Plenary Presentation and Discussion Theme 2: Near surface wind retrievals and detection of extremes

Ad Stoffelen, Doug Vandemark, Romain Husson, Marcos Portabella, Will Perrie, Alexis Mouche

Content

Starting from SEASAR 2012 White Paper on Wind Retrieval:

"WIND RETRIEVAL FROM SYNTHETIC APERTURE RADAR – AN OVERVIEW"

by Knut-Frode Dagestad et al. 2012

1. Fundamental relationships between SAR observables and wind
2. Wind inversion
3. Applications
4. Connecting SAR and Scatterometers winds

1. Fundamental relationships between SAR observables and wind

SAR imagery provides a variety of wind-related observables

- Co-polarized Sigma0 [e.g. Stoffelen et al 2017],
- Cross-polarized Sigma0 [e.g. Zhang and Perrie 2012, Zhang et al 2017, Mouche et al. 2019],
- CCPC (Co- Cross- Polarization Coherence) [Longepe et al 2021],
- Doppler shift [e.g. Moiseev et al 2020],
- IMACS (MeAn Cross-Spectra) [e.g. Li et al. 2019],
- Wind streaks orientation

    ⇒ Talk from Zecchetto et al.: “High-Resolution SAR Winds from Deep Learning in Coastal Areas”

    ⇒ Talk from Marquart et al.: “Analysis Of SAR Ocean Scenes Texture For Wind Direction Retrieval And Generation Of Synthetic Images”

⇒ Interrelation with the other variables (Waves and Current/Doppler shift retrieval)

⇒ Some variables can only be estimated from SLC data, (e.g. like for Wave and Current/Doppler)

⇒ They are available at different resolutions - from 10 m to 10 km

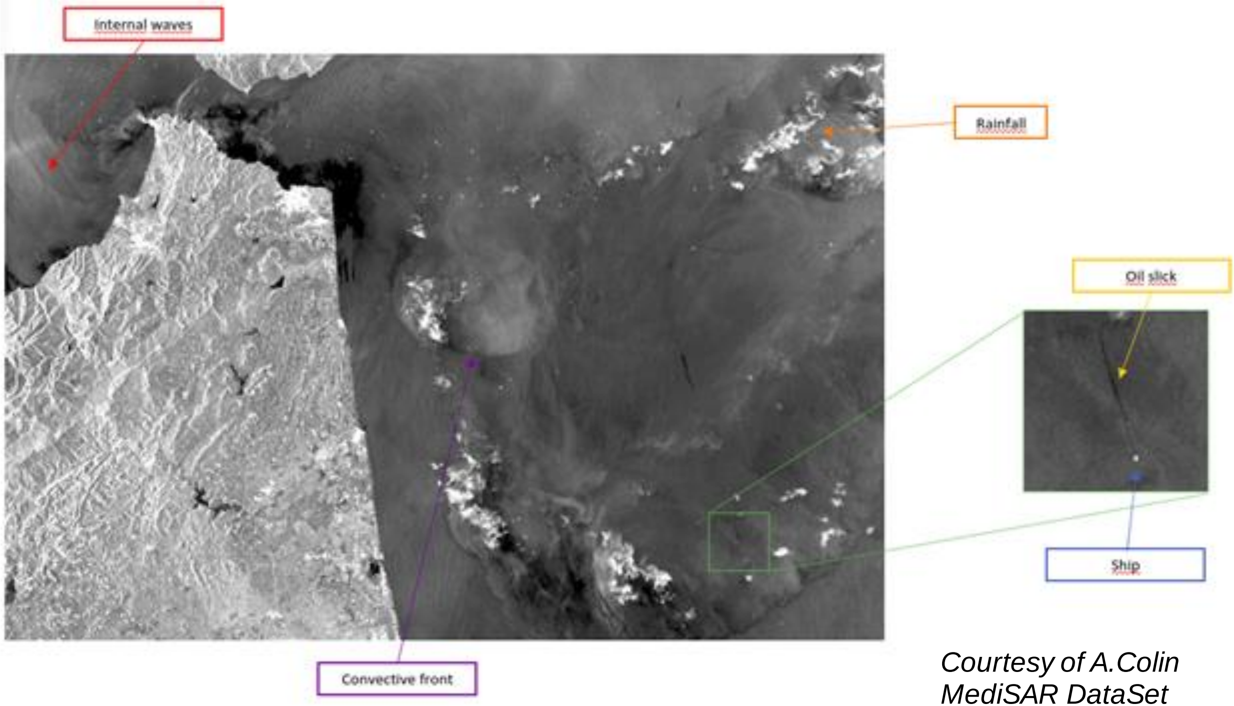
1. Fundamental relationships between SAR observables and wind

The wind-relevant SAR observables can also be affected by other phenomena like:

- Rain
- Sea Ice
- Waves (swell, breakers, …)
- Currents
- Slicks
- MABL coherent structure

⇒ Link with the other theme: Methodology&Techniques + Sea Ice + Currents + Waves

⇒ Will require pre- and post-processing steps (e.g. rain) and more synergistic retrieval approaches

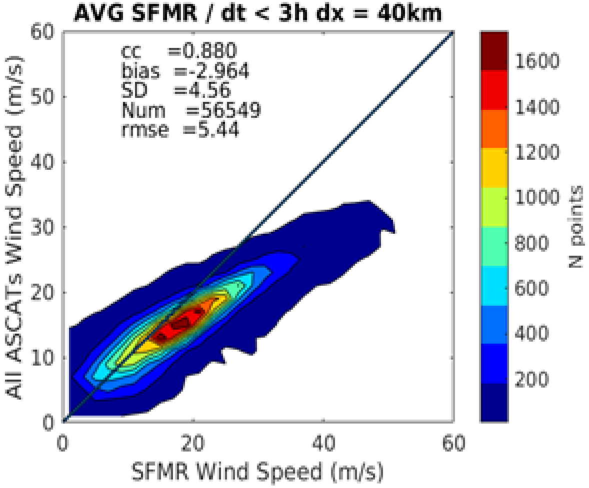


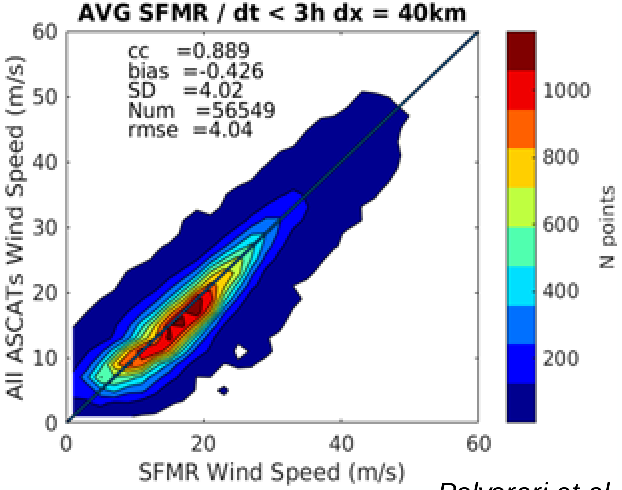
Courtesy of A.Colin
MediSAR DataSet

1. Fundamental relationships between SAR observables and wind

Co-polarized Sigma0

- **CMOD5.N** or **CMOD7**, particularly adapted to buoy winds (left panel), are commonly used both for C-band SAR and SCAT
- **CMOD7D**, particularly adapted to dropsonde and SFMR winds (right panel), to be used by C-band SAR and SCAT for TC nowcasting purposes





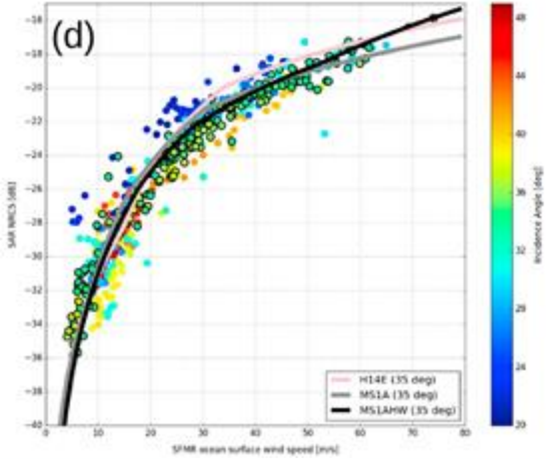
Polverari et al., 2022
Ni et al., 2022
Portabella et al., ATBD, 2022

Inconsistency between buoy & dropsonde winds yet to be addressed

1. Fundamental relationships between SAR observables and wind

Cross-polarized Sigma

- Particularly adapted to extreme winds (20 to > 80m/s)
- Numerous cross-pol GMF (H14E, C2-PO, MS1A, MS1AHW), with strong sensitivity to:
  - Size of validation dataset, much reduced due to few co-locations with extreme winds
  - Source reference (few SFMR colocations in the past, using SMAP/SMOS)
  - SAR sensor accurate noise annotation and correction.
  - Non-wind phenomena (e.g. rain, often met but less well detected in storm conditions)



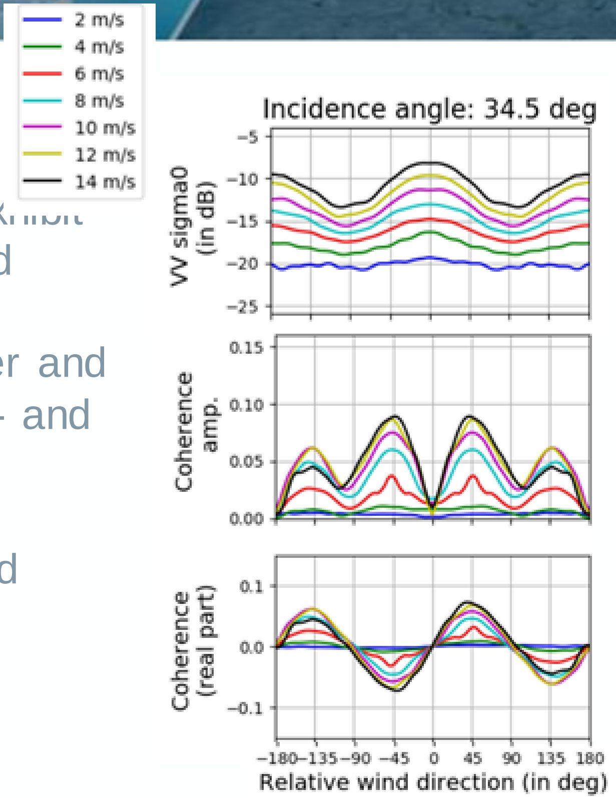
From Mouche et al. 2019

Noted correlation with L-band passive brightness temperature observations - how to better understand and exploit…

