

Annual Report for Period: 01/2000 - 12/2000

Submitted on: 11/21/2000

Principal Investigator: Barth, John A.

Award ID: 9907854

Organization: Oregon State University

Collaborative Research: Coastal Ocean Advances in Shelf Transport (COAST)

**Project Participants****Senior Personnel****Name:** Barth, John**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Allen, John**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Wheeler, Patricia**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Abbott, Mark**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Co-PI with R. Letelier on component to study phytoplankton physiology.

**Name:** Boyd, Timothy**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Co-PI with M. Levine and P. M. Kosro on mooring component of COAST.

**Name:** Caldwell, Douglas**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Co-PI with J. Moum on turbulence component of COAST.

**Name:** Cowles, Timothy**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Co-PI on bio-optical component of COAST.

**Name:** Desiderio, Russell**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Research Associate working with T. Cowles on bio-optics component of COAST.

**Name:** Hales, Burke**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Co-PI working on macronutrient component of COAST.

**Name:** Kosro, P**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Co-PI with M. Levine and T. Boyd on mooring component of COAST.

**Name:** Letelier, Ricardo**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Co-PI with M. Abbott on phytoplankton physiology component of COAST.

**Name:** Moum, James

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Co-PI with D. Caldwell on turbulence component of COAST.

**Name:** Peterson, William

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

co-PI on zooplankton component of COAST.

**Name:** Pierce, Stephen

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Research Associate working with J. Barth on hydrographic, velocity, bio-optical and bioacoustic mapping component of COAST.

**Name:** Samelson, Roger

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Co-PI on atmospheric and oceanic modeling components of COAST.

**Name:** Spitz, Yvette

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Co-PI working with J. Allen on ecosystem modeling component of COAST.

**Name:** Levine, Murray

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Co-PI working on mooring component of COAST.

**Post-doc**

**Name:** Karp-Boss, Lee

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Postdoc working with P. Wheeler on characterizing particulate and dissolved organic material as part of COAST.

**Name:** Bielli, Soline

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Postdoc working with R. Samelson on atmospheric modeling component of COAST.

**Name:** Perlin, Alexander

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Postdoc working with J. Moum and D. Caldwell on turbulence component of COAST.

**Name:** Gan, Jianping

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Postdoc working with J. Allen on ocean modeling component of COAST.

**Graduate Student**

**Name:** O'Keefe, Sheila

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Graduate Student working with P.M. Kosro on mapping of surface currents by land-based radar as part of COAST.

**Name:** Eisner, Lisa

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Graduate student working with T. Cowles on bio-optics component of COAST.

**Undergraduate Student****Organizational Partners****University of North Carolina at Chapel Hill**

John Bane is a co-PI on our COAST project. He is providing remote sensing and atmospheric measurements from a small plane. Dr. Bane will participate in the 2001 field experiment staged using OSU facilities.

**Columbia University Lamont Doherty Earth Observatory**

Dr. Alexander van Geen is a co-PI on our COAST project. He is responsible for iron measurements. Dr. van Geen and his graduate student, Zanna Chase, will participate in the 2001 and 2003 field experiments using OSU research facilities.

**Other Collaborators or Contacts**

Our project is one of two funded under the CoOP Northeast Pacific program. We have had extensive contact with the other project, Wind Events and Shelf Transport (WEST), headed up by John Largier at Scripps Institution of Oceanography. These include a meeting of the PIs at a CoOP Scientific Steering Committee meeting (May 2000), a visit to OSU by two WEST colleagues (April 2000) and a meeting of several COAST and WEST co-PIs at the Oct 2000 Eastern Pacific Ocean Conference. There have also been many email conversations between COAST and WEST co-PIs who are working on similar aspects under each project (e.g., zooplankton collection, modeling, etc.). The intent of the collaboration is to compare and contrast our results for two different wind-driven west coast shelf regions.

