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

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Introduction

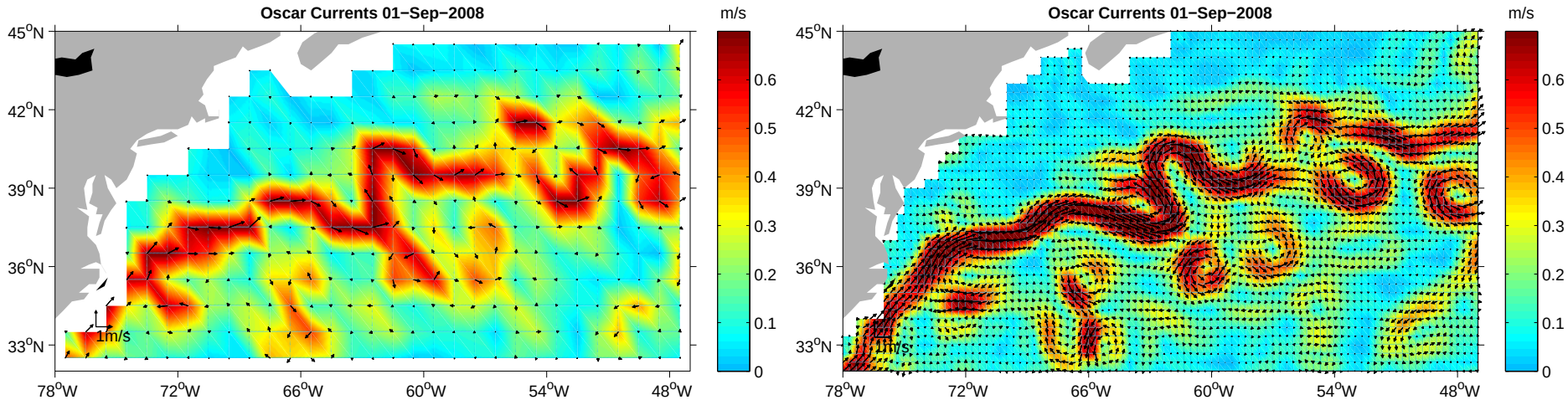
Ocean Surface Currents Analyses Realtime processing system (OSCAR) is a satellite-derived surface current database based on a combination of quasi-steady geostrophic and locally wind-driven dynamics (Bonjean and Lagerloef, 2002).

- 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.
- Data available at http://www.oscar.noaa.gov.

Introduction

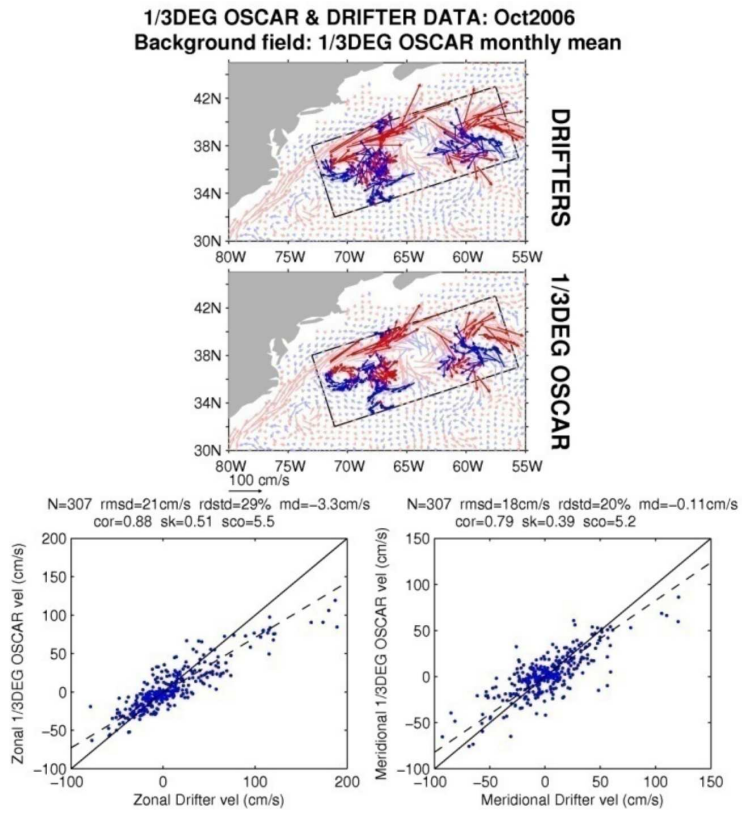
- The aim of this study is to evaluate the accuracy of NCEP Reanalysis-2 and ECMWF ERA-40 Reanalysis GCM products at measuring ocean surface winds through comparisons with mooring wind data and QuikSCAT winds to begin to asses the feasibility of using GCM forecasts for OSCAR forecast currents.
- Results 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.

