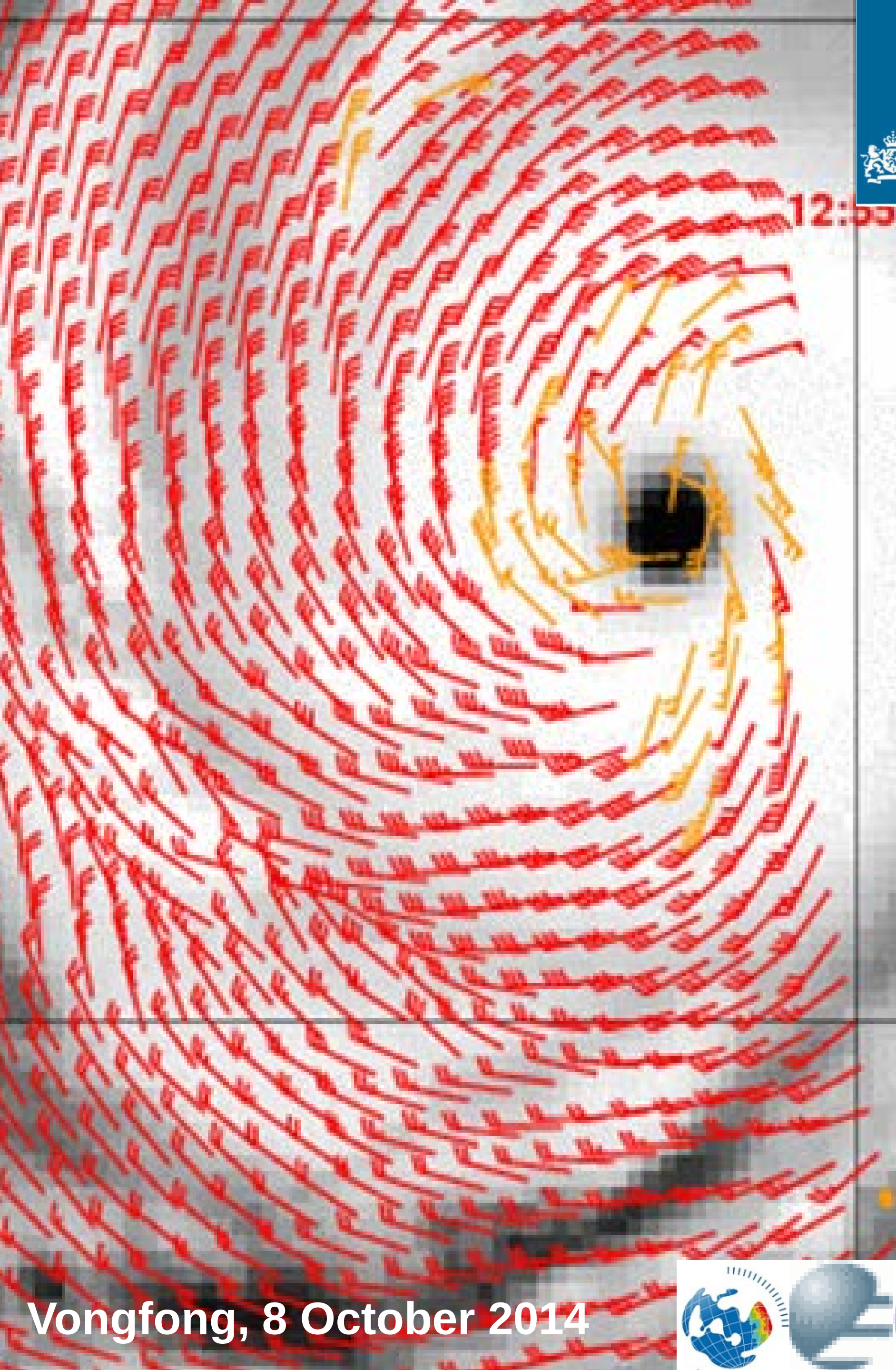
Vongfong, 8 October 2014

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# Scatterometer Calibration

Ad.Stoffelen@knmi.nl
Maria Belmonte
Jeroen Verspeek
Jos de Kloe

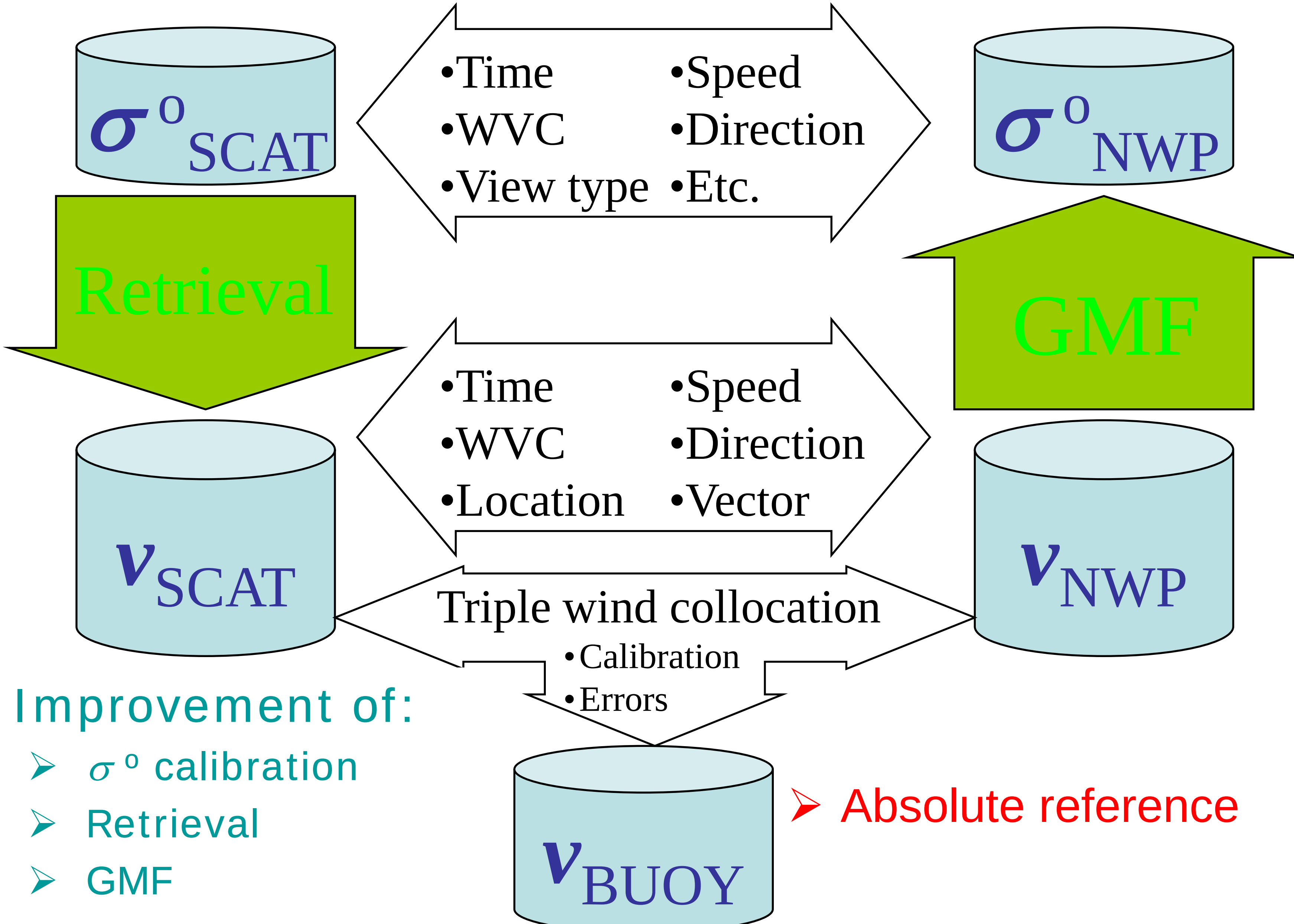
# ASCAT SAG recommendations (2012, 2013)