**Activities and Findings****Project Activities and Findings:**

Since our first field effort is scheduled for 2001, we have spent much of 2000 doing continued ocean circulation, ecosystem and atmospheric modeling, analyzing existing data sets and preparing instrumentation for use during spring and summer 2001. In order to optimize sampling during COAST, we have been analyzing data from the 1999 NOPP-sponsored and 2000 GLOBEC-sponsored field programs off Oregon. In addition, a comparison between satellite scatterometer measured winds and atmospheric model winds has been very enlightening regarding the temporal and spatial scales of the atmospheric forcing off the northwest coast.

We spent considerable time working with the UNOLS ship schedulers to schedule two research vessels, R/V Wecoma and R/V Thomas Thompson, for both a May-June 2001 early-upwelling study and an August 2001 mature-upwelling study. Coordination of the aircraft overflights with ship activities continues, including a July 2000 meeting of UNC collaborator John Bane with OSU scientists in Corvallis. We are also coordinating the iron measurement program (A. van Geen, LDEO) with the rest of the COAST effort, in particular adding a few backscatter sensors to the moorings in order to assess the origin of iron inputs over the shelf.

During this year, we have made progress on implementing a new fiber-optic tow cable system for the undulating vehicle SeaSoar. This will allow high-data rate instruments (e.g., bio-optical, microstructure) to be flown aboard SeaSoar. A test cruise is scheduled aboard R/V Wecoma for January 2001.

A second test cruise aboard the R/V Thompson will test a new high-speed vertical pumped profiler system in March 2001. This cruise will also be used to work out a sampling protocol for simultaneous use of the pumped profiler and a microstructure profiler so that the turbulent flux of nutrients and carbonate species may be estimated.

The following are short reports from the COAST subcomponents.

Besides implementing the fiber-optic, high-bandwidth towing capability for SeaSoar, the high-spatial resolution mapping component of COAST led by J. Barth has concentrated on analyzing the existing 1999 and 2000 data sets from the COAST region. More details about the importance of Heceta Bank to circulation off the Oregon coast have been elucidated (Barth et al., 2000). The midshelf, southward coastal upwelling jet follows the Bank topography as it widens offshore. The jet reaches the southern end of the Bank, where the shelf break turns almost 90 degrees back toward the coast. The ensuing adjustment involves the offshore transport of coastal water and the material it contains. There is evidence for an anticyclonic circulation feature in the 'lee' of

the Bank. These analyses will help guide the sampling protocol for the 2001 COAST mapping surveys.

W. Peterson hired a faculty research assistant, Anders Roestad, who works on zooplankton acoustics. During 2000, he received training from Hydroacoustic Technology, Inc. and became fully familiar with operation of the acoustics system and with data processing through participation in GLOBEC-sponsored cruises. In addition, he spent one week with a zooplankton acoustics expert in Alaska in August where he learned how to integrate zooplankton ground-truth sample data with acoustics data to make estimates of zooplankton biomass. He is presently learning how to enumerate zooplankton from MOCNESS samples so as to produce acoustics estimates of different taxa, with an emphasis on euphausiids, pteropods and siphonophores. All these skills will be applied to the COAST field work in 2001 and data analysis.

The microstructure work has progressed through the hiring of Alexander Perlin, a postdoc working with J. Moum. He is learning how to handle the microstructure data streams and analyzing measurements of the bottom boundary layer from the Oregon shelf in preparation for COAST. The microstructure group is building three new Chameleons and two new winches specifically for the COAST project in 2001, in order to handle the expected heavy use. By 2001, it is hoped that a three-velocity component pitot tube will be working and able to be deployed on the microstructure profiler during COAST. This will provide unambiguous estimates of turbulent kinetic energy and help us to understand

the vertical structure of the turbulence in the bottom boundary layer.

The nutrient and carbonate species sampling effort (B. Hales) has centered on building the high-speed vertical profiling system. To date, the profiling winch, cable, and in situ and shipboard CTD packages have been specified and purchased. The automated winch control interface has been written and tested with a simulated transect over archived, high-resolution bathymetry of Heceta Bank. Components of the high-speed nutrient analysis system have been purchased and the silicate, nitrate, nitrite, and phosphate analysis speeds have been brought up to 6 measurements per minute (10 second analysis intervals). Several components of the PCO<sub>2</sub> analysis system and of the data collection and instrument control network have been purchased. Winter surfzone sampling will begin in Winter 2000. Completion of the PCO<sub>2</sub> system and control/acquisition network will take place over the next two months, as will addition of ammonia to the suite of high-speed nutrient analyses. Construction of the in situ instrument vehicle will be completed in the same time frame. Purchase and construction of the TCO<sub>2</sub> analysis system will take place in early 2001, prior to the test cruise aboard R/V Thomas Thompson in March.