1. Fundamental relationships between SAR observables and wind

CCPC (Co- Cross- Polarization Coherence)

- This variable needs to be calibrated before used
- The CCPC amplitude but also the real and imaginary parts exhibit an azimuthal modulation. This modulation increases with wind speed and incidence angle.
- The azimuthal modulation is complementary with both Doppler and NRCS as the maximum/minimum are not reached around up- and down- wind directions.
- Not useful below 5 m/s.
- Behaviour wrt. wind would need to be extended to higher wind speeds
- Resolution: ~ 10km

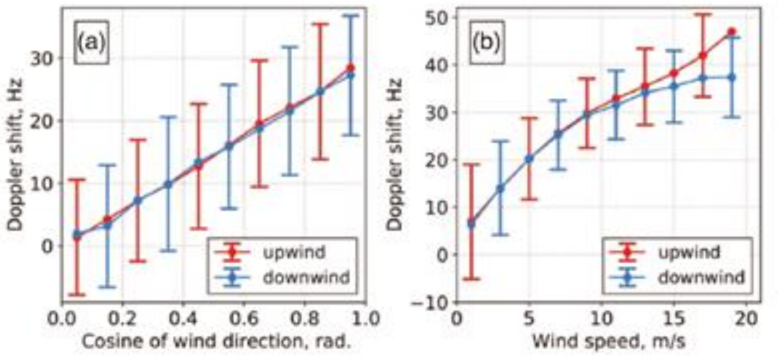


From Longepe et al. 2021

1. Fundamental relationships between SAR observables and wind

Doppler shift

- Does not saturate at extreme high winds
- Calibrated products are not available straight forward
- Information available at 2-4 km resolution (IW-EW)
- Also seeing geophysical doppler <-> wind speed relationship near nadir in SAR altimetry (Egido et al…) - and will likely be seen in SWOT data…



From Moiseev et al. 2020

1. Fundamental relationships between SAR observables and wind

Wind streaks as a proxy for surface wind direction

- Wind streaks (if present) provide information on the MABL (mean wind direction and atm. stability)
- Their orientation is close to the wind direction but often with significant bias (see next slides and [Foster 2005])
- Large differences can exist between streaks orientation and actual wind direction
- Orientation estimation techniques: Fourier Transform, Local Gradient, Continuous Wavelets, ResNet
- Available at ~1 to 10 km resolution depending on the method
- ResNet:

  1- to get high resolution wind fields suitable for coastal areas, lagoons and Artic fjords,

  2- to investigate the spatial characteristics of the marine surface wind speed and direction at fine scales

From S. Zecchetto

Fig. 1

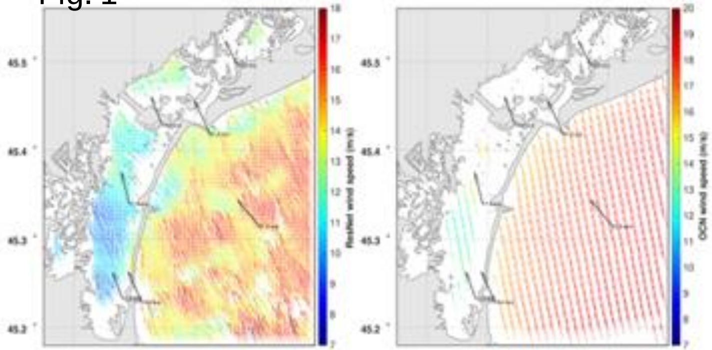
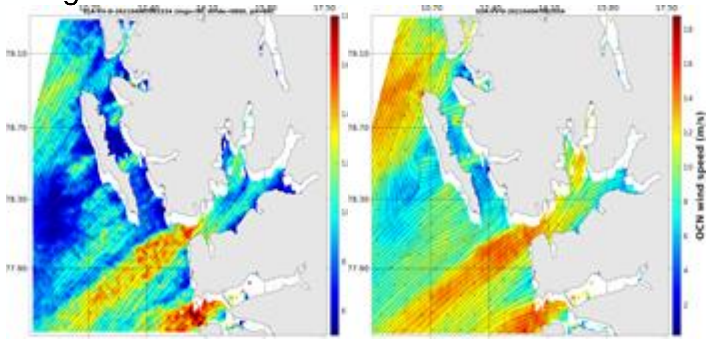


Fig. 2

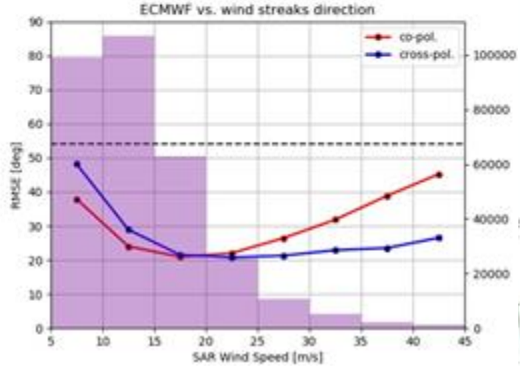


ResNet OCN

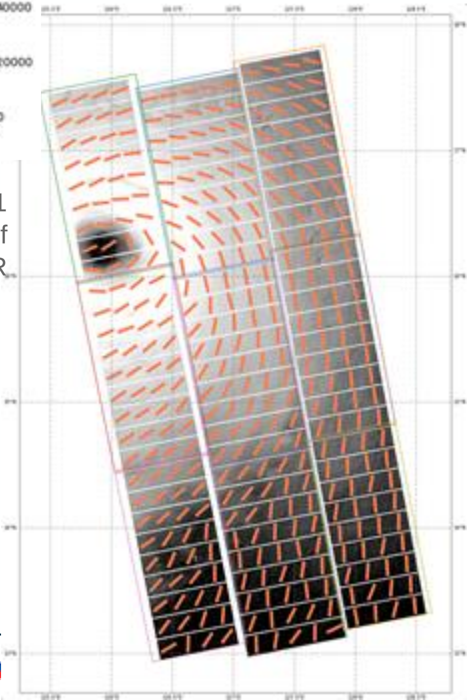
1. Fundamental relationships between SAR observables and wind

Wind streaks as a proxy for surface wind direction

- Under extremes, VH texture brings complementary information to VV texture, as VV becomes more sensitive to co-existing long waves than to wind streaks.
- Estimating the uncertainty associated with their estimated orientation helps combining them to provide a single dual-pol wind streaks direction with associated uncertainty
- Uncertainty is critical for potential inclusion in a downstream Bayesian inversion



S1 IW GRDH wind streaks vs. ECMWF model for VV (red) and VH (bleu) wrt. SAR wind speed [Husson et al. 2021]

