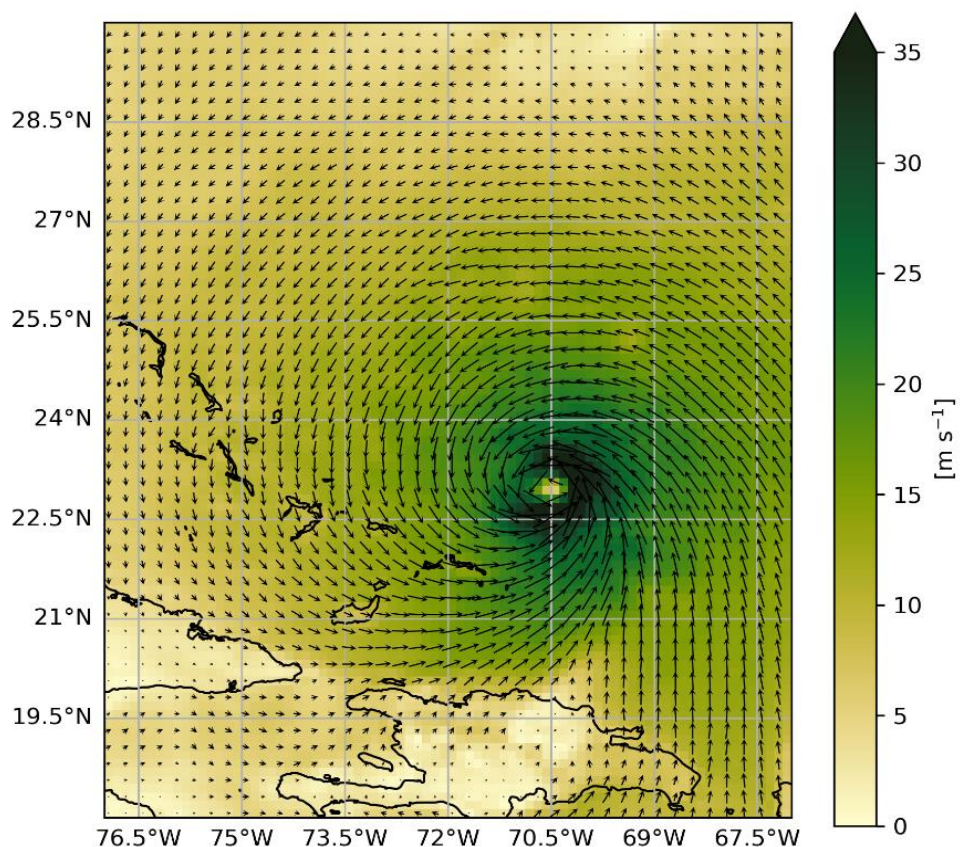




## Improving ocean surface vector wind products from satellite observations

Hurricane Erin on 18 August 2025



[Ad.Stoffelen@KNMI.nl](mailto:Ad.Stoffelen@KNMI.nl)

KNMI OSI SAF team, ICM, CNR  
Wind TAC, KNMI, CLS, OceanScope, IFREMER  
Xingou Xu, NSSC, Beijing, China  
Vaibhav Tyagi, IIT, Indore, India



Royal Netherlands  
Meteorological Institute  
Ministry of Infrastructure  
and Water Management

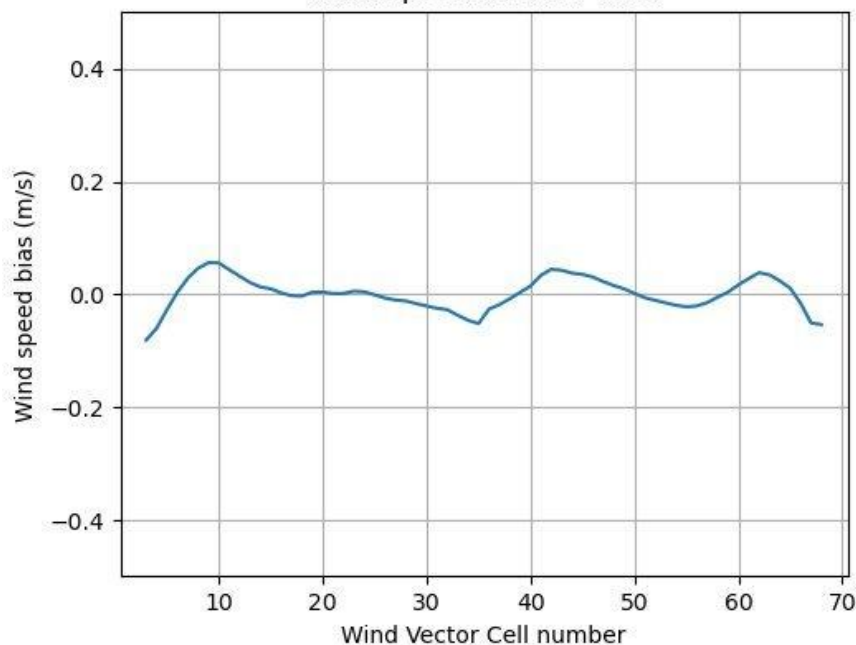


- ASCAT-B, C and HY2-B, C, D, OceanSat3 processed operationally up to L4; HY2D currently not available due to anomaly
- We anticipate this year's launches of SCA-A, OceanSat-3A, and HY2-E and commissioning to follow in close collaboration with producers
- KNMI reprocesses legacy scatterometers ERS, QuikScat, OSCAT, ASCAT, all intercalibrated (cone metrics); Verspeek et al.
- Histova-Veleva et al., Multi-sensor Worldwide Ocean Winds
- Vaibhav Tyagi, ITT Indore, India, OSI SAF Visiting Scientist Activity OSI\_VSA25\_04, Comparison between OSI SAF and ISRO ScatSat wind vectors and ground-based rain radars, ongoing
- Xingou Xu, NSSC, Beijing, China, Resolution enhancement of Ku-band scatterometer vector winds in tropical cyclones (ESA MAXSS CCN)
- Zhao et al., 2025, A rain effect elimination approach using FengYun-3E WindRAD dual-frequency measurements
- Grieco et al., 2025, Validation of SeaWinds-Derived Winds Against Coastal Buoys, now extended to HY2B
- Cossu et al., 2025, Analysis of the sea state dependency of VV and HH surface returns, EUMETSAT OSI SAF OSI\_VSA23\_01
- Wang et al., in review, A GMF with SST for all scatterometry incidence angles
- Rabaneda et al., in review, Inter-calibration of scatterometers and radiometers for extreme winds using NOAA flight data
- [Chen et al., 2025, SAR NRCS is highly resolved, while SAR winds are not, shown by ASCAT and SAR validation with global buoys](#)
- Payez et al., 2025, An extreme value method to study decadal hurricane wind trends (ESA MAXSS)
- Collas et al., Met.No, Triple collocation for wave height error analysis in altimeters, buoys and high-resolution models
- Samuel et al., Optimizing 1D-Var Near-Surface Wind Speed from SSMIS with RapidScat; consolidate passive and active retrievals to prepare for SCA and MWI and for CIMR and HY2

# WindRad C-band only

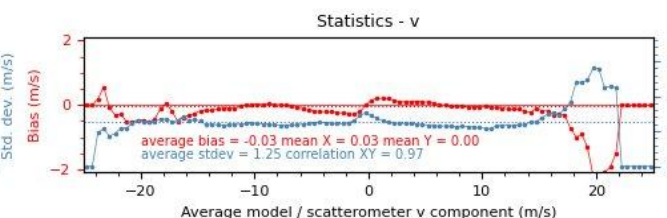
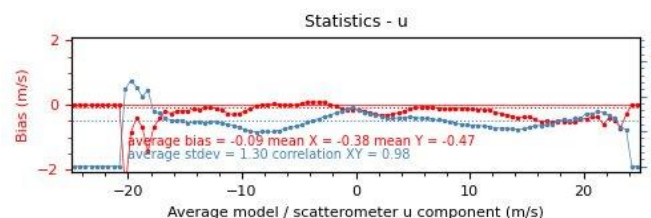
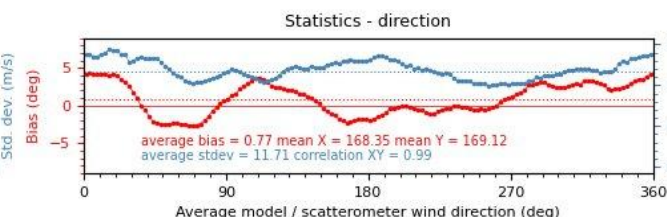
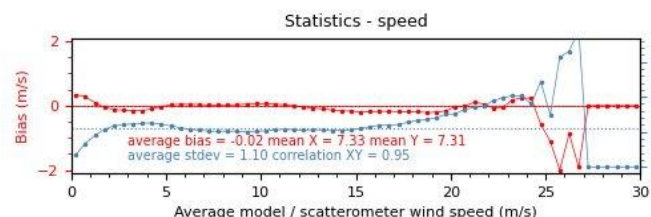
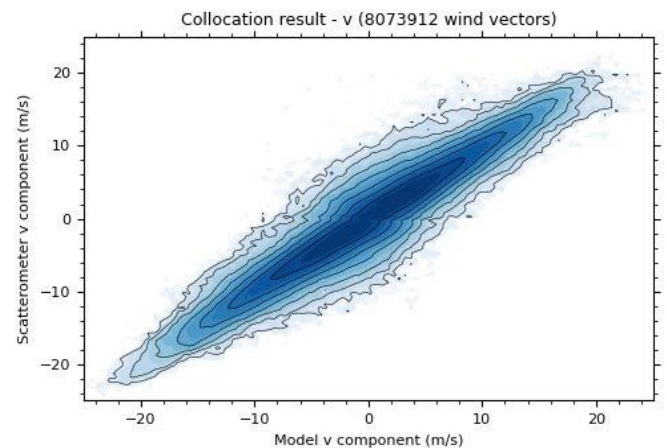
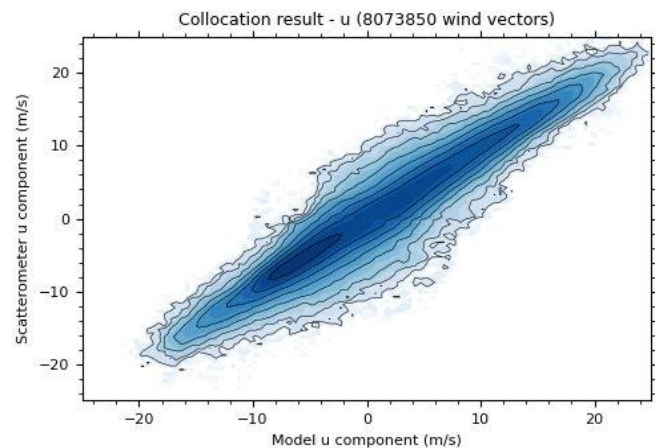
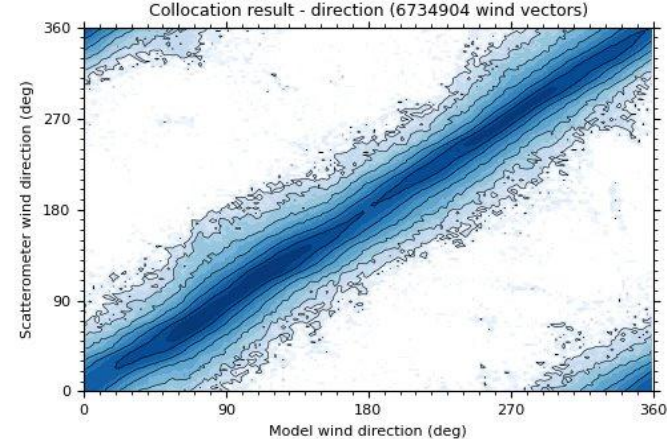
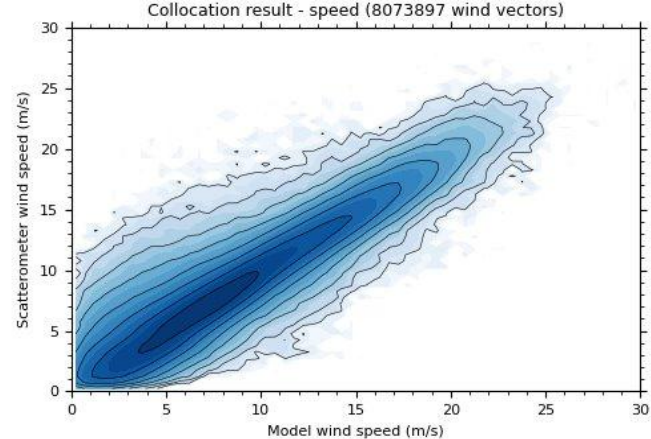
(data in April 2025)

Wind speed bias vs. WVC



HOC + NOCant, and manual delta adjustment on C-HH and C-VV to make the wind speed bias flat across the swath.

Global wind statistics slightly worse than PenWP products, while acceptable



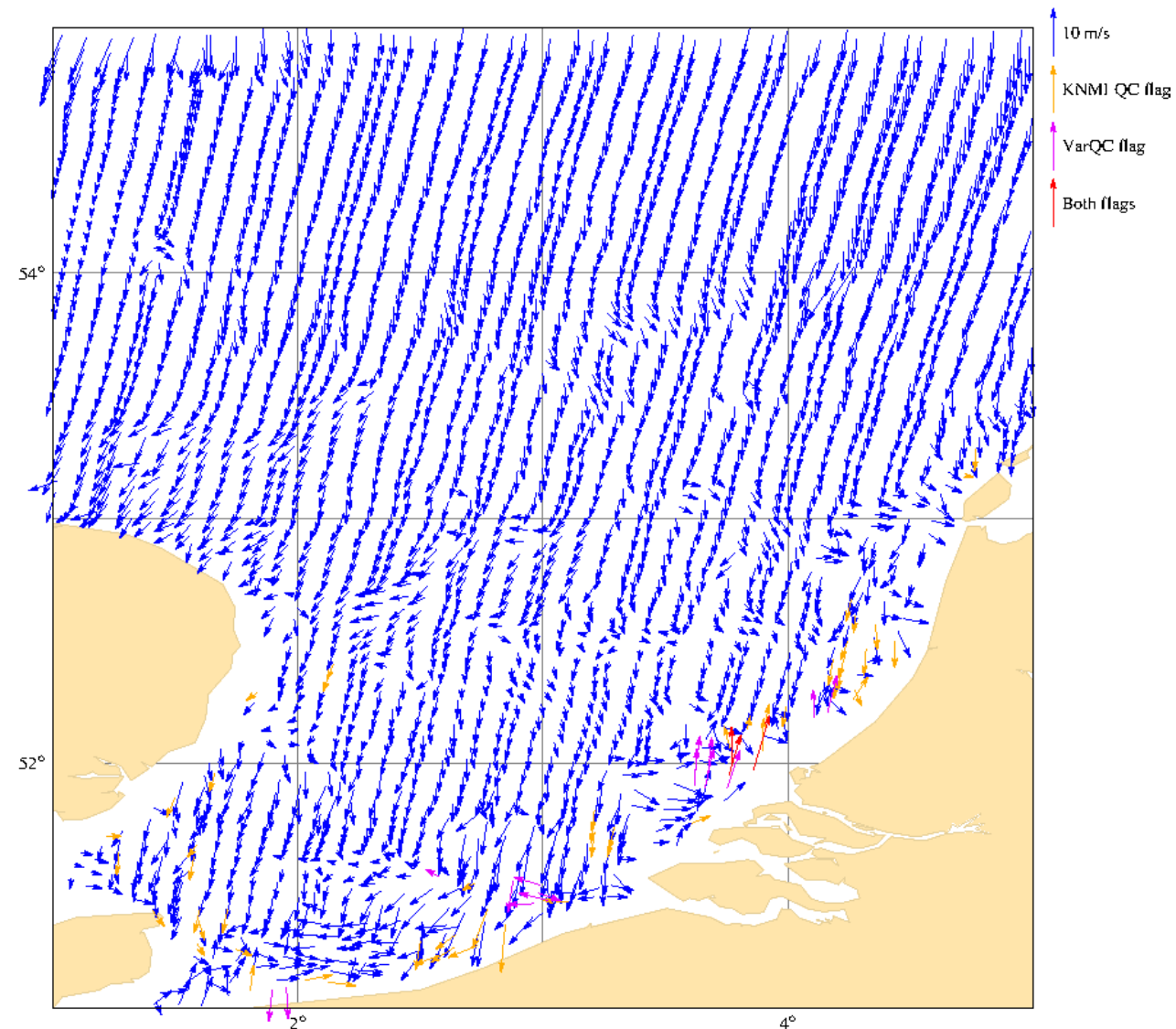


# Slice outlier removal

- > Thresholding
- > Next step is using median values, which might be applied everywhere
- > Relate median to mean over open ocean

See Anton Verhoef this IOVWST

2 times value removed





# Ku-band extremes (ESA MAXSS CNN)



Copernicus  
Marine Service

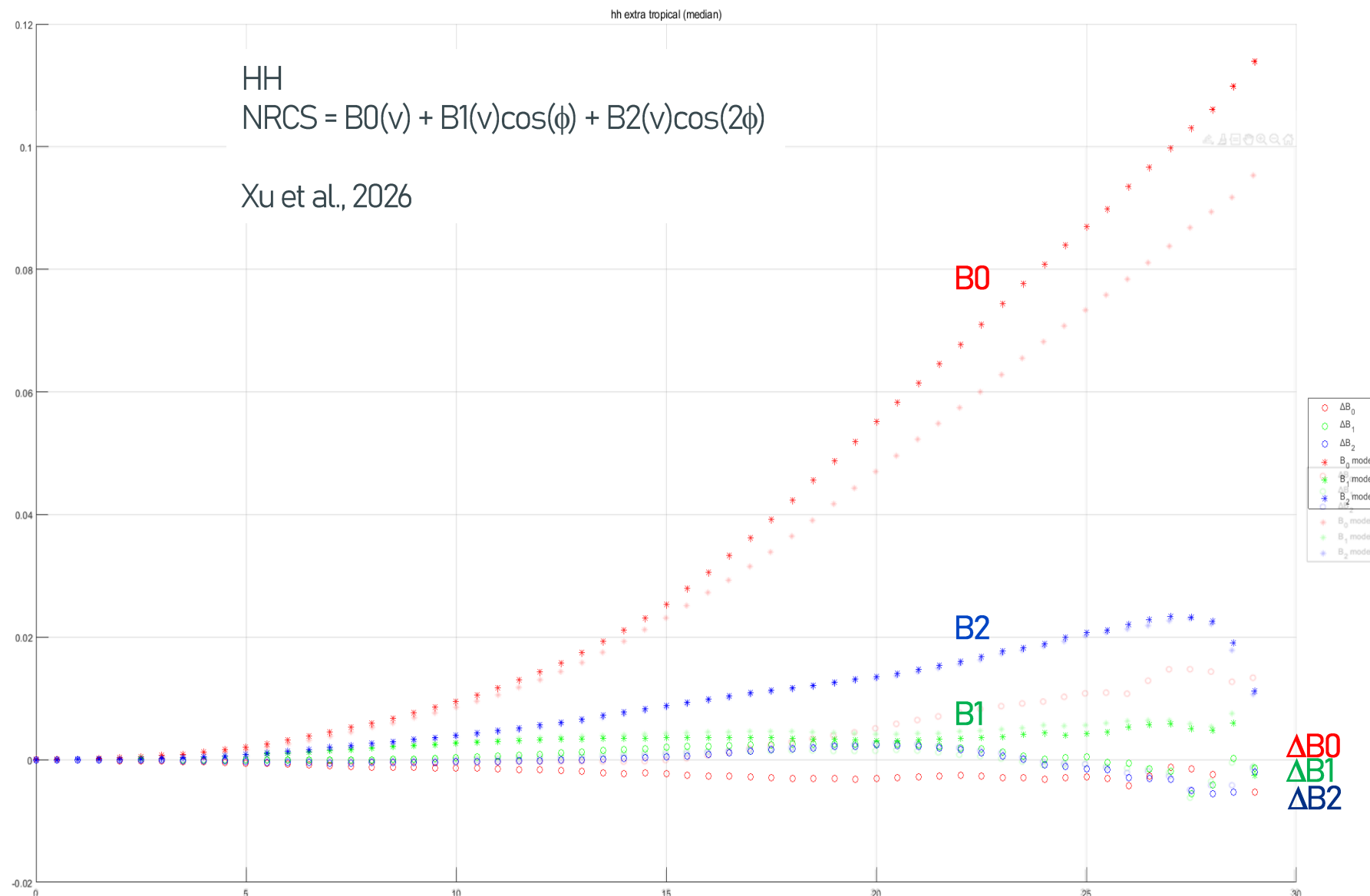


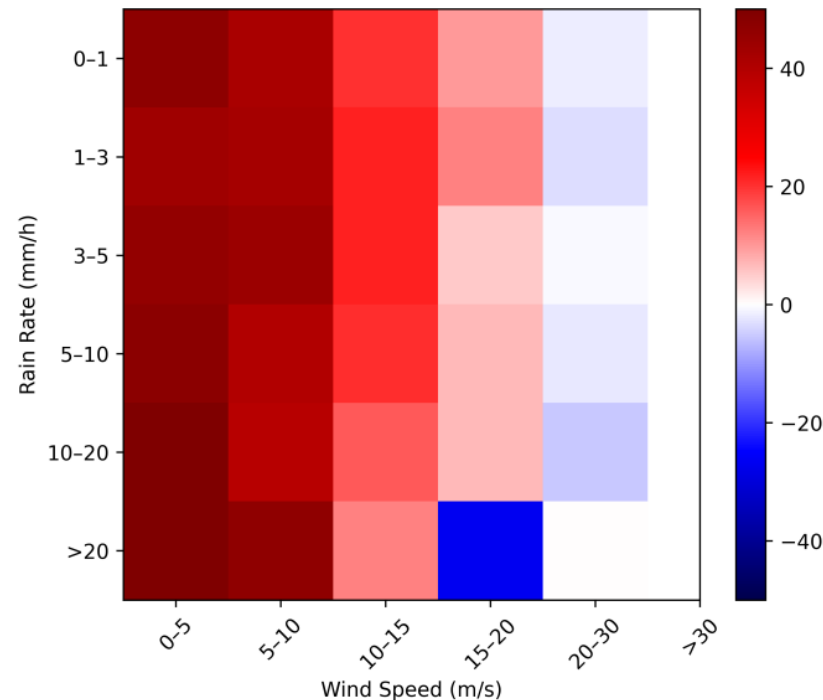
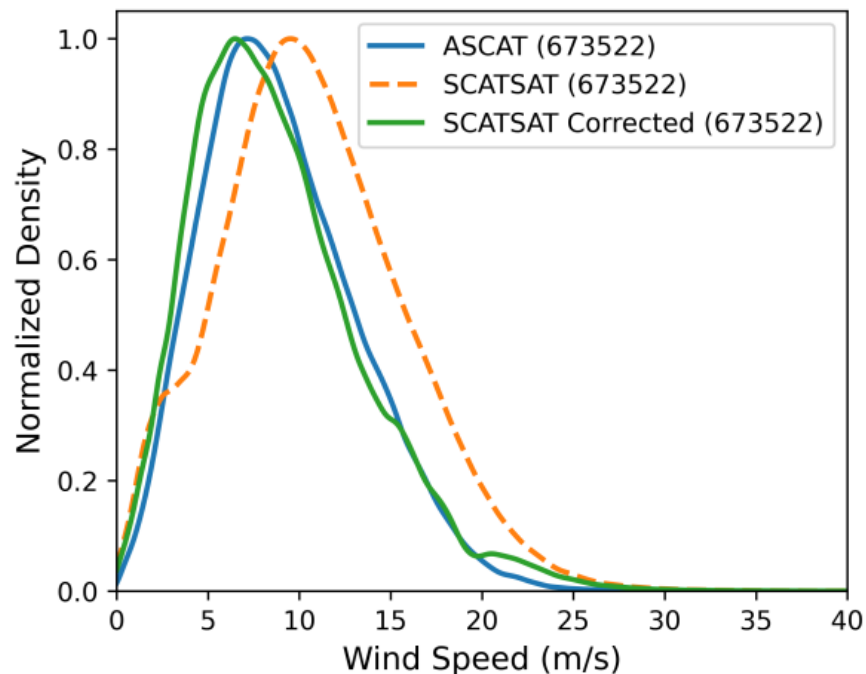
EUMETSAT  
OSISAF

marine.copernicus.eu

osi-saf.eumetsat.int

- Ku-band GMF at OSCAT incidence angles, VV and HH
  - Collocated OSCAT and ASCAT binned in speed and direction
  - KNMI NOC applied
  - Extra-tropical to avoid rain at extreme winds
  - Median NRCS values to avoid rain effects
  - Below 15 m/s Bi has little bias and it is not our objective to change B0 for moderate winds with this method
  - Light colours: NSCAT4DS
  - Bright: new NSCAT GMF
- For now, only a B0 correction is applied above 15 m/s





