OS11O-10 1125h

Responses of California Current populations to environmental variability

Cathryn A Lawrence[1] (530-752-1270; clawrence@ucdavis.edu)

Louis W Botsford[1] (530-752-6169; lwbotsford@ucdavis.edu)

Mark F Hill[2] (hill@itd.ucdavis.edu)

Alan Hastings[3] (530-752-8116; amhastings@ucdavis.edu)

[1]Department of Wildlife, Fish, and Conservation Biology, University of California, Davis, CA 95616, United States

[2]Institute of Theoretical Dyanmics, University of California, Davis, CA 95616, United States

[3]Department of Environmental Science and Policy, University of California, Davis, CA 95616, United States

Fishery and environmental data indicate California Current Dungeness crab chinook salmon and coho salmon populations respond to common forcing by a California Current Index which is the first EOF of ocean temperature, sea level and upwelling index, and represents warm/cool ocean conditions. However, these populations respond to the environment in different ways. Coho salmon varied synchronously along the coast on a one year time scale, and collapsed in the mid-1970s. Chinook salmon varied with a spatial pattern, on 3-5 year time scales, and did not collapse. With a model of single population dynamics, we show that a common explanation for these differences, greater variability in spawning age in chinook salmon, does not hold. With a metapopulation model with straying among populations we show that a small amount of straying can reduce the propensity for population decline. However, there is not a demonstrated difference in straying between these species. We conclude that it is likely that the difference in response is due to some other, biophysical interaction.

OS11O-11 1140h

Variability of One-Dimensional Mixing Processes on the Southeast Bering Sea Shelf

Carol Ladd[1] (206-526-6024; carol.ladd@noaa.gov)

Phyllis Stabeno[1] (206-526-6453; phyllis.stabeno@noaa.gov)

James Overland[1] (206-526-6795; James.E.Overland@noaa.gov)

[1]NOAA/Pacific Marine Environmental Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115-6349, United States

A seven-year time series of current velocities, temperature, salinity, and fluorescence (among other variables) has been obtained from a mooring on the southeast Bering Sea shelf. During the summer, currents are weak in this area, suggesting that the primary stratification/mixing processes are one-dimensional. Using the mooring data, a mixed layer model has been tuned to represent the physical environment of the region as accurately as possible. During the seven years for which we have data, the mixed layer model reproduces the observed temperature structure, heat content, and timing of mixing events during the summer months amazingly well, confirming the one-dimensionality of the system.

Using NCEP Reanalysis sea surface temperature to initialize the model each spring, and windstress and heat fluxes to force the model, a series of summer model runs is executed covering the period from 1948 to the present. This period includes the regime shift of the mid-1970s allowing examination of the physical environment in this region during the two different regimes.

As the surface warms due to increasing solar radiation in early spring, the resulting stratification allows for an early spring phytoplankton bloom. Subsequently, the surface water becomes nutrient depleted such that further mixing events are necessary for further primary productivity. As these mixing/stratification processes are important to the ecology of the region, a better understanding of the variability in the physical environment and mixing processes is needed. Using the model output since 1948, variability of the physical environment over the last 50+ years on interannual to decadal timescales will be discussed.

OS11P HC: 314 Monday 0830h

Interactions Between Macro- and Microorganisms in Aquatic Sediments I

Presiding: **E Kristensen,** Odense University**; J Kostka,** Florida State University

OS11P-01 0830h INVITED

Interactions Between Macro- and Micro-organisms in Sediments: The Role of Density-dependence

Roberta L Marinelli (410-326-7201; marinelli@cbl.umces.edu)

Chesapeake Biological Laboratory, Univ. of Maryland Center for Environmental Science, P.O. Box 38, Solomons, MD 20688, United States

Ecologists have long recognized that interactions among organisms, and community dynamics, shift dramatically when organisms reach critical densities. Such nonlinearities form the basis for the examination of complex interactions in ecosystems and frequently involve the study of processes occurring over multiple spatial and temporal scales. In sedimentary environments, interactions among macro-organisms and microbes are likely to be similarly influenced. To date, there is ample evidence that critical densities of macro-organisms, or their structures, impact the fluid dynamic environment and influence benthic boundary layer processes. However, the effects of organism density on surface chemistry or subsurface processes are less explored, from an experimental or theoretical point of view. There are few experiments that specifically test the effects of macro-organism density on rates and fluxes of geochemical properties, and at the same time, characterize the feedback of these interactions on ecological processes in sediments. Yet there is ample evidence to suggest that these processes have significant implications for biogeochemistry. Our current modelling approaches also do not reflect the realities of community structure. In general, concentration-based models address the "average environment", perhaps reflecting the activities of one or more organisms without considering how the density of these organisms may change the emergent properties of the habitat. Individual-based models can include such characteristics but are limited in the number of processes they can consider, or the areal extent of consideration, due to computational intensivity. Examples of density dependent processes and feedbacks between macro-organisms and sediments will be discussed and new data concerning the effects of infaunal density on surface and subsurface geochemical processes will be presented. The relationship between density dependence, reaction kinetics and primary productivity will be explored.

