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A Novel Approach To SAR
Ocean Wind Retrieval

by Vegard Nilsen, (Geir Engen, Harald Johnsen)

Norut Research Institute
• Extract wind information from SAR ocean cross spectrum.
• Independent of a priori information.
• Data driven model
  • Based on new parameters
    • ISV
    • Plane slope values
  • Bayesian system
  • Solve azimuth ambiguity
S1B-201610-WV1 average phase plane $U_{10} = 8.78638$ [m/s], $\theta = 0.454521$ [deg]

Plane ($\alpha, \beta$) area

ISV area
AVERAGE AZIMUTH SLOPE BY WIND DIRECTION

- Total
- Symmetric
- Anti Symmetric
DATA DESCRIPTION

• Sentinel 1A: January 2017 (#16353), Sentinel 1B: October 2016 (#17887) and January 2017 (#28857)
  • WV1 for better SNR

• Collocated with atmospheric model ECMWF
  • Training
  • Validation

• Ascat data (Omitted)
DIRECTIONAL DISTRIBUTION OF PARAMETERS

- Directional distribution of ISV
- Directional distribution of range slope ($\beta$)
- Directional distribution of azimuth slope ($\alpha$)
- Directional distribution of NRCS

Wind direction degrees (from range) (deg)
MODEL BUILD UP

\[
J(U_{10}, \theta) = \frac{(x_{\text{obs}} - x_{\text{isv}})^2}{\sigma_{\text{isv}}^2} + \frac{(x_{\text{obs}} - x_{\text{ra}})^2}{\sigma_{\text{ra}}^2} + \frac{(x_{\text{obs}} - x_{\text{az}})^2}{\sigma_{\text{az}}^2} + \frac{(x_{\text{obs}} - x_{\text{nrCs}})^2}{\sigma_{\text{nrCs}}^2}
\]

minimize $J(U_{10}, \theta)$

where

\[
x_{\text{mod}}(\sigma_0, \theta, \rho) = \sum_{i=0}^{M} \sum_{j=0}^{N} \sum_{k=0}^{K} \alpha_{ijk} \sigma_0^i \rho^j (\cos(k \ast \theta) + \sin(k \ast \theta))
\]

\[
x_{\text{nrCs}}(U_{10}, \theta, \rho) = \sum_{i=0}^{M} \sum_{j=0}^{N} \sum_{k=0}^{K} \alpha_{ijk} U_{10}^i \rho^j \cos(k \ast \theta)
\]
WIND ESTIMATE

Wind direction estimate versus ECMWF wind direction in degrees, std: 30.6, bias: -2.5

Wind speed ($U_{10}$) estimate versus ECMWF wind speed ($U_{10}$), std: 1.79, bias: 0.009
WIND ESTIMATE DENSITY

- Estimation density of wind speed vs ECMWF (2017-01): std 1.79, bias 0.009
- Estimation density of wind direction vs ECMWF (2017-01): std 10.6, bias 2.5
## PERFORMANCE

### Test data for all wind speeds.

<table>
<thead>
<tr>
<th>Model Data</th>
<th>Test data</th>
<th>nr. scenes</th>
<th>mode</th>
<th>std ($U_{10}$)</th>
<th>bias ($U_{10}$)</th>
<th>std ($\theta$)</th>
<th>bias ($\theta$)</th>
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<tbody>
<tr>
<td>S1B-201610</td>
<td>S1B-201610</td>
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<td>1.75</td>
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### Test data for ECMWF wind speeds above 7 m/s.

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<th>bias ($U_{10}$)</th>
<th>std ($\theta$)</th>
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FUTURE WORKS

1. Revisit the model for estimating wind speed.
2. New elliptical weight function for the plane.
3. Creating a regularized minimization model.
4. More high wind speed data (124 samples >20 m/s).
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