sulfate reduction and methane oxidation rate measurements. Total cell numbers and biomass of methane consuming bacteria were compared in the two habitats. Identification of methane oxidizing consortia using FISH (Fluorescent in-situ hybridization) is planned. Macrofaunal composition and distribution were examined along the chemical gradients with a focus on oxygen and sulfide concentrations. While biological studies at methane seeps have mainly concentrated on sediment surface communities, our investigations also included the infauna organisms.

Clambeds and bacterial mats exhibited striking differences not only in methane concentrations but also in the stable isotopic signature of methane (up to 20 per mil) as well as in the intensity and vertical distribution of sulfate reduction and methane oxidation rates within the sediments. Phylogenetic studies are under way to find out if this difference is also reflected in the microbial diversity. Sulfide concentrations were extremely high (10 - 15 mM) within the bacterial mats, even in the top centimeters. In comparison, the values in the clam beds were much lower and concentration peaked (2 mM) in the zone of highest sulfate reduction. No macrofaunal taxa tolerated the highest sulfide concentrations of 10 - 15 mM: most of the seep infauna were sulfide intolerant. However, a complex of dorvelleid polychaete species tolerated sulfide to concentrations of 1 - 5 mM, as did microbial mats composed of filamentous sulfur oxidizing bacteria.

The extreme conditions characteristic of methane seep sediments are likely to yield new understanding of the interaction of microbial processes, geochemical gradients and benthic assemblages.

OS12H-03 1400h

Importance of Benthic Nutrient Regeneration for the Initiation of Macroalgal Blooms in Shallow Embayments

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Despite remedies to counteract eutrophication in coastal marine ecosystems in Sweden, the problem with floating macroalgal mats in embayments still remains. The reason may be that shallow embayments, due to nutrient loading of sediments during recent decades, now function as self-regenerating systems, favouring the growth of opportunistic macroalgae. The role of sediment biogeochemistry for inorganic nutrient efflux was studied in two bays during the pre-bloom and initial growth period of green algal mats. Sediment/water nutrient fluxes were measured, in situ and in the laboratory, together with denitrification, primary productivity, sediment nutrient profiles, and microphytobenthic and faunal biomass and composition. The sediment pool of inorganic nutrients could, depending on site, meet the entire N demand and up to 70 per cent of the P demand of the initial green-algal growth. The availability of this nutrient pool was, however, influenced by the functional type of infauna, and competition by microphytobenthos. The net efflux of inorganic N and removal of N by denitrification were within the same magnitude. The conclusion is that sediment nutrient efflux alone can be sufficient to initiate the growth of algal mats, implying that a delayed effect of decreased nutrient load to the coastal zone can be expected.

OS12H-04 1415h

Density-Dependent Impacts of Bioirrigation by the Burrowing Shrimp *Upogebia pugettensis* on Benthic Fluxes and Porewater Solute Distributions in Pacific Northwest Estuaries

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Burrowing thalassinid shrimp are major ecosystem engineering species of Pacific estuaries and can structure the physical, chemical, and biotic properties of sediments. Feeding and burrow irrigation by benthic organisms can increase the remineralization rates of organic material (OM) and the interfacial solute fluxes. This study utilized a combination of benthic chambers and porewater peepers to quantify the role of *Upogebia pugettensis* population density on benthic fluxes and porewater solute distributions in Yaquina Bay, Oregon.

Sediment oxygen uptake was 3-7 times greater in the presence of shrimp and increased linearly with shrimp burrow density ($R^2 = 0.8$). Similarly, the Dissolved Inorganic Nitrogen (DIN = ammonium and nitrate) flux from sediments to overlying water increased with burrow density ($R^2 = 0.66$). At mid and high shrimp densities (55 and 130 burrows 0.25 m^{-2}, respectively), nitrate became proportionally more important to DIN efflux from the sediments indicating a potential density-dependent increase in nitrification. *U. pugettensis* also affected porewater solute profiles to ∼ 50 cm. The inventory of PO_4 and NH_4 was inversely related to burrow density with the greatest impact seen in PO_4 where integrated concentrations were 8 times greater in no shrimp habitat compared to areas with high shrimp densities. Ammonium and phosphate porewater profiles were most affected by mid- and high densities of shrimp burrows where there was lower solute concentrations in the top 30 cm of the sediment column, presumably due to bioirrigation. In contrast, the solute profiles in the low density (20 burrows 0.25 m^{-2}) and no shrimp areas were dominated primarily by diffusive transport.

