in structuring kelp assemblages in Western Australia. Physical disturbance in the form of winter storms and swell events is the major forcing agent, creating gaps in the dominant kelp canopy. Studies have shown that E. radiata control kelp bed assemblage structure by modifying the surrounding physical environment. It has however also been shown that physical environment and turf algae in gaps may control E. radiata distribution. Consequently, there is now good evidence for mechanisms maintaining alternative states in West Australian kelp beds. Petraitis and Latham (op. cit.) also emphasized the importance of spatial scale in alternative state initiation, i.e. the presence of disturbance size thresholds needed to change from one state to another. This idea is implicitly included in most alternative states models, but it remains largely untested experimentally. Results will be presented from an experiment where we tested the hypothesis that there is a threshold level of disturbance (gap size) above which gaps will persist and that this threshold is lower in more stressful environments (higher wave exposure). Clearings ranging in size from 0 - 200 m2, covering the range of naturally occurring gaps, were made in kelp beds on exposed and sheltered reefs and kelp recruitment monitored for 18 months including two annually occurring recruitment events.

OS22D HC: Hall III Tuesday 1330h

Transport and Transformation of Biogeochemically Important Materials in Coastal Waters I

Presiding: **B J Eadie,** NOAA - Great Lakes Environmental Research Laboratory

OS22D-207 1330h POSTER

Phytoplankton Community Structure and Seasonal Succession in Tomales Bay, CA.

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Tomales Bay, Northern California, is situated just north of Point Reyes, in the Gulf of the Farallons National Marine Sanctuary. Previous studies made as part of the Land Margin Ecosystem Research Study showed Tomales Bay to receive oceanic inputs from both the Gulf of the Farallons, and near-shore sources. Upwelling fronts in the Gulf move shoreward during relaxation events bringing planktonic larvae in contact with warmer, low salinity waters. At this interface, mixing of waters from Tomales Bay, and upwelled coastal waters, may provide phytoplankton seed for bloom events, and a food source for planktonic larvae. As part of the LMER project, the phytoplankton community structure was described for a single annual cycle in a dry year. How community structure changes with inter annual cycles and as a result of upwelling events is yet unknown. This study describes the phytoplankton community structure and seasonal succession in Tomales Bay at two sites, over an eighteen-month period, from April 2000 to October 2001. Phytoplankton were identified and counted using the Utermohl technique and inverted microscopy, along with measurements of chlorophyll a. Peaks in phytoplankton abundance occurred in summer of both years with different taxa dominating each year. Samples for hydrographic and nutrient analyses were made during these bloom times. This poster focuses on phytoplankton community structure and bay nutrient regimes, as they may compare to near-shore biologic and oceanographic conditions.

OS22D-208 1330h POSTER

Temporal and Spatial Distributions of Nutrients and Phytoplankton Productivity in a Northern California Upwelling Region Measured During CoOP-WEST

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Nutrients and phytoplankton uptake rates of nitrate and ammonium were measured in the upwelling region off Bodega Bay in Northern California as part of the NSF CoOP-WEST interdisciplinary study. Water samples were collected over the continental shelf and offshore during the upwelling season in late spring 2000 and 2001. To assess the contribution of different phytoplankton size classes to the uptake of nitrate and ammonium, samples of water incubated with either 15N-nitrate or 15N-ammonium were filtered on either GF/F filters for total phytoplankton community or on 5um silver filters to sample the larger phytoplankton cells. Upwelling areas are typically high new production ecosystems and nitrate uptake is expected to be greater than ammonium uptake. Also, the larger phytoplankton cells tend to dominate both the nitrate uptake rates and the total biomass. In both years of the present study, strong wind-driven upwelling resulted in high concentrations of surface nitrate and silicate near the coast from a source depth of 200m. During the subsequent relaxation period, nitrate uptake increased and was dominated by the larger phytoplankton cells. In contrast, the lower nutrient offshore waters contained a larger concentration of smaller cells taking up ammonium. The relationship between wind events and relaxation plays a crucial role in the realization of productivity in this upwelling ecosystem.

URL: http://userwww.sfsu.edu/~phytopl

OS22D-209 1330h POSTER

Inter and Intra-annual Patterns of Phytoplankton Assemblages During Upwelling Events off the Coast of Northern California (CoOP WEST Study)

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As part of a NSF funded project (Coastal Ocean Processes; Wind Events and Shelf Transport - CoOP WEST) to determine the fate of upwelled nutrients and primary productivity, the composition of the phytoplankton assemblage was examined off northern California during June, 2000 and May/June, 2001 during upwelling season. Phytoplankton were enumerated using the Utermohl technique, and biomass (as chlorophyll a) was measured for the community as a whole and for cells greater than 5um in diameter. For both years, high levels of chlorophyll and phytoplankton cells occurred following upwelling events. At the height of the blooms, total chlorophyll concentrations and phytoplankton biomass were approximately twice as high in 2000 as in 2001, as were the concentrations of available silicate and nitrate just prior to the blooms. Taxonomic observations for each year show that diatoms (especially Chaetoceros spp.) dominated when larger cells were the major contributors to total phytoplankton biomass. As nutrients were consumed during periods of relaxation, diatom cell numbers increased in populations over the shelf and closer to the coast. In 2000 the off shore population in less nutrient rich waters was dominated by smaller, flagellated phytoplankton. In 2001 the spatial shift seen in 2000 from an inshore community dominated by diatoms to an offshore community dominated by flagellates was not observed. Also different in 2001 was the appearance of picoplankton such as Synechoccocus sp. that were observed towards the end of the field study. These differences in the phytoplankton assemblages are likely attributable to different wind event patterns between the two study years.

URL: http://userwww.sfsu.edu/~phytopl

OS22D-210 1330h POSTER

Nitrogen cycling during winter/spring transition in southern Lake Michigan

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Nitrogen is not limiting in Lake Michigan, but it can be a "currency" to assess microbial food web processes and carbon sources. Nutrient-addition experiments were conducted in March and June 1999 and March and May 2000 to measure net direction and magnitude of NH4+ fluxes and relate the results to microbial food web composition. Lake water was fortified with four mM (final concentration) 15NH4+, or a 15N labeled amino acid mixture, and incubated for 24 h in 70-ml bottles to observe net fluxes of these dissolved nitrogen compounds under natural light and dark conditions. Microbial food web components were quantified at the same stations. Net ammonium uptake in the light occurred at most (57 to 86%) of the stations in the different cruises. Net ammonium production was observed in zero to 29% of stations in the four cruises, and no significant change in ammonium concentrations occurred in 13 to 25% of stations. The presence of natural light affected fluxes in 29-75% of the stations, but the remaining stations did not show significant differences. Addition of phosphorus had a moderate but significant effect on ammonium uptake in 43 to 63% of the stations. Amino acid concentrations in lighted bottles showed a net uptake in 13 to 42% of the stations, net production in 25-63% of the stations, and no significant change in 17 to 38% of stations. Overall, amino acid demand was negligible except for a few stations. Light affected amino acid uptake in 5 to 50% of stations. Chlorophyll levels and microbial food web abundance were higher at stations near the St. Joseph River mouth than other stations. Likewise, uptake rates of ammonium and amino acids were higher and rates differed more between light and dark bottles at the St. Joseph River mouth stations. Correlation significance between uptake rates and food web characteristics at the different stations depended on the inclusion of St. Joseph River mouth stations. We conclude that winter/spring microbial food web abundance and nitrogen cycling activity were higher in the river plume region than other regions of the southern lake.

