COMPARISON OF MODELED LAGRANGIAN TRAJECTORY STATISTICS

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Hypothetical oil spill trajectory estimates are made for a set of forcing fields and ocean model currents. These driving mechanisms include (1) buoy-derived wind transition probability matrix and the 3.5-percent-of-the-wind-speed rule, (2) Limited Fine Mesh (LFM) gridded wind fields and the 3.5-percent rule, (3) prognostic ocean model currents calculated with LFM gridded wind forcing, and (4) ocean model currents with both LFM wind forcing and superimposed tidal currents. The model that calculates the current fields is the Dynalysis of Princeton sigma-coordinate primitive equation model on a curvilinear grid for the east coast of the United States. For the cases that include tidal forcing, the tidal currents were derived from a run of the model with only sea-level tidal forcing specified at the offshore boundary, using the constituents of the Schwiderski Tidal Model.

Simulated oil spills are started from locations near buoy stations and existing current meter observation sites. Figures 1 through 4 show the trajectories for the methods numbered (1) through (4) above, respectively. Figure 5 shows the observed trajectories of near-surface drifting buoys deployed as part of the Minerals Management Service's Frontal Eddy Dynamics Experiment. These plots show visual correspondence between the observed and model-generated trajectories.

The trajectories are produced to estimate the Lagrangian statistics of the various methodologies. Autocovariance functions, integral time and space scales, and particle dispersions of the trajectories are estimated. Statistical comparisons show that a lower degree of cross-stream variability is found in methods (2) and (3) than in methods (1) and (4). Methods (2) and (3) also give a much larger maximum displacement than methods (1) and (4). Results of the comparison of the statistics with drifter records indicate possible improvements to applied oil spill trajectory modeling. This work supports the Department of the Interior's Oil Spill Risk Analysis model, which provides quantitative information for environmental impact analysis of potential offshore oil production and transportation.

Reference

1. Evans-Hamilton, Inc., 1988. Frontal Eddy Dynamics Experiment of North Carolina. Draft final report. OCS study MMS-86-0082. Seattle, Washington

