

## Development of a 11-year ERA\* high resolution ocean forcing dataset

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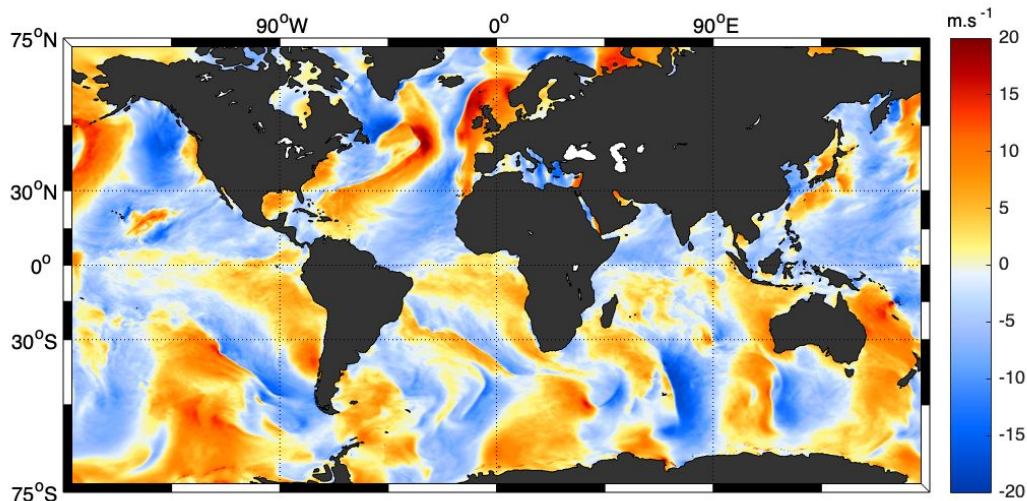
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# ERA\* wind & stress product



## Development of ERA\*:

### 1. Scatterometer-based corrections:

$$SC(i, j, t_f) = \frac{1}{M} \sum_{t=1}^M (u_{10s}^{SCAT^k}(i, j, t) - u_{10s}^{ERA5}(i, j, t))$$

$N$  length of the temporal window (d);

$k$  Scatterometer combinations

$M$  is the number of scatt. and ERA collocations

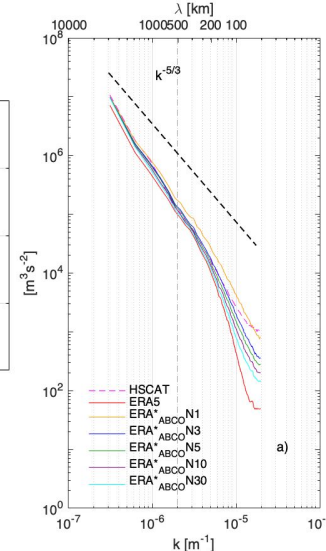
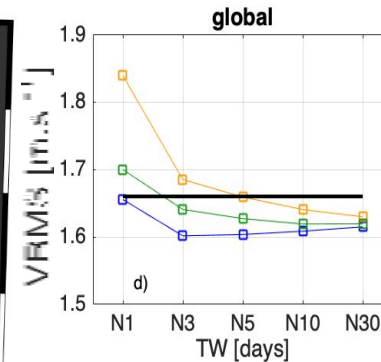
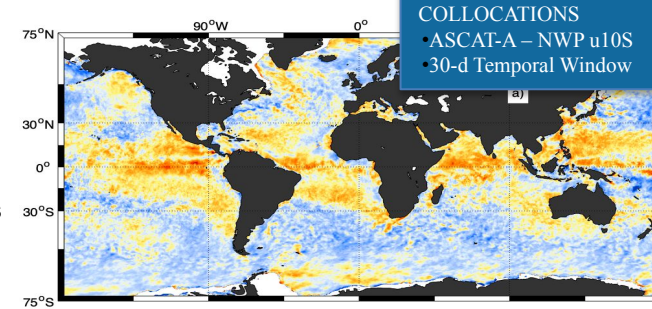
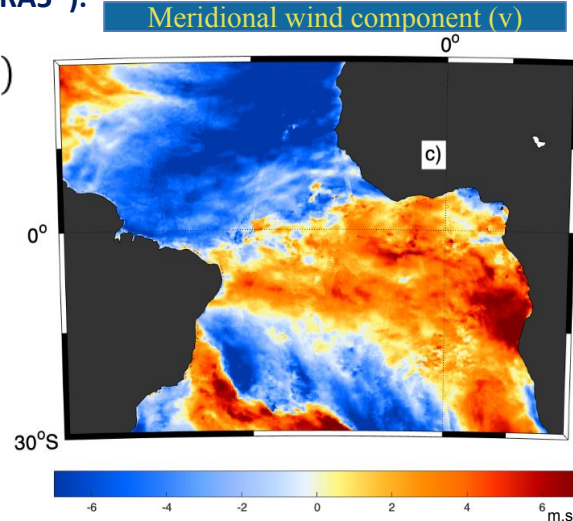
Applied at every forecast time

