of the two major euphausiid species as part of the NEP-GLOBEC program in the spring and summer 2000. Lipofuscins were extracted from neural tissues (eye and eye-stalk), quantified, and normalized to protein content to allow comparisons across species and animal sizes. Multiple fluorescent components from krill were observed with the major product having a maximum fluorescence at excitation of 350nm and emission of 470nm. Field-collected krill contained variable levels of lipofuscins dependent on size. Total lipid content of seston (as potential diets) ranged from 25 to 108 (mg/g dry weight) with krill 50 to 152 (mg/g dry weight) and both mainly composed of phospholipids. The fatty acids 16:0, 18:1(n-9), 20:5, and 22:6 were major components in krill and showed only minor shifts between seasons and over spatial scales. In seston, the 16:1(n-7), 16:0, 18:1(n-9), and 18:0 were important fatty acid components and showed significant seasonal and spatial compositional changes. Polyunsaturated fatty acids such as 20:5 (rich in diatoms) and 22:6 (rich in dinoflagellates and chrysophytes), known to be essential fatty acids for the growth and development of fish larvae and juveniles were absent or were at low in seston from offshore stations. Cholesterol was the dominant sterol in all animals (up to 89% of total sterols), with furcilia also containing a number of other sterols from dietary sources. A suite of 15 other sterols was found in seston, a number of which represent specific algal taxa. These results suggest that lipofuscin can be measured among individual krill, and that animals may show ontogenetic changes in lipid composition with age.

OS21O HC: 319 A Tuesday 0830h

Biogeochemical Linkages Between Rapidly Urbanizing Coastal Watersheds and the Coastal Ocean I

Presiding: **E H De Carlo,** University of Hawaii at Manoa**; K J Spencer,** Los Alamos National Laboratory**; F T Mackenzie,** University of Hawaii

OS21O-01 0830h INVITED

The Role of Monsoon and Typhoon Rains in Nurturing Shelf Productivity

Chen-Tung Arthur Chen[1] (886-7-5255136; ctchen@mail.nsysu.edu.tw)

Anond Snidvongs[2] (anond@start.or.th)

Nerisahah Saadon[3] (neri@hotmail.com)

Tengku Mohamad Tengku Rozaina[4] (trmseafdec@po.jaring.my)

Manuwadi Hungspreugs[2] (Manuwadi.H@chula.ac.th)

[1]Chen-Tung Arthur Chen, Institute of Marine Geology and Chemistry, National Sun Yat-Sen University, Kaohsiung 80424, Taiwan

[2]Anond Snidvongs, Manuwadi Hungspreugs, Department of Marine Science, Chulalongkorn University, Bangkok 10330, Thailand

[3]Nerisahah Saadon, Universiti Putra Malaysia Terengganu, Kuala Terengganu 21030, Malaysia

[4]Tengku Mohamad Tengku Rozaina, Marine Fishery Resources Development and Management Department, Southeast Asian Fisheries Development Center, Chendering, Kuala Terrengganu 21080, Malaysia

Stretching from northeast Africa and India to east Asia and north Australia lies a vast area highly influenced by both monsoons and typhoons/hurricanes, and naturally many aspects of the oceanic environments of the north Indian Ocean, the East and South China Seas and the many seas of Southeast Asia are no less affected. Torrential rains accompanying southwest monsoons and typhoons, although often raising havoc on many coastal areas, are for the most part greatly welcomed by farmers as these nurture the frequently parched land at the end of the dry, northeast monsoon season.

It is well known that the southwest monsoon induces upwelling of nutrient-rich subsurface waters off the eastern coast of a land mass, such as that off Somalia, the Arabian Peninsula and Viet Nam. In so doing, biological productivity is enhanced. Off the western coast, on the other hand, the southwest monsoon normally induces downwelling, but here it is shown that the increased buoyancy forcing brought on by a larger runoff in the wet season also seems to have induced a weak upwelling off Sarawak, Sabah and Brunei Darussalam despite unfavorable wind conditions. In other words, monsoon rains also appear to nourish the coastal oceans regardless of the direction of the prevailing winds. As a result, nutrient concentration increases, while pCO2 decreases presumably due to higher primary productivity. Similarly, coastal downwelling was seen to shift to a clear upwelling, and primary productivity was found to increase off northwestern Taiwan after a typhoon passed, perhaps also due to the enhanced buoyancy effect.

