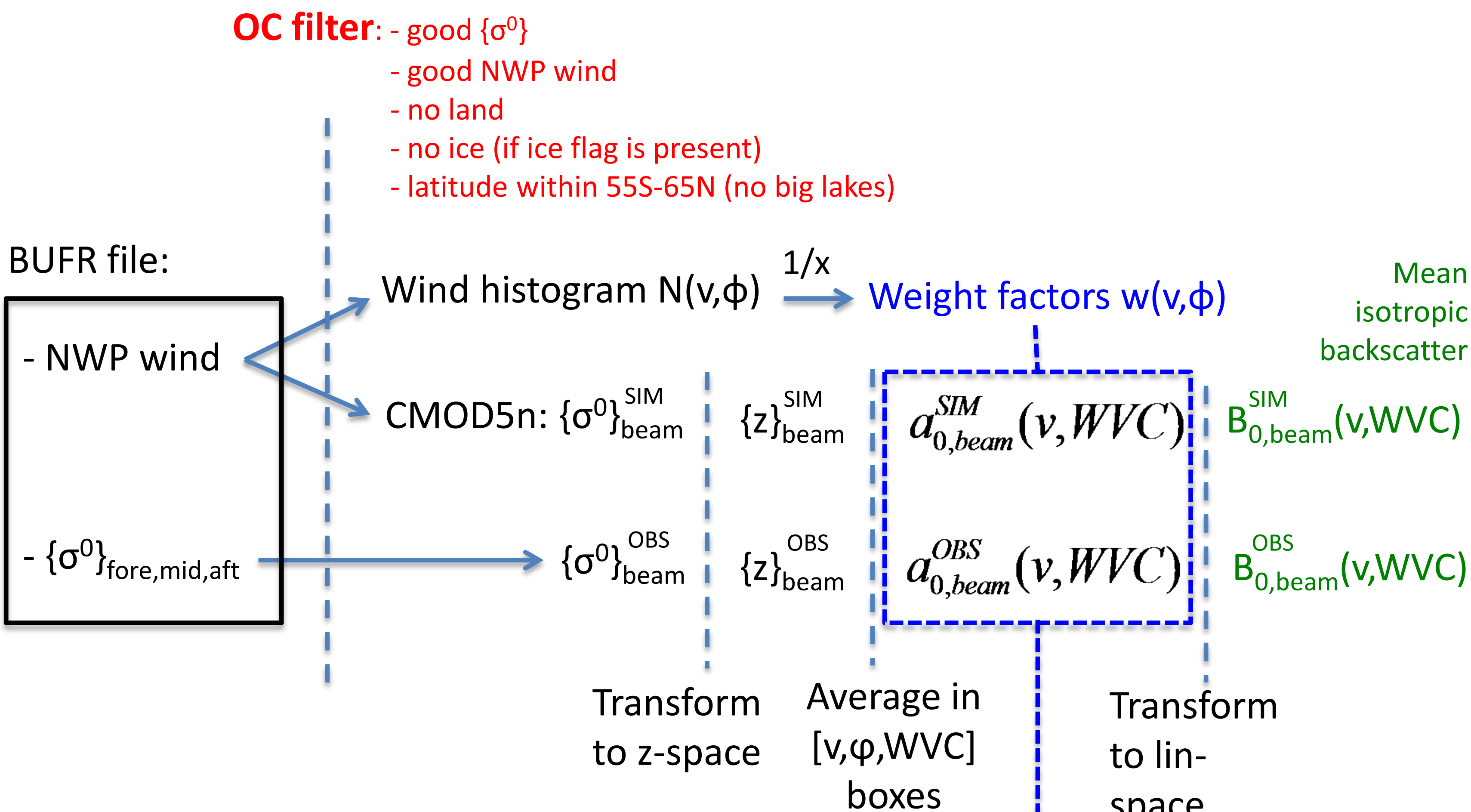

Joint PDF of ocean winds N(v,$\phi$)




PDF of ocean wind speeds *N(v)*

$$a_0 = \int N(v) \cdot a_0(v) dv$$

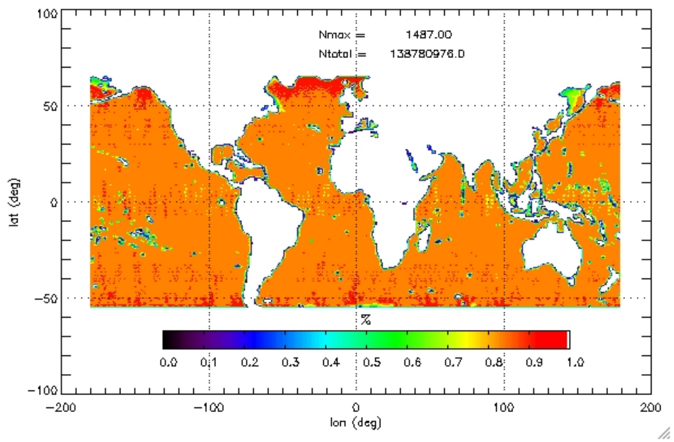
# NWP OCEAN calibration




Forcing a uniform distribution in wind direction ϕ:

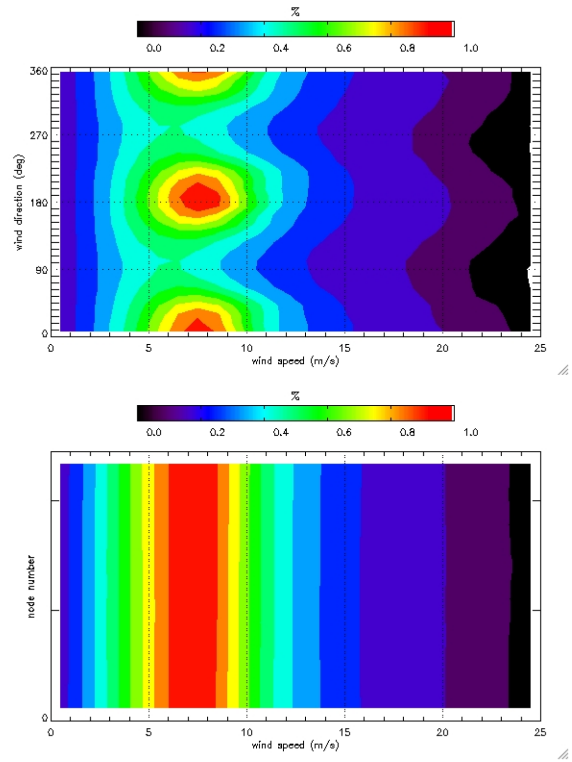
$$z(v,\phi)=\frac{1}{2}a_0(v)+a_1(v)\cos\phi+a_2(v)\cos 2\phi \;\longrightarrow\; a_0(v)=2\sum_{\phi} z(v,\phi)\cdot w_{NWP}(v,\phi)$$