### 2. ERA5-corrected stress-equivalent winds (ERA5\*):

$$u_{10s}^{ERA5^*}(i, j, t_f) = u_{10s}^{ERA5}(i, j, t_f) + SC(i, j, t_f)$$

ERA\* corrects for large-scale circulation errors and adds small-scale true wind variability, due to oceanic features such as wind changes over SST gradients and ocean currents.

ERA\* error variance (w.r.t. HSCAT-B) is 9% lower than that of ERA5



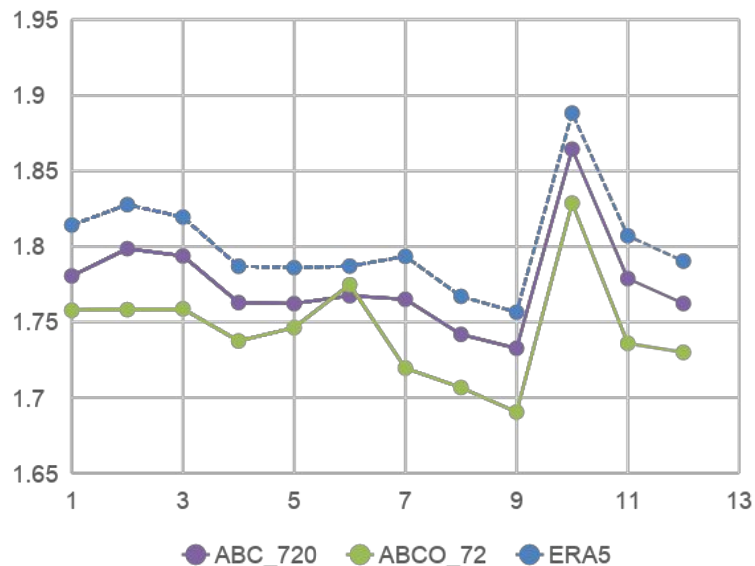
- Scatterometer constellation in 2010-2020 (only C-band & Ku-band with global, continuous coverage)
  - 2010-2012: ASCAT-A & OSCAT
  - 2013: ASCAT-A, ASCAT-B & OSCAT
  - 2014-2016: ASCAT-A, ASCAT-B
  - 2017-2018: ASCAT-A, ASCAT-B & OSCAT2
  - 2019-2020: ASCAT-A, ASCAT-B, ASCAT-C & OSCAT2, HSCAT-B
- HSCAT-A and RapidSCAT don't have full coverage and/or continuous coverage, therefore used for verification purposes only
- The 2019 period is used as testbed for ERA\* optimization over the entire period since it contains all the possible combinations of C-band and Ku-band scatterometer sampling
- Validation against buoys is added to independent scatterometer verification

# ERA\* wind & stress product

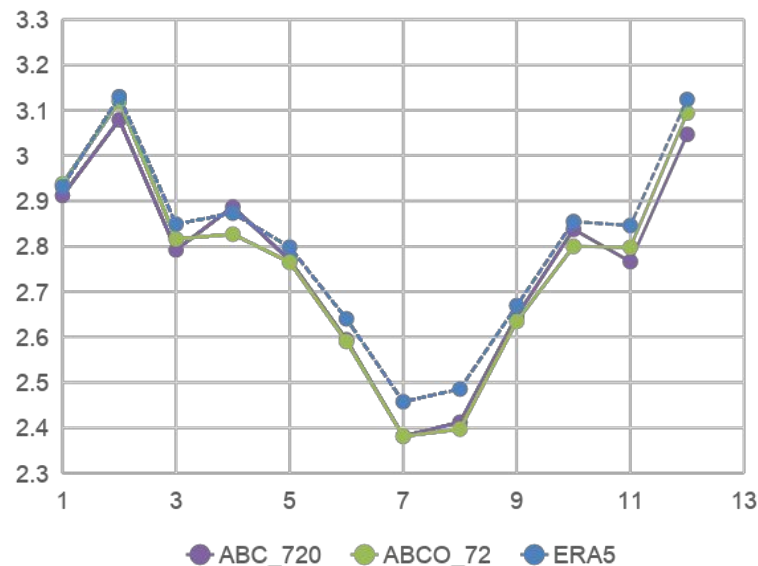


## Global

### HSCAT



### Buoys



$$VRMS = \sqrt{\frac{1}{N} \sum_{i=1}^N \left( (u_{i,REF} - u_{i,NWP})^2 + (v_{i,REF} - v_{i,NWP})^2 \right)}$$