OS22D-211 1330h POSTER

The Spatial and Temporal Distribution of Phosphorus in Western Lake Superior

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Phosphorus is the limiting nutrient for biological production in many lacustrine ecosystems, including oligotrophic Lake Superior. In the past, surveillance programs and other investigations have focused primarily on the measurement of total phosphorus (TP) at the lake surface as a measure of the trophic state of Lake Superior. Although TP concentrations are useful for this purpose, these data alone tell us nothing about the biogeochemical cycling of this important nutrient. At present, little is known about the spatial and temporal distribution of phosphorus and its speciation in Lake Superior. This lack of knowledge stems, in part, from the inability of many standard techniques to resolve low concentrations of soluble reactive phosphorus (SRP). Moreover, total dissolved phosphorus (TDP) has not been routinely measured. Over the last two years, we have sampled the water column at several stations along a transect from the shallow bay waters near Duluth-Superior Harbor to the deep coastal waters. The detailed profiles of TP, TDP, and SRP show that the distribution of phosphorus in its dissolved and particulate pools can vary significantly spatially and seasonally. The data suggest that the soluble non-reactive phosphorus (SNP) pool, which is comprised primarily of dissolved organic phosphorus and is calculated as the

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difference between TDP and SRP, may be an important component of the biological pump. We determine and examine the relationships between phosphorus and other biogeochemical cycles as well as the impact that physical processes, such as coastal upwelling, have on the distribution and fate of these materials.

OS22D-212 1330h POSTER

Effects of Boundary Layer Processes on Nutrient Uptake By Shoals Within Florida Bay

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Florida Bay is exposed to nutrients from anthropogenic sources. These nutrient laden waters traverse the bay and pass over shallow shoal communities before entering the Atlantic Ocean. These shoals are characterized by fast moving unidirectional water flow. Rates of nutrient uptake by benthic communities such as these shoals control important ecological processes (e.g. photosynthesis, calcification) and can be strongly mediated by water velocity, which controls characteristics of the diffusive boundary layer adjacent to uptake surfaces. These shoals are characterized by a complex biological community comprised of seagrass, corals, sponges, macroalgae and other associated organisms that collectively form rough surfaces that affect velocity boundary layer characteristics (i.e. turbulence). In turn, boundary layer characteristics influence the transport of nutrients to and from the benthos and the amount of nutrients moving onto coral reefs in the Atlantic Ocean. In this study, we used hydrodynamic data to predict the efficiency of shoal communities in the Florida Keys to estimate rates of nutrient uptake by the shoals. Results from flume experiments demonstrated that uptake of nutrients by the benthos is velocity dependent and that the effects of whole community uptake is reflected in uptake of individual components (i.e. seagrass, corals, macroalgae, and plankton). of the community. Flow dependent uptake by individual components of the community was verified using stable isotope tracers. Estimates of shear velocity were obtained from velocity profiles collected in the field and used to calculate a friction coefficient. Hydrodynamic models combined with estimates of friction coefficient and measurements of nutrient concentrations in situ were used to estimate the amount of nutrients removed from the water column over a tidal cycle by these shoals.

URL: http://www.chuma.cas.usf/~cornelis

OS22D-213 1330h POSTER

Mediation of Shelf Sea Suspended Particle Properties by Plankton and Turbulence.

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Particle size and properties of suspended particulate matter (SPM) were determined at sites in UK tidal shelf seas in order to measure biological mediation and turbulence forcing of particle aggregation. Specific carbohydrates (monosaccharides) in particle aggregates were determined as proxies of plankton photosynthetic activity during a bloom in the Irish Sea; arabinose was used as a proxy for the dinoflagellate Phaeocystis which dominated the bloom. Mean particle size and settling velocity were proportional to the concentration of arabinose in SPM: hence larger particles and increased settling velocity were closely associated with increased Phaeocystis activity. This is compelling evidence for plankton control of particle aggregation and enhanced settling flux of biodetritus which leads to rapid deposition of benthic fluff.

In the stratified northern North Sea, SPM characteristics were measured concurrently with TKE dissipation. Resuspension of benthic fluff was observed during spring tides and storms. Particle size was inversely proportional to TKE dissipation rate e: the largest particles occurred at the base of the thermocline where e was a minimum and the smallest particles occurred at the seabed where e was a maximum. Hence aggregation occurred in the thermocline and disaggregation at the seabed. The same phenomenon was observed in stratified waters of the Clyde Sea where, in addition, the particle size maximum in the thermocline was accompanied by a chlorophyll minimum. Hence aggregation in the themocline gave rise to loss of chlorophyll due to enhanced settling flux of chlorophyll-rich particles. Turbulence control of aggregation was therefore an important influence on vertical flux of organic matter and deposition of benthic fluff at the seabed.

OS22D-214 1330h POSTER

Distribution and Size Structure of Zooplankton off Northern California as Determined by Optical Plankton Counter: Results From CoOP/WEST.

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As part of the interdisciplinary COOP WEST program studying the role of that wind-driven transport in productivity over the northern California shelf, we are assessing the direct effects of wind-induced advection upon zooplankton distributions and the indirect effects of trophic interactions (i.e., fluctuations of food resources due to wind induced upwelling) on the zooplankton dynamics. In addition to conventional net sampling, we are using an Optical Plankton Counter (OPC) mounted on a ScanFish Mk II towed vehicle, to assess the zooplankton abundances, biomass, size distribution, and vertical distribution. Both cross-shelf and along-shelf transects were undertaken during month-long cruises in early-summer of 2000 and 2001. Preliminary results from 2000 include onshore to offshore decreases of zooplankton abundance, size and biomass in conjunction with a decrease in light attenuance. In addition, increases of size structure, abundance, and biomass in the upper water column after dusk indicate a presence of diel vertical migration. These results, as well as those from 2001, will be discussed in relation to hydrographic features, wind events, and phytoplankton (Chl a).

OS22D-215 1330h POSTER

Broad-Scale Distribution, Community Composition and Relative Grazing Impact of Zooplankton off Northern California: Results From CoOP/WEST.