Thus, populations of *U. pugettensis* have a significant impact on OM and nutrient cycling in Yaquina Bay, which implies an important role for burrowing shrimp in the biogeochemistry of Pacific Northwest estuaries.

OS12H-05 1430h

The Role of Bioturbation in Benthic Nutrient Dynamics and Sediment-Water Interface Exchange.

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The contribution of regenerated sources of nutrients from benthic systems has been paid little attention. Trawl disturbances to the seabed potentially cause a wide range of impacts that can modify the assemblage of benthic organisms. Alterations to benthic community structure are likely to have geochemical consequences. Mortality due to trawling is size dependant within and between species, and can effectively cause a shift from large, slow reproducing species to smaller organisms with high turnover rates in those areas subject to repeated benthic disturbance. As bioturbation activity (the natural reworking of sediment by organisms) is positively correlated to body size, the concomitant effects of this could cause significant impacts on the transformations of organic matter by bacteria and the regeneration of, and sediment-water fluxes of, nutrients. This study investigates the role of benthic fauna in modifying the sediment-water fluxes of nutrients in a number of controlled mesocosm experiments. Replicate mesocosms containing five separate treatments were set up. These included; 1, Molecular diffusion controls. 2, Untrawled sediment fauna (Larger organisms). 3, Trawled sediment fauna (Smaller organisms). 4, Density manipulated fauna (To isolate organism interactions). 5, Disturbed sediment systems (Trawl mimicked). Following a stabilisation period the sediment was incubated under flux chambers for 40 hours to determine nutrient concentrations at regular intervals. Based on these measurements benthic-pelagic nutrient fluxes were calculated. Biogeochemical consequences of altered macro benthic interactions are discussed and evaluated.

OS12H-06 1445h

Vertical Distribution of Denitrification Rates in Intertidal Sediments

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Denitrification plays a key role in organic carbon mineralization and nitrogen removal in estuarine sediments. The vertical variation in denitrification rates was determined at two different sites in the Scheldt estuary (Belgium, The Netherlands), using two different methods. Microsensors were used to record N_2O profiles in the presence of the N_2O reductase inhibitor acetylene; the actual *in situ* as well as potential denitrification rates were obtained. This method allows a high spatial resolution with negligible disturbance of the sediment. Additionally, intact sediment plugs of 1 cm, from 4 different depths were incubated in flow-through reactors to determine denitrification rates. This method has a lower resolution than the microprofiling, but in addition to nitrate reduction rates, kinetic parameters like K_s and R_m can be calculated. Highest denitrification rates, on average 300 μMNh^{-1} by microprofing and 400 μMNh^{-1} by plug flow-through reactor, were found in fresh water sediment. In the brackish sediment rates were lower being on average 100 μMNh^{-1} determined by plug flow-through reactor incubation. Unexpectedly, high denitrifying activity was determined at depths were oxygen, as well as nitrate, were found depleted by classical pore water analysis and microprofiling. This indicates supply of nitrate at deeper depth, either due to microbial activity, bioirrigation or frequent physical mixing of the top sediment layers. Due to the high abundance of oligochaetes we suspect that bioirrigation is the process responsible for supply of nitrate and oxygen at deeper depths, thus sustaining active denitrification. The combination of the two methods, allowing fine-scaled resolution or determining kinetic parameters, seems promising in predicting denitrifying reaction rates in response to environmental variables (e.g. salinity, carbon, nitrate) and in intertidal sediments.

MON

OS12I HC: 317 B Monday 1330h

Synthesis of the Arabian Sea Expeditions III

Presiding: **S L Smith,** University of Miami**; P Burkill,** Plymouth Marine Laboratory**; S W Naqvi,** National Institute of Oceanography

OS12I-01 1330h

The "North Arabian Sea High Salinity Water" annually ventilates the upper part of the pycnocline north of 21-22N

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The salinity maximum in the northern Arabian Sea poleward of 21-22oN in the pycnocline at or slightly deeper than the 25 g dm-3 isopycnal, which KB had mentioned in 1968 and described in 1984, is being revisited, principally based on seasonal coverage along five sections each between May 1975 and August 1976. Geographically this "Northern Arabian Sea High Salinity Water" (NASHSW) replaces the Arabian Sea High Salinity Water (ASHSW) of several authors, which is present in the central and eastern Arabian Sea at about 24 g dm-3. Convection appears to renew the NASHSW during each winter at least partially. It ventilates the permanent pycnocline to 150 m or slightly deeper, analogous to the subduction of high-salinity water near the subtropical convergences of the principal oceans.