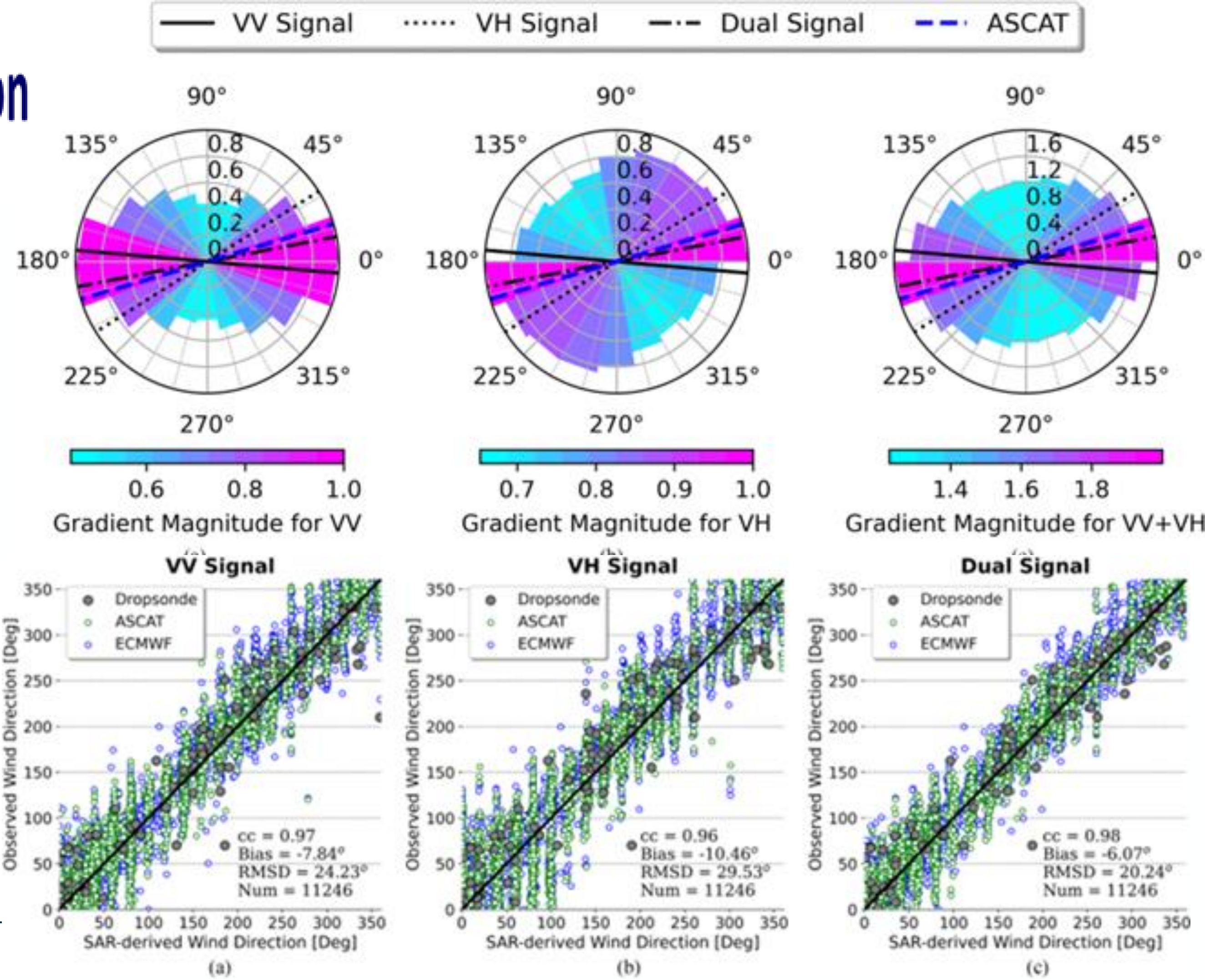


Surigae TC from Level-1 SLC, courtesy of IFREMER

Improved SAR wind direction

- Gradient method
- Compare SAR VV, VH and both
- Dropsondes
- ASCAT
- ECMWF

> SAR VV and VH direction are opposed w.r.t. ASCAT



www.doi.org/10.1109/JSTARS.2022.3230441 ,
Ni et al., 2023

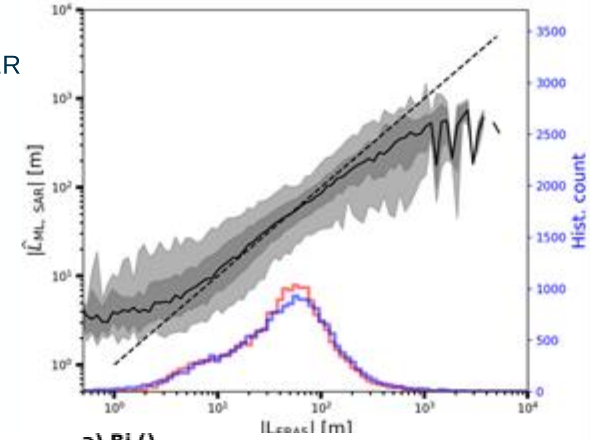
1. Fundamental relationships between SAR observables and wind

Texture characteristics

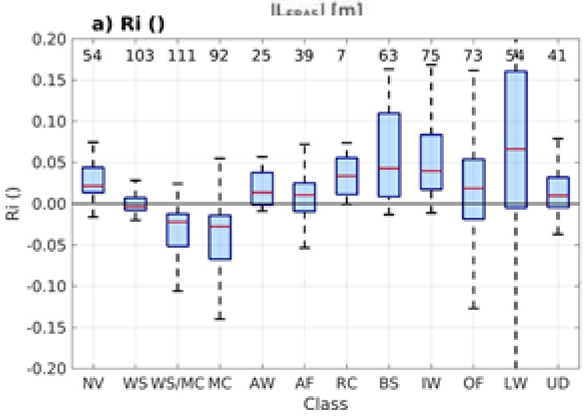
- On top of their **orientation**, using texture from SAR scene to estimate streaks **width.**
- ⇒ Good correlation for estimating the Obukhov length L, an atmospheric surface-layer stability metric.
- Sigma0 texture also provides unique information on atmospheric stratification

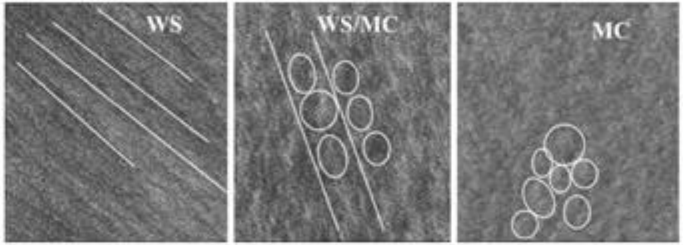
  ⇒ Theme “Methodology and Techniques”

Courtesy of O. Driscoll/IFREMER



Courtesy of Justin Stopa





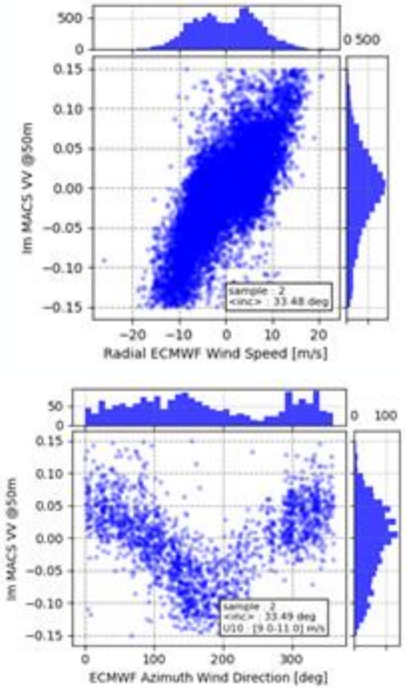
1. Fundamental relationships between SAR observables and wind

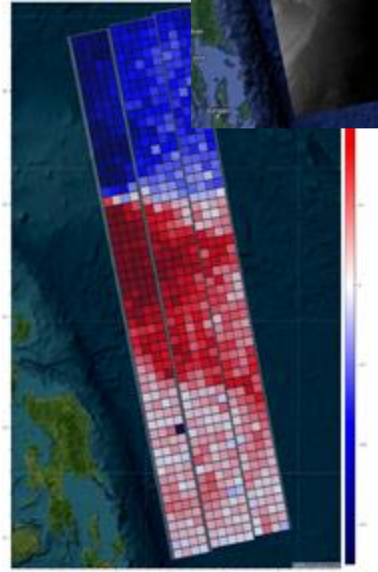
IMACS (MeAn Cross-Spectra)

- Contains a sea-state signature due to local wind and complementary to the normalized radar-cross section
- Azimuth modulation is not the same and very similar to Doppler analysis from Mouche et al., 2012.

⇒ The strong similarity between IMACS and Doppler also suggests that IMACS could be used for Doppler calibration and/or estimate the sea-state contribution of the Doppler

Courtesy of IFREMER





→ THE EUROPEAN SPACE AGENCY

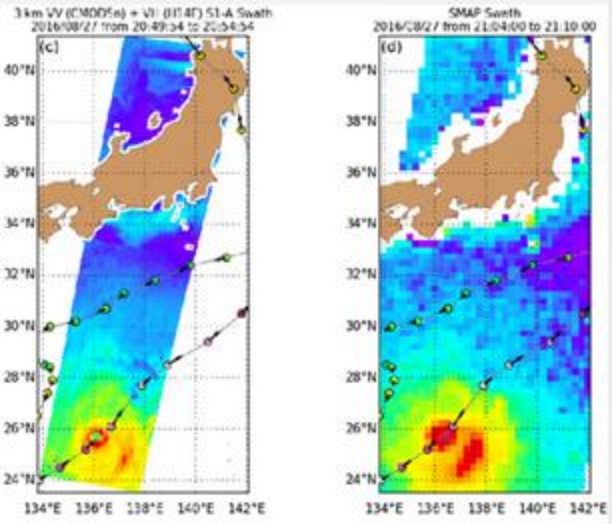
2. Wind inversion

1. Examples of wind inversion schemes

⇒ Talk from Hindberg et al.: “Operational Wind Retrieval Using Cross-Polarization And Doppler Data”

1. Validation methods and source references
2. Necessary pre-processing and post-processing steps
3. Available software tools

2. Wind inversion



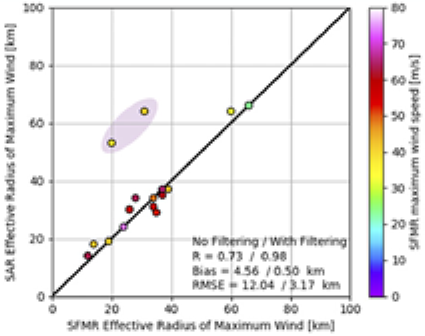
Dual-pol wind inversion

- The use of dual polarized channels (both co- and cross-polarization) allows for more sensitivity at strong winds. This proves to be very efficient for extremes such as Tropical Cyclones

⇒ This is used to produce TC wind field and to derive TC parameters related to the TC wind structure such as Wind Radii or Radius of Maximum Wind Speed (Mouche et al., 2017, 2019).

⇒ SAR has proven to be the best sensor to derive from space estimate of Radius of Maximum Wind Speed (Combot 2020).

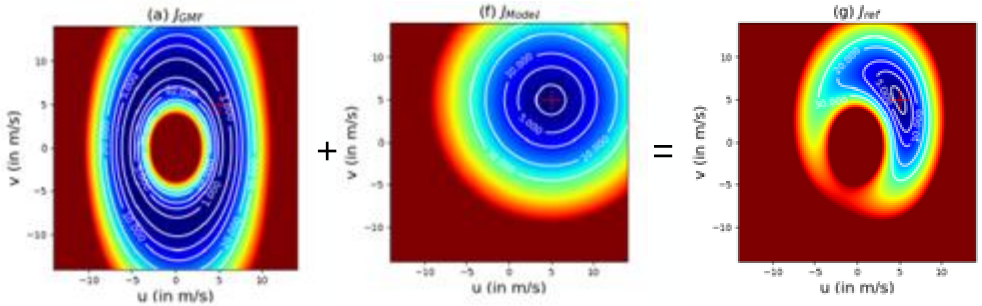
Courtesy of IFREMER



2. Wind inversion

Combining SAR observables

- Cross-pol GMF is omnidirectional
- Current wind vector inversion is strongly influenced by a priori NWP (Numerical Weather Prediction) model
  ⇒ This can lead to inconsistencies between speed and direction if model does not correspond to effective wind situation
- Combining more than only dual-pol Sigma0 can bring much more independency and avoid using any priori
- Consistency between SAR observables can be used to derive data quality flag based on residual in the minimized cost function