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The Coastal Ocean Processes (CoOP) Wind Events and Shelf Transport (WEST) project is an interdisciplinary project designed to determine the effects (both direct and indirect) of wind-driven transport on productivity over the shelf off northern California. Some specific objectives of this research include the determination of broad-scale distribution, community composition and relative grazing impact of zooplankton in response to shelf transport and resource variation. Zooplankton were sampled using 335um mesh bongo nets (for distribution and community composition) and 73um mesh ring nets (for grazing impact) during June 1-30, 2000 and May 15-June 15, 2001 cruises. Relative grazing impact was determined by the gut fluorescence method, which uses gut pigment as a proxy of gut content. Winds during June 2000 were characterized by relaxation, i.e., generally low winds early in the month, punctuated by modest upwelling-favorable winds mid-month, followed by generally low winds. May/June of 2001, in contrast, was characterized by stronger, more persistent upwelling-favorable winds. The dominant taxa from the 335 um bongo net catches included copepods of the species *Pseudocalanus newmani*, *Metridia pacifica-lucens* and *Tortanus discaudatus*, as well as euphausiids. Total mesozooplankton abundance in June 2000 was generally highest off Point Reyes and declined to the north and inshore. Abundance of zooplankton > 335 um throughout the study area changed little during the relaxation period of June 2000, although smaller size classes of zooplankton increased dramatically. Grazing impact of mesozooplankton showed even more dramatic variation, especially between years. During late June 2000, mesozooplankton grazing impact (% phytoplankton consumed per day) averaged 110% (range = 25-300%). This is in contrast to an average 21% (range = 1-48%) mesozooplankton grazing impact observed in May-June 2001. These results suggest that grazing impact of mesozooplankton on phytoplankton in upwelling areas can co-vary with wind conditions, being substantially higher during relaxation events than during active upwelling.

OS22D-216 1330h POSTER

Cross-Shelf Distribution and Diel Vertical Migration of Mesozooplankton off Northern California: Results From CoOP/WEST.

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Coastal upwelling areas are amongst the most productive aquatic systems on earth, yet a fundamental question remains as to how zooplankton balance the benefits of high primary productivity with the potential costs of advection off the shelf and into less favorable habitats. As part of the interdisciplinary Coastal Ocean Processes (CoOP) programs Winds Events and Shelf Transport (WEST) project, we made concurrent biological and physical oceanographic observations on the continental shelf off northern California during the summers of 2000 and 2001. Our overall goal is to critically examine the role that wind-driven transport plays in shelf productivity. One of our more specific research questions with regard to zooplankton is: Does wind-driven transport of water directly affect the distribution of zooplankton on the shelf, or are they behaviorally adapted to avoid such transport via diel vertical migration? Our sampling consisted of several broad-scale (along-shelf and cross-shelf) surveys with bongo and ring nets, as well as underway hydrographic sampling using a Scanfish. Additionally, vertically stratified sampling of mesozooplankton, consisting of replicate daytime and nighttime tows of a MOCNESS system, was undertaken at inner shelf (40m), mid-shelf (90m) and outer shelf (150m) stations. Moored ADCP observations of currents were collected at the mid-shelf station during 2000 and at the inner shelf station following the cruise, as well as at all three stations during 2001. The composition of the mesozooplankton community varied in the cross-shelf direction, being dominated by copepods of the genera *Acartia* and *Pseudocalanus* on the inner-shelf, *Pseudocalanus* and *Metridia* on the mid-shelf, and *Metridia*, *Pseudocalanus* and euphausiids on the outer-shelf. The vertical distribution and diel vertical migration (DVM) behavior of the copepods varied dramatically between taxa, e.g., *Acartia* generally showed weak or non-existent DVM, *Pseudocalanus* demonstrated modest DVM, and *Metridia* undertook strong and persistent DVM. While currents were weakly sheared over the inner shelf, currents over the mid-shelf exhibited significant vertical shear, especially the cross-shelf component, being generally offshore at the surface and inshore at depth. Thus the DVM behavior exhibited by *Metridia*, and to a lesser extent *Pseudocalanus*, resulted in the maintenance of these populations within the food-rich middle-shelf. The sensitivity of these population distributions to variation in wind intensity and duration will be discussed.

OS22D-217 1330h POSTER

On the Roles of Wind Forcing, Wind Stress Curl, Buoyancy and Bottom Topography in Eastern Boundary Current Systems

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To investigate the roles of wind forcing, wind stress curl, buoyancy, and bottom topography in generating currents and eddies in eastern boundary current (EBC) systems, three EBC regions, the California Current System (CCS), the Northern Canary Current System (NCCS), and the Leeuwin Current System (LCS) are investigated with the use of a fine-resolution numerical model. Results for both the CCS and the NCCS show the generation of classical features on west coasts including coastal equatorward currents and poleward undercurrents, while results for the anomalous LCS show the generation of coastal poleward currents and equatorward undercurrents. While all three regions show highly energetic mesoscale features such as meanders and eddies, only the CCS and the NCCS show the formation of filaments. In the NCCS, many of the classical wind-driven features such as upwelling and filaments are diminished in the Gulf of Cadiz, which is a large embayment that separates the west coast of Portugal from the west coast of Morocco in the NCCS. Meddies and the Iberian Current are also formed in the NCCS model, the former due to the presence of Mediterranean Outflow and the latter due to thermohaline gradients. Finally, sensitivity studies with and without bottom topography, are conducted. Wind forcing (thermohaline gradients) is (are) shown to be the primary mechanism for the generation of currents, meanders, and eddies in the CCS and NCCS (LCS), while bottom topography is shown to play important roles in intensifying and trapping currents near the coast, in weakening subsurface currents and in intensifying eddies off capes.

OS22D-218 1330h POSTER

Airborne Hyperspectral Ocean Color Measurements off the Oregon Coast

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Transport during wind-driven events was the primary focus of the Coastal Ocean Advances in Shelf Transport (COAST) project during the Summer of 2001. Hyperspectral remote-sensing and mapping of surface ocean color properties provide a valuable tool for determining the structure and transport of important biological components in the coastal waters.

An instrumented light aircraft was used during COAST to remotely measure ocean color and upper-ocean temperature, as well as conduct simultaneous atmospheric measurements of horizontal winds, air temperature, pressure, and humidity. The aircraft provided rapid coverage over the study area along eight 60-80 km cross-shore transects in about 5 hours.

Two hyperspectral radiometers were mounted on the aircraft, one to measure downwelling irradiance (E_d) and one to measure upwelling radiance (L_u). Both radiometers have a spectral resolution of $\sim$1.3 nm from 400 nm to 720 nm giving 256 channels in the visible spectrum, capable of sampling at 3 Hz. The spatial resolution of the upwelling radiance measurement is $\sim$10 m when the aircraft is flown at an altitude of 300 m with one pixel sampling alongtrack of the aircraft.

