constant N/P ratio for horizontal supply of 14.5, which may underestimate nitrate supply in the late summer and fall period. Model simulations showed that increased nitrate supply during this period required increased nitrate utilization in the spring-summer period to close the annual nitrate budget. This furthered increases spring-summer nitrate utilization, hence seasonal variability in the N/P ratio of horizontal supply cannot reduce the simulated excess nitrate utilization in summer.

Preferential recycling of PON over POP below the mixed layer degrades the simulation and cannot produce results that satisfy both the observed seasonal nitrate and phosphate cycle in the mixed layer. The most realistic model simulation is obtained with preferential recycling of POP over PON but again this mechanism alone is incapable of satisfying the summer nitrate and phosphate data.

With the inclusion of a labile DOM pool in our model we were able to reproduce the observed seasonal mixed layer nitrate and phosphate cycles. Satisfactory results can be achieved through various combinations of the DON/DOP ratio and the lifetime of the labile DOM. We postulate that DOM is an important component for closing the seasonal nutrient budget in the late summer and we expect that DOC will also play a role in the seasonal evolution of the fCO2. Seasonal observations of DOP, DON and DOC are needed to confirm this hypothesis.

OS12L-09 1615h

Elemental composition (C, N, and P) of particulate material exported in the Ross Sea, Antarctica.

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The fate of particualte material exported below the euphotic zone was characterized during the multidisciplinary 1996-1998 oceanographic program Research on Ocean-Atmosphere Variability and Ecosystem Response in the Ross Sea (ROAVERRS), Antarctica. Concurrent distributions of suspended particulate organic carbon, nitrogen and phosphorus, and of suspended particulate inorganic phosphorus, are presented for the open ocean water column. Samples were collected from throughout the Ross Sea at multiple depths (between 0 to 500 m) and stations that were monitored several times as the phytoplankton bloom developed. The elemental composition of surface sedimentary organic matter was measured at each location and sinking particulate organic matter was measured with moored sediment traps over an annual period at multiple water depths. In addition to elemental compositions, C:N, C:P and N:P ratios were also calculated. Preliminary results indicate C:P and N:P ratios of suspended particulate material collected at 6 m water depth increase from below to above Redfield ratios towards the western portion of the Ross Sea. Changes in the C:P and N:P ratios of suspended particulate material collected throughout the upper 150 m water column either remain constant or decrease with increasing depth, or show sub-surface maximum depending on station location. The contribution of particulate organic phosphorus to the total particulate phosphorus pool generally decreases with increasing water depth over the upper 150 m. Furthermore, the weight percent total phosphorus in the surface sediment is largest in the southwestern Ross Sea. Initial sediment trap results indicate higher C:P export flux ratios in Phaeocystis dominated regions than in diatom dominated regions of the Ross Sea. Relationships between the biogeochemical cycling of phosphorus and the phytoplankton taxonomic composition, polynya dynamics, and upper ocean hydrography will be discussed.

OS12L-10 1630h

δ^{15}N of Surface and Deep Organic Matter in the Subantarctic and Polar Frontal Zones of the Southern Ocean South of Australia.

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The δ^{15}N of organic matter offers promise as a paleo-proxy for nitrate consumption in surface waters. Here we examine whether spatial and temporal patterns of $\delta^{15}N_{PON}$ at the surface and in deep sediment traps in the Subantarctic (SAZ) and Polar Frontal Zones (PFZ) of the Southern Ocean conform with patterns expected from isotopic fractionation and during the drawdown of nitrate. PON samples were collected at the surface from six north-south cruises between September 1997 and March 1998 and in moored sediment traps at 1060, 2050 and 3850 m in the Subantarctic Zone (47°S), 3080 m under the Subantarctic Front (51°S) and 830 and 1580 m in the Polar Frontal Zone (54°S). Based on observed seasonal nitrate depletion (up to 8.5 μM in the SAZ and 3.9 μM in the PFZ), Rayleigh fractionation equations predict a $\delta^{15}NO_3$ increase of ~4 to 5$^o/_{oo}$ in the SAZ and ~1$^o/_{oo}$ in the PFZ from September to March using an ε of 5-7$^o/_{oo}$. Observed winter - March $\delta^{15}NO_3$ increases were similar in the SAZ (4.5$^o/_{oo}$) at 47°S but somewhat higher (2.5$^o/_{oo}$) in the PFZ at 54°S. $\delta^{15}N_{PON}$ should increase in parallel, by up to ~4 to 5$^o/_{oo}$ in the SAZ and ~1$^o/_{oo}$ in the PFZ but was relatively constant in the SAZ surface waters (~1$^o/_{oo}$) and decreased in the PFZ surface waters from ~0 to ~-5$^o/_{oo}$. In contrast, deep trap $\delta^{15}N_{PON}$ decreases seasonally in both regions, from ~4 to ~1$^o/_{oo}$ in the SAZ and from ~3.5 to ~0.5$^o/_{oo}$ in the PFZ. We hypothesise that the utilisation of ammonia later in the season may lead to lower than expected $\delta^{15}N_{PON}$ values in both surface and deep organic matter. Implications for the interpretation of $^{15}N_{org}$ sedimentary records will be discussed.