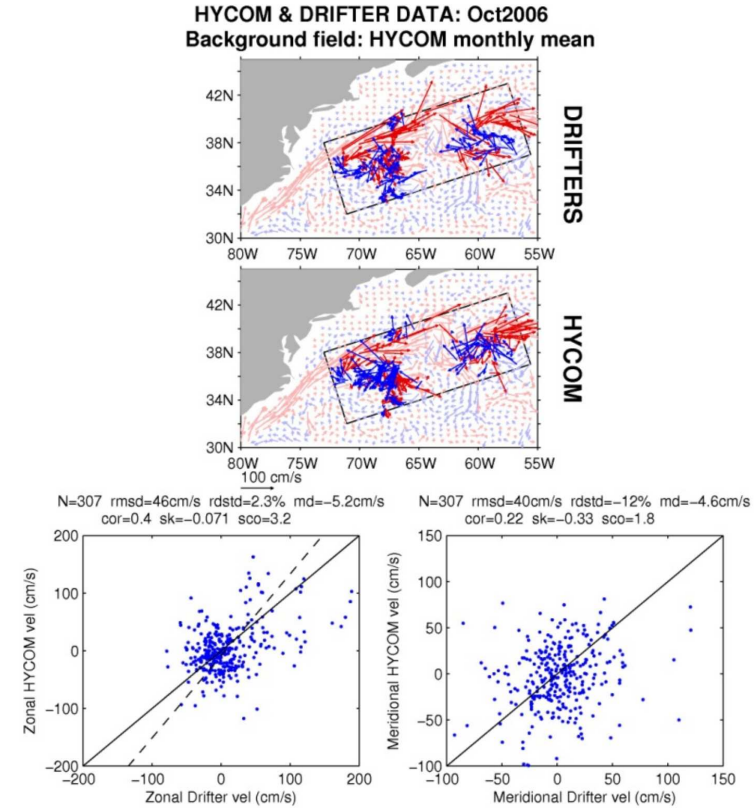
OSCAR LATEST DEVELOPMENTS



- 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.