OS21O-02 0850h INVITED

Anthropogenic drivers of nutrient cycling in the coastal waters of Southeast Asia

Liana Talaue McManus[1] (305 361 4760; lmcmanus@rsmas.miami.edu); Douglas McGlone[2] (632 922 3944; mcgloned@upmsi.ph); Wooi Khoon Gong[3] (604 657 7888; wkgong@usm.my); Gullaya Wattayakorn[4] (662 218 5407; gullaya@chula.ac.th); Hoang Tri Nguyen[5] (nguyenhoangtri@hn.vnn.vn); Ma. Lourdes San Diego-McGlone[2] (mcglonem@upmsi.ph)

[1]Division of Marine Affairs, Rosenstiel School of Marine & Atmospheric Science, 4600 Rickenbacker Causeway, Miami, FL 33149, United States

[2]Marine Science Institute, University of the Philippines, Diliman, Quezon City 1101, Philippines

[3]Centre for Marine & Coastal Studies, Universiti Sains Malaysia, 11800, Penang, Malaysia

[4]Chulalongkorn University, Department of Marine Science, Chulalongkorn University, Bangkok 10330, Thailand

[5]Center for Natural Resources and Environmental Studies, Vietnam National University, 7 Ngo 115, Nguyen Khuyen, Hanoi, Viet Nam

Major economic activities in four coastal watersheds in Southeast Asia were assessed for their impacts in terms of nutrient waste generation, their contribution to nutrient loading into and the resulting metabolic state of associated coastal basins. The study areas included a section of the Red River Delta (Viet Nam), Bandon Bay (Thailand), Lingayen Gulf (Philippines), and the Merbok Estuary (Malaysia). Nutrients released by economic activities were estimated using an economic input-output modeling approach. Non-conservative fluxes of dissolved inorganic nitrogen and phosphorus (DIN, DIP)and system metabolic states were quantified using the LOICZ Biogeochemical Modelling Guidelines (Gordon et al. 1996)

Results indicate that agriculture contributed the most to the total DIN (20-80%) and to the total DIP (20-80%) coming from economic activities in the watershed. In the two sites (Ban Don Bay and Lingayen Gulf) where the household sector was endogenized as an economic sector, sewage was shown to contribute 15-20% of total DIN waste and 15-50% of total DIP waste. An index ratio between generated nutrient waste and total nutrient loading, where 1 indicates highest anthropogenic impact to receiving coastal waters; values $>$ 1, high assimilative capacity; and values $<$ 1, high loading and high impact from natural sources, was used to compare anthropogenic influence on nutrient (DIN, DIP) loading. The Red River Delta showed highest buffering capacity followed by the Merbok Estuary. Lingayen Gulf received the most impact from human generated waste. Ban Don Bay showed the most pristine condition in that loading from natural sources exceeded anthropogenic waste by a factor of 6 in the case of DIN. Except for the Merbok Estuary, all three basins were net autotrophic.

The protocols used in this regional study indicate prospects of assessing anthropogenic influences on biogeochemical cycling in coastal waters using relatively simple but robust approaches that are amenable to iterative validation. Scientists in both developed and developing countries can use these in evaluating their study sites, thus allowing for more sound comparisons across wider areas.

OS21O-03 0910h

Climatic Regulation of Water and Nutrient Export from a Coastal Watershed to the Coastal Waters in Barkley Sound, British Columbia, CANADA

Irena F Creed[1,2] (519-661-4265; icreed@uwo.ca)

Chelene C Krezek[2] (ckrezek@uwo.ca)

Charles G Trick[2] (trick@uwo.ca)

[1]Department of Geography, The University of Western Ontario, London, ON N6A 5C2, Canada

[2]Department of Plant Sciences, The University of Western Ontario, London, ON N6A 5B7, Canada

