

The purpose of this work is to derive the near-real time profiles of temperature and salinity in the upper ocean and then estimate the heat and salt storage associated with the surface circulation in the Indian Ocean, using the combination of sea-level anomalies from TOPEX/Poseidon (T/P) and JASON-1 altimetry, and in-situ sea-level computed from climatological hydrographic data. This new technique is explained in Shi et al. (2002). The accuracies of the synthetic temperature and salinity, and heat and salt storage were evaluated using available hydrographic data. Further, the altimeter data derived sea surface salinity will also be used for validating the sea surface salinity estimated from satellite derived Outgoing Longwave Radiation (OLR). Murty et al. (2002) discussed the new method of estimating sea surface salinity using OLR, through a parameter the 'Effective Oceanic Layer'.

OS52A-0205 1330h POSTER

A Preliminary Comparison of Global Air-Sea Gas Transfer Velocity Fields Derived From the Jason-1 and TOPEX Altimeters

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The availability of collocated, near-coincident normalized radar backscatter data from the TOPEX and Jason-1 altimeters presents a unique opportunity to intercalibrate the two platforms and to compare derived fields of geophysical parameters. We recently reported on an altimeter algorithm [see URL] for estimating air-sea gas transfer velocities from the mean square slope of short wind waves (40-100 rad/m) and derived a six-year time-series of global monthly gas transfer velocity fields from the dual-frequency TOPEX altimeter. In this report, we update the time series to span the entire TOPEX mission to date (1993-2002) and compare the algorithm results from the first eight months of joint TOPEX/Jason-1 operations. Initial results suggest that the monthly gas transfer velocity maps generated from the two altimeters are very similar, although the Jason-1 product appears generally 'hotter'. Jason-1 transfer velocity fields show slightly higher global averages (~ +2 cm hr bias) relative to TOPEX and significantly higher discrepancies (~ 20 cm hr) at high latitudes (e.g. Southern Ocean). Comparison of along-track Ku- and C-band normalized backscatter suggests that the discrepancies are due to significant offsets between TOPEX and Jason-1 in both bands. Prospects for extending the time series to observe decadal trends and for improved spatial coverage with the repositioning of TOPEX will be discussed.

URL: <http://remotesensing.whoi.edu/~david/ktrans/ktrans.html>

OS52A-0206 1330h POSTER

Interannual Volume Changes and Heat Transport Pathways in the Tropical Pacific

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Previous observational and numerical modeling studies have arrived at contradictory conclusions about mass and heat transport, particularly meridional transport, in the tropical Pacific during El Niño events. The present study uses TOPEX/Poseidon altimetric heights and a sigma-coordinate model to assess tropical Pacific volume changes during El Niño. We have previously presented results concerning the large-scale pattern of El Niño related volume redistribution, in which we showed that volume is indeed lost from the tropics during events, although this loss is smaller than the redistribution within the tropics. The volume redistribution was shown to be dominated by transports of heat. Recently, we have used Lagrangian techniques to examine the specific three dimensional pathways of heat transport through an El Niño event. The redistribution of heat, and therefore volume, occurs both along the equator and through interior pathways in both hemispheres. These interior pathways are anomalously strong and shallow during El Niño, bringing warm water into the eastern equatorial Pacific. Anomalous upwelling is an important factor in the cold anomalies in the western near-equatorial Pacific during El Niño. Similarly, anomalous downwelling leads to off-equatorial warm anomalies along the coasts of North and South America, and to anomalies near 20°S and 20°N.

OS52A-0207 1330h POSTER

The Satellite Altimetry Yellow Pages; A Guide for Users

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Satellite altimetry missions have reached a distinctive point of maturity and relevance in the scientific community. A directory of ocean altimetry data applications, the Satellite Altimetry Yellow Pages, is being developed as a directory to new and potential applications and data users. The Yellow Pages directory is designed to serve as a tool to clearly identify the operational and research applications of these highly effective ocean-observing systems, as well as the key players involved. The directory will serve as a professional guide for satellite altimetry users, both experienced and new.

This directory is designed to be a ready reference for defining satellite altimetry systems, exploiting them, validating and using the data, and will outline outreach activities associated with the projects. This database of altimetry applications will be the reference standard for the international satellite altimetry community; who is using the data, what they are doing with it, and how do you contact them.