COMPARISON WITH DRIFTERS

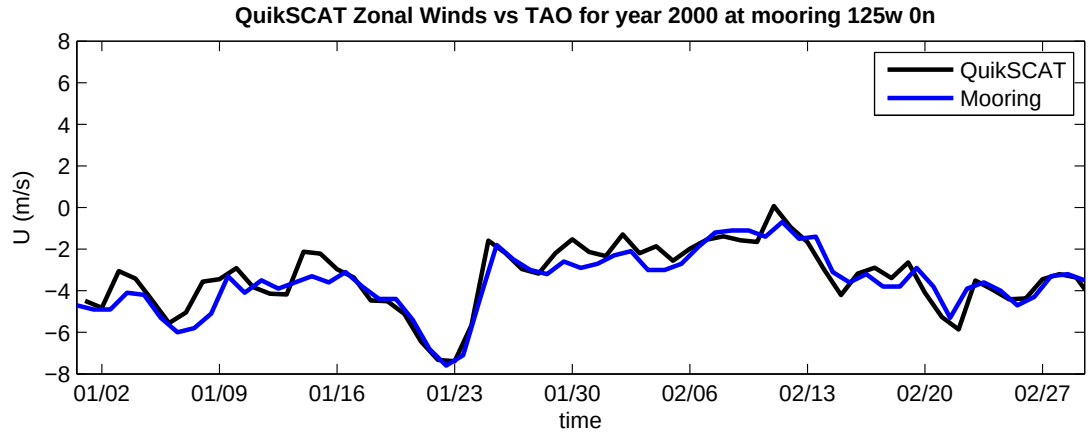


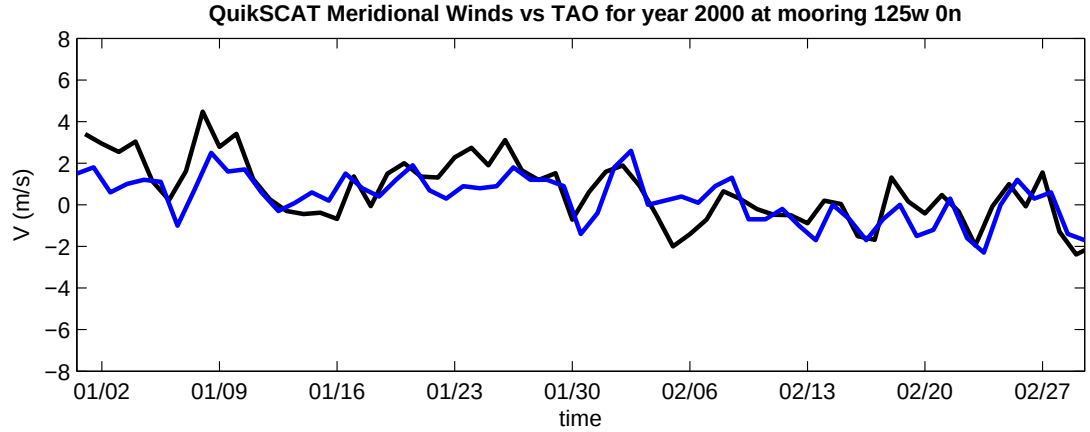


- Currents are interpolated onto the drifter locations (averaged over 1 day). Zonal and meridional currents *vs* drifter velocities.
- We want to incorporate faster wind-driven mixed layer currents than our current quasi-steady model allows. This requires an extension from 5-day to 1-day timebase and time-dependent terms in the momentum equations.

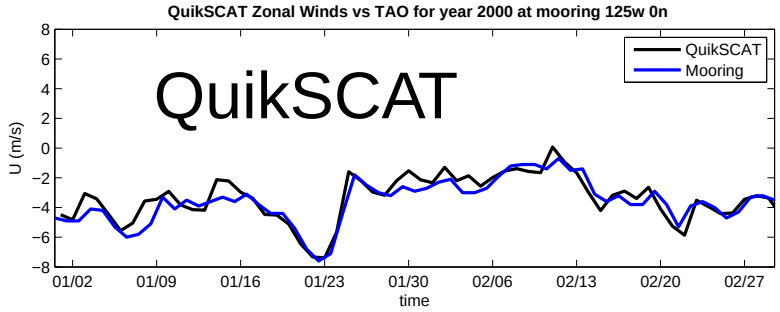
QuikSCAT Comparisons with moorings

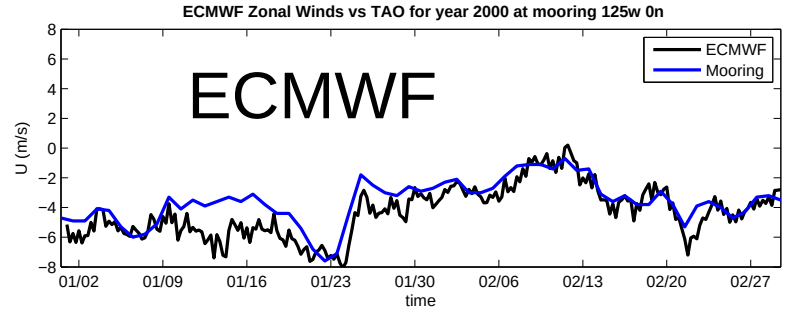
- Time series of mooring at $(125^o W, 0^o N)$ and QuikSCAT data over 2 months.
- U (top) and V (bottom)
- Mooring (blue) and QuikSCAT (black).