Twenty-seven flights were conducted during the Summer 2001 COAST field project. Several of these flights surveyed the various stages of spin-up, progression, and slackening of upwelling cycles. Preliminary color products show typical distributions of higher chlorophyll concentrations corresponding to cold upwelled waters nearshore, as well as spectrally complex waters near river and bay outflow areas. Also, sequences of flights mapped residual plumes and their movement several days after the upwelling conditions were gone. These and other observations will be presented in detail in this poster.

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

OS22D-219 1330h POSTER

Biogeochemical Evolution of the Atmospheric CO_2 Sink in a Long-Lived Mesoscale Eddy in the Northeast Pacific Ocean

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Large, anti-cyclonic rings (called Haida eddies) which form off the coast of British Columbia in late winter often track due west, carrying large quantities of coastal water into the High Nutrient-Low Chlorophyll region of the eastern North Pacific. We successfully tracked one such eddy (Haida-2000) with TOPEX altimetry for more than two years, as it travelled offshore, allowing us to repeatedly sample its biogeochemistry on 6 ship-based expeditions. Based on the difference between observed changes in dissolved inorganic carbon concentrations and estimated biological carbon consumption derived from nutrient drawdown, we found that Haida-2000 was a much more efficient CO_2 sink than the surrounding open ocean waters, which typically absorb little atmospheric CO_2 over the net annual cycle. These observations are consistent with independent observations of high biomass and primary production associated with the eddy, and therefore, westward propagating Haida eddies may play a significant role in sequestering carbon in the North Pacific. However, confirmation of this hypothesis will require a better understanding of interannual variability in the occurrence and properties of Haida eddies.

OS22D-220 1330h POSTER

Aging Mesoscale Eddies: Biological Processes and Their Consequences

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Haida-type anti-cyclonic mesoscale eddies are generated yearly in winter off the coast of the Queen Charlotte Islands, British Columbia. These eddies move offshore, carrying a core of high nutrient, fresh, warm water into the Gulf of Alaska. Such eddies persist for one to several years, over which time biomass distribution, phytoplankton size spectra, and rate of biological carbon fixation change. Biomass distribution does not appear to change seasonally, but as a function of the aging process. The highest chlorophyll a and particulate carbon/nitrogen concentrations exist first in the eddy center, moving to the margins in autumn, and back to the center as the eddy ages in the second year. This was consistent with highest loss of nitrate and total dissolved inorganic carbon (C_T) in the center of the eddy during spring. Consumption of nitrate and C_T decreased significantly during summer at the center; carbon consumption at center and edge was similar during this period. A comparison with coastal and oceanic reference stations showed that the eddy lost four to ten times more nitrate and three times more C_T. Our findings indicate that not only cyclonic eddies but also anti-cyclonic eddies have an enhanced biological production.

OS22D-221 1330h POSTER

Nearsurface Circulation in DeSoto Canyon: Comparison of Current Meters, Satellite Observation, and Model Simulation

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This study evaluates a data-assimilated model simulation of nearsurface circulation in the DeSoto Canyon (DSC), Gulf of Mexico, with emphasis on analyzing moored current-meter observations and comparing them with satellite data and model results. The study period is for two years from April 1997 to April 1999. The model result is from a high-resolution Gulf of Mexico model forced by wind and surface heat flux. Two types of data are used to deduce nearsurface circulation: moored current meters at thirteen locations in the DSC and satellite sea level anomaly. The moored currents are mapped through multivariate objective analysis to produce surface currents and geopotentials, against which satellite and model derived sea surface heights and geostrophic currents are compared. Coupled patterns between the observations, model results, and satellite data, are obtained using singular value decomposition. There are two dominant modes: a single-eddy mode where currents are concentrated at the foot of the canyon and an eddy-pair mode where one eddy is at the foot of the canyon and the other, a counter-rotating eddy, is over the head of canyon. Mode-1 appears to be associated with the mesoscale eddy travelling around Loop Current crest and trough, and mode-2 is associated with the intrusion of Loop Current crest/trough over the West Florida shelf. The observed and model currents are in good agreements about the means and variances. The model currents also appear to be well constrained by the steep topography. However, the model velocity field contains only the first mode. The satellite-derived velocity field, on the other hand, contains both the first and second modes; though, the satellite field does not adequately resolve velocity structures over the slope.

TUE

OS22D-222 1330h POSTER

Organic Material in the Oregon Upwelling Zone: Distributions and Processes

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The upwelling system off the Oregon coast is characterized by high biological productivity. Despite conceptual and quantitative advances in the understanding of upwelling systems, little is known about the processes that control distributions and fate of organic matter in such systems. As part of the Coastal Ocean Advances in Shelf Transport (COAST) project we studied distributions of chlorophyll and particulate and dissolved organic matter. These measurements were done in conjunction with high-resolution measurements of physical and chemical parameters. Preliminary results show high (but greatly variable in space and time) concentrations of chlorophyll, particulate organic carbon (POC) and particulate organic nitrogen (PON) at the surface. A persistent feature, observed over the shelf, is the presence of relatively elevated concentrations of chlorophyll (2-28 ug/l), POC (90-740 ug/l) and PON (18-125 ug/l) near the bottom (at 25-50 m). A minimum in the concentrations of these parameters was typically observed in the middle portion of the water column. POC and PON near the bottom are strongly correlated with chlorophyll. C/N ratios further suggest that this organic material is relatively fresh. Processes that could lead to observed distributions and their implications to the dynamics of organic material in the Oregon upwelling zone will be discussed.

OS22D-223 1330h POSTER

Vertical Profiles of Potential Anaerobic Activity in the Humboldt Current System off Northern Chile

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The presence of the subsurface oxygen minimum layer (OML) in extensive areas off northern Chile associated to the Gnter Current has important effects on the metabolism of the organisms that inhabit this environment. Planktonic species have to deal with the hypoxic and anoxic environment relying on biochemical as

well as physiological mechanisms related to anaerobic metabolism. The enzymatic adaptation of microplankton to these low oxygen conditions in the Humboldt Current System (HCS) remains unknown. Here we characterize, for the first time, the potential enzymatic activities involved in anaerobic energy metabolism in microplanktonic organisms (<200 mm), the relationship between them and its association to the OML and adjacent areas of the water column.

The sampling program was conducted during the MINOX cruise (March 2000) off Iquique northern Chile (20 20.5S; 70 10.05W). The enzymes analyzed were the following: Pyruvate oxidoreductases (LDH, OPDH, ALPDH and STRDH), Ethanol dehydrogenase (EtOHDH), Malate dehydrogenase (MDH), Citrate synthase (CS), and Nitrate reductase (NR). ATP-P determination was done as biomass measure.

