Conception. Data from these moorings allow examination of processes on time scales ranging from storm-forced current events to inter-annual anomalies such as those associated with the 1997-1998 El Nio. Over time the array has been augmented with other observational systems including additional moorings and shipboard sampling. In 1998 an array of high frequency radars was added for observing surface currents in the Santa Barbara Channel and the upwelling center off Point Conception. In 1999 the Partnership for Interdisciplinary Studies of the Coastal Ocean (PISCO) program established inter-tidal time series stations to quantify regional patterns of recruitment of various marine fish and invertebrate species. Moorings and bottom mounted current profilers deployed as part of PISCO record the changing oceanographic conditions on the inner shelf in the region. More recently, additional moorings and time series sites to quantify changes in kelp reef habitats due to terrestrial and oceanic influences have been established as part of the Santa Barbara Coastal Long Term Ecological Research Program (SBC-LTER) program. Together these systems are providing observational data to examine links on multi-year time scales between coastal marine ecosystems and circulation in this eastern boundary current region.

URL: http://sbc.lternet.edu http://www-ccs.ucsd.edu http://www.piscoweb.org http://www.icess.ucsb.edu

OS12M-09 1550h

Multi-disciplinary and Multi-platform Observations of Coastal Oceanographic Processes in Santa Monica Bay, CA

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Santa Monica Bay is a coastal embayment characterized by important natural resources heavily impacted by urbanization of the adjacent watershed. Conservation and management of these resources requires an understanding of the interplay between biological, geochemical, and physical processes in the bay. UCLAs Institute of the Environment conducts a multi-platform measurement program involving satellite remote sensing (chlorophyll biomass derived from SeaWiFS radiometer, sea surface temperature derived from AVHRR radiometers, anomalies of sea level derived from TOPEX/Poseidon radar-altimeter, atmospheric precipitation derived from SSM/I radiometers), boat surveys (CTD, undulating towed CTD/optical package, plankton tow, water sampler), and a recently deployed mooring (N 33 55.900, W 118 42.937; TS-String, Surface CTD, ADCP, metsystem; www.ioe.ucla.edu/mucla). These observations, complemented by high resolution computer simulations of physical and ecosystem processes using the Regional Ocean Modeling System (ROMS), are interpreted to quantify important coastal phenomena such as the residence time and eddy structure in the bay, cycling of key geochemical constituents such as nitrogen and carbon, and seasonal and interannual dynamics of phytoplankton, zooplankton, and higher trophic levels such as squid.

OS12M-10 1605h

Development and Validation of a Nested HF-Radar System for the New Jersey Shelf Observing System (NJSOS)

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A nested grid of HF-Radar systems has been deployed in the New York Bight (NYB) off the New Jersey coast. This network of CODAR HF-Radars consists of standard, long-range, and bistatic systems. The standard system, operational since 1998, provides hourly vector maps extending 40 km offshore and 50 km alongshore with a grid resolution of 1.5 km. The standard system has been used in antenna pattern validation studies and multi-disciplinary research conducted within the LEO-15 observatory. An important aspect of this validation has been to test the role of antenna pattern distortions in both the accuracy and coverage of the measurements. Experiments have shown that the local environment plays a significant role in antenna pattern distortion. Calibrating the radar sites with the antenna patterns was shown to improve correlation statistics with a moored ADCP. In June 2000, the first long-range system was deployed in Loveladies, New Jersey. Since that deployment, three more systems have been added to the network to provide total surface current maps that extend as far offshore as 160 km along the entire New Jersey coast with a grid resolution of 6 km. The overlapping coverage of the standard and long-range systems near LEO-15 provides an excellent testbed for validating and understanding the nature of the two measurements. The long-range system measures the scattered signal off a longer ocean wave than the standard system. In addition the long-range data cannot resolve smaller scale spatial features captured in the higher resolution standard current fields. Using a moored ADCP array, the nature and magnitude of the differences between co-located long-range and standard datasets were examined. The third system currently being developed at NJSOS, the bistatic system, compliments both the long-range and standard systems. By moving a transmitter offshore, additional surface current information is available for total vector calculations. These additional vectors reduce the GDOP error seen in HF-Radar fields and extend the data footprint to the coastal boundary. During a week-long cruise in the NYB, a buoy-mounted transmitter was coupled to a standard site and a vessel-mounted transmitter was coupled to a long-range site. This nested multi-radar system will provide longterm surface current measurements as an integral part of the New Jersey Shelf Observing System (NJSOS). NJSOS is one of a series of linked regional observatories envisioned to form the NorthEast Observing System (NEOS).

