from which a community can assemble a collaborative environment that fits their needs. The design of CHEF has been influenced by our experience developing the Space Physics and Aeronomy Research Collaboratory (SPARC, http://www.si.umich.edu/SPARC), which provides integrated access to a wide variety of heterogeneous data sources, including community-standardized data bases. The design has also been heavily influenced by our involvement with an effort to extract and codify the broad underlying technical and social elements that lead to successful collaboratories (http://www.scienceofcollaboratories.org). A collaborative environment is in itself also not the complete answer to data handling, rather, it provides a facilitating environment in which community efforts to integrate, publish, archive, and share data using standard formats and practices can be taken advantage of by the end-users, the scientists. We present examples of how CHEF and its predecessors are utilized in a wide variety of scientific communities, including engineering, chemistry, and the geosciences. In particular, we focus on CHEF's utilization by the earthquake engineering community, whose Network for Earthquake Engineering Simulation (NEES, http://www.nees.org) involves a community effort to develop data standards and practices. In this context NEES is using CHEF as the "integration" environment in which to place the "tools" that bring together scientists and data; this includes data browsers, meta-data search engines, real-time and archival data viewers, etc. By developing these tools within the CHEF framework and exposing the community-developed data standards to the framework, they automatically gain the features, functionality, and capabilities offered by the collaborative environment. We also explore how a collaborative environment, in conjunction with community developed standards and practices for data integration, publishing, and archiving, could benefit the ocean science community.

URL: http://chefproject.org

OS61D MCC: 270 Saturday 0830h

Wind-Driven Processes Along the U.S. West Coast Continental Shelf I

(joint with B, T)

Presiding: **T Garfield,** San Francisco State University**; P A Wheeler,** Oregon State University

OS61D-01 0830h INVITED

Investigation of the Wind-Driven Coastal Ocean off Oregon: A COAST Overview

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The Coastal Ocean Advances in Shelf Transport (COAST) project seeks to understand and quantify cross-shelf transport and transformation processes in the strongly wind-driven coastal ocean off central Oregon. Two intensive field efforts were conducted in summer 2001 together with coordinated ocean circulation/ecosystem and atmospheric modeling. A primary goal is to contrast the coastal ocean response in a region of relatively simple alongshore bottom topography versus that associated with a substantial submarine bank. Heceta Bank (44.3N) rises to over 50% of the surrounding continental shelf water depth and widens the shelf to 60 km from the relatively narrow, straight 25-km wide shelves both to the north and south. High ocean production is associated with Heceta Bank and cold, chlorophyll-rich upwelled water has been observed well seaward of the continental shelf break south of the Bank.

During May-June and August 2001, two vessels conducted interdisciplinary research off central Oregon. One ship conducted rapid, high spatial resolution surveys of the three-dimensional thermohaline, bio-optical, zooplankton and velocity fields using SeaSoar, shipboard ADCP and a towed, multi-frequency acoustics instrument. Surface maps of nutrients, pCO2 and iron were also made. A second ship collected high-vertical resolution cross-shelf profiles of water properties: temperature, salinity and turbulence parameters from a loosely tethered microstructure profiler; nutrients, carbonate species, phytoplankton photosynthesis parameters, and particulate and dissolved organic material from a pumped profiling system. An instrumented aircraft measured properties of the lower atmosphere and upper ocean during and between the month-long intensive field experiments. A set of moorings measured physical and bio-optical parameters from May-August and a land-based radio system continuously measured surface currents hourly over a region encompassing the Bank. A high-resolution, three-dimensional shelf circulation and coupled ecosystem ocean model and a mesoscale atmospheric model are being used to investigate the dynamics of the system.