EUMETSAT OSISAF

## Understanding and characterization of rain-induced contamination in Ku-band Scatterometer Winds

OSI\_VSA25\_04

Vaibhav Tyagi<sup>1</sup>, Ad Stoffelen<sup>2</sup>, Saurabh Das<sup>1</sup>

<sup>1</sup> Indian Institute of Technology Indore (IIT Indore)

<sup>2</sup> Royal Netherlands Meteorological Institute (KNMI)

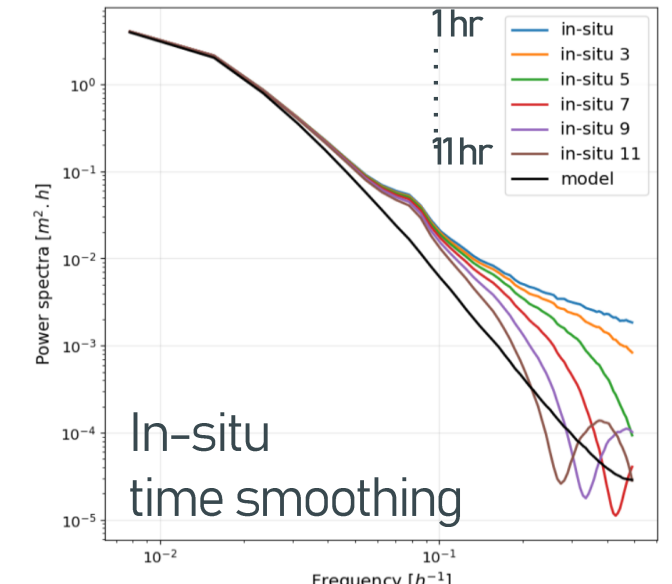
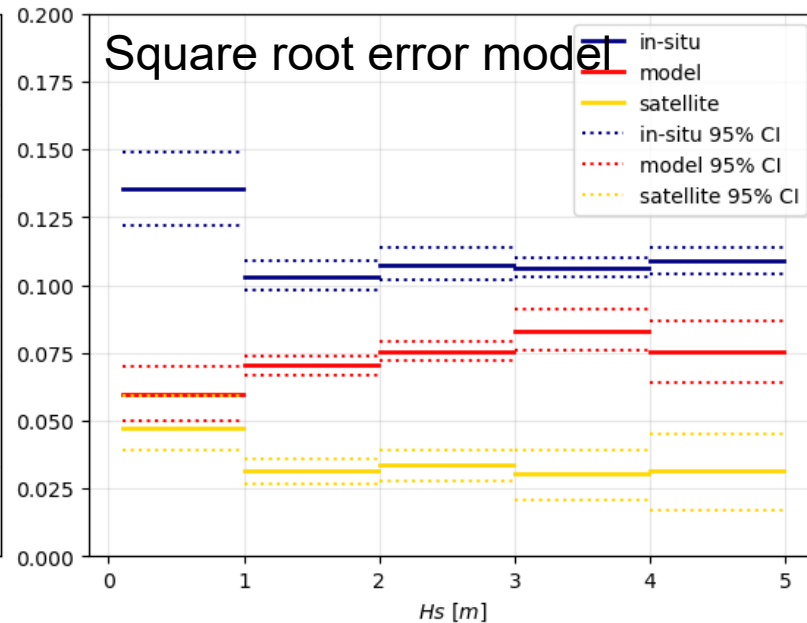
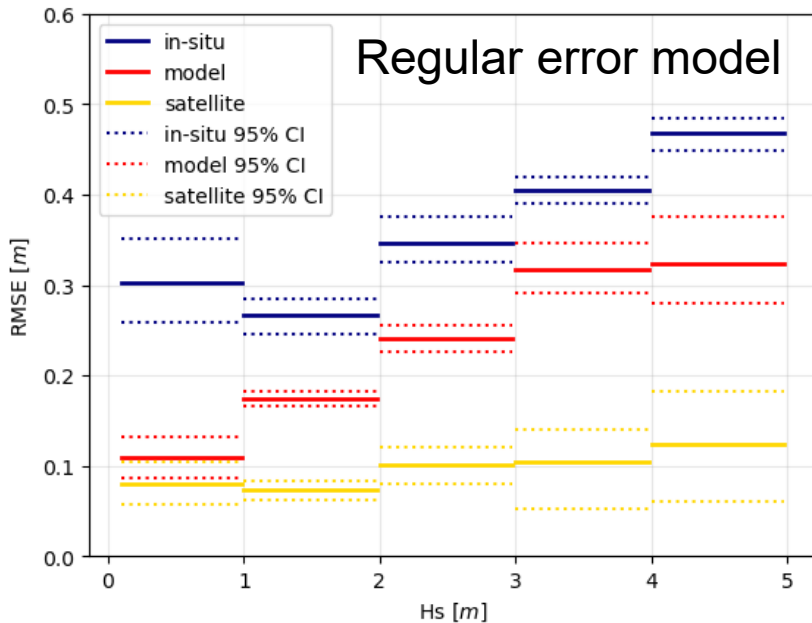
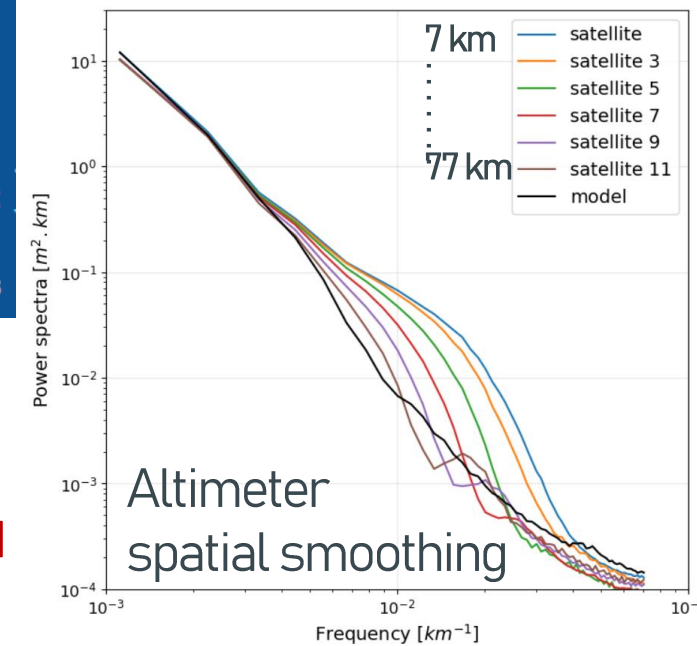
- Collocated ASCAT reference winds are much better than ECMWF winds near rain (Lin et al., 2015), GPM used for rain
- The correction model of [Gopalan et al. \(2019\)](#) works well for low to moderate rain, but not in heavy rain
- The rain correction model cannot cope well with the relatively low rain NRCS at winds above 20 m/s (higher wind NRCS)
- Using a WVC rain area fraction model, segregating rain and wind by area, may be a more effective model (Zhao et al.)
- Future plan includes using high-resolution ground-based radar observations to study rainfall effects (cf. Priftis et al., while extending to Ku-band) and evaluating the quality flags of Ku-band scatterometers

# Guidelines for triple collocation validation of significant wave height measurements: application to satellite altimeters, in-situ data, and the new NORA3 hindcast

Fabien Collas<sup>1,2</sup>, Patrik Bohlinger<sup>1</sup>, Ad Stoffelen<sup>3</sup>, Øyvind Breivik<sup>1,2</sup>, Birgitte

<sup>1</sup>Norwegian Meteorological Institute, Bergen, Norway, <sup>2</sup>University of Bergen, Bergen, Norway, <sup>3</sup>KNMI, De Bilt, Netherlands

- Triple collocation error model (Stoffelen, 1998)
- Show heteroscedasticity and provide an alternative error model
- Consider resolution of the systems (representativeness error); **poor resolution wave model**



- Golden age for scatterometry
- Advances in products
- Focus needed on applications
- Radiometers will complement coverage
- GNSSR will complement time sampling of wind speeds

Next talk I address the CGMS OSW recommendations by the IWWg (Ocean Surface Winds Task Group) :

- With contributions from NSOAS, EUMETSAT, ISRO and CMA, to the global virtual OSVW constellation, a golden age of wind scatterometry is approaching with high-quality wind vector field observations several times a day. Moreover, the constellation allows intercalibration activities and optimization and standardization of the wind and ocean stress products. For forecasting applications **global timeliness requirements** appear currently the most difficult to meet and further emphasis on this by the data providers would be appreciated;
- Many GNSS-R ocean surface wind speeds from China's Fengyun-3 and Tianmu-1 (TM-1) and from Muon satellite constellations will become available. While spatial contiguousness is limited, their spatial and temporal gap filling is a useful complement to other surface wind-sensing missions;

These follow from the CGMS International Winds Working group (IWWg) meeting presentations and discussions.



[marine.copernicus.eu](https://marine.copernicus.eu)



[osi-saf.eumetsat.int](https://osi-saf.eumetsat.int)

Backup slides



- NWP Ocean Calibration (NOC) NRCS beam pattern has been used for ERS, ASCAT-A, ASCAT-B and ASCAT-C commissioning
  - Absolute reference are **global moored buoys** and NOT the ECMWF model; triple wind collocation links scatterometer, buoy and ECMWF model biases
  - An accurate Geophysical Model Function (GMF CMOD7) is used as consolidated reference (applicable to WindRad, ASCAT and ERS), though empirical
  - An empirical C-band VH (based on SAR) and HH GMF (NOT based on SAR, but on WindRad) exist and these can be used for SCA commissioning
  - NOC-corrected NRCS data also help other applications, such as sea ice products
- Cone metrics was elaborated by Maria Belmonte Rivas (2017) as intercalibration method for C-band scatterometers
  - Uses the idea of an expected and fixed relationship between the NRCS from fore, mid and aft beams
  - Links the beam pattern of one instrument to another, or from left swath to right swath (Simon)
  - Cone metrics and NOC variations in beam pattern are generally consistent over a year to within 0.1 dB (ECMWF/GMF uncertainty in NOC)
  - Cone metrics for ERS and ASCAT has been very stable over many years (within a few hundredths of dB, apart from few anomalies)
  - Useful for SCA monitoring (Simon)
- Could be extended to Ku-band scatterometer intercalibration, but no resources for development yet (ECV)



# Cone metrics ASCAT-A vs ASCAT-B 2017



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Marine Service

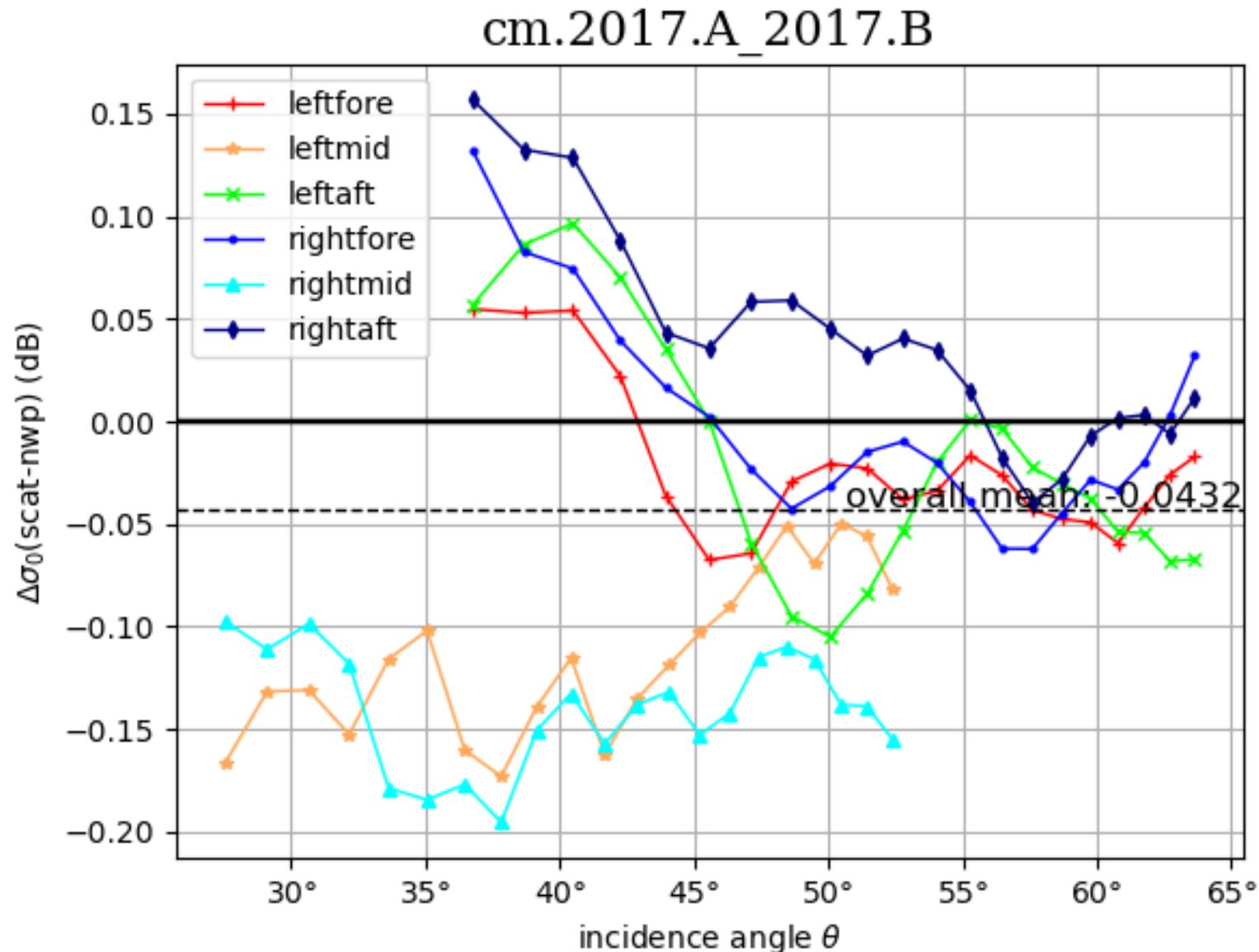


EUMETSAT  
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marine.copernicus.eu

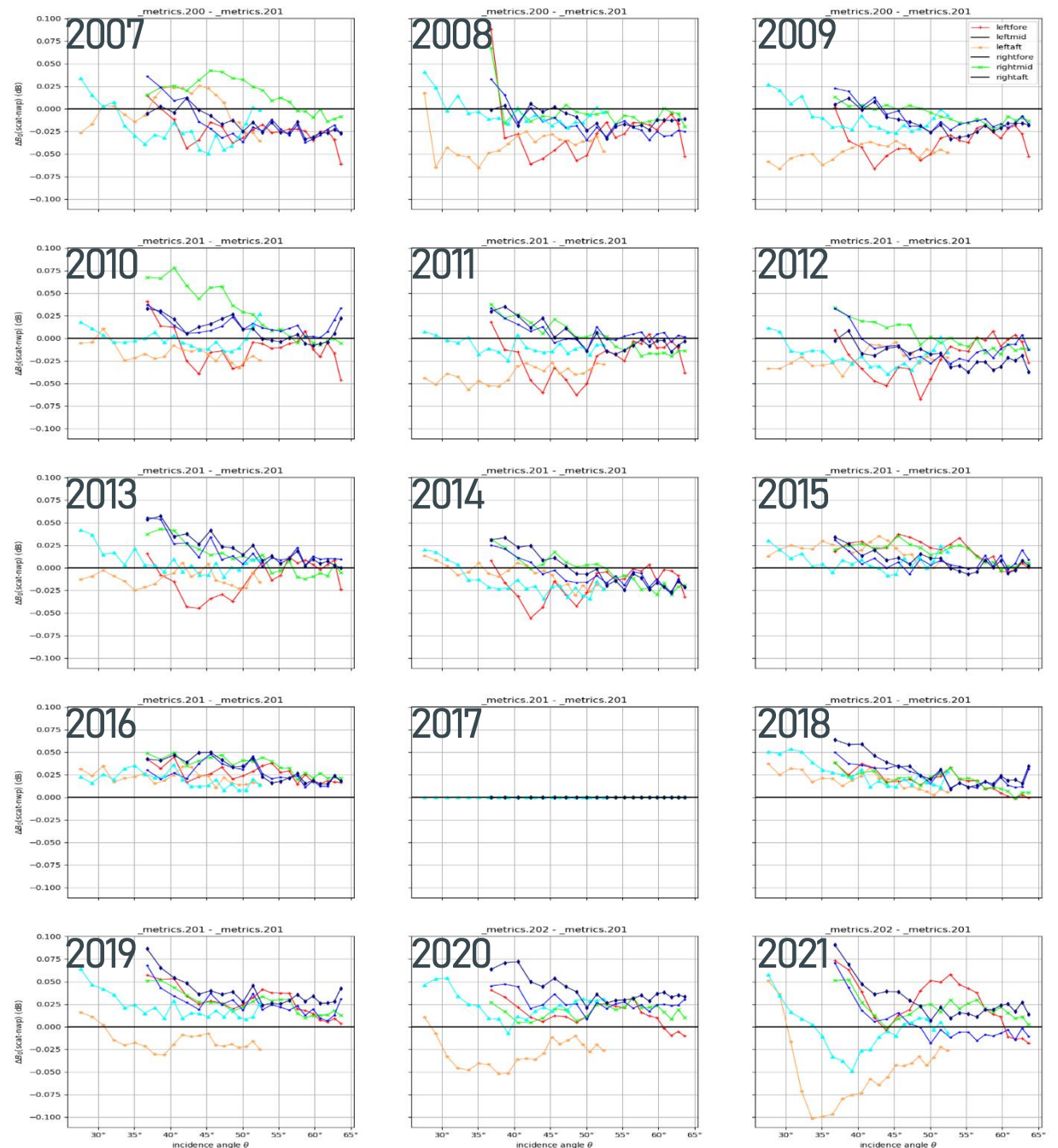
osi-saf.eumetsat.int

- Cone metrics of 2017 ASCAT-A data against 2017 ASCAT-B data
- Most recent EUMETSAT data
- No KNMI corrections
- ASCAT-A mid beam about 0.15 dB lower than ASCAT-B mid beams
- Inner part fore/aft beams 0.10 dB higher than ASCAT-B fore/aft beams
- 0.1 dB implies about 0.1 m/s
- Decadal stability requirement wind CDR is 0.1 m/s
- Correction needed for ASCAT-A NRCS beam pattern w.r.t. 2017 ASCAT-B
- CMOD7 GMF correction needed for new 2017 ASCAT-B as a function of  $\theta$
- ASCAT-B beam pattern corrections needed too probably



# ASCAT-A vs ASCAT-A

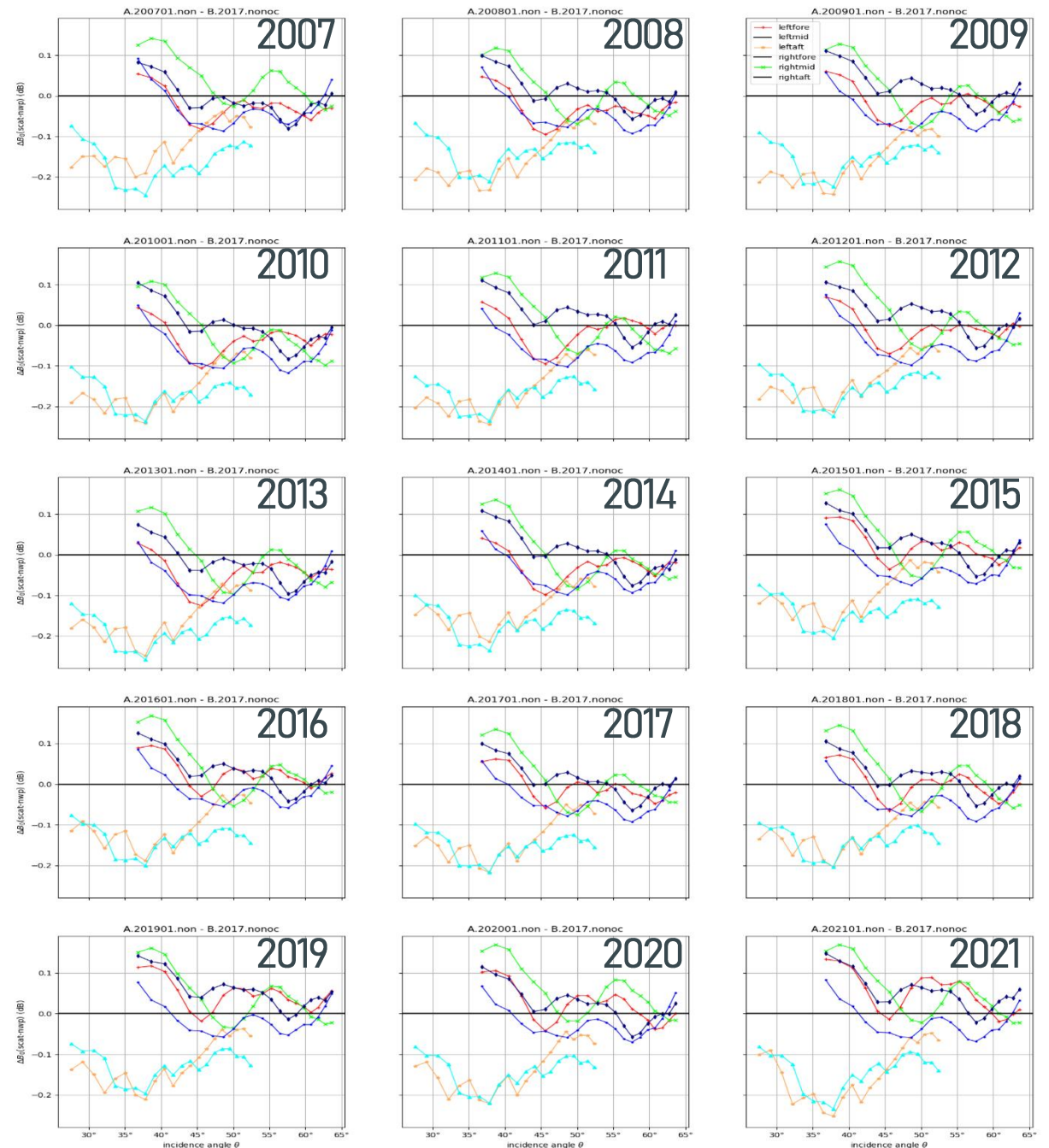
- Cone metrics of ASCAT-A January data against 2017 ASCAT-A data (with anomalies!)
  - Most recent EUMETSAT data
  - No KNMI corrections
  - Vertical scale from -0.1 dB to +0.1 dB, range ~0.2 dB
  - 0.1 dB implies about 0.1 m/s
  - Decadal stability requirement wind CDR is 0.1 m/s
- ASCAT-A has been very stable generally
- Remaining end 2014 (left fore beam) anomaly visible, though small
- Beam patterns drift towards the end of the ASCAT-A mission, i.e., the ASCAT-A measurements shift
- Would beam patterns also drift over an orbit due to changing sun illumination?