URL: http://marine.rutgers.edu/cool

OS12M-11 1620h

Acoustically Linked Ocean Observatories- Initial Results From Three Installations

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An acoustically linked ocean observatory infrastructure has been developed that is capable of providing real-time data to shore-based investigators in a variety of marine environments. This system uses acoustic modems, which were developed at WHOI, to transfer data from in situ instrumentation to buoys equipped with RF links that forward the data to shore. Acoustically linked observatories have been deployed in coastal environments and in the deep ocean. Coastal systems are deployed in Massachusetts Bay and the Gulf of Mexico. In each of these installations, hourly ADCP data are telemetered in near real time from two separate sites. The Massachusetts Bay system uses RF modems to link to a shore station that is connected to the Internet via a landline. The two-way capability of the RF modems is used to modify acoustic system parameters to optimize system performance. The Gulf system uses Argos transmitters to send the data to shore, thus making this system easily portable and avoiding the need to maintain shore stations.

A third implementation of the acoustically linked observatory has been developed to deliver data from deepwater moorings. The deepwater system, known as ULTRAMOOR, uses acoustic links to collect data from a number of discrete instruments, but does not use a surface buoy to support the RF link. Instead, it employs expendable data capsules, which are released at intervals over the five-year deployment period. The data capsules float to the surface, where they send their accumulated data via Argos or Orbcomm transmitter. Thus, the data are not real time, but are periodically updated. The subsurface mooring approach was used to avoid maintenance and reliability issues inherent with surface buoy moorings that are deployed over multiple year time periods. The ULTRAMOOR prototype was deployed for three months in 2000 and operated successfully. It will be set for a three-year period beginning in November 2001 in 4500m of water offshore Bermuda.

Analysis of the performance of these systems during their early trials shows that the acoustically linked observatory concept is a robust approach that can reliably deliver low bandwidth data from a variety of locations under all kinds of weather conditions. They are easy to deploy and represent a cost effective approach to achieving real time (or periodic) data updates over extended periods. A comparison of energy efficiency, data reliability and system costs for each of the implementations will be presented. Plans to increase the acoustic data rate and to implement an Iridium RF link will be discussed.

OS12M-12 1635h

Visualization and Feasibility Analysis of GODAE Profile Data

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The Global Ocean Data Assimilation Experiment (GODAE) is an endeavor that will likely change the path of oceanography for many years. This attempt to assimilate, organize and provide massive quantities of widely varied oceanographic and meteorological data to the world could be a catalyst for new and innovative research opportunities. One of the data sources important to GODAE and of great possible value, the Array for Real-Time Geostrophic Oceanography (ARGO), is another innovation that may lead to significant improvements in oceanographic modeling and research. The concept of thousands of autonomous floats, reporting ocean conditions to a database that can assimilate and provide this data in real or near-real time, affords countless opportunities for new methods of ocean prediction. The true test of GODAE is to assess the utility of the data available in a real world setting, and ascertain the relative usefulness as it relates to research opportunities and operational data needs. Here we assess the utility of the USGODAE data server by retrieving, processing, visualizing and employing the data in observing conditions for the North Atlantic Ocean and the Kuroshio Current regions from September, 2000 to March, 2001. By attempting to use the data server in a method similar to future research and operational use, an understanding of its true potential may be reached.

OS12N HC: 323 B Monday 1330h

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

Presiding: **R C Dugdale,** Romberg Tiburon Center**; F Chai,** University of Maine

OS12N-01 1330h INVITED

A Comparison Between Nutrient-Induced Fluorescence Transients (NIFTS) and Growth Bioassays as a Measure of Nutrient Status of Algae: are Phytoplankton ever Really Nutrient Limited?