During summer 2001, upwelled water was present near the coast and a wide ($\geq$ 75 km) cold region over the Bank showed elevated surface chlorophyll with peak values in excess of 15 mg m^{-3}. In the north, upwelling over simple bottom topography exhibited a classic response with a mid-shelf baroclinic coastal jet accompanied by upwelled isopycnals. On the southern edge of the Bank, the flow is highly three-dimensional including a strong baroclinic, equatorward jet near or seaward of the shelfbreak, a region of northward recirculation flow over the Bank and a small area of weaker upwelling adjacent to the coast. Lastly, although the COAST program is scheduled to study wintertime downwelling in Jan-Feb 2003, strong summertime downwelling was experienced during August 2001 when a remnant tropical typhoon transited the area with southerly winds in excess of 40 knots. The thermohaline, bio-optical and velocity response to this event are contrasted to those observed during relaxation, i.e. periods with weak or no wind forcing when pressure forces can drive inshore northward flow but isopycnals remain upwelled.

URL: http://damp.coas.oregonstate.edu/coast

OS61D-02 0850h

Atmospheric Forcing of the Oregon Shelf During COAST 2001

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During the COAST summer 2001 field program off central Oregon, detailed observations of the coastal atmosphere were made using moored buoys, land stations, satellites, ships and an aircraft. These observations reveal the structure and variability of the atmosphere in the study region, and they provide insight into the processes that give rise to the atmospheric forcing of the ocean there. We present an overview of the COAST atmosphere throughout the summer, relating local winds and thermal structure to the synoptic conditions over the eastern Pacific and northwestern North America. Coastal orographic effects and air-sea heat exchanges are found to modify the prevailing conditions locally, sometimes giving rise to enhanced or reduced near-surface winds and cool air temperatures along the coast. Although the winds are predominantly upwelling favorable (northerly) during summer in this region, southerly winds were experienced 25 percent of the time during COAST. We will describe the atmospheric thermal and wind structure during typical northerly and southerly wind episodes, relate these to synoptic conditions and local processes, and give brief examples of the oceanic circulations that these differing wind regimes create.

URL: http://www.marine.unc.edu/cool/COAST

OS61D-03 0905h

Upwelling Along the Oregon Coast is a Sink for Atmospheric CO2

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High-resolution cross-shelf sections of nutrient and PCO2 measurements made during May and August of 2001 off the Oregon Coast show the effects of strong upwelling of nutrient-and CO2-rich water, followed by rapid uptake of these chemicals by biological productivity. Photosynthetic production draws nitrate from over 30 micro mol/kg to undetectable levels; along with this nitrate uptake, PCO2 is drawn down from values of 300 micro atm above, to 200 micro atm below, atmospheric saturation. High PCO2 surface waters are confined to a narrow region near the coast; low PCO2 conditions persist seaward over areas covering most of the shelf. If these conditions are representative of other upwelling areas in the Eastern North Pacific over the duration of the upwelling season, CO2 transfer into such waters may represent a significant contribution to the total summer-time uptake of CO2 by the entire North Pacific.

This phenomenon makes the Oregon Coast unique among upwelling regions of the world oceans, which are typically sources of CO2 to the atmosphere. Three factors appear to contribute to this singularity: 1) Upwelled source waters have high preformed nitrate relative to total CO2 (TCO2), which allows for the necessarily high alkalinity:TCO2 ratios implied by the observed low PCO2; 2) Productivity is able to rapidly consume all upwelled nitrate, along with a stoichiometric proportion of TCO2; and 3) upwelled waters are only moderately warmed in comparison to lower-latitude upwelling regions.

