remineralization rates however appear to be extremely variable, with a number of near-shore cores showing no significant P remineralization.

OS31R-09 1055h

Relationship Between Periodic Resuspension Events and Phytoplankton Community Structure in Lake Michigan: A Field and Laboratory Investigation

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Lake Michigan provides an ideal location for comparing episodic physical forcing events (storms) on phytoplankton processes and the more persistent seasonal variability of phytoplankton communities. This is due to the duration and extent of a highly turbid, recurrent coastal plume (RCP) in the lake during the winter/early spring. Although the RCP can coincide with initiation of the basin wide spring bloom, linkages between duration and intensity of the plume and the prominent role of light availability in regulating Lake Michigan phytoplankton growth during the spring isothermal period have been postulated, but not verified. As such, the concurrent physical and biological events provide a novel opportunity to examine phenomena associated with the RCP affecting distribution and abundance of species and the subsequent evolution of assemblages in Lake Michigan phytoplankton flora. In this study, phytoplankton assemblages from pre, post and active plume events during spring were examined from stations along Lake Michigans southern shoreline. The assemblages included chlorophytes and chrysophytes, but were dominated by diatoms. Species abundance changed rapidly during storm events. Sediment resuspension via storm activity created a sub-optimal growth environment. Post-storm event phytoplankton communities were floristically distinct from pre-storm event communities, with resting cell-forming taxa playing a significant role in these community-restructuring periods. Laboratory simulations of resuspension events using Lake Michigan sediments were conducted under a variety of environmental conditions. Parameters varied included day length, temperature, and silica. The resulting assemblages were quantitatively counted. A statistically significant relationship was identified between day length and vegetative growth of many resting cell-forming diatom species. When day length was calculated for post-storm event field data, it revealed a high correlation between post-storm event communities and those predicted by the laboratory simulations. Both timing of storm events and latitudinal position of the system determine day length, which is an important element to consider when predicting phytoplankton community structure.

OS31R-10 1110h

Optical Properties Across the Coastal Margin of Lake Superior

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This study was conducted as part of the Keweenaw Interdisciplinary Transport Experiment in Superior (KITES), and is based on three years of field data focusing on cross margin transport in western Lake Superior. In this paper we examine the apparent optical properties of this coastal margin on a seasonal basis. In particular we compare spectral 1% light level depths, normalized spectral K_d, K_d spectral ratios, spectral Rrs, and spectral Rrs ratios across the range of water types existing in this coastal margin. The objectives of this work were (1) to compare our intensive survey to past optical research on the lake to document any changes in the optical properties that may have occurred; (2) to study the spectral characteristics of the light field, including the UV radiation, which have not been thoroughly documented with modern instrumentation; and (3) to establish the context for the application of remote sensing to aid in understanding the seasonal and spatial variability of chl a, TSS, and CDOM over temporal and spatial scales.

OS31R-11 1125h

The Effects of a Spring Resuspension Event on In-situ Optical Parameters and Phytoplankton Light Utilization

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As part of the Coastal Ocean Processes-Episodic Events in the Great Lakes Experiment (CoOP-EEGLE) in-situ optical data was collected during an episodic turbidity plume in southern Lake Michigan during spring 1999 and 2000. This recurrent sediment plume is formed onshore before advecting offshore and is characterized by high surface reflectivity. The formation of this offshore optical gradient provides a wide range of optical conditions to help develop remote sensing algorithms and serves as a model testing ground for studying the effects of constrained light parameters on phytoplankton communities. Measured inherent optical properties (IOPs) were used to compute spectral radiance distributions using Hydrolight 4.1 in natural water columns based on collected in water AC-9 (Wetlabs) data. Calculated AOPs and remote sensing reflectances were compared to measured values; in-situ AOPs were measured using Satlantic OCR-200 and hyperspectral TSRB radiometers. Measured and modeled optical properties showed good agreement especially in clearer water offshore stations ($R^2 = 0.91$). Although absorption and scattering are both increased within the plume (up to 3X), total light attenuation was dominated by scattering and was highest in the blue wavelengths of light. The increased attenuation within the plume alters both the intensity and spectral quality of light available to phytoplankton leading to a decrease in total primary production and a shift in phytoplankton community composition. Diatoms tend to dominate onshore stations while cryptophytes, which are always present, become the dominant species (comprising up to 75% of the population) in the offshore stations and at depth. The light field in these areas is sharply skewed to the green wavelengths of light thus favoring the cryptophytes who are better able to harvest the available light utilizing their accessory phycobilin pigments (max absorption = 545nm). The calculated integrated photon absorption for cryptophytes in this light environment is 2.5X that for diatoms at depth.