Work under the iron measurement component of COAST (A. van Geen, LDEO) during the past year has focused on the analysis and interpretation of results obtained during a cruise in the COAST region in July, 1999. A manuscript describing these results is close to submission. This cruise was a first trial of the flow injection system which will be used to measure iron and nitrate concentrations underway during the COAST program. Incorporating insights from this cruise, modifications to the instrumentation as well as to our conceptual view of the iron cycle off Oregon have been made. An important result to come out of the work this past year has been to identify several potential mechanisms for bringing sedimentary iron to surface waters during the upwelling season, and to identify how these mechanisms relate to wind forcing. Potential mechanisms are (1) wind-mixing during strong winds, (2) thickening of the bottom mixed layer during weak or downwelling-favorable winds, and (3) outcropping of the bottom boundary layer followed by offshore advection (the upwelling 'conveyor'), during upwelling-favorable winds. Work this past year has also shown that much of the iron in the coastal region is in the particulate form. This observation prompted two important modifications to the COAST iron program. First, analytical attention will be focussed on distinguishing between different forms of iron, both underway and with discrete samples. The second modification is related to the insight into modes of iron input. Namely, because so much iron is in the particulate form, much can be learned about iron inputs to surface waters by monitoring particles. On this basis, additional support was requested from NSF to add 2 particle concentration sensors (light scattering sensors) to the COAST mooring array. The additional sensors will be added to the existing 3 particle sensors to provide additional depth coverage, which will help evaluate the origin and transport of particles (and iron) with respect to wind forcing.

P. Wheeler has been pursuing the goal to determine the effect of physical and biological processes on the concentrations and distributions of particulate and dissolved organic material. During the first year of COAST, this was examined through analysis and comparison of two broad geographical samplings off the coast of Oregon (July 1997 and September 1999) and underway sampling on the GLOBEC LTOP cruises (April and September 2000). Fine-scale spatial heterogeneity was examined by connecting an attenuation-absorption meter (ac-9) and a fluorometer to the ship's uncontaminated seawater line. Results from the initial flow-through comparisons will be presented at ASLO 2001 (L. Karp-Boss et al., 2000). Additional comparisons and refinement of sampling techniques will be conducted in April 2001 prior to the first COAST upwelling cruise in May 2001.

The bio-optics subcomponent of COAST led by T. Cowles has been preparing existing instruments for deployment in the upcoming field program, and planning the integration of those instruments into the underway and profiling data systems (see Hales high-speed vertical profiling component). The summer 2000 field program within GLOBEC provided solid testing of the instrument integration and data analysis that will be used during the 2001 COAST SeaSoar work. In addition, we have been evaluating the configuration of the optical packages that will be deployed on the COAST moorings. Six optical packages will be purchased in January 2001 and will be deployed on the current meter moorings in May 2001. One graduate student is supported to work on bio-optics for academic year 2000-2001 with COAST funding.

M. Levine, T. Boyd and M. Kosro are planning for the deployment of moorings in 2001 to coincide with the shipboard field programs. To

determine the best location to place the moorings, data from previous experiments as well as results from modeling studies have been evaluated. Information on fishing activity in the area, particularly bottom trawling, has been gathered to help guide the mooring placements in order to minimize impacts on the moorings. Studies are under way to determine the optimum set of instrumentation to purchase. Collaboration with other COAST investigators (Letelier, Abbott, Cowles, van Geen), who will attach their sensors to the moorings, are underway. Mooring deployment (May 2001) and recovery (October 2001) cruises have been arranged on R/V Wecoma.