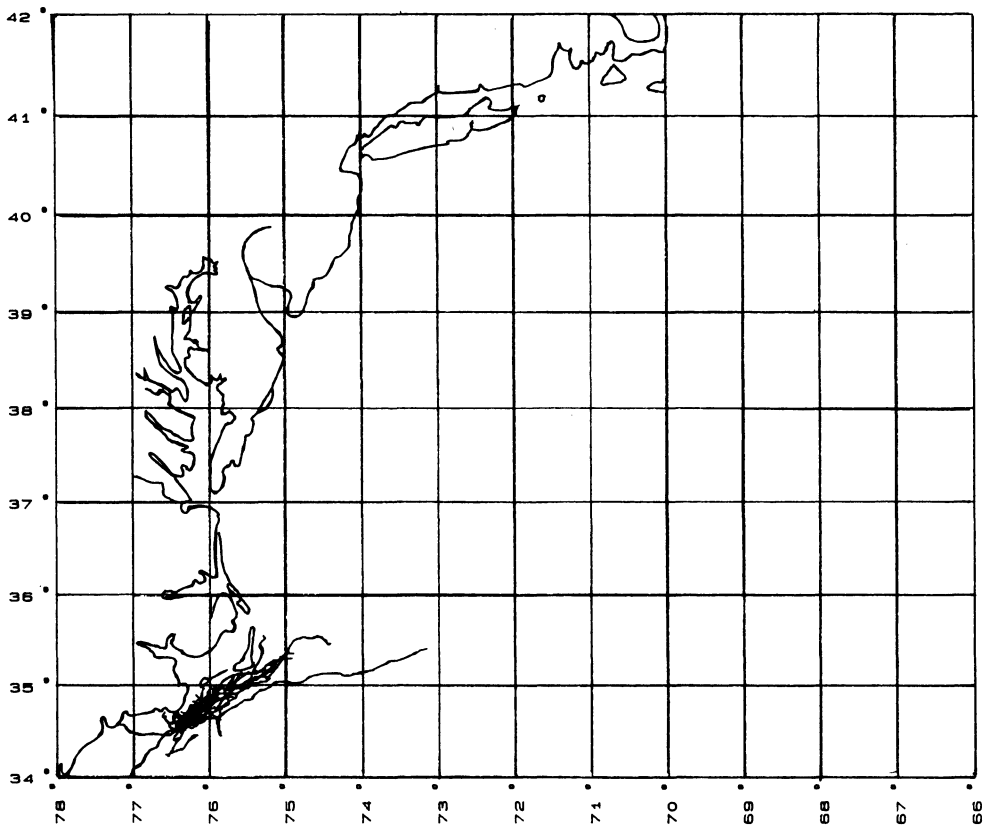

Figure 1. Trajectories simulated using the wind transition matrix and the 3.5-percent-of-the-wind-speed algorithm—The wind transition matrix was derived from data buoy 41001 and assumes that the transitions are described by a first order Markov process.

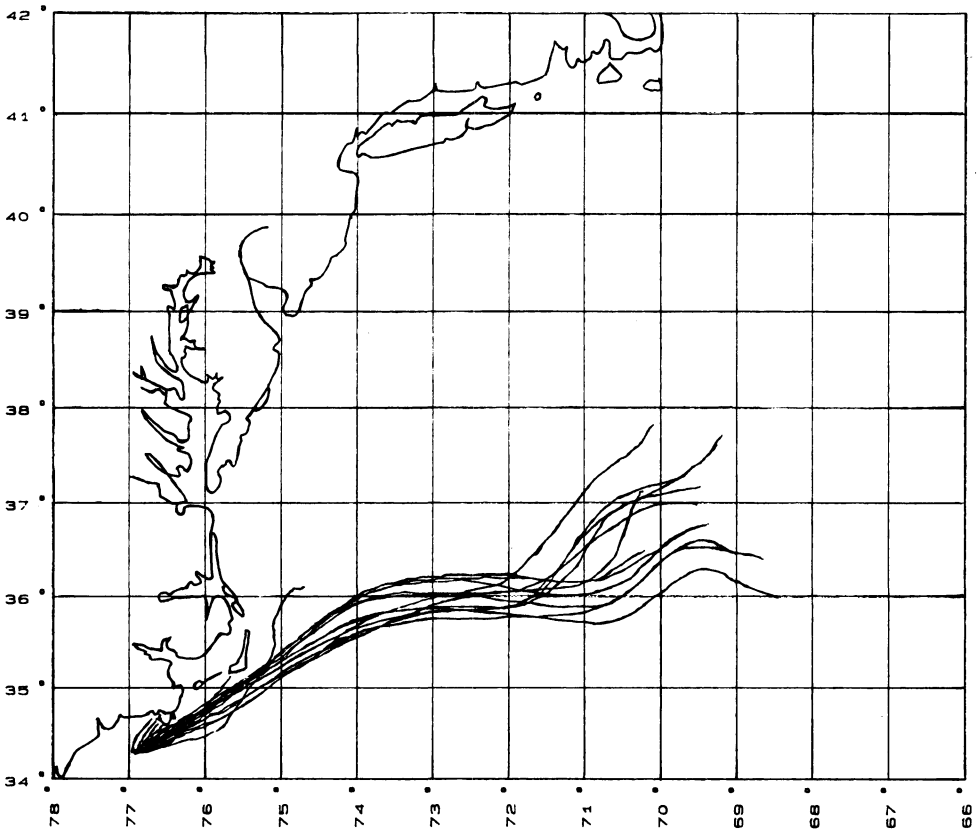

Figure 2. Trajectories simulated using time series of the Limited Fine Mesh gridded atmospheric model winds and the 3.5-percent-of-the-wind-speed algorithm—A climatological mean Gulf Stream calculated using a diagnostic model is included to represent the ocean currents.