## Only those related to SCIROCCO:

| | | |
|---|---|---|
| 36.1 | EUMETSAT /OSI SAF to investigate the effects of corner-reflector signals in the wind data record, particularly in coastal areas | EUM/H/OSI SAF coordination, workshop Q3 2014 |
| 36.2 | ESA/EUMETSAT to investigate ways to support aspirational innovation applications and use of data to improve the diversity in scatterometer applications. | Role of the SAFs and scientific studies clarified |
| 36.3 | The SAG sees the need to keep the ERS SCAT data in the context of exploitation going beyond the need of simple data access and recommends ESA to implement the presented Phase F work plan, including the SIROCCO project and the science market approach. | -- |
| 37.1 | EUMETSAT/ESA to consider organising C-band scatterometer science conferences on a regular basis. | **February 2016** |
| 37.2 | EUMETSAT/ESA to consider a better name for the SCA mission, considering the instrument heritage and the continuity (towards the users) of European C-band Scatterometer data services | Scientists suggested **CSCAT** |

- **Next SAG: 16-17 June**

# Ocean Calibration Overview




- Improvement of:
  - $\sigma^o$ calibration
  - Retrieval
  - GMF

- Absolute reference

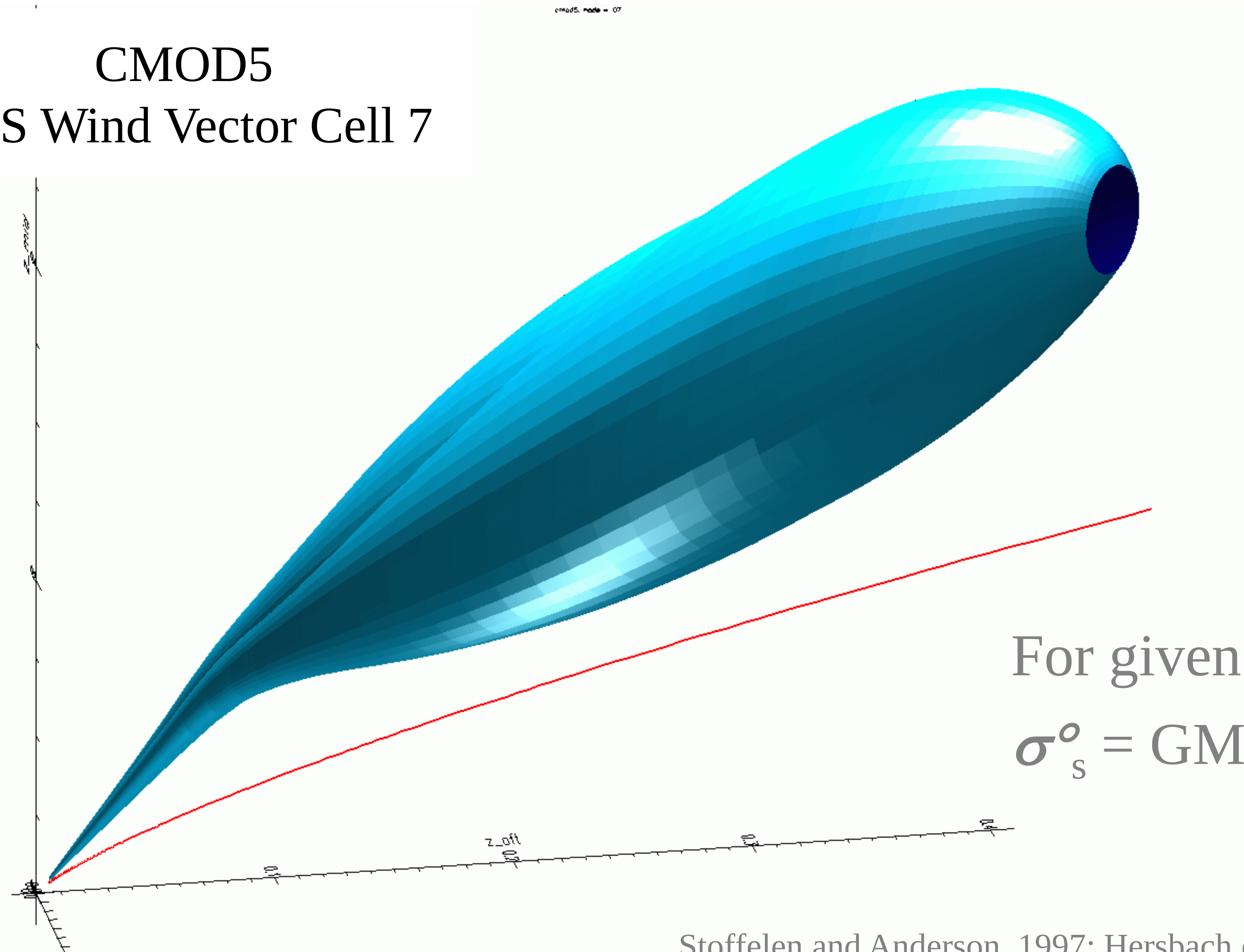
# Geophysical Calibration

- Time invariant targets: sea ice, rain forest
  - Determine map of time invariant points and estimate geophysical state (constant $\sigma^0(\theta)$)
  - Estimate beam biases and SD w.r.t. $\sigma^0(\theta)$
- Known subdomain (wind cone, sea ice line)
  - GMFs well-known from ERS; sensor compatibility
  - Only bias and SD normal to surface/line