# NOC results

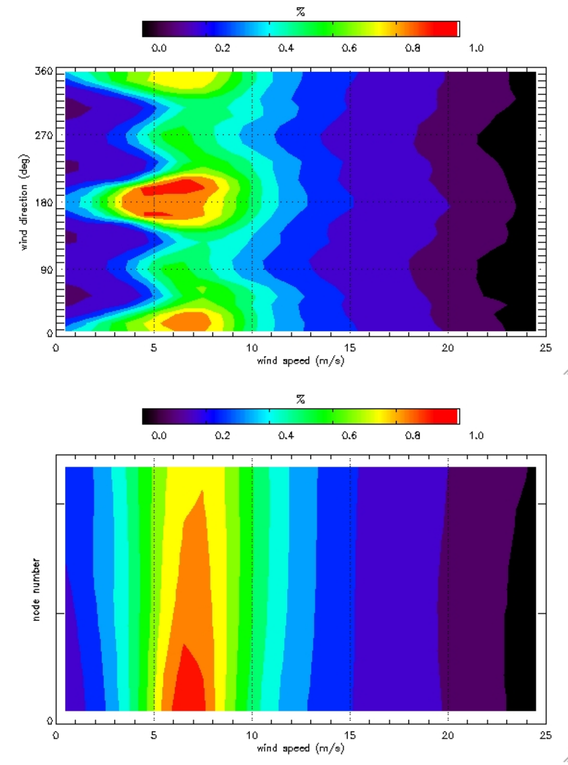


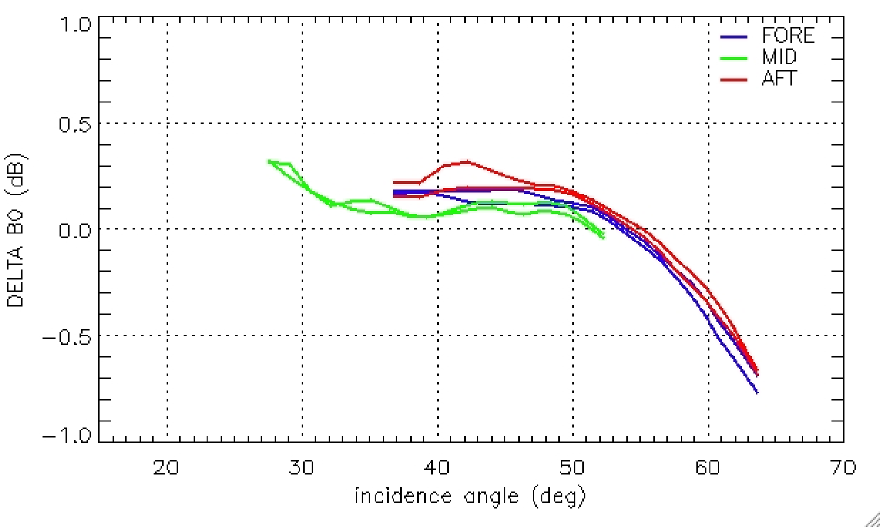

## ASCAT A 2014

## PDF NWP

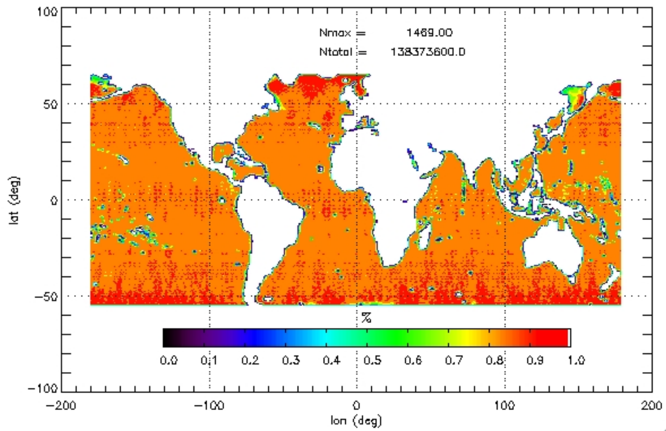



## PDF scat



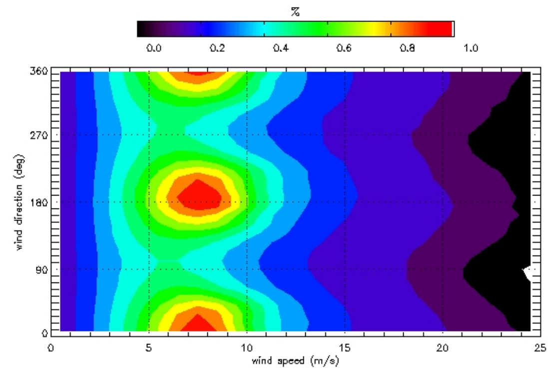



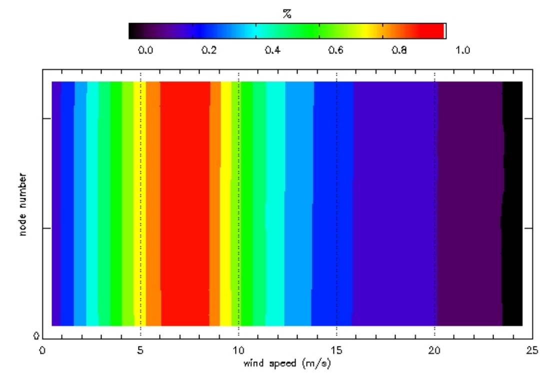
# NOC results




## ASCAT B 2014

## PDF NWP

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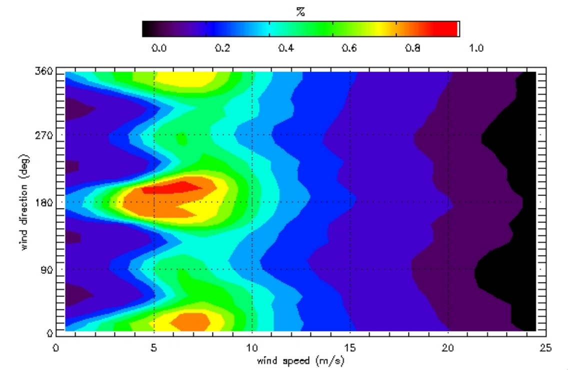