In the very top of the pycnocline, above the salinity maximum formed by the NASHSW, a thin (decameters) salinity minimum usually occurs, which in one-third of the observed pairs of samples is less well aerated than the first depth of the NASHSW below. Its origin cannot be ascertained, but based on T-S relations, advection and subduction from the east after the close of the NE Monsoon (surface low-salinity water spreading along the west coast of India) and from the southwest (upwelling off Oman due to the SW Monsoon) are possible. The often low oxygen content, though, is puzzling (median saturation of 18 cruise x section medians is 52%, range 20-85% after, omitting a few full-saturation values).

The salinity maximum, occasionally accompanied by the overlying salinity minimum, was found at and above about 22oN in all years with data (1961, 1965, 1966-68, 1974, 1975/76, 1986, 1987, and 1992-1994 [here, with few occurrences among 20-25 offshore stations during each of four cruises]), but not in 1995. It was also observed east of 60oE, at about 20oN and further south in 1986 and 1987, but not during 1965 and 1994/95.

OS12I-02 1345h

Arabian Sea eastern continental margins : Natural laboratory for biogeochemical and paleoceanographic studies

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The eastern continental margins of the Arabian Sea experience the vagaries of monsoon and its manifestations, the underlying sediments well preserve the past records of these events. Whereas the southwest monsoon winds cause upwelling in the margin regions, very high rainfall occurs between the western Ghats and the Indian west coast. From ∼22°N to ∼10°N, the rainfall increases from ∼30cm/year (Port Okha) to ∼400cm/year (near Mangalore) with a gradient of ∼40cm/degree latitude. Especially between ∼20°N and ∼10°N there is very high precipitation almost all of which rushes into the adjacent coastal region creating salinity lowering. It has been shown that the past monsoonal precipitation record can be deciphered from that of d18O in G.sacculifer and that there has been an increasing trend in the precipitation between ∼10 ka BP to ∼2 ka Before Present. The wind-induced surface productivity as measured in d13C of G.sacculifer and organic carbon (in sediments) has increased during the above mentioned period. The subsurface denitrification deduced from d15N of the sedimentary organic carbon which is an indication of the surface productivity exhibits the same trend. Due to the presence of a perennial near-anoxic water column between ∼200 and ∼1000m depths, organic carbon is well preserved in sediments collected from water depths $\lesssim$1000m.

Geochrnonology of four of the cores was achieved by AMS 14C measurements on planktonic foraminiferal seperates which enabled the assignment of calendar ages up to∼40 ka. In addition to 14C and stable isotopes studies a suite of major and trace elements have also been measured which enable the understanding of changing geochemitsry due to varying redox conditions in this region. An uptodate account of the study which is still in progress, will be presented.