☞KNMI will investigate cone metrics of ASCAT and ERS to judge linearity aspects

# ERS / ASCAT Conical Manifold

CMOD5
ERS Wind Vector Cell 7

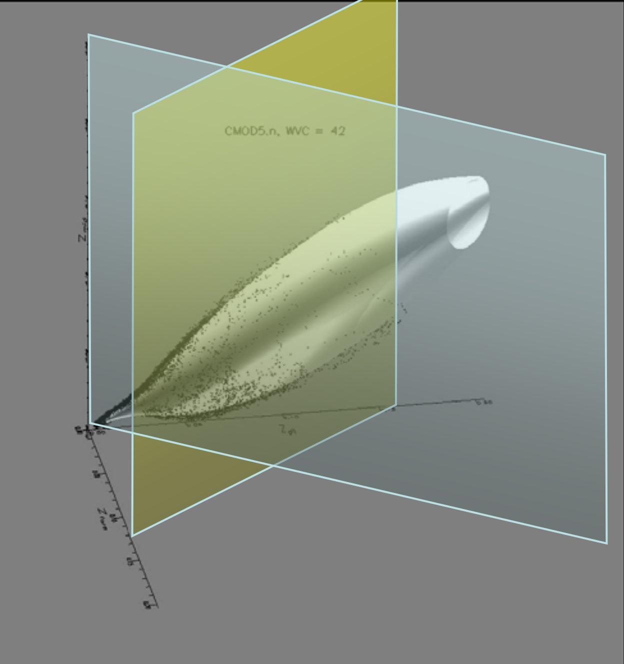


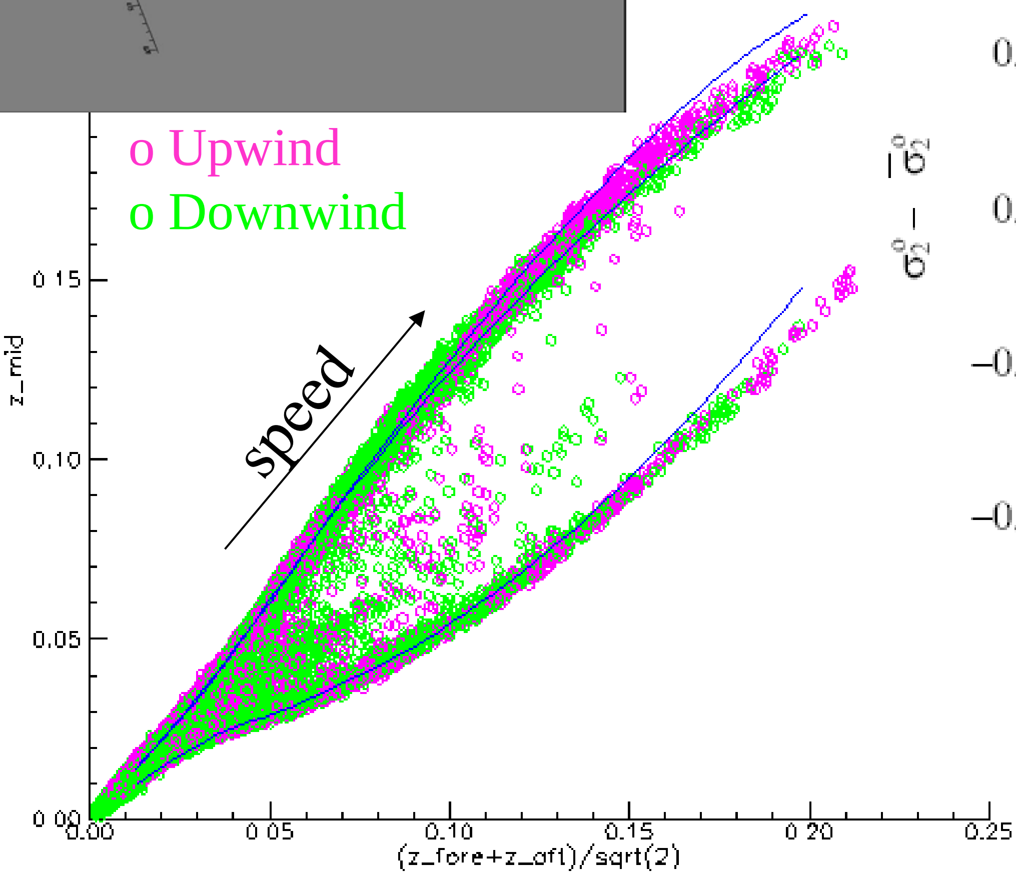

For given $\boldsymbol{\theta}_S$

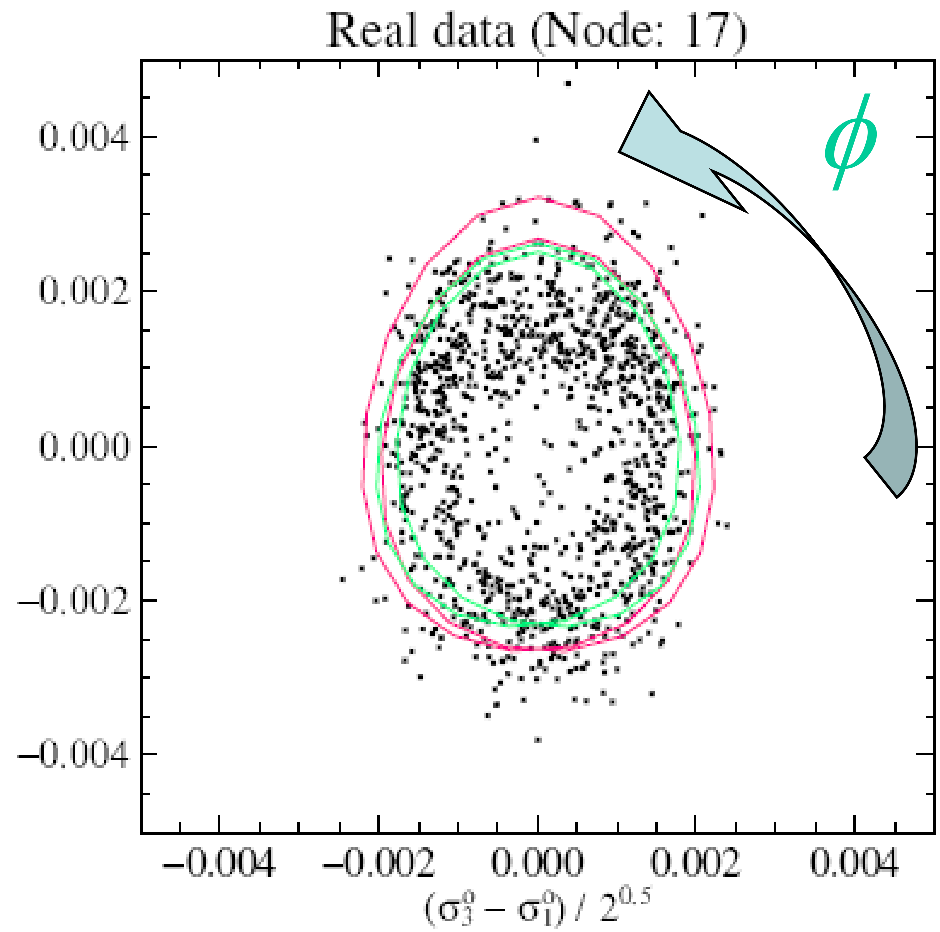
$\boldsymbol{\sigma}^{o}_{s} = \mathrm{GMF}(\mathbf{v}_s)$