In recent years, pressures to develop watersheds in the Canadian pacific region have intensified. The Land-to-Oceans Project is a new initiative that seeks to improve our understanding of coastal watershed processes to their impacts on the coastal ecosystem. Specifically, the objectives of the Land-to-Oceans Project are to develop a coastal watershed model that predicts the export of water and nutrients that can be scaled to other coastal watersheds in the Strait of Georgia and along the western coast of Vancouver Island; and to explore linkages between changes in Land Use or Land Cover (LU/LC), changes in loadings of dissolved and particulate organic matter from the watersheds to the coastal zone, and the patterns of growth and toxicity of harmful algal blooms. Our initial focus has been on the Carnation Creek watershed, the focus of harvesting experiments over the past 30 years, which drains into Barkley Sound along the west coast of Vancouver Island. In this watershed, the climate is complex, with multi-temporal climatic oscillations including El Nino, La Nina and the Pacific Decadal Oscillation, and thus, the natural variability in hydrological linkages between the watershed and the coastal waters had to be established before the potential impacts of LU/LC changes could be considered. A coastal watershed model was used to establish the relationship between return period (ranging from 1 to 100 years) and peak discharges and, in turn, the relationship between peak discharges and their contributing source areas within catchments of the watershed. A comparison of these relationships for natural and disturbed conditions indicated that LU/LC activities resulted in an increase in: (1) number of peak flows; (2) magnitude of smaller peak flows ($<$ 1 yr return period); and (3) magnitude of associated surface saturated areas. These relationships and associated maps provide simple management tools that can be used to minimize the potential impacts of harvesting activities. By introducing the concept of risk (as defined by the return period) into harvest plans, the climatically-influenced susceptibility of catchments to changes in the distribution of surface saturated areas and the frequency and magnitude of peak flows to harvesting practices may be evaluated. By understanding the climatic controls on the contributing source areas of water to the stream, we can extend the coastal watershed model to predict the export of water-soluble nutrients, pollutants or contaminants to coastal waters.

OS21O-04 0925h

Nutrient Loading as Reflected by Tissue N and P Concentration of Three Marine Macrophytes

Joanne C Bintz[1] (202 334-2714; jbintz@nas.edu)

Scott W Nixon[2] (401 874-6618; snixon@gso.uri.edu)

Betty Buckley[2] (401 874-6618; bbuckley@gso.uri.edu)

Stephen Granger[1] (401 874-6618; sgranger@gso.uri.edu)

[1]National Academy of Sciences, 2101 Constitution Ave, NW HA 470, Washington, DC 20418, United States

[2]University of Rhode Island Graduate School of Oceanography, South Ferry Road, Narragansett, RI 02882, United States

Mesocosm experiments were used to determine the relationship between nitrogen (N) and phosphorus (P) loading and the resulting tissue nutrient content (percent dw) of eelgrass shoots (Zostera marina), and two species of macroalgae, Ulva lactuca and Gracilaria tikvahaie. Data were combined from two experiments in which treatments consisted of high N and high P loading (HNHP), high N and low P loading (HNLP), low N and low P loading (LNLP) and controls with no added nutrients. Loading rates (mmol m-2 d-1) for the treatments consisted of 8.24 N and 1.7 P in the HNHP, 8.24 N and 0.22P in the HNLP and 1.94 N and 0.15 P in the LNLP. Controls received 0.35 N and 0.11 P from incoming water and wet and dry deposition. The selected macrophytes from highly loaded (N or P) mesocosm treatments had significantly higher tissue nutrient concentrations than those from treatments with low loading or controls. N and P loading rates were significantly ($p<0.05$) correlated with tissue nutrients for all species during the summer months. The ranges in tissue concentrations in these species along with tissue nutrient concentrations from the literature were used to create a preliminary index of nutrient loading. The index and correlation analysis may provide valuable information for ecosystem modelers and managers.

OS21O-05 0940h

Chemical Indicators of Anthropogenic Nitrogen Loading in Four US Estuaries

Brian Fry[1] (808 522 8230 x.113; brianfry@fs.fed.us)

Arian Gace[1] (ariang@hotmail.com)

Jim McClelland[2] (jmcclelland@mbl.edu)

[1]Department of Oceanography and Coastal Ecology Institute, LSU, Baton Rouge, LA 70803, United States

[2]Ecosystems Center, Marine Biological Laboratory, Woods Hole, MA 02543, United States

Inputs of anthropogenic nitrogen are altering the trophic status of estuaries worldwide. New approaches are needed to assess the onset and magnitude of this nitrogen loading, and two approaches have been proposed in recent years, use of C/N ratios in macroalgae and use of nitrogen isotope (d15N) measurements in estuarine sediments and biota. We compared these approaches with results from more conventional nutrient concentration measurements, testing especially whether d15N assays were robust indicators of watershed N loading across different estuarine systems. Four study estuaries were chosen that were associated with the National Estuarine Research Reserve (NERR) system and located at widely spaced intervals on the west coast of the United States: Padilla Bay (Washington), South Slough (Oregon), Elkhorn Slough (central California), and Tijuana River (southern California).