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Nutrient-induced fluorescence transients (NIFTS) are potentially very sensitive indicators of nutrient status of microalgal cells. In a number of studies on freshwater and estuarine systems, we have shown that conventional growth bioassays suggest that the populations examined were potentially N or P limited, depending on sampling site. However, natural phytoplankton populations will not exhibit NIFT responses

until several days after enclosure of samples in bottles in the laboratory. As phytoplankton populations increase in these incubations, so they begin to exhibit NIFT responses. Given the delay in appearance of the NIFTS until population size had increased following entrainment, it is argued that NIFTS give a measure of instantaneous nutrient status whereas conventional bioassays indicate potentially limiting nutrients. The corollary to this is that the phytoplankton population *in situ* is still in a balanced state and it is only when it is removed from sources of nutrient regeneration, or when population density leads to nutrient demand greater than supply, that phytoplankton exhibit symptoms of nutrient limitation or starvation.

OS12N-02 1350h INVITED

Use of LOICZ Biogeochemical Budgets for Global Coastal Marine Ecosystem Comparison

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This talk is presented on behalf of the community of researchers who have contributed to LOICZ biogeochemical modeling efforts. A primary goal of the IGBP-LOICZ project is the estimation of the role of the global coastal zone in affecting the fluxes of materials from land, through the coastal ocean to the open ocean. In order to meet this goal, LOICZ established a simple budgetary analysis strategy that is widely applicable around the global coastal zone. A challenge has been the use of an analytical technique that could be widely applied to relatively minimal data sets worldwide. The strategy derived includes the use of water and salt budgets to estimate water exchange; the deviations of nutrient budgets from simple conservative behavior with respect to water and salt as a measure of net internal reactions; and stoichiometric comparisons among nitrogen and phosphorus budgets to infer biogeochemical pathways of net system responses. This talk will summarize statistical results which have been obtained from approximately 100 budgets worldwide.

URL: http://data.ecology.su.se/MNODE/

OS12N-03 1410h

The Effects of Nutrient Supply and Concentration on Phytoplankton Biomass and Distribution in Western Florida Bay and the Inner Southwest Florida Shelf

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Our research examined nutrient-phytoplankton relationships along the southwest Florida Shelf between December 1998 to December 2000. The study region included, from north to south, Cape Romano and the Ten Thousand Islands, the Shark River and Cape Sable, western Florida Bay. Netplankton chlorophyll a (>5um size fraction) and biogenic silica (BSiO2) serve as indices of diatom biomass.

Chlorophyll a concentrations show a seasonal increase in phytoplankton biomass in southwest Florida inner-shelf and western Florida Bay. The relative abundance of diatoms increased over the course of summer and fall with peak phytoplankton biomass in October, when chl a concentrations reach > 16 ug/L. The chl a maxima was in western Florida Bay in 1999, and on the inner-shelf (west of Cape Sable) in 2000.

Diatom cells were identified and enumerated in surface water samples collected off Cape Sable. Diatom abundance averaged 10,000 cells/L during non-bloom periods, increasing to 40,000-100,000 cells/L in October. In October 1999 and 2000, diatom biomass was dominated by Rhizosolenia sp., which accounted for 56 and 73% of diatom cells, respectively. Nitzschia spp.were also an important component of the diatom blooms, accounting for 32 and 21% of total diatom cells.

The Shark River was the major freshwater source for western Florida Bay. Salinity isopleths reveal elevated salinities near the Shark River and in western Florida Bay throughout 2000. Freshwater discharge from the Shark River was calculated from canal flow into the Shark River Slough, with an annual maximum in October. Flow rates in 2000 were 1/3 that in 1999. Phytoplankton biomass increased seasonally in response to increasing discharge form the Shark River. Although annual variability exists in freshwater discharge, maximum phytoplankton densities varied by less than 10%. However, freshwater input did influence the spatial extent and location of the diatom bloom.

