Scatterometer winds for mesoscale dynamics

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Overview

- Convection
- Geophysical Model Function departure, cone distance or MLE
- QC
Convection

Core

Downdraughts

Gust front

Rainfall

Updraughts

Inflow/outflow boundary

Flanking line
Convergence and curl structures associated with convective cell

Inflow convergence

Precipitation is associated with wind downburst

Shear zones with curl (+ and -)
ASCAT

Large-scale gust front

Large wind change in 50 minutes over 200-km area

25 February 2014, near 2W, 4N
Developing gust band

25 February 2014, near 2W, 4N

ASCAT div

ASCAT rot
The GMF represents mean conditions on the globe; locally differences occur due to non-nominal conditions:

- Sub-WVC wind variability
- Rain splash
- Rain cloud attenuation and backscatter (Ku band)
- Land contamination
- Sea ice contamination
- Sea structures
- . . .

- For ASCAT sub-WVC wind variability appears most prominent; most extreme near lows, fronts and convection
Increased wind variability near rain: Downdrafts
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?
ASCAT ambiguities+MLE

ECWMF wind+MLE

ASCAT solutions+MLE

Use MLE

- Denotes flow boundaries
- Nowcasting
- Ambiguity removal
- Proxy for large and short-scale forecast errors
- QC to remove unrepresentative observations in data assimilation

ASCAT solutions+speed

{-8, 95}
ASCAT-B and ASCAT-A

~50 minutes difference only!

33, -137; 18:40/19:30 March 28, 2013
Tropical variability

1. Dry areas reasonable
2. NWP models lack air-sea interaction in rainy areas
3. ASCAT scatterometer does a good job near rain
4. QuikScat, OSCAT and radiometers are affected by rain droplets

- Portabella et al., TGRS, 2011
ASCAT 25 km (selected) winds closer to buoy winds than ECMWF winds in rainy areas (buoy rain data).
ASCAT-A ASCAT-B collocation

- Global, $\Delta t=50\text{min.}$

- Small spread in NWP due to 50 minutes time difference (smooth wind fields)

- Larger spread in ASCAT due to much smaller resolved scales (e.g., convection)
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).
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**

\[ \text{MLE} = +18.6 \]

- \( \text{SD}_f = 2.31 \text{ m/s}^{-1} \)
- \( \text{SD}_f = 1.84 \text{ m/s}^{-1} \)
- \( \text{SD}_f = 0.6 \text{ m/s}^{-1} \)
KNMI HY2A vs ECMWF

- NWP ocean calibration (standard for wind processing)
- Speed, direction and vector components
- Outlier detection
- Small scales evolve fast, so when we want to determine (initialize) them in 4D, we will need many observations
Summary

- ASCAT-A and –B tandem are excellent for investigating dynamical aspects of convection
- MLE denotes gustiness and wind variability
- MLE complements imagery, particularly in case of convection or in pin-pointing extratropical fronts under a heavy cloud deck
- MLE could be used in 2DVAR and NWP
- Do not throw valuable ASCAT data away, unless you cannot handle it 😊
## Triple collocation

Data from November 2012 to January 2013

- Errors on scatterometer scale
- A and B very similar

### Table

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<th></th>
<th>Scatterometer</th>
<th>Buoys</th>
<th>ECMWF</th>
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<tr>
<td></td>
<td>$\sigma_u$</td>
<td>$\sigma_v$</td>
<td>$\sigma_u$</td>
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<tr>
<td>ASCAT–A 25–km</td>
<td>0.63</td>
<td>0.71</td>
<td>1.21</td>
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