OS12L-11 1645h

Depth Dependent Elemental Compositions of Particulate Organic Matter in the Ocean

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The production and downward transport of particulate organic matter (POM) is an important process in the marine carbon cycle affecting the CO_2 exchange between ocean and atmosphere (biological pump). Sinking particles export carbon and nutrients from the surface into the deep ocean, and C:N:P:O element ratios of POM determine the relative magnitudes of downward phosphorus, nitrogen and carbon fluxes. Currently, it is common practise to use Redfield ratio C:N:P:O which is constant in space and time for flux estimation and biogeochemical modeling. However, there is evidence that particle compositions underly systematic variations and models using the constant Redfield ratios may underestimate downward carbon fluxes markedly. For the determination of elemental ratios of POM and their impact on the marine carbon cycle we use C/N ratios measured on particles, and we assembled particle data from many different sources into a single data collection for joint evaluation. The dataset contains approximately 9200 single values of C/N ratios, encompassing all major oceans and latitudes, oligotrophic and high productive regions as well as areas of seasonal ice coverage. Analysis of this global dataset shows that C/N ratios are highly variable in space and time, ranging from values below the Redfield ratio (C/N = 6.6) to values greatly exceeding it. There is a systematic and statistically significant trend of C/N ratios increasing with depth by 0.4 units per 1000 m depth. After correcting for the contribution of terrigeneous material C/N ratios of marine POM are also found to increase with depth by about 0.2 units per 1000 m depth. Arguments on how these results from the analysis of POM can be reconciled with previous studies based on dissolved nutrient fields are presented. Depth dependent C/N element ratios should be implemented in biogeochemical models to correctly represent the relative strengths of downward carbon and nitrogen fluxes.

OS12M HC: 315 Monday 1330h

Multidisciplinary Ocean Observations and Observatories II

Presiding: **T Dickey,** University of California, Santa Barbara**; S Wilson,** National Oceanic and Atmospheric Administration

OS12M-01 1330h

Toward Global Multi-disciplinary Time-series Observations

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Solutions to problems such as global climate change and carbon cycling are primarily hindered by insufficient data. Relevant data sets need to be interdisciplinary, collected simultaneously, and span ten orders of magnitude in time and space scales to observe key processes. Autonomous measurements now include several key chemical, bio-optical, and biological variables. Mooring results will be presented from sites including the equatorial Pacific, the Arabian Sea, and off Bermuda. Visions of new sensor technologies and a network of integrated, interdisciplinary, global scale, three-dimensional time series observations and modeling are presented.

OS12M-02 1345h

Prospects for Glider Ocean Observation Networks

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Ocean glider vehicles offer cost-effective means for constructing a network of long-term ocean observations. Because they can sample deliberately along transects or at fixed locations without reliance on ships, they are well suited to regularly sampling on a specified remote grid. They can operate for a year for the cost of operating a research vessel for a single day.

Gliders are small, smart, inexpensive, reusable autonomous underwater vehicles. They operate by remote control, reporting measurements and responding to commands in near real time via wireless telemetry. They glide from the ocean surface to a programmed depth and back while measuring temperature, salinity, depth-averaged current and other quantities along a sawtooth trajectory through the water. Gliders are designed for missions of several thousand kilometers range and many months duration.

