Evaluating Ocean Wind Products for Short-range Forecast Analyses of Wind-Driven Surface Currents

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Ocean Surface Currents Analyses Realtime processing system (OSCAR) is a satellite-derived surface current database based on a combination of quasi-steady geostrophic and locally wind-driven dynamics (Bonjean and Lagerloef, 2002).

- The geostrophic term is computed from the gradient of surface topography fields (AVISO/CLS).
- Wind-driven velocity components are computed from an Ekman/Stommel formulation with variable viscosity using QuikSCAT winds (FSU/COAPS)
- with a thermal wind adjustment using satellite SST data.
The aim of this study is to evaluate the accuracy of NCEP Reanalysis-2 and ECMWF ERA-40 Reanalysis GCM products at measuring ocean surface winds through comparisons with mooring wind data and QuikSCAT winds to begin to assess the feasibility of using GCM forecasts for OSCAR forecast currents.

Results presented here:
- comparisons of the three winds with the TAO/TRITON and PIRATA mooring arrays
- comparisons of the currents with drifters using the different winds in OSCAR.

The ultimate goal is to extend OSCAR to real-time and short-range forecast currents on a 1-5 day timebase which includes faster wind-driven currents.
Newest development of OSCAR: increase resolution from one degree to 1/3 degree.

- Smaller-scale features in higher resolution model, e.g. Gulf Stream region.
- Much closer to coasts with optimal coverage at each time step.
- Improved model for equatorial currents.
Currents are interpolated onto the drifter locations (averaged over 1 day). Zonal and meridional currents vs drifter velocities.

We want to incorporate faster wind-driven mixed layer currents than our current quasi-steady model allows. This requires an extension from 5-day to 1-day timebase and time-dependent terms in the momentum equations.
QuikSCAT Comparisons with moorings

- Time series of mooring at (125°W, 0°N) and QuikSCAT data over 2 months.
- U (top) and V (bottom)
- Mooring (blue) and QuikSCAT (black).
All winds comparisons with moorings

**QuikSCAT**

- Zonal Winds vs TAO for year 2000 at mooring 125w 0n
- Meridional Winds vs TAO for year 2000 at mooring 125w 0n

**ECMWF**

- Zonal Winds vs TAO for year 2000 at mooring 125w 0n
- Meridional Winds vs TAO for year 2000 at mooring 125w 0n

**NCEP**

- Zonal Winds vs TAO for year 2000 at mooring 125w 0n
- Meridional Winds vs TAO for year 2000 at mooring 125w 0n
All winds comparisons with moorings

QuikSCAT Zonal Winds vs TAO for year 2000 at mooring 125w 0n

QuikSCAT Meridional Winds vs TAO for year 2000 at mooring 125w 0n

ECMWF Zonal Winds vs TAO for year 2000 at mooring 125w 0n

ECMWF Meridional Winds vs TAO for year 2000 at mooring 125w 0n

NCEP Zonal Winds vs TAO for year 2000 at mooring 125w 0n

NCEP Meridional Winds vs TAO for year 2000 at mooring 125w 0n
Correlations with each mooring. The products are interpolated onto each mooring location at the mooring times. Statistics are calculated from 20-Jul-1999 to 31-Aug-2002.

- U component on the left, V on the right.
- QuikSCAT, ECMWF, NCEP
\[ SKILL = 1 - \frac{\text{std}(U_{\text{mooring}} - U_{\text{product}})}{\text{std}(U_{\text{mooring}})} \]
Relative Standard Deviation

Relative standard deviation is a measure of the comparison between variances of products.

\[
RSTD = \frac{\text{std}(U_{\text{mooring}}) - \text{std}(U_{\text{product}})}{\text{std}(U_{\text{mooring}})}
\]
## Overall Score

<table>
<thead>
<tr>
<th>$\Delta T = 1\text{day}$</th>
<th>CorrU</th>
<th>CorrV</th>
<th>SkillU</th>
<th>Skill V</th>
<th>Rstdu</th>
<th>Rstdv</th>
<th>ScoreU</th>
<th>ScoreV</th>
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</thead>
<tbody>
<tr>
<td>QuikSCAT</td>
<td>0.91</td>
<td>0.90</td>
<td>0.57</td>
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<th>Skill V</th>
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<th>Rstdv</th>
<th>ScoreU</th>
<th>ScoreV</th>
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<tr>
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<td>4.89</td>
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</table>

Final score (out of 10) reflects the overall ability to match the mooring data.

\[
SCORE = \frac{(1 + COR) \times (1 + SKILL)}{1 + |RSTD|} \times 2.5
\]

$\Delta T = 5\text{ days}$ indicates statistics for data mapped onto OSCAR timebase: 5-day and smoothed over 10 days.
OSCAR currents are calculated on a 1-day timebase using 1-day winds with interpolated SSH and SST values. No acceleration term included in the model. Sample output.

Comparison with drifters:

- Data from drifters in the box are averaged over one day.
- Model currents are interpolated onto the drifter locations at each day.
- Statistics are calculated on the ensemble of points during 01-Mar-2000 to 31-May-2000.
Zonal and meridional OSCAR currents using QuikSCAT winds vs drifter velocities. Results are very similar between winds.

<table>
<thead>
<tr>
<th>Corr</th>
<th>Skill</th>
<th>Score</th>
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<tbody>
<tr>
<td>u</td>
<td>0.63</td>
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</tr>
<tr>
<td>v</td>
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COMPARISON WITH DRIFTERS

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<th>CorrV</th>
<th>SkillU</th>
<th>Skill V</th>
<th>Rstdu</th>
<th>Rstdv</th>
<th>ScoreU</th>
<th>ScoreV</th>
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<td>0.49</td>
<td>0.46</td>
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Better results for increased time resolution is promising for extending surface currents beyond the quasi-steady 5-day model.
Future Work

We have presented a preliminary assessment of QuikSCAT, ECMWF and NCEP winds for the purpose of an improved wind-driven component to the OSCAR system. More analyses will be performed, in particular spatial comparisons (e.g. comparisons of EOF structures) and evaluation of forecast products.

Goals:

- include time-dependent dynamics in OSCAR to include high-frequency wind-driven currents
- extend OSCAR capability to nowcast and forecast
- improve the wind-driven turbulent mixing scheme.