OS11P-02 0900h

Effects of Macrophytes and Macrofauna on Saltmarsh Pore Water Redox Chemistry (Sapelo Island, GA, USA)

Carla Koretsky[1] (616-387-5337; carla.koretsky@wmich.edu)

Christof Meile[2] (31-30-253-3264; meile@geo.uu.nl)

Philippe Van Cappellen[2] (31-30-253-6220; pvc@geo.uu.nl)

[1]Western Michigan University, Geosciences Dept., Kalamazoo, MI 49008, United States

[2]Utrecht University, Faculty of Earth Sciences, Utrecht 3584 CD, Netherlands

The redox geochemistry of saltmarsh sediments is influenced by factors such as tidal flushing, microbial activity, bioturbation and the presence of vegetation. This leads to distinct spatial trends in redox conditions, which are assessed here at an unvegetated tidal creek bank, a densely vegetated levee and a sparsely vegetated ponded marsh. At the ponded marsh, vertical pore water profiles measured from the surface to 50cm define a depth sequence of oxic, suboxic, sulfidic and, sometimes, methanic zones. At the creek bank, only oxic and suboxic zones are observed. Redox zonation at the levee site is intermediate, with oxic and suboxic zones, and, in some seasons, a sulfidic zone.

The influence of burrowing macrofauna on pore water geochemistry is assessed here using a new 3D stochastic burrow network model. Burrow networks are constructed using probability distributions derived from ecological data describing burrow sizes, shapes and densities for polychaete worms, fiddler and mud crabs and shrimps. Mean densities and wall surface areas of burrows, and their variabilities with depth, are extracted from the networks. Nonlocal bioirrigation coefficients are calculated from burrow surface areas and the characteristic reactive length scale across the burrow-sediment interface, which is estimated from measured sulfate reduction rate profiles (Kostka et al., 2001, Biogeochem., in press). Bioirrigation intensity is highest and deepest at the creek bank site and lowest and shallowest at the ponded marsh site.

S. alterniflora roots are capable of pumping O2 into the surrounding sediment (Lee et al., 1999, L&O 44, 1155). However, macrophytes also increase sediment organic matter content by increasing primary productivity and releasing root exudates, or by trapping organic-rich detrital material, which is subsequently mixed into the sediment via bioturbation. The influence of macrophytes on pore water redox geochemistry is assessed here using measurements of pore water solutes at two sites, separated by 1.5m, located on the edge of a tidal creek. One site is entirely unvegetated, and the other is being actively colonized by S. alterniflora. Pore water Mn(II), Fe(II), and sulfide concentrations are considerably higher at the vegetated site. Because reoxygenation reactions produce protons, significant root release of O2 should result in decreased pH at the vegetated site. However, pH profiles measured at the two sites are quite similar. This suggests that the addition of organic matter in vegetated zones stimulates anaerobic respiration to such a great extent that the effects of O2 introduced by roots remain localized to the sediment immediately adjacent to the roots.

This study demonstrates that macrofauna and macrophytes are primary causes of spatial gradients in pore water redox chemistry observed at the Sapelo Island saltmarsh. At an unvegetated creek bank, intense, deep irrigation leads to extensive reoxidation of reduced solutes. This, together with less labile organic carbon input than at vegetated sites, creates relatively deep oxic and suboxic pore water zones. At a ponded marsh site, less intense, shallower irrigation, together with labile organic carbon input from S. alterniflora creates more compressed redox stratification, with oxic, suboxic, sulfidic and even methanic zones present in the upper 50cm. Redox conditions at a levee site are intermediate because organic carbon is supplied via dense stands of S. alterniflora, yet intense, relatively deep bioirrigation leads to extensive reoxidation of reduced solutes.