Field trials with Seaglider, a battery-powered upper ocean vehicle, have demonstrated the ability of gliders both to make repeated transects and to maintain geographic position as they profile. In one demonstration, a pair of Seagliders was used to collect time series of density profiles and depth-averaged currents at distinct locations from which absolute geostrophic current profiles were inferred. These were verified by comparison of surface geostrophic current with that estimated from glider surface drift. Seagliders have also been used to collect dissolved oxygen, fluorescence, and optical backscatter profiles.

Networks of gliders making long term measurements of open ocean, boundary current, coastal, and estuarine environments are feasible. Because of their modest cost, monitoring of entire current systems with adequate space-time resolution appears economical.

OS12M-03 1400h

GoMOOS: Transition to an Operational Observing System

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Scientists from states and provinces around the entire Gulf of Maine are developing GoMOOS, the Gulf of

Maine Ocean Observing System. GoMOOS began producing research-quality data in the summer of 2001, and the research community can access the data in near real time, for free. GoMOOS is pursuing interoperability with other observing systems around the nation, thereby working toward a national federation of linked regional systems. The ultimate objective is an operational, multi-user coastal ocean observing system consistent with the broad outline in The Ocean Observations Task Team Report that can be found at www.nopp.org.

GoMOOS continues to evolve in two critical areas: (1) response to user needs and (2) transition to a 24/7 operational system. To serve the wide variety of user needs in both scientific and non-scientific communities, GoMOOS became a non-profit membership organization. Members represent a wide variety of users in the public and private sectors, and the Board of Directors that governs GoMOOS is drawn from its membership. This organizational model allows users in the region to become stakeholders in the observing system, which facilitates and virtually guarantees that the observing system will respond to user needs. Experience so far demonstrates strong support for this model.

GoMOOS is beginning the transition to an operational system. The transition requires a well-defined relationship between operations and research. Our philosophy embodies the Nowlin et al. (2001, BAMS, p1369) metaphor of a tree, with "operational activities as 'branches' emanating from the research base ('trunk'); both the branches and the trunk will continue to prosper with the strength of one enhancing the strength of the other." Our business plan for the sustained regional system seeks the optimal cost-effective relationship between the two.

URL: http://www.gomoos.org

OS12M-04 1415h

A Model for a National Network of Regional Coastal Ocean Observatories

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Regional-scale coastal ocean observatories are being operated and expanded along many U.S. coasts. Common observational elements include satellite remote sensing data, HF radar surface current maps, and time series of in situ observations at high-interest locations. In the Northeast U.S., regional-scale observatories such as the Gulf of Maine Ocean Observing System (GoMOOS) and the New Jersey Shelf Observing System (NJSOS) already distribute data products of proven interest to the scientific community and the general public. Plans to link GoMOOS, NJSOS, and other ongoing observation efforts into the NorthEast Observing System (NEOS) are underway. One driving force for the linkage is the desire to produce new regional or larger-scale composite products that can only be accomplished by combining datasets from multiple observatories. These include (a) level 2 satellite data products with multiple vicarious calibration points derived from the international constellation of high-resolution ocean color satellites; (b) surface current maps from nested grids of standard, long-range and bistatic HF Radar systems from multiple operators; and (c) subsurface datasets designed to fill in the gaps between the widely-separated time-series point measurements using fleets of long-duration autonomous underwater Gliders. As a first step, a collaborative plan to construct a HF-Radar backbone for NEOS has been proposed. It includes an oversight committee, coordinated sampling protocols, calibration methods, standard data formats and a method for data sharing, while leaving the final product preparation and distribution to the discretion of the individual institution.

NEOS serves as a prototype for a national federation of linked regional observatories. Using GoMOOS and NJSOS as regional models, it would require between 20-30 regional centers to cover the U.S. East, Gulf and West coasts, Hawaii, and the Gulf of Alaska. A typical regional center would operate an X-Band Satellite Data downlink, about 5 Long-range HF Radar systems, and about 10 Long-duration underwater Gliders. Personnel requirements would be about 15 people, including operators for the different sensors and a 24x7 forecast watch. This is similar in magnitude to the existing National Weather Service regional forecast offices that operate the Doppler weather Radar network, or the U.S. Coast Guard Air Stations responsible for launching aircraft search and rescue missions. The personnel requirements to establish this system while still fulfilling the growing needs of existing operational oceanography efforts in the Navy and NOAA could motivate some universities to begin training a new generation of students in the now rapidly evolving profession of operational oceanographer. Based on the meteorological paradigm and over 10 years experience at existing observatories, Masters level oceanography students with practical training in an operational environment are targeted.