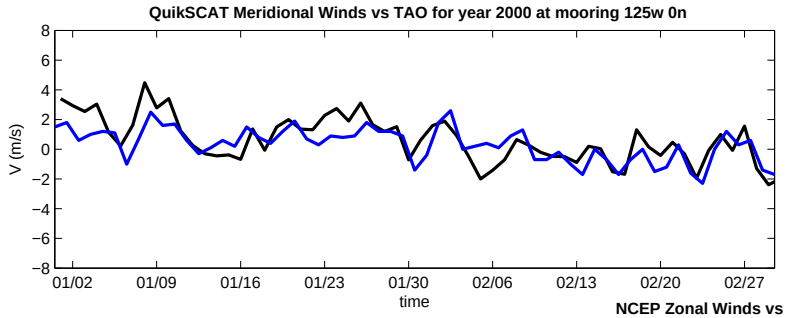


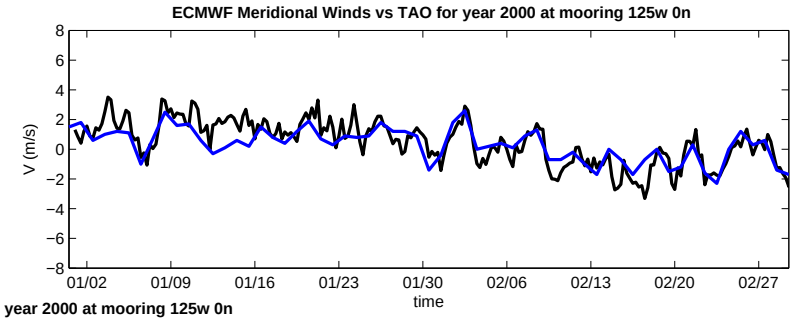


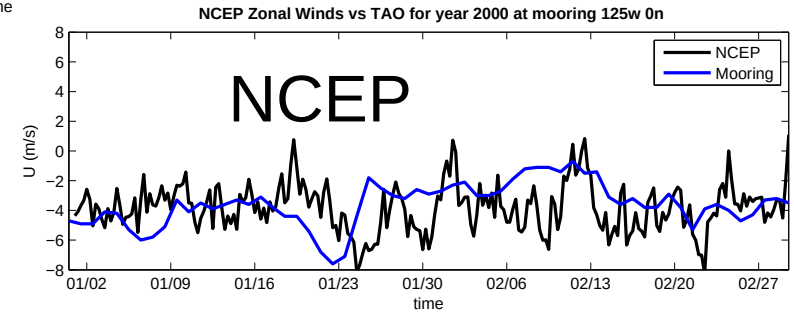
All winds comparisons with moorings

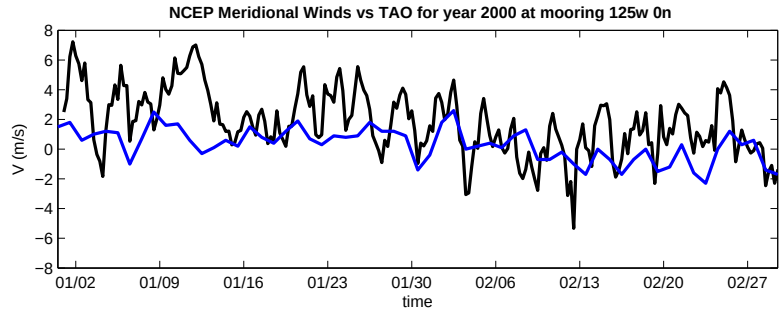




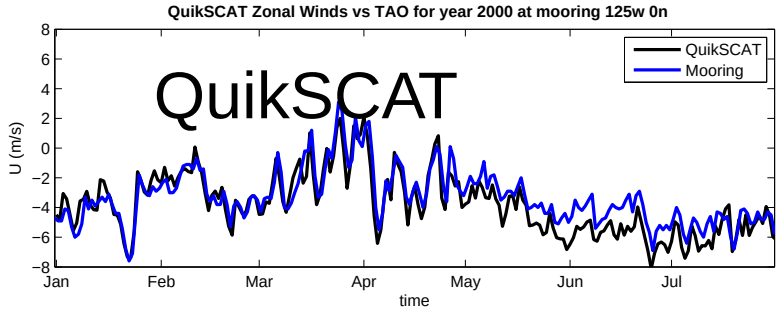


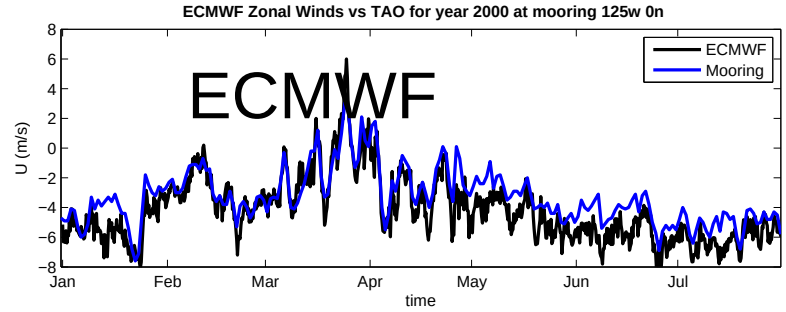


