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A land-corrected ASCAT coastal wind product

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Introduction

- Clear user need for coastal winds
- Scatterometers hindered by land contamination

- ASCAT product on 12.5 km grid size:
  - Originally at least 35 km from the coast, because of aggregation of σ^0 values over a square area of 50 km by 50 km with Hamming window
  - Current coastal product has aggregation over a circular area with 15 km radius and approaches the coast down to 20 km or slightly less

Motivation

- EUMETSAT developed a new L1B full resolution σ^0 product with a land fraction for each full resolution σ^0 value
- Land fraction based on Spatial Response Functions (SRF) from Lindsley and Long (BYU) and the high-resolution coastline map (GSHHG) from Wessel and Smith (JGR, 1996)
- For this study EUMETSAT prepared one year of new L1B data (2017) for ASCAT-B
- Land fraction takes the shape of SRF into account, but standard coastal processing with the new land fraction yields only few new coastal WVCs
- Something else is needed…

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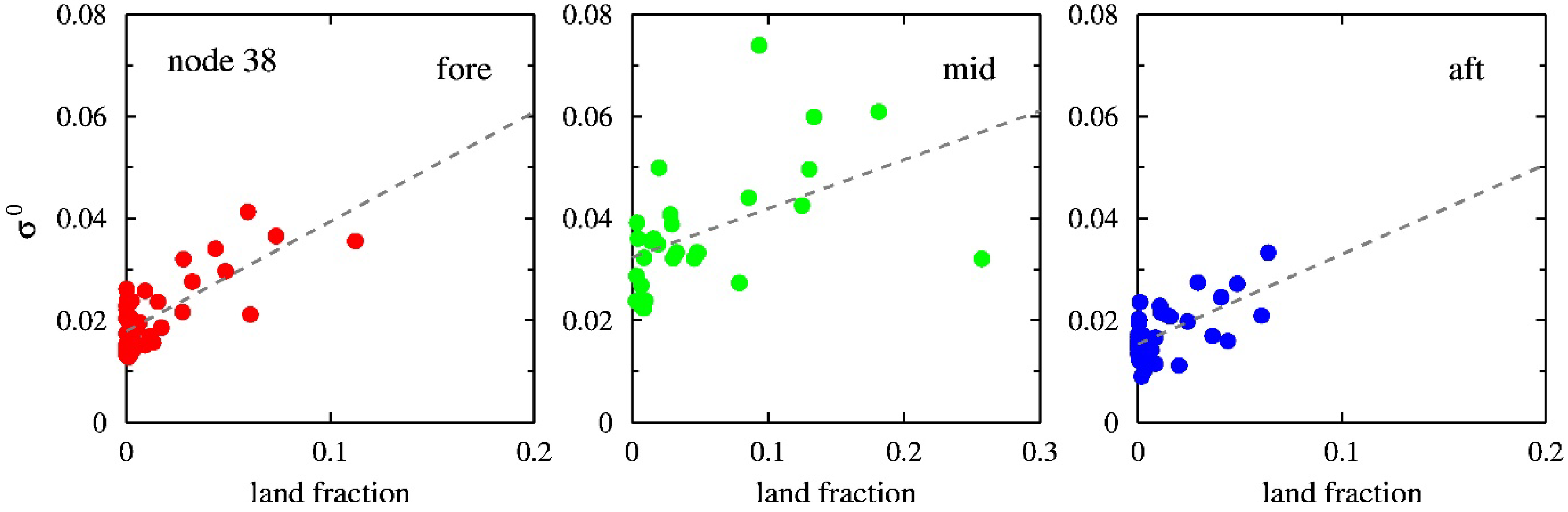
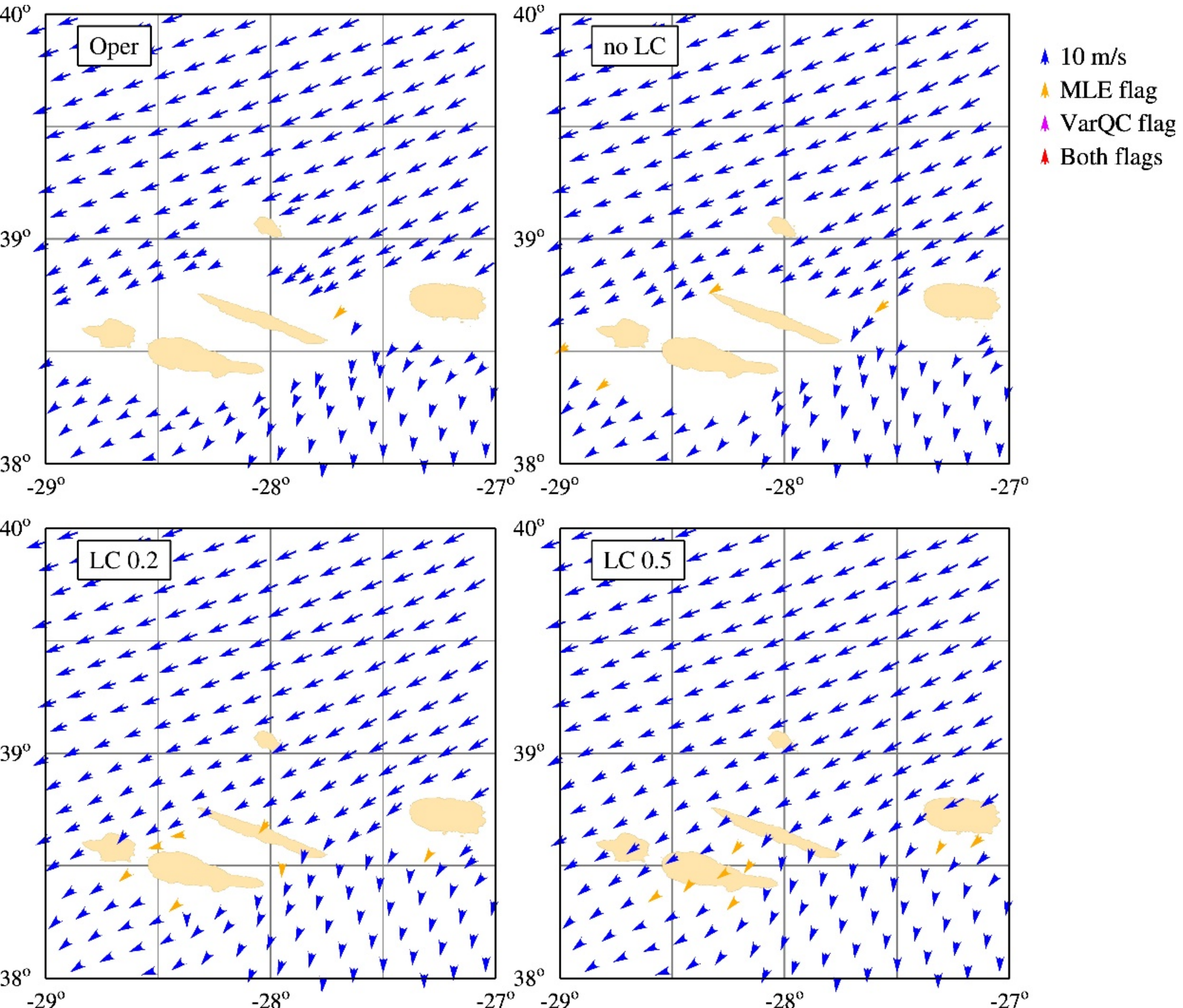
Idea



- Make a simple linear regression analysis of σ^0 against land fraction f_L for all σ^0 values contributing to a WVC and for each beam separately
- $\sigma^0 = af_L + b$ (see figure above; dashed line is the regression line)
- Assume $\sigma^0_{sea} = b \ \ (f_L = 0)$ and $\sigma^0_{land} = a + b \ \ (f_L = 1\ )$
- Land correction: $\sigma^0_{corr} = \sigma^0 - af_L$, f_L in [0,f_L^{max}]

Maximum land fraction



Madeira Isles (Portugal)

Oper: current operational product

no LC: current processing with new land fraction (few new WVCs)