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

OS12M-05 1430h

Pioneer Seamount Ocean Acoustic Observatory

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A four-element vertical hydrophone array has been installed atop Pioneer Seamount and is cabled to a shore station near Half Moon Bay, California, approximately 50 nm away. The array is unique in that real-time data can be monitored on the Internet. The installation was funded by NOAA's Ocean Exploration Program. Ambient noise data from Pioneer Seamount and acoustic thermometry travel time data received from the recently re-activated acoustic source near Kauai, Hawaii will be presented. Future plans for the expansion of the Ocean Exploration acoustic network will also be presented.

URL: http://www.oceanexplorer.noaa.gov/explorations/sound01/sound01.html

OS12M-06 1505h

Marine Observations from the International SeaKeepers Society's autonomous VOS fleet

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The International SeaKeepers Society has funded the development, installation and maintenance of autonomous, ocean data collection and transmission modules. Among those variables that are monitored by the SeaKeepers modules are wind speed/direction, air temperature, barometric pressure, sea surface temperature, salinity, oxygen concentration, and fluorescence. Deployed on a fleet of privately owned yachts, cruise ships, and research vessels, these modules are ideal for the collection of time series of marine observations in often poorly-sampled areas of the world ocean. Ten-minute averages of the data are delivered hourly to the University of Miami in real-time via the module's INMARSAT connection. These real-time observations are then passed on to NOAA/NWS as Volunteer Observing Ship (VOS) contributions for worldwide dissemination. Full resolution time series data from each vessel are delivered later on disk for analysis and integration into the SeaKeepers database. A web-based interface to this database and related graphical products has been developed for the dissemination of information to interested scientists.

The real-time data collected from the SeaKeepers modules are reviewed daily for temporal and spatial consistency, and they are compared monthly to the daily NCEP surface analyses. Any module that exhibits recurring or systematic quality problems will be removed from the real-time data flow and scheduled for maintenance/replacement. To best evaluate the quality of the SeaKeepers marine observations during the initial phase of the deployment of the modules, the real-time reports from 2001 have been compared to a variety of independent, global daily reference fields, including QuikSCAT wind fields, Pathfinder AVHRR SST maps, and SeaWiFS chlorophyll estimates. Time series of the differences from these references for each vessel have enabled the production of quality estimates. Although there are issues inherent in marine observations taken from moving vessels, the overall quality and quantity (per module) of the SeaKeeper vessels' marine observations are high and have been found – even during the early phase of deployment – to exceed those of the global VOS fleet.

OS12M-07 1520h

Network for Environmental Observation of the Coastal Ocean (NEOCO)

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Over the last year a new initiative in coastal ocean observing has been developed in California. The Network for Environmental Observations of the Coastal Ocean (NEOCO) addresses the need both for long-term high-resolution data and for concurrent physical, chemical and biological measurements. Supported by the University of California Environmental Quality Initiative, NEOCO initially establishes seven sites reporting temperature, salinity, chlorophyll fluorescence, light transmission and sea-level data in real-time. Along much of the Californian coast, pier-based data are expected to reasonably represent offshore coastal waters. This spatially distributed observatory will use standard electronic instrumentation with wireless data transfer to a relational database management system with web accessibility and reliable archiving. NEOCO extends a multi-decadal record of daily temperature and salinity at several West coast sites. In addition to routine quality assurance, the new data record will be compared with historical trends and ongoing manual samples. Future NEOCO expansion can include other research-based marine labs along the west coast. In the presentation, the NEOCO design criteria and methodology will be outlined. The relational database management system provides a uniquely powerful infrastructure for large oceanographic data sets. Scientific benefits of NEOCO include spatial comparative studies between marine research groups along the west coast, with opportunity for novel interdisciplinary work.

URL: http://www.es.ucsc.edu/~neoco

OS12M-08 1535h

An Observational Network for Multidisciplinary Time Series on the Central California Coast

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We describe a multidisciplinary network for observing changes in an eastern boundary current coastal ecosystem and its links with circulation processes. Since 1993 an array of four moorings has collected time series of currents and temperature along the continental shelf off the Central California coast near Point

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