

THE IMPACT OF A HIGH DISCHARGE EVENT ON THE STRUCTURE AND EVOLUTION OF THE CHESAPEAKE BAY PLUME BASED ON MODEL RESULTS*

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A study was conducted to determine how well a quasi-operational ocean forecast model, given its present configuration and constraints, could reproduce and characterize a mesoscale circulation feature near the U.S. East Coast, specifically the Chesapeake Bay plume. A secondary goal was to determine the impact of anomalous discharge from the Bay on the circulation over the adjacent shelf, following a major precipitation event, Hurricane Fran. Two model runs were conducted for the period from mid-August through mid-September, 1996. One run used a discharge function based on daily "observed" river inflows to the Bay. The second run employed the climatological data used routinely in the model. Both runs employed realistic tidal forcing and surface winds from a high-resolution atmospheric forecast model.

The primary outflow following Hurricane Fran, based on the observed discharge function, was concentrated over a period of just a few days, producing what was expected to be the maximum impact on the behavior of the plume. For comparison, observations of surface salinity acquired from a recently-developed airborne microwave

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radiometer are compared with model output fields in the near-field region of the plume ($\leq \sim 20$ km from the mouth of the Bay). Salinity maps from the airborne radiometer showed that the discharge function based on daily stream flow data produced significant improvements in characterizing the near-field region of the plume compared to the monthly climatological outflow time history. The remote observations also revealed a significant reduction in surface salinity near the mouth of the Bay between the 14th and the 19th of September 1996, which was not apparent in the model-generated salinity maps for the same period. This discrepancy is attributed to the inherent difficulties in specifying the initial conditions at the mouth of the Bay.

Although direct verification of the model results could not be made beyond the coverage provided by the airborne radiometer, the model-generated plume exhibited structure and temporal behavior which are consistent with past observations. A separate calculation of the Kelvin number from model output indicated that earth rotation should be important in determining the orientation of the plume. The surface circulation in the far-field region of the plume was strongly influenced by local winds and, to a lesser extent by the salinity gradients associated with the plume, according to the model results. Also, the structure of the plume responded quickly to rapid changes in outflow from the Bay, to wind forcing, or to both, on time scales of several days or less. A sequence of model-generated salinity profiles along a line close to the axis of the plume indicated that the strength of the halocline weakened, and that the depth of the halocline decreased from roughly 10 m near the mouth of the Bay to 5 m or so at distances of 60–75 km offshore.

Keywords: Chesapeake Bay; plume; coastal ocean forecast system; discharge function; Hurricane Fran; salinity; surface currents; salinity mapper; Kelvin number

1. INTRODUCTION

1.1. General

An ocean forecast system which includes a three-dimensional ocean circulation model, together with a coupled atmospheric forecast model and ocean data assimilation, is nearing completion as the first fully-operational, real-time coastal ocean forecast system to be developed for U.S. coastal waters (*e.g.*, Kelly *et al.*, 1997). This model, called the Coastal Ocean Forecast System (COFS), has been used to make experimental forecasts of the state of the coastal ocean for a region off the U.S. East Coast on a daily basis since 1993. The model domain extends from 27° to 48°N , and from the East Coast out to 50°W , covering an area of roughly $4 \times 10^6 \text{ km}^2$. The model domain was chosen to include the Gulf Stream because of its importance in influencing the circulation closer to the coast. Because of computational considerations, the model's horizontal resolution was selected to be approximately 10 km near the coast. Further offshore the resolution decreases slightly. In the vertical, 18 layers were considered sufficient