Coastal and Estuarine Studies, 56 Coastal Ocean Prediction

Christopher N.K. Mooers, Editor.
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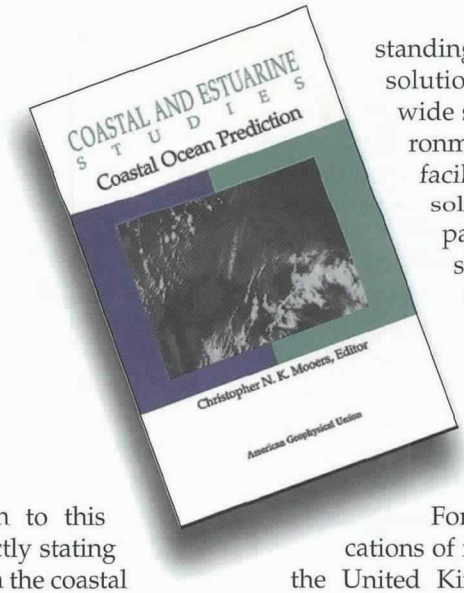

Christopher Mooers' introduction to this collection of papers opens by succinctly stating that there is an explosion of interest in the coastal ocean. Every one of the 20 papers introduces its subject with the importance of understanding the dynamics of the coastal ocean to humans, since most of us live on or near the coast. Mooers also explains that a growing variety of people make it their business to try to understand the coastal ocean physical fields from water circulation, and mass fields to tides, tsunamis and ice flows; and then one must add sea breezes and coastal low level jets. His first paper, "Introduction to Coastal Ocean Prediction," written by Mooers himself, sets the stage for the variety of coastal prediction efforts so we are prepared for the large scope of problems for researchers to solve and the many requirements of the operational forecasters throughout the papers. He supports us with a vision of coastal forecasting to be able to absorb the tools presented in the papers.

I read this book from the perspective of a coastal ocean user. The book is interesting to read because the collection of papers allows one to read it in small bites. With the many equations, it would appeal to all dedicated students and researchers of the coastal ocean who have had the undergraduate level courses in order to have the background and appreciation for the complexity of coastal ocean models. Mooers says that the book is also for environmental, marine operations, and fisheries managers. I do not believe that these managers would want to wade through the equations, however other sections provide valuable information on coastal zone solutions for managers.

Mooers doesn't try to define the coastal ocean nor do others in this book. The extent of the coastal ocean depends upon the size and application of the physical fields one is trying to predict.

The strength of this book is the collective understanding that comes from reading about model solutions and observational studies with a wide scope of situational applications of environmental prediction methods. The collection facilitates comparisons of models and their solutions that vary geographically. The papers are well referenced and seem to be state-of-the-art in their solutions to the dynamics and complex difficulties of modeling estuarine areas and the coastal environment.

A European perspective is certainly necessary with the reputation and expertise of the European Center for Medium Range Weather Forecasting (ECMWF). Researchers' applications of modeling techniques are presented from the United Kingdom, Denmark, Norway, and Asia. Additional discussions include explanations of polar ice predictions that cover a substantial part of the worldís shallow water systems. More examples of other nationís efforts would have been a valuable addition to this book.

The second paper, "Coastal Meteorology", provides instruction on the different causes of offshore flow, and on models to fit the data. It also defines the mesoscale features in the coastal regions.

The third paper, "An Overview of Coastal Ocean Models," is like another introduction to the rest of the book in that it instructs us on the basics of models and provides numerous references. It covers the diagnostic and predictive models and explains the physical models that can incorporate various modules. Modules like those on biological processes support an understanding of marine ecology. The paper provides insight into the complexity of ocean models without the multitude of equations, yet provides some equations to explain the scope of effort needed to predict parameters of the coastal ocean. It also discusses the atmospheric processes involved in coupling to ocean models.

The fourth, and eighth through tenth papers are all examples of specific applications of models as planning tools for circulation problems or as solutions to environmental predictions. The unique areas of coastal ocean circulation discussed are: hydroelectric plant discharge of Doubtful Sound, New Zealand, the two day forecasts for lake Erie by National Oceanic and Atmospheric Administration's (NOAA) Great Lakes Forecasting System, the simulations of temperature structure of the coastal shelf waters of Northwest Europe, and the modular coastal ocean and atmosphere prediction system of the irregular Danish coastal waters.

The fifth paper discusses the well-known worldwide Harvard Ocean Prediction System (HOPS) and its many applications in the Mediterranean Sea and the North Atlantic coast. Dr. Allan Robinson indicates that a sustained accurate oceanic field estimate is now possible because of ocean prediction systems, and also says that the real objective centers on adaptive sampling, data assimilation, and feedback between models and observational improvements. So, even the best models still need sustained reliable observations.

The sixth paper, "Coastal Ocean Coupling," uses the Gulf Steam to clearly show that instead of the common understanding of the marine atmosphere driving the coastal ocean, it is a true exchange of physical parameters which typically establishes the interaction of buoyancy and momentum at the air/sea interface. Real-time examples for students are explained and can be seen today in each hurricane that strengthens over a Gulf of Mexico warm eddy or, like hurricane Dennis, gains strength over the Gulf Stream.