REF: HSCAT, buoys  
NWP: ERA5, ERA\*

72: 3-day window  
720: 30-day window

A: ASCAT-A  
ABC: ASCAT-A, -B & -C  
ABCO: ASCAT-A, -B, -C & OSCAT2

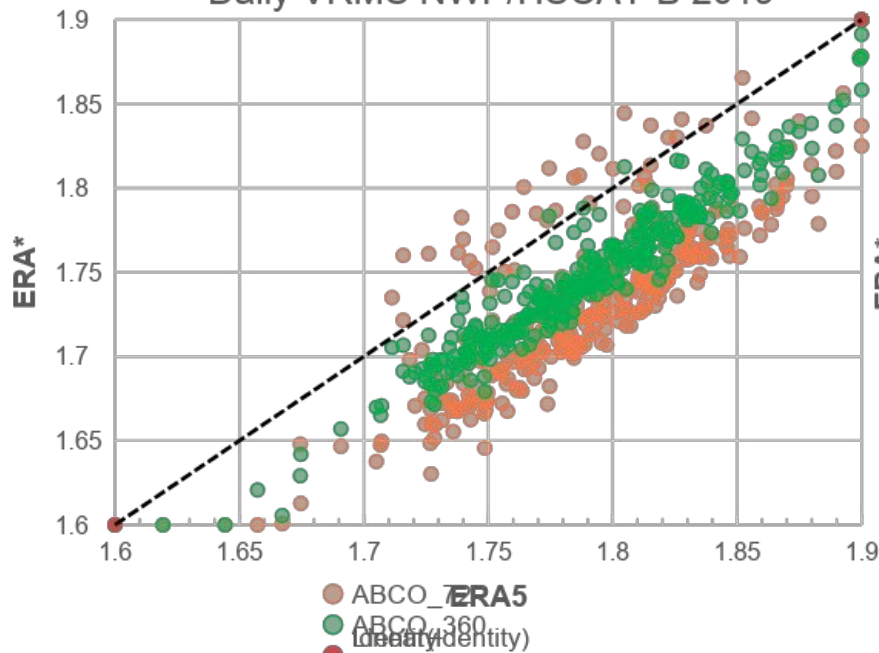


# ERA\* wind & stress product

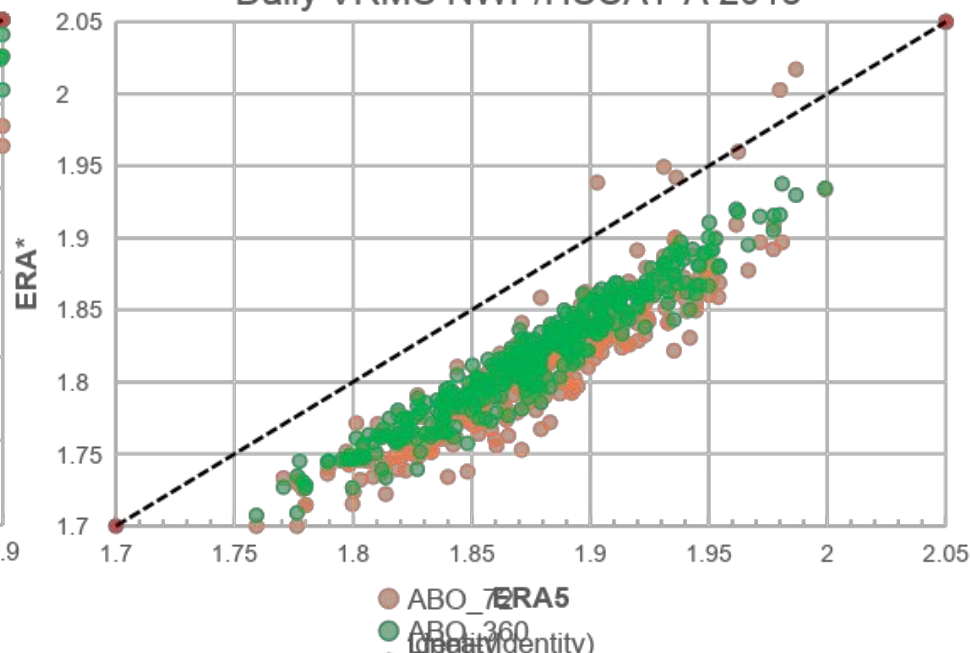


Global

Daily VRMS NWP/HSCAT-B 2019



Daily VRMS NWP/HSCAT-A 2013



$$VRMS = \sqrt{\frac{1}{N} \sum_{i=1}^N \left( (u_{i,REF} - u_{i,NWP})^2 + (v_{i,REF} - v_{i,NWP})^2 \right)}$$

