Newsletter of
Coastal Ocean Processes

OCEANS: Ocean Biogeochemistry and Ecosystems Analysis - Open Science Conference

Paris, France 7-10 January 2003
co-sponsored by IGBP and SCOR
more information at http://www.igbp.kva.se/obe/

The conference will focus on integrated studies of ocean biogeochemistry and ecosystem dynamics in the context of the earth system and global change. It is designed to assist the development of a new ten-year international research project. Questions include:

1.How does global change, represented by changes in natural climatic modalities and anthropogenic forcings, impact marine biogeochemical cycles and ecosystem dynamics?

2.How do these impacts alter the mechanistic relationships between elemental cycling and ecosystem dynamics?

3.What are the feedback mechanisms to the earth system from these changes?

IGBP and SCOR invite your input into the development of the science focus of this project through this Open Science Conference. The meeting will include plenary sessions and the following working groups:

1.Trace elements in ecological and biogeochemical processes

2.Physical forcing on biogeochemical cycling and marine food webs

3.Climatic modulation of organic matter fluxes

4.Direct effects of anthropogenic forcing on biogeochemical cycles and ecosystems

5.Integrating food web dynamics and biogeochemical cycles

6.Continental margins

7.The mesopelagic layer

8.Biogeochemical hotspots, choke points, triggers, switches and non-linear responses

9.Feedbacks to the Earth System and linkages with other Earth System components

10.Modelling approaches to biogeochemical cycles and ecosystems and their integration

Buoyancy-Driven Transport Update: The NSF call for proposals closed 24 July 2002. Coordinated interdisciplinary and/or individual proposals were received for research on both the US East and West coasts and the Gulfs of Alaska and Mexico.

Project Updates: The Special Session at Ocean Sciences 2002 developed by the CoOP KITES, EEGLE, WEST and COAST Projects was very successful. A total of 48 oral presentations and 29 posters were included in the Session entitled Transport and Transformation of Biogeochemically Important Materials in Coastal Waters. KITES and EEGLE are preparing a special issue in JGR-Oceans (titles on p.5) and planning a special issue of the Journal of Great Lakes Research. Reports from the WEST and COAST Projects are included here on p.6 and 3.

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Executive Summary Draft
Coastal Observatory Science Workshop

R. Jahnke, L. Atkinson, J. Barth, F. Chaves, K. Daly, J. Edson, P. Franks, J. O'Donnell and O. Schofield

Efforts are currently underway to design and implement an Integrated Ocean Observing System (IOOS) for the U. S. The coastal component of the system is envisioned as a federation of regional observing systems nested in a federally-supported national infrastructure with a backbone of core measurements and shared communications and data management. In addition to the common backbone, each regional observing system would be augmented to focus on measurements and processes of special interest to each specific region. Research observatories embedded within IOOS are an important component of the overall implementation plan. Previous workshops have described the substantial new benefits an observing system will provide to society. To provide focus and direction for the development of observatory research science, a workshop was held (Savannah GA, 7 - 9 May, 2002) to articulate the advancements in coastal research that could be achieved through the use of coastal observing systems. Specifically, workshop participants were asked to: 1) identify research topics that can best be studied through coastal observatories and observing systems; 2) identify current capabilities that are critical to those research topics; and 3) identify observatory development areas that would provide the greatest benefit to future coastal research.

Coastal observatories represent an exceptional enabling technology that will significantly advance future research efforts by expanding the space and time scales over which coastal processes are observed. In many instances, realizing the benefits for society will require major improvements in our scientific understanding of coastal processes and phenomena, which may only be achievable through an observatory system. These systems will provide fundamental new opportunities for research and development and, as such, represent a unique resource for supporting and augmenting coastal research. The four-dimensional complexity of ocean systems must be challenged. Observatories will permit researchers to resolve the mean and variance of annual and seasonal signals, as well as individual events. Examples of research areas that will significantly benefit from the development of observatories include the study of: the variability in the large scale circulation fields, material mass balances such as nutrient and carbon budgets, ecosystem studies, and shoreline morphology and beach erosion. Of particular importance is the study of episodic and extreme events. Coastal observatory technologies have the potential to provide the high resolution, long time-series measurements necessary to capture rare events and to provide the in situ information to direct targeted and remotely controlled sampling campaigns to examine specific features. While at present direct sensor measurements are dominated by physical parameters, numerous research opportunities have been identified for coastal biological and chemical systems by providing the physical context, by deployment of emerging biological and chemical sensors and by directing targeted sampling programs.