None of the estuaries was truly pristine, with all estuaries receiving varying levels of anthropogenic nutrient loading from local watersheds. The DIN (dissolved inorganic nitrogen) concentrations ranged from 3 micromolar in streams at the southern end of the forested South Slough watershed, to 1000 micromolar in the Elkhorn and Tijuana estuaries that respectively received high agricultural and sewage inputs. Comparisons made within and between estuaries showed that C/N ratios in green macroalgae were not closely correlated with d15N or DIN levels, and were useful for detecting N loading patterns only in the least impacted estuary, South Slough. Nitrogen isotope assays failed to detect N-loading under conditions of very high ammonium inputs from sewage, but were otherwise useful indicators of estuarine N status. Overall, using a combination of nutrient and isotope measurements was the best strategy for detecting watershed N loading. The combination approach could be used to generate maps of low, medium and high N loading in each of the four study estuaries. Such maps can be useful for identifying sites that currently need clean-up efforts, for future eutrophication monitoring, and for checking N input budgets developed from land-use models

OS21O-06 0955h

Bacterial Degradation of Aromatic Hydrocarbons in Surface Sediments of Temperate and Tropical Coastal Ecosystems.

Michael Thomas Montgomery[1] (202-404-6419; mtm@ccf.nrl.navy.mil)

David C Smith[2] (401-874-6172; dcsmith@gso.uri.edu)

Chris L Osburn[1] (202-767-1700; cosburn@ccsalpha3.nrl.navy.mil)

Thomas J Boyd[1] (202-404-6424; tboyd@ccsalpha3.nrl.navy.mil)

[1]Naval Research Laboratory, 4555 Overlook Avenue, Washington, DC 20375, United States

[2]Graduate School of Oceanography, University of Rhode Island, Narragansett, RI 02882, United States

Anthropogenic inputs of aromatic hydrocarbons are a common stress to coastal ecosystems. Petroleum-derived compounds from point and non point sources can accumulate in surface sediments and affect changes in the associated biota. Elevated hydrocarbon concentrations can provide a selective pressure for strains that can metabolize these compounds, but the response of the assemblage can also be affected by environmental factors. We examined the effect of various chemical and physical conditions on bacterial production and aromatic hydrocarbon mineralization in surface sediments of five coastal ecosystems that have significant anthropogenic impacts. The data were gathered during thirty research cruises over the past four years in Pearl Harbor, San Diego Bay, Charleston Harbor Estuary, Chesapeake Bay, and Delaware Bay. Sediment from temperate coastal systems had large seasonal variation in mineralization rates and turnover times of sentinel aromatic hydrocarbons (i.e. naphthalene, phenanthrene, and fluoranthene), though there was little correlation with temperature. Aromatic hydrocarbon mineralization, as measured using 14C-radiotracer additions, was dramatically reduced when bottom water dissolved oxygen saturation was below 70 percent. Low ambient hydrocarbon concentration (below 10 μg per g sediment) did not appear to support bacterial assemblages capable of rapid mineralization of the hydrocarbons. Hydrocarbon mineralization rates generally ranged from 10E-6 to 10E-4 μg per g sediment per d in both temperate and tropical systems but were highest in chronically impacted sediments in Charleston Harbor (7.0 x 10E-1 μg fluoranthene C per g sediment per d) and Pearl Harbor (1.21 x 10E-1 μg fluoranthene C per g sediment per d. Turnover times were often less than 100 d in these latter sediments even though they often had elevated hydrocarbon concentrations. Despite its lower molecular weight and relatively high aqueous solubility, naphthalene generally had lower mineralization rates than those for both phenanthrene and fluoranthene. Understanding environmental factors that control hydrocarbon metabolism by the natural bacterial assemblages may help us determine the capacity for estuarine sediments to assimilate contaminants as well as identify areas that are at risk of ecological damage.

OS21O-07 1030h

Water Column Trace Metal Concentrations and Speciation in the Elizabeth River, Virginia

John R. Donat[1] (757-683-4098; JDONAT@odu.edu)

Gonzalo G. Carrasco[2] (757-683-4099; GCARRASC@odu.edu)

John A. Consolvo[3] (215-685-1433; John.Consolvo@phila.gov)

[1]Dept. of Chemistry and Biochemistry, Old Dominion University, Norfolk, VA 23529-0126, United States

[2]Dept. of Ocean, Earth and Atmospheric Sciences, Old Dominion University, Norfolk, VA 23529-0276, United States

[3]Bureau of Laboratory Services, Central Lab, Philadelphia Water Dept., 1500 E. Hunting Park Ave., Philadelphia, PA 19124-4941, United States

The Elizabeth River (ER) is a sub-estuary of the Chesapeake Bay, the largest, and historically most productive estuary in the United States. Two major regional centers of commercial shipping and the world's largest naval base are located on the ER, and the ER supports a diverse mix of heavy industry and chemical and fertilizer companies. Metal contamination is a significant issue in the ER. For example, the loading of dissolved Cu to the ER has been estimated at 26,300 kg/yr, of which 68% results from US Navy activities, and 25% results from commercial vessel and shore discharges. Sediment concentrations of Cu, Zn, Cd, and Pb in the industrialized portions of the ER are enriched relative to crustal abundances. Sediment concentrations of Zn and Pb in the ER exceed their respective Probable Effects Levels, and are therefore considered to pose considerable risk of adverse effects to aquatic life. In 1983, the EPA's Chesapeake Bay Program identified the ER as one of the most heavily polluted bodies of water in the Chesapeake Bay watershed, and subsequently designated it a "Region of Concern".

