Improved ocean wind forcing products

Combining scatterometer observations and numerical weather prediction model winds into global high-resolution L4 ocean surface wind fields

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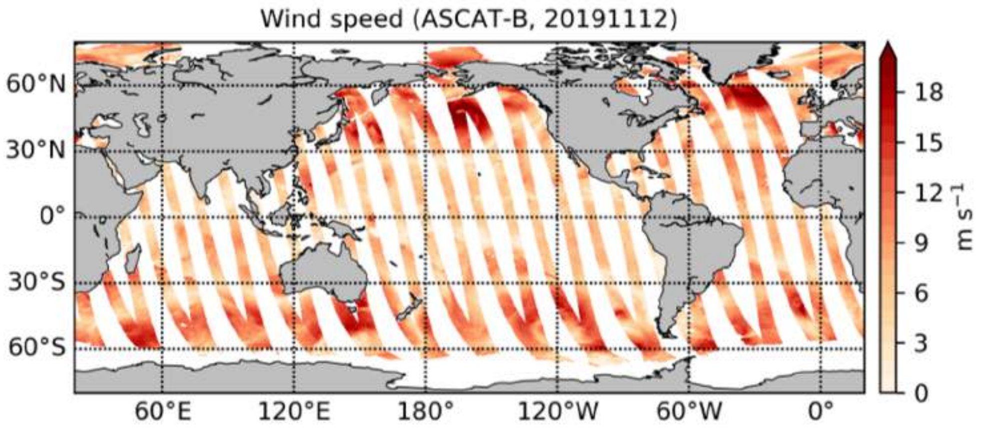
Context

Ocean surface wind fields from satellites (scatterometer) and numerical weather prediction (NWP) models both have strong properties