Our results demonstrate the existence of significant potential enzymatic activity of anaerobic pathways in the OML implying that this zone of the water column is biogeochemically active. The data suggest that the limit of oxygen concentration where microplanktonic biomass correlates well with aerobic metabolism up to 0.1 mL/L. Below that concentration, anaerobic enzyme activities and ATP-P correlate well but there is no relationship with oxygen content of the water column. MDH correlates best with all other enzymes analyzed and specially with NR in the OML. The latter, seems to have an important role in nitrate respiration in the poor oxygen condition. In addition MDH is well correlated with microplanktonic biomass, determined from ATP-P (Rsq = 0.8; p<0.00001) above and below the OML. This fact is consistent with the role of this enzyme shuttling reducing equivalents between the mitochondria and cytoplasm in aerobic conditions and in the in maintaining cytoplasmic redox balance during intense anaerobic metabolism. Finally, we hypothesize that MDH activity could be a good indicator of the status of the energetic metabolism of the microplanktonic community of the entire water column where OML is present.

OS22D-224 1330h POSTER

High Resolution Mapping of Radionuclide Inventories at the High Deposition Area in Southern Lake Michigan

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For at least the last 3500 years, fine grained sediments have preferentially accumulated along the eastern side of Lake Michigan, although source materials derive mainly from erosion of bluffs on the western side. In the southern part of the lake, an area (HiDep) of quite limited extent (< 1000 km^2), located ca 20 km offshore in water depths from 30 to 100 m, has the highest rate of sediment accumulation in the lake. Recent studies indicate that the build-up of sediment is likely accomplished by late winter wind-driven resuspension events that move large quantities of sediment eastward around the southern margin of the lake toward the HiDep area. In the present study, we measured the inventories of fallout ^{137}Cs($t_{1/2}$ = 30 yr) to determine patterns of accumulation during the past 50 years, and cosmogenic ^{7}Be ($t_{1/2}$ =53 days) to determine patterns associated with seasonal re-suspension events. A total of 140 box cores were collected from a 3x3 km grid over the HiDep area in Sep. 1998 and Feb., Apr. and Jun. 1999. While the pattern of ^{137}Cs accumulation was consistent with historical deposition, ^{7}Be deposition was characteristic of excursions of resuspended materials over the HiDep area. Long-term deposition patterns may require many annual cycles of re-suspension and re-deposition and/or subsequent redistribution of newly deposited particles within the HiDep area.

OS22D-225 1330h POSTER

The Dynamics of Th-234/U-238 Disequilibria in Nearshore Lake Michigan as Determined by Daily Measurements.

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Suspended sediment concentrations and activities of dissolved (< 0.45 um) and particulate Th-234 were measured on a daily basis from 14-Jan-2000 to 26-May-2000 on raw water samples taken from the Milwaukee water filtration plant (MWFP) intake located several kilometers off shore at a water column depth of 20 meters. Ancillary data on particle size distribution, turbidity and conductivity were collected by the MWFP. Water column and lake bed sediment inventories of Th-234 were also measured on a cross margin transect off Milwaukee in water column depths of 10, 20, 30 and 40 meters during three 10 day cruises in March, April and May of 2000. Concomitant measurements of vertical and horizontal particle fluxes were made using sediment traps and an instrumented benthic tripod.

Changes in water column and lakebed Th-234 inventories in relation to local meteorological conditions and the relationship between Th-234 derived sediment fluxes to those measured empirically by sediment traps and the benthic tripod will be discussed.

OS22D-226 1330h POSTER

Characterization of Marine Acid Polysaccharides Responsible for Binding Th Isotopes

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Particle flux studies in the upper ocean have long used isotopes of Th (IV), one of the most particle-reactive elements in the ocean, to obtain rates and mechanisms of marine carbon cycling used to parameterize the fluxes of organic carbon in global carbon models. Recently, our results have shown that Th (IV) isotopes strongly associate with acid polysaccharides in the ocean. Polysaccharides are the most surface reactive organic biopolymers in marine environments. Acid polysaccharides, even though only a small fraction of the polysaccharide pool, play a critical role in the formation of marine snow flocs, mucilaginous aggregates, and the removal of trace elements and radionuclides from the water. We report here, for the first time, results from the determinations of the functional group composition of acid polysaccharides, isolated using cross-flow ultrafiltration, separated using isoelectric focusing and polyacrylamide gel electrophoresis (PAGE), and radiolabeled using ^{234}Th. Phosphate and sulfate concentrations in samples from the Gulf of Mexico, using spectrophotometry and ion chromatography/HPLC, are reported here.

URL: http://loer.tamug.tamu.edu

OS22D-227 1330h POSTER

Determination of Particle Residence Times in Lake Superior Using Radioactive Tracers

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Cross-margin transport of BIM (Biogeochemically Important Materials) along the coastal region of Keweenaw Peninsula has been studied in the KITES project, a multi-disciplinary study of Lake Superior. Particle-reactive radioisotopes are being utilized to determine the particle residence times in the nearshore zone, i.e. the rate and time scale of cross-margin transport. In addition to determining the time scale of the particle movements (sediment transport) in the nearshore region of Lake Superior, this study also is investigating the factors regulating the particle movements. Inventories of several naturally occurring or artificial radionuclides (^{210}Po, ^{210}Pb, ^{137}Cs) have been measured along transects running perpendicular to shore. Isotope residence time is defined as the inventory divided by the flux. For isotopes (such as ^{210}Pb) with nearly constant inputs from atmospheric fallout, residence times can be determined. Box models with different boundaries are used to determine the influence of bathymetry, waves, and currents. This residence time is the collective result of all processes affecting isotope transport in the system, as well as the isotope decay. Particle residence times can be determined from the residence times of particulate-bound isotopes. This approach allows determination of particle residence time in non-depositional zones of the lake, as well as the rate of cross-margin transport. Preliminary results indicate isotope residence times vary from a few weeks in the very shallow nearshore region to a few years at water depths of 100 meters, and up to several years in water depth of more than 150 meters. Ratios of ^{210}Pb:^{137}Cs and ^{210}Po:^{210}Pb change systematically along the transect in response to changing rates of resuspension and changes in sediment provenance.

OS22D-228 1330h POSTER

Oxygen Measurements in Carr Inlet, Puget Sound: A Time Series From a Moored Profiler (ORCA)

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Carr Inlet, in South Puget Sound, is an area of rapid and large human development. To measure the impacts of the development on water quality in South Puget Sound, we deployed a moored profiler (ORCA: Oceanic Remote Chemical-Optical Analyzer) with a CTD, oxygen electrode, transmissometer, fluorimeter, and weather station. All sensors take measurements 4 to 6 times each day, and the data is transmitted back to shore every night via cellular phone. The high frequency of our measurements results in a very detailed time series, which shows variations within the data on both diurnal and seasonal time scales. Surface oxygen saturation values show a dramatic seasonal change, from approximately 150% in the summer to 80% in the winter; surface temperatures vary from around 18°C in the summer to 10°C in the winter; salinity varies from around $29^{o}/_{oo}$ in the summer to $30^{o}/_{oo}$ in the winter. Surface oxygen values vary through the day by up to 20%. Daily dissolved oxygen variations from late May to mid-December 2000 have been inspected and compared with variations in density, chlorophyll, light, wind speed, and vertical gradients to determine which of these factors have the most impact on oxygen, and to determine the magnitude of net biological oxygen production (J). Values for J decrease from midsummer through fall and into winter. In June, J = 0.7 ± 0.4 mol O_2 m^{-2} d^{-1}; in August, J = 0.5 ± 0.09 mol O_2 m^{-2} d^{-1}; in September, J = 0.3 ± 0.2 mol O_2 m^{-2} d^{-1}. We compared J with estimates of primary productivity (PP) and found that the J/PP ratio, when both are converted to O_2 m^{-2} d^{-1} using a ΔO_2 to ΔC ratio of 1.45, ranges from 0.95 in mid summer to 0.3 in the fall.

