The Coastal Ocean Processes (CoOP) Program

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LONG-TERM GOAL

The Coastal Ocean Processes (CoOP) program seeks to plan and implement multi-investigator, interdisciplinary research in the coastal ocean. CoOP encompasses the disciplines of Biological, Chemical, Geological and Physical Oceanography, plus Marine Meteorology. The goal of CoOP is to obtain a new level of quantitative understanding of the processes that dominate the transports, transformations and fates of biologically, chemically and geologically important matter on continental margins.

SCIENTIFIC OBJECTIVES

CoOP's underlying scientific planning assumption is that a series of well designed, interdisciplinary processes studies at locations that are characterized by different combinations of fundamental transport processes will provide significant new information to advance our understanding of coastal oceans and be applicable to continental margins around the world. Coupled process studies and modeling are the core of CoOP research programs.

APPROACH

The CoOP research plan is to conduct process and modeling studies on shelves which differ in the dominant physical processes which influence cross margin transport. CoOP studies will thus attempt to isolate the key processes that have some global generality and to study these in detail on margins where effects can be isolated with a maximum degree of confidence. Modeling studies will be integrated with the process studies and used as a means to synthesize and generalize study results. Five shelf types that CoOP has proposed to study are:

Wind-driven Transport - The defining characteristic of this shelf type is that current fluctuations are predominantly driven by winds (either locally or remote) on time scales longer than a day. A subset of these shelves are those where seasonal upwelling occurs, such as off the California and Oregon coasts as well as shelves of Portugal, Southwest Africa and western South America. The broader category of wind-driven transport would include all of the U.S. continental shelves.

Tidally-driven Transport - In areas such as Georges Bank and the Bering Sea, strong tides can determine mixing processes and mean flows. High tidal amplitudes are generally the result of a wave

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resonance in a “cavity”, so that tidally dominated regions tend to be in or near areas with complex coastlines.

Buoyancy-driven Transport - Fresh water discharge from rivers creates an alongshore flow. In areas where the freshwater discharge is relatively low (Middle Atlantic Bight) buoyancy-driven transport is limited to the inner shelf. However, in areas of heavy precipitation such as the south coast of Alaska and off Norway, buoyancy-driven flows can dominate the entire shelf.

Western Boundary Current (WBC) shelves - Cross-margin transport on these shelves can be influenced by strong ocean offshore currents such as the Gulf Stream and Kuroshio as well as by eddies that originate from strong boundary currents. This category would thus include all of the Atlantic seaboard as well as the Gulf of Mexico (due to the Loop Current).

Ice-covered Shelves - In the Great Lakes and Northern Alaska there are seasonally ice-covered shelves. Ice formation and brine rejection can result in the formation of deep or intermediate water mass formation which can contribute to cross-shelf transport. Once ice is formed, it can strongly mitigate exchanges of heat and momentum between the ocean and atmosphere.

WORK COMPLETED

Inner Shelf Dynamics - The first CoOP study was initiated off Duck, NC in 1992 as a collaborative research effort with funding from the Office of Naval Research (ONR), the National Science Foundation (NSF) and the Army Corps of Engineers. The near shore region has not been widely studied because the strong wave activity on the inner shelf makes it is difficult to maintain moorings and to operate ships. The interdisciplinary CoOP project focused on the suspension and cross-shelf transport of sediments and the planktonic larvae of inner shelf benthic invertebrates. The basic hypothesis guiding the research was that planktonic larvae of nearshore-dwelling organisms exploit the vertical variation of inner-shelf circulation to control their cross-shelf transport. The investigators used both a cross-shelf array and ship surveys to study the physics, sediments and plankton of the inner shelf. This project has resulted in 19 peer-reviewed journal publications to date.

Coastal Air-Sea Chemical Fluxes - In 1995 a cooperative program was developed between CoOP and the ONR-sponsored Marine Boundary Layer Research Initiative and the Minerals Management Service (MMS). CoOP investigators focused on air-sea gas exchange; MMS studied surface flux and Langmuir circulation dynamics; and ONR’s research effort focused on exchange of momentum, heat aerosols, and the dynamics of the atmosphere and oceanic boundary layers. CoOP investigators developed new underway mapping systems and moored in situ sensors to measure gases. To date, these measurements have resulted in 16 published manuscripts.

In the last year, the CoOP Office has moved to the Skidaway Institute of Oceanography. Additionally, newsletters have been distributed to over 1600 marine scientists in January and August and numerous changes and additions have been made to the CoOP web site.

CURRENT PROJECTS

The CoOP Program currently supports over 85 Principal Investigators. A brief overview of the research programs and activities follows.

Great Lakes Processes Studies - In 1997 CoOP, in collaboration with the NOAA Coastal Ocean Program, began interdisciplinary process studies on cross-margin transport in the Great Lakes. The study of Episodic Events: Great Lakes Experiment (EEGLE) has focused on the role of the annually recurrent southern Lake Michigan plume in transporting material across the margins of Lake Michigan. Mooring arrays, ship surveys, drifter studies and radar sites are used to track the plume, surface currents and the particle field. Work to date has addressed numerous aspects of the biogeochemical and transport characteristics and consequences of this annual plume. Recently, a model has been developed to simulate sediment resuspension, transport and deposition (Figure 1) within the lake.