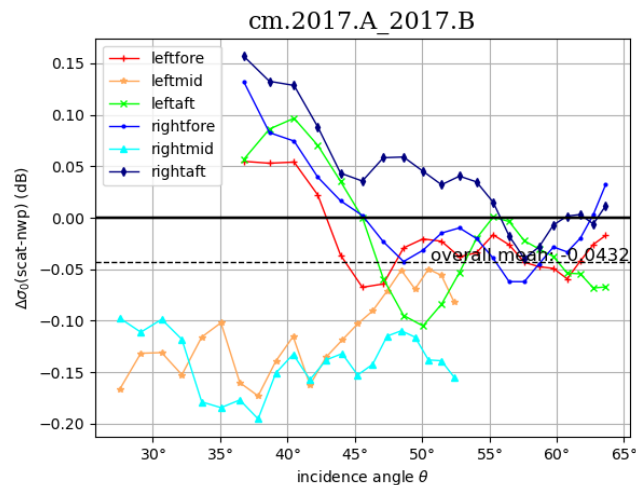
# NOC Jan. A w.r.t. 2017 B

- NWP Ocean Calibration (ERA5, CMOD7) of ASCAT-A Jan data w.r.t NOC of ASCAT-B 2017
- Most recent EUMETSAT data
- **No KNMI corrections**
- Vertical scale -0.3 dB to +0.2 dB, **range ~0.5 dB**

➤ **Beam pattern similar to cone metrics**

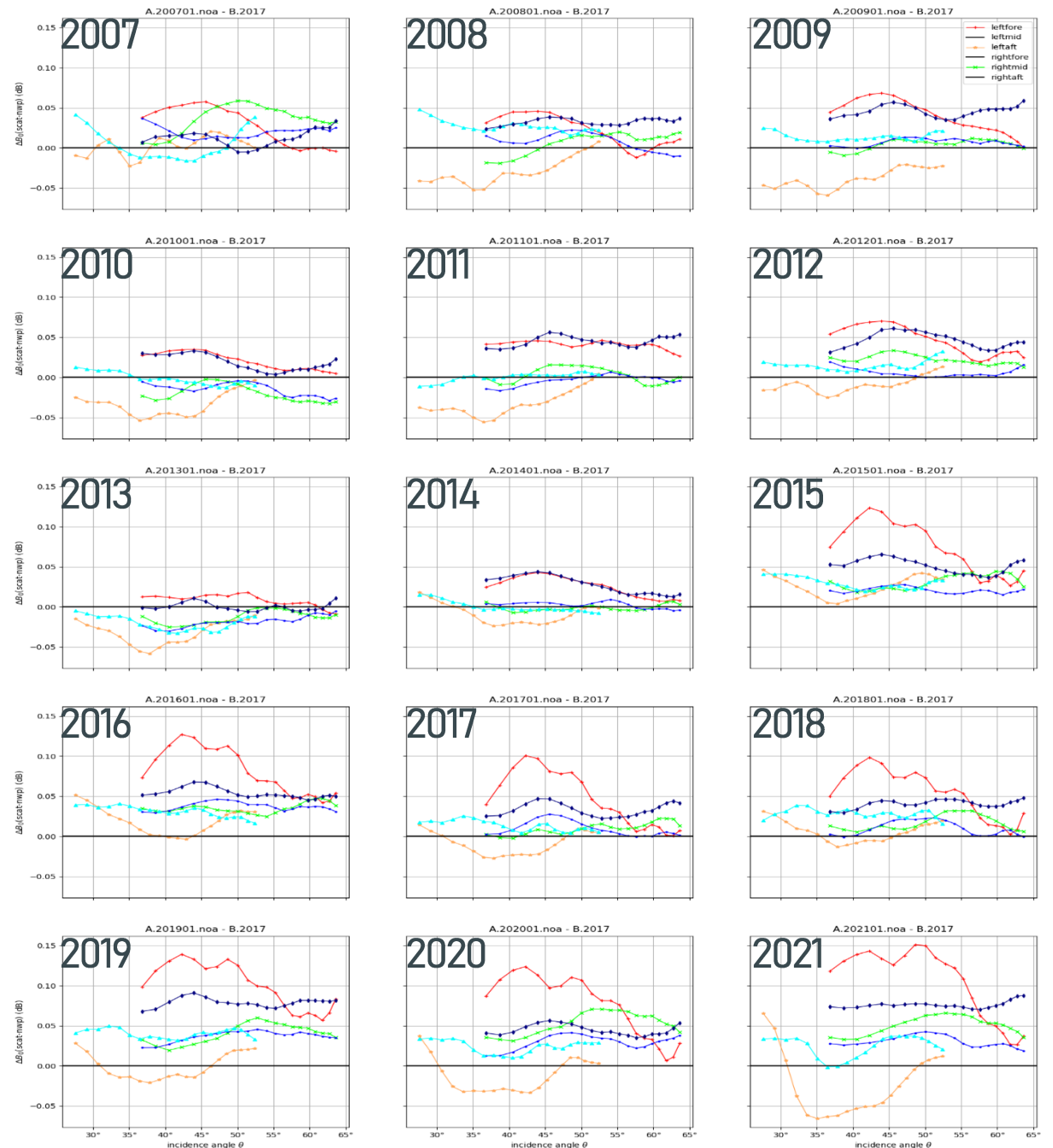


Recall cone metrics result:



# NOC Jan. A w.r.t A

- NWP Ocean Calibration (ERA5) of ASCAT-A Jan data w.r.t. ASCAT 2007- Jul. 2014 (pre anomalies)
  - Most recent EUMETSAT data
  - **KNMI NOC corrections (2007-Jul.2014)**
  - Vertical scale -0.05 dB to +0.15 dB, **range ~0.2 dB**
  - 0.1 dB implies about 0.1 m/s
  - Decadal stability requirement wind CDR is 0.1 m/s
- ASCAT-A has been very stable generally
  - Beam pattern evolution similar to cone metrics
  - **2014 anomalies appear more pronounced in NOC w.r.t. cone metrics**
  - **In particular on left fore beam**
  - **Left aft beam drift similar to cone metrics at end of life, though more variability in drifts (diurnal ECMWF cycle)**

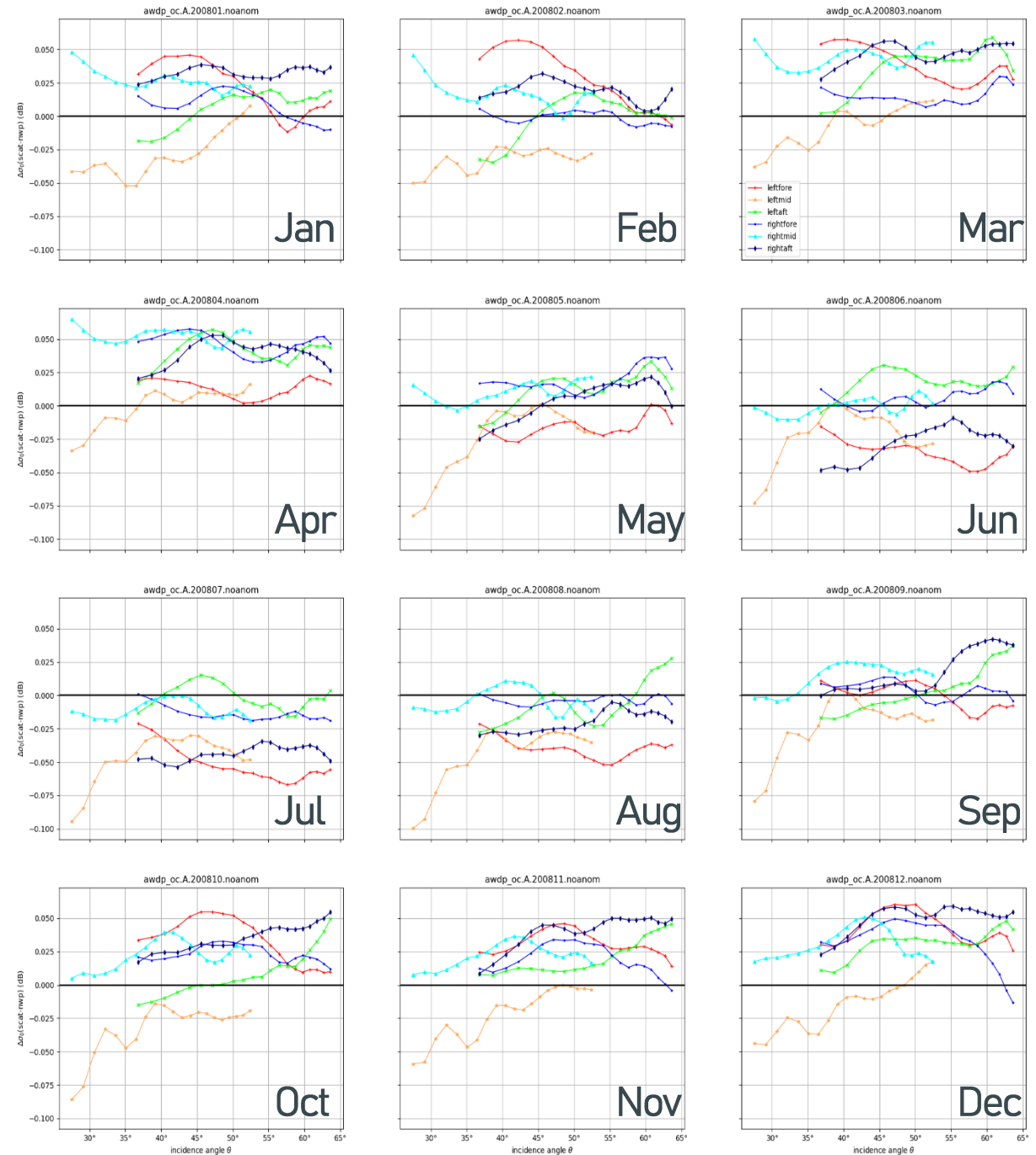


# ASCAT-A NOC per month

- NOC of every month in 2008 of ASCAT-A data
- Most recent EUMETSAT data
- KNMI AWDP NOC corrections (old)
- Vertical scale -0.1 dB to +0.1 dB, range  $\sim 0.2$  dB
- 0.1 dB implies about 0.1 m/s
- Decadal stability requirement wind CDR is 0.1 m/s

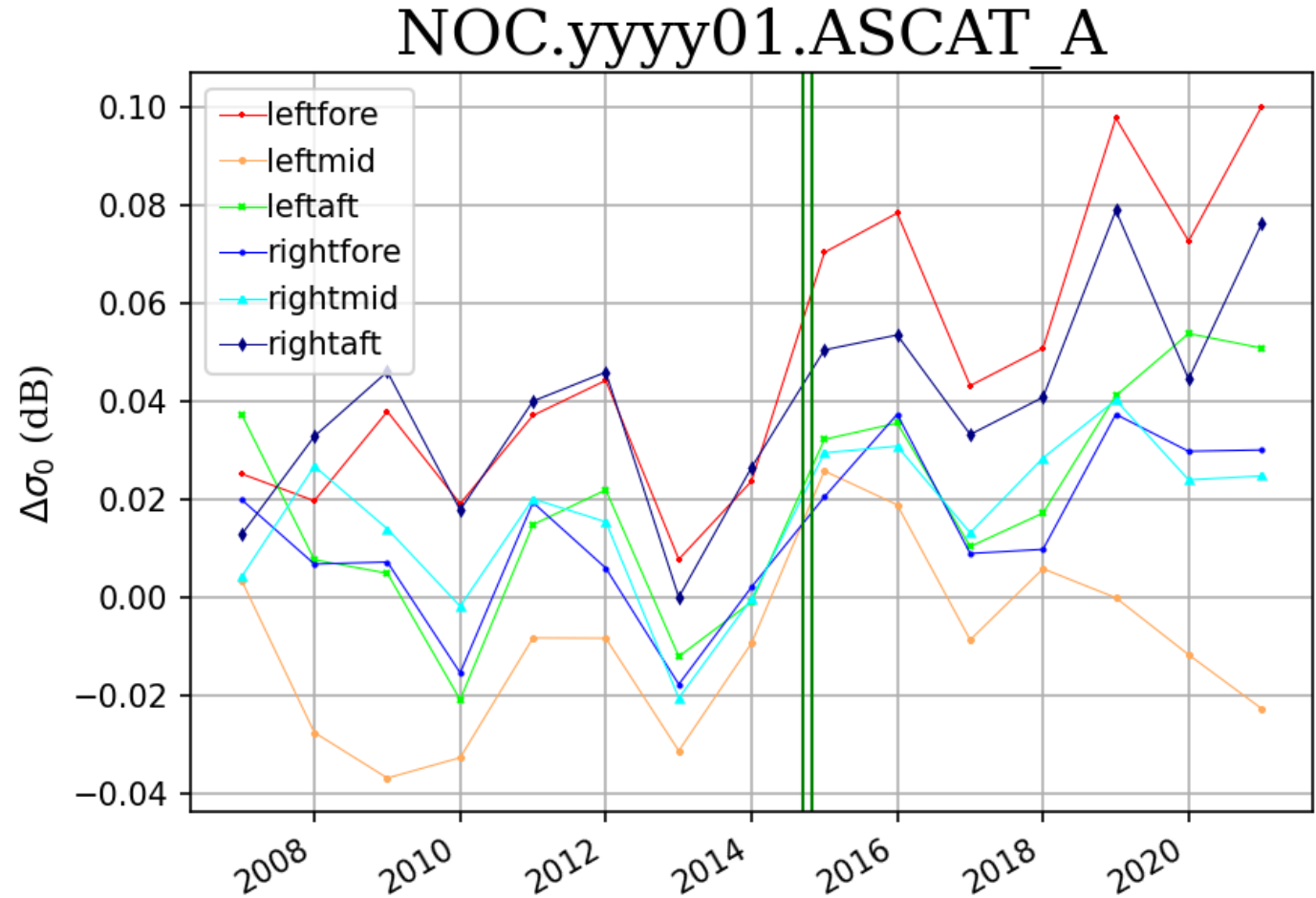
➤ NOC is rather stable over the months

➤ Beams jump by about 0.1 dB due to (varying) ECMWF biases and GMF errors in a month



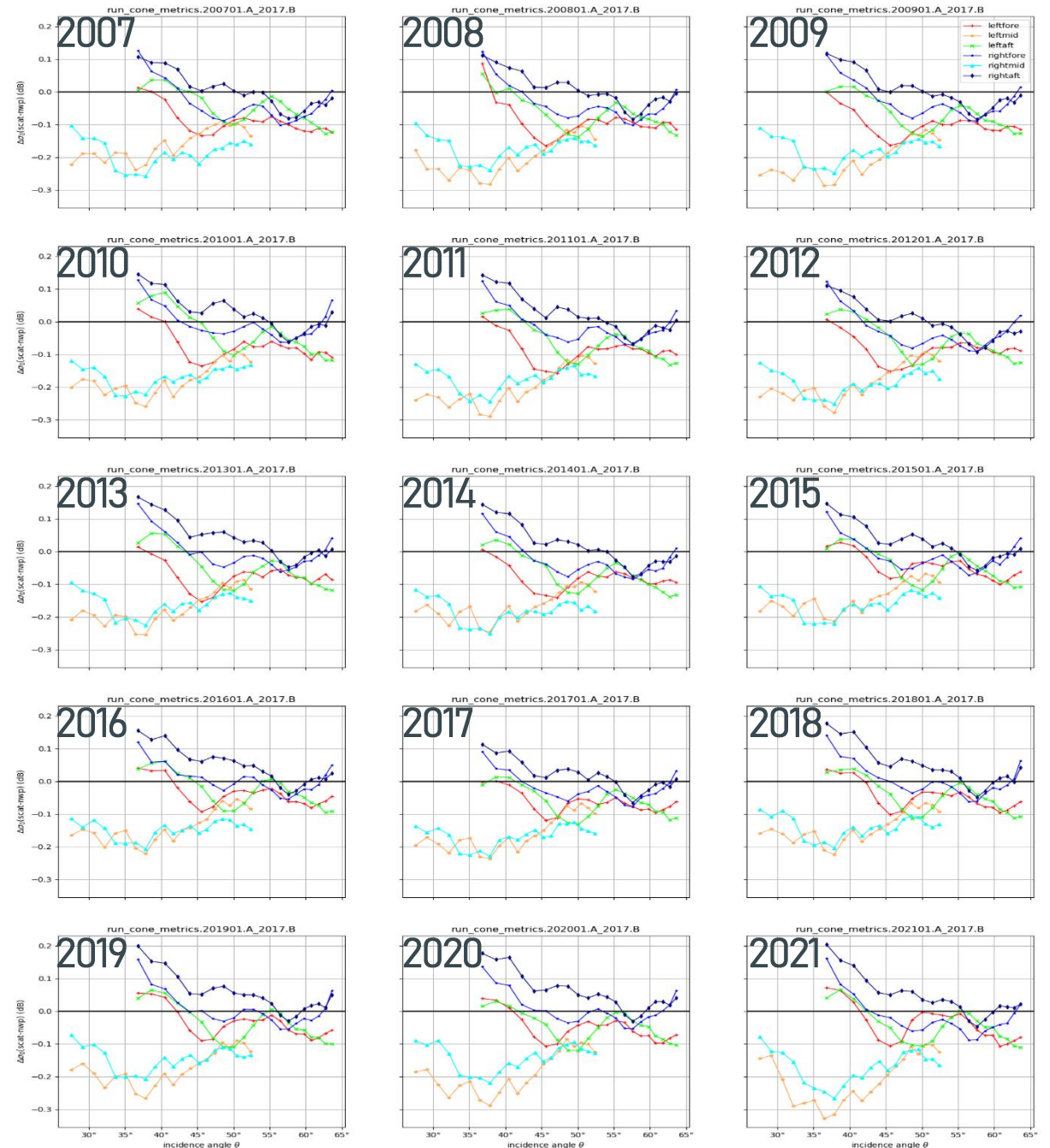
# ASCAT 2014 anomaly corrected?

- NOC uncertainty over a month around  $\sim 0.05$  dB
- All beams jump up by  $\sim 0.02$  dB
- This is the difference between the (old) KNMI AWDP correction and the current EUMETSAT L1b correction
- Note: beam pattern oscillation to be corrected on left fore beam
- End of life instrument drifts are substantial too, in particular left aft beam pattern
- Test MLE, QC and wind quality as a function of WVC before and after beam corrections



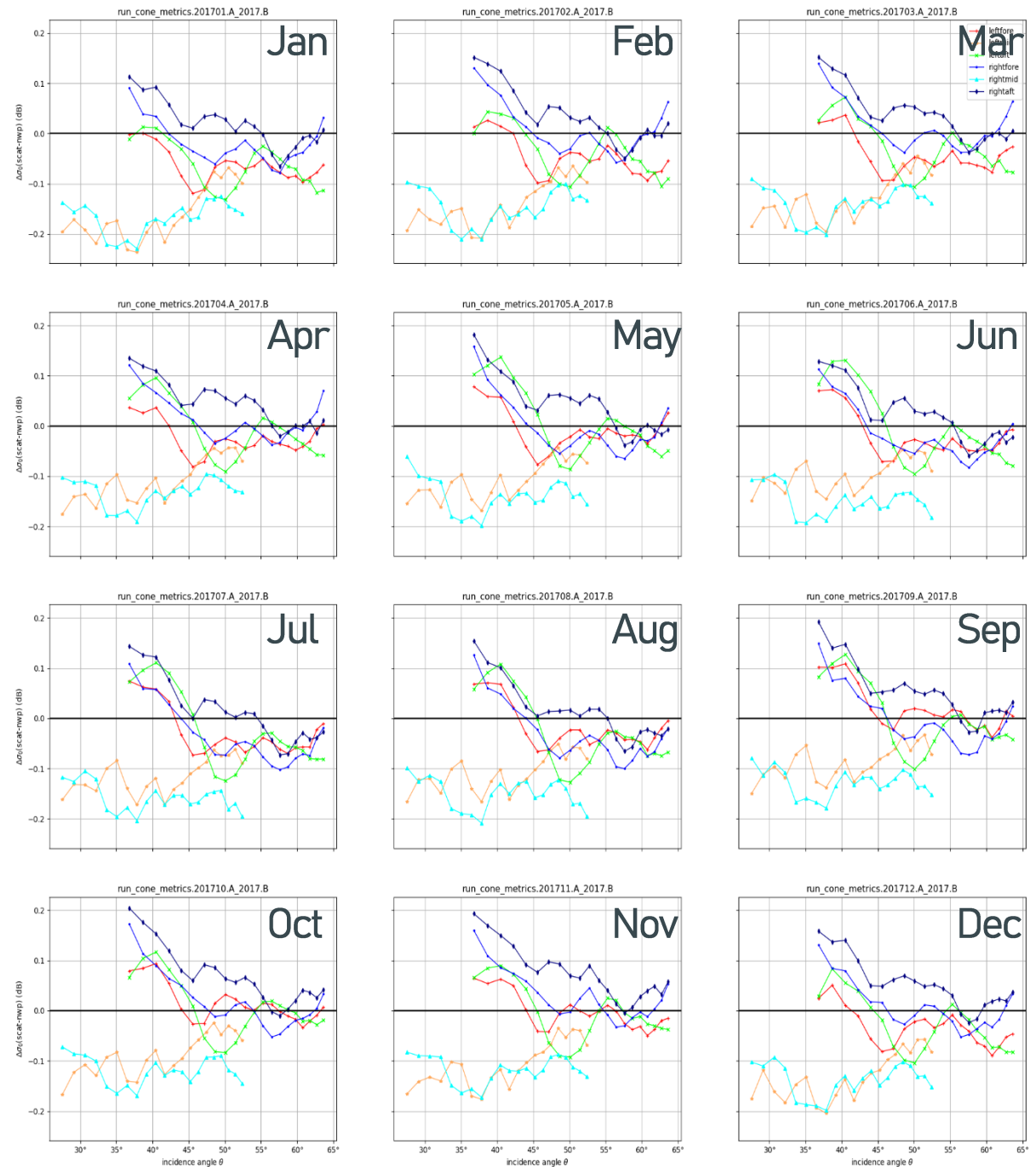
# ASCAT-A vs ASCAT-B

- Cone metrics of ASCAT-A Jan data against 2017 ASCAT-B data
  - Most recent EUMETSAT data
  - No KNMI corrections
  - Vertical scale -0.3 dB to +0.2 dB, range ~0.5 dB
  - 0.1 dB implies about 0.1 m/s
  - Decadal stability requirement wind CDR is 0.1 m/s
- 
- ASCAT-A mid beam about 0.15 dB lower than ASCAT-B mid beams
  - Inner part fore/aft beams 0.10 dB higher than ASCAT-B fore/aft beams
  - ASCAT-A has been very stable generally



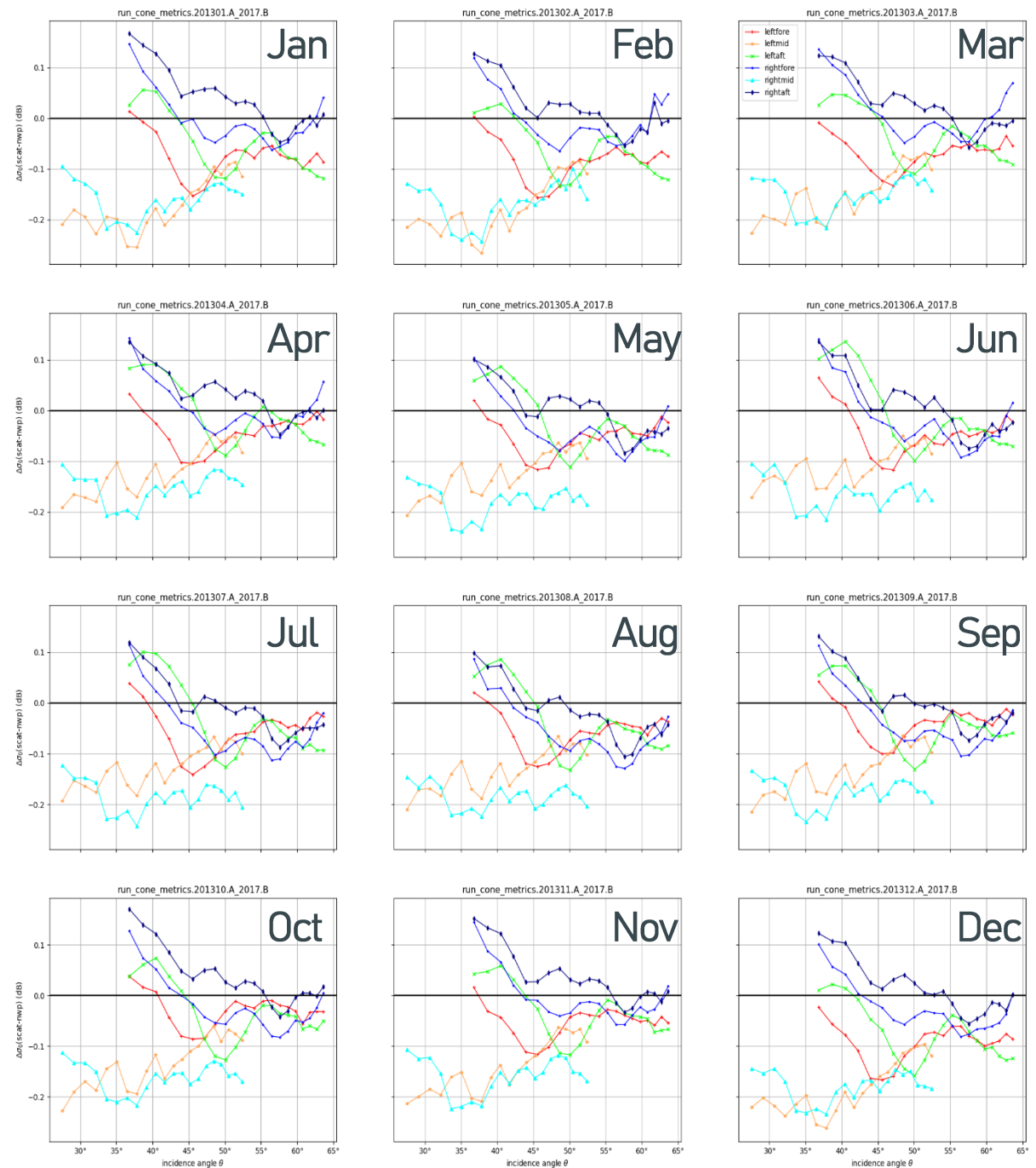
# ASCAT-A per month 2017

- Cone metrics of every month in 2017 of ASCAT-A data against 2017 ASCAT-B data
  - Most recent EUMETSAT data
  - No KNMI corrections
  - Vertical scale -0.3 dB to +0.2 dB, range ~0.5 dB
  - 0.1 dB implies about 0.1 m/s
  - Decadal stability requirement wind CDR is 0.1 m/s
- 
- ASCAT-A mid beam about 0.15 dB lower than ASCAT-B mid beams
  - Inner part fore/aft beams 0.10 dB higher than ASCAT-B fore/aft beams
- 
- Cone metrics is rather stable over the months, cf. Belmonte Rivas et al. (2017)



# ASCAT-A per month 2013

- Cone metrics of every month in 2013 of ASCAT-A data against 2017 ASCAT-B data
  - Most recent EUMETSAT data
  - No KNMI corrections
  - Vertical scale -0.3 dB to +0.2 dB, range  $\sim 0.5$  dB
  - 0.1 dB implies about 0.1 m/s
  - Decadal stability requirement wind CDR is 0.1 m/s
- Cone metrics is rather stable over the months, cf. Belmonte Rivas et al. (2017)
- Mean level up by  $\sim 0.05$  dB w.r.t. 2017 (2014 anomaly?)
- Left fore beam jumps (2014 anomaly?)