OS61D-04 0920h

Bottom Boundary Layer Behavior during COAST

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Rapidly-repeated transects of currents, and density and turbulence through the bottom boundary layer across a relatively uniform stretch of the continental shelf off Oregon reveal the response of the bottom boundary layer to a sequence of strong upwelling followed by relaxation and thence a resumption of upwelling. Dense, near-bottom fluid was observed to move upslope with upwelling and back down the slope with relaxation from upwelling. By tracking the intersection of near-bottom isopycnals with the bottom over successive transects, we estimate the cross-shore speed of fluid in the bottom boundary layer. This agrees well with simple estimates of bottom Ekman velocity from alongshore currents. Modifications to both the Ekman velocity due to buoyancy forcing and to the speed at which locations of isopycnal intersection with the bottom move down the slope due to turbulent mixing improve agreement, but they are small. Boundary layer thickness is greater during the relaxation from upwelling and turbulence in the bottom boundary layer is more intense at this time. Evidence exists for convectively-driven mixing in the bottom boundary layer during the relaxation. This is presumably forced by the downslope movement of lighter bottom fluid beneath dense fluid. During upwelling, fluid in the bottom boundary layer which has been drawn up the slope is observed to become isolated from its downslope source. It is argued that this is due to divergence of the Ekman bottom flow beneath a cross-shore varying current. TS properties of this water are similar to TS properties of isolated dense pool observed 90 km further south over the broader shelf, and it appears that the water is connected all the way along the coast.

URL: http://mixing.coas.oregonstate.edu

OS61D-05 0935h INVITED

Wind Events and Shelf Transport (WEST): Understanding the Role of Wind-Driven Transport in Shelf Productivity.

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WEST is a major interdisciplinary project supported by the Coastal Ocean Processes program at NSF. WEST combines modeling and intensive fieldwork off Bodega Bay, northern California, with the aim of better understanding the sequence of forcing and interaction from wind through currents and stratification to water quality and the productivity of planktonic systems over wind-driven shelves. Given the two negative responses to increased winds (decreased average light levels, increased export from shelf waters), and only one positive response (increased nutrient supply), why is it that shelf waters in coastal upwelling regions can be so productive?

Moorings, ship surveys, and remote sensing are combined to offer synchronous views of the relevant physics, chemistry and biology of plankton systems over the shelf off northern California. The overlap of observations at a variety of space and time scales, combined with modeling approaches, allows a description of the similarities and differences in the spatial and temporal structure of winds, currents, stratification, water quality, phytoplankton, and zooplankton. Preliminary results of this integrative approach will be presented and the importance of specific space and time scales of forcing will be discussed. Where biological structure is observed to match physical forcing, it will be shown that this match may result from being subject to common transport patterns or from the role that physical forcing plays in modulating conditions conducive to plankton productivity (habitat variability). Particular attention will be given to blooms of phytoplankton and selected zooplankton populations, and concurrent environmental conditions, observed off Bodega Bay in the summers of 2000 and 2001. The results of specific WEST studies will be discussed in presentations that follow this overview of integrative science in WEST.

URL: http://www.ccs.ucsd.edu/coop/west/

OS61D-06 1015h

WEST Surface Wind and Wind Stress Measurements

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The Wind Events and Shelf Transport (WEST) is a study of the role of wind-driven transport in shelf productivity along Northern California off Bodega Bay. A major field program to directly measure the winds is based upon an inner array of 5 meteorological buoys and three coastal stations. The buoy at the center of the wind array is 5 km offshore in 90 m depth. Four additional buoys form a diamond about the central buoy, so that there are three buoys in a line cross-coast and three buoys in a line along-coast, with 20 km separating the most distant along shore and cross shore buoys.

The winds at the buoys are at a common height and minute averaged. The bulk wind stress is constructed at each buoy. The array will provide a direct measurement of the wind stress over the shelf. The along and cross shore wind stress measurements are used to compute the wind stress curl and the long term variation of the wind stress curl.

During the summer of 2001, the winds were generally coherent over the array with all buoys responding to the synoptic scale variations. There is a diurnal variation such that the cross coast wind and stress differences are most at late evening and early morning. The measured wind stress curl time series has great variation in strength and sign

OS61D-07 1030h

Moored Observations of Wind-Driven Oceanographic Variability Over the Shelf Near Bodega Bay, California During the Summer of 2001

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As part of the WEST (NSF CoOP) program, 5 moorings were placed off Bodega Bay, CA beginning in May 2001. The moorings were deployed in a diamond pattern over the shelf with an inner-shelf (40 m total depth) mooring, 3 mid-shelf (90-100 m) moorings, and an outer shelf (130 m) mooring. Distances between moorings were 5-20 km and oceanographic events are correlated over the extent of the mooring array. All moorings included anemometers, temperature loggers, acoustic Doppler current profilers (ADCPs) and near-surface salinity, fluorescence, and light transmission measurements. The central mid-shelf mooring included additional meteorological measurements, near-surface nitrate measurements, and subsurface salinity, fluorescence, and light transmission measurements.