Extracted from Longépé et al. 2021

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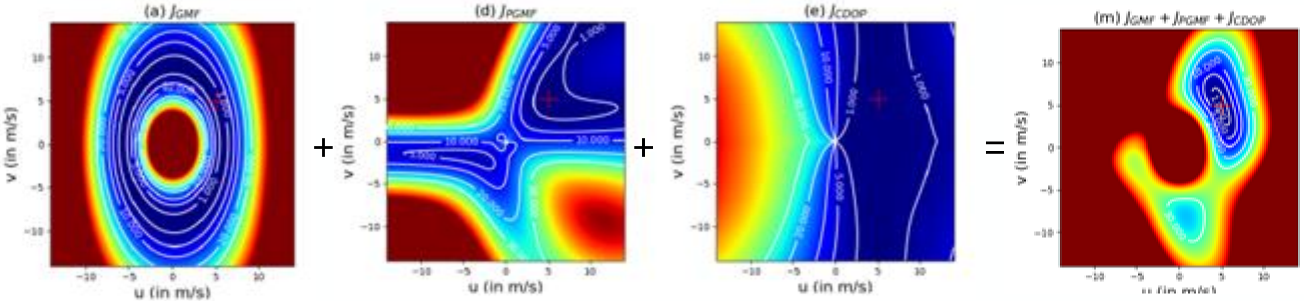
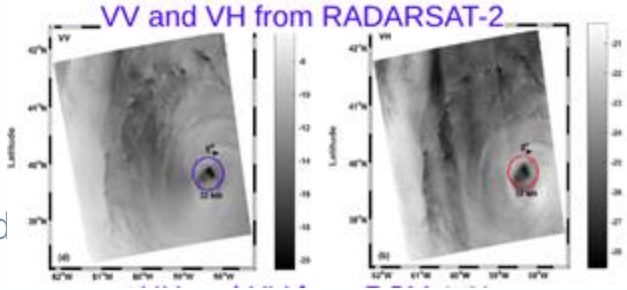


Extracted from Longépé et al. 2021

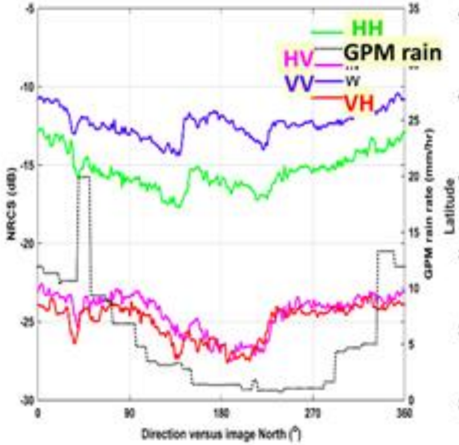
2. Wind inversion

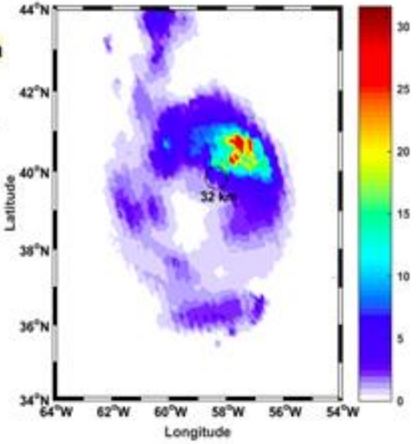
Rain impact

- Rain-induced NRCS attenuations are ~1.7 dB for HH and VV, and 2.2 dB for HV and VH, when the rain rate is 20 mm/hr.
- These attenuations are associated with rain-induced turbulence and atmospheric absorption.
- Filtering non-wind related phenomena is crucial
  ⇒ Method & Techniques talks



Courtesy of W. Perrie (MAXSS 2023)





GPM rain rate (mm/hr)

3. Applications

3. Operational implementations and processes understanding
   1. AODN

⇒ Talk from Khan et al.: “Australian Coastal SAR Ocean Winds: Data, Portal, and Next products”

   1. Tropical cyclones

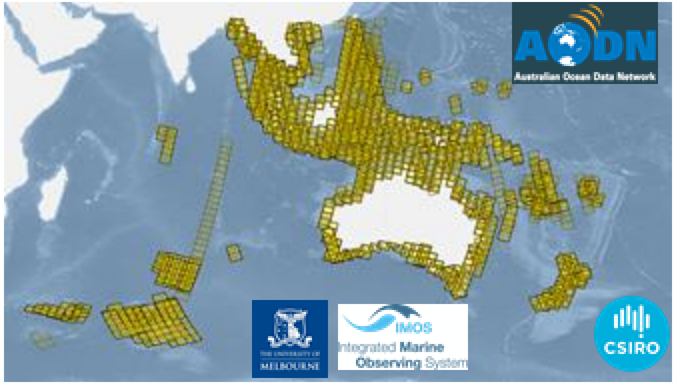
⇒ Talk from Stoffelen et al.: "SAR and Scatterometer winds" in section 4.

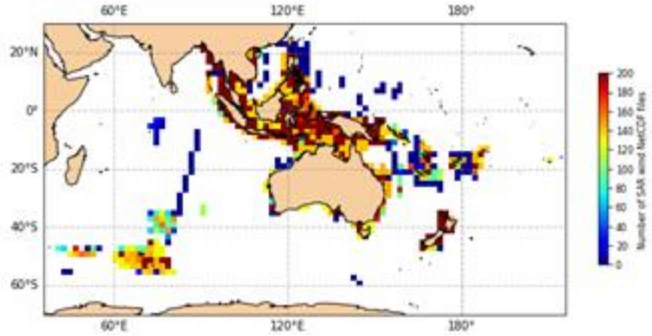
   1. Other extreme phenomena
3. Weather Prediction
4. Offshore Wind Farms

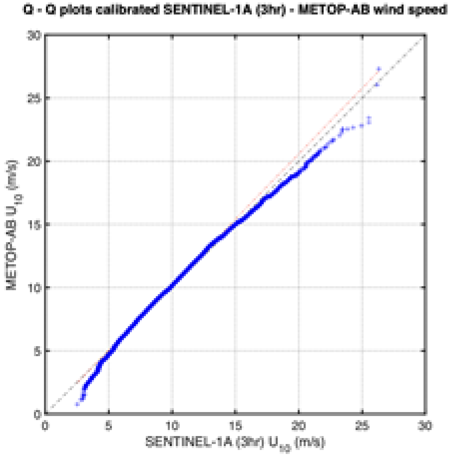
⇒ Talk from Dimitriadou et al.: "SAR for Offshore Wind Fields in the Mediterranean Sea"

3. Applications

AODN (https://portal.aodn.org.au/)
To augment scatterometer global wind speed and direction record in Australasian nearshore areas with high-resolution SAR wind data (Sentinel-1 currently)







⇒ SAR winds in Australian waters, uniformly processed over time, calibrated, and validated against Metop-A and -B (Khan et al., 2023) starting from ESA level-2 Sentinel-1 ocean wind product as source.

3. Applications

TC observations

- RS-2 from NOAA / CSA (Hurricane Watch)
- Enriched with RCM constellation (3 sats)
- ALOS-2 acquisitions jointly with ESA/JAXA

⇒ Initial SAR obs, quite sparse, now reaching very dense TC sampling.

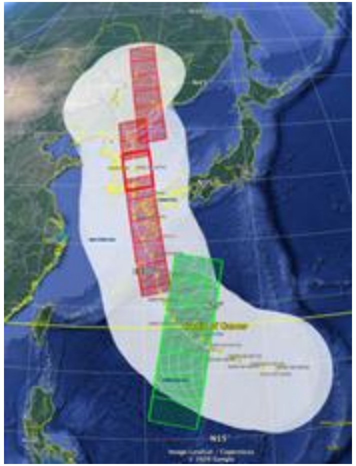
- Can it be further improved ? Chances to catch TC centers: 70% vs. 10% if planned within 1 day vs. 5 days

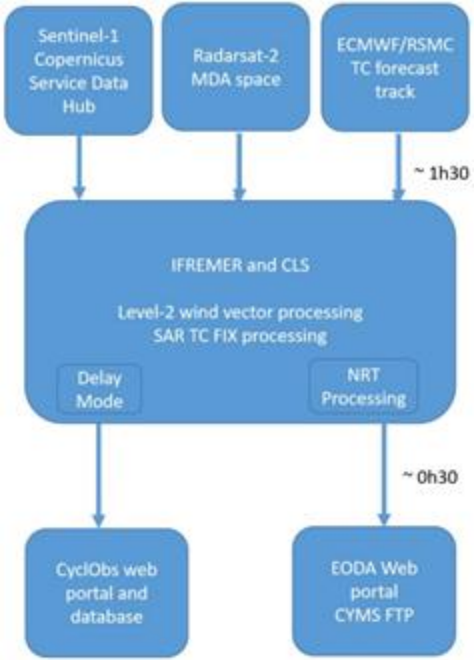
Two initiatives for TC monitoring:

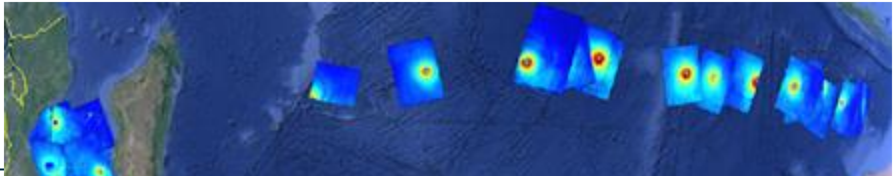
- CyclObs / EODA for Archive and NRT (www.esa-cyms.org/)
- NOAA/NESDIS/STAR(https://www.star.nesdis.noaa.gov/socd/mecb/sar/AKDEMO_products/APL_winds/tropical/index.html)

⇒ Extensively used by WMO TC forecasters (Jackson et al. 2021, Howell et al. 2022, Duong et al. 2021)

⇒ Need to conduct inter-calibration between different C-band SAR missions (RS2, RCM, S1).