Coastal observatories must be configured to maximize the space and time scales over which observations can be made. It is envisioned that coastal observatories will be comprised of three basic observing components. A widely-spaced distributed set of backbone moorings will span and link all regions. Within each region, dedicated observatories and cross-margin arrays will be positioned to maximize observations of features and processes most important to the region. Finally, **Re**locatable **C**oastal **O**bservatory **R**esearch and **D**evelopment (ReCORD) arrays are proposed that would serve to provide detailed information about targeted processes and for the development of new observatory technologies. These pioneer arrays would be dedicated to a particular study and deployed for appropriate periods (3-5 years) after which they would be recovered and reassigned. For updates and more information, see http://www/skio.peachnet.edu/coop/future.html.

OCEAN.US IOOS Workshop Update

An OCEAN.US workshop was held 10-14 March 2002, at Airlie Center in Warrenton, Virginia. Over 100 attendees worked from Sunday evening to Friday noon in intensive group sessions to complete a phased and prioritized implementation plan for the development of an integrated ocean observing system.

Three documents will result from the workshop. The first document is a summary version of the IOOS workshop report, entitled *An Integrated and Sustained Ocean Observing System for the United States: Design and Implementation.* Thi s summary will be provided to Congress through the White House Office of Science and Technology Policy (OSTP). It is available on the OCEAN.US website (http://www.ocean.us.net). A complete workshop proceedings and a detailed multi-year phased implementation plan are in progress. Check the website for updates and more information.

Evolution of the Cross-shelf Structure of the Oregon Coastal Upwelling System During COAST 2001

J.N. Moum, A. Perlin and J.M. Klymak
College of Oceanic & Atmospheric Sciences, Oregon State University

As a component of COAST (Coastal Ocean Advances in Shelf Transport), intensive turbulence and small-scale profiling of the coastal ocean off Oregon was executed with the profiler CHAMELEON during 2 cruises in summer 2001 (May/June and August). With the use of a protective ring guarding the probes, profiles were made into the ocean bottom, resulting in measurements to within 2 cm of the bottom. In all, >15,000 profiles were obtained in this manner, with only minor mishaps. Combined with shipboard ADCP measurements, these provide a detailed look at the structure and evolution of coastal processes. These observations were made at the same time as a pumped profiler (Burke Hales, OSU) continually cycled from surface to bottom, sampling water for chemical and biological analysis.

A particular effort was made to observe the evolution and cross-shelf structure of the coastal upwelling current in a region of relatively simple topography (both across and along the shelf) off Cascade Head. With considerable good fortune, we were able to document two distinct upwelling cycles and the intervening relaxation while conducting a sequence of 12 consecutive transects across the shelf over a period of 8 days (Figure 1). Intensification of the southward coastal current (V) is clear when upwelling-favorable winds persist. During relaxation from upwelling winds, a northward current first appears offshore at depth and subsequently inshore. An indicator of motion in the bottom boundary layer (BBL) is taken to be the σ_θ=26.6 isopycnal, which is highlighted in Figure 1. The location of this ipsoycnal's intersection with the bottom moves onshore and up the slope with the first upwelling event, offshore during the relaxation and back onshore when upwelling resumes.