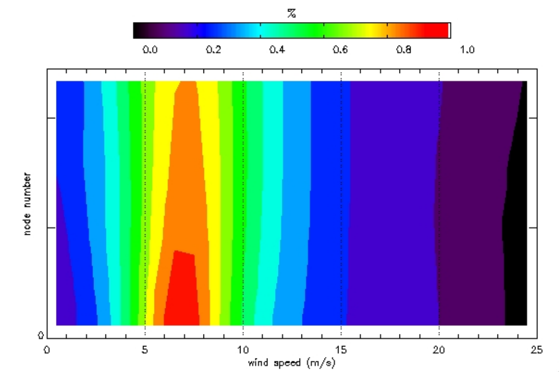


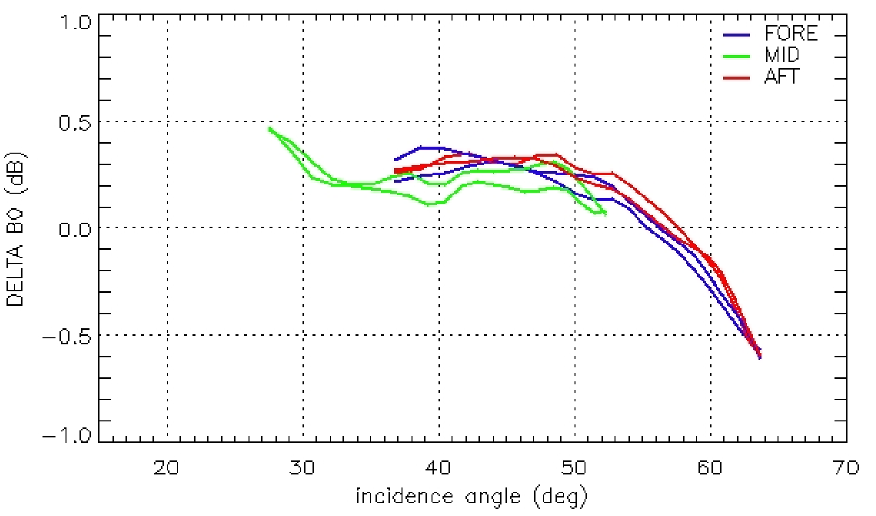

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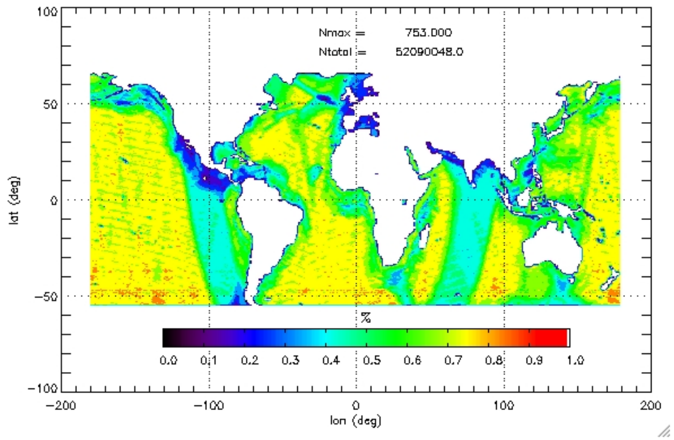
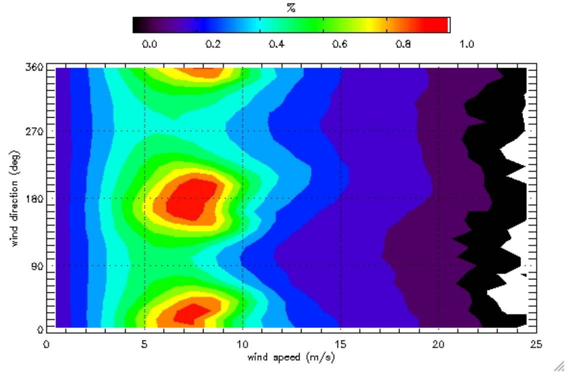
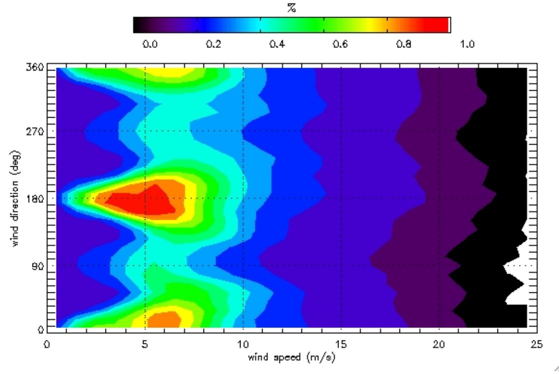