We are part of a team of investigators performing an integrated study of the biogeochemical cycling of Cu, Cd, and Zn in the ER. We are studying the interrelationships among: (1) metal concentrations, complexation and speciation (Donat, Carrasco, Consolvo); (2) in situ microbial production of Cu chelators (Gordon, Donat, Dryden, Ericsson); (3) phytoplankton metal uptake (Sunda, Huntsman, Donat); and (4) fluxes of metals and chelators from sediments (Donat, Burdige, Carrasco).

Water column trace metal results from our two field studies in July 1999 and May 2000 indicate that concentrations of total dissolved Cu, Zn, and Cd all increased upriver by factors ranging from 4-fold (Cd) to 165-fold (Zn). In all surface water samples, Cu was more than 99.9% complexed by one strong organic ligand class, L (average log K'= 12.2), while Zn and Cd were variably organically complexed by two ligand classes. The concentrations of free Cu^{2+}, Zn^{2+}, and Cd^{2+} (the toxic/bioavailable forms of these metals) all increased upriver by 10-fold (Cu^{2+} and Cd^{2+}) to 300-fold (Zn^{2+}). While free Cu^{2+} and Cd^{2+} were generally below literature-reported estuarine phytoplankton toxic response levels, free Zn^{2+} concentrations upstream reached toxic levels.

OS21O-08 1045h

Benthic Fluxes of Copper, Zinc and Cadmium and Their Complexing Ligands in the Elizabeth River, Virginia and the Chesapeake Bay

Gonzalo G. Carrasco[1] (757-683-4099; gcarrasc@odu.edu)

John R. Donat[2] (757-683-4098; jdonat@odu.edu)

David J. Burdige[1] (757-683-4930; dburdige@odu.edu)

[1]Dept. of Ocean, Earth and Atmospheric Sciences, Old Dominion University, Norfolk, VA 23529-0276

[2]Dept. of Chemistry and Biochemistry, Old Dominion University, Norfolk, VA 23529-0126

The Elizabeth River (ER) is a sub-estuary of the Chesapeake Bay, the largest, and historically most productive estuary in the United States. Two major regional centers of commercial shipping and the world's largest naval base are located on the ER, and the ER supports a diverse mix of heavy industry and chemical and fertilizer companies. Metal contamination is a significant issue in the ER. Sediment concentrations of Cu, Zn, and Cd in the industrialized portions of the ER are enriched relative to crustal abundances. Sediment concentrations of Zn in the ER exceed its respective Probable Effects Levels, and are therefore considered to pose considerable risk of adverse effects to aquatic life. In 1983, the EPA's Chesapeake Bay Program identified the ER as one of the most heavily polluted bodies of water in the Chesapeake Bay watershed, and subsequently designated it a "Region of Concern".

We are part of a team of investigators performing an integrated study of the biogeochemical cycling of Cu, Zn and Cd in the ER. We are studying the interrelationships among: (1) metal concentrations, complexation and speciation (Donat, Carrasco, Consolvo); (2) in situ microbial production of Cu chelators (Gordon, Donat, Dryden, Ericsson); (3) phytoplankton metal uptake (Sunda, Huntsman, Donat); and (4) fluxes of metals and chelators from sediments (Donat, Burdige, Carrasco).

To further understand the factors controlling the cycling of Cu, Zn and Cd in coastal waters, we have examined total dissolved metal and total metal complexing ligand benthic fluxes from sediments of the ER estuary in two cruises in 1999 and 2000. This work built upon previous work in which we have shown that such benthic fluxes could potentially supply 10 to 50 % of the Cu complexing ligands in the mainstem of the Chesapeake Bay. At the two sites we studied, near the Norfolk Naval Shipyard and the Norfolk Navy Base, we observed that total dissolved Zn fluxes were greater than total dissolved Cu fluxes, which were greater than total dissolved Cd fluxes. Such observations are consistent with metal concentrations in the sediments. For almost all metals, metal complexing ligand fluxes were much greater that total dissolved metal fluxes in 1999 but not in 2000. More importantly, metal complexing ligand fluxes appear to be uncoupled from metal fluxes. When compared with our Chesapeake Bay results, we see that Cu complexing ligand fluxes are positively correlated with the rates of sediment C remineralization. In this talk we will use these data to begin to examine the controls on total dissolved metal and metal complexing ligand benthic fluxes.

