Impacts of Satellite Scatterometer – Derived Wind Forcing on the West Florida Shelf Ocean Circulation

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A deficiency in regional to coastal scale ocean modeling is the availability of wind forcing products that accurately represent energetic weather systems. These tropical and extratropical storms have a profound impact on the upper ocean circulation, particularly in shallow regions. This research explores methods of using data from the Seawinds scatterometer aboard the QuikSCAT satellite to force a regional ocean model. A numerical simulation of the Gulf of Mexico using the Navy Coastal Ocean Model (NCOM) [*Martin*, 2000] is forced with three different wind data sets, the Eta-29 numerical weather prediction model, an objectively gridded scatterometer data set, and a hybrid of the two products. The ocean model solution over the West Florida Shelf (WFS) is compared to observations for the time period of August - September, 1999, which includes the passage of Tropical Storm Harvey. The WFS is chosen as a testbed for the study of the impacts of these wind products because it has been shown that the circulation in this region is dominantly controlled by the local wind stress [*Weisberg*, et al., 2001]. The model to data comparisons yield information about how the modeled ocean responds to the wind forcing. The results are used to evaluate a new approach to using winds measured from a polar orbiting satellite scatterometer to force regional or coastal ocean models.

The NCOM is a three-dimensional primitive equation hydrostatic ocean model developed at the Navy Research Laboratory. The model's hybrid sigma (terrain following) and z (geopotential) level vertical coordinate is useful for simulating upper ocean processes in domains encompassing both deep ocean basins and very shallow shelves. The Gulf of Mexico simulation domain encompasses entire Gulf of Mexico and Caribbean north of Honduras (15° 30' N) to 80° 36' W with 1/20° between like variables on the C-grid, 20 sigma levels above 100 m and 20 z-levels below 100 m to a maximum depth of 4000 m. The model is forced by 30 rivers discharging freshwater with monthly climatology flow rates, transport through the open boundary (with monthly climatology temperature and salinity) yielding a mean transport through the Yucatan Strait of approximately 30 Sv, monthly climatological heat flux and 12-hourly winds.

Three gridded wind products are used to force the ocean model: the 29 km Eta model 10 m winds, QuikSCAT winds objectively mapped to a 1/2° grid using winds from the same scatterometer data to create a background field, and another mapping of the QuikSCAT winds using the Eta winds as the background field. The scatterometer winds are objectively gridded using the variational method described by *Pegion et al.* [2000] (Figure 1).

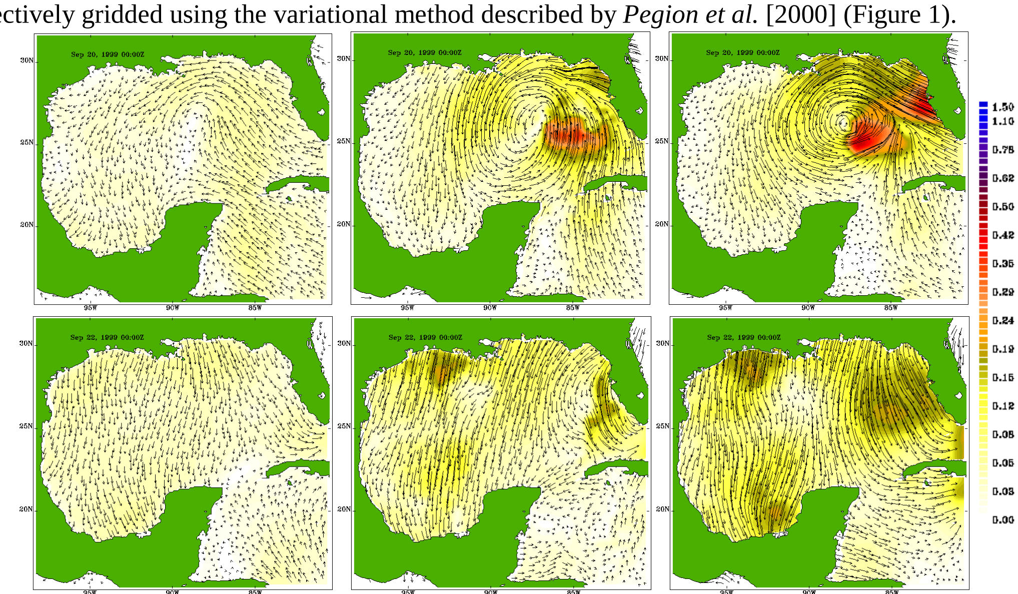

Figure 1. Wind stress (Pa) fields from the Eta model (left), gridded QuikSCAT winds (middle) and gridded QuikSCAT winds with the Eta background field (right) before (top) and after (bottom) T.S. Harvey passed eastward over the WFS.