MON

OS11P-03 0915h

Elucidating the Effects of Macrofauna vs. Macrophytes on Sediment Biogeochemistry in the Georgia Saltmarsh

Joel E Kostka[1] (850-645-3334; jkostka@ocean.fsu.edu)

April C Smith[1] (850-645-4819)

Yoko Furukawa[2]

Clark R Alexander[3]

[1]Department of Oceanography, Florida State University, 317 OSB, Tallahassee, FL 32306-4320, United States

[2]Naval Research Laboratory, Seafloor Sciences Branch, Code 7431, Building 1005, Stennis Space Center, MS 39529, United States

[3]Skidaway Institute of Oceanography, 10 Ocean Science Circle, Savannah, GA 31411

Previous studies have shown that macroorganisms stimulate the rates and pathways of anaerobic microbial respiration coupled to organic matter mineralization in saltmarsh sediments. However, the complexity of biogeochemical cycles in the marsh has so far obscured our interpretation of the mechanisms by which various macroorganisms control predominating diagenetic reactions. In this study, we sampled the top 10 cm depth of four sites exposed to a similar hydrologic regime which differed according to the abundance of dominant macrophyte plants (Spartina alterniflora) and invertebrate macrofauna (Uca pugnax). Sediment geochemistry, counts of anaerobic bacteria, and rates of microbial metabolism were monitored at each of the four sites. Using a most probable number (MPN) approach, counts of sulfate-reducing bacteria (SRB) displayed a range of 5 orders of magnitude and were higher at nonbioturbated as compared to bioturbated sites. In contrast, counts of Fe(III)-reducing bacteria (FeRB) were an average of 1 order of magnitude higher at bioturbated sites. The root zone appeared to influence both SRB and FeRB, as counts increased with sediment depth at vegetated sites whereas they decreased with depth in the absence of vegetation. Molybdate, a specific inhibitor of sulfate reduction, inhibited 50 to 70 percent of carbon oxidation when added to sediment incubations from nonbioturbated sites, whereas only 7 to 26 percent of carbon oxidation was inhibited by molybdate in incubations from bioturbated sites. Sulfate reduction rates (SRR) measured in intact cores were generally higher at vegetated sites, especially below 5 cm depth, whereas a depression in rates was observed at 0 to 5 cm depth at bioturbated sites. The impacts of macroorganisms were also examined through profiling of particle-reactive radionuclides (Be-7 and

Pb-210). Be-7 was observed to at least 5 cm depth in sediment cores, indicating intense mixing. In the Georgia marsh, the abundance and activity of SRB appears to be enhanced by carbon substrate addition from Spartina. Conversely, though the FeRB were slightly more abundant in vegetated sediments, bioturbation by Uca played a larger role in stimulating the abundance/ activity of FeRB by increasing the supply of reactive Fe(III), leading to a depression in the SRB population.

URL: http://ocean.fsu.edu/~jkostka/

OS11P-04 0930h

The Influence of Bioturbation on the Seasonal and Three-Dimensional Distribution of Redox Species in Salt Marsh Sediments

Martial Taillefert[1] (404-894-6043; mtaillef@eas.gatech.edu)

David C Bull[1] (404-894-1579; dbull@eas.gatech.edu)

[1]School of Earth & Atmospheric Sciences, Georgia Institute of Technology, 221 Bobby Dodd Way, Atlanta, GA 30332-3340, United States

Salt marsh sediments are subject to strong physical disturbance due to tidal fluctuations and bioturbation. In order to understand and quantify the biogeochemical cycling of carbon, metabolites, and their products in sediments, it is necessary to monitor their spatial distribution in situ and over time. Voltammetric methods are the most suitable for such investigation because they can monitor several species at once, e.g., O_2, ΣH_2S (= H_2S + HS^- + S^{2-} + $S^{(0)}$ + $S_x{}^{2-}$), $FeS_{(aq)}$, $Fe^{III}{}_{(aq)}$, Fe^{2+}, and Mn^{2+}, minimize physical disturbance of sediments, and allow high resolution profiles with depth and time.

We report electrochemical profiles from unvegetated surficial sediments of a Georgia salt marsh. In creek bank sediments, the absence of ΣH_2S or $FeS_{(aq)}$, and the presence of Fe^{III}-organic complexes ($Fe^{III}{}_{(aq)}$), suggest that Mn and Fe reduction dominates at least the top ca. 5 cm of the sediment column, in contrast to the conventional view that sulfate reduction is pervasive in these environments. In unvegetated flats, accumulation of ΣH_2S indicates that sulfate reduction dominates over the same depth. A summer release of dissolved organic species from the dominant tall form Spartina alterniflora, together with elevated temperatures, appear to result in increased sulfate reduction intensity and hence high summer concentrations of ΣH_2S in flat sediments. However, increased bioturbation and/or bioirrigation seem to prevent this from happening in bank sediments. Studies of biogeochemical processes in salt marshes need to take such spatial and temporal variations into account if we are to develop a good understanding of these highly productive ecosystems. Furthermore, multidimensional analyses are necessary to obtain adequate quantitative pictures of such heterogeneous sediments. The development of a voltammetric microprofiler for in situ measurements in coastal environments is under way.