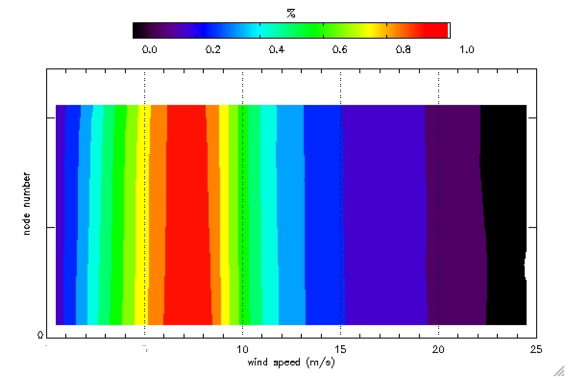

ERS2 knmi 1997

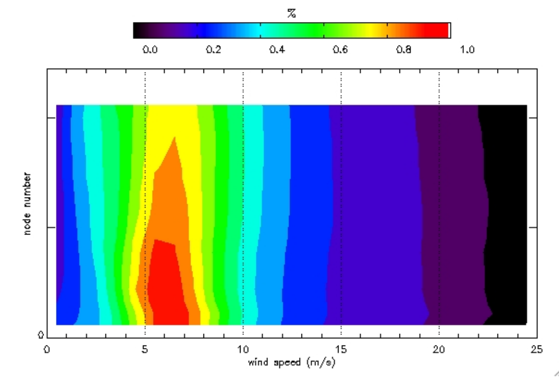
PDF NWP

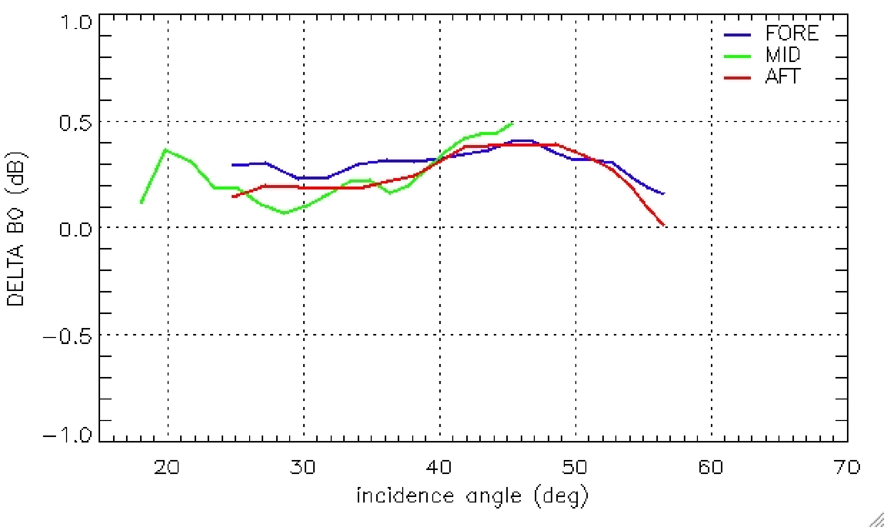
PDF scat



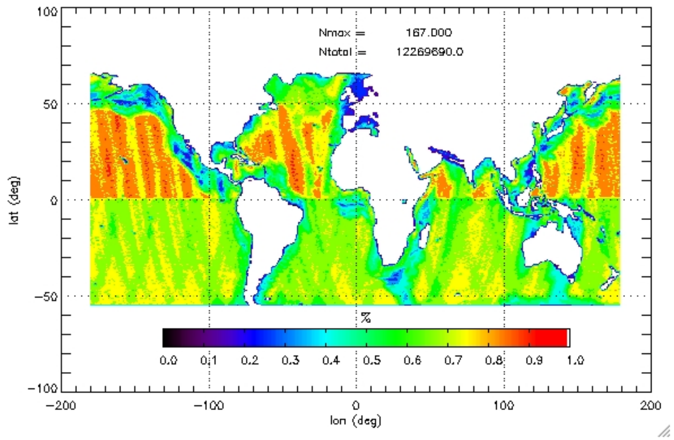



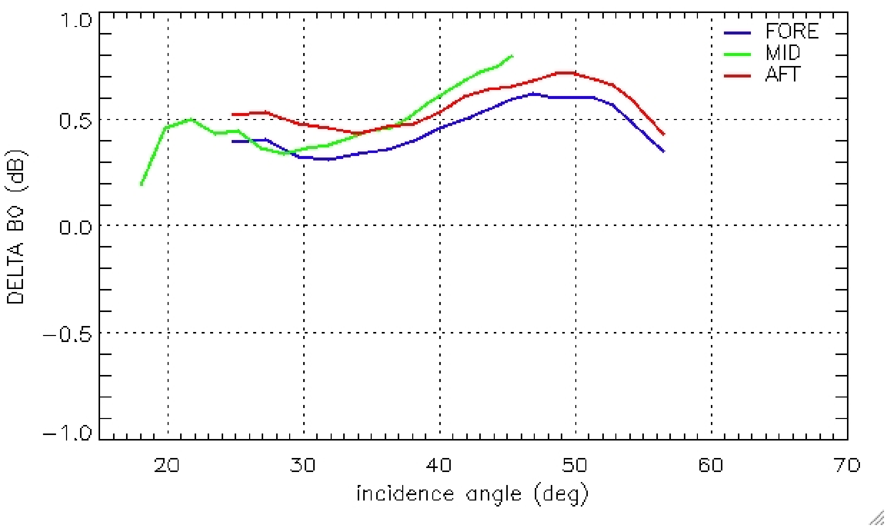



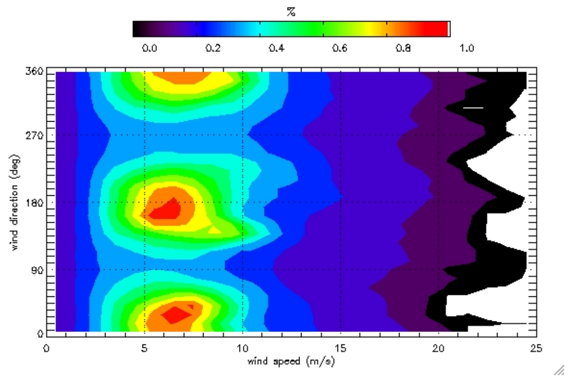
# NOC results

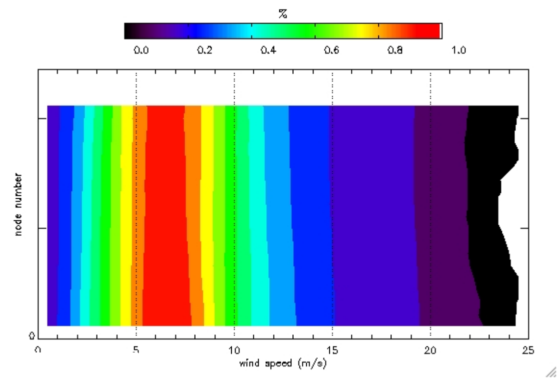



# ERS2 ASPS tandem




## PDF NWP

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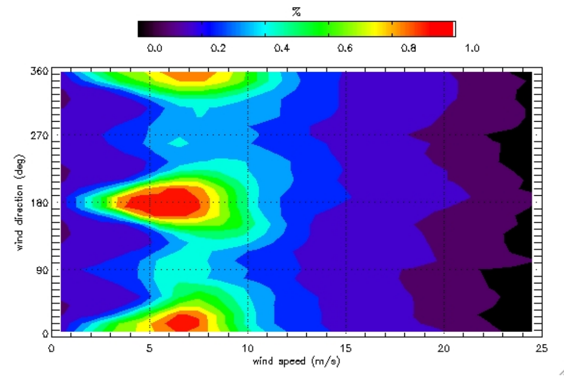
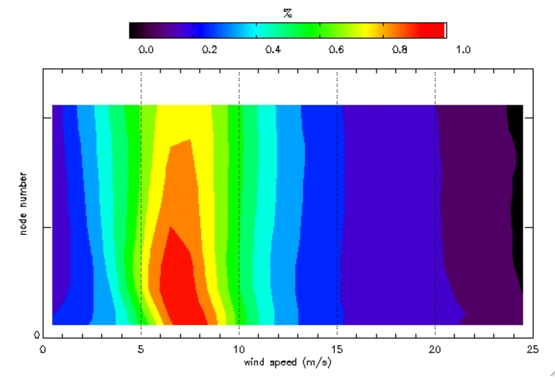
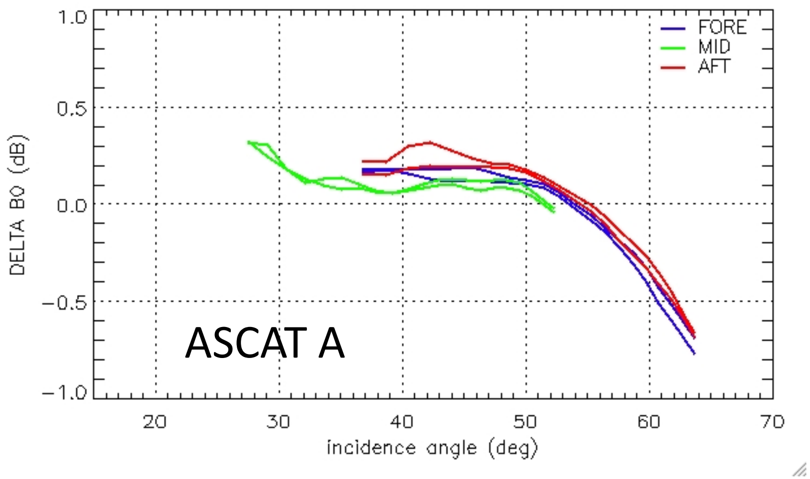
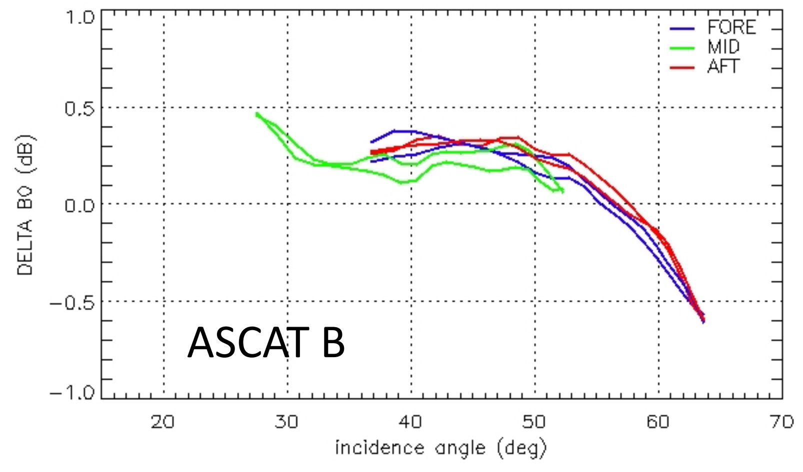
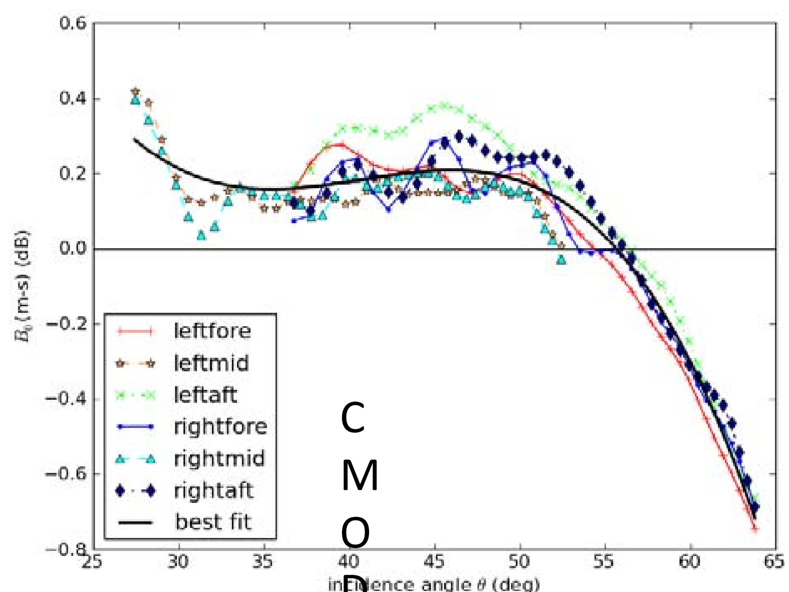