M. Kosro has been operating a network of SeaSonde High-Frequency radio systems along the central Oregon coast. These systems provide maps of surface currents over the coastal ocean between about 44.35N and 45.1N, to an offshore distance of about 45 km. An additional system, purchased with funds from the PISCO program, was recently installed at 44.15N; this system will extend mapping capability nearly to the southern flank of Heceta Bank. A web site, <http://bragg.oce.orst.edu/seasonde>, is providing near real-time daily-averaged maps of the currents between Newport and Waldport, Oregon. During spring and summer 2000, maps from the full array have provided clear views of several events showing the diversion of the alongshore coastal jet by the submarine Stonewall and Heceta Banks, showing the importance of alongshore topographic variations in producing three-dimensional cross-shelf transport processes (hypothesis H2 of the program) (Kosro, et al., 2000).

Progress on the aircraft observational program (J. Bane, UNC) is summarized as follows. During this year, preparations got underway for making measurement flights during the 2001 COAST field program. Two modifications will be made to the research aircraft for COAST - a pair of hyper-spectral ocean color radiometers will be added to the aircraft's equipment suite, and a new set of computers will be prepared to replace those used in previous studies. The new computers will provide better performance over those used earlier and will allow logging and in-flight display of data from the new color radiometers. The two new computers have been acquired and programmed, and the data translation equipment in the aircraft sensor system is now being updated to communicate with them. John Bane and Sara Haines (UNC) visited NASA Wallops to get briefed on the color radiometers and to arrange for their long-term loan to UNC. The radiometers should arrive at UNC by the first of the year. Additionally, a new flight situation display computer has been installed in the aircraft to aid in flight pattern execution. The 2001 field program will use almost 500 AXBTs. About a quarter of these have been shipped to OSU, and the order for another 375-400 has been placed. These should arrive at OSU in early May 2001. Some of the particular flight patterns to be used off Oregon have been programmed into the UNC flight simulator, and flights have been 'flown' for timing, execution details and pilot familiarization. John Bane attended a meeting at OSU during July 2000 to discuss aircraft survey plans with the other observational PIs.

The physical circulation and ecosystem modeling component of J. S. Allen, J. Gan, and Y. Spitz has work in progress on several fronts. Initial studies involving applications of the Princeton Ocean Model (POM), formulated on high-resolution, limited-area grids, to three-dimensional flows on the Oregon shelf, including the region of the COAST field experiment, and on the northern California shelf, including the region of the WEST field experiment, are near completion. The model application for the Oregon shelf involves wind stress forcing obtained from the mesoscale atmospheric model of R. Samelson. Comparisons of model results, including experiments where the forcing is provided by measured buoy winds that are assumed spatially uniform, with NOPP project current measurements show advantages to using the mesoscale atmospheric model forcing fields. Model applications off northern California have concentrated on comparison of direct simulations with measurements made during the CODE experiment in 1982 and on idealized process studies to examine the dynamics of the observed, but previously unexplained, shelf flow response to relaxation of upwelling winds. It is found that, following the weakening of southward winds, currents over the inner shelf are forced northward by pressure gradients established by the interaction of the wind-forced shelf flow with alongshore variations in shelf bottom topography. Characteristics of the evolution and set up of the pressure fields have been investigated and clarified. Work with the ecosystem model has involved studies, utilizing POM with a two-dimensional approximation, of the ecosystem response to upwelling off the Oregon coast. In particular, the comparative behavior of three different nitrogen-based models has been evaluated and rationalized. Applications of one of the better ecosystem models in three-dimensional circulation model studies are in progress.

The initial meteorology effort (R. Samelson) has focused on completion of the study of the summertime diurnal cycle begun under the NOPP program (Bielli et al., submitted), preparation of the summer 2000 surface forcing archive for analysis and for use by ocean modelers, and a preliminary comparison of scatterometer and model winds along the Oregon coast (Bielli et al., 2000). The ocean dynamics effort will begin in 2001.