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OS12I-03 1400h

The Eastern Arabian Sea: A Region of Unusual Biogeochemical Cycling

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There are several distinguishing features of the oceanography of the eastern Arabian Sea. Like the other currents of the northern Indian Ocean, the West India Coastal Current (WICC) also reverses direction every six months - it flows poleward during winter and equatorward during summer. The winter flow, enigmatically headed into the wind, brings large volumes of warmer, fresher and nutrient-impoverished water off the Indian coast causing downwelling and low rate of primary production (PP). In contrast, the summer flow favours upwelling that may be sustained over a long period (May-December with appreciable inter-annual variability) by a coastally-trapped Kelvin Wave originating in the eastern equatorial Indian Ocean. A well-developed poleward undercurrent found below the surface layer during this season supplies fresher, more-oxygenated waters to the more-saline, oxygen-depleted zone, suppressing denitrification. However, as the water upwells and moves over the Indian shelf, it loses oxygen rapidly due to bacterial decay of organic matter leading to the development of a shallow suboxic zone that is seasonal and is not linked with the deeper, perennial suboxic zone of the Central Arabian Sea. The acute near-bottom oxygen depletion is promoted by the presence of a thin (5-10 m) warm fresher layer (arising from the intense monsoon rains) that floats over the cold upwelled water and restricts oxygen-supply from the surface, and a high oxygen consumption rate in the deeper layer owing to high PP (up to 7 g C m-2 d-1 with the chlorophyll a reaching up to 12 mg m-3). The PP is largely fuelled by nutrients supplied through upwelling, but it has probably been enhanced further by recent increases in fertilizer runoff from land. Oxygen levels in the sub-pycnocline waters begin to decrease in May and are sufficiently low to trigger denitrification by July. Complete loss of oxidised nitrogen by August-September is followed by sulphate reduction in the inner and mid-shelf regions. Anoxic conditions gradually propagate northward and last until November/December. Currently, there appears to be a trend of intensification and expansion of the coastal oxygen-deficient zone. In 2001, for instance, sulphide-bearing waters covered the shelf down to 70 m depth off the central west coast of India, in spite of lower-than-average rainfall and consequently weaker thermohaline stratification. Besides affecting the abundance and composition of marine organisms, anoxic conditions greatly influence the cycling of redox-sensitive elements and greenhouse gases. Concentration of nitrous oxide (N2O) and partial pressure of carbon dioxide (pCO2) (up to 436 nM and 700 matm, respectively) are among the highest recorded in the oceanic surface waters. Interestingly, denitrification, which generally causes a net consumption of N2O, seems to be the process responsible for its anomalous build-up in the coastal suboxic zone. The loss of fixed nitrogen through denitrification decreases the N:P ratio in water such that the process should eventually limit PP, but once the sulphate reduction sets in, the regenerated ammonium can fulfil the N requirement of phytoplankton. The excess P regenerated through denitrification/sulphate reduction should at some point favour N-fixation. However, blooms of the diazotroph Trichodesmium, which used to be frequently encountered in the region about two decades ago, are now rarely seen, presumably reflecting an overall increase in N-loading of coastal waters.

OS12I-04 1415h

Application of the Spectral Matching Algorithm to Recover Chlorophyll Time Series During the Arabian Sea Southwest Monsoon

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In the Arabian Sea, the seasonality of satellite-derived surface chlorophyll has been incompletely characterized because of poor data retrieval during the SW monsoon. In part, this stems from the limited ability of current atmospheric correction algorithms to deal with absorbing aerosols such as dust, which tend to be widespread in the region. To try to ameliorate this problem, a new spectral matching algorithm (SMA) was applied to a year of SeaWiFS data from June to October. The use of SMA significantly increased data recovery over large areas especially in June-August. For example, a prolonged bloom with associated filaments and gyres could be observed in the Oman upwelling area, which was otherwise completely masked using the standard processing. However, the SMA tended to yield higher chlorophyll values compared to standard results, indicating a need for better calibration of the method. This preliminary analysis demonstrates the promise and limitations of the present technique.

OS12I-05 1430h

Sedimentary Nitrogen Cycling Over the Western Continental Shelf of India

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Most the oceanic sedimentary mineralization, to which denitrification makes a very substantial contribution, is believed to occur over the continental margins, but data on sedimentary denitrification rate (SDR) are not available from many important continental margins. Using the acetylene block technique, we have measured for the first time the SDR at depths varying from 23 to 300 m over the western continental shelf of India. The SDR was found to range between 80 and 667 moles m-2 d-1. Extrapolating to the area of the continental shelves the overall SDR in the Arabian Sea is estimated to be between 0.4 and 3.5 Tg N y-1. This rate is quite modest and comparable with similar estimates from other areas. The highest SDR was found over the inner shelf region. Although no definite relationship could be established between the SDR and bottom water oxygen concentration, there was a weak inverse correlation between the SDR and bottom water nitrate levels. However, bottom water chemical composition varied considerably. For example, oxygen and nitrous oxide (N2O) concentrations ranged from 2.7 to 74.8 M and from 26.2 to 111.9 nM, respectively. These results indicate a highly dynamic system with rapid changes in near-bottom redox conditions. Thus, while the interstitial water chemistry is expected to be controlled by the composition of bottom waters, a one-to-one relationship may not always occur at a given time. Nitrate and nitrite concentrations were higher in surficial sediments and declined with depth indicating losses through denitrification. Porewater nitrate concentrations were lower than those in the overlying water indicating an uptake of nitrate by the sediments. While a net production of N2O seems to occur at the sediment surface, it is consumed at deeper levels. N2O production in subsurface sediments varied from 3 to 60 moles N2O l-1. Our results show that denitrification process in sediments is an important but not the dominant sink for fixed nitrogen in all areas.

