Mark H Carr[2] (831-459-3958; carr@biology.ucsc.edu)

Pete T Raimondi[2] (831-459-5674; raimondi@biology.ucsc.edu)

Jared D Figurski[2] (831-459-3958; jared_figurski@yahoo.com)

[1]University of California Santa Cruz, Ocean Sciences Department 1156 High Street, Santa Cruz, CA 95064, United States

[2]University of California Santa Cruz , Long Marine Laboratory 100 Shaffer Road, Santa Cruz, CA 95060, United States

Thermistor chains and acoustic Doppler current profilers (ADCPs) were deployed at the northern and southern ends of Monterey Bay to examine the thermal and hydrodynamic structure of the inner (h 20 m) shelf of central California. The thermistor chains and ADCPs sampled temperature and current velocity at two-minute intervals over a 13-month period (06/2000-07/2001). These instruments were deployed as part of the Partnership for Interdisciplinary Studies of the Coastal Oceans (PISCO). PISCO is a marine science research program that focuses on understanding nearshore ecosystems of the U.S. West Coast. Time series of temperature and current velocity, in conjunction with data from Advanced Very High Resolution Radiometer (AVHRR) and Coastal Ocean Dynamics Applications Radar (CODAR), help to establish the basic hydrography for Monterey Bay. Analyses of time series data reveal that semi-diurnal and diurnal tidal motions dominated the temperature and current records. The transitions from ebb to flood tide were rapid, often exhibiting characteristics of tidal bores. Analyses also show that when thermal stratification was high, during the spring and summer months, more than 2000 high frequency (Tp 4 to 20 min) internal wave events in packets of 8-10 occurred. Typically, these internal wave packets followed the transition from ebb to flood tide. Previous studies along the west coast of the U.S. have concluded that internal waves and tidal bores may play a significant role in the onshore transport of larvae. The implications for larval transport and recruitment in Monterey Bay will be discussed.

URL: http://www.piscoweb.org/what/index.html

OS12K-10 1605h

Inner-Shelf Circulation Near Point Conception, California

Cynthia Cudaback[1] (805-893-5145; cudaback@lifesci.ucsb.edu)

Libe Washburn[2] (805-893-7367; washburn@icess.ucsb.edu)

[1]Marine Science Institute, University of California, Santa Barbara, CA 93106, United States

[2]Institute for Computational Earth Systems Science, University of California, Santa Barbara, CA 93106, United States

Some nearshore fish and invertebrate species have widely dispersing larvae that must cross the inner shelf twice, first to enter the coastal currents and later to settle in their adult habitat. Transport across the inner shelf may thus significantly affect coastal marine ecosystems. We examined the flow over the inner shelf at three contrasting sites near Point Conception, California. We found that coastal and inner-shelf currents follow similar seasonal patterns, but currents over the inner-shelf (15 m isobath) are slower than currents over the mid-shelf (100 m isobath) by a factor of 4-5. North of the Point, strong along-shore winds drive temporal variations in currents and water temperature. Cross-shore currents are vertically sheared, suggesting wind-driven upwelling, and along-shore currents have a profile consistent with a balance between direct wind forcing and bottom friction. As Lentz (1994) observed in Northern California, classical Ekman theory over-estimates inner-shelf transport by a factor of four. East of the Point, classical wind-driven upwelling is not observed. At one location, the dominant cross-shore winds drive the cross-shore component of circulation. Along-shore currents at this location are correlated with winds only during winter storms; prior studies have indicated that along-shore currents are due to non-local forcing. At the third location, also East of the Point, winds near the shore are generally weak and variable, and along-shore winds are correlated with along-shore currents only during winter storms, suggesting direct wind forcing. Inner shelf temperatures measured at six locations (three on either side of the Point) show remarkable along-shelf coherence in meteorologic and seasonal-scale variability. Strong thermal gradients are observed only in late summer, when coastal currents converge at Point Conception.