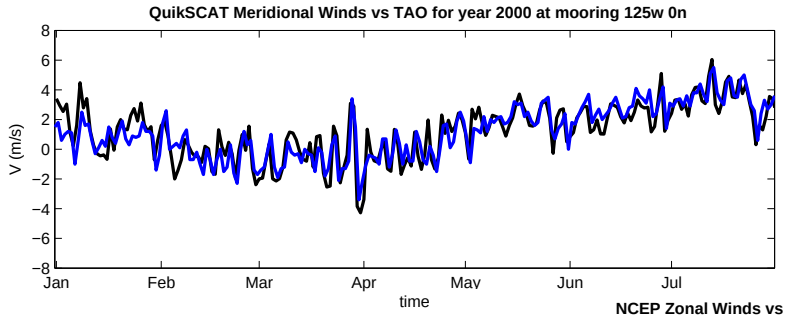


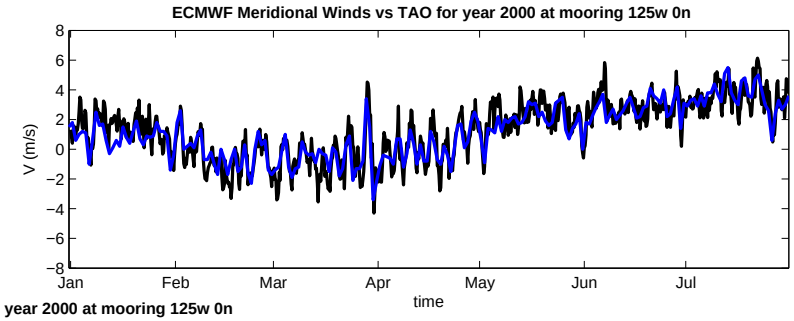


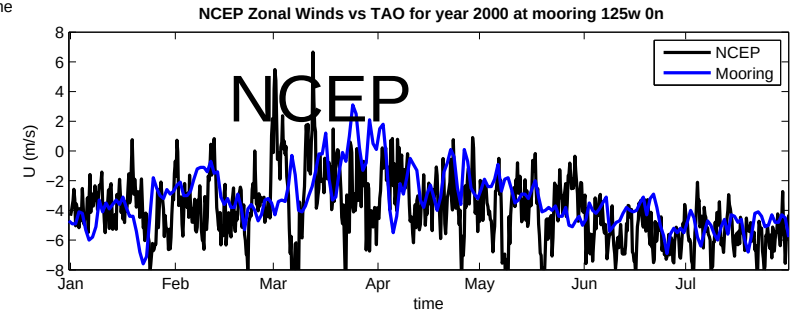
All winds comparisons with moorings

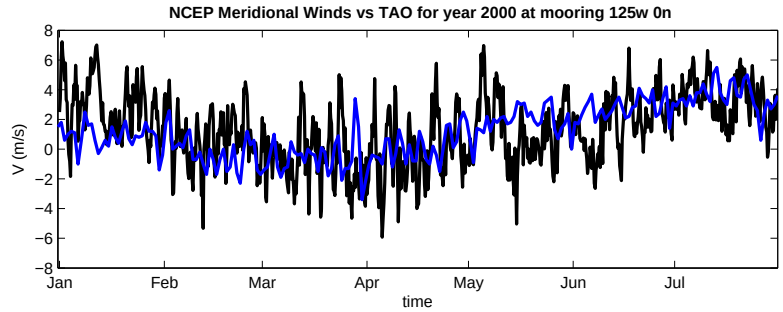




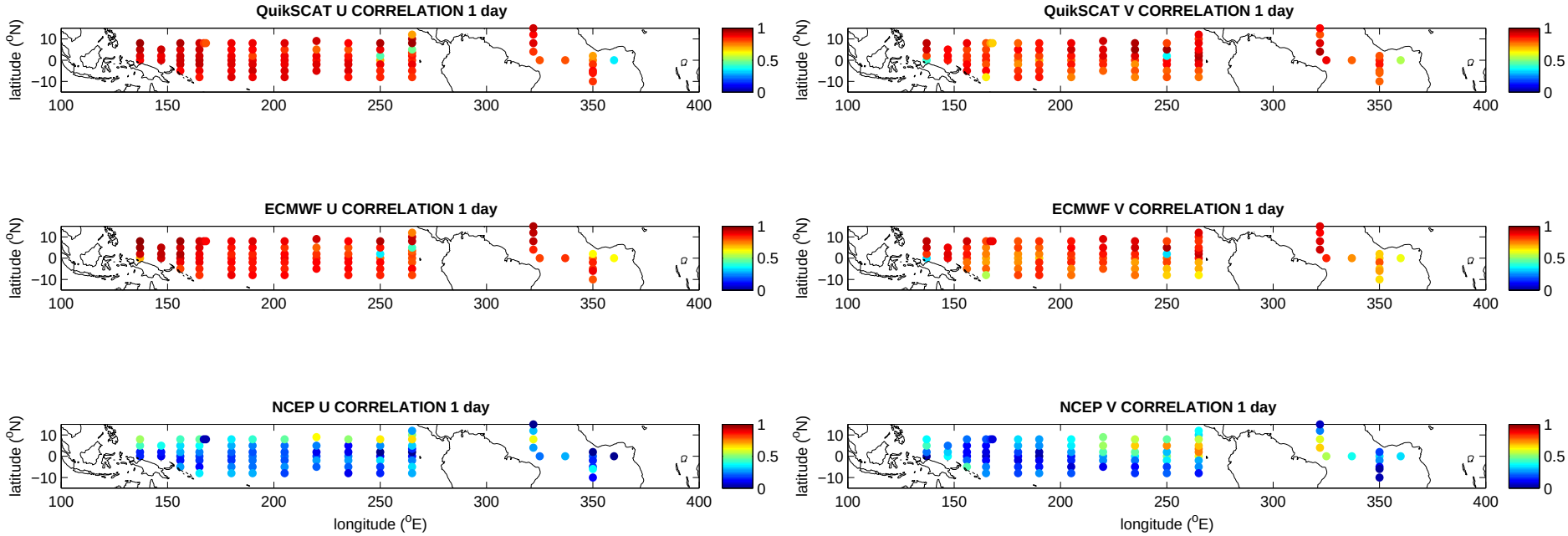






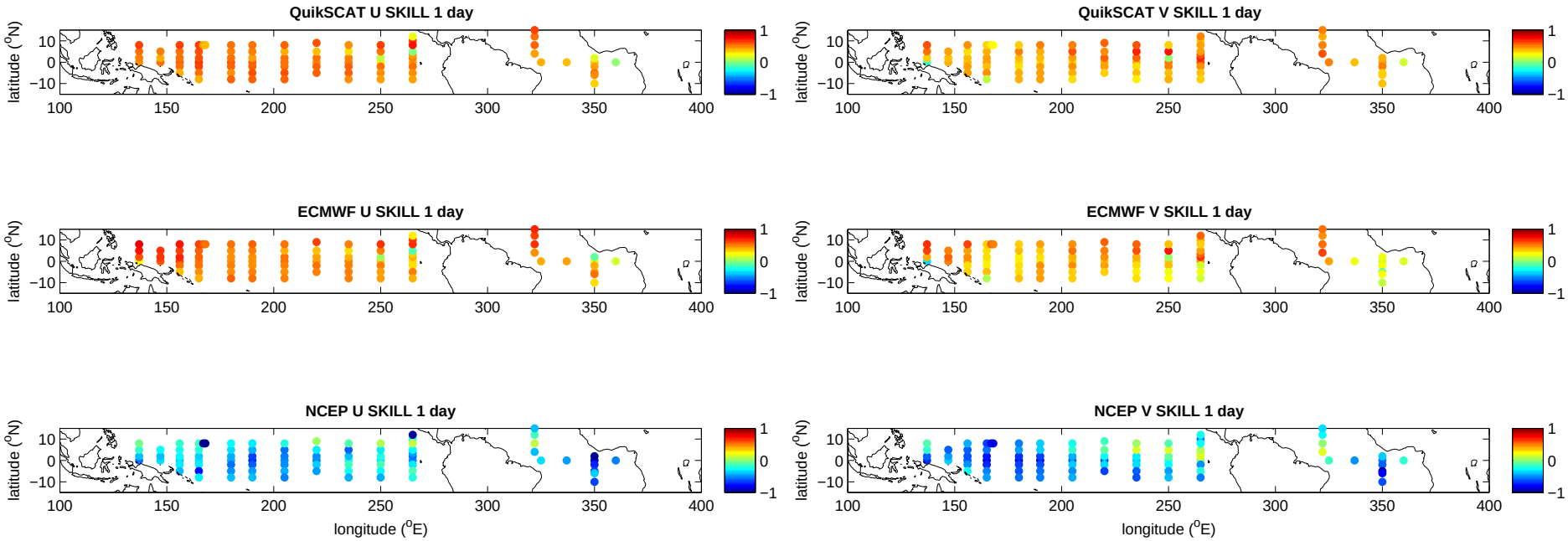