The Yellow Pages will serve as a working guide to define and track altimetry applications, identify key players in each user category, and facilitate communication between current and potential data users. It is also designed to serve as a model working method for close collaboration between scientists and commercial users to clarify distinct uses and to accurately describe and present the application of altimetry data.

The Yellow Pages directory will live on the AVISO web site, with a link from the NASA Ocean Surface Topography web site. A standardized format is in development that will provide a consistent layout for all entries, and aid information and content searches.

The focus of each Yellow Page summary will be distinct, with respect to the use of the data, to avoid redundancy with other summaries. Interesting and compelling graphics will be featured with each summary. Examples presented here include the Mercator ocean forecasting system, and marine mammal habitat studies.

URL: http://www.aviso.oceanobs.com/html/applications/welcome_uk.html

OS52A-0208 1330h POSTER

GEOSAT Follow-On Radar Altimeter Satellite Performance Studies

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Under a Navy Contract with Ball Aerospace and Technologies Corporation, the first GFO satellite was completed in 1997 and launched on 10 February 1998 on an Orbital Taurus launch vehicle. The satellite was operationally accepted on 29 November 2000. With an anticipated 8-year or more life, GFO (<http://gfo.bmpcoe.org/Gfo>) is a DoD satellite mission managed by the Space and Naval Warfare Systems Command's (SPAWAR's) Meteorological and Oceanographic (METOC) Systems Program Office (PMW 155) located in San Diego, California. The satellite is in the same Exact Repeat Orbit (ERO) as the original GEOSAT (800 km by 108 degrees inclination). All GFOs data products are available to the scientific community and are distributed by NOAA's Laboratory for Satellite Altimetry. The primary program objective was to develop an operational series of radar altimeter satellites to maintain continuous ocean observation for accurate global measurements of both mesoscale and basin-scale oceanography. Since its acceptance, Computer Sciences Corporation (CSC), under contract with the Navy, has provided a team known as the GFO Cal/Val and assisted by NASA and NOAA personnel has undertaken extensive and continuing calibration and validation activities on an exact repeat cycle basis.

This paper will discuss the results of those Cal/Val efforts and present charts showing the performance history of the satellite, its sensors (both the Radar Altimeter and the Water Vapor Radiometer), and other relevant performance measures such as orbit accuracy. URL: <http://gfo.bmpcoe.org/Gfo>

OS52A-0209 1330h POSTER

Low-Frequency Variability in the Kuroshio Extension System: Observations and Causes

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TOPEX/Poseidon altimeter data from the last decade are used to investigate large-scale circulation changes in the Kuroshio Extension and its neighboring recirculation gyre regions. Over the decade-long period from 1992, the large-scale changes of the Kuroshio Extension (KE) are characterized by the oscillation between an elongated state and a contracted state. In the elongated state, the KE has a larger eastward surface transport, a greater zonal penetration, and a more northerly zonal-mean path. The reverse is true when the KE is in the contracted state. Causes for this structural change in the downstream KE region (east of 158°E) are found to be due to the interior surface wind forcing accumulated along the long baroclinic Rossby wave characteristics from the east. In the upstream KE region, much of the observed low-frequency changes is found to be associated with the fluctuations of the southern recirculation gyre.

OS52B MCC: Hall D Friday 1330h

Integrating Marine Ecology and Ocean Carbon Cycle Dynamics: Data Synthesis, Numerical Modeling, and Data Assimilation Studies Posters (joint with B, GC)

Presiding: S Doney, National Center for Atmospheric Research; K Moore, National Center for Atmospheric Research

OS52B-0210 1330h POSTER

Comparing Satellite and In-Situ Chlorophyll Measurements

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Obtaining accurate measurements of surface chlorophyll-a concentration in the world's oceans is critical for primary productivity and carbon cycle modeling. The satellite sensor, Sea-viewing Wide Field-of-view Sensor (SeaWiFS), has provided a continuous record of ocean chlorophyll measurements since September 1997. Statistical comparisons of in-situ versus SeaWiFS data were made to determine how well 9-km SeaWiFS observations match up with direct surface measurements. Results show that the agreement is fairly good (r-squared of 0.78), though SeaWiFS chlorophyll values are somewhat higher than their in-situ counterpart in 60% of the match-ups, particularly in low-chlorophyll areas. Yet while the global area-weighted mean is higher for SeaWiFS, regional differences among the major oceanic basins are evident. For example, the SeaWiFS values in the Antarctic are generally lower than the in-situ measurements. Comparisons were made using SeaWiFS mapped and binned data products and the results were similar.