The Shark River is an important silicic acid and nitrate source to the southwest Florida Shelf. Maximal nitrate concentrations in 1999 were twice that in 2000, with the exception of August 1999, when concentrations were below detection. Nitrate concentrations were greatest in October, when freshwater discharge and phytoplankton biomass were also maximal. Silicic acid and salinity values for coastal and bay stations were inversely related in 1999. The relationship was most pronounced during summer and fall months when uptake by diatoms reduced concentrations below the limit of detection. During these months, biogenic silica and silicic acid concentrations were also inversely related.

Phosphate sources near Cape Romano produced a horizontal concentration gradient towards the south. The combined supplies of phosphate and silicic acid in the Ten Thousand Islands area may explain elevated phytoplankton biomass, primarily diatoms. Nutrient sources and distributions suggest phytoplankton may be nitrogen-limited near Cape Romano, and nitrogen- or phosphorus- limited near the Shark River (depending on season and discharge). Nitrogen, phosphorus, and silicic acid may limit phytoplankton biomass in northwestern Florida Bay.

OS12N-04 1425h

Modeling Nutrients and Phytoplankton Dynamics in the Gulf of Maine

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The rich productivity of the Gulf of Maine is a result of the complex interplay between biological and physical processes. As a temperate region, the Gulf of Maine exhibits a strong seasonal cycle in physical and biological properties. To provide a quantitative measure of physical and biological coupling in the Gulf of Maine, a general ecosystem model structure is embedded into the Princeton Ocean Model for the Gulf of Maine. The ecosystem model includes nitrate, silicate, two-sized phytoplankton and zooplankton, ammonium, and detritus nitrogen and silicate. Nutrient fluxes associated with different processes (river inflow, winter convection, tidal mixing, and nutrient recycling) are estimated from the model. The circulation, stratification, nutrient fluxes, and solar irradiance are used to quantify the annual cycle of phytoplankton production in the Gulf of Maine, emphasizing the differences between the coastal zones, the interior Gulf, and the offshore banks and the differences between the western and eastern basins. The modeled surface phytoplankton biomass compares well with the ocean color data from the SeaWiFS mission (1997-2001) on both temporal and spatial scales.

OS12N-05 1440h

Climate Impacts on Primary Production in Central San Francisco Bay

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The spring bloom in San Francisco Bay is the outstanding annual primary production event although sporadic, lower level bursts of chlorophyll occur throughout the summer and low levels occur more or less throughout the winter as well. During late fall and winter, low levels of ammonium uptake continue, but nitrate uptake is virtually zero, probably suppressed by the high concentrations of ammonium (>6 uM) characteristic of the Central Bay system. The spring bloom, initiated primarily by the onset of favorable light conditions, consists primarily of diatoms whose rapid growth is based upon high nitrate uptake rates coincident with greatly reduced ammonium concentrations (<2 uM). Both nitrate and ammonium concentrations are both reduced during the spring bloom, a result of both the activities of the diatom population and of seasonal changes in the flow regime in the upper estuary. Although the nutrient conditions are influenced to some extent by the inflow of seawater from the Golden Gate, major sources of nitrate and ammonium are from treatment plant effluent and from agricultural drains into North San Francisco Bay (north of Suisun Bay). High levels of silicate are maintained in the estuary from the river inputs and by regeneration at the sediment water interface.

Climate variability influences these ambient nutrient concentrations through variability in precipitation that dilutes anthropogenic nutrients. High precipitation years result in increased dilution, especially ammonium concentrations, and aid in the initiation of high nitrate uptake rates and high levels of diatom chlorophyll. High precipitation also increases surface region stability and favorable light conditions for primary production. These effects are illustrated with data from the high precipitation El Nino year 1998 accompanied by a strong spring bloom, and the lower precipitation La Nina year 1999, with a reduced spring bloom. Data from 2000 and 2001 are also presented as examples of the influence of climate through precipitation on the spring diatom bloom.