### **Project Training and Development:**

#### **Research Training:**

A graduate student, Sheila O'Keefe, continues to get experience in operating and using the data from a land-based radar system to map ocean surface currents. This technique is still relatively new but catching on rapidly, so her skills should be in demand in the future. Another graduate student, Lisa Eisner, continues to gain experience in using bio-optics to understand phytoplankton distributions. This includes extensive sea-going experience. Four postdocs are receiving training in oceanic (J. Gan) and atmospheric (S. Bielli) modeling, in turbulence measurements and analysis (A. Perlin), and in assessing the concentration and distributions of particulate and dissolved organic material (L. Karp-Boss).

#### **Outreach Activities:**

### Journal Publications

S. Bielli, P. Barbour, D. Chelton, M. Freilich, R. Samelson, and E. Skyllingstad, "Scatterometer and model estimates of orographically intensified coastal winds", *Eastern Pacific Ocean Conference abstract*, p. 1, vol. , (2000). ) Conference abstract

S. Bielli, P. Barbour, R. Samelson, E. Skyllingstad, and J. Wilczak, "The diurnal cycle along the Oregon coast during summertime", *Monthly Weather Review*, p. , vol. , (2000). ) Submitted

Barth, J. A., P. M. Kosro and S. D. Pierce, "A submarine bank's influence on coastal circulation: Heceta Bank, Oregon", *Eos, Transactions, American Geophysical Union*, p. 1, vol. , (2000). ) Conference abstract

Kosro, P. M., J. D. Paduan and L. Washburn, "Time-series mapping of currents in the coastal ocean.", *Eos, Transactions, American Geophysical Union*, p. 1, vol. , (2000). ) Conference abstract

Karp-Boss, L., P. A. Wheeler and R. M. Letelier, "Spatial variability of particulate and dissolved material in relation to hydrographic parameters in an upwelling system.", *American Society of Limnology and Oceanography*, p. 1, vol. , (2001). ) Conference abstract

### Books or Other One-time Publications

#### Web/Internet Sites

**URL(s):**

<http://www.oce.orst.edu/po/COAST/>

**Description:**

This web page contains a brief overview of our COAST project. It will be expanded as the project enters its first field year in 2001.

#### Other Specific Products

**Product Type:** Data or databases

**Product Description:**

Near real-time daily-averaged maps of the ocean surface currents between Newport and Waldport, Oregon. These maps are produced by a network of SeaSonde High-Frequency land-based radio systems.

**Sharing Information:**

The near real-time ocean surface current maps are available at a website <http://bragg.oce.orst.edu/seasonde>.

**Product Type:** Atmospheric model forecasts

**Product Description:**

Experimental daily weather forecasts for Oregon and the Pacific Northwest using the ARPS (Advanced Regional Prediction System) mesoscale meteorological model.

**Sharing Information:**

The daily weather forecasts are available at a web site <http://www-hce.oce.orst.edu/~cmet/Coast1.html>

#### Contributions

**Contributions within Discipline:**

**Contributions to Other Disciplines:**

**Contributions to Human Resource Development:**

**Contributions to Science and Technology Infrastructure:**

**Beyond Science and Engineering:**

**Special Requirements****Special reporting requirements:**

We request an addition of \$90,855 in year 2 and \$94,829 in year 3 to fund a fulltime postdoc with some modest support costs (e.g., computer hookup fees). This request is to enable physical circulation modeling and coordinated ecosystem modeling for the CoOP Wind Events and Shelf Transport (WEST) project. The transfer of funds from WEST to COAST is per the agreement between Dr. John Allen at Oregon State University and Dr. Louis Botsford at University of California at Davis.

Our unobligated funds balance results from a number of reasons including: delayed equipment purchases in an effort to optimally design the field effort; a delayed fiber-optic SeaSoar tow cable test cruise; and delays in hiring at the FRA and postdoc levels. In particular, a large amount of the unobligated funds will be obligated in late 2000 or very early in 2001 for the purchase of moored instrumentation. All the unobligated funds will be needed in year 2 to complete the proposed research.

**Change in Objectives or Scope:** None

**Unobligated Funds:**

\$500,000.00

**Animal, Human Subjects, Biohazards:** None

**Categories for which nothing is reported:**

Activities and Findings: Any Project Training and Development

Activities and Findings: Any Outreach Activities

Any Book