OS52B-0211 1330h POSTER

The Role of Ecosystem Dynamics on the Global Ocean Carbon Cycle: Exploratory 3-D Simulations in the CCSM-Ocean Model

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Over the last decade, JGOFS and related field studies have dramatically altered our basic conceptualization of ocean biogeochemistry, highlighting the importance of (among other things) trace-metal limitation, community structure, and planktonic "geochemical functional groups" (e.g., diatoms, nitrogen fixers, calcifiers). These plankton groups provide important links between ocean carbon and the biogeochemical cycles of other key species (e.g., macro- and micro-nutrients, alkalinity, silica). To better quantify the role of marine ecosystem dynamics on the global ocean carbon cycle, we have developed a new global, three-dimensional coupled eco-biogeochemistry model under the framework of the CCSM-Ocean model. Community structure is determined prognostically by a balance of temperature, light, and multi-nutrient limitation (Fe, P, N, Si) as well as zooplankton grazing. The ecological components are linked with full carbonate system chemistry and an iron biogeochemical cycle. We will present results from preliminary global simulations, focusing on model-data evaluation against standard metrics including: local time-series stations; SeaWiFS ocean color and primary productivity; export production; and air-sea CO₂ flux.

OS52B-0212 1330h POSTER

A Coupled Epipelagic-Meso/Bathypelagic Particle Flux Model for the Bermuda Atlantic Time-series Station (BATS)/Oceanic Flux Program (OFP) Site

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Of considerable scientific interest is the role remineralization plays in the global carbon cycle. It is the "biological pump" that fixes carbon in the upper water column and exports it for long time periods to the deep ocean. From a global carbon cycle point-of-view, it is the processes that govern remineralization in the mid- to deep-ocean waters that provide the feedback to the biogeochemical carbon cycle. In this study we construct an ecosystem model that serves as a mechanistic link between euphotic processes and mesopelagic and bathypelagic processes. We then use this prognostic model to further our understanding of the unparalleled time-series of deep-water sediment traps (21+ years) at the Oceanic Flux Program (OFP) and the euphotic zone measurements (10+ years) at the Bermuda Atlantic Time-series Site (BATS). At the core of this mechanistic ecosystem model of the mesopelagic zone is a model that consists of an active feeding habit zooplankton, a passive feeding habit zooplankton, large detritus (sinks), small detritus (non-sinking), and a nutrient pool. As the detritus, the primary source of food, moves through the water column it is fed upon by the active/passive zooplankton pair and undergoes bacterially mediated remineralization into nutrients. The large detritus pool at depth gains material from the formation of fecal pellets from the passive and active zooplankton. Sloppy feeding habits of the active zooplankton contribute to the small detrital pool. Zooplankton mortality (both classes) also contribute directly to the large detritus pool. Aggregation and disaggregation transform detrital particles from one pool to the other and back again. The nutrients at each depth will gain from detrital remineralization and zooplankton excretion. The equations that model the active zooplankton, passive zooplankton, large detritus, small detritus, and nutrients will be reviewed, results shown and future model modifications discussed.

OS52B-0213 1330h POSTER

Influence of Meso- and Submeso-scale Variability on Biological Productivity Along the U.S. West Coast

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In the last decade, the importance of meso- and submeso-scale variability for controlling biological productivity in the ocean has become increasingly clear and the subject of much research. So far, most of this research focused on the open ocean, where mesoscale variability tends to be dominated by eddies. We focus here on the coastal environment, where much of the variations are driven by submeso-scale features such as squirts, jets, and filaments, which are captured only at very high resolution.

We employ a coupled physical-biogeochemical model for the U.S. West Coast (USWC) that uses the Regional Ocean Modeling System (ROMS). The biogeochemical model is based on a traditional NPZD model (nitrogen as single limiting nutrient, one phytoplankton and one zooplankton class, a small and a large detritus class) and includes the cycling of oxygen and carbon. The sinking of phytoplankton, detritus, and CaCO₃ is explicitly treated.