OS12N-06 1515h

Effect of Nitrogen and Silicon Pools on the Production and Composition of Siliceous Microplankton in the Western Equatorial Atlantic Ocean

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The seasonal discharge of nutrients from the Amazon River has great potential to structure the microplankton community in the western equatorial Atlantic Ocean. We assessed the effects of riverine inputs on the nutrient physiology and species composition of the microplankton assemblage during winter (Jan-Feb 2001) and summer (Jul-Aug 2001) cruises between $2-14^{\circ}$N and $57-40^{\circ}$W. Our results reveal that pools of both N and Si were limiting factors of primary and silica production. Short-term (hours) nutrient amendment experiments were performed at all stations occupied, and generally resulted in an increase in the silica production rate by a factor of 1.5-5. Despite surface concentrations of dissolved silicon (dSi) as high as 27μM in the winter, the rate of silica production was limited by dSi concentrations at the majority of stations in both seasons. Silica production was also stimulated by the addition of nitrate or ammonium. At two stations, silica production rates increased by two orders of magnitude with the addition of 1μM ammonium.

Nitrogen and silicon limitation of production occurred across several distinct assemblages of siliceous plankton. Either mixed diatom assemblages or virtually monospecific diatom populations occupied the relatively fresh waters that were characterized by high dSi and low inorganic nitrogen concentrations. A bloom of *Skeletonema sp.* occurred at a station at which surface concentrations of dSi were high (25μM), combined dissolved inorganic nitrogen concentrations (DIN) were low (0.04μM) and salinity was <30ppt. A bloom of *Hemiaulus hauckii* occurred at a more oceanic station, with surface dSi of 6μM and DIN of 0.13μM. These diatoms were associated with the cyanobacterium, *Richelia intracellularis*, which were fixing N_2 at a rate adequate to supply the microautotrophs with their N needs, at Redfield ratios. Thus, the combined effects of both Si and N pools affect the species composition and rate processes of natural assemblages in the nutrient rich Amazon plume occupying the western equatorial Atlantic Ocean.

OS12N-07 1530h

Pelagic foodweb interactions and modelling responses of marine plankton communities stressed by the antifouling agent Seanine 211

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Trophic interactions and food web dynamics of plankton communities are controlled by a variety of

bottom-up and top-down pressures. Nutrients and grazing activities are important candidates to explain natural events and represent the basis for most modelling activities in the pelagic zone. Stress factors like toxic compounds are, however, seldom incorporated in this scenario. In this study, we examined community dynamics and modelling responses of natural marine plankton communities exposed to the antifouling agent Seanine 211. Seanine 211 is a bioaccumulating and highly toxic biocide used as an antifouling paint on ships. Natural populations of marine plankton communities were incubated in subsurface plastic mesocosms for 9 days with and without added Seanine 211 (0 to 320 nM). Community responses included an initial knockdown effect on algae, bacteria, heterotrophic flagellates, and mesozooplankton followed by a rapid bacterial growth and a successive growth of heterotrophic flagellates and phytoplankton. EC50 for phytoplankton chlorophyll was 35 nM immediately after adding Seanine 211. Rates of Acartia egg production and mortality were followed by adding fresh animals to the toxified enclosures. Egg production was negatively correlated to the added Seanine concentration with EC50 values ranging between 12 and 73 nM. Mortality rates of adult Acartia gave an EC50 value of 5 nM immediately after Seanine 211 additions, but 4 and 6 days after there were no effects on mortality rates. A mathematical model description of the community effects mimicked the observations and suggested an initial immediate toxic effects on all organisms, a subsequent rapid increase in the bacterial production followed by a re-growth period of heterotrophic flagellates and phytoplankton.