OS31R-12 1140h

Bio-Optical Properties of Phytoplankton Communities in Southeastern Lake Michigan and Implications for Modeling Primary Production

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Key parameters for modeling primary production include the maximum chlorophyll-specific rate of photosynthesis (P^Bmax, gC gChl^{-1} h^{-1}), chlorophyll-specific optical absorption cross-section (a^*_{ph}, m^2 mg chlorophyll a^{-1}) and maximum photosynthetic quantum yield for carbon fixation (ϕ_{max}, mol C mol quanta^{-1}). Information about these parameters in the Great Lakes is limited, particularly in areas subject to episodic sediment resuspension. These bio-optical properties were characterized in southeastern Lake Michigan during March through June in 1998, 1999 and 2000. Observations were made during non-stratified periods across optical gradients associated with a recurrent sediment plume as well as following the onset of summer stratification. Despite nearly homogeneous vertical physical structure in March and April, a^*_{ph} and ϕ_{max} varied with depth. This was evidence that photoacclimation occurred on time scales more rapid than that of vertical mixing. General trends were that a^*_{ph} decreased with increasing depth, consistent with the presence of larger or more heavily pigmented cells in deeper waters. In contrast, maximum quantum yield of photosynthetic carbon fixation increased with depth, reflecting increased efficiency of light utilization by deep populations. A decreasing trend with depth in P^Bmax was evident during stratified conditions, an indication that responses of this parameter to environmental variation occur over longer time scales. Other observed trends were related to the time of year, bottom depth, and turbidity. Estimates of primary production will be most sensitive to light-limited photosynthetic parameters (a^*_{ph}, ϕ_{max}) during non-stratified conditions and in high turbidity regions impacted by sediment resuspension or inputs of dissolved organic materials. We consider the impact of observed variations in photosynthetic parameters on primary production in the context of ambient variations in light availability and spectral quality.

OS31S HC: 316 B Wednesday 0830h

The North Atlantic Ocean and Its Changing Climate V

Presiding: **B Dickson,** CFEAS, The Laboratory**; T M Joyce,** Woods Hole Oceanographic Institution

W E D

OS31S-01 0830h

The High Frequency Variablity of the North Atlantic, Comparisons Between a 0.1°Resolution Model and Data

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The North Atlantic changes on a variety of scales. To accurately predict changes at frequencies higher than seasonally, a model must be capable of reproducing such features. We investigate the variability on the time scales shorter than a season using both a primitive equation, level numerical model (POP) at 0.1°resolution and data (altimetry and in situ). The model has been forced with a realistic momentum flux (NOGAP winds) spanning the time period of the observations (1992-1998). First, we quantify the realism of the model by comparing its output, sampled either daily or an average of 3 days, to measurements of altimeter/tide gauge SSH or data from current meters and buoys. These sparse time series show that the model reproduces much of the signal seen in observations at these locations. Second, we examine the SSH error fields of the model using a joint (with altimeter data) estimation procedure. Third, the spectra of various model fields are examined and where available, are compared to the spectra of the data. We examine the spatial distribution of the spectra and note the similarities and differences between the model fields and the data. Where possible, we examine SSH, temperatures, and current spectra.

OS31S-02 0845h

Preliminary Results From a Global 1/10th Degree POP Ocean Simulation

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A high resolution fully global configuration of the Parallel Ocean Program (POP) has been spun up for almost a decade of model time. The horizontal grid has the north pole displaced into the North American continent, allowing for the inclusion of the Arctic Ocean, and has a resolution of 1/10th degree at the equator with latitudinal resolution decreasing toward the poles. The vertical grid consists of 40 unequally spaced levels. Surface forcing is computed with bulk formulae using ocean model SST and an applied atmospheric state. Many features of the model circulation will be discussed, including mass and heat transports, and comparison of eddy variability with altimeter data. Extensive comparisons will also be made with two previous POP simulations: an almost global 0.28 degree, 20 level model, and a 1/10th degree, 40 level North Atlantic basin model. Preliminary results show that the current simulation is a significant improvement over the lower resolution global run, but results are mixed in comparison to the high resolution North Atlantic model.