The wind, temperature, and velocity time series show upwelling/relaxation responses characteristic to the region. These upwelling processes influence time series variability of salinity, nitrate and light transmission. Salinity time series show peaks during strong upwelling events. As the summer progresses upwelling salinity peaks weaken. The salinity trend implies the water masses being upwelled change over the course of the summer. The nitrate+nitrite (DIN) time series trend is similar. Peak DIN levels (30 uM/l) occur in early May. Subsequent upwelling events have weaker DIN peaks. On shorter time scales, DIN levels respond immediately to changes in the wind stress. As upwelling winds slacken, DIN levels are rapidly depleted to 0 uM/l. DIN depletion occurs prior to temperature or salinity changes associated with relaxation. DIN levels are highly correlated with light transmission. Freshly upwelled water is high in DIN and relatvely clear. Conversely, DIN levels are negatively correlated with fluorescence.

OS61D-08 1045h

The Response of Phytoplankton Size Spectra and Chlorophyll Biomass to Wind-driven Coastal Upwelling off Northern California During the CoOP-WEST Study.

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During the WEST (Wind Events and Shelf Transport) summer studies of the coastal upwelling region off Bodega Bay, CA, chlorophyll concentrations consistently reached phytoplankton bloom levels following wind driven upwelling events that resulted in high concentrations of pCO2 and nutrients. In most coastal upwelling areas, upwelled nitrate and high rates of new production lie close to the coast in a distinct plume, and their consequences (a band of enhanced chlorophyll) are propagated seaward far beyond the point where upwelled nutrients have been exhausted. Most likely grazing on advected diatoms results in release of regenerated N (ammonium and urea) that is taken up by the small-sized phytoplankton that out-compete diatoms for ammonium and consequently carry coastal new production offshore in the upper layer current system. However in the WEST study area the growing phytoplankton (showing high rates of new production) and productivity are retained on the shelf, and apparently transported alongshore rather than offshore most of the time. The elevated chlorophyll (reaching over 30 μg/l in June 2000) is made up of mostly larger phytoplankton cells with the diatom Chaetoceros spp. dominating during the bloom events. These cells may be grazed or sink and be carried in sub surface currents and re-entrained in the undercurrent, unlike smaller cells that remain in the upper layer. Surface distributions of chlorophyll and phytoplankton size spectra and fluorescence obtained using a CytoSense flow cytometer will be compared between upwelling spring cruises and a non upwelling winter cruise to the CoOP-WEST study site off Bodega Bay, CA.

OS61D-09 1100h INVITED

Progress on physical circulation and ecosystem modeling in the COAST and WEST programs