High levels of turbidity are due to two factors. At the bottom, sediment is resuspended by the action of BBL turbulence as indicated by a strong correlation between turbulent dissipation rate (ε) and turbidity in the BBL. In mid-water column and inshore the source of the high

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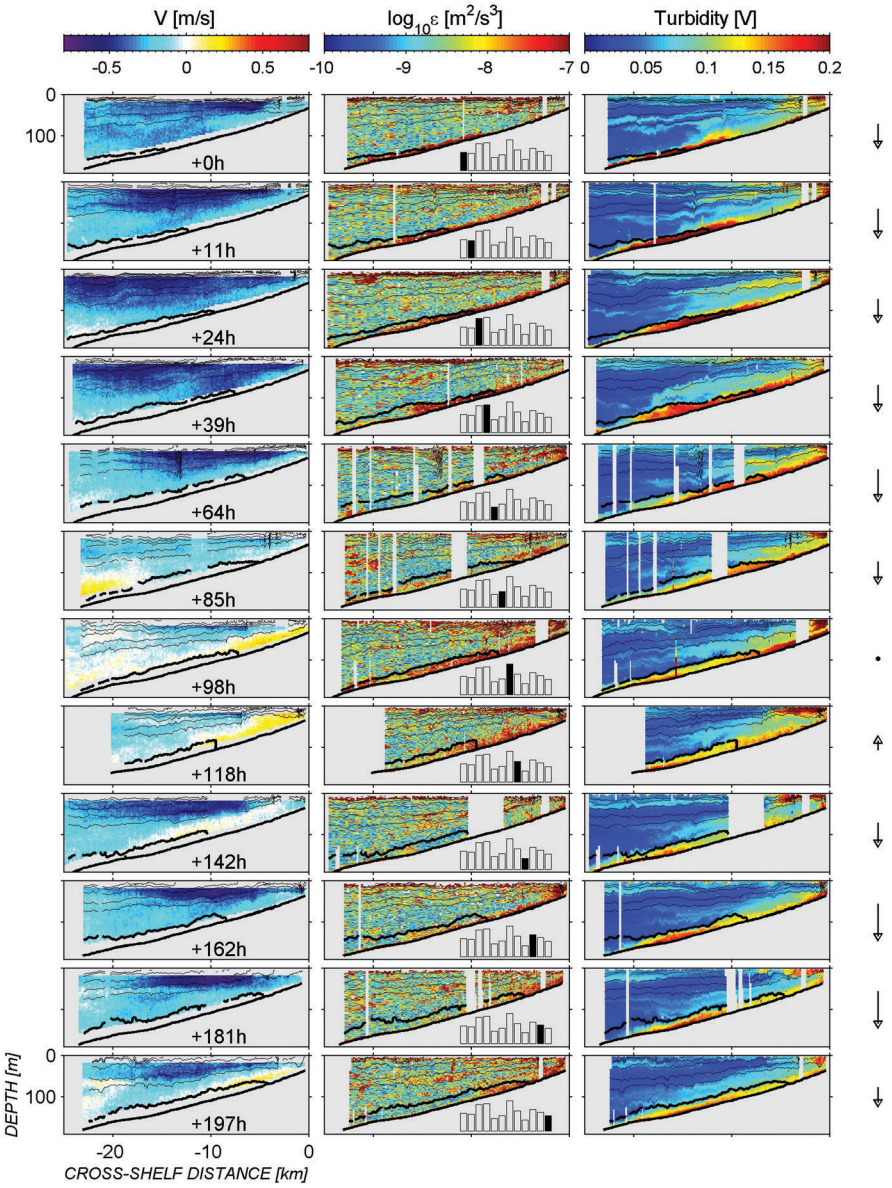

Figure 1 – Summary of alongshore currents (V; lefthand column), turbulent dissipation rate (ε ; middle column) and turbidity (from and 880 nm optical backscatter measurements; right column) from an 8 day period in May/June 2001 during which 12 transects were made across the shelf off Cascade Head. Isopycnals are plotted over each image, the 26.6 isopycnal highlighted as an indicator of cross-shelf motion of the bottom boundary layer. Relative wind stress averaged over the 24 h period preceding each transect is shown to the right (upwelling-favorable down). The relative time of each transect is shown in the leftmost column, starting with 0 h at the beginning of the first transect. In the lower right hand corner of the ε image plot is shown the transect-averaged dissipation (units of W per m of alongshore distance linearly scaled from 0-150); the highlighted bar represents the current transect.