URL: http://www.oc.nps.navy.mil/navypop/

OS31S-03 0900h

High Resolution POP and Observations

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A high-resolution (0.1°, 40-level) global configuration of the Parallel Ocean Program (POP) model is being spun-up on a displaced North Pole grid. This state-of-the-art eddy-resolving model will eventually be used as the ocean component of a coupled global air/ocean/ice prediction system for Navy needs as well as in short-term climate studies. The model was initialized using the Navy's 1/8° January climatology outside of the Arctic, and the University of Polar Hydrography winter climatology in the Arctic. Surface momentum, heat, and salinity fluxes were calculated using bulk formulae based on the model surface temperature and an atmospheric state comprised of a variety of sources. The evolution of the spin-up is discussed in terms of energy levels, mixed layer depths, and water mass characteristics. Comparisons with Eulerian velocity statistics from surface drifting buoys, mixed layer depths from XBTs, and water mass structures from hydrography data will be used to provide measures of the realism of the spin-up. Lagrangian statistics from an earlier 0.1°, 40-level North Atlantic POP simulation and surface drifters demonstrate the very realistic instrinsic scales reproduced at this resolution.

URL: http://www.oc.nps.navy.mil/navypop

OS31S-04 0915h

Combining Observations and Simulation in a Fully Eddy Resolving North Atlantic Regional Model

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As routine sensor networks emerge for global monitoring of oceans, the challenge of data synthesis and analysis becomes more significant. Technology to process raw instrument data and to distill essential information is, therefore, a key ingredient of a true global observing system. The implied data processing presents a daunting challenge. The data capture a mix of processes on all scales and frequently are made by disparate forms of instrumentation. Producing a meaningful synthesis of this varied and large dataset is far from straightforward.

We describe eddy-resolving scale synthesis effort that is taking place as part of the Estimating the Climate and Circulation of the Ocean (ECCO) project. Two areas are being explored. First we are exploring the role of a nested state-estimation strategy in which a regional, eddy-resolving model is embedded within an observationally constrained large-scale, global simulation. We apply an adjoint technique to the eddy-resolving model to determine the sensitivities of the discrepancy between the model and in-situ and remotely sensed observations. The sensitivities are directly controlled by mesoscale and sub-mesoscale dynamics. The results suggest that accurate observations of these processes with adequate spatial and temporal coverage would provide a basis for ongoing regional open-ocean state estimation. From this work we can make estimates of the temporal frequency and spatial density of observations required for attaining improved estimates of the mesoscale ocean state.

Related research that can further refine the observational coverage estimates will also be discussed. This work explores an approach to quantifying, on long time scales, predictability of sub-mesoscale simulations. On long time scales many standard approaches to combining observations and simulations face significant challenges due to the mathematical properties of turbulent eddy fields. In this work, the sensitivity of a conserved passive tracer distribution to various injection sites is examined. We show that this approach produces bounded sensitivities in an eddy-resolving regime on long time scales. The resulting sensitivity patterns therefore convey predictability of large-scale behavior that underlies the mesoscale "noise". Using these maps we show that, particularly in the presence of uneven topography, predictability varies with horizontal location and with depth. This suggests that the estimates of observational coverage could be reduced in some regions of the real ocean without compromising the accuracy of the resulting state estimates.

Significant investments in in-situ and remote sensing networks are being made. To realize the full potential of these systems, attention must be paid to complementary innovations in rigorous and semi-automated techniques for combining measurements, dynamically-based simulation and analysis tools.

OS31S-05 0930h

Constraining the North Atlantic Circulation with Chlorofluorocarbon Observations

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The capability of chlorofluorocarbon observations to constrain the North Atlantic ocean circulation is investigated. An idealized tracer is introduced into a one dimensional model. The analytical solution shows that the transient stage is a very complex function of the advective and mixing rates entangled with various time scales; while the steady state distribution is very simple. This suggests that inferring mixing rates or flow fields from transients is more difficult than from steady tracers. Chlorofluorocarbon, temperature, and salinity observations are compared with model results in the North Atlantic. Major problems in the model, i.e., too much vertical penetration of surface values in high latitudes, too thick and volumetric Labrador Sea Water along the western boundary, and the absence of OW, can be identified in all tracer fields. Problematic deep convection is indicated by both T-S and CFC fields: too deep vertical homogenization of the tracer properties. Distributions of salinity and CFCs show a strikingly similar ventilation pathway of the LSW in the model, hence providing us information about the ocean renewal. Optimization at high latitudes is obstructed by the poorly parameterized deep winter convective process, which is beyond the resolving power of the model used in this study. By adjusting only the boundary conditions of CFCs, the $1^o \times 1^o$ offline model and the data can be brought into near-consistency, between 4.5^oS and 39.5^oN in the North Atlantic. The model-data misfit is reduced mainly by adjusting the CFC concentrations in the NADW at the northern open boundaries. Due to the large uncertainty of the time histories of transient tracer boundary conditions, existing transient tracer data provide little new information about the ocean circulation to the model, which is already tightly constrained by the dynamics and steady tracer balances.