TUE

OS21O-09 1100h

Copper-Responsive Production of Copper-Complexing Ligands by Estuarine Microbial Communities.

Christina L Dryden[1] (cdryden@odu.edu)

Andrew S Gordon[2] (757-683-3595; agordon@odu.edu)

John R Donat[1] (Jdonat@odu.edu)

Amber J Ericsson[1] (aericss@odu.edu)

[1]Department of Chemistry and Biochemistry, Old Dominion University, Norfolk, VA 23529, United States

[2]Department of Biological Sciences, Old Dominion University, Norfolk, VA 23529, United States

In most natural waters, the speciation and bioavailability of copper are determined by its complexation with organic ligands. Several researchers have hypothesized a biological feedback mechanism involving metal-responsive ligand production by microorganisms (particularly picoplankton) in natural waters. We tested this hypothesis using in situ incubation of the natural resident microbiota in a major U. S. Naval harbor, the Elizabeth River (Virginia). In initial laboratory experiments we determined the copper levels and incubation times required to elicit microbial ligand production. The presence and absence of a copper addition, addition of a metabolic inhibitor (sodium azide), a 0.22μm filtered sample, a 3μm filtered sample and light/dark bottles were the experimental conditions used in our in situ studies. We will present results from in situ experiments conducted in May 2000, November 2000 and May/June 2001. Copper additions to microbial communities incubated in situ increased the concentration of copper-complexing ligands in all incubations, with a corresponding decrease in the bioavailable free Cu2+ ion. When microbiota were removed by filtration (0.2 μm) or killed, ligand production was inhibited. Ligand dynamics in the light and dark were not significantly different suggesting that heterotrophic microorganisms were the major contributors to ligand production in this environment. Removal of organisms larger than 3 μm either increased or did not affect rates of ligand production in separate experiments indicating that bacteria-sized microbes were the principal contributors to ligand production. These results support the hypothesis that microbial communities in estuarine waters are capable of buffering their environment against toxic levels of Cu2+ by producing extracellular copper-complexing ligands and implicate heterotrophic bacteria as important sources of these ligands.

OS21O-10 1115h

The Formation of an Iron Curtain in the Subterranean Estuary of a Coastal Bay

Matthew A Charette[1] (508-289-3205; mcharette@whoi.edu)

Edward R Sholkovitz[1] (508-289-2346; esholkovitz@whoi.edu)

[1]Woods Hole Oceanographic Institution , Department of Marine Chemistry and Geochemistry , Woods Hole, MA 02543, United States

Recent studies indicate that groundwater may contribute significant fluxes of dissolved chemical species to the oceans. The magnitude of such fluxes is influenced by biogeochemical processes occurring in the subterranean estuary, defined as the mixing zone between groundwater and seawater in a coastal aquifer. In contrast to surface estuaries, little is known about chemical reactions in subterranean estuaries mainly because they are difficult to sample due to their subsurface location. Here we report the discovery of an "Iron Curtain" in a subterranean estuary on Cape Cod. The term "Iron Curtain" refers to the precipitation of groundwater-borne dissolved ferrous iron and subsequent accumulation of iron oxides onto subsurface sands at the groundwater-seawa ter interface. The formation of an Iron Curtain is not likely limited to the study area of interest; any coastal aquifer bearing high concentrations of dissolved ferrous iron that intercepts surface water is likely to exhibit this feature. As naturally-occurring iron oxides are strong adsorbers and concentrators of many dissolved chemical species, the occurrence of an Iron Curtain has broad implications for transport of natural and anthropogenic materials from aquifers into coastal waters.