# Comparison of NOC results

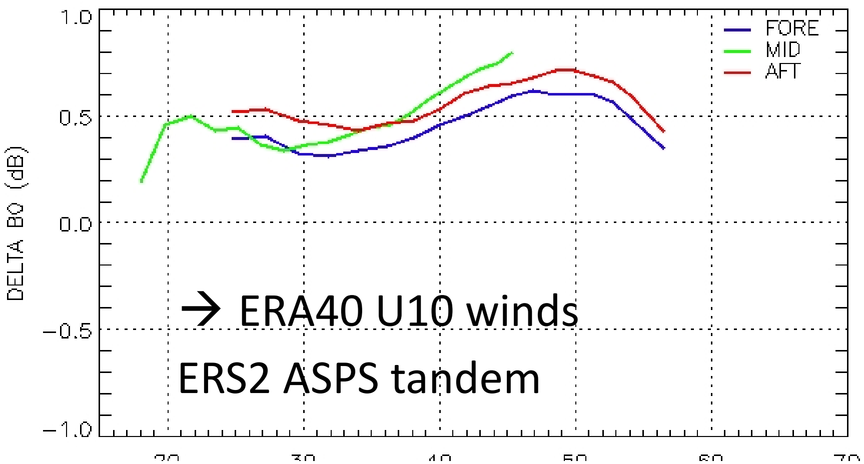


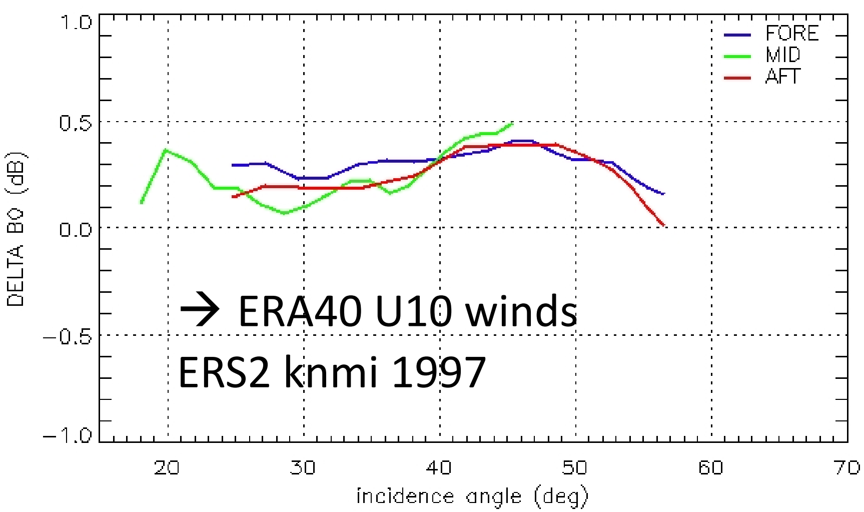



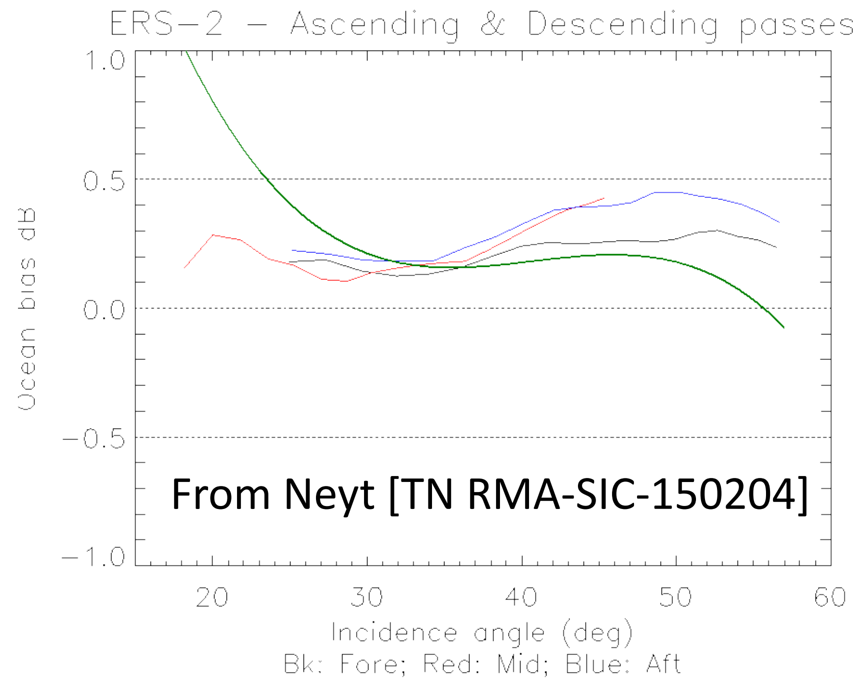




[Verspeek, TGRS, 2011]
“Improved retrieval…
using ocean calibration”

# Comparison of NOC results




**Model bias relative to CMOD5n - Green curve: CMOD6 model bias wrt CMOD5n**

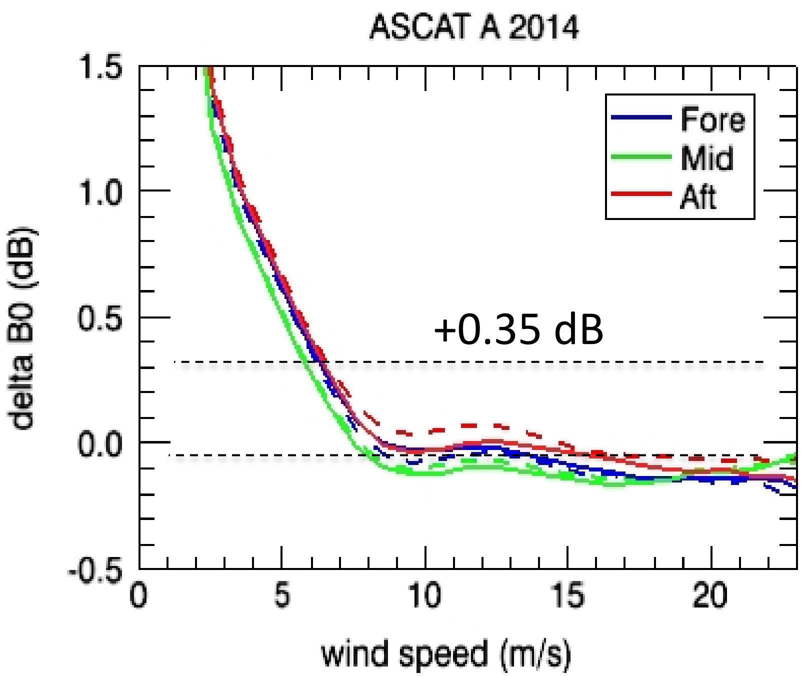
→ similar shapes but KNMI results 0.2-0.3 dB higher than RMA's ??