OS31S-06 0945h

Model Simulations of CFC Uptake in the Atlantic Ocean: Effects of Parameterizations and Grid Resolution

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CFCs are powerful tools for the study of important parts of the global overturning circulation, like deep water formation in subpolar latitudes and subsequent southward transport. They are routinely being used to assess the simulated circulation in ocean models over decadal timescales. Observational evidence suggests that they can be used as proxies for anthropogenic CO_2. Integral measures like the amount of a tracer taken up by the ocean over a given time span are important in quantifying the ocean's role in the global carbon cycle and in climate change scenarios with changing atmospheric CO_2 concentrations. In this paper we discuss the influence of parameterizations for air-sea gas exchange and subgrid scale processes on the uptake of CFC-11 in the North Atlantic Ocean using a series of numerical experiments with models from medium ($4/3^\circ$) to eddy-permitting ($1/3^\circ$) horizontal resolution. Model results are compared to observational estimates of tracer inventories in order to evaluate to which degree the simulations capture realistic CFC distributions. While higher resolution is needed for CFC simulations to compare well with individual hydrographic sections, the medium resolution models are able to simulate quantitatively satisfying CFC inventories in different water masses. The medium resolution inventories show a critical dependence on details of the parameterization of the mixing effect of mesoscale eddies and on the representation of bottom boundary layer processes. The rate at which CFC-11 is exported southward from the subpolar North Atlantic does not vary significantly over the suite of model experiments. First results from a high-resolution experiment including both CFC and anthropogenic CO_2 will be presented and the relation between simulated CFC and CO_2 distributions and inventories will be discussed.

OS31S-07 1020h

Labrador Sea Water in the Northeast Atlantic: Characterization and Age Determination with a New Approach of CFCs and CCl_4 Use

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Labrador Sea Water (LSW), formed during deep convection in the Labrador Sea, is an important water mass in the Atlantic deep circulation. The rate of LSW formation was strongly enhanced from 1988 to 1995, coinciding with a period of high North Atlantic Oscillation (NAO) index. The LSW formed during this period had modified temperature and depth, and spread rapidly in the North Atlantic. Our objective in this work was to use CFCs and CCl_4 to characterize the LSW in the Northeast Atlantic and to determine its age according to a new approach of use of these compounds as transient tracers. Sampling was carried out in June and July 1998, from 39.4°N to 46.4°N and from 21.5°W to the European continental shelf, during the ARCANE 3 cruise. Depth profiles from this region revealed remarkable maxima of CFCs and CCl_4 concentrations in the LSW. These maxima were observed in a thick layer from 1300 to 2200 m depths at the western part of the studied area, suggesting the presence of a sizeable quantity of LSW. Moreover, these high values suggest that the sampled LSW had been formed relatively recently. Combining the ARCANE 3 and WOCE hydrological datasets enabled the observation of temperature and depth changes of the LSW in the studied area, which indicated that the LSW sampled during this study was formed after 1988 and that this "new" LSW reached the area before 1997. The usual method of CFCs and CCl_4 use, as transient tracers, cannot be applied to determine the age of LSW; it provides a formation year previous to 1988. Therefore, we used, for the first time, a new approach, which consisted of comparing the ratios of concentrations observed in the sampled LSW to those directly observed in LSW in the Labrador Sea, since the beginning of the nineties, and to those observed on the LSW spreading course. The results obtained using this approach show that the sampled LSW was formed in 1994-1995, implying an age of 3.5-4.5 years and, thus, a mean speed of 1.9-2.5 cm s^{-1} along its direct journey from the Labrador Sea.