LC 0.2: land correction with $f_L^{max} = 0.2$ (a lot more coastal WVCs)

LC 0.5: land correction with $f_L^{max} = 0.5$ (still more coastal WVCs, but wind direction pattern tends to be flatter)

$f_L^{max} = 0.2$ seems a good choice

Refinements (1)

- Many coastal WVC's with the K_p flag set;

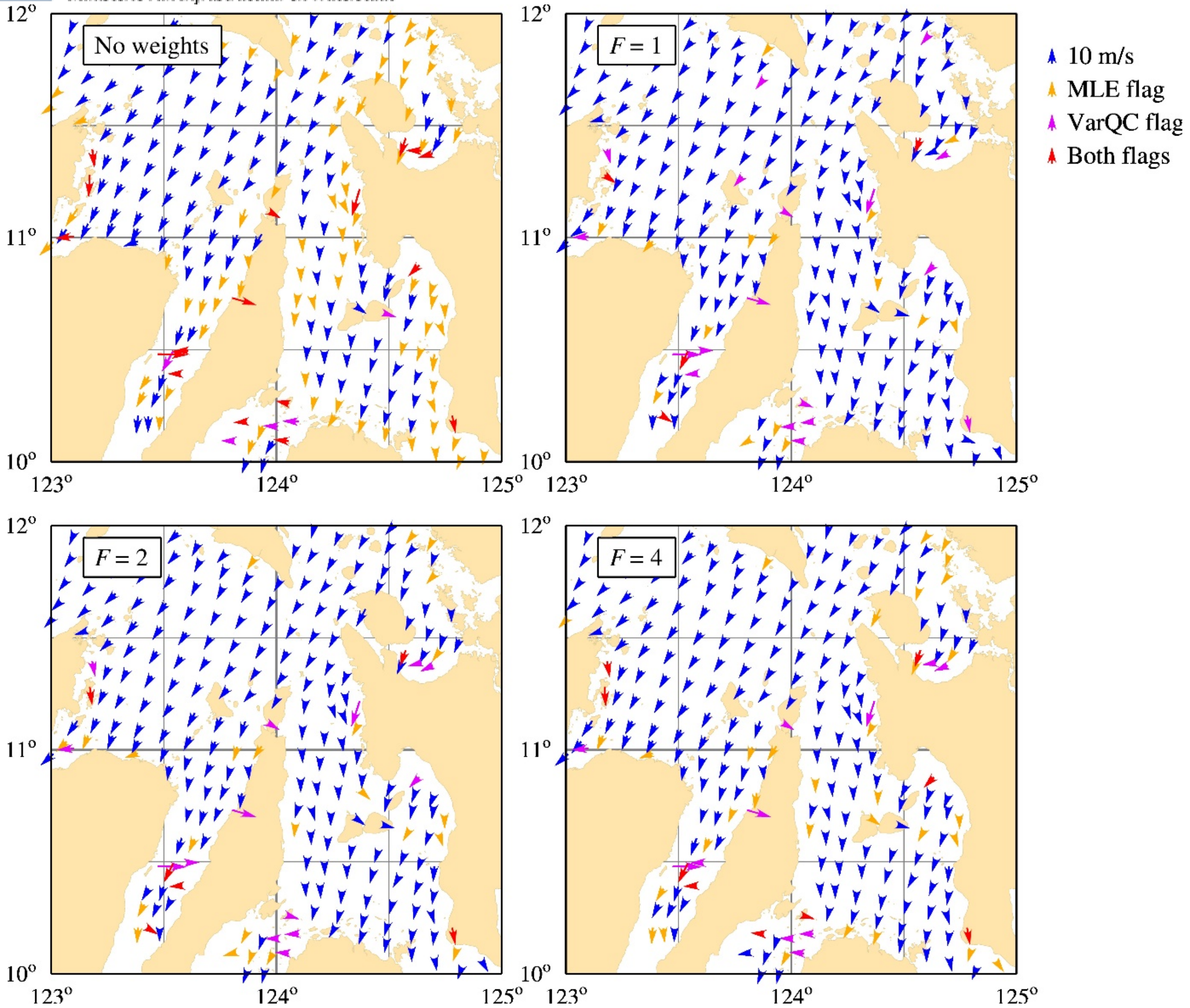
  K_p is a measure of the spreading of the σ^0 values contributing to a WVC