The USWC model domain extends approximately from the Mexican to the Canadian border, and about 1500 km off-shore. The model is discretized in coastline- and terrain-following curvilinear coordinates with 20 vertical levels. A radiation boundary scheme is used on the open boundaries.

In order to investigate the influence of the magnitude of meso- and submeso-scale physical variability on biological productivity, we run the model at grid resolutions varying between 5 and 20 km. Submeso-scale features like jets and squirts are fully resolved in the 5 km model, but not in the 20 km model, leading to a fourfold difference in eddy kinetic energy between the two model resolutions. Based on the open ocean results, one would expect an increase in biological productivity with increasing mesoscale activity. However, our preliminary results indicate that net primary productivity (NPP) is significantly (about 50 %) lower in the 5 km model compared to the 20 km model. We will present and discuss the reasons for this unexpected result.

OS52B-0214 1330h POSTER

Modified Model Parameterization for N₂-Fixation is Required to Balance the Summer Carbon Budget in the Baltic Sea

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Measurements in several oceanic regions (e.g. Bermuda, Baltic Sea) have shown, that dissolved inorganic carbon concentrations in the upper water column continue to decrease after complete dissolved inorganic nitrogen depletion. This requires either a new external supply of nitrogen without a concomitant supply of carbon, or a highly non redfieldian ecosystem stoichiometry. In order to investigate this question in the eastern Gotland Sea, a biogeochemical model, containing 10 state variables including diatoms, flagellates and nitrogen fixing bacteria, is coupled to a 1D physical model. The results for the winter period until the onset of the spring bloom of 1997 give reasonable pCO₂ values compared with measurements of the pCO₂. However, even the introduction of a seasonal DOC excess production and variation of different process parameterization can not simulate the observed pCO₂ drawdown for the period after the spring bloom until late summer. Only the switch from a sharp to a moderate temperature dependency, that implies an early onset of the nitrogen fixation bacteria (June instead of August), plus an increase in the C:P ratio (260 instead of 106) of these organisms make it possible for the model to match the pCO₂ observations. The resulting total nitrogen fixation (240

- 300 mmol m⁻²yr⁻¹) exceeds previous measurement based estimates for 1997 (101-140 mmol m⁻²yr⁻¹) by a factor of about 2. These estimates do not include the full summer period and new monthly cruises, covering the period from April (pre-spring bloom situation) until September 2001, with special emphasis on the seasonal variation of the inorganic/organic carbon budget and the availability of inorganic/organic phosphorus, are consistent with the model simulations and thus confirm the adequacy of the process parameterizations in the biogeochemical model.

OS52B-0215 1330h POSTER

Sensitivity of Interannual Fluctuations of the Marine Ecosystem to Changes in the Ocean Circulation.

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Factors controlling the interannual distribution of phytoplankton or zooplankton are largely unknown and thus resulting in large uncertainties in the prediction of sources and sinks of CO₂ in the ocean. We are using two coupled ocean general circulation - marine ecosystem models with different resolution, the NPZD-type HAMOCC4 coupled to the LSG and the C-HOPE, to explore how different physical resolutions and parameterizations can explain some of the agreements and discrepancies between the data and the model. In addition, sensitivity experiments by variation of the ecosystem parameters and by including an empirical chlorophyll-to-carbon ratio have been carried out to study and discuss potential causes of the model-data differences between the observed and simulated chlorophyll concentrations. These sensitivity experiments are designed to be a first step towards a currently developed inverse ecosystem model to quantify large-scale interannual-to-decadal fluctuations of the marine carbon cycle and to provide more accurate predictions of the climate system.

OS52B-0216 1330h POSTER

Iron Resources and Oceanic Nutrients: Advancement of Global Environment Simulations