OS12I-06 1505h

Vertical Distributions of Macrozooplankton and Micronekton in the Arabian Sea Oxygen Minimum Zone

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The presence of a pronounced oxygen minimum zone (OMZ), such as in the Arabian Sea, can influence distributions of macrozooplankton and micronekton, thereby influencing the amount and form of carbon transferred to depth. As part of the U. S. JGOFS program, samples were collected from 0 - 1000 m in the Arabian Sea using a double 1 m^2 MOCNESS (153 μm mesh nets). Day and night tows were done at six stations on four cruises (Late Northeast Monsoon, Spring Intermonsoon, Southwest Monsoon, Early Northeast Monsoon) during 1995. Macrozooplankton and micronekton from 300 - 1000 m (in the oxygen minimum zone) were identified to the lowest taxon possible and enumerated. Use of narrow vertical strata (∼100 m) allowed detailed determination of vertical distributions and abundances for each organism. Vertical profiles of abundance were compared with temperature, salinity, and oxygen profiles. Relationships between oxygen concentrations and animal distributions varied with species. Organisms could be grouped into at least two categories: daily vertical migrators (euphausiids, myctophids, and the fish *Bregmaceros* spp.) and residents of a subsurface biomass peak at the lower end of the OMZ (the shrimp *Gennadas sordidus* and the fish *Cyclothone* spp.). Implications for the role of these animals in carbon cycling will be discussed.

OS12I-07 1520h

Diversity and Distribution of Midwater Fish and Macrozooplankton in the Arabian Sea

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The diversity and distribution of the Arabian Sea fauna is thought to be strongly affected by monsoonal forcing of primary production, and the extensive suboxic zone that extends between about 150 and 1000 m. The effects of these environmental features on the diversity and biomass macrozooplankton and fishes were examined on two cruises of the R.V. Malcolm Baldrige in 1995. The first cruise was during the intermonsoon period in April-May, and the second during the summer or southwest monsoon, in August. We used a 10 m2 MOCNESS trawl (3 mm mesh) to make 65 replicated, day/night, stratified tows to 1000 m or more at a total of 12 stations, off the coast of Somalia, at the JGOFS mooring site, along the coast of Oman, and in

the Omani Basin. From these samples we have now identified and enumerated 272 species of invertebrate macrozooplankton and 229 species of fishes, and determined both numerical abundance and biomass distributions for all major groups. At stations off Somalia and in the Omani Basin, the overall numbers of species was 50% higher in May than August, but were the same at the JGOFS mooring in the central Arabian Sea. The most abundant crustacean macrozooplankton included the euphausiids Euphausia diomedeae, Gennadas brevirostris and Sergestes semissus. Important non-crustacean plankters were the pteropods Cymbulia peroni and Cavolinia longirostris, the salp Thalia rhomboides, and the hydromedusa Pantachogon haeckelii. Twnty-nine species of cephalopods were collected, with the greatest diversity off the Somali coast. The fish fauna was dominated by 5 species of Cyclothone, and the myctophids Lampanyctus macropterus, Benthosema pterotum and Diaphus arabicus. Two new species of fish were described from these collections, Monognathus berteli and Polyipnus limatulus, and at least two others await description. Distributions relative to the oxygen minimum zone varied for different groups. Cyclothone spp. and decapod shrimp remained within the suboxic layer at all times, while most myctophids and euphausiids made diel migrations into the surface waters at night. Diversity of the various groups relative to station and season, and in comparison with previous collections will be discussed further.