OS11P-05 0945h

Biogeochemical Mass Transfer in Bioturbated and Vegetated Saltmarsh, Skidaway Island, Georgia, USA

Yoko Furukawa[1] (228-688-5474; yoko.furukawa@nrlssc.navy.mil)

April Smith[2] (agold@ocean.ocean.fsu.edu)

Joel E. Kostka[2] (jkostka@ocean.fsu.edu)

[1]Naval Research Laboratory, Seafloor Sciences Branch, Stennis Space Center, MS 39529, United States

[2]Department of Oceanography, Florida State University, Tallahassee, FL 32306, United States

The water/sediment interface (WSI) and burrow walls (BW) in aquatic sediments are sites of intense chemical mass transfer. Quantitative realization of their significance is, however, difficult because the chemical mass transfer creates steep biogeochemical gradients that cannot be captured by conventional sampling and analytical techniques. Moreover, capturing of the steep gradients alone is insufficient to evaluate the quantitative significance of WSI and BW in the overall biogeochemical diagenesis. We used pH and O2 microprofiles, centimeter-scale pore water profiles and multicomponent reaction-transport modeling in order to quantitatively realize the significance of biogeochemical reactions occurring in the vicinity of WSI and BW at four separate saltmarsh sites in Skidaway Island. The flux and microbial oxidation rates of labile organic matter (OM) were evaluated using the measured microprofiles, and they were used in the reaction-transport model which simulated all major reactions that occur in the saltmarsh systems. The simulation parameters were refined so that the calculated profiles depict measured centimeter-scale profiles. The results quantify (1) the difference in OM flux and oxidation rates among the four sites with different amounts of bioturbation and vegetation; (2) difference in the magnitude of chemical mass transfer between the immediate vicinity of WSI and BW; and (3) the significance of WSI and BW in the overall diagenesis.

OS11P-06 1020h

Sulfate-Reducing Bacteria in the Seagrass Rhizosphere

Richard Devereux[1] (850-934-0346; devereux.richard@epa.gov)

Sherry S. Wilkinson[1] (850-934-9286; wilkinson.sherry@epa.gov)

Diane F. Yates[1] (yates.diane@epa.gov)

April C. Smith[2] (agold@ocean.ocean.fsu.edu)

Joel E. Kostka[2] (jkostka@ocean.ocean.fsu.edu)

[1]US EPA National Health and Envrionmental Effects Research Laboratory, Gulf Ecology Divsion 1 Sabine Is. Drive, Gulf Breeze, FL 32561, United States

[2]Florida State University, Department of Oceanography, Tallahassee, FL 32306, United States

Seagrasses are rooted in anoxic sediments that support high levels of microbial activity including utilization of sulfate as a terminal electron acceptor which is reduced to sulfide. Sulfate reduction in seagrass bed sediments is stimulated by input of organic carbon through the deposition of periphyton from the leaves and exudation of organic acids from the roots. Release of oxygen from the roots establishes a redox gradient and prevents sulfide from approaching levels that could otherwise be toxic to the plants. Bacteria considered to be obligate anaerobes (sulfate reducers, methanogens and acetogens) internally colonize roots of the submerged macrophyte *Halodule wrightii*. The distribution of these bacteria observed in root cross sections suggests their alignment along a redox gradient emanating from the center of the root. The in situ activities of these obligately anaerobic endorhizobacteria, and whether their association with the roots may be beneficial or harmful to the plant, are not known. In order to begin to address these questions, a sulfate-reducing bacterium, Summer lac-1, was isolated from *H. wrightii* roots by selective enrichment with lactate. The isolate has physiological characteristics typical of *Desulfovibrio strains*, yet a 16S rRNA sequence that is only 90% similar to sequences from other *Desulfovibrionaceae*. The sequence of the bisulfite reductase gene, *dsr*, from Summer lac 1 has been determined and used to develop PCR primers. RT-PCRs with the *dsr*-specific primers and RNA extracted from Summer lac-1 cells grown under sulfate reducing conditions yield a band of the expected size whereas RT-PCRs with RNA from Summer lac-1 cells grown fermentatively do not yield the expected band. In situ RT-PCR for bisulfite reductase mRNA can differentiate Summer lac-1 cells grown with sulfate from those grown without sulfate. This method is being further developed to determine whether sulfate reduction occurs within seagrass roots.