- Apply weighted averaging: $\sigma^0_{WVC} = \frac{\sum_i w_i \sigma_i^0}{\sum_i w_i}$, with

  $w_i = \exp\left(-\left[\frac{\Delta}{\sigma_e}\right]^2\right)$ and i runs over all footprints

- σ_i^0 is the land-corrected radar cross section
- $\Delta = \sigma_i^0 - af_L - b$ is the distance to the regression line
- σ_e is the regression error (average of Δ)

Refinements (2)



Philippines, January 1, 2017

f_L^{max}=0.5

Weighted averaging of σ^0:

$$w_i = \exp\left(-\left[\frac{\Delta}{F\sigma_e}\right]^2\right)$$

$F = 1$ yields reliable looking results; K_p flagging much reduced (K_p flag is part of the MLE flag depicted in orange)

$F \rightarrow \infty$ corresponds to no weights

How to validate?

- Visual inspection of wind fields, but that is qualitative

- Comparison with NWP:
  - Known to be problematic near the coast
- Comparison with buoys:
  - Representativeness in coastal regions may be a problem due to high wind variability in coastal regions

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Comparison with ECMWF

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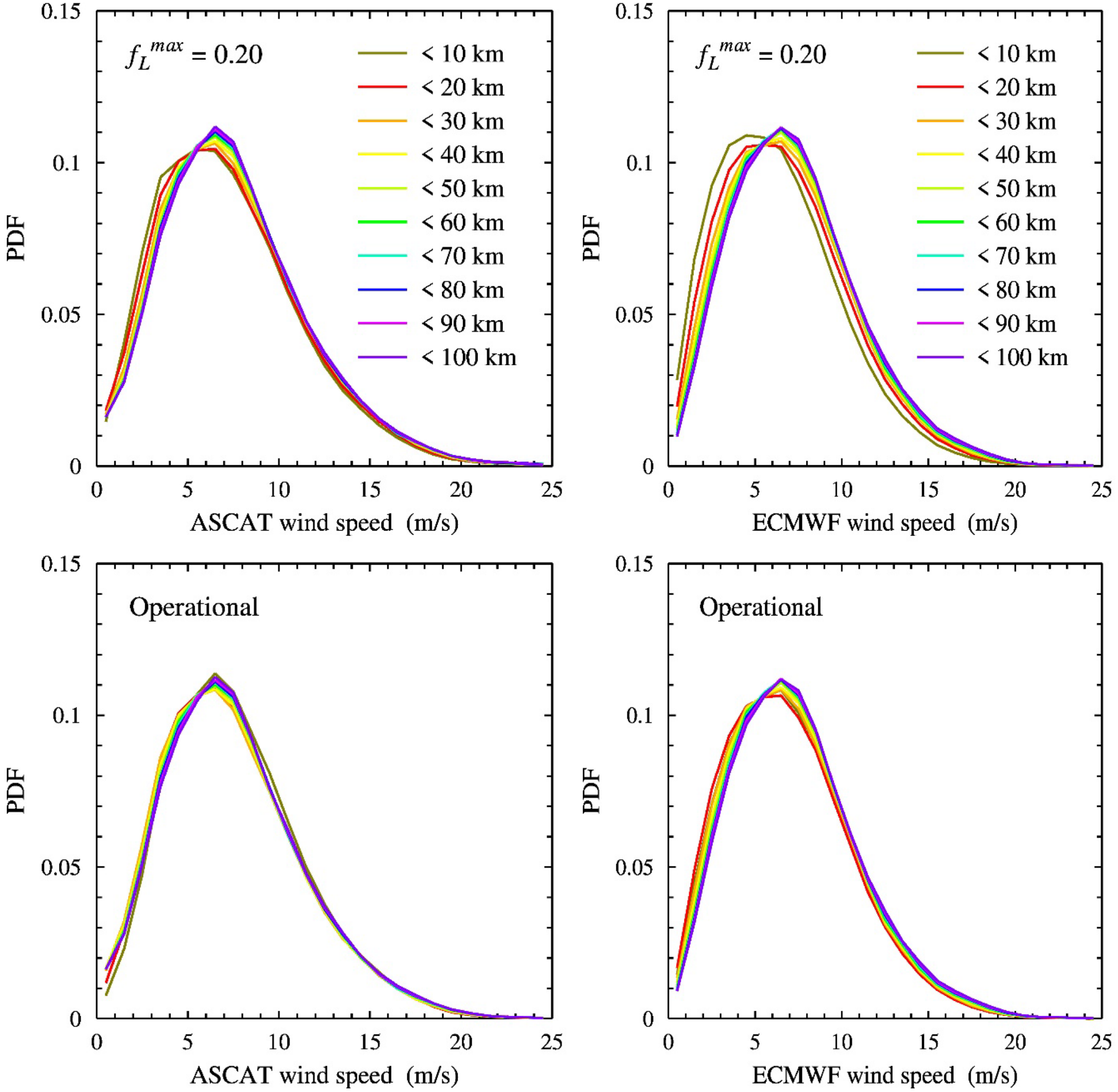
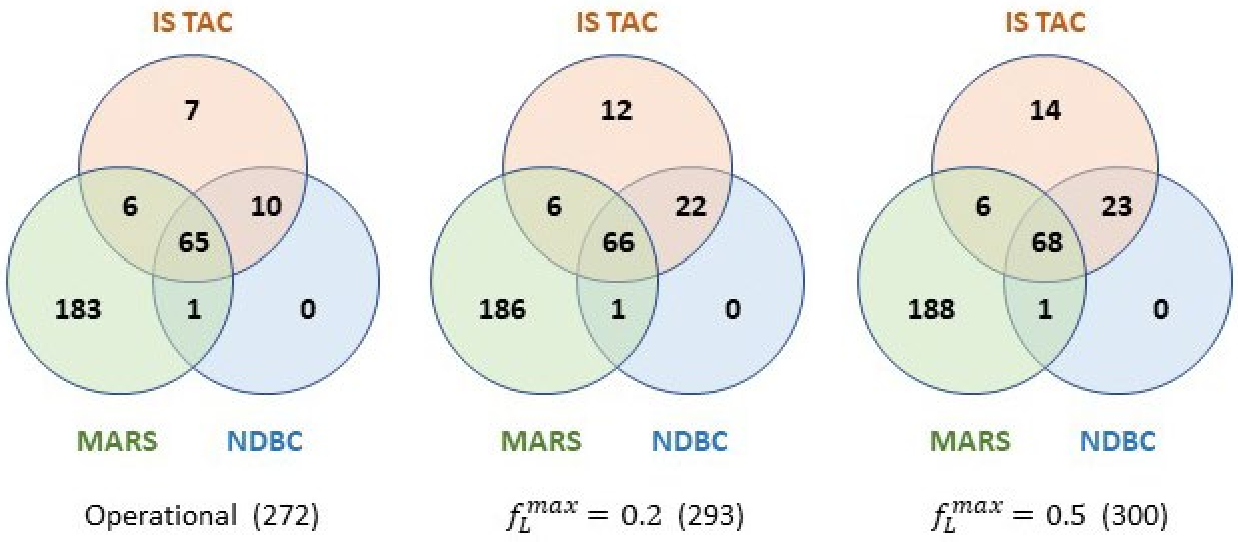


- Wind speed pdf as a function of the distance to the coast in 10 km bins (colors)
- ASCAT (left hand panels) and collocated ECMWF (right hand panels)
- Land corrected (upper) and operational (lower)
- ECMWF “feels” the land already far from the coast; for the land-corrected ASCAT this effect is weaker
- For the operational ASCAT product very little land effect; slightly stronger in ECMWF

Comparison with buoys (1)