Gordon Research Conference on Permeable Sediments
15 -20 June 2003, Bates College, Lewiston ME

Richard A. Jahnke (SkIO; rick@skio.peachnet.edu) and Ian Webster (CSIRO; ian.webster@cbr.clw.csiro.au)

Permeable sediments are increasingly recognized as major factors controlling the biogeochemistry of coastal, estuarine and riverine systems, yet they are fundamentally different from the fine-grained muds upon which most present models of sediment - water column interactions are based. Arising from the groundwork of two SCOR Working Groups (WG112 and WG114), a new Gordon Research Conference has been created to bring together the isolated, individual disciplinary groups that are currently working on permeable sediments and thereby increase the awareness of new developments in the field. The conference will facilitate dialog on pressing problems and effective research strategies, and promote interest in the field of permeable sediments within the larger community of earth, ocean and environmental scientists.

Draft Agenda

Session 1. Opening address **(introduction to permeable sediments)** *Fundamental principles and challenges; aim of conference; SCOR Working Groups 114 and 112; potential global importance of permeable sands*

Session 2. Fluid and particle transport in permeable sediments **(the physics)** *Effects of currents, waves and density gradients; advection, convection, dispersion, pressure gradients, wave pumping, flow driven by gas bubbles; radionuclide distribution, tracer studies; pore flow measurements, filtration rates; spatial and temporal variability; key sediment characteristics, carbonate and silicate sands, peat, gravel, layered beds, clay layers*

Session 3. Biogeochemistry of sands **(the chemistry)** *POC and DOC uptake and release, reaction rates, mineralization rates, burial rates; oxygen penetration and dynamics; nitrification/denitrification; iron and manganese dynamics; sulfate reduction layers; fluxes of metabolites; geochemical zonation and its spatial and temporal variation; seasonalities; sorption and desorption*

Session 4. Life in permeable beds **(the biology)** *Microbial community of sands, its characteristics and activities; the flushed interstitial space as an ecosystem with an extremely diverse meiofauna; macrofauna of sands and its impact on sediment characteristics, mechanical stress in sands; photosynthesis and benthic primary production in sands; biological impact on sediment permeability via burrow construction, pelletization, mucus production, sediment sorting, irrigation, bioturbation*

Sessions 5a and 5b. Case studies **(the examples)** *Rivers, estuaries, continental shelf sands; beaches, intertidal sand flats, coral reef frameworks; deep aquifers, groundwater seeps and submarine vents; hurricane effects, tsunamis; effects of plate tectonics, sea level rise; effects of changing temperature or salinity, sea ice, climate change; effects of changes in groundwater and surface water usage, changing coastal hydrology*

Sessions 6a and 6b. Methods and modeling **(the techniques)** *Tracer techniques; flux measurements, coring, flume measurements, chamber incubations, in-situ measurements, microsensor techniques, pore flow measurements, non-invasive techniques; experimental/ manipulative approaches; transport models, reaction models, modeling approaches; available software*

Session 7. Final conclusions **(summary and outlook)** *What did we learn; what needs to be done; what are the best ways to get these things done; what was missing; where do we meet next time; future prospects, projects and conferences*

For more information and updates, check
http://www.grc.org and
http://www.skio.peachnet.edu/grc
SCOR WG114 - Transport and Reaction in Permeable Sediments: http://www.scor-wg114.de
SCOR WG112 - Magnitude of Submarine Groundwater Discharge and Its Influence on Coastal Oceanographic Processes: http://www.jhu.edu/~scor/wg112.htm

CoOP Representation at Conference

John Largier represented CoOP and the WEST and COAST Projects at the Southern African Marine Sciences Symposium in Swakopmund, Namibia, recently. The meeting is held every 3 years in southern Africa and is the primary place to exchange information with researchers working on the Benguela system. The WEST/COAST presentation co-authored by John Largier and Jack Barth was received very well and with much interest.