OS31S-08 1035h

Obtaining the Mean Structure of the North Atlantic Current-Subpolar Front System by Combining RAFOS Float Data With Historical Hydrography

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The North Atlantic Current (NAC) Subpolar Front (SPF) current system serves as a conduit of warm salty waters into the northern North Atlantic. It is the upper limb of the thermohaline circulation of the Atlantic ocean, and plays a crucial role in the moderation of European Climate. Its transport and corresponding heat fluxes remain uncertain, mainly because the structure of the system is not well known. This paper presents a method to obtain the mean structure of temperature, specific volume anomaly, and velocity for the NAC-SPF region, using isopycnal float data combined with Gravest Empirical Mode (GEM) fields calculated from historical hydrography. A GEM field is a projection on geostrophic streamfunction space of hydrographic data, which captures most of the vertical structure associated with frontal regions. The performance of the float-GEM method is tested in two ways. First, two synoptic hydrographic sections (one across the NAC and the other across the SPF) are reconstructed from simulated isopycnal float pressure measurements. The baroclinic transports (relative to 1000db) are 24Sv for the NAC, and 11Sv for the SPF. The corresponding baroclinic temperature fluxes are 1.23PW and 0.39PW, respectively. The fluxes from the float-GEM generated sections are 23±2Sv and 10±1Sv for volume, 1.03±0.15PW and 0.34±0.03PW for temperature. Note that the relative errors are about 10%. These results show that the method proposed reproduces with high accuracy and precision the structure of specific volume anomaly and temperature associated to the NAC-SPF. For the second test, horizontal maps of pressure and temperature on the $\delta = -12.7 \times 10^{-8} m^3/kg$ specific volume anomaly surface ($\sigma_\theta \approx 27.5$) are produced, using RAFOS float data from two experiments taken place in the region between 1993 and 2000. These maps compare quite well with similar maps found in the literature, and establish the consistency of the method.

The good performance of the float-GEM method provides with a novel way of using isopycnal floats to obtain information on the structure of the ocean. We are particularly interested in studying changes in the absolute transports and heat fluxes along the NAC-SPF system. For this we are applying the float-GEM method combined with velocity measured by the RAFOS floats. Preliminary results of this application will be presented.

OS31S-09 1050h

Heat Budget in the Gulf Stream Region

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A simple three-dimensional thermodynamic model is used to study the heat balance in the Gulf Stream region (30 N - 45 N, 40 W - 75 W) during the period November 1992 to December 1999. The model is forced by surface heat flux derived from NCEP variables, with geostrophic surface velocity specified from sea surface height measurements from the TOPEX/POSEIDON altimeter and Ekman transport specified from NCEP wind stress. The mixed layer temperature and mixed layer depth from the model show good agreement with the observations on seasonal and interannual time scale. Although the annual cycle of the upper ocean heat content is underestimated, the agreement of the interannual variations in the heat content and the sea surface height are good; both are dominated by the large decrease from 1994 to 1997 and the increase afterward. As expected from previous studies, the surface heat flux dominates the seasonal variations in the mixed layer temperature and in the upper ocean heat content. The surface heat flux is also the largest contributor to the interannual variations in the mixed layer temperature. However, the interannual variations in the upper ocean heat content are dominated by the advection-diffusion term. Within the advection term itself, the largest variations are from the geostrophic advection anomaly. Both the advection of the mean temperature by the anomalous current and the advection of the anomalous temperature by the mean current are important to the anomalous advection. Other studies have shown that wintertime mixed layer temperature, or even better, upper ocean heat content, are more robust indicators of the potential contribution of the ocean to interannual heat flux anomalies. The analysis here shows that heat advection by geostrophic current anomalies is the dominant term in interannual variations in heat content in the Gulf Stream region.

OS31S-10 1105h

The Mediterranean Overflow and its Influence on the North Atlantic Circulation in a Global Ocean Model

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Observational studies based on climatological hydrographic data provided ambiguous pictures of the role the Mediterranean water plays in the global thermohaline circulation. Global ocean general circulation models ought to offer a valuable tool to resolve this uncertainty, but the narrowness of the Strait of Gibraltar and the complex dynamics that control the downslope evolution of the Mediterranean Overflow present great difficulties. Often crude parameterisation is used to represent the watermass in coarse resolution ocean models, to bypass the need to resolve the physical processes that determine the initial spread of the Overflow. Here we make an attempt to explicitly include the Mediterranean Overflow in a fully global ocean model with a horizontal resolution of 1/4 degree and the vertical coordinate discretised on geopotential levels. The Strait of Gibraltar is represented by a channel of approximately 50km wide, 85km long and a constant depth of 320m (10 model levels). Despite the poor resolution of the Strait and the stepwise topography, we show that the model produces a reasonable outflow flux (1 Sv) of the dense and saline Mediterranean water through the Strait, which then mixes intensely with the ambient watermasses while descending down the steps to increase its transport by a factor of 3 within a short distance of the Strait. The saline water spreads northward, westward and southward away from the Gulf of Cadiz, with the core at a depth near 900m, slightly shallower than but not significantly different from climatology. Making use of a parallel experiment in which the Strait of Gibraltar is closed, we will discuss the influence of the Mediterranean water on the large scale circulation of the North Atlantic.