Correlation



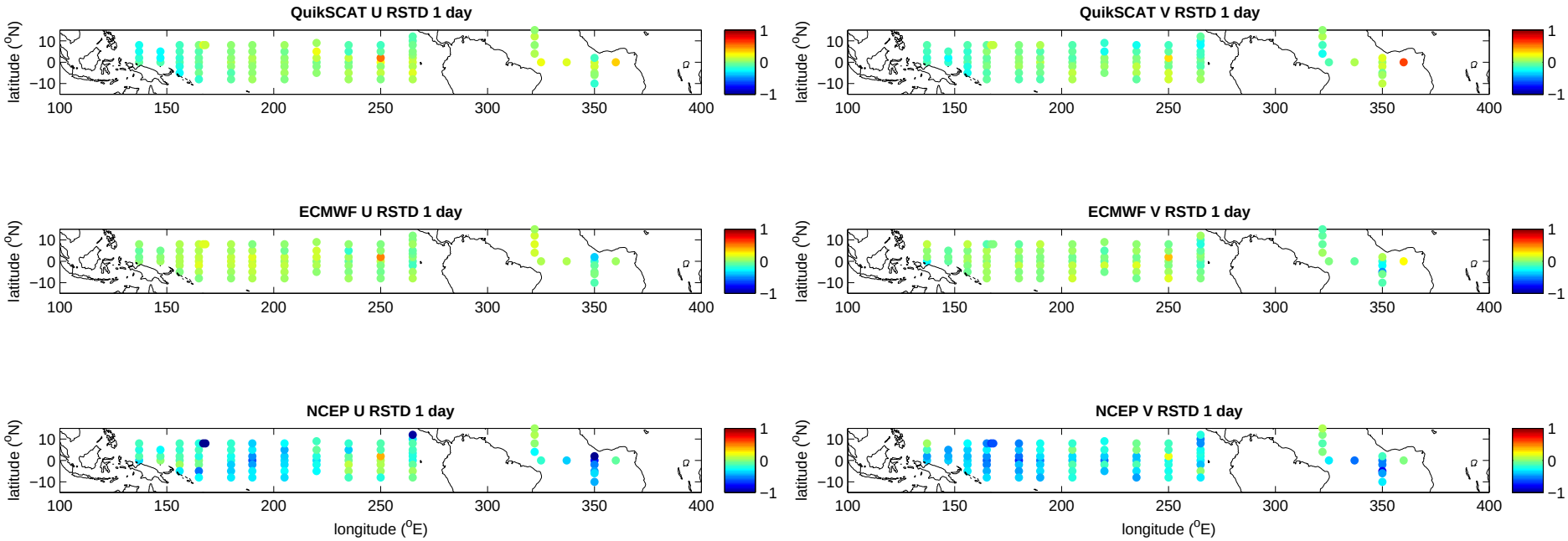
- Correlations with each mooring. The products are interpolated onto each mooring location at the mooring times. Statistics are calculated from 20-Jul-1999 to 31-Aug-2002.
  - U component on the left, V on the right.
  - QuikSCAT, ECMWF, NCEP