OS11P-07 1035h

Influence of the Seagrass *Thalassia testudinum* on the Community Composition and Activity of Sulfate-reducing Bacteria in an Essential Coastal Marine Habitat

April C. Smith[1] (agold@ocean.fsu.edu)

Joel E. Kostka[1] (jkostka@ocean.fsu.edu)

Richard Devereux[2] (Devereux.Richard@epamail.epa.gov)

Diane Yates[2] (Yates.Diane@epamail.epa.gov)

[1]Florida State University, Department of Oceanography, Tallahassee, FL 32306

[2]U.S. Environmental Protection Agency, Gulf Ecology Division 1 Sabine Drive, Gulf Breeze, FL 32561

Biogeochemical cycling of nutrients and sulfate reduction rates (SRR) were studied in relation to the community composition of sulfate-reducing bacteria (SRB) in a *Thalassia testudinum* bed and in adjacent unvegetated areas. Sampling took place in Santa Rosa Sound, Pensacola, Florida, during February and July 2001. There was a noticeable downward extension of the *Thalassia* root zone by approximately 4 cm in summer compared to winter that had a profound effect on SRR, sediment geochemistry, and bacterial cell numbers. Depth-integrated SRR were three times higher in vegetated (1-7 mmol m^{-2} d^{-1}) versus unvegetated (0-1 mmol m^{-2} d^{-1}) sediments during winter. Rates measured during summer were seven times higher in vegetated (5-10 mmol m^{-2} d^{-1}) versus unvegetated (0-3 mmol m^{-2} d^{-1}) sediments. SRR were consistently higher in surface sediments (0-3 cm depth) at the vegetated site. Overall, sulfate concentrations were high, and sulfate depletion was only observed at the unvegetated site during summer. Little accumulation of sulfides, a mid-depth maximum of $NH_4{}^+$ with low $NO_3{}^-$ concentrations were observed throughout all vegetated cores. Organic carbon (OC) content did not change from winter to summer, but OC in vegetated sediments was consistently double OC in unvegetated sediments. During summer, most probable number (MPN) counts of SRB were two orders of magnitude higher in vegetated (7.0×10^6 cells ml^{-1} sediment), as compared to unvegetated sediment (2.0×10^4 cells ml^{-1} sediment). Direct counts using epifluorescence microscopy determined that total bacterial cell numbers were higher than SRB from MPN counts. Molecular characterization of the SRB communities via restriction fragment length polymorphism (RFLP) analysis of the dissimilatory sulfite reductase gene (*dsr*) indicated that both vegetated and unvegetated sites were extremely diverse with respect to SRB species. The sequencing of unique clones has identified the *Desulfobacteriaceae* family as being important for sulfate reduction activity in the vegetated sediment. These data indicate that depth of the root zone and the physiologically active growth state of above-ground biomass affect the activities and cell numbers of SRB by controlling organic matter and oxidants delivered to the sediment. An intense sulfate-reduction zone appears to be fueled by vegetation just above the depth of the root zone.

OS11P-08 1050h

Impact of the Actively Irrigating Polychaete *Nereis diversicolor* on Degradation of Fresh and Aged Macroalgal Detritus in Coastal Marine Sediment.

Erik Kristensen[1] (45-65-502754; ebk@biology.sdu.dk)

Ole L. Mikkelsen[1]

[1]Odense University, SDU, Campusvej 55, Odense M DK-5230, Denmark

It has long been recognized that bioturbating animals significantly increase carbon oxidation in sediments. However, the underlying mechanisms for this stimulation have not yet been fully clarified. It has been argued that injection of oxygen into actively irrigated burrows of polychaetes like *Nereis* spp. enhances decomposition of organic matter. Recently, a number of studies have emphasized that aerobic and anaerobic decomposition are comparable for fresh and reactive organic substrates, while aerobic processes proceeds much faster for partly degraded and refractory detritus. Accordingly, it was hypothesized that the oxidation effect of irrigation primarily enhances the decomposition of old and partly degraded organic matter buried within the bioturbated depth of sediments.