	Scat	NWP
Spatial resolution	+	-
Spatial coverage	-	+
Temporal coverage	-	+

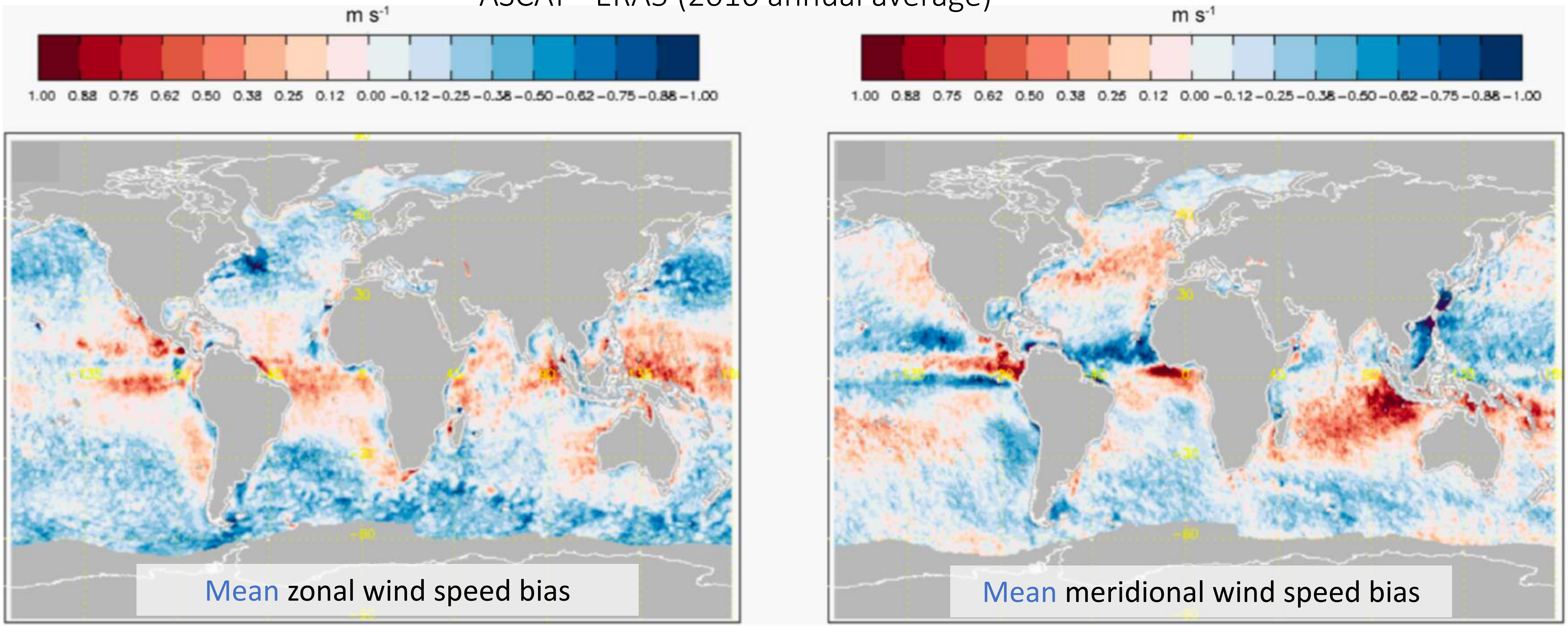


How to best combine scatterometer observations and NWP model fields into global ocean wind forcing products with high temporal and spatial resolution?

> First explore the differences between scatterometer (MetOp-A ASCAT) and NWP model (ECMWF ERA5)

Systematic large-scale biases in NWP model winds, particularly in the tropics and the mid-latitudes

ASCAT - ERA5 (2016 annual average)