The seventh paper, "The Coupled Ocean/Atmosphere Mesoscale Prediction System (COAMPS)," describes in detail the Navy's three-dimensional model, brings in the Wave Model (WAM), and mentions the addition of topography, radiation, and nested grids. The equations are daunting at best, but the examples help to allow a good understanding of the model. It shows that a coupled model is the only way to predict accurate air/sea interactions over time. The COAMPS model will continue to be developed as an operational system, first for the atmosphere then as a coupled data assimilation system.

The eleventh paper, "A Shallow Water Analysis and Forecast System (SWAFS)," describes the design methodology and application of a basin model to the Persian Gulf and other semi-enclosed seas. A real-time oceanographic prediction system is optimized for coastal areas with an optimal interpolation-based data assimilation scheme and connectivity with meteorological forecasts. The paper does this without many equations.

Papers twelve through fifteen deal with the oldest form of coastal prediction, tides and tidal currents. With a significant amount of detail, adding hydrodynamics to statistical methods, the authors describe the prediction of water levels. Lateral tidal boundary forcing is explored in another paper using the Princeton Ocean Model. A well-referenced paper, "Tsunami Predictions in U.S.Coastal Regions," explains the current short term and long term prediction techniques. Since most damage occurs only minutes from the source, predictions are centered on understanding tsunami dynamics and disaster mitigation. A complicated statistical paper, "Coastal Sea Level Prediction for Climate Change," is an analysis of various techniques associated with flooding probabilities that depend upon tidal and surge influences as well as mean sea level and other minor factors. The bottom line is that humans will always live near the sea and good engineering practices are the best solutions to rising sea levels.

Paper sixteen, "Prediction in Ice-Covered Shallow Seas," suggests four forecast systems to predict coastal ocean conditions in areas complicated by sea ice cover. All sea ice covered regions are included.

Paper seventeen discusses the near shore wave-current interaction and drag in the Irish Sea. It complements previous discussions of young sea waves, air/sea interaction and the WAM model. The many equations complicate the short paper.

The last three papers present a NOAA, Navy, and Norwegian perspective, respectively. They review coastal ocean forecasting programs and solutions to safety at sea as well as the many other needs of coastal constituents around the world.

The NOAA paper describes the existing rudimentary coastal forecast systems in place, their long-range strategy and an evolutionary development of a Coastal Ocean Forecast System (COFS). A short review of research and development activities is also included. The authors mention the 84 more stations for buoy observations ready for implementation when funding becomes available. No mention is made if funding of these stations has any priority. Satellite data, NEXt generation RADar (NEXRAD) data, water level data sources, and Physical Oceanographic Real-Time System (PORTS) are discussed and are key components to COFS.

The Navy perspective includes their long-standing history of forecasting the environment worldwide. The requirement of dominance in littoral operations requires that they are leaders in establishing a flexible global meteorology and oceanography capability. Therefore, they have taken the lead in developing a coupled ocean/atmosphere model, COAMPS, a coastal implementation of the WAM model, the Optimal Thermal Interpolation System (OTIS) producing surface to bottom ocean thermal structure, the Navy Operational Regional Atmospheric Prediction System (NORAPS) and the Shallow Water Analysis and Forecast System (SWAFS).

The Norwegian perspective describes the need for orchestrating observations, models, human expertise and a strong interaction with the coastal populace to enable the development of forecasting capabilities. This paper starts with requirements and refreshingly uses ocean wave forecasting as the example. A complete ocean forecasting system includes the expertise needed to adjust products to users' specific demands as well as establishing user specific monitoring systems. Observations and user interface again comes to the forefront of a COFS. A modular approach is taken to include recording and forecasting of biological events

In providing a taste of the coastal prediction problem, Mooers' collection of papers is also introduced as

helping to provide a foundation for the Global Ocean Observing System (GOOS). It is also a foundation for the recent Coastal GOOS design and implementation effort.[1] The need for coastal observations of a multitude of parameters is a common thread through all of the 20 papers.

The NOAA perspective, mentioned in paper eighteen, suggests that the three fundamental conceptual elements of any forecast system are observations, knowledge and models. Although the various authors discuss the importance of observations to the accuracy of the models, they do not seem to emphasize enough the criticality of a robust observation system to the survivability of any model. Anyone who has attempted to operationally forecast environmental parameters in the rapidly changing and complex coastal ocean would first consider the observations available and the long term solutions to provide continuous observation systems. This is always a major factor in transitioning a system from research to operations.

Even with the fast pace of the advancements in coastal predictions due to massively parallel computer processing, use of remote sensing, and data assimilation techniques, this book is timely and a good resource for applications of coastal modeling techniques. It demonstrates that the coastal environment from river runoff to tsunamis and sea ice is dynamic and complex in time and space. The evolution of the coupled atmosphere and coastal ocean model to operations along with coupling the chemical and biological processes to physical ocean processes is the clear goal for solving coastal forecasting problems

As with any work that is a collection of papers, its review is different when each paper can stand on its own. One would hope that the whole collection would weave a more complete story or holistic purpose as intended by the authors. In this case the sum of the 20 papers in this collection provides the reader with a launch pad for additional applications and methods of coastal ocean observing and forecasting that will surely follow.

The book is a good resource and destined for "dog eared" pages, highlighted passages, and many colored sticky tabs.

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[1]*NOAA South Carolina Sea Grant, et al., 1999:* Challenges and Promise of Designing and Implementing An Ocean Observing System for U.S. Coastal Waters *(Unpublished Workshop Report)*