OS12N-08 1545h

The recycling of silicon in coastal waters of western Europe

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For decade the coastal waters of western Europe has received considerable inputs of nitrate originated from cultivated lands leading to drastic modifications of their chemical composition. Previous studies have shown that silicic acid can now limit the production of diatoms, which predominate the phytoplankton composition during spring. So determining the recycling rate of Si in those waters is of major importance. Here we report the first determination of biogenic silica dissolution rates in parallel to silica production rates in coastal European waters, using a mass spectrometry technique. The study area -the Bay of Brest - is typical of western Europe. It is a semi-enclosed ecosystem which waters are rapidly renewed by the North Atlantic Ocean. During spring 2001, in the surface waters of the Bay the dissolution rates ranged from 0 to 0.94 mol l-1 d-1 (mean: 0.16 mol l-1 d-1), the production rates ranging from 0.21 to 2.63 mol l-1 d-1 (mean: 0.84 mol l-1 d-1) in line with the variations of the silicic acid concentrations. The dissolution and production rates integrated over the water column averaged 4.6 and 14 mmol m-2 d-1, respectively. The dissolution/production (D/P) ratio averaged only 0.2 during the blooming period, which is in the lower part of the range of what has been reported previously in various coastal ecosystems. So in spring 2001 the in situ recycling of Si in the Bay of Brest waters was not able to satisfy alone the diatom Si(OH)4 requirements, which mainly layed on the inputs from rivers and from the Atlantic Ocean, i.e. on processes that are affected by strong climate variability.

OS12N-09 1600h

Theoretical Constraints on the Uptake of Silicic Acid Species by Diatoms

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Two major chemical forms of dissolved silicon (H_4SiO_4, $H_3SiO_4^-$) are in chemical equilibrium in seawater. The species actually taken up by diatoms is still under discussion. Phytoplankton cells are surrounded by a diffusive boundary layer (DBL) which has an effective thickness of the order of the (surface equivalent) cell radius. The transport through this layer is by diffusion only and thus may limit the supply of silicic acid to the cell. Due to uptake of one or both of the species of silicic acid by the cell, the system in the DBL is out of chemical equilibrium and the conversion between different species of silicic acid is governed by kinetics.

We have developed a diffusion-reaction model for the components H_4SiO_4, $H_3SiO_4^-$, OH^-, and H^+ in the DBL which allows us to calculate an upper limit to the uptake rates of a given chemical species of dissolved silicon as a function of the bulk concentration of dissolved silicon, pH, and cell radius. Together with experimental results constraints on the silicic acid species taken up by diatoms are developed.

OS12N-10 1615h

The Photosynthetic Iron Requirements of Coastal and Oceanic Diatoms

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Phytoplankton acclimate to low light by modulating the abundance and stoichiometry of Fe-rich electron transport components (photosystem II (PSII), the cytochrome b6f complex (Cyt b6f) and photosystem I (PSI). The photosynthetic cytochromes and Fe-S proteins constitute the largest catalytic Fe pool in eukaryotic phytoplankton, and photoacclimation to low irradiance is hypothesized to increase cellular Fe requirements. Experiments were conducted to examine the photosynthetic Fe requirements of the coastal diatom Thalassiosira weissflogii, and the oceanic diatom, T. oceanica, grown over a broad range of irradiances in Fe-rich and Fe-deplete seawater. Photosynthetic characteristics were determined by measuring oxygen evolution and PAM fluorometry. PS I, the Cyt b6f complex, and PS II were quantified to construct a cellular Fe budget.

The Fe content of the neritic diatom, T. weissflogii, was substantially greater at low growth irradiance. Increased cellular Fe content was highly correlated with the changes in the biologically active Fe-containing photosynthetic components. The photosynthetic complexes contained the majority (50-80%) of cellular Fe. Photosynthetic cytochromes made up the largest catalytic Fe pool in this species and cellular concentrations were modified by growth irradiance but not by Fe limitation. PSI content was disproportionately affected by Fe limitation, but the reduction in P700 content was not associated with a substantial reduction in growth rates and photosynthetic capacity. The increased Fe requirement of low light cells did not result in heightened susceptibility to Fe limitation and, as a consequence, growth at low Fe and light does not necessarily result in co-limited growth. Instead, Fe stress was greatest when cells were growing at or near their maximum capacity under high growth irradiance, when their Fe demand per unit time was the greatest.