OS12I-08 1535h

Characteristics of the NE and SW Monsoon Blooms and its Relevance for the CO_2 Emission from the Arabian Sea

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Sediment traps are at present the only tools which can continuously intercept the export of carbon and associated elements from the surface ocean into the deep ocean. Although the accuracy of sediment trap measurements can be biased by hydrodynamic and biological effects, the results of sediment traps deployed at water depth >1200 m reveal an acceptable accuracy. During the field phase of JGOFS in the Arabian Sea, sediment trap experiments were carried out at 9 different sites. The deep ocean fluxes can be linked to upper ocean and meteorological processes obtained from satellite measurements and from the literature. This exercise reveals that the known monsoon driven flux pattern with enhanced fluxes during the SW and NE monsoons is restricted to the area north of 10^{o}N. There, the material transport into the deep-sea is mainly influenced by diatom blooms succeeding blooms of carbonate producing organisms. The succession seems to be caused by variations in the depth of the mixed layer and the euphotic zone, except during the SW monsoon where the velocity of the wind-induced upwelling generally controls the composition and the height of fluxes into the deep Arabian Sea. Thus, changes in the strength the of the monsoon driven physical forcing mechanisms are assumed to lead to variations in the chemical composition of sinking material.

On annual time scales, satellite derived primary production rates can be quantitatively related to deep ocean fluxes which suggests a mean annual export production ranging between 83 and 91 10^{12} g C a^{-1}. This meets estimates of annual mean CO_2 emission from the Arabian Sea and indicates that already small changes in the efficiency of the organic carbon pump due to, e.g., a varying composition of exported matter can affect the CO_2 emission, significantly.

OS12I-09 1550h

Extant planktic foraminifera from the Arabian Sea: A review

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The Arabian Sea is a unique and fascinating region to study the biogeochemical processes because, the seasonally reversing monsoon wind system operating over the region greatly influences the circulation pattern and hydrography resulting in seasonal variation in upwelling and productivity. It is also reflected in the planktic foraminiferal composition and their temporal distribution pattern in the Arabian Sea.

Foraminiferal studies in the Arabian Sea have established that these organisms strongly respond to the reversing monsoons resulting in distinct seasonal variation in productivity, shell flux and relative abundance of species composition. Studies from sediment traps deployed latitudinally across the central Arabian Sea have revealed that the productivity is about 2-3 times greater in the western Arabian Sea where the fauna is dominated by Globigerina bulloides and Globigerinita glutinata due to intense upwelling during the SW monsoon than the central and eastern Arabian Sea. For instance, G. bulloides production increased by a factor of three reaching a maximum flux rate of 9000/m -2/d-1 and also most of the other species such as Globigerinoides ruber, Globigerina tennellus, and Globorotalia menardii exhibit an increase in their productivity both during SW and NE monsoons. Besides, significant decrease in sea surface temperature ('4o C) has been recorded in the western Arabian Sea during SW monsoon. Foraminiferal fluxes in the central Arabian Sea display almost same seasonal patterns as in the western Arabian Sea, but overall the rate of productivity is lower by a factor of 2. Here the most abundant species encountered are G.bulloides and G. ruber. Interestingly, the highest abundance for seasonal species G. sacculifer, G. glutinata, G. aequilateralis and Pulleniatina obliquiloculata occur during NE monsoon rather than the SW monsoon. The increase in foraminiferal production during NE monsoon is more prominent than in the western or eastern Arabian Sea. Unlike the western and central Arabian Sea, lowest foraminiferal productivities are observed in the eastern Arabian sea. As in the central Arabian Sea, G bulloides and G. ruber dominate the assemblage during SW monsoon. Contrary to the significant increase in the production observed during NE monsoon in the western and central Arabian Sea, absolutely no increase was seen in the eastern Arabian Sea. Thus, there is a very conspicuous change in the distributional pattern of foraminifera which shows that there is a gradual decrease in the foraminiferal flux from the western to the eastern Arabian Sea.

In general it has been established that during the intermonsoons the foraminiferal production is minimal and the bulk of the annual foraminiferal flux in the Arabian Sea is largely contributed during the monsoons. Studies carried out till date have demonstrated that the foraminiferal population is largely governed by the interaction of biological and physical processes.

OS12I-10 1605h

What Causes the Sporadic Summer Bloom SE of Madagascar?