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High resolution physical circulation and ecosystem models have been applied to study the mesoscale shelf flow field and ecosystem response off Oregon and northern California in the regions of the COAST and WEST field experiments. Localized, regional domains that extend approximately 400-600 km alongshore and 200-300 km offshore are utilized to allow high horizontal grid resolutions of 1-2 km. The Princeton Ocean Model (POM) is used for Oregon while the ROMS model is used for northern California. The Oregon ecosystem model is a five component nitrogen-based NNPZD model. In the most basic, workhorse configuration, periodicity conditions are used at the alongshore boundaries, allowing the specification of well-posed problems. For these shelf flows, where the mesoscale behavior is dominated by the interaction of wind-driven currents with variable shelf topography, that approximation leads to model results that generally show good agreement with observations. Open boundary conditions have also been developed to allow the application of spatially-variable forcing obtained from a high resolution mesoscale atmospheric model. In addition, off Oregon a data assimilation system utilizing HF-radar surface current measurements and a sequential optimal interpolation scheme is being utilized to improve estimates of the circulation. These models have been applied to the spring and summer 2001 time periods of the COAST and WEST field experiments. The modeled mesoscale shelf flow field off Oregon is strongly influenced by interactions with Heceta Bank while the flow off northern California is affected in a major way by Point Reyes. The structure of model sea surface temperature fields reflects the shelf flow interaction with these topographic features and is in good qualitative agreement with comparable satellite-measured fields. New information on the three-dimensional time-dependent nature of the velocity, temperature, and turbulent kinetic energy fields, tested with model/data comparisons where possible, is produced by the model results. Examination of model dynamical balances has helped provide rationalizations for the structure of the circulation processes responsible for the structure of these fields. In particular, analyses of model results have shown the prevalence and importance of pressure-gradient-driven northward flows near the coast after the relaxation of southward upwelling-favorable winds. More detailed accounts of the results from these modeling studies are reported at this meeting by colleagues J. Gan, Y. Spitz, S. Couch and A. Kurapov.

OS61D-10 1120h INVITED

The Influence of Iron on the Biology and Biogeochemistry of the California Coastal Upwelling Area

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Although iron limitation of phytoplankton growth is now widely accepted for oceanic HNLC regimes, the role of iron in controlling biological production in coastal waters remains less well understood. Our research over the past several years demonstrates that iron is often limiting to primary producers in parts of the California coastal upwelling regime, and also exerts a strong influence on community Si:N, Si:C, and N:P ratios. The importance of iron limitation in this area is highly variable, depending on the ratio of Fe: nitrate in upwelling source waters. This in turn depends on the degree to which upwelled water has previously interacted with Fe-rich continental shelf sediments, resulting in a complex spatial mosaic of iron availabilities. Iron limitation effects also vary considerably temporally, over both seasonal and shorter timescales.

We will present the results of a large-scale Fe limitation survey of northern California coastal waters, in which we carried out nearly 50 small-scale Fe addition experiments to examine spatial and temporal variability in phytoplankton growth limitation and elemental ratios. This large data set has allowed us to develop an "Iron Limitation Index" to quantitatively assess the degree of community Fe stress, and to correlate the level of algal Fe stress with biological and biogeochemical parameters.

Results support the hypothesis that shelf-derived Fe input is the primary determinant of community Fe limitation off California. Fe limitation is most common and severe in nearshore waters with narrow continental shelves, but also frequently occurs further offshore in regions with wide, shallow shelves. Fe limitation is also most severe during relaxation periods, and is alleviated to a variable degree by subsurface Fe supplies during periods of strong winds and active upwelling. Our large survey data set demonstrates that Fe limitation is a frequent and widespread phenomenon across large expanses of central California coastal waters. These results will be incorporated into a general conceptual model of the Fe-driven biogeochemical evolution of upwelled water parcels in the West Coast upwelling regime.

OS61D-11 1140h

The Influence of Shelf Geometry on the Supply of Iron and Manganese to Surface Waters in a Coastal Upwelling System

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Iron can be a key element regulating ecosystem structure and primary productivity in coastal upwelling systems. Shelf sediments are the most important source of iron to these systems. In July, 2002, we tested the hypothesis that regions of the coast where the continental shelf is narrow will receive relatively less iron input than regions of the coast where the shelf is broad. We used a combination of underway surface mapping of iron, manganese, nutrients and pCO_2, vertical profiles of Fe, Mn and biological parameters, and high resolution 3-dimensional mapping of nitrate, particle abundance, chlorophyll fluorescence, and dissolved organic matter concentration from a towed, undulating platform.