Stoffelen and Anderson, 1997; Hersbach et al, 2006

# Cone analyses




Stoffelen and Anderson, 1992+

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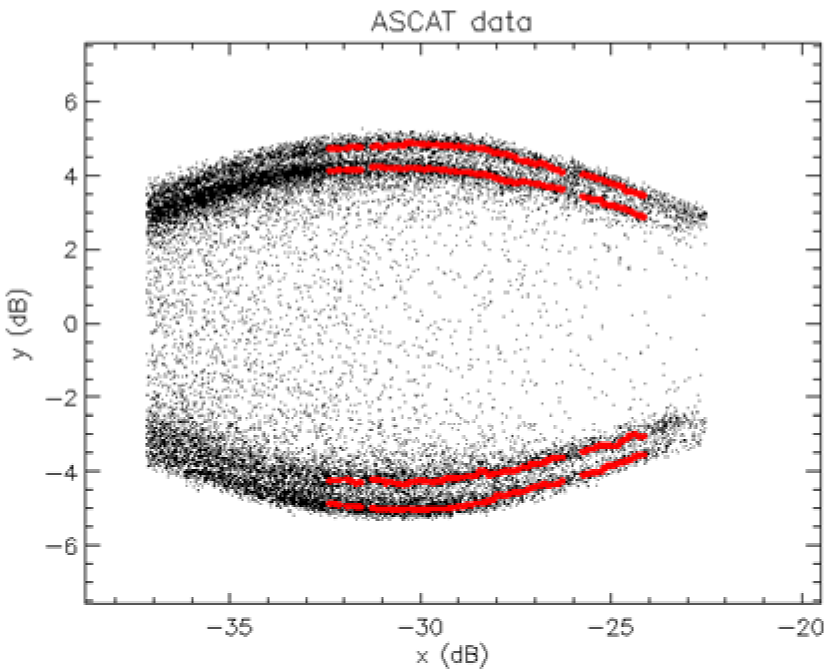
# Detailed cone analysis