OS22D-229 1330h POSTER

In Situ Chemical Sensor Measurements in a Lake During Turnover and Stratification: Comparisons Between Observations and Results From Physical and Biogeochemical Modeling

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Several autonomous, *in situ* sensors were deployed on a subsurface mooring in a freshwater lake to measure the partial pressure of CO_2 (pCO_2), dissolved O_2 (DO), temperature and several other variables. These high temporal resolution time-series were obtained during the important transitional period from ice cover to summer stratification. Data from periodic measurements and local and regional meteorology were obtained to aid the interpretation of the *in situ* data.

Vertically distributed sensors within the water column showed that convective currents led to lake turnover and complete mixing under ice. A one-dimensional (vertical) physical mixed-layer model for the upper ocean was adapted for use in freshwater. The model simulated the thermal structure of the lake exceptionally well in both ice-covered and ice-free conditions. Simple two-box biogeochemical models were developed for pCO_2 and DO and were coupled to the mixed-layer depth output from the physical model. The biogeochemical models were used to quantify the relative importance of biology, air-water gas exchange, mixing, and heating and cooling on pCO_2 and DO. Net community production dominated the average daily variability of pCO_2 (78%) and DO (98%) under ice. After ice out, net community production, gas exchange, mixing, and heating and cooling each contributed 33, 30, 14, and 23%, respectively, to pCO_2 variability in the surface mixed-layer. These same processes contributed 36, 45, 19, and 0% to the DO.

OS22D-230 1330h POSTER

Biogeochemical Cycling of Methane and Sulfur in Methane Hydrate-Rich Sediments Along the Continental Slope, Gulf of Mexico.

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Methane is a radiative trace gas, thus changes in atmospheric methane concentrations can alter global temperatures. Methane hydrates represent one of the most important and dynamic reservoirs of organic carbon on Earth. Destabilization and dissociation of nearshore hydrate reservoirs has been correlated with significant geologic time scale variations in global temperatures. While hydrate destabilization could transfer large amounts of methane from oceanic to atmospheric reservoirs over short time scales, oxidation of hydrate-derived methane within sediments and in the oceanic water column could ameliorate the transfer of hydrate-derived methane to the atmosphere.

We examined the rates and controls on anaerobic methane oxidation in methane hydrate-associated sediments, in sediments near hydrates and in control sediments lacking hydrates at several sites along the Gulf of Mexico continental slope. Sediment push cores were collected at well-characterized sites using the research submersible Johnson Sea Link. A suite of standard geochemical parameters and stable isotopic ratios of solid phase and gaseous C species were determined over depth in sediment cores. Rates of anaerobic methane oxidation and sulfate reduction were determined in push core sub-samples using standard radiotracer (14C and 35S) techniques applied to whole cores. The identity of the microorganisms likely involved in anaerobic methane oxidation was examined using published probes for methanogenic Archaea and sulfate reducing Bacteria and FISH. Laboratory substrate manipulation (e.g., methane, acetate, hydrogen, sulfate, etc.) and metabolic inhibitor experiments were conducted to identify the environmental controls on anaerobic methane oxidation in these environments.

Isotopic and geochemical evidence suggested rapid rates of methane and sulfur cycling within hydrate-associate sediment. Direct measurements of activity confirmed the indirect geochemical data, illustrating extremely high rates of methane oxidation and sulfate reduction in hydrate-associated sediments and in sediments adjacent to hydrates. As expected, rates of both processes were substantially lower in control sites lacking visible hydrates and having background (10's of M) methane concentrations. Results from FISH of sediments within peak activity zones corroborated results from similar studies in other hydrate environments suggesting that a consortium of methanogenic Archaea and sulfate-reducing Bacteria are involved in anaerobic methane oxidation.

OS22D-231 1330h POSTER

Results of a 3-Year Field Study of Sediment Resuspension in Southern Lake Michigan: Effects on the Cycling of Persistent Organic Pollutants

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Sediment burial provides a pathway by which persistent organic pollutants (POPs) may be removed from the Great Lakes, acting as a sink. However, surficial sediments resuspended because of intense, large-scale storms during the late winter in southern Lake Michigan may be a source of POPs to the water column. To examine the impacts of large-scale sediment resuspension in southern Lake Michigan, spatially coordinated air, water, and settling sediment samples were collected. Field sampling was conducted during the late winter and spring of 1998, 1999, and 2000 when the lake was unstratified. This resulted in nearly 400 samples that were analyzed for polychlorinated biphenyl congeners (PCBs), polycyclic aromatic hydrocarbons (PAHs), and chlorinated pesticides such as DDT and its daughter compounds.

In March 1998, an estimated 7.5 x 10^9 *kg* of sediment was resuspended in southern Lake Michigan (Schwab *et al. Estuarine, Coastal, and Shelf Science.* **2000**, *50*, 49-58.), which was 2.5 times the annual average for the last 100 years. Results of our study indicate that an estimated 400 kg of PCBs were associated with those sediments. Although it is not clear, the drop in measured dissolved-phase PCB concentrations (from 219.4 $\pm$ 54.4 $pg\ L^{-1}$ in January 1998 to 128.4 $\pm$ 41.8 $pg\ L^{-1}$ in March 1998) suggests that some fraction of the sediment-associated PCBs was scavenged from the water by the resuspended sediment. Implications of this drop include an increase in atmospheric deposition from gas exchange.

Samples were collected during three years in which the intensity, spatial extent, and duration of sediment resuspension differed. Data from the three years of field sampling and process modeling is being used to evaluate these event-related effects on (a) the concentration of POPs in air, water, and settling sediment; (b) the short-term fate by using the unique chemical characteristics and patterns of POPs to trace the sources of resuspended sediment; and (c) the long-term fate and bioavailability by using changes in partitioning of POPs between air, water, and settling sediment.