KITES and EEGLE Update: Special Issue of Journal of Geophysical Research

The CoOP KITES and EEGLE Projects will be the focus of a special issue of Journal of Geophysical Research - Oceans. John Klinck will be JGR editor for the special issue, and Sarah Greene (Michigan Technological University), Rich Garvine (University of Delaware), Marie Bundy (Academy of Natural Sciences) and Matt Julius (Saint Cloud State University) will be guest editors. Submissions completed or anticipated at press time are listed below.

Physical

Rao, Y.R., R. Murthy, M. McCormick, G. Miller and J. Saylor. Circulation and coastal exchange characteristics during winter and northerly storm episodes in Southern Lake Michigan.

Ralph E.A., H.J. Niebauer, J. Churchill and K. Aagaard. The climatology of the Keweenaw Current.

Schwab, D., P. Roebber, D. Beletsky and B.J. Eadie. Climatology of resuspension events in Lake Michigan.

Chen, C., K. Kang, E.A. Ralph and J.W. Budd. Seasonal variation of circulation and transport in Lake Superior: A Lagrangian model exploration.

Meadows, L.A., J.F. Vesecky, C.C. Teague and Y. Fernandez. HF radar measurements of surface currents during episodic resuspension events in Lake Michigan.

Biogeochemical

Eadie, B.J., M.B. Lansing, A. Winkelman and T. Johengen. The importance of episodic events to mass and nutrient fluxes in the southern basin of Lake Michigan.

Klump J.V., J.T. Waples, K. Orlandini and D. Edgington. Short lived Th isotopes as tracers for alongshore and cross margin transport during episodic resuspension of coastal sediments.

Harting, S., W.C. Kerfoot and E. Brown. Mercury from metal ores: Sediment profiles and inventories introduce a concern with global implications.

Brown, E., J. Musielewicz, J. Agnich and D. Edgington. Copper-rich mine tailings as a tracer of sediment transport in the Keweenaw Current of Lake Superior.

Smith, G., B.J. Eadie, M.B. Lansing and K. Hornbuckle. Persistent organic pollutants as tracers of resuspension of contaminated sediment and eroded coastal material.

Ecological

Lavrentyev, P., P. Kovalcik, D. Hersha and W. S. Gardner. The microbial food web during a major re-suspension event in Lake Michigan.

Green, S.A., A.Vodacek and J.W. Budd. Photon budgets in coastal Lake Superior.

Ecological, cont.

Chen, C., X. Wang, R. Ji, D. Schwab, D. Beletsky, J.W. Budd, G. Fahnenstiel, H.A. Vanderploeg, B.J. Eadie, W.S. Gardner, J.B. Cotner and M.H. Bundy. Lower trophic level food dynamics in Lake Michigan: A comparison between the 1998 and 1999 plume events.

Bundy, M.H., H.A. Vanderploeg, P.V. Lavrentyev and P. Kovalcik. The potential impacts of food web changes on mesozooplankton populations during late winter/early spring resuspension events in Lake Michigan.

Fahnenstiel, G., S.E. Lohrenz, O. Schofield and D.F. Millie. The effect of the recurrent coastal plume on phytoplankton photosynthesis, growth and light absorption.

Schofield, O., T. Bergmann, S.E. Lohrenz, G. Fahnenstiel and D.F. Millie. Modeling the inherent optical properties in a coastal sediment plume: Impact of abiotic particles on ocean color remote sensing.

Julius, M.L. and L.M. Goad. Impact of episodic resuspension events on restructuring spring phytoplankton species composition.

Kerfoot, W.C., X. Ma and L. Weider. Coastal corridor in southern Lake Superior: rapid zooplankton species replacements and evolution.