Royal Netherlands  
Meteorological Institute  
*Ministry of Infrastructure  
and Water Management*

# Reducing the impact of unexpected reflections on ASCAT winds

- Ships
- Wind mills
- RFI
- Beaches

Anton Verhoef and Ad Stoffelen

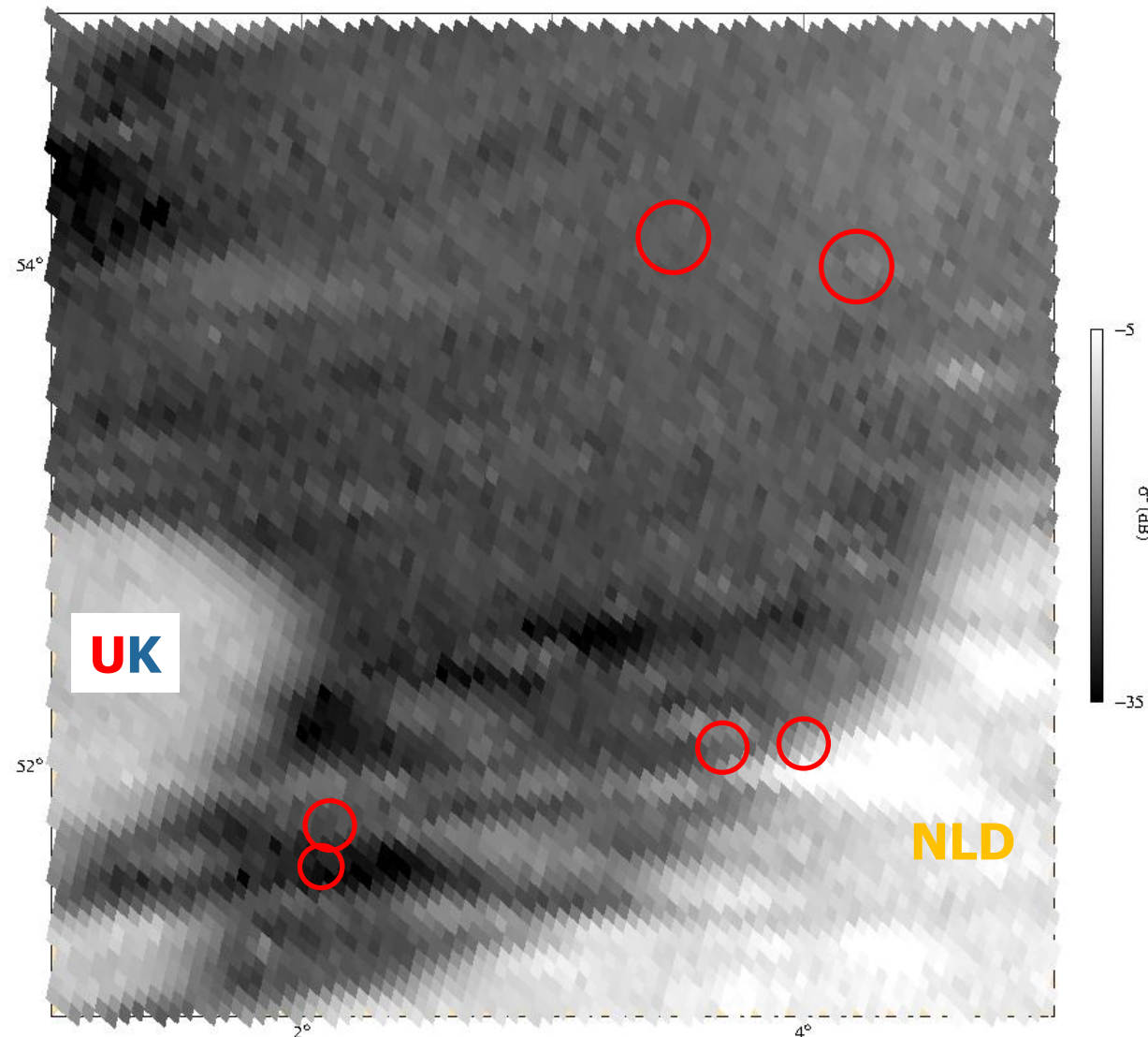
March 2026





# Full resolution sigma0

- > The full resolution backscatter data (slices) show several areas with high sigma0 values that can be associated with ships
- > The red circles show locations that will be assessed in more detail in the following slides
- > Data are from 12 September 2023, 9:30 over the North Sea

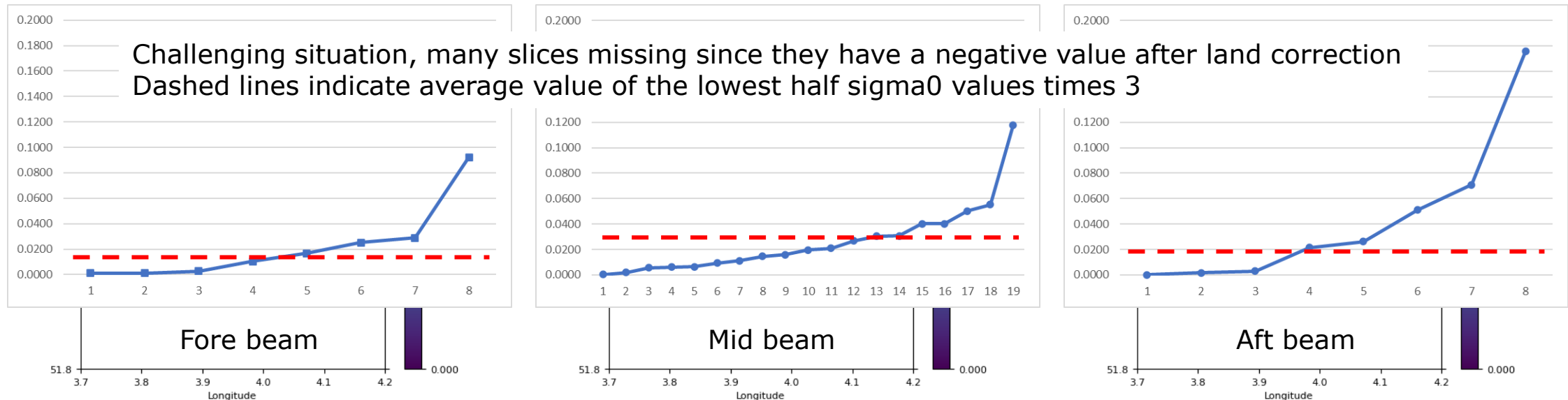
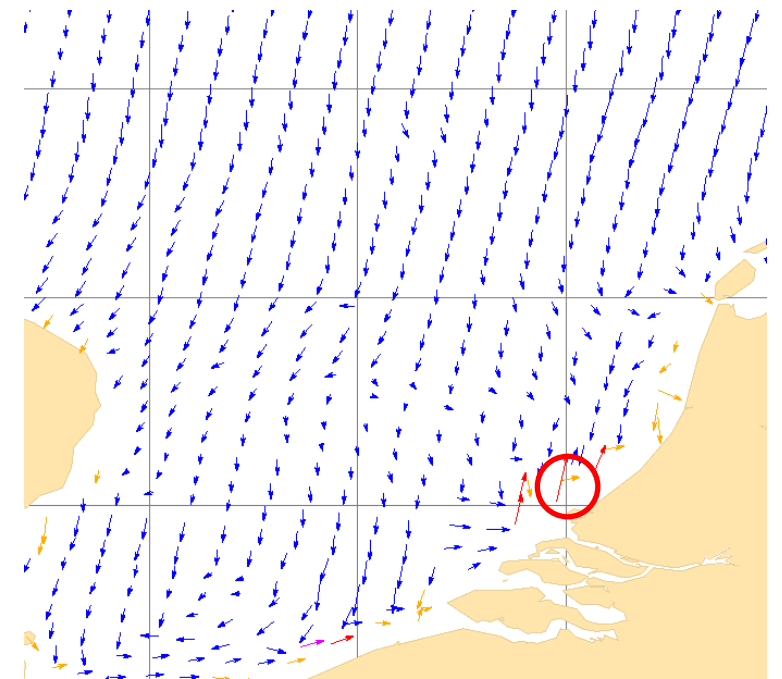


Aft beam



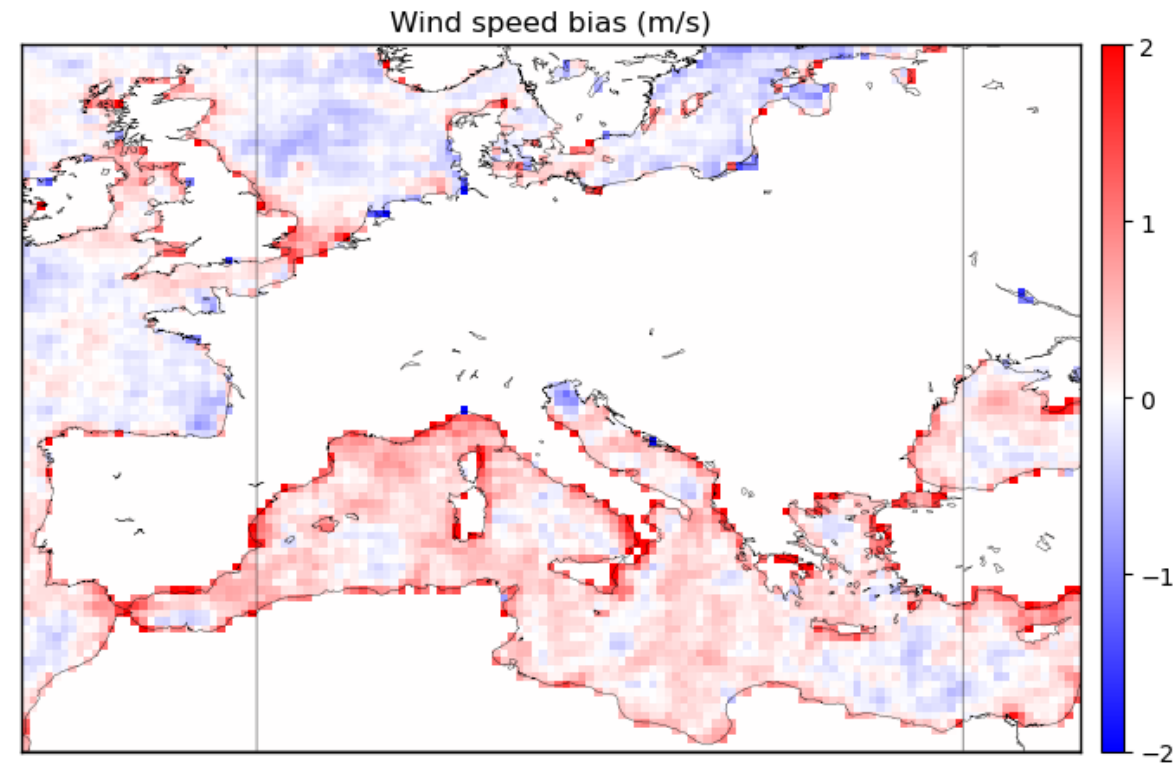
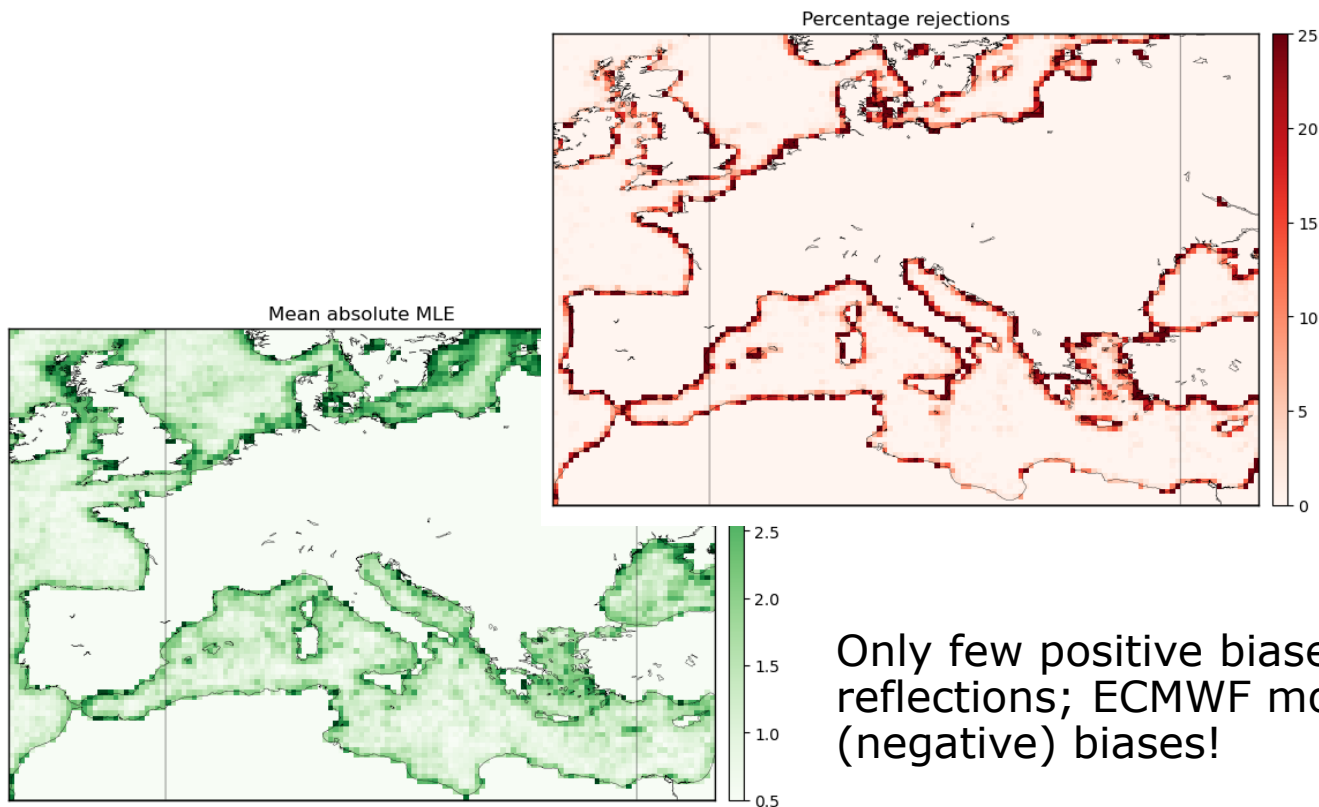
# Slice backscatter – 12.5 km

- > The plots below show the land-corrected sigma0 values (linear space) of individual slices contributing to the beam backscatter of the WVC (indicated in the red circle)
- > lat 52.09, lon 3.98 (row 68, node 58), 12 September 2023
- > wind speed **6.70 m/s**, MLE 0.20, **HvH 3.0 m/s, 260° (W)**
- > KNMI QC set, Kp flag set, VarQC set



# Slice outlier removal

- > The outlier removal results in marginal reductions in wind speed bias and QC rejection rates and a small increase in MLE

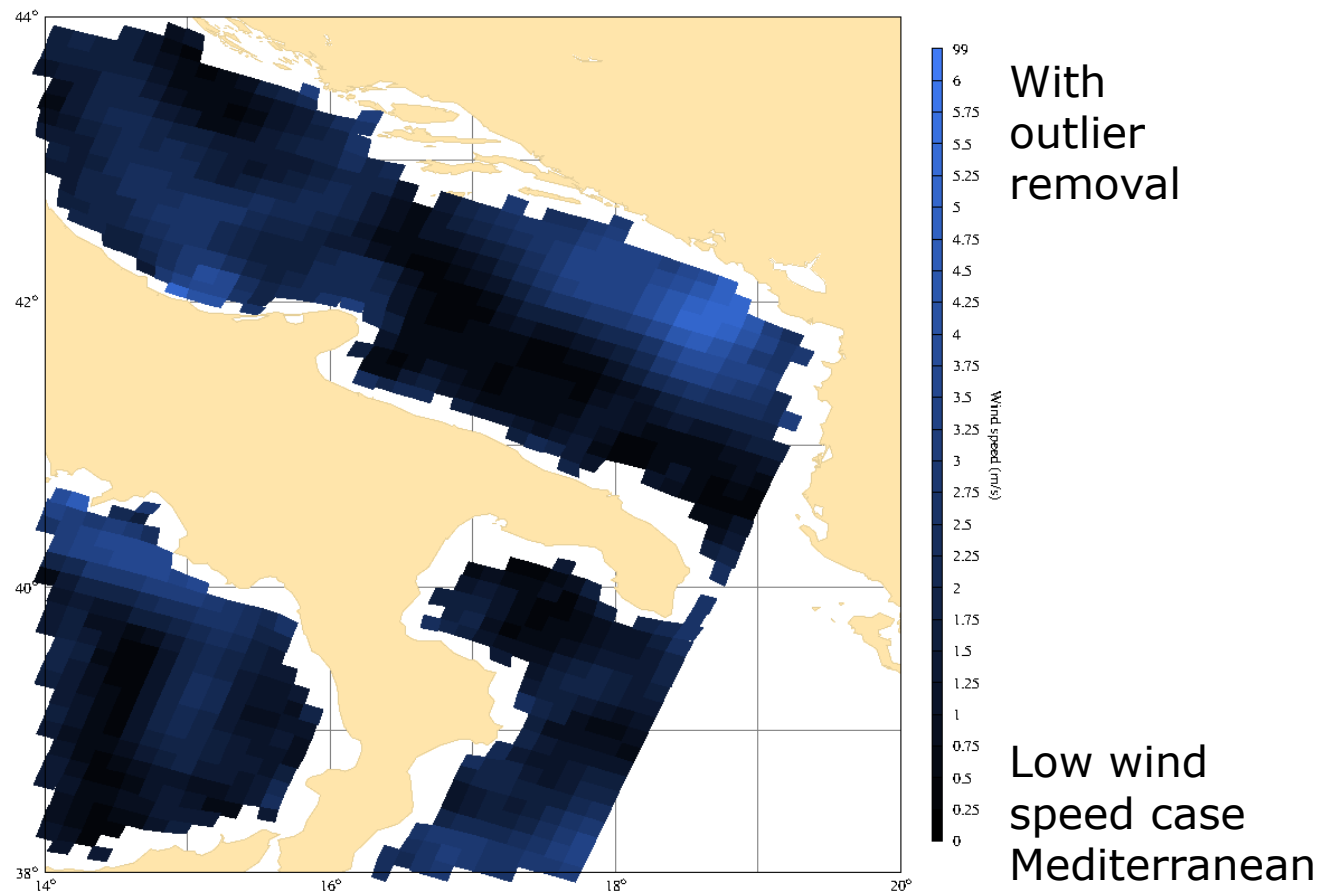
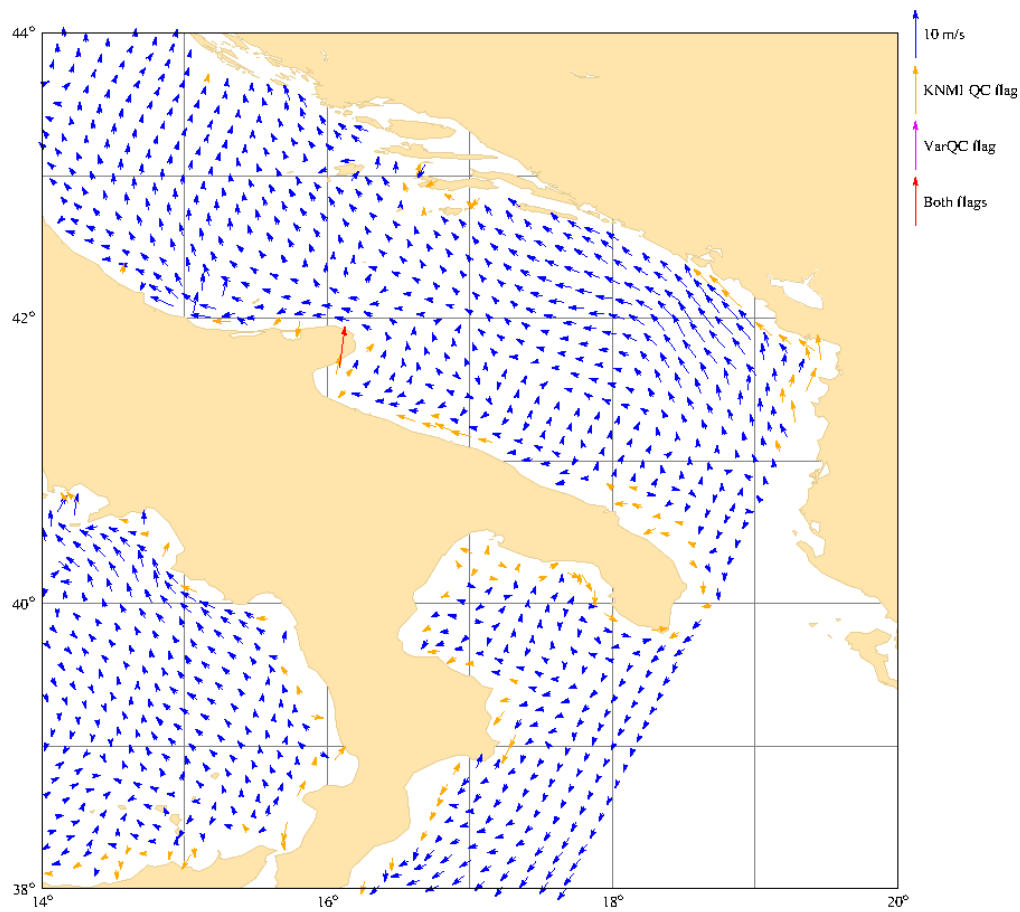


Only few positive biases are due to ship reflections; ECMWF model winds have (negative) biases!