OS22D-232 1330h POSTER

Geochemistry of Surface Sediments in the Aegean Sea (Greece). Implications of River Runoff, Anthropogenic Pollution and Bottom Topography

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The northwestern Aegean Sea comprises the gulf of Thermaikos and the Sporades Basin, forming a system of a wide continental shelf, a sharp continental slope and a deep basin, reaching 1400 m depth. The perennial rivers Axios, Aliakmon, Pinios, Loudias and Gallikos supply annually the marine area with 6x10^9 m^3 of freshwater and 0.633x10^6 T^{-1} of sediment. The river discharges are enriched in nutrients, heavy metals, pesticides and fertilizers, resulting from various anthropogenic activities in the catchment area. Thessaloniki city (population 1500000) is situated in the northernmost part of the area and supplies the gulf of Thermaikos with domestic and industrial effluents partly untreated. The main scope of this communication is to present the distribution patterns of major/trace element content of surface sediments in the NW Aegean Sea. Sediments' geochemistry has been assessed on the basis of 112 samples collected during a number of cruises of the R/V Aegeao in the area and analyzed by X-Ray Fluorescence. Possible element sources are addressed, as well as relations to the sediment grain-size and bottom topography are discussed. The shelf is covered by silty sediments, except for the central/eastern section, where sandy relict sediments prevail; the latter were deposited during the last sea transgression. Clayey sediments cover the Sporades Basin seafloor. Organic carbon content is markedly increased near Thessaloniki, whereas relatively elevated values were observed in the vicinity of the river mouths. Al, Ti, Fe, K, Mg, Na contents were found increased along the western coastline, where most rivers discharge, as well as in the Sporades Basin. These major elements are related to terrigenous material (aluminosilicates) of riverine origin. However, Si distribution patterns exhibited elevated values in the central/eastern part of the shelf, attributed to pure quartz, which is abundant in the relict sands. Ca and Sr, which represent the biogenic part of the sediment were found elevated in the Sporades Basin and the south continental slope. Elevated values for P and S were observed in bay of Thessaloniki, indicating elevated domestic inputs and anoxic conditions. Heavy metal distribution patterns were found highly complex, reflecting in some cases directly the major sources. In general heavy metal values were following grain-size distribution, i.e., elevated contents were found in the silty and clayey sediments of the western coast and the deep basin. Enriched heavy metal contents near the river mouths revealed that Axios River is the most important supplier for Cu, Zn and Pb, Aliakmon River for Cr, Co, Ni, Mo and As, whereas Pinios River contributes in a lesser extent for Co, Ni and As. These results are consistent with the stream sediment chemistry performed by other investigators. A significant part of the heavy metals is related to each catchment's lithology, as the rivers drain different types of parent formations including ophiolites, ultrabasic, metamorphic and volcanic rocks. The sediments of Thessaloniki Bay were found enriched in Cu, Zn, As and Pb, highlighting anthropogenic pollution.

TUE

OS22D-233 1330h POSTER

Observations and Modeling of the Transport of Effluents Discharged to the New Jersey Coastal Ocean

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Secondarily treated sewage effluent is discharged to New Jersey's Coastal Ocean through 14 ocean outfalls. The average total effluent discharge rate through these outfalls is about 10 m3/s. The seaward extent of the outfalls varies from 500m to 2300m and all terminate in a multiport diffuser section. Water depths at the diffuser sections vary from 10-20m. A three-year study of the initial dilution and subsequent transport and mixing of effluent discharged through two of these outfalls has been completed. Field observations included 15-day continuous dye release studies through each outfall and mapping, on at least 10 different days at each outfall, of the spatial distribution of the dye at horizontal distances of up to 10km from the outfall. Receiving water characteristics were observed using a fixed bottom-mounted acoustic Doppler current profiler, ADCP, and a towed ADCP. The vertical salinity and temperature distributions were observed with frequent CTD casts. Additional ADCP current observations were obtained over several months at each outfall.

The data collected during the dye release experiments were initially analyzed to determine the relative capability of 6 widely used, USEPA supported, initial dilution models to predict the observed near-field dilution of the effluent, which results from its initial discharge momentum and buoyancy. Initial dilution model predictions for the height of rise of the plume and its vertical thickness were also compared with observations. A transport model using current velocities observed at just one location in the vicinity of the outfall and a one-parameter, scale-dependent diffusion model was developed to predict the subsequent dilution of the effluent plume. This model uses an initial dilution model to predict the height of rise and layer thickness of the effluent plume. A vertical line source extending over this layer thickness is located at each open port of the diffuser. The continuous discharge at each port is modeled by the discharge at this line source of a sequence of instantaneous releases at 10-minute intervals. Ten-minute average current speeds are then used to advect each modeled release while these individual patches diffuse accordingly to a 2-dimensional scale-dependent, axisymetric diffusion model. Far-field concentrations are computed by a superposition of all diffusing releases. Comparisons of model predictions of the far-field concentrations with the observed dye distributions were reasonably accurate.

OS22D-234 1330h POSTER

Chromium Immobilization in Harbor Sediment Mesocosms

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In the environment Cr exists primarily as Cr(VI), the soluble and carcinogenic form, and Cr (III), which is less soluble and non-toxic. Cr(VI) is widely used as an antifouling and anticorrosive agent and some harbor sites have up to 12 mM of total Cr. To determine the fate of Cr(VI) entering marine sediments from the water column, we performed mesocosm experiments with 37.85 L aquaria containing sediment, seawater, and paddles to simulate modest wave action. Sediment was collected from San Diego Bay, homogenized and put into five aquaria with 20 L of overlying seawater. Two aquaria were used as controls without Cr(VI), two with 0.25 mM Cr(VI) (low- Cr), and one with 1.5 mM Cr(VI) (high- Cr). Cr(VI) levels were maintained by adding Na2CrO4 as needed. After two months, two 10 cm cores from each aquarium were taken, sliced at 5 mm intervals, and total Cr, Fe, and Mn concentrations measured by ICP-OES. Organic carbon content was determined by the ignition method. We also investigated the role of the bacteria for Cr(VI) reduction, examining the microbial community structure using denaturing gradient gel electrophoresis (DGGE).

The profiles of metals and organic carbon with depth in the sediment were investigated. Concentrations of total Cr (1 mM) were found in the control aquaria throughout depth and considered as a background. Concentrations up to 9 mM and up to 14 mM of Cr were found in the low- and high- Cr aquaria, respectively. Most of the chromium was immobilized within the first 2-3 cm. The concentrations of Fe, Mn, and organic carbon in sediment cores did not indicate significant stratification in most mesocosms. We attempted to find correlations between Cr and investigated parameters. For example, Cr correlated with Fe in the control and low-Cr aquaria ($r = 0.74$ to 0.80; $p < 0.01$) and with Mn in all three sets of aquaria ($r = 0.57$ to 0.65; $p < 0.05$). The correlation between organic carbon distribution and Cr was not very clear. However, there was a correlation between Cr and organic carbon ($r = 0.90$, $p < 0.01$) in one core from a low- Cr aquarium, that had the highest concentrations of Cr and organic carbon (18 mM and 7.34 %, respectively) in the surface sediment layer. These observations suggest that when Cr concentrations are high (12 to 14 mM), neither organic carbon or solid Fe phases have sufficient capacity to adsorb or react with Cr(VI).