Kerfoot, W.C., X. Ma, B.J. Eadie and H. Vanderploeg. Ecological importance of winter storms: Daphnia resting egg production, resuspension, and formation of “egg banks”.

Johengen, T.H., B. Biddanda and J.B. Cotner. The impact of sediment resuspension and riverine inputs on biological productivity in the nearshore zone.

Gardner, W.S., J.F. Cavaletto, M. McCarthy, P.J. Lavrentyev and B.J. Eadie. Nitrogen dynamics and microbial food web composition in southern Lake Michigan and St. Joseph River plume during winter-spring, 1999-2000.

Millie, D.F., G.L. Fahnenstiel, S.E. Lohrenz and O. Schofield. Relating phytoplankton photosynthetic parameters and production to episodic sediment resuspension in southeastern Lake Michigan.

Vanderploeg, H.A., T.H. Johengen, G.A. Lang, M.A. Agy, S.A. Ruberg, J.R. Liebig, P. Lavrentyev, M.H. Bundy, G.S. Miller, M.J. McCormick, J.H. Saylor and W.C. Kerfoot. Fronts and plumes as organizers of spatial distribution of nutrients and plankton in southern Lake Michigan.

Chen, C., X. Wang and R. Ji. Roles of the light inhibition in the growth of phytoplankton in Lake Michigan.

Cotner, J.B., B.A. Biddanda and T.H. Johengen. Microbially mediated P-fluxes in Lake Michigan.

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Investigating the Summer Wind Field Along California and Baja California: Stalking the True Coastal Winds

Clive Dorman, SIO, UCSD (cdorman@ucsd.edu) and Darko Koracin, DRI, UNR (darko@dri.edu)

Presented here is a brief look into some of the ongoing work being done on the coastal wind field. A more in-depth report is posted at http://www.skio.peachnet.edu/coop/westwind.html

The coastal surface wind field has great structure and variation over periods on the order of a day. The larger distance scale is the synoptic scale which is driven by mid-atmospheric level, synoptic elements that sweep through the area, pushing around the north Pacific Anticyclone and stroking the marine layer underneath. The exact shape and location of the high-speed wind area depend upon the synoptic scale feature orientation location. Superimposed on the synoptic scale are topographically forced mesoscale hydraulic responses of the marine layer that are proportional to the size of the land topographic feature (Rogers et al. 1998). The most outstanding is a wind speed maximum in the lee (Dorman and Winant 2000). Smaller and harder to see in these scale figures are the weaker winds on the upwind side.