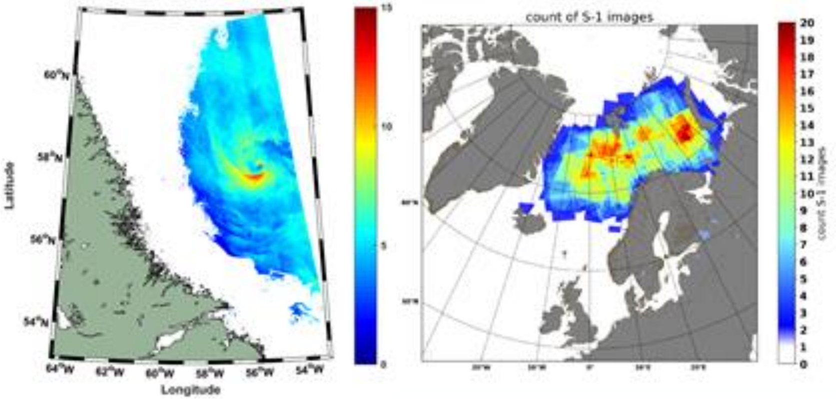
SAR acquisitions over TC Freddy with RS2, RCM1-2-3, S1-A

3. Applications

Polar lows (PL), medicanes, Extra-Tropical Cyclones…

PL

- Higher frequency revisit at higher latitudes
- SAR discriminates sea ice and open water
  ⇒ "Sea Ice" theme presentation
- Extract wind directions from local gradient (LG) method.
- May require pol. ratio depending on polarizations (VV+VH or HH+HV)
- SAR can provide reasonable polar low centers and tracks using high-resolution and multi-temporal satellite data

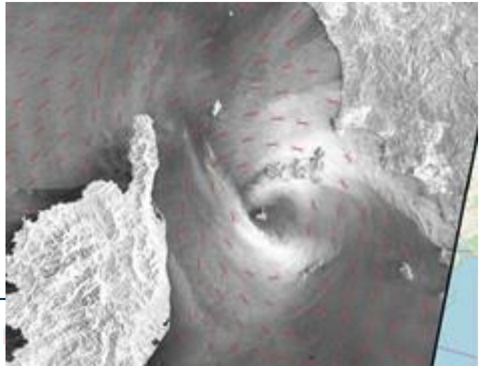


Left: Example of Sentinel-1 observation over Polar Low (Courtesy of W. Perrie). Right: Total number of Sentinel-1 acquisitions over Polar Lows available since Sentinel-1 A launch (Courtesy of IFREMER using Rojo et al. 2019)

ETC and medicanes

- While TC monitoring with SAR worldwide is benefiting from numerous missions, over Europe there are very few acquisitions
- Rare SAR acquisitions over mid-latitude extremes

Medicane Blas caused heavy rainfall and intense winds (here on 2021-11-15) with wind streaks (red bars)



3. Applications

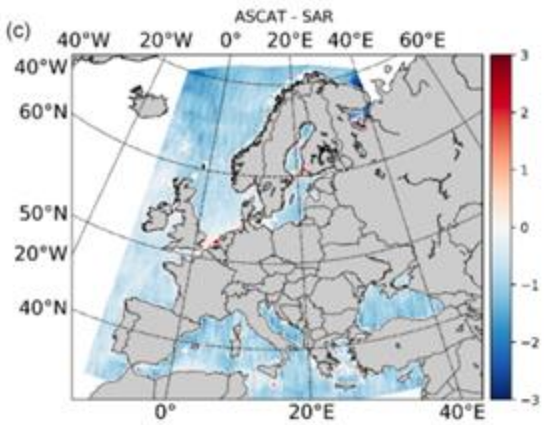
Offshore Wind Farms (OWF)

- SAR-derived wind measurements at high-res. have unique capability to depict **coastal** winds.
- **20 year** archive of Sentinel-1 + ENVISAT acquisitions with major sampling over European waters.
- WRA (Wind Resource Assessment) based on remote sensing requires **homogeneous and inter-calibrated** reprocessing [e.g. Hasager et al. 2020]
- SAR provide unique **wake** observations, particularly useful with expanding wind farms for design [Ahsbahs et al. 2020]
- SAR measurements can be combined with models and/or in situ to provide **hub-height** AEP (Annual Energy Production) [Badger et al. 2016, Montera et al. 2022]
- Requires most accurate winds in **[3-12m/s]** due to turbine production curves.

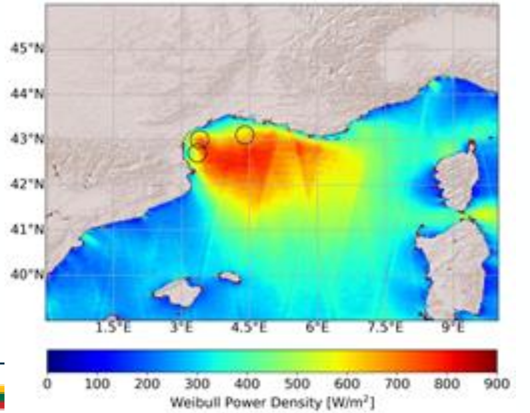
⇒ Requires **extensive correction** of SAR-derived winds (e.g. inc. or antenna patterns).

⇒ Can be improved learning from a local truth to avoid multiple in situ campaign

⇒ Presentation by **K. Dimitriadou (DTU):** The Gulf of Lion is the current hotspot for OWF placement with complex topography and various local wind regimes.



Comparison of mean wind speed (m/s) at 100 m height: ASCAT minus SAR (Hasager et al. 2020)



4. Connecting SAR and Scatterometers winds
SAR Winds

Objective

- Km-scale wind vectors, mesoscale wind structure, extremes

Innovations (see all previous slides)

- VH pol (also on EPS-SG SCA, based on RadarSat-derived GMF)
- Doppler (induced by local wind), CDop GMF
- Gradient methods for wind direction
- Hurricane data base 2008-present (SHOC, CYMS, MAXSS, ..) with 34-, 50-, 64-kt wind radii; based on C-band SAR (and other collocated instruments), allowing enough samples for many innovative applications
- Such as, intercalibration of extremes for SAR, scatterometers and radiometers, adjusted to either moored buoys or dropsondes
- Much science on wind structure and the interaction of winds, waves and currents, . . .

4. Connecting SAR and Scatterometers winds
SAR Winds

Knowledge gaps

- Km-scale wind vectors, to get both speed and direction remains a weak point
- Calibrated NRCS down to 0.1 dB is needed for high-quality 1-km-scale winds by a 3-view SAR, 3 views could be angles, but also combinations of VV, VH, CDop, etc., see previous slides

Outlook and Recommendations

- Make SAR winds a constellation and operational
- Compare operational products for consolidation and to motivate standardization for user convenience
- Verify consistency with scatterometers on 20-km scale
- Compare with Hurricane Hunter underflights, in particular the (new) rain and wind instrument IWRAP
- Urge for improvements in an extremes in-situ wind speed reference for all satellite wind calibration

4. Connecting SAR and Scatterometers winds
SAR Winds

SAR

- Shows details of processes, in particular extremes, coastal and air-sea interaction, useful for scatterometers
- Cannot capture the temporal variability of the atmosphere
- Are poorly calibrated with respect to scatterometers
- Different producers generate wind products with different characteristics

Scatterometers

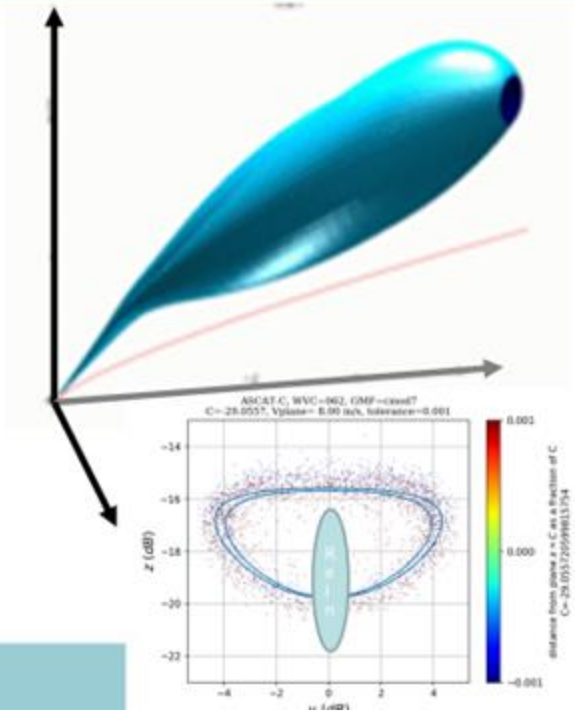
- Scatterometers show much more details of mesoscale weather processes than global NWP models do
- The virtual international constellation of Chinese, European and Indian wind scatterometers can capture the temporal variability of the atmosphere on a sub-daily scale
- Scatterometers are generally very stable and well calibrated; NRCS and wind errors are well known and low as compared to in-situ data and model data
- The same GMFs are used for different instruments
- Very similar retrieval is used for different instruments
- The CGMS Ocean Surface Winds Task Group is tasked to standardize wind products for users

Knowlege by cone data science

- ERS and ASCAT cones match
- CMOD7 GMF matches cone (~0.1 dB or m/s)
- CMOD8 will be cone based (~0.02 dB ?)
- inversion MLE is distance-to-cone
- Normalized MLE is associated with sub-WVC wind variability, likely due to view footprint (ISRF) mismatches
- Amplitude parameter matches closely with wind speed over WVC, irrespective of long wave state
- Direction as described by a double harmonic verifies closely with (buoy) wind direction
- u and v scatter plots suggest that differences are mainly due to wind variability, i.e., 3D wind turbulence (spatial representation error)
- 20-km SAR should be fully consistent with scatterometer findings

Cone metrics for static beams

- ➢ Relative beam pattern calibration (~0.02 dB)
- ➢ Noise assessment
- ➢ GMF development
- ➢ Rain screening, QC
- ➢ Satellite pointing to be elaborated in DopScat
- ➢ Profit from high scatterometer SRL



Quadruple/Quintuple Collocation Analysis of In-Situ, Scatterometer, and NWP Winds

Jur Vogelzang & Ad Stoffelen,
https://doi.org/10.1029/2021JC017189
https://doi.org/10.3390/rs14184552