# NOC open issues

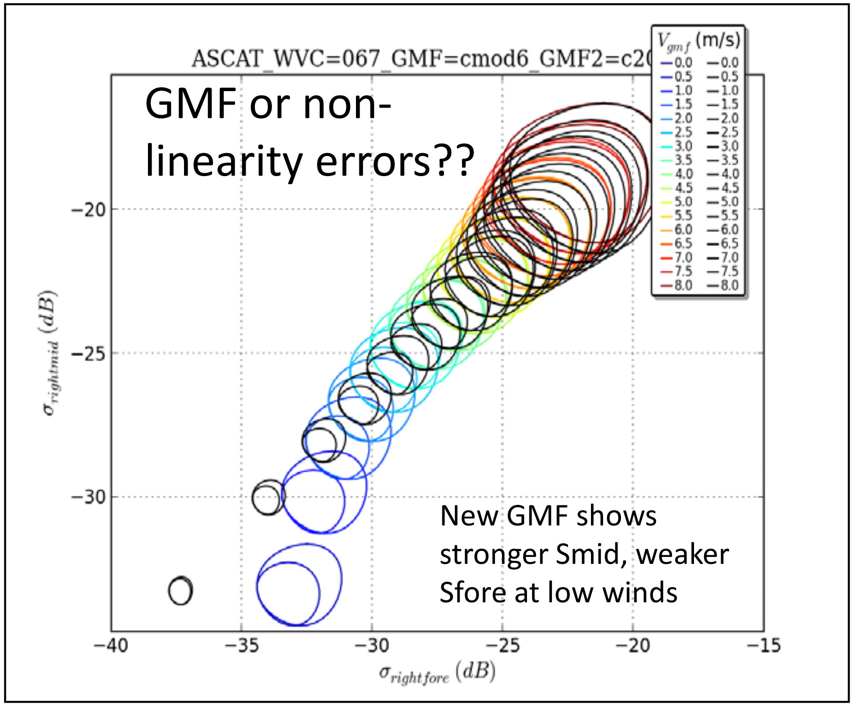
- Sensitivity to non-linearity/GMF error
- Sensitivity to wind speed error
- Sensitivity to directional NWP wind error
- Time stability
- Relative NOC

# Sensitivity to non-linearity/GMF error

- NOC coefficients ($B_0^{OBS}$ minus $B_0^{SIM}$) are estimated relative to a reference GMF (CMOD5n)…

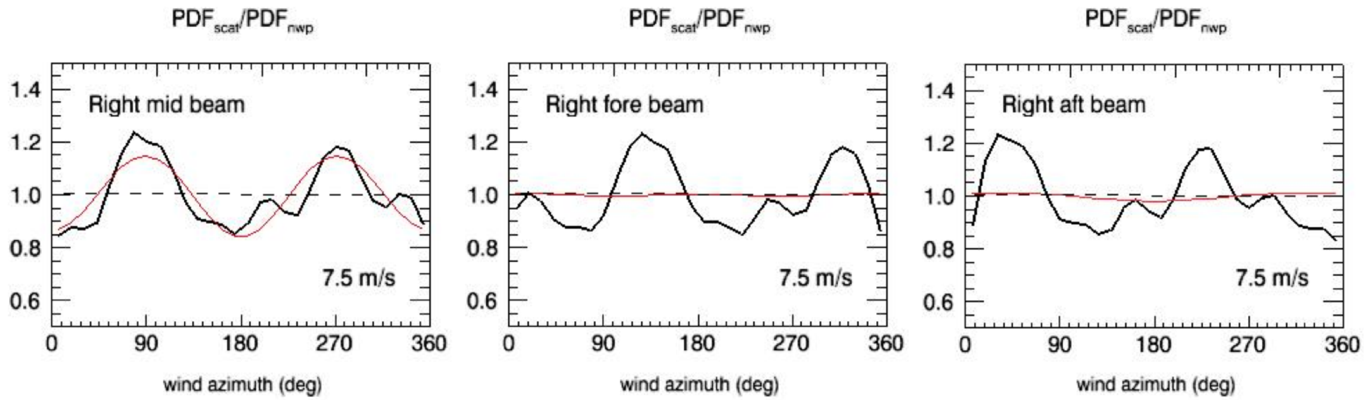



Strong dependence on windspeed




→ Without dependence on windspeed there is no dependence on wind speed error

# Sensitivity to directional NWP errors

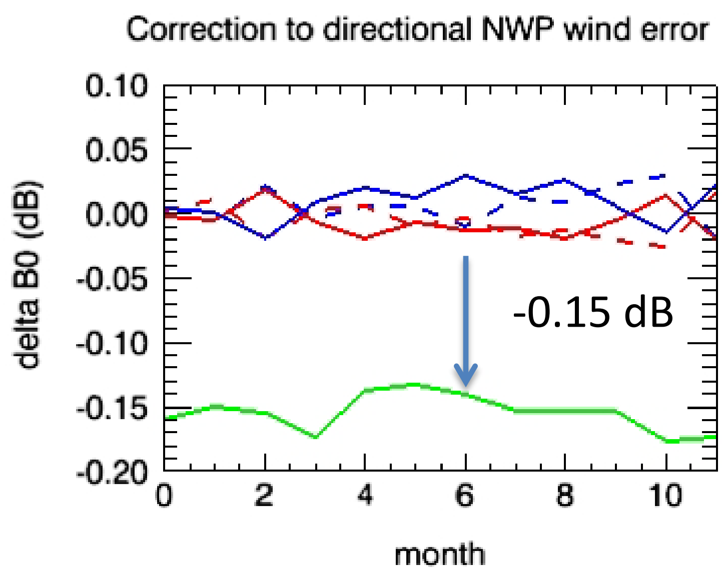



$$w(\phi_{beam}|v)N_{true}(\phi_{beam}|v) = \frac{1}{2\pi}(1 + m \cdot cos\phi_{beam} + n \cdot cos2\phi_{beam})$$

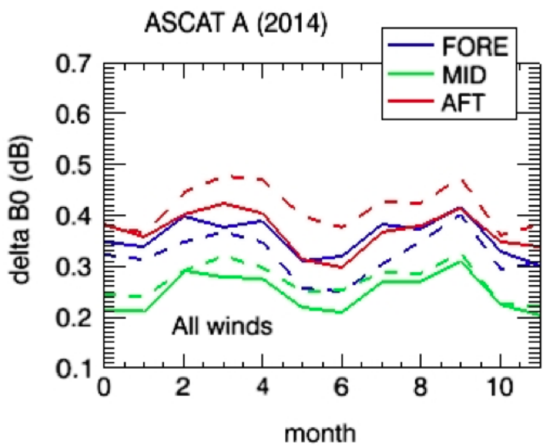
$$m = 2\int_0^{2\pi} w(\phi|v)N_{true}(\phi|v) \cdot cos\phi d\phi$$

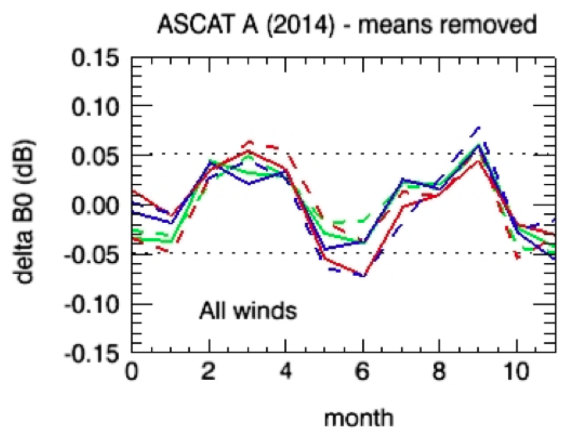
$$n = 2\int_0^{2\pi} w(\phi|v)N_{true}(\phi|v) \cdot cos2\phi d\phi$$

