Standards in the Evaluation of Scatterometer Wind Products

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Motivation

- Several producers provide OVW FCDRs, which are usually defensible by their own verification metric.
- However, these products cannot be easily understood nor combined by the user community.
- Mature stable products exist over long times, but not reprocessed according to GCOS guidelines; some uncoordinated L2 and higher reprocessing plans exist.
- Matchup data bases exist too, but by producer.
- Moored buoys are the main reference.
- Quality metrics and assessment standards (software) exist too by producer, but resolution, wind scale, wind quality to be coordinated/agreed.
- The IOVWST could address ECV coordinated needs (when mandated as such).
- Cal/val support for OSCAT has been very successful; the combined IOVWST methods work well!
L1 Calibration

- Transponder procedure in development for ASCAT
- Rain forest (stable points)
- Sea ice / snow /desert (stable points)
- Geographically limited, while some errors may be orbit phase dependent

- NWP ocean calibration successfully used for winds
- Need to combine all methods of calibration, including ocean calibration
- Calibration procedures and GMFs need to be shared between producers to achieve intercalibrated NRCS
Monitoring

www.knmi.nl/scatterometer

- Confirm stability of instrument over full record
- Automatic alerts based on multiparameter flag
- NOC provides improved cone positions and more uniform quality winds
- Separates backscatter inconsistencies from GMF errors
For a given cross-track swath WVC number, the incidence angles of all beams are fixed.

Since

\[ \sigma^0 = \text{GMF}(U10N, \phi, \theta, \lambda, \text{pol}) \]

only $U10N$ and $\phi$ change when the satellite is orbiting the earth.

$U10N$ and $\phi$ span a cone-like surface:

- $U10N$ increases away from the origin
- Wind direction $\phi$ opens the cone surface

The GMF cone is very close to the $\sigma^0$ triplets (<5 %)

$U10N$, i.e., add $\rho_{\text{AIR}}(\text{ECMWF})$
QC: Which error is acceptable?

- We can produce winds with SD of buoy-scatterometer difference of 0.6 m/s, but would exclude all high-wind and dynamic air-sea interaction areas.
- The winds that we reject right now in convective tropical areas are noisy (SD=1.84 m/s), but generally not outliers!
- What metric makes sense for QC trade-off?

**MLE>+18.6**

\[ \text{SD}_f = 2.31 \text{ ms}^{-1} \]

\[ \text{SD}_f = 1.84 \text{ ms}^{-1} \]
Ambiguity

- Ambiguities show streamlines of the flow; can you follow them?
- Is ECMWF right?
- Do you see consistency in the ASCAT winds and the ASCAT MLEs?
- Are there better ASCAT solutions to the ambiguity problem?
- We evaluate area-mean (WVC) winds in the empirical GMFs.
- 25-km areal winds are less extreme than 10-minute sustained in situ winds (e.g., from buoys).
- So, extreme buoy winds should be higher than extreme scatterometer winds.
- Extreme global NWP winds should be generally lower due to lacking resolution (over sea).
NWP comparison

- NWP ocean calibration (standard for wind processing)
- Speed, direction and vector components
- Cross-track WVC dependencies
- Outlier detection
- $U_{10N_{OPS}} \approx U_{10N_{ERA}} + 0.2 \text{ m/s}$
- ECMWF coastal $U_{10N}$ is best obtained on reduced Gaussian grid; KNMI makes ECMWF $U_{10N}$ available for ERA (and OPS)
Precision, accuracy: triple collocation