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The hybrid QuikSCAT/Eta winds have a complex correlation magnitude of r=0.92 with winds from the National Data Buoy Center buoy 42036 situated west of Tampa, FL. The Eta and QuikSCAT fields have r=0.85 and r=0.84, respectively. The phase angles of the complex correlations of each wind product with the buoy are less than 8°. The hybrid winds have a mean wind speed 10% greater than the height adjusted buoy wind speed, and the Eta and QuikSCAT mean wind speeds are 2% greater and 26% less, respectively, than the buoy measured winds.

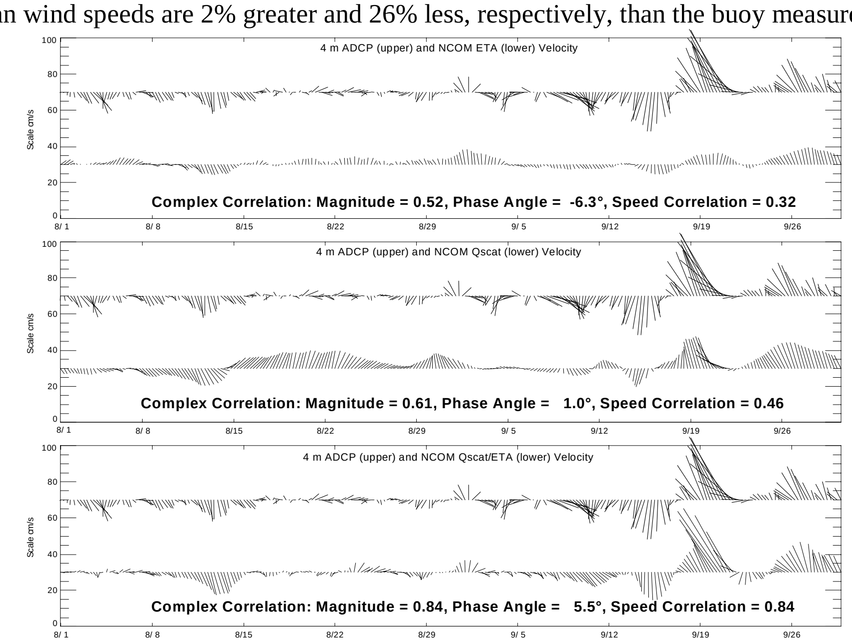

Figure 2. Vector velocity at 4 m depth from the COMPS CM23 ADCP (upper vectors) and NCOM (lower vectors) forced by the Eta (top), QuikSCAT (middle) and Hybrid Eta/QuikSCAT (bottom) winds.

The NCOM is validated against ADCP data from the University of South Florida Coastal Ocean Monitoring and Prediction System (COMPS) mooring CM23 located at the 50 m isobath west of Tampa (Figure 2). Results show that the NCOM velocities from the simulation forced by Eta winds do not compare well with the measured velocities. The simulation forced by the QuikSCAT winds has more reasonable velocity magnitudes, but shows an extended period of anomalously northward velocity during the second half of August. The simulation forced by the hybrid QuikSCAT/Eta winds performs best with both vector velocity and linear speed correlation coefficients of 0.84 compared to the ADCP data.

The use of the satellite scatterometer data can improve the accuracy of the winds used to force a regional scale ocean model by capturing well the spatial structure of the wind field. The frequency of the band-like sampling is, however, low (12 to 24 hours) compared to the output from the numerical weather prediction models (3 hours) so that problems may occur sampling rapidly moving storms. Using the atmospheric model data as a background field reduces the impact of spurious features that may occur when using the smoothed scatterometer data as the background field in the gridding process.

References

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