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The concept of a single factor limiting plankton blooms, is presently giving way to co-limitation by light, and the nutrients N, P, Si and Fe. Primary production, export into the deep sea, and CO₂ uptake from the atmosphere together form the 'biological pump' in Ocean Biogeochemical Climate Models (OBCM's). Thus far OBCM's assume just one limiting nutrient (P) and one universal phytoplankton species, for C budgets and CO₂ exchange. New realistic OBCM's are being developed for budgeting and exchanges of both CO₂ and DMS, implementing (i) co-limitation by 4 nutrients of 5 major taxonomic classes of phytoplankton, (ii) DMS(P) pathways, (iii) global iron cycling, (iv) chemical forms of iron and (v) iron supply into surface waters. The new OBCM's will predict realistic climate scenario's, notably climatic feedbacks on oceanic biogeochemistry. IRONAGES is a European consortium of twelve institutes and is coordinated by Royal NIOZ. Input from below of iron from anoxic sediments of coastal margins has been assessed (March 2002) along a 2-D vertical section from Europe into the centre of the north Atlantic. Input from above of Fe(II) dissolved in rainwater from Sahara dust blown over the central Atlantic will be quantified at sea (October 2002), and related to observed plankton production. Different chemical forms of iron are being assessed and a certification exercise for Fe in seawater also under aegis of SCOR Working Group 109 is being completed (December 2002). For two major DMS-producing algal groups *Phaeocystis* sp. and *Emiliania huxleyi* the life cycle, Fe limitation, export production, CO₂ uptake and DMS emissions have been synthesized from existing literature and laboratory experiments. This is being fed into ecosystem modeling, as well as into DMS(P) pathway modeling. Also know-how has been synthesized for three other major classes (diatoms, N₂-fixing Trichodesmium and nano-pico-plankton) and fed into the ecosystem modeling. Pathways of DMS(P) in blooms are being simulated. An existing plankton ecosystem model already well predicts limitation by four nutrients (N, P, Si, Fe) of two algal groups (diatoms and

nanoplankton) including export and CO₂ air/sea exchange. This is being expanded with 3 other groups of algae and DMS(P) pathways. Next this extended ecosystem model is being simplified while maintaining reliable output for export and CO₂/DMS exchange. This unit will then be put into two existing OBCM's. Inputs of Fe from above and below into the oceans have been modeled. Moreover a simple global Fe cycling model has been verified versus field data and insights. Two different OBCM's with same upper ocean ecosystem/DMS unit and Fe cycling will be verified versus pre-industrial and present conditions. Next climate change scenario's, notably changes in Fe inputs, will be run, with special attention to climatic feedbacks (warming) on the oceanic cycles and fluxes.

OS52B-0217 1330h POSTER

Incorporating 1-D Observed Patchiness Into 2-D Fields for Flux Calculations: an Example from Georges Bank, Northwest Atlantic GLOBEC

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Physical and biological controls on fluxes of carbon in oceanic systems are patchy over a range of spatial scales. Accurately characterizing this patchiness has ramifications for the estimates of fluxes resulting from large-scale models. Surveys of Georges Bank during US GLOBEC Northwest Atlantic yielded continuous along-track measurements of temperature, salinity, fluorescence and acoustic backscatter in January, March, and June of 1998 and 1999. These observations can be used to characterize seasonal patchiness of physical and biological factors around the Bank on scales of 10⁸ of meters to 10⁸ of kilometers. Localized characterization of these parameters is necessary in the hydrographically diverse regions of the Bank. Wavelet analysis allows determination of localized spectra, the slopes β of which provide fractal measures that can be used to constrain a stochastic model of patchiness based on the observations. Using fluorescence and acoustic backscatter as proxies for prey and predators, first order calculations of potential flux, based on spatial overlap, indicate bounds on possible fluxes consistent with observed patchiness. A fractal interpolation scheme is demonstrated that allows calculation of potential flux over a 2-D field developed from localized characterization along 1-D tracklines from the survey.

OS52B-0218 1330h POSTER

An Ecosystem Model Including C, N and P Cycles Applied to Stn ALOHA: Simulating Primary Production, Organic Matter Stoichiometries and Export

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We have applied a one dimensional model to simulate the production, recycling and export of organic matter at Station ALOHA, Hawaii. Our ecosystem model is a modified version of the NEMURO formulation, with modifications including addition of nitrogen fixation, carbon and phosphorous cycles and variable stoichiometries. We also compared versions of the model with and without a formulation for the cycling of dissolved organic matter (DOM) via the Microbial Food Web (MFW). Stoichiometries of all living organisms are constant (although differing significantly by type of organism), but stoichiometries vary for non-living organic matter. Using differential rates for remineralization of C:N:P in DOM and POM, the model can simulate the observed mean stoichiometry of POM in traps at 150 meters depth and some of the observed variations with depth in the stoichiometry of DOM. Differential remineralization allows the ecosystem to recycle nutrients and increase net production, but still only to about 20% of the observed primary productivity (mean of 480 mg C m⁻² d⁻¹). High ratios of C:N uptake by phytoplankton and especially diazotrophs have been cited as a possible explanation for high productivity in oligotrophic regions. Using high uptake ratios of C:N and allowing diazotrophs to take up ammonium, mean simulated production increased to 640 (standard model)