<table>
<thead>
<tr>
<th></th>
<th>$u$</th>
<th>$v$</th>
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</thead>
<tbody>
<tr>
<td>Bias ASCAT (m/s)</td>
<td>0.15</td>
<td>-0.02</td>
</tr>
<tr>
<td>Bias ECMWF (m/s)</td>
<td>0.28</td>
<td>0.08</td>
</tr>
<tr>
<td>Trend ASCAT</td>
<td>1.01</td>
<td>1.01</td>
</tr>
<tr>
<td>Trend ECMWF</td>
<td>1.03</td>
<td>1.04</td>
</tr>
<tr>
<td>$\sigma$ ASCAT (m/s)</td>
<td>0.69</td>
<td>0.81</td>
</tr>
<tr>
<td>$\sigma$ ECMWF (m/s)</td>
<td>1.50</td>
<td>1.52</td>
</tr>
<tr>
<td>Representation error (m/s)</td>
<td>0.79</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Representation error is part of ECMWF error

- OSI SAF NRT req. 2 m/s, WMO in speed/dir.

See also Vogelzang et al., JGR, 2011
Since QC differs by product, comparison of validations of different products are only useful when the same sample of WVCs is used, i.e., collocated products.

- Holds for all validation metrics (buoy, NWP)
- The other rejection categories may be tested too.

<table>
<thead>
<tr>
<th>OSCAT 50-km product SDs v2010</th>
<th>SD Speed m/s</th>
<th>Direction degree</th>
<th>SD u m/s</th>
<th>SD v m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>L2B, collocated OWDP, ≥ 6 m/s</td>
<td>1.34</td>
<td>19.40</td>
<td>2.41</td>
<td>2.30</td>
</tr>
<tr>
<td>OWDP, collocated L2B, ≥ 6 m/s</td>
<td>1.33</td>
<td>16.67</td>
<td>2.02</td>
<td>2.12</td>
</tr>
</tbody>
</table>
Independent verification

1. ISRO/NRSC (ver. 1.3)
   - 50 km resolution
2. NOAA/NESDIS
   - 25 km resolution
   - 1 Jan. 2012 – 31 Mar. 2012 (3 months)
3. KNMI/OSI SAF
   - 50 km resolution
4. JPL/PODAAC
   - 12.5 km resolution
   - Rain correction + Cross-track bias correction

- Still QC differences need to be documented
- At least same buoy QC
- Ebuchi plots!

Naoto Ebuchi, Tokai Un., Japan
coops.fsu.edu/scatterometry/meeting/past.php#2013
Gridded daily L3 products

www.myocean.eu

- Use L2 $U10N$ and $\tau$
- No time mixing
- New swath grid for derivatives $\nabla \cdot \tau$ and $\nabla \times \tau$
- Both for NWP and scatterometer fields
- Scatterometer NWP sampling may be compared with uniform mean NWP field to obtain sampling error
- Correct for it?
Define Uncertainty, Stability, Resolution

- Users have little clue how different products compare and whether they use the product most fit for their purpose
- Standardization of methods (software?) to assess uncertainty, resolution and stability to be discussed in the IOVWST
  - NWP ocean calibration, triple collocation, CDF matching
  - The resulting speed scale standard would be applicable to scatterometers, radiometers, altimeters and SAR
  - Accuracy of speed scale TBD (speed dependent)
    - Need dropsondes and SFMR records for extremes
- Producers to share match-up data bases
- Independent cal/val (e.g., Ebuchi)
- Publish / post results for users (in central place(s))
Suggested actions

- Obtain data set details from producers and make ECV inventory
- Reprocessing of all satellite winds following GCOS guidelines
- Share matchup data bases (incl. accurate NWP inputs)
- Collocate collocations
- Coordinate quality metrics and assessment standards (software) on resolution, wind scale, wind quality
- IOVWST to collect and address wind ECV coordinated needs
- Perform scatterometer intercalibration, also using RapidScat
- Develop a reference wind scale (intercalibration) for all satellite winds, scatterometer, radiometer, altimeter, SAR (incl. extremes)

- CEOS VC (satellite agencies) to promote satellite coordination and intercalibration (OSCAT was great success)
- Maintain L1 reprocessing facilities (e.g., ESA ERS) Extend moored buoy network in open ocean