

# Development of a Real-Time Regional Ocean Forecast System with Application to a Domain off the U.S. East Coast<sup>1</sup>

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## INTRODUCTION

The population of coastal regions around the continental U.S. has increased dramatically over the past 60 years and is expected to continue to increase in the foreseeable future. Over 50% of the U.S. population now resides along our coastlines. Populations in a majority of coastal counties from Texas through North Carolina have increased almost fivefold between 1950 and 1990 (Pielke and Pielke, 1997). The greatest increase in population occurred in Florida where the increase was over 500%. By the year 2025, nearly 75% of all Americans are expected to be living and working in coastal areas (Hinrichsen, 1998). Such increases in human population are affecting the coastal oceans more profoundly and more rapidly than is global climate change (Hay and Jumars, 1999). The pollution problem due to terrestrial, atmospheric, and *in situ* sources continues to degrade the quality of coastal waters surrounding the U.S. Over two trillion gallons of partially treated sewage plus more than 2 million tons of chemical wastes are discharged into U.S. coastal waters each year (Hinrichsen, 1998).

## ABSTRACT

This paper discusses the needs to establish a capability to provide real-time regional ocean forecasts and the feasibility of producing them on an operational basis. Specifically, the development of a Regional Ocean Forecast System using the Princeton Ocean Model (POM) as a prototype and its application to the East Coast of the U.S. are presented. The ocean forecasts are produced using surface forcing from the Eta model, the operational mesoscale weather prediction model at the National Centers for Environmental Prediction (NCEP). At present, the ocean forecast model, called the East Coast-Regional Ocean Forecast System (EC-ROFS) includes assimilation of sea surface temperatures from *in situ* and satellite data and sea surface height anomalies from satellite altimeters. Examples of forecast products, their evaluation, problems that arose during the development of the system, and solutions to some of those problems are also discussed. Even though work is still in progress to improve the performance of EC-ROFS, it became clear that the forecast products which are generated can be used by marine forecasters if allowances for known model deficiencies are taken into account. The EC-ROFS became fully operational at NCEP in March 2002, and is the first forecast system of its type to become operational in the civil sector of the United States.

As one of the tools to manage environmental problems created by the above mentioned causes, interest in developing a capability to provide short-term forecasts of coastal ocean conditions is now rapidly growing. This is, however, a formidable task since the coastal oceans represent some of the most challenging marine environments for modeling in the world (Haidvogel and Beckmann, 1998). The time and space scales of interest associated with short-term coastal circulation may be as short as a few hours and as small as a few tens of meters or less. Irregular coastlines and steep and variable bottom topography near the coast (and at the shelf break) can create highly complex patterns of flow. Circulation on the continental shelf is primarily governed by factors such as winds, tides, buoyancy fluxes, throughflow (i.e. the permanent and seasonal alongshelf currents), and cross-shelf forcing by basin scale processes, etc. (e.g., Johnsen and Lynch, 1995). Within this framework, many (but not all) coastal processes occur. Wind forcing produces both surface and internal waves, and contributes

to surface flow directly through wind drift, Ekman transport, and Stokes drift. Tidal forcing, in addition to the depth-independent barotropic processes, also includes internal tides which are often generated at the shelf break (Wiseman et al., 1984). Coastal waters are particularly sensitive to major atmospheric events which may occur frequently (Brink et al., 1990). Fresh water discharge from various bays and estuaries along the coast add buoyancy fluxes which further complicate the water motions locally. Also, in coastal areas, water mass integrity breaks down and the property relationships which characterize these water masses in the deep ocean often do not apply in shallow coastal areas where the effects of local mixing often destroy their coherent nature. As noted by Mooers (1976), however, the situation is not hopeless since the circulation, although complex, is not simply an unstructured, incoherent, noise-like turbulence, but rather can be interpreted (and thus modeled) in terms of (albeit many) simple processes.

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