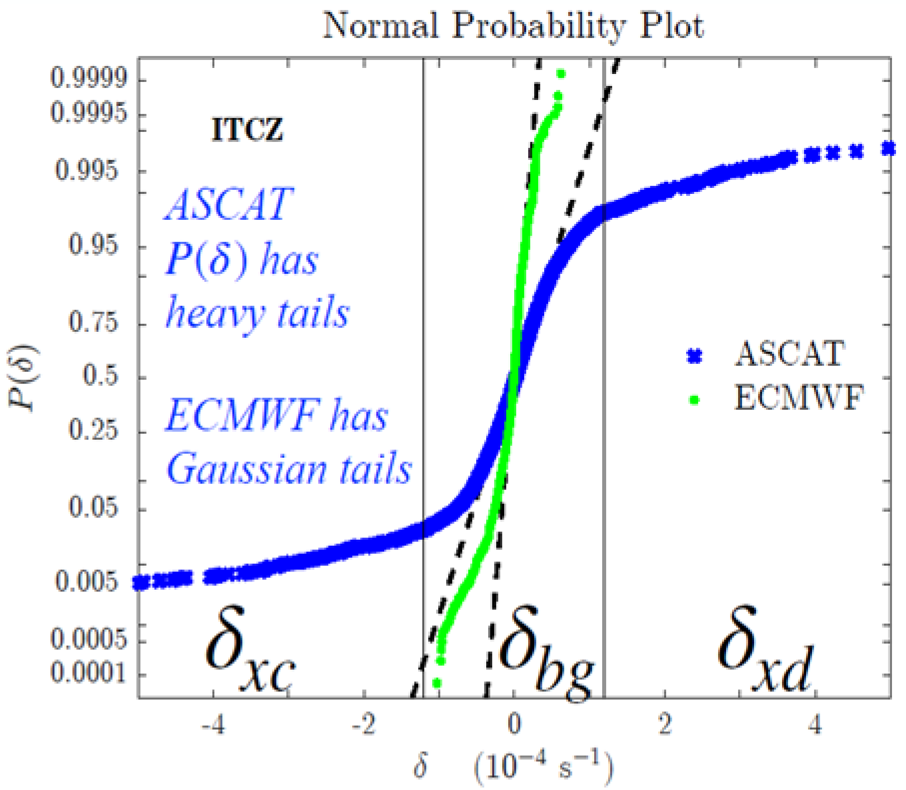
b: buoy
A: ASCAT
S: ScatSat
E: ECMWF

Subset	Buoys		ASCAT-A		ScatSat		ECMWF	
	σ_u	σ_v	σ_u	σ_v	σ_u	σ_v	σ_u	σ_v
bAS	1.03	1.12	0.41	0.49	0.78	0.65	--	--
bAE	1.06	1.15	0.34	0.41	--	--	0.94	1.03
bSE	1.09	1.21	--	--	0.72	0.59	0.92	1.03
ASE	--	--	0.43	0.49	0.76	0.65	0.90	0.98
range	0.06	0.09	0.09	0.08	0.06	0.06	0.04	0.05

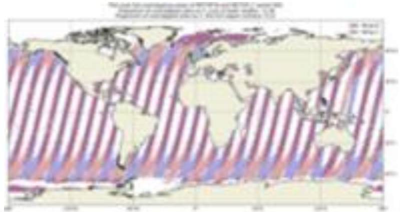
Note than the buoy error is mainly the spatial variance within a scatterometer WVC and hence (ideally) resolved by SAR

4. Connecting SAR/SCAT winds
Spatial derivatives of wind and stress fields

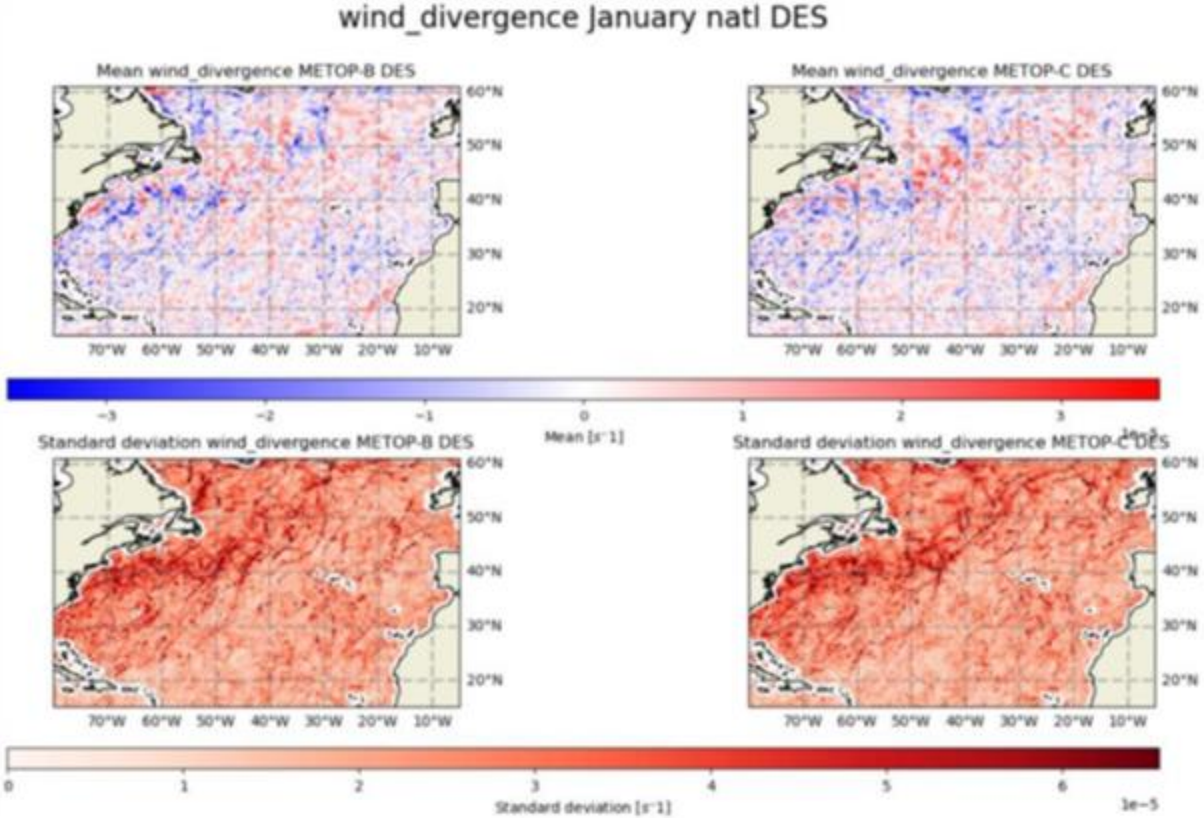
- King et al. showed association of extreme ASCAT convergence and divergence to heavy rain
- ECMWF div. is close to Gaussian (straight line)
- Pencil-beam winds also show extremes, but particularly less extreme (small-scale) convergence
- How to deal with this in Copernicus L4 products?
- What about the MAXSS L4 winds?



4. Connecting SAR/SCAT winds
Spatial derivatives of wind and stress fields



- MetOp-B and C spatially overlap
- B and C are separated by 50 minutes
- Divergence changes substantially in 50 minutes
- Large divergence associates with large SST gradients
- Global model does not show this variability (too fast to track)



4. Connecting SAR and Scatterometers winds Objectives

ESA MAXSS project on extremes:

- Intercalibration of winds from different satellites for nowcasting user convenience
- Exploit SAR winds in hurricanes (Cyclobs) for resolution enhancement of C- and Ku-band scatterometers

EUMETSAT OSI SAF (CHEFS project) and EU Copernicus Marine Services Wind TAC

- Use stress-equivalent winds for microwave satellite wind validation (de Kloe et al., 2017)
- Intercalibration, GMF development, QC/rain
- Develop coastal scatterometer winds, informed by SAR collocations
- Exploit C-band VH on SCA, to be launched in 2025; use RadarSat-derived VH GMF from SAR
- Error assessment of in situ, scatterometer and NWP/ERA5 model biases; **relevant for SAR**: general monthly local model biases are larger (hence more important) than sub-25-km scale wind variability
    - Estimate the large model biases, understand their origin and prevent error propagation into applications
    - Improve currently ineffective wind data assimilation due to these model biases
    - Avoid errors in air-sea coupling due to observed model biases

4. Connecting SAR and Scatterometers winds Innovation

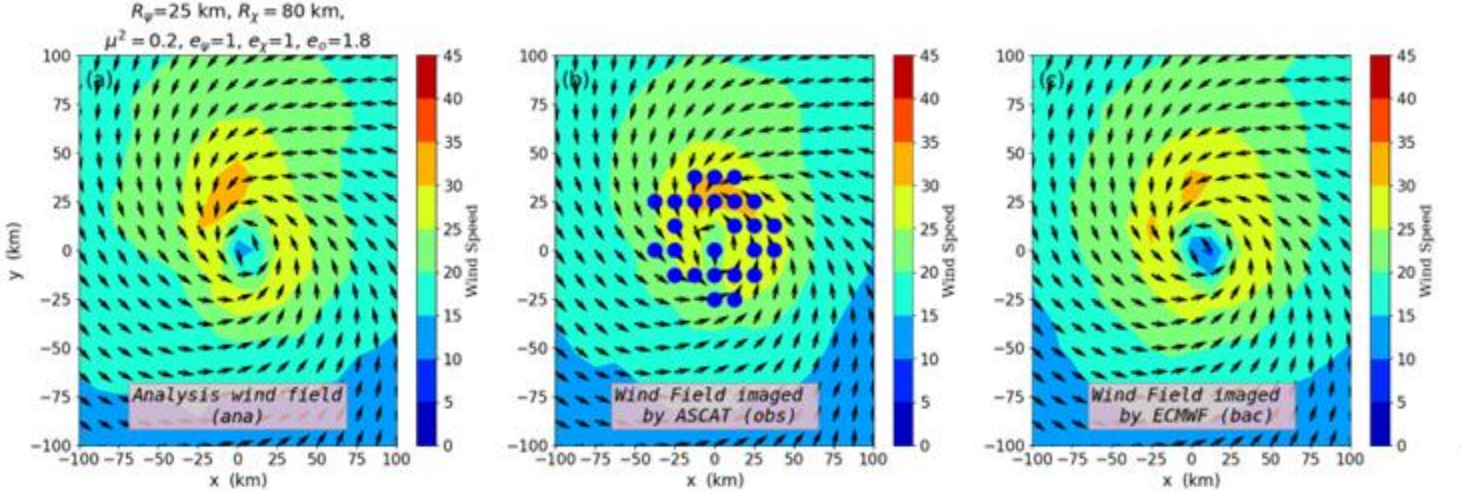
ESA MAXSS project on extremes:

- ✓ Intercalibration and error assessment of scatterometer winds from different satellites
- ✓ Exploit SAR winds in hurricanes (Cyclobs) for resolution enhancement of C-band scatterometers
- Exploit SAR winds in hurricanes (Cyclobs) for resolution enhancement of Ku-band scatterometers

EUMETSAT OSI SAF and EU Copernicus Marine Services Wind TAC

- o Coastal ASCAT scatterometer winds are operational (EUMETSAT OSI SAF), reprocessing in preparation, pencil-beam scatterometer coastal processing in development, exploiting SAR collocations
- o Stress-equivalent winds for microwave satellite wind validation slowly accepted
- ✓ Scatterometer NRCS intercalibration, GMF development, QC/rain
- ✓ Error assessment of in situ, scatterometer and NWP/ERA5 model biases, incl. uncertainty of errors
    - o Large model biases are known and EU Marine Services provides corrected winds, stress and spatial derivatives
    - o Wind data assimilation avoiding biases is in progress at ECMWF with support from KNMI/NUIST

2DVAR resolution enhancement using SAR learning (MAXSS)



In development

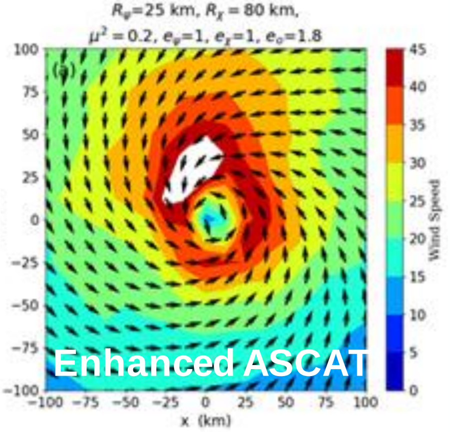
Storm-centered background (max. R^2 centre)

Empiricial "hurricane" spatial B error structure functions, depending on category

Sensitivity tests for varying radii and rot/div ratio

Now 12.5 km product, later 5.6 km

Wind speed scaling is last step



4. Connecting SAR and Scatterometers winds Remaining knowledge gaps

Extremes:

- Intercalibration of satellite winds, which all lack absolute calibration, with a scientifically viable and consolidated (in-situ) wind speed reference; operational standards are based on dropsondes, which remain rather inconsistent with moored buoys (Stoffelen et al., 2021)
- SAR winds in hurricanes (Cyclobs) can potentially be used for resolution enhancement of Ku-band scatterometers, using recent progress in resolution enhancement with C-band scatterometers and progress in Ku-band rain detection/correction (Stoffelen et al., 2023; SeaSar23)

SAR for L2/L3/L4 Scatterometer Winds

- Ku-band rain detection has much improved, but now rain correction needs improvement (Zhao et al., 2023), e.g., using SAR
- Exploit SAR to develop coastal scatterometer winds for more scatterometer instruments
- Use stress-equivalent winds for microwave satellite wind applications (de Kloe et al., 2017); use CMOD7/8 (not CMOD5)
- Understanding the origin of large ERA/NWP model biases and preventing propagation of these errors into applications needs further elaboration exploiting the current extensive virtual scatterometer constellation capabilities
    - Improve currently ineffective scatterometer wind data assimilation due to biases
    - Avoid errors in air-sea coupling due to the large observed model biases by the virtual scatterometer constellation
- SAR NRCS calibration is problematic (variable) when comparing to scatterometers (beyond 25-km-scale variability)
- Some GMFs may be further explored from SAR

4. Connecting SAR and Scatterometers winds Recommendations and outlook

esa

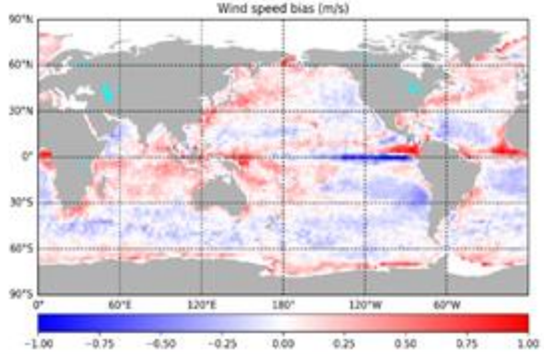
Extremes:

- Develop a scientifically viable and consolidated (in-situ) wind speed reference for better physical understanding of extremes
- Use SAR winds in hurricanes (Cyclobs) for resolution enhancement of Ku-band scatterometers, using recent progress in resolution enhancement with C-band scatterometers and progress in Ku-band rain detection/correction

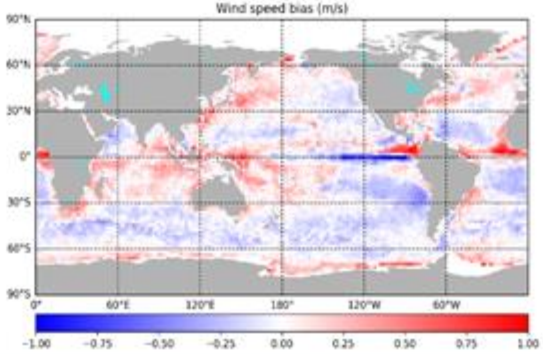
Marine Wind Services

- Ku-band rain detection has much improved, but now rain correction needs improvement (Zhoa et al., 2023) (EE11 SeaStar)
- Understanding the origin of large ERA/NWP model biases and preventing error propagation into applications (e.g., air-sea coupling, data assimilation) needs further elaboration exploiting the current extensive virtual scatterometer constellation
- Develop consistent coastal SAR and scatterometer winds for more instruments, with SAR as validation resource
- Use stress-equivalent winds for microwave satellite wind applications (de Kloe et al., 2017)
- Exploit scatterometer data, lessons learned and scientific assets in new SAR wind missions
- Besides further application of scatterometer winds, new ocean-scale missions will be needed to better understand and validate the dynamics at the air-sea interface, currently seemingly poorly represented in ERA/NWP/ocean models; both climate dynamics and earth system science are strongly depending on the modelling of the air-sea interface (>70% of earth's surface)

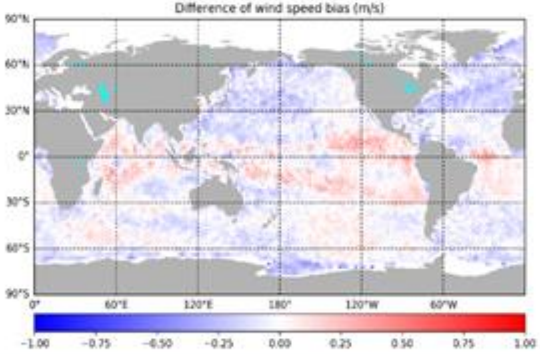
4. Connecting SAR/SCAT winds
Wind speed biases of SCA - NWP



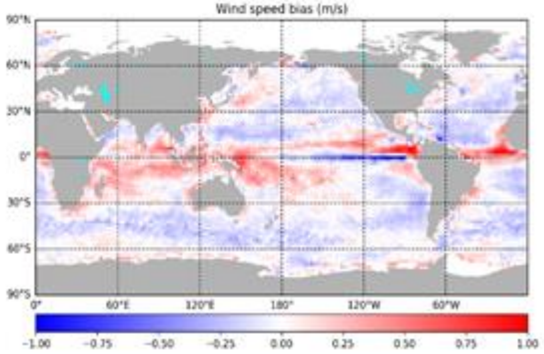
ASCAT-B NRT



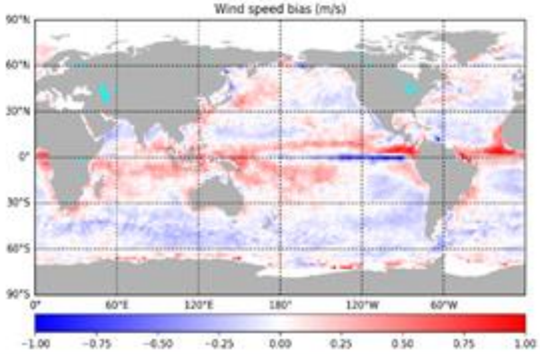
ASCAT-C NRT



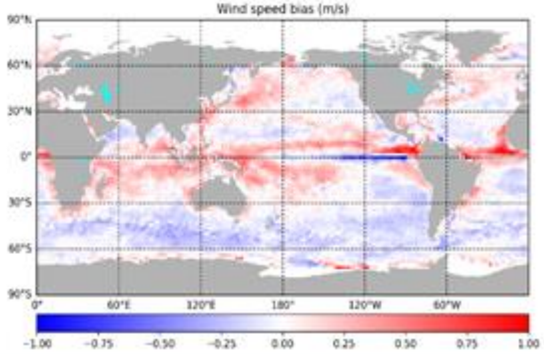
ASCAT-B/NRT – HSCAT-B/Rep02



HSCAT-B Rep02

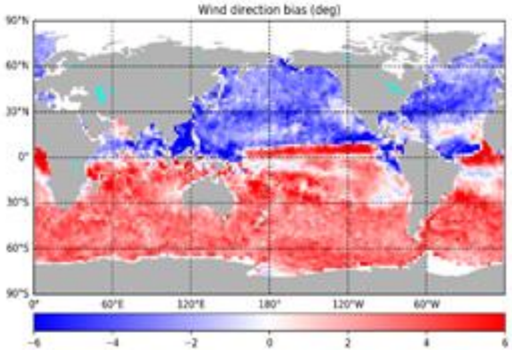


HSCAT-C Rep02

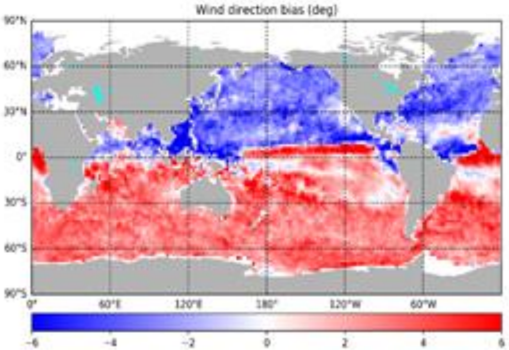


HSCAT-D Rep02

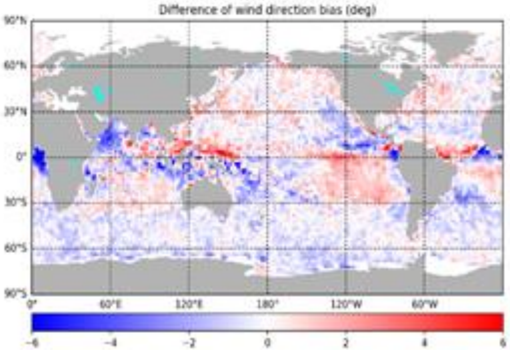
4. Connecting SAR/SCAT winds
Wind speed direction of SCA - NWP



