High-resolution scatterometer winds near the coast

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coastal motivation for box winds

• Problem: radar backscatter from land is much higher than from sea, therefore a conservative land mask is necessary
• Hence no winds can be computed near the coasts, in bays and in areas between islands
• Wind data in coastal areas are very important since they are close to densely populated areas
WVC backscatter

- Hamming filtering does not allow processing near the coast
- Reliable winds cannot be obtained closer than \(~70\) km (25 km product) or \(~35\) km (12.5 km product) from the coast
Idea for coastal product

- Use full resolution (FR) product with all footprints
- Use only these measurements that are over sea (high-res land-sea mask)
- Box averaging of backscatter rather than Hamming filtering reduces smearing, but may increase the noise
Operational vs. coastal, 12.5 km

- Coastal winds 15-20 km from land vs. ~35 km for operational product
- Coastal winds are consistent, but what is their quality?
Box averaging in open ocean

- Kp noise is constant for a constant effective averaging area, which can be set.
- Adding footprints to an IFOV leads to observed areas well outside the WVC; this causes correlation between WVCs and suppresses aliasing.
- Aliasing contributions would occur in different azimuth directions for the three beams and is thus further suppressed by the wind retrieval.
- Box IFOV smaller scale than Hamming.
- The three different IFOVs correspond to different area-mean winds; this causes the so-called geophysical noise in the wind retrieval, only substantial for low winds.
Hamming filter

- Backscatter variations are smoothed out since measurements of up to 70 km away from the WVC centre are used in the spatial averaging (25 km product); local details are lost/reduced.
- Broad filter: larger-scale variations dominate over smaller-scale variations due to spectral slope of $k^{-5/3}$; IFOV wind differences may persist and thus geophysical noise near fronts/lows.
Box versus Hamming

- Find a difference
- Small QC and AR differences
Box versus Hamming

- Find a difference
- Small QC and AR differences
Validation against buoy winds

- Processed six months of ASCAT data
- Use two sets of buoys: one with buoys > 50 km from the coast and one with buoys < 50 km from the coast
Validation against buoy winds

- 6-7% more vectors, mainly low winds; the smaller box, the lower QC and the more winds
- $R_{\text{max}}=12.5\text{-km}$ slightly noisier than collocated Oper.
- $R_{\text{max}}=15\text{-km}$ and 20 km less noisy than Oper.

<table>
<thead>
<tr>
<th>12.5-km product</th>
<th># wind vectors</th>
<th>speed bias</th>
<th>stdev u</th>
<th>stdev v</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Operational</td>
<td>14513</td>
<td>-0.28</td>
<td>1.46</td>
<td>1.58</td>
</tr>
<tr>
<td>2 $R_{\text{max}} = 20 \text{ km}$</td>
<td>15373</td>
<td>-0.29</td>
<td>1.43</td>
<td>1.56</td>
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<td>3 $R_{\text{max}} = 15 \text{ km}$</td>
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<td>1.46</td>
<td>1.59</td>
</tr>
<tr>
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<td>1.48</td>
<td>1.61</td>
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<tr>
<td>5 Operational, collocated data set</td>
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<td>-0.28</td>
<td>1.43</td>
<td>1.56</td>
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<tr>
<td>6 $R_{\text{max}} = 20 \text{ km}, \text{collocated data set}$</td>
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<td>-0.28</td>
<td>1.43</td>
<td>1.54</td>
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<tr>
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<td>-0.29</td>
<td>1.44</td>
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</tr>
<tr>
<td>8 $R_{\text{max}} = 12.5 \text{ km}, \text{collocated data set}$</td>
<td>12761</td>
<td>-0.29</td>
<td>1.45</td>
<td>1.57</td>
</tr>
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Validation against buoy winds

- Coastal winds are more variable due to sea breezes, katabatic winds, currents, etc.
- Buoys scores similar to open ocean however
- $R_{\text{max}}=12.5$-km noisiest, $R_{\text{max}}=15$-km/20-km less noisy

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<tr>
<td>1 $R_{\text{max}} = 20$ km</td>
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<td>4 $R_{\text{max}} = 20$ km, collocated data set</td>
<td>4596</td>
<td>-0.23</td>
<td>1.51</td>
<td>1.57</td>
</tr>
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<td>5 $R_{\text{max}} = 15$ km, collocated data set</td>
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Validation against buoy winds

• Coastal data set
Spectra

- Box products close to 3D turbulence spectra of $k^{-5/3}$
- $R=20$ km shows small tail effect (aliasing)
- $R=15$ km spectrally very similar to operations
Conclusions

• We succeeded to create an ASCAT coastal wind product from the full resolution level 1 product
• The coastal product approaches land as close as 15-20 km
• The product quality at full sea is as good as the quality of the nominal 12.5-km product for R=15km
• The product quality near the coasts is very similar to that at full sea
• Product has been under review by beta users and EUMETSAT and is publicly available
• The limited noise in the products is very encouraging; ultra-high resolution winds in variable conditions may well be feasible (e.g., polar lows, TCs)
The future: 6.25 km data grid?

- Left: coastal product at 12.5 km grid size, right: ultra high resolution product at 6.25 km grid size
- Product still looks consistent but data quality not yet validated