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A major summer bloom in the SW Indian Ocean near Madagascar was recently described with SeaWiFS imagery. It covers a high energy eddy field SE of Madagascar roughly 1500 by 3000 km. The bloom starts in January-February, reaches its peak in March and dissipates by the end of April. It is not observed every year: it was seen in Polder images in 1997, was absent in SeaWiFS images in 1998, peaked in intensity and eastward extent in 1999, was strong but not as wide in 2000 and was absent again in 2001. Entrainment of nutrient-rich deep water at the bottom of the surface mixed layer, spatially modulated by the mesoscale eddy field has been suggested as the probable cause. Our view with NCEP re-analysis winds and remotely sensed data from multiple satellite sensors is not consistent with this mechanism. The SE Madagascar bloom shows interesting deviations from typical blooms and its cause remains unexplained. Its sporadic nature suggests that it may be initiated by a combination of factors, such as seasonal changes, phase of large eddies and/or meanders of the retroflected East Madagascar current and secondary effects of tropical cyclones.

OS12J HC: 317 A Monday 1330h

Satellite-Measured Ocean Color Variability in the Ocean II

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

OS12J-01 1330h INVITED

Japanese Ocean Color Activities: OCTS to GLI

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National Space Development Agency of Japan (NASDA) launched on Advanced Earth Observing Satellite (ADEOS). One of the core sensors, Ocean Color and Temperature Scanner (OCTS), collected high resolution global data from November 1996 to June 1997. The mission broke through the 10 years of blank of satellite ocean color data from Coastal Zone Color Scanner (CZCS). The operation was terminated by stop of ADEOS; however following mission of SeaWiFS has been extended the time series for nearly 5 years with only two-months gap. NASDA will launch ADEOS-II on 2002, and Global Imager (GLI) will measure ocean color. Some examples of application of OCTS will be presented with plan of GLI.

OS12J-02 1345h

Seasonal and inter-annual variability in algal biomass and primary production in the Mediterranean sea derived from a four year-long seawifs data series

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The variability of chlorophyll concentration in the upper layer of the Mediterranean Basin has been described and analyzed using the weekly Level-3 products derived from four years of SeaWiFS observations. The data available during the investigation allowed us to perform the first study of seasonal and interannual variability of algal biomass in the different hydrologic regions of the Basin. SeaWiFS chlorophyll data are systematically overestimated for low concentrations. Hence new estimates of chlorophyll concentration were performed by developing a regional algorithm, and compared to those provided by the current algorithm of SeaWiFS Project (OC4V4). The most oligotrophic areas (i.e. Ionian sea, Levantine Basin) are generally stable, whereas the areas subject to seasonal blooms (i.e. Liguro-Provencal Basin, Gulf of Lions) show large interannual variations. Primary production was estimated on a pixel-by-pixel basis from surface biomass fields using a light-photosynthesis model adapted to the use of satellite data. Seasonal and interannual variations of primary production, which are mainly controlled by the variations in algal biomass, temperature and surface irradiation, were derived for the various regions of the Mediterranean Basin. Results were compared with in situ primary production data available in literature. The carbon fixation rates in each sub-region have been computed and compared with those previously derived in the Mediterranean Sea from CZCS data.

OS12J-03 1400h

Interannual Variability of SeaWiFS Chlorophyll in Continental Shelf and Slope Waters off the U.S. Northeast Coast

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SeaWiFS-derived chlorophyll from ocean margin waters off the Northeast U.S. were analyzed and compared to temperature and salinity measurements between fall 1997 and fall 2001. During the SeaWiFS era, the Gulf Stream position shifted northward as evidenced in AVHRR SST imagery as well as in temperature and salinity measurements collected by the merchant ship CMV Oleander on its weekly roundtrip between New Jersey and Bermuda. Recent studies point to a thermohaline forcing of the north-south position of the Gulf Stream: a displacement to the south happens when there is a greater than average supply of cold Labrador Sea waters flowing west along the Canadian shelf towards the mid-Atlantic Bight Slope waters; and vice versa when the Gulf Stream is displaced northward. Some of the interannual variability in the chlorophyll timeseries is correlated with the northward migration of the Gulf Stream, while some of the variability appears to have another forcing mechanism (e.g. wind-driven or non-physical). Curiously, the largest bloom in the Slope Sea during the four-year series took place in spring 2000 when the Gulf Stream was well north of its average path and temperatures were warmer than in other years. Mechanisms to account for this unanticipated finding are under investigation.