The DGGE profile showed that the bacterial community was similar at all depths in all conditions except the first cm of sediment where Cr was significantly accumulated. This result showed that Cr affected the microbial community and enriched for bacteria that might be key players in the immobilization and detoxification of Cr(VI). Our findings indicate that Cr(VI) reduction and precipitation take place in the surface layers of sediments where complex interactions between geochemical factors and microbial populations occur. The contribution of bacteria to Cr immobilization and the natural attenuation of Cr(VI) pollution is currently being investigated.

OS22D-235 1330h POSTER

Examination of Molecular Markers Specific to Urban Stormwater Runoff

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Tracing pollutants in coastal marine sediments is a challenging task, since inputs from various sources may have undergone heavy mixing before deposition. One approach is to employ molecular markers that are abundant in the environment, specific to an input source, and resistant to physical, chemical, and biological modifications. In southern California, municipal wastewater outfalls and stormwater runoff have been the major sources of contaminant inputs to the coastal ocean. While sewage markers have been widely utilized, no viable stormwater runoff markers are known in spite of a few previous efforts.

In this study, we focused on potential marker compounds of urban surface runoff. Source specificity and persistence of several sulfur-polycyclic aromatic hydrocarbons (S-PAHs), nitro-PAHs (N-PAHs), and triphenylene, which are associated with automobile tires, engine exhausts, and break liners, were examined via analyses of stormwater runoff and wastewater effluent samples and spiked samples upon exposure to sunlight. Samples were collected during the 1997/1998 wet weather season from two major storm channels and four major wastewater treatment plants in southern California. Among the target compounds examined, 2-(4-morpholinyl)benzothiazole, dibenzothiophene, and triphenylene were detected in storm runoff only. However, 2-(4-morpholinyl)benzothiazole appeared to degrade rapidly in seawater and sediment after sunlight exposure, which might impede its use as a runoff indicator. Dibenzothiophene and triphenylene also degraded quickly in sunlight-exposed seawater samples, but remained fairly abundant in sediments after six months of exposure to sunlight. They are by far the most promising candidates of urban runoff markers based on the criteria of abundance, source specificity, and persistence, although more research efforts are needed to ensure that no other sources would also contribute significantly to their presence in the aquatic environment.

OS22E HC: Hall III Tuesday 1330h

Stratified Coastal and Estuarine Circulation I

Presiding: **J A Whitehead,** Department of Physical Oceanography; **M A Sundermeyer,** University of Massachusetts Dartmouth

OS22E-236 1330h POSTER

On Small-Scale Instability in the Topographic Flow in Knight Inlet

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Recent observations by Farmer and Armi (1999) of a topographic flow in Knight Inlet (British Columbia) provide an example of a phenomenon that is very rich in the fundamental hydrodynamic interactions. In its fully developed form this flow constitutes a high velocity jet at the lee slope of the topography and include a hydraulic jump of the kind that may be generated in one-layer unstratified flow over an isolated obstacle. This flow also bears a striking resemblance to severe downslope atmospheric windstorms that are often observed in the lee of major mountain ranges. An important condition, namely the existence of mixed intermediate layer is required for the existence of such a flow. The dynamical sequence which leads to the formation of the mixed layer, however is not completely understood. Our concern in the present study will be to address the hydrodynamical issue of the development of the small scale shear instability in the flow. For this purpose very high resolution simulations were performed to reproduce explicitly the small scale instability.

URL: http://www.physics.mun.ca/~yakov

OS22E-237 1330h POSTER

Internal solitons in Knight Inlet, British Columbia

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Knight Inlet, British Columbia provides a natural laboratory for the study of a variety of geophysical flows involving the interaction of stratified fluid with topography. Results are presented from a recent experiment conducted in Knight Inlet, focusing on the generation and propagation of internal solitons near the sill during ebb tide. High quality echo-sounder and ADCP measurements were obtained in a novel fashion, using instrumentation carried aboard an inflatable Zodiac. A set of photographic images of the surface expression of the internal waves were also acquired and these serve to situate the acoustic data within the larger scale structure of the internal response within the inlet. Also discussed are fully nonlinear numerical simulations illustrating the generation mechanism and propagation of the internal solitons.

OS22E-238 1330h POSTER

Generation of Intense Internal Waves by Surface Intrusions on Shelf

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An evidence of internal wave generation by moving surface intrusion of warmer and fresher water was obtained during long-term observations of internal waves on a shelf. Observations were made from stationary pile-supported platform in the Northwest part of the Black Sea, located 60 km from the nearest shore. A change of water masses occurred in the study area, leading to an appropriate change in the thermocline structure of the upper layer of the sea. At this time a long-term train of intense internal waves was recorded. All data indicated the passage of a local front: a mass of freshened warm water intruded into the portion of the sea having salinity that is uniform with depth. The intrusion occurred at the surface and lasted several days; the salinity during this time fell by 2.1 promille. The freshened waters moved in the direction from the shore regions outward toward the sea. The process of surface intrusion propagating above sharp thermocline was also investigated by numerical modeling. The numerical model is based on solving full Navier-Stokes and diffusion equations. Results from numerical modeling are in a good agreement with observed data. The research work described in this publication was made possible in part by a grant of Award No. RP2-2255 of the U.S. Civilian Research and Development Foundation (CRDF).

OS22E-239 1330h POSTER

Scattering of semidiurnal internal tide observed in Uchiura Bay

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Large amplitude of semidiurnal internal tide is frequently observed in Uchiura Bay at the head of Suruga Bay in Japan (Matsuyama, 1991, Tidal Hydrodynamics, p.449-468). To clarify vertical structure of internal tide in the bay, mooring observation, using memorable thermometer and workhorse ADCP, was performed in the bay from July 25 to August 8, 2000. Vertical displacement and along-bay current for semidiurnal internal tide were mainly represented by the first mode, and their phase relation indicated the property of standing wave. However, the second and third modes for the across-bay current with semidiurnal period were predominant. The difference of vertical structure between the along-bay and across-bay currents suggested that the across-bay current for the higher mode internal wave have been generated in the bay. Detailed analysis for the across-bay current with the semidiurnal period revealed vertical phase propagation with wavelengths of 50 120 m in vertical and about 13 km in horizontal. The generation mechanism of the across-bay current was investigated by using a 3D numerical model with simple topography. The model result well represented the observed structure of across-bay current. From the numerical model, the across-bay current was found to be caused at the shallow region along the south coast of Uchiura Bay by the scattering of the along-bay current associated with standing wave in the bay.