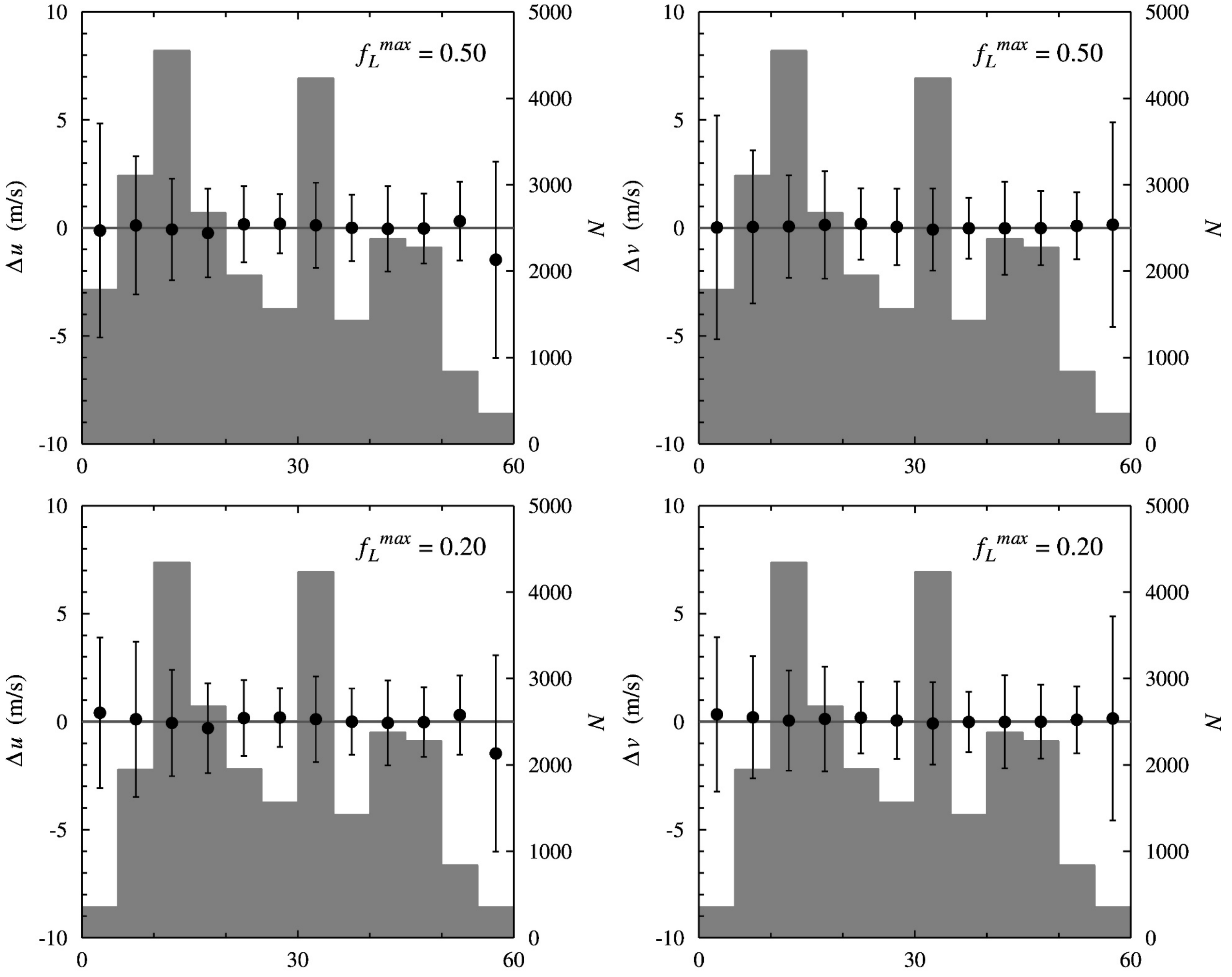
Buoy data from

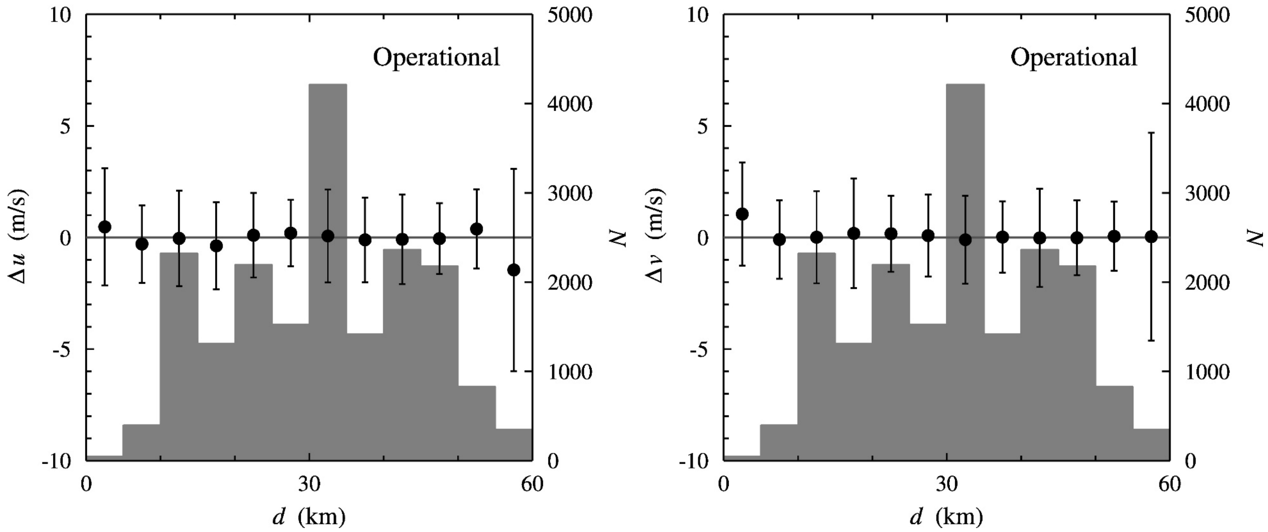
- IS TAC (NetCDF)
- MARS (BUFR)
- NDBC (ASCII)

- Most buoy data from MARS
- IS TAC adds a few buoys
- NDBC adds no buoys (but is often more complete)
- No blacklisting!

Comparison with buoys (2)

All buoys all 2017





- Buoy data binned according to their distance to the coast in 5 km bins
- Difference with buoys increases with decreasing distance to the coast
- Some severe outliers

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Maximum land fraction revisited