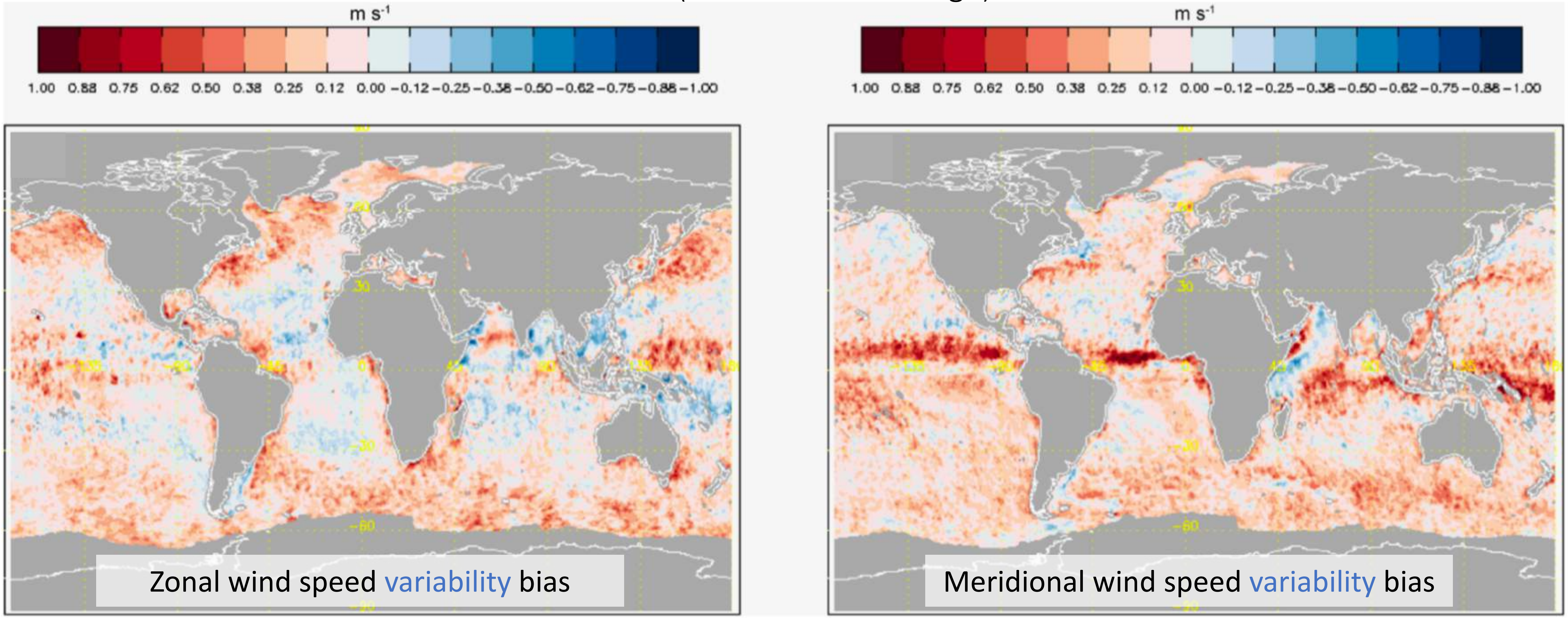
Mean zonal wind speed bias

Mean meridional wind speed bias

Belmonte Rivas, M. and A. Stoffelen (2019): *Characterizing ERA-Interim and ERA5 surface wind biases using ASCAT*, Ocean Sci., 15, 831–852, doi: 10.5194/os-15-831-2019.

Small-scale variability is largely underestimated in NWP model

ASCAT - ERA5 (2016 annual average)



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Scatterometer-based correction to ERA-Interim surface wind fields

$$SC(i,j,t_f) = 1/M \sum_{t=1}^{M} u_{10s}^{SCAT}(i,j,t) - u_{10s}^{ERAi}(i,j,t)$$

SC	Scatterometer-based correction
(i, j)	Grid point
t_f	NWP model forecast time
M	Number of scatterometer observations at *(i, j)* in time window of *N* days
t	Observation time
u_{10s}^{SCAT}	Stress-equivalent wind speed from scatterometer
u_{10s}^{ERAi}	Stress-equivalent wind speed from NWP model interpolated to *(i, j, t)*

Trindade, A., M. Portabella, A. Stoffelen, W. Lin and A. Verhoef (2019), *ERAstar: A High-Resolution Ocean Forcing Product*, IEEE Trans. Geosci. Remote Sens., 1-11, doi: 10.1109/TGRS.2019.2946019.