We tested this hypothesis in a laboratory experiment using 4 series of microcosms containing sandy sediment with and without the addition of 1500 *Nereis diversicolor* m^{-2}. Fresh or aged (pre-decomposed for 55 days) ^{14}C labelled *Fucus serratus* detritus was added to the microcosms, either at the surface or buried at 3 cm depth into anoxic sediment. By following the release of ^{14}C labelled CO_2 and DOC for a 18 day period as well as recovering the remaining ^{14}C label in the form of POC (detritus and worms) and dissolved porewater solutes, the impact of *N. diversicolor* was resolved. The results showed that decomposition of aged detritus was generally stimulated twice as much as fresh detritus by the activities of *N. diversicolor*. However, the stimulation of both types of detritus was 5-10 times faster when buried into the sediment than deposited at the surface. In the latter case, the stimulation was limited (20% for fresh and 40% for aged detritus). As *N. diversicolor* feed on detritus, the measured decomposition is a mixture of microbial and worm action. After subtracting the worm contribution, the microbial decay of fresh surface deposited detritus was hampered (17%) by the worm activity, while the microbial decay of surface deposited aged detritus was stimulated slightly (20%). The microbial decay of subsurface deposited aged detritus was stimulated 300% by the worm activities, while the corresponding stimulation for fresh detritus was only 90%.

In conclusion, the oxidation effect of irrigation strongly enhances the microbial decomposition of aged detritus buried into anoxic sediment compared with fresh detritus. The limited, but significant, faunal enhancement of microbial decay of fresh detritus buried into anoxic sediment may be caused by other mechanisms than oxidation effects of irrigation, e.g. removal of inhibitory metabolites. The deposit-feeding *N. diversicolor* also enhances (although only slightly) the removal of detritus deposited at the sediment surface. However, feeding activities and metabolism of the worm itself largely causes this effect. It appears that *N. diversicolor* competes with bacteria for surface detritus, ultimately resulting in reduced microbial decay of particularly fresh detritus.

OS11P-09 1105h

Bioturbation Effect on Mineralisation Rates of Organic Matter in Estuarine Sediments: The Importance of gas Exchange

Paul van Nugteren[1] (31-113-577488; nugteren@cemo.nioo.knaw.nl)

Peter M.J. Herman[1] (31-113-577300; herman@cemo.nioo.knaw.nl)

Jack J. Middelburg[1] (31-113-577300; middelburg@cemo.nioo.knaw.nl)

[1]Netherlands Institute of Ecology, Centre for Estuarine and Coastal Ecology, P.O.Box 140, Yerseke 4400 AC, Netherlands

Bioturbation has a profound influence on mineralisation of organic matter and the profiles of organic carbon, nutrients and oxidised and reduced chemical species in the sediment. However, the interaction between bioturbation and mineralisation is a complex phenomenon that can be divided into different components. Here we present results from an experiment in which simulated improved transport of dissolved gases, pure physical mixing of organic and mineral particles, and bioturbation by *Nereis diversicolor* ($\sim$1500 m^{-2}) were investigated with respect to mineralisation rates. These were combined with some preliminary results from a similar experiment in which the influence of bioturbation by *Nereis diversicolor* on the degradation ^{13}C enriched fresh algal material was investigated.

Mineralisation rates were derived from sediment ΣCO_2 production measured in closed sediment cores placed in a continuous flow system combined with ΣCO_2 and NH_4^+ pore water profiles. During the experiment ΣCO_2 accumulated in the pore water of the control cores while in the other treatments ΣCO_2 was, to a different extent, removed from the bioturbated zone. In order to get the true mineralisation rates the measured ΣCO_2 production rates were corrected for these differences in inventory ΣCO_2, resulting in an enhancement of mineralisation rate by the presence of *Nereis diversicolor* (125%), simulated improved gas transport (60%) and physical mixing (15%). Pore water profiles of the ^{13}C enriched cores revealed that bioturbated sediment, in contrast to defaunated sediment, showed elevated levels of $\delta\ ^{13}C$ (also in the deeper parts) while $\Sigma^{13}CO_2$ levels were much lower. This indicates mineralisation of labile organic matter throughout the sediment column and an efficient mechanism to transport CO_2 out of the sediment. $\delta\ ^{13}C$ depth profiles of particulate organic carbon should reveal whether this was the result of burrow ventilation or physical mixing. NH_4^+ pore water profiles showed the same pattern as ΣCO_2 with the difference that ammonium was almost absent in the bioturbated zone of the *Nereis diversicolor* and the improved gas transport treatments.