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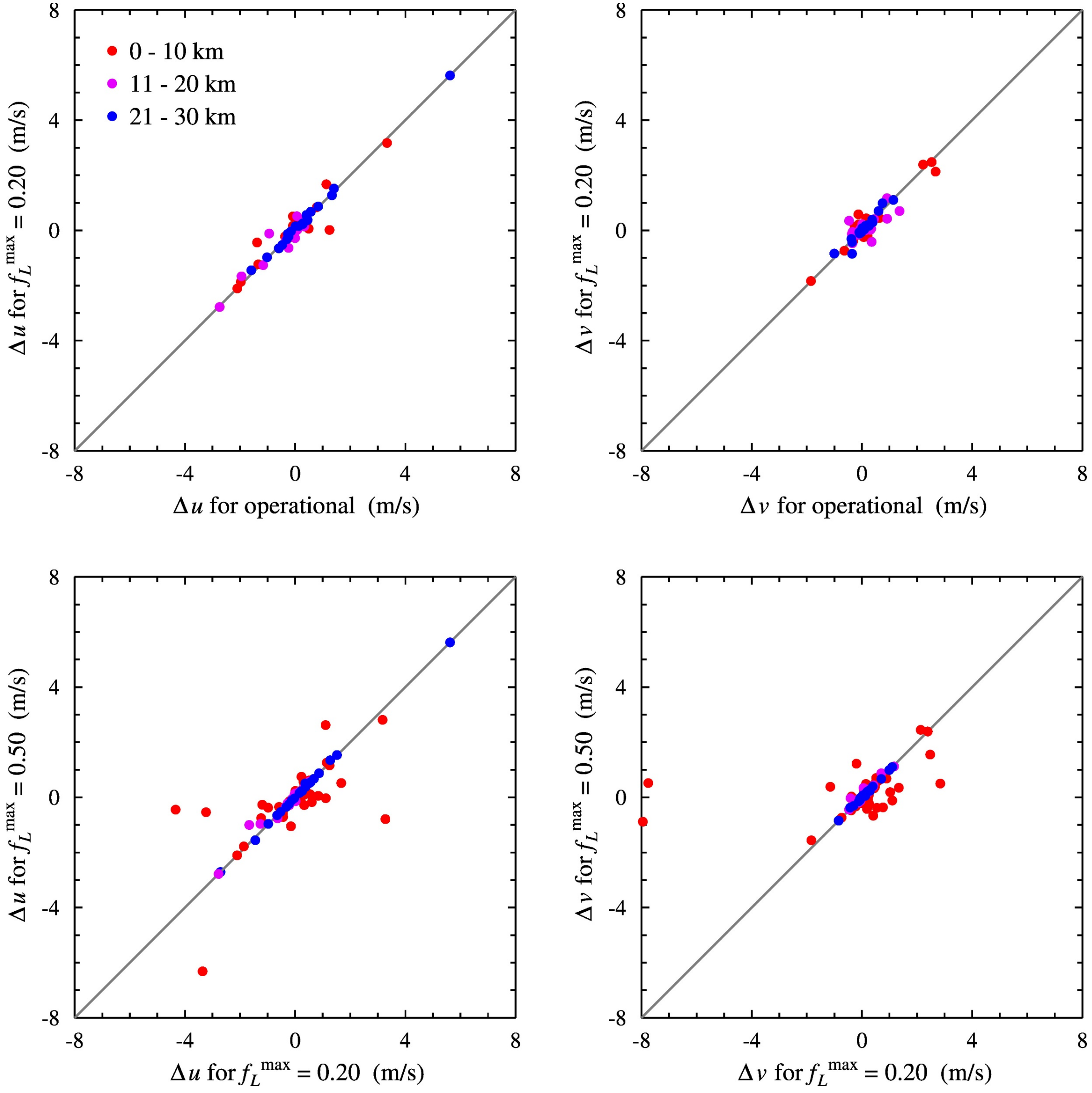

Scatter plots of the average difference with buoys for the three products and three distance to coast classes

- $f_L^{max} = 0.20$ differences about the same as operational differences
- $f_L^{max} = 0.50$ differences deviate more from $f_L^{max} = 0.20$ differences

- Spreading strongest for 0 - 10 km class (red dots)
- Some blacklisting needed!

Final result

Distance to coast (km)	Operational		$f_L^{max} = 0.20$		$f_L^{max} = 0.50$	
	Δu (m/s)	Δv (m/s)	Δu (m/s)	Δv (m/s)	Δu (m/s)	Δv (m/s)
0 – 5	2.6	2.3	3.5	3.6	4.3	4.5
5 – 10	1.7	1.8	3.4	2.7	2.9	3.4
10 – 15	2.1	2.1	2.4	2.3	2.3	2.3
15 – 20	2.0	2.5	1.8	2.4	2.0	2.4
20 – 25	1.9	1.7	1.4	1.7	1.8	1.7
25 – 30	1.5	1.8	2.0	1.8	1.4	1.8
30 – 35	2.1	2.0	1.5	1.9	2.0	1.9
35 – 40	1.9	1.6	2.0	1.4	1.5	1.4

Results after removal of 14 buoys that have largest difference with ASCAT:

1 near Alaska
1 near Haiti
12 in Great Lakes

Increase in difference for buoys less than 10 km offshore

Conclusions

- ASCAT land correction based on regression analysis shows good results
- Maximum land fraction of 0.2 and σ^0 averaging with Gaussian weights performs well
- Comparisons with ECMWF and buoys look reliable, notably for buoys more than 10 km offshore
- More validation with reliable buoy measurements up to 30 km offshore would be welcome – but how to get the metadata?
- Consider HF radar and/or SAR for comparison
- Blacklist needed for coastal buoys
- Experience from beta testers will be helpful

A final note by Jur

This is my last contribution to IOVWST, as I will retire coming July.

I wish you all the best in your future work