and 470 (MFW model) mg C m⁻² d⁻¹. If only half of the DOC is counted in primary production, consistent with experimental evidence, the simulated production is roughly 20% lower. Thus the simulated primary production approaches the measurements (but is still lower for the MFW model), while the model simulates reasonably well the mean fluxes of POM and the profiles of DIN, DIP and DOM.

URL: <http://www.h4.dion.ne.jp/~greentea/AGU2002.html>

OS52B-0219 1330h POSTER

Spatial Patterns of Organic Carbon, Opal and CaCO₃ Fluxes in Sediment Traps: Application to the LGM Carbon Cycle.

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Model studies have shown that possibly the most important factor driving interglacial glacial variations in atmospheric pCO₂ is a change in the Particulate Organic Carbon/CaCO₃ (POC/PIC) rain ratio to the sediments caused by shifts in the plankton community in surface water. In a study of vertical flux composition from deep-sea sediment traps we show that deep-sea fluxes of organic carbon are linearly related to mineral fluxes opal, CaCO₃ and lithogenic material with most of the POC export being associated to the flux of CaCO₃ to the deep ocean. We also analyze spatial variability of opal/CaCO₃ flux ratios from deep-sea sediment trap experiments in an attempt at parametrising export flux of opal and calcium carbonate. Our results indicate that variability of opal/CaCO₃ export fluxes shows different trends depending on region. Comparison between CaCO₃ and opal fluxes with environmental parameters points toward the importance of temperature or silica in determining the relation between CaCO₃ and opal fluxes. In high latitude regions (mean sea-surface temperatures below 7°C-10°C, silica > 10 μM) the opal/CaCO₃ flux ratios increase linearly with opal fluxes in warmer regions (mean sea surface temperature above 7°C-10°C, silica < 10 μM) CaCO₃ and opal fluxes are correlated; comparison with environmental conditions indicates that CaCO₃ fluxes respond to increases in nutrient availability (including iron deposition) as do opal fluxes. We use the results of the sediment trap analysis to constrain variations in the export production of opal/CaCO₃ and organic carbon deposition in deep-sea sediments in a coupled circulation-carbon cycle model LSG-HAMOC2 and simulate the effect of plankton community changes on glacial/interglacial pCO₂ variability.

OS52B-0220 1330h POSTER

World Ocean Database 2001 and World Ocean Atlas 2001

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The World Ocean Database 2001 (WOD01) CD-ROM's, containing observed and standard level profile, plankton and surface data, represent an update of the World Ocean Database products first released as World Ocean Atlas 1994 (WOA94), and followed by World Ocean Database 1998 (WOD98). WOD01 expands on WOD98 by including new variables and data types. During the past three years, the number of data sets received at NODC/WDC, Silver Spring (National Oceanographic Data Center/World Data Center for Oceanography, Silver Spring) has increased, from over 5 million to 7 million stations, as a result of projects such as the Intergovernmental Oceanographic Commission (IOC)/NODC Global Oceanographic Data Archaeology and Rescue project (GODAR), NODC Global Ocean

Database project, IOC World Ocean Database project, Global Temperature-Salinity Profile Project (GTSPP), World Ocean Circulation Experiment (WOCE), Joint Global Ocean Flux Studies (JGOFS), Ocean Margin Experiment (OMEX), and many others.

The World Ocean Atlas 2001 (WOA01) contains statistics and objectively analyzed fields for one-degree and five-degree squares generated from World Ocean Database 2001 observed and standard level flagged data. The ocean variables included in the atlas are: in-situ temperature, salinity, dissolved oxygen, apparent oxygen utilization, percent oxygen saturation, dissolved inorganic nutrients (phosphate, nitrate, and silicate), chlorophyll at standard depth levels, and plankton biomass integrated from 0 - 200 meters.

The data and analyzed fields, presented in WOD01 and WOA01 are critical for understanding changes in the distribution of these variables over the past decades and for initiation and validation of biogeochemical numerical models.