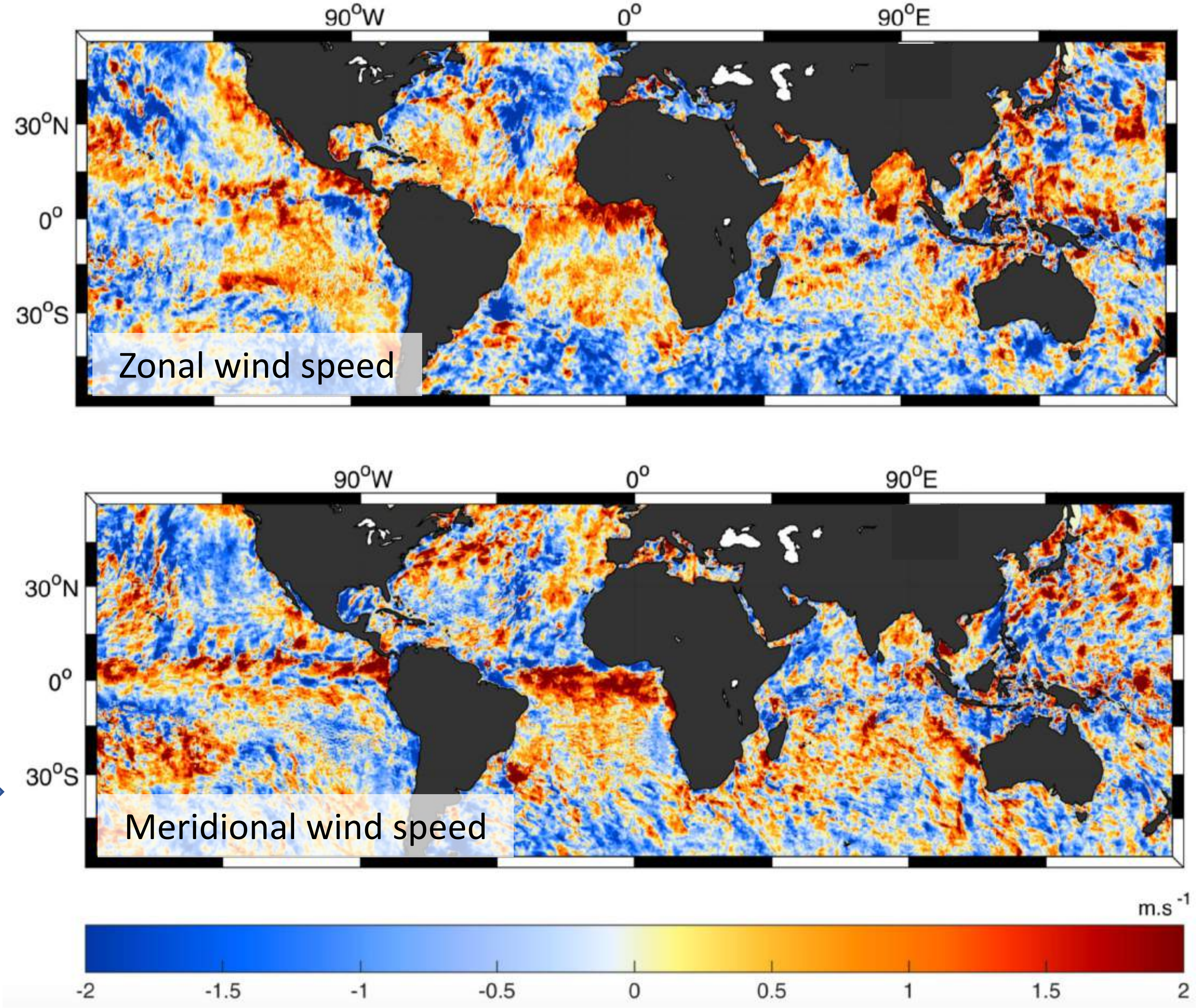
Example SC

SCAT MetOp-A ASCAT

t_f 15 January 2013, 6 UTC

N 5 days

The large systematic biases are associated with slowly evolving ocean conditions, rather than with fast atmospheric processes