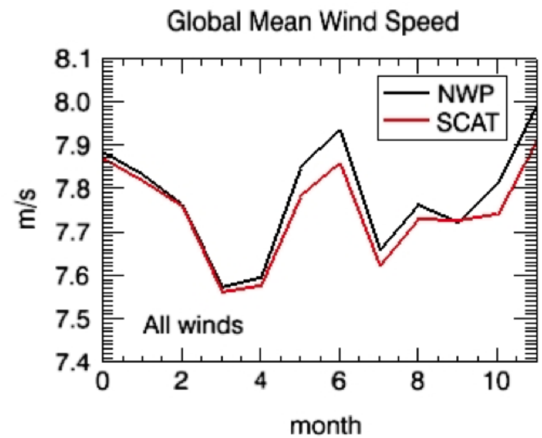
$$\delta_r(v) = \frac{< w(v,\phi) \cdot z(v,\phi) >_\phi}{\frac{1}{2}a_0(v)} = \frac{m}{2}B_1(v) + \frac{n}{2}B_2(v)$$



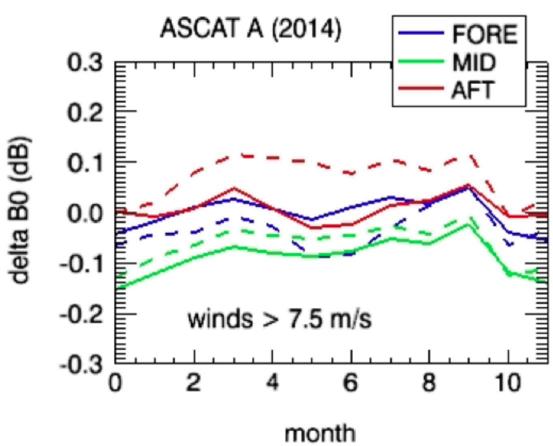
# Time stability

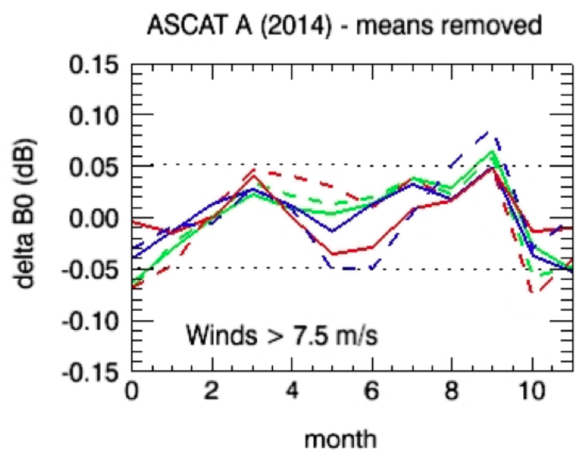


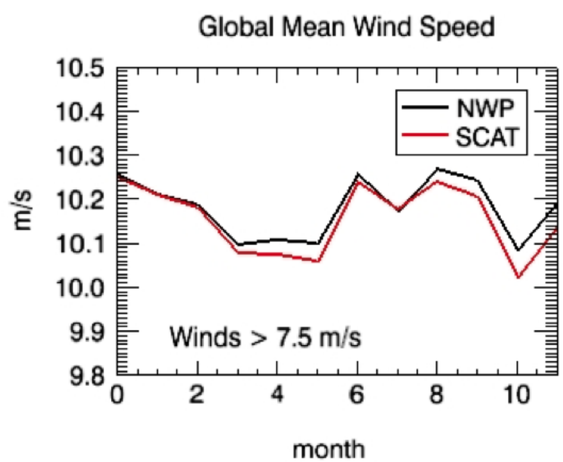




Stability in time series of NOC factors (ALL winds): 0.1 dB annual cycle

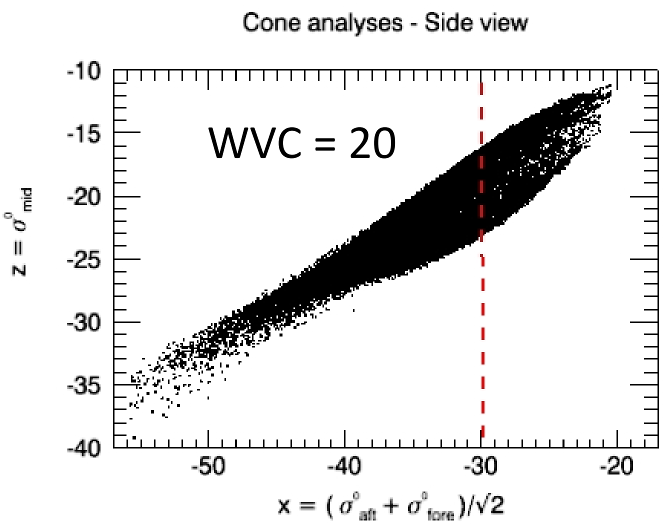


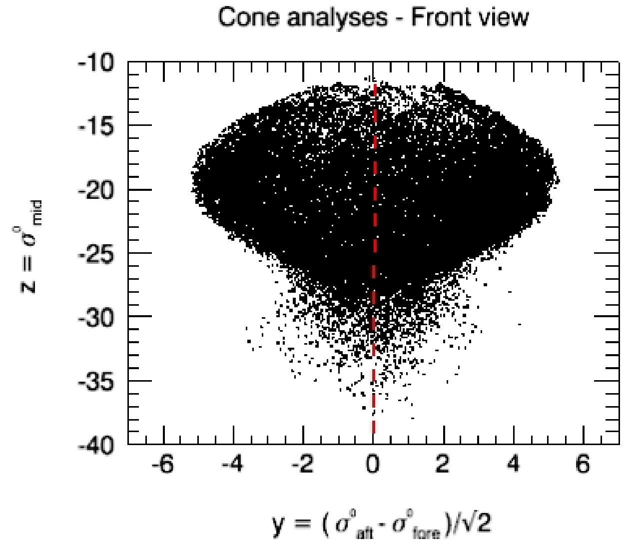



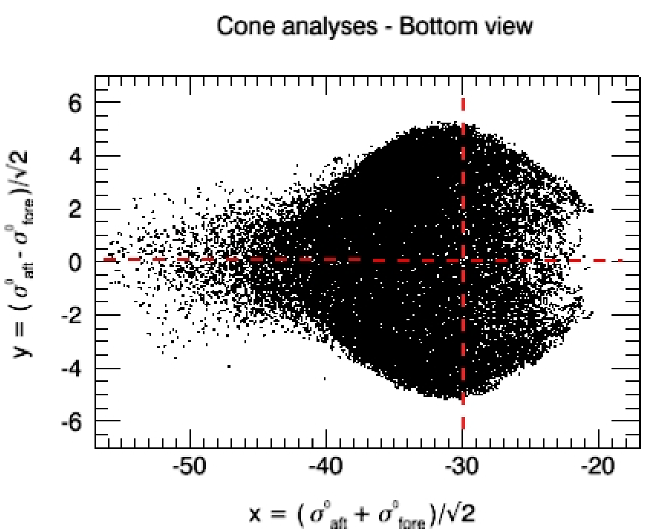




Stability in time series of NOC factors (winds > 7.5 m/s): 0.1 dB annual cycle

# Cone analyses



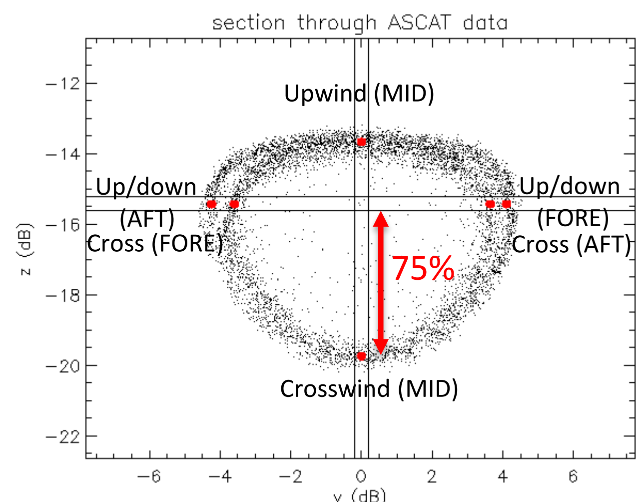




$$x = \frac{(\sigma^0_{fore} + \sigma^0_{aft})}{\sqrt{2}}$$

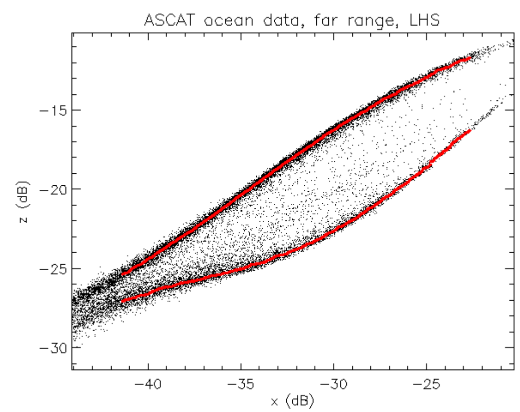
$$y = \frac{(\sigma^0_{fore} - \sigma^0_{aft})}{\sqrt{2}}$$

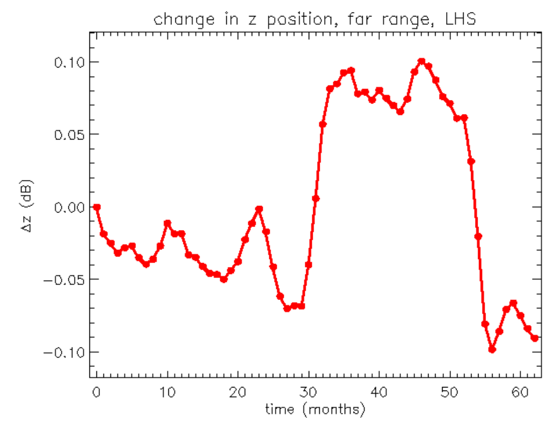
$$z = \sigma^0_{mid}$$




[Anderson, IOVWST, 2012 ]

# Cone analyses



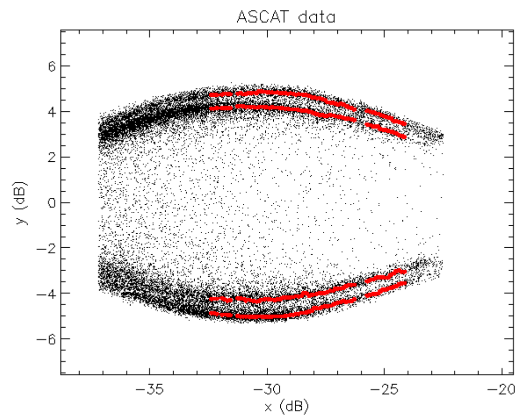



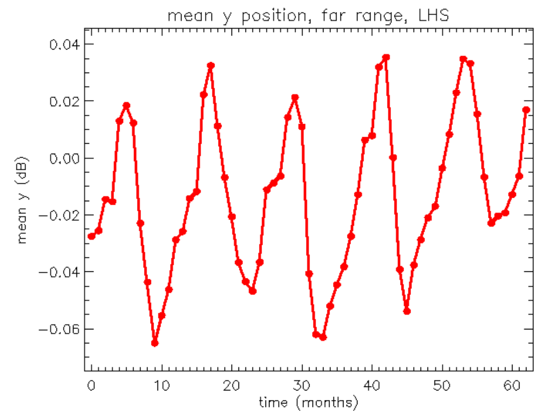

Changes in upper branch Z:

Evolution of MID beam offsets

[Anderson, IOVWST, 2012 ]

ASCAT A (2007-2012)




Changes in left branch Y:

Evolution of FORE/AFT beam offsets

+ Changes in upper/lower branch X → evolution of MID, FORE and AFT beam offsets

<u>To compare against NOC offsets</u>

# Conclusions

- Local implementation of NOC validated
- Disagreement with RMA on ERS2 ASPS NOC
- Ongoing discussion on NOC sensitivities:
  - Non-linearity/GMF error → +0.35 dB bias ALL