2 times value removed

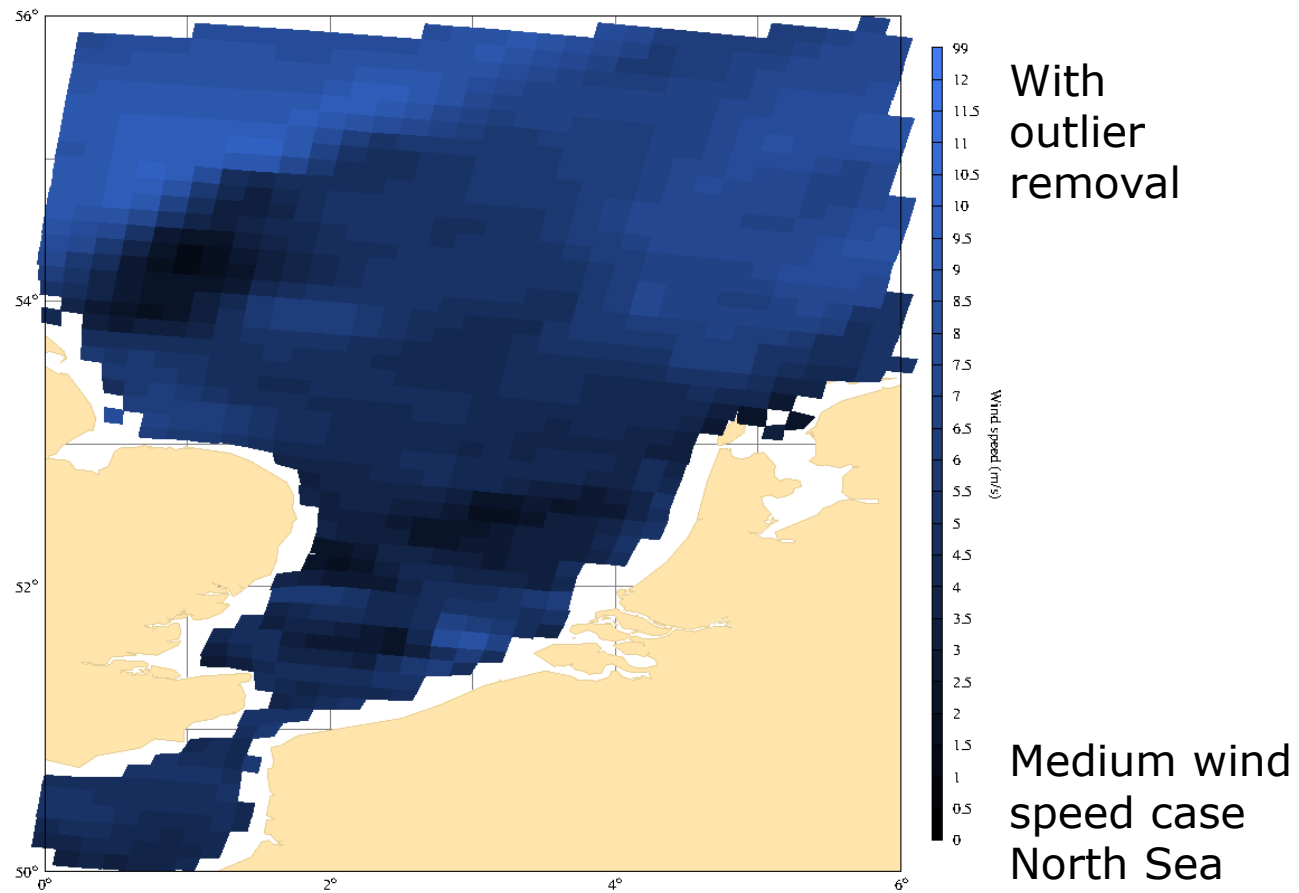
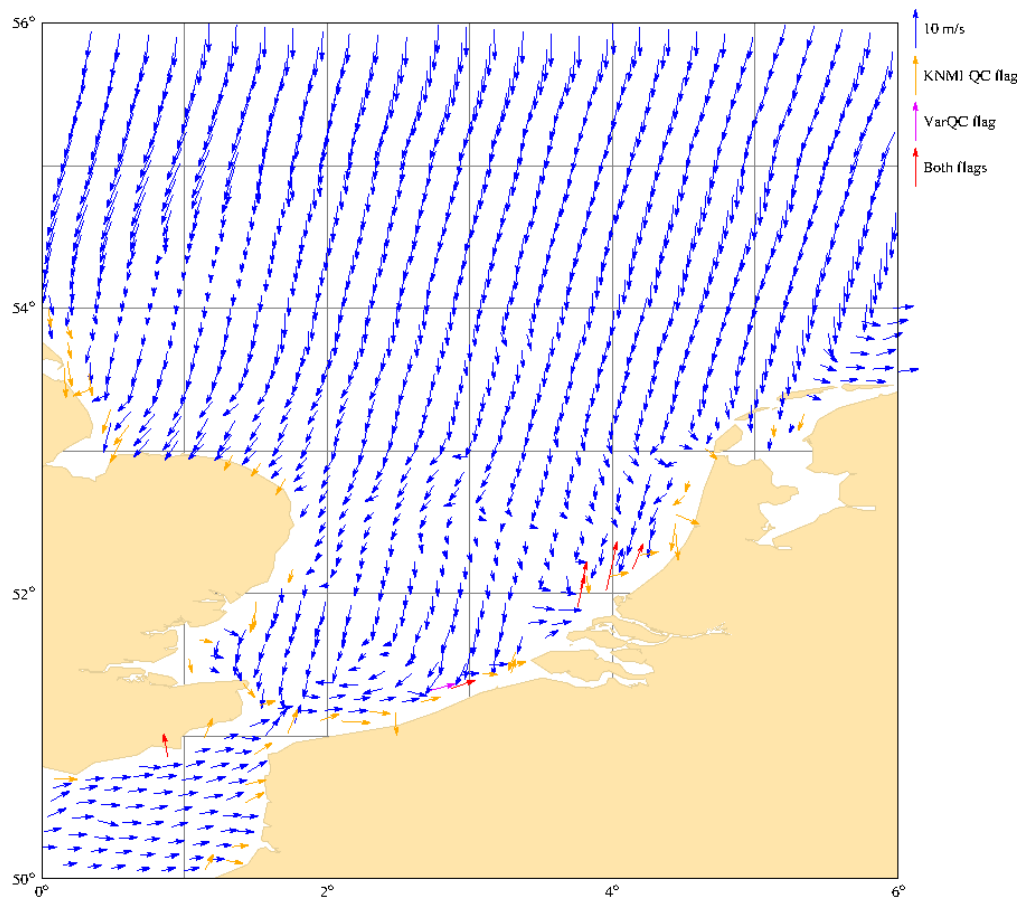


# Effect of outlier removal



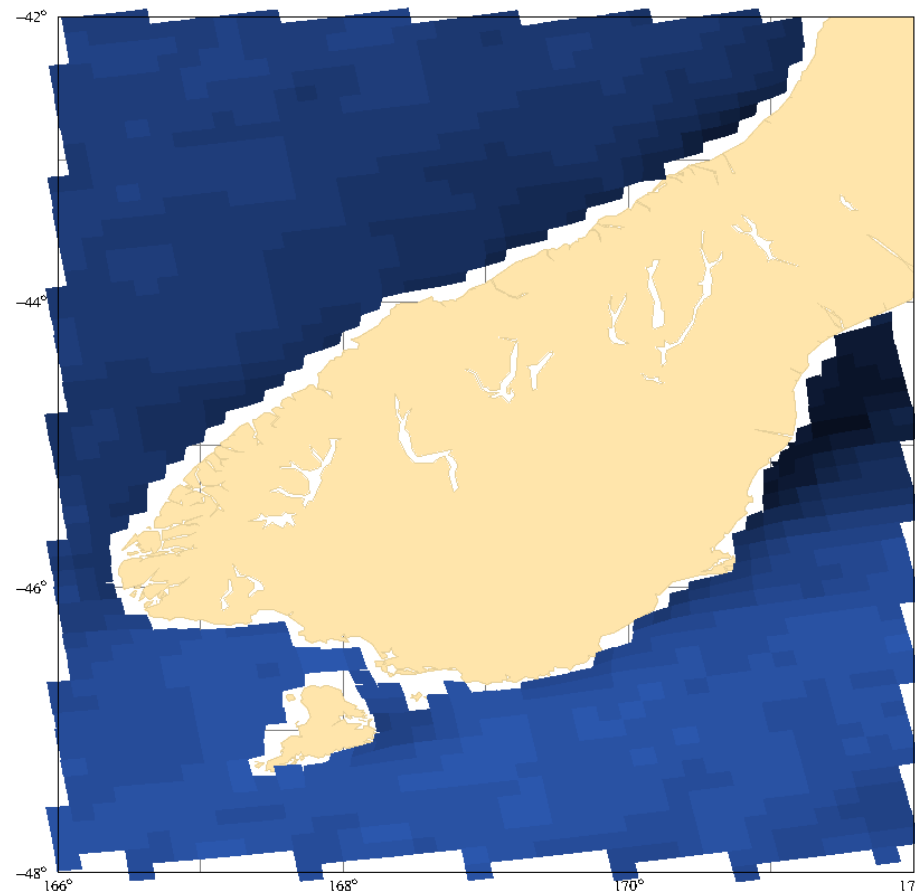
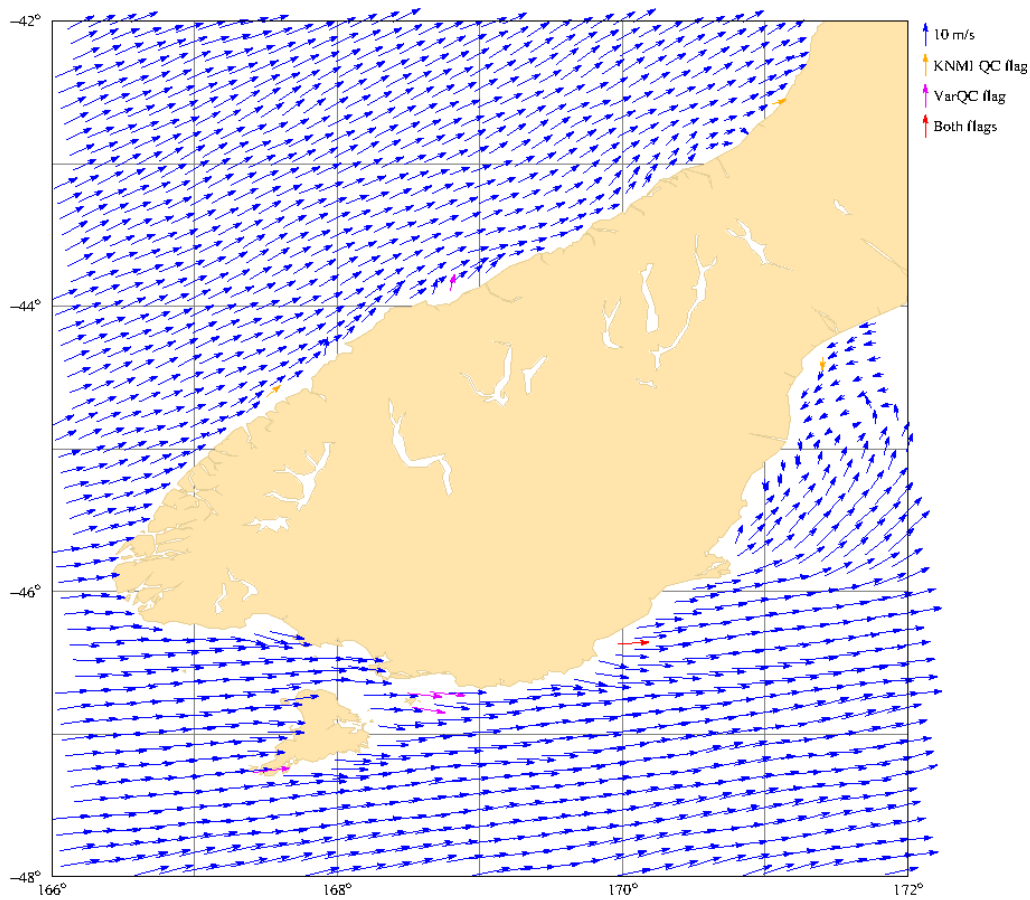


# Effect of outlier removal





# Effect of outlier removal



With outlier removal

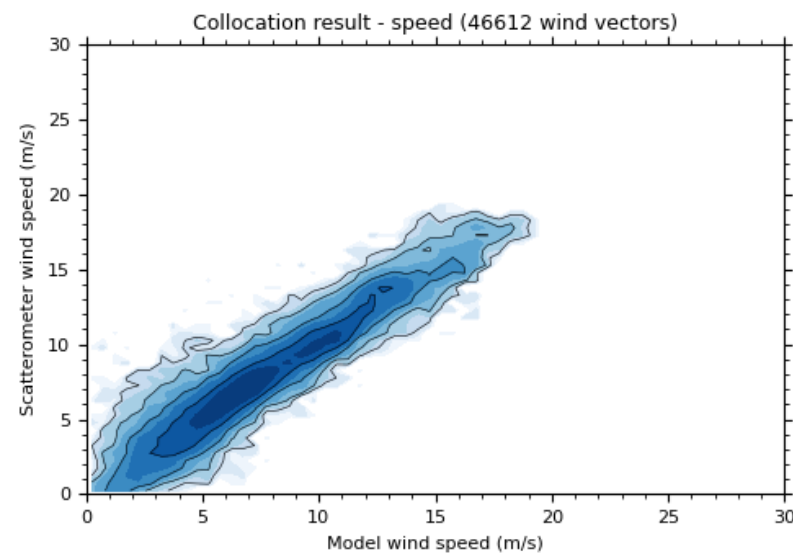
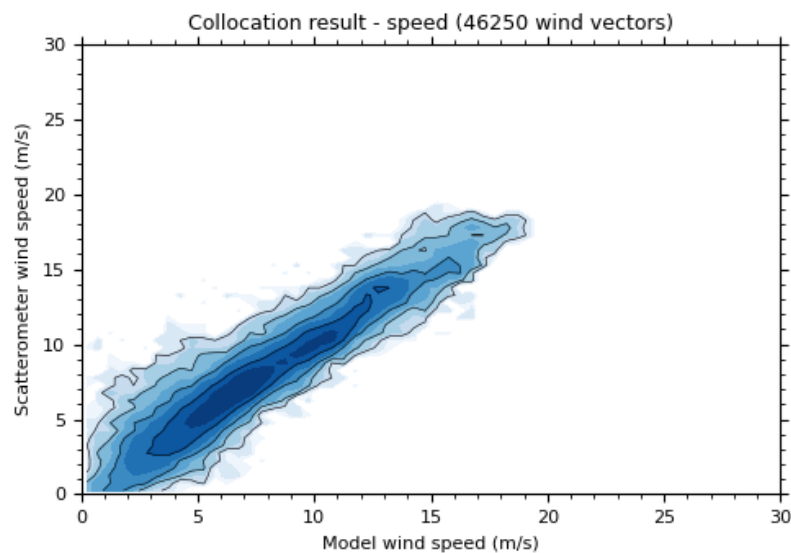
High wind speed case New Zealand



# Effect of outlier removal (winds over the North Sea)

	No outlier removal	With outlier removal
Nr. of coastal winds	46250	46612 (+0.8%)
Speed bias (m/s)	0.24	0.21
Stdev diff. u (m/s)	1.28	1.24
Stdev diff. v (m/s)	1.60	1.56

4 weeks of data

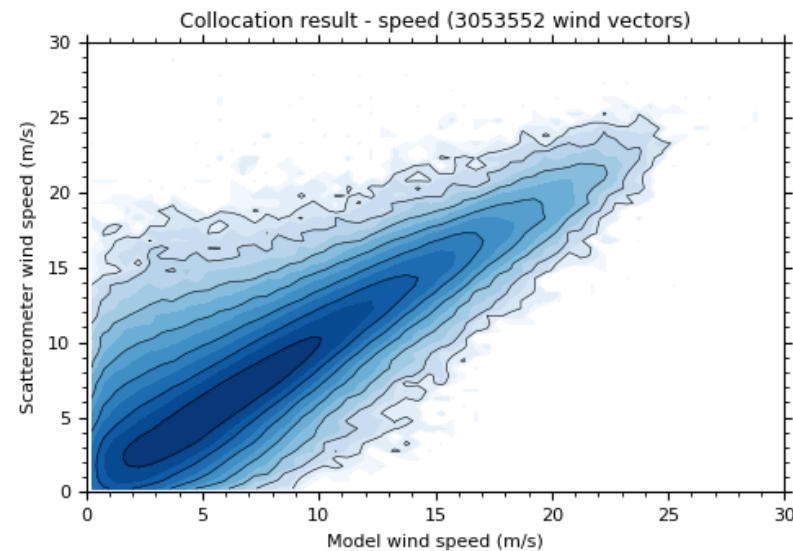
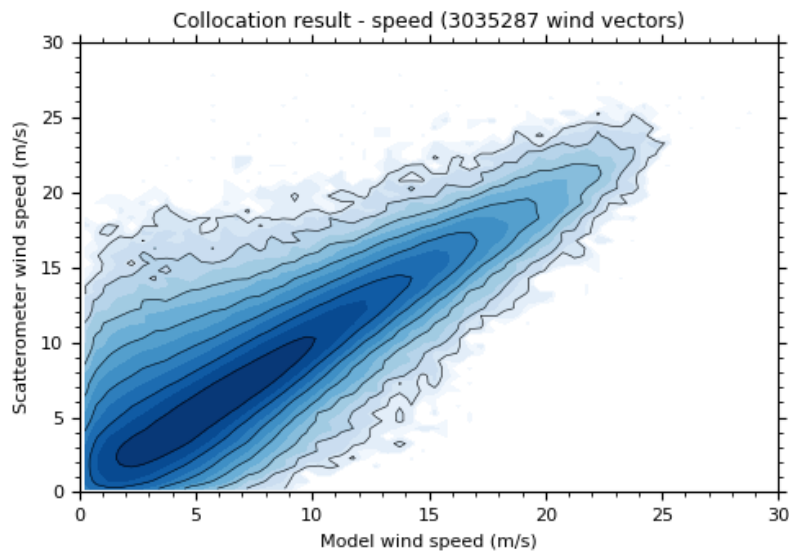




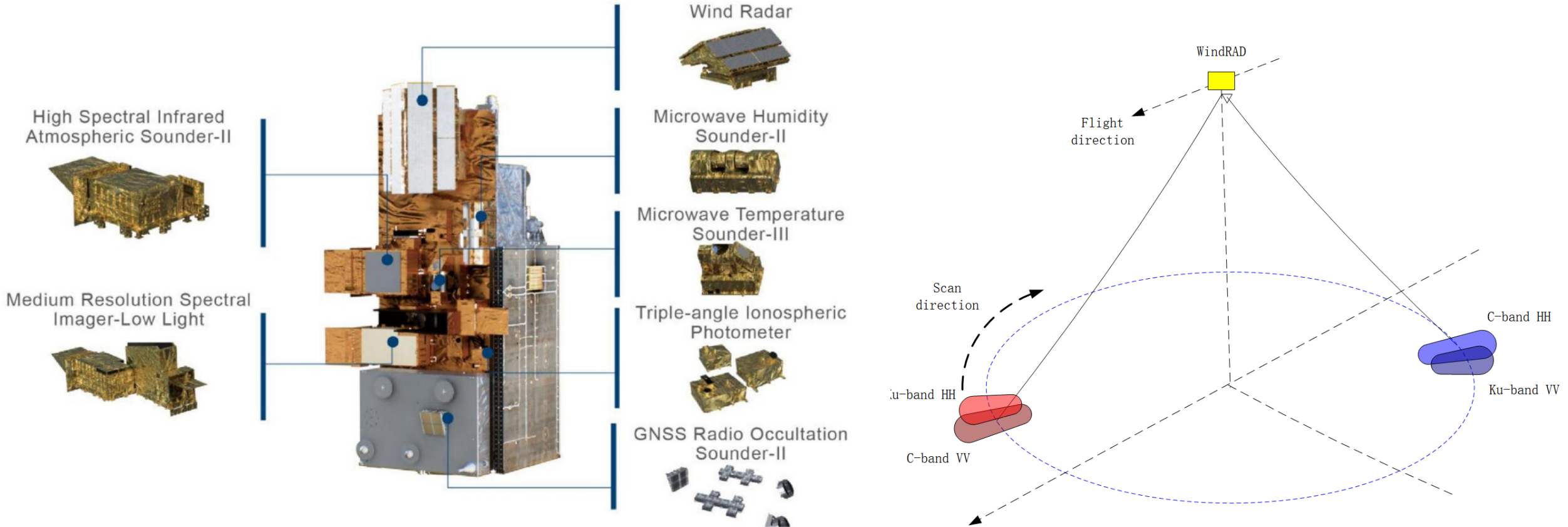
# Effect of outlier removal (global coastal winds)

	No outlier removal	With outlier removal
Nr. of coastal winds	3035287	3053552 (+0.6%)
Speed bias (m/s)	0.36	0.34
Stdev diff. u (m/s)	1.86	1.86
Stdev diff. v (m/s)	1.97	1.96

4 weeks of data



**WindRAD** onboard **FY-3E** satellite launched on 9<sup>th</sup> July 2021 by CMA .  
**WindRAD** is a **dual frequency (C and Ku)** **rotating fan-beam** scatterometer.

