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 $\sigma^0$ 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 $\sigma^0$ product with a land fraction for each full resolution $\sigma^0$ 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...
• Make a simple linear regression analysis of $\sigma^0$ against land fraction $f_L$ for all $\sigma^0$ 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 $[0,f_L^{\text{max}}]$
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 $\sigma^0$ values contributing to a WVC

- Apply weighted averaging: $\sigma_{WVC}^0 = \frac{\sum_i w_i \sigma_i^0}{\sum_i w_i}$, with
  $$w_i = \exp \left( - \left[ \frac{\Delta}{\sigma_e} \right]^2 \right)$$ and $i$ runs over all footprints

- $\sigma_i^0$ is the land-corrected radar cross section
- $\Delta = \sigma_i^0 - a f_L - b$ is the distance to the regression line
- $\sigma_e$ is the regression error (average of $\Delta$)
Refinements (2)

Philippines, January 1, 2017

$f_L^{max} = 0.5$

Weighted averaging of $\sigma^0$:

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

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

$F \to \infty$ 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
Comparison with ECMWF

- 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)

- 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
Maximum land fraction revisited

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

- $f_{L\text{max}} = 0.20$ differences about the same as operational differences
- $f_{L\text{max}} = 0.50$ differences deviate more from $f_{L\text{max}} = 0.20$ differences

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

<table>
<thead>
<tr>
<th>Distance to coast (km)</th>
<th>Operational</th>
<th>$f_L^{max} = 0.20$</th>
<th>$f_L^{max} = 0.50$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\Delta u$ (m/s)</td>
<td>$\Delta v$ (m/s)</td>
<td>$\Delta u$ (m/s)</td>
</tr>
<tr>
<td>0 – 5</td>
<td>2.6</td>
<td>2.3</td>
<td>3.5</td>
</tr>
<tr>
<td>5 – 10</td>
<td>1.7</td>
<td>1.8</td>
<td>3.4</td>
</tr>
<tr>
<td>10 – 15</td>
<td>2.1</td>
<td>2.1</td>
<td>2.4</td>
</tr>
<tr>
<td>15 – 20</td>
<td>2.0</td>
<td>2.5</td>
<td>1.8</td>
</tr>
<tr>
<td>20 – 25</td>
<td>1.9</td>
<td>1.7</td>
<td>1.4</td>
</tr>
<tr>
<td>25 – 30</td>
<td>1.5</td>
<td>1.8</td>
<td>2.0</td>
</tr>
<tr>
<td>30 – 35</td>
<td>2.1</td>
<td>2.0</td>
<td>1.5</td>
</tr>
<tr>
<td>35 – 40</td>
<td>1.9</td>
<td>1.6</td>
<td>2.0</td>
</tr>
</tbody>
</table>

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 $\sigma^0$ 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.