REF: HSCAT  
NWP: ERA5, ERA\*

72: 3-day window  
360: 15-day window

A: ASCAT-A  
ABC: ASCAT-A, -B & -C  
ABCO: ASCAT-A, -B, -C & OSCAT2

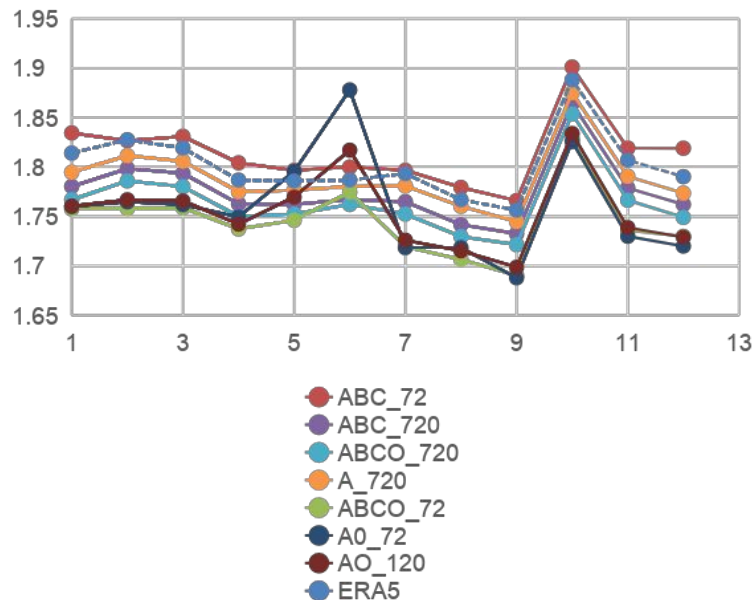
- ERA\* baseline configuration:
  - 2010: 30-day time window (since 25% of the time only ASCAT-A available)
  - 2011-2013 & 2017-2020: 15-day time window for combined C- & Ku-band
  - 2014-2016: 15-day time window for C-band only
- ERA\* optimized configuration:
  - **2013 & 2017-2020 (TBC):** 3-day time window for combined C- & Ku-band
- Future developments (beyond WOC)
  - ERA\* operational implementation in CMEMS (KNMI)
  - Machine learning approach to directly relate ECMWF forecast U10S & MBL parameter fields to NWP-scatterometer differences

# ERA\* wind & stress product

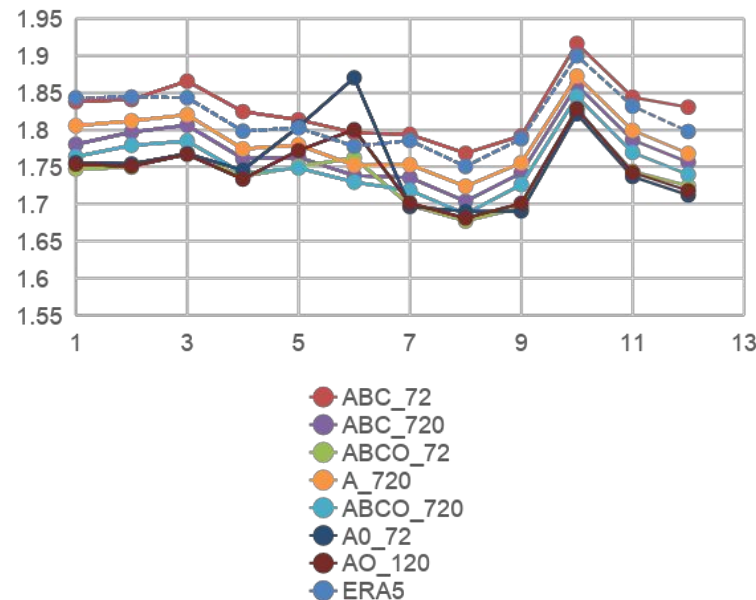


## AO performance (against HSCAT)

Global



Tropics



$$VRMS = \sqrt{\frac{1}{N} \sum_{i=1}^N \left( (u_{i,REF} - u_{i,NWP})^2 + (v_{i,REF} - v_{i,NWP})^2 \right)}$$

REF: HSCAT, buoys  
NWP: ERA5, ERA\*

72: 3-day window  
720: 30-day window

A: ASCAT-A  
ABC: ASCAT-A, -B & -C  
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