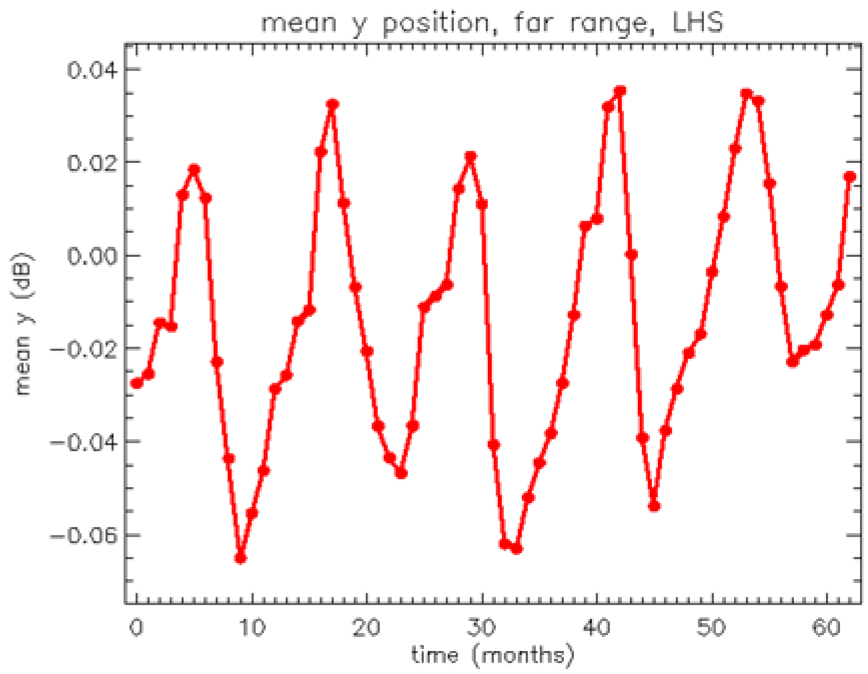



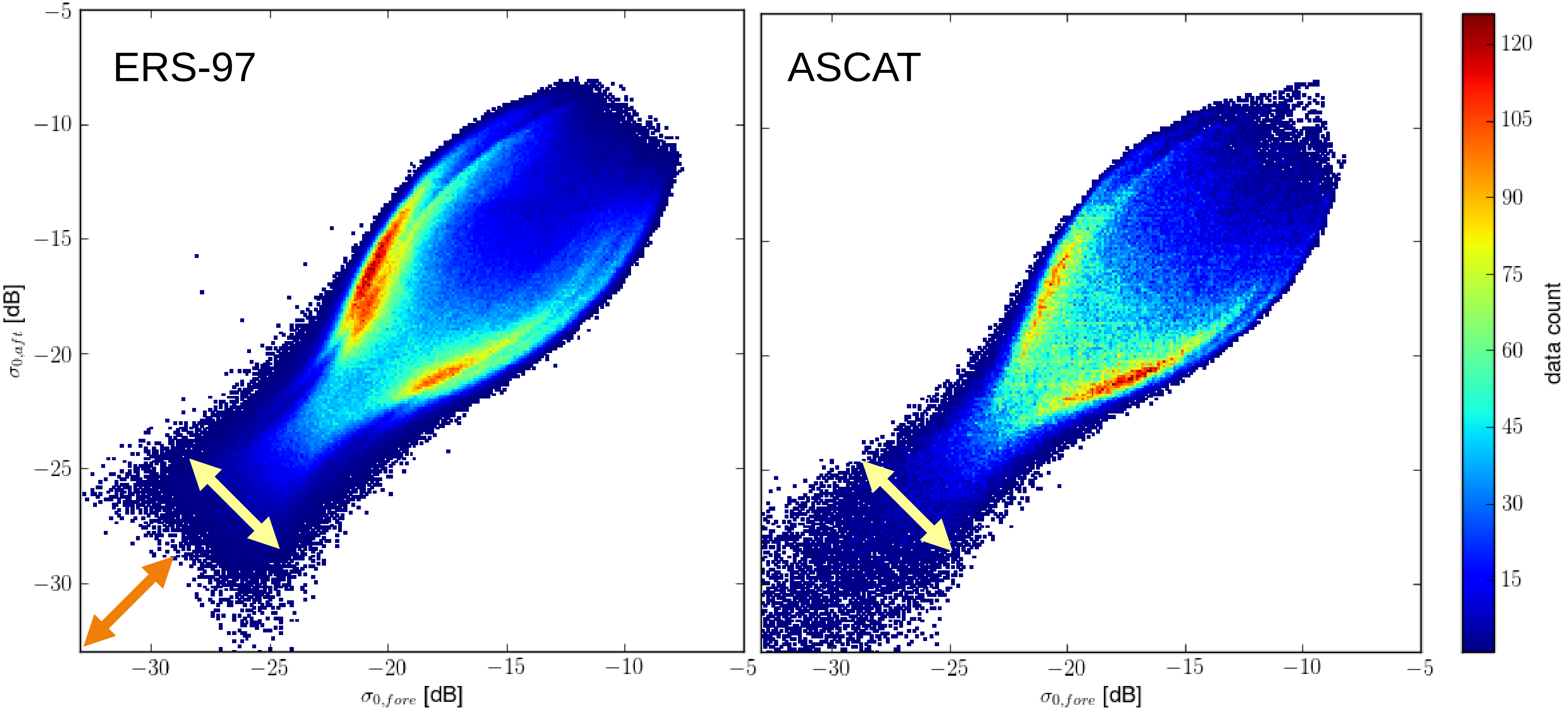

*Figure 5. ASCAT data (black) and position of peak density (red) in multiple slices along the x axis.*

*Figure 6. Time series of the mean y position of the ocean cone.*

- KNMI will investigate cone metrics of ASCAT and ERS to judge linearity aspects

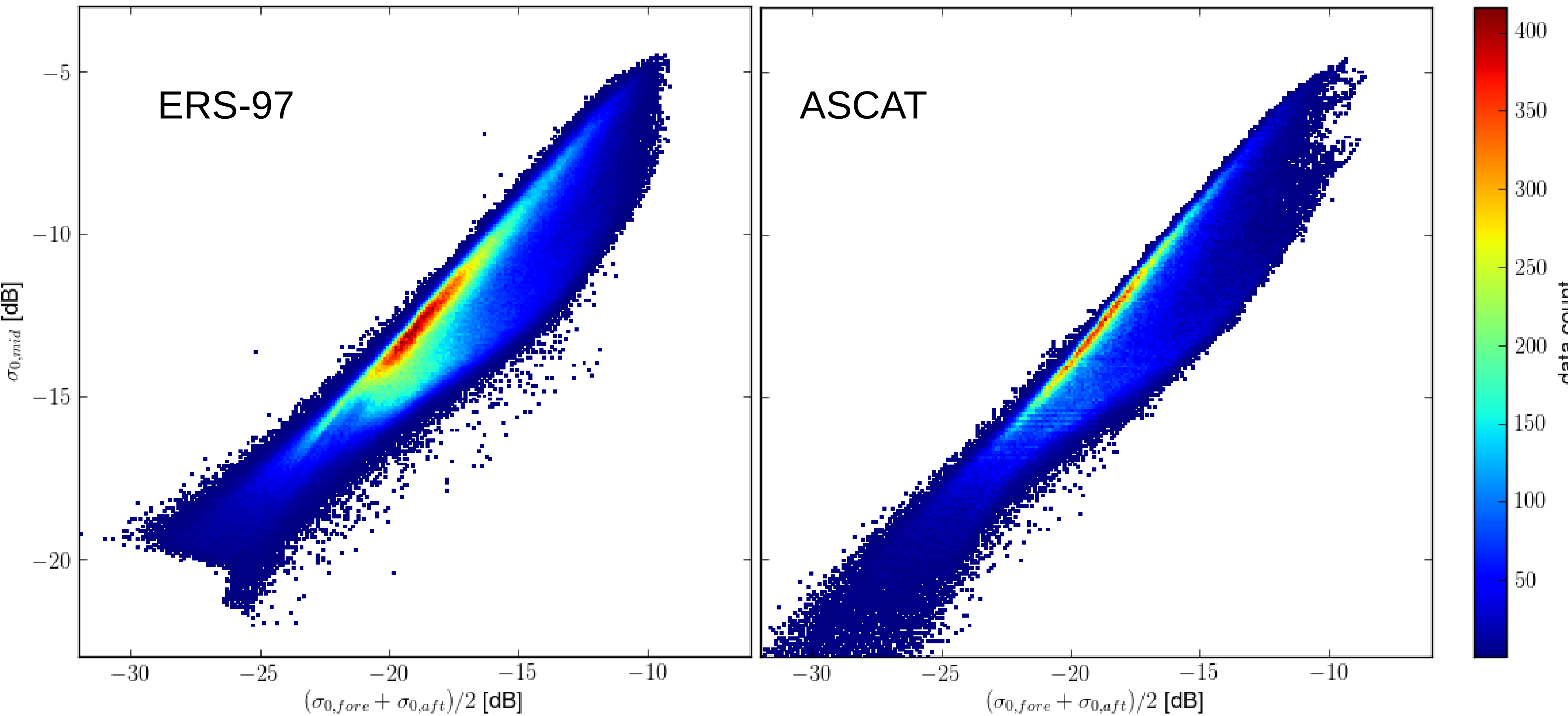
# ERS vs ASCAT in Jan.

- Similar WVC provides different cone features
- ERS has more spread at low backscatter
- ERS has no fore+aft backscatter below -28 dB ??



# ERS vs ASCAT

- Similar WVC provides different cone features
- ERS has more spread, particularly at low backscatter
- ERS has little mid beam backscatter below -20 dB ??