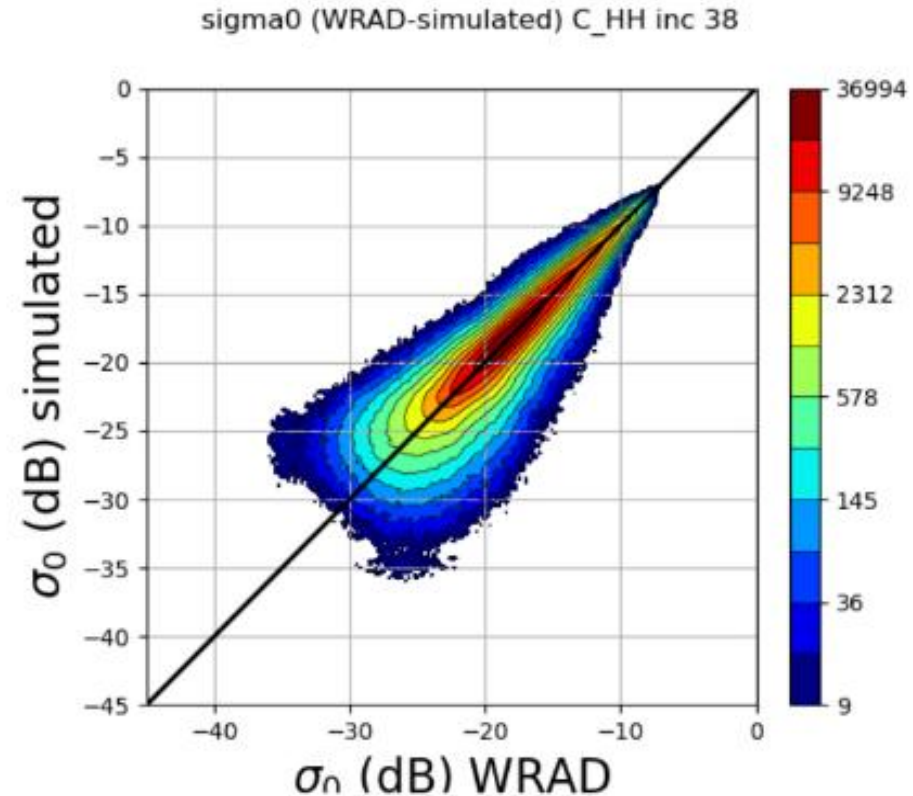
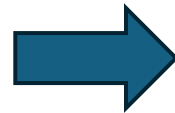
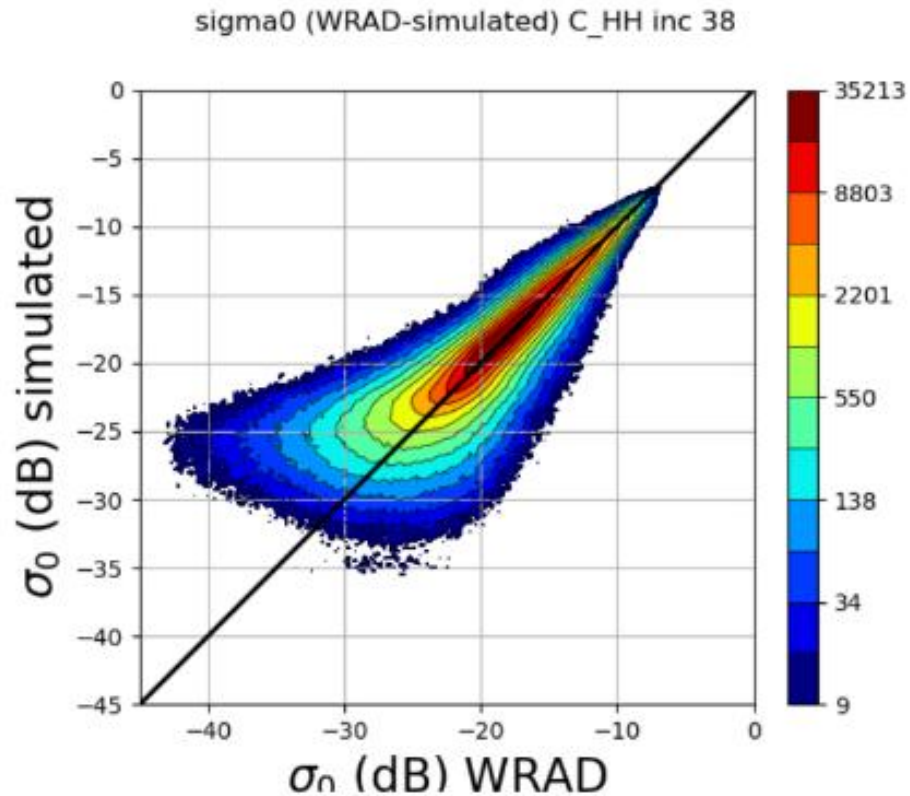


## Data situation

The Ku-band ceased operation in mid 2024, and after recovery it has experienced distortions in the sigma0 distribution. Therefore, only the C-band is currently operational, providing 20 km and 40 km products. KNMI developed a C-band-only processor that now produces stable winds.

## Calibration method:

- Higher Order Calibration (**HOC**) => remove the non-linearity in the sigma0s distribution.
- NWP Ocean Calibration as a function of incidence angle and azimuth angle (**NOcant**) => remove the azimuth asymmetry in the sigma0s distribution
- New HH GMF based WindRad HH/VV ratio as a function of speed and direction (Wang et al.)



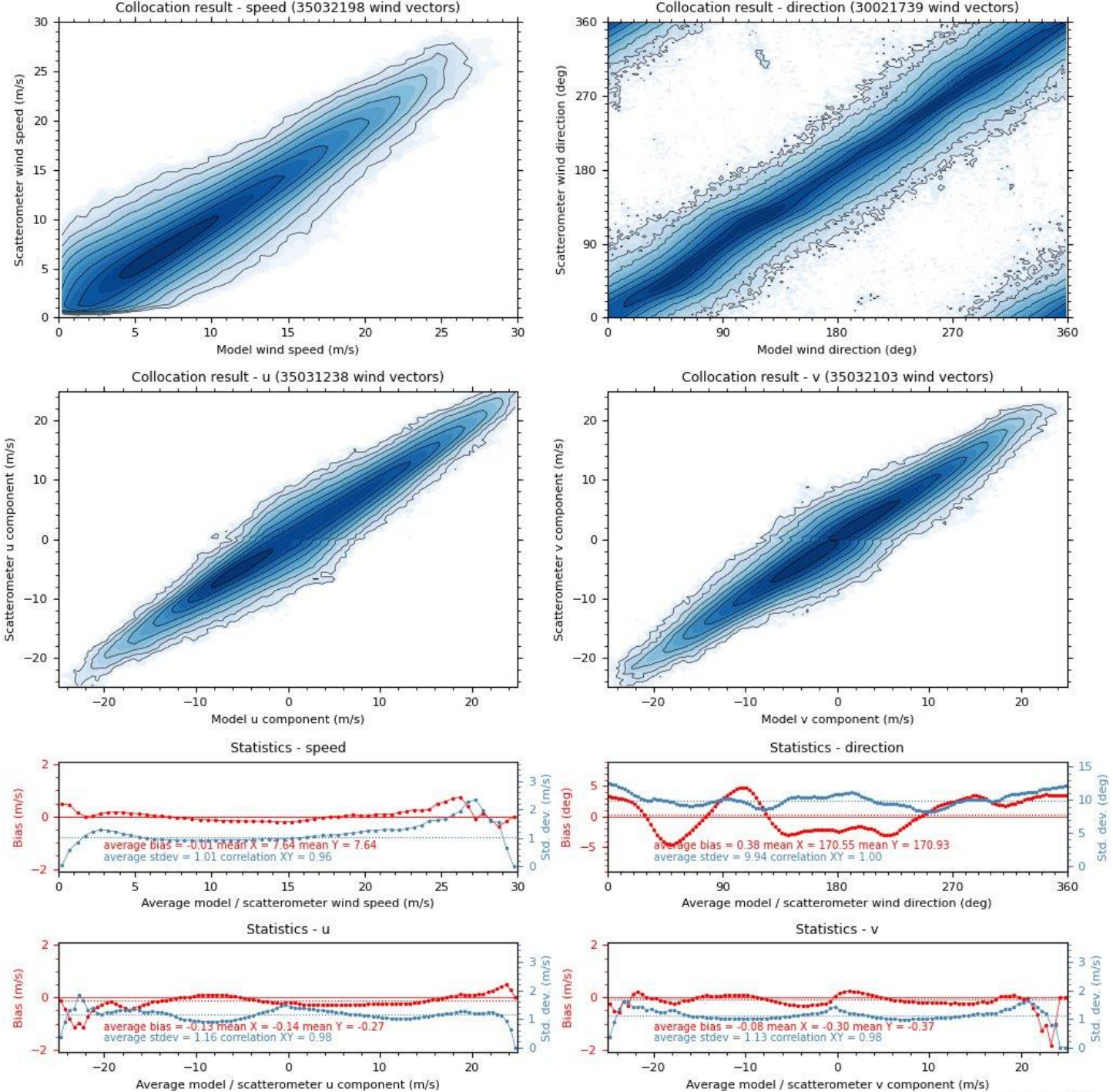
C&Ku band:  
Jan - March 2024  
A stable WindRad period

C and Ku HOC + NOCant, and manual delta adjustment on HH and VV to make the wind speed bias flat across the swath.

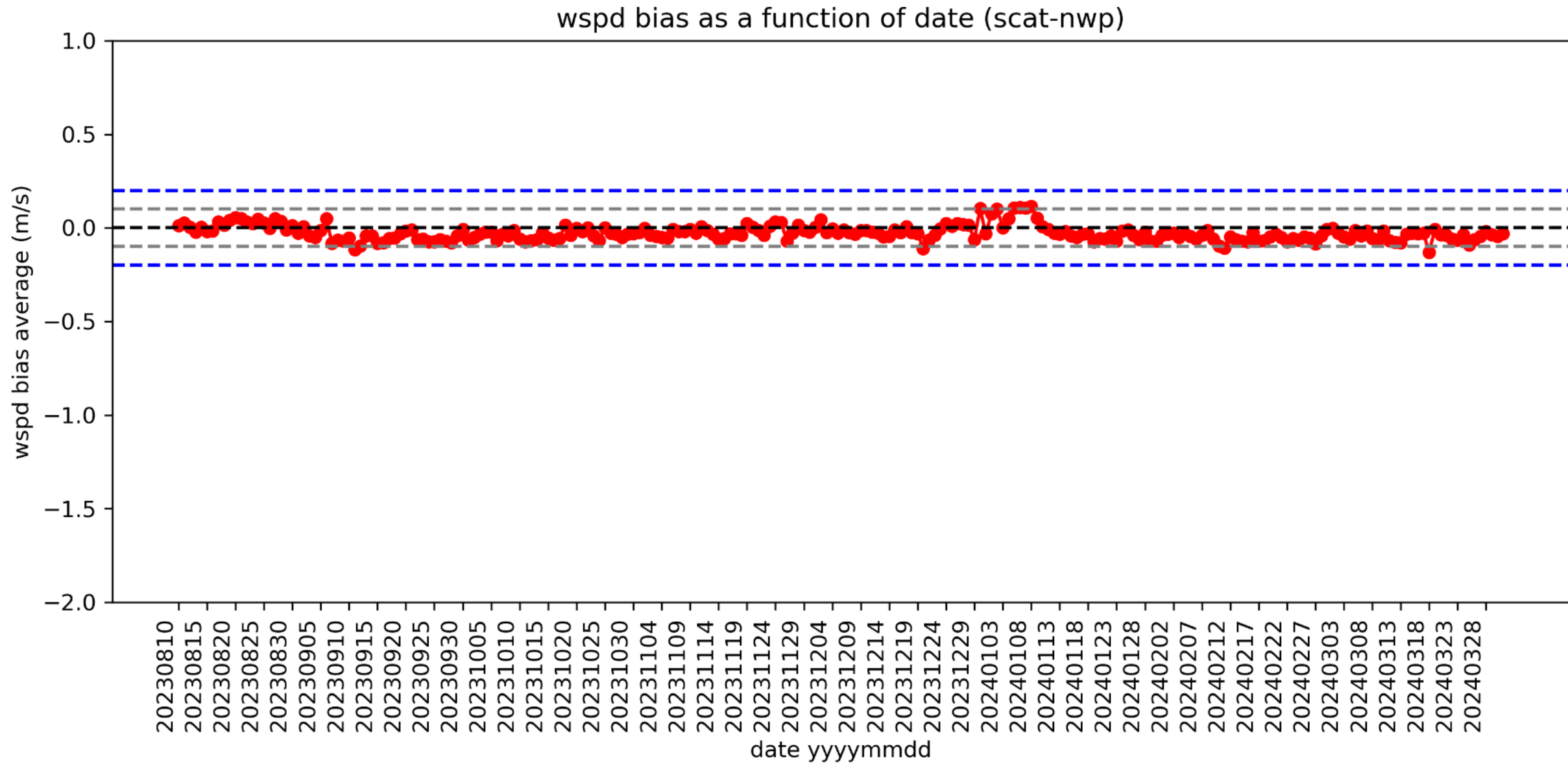
Global wind statistics comparable to PenWP products

See also:  
[WindRAD Scatterometer Quality Control in Rain](#)

Zhen Li, Anton Verhoef, Ad Stoffelen  
Remote Sensing 17 (3), 560

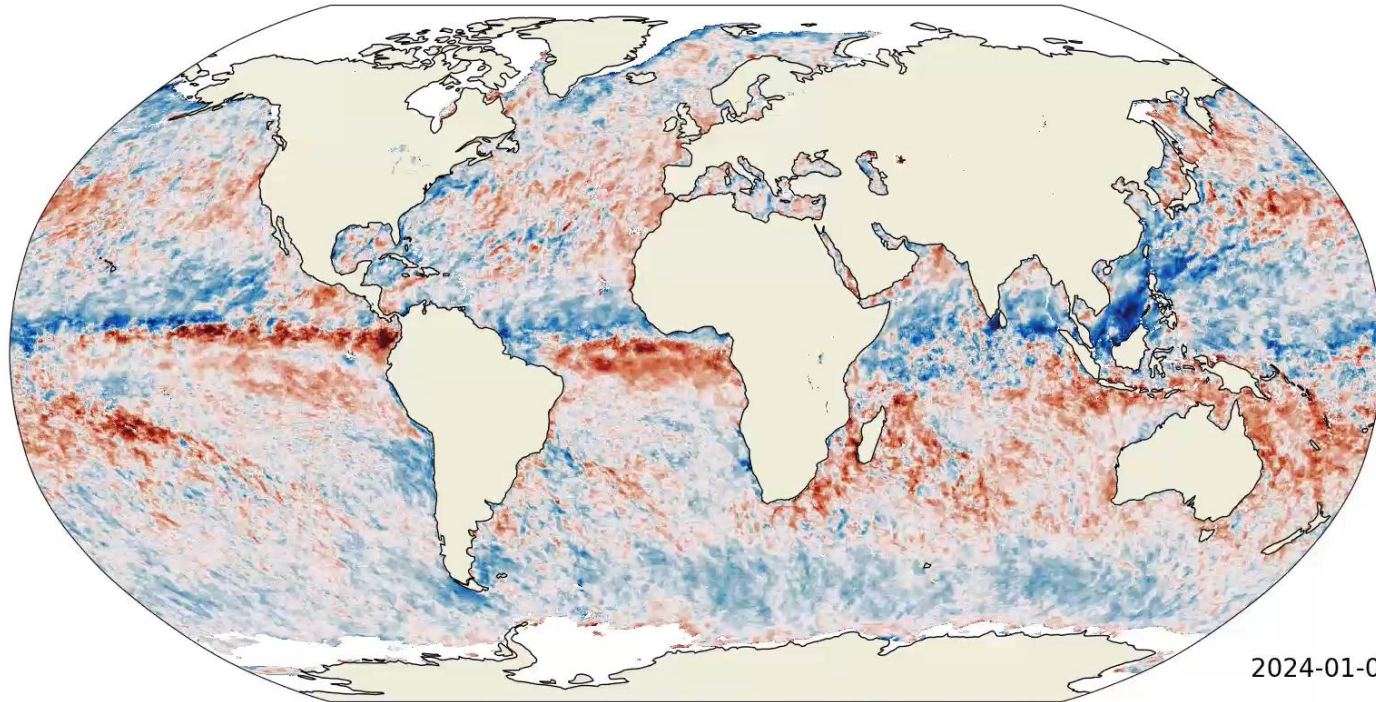


# Wind speed bias over longer period (C&Ku)



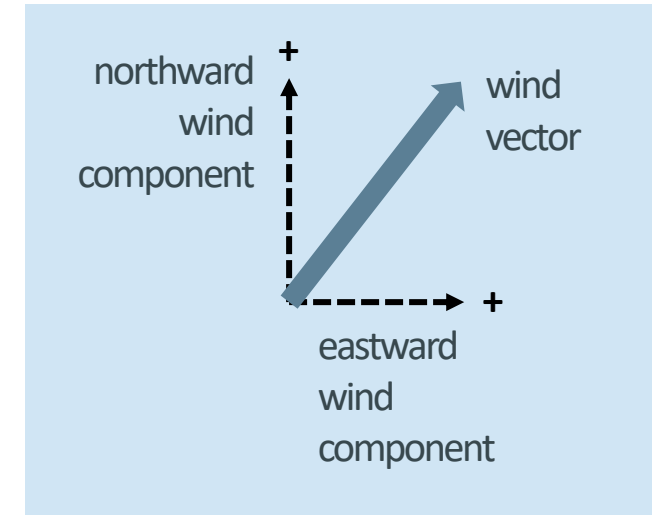
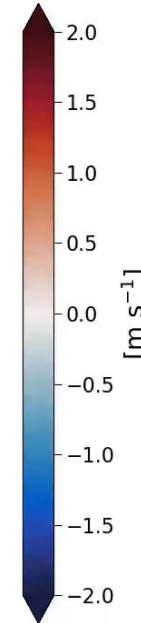


## Problem: numerical weather model winds contain persistent biases



2024-01-01

Bias of the northward wind component [scatterometer – model]



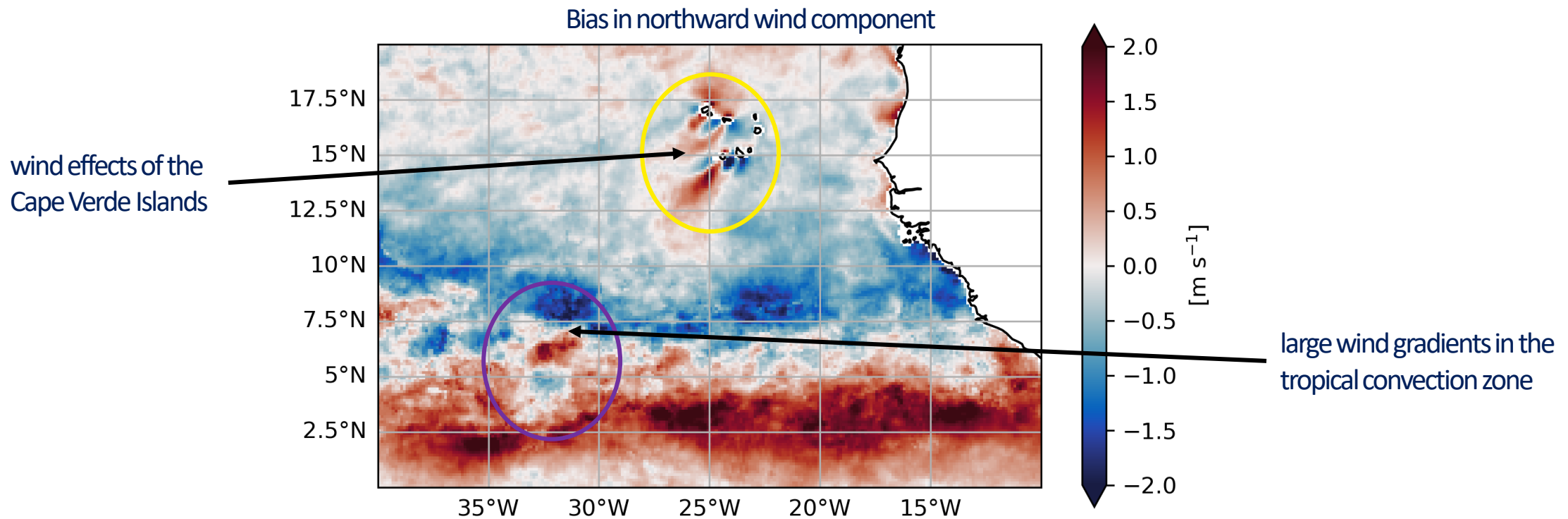
These biases affect the quality of applications using model winds

- Daily L3 swath-based vector winds, stress, wind derivatives (curl, div) and variances, including ECMWF equivalents
- Hourly L4 product with corrected wind vectors
- VSA from Eugenia Makarova on ML corrections, applicable in forecasts (Marcos)
- CHERRI project on ERA7 model diagnostics (ML, hybrid and classical prototypes)
- Interest from C3S



## Solution

Use persistent bias patterns to create improved surface wind products

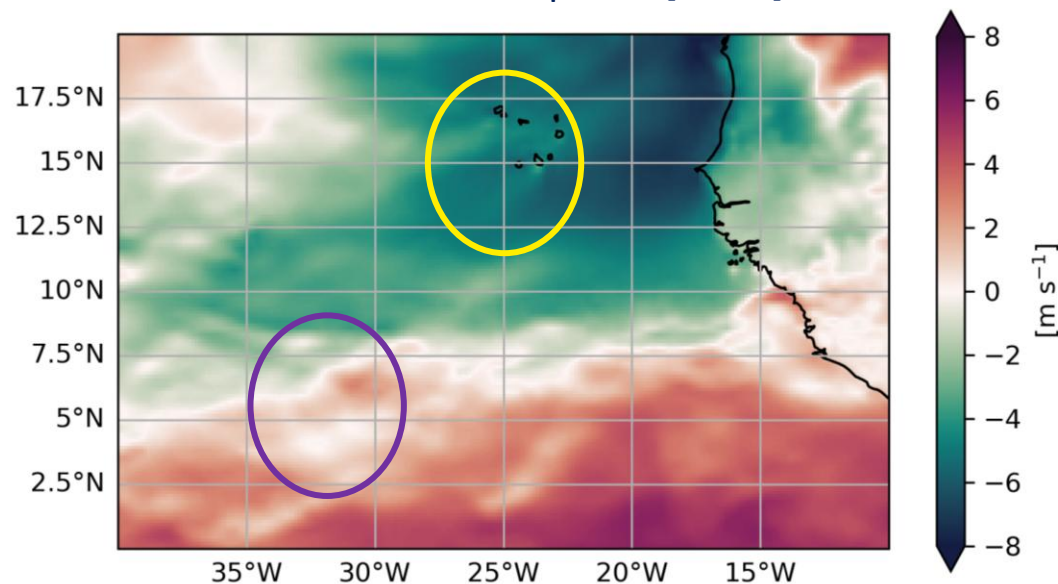




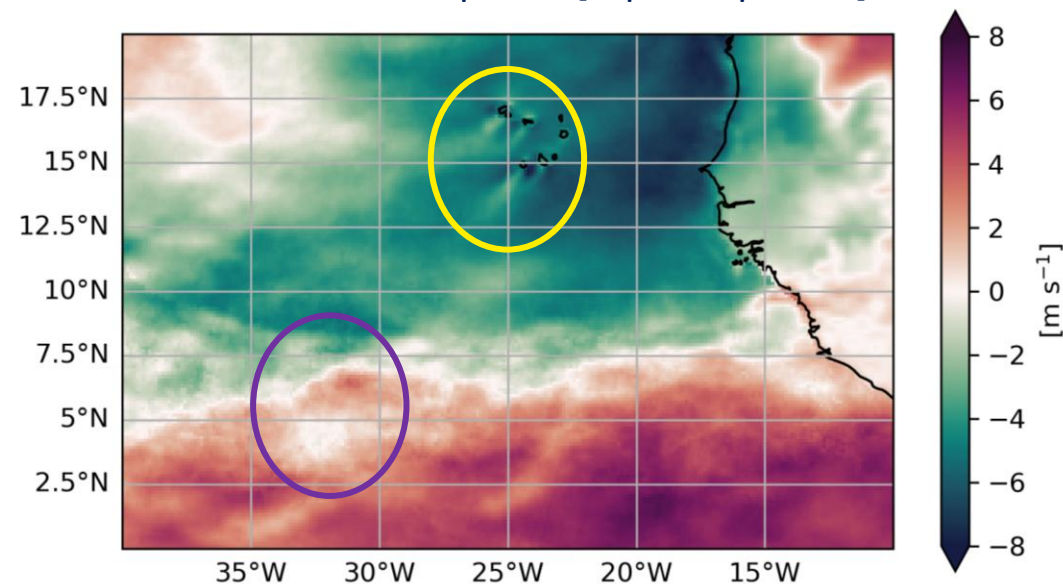
## Improved surface wind products have

- persistent biases removed
- more spatial detail
- no gaps in space and time

northward wind component [model]



northward wind component [improved product]





Improved ocean surface wind fields are available through the Copernicus Marine Service:

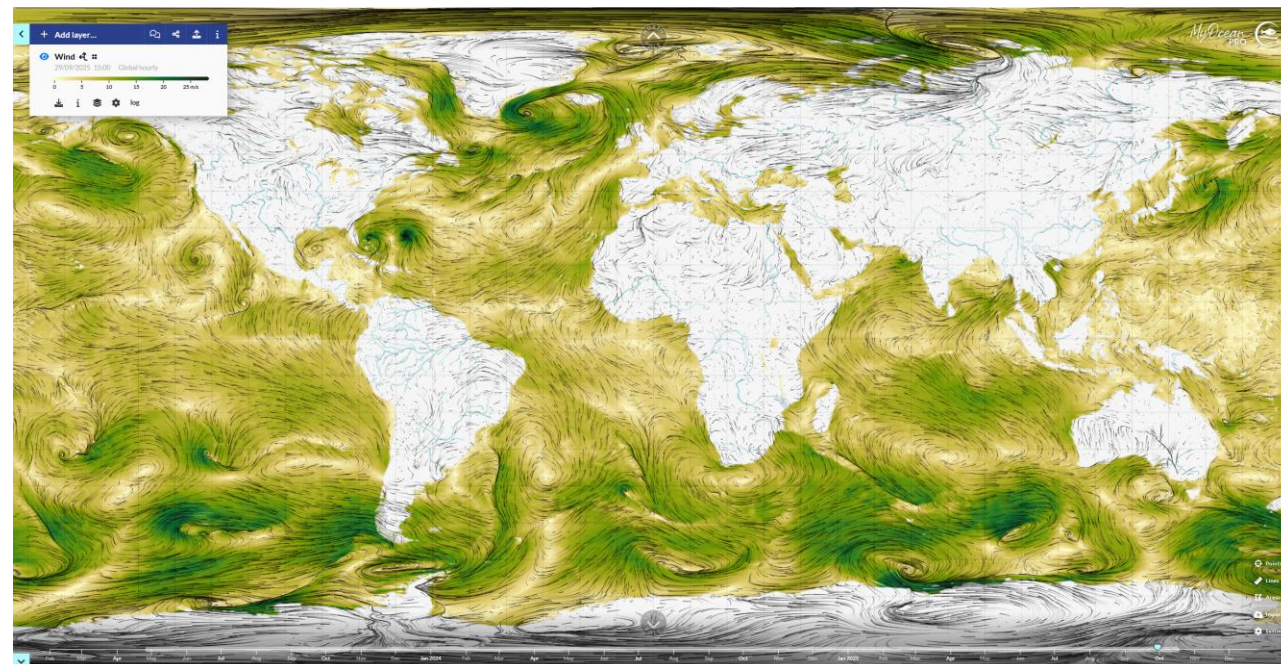
Near real-time  
hourly wind product  
[past 2 years]



Multi-year  
hourly wind product  
[1994-2025]



Copernicus Marine Service viewer





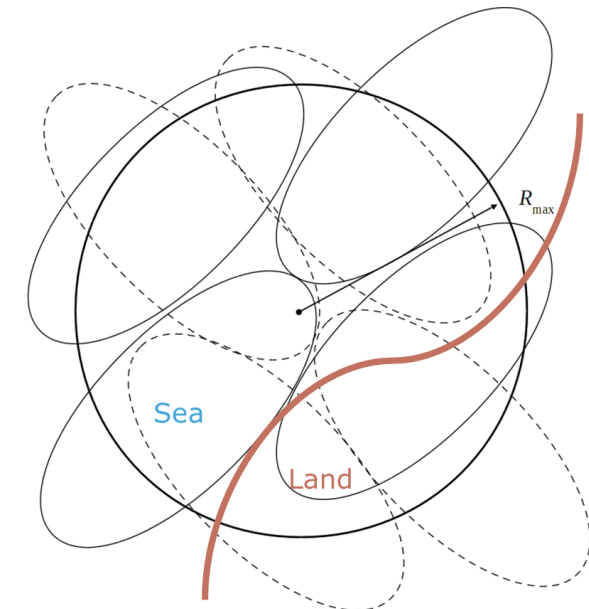
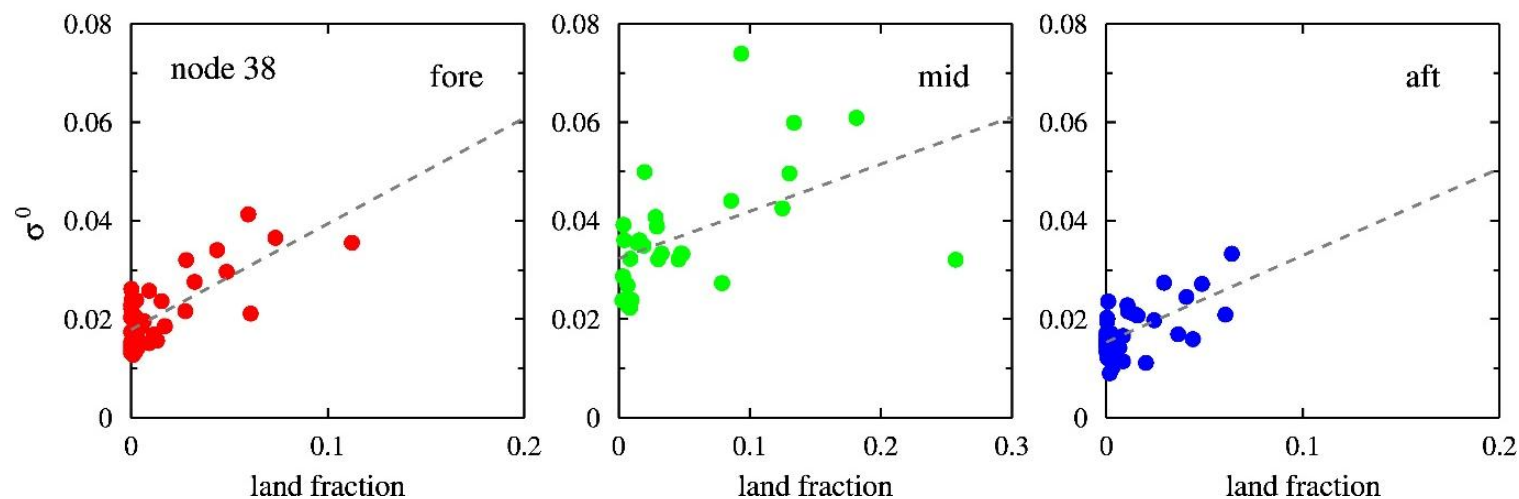
# Introduction

- › Radar reflections by ships and other metal structures can significantly enhance the observed backscatter in scatterometer observations, this leads to enhanced retrieved wind speeds
- › The impacted winds are sometimes flagged by Quality Control, but not always
- › An attempt is done to identify the spurious backscatter data and if possible, to reduce their effect on the wind retrievals
- › This work uses ASCAT data, it can be expected that similar issues impact Ku-band scatterometers
- › In December 2024, the level 1b land mask was slightly updated by EUMETSAT, to correct the locations of some islands and other coastlines (V11-5), level 1b test data received from EUMETSAT were used to test; the data set covers six dates: 20230912, 20230913, 20231108, 20231109, 20240206, 20240207
- › Some other tests cover the periods of 10 – 25 December 2024 and 10 – 25 April 2025

# Land correction in ASCAT



- › In November 2022, a new Land Contribution Ratio was introduced in the ASCAT full resolution level 1b data
- › The ASCAT 12.5 km coastal product was updated in 2022, a land correction was introduced using linear interpolation of sea contributions and land contributions to the sigma0 data
- › The slice sigma0s are corrected before averaging, with a land contribution which is based on the regression line:  $\sigma_0(\text{sea}) = \sigma_0 - a \times (\text{land fraction})$  (see picture)
- › This reduced the lowest distance of the wind retrievals to the coast from  $\sim 20$  km to  $\sim 10$  km
- › The method is sensitive to outliers and these are downweighted;



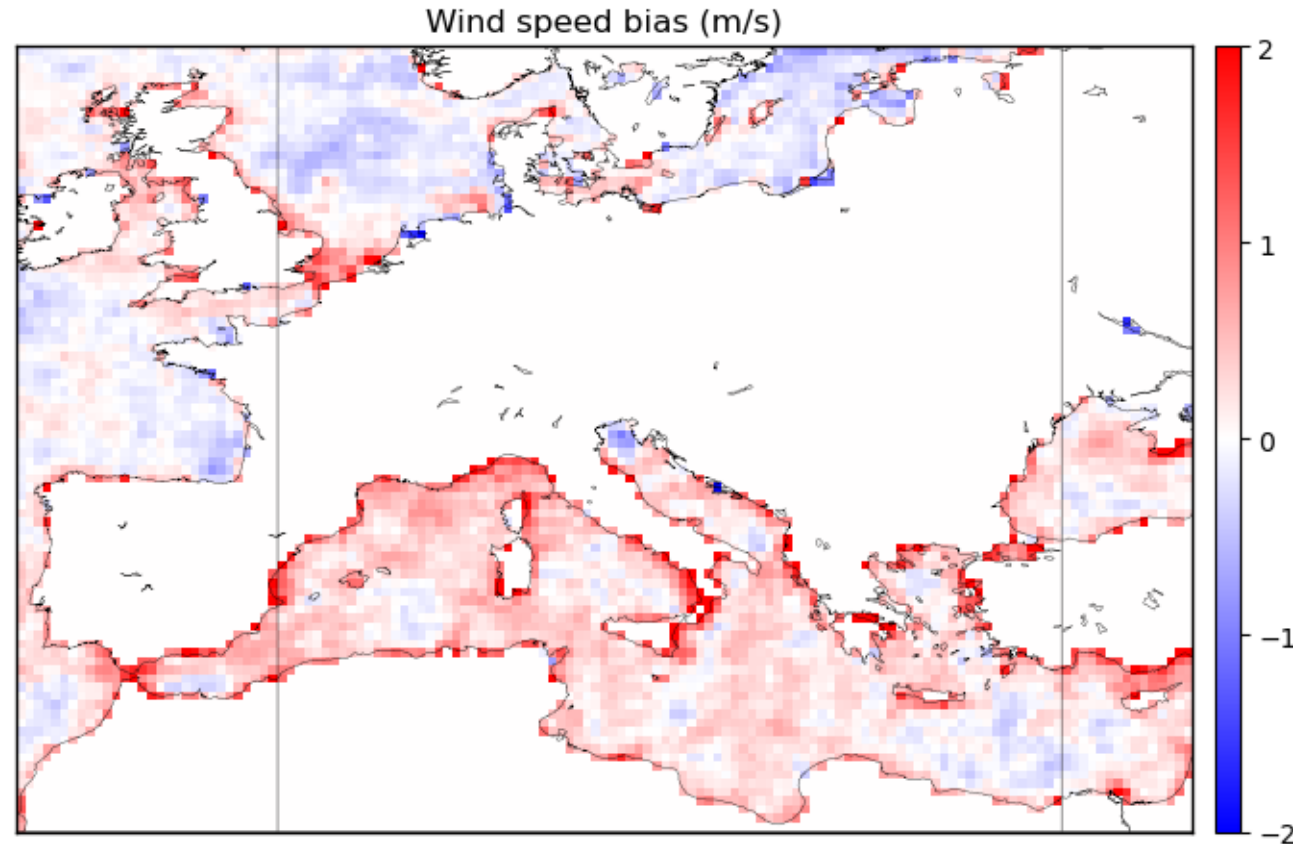


# Improvements and fixes in AWDP

- › Some fixes and improvements have been implemented in AWDP, before starting this work
  - Added QC check on negative MLEs in case of coastal WVCs, this leads to more QC rejections in the coastal areas
  - Bug fix in the computation of the weighted  $\sigma_0$  variance and  $K_p$  in slice averaging near the coast, this leads to less zero  $K_p$  values and hence more QC rejections
  - Use only one routine for backscatter aggregation and land correction for 12.5 and 6 km products (code optimisation), this used to happen in two separate routines
  - The maximum land fraction for a (full resolution) slice is now 0.50 (was 0.20). The maximum beam land fraction in a view (averaged over all slices) is now 0.30 for 12.5 km and 0.25 for 6 km (was unlimited). This results in 1% less coastal winds and at the same time a reduction of 0.07 m/s of  $u$  and  $v$  standard deviations w.r.t. ECMWF
  - Improved land fraction dependent weighting of full resolution data (-wgeo option): take land fraction ( $1 - lfrac$ ) into account in the regression. This results in 0.5% extra coastal winds and a reduction of 0.01 of  $u$  and  $v$  standard deviations w.r.t. ECMWF

# Wind speed bias vs. ECMWF

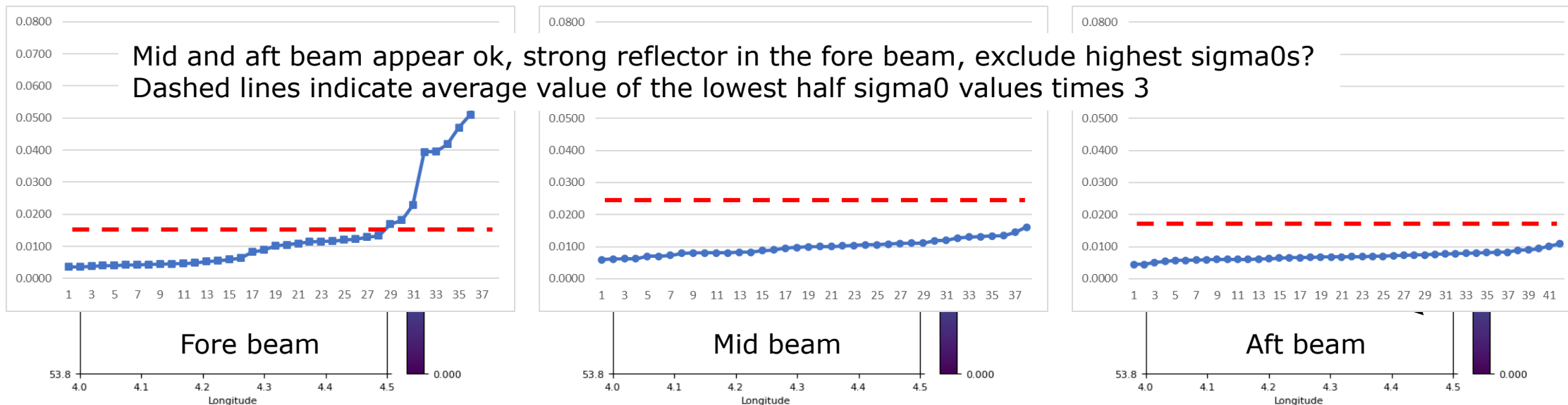
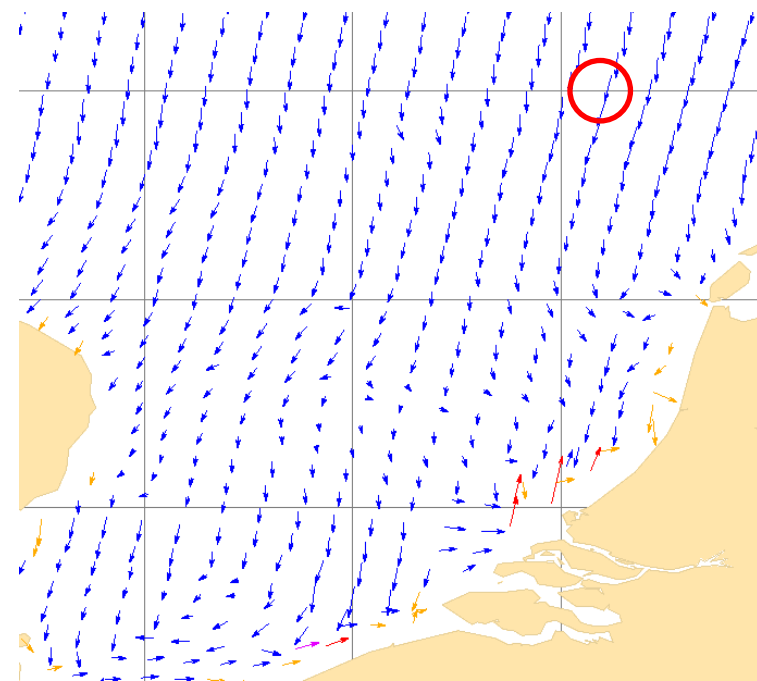
- › The plot shows the wind speed bias of 12.5 km ASCAT winds w.r.t. ECMWF forecast winds (Dec 2024, Apr 2025)
- › The model wind biases are the largest, particularly near the coast
- › Near the coasts some high biases are visible, these may be associated with residual land contamination in the ASCAT backscatter and with ECMWF wind errors due to resolution limitations and poor representation of coastal wind effects
- › The high wind speed biases near the Rotterdam and Hamburg ports, and in the English Channel are likely associated with ship reflections, based on SAR verification
- › In the Mediterranean, the biases are mainly due to systematic (ECMWF) biases and to a lesser extent to ship reflections





# Slice backscatter – 12.5 km

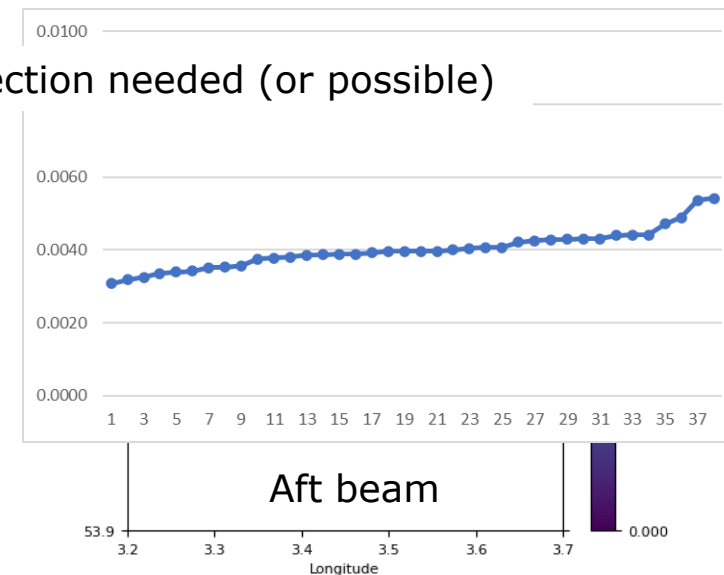
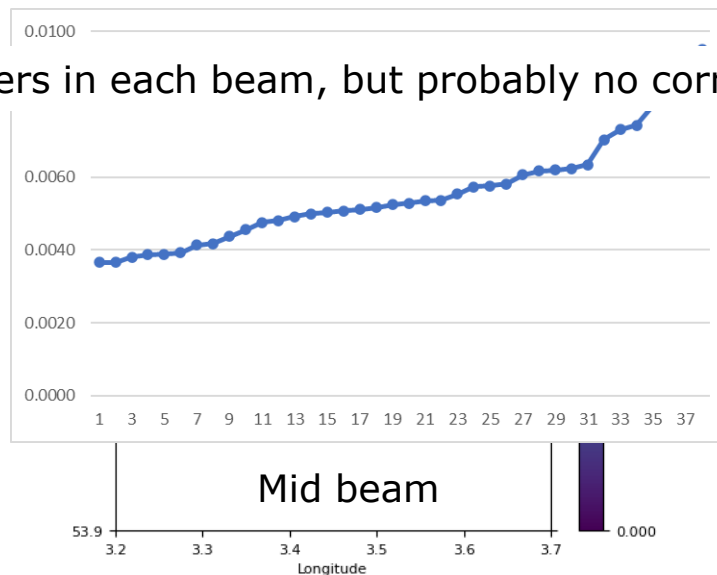
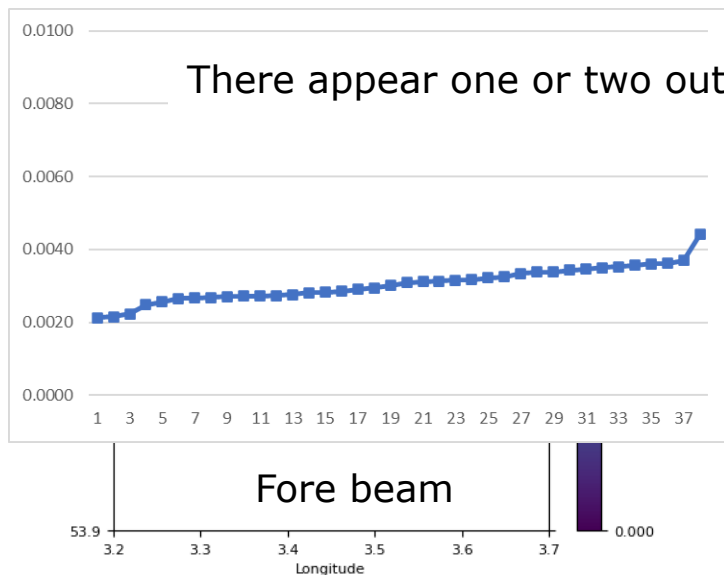
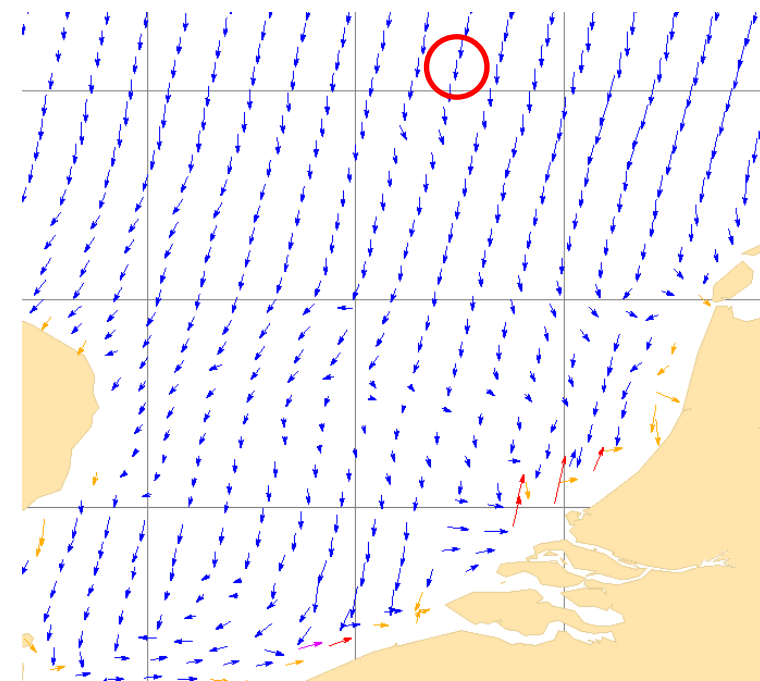
- > The plots below show the  $\sigma_0$  values (linear space) of individual slices contributing to the beam backscatter of the WVC (indicated in the red circle), arrows point to the satellite
- > lat 54.07, lon 4.24 (row 50, node 60), 12 September 2023
- > wind speed 8.62 m/s, MLE -1.80
- > KNMI QC set, Kp flag set, VarQC not set