Surface-water iron and manganese concentrations were significantly lower south of Monterey Bay, off Point Sur, where the shelf is about 1.5 km wide, than north of Monterey Bay, near Davenport, where the shelf is about 10 km wide. During non- upwelling conditions over the broad shelf, dissolvable iron concentrations in surface waters were as high as 3.5 nM nearshore, and decreased to 0.4 nM 20 km from shore. Dissolved manganese concentrations measured at the same time were about 25 nM nearshore and 6 nM 20 km from shore. During non-upwelling conditions over the narrow shelf, in contrast, dissolvable iron concentrations in surface waters were less than 1.6 nM nearshore, and decreased to less than 0.4 nM within 10 km from shore; surface manganese concentrations in the region were uniformly around 3 nM. The onset of upwelling brought higher iron concentrations to the surface in both regions. However, whereas iron levels reached 6 nM in upwelled water over the broad shelf, they were less than 2 nM in upwelled water over the narrow shelf. In general the distribution of manganese was coupled to that of iron, with significant decoupling most likely driven by photochemistry. For example, vertical Mn profiles all showed a near-surface maximum, while Fe profiles did not, and surface Mn concentrations were biased towards higher values during daytime. These results will be discussed in the context of mechanisms of trace metal supply and mobilization, the contrasting biological productivity in the two regions, and implications for iron input during glacial periods of low sea-level stand.

OS62A MCC: Hall D Saturday 1330h

Wind-Driven Processes Along the U.S. West Coast Continental Shelf II Posters *(joint with B, T)*

Presiding: **T Garfield,** San Francisco State University**; P A Wheeler,** Oregon State University

OS62A-0225 1330h POSTER

Particle Size Distributions Over the Oregon Continental Shelf During Upwelling: Relationship to Inherent Optical Properties

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Phytoplankton size is a significant factor in the flow of energy within a pelagic community, whereby larger particles are often indicative of regions with high nutrients, productivity, and export. Particle size distributions have traditionally been measured using a variety of techniques that require discreet sampling (e.g. Coulter Counter), but may also be derived from optical parameters, which provide the possibility of continuous measurement. Several studies have shown theoretical and empirical relationships between the slope of a particle size distribution and the slope of light attenuation as a function of wavelength. The exact relationship depends on the type of particles that make up the size distribution, specifically their absorption and scattering characteristics.

Here we look at the variability of particle size distributions and corresponding fluctuations in spectral attenuation for natural assemblages of phytoplankton off the Oregon coast during the upwelling season. Particle size and optical data were collected during May-June 2002 as part of the NEP GLOBEC program. Size distributions in the range of 2-60 μm were measured from discreet samples using a Coulter Multisizer II (Beckman Coulter), and attenuation by particles was measured continuously along the cruise track at nine wavelengths using two ac9s (WET Labs). Size distributions varied substantially over the study region in both the along-shore and cross-shore directions. Distinct size populations were present in different water masses as indicated by physical parameters. Optical properties varied in a similar fashion, and were largely driven by chlorophyll concentrations. The spectral slope of attenuation was related to both chlorophyll concentration and size distribution. Optical modeling using Mie Theory was consistent with the empirical observations, and both suggest unique relationships between size distribution and attenuation for sediment-dominated waters (previous studies) and phytoplankton-dominated waters (this study), respectively. Given the relationship for phytoplankton-dominated waters, we propose that optical surveys may be used as a proxy to monitor spatial and temporal variations in phytoplankton size distributions in coastal regions, and therefore to study the dynamics and fate of primary production.