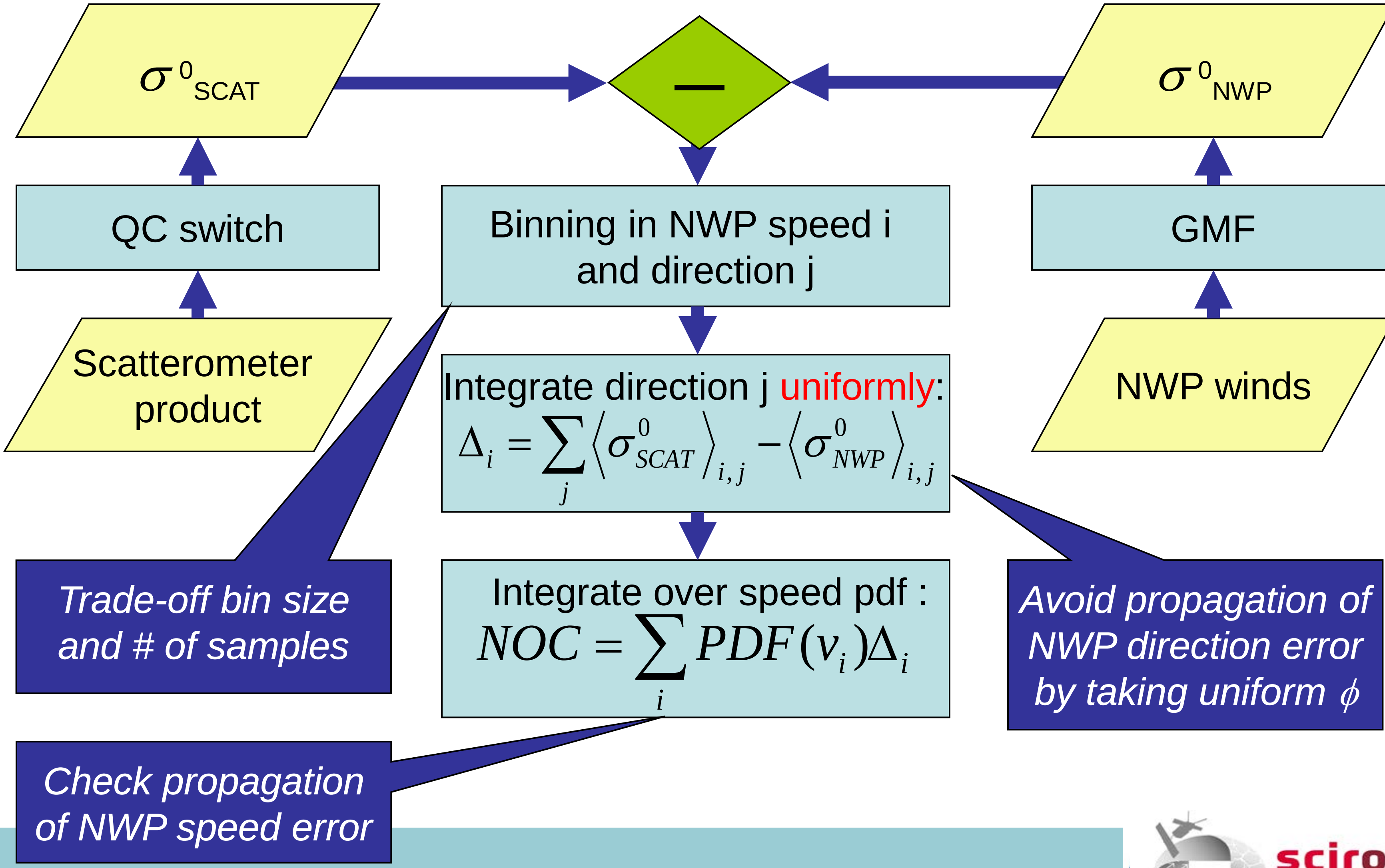
# Geophysical Calibration

- Time invariant targets: sea ice, rain forest
  - Determine map of time invariant points and estimate geophysical state (constant $\sigma^0(\theta)$)
  - Estimate beam biases and SD w.r.t. $\sigma^0(\theta)$
- Known subdomain (wind cone, sea ice line)
  - GMFs well-known from ERS
  - Only bias and SD normal to surface/line
- Predictable geophysical state
  - Ocean calibration; NWP winds; fast
  - NWP wind calibration by triple collocation; slow

# NWP Ocean Calibration

- Based space backscatter; double harmonic only
- on measured minus ECMWF simulated backscatter with CMOD5.n
- *z* Filter to uniform ECMWF wind direction PDF in all speed bins
- Prone to ECMWF wind direction errors: ~0.1 dB
  - Seasonally (weather) dependent
  - Avoid trade latitudes (verified by simulation)