# Slice backscatter – 12.5 km

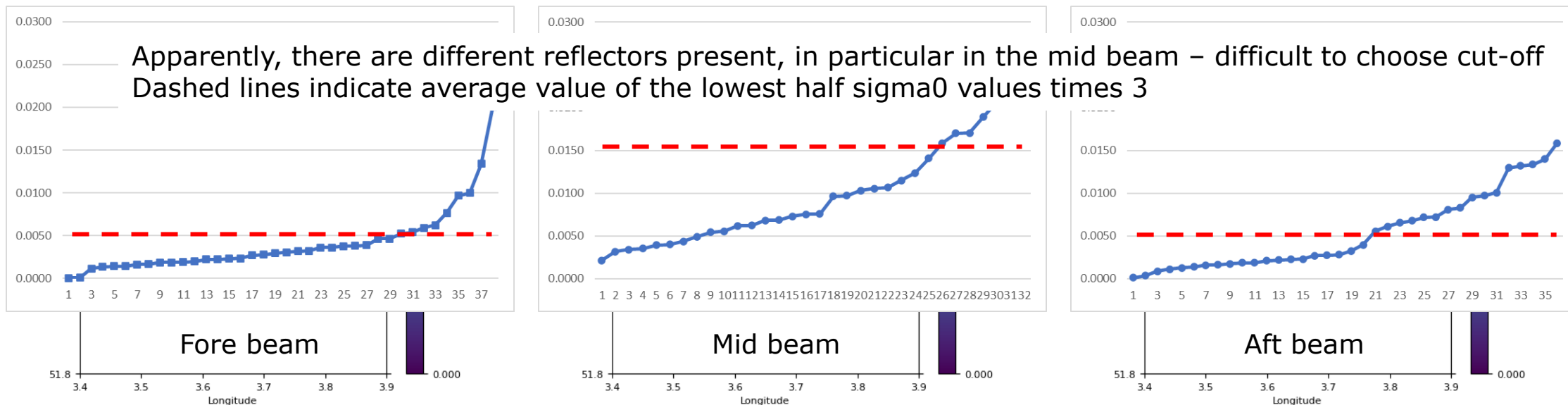
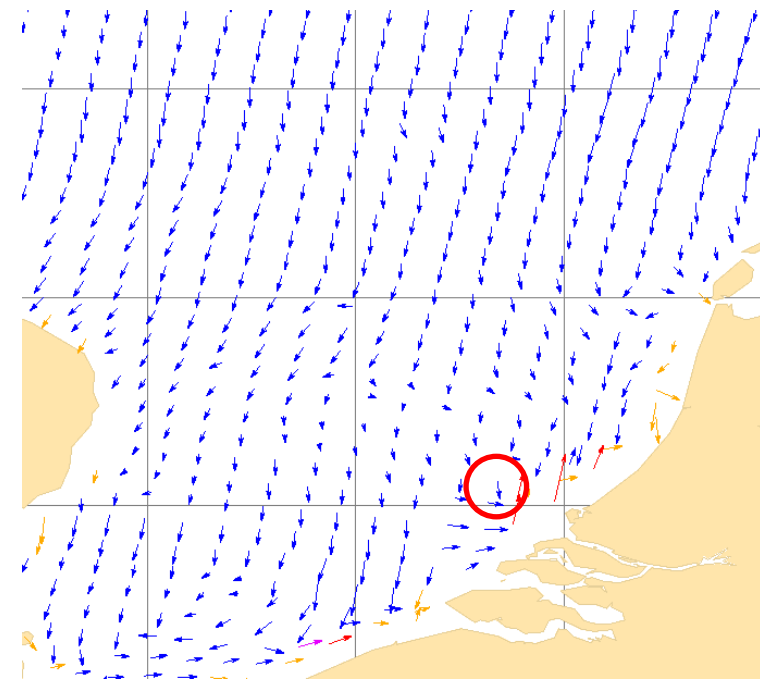
- > The plots below show the  $\sigma_0$  values (linear space) of individual slices contributing to the beam backscatter of the WVC (indicated in the red circle)
- > lat 54.14, lon 3.49 (row 50, node 64), 12 September 2023
- > wind speed 5.16 m/s, MLE 0.00
- > KNMI QC not set, Kp flag not set, VarQC not set





# Slice backscatter – 12.5 km

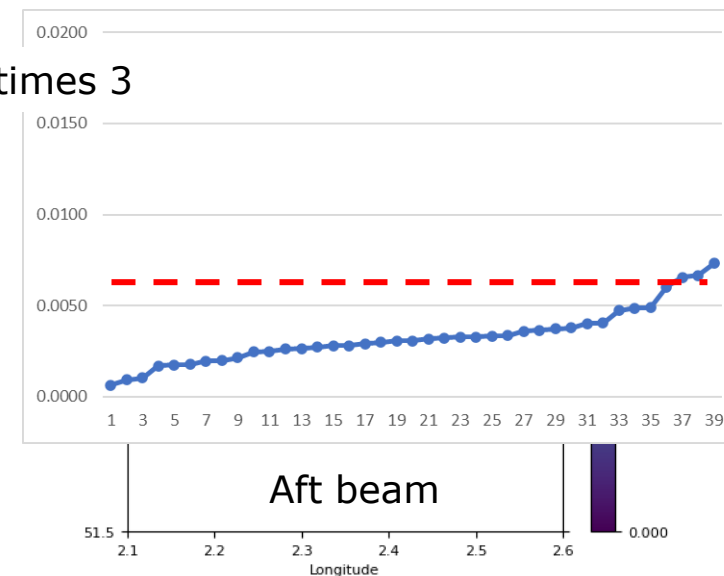
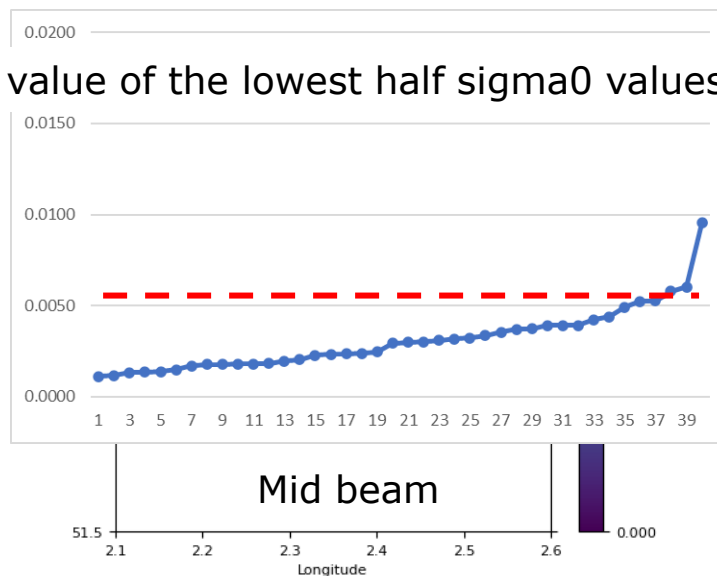
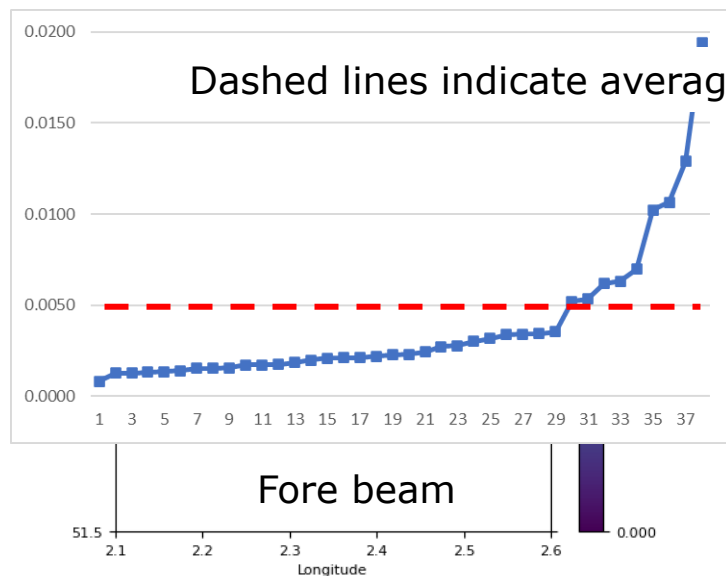
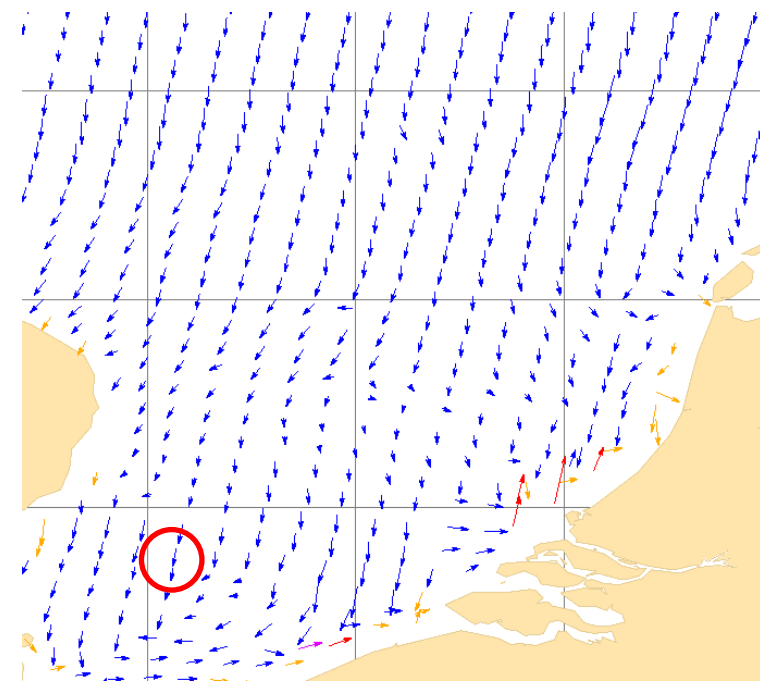
- > The plots below show the land-corrected  $\sigma_0$  values (linear space) of individual slices contributing to the beam backscatter of the WVC (indicated in the red circle)
- > lat 52.11, lon 3.68 (row 68, node 60), 12 September 2023
- > wind speed 4.71 m/s, MLE 0.50
- > KNMI QC not set, Kp flag not set, VarQC not set





# Slice backscatter – 12.5 km

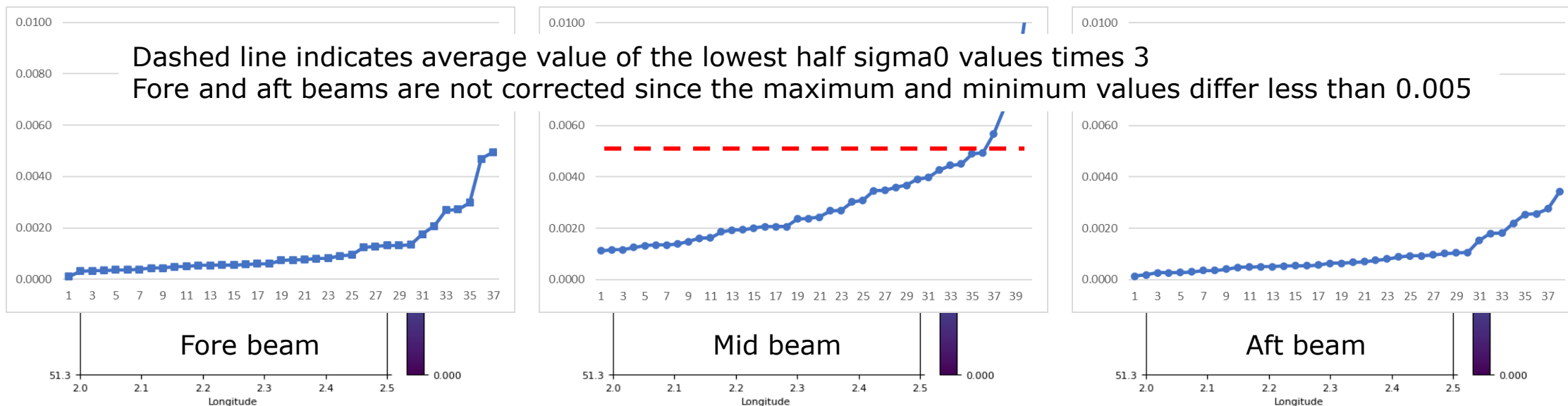
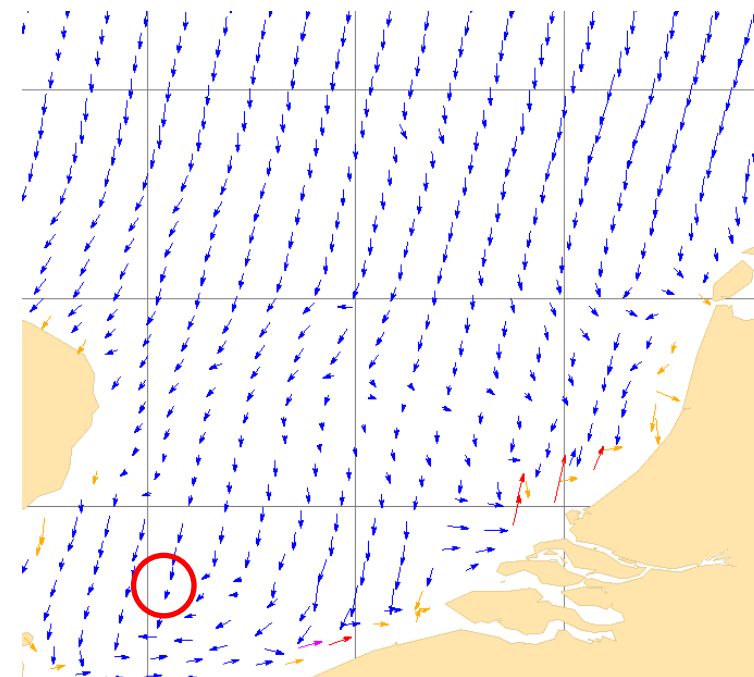
- > The plots below show the  $\sigma_{00}$  values (linear space) of individual slices contributing to the beam backscatter of the WVC (indicated in the red circle)
- > lat 51.81, lon 2.14 (row 72, node 67), 12 September 2023
- > wind speed 6.13 m/s, MLE -2.00
- > KNMI QC set, Kp flag set, VarQC not set





# Slice backscatter – 12.5 km

- > The plots below show the  $\sigma_{0}$  values (linear space) of individual slices contributing to the beam backscatter of the WVC (indicated in the red circle)
- > lat 51.60, lon 2.09 (row 74, node 67), 12 September 2023
- > wind speed 2.57 m/s, MLE 0.10
- > KNMI QC not set, Kp flag not set, VarQC not set

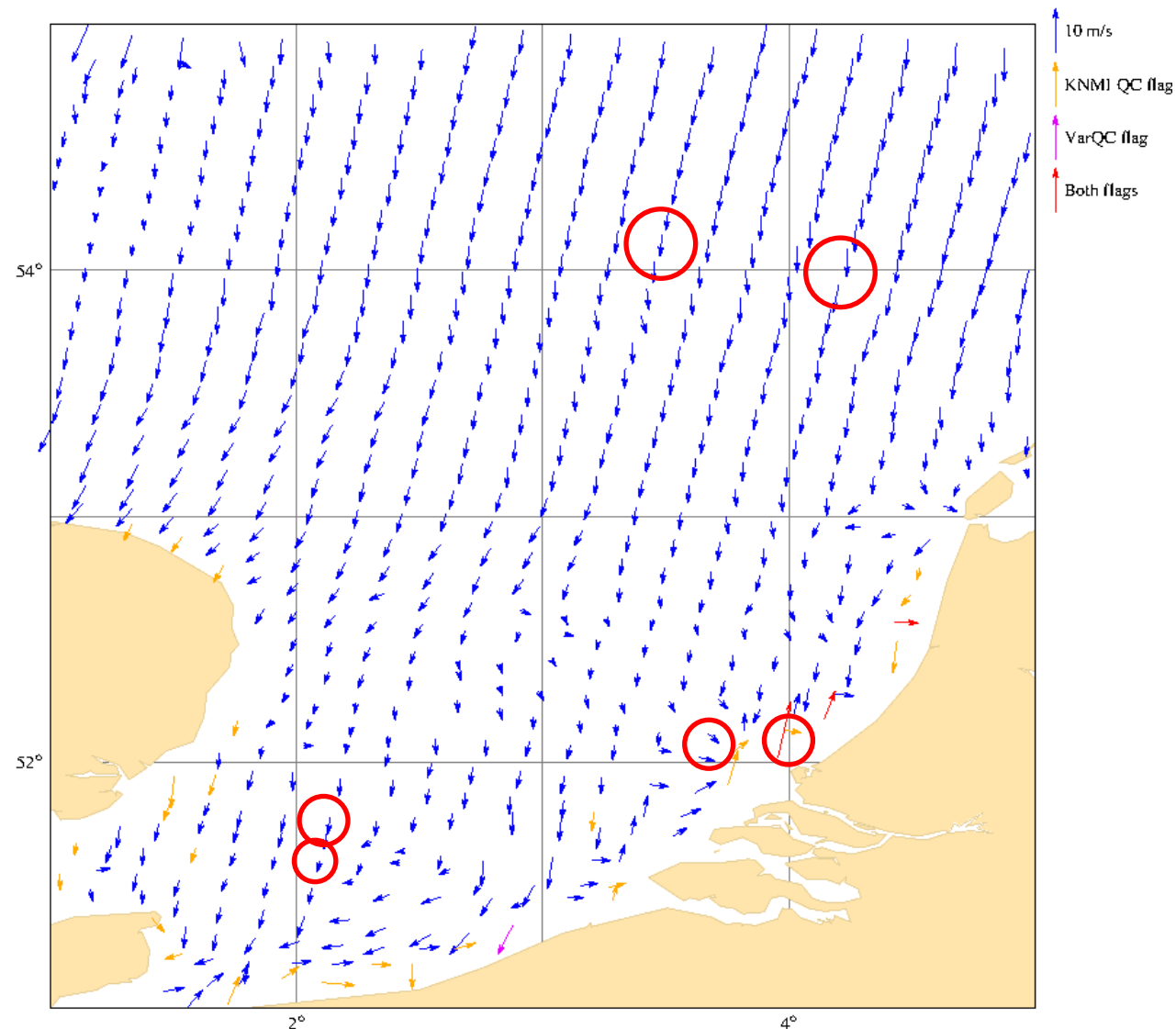




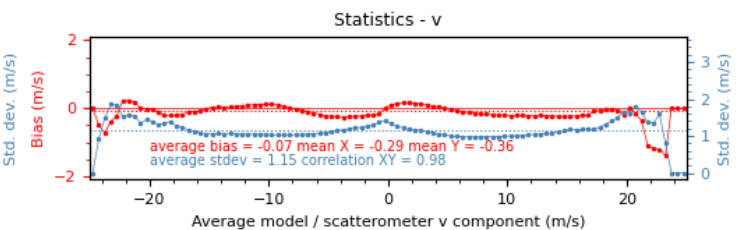
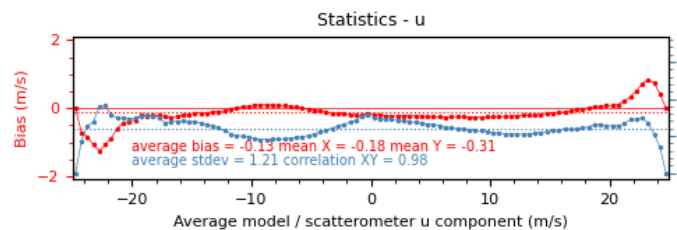
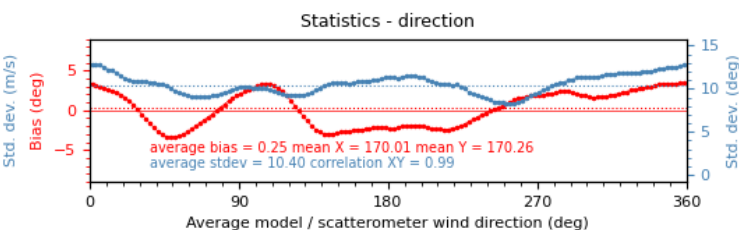
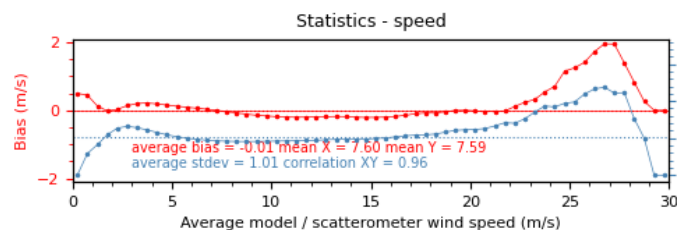
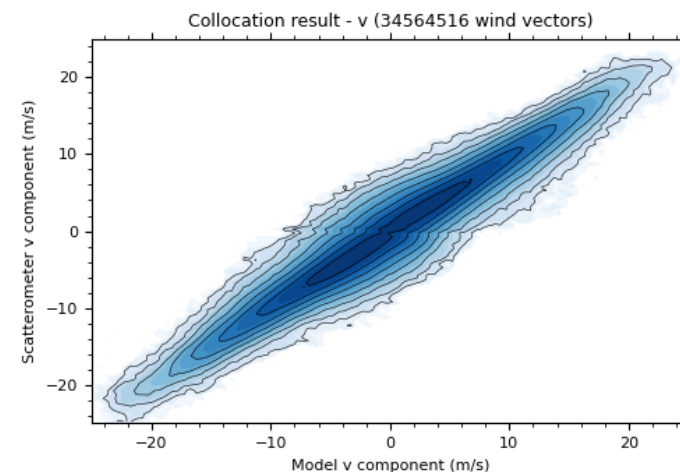
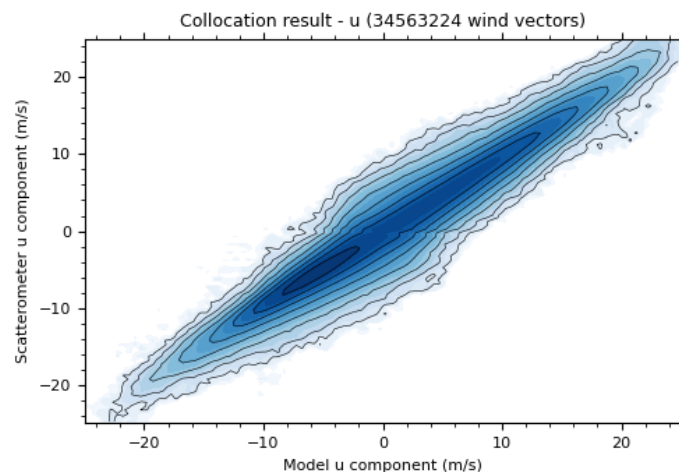
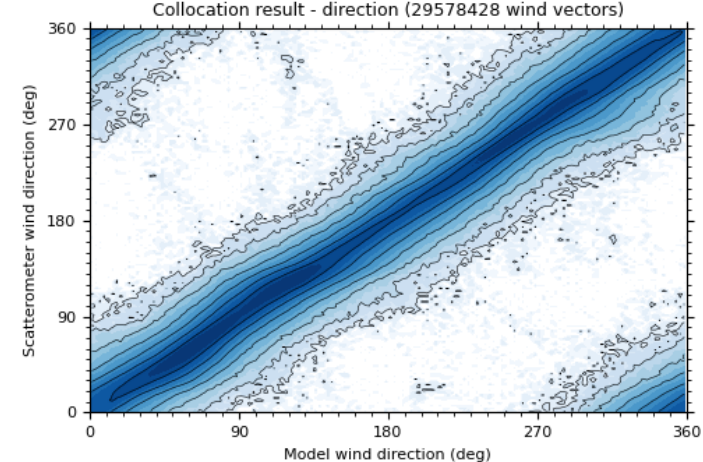
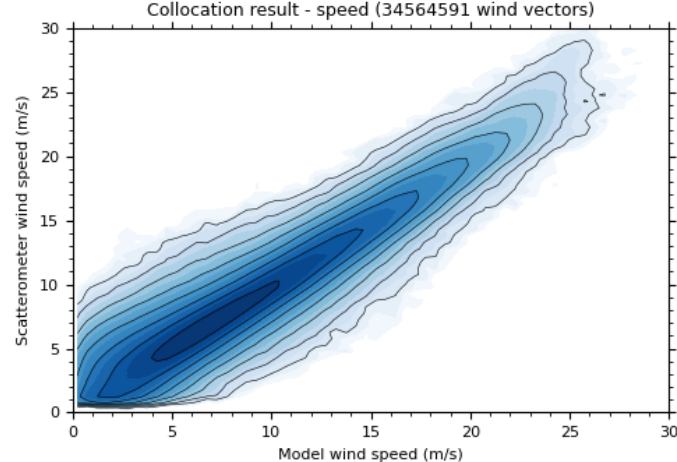
# Slice outlier removal

- > The sigma0 average value of the lowest half of the slices is computed
- > All slices having a sigma0 value of more than 3 times (2 / 1.5 times) this average are removed before averaging slice values to a WVC view (coastal and non-coastal WVCs)
- > This is done only when the difference between highest and lowest slice sigma0 value is larger than 0.005 (indicating a local corner reflection) and the lowest slice value is lower than a GMF cross wind value of 10 m/s (indicating a wind speed of less than 6 – 10 m/s)
- > Using three times the average leads to 0.3% extra accepted WVCs in coastal areas

1.5 times value removed



Ku-band only:  
Jan - March 2024



Note: Ku-band data are not available in 2025, so here demonstrate with the data in 2024