It was concluded that improved transport of dissolved gases is more important with regard to mineralisation rate enhancement of refractory organic matter than pure physical mixing of organic and mineral particles and that this might be the result of stimulated coupled nitrification/denitrification. In the case of labile organic matter physical mixing might play a more significant role in enhancement of mineralisation rates.

URL: http://www.nioo.knaw.nl/cemo.htm

OS11P-10 1120h

Relative influences of bioturbation and physical mixing on degradation of algal material deposited on the sediment-water interface: evidence from chloropigments

Ji-Hong Dai[1] (706-542-2668)

Ming-Yi Sun[1] (706-542-5709; mysun@arches.uga.edu)

[1]University of Georgia, Department of Marine Sciences, Athens, GA 30602

We have conducted a series of microcosm experiments to test the relative influences of biological mixing (bioturbation) versus physical turbulence on degradation of algal organic matter deposited on the sediment-water interface. Isotopically labeled (13C and 15N) algal cells were initially spiked on the top 1 mm of homogenized sediment cores, simulating a natural deposition of bloom-produced organic matter. Biological mixing was carried out by adding group macrofauna or individual species into sediment cores which were previously sieved. Physical mixing was manipulated by mechanically stirring the top 5 cm of the sieved sediment cores. We followed the time-dependent and depth-dependent variations of chlorophyll-a and phaeopigments in different mixing regimes. The analysis results showed that chlorophyll-a degraded at different rates in biological and physical mixing regimes, which was likely related to redox conditions established in different mixing regimes. Physical stirring moved the fresh algal materials permanently down to the anoxic zone, resulting in a remarkable slower degradation for algal chlorophyll-a. No matter how frequently the physical stirring events occur, similar amounts of chlorophyll-a were remained in sediment cores over one month incubation. Bioturbation created an oscillated oxic/anoxic environment for organic matter degradation but the roles depended on animal species and their behaviors. Crustacea used in our experiments played a much stronger influence on chlorophyll-a degradation than polychaeta and mollusca. In no mixing cases, chlorophyll-a in spiked algal material degraded on the interface with oxic conditions and the rate was similar to that in bioturbation case.

OS11P-11 1135h

Controls on the Benthic Oxygen Flux in Estuarine Sediments: Impact of Macrobenthic Organisms During a Long-term Laboratory Experiment

Marc J Alperin[1] (919-962-5184; alperin@email.unc.edu)

Brenton J Ream[1] (919-962-0014; bream@email.unc.edu)

Yonghong Nie[1] (919-962-0014; ynie@email.unc.edu)

Sean P Powers[2] (252-726-6841; spowers@email.unc.edu)

[1]Department of Marine Sciences, University of North Carolina 12-7 Venable Hall, Chapel Hill, NC 27599-3300, United States

[2]Institute of Marine Sciences, University of North Carolina 3431 Arendell Street, Morehead City, NC 28557, United States

Periodic O_2 depletion is an annually recurring condition in the bottom water of the Neuse River estuary in North Carolina (USA). In the mesohaline portion of the estuary, intervals of anoxic bottom water lasting hours to days are common during the summer. Continuous monitoring records show that minimum daily bottom-water O_2 concentrations are highly variable between June and August, but fall below 1 mg L^{-1} about 50% of the time. Oxygen consumption in the sediments and sub-pycnocline water column are comparable ($\sim$30 mmol m^{-2} d^{-1}), indicating that both benthic and pelagic respiration contribute to bottom water hypoxia.

We conducted a long-term laboratory experiment to better understand factors that control sediment O_2 demand. Triplicate sediment cores were collected from the central channel at mid-estuary and incubated in the dark at in situ temperature (27°C) for >400 days. The overlying water was replaced frequently and sediments were subjected to periodic anoxia (lasting 1-4 days) to simulate natural O_2 dynamics. Benthic fluxes of O_2, NH_4, and NO_3 were monitored on weekly to biweekly intervals. Fluxes of ΣCO_2, ΣH_2S, and Fe(II) were also measured, but less frequently. Oxygen microelectrode profiles were determined on several occasions and macro- and meiofauna populations were sampled at the end of the experiment.