# NWP Ocean Calibration

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# NWP Ocean Calibration

- Based on measured minus ECMWF simulated backscatter with CMOD5.n
- $z$ space backscatter; double harmonic only
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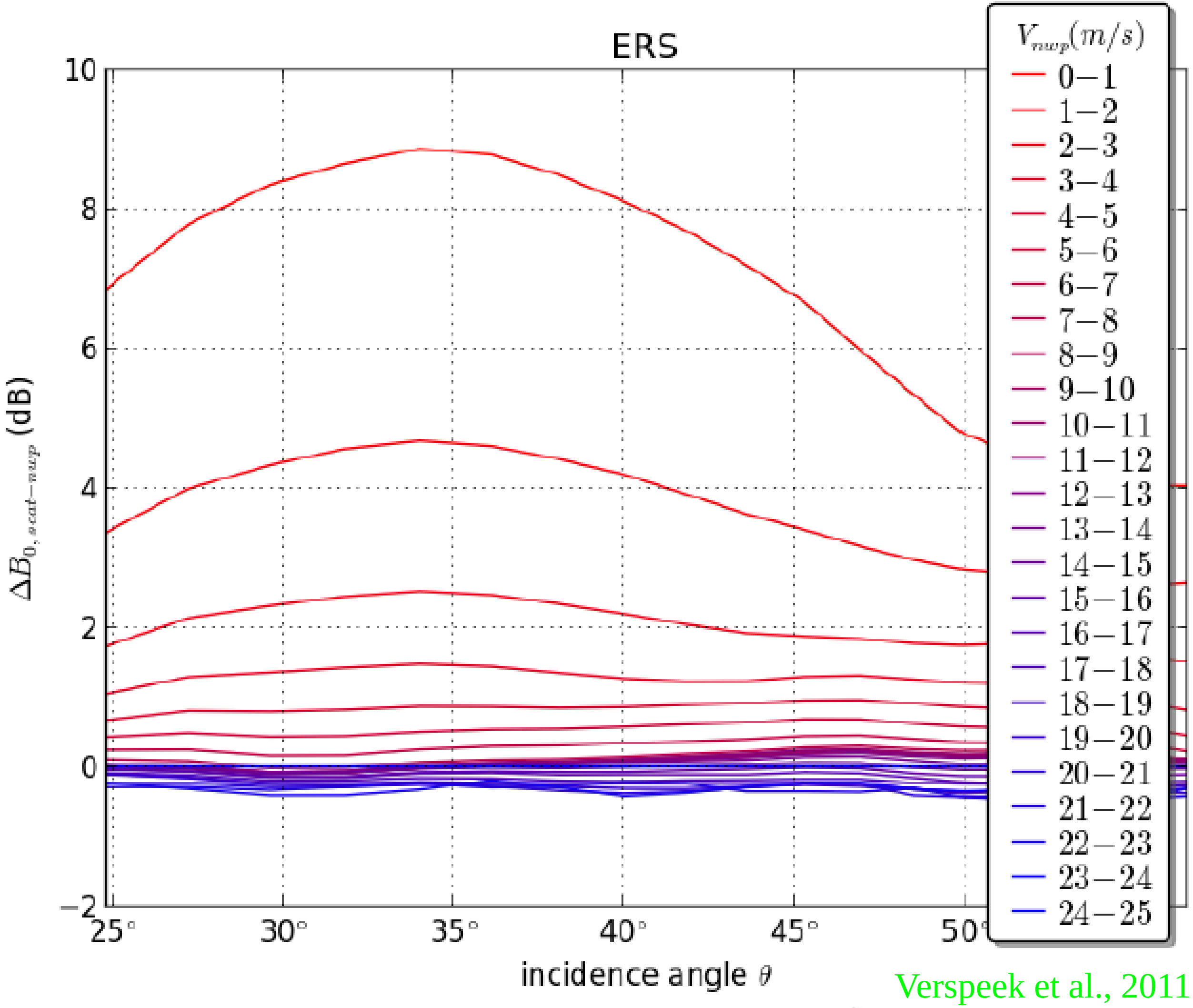
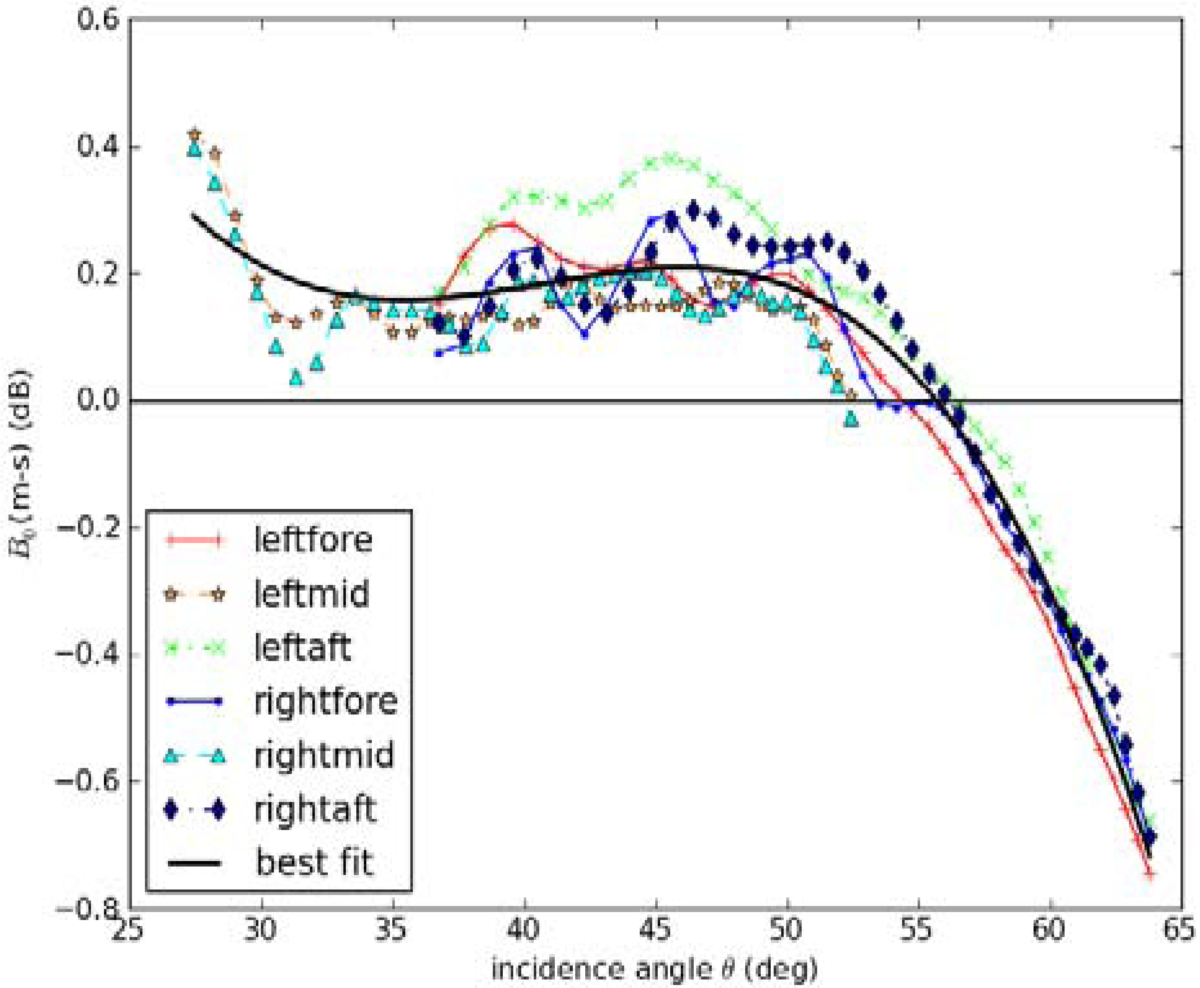
# ERS NOC 1997