  - Directional NWP wind error → -0.15 dB bias MID
  - Time stability → 0.1 dB annual cycle – instrumental?
  - Relative NOC: is it error-proof?
- Cone analyses: bring NOC and cone results in line for studies on calibration stability.

# GMF slice fixed windspeed

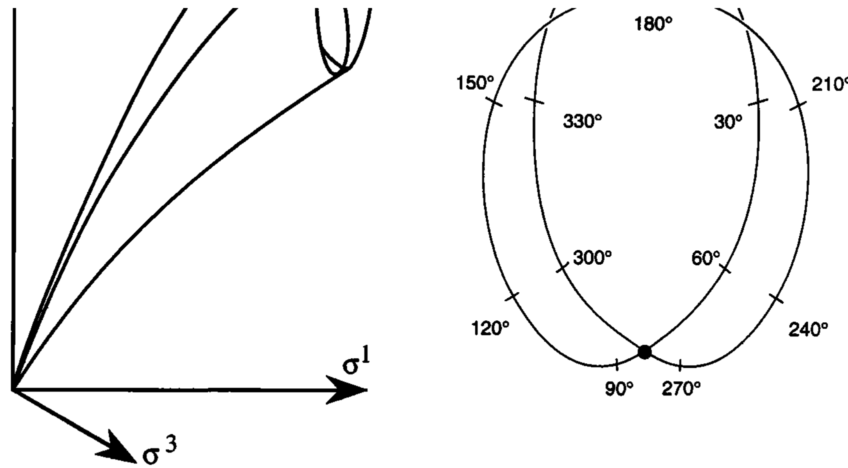



**Figure 1.** (a) Parametric representation of the ERS1 GMF in the sigma-0 space (3-D). When progressing along a directrix of the cone the wind speed varies; the different sheets of the manifold correspond to different wind direction. (b) Graph obtained for a section at constant wind speed showing the possibility of ambiguities in the wind directions.

ıape and amplitude of the Lissajous curve giving the wind ıth depends on the wind speed (Figure 1a), the knowl- of the speed improves the determination of the azimuth. ıe other hand, the wind speed dependence with the azi- seems weaker, except at very low wind speeds, which are nor interest in meteorology and oceanography.

ce the sigma-0 measurements strongly depend on the

field at the scatterometer scale [*Thiria et al.*, 1993], the inpu of the neural networks *S-NN* and *A-NN* consist of the sigma triplets corresponding to the measurements of the three a tenna taken over a spatial window centered on the cell of tl swath where the wind vector is determined (Figure 3); tl input data set is denoted as $G(\sigma_0)$. The size and the shape the neighborhood we deal with represents an adequate trad