Development Of A Regional Coastal And Open Ocean Forecast System

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LONG-TERM GOALS

The long term goal is to construct, verify and demonstrate an efficient system for the realistic, accurate and efficient estimation of oceanic fields which can be deployed rapidly in any region of the world ocean: the coastal and shelf ocean, across the shelfbreak and the open ocean.

OBJECTIVES

The objectives of this research are: i) to continue the development of a relocatable, portable and efficient ocean prediction system for realtime forecasting and interdisciplinary research; ii) to demonstrate and validate HOPS in realtime exercises at sea and on land; iii) to implement regional forecast system methodologies; and, iv) to share software with the modeling and operational community.

APPROACH

The approach to software implementation within the Harvard Ocean Prediction System allows simple and flexible inter-module flow of information and the addition of models and procedures developed in-house or elsewhere. Standard data management procedures, data formats, generic data assimilation schemes amenable for use in diverse models are required. The approach to data assimilation emphasizes treatment of the data before assimilation via Structured Data Models (e.g. feature models and EOFs) which are used to represent synoptic structures. The approach to regional forecast system development involves: an Exploratory phase in which dominant scales, processes and interactions are identified; a Dynamical phase which establishes the circulation structures, the processes of synoptic evolution and events, and calibrates the regional system; and, a Predictive phase involving forecast experiments to verify the regional forecast system.

WORK COMPLETED

The development of real time, advanced, generic, portable, multiscale, interdisciplinary ocean observing and prediction systems (OOPS) is ongoing and is documented in (6, 7, 11, 16, 17). Important issues in interdisciplinary (coupled biological-physical) data assimilation and multiscale adaptive sampling are addressed in (4, 5, 7, 11). Nesting methodologies and tidal applications have been completed during the past year.

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Efforts within this program are closely linked with those of the Littoral Ocean Observation and Prediction System (LOOPS) and Advanced Fisheries Management Information System (AFMIS) development efforts. Certain concepts critical to the development of LOOPS are documented in (6). The progress of AFMIS is presented in (1). Fish dynamics models and circulation feature models for the Gulf of Maine have been developed as part of the AFMIS research.

At the request of the National Marine Fisheries Service (NMFS), the HOPS group simulated the path of a drifting dead whale in an attempt to determine the probable strike location by a vessel. This simulation provided NMFS with a series of potential strike locations which were dependent upon the time at which the whale was struck. The information provided enabled NMFS to potentially determine the identity of the ship which caused the whale's death.

ESSE codes have been updated for atmospheric forcings (1, 2, 12) and an ESSE-based three-dimensional, multivariate objective analysis software further developed and its use in real-time demonstrated (10, 11).

RESULTS

The LOOPS and AFMIS programs have provided substantial opportunities to exercise and develop HOPS. Algorithms developed within our 6.1 research ("Dynamics of Oceanic Motions") have been transitioned and put to use. Dynamical studies of Massachusetts Bay and the Gulf of Maine continue to elucidate the dynamics of circulation patterns and to characterize the internal and external forcings. The use of HOPS during the real time MBST-98 experiment was very successful.

HOPS is vertically integrated within the Harvard oceanography research group, facilitating interactions in fundamental and applied areas of research. HOPS is used for demonstration and validation of regional forecasting systems, fundamental research in ocean processes in the coastal and shelfbreak regions, a testbed for new data assimilation schemes and interdisciplinary work in biogeochemical modeling and simulations. The system has been distributed to several national and foreign research and operational sites. On-going training and collaborations using HOPS in various regions of the world ocean are presently being pursued. Important operational plans are for: a March/April 2000 real-time demonstration of concept exercise in the Georges Bank/Gulf of Maine region for the AFMIS program; Linked Seas 2000, a NATO Rapid Environmental Assessment (REA) exercise off the coast of Portugal in March 2000; and, GOATS/MEANS 2000, a NATO exercise in Sept./Oct. 2000 which will have REA, Mine Counter Measure and Multiscale Environmental Assessment Network Studies (MEANS) components.

IMPACT/APPLICATIONS

Ocean Observing and Prediction Systems (OOPS's) for contemporary ocean science and marine technology consist generally of: i) a set of coupled interdisciplinary models; ii) an observational network with multiple platforms and sensors; and, iii) data assimilation schemes with measurement models and error models. The nowcasts, forecasts and data driven simulation products of OOPS's have important applications for: i) the efficient conduct of real-time scientific research in the intermittent

ocean; ii) marine resource exploration, exploitation and management; and, iii) naval and marine operations.

TRANSITIONS

Completed and continuing research transitions and collaborations are with: Portugese Navy Hydrographic Office, MIT Sea Grant; Southampton Oceanography Center; NRL Stennis; Naval Postgraduate School; SACLANT Undersea Research Centre; WHOI; SIO; Univ. of Colorado; JPL Pasadena; Old Dominion University; Institute of Marine Sciences, Turkey; U. Tokyo; CNR Ancona, Italy; Dartmouth College; University of Warwick, UK; Penn State Univ., Applied Research Lab.; and U. Mass. Dartmouth, Center for Marine Science and Technology.

RELATED PROJECTS

The collaborations with the SACLANT Undersea Research Centre's Oceanography Group (Dr. Jurgen Sellschopp) are evidenced by the related projects Linked Seas 2000, and GOATS/MEANS 2000. This project has relationships to the National Ocean Partnership Program in the development of the scientific and technical conceptual basis of a generally applicable Littoral Ocean Observing and Predictive System (LOOPS) with Johns Hopkins University (APL), MIT - AUV Lab., MIT - Sea Grant, MIT - Ocean Engineering, Naval Underwater Warfare Center, National Marine Fisheries Service, Raytheon, Tracor Applied Science, Univ. of California - Santa Barbara, Univ. of Massachusetts – Dartmouth; research towards the construction of an Advanced Fisheries Management and Information System (AFMIS) with U. Mass-Dartmouth (Prof. B. Rothschild), BIO-OPTICS research (Dr. Jeffrey Dusenberry), the Shelfbreak PRIMER and Harvard 6.1 research (“Dynamics of Oceanic Motions”), as well as external collaborations in conjunction with transitions.

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