Verspeek et al., 2011

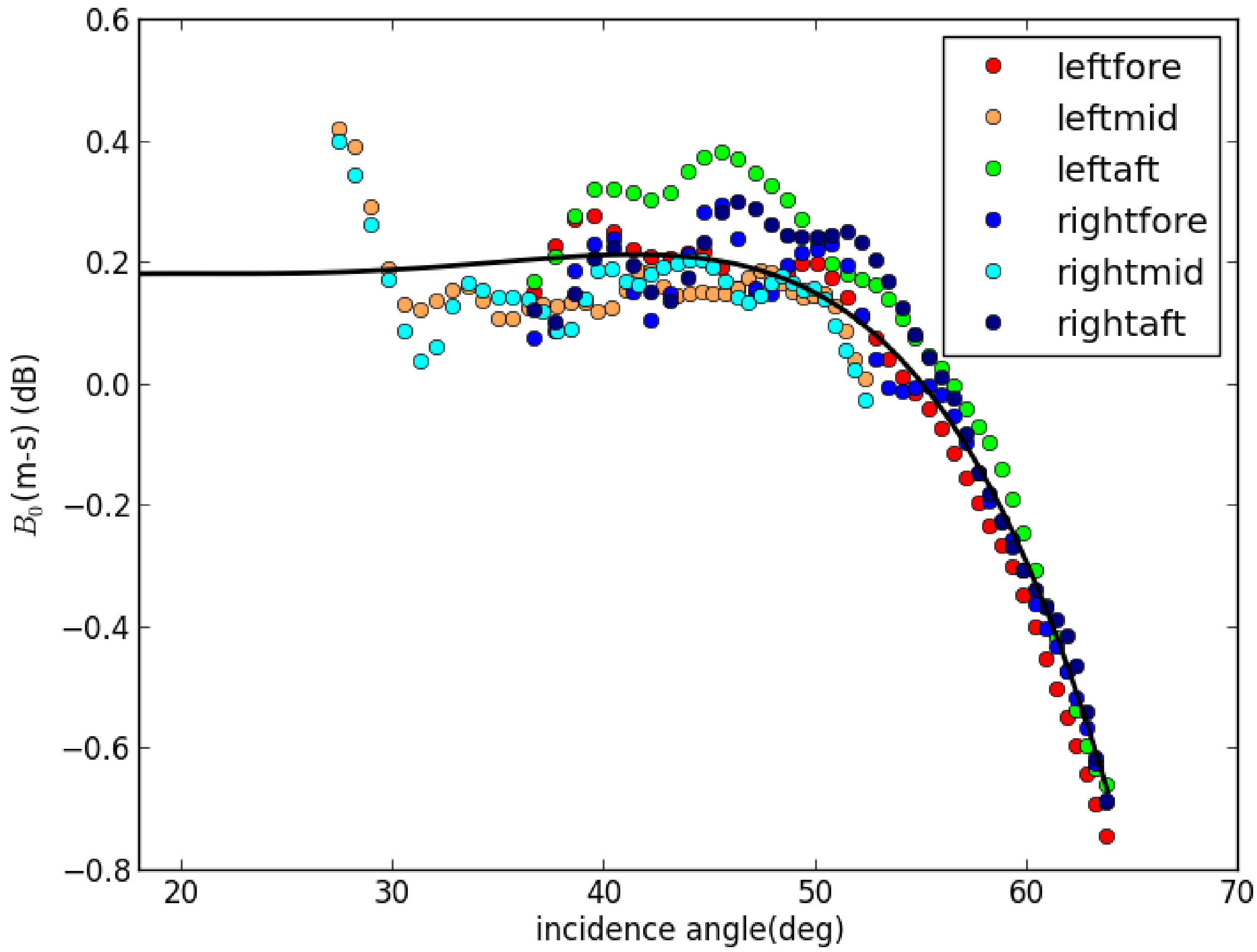
# CMOD5.na

- Verspeek et al. 2011
- 3rd order polynome in incidence angle
- Strong curvature at low incidences
- Implies incorrect extrapolation to ERS low incidence angles from 18-25 degrees



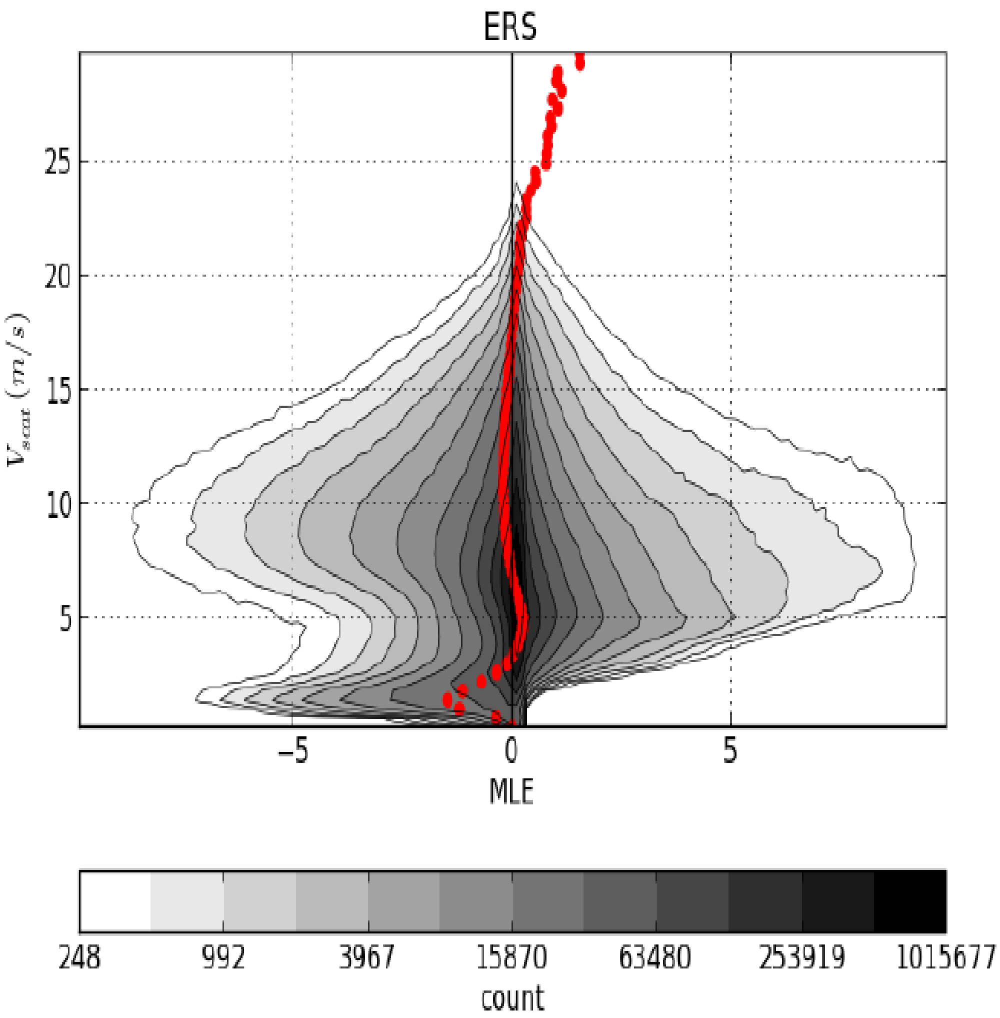
# CMOD6

- 5th order polynome
- Zero derivative at 20 degrees incidence to avoid higher-order ASCAT extrapolation to ERS incidences
- Leaves large ASCAT ripple at 25 degrees !



# CMOD7

- CMOD is based on ERS data with anomalies at low backscatter
- This lead to errors at low winds, visible in MLE statistics
- Using C2013 from RSS, based on ASCAT we are repairing CMOD6
- Before producing an ASCAT CDR later this year we will moreover perform an incidence-angle dependent speed calibration



# Wind stress ECV

- Radiometers/scatterometers measure ocean roughness
- Ocean roughness consists in small (cm) waves generated by air impact and subsequent wave breaking processes; depends on water mass density $\rho_{\mathrm{sea}}$ = 1024±4 kg m$^{-3}$ and e.m. sea properties (assumed constant)
- Air-sea momentum exchange is described by $\boldsymbol{\tau} = \rho_{air}\, u_* \boldsymbol{u}_*$, the stress vector; depends on air mass density $\rho_{air}$, friction velocity vector $\boldsymbol{u}_*$
- Surface layer winds (e.g., $\boldsymbol{u}_{10}$) depend on $\boldsymbol{u}_*$, atmospheric stability, surface roughness and the presence of ocean currents
- Equivalent neutral winds, $\boldsymbol{u}_{10\mathrm{N}}$, depend only on $\boldsymbol{u}_*$, surface roughness and the presence of ocean currents and is currently used for backscatter geophysical model functions (GMFs)

- $\sqrt{\rho_{air}} \cdot \boldsymbol{u}_{10\mathrm{N}}$ is suggested to be a better input for backscatter GMFs

(under evaluation by IOVWST)

# Summary

- Maria Belmonte
- CMOD6
- Next: cone metrics on reprocessed ERS data in comparison to ASCAT metrics
- Test linearity of ERS (wrt ASCAT)
- When proven linear: ocean calibration, AWDP wind validation and monitoring