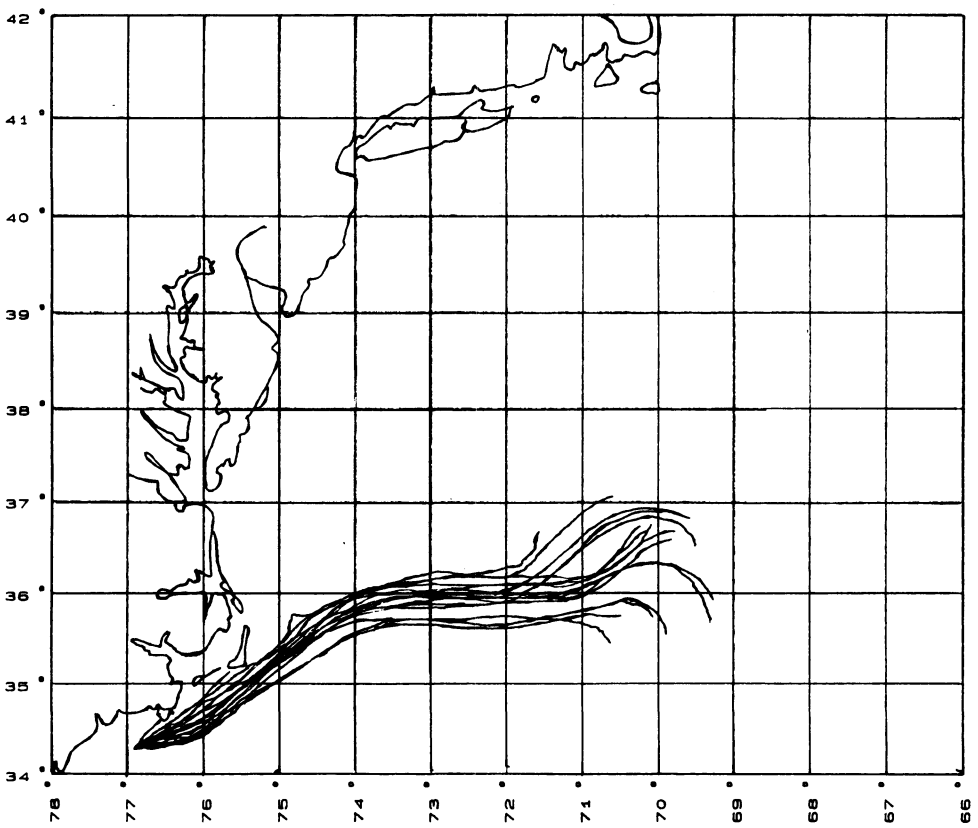

Figure 3. Trajectories simulated using the surface currents calculated by a prognostic ocean model forced with the Limited Fine Mesh Gridded winds and a seasonal density field

