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VERIFICATION OF SURFACE CURRENT PREDICTIONS FROM THE BIO OCEAN FORECASTING SYSTEM

C.L. Tang and E. Dunlap

Ocean Sciences Division, Bedford Institute of Oceanography
Fisheries and Oceans Canada
Dartmouth, NS, B2Y 4A2, Canada

The BIO ocean forecasting system: Ice-Ocean Forecasts for the East Coast of Canada (http://www.mar.dfo-mpo.gc.ca/science/ocean/icemodel/ice_ocean_forecast.html) produces two-day forecasts of surface currents, waves, water level and ice cover for eastern Canadian seaboard. The model used in the forecasts is a coupled sea-ice model and Princeton Ocean Model. The model domain includes the Grand Banks, N.E. Newfoundland Shelf, Labrador Shelf and Labrador Sea. The forcings are six hourly surface winds, air temperature, dew point temperature, and cloud cover. On the open boundaries, temperature, salinity, sea surface elevation and volume transport are fixed for each season. Forecast currents are generated on a 20 km by 20 km grid at 16 sigma levels in the vertical.

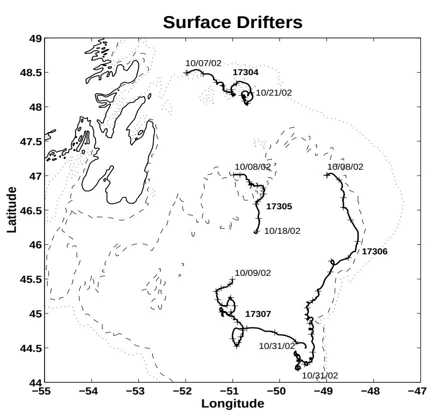

Figure 1. Trajectories of surface drifters.

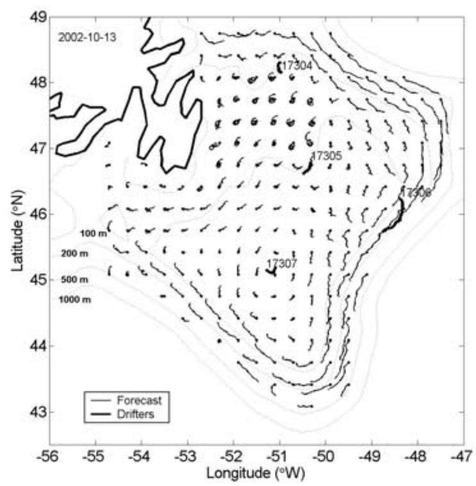

Figure 2. 48 hour surface current trajectories during low wind.

To verify the surface current predictions, trajectories calculated from the model current fields are compared with trajectories of four surface drifters deployed over the Grand Banks by Canadian Coast Guard in October 2002. The drifters were deployed in October 7-9, 2002, and lasted from 11 to 48 days. Data were transmitted via satellite at the rate of 3-4 fixes per hour. Noise in the drifter positions was removed and the positions data were fitted with a second-order polynomial with a window of 24 hours. Figure 1 shows the drifter trajectories within the Grand Banks.

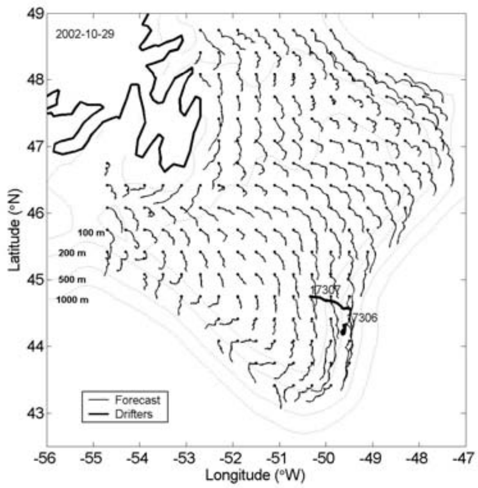

Figure 3. 48-hour surface current trajectories during high winds. Thin lines are model trajectories. Thick lines are drifter trajectories.

Daily three-dimensional model current fields were outputted from the forecast system. From these velocity fields, 2-day trajectories were obtained using model outputs at the first sigma level and averaged within 10 m and 30 m from the surface. The differences among them are not large. The agreement between the model and the drifter trajectories depends on wind conditions and location. Under low-wind condition, the velocity field reflects the mean currents. This is illustrated in Figure 2 where dots mark trajectory starting points and 24 hour intervals. The mean circulation is dominated by the Labrador Current, which flows along the 500 m isobath in Northeast Grand Banks, and continues south along the eastern shelf edge of Grand Banks. In the interior of Grand Banks, the mean currents are small.

During high winds, there are large discrepancies between model and observation in both speed and direction. On October 29, winds over central Grand Banks were in the eastward direction and had speeds of about 20 ms^{-1}. Figure 3 shows the model trajectories with the drifter trajectories superimposed. The model current speed is too small and the direction is 80^o to the right of the drifter direction.

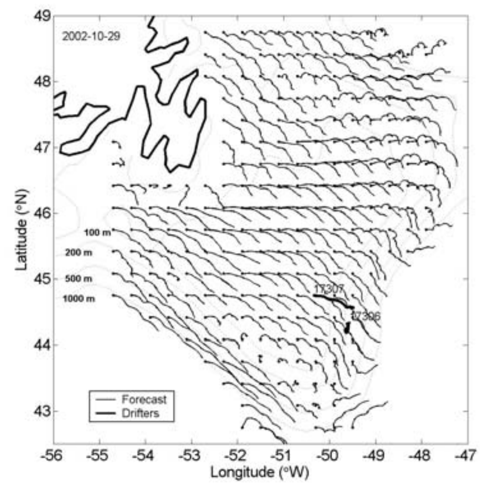

Figure 4. 48-our surface current trajectories including the Stokes drift. Thin lines are model trajectories. Thick lines are drifter trajectories.

In the model, wave effects are not considered. In experimental studies, Wu (1983) shows wave induced Stokes drift is a significant component of surface drift. The Stokes drift can be parameterised by wind speed and fetch, L. It increases from 2% of wind speed for L=100 m to 2.5% for L=100 km. As a first correction to model surface currents, wave-induced surface currents calculated from Wu's equation assuming a constant fetch of 10 km is added to the model currents. Figure 4 shows the model trajectories including the Stokes drift. A significant improvement is achieved.

Statistics of the separation of model and drifter trajectories after two days are calculated using daily 2-day trajectories. With the Stokes drift, the separation is reduced from 26 km to 20 km. The correlation coefficient between the model distance and drifter distance is increased form 0.58 to 0.79.

Wave effects on velocities in the Ekman layer have been investigated by Jenkins (1987) and other investigators. Based on Jenkins' theory, a general formulation to incorporate the wave effects into an ocean model has been proposed by Perrie et al. (2003). Application of the coupled wave-ocean model to the Labrador Sea produced surface velocities 40% higher than velocities without wave-ocean coupling.

References

Wu, J., 1983. Sea-surface drift currents induced by wind and waves. *Journal of Physical Oceanography,* **13**, 1441-1451.

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