Despite the lack of new primary production in the benthic chambers, sediment O_2 demand increased at the outset of the experiment from an initial value of 30 mmol m^{-2} d^{-1} to almost 60 mmol $m^{-2} d^{-1}$ at day 120. The O_2 flux decreased gradually thereafter, reaching a value at day 440 comparable to the initial flux. Populations of deposit-feeding bivalves (*Macoma balthica*) and polychaete worms (*Spionidae*) were present throughout the experiment in spite of periodic anoxia and lack of fresh phytoplankton. Macrofauna contributed to the initial increase in sediment O_2 demand via respiration, porewater irrigation, an increase in sediment surface topography (creation of mounds and burrows), and excretion of pseudofeces. The O_2 penetration depth through surface fecal matter was less than 0.1 mm, implying O_2 consumption rates of 350 μM min^{-1}. A short distance from the fecal deposit, O_2 penetration increased to 1 mm and the consumption rate dropped to 70 μM min^{-1}. The fact that these sediments maintained high O_2 demand after >1 year without fresh phytoplankton input suggests an abundant stock of reactive organic matter. This implies that bottom water hypoxia in the Neuse River estuary will respond slowly to decreases in anthropogenic nutrient loading.

OS11Q HC: 317 A Monday 0830h

Satellite-Measured Ocean Color Variability in the Ocean I

Presiding: **A Thomas,** University of Maine**; C McClain,** NASA GSFC

MON

OS11Q-01 0830h INVITED

SeaWiFS Mission Highlights After Four Years of Data Collection

Charles R. McClain[1] (301-286-5377; mcclain@calval.gsfc.nasa.gov)

Gene C. Feldman[1] (301-286-9428; gene@seawifs.gsfc.nasa.gov)

[1]NASA Goddard Space Flight Center, Code 970.2 Code 970.2 NASA Goddard Space Flight Center, Greenbelt, MD 20771, United States

The Sea-viewing Wide Field-of-View Sensor (SeaWiFS) has been operational for over four years and has provided routine global ocean and land data of exceptional quality. It is the first ocean color data set to provide global coverage over an entire seasonal cycle. During its operation, a wide variety of events have occurred ranging from the global (e.g., the 1997-1998 El Nio-La Nia) to the regional (e.g., persistent coccolithophore blooms in the Bering Sea) in scale. The presentation will review some of the more dramatic geophysical events that have been captured in the imagery and scientific highlights that have been derived from the data set. Also, with a fourth complete data set reprocessing being planned in early 2002, a preliminary summary of the processing improvements will be described.

OS11Q-02 0845h

Decadal Changes in Global Ocean Chlorophyll

watson w gregg[1] (301-614-5711; gregg@cabin.gsfc.nasa.gov)

margarita e conkright[2] (301-713-3290; mconkright@nodc.noaa.gov)

[1]NASA/GSFC, Code 971, Greenbelt, MD 20771, United States

[2]NOAA/NODC, Ocean Climate Lab, Silver Spring, MD 20910, United States

The global ocean chlorophyll archive produced by the Coastal Zone Color Scanner (CZCS) was revised using compatible algorithms with the Sea-viewing Wide Field-of-view Sensor (SeaWiFS). Both archives were then blended with in situ data. This methodology permitted a quantitative comparison of decadal changes in global ocean chlorophyll from the CZCS (1979-1986) and SeaWiFS (Sep. 1997-Dec. 2000) records. Here we show that global spatial distributions and seasonal variability of ocean chlorophyll were similar, but global means decreased over the two observational segments. Major changes were observed regionally: chlorophyll concentrations decreased in the high latitudes while chlorophyll in the low latitudes increased. Mid-ocean gyres exhibited limited changes. The overall spatial and seasonal similarity of the two data records suggests that the changes are due to natural variability, and provides evidence of how the Earth's climate may be changing and how ocean biota respond. Furthermore, the results have implications for the global ocean carbon cycle.

OS11Q-03 0900h

A Global Perspective of Chlorophyll from SeaWifs: 1998-2000

Paul Fortier[1] ((508) 999-8544; pfortier@umassd.edu)

Avijit Gangopadhyay[1] ((508) 910-6330; avijit@umassd.edu)

Amit Tandon[1] ((508) 999-8357; atandon@umassd.edu)

Vishal Shah[1] ((508) 999-8493; g-vshah@umassd.edu)

[1]University of Massachusetts Dartmouth, 285, Old Westport Road, N. Dartmouth, MA 02747

This study focuses on developing a multiscale perspective on the distribution of sea surface chlorophyll with respect to their underlying water masses. Three years of available Chlorophyll data from SeaWifs have been analyzed to determine the monthly and seasonal distribution in six different oceanic regions. These regions are North and South Atlantic, North and South Pacific and North and South Indian Oceans. Monthly