OS62A-0226 1330h POSTER

Mesoscale Structure of Bio-Optical Properties Within the Northern California Current System, 2000-2002

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Mesoscale mapping of the hydrographic and bio-optical properties of the Northern California Current System was conducted during spring and summer 2000, 2001, and 2002 off the Oregon coast. A towed, undulating vehicle carried a CTD, two fluorometers, a multi-wavelength absorption and attenuation meter (ac-9), and a PAR sensor. In addition, an ac-9 and a Fast Repetition Rate fluorometer (FRRf) collected bio-optical data on surface waters throughout the mesoscale surveys. Multiple onshore-offshore transect lines provided repeated crossings of velocity jet and frontal boundaries, and allowed resolution of physical and bio-optical parameters on horizontal scales of 1km or less and on vertical scales of 1-2m. Our multi-year results permit assessment of the linkages and the degree of coupling between physical and bio-optical patterns during strong upwelling and strong downwelling events, as well as during low-wind relaxation intervals. The location of the coastal jet and the upwelling front fluctuated considerably under the variable forcing regime, with more extensive mesoscale structure in all parameters in late summer relative to spring, as current meanders developed around subsurface topography (Heceta Bank) and moved offshore near Cape Blanco. Sharp horizontal gradients in autotrophic biomass were observed across the boundaries of the coastal jet and the upwelling front, with chlorophyll levels often in excess of 5-10 mg m^{-3} on the inshore side of the fronts. Horizontal gradients also were observed in the spectral slope of attenuation and dissolved absorption as well as in the physiological properties of the autotrophic assemblages (as determined with FRRf). Details of the spatial correlations of physical and bio-optical parameters will be presented.

OS62A-0227 1330h POSTER

Dye tracer studies of wind-driven upwelling on the Oregon shelf

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A series of dye releases from a small boat during the summers of 2001/2002 has investigated cross-shelf circulation in a region dominated by intermittent wind-driven upwelling. The aim was to make direct, Lagrangian observations of the pathways of cross-shelf flow during active upwelling. Lagrangian techniques provide insight that is not available from Eulerian measurements because of the dominance of alongshelf flow.

Preliminary results will be reported, with emphasis on a release from August 2002, made as winds transitioned from weakly downwelling-favorable to weakly upwelling-favorable. Dye was seeded in an alongshore streak at 20m depth in 55m of water, a little beneath the pycnocline. Of note was the rapid onshore spreading of the dye patch, having a cross-shelf extent of 5km after 48 hours, and extending into shallow water (less than 20m bottom depth). The dye remained largely isopycnal, following the upper edge of the bottom boundary layer onshore. The offshore edge of the patch became associated with a strong temperature inversion - a warm layer, apparently composed of subducted near-surface water. This dataset will provide an opportunity to determine the source of water in such inversions and to evaluate potential mechanisms for their formation.

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Modeling study of upwelling processes over the Oregon shelf

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Time-dependent, three dimensional circulation on the continental shelf off Oregon is studied using the Princeton Ocean Model (POM). The objective is to investigate the flow dynamics, the across-shelf transport, and the nature of the small scale turbulence field associated with the temporal and spatial variability of upwelling on the Oregon shelf during summer 2001. The study applies forcing from observed winds and heat flux for May-August 2001. Model variables compare favorably with current, temperature, hydrographic and turbulence measurements from the 2001 Coastal Ocean Advances in Shelf Transport (COAST) field experiment. The results show that strong offshore transport occurs in the surface/bottom layers near the coast and over Heceta Bank during upwelling/relaxation, respectively. Opposite conditions occur, however, onshore of the 100 m isobath over the south-east region of the bank where northward currents associated with a cyclonic circulation are found. Relatively large values of across-barotropic-streamline transport are found at the outer edge of the bank along the 200 m isobath and off Cape Blanco. Analysis of the balance of terms in the equation for potential temperature reveals that decreasing water temperatures over the bank are caused mainly by across-shelf and vertical advection. Alongshore advection, however, leads to low-density water around the southeast edge of the bank. Relatively large values of turbulent kinetic energy (TKE) are found in both the surface and the bottom boundary layers, with the higher intensity near the coast and over the bank during upwelling. As the upwelling wind relaxes, the TKE weakens quickly at the surface while high values remain near the bottom during the development of northward currents as part of the pressure gradient driven relaxation response. In the time-averaged alongshore momentum equation, strong nonlinear advective effects balance a northward ageostrophic pressure gradient force over the bank contributing to the formation of a local cyclonic circulation.

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