OS31S-11 1120h

Investigating the Transport of Mediterranean Water in the Eastern North Atlantic Using Hydrographic and Model Data

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The influence of Mediterranean Water can clearly be seen at intermediate depths on maps of North Atlantic hydrography. It is presently undetermined how much of this water flows northwards along the Iberian continental slope and how much flows westwards into the ocean interior from its source in the Gulf of Cadiz. Our objective is to quantify this transport. We have used WOCE hydrographic sections at 41N, 20W and 24N to create a three sided box (the Med Box) around the Strait of Gibraltar, encompassing the Mediterranean Outflow. Mediterranean Water can be seen at mid-depths across the entire north edge of the box, concentrated in a northward flowing current close to the eastern boundary. In addition, a westward flowing current of Mediterranean Water crosses the western boundary between 35N and 40N. The overturning circulation within the Med Box produces a 4 Sv inflow of surface waters above 600 m, with a corresponding outflow of higher salinity intermediate waters between 600 and 1800 m. To assess the robustness of the circulation, comparisons are made between two realisations of the hydrographic Med Box, one from the late 1980s and one from the late 1990s, the seasonal Levitus climatology, and a fine resolution ocean general circulation model.

OS31S-12 1135h

Can We Observe and Study the Mediterranean Outflow and Meddies from Satellite Remote Sensing?

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Previous studies of the Mediterranean outflow and meddies (O&M) were limited by poor spatial and temporal resolution of the conventional observations. Little is known about meddies formation and transport, and the spatial and temporal variation of its trajectories. Generally speaking, most of the satellite observations are confined to the ocean's surface or its surface layer, while meddies were located, on an average, at a depth of 1000m. We developed a new remote sensing method to observe and study the O&M through unique approaches in satellite multi-sensor data integration analyses. Satellite altimeter, scatterometer, SST and XBT data were used to detect and calculate the trajectories and the relative transport of the O&M. Two experiments [A Mediterranean Undercurrent Seeding Experiment (AMUSE) and Structures des Echanges Mer-Atmosphere, Proprietes des Heterogeneites Oceaniques: Recherche Experimentale (SEMAPHORE)] from 1993 to 1995 were used to validate our method. Monthly mean features of the floats in meddies and our method were well agreed with each other. We found that more northwestward meddies occurred in the spring and more southward meddies occurred in the fall than previously thought. Streamfunctions using T/P altimetry and time-frequency energy distribution using Hilbert-Huang Transform (HHT) were computed to evaluate the meddy interactions with the sea surface. Since the O&M play a significant role in carrying salty water from the Mediterranean into the Atlantic and contribute to the North Atlantic Deep Water (NADW) formation, such new knowledge about their trajectories, transport and life histories is important to understand their mixing and interaction with the North Atlantic water, and hence, to lead to a better understanding of the global ocean circulation and the global change.

W E D

OS31T HC: 317 A Wednesday 0830h

Ocean Remote Sensing and Optics

Presiding: **R A Maffione,** Hydro-Optics, Biology Instrumentation Laboratories

OS31T-01 0830h

Estimation of Primary Production in Antarctic Coastal Waters: A Bio-optical Modeling Study

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Due to restricted accessibility and logistics, the Southern Ocean is a poorly sampled region in terms of bio-optical properties, which are an integral part of estimating primary production. In this study, the surface irradiance was estimated and parameterized at sites along the western Antarctic Peninsula and in the Ross Sea using a clear sky radiative transfer model. Application of the clear sky model included using an empirically-derived parameterization that corrects for cloud cover and multiple reflection effects between the ground and clouds (high albedo). Next, the inherent optical properties (IOP's), such as the absorption coefficient ($a(\lambda, z)$) and the backscatterng coefficient ($b_b(\lambda, z)$), were computed based on bio-optical constituents within the water column, and these inherent optical properties were combined to calculate the spectral diffuse attenuation coefficient, $K_d(\lambda, z)$, used for the construction of underwater light fields. Along with the constructed underwater light fields, different vertical biomass profiles and quantum yields were generalized to obtain primary production estimation at selected sites. The modeled primary production estimates are then compared with those obtained from *in situ* measurements. These comparisons show good agreement and indicate that this approach allows for development of regionally-based models for estimating primary production of Antarctic coastal waters.