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ERA*

$$u_{10s}^{ERA^*}(i,j,t_f) = u_{10s}^{ERAi}(i,j,t_f) + SC(i,j,t_f)$$

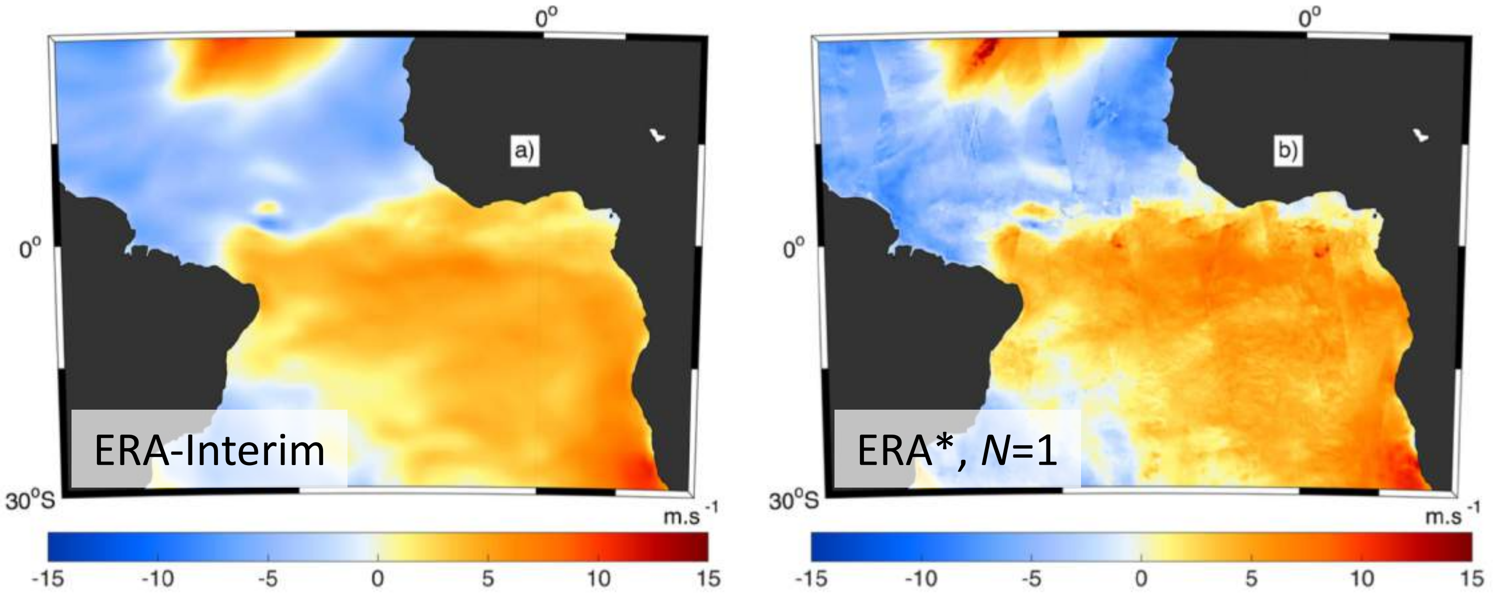
Available

- on a global grid
- at 0.125° x 0.125° horizontal resolution
- at 3-hourly temporal resolution (ERA-Interim)

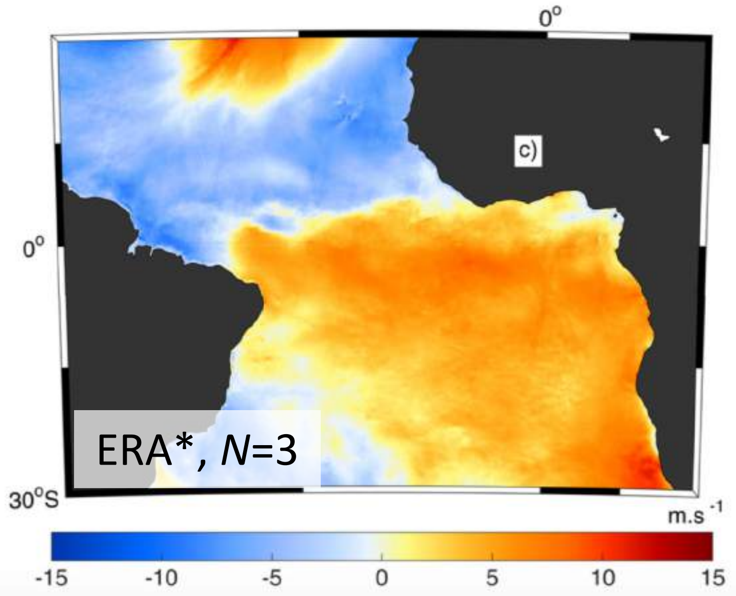
Trindade, A., M. Portabella, A. Stoffelen, W. Lin and A. Verhoef (2019), *ERAstar: A High-Resolution Ocean Forcing Product*, IEEE Trans. Geosci. Remote Sens., 1-11, doi: 10.1109/TGRS.2019.2946019.

Example ERA*

SCAT	MetOp-A ASCAT MetOp-B ASCAT Oceansat-2 OSCAT
t_f	15 January 2013, 6 UTC
N	1 day (b) 3 days (c)



- ERA* is less smooth than ERA-Interim
- Small-scale variability captured with *N*=1
- Artifacts (N=1) not present with *N*=3