OS21O-11 1130h

Flushing Rates of Coastal Bays and Inlets Revisited: Implications for Coastal Planning and Ecological Studies

Mark Turner Gibbs (64 3 548 2319; markg@cawthron.org.nz)

Cawthron Institute, 98 Halifax St. East, NELSON, New Zealand

Many coastal inlets and embayments are under constant or increasing pressure to support the competing requirements of commercial, customary and recreational fisheries, acting as sinks for effluent and pollutants, hosting aquaculture activities; and ribbon coastal development. Management of these activities also varies significantly. For example, wild stock fisheries are often managed over large spatial scales. By contrast, aquaculture activities, effluent discharges and coastal constructions are generally managed over very small spatial scales (O(100s of metres)). Therefore in the case of embayments and coastal inlets, often different sectors and activities are managed completely independently of one another. However, in reality many of these activities are connected through water current flows. The traditional method of accounting for movents in bays and inlets has been to determine the flushing rate for the entire inlet. However, these calculations almost always contain no spatial information and the results can be extremely sensitive to different forcing processes. Furthermore, the lack of spatial information can lead to implied assumptions about spatial scales of ecological processes, particularly larval transport and recruitment. Circulation, and therefore the distribution of seston in embayments and inlets is driven primary by tidal processes, local and in some cases remote winds. Forcing processes acting over seasonal scales also play important roles in many cases. Therefore the individual and combined responses to these forcing processes ensures high spatial and temporal viability in flows implying that simplifying flows and exchange into a single flushing rate calculation is entirely inappropriate.

The use of high-resolution numerical models has revealed the true complexity of circulation processes in many coastal embayments and inlets. However the full implications of this variability is often overlooked, particularly in the design of environmental impacts assessments and marine ecological investigations. The implications of high spatial and temporal viability in circulation in embayments and coastal inlets is discussed.

OS21O-12 1145h

Pollution Hazards off the Southern California Coast: Satellite and In-Situ Observations of Naturally Occurring Oil Seepage and Storm Water Runoff Plumes

Paul M. DiGiacomo[1] (1-818-354-0697; pmd@pacific.jpl.nasa.gov)

Benjamin Holt[1] (1-818-354-5473; ben@pacific.jpl.nasa.gov)

Libe Washburn[2] (1-805-893-7367; washburn@icess.ucsb.edu)

[1]Jet Propulsion Laboratory, California Institute of Technology, MS 300-323, 4800 Oak Grove Drive, Pasadena, CA 91109-8099, United States

[2]Institute for Computational Earth System Science, Department of Geography, University of California, 6818 Ellison Hall, Santa Barbara, CA 93106-3060, United States

The coastal waters off southern California are characterized by anthropogenic and naturally occurring pollution hazards. Pollutant-laden storm water runoff plumes are common coastal ocean features throughout the Southern California Bight following winter storms. In Santa Monica Bay, these plumes have been associated with high toxicity and water-borne pathogens. Natural liquid oil seepage is observed throughout the year in the Santa Barbara Channel off Coal Oil Point, and in Santa Monica Bay off Redondo Beach. The size and episodic nature of these phenomena, however, make them difficult to characterize by conventional shipboard sampling. Space-borne synthetic aperture radar (SAR) sensors are well suited to observing them since they provide frequent, synoptic, high-resolution, all-weather observations. The aim of this project is to initially quantify the frequency of occurrence, spatial extent, and dynamics of natural oil slicks and storm water runoff plumes off the coast of southern California using multi-sensor SAR data (e.g., Radarsat, ERS-1, ERS-2). Surfactants from these pollution hazards smooth surface waters, making them readily observable by SAR. These SAR observations will be complemented by other satellite (e.g., ocean color, AVHRR) and coincident field data (e.g., surface currents from HF coastal radar arrays and buoys, winds, precipitation, discharge) where possible. In particular, we hope to characterize the time-space response of these phenomena to variable oceanographic and atmospheric conditions. In this regard, the observation of natural oil slicks could provide important insights into the movement of accidental oil spills, including likely dispersal patterns. We expect this research will contribute to an improved understanding of pollution hazards in southern California coastal waters, and provide valuable information for coastal management.

OS21P HC: 323 B Tuesday 0830h

Nutrient Dynamics in Coastal Ecosystems: Linking Physical and Biological Processes III

Presiding: **J M Caffrey,** Center for Environmental Diagnositics and Bioremediation University of West Florida**; T K Frazer,** University of Florida Department of Fisheries and Aquatic Sciences

OS21P-01 0830h

Porewater Flows and Organic Matter Decomposition in Carbonate and Silicate Sands

Markus H Huettel[1] (49-421-2028-630; mhuettel@mpi-bremen.de)

Elimar Precht[1] (49-421-2028-655; eprecht@mpi-bremen.de)

Mohammed Rasheed[1] (49-421-2028-644; mrasheed@mpi-bremen.de)

Francis J. Sansone[2] (1-808-956-8370; sansone@soest.hawaii.edu)

[1]Max Planck Institute for Marine Microbiology, FLUX Research Group, Celsiusstr. 1, Bremen 28359, Germany