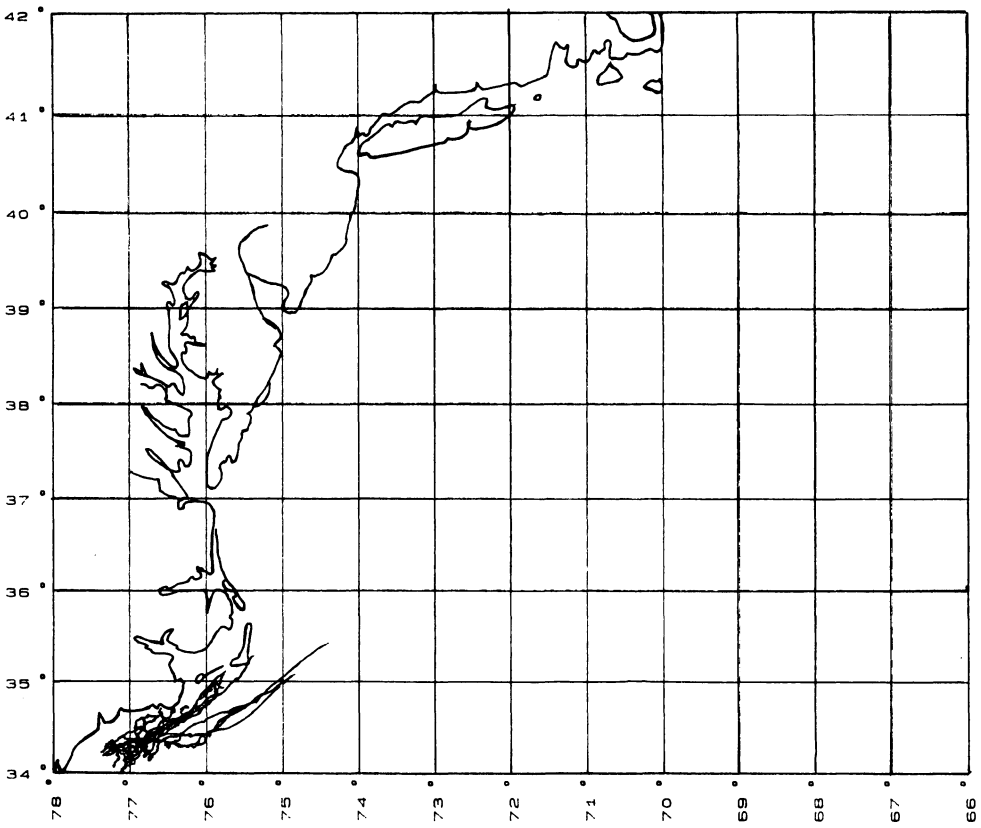

Figure 4. Trajectories simulated using the surface currents calculated by a prognostic ocean model forced by the Limited Fine Mesh gridded winds, a seasonal density field, and superimposed tidal currents (fall season)

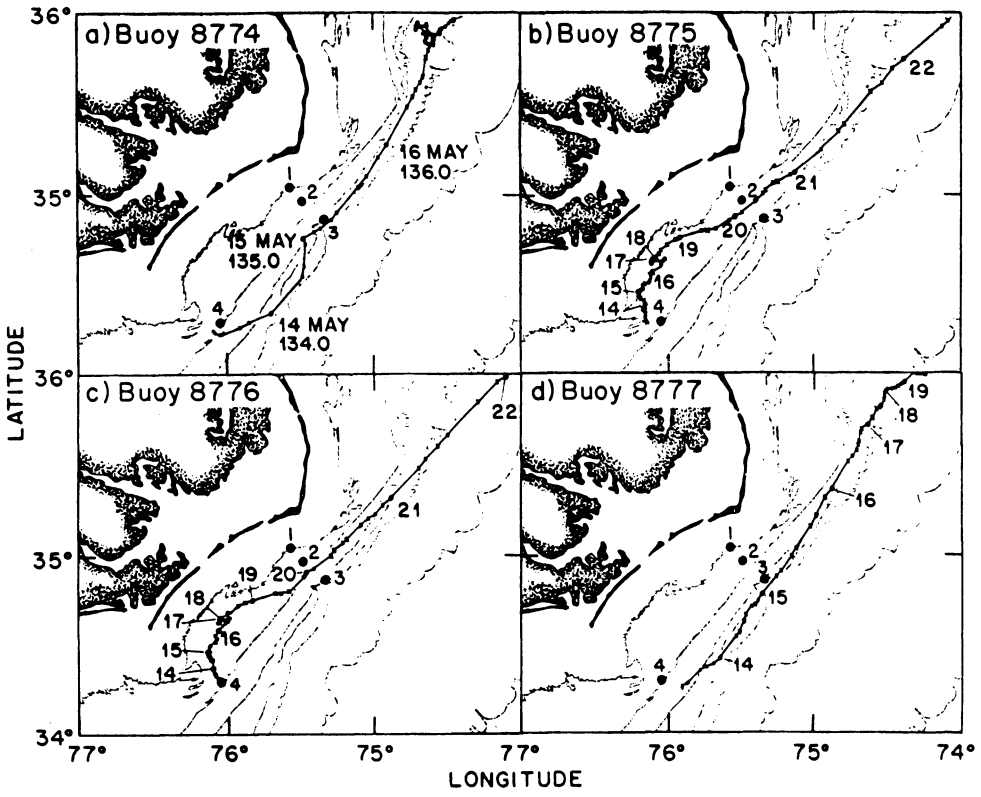

Figure 5. Trajectories of four drifting buoys deployed in an eddy: (a) buoy 8774, (b) buoy 8775, (c) buoy 8776, and (d) buoy 8777—x = observed positions; dots = observed position closest to the beginning of a given day in May (numbers 14-22)[1]