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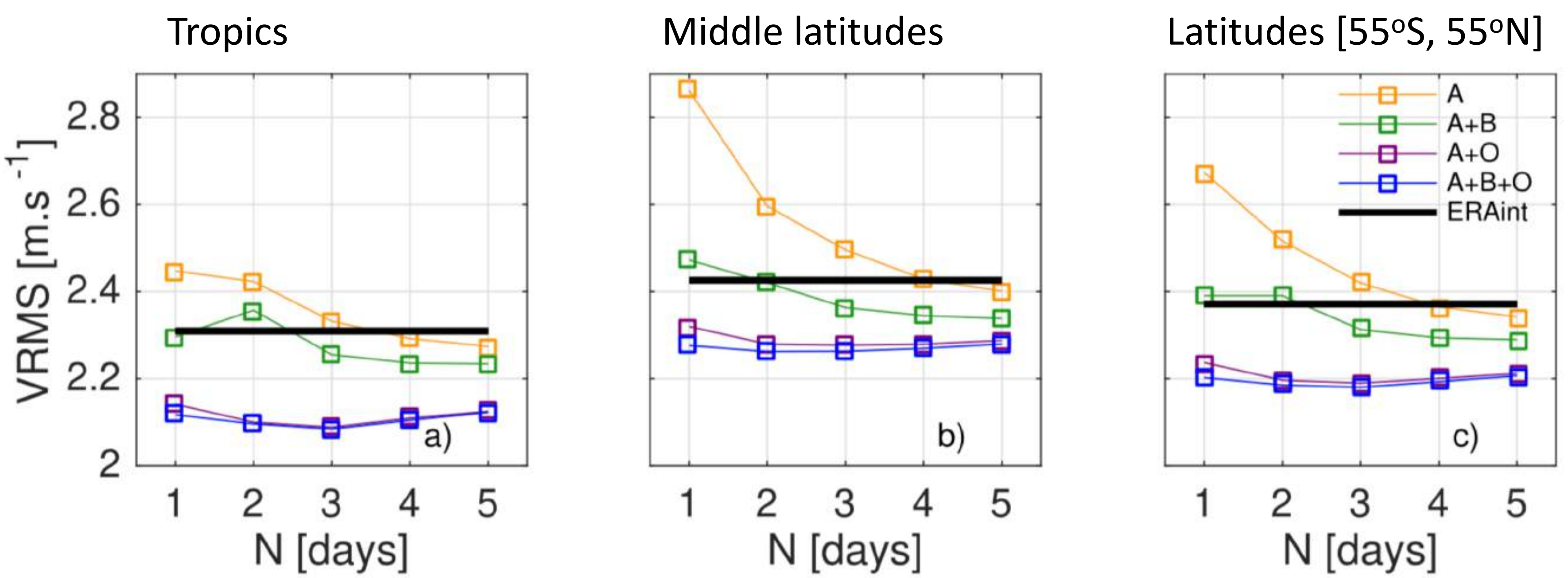
What are the optimal scatterometer combination and temporal averaging window?

Vector root-mean-squared difference between ERA* and an independent scatterometer (HY-2A HSCAT) for a number of scatterometer combinations and averaging windows *N*



A MetOp-A ASCAT

B MetOp-B ASCAT

O Oceansat-2 OSCAT

Optimum:
at least two satellites with complimentary orbits and N=2 or 3

Trindade, A., M. Portabella, A. Stoffelen, W. Lin and A. Verhoef (2019), *ERAstar: A High-Resolution Ocean Forcing Product*, IEEE Trans. Geosci. Remote Sens., 1-11, doi: 10.1109/TGRS.2019.2946019.

Conclusions

- **Large systematic and persistent biases** exist between scatterometer observations and NWP model surface wind fields
- NWP model surface winds **lack small scales**, which also appears persistent
- The scatterometer wind structures express **local air-sea interaction**, relevant for ocean forcing
- ERA* shows a **significant increase in small-scale variability** compared to ERA-Interim
- The optimal configuration consists of **complementary scatterometers** and a **temporal averaging window of 2-3 days**
- For fewer scatterometers, **longer windows can be used**, as error growth is rather slow for an increasing number of days
- **ERA* has high potential** for a Level 4 (CMEMS) wind product

Outlook

Short-term

- Test ERA* wind fields in regional ocean models
- Apply the method to the ECMWF ERA5 dataset > ERA5*
- Compare to existing L4 wind products (CMEMS)

Long-term

- Work towards ERA* near-real time and multi-year L4 wind products (CMEMS)

Questions? Contact us!

1. Chat with Rianne during the live session on **Friday 8 May, 10:45–12:30**

2. Upload your comments on the **EGU2020 website**

3. Send an email to Rianne: **rianne.giesen@knmi.nl**

Link to the session:
https://meetingorganizer.copernicus.org/EGU2020/EGU2020-15559.html