[2]University of Hawai'i at Manoa, Department of Oceanography, 1000 Pope Road, Honolulu, HI 96822, United States

Bottom currents and surface gravity waves cause advective pore water exchange in permeable sandy sediments. In flume experiments and in in-situ measurements we quantified the advective exchange rates and used these data to design experiments simulating the percolation of bottom water through the sediment surface layers. In these column experiments we investigated mineralization of organic matter in permeable sands of different mineral composition. In carbonate sands that were characterized by a high specific surface area the decomposition rates exceeded those in silicate sands with the same grain size but a relatively lower specific surface area. We concluded that the sand sediments acted as biocatalytic filters and that the mineral composition of the sand and the surface structure of the grains significantly affected the mineralization efficiency of the sand filters.

URL: http://www.scor-wg114.de/

OS21P-02 0845h

Coupled Biological-Physical Dynamics in Massachusetts Bay during late summer 1998 computed by Error Subspace Statistical Estimation

Pierre FJ Lermusiaux[1] (617-4950378; pierrel@pacific.harvard.edu)

Allan R Robinson[1] (617-4952819; robinson@pacific.harvard.edu)

[1]Harvard University, Division of Engineering and Applied Sciences, Pierce Hall, 29 Oxford Street, Cambridge, MA 02138, United States

The coupled estimation of physical and biological variabilities and uncertainties in Massachusetts Bay is carried out for August-September 1998. The multiscale interdisciplinary data sets were collected during the LOOPS-98 experiment.The models employed are part of the Harvard Ocean Prediction System. The physical model is a 4-d primitive-equation model governing the velocity, temperature and velocity fields. It is coupled to a 4-d biochemical model which governs the interactive evolution and spatial distribution of phytoplanktons, zooplankton, detritus, nitrate, ammonium and cholorophyll.

The use of first-order dynamical balance for the initialization of biological fields and calibration of biological parameters is presented. A multiscale methodology for the initialization of the dominant components of error/variability covariances is illustrated. With the resulting initial fields and error estimates, multivariate data assimilation via Error Subspace Statistical Estimation is carried out. The skill of the physical and biological models are evaluated based on classic and new skill metrics. ESSE smoothing is used to estimate the initial conditions based on future data and dynamics. The properties of the error/variability probability density functions of the coupled state variables are studied.

The impacts of wind-driven advections, buoyancy circulations and vertical mixing on nutrients and plankton fields are quantified. The different regions of trophic enrichment and accumulation in late summer are synthesized and possibly generic coastal biophysical processes outlined. A few dominant dynamical balances, time and space scales are identified. In the light of the recent multiscale ASCOT-2001 experiment in Massachusetts Bay and Gulf of Maine, selected issues and directions for future work are summarized.

OS21P-03 0900h

Estimation of Water and Nutrients Exchanges Between the Continental Shelf and the Deep sea in an Enclosed Marine Environment (the Black Sea)Using a 3D Coupled Hydrodynamical-Biogeochemical Model at Basin Scale.

MARILAURE GREGOIRE[1] (32 4 3663354; mgregoire@ulg.ac.be)

JEAN-MARIE BECKERS[1] (32 4 3663358; jm.beckers@ulg.ac.be)

[1]GHER, University og Liege, GHER, University of Liege, B5 Sart-tilman,, Liege 4000, Belgium

A 6-compartment biogeochemical model of nitrogen cycling and plankton productivity has been coupled with a 3D general circulation model in an enclosed environment (the Black Sea) so as to quantify and compare, on a seasonal and annual scale, the typical internal biogeochemical functioning of the shelf and of the deep sea as well as to estimate the nitrogen and water exchanges at the shelf break. Model results indicate that, regarding the deep sea, the shelf acts, throughout the year, as a nutrient source and the total annual nitrogen export to the deep sea roughly corresponds to the annual load of nitrogen discharged by the rivers on the shelf.

The model estimated vertically integrated gross annual primary production is 130 gC m-2 year-1 for the whole basin, 220 gC m-2 year-1 for the shelf and 40 gC m-2 year-1 for the central basin. In agreement with sediment trap observations, model results indicate a rapid and efficient recycling of particulate organic matter in the sub-oxic portion of the water column (60-80 m) of the open sea. More than 95% of the PON produced in the euphotic layer is recycled in the upper 100 m of the water column, 87 % in the upper 80 m and 67 % in the euphotic layer. The model estimates the annual export of POC towards the anoxic layer to 4 1010 mol year-1. This POC is definitely lost for the system and represents 2 % of the annual primary production of the open sea.