Unlike the coastal species, the cellular and photosynthetic Fe content of the oceanic species, T. oceanica, was not significantly affected by growth irradiance. As has previously been observed, T. oceanica had significantly lower Fe requirements compared to the coastal species. Photosynthetic Fe requirements were also significantly lower, due primarily to ~10-fold lower cytochrome content. The results of this study provide a biochemical basis for the difference in Fe requirements between coastal and oceanic species and suggest that photoacclimatory stategy is a primary determinant of cellular Fe requirements.

OS12N-11 1630h

The Inner Front of the Southeastern Bering and Effects on Phytoplankton Abundance.

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We investigated the Inner Shelf Front of the Southeastern Bering Sea in four regions (Slime Bank, Port Moller, Cape Newenham and Nunivak Island), for three years between 1997 and 1999. The front separates the vertically homogenous inshore water from the two layered system offshore. We hypothesized that the inner front was responsible for prolonging production within the area well into the late summer, while nutrients would be depleted further offshore. A definition of the fronts was developed at NOAA PMEL by Stabeno and colleagues, based on specific dT/dz criteria.

To understand the biological implications we analyzed whole water samples preserved with neutral Lugol's solution for phytoplankton species composition. Higher phytoplankton concentrations were found within and along the outer edge of the frontal zone at the Cape Newenham and Nunivak study areas. The front was less important at Port Moller and Slime Bank, where Pacific waters tended to have a greater influence over the phytoplankton concentrations.

During the study period, there was an extensive coccolithophore bloom in the Cape Newenham and Nunivak Island area. Phytoplankton populations in all four areas, however, were a mixture of coccolithophores, phaeocystis, diatoms, dinoflagellates, and others. Phaeocystis was seen in larger concentrations in the Slime Bank area, accounting for the higher total concentrations there. Concentrations of cells per mL ranged from 99 to 52,290 over the three year study, with higher concentrations being observed in spring then in late summer for all station with the exception of Nunivak in 1999.

Pumping of nutrients at the frontal zone was not always observed, and at times the frontal zone was weak or not present. The front did, however, function to prolong production in the area as evidenced by higher cell counts.

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The Inner Front of the Southeastern Bering and Effects on Primary Production.

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We investigated the Inner Shelf Front of the Southeastern Bering Sea in four regions (Slime Bank, Port Moller, Cape Newenham and Nunivak Island), for three years between 1997 and 1999. The front separates the vertically homogenous inshore water from the two layered system offshore. We hypothesized that the inner front was responsible for prolonging production within the area well into the late summer, while nutrients would be depleted further offshore. A definition of the fronts was developed at NOAA PMEL by Stabeno and colleagues, based on specific dT/dz criteria.

During each cruise we measured phytoplankton Production vs. Irradiance curves in on-deck incubators and also measured primary production at 4 depths in situ. The P-I data were least squares fitted with the Platt hyperbolic tangent equations which were then used to calculate profiles of photosynthesis and integrated for daily production. These profiles utilized measured incident surface irradiance (PAR), underwater irradiance (PAR), and chlorophyll concentrations (both extracted and derived from in situ fluorometry). Of the 24 possible transects (4 grids x 2 times/yr x 3 yrs) we completed 18. The frontal zone appeared to stimulate production either at the front or seaward of the front on 8 transects, with another 4 being probably stimulatory. Only once was the front clearly not stimulatory, while the remaining 6 transects were conducted at times when stratification was weak or non-existent.

Two cruises were made in each of the three years to compare late spring with late summer. Mean daily production was somewhat lower by late summer in the first two years, but significantly greater in the last year. There seemed to be a trend of increasing production during the three years of the study. This was probably related to recovery from an unusual year in 1997 when tele-connections to an El Nino event were linked to a variety of unusual circumstances in the Bering Sea including warmer surface temperatures, an extremely large coccolithophore bloom, a massive seabird die-off, unusual observations of marine mammals.

The hypothesis that the front would stimulate prolonged production throughout the summer could not be rejected. Comparing paired transects (based on whether the front was effective) showed that out of 8 possible pairs, maximum daily production rates were higher in the late spring cruise on 3 of the transects, while they were higher in late summer cruise on 5 transects.