SKILL



$$SKILL = 1 - \frac{std(U_{mooring} - U_{product})}{std(U_{mooring})}$$

Relative Standard Deviation



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

$$RSTD = \frac{std(U_{mooring}) - std(U_{product})}{std(U_{mooring})}$$

Overall Score

$\Delta T = 1$day	CorrU	CorrV	SkillU	Skill V	Rstdu	Rstdv	ScoreU	ScoreV
QuikSCAT	0.91	0.90	0.57	0.50	-0.06	-0.11	7.10	6.41
ECMWF	0.91	0.87	0.58	0.49	0.06	0.02	7.13	6.83
NCEP	0.51	0.55	-0.07	-0.06	-0.15	-0.21	3.04	3.03

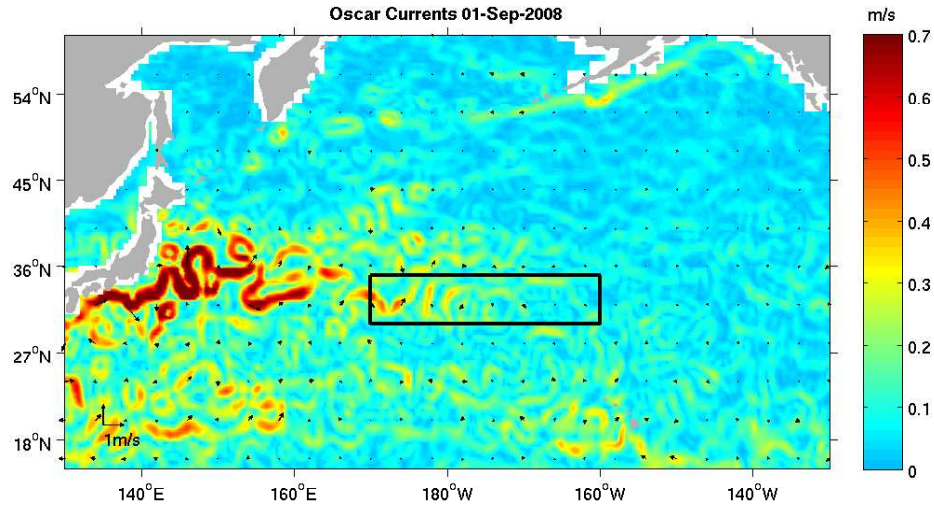
$\Delta T = 5$days	CorrU	CorrV	SkillU	Skill V	Rstdu	Rstdv	ScoreU	ScoreV
QuikSCAT	0.94	0.93	0.65	0.57	-0.08	-0.15	7.43	6.59
ECMWF	0.95	0.92	0.69	0.60	0.07	0.03	7.68	7.39
NCEP	0.71	0.77	0.22	0.27	-0.07	-0.13	4.89	4.97

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

$$SCORE = \frac{(1 + COR) * (1 + SKILL)}{1 + |RSTD|} * 2.5$$

- $\Delta T = 5$ days indicates statistics for data mapped onto OSCAR timebase: 5-day and smoothed over 10 days.