OS52B-0221 1330h POSTER

Linkage between transient physical forcing and export flux of bioreactive materials to the deep oligotrophic ocean

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Considerable attention has recently been focused on the role of eddies in affecting biogeochemical fluxes and budgets of the Sargasso Sea. The Bermuda Testbed Mooring (BTM) and Bermuda Atlantic Time Series (BATS) shipboard sampling evidenced a large phytoplankton bloom at the Bermuda time-series site in late fall 1996 which was strongly forced by the interplay between seasonal mixed layer destratification and perturbation of mixed layer dynamics due to the presence of a warm mesoscale feature, possibly an eddy remnant, which was characterized by a thick warm, low salinity thermocline more than 180m in depth. Nutrients, chlorophyll and pigment profiles indicated high primary production stimulated by nutrient entrainment and intermittent deep mixing. Zooplankton biomass and 200 m export flux also were greatly elevated.

Nearly coincident with the arrival of this feature in surface waters, the Oceanic Flux Program (OFP) sediment traps recorded an abrupt, factor of 2.5 increase in mass flux at 3200 m depth. More dramatic was the increase in flux of labile bioreactive organic matter. Fluxes of primary phytoplankton and bacteria-derived compounds and their early degradation products increased by factors of 5-30. Their covariation indicated that the settling phytoplankton bloom material contained elevated bacterial populations and was undergoing active degradation when it entered the 3200 m trap cup.

These results show that transient, physical forcing by warm mesoscale features - which include but are not limited to eddies - can have an enormous effect on the export flux of bioreactive organic material. The contribution to the longer term average is not presently known, but the occurrence of episodic high flux events throughout the OFP time-series record suggests that they may be responsible for a significant fraction of the total export of bioreactive carbon and associated elements to the deep oligotrophic ocean.

OS52B-0222 1330h POSTER

Multi-tracer constraints on ocean storage of anthropogenic CO₂

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During the second phase of the Ocean Carbon-Cycle Model Intercomparison, 13 models simulated oceanic uptake of anthropogenic CO₂ for the period 1765 to 2000. For the 1980s, models agreed to within +/- 22% (1.99 +/- 0.43 Pg C yr⁻¹, half the range over the mean). For the 1990s the OCMIP-2 models predict a 24uptake increase (2.38 +/- 0.53 Pg C yr⁻¹), in contrast with the 1980s-to-1990s decrease predicted by the most recent IPCC Third Assessment Report Chapter 3. However, the IPCC's estimates are based on atmospheric O₂ measurements which are susceptible to error due to interannual variations in air-sea O₂ fluxes. It appears likely that the OCMIP-2 range for the modern uptake of anthropogenic CO₂ brackets real ocean uptake for four reasons: (1) the large model diversity; (2) the range of OCMIP-2 models bracket observed tracer constraints (CFC-11 along sections, global mean deep-ocean ¹⁴C); (3) the simulated global storage of anthropogenic CO₂ correlates with the simulated global storage of CFC-11 and the simulated global-mean, deep-ocean natural ¹⁴C; (4) the simulated global inventories of anthropogenic CO₂ bracket data-based estimates for that same tracer. In theory, the CFC-11 and C-14 data constraints should allow us to weight the models, and thus narrow uncertainties, based on how models perform in regards to matching ocean inventories of these independent tracers. Here we will discuss progress on this effort, in regards to global and regional inventories.

URL: <http://www.ipsl.jussieu.fr/OCMIP>

OS52B-0223 1330h POSTER

A 3-D Model of the Ocean Carbon Cycle: Sensitivity to the Biological Pump

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At the Canadian Climate Centre, an ocean carbon model is being developed and tested as part of a coupled carbon general circulation model for use in projections of future climate change. Different biotic pumps have been implemented. Initially a biotic pump has been incorporated as in OCMIP-2, generating the export production by restoring surface layer phosphate concentrations to observed levels. Results are much closer to observations than in the abiotic, solubility pump, model - although different initial conditions result in slightly different equilibrium solutions. Maps of sea-air CO₂ exchange for both abiotic and biotic simulations are compared with maps derived from observations. Maps of dissolved inorganic carbon and total alkalinity at different depths are compared with maps derived from recent data analyses. The biotic model replicates the clear differences between the North Pacific ocean and the North Atlantic ocean. A dynamic NPZD (Nutrient-Phytoplankton-Zooplankton-Detritus) biotic pump has also been implemented. Model results are compared to observations and to results from equilibrium solutions involving the phosphate-restoring biotic pump.