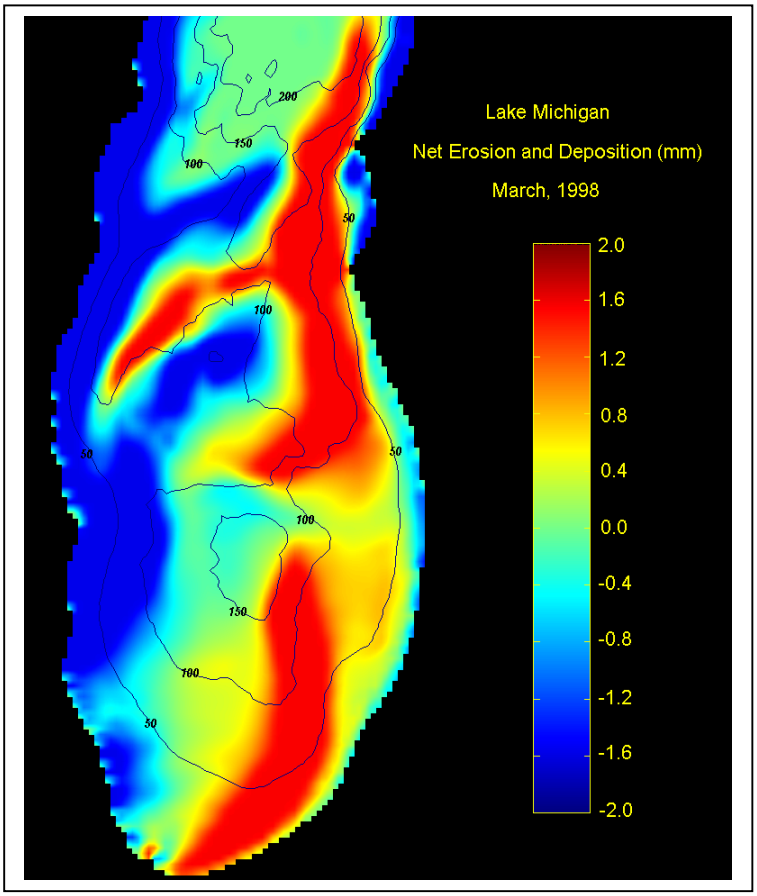

Figure 1. Net sediment erosion and resuspension during March 1998 estimated from a numerical simulation of coastal circulation, wind-waves and sediment transport. Results qualitatively agree with transport plumes observed from satellite imagery (Schwab et al. in press). Model results further capture the episodic circulation in the early spring which is almost entirely wind-driven.

The Keweenaw Interdisciplinary Transport Experiment in Superior (KITES) is a second CoOP coordinated program in the Great Lakes. The Keweenaw Current forms a semi-permeable barrier along the southern coast of Lake Superior that inhibits shore and river derived material from crossing the margin system and entering the central basin of the lake. Water movement in this current is the primary means for transport of material from the western to eastern lake basin and is therefore likely to be important in dictating productivity throughout the whole lake.

Wind-Driven Cross Margin Transport Studies - Following a modeling study by John Allen (Oregon State University) to investigate the effects of three dimensional wind-forced circulation processes on ecosystem dynamics under both upwelling and downwelling conditions, two process studies were initiated in January 2000 along the California and Oregon continental margins. The central focus of these studies is to determine the processes that control the cross-margin transport of biological, chemical and geological materials in a strongly wind-driven system. The Coastal Ocean Advances in Shelf Transport (COAST) project will examine wind-driven transport processes during upwelling and downwelling favorable conditions at two locations off the Oregon coast that differ significantly in bottom topography. The other study entitled "The Role of Wind-driven Transport in Shelf Productivity (WEST - Wind Events in Shelf Transport) is focused off the Northern California coast and examines the relationships among wind-driven transport, nutrient inputs and biological productivity. Both

programs successfully initiated preliminary field programs this year in preparation for major field efforts in 2001.

Buoyancy-Driven Transport - In the fall of 1998 CoOP conducted an open workshop to develop a Science Plan for a buoyancy-driven transport study. The final workshop report was released in the winter of 1999/2000. With support from ONR, four groups have been funded to produce review papers that synthesize important interdisciplinary issues in coastal systems with large freshwater inputs. Topics include: the transport and transformation of dissolved and particulate materials in continental shelf plumes from large rivers; transport and dispersal of sediment in buoyant plumes; the role of the seabed and sediment-water interactions in the transport and transformation of materials on continental shelves influenced by large rivers; and the chemical distribution and biota in the Alaska coastal current. Drafts of these review papers will be available in time to assist with the development of the Announcement of Opportunity for the anticipated process study and will be distributed to interested applicants.

WORK PLANS

Together with the workshop report, the review papers will be utilized to develop a Science Plan for interdisciplinary research in systems with substantial freshwater inputs and eventually an Announcement of Opportunity. Additionally, in the coming 12 months, the Steering Committee will begin to develop the focus for the next CoOP workshop and future interdisciplinary study.

CoOP INFORMATION

Copies of the CoOP reports and NEWSLETTER can be obtained through the CoOP office (djahnke@skio.peachnet.edu). A description of the CoOP program and the various process and modeling studies and links to web sites of the individual research programs and include recent results can be found at the CoOP web site (http://www.skio.peachnet.edu/coop/).