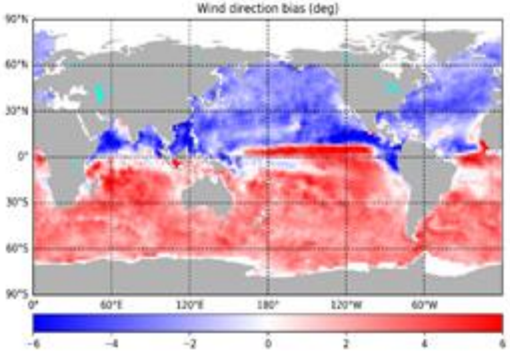
ASCAT-B NRT



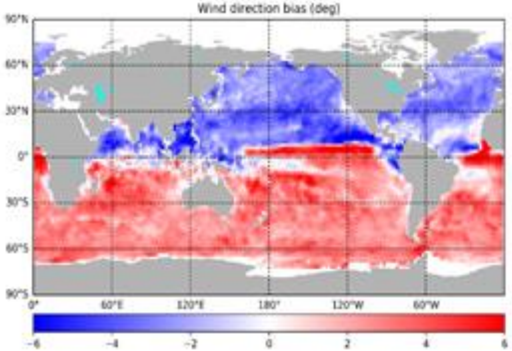
ASCAT-C NRT



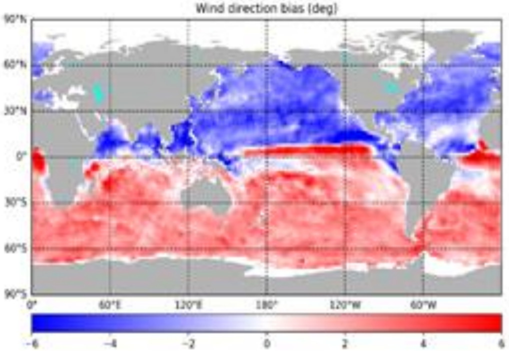
ASCAT-B/NRT – HSCAT-B/Rep02



HSCAT-B Rep02

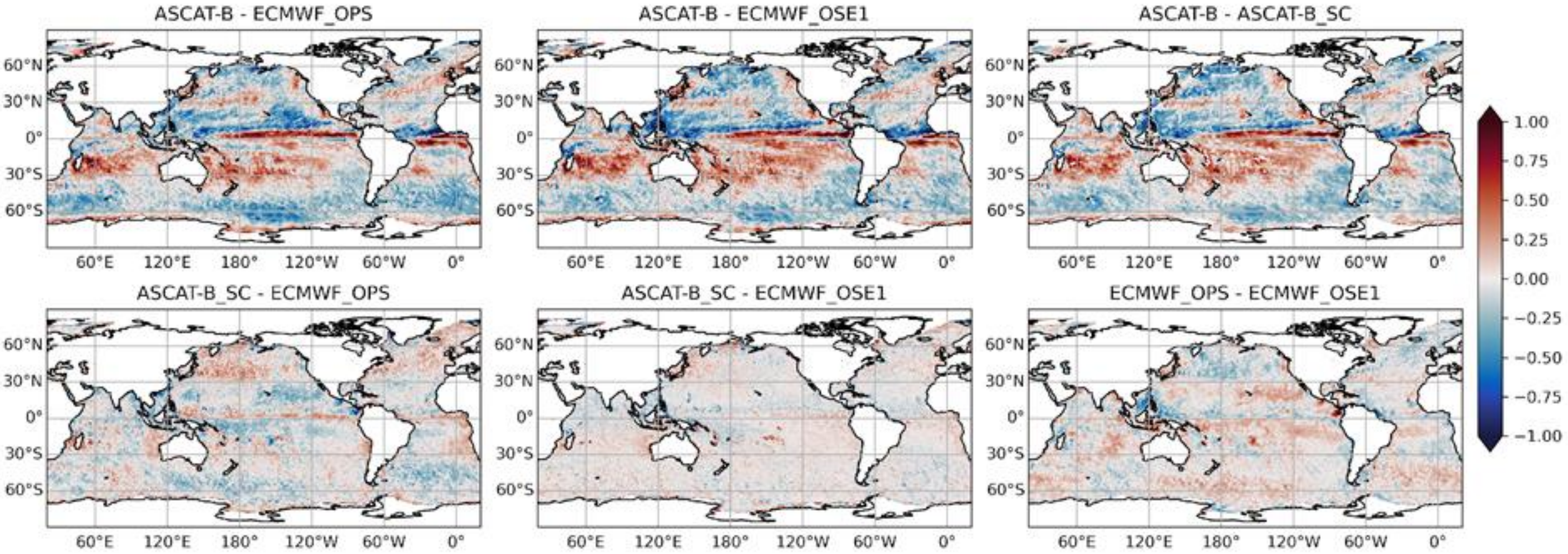


HSCAT-C Rep02



HSCAT-D Rep02

4. Connecting SAR/SCAT winds
Meridional (v) model bias adjustment

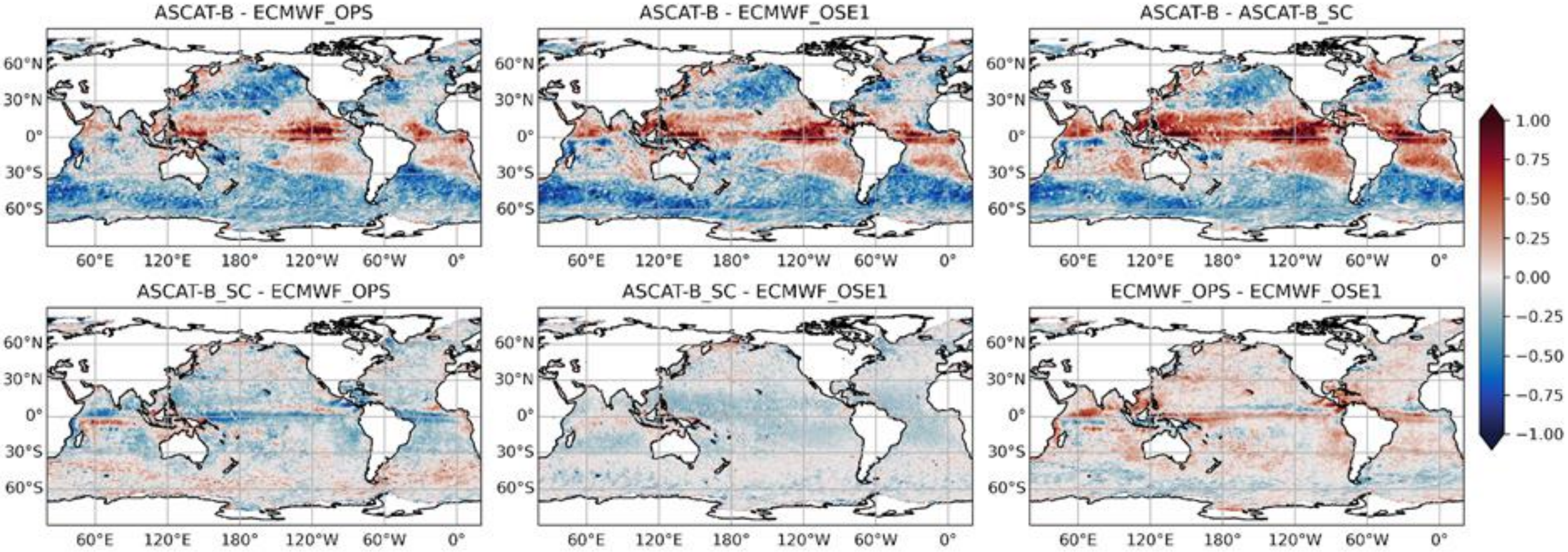


- Top: large v first guess biases, both in runs with (OPS) / without (OSE1) ASCATs and HY2B used
- Bottom: ASCATB_SC is adjusted to OSE1 and not to ECMWF_OPS, while with small biases

- Top: large v first guess biases, both in runs with/without ASCATs and HYB assimilated
- Bottom: ASCATB_SC is well adjusted to OSE1

- Top: large v biases in ASCAT-B_SC as expected
- Bottom: ECMWF_OPS minus OSE1 is complement of ASCAT-B_SC minus OPS (on left)
- OPS FG biases adjust only a little to the scatterometers

4. Connecting SAR/SCAT winds
Zonal (u) model bias adjustment



- Top: large u first guess biases, both in runs with (OPS) / without (OSE1) ASCATs and HY2B
- Bottom: ASCATB_SC is adjusted to OSE1 and not to ECMWF_OPS, while with small biases

- Top: large u first guess biases, both in model runs with/without ASCATs and HYB
- Bottom: ASCATB_SC is well adjusted to OSE1

- Top: large u biases in ASCAT-B_SC as expected
- Bottom: ECMWF_OPS minus OSE1 is complement of ASCAT-B_SC minus OPS (on left)
- OPS FG biases adjust only a little to the scatterometers

What's next ?

- Thursday - Friday
  - 4 Panel Breakout sessions to discuss the submitted abstracts more extensively and prepare the panel report

- Friday (30 minutes for wind retrieval)
  - Panel Repor

- Saturday - 1h30 altogether
  - Summary and Final Recommendations