OS52B-0224 1330h POSTER

A 3-D Model of the Ocean Carbon Cycle: Sensitivity to Mixing Based on Bathymetry Roughness

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Earlier as well as more recent model circulation assessments using natural C-14 have revealed the possibility for large differences between ocean models in simulating deep ocean C-14 penetration, for example in the North Atlantic where many models appear to have too slow deep circulation resulting in an overestimation of the ventilation timescales for deep water renewal. Significant differences between models in simulating the vertical modes of circulation, many at variance with observations, have also been shown in recent studies using CFC-11 as a chemical tracer.

At the Canadian Climate Centre, an ocean carbon model is being developed and tested as part of a coupled carbon general circulation model for use in projections of future climate change. Experiments with the abiotic carbon model that included C-14 and CFC-11 exhibited similar tendencies: the mid to deep ocean circulation, especially in the North Atlantic, appeared to be too slow. As a remedy, a novel mixing scheme was incorporated in the model. It involves spatially variable eddy diffusivity as a function of sub-grid scale bathymetry roughness. Model experiments using this scheme instead of constant background eddy diffusivity resulted in noticeable improvement in the North Atlantic and the Pacific ocean circulations as diagnosed by the Delta-C14 ratio and CFC-11. Model results were compared to data.

OS52B-0225 1330h POSTER

New Techniques for the Remote Sensing of Trichodesmium

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Ocean color remote sensing of *Trichodesmium* spp. provides a method to estimate the importance of N₂ fixation in global ocean biogeochemical cycling. In order to do this a globally applicable bio-optical model must exist that relates the in situ *Trichodesmium* biomass to its water leaving radiance signal. A global dataset containing concurrent measurements of *Trichodesmium* abundance and radiometric measurements was compiled and used for model testing and development. Previous efforts have shown that empirical models are not sufficient and that alternative approaches must be developed. Here, state-of-the-art semi-analytic formulations are used to estimate *Trichodesmium*-specific quantities with varying degrees of success. In particular, a *Trichodesmium*-specific inverse reflectance model was developed and tested against available data. Preliminary results point to some fundamental differences between in situ and theoretical optical characteristics of this organism. These differences must be reconciled in order to achieve adequate predictive capability through the use of ocean color data. Additional techniques for estimating *Trichodesmium* biomass are also discussed.

OS52C MCC: Hall D Friday 1330h

Quantitative Developments in Coastal Oceanography II Posters

Presiding: K Brink, Woods Hole

Oceanographic Institution; E

Thornton, Naval Postgraduate School; J

Barth, Oregon State University

OS52C-0226 1330h POSTER

Chalk-Ex: An Ocean Optics Manipulation Experiment on the Fate of Calcite Particles

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Large-scale manipulation experiments such as Iron-Ex have allowed the testing of fundamental hypotheses about the ocean, not easily approachable with typical bench-style experimentation. Manipulation experiments provide tremendous insight by integrating the entire biogeochemical system into the results; they arguably give some of the most valuable tests for today's complex numerical models, at relatively fine spatial scales. One poorly understood biogeochemical cycle is that of CaCO₃. About one quarter of the earth's marine sediment is CaCO₃, much of which is composed of small coccoliths. How these particles are transported to the sea floor is still an open question. In this talk, we will present an overview of experiments from November 2001 from Continental Shelf and Slope waters off the NE U.S., in which Cretaceous coccolith chalk was dispersed into a patch of about 1.5 km² (dubbed "Chalk-Ex"). The chalks extremely well-defined light scattering and stable isotope properties made it possible to monitor the patch evolution and examine the importance of physical processes (horizontal shear, vertical mixing), grazing (macro- and micro-zooplankton), aggregation, interactions with dissolved organic carbon and sinking (estimated with drifting sediment traps). Lagrangian drifters were used to follow the patch and an instrumented drifter was used to characterize T-S properties over several days. From a particle perspective, the power of Chalk-Ex was that it simplified particle turn-over calculations. That is, while most particle experiments must simultaneously quantify both the