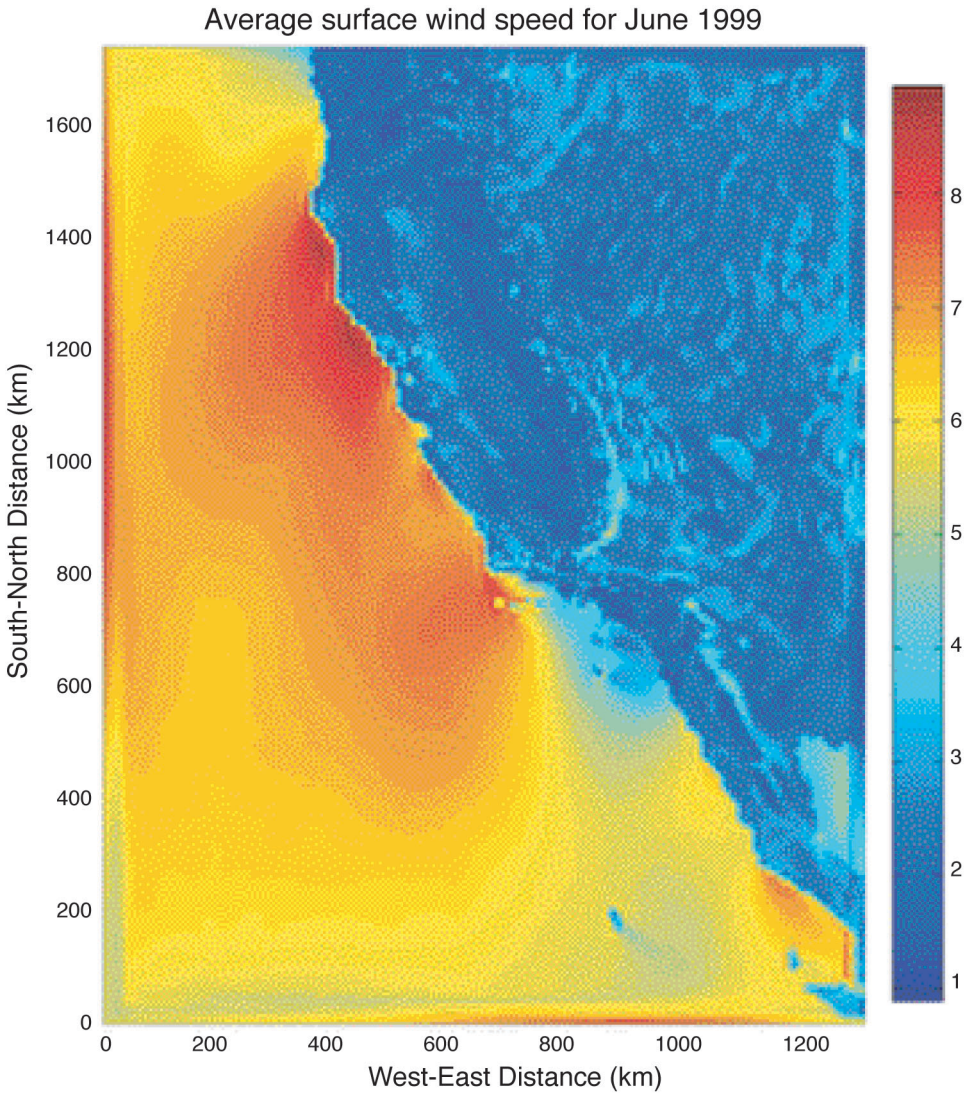

Figure 1. MM5 simulated surface wind as averaged for June 1999.

There are prominent problems in simulating winds over the ocean. Large-scale models (ECMWF, NOGAPS, etc.) generally do not have sufficient resolution to resolve coastal interface, coastal topography and sea-surface temperature gradients; consequently they cannot provide accurate predictions of winds over the ocean. Regional and mesocale models (MM5, COAMPS, RAMS, etc.) generally have sufficient resolution to resolve the coastal interface; however, they do not have accurate boundary and initial conditions for their wind prediction. The only solution is to use additional high-resolution measurements over the ocean to provide improved model initial and boundary conditions as well as to be assimilated into and guide the model for the entire period of simulation. One of the goals of the CoOP WEST is to reduce the model uncertainty by using a combination of surface measured buoys, satellite measurements and the MM5 atmospheric mesoscale model. The MM5 model setup with 9-km horizontal grid point resolution is an efficient tool to reproduce the hydraulic nature of the marine layer as shown by Koracin and Dorman (2001). We have already shown that MM5 coupled with the Princeton Ocean Model (POM) is a useful tool to reproduce ocean forcing by atmospheric dynamics (Beg-Paklar et al. 2001). The main purpose of the atmospheric mesoscale modeling is to provide high-resolution simulation results with sufficient detail necessary for estimation and prediction of the wind, wind divergence, wind stress, and the curl of the wind stress over the ocean. This effort is being conducted by the authors of this report who show here a preliminary step in stalking the elusive "true" wind field.

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June 1999 was selected to test the MM5 model using a grid with a 9-km horizontal resolution. The mean surface wind for all of June 1999 is shown in Figure 1.