TOWARDS FASTER TIMESCALES



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.**

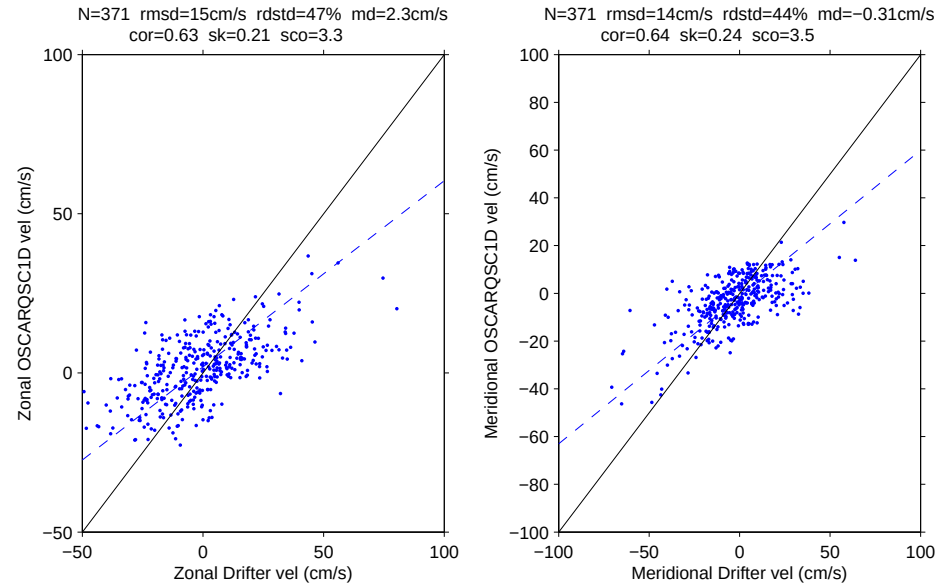
Comparison with drifters:

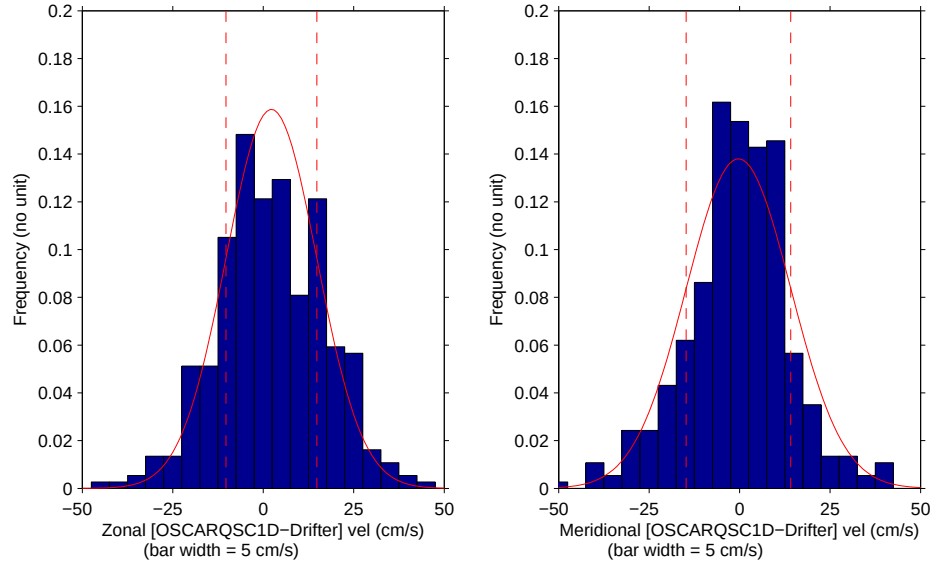
- Data from drifters in the box are averaged over one day.
- Model currents are interpolated onto the drifter locations at each day.
- Statistics are calculated on the ensemble of points during 01-Mar-2000 to 31-May-2000.

COMPARISON WITH DRIFTERS

- Zonal and meridional OSCAR currents using QuikSCAT winds *vs* drifter velocities. Results are very similar between winds.

	Corr	Skill	Score
u	0.63	0.21	3.35
v	0.64	0.24	3.53





COMPARISON WITH DRIFTERS

$\Delta T =$ 1day	CorrU	CorrV	SkillU	Skill V	Rstdu	Rstdv	ScoreU	ScoreV
QuikSCAT	0.63	0.64	0.21	0.24	0.47	0.44	3.35	3.53
ECMWF	0.64	0.67	0.21	0.26	0.47	0.44	3.37	3.65
NCEP	0.60	0.63	0.19	0.24	0.47	0.42	3.24	3.56

$\Delta T =$ 5days	CorrU	CorrV	SkillU	Skill V	Rstdu	Rstdv	ScoreU	ScoreV
QuikSCAT	0.57	0.63	0.16	0.23	0.49	0.46	3.06	3.43

- 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.