Figure 1 is evidence of the significant effects of the coastal topography on the marine flow that can be seen in the monthly wind averages. A noticeable sequence of expansion fans and deceleration areas is present with a monthly mean average of close to 10 m s^{-1} in the lees of major capes. The primary wind maxima are in the lees of Cape Mendocino, Point Arena, Point Sur, and Point Conception. The secondary smaller maxima are in the lees of Cape Blanco, southern California, and Baja California. The figure also suggests that the California coast from Cape Mendocino to Point Conception represents a regional scale lee that can be seen in the monthly wind statistics with the enhanced winds propagating about 200-400 km in the offshore direction. The figure also shows that the islands significantly modify the flow as seen in monthly averages.

The present simulations represent an excellent basis for an understanding of coastal dynamics. In order to cover time scales of interest for atmospheric and oceanic processes, in this first phase of the analysis the hourly, daily, multi-day, and monthly characteristics of wind along the California coast have been revealed. In the next phase of the project, the simulation results will be used to compute the wind divergence, wind stress, and the curl of the wind stress and consequently to investigate the wind forcing of the ocean dynamics and marine ecology.

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Rogers, D., C. Dorman, K. Edwards, I. Brooks, K. Melville, S. Burk, W. Thompson, T. Holt, L. Strom, M. Tjernstrom, B. Grisogono, J. Bane, W. Nuss, B. Morley, A. Schanot, 1998: Highlights of coastal waves, 1996. Bulletin American Meteorological Society, 7, 1307-1326.

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Sediment Transport

Schwab, D. and D. Beletsky. The physical mechanisms for offshore transport of bottom sediments during episodic resuspension events in Lake Michigan.

Churchill, J.H., A.J. Williams and E.A. Ralph. What controls sediment resuspension and transport off Lake Superior's Keweenaw Peninsula?

Bedford, K., V. Velissariou and D. Welsh. Age, route and fate of sediments transported along- and offshore during episodic events in Lake Michigan.

Hawley, N. and B. Lesht. Field observations of episodic sediment resuspension in southern Lake Michigan.

Robbins, J.A., B.J. Eadie, D. Edgington, N.R. Morehead and V. Klump. Time scales for sediment focusing within the high depositional area of southern Lake Michigan: Insights from radionuclide studies.

Budd, J.W., D.S. Warrington, A. Vodacek and S. A. Green. Material transport by the Keweenaw Current as viewed by remote sensing imagery.

Kerfoot, W.C., S. Beske-Diehl and E. Brown. Episodic sloughing of shelf sediments: A simple hypothesis for the origin of paleo-redox zones.

Budd, J.W., D.S. Warrington, W.C. Kerfoot and R.P. Stumpf. Ecosystem mosaics: Winter storms and spring trophic pulses.

CoOP Project Websites

Episodic Events - Great Lakes Experiment - EEGLE: http://www.glerl.noaa.gov/eegle/

Keweenaw Interdisciplinary Transport in Superior - KITES: http://kites.chemistry.mtu.edu/KITES/kites.html

Coastal Ocean Advances in Shelf Transport - COAST : http://damp.coas.oregonstate.edu/coast

Wind Events in Shelf Transport - WEST: http://ccs.ucsd.edu/coop/west/

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turbidity appears to be phytoplankton (this will be tested with biological measurements made by other investigators participating in this experiment). Long and thin tendrils of high turbidity extend from the inner shelf to at least 25 km offshore.

High turbulence levels in the BBL are observed beneath and inshore of the coastal jet; these are typically coincident with high turbidity. Highly sheared interfaces beneath strong near-surface currents are also sites of high ε (this can be seen in the final 2 transects, at +181h and +197h at about 10 km offshore). During relaxation (+98h, +118h), the strong northward current at the inshore end is associated with high levels of turbulence both in the BBL and, from 0-5 km, throughout the water column. Strong inshore mixing throughout the water column is a consequence. Integrated over the observed wedge of shelf (shown in the bar graphs in the lower right hand corner of the image plots), the highest net dissipation of turbulent kinetic energy is 150 W per m of alongshore distance and coincides with the weakest winds (+98h).

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