OS12L HC: 319 A Monday 1330h

The Cycle of Carbon in the Southern Ocean (S.O.) II

Presiding: **U Bathmann,** Alfred Wegener Institute**; D A Hutchins,** College of Marine Studies,University of Delaware**; I Peeken,** Intitut of Marine Research**; J Tremblay,** McGill University**; M J Lutz,** Stanford University

OS12L-01 1330h INVITED

Satellite-based Primary Production Estimates in the Southern Ocean: a Comparative Study

Mary-Elena Carr[1] (818-354-5097; mec@pacific.jpl.nasa.gov)

Marjorie Friedrichs[2] (757-683-5560; marjy@ccpo.odu.edu)

J. Keith Moore[3] (303 497-1692; jkmoore@ucar.edu)

Richard Barber[4] (252 504 7578; rbarber@duke.edu)

[1]Jet Propulsion Laboratory, California Institute of Technology; MS 300-323, 4800 Oak Grove Dr., California Institute of Technology;, Pasadena, Ca 91101-8099, United States

[2]Old Dominion University, Crittenton Hall, 768 52nd Street, Norfolk, VA 23529, United States

[3] National Center for Atmospheric Research, P.O. Box 3000, Boulder, CO 8035, United States

[4]Duke University, 135 Duke Marine Lab Road, Beaufort, NC 28516, United States

Ocean color sensors and the suite of models that derive primary production from satellite data provide global maps of marine photosynthesis at unprecedented temporal resolution. This satellite approach is particularly attractive for the Southern Ocean where field campaigns are costly and labor intensive. However the Southern Ocean presents a challenge for space-based primary production models, as temperature dependent functions for the global ocean may fail at extreme values, macronutrient distributions do not always determine photosynthetic performance, and high growth rates are not necessarily accompanied by high biomass. Likewise, most models are not parameterised for the Southern Ocean due to data constraints. In fact satellite-based estimates tend to be smaller than recent in situ carbon uptake measurements. Here we present early results from a comparison study of space-based primary production models, the third Primary production Algorithm Round Robin (PPARR3), focussing on model behaviour in the Southern Ocean. In this exercise we compare the output of several primary production models among themselves, and with a limited set of in situ carbon uptake measurements. We find that although the spatial patterns and basin-wide averages are very similar for the tested models, point values and regional means can vary by a factor of two or more. The models diverged most in regions of very cold temperatures. A direct comparison between carbon uptake measurements made along 170W in early March 1998 and different models using the monthly satellite-derived mean chlorophyll along the transect led to generally similar distributions. However, the modeled values were consistently smaller than those measured in situ (30-50%). One simulation was run using the cruise-measured value of a key model parameter instead of the globally-tuned derivation; this run yielded a higher estimate of primary production than was measured. The goal of PPARR3 is to provide a forum for model improvement by providing identical input fields, systematic intercomparison of model output, and a quality-controlled in situ database to refine parameterization. We anticipate that this exercise will enable the next generation of satellite-based primary production models for the Southern Ocean.

OS12L-02 1400h

Chlorophyll Variability in the Agulhas Current System: a Wavelet Analysis on Modelled and SeaWIFS Chlorophyll Fields

Jerome LLIDO[1] (+33 561332785; jerome.llido@cnes.fr)

Eric MACHU[2] (+33 561193012; eric.machu@cerfacs.fr)

Isabelle DADOU[1] (+33 561332954; isabelle.dadou@cnes.fr)

Veronique GARCON[1] (+33 561332957; veronique.garcon@cnes.fr)

[1]LEGOS/CNRS, 18 Ave Edouard Belin, TOULOUSE 31401, France

[2]CERFACS, 42 Ave Gaspard Coriolis, TOULOUSE 31057, France

The frontal system formed by the Agulhas Return Current (ARC) and the Subtropical Convergence (STC) is a region of intense mesoscale activity presenting enhanced levels of biological production and chlorophyll a. The ARC is a meandering Rossby wave initiated in the Agulhas Retroflection area clearly identified in the ocean color signal.

A wavelet analysis is performed on the 4-years (October 1997- September 2001) time series of SeaWIFS chlorophyll a data in the Agulhas Current system to determine the range of the dominant wavelengths of the Rossby wave associated to the meanders of the ARC. A similar analysis is carried out on modelled chlorophyll distributions. Two versions of a three dimensional coupled physical/biological model are examined : a coarse (1.2 degree) and an eddy-permitting version (1/3 of a degree). The range of wavelengths associated to the Rossby wave varies between 380 and 760 km. The meridional average of the power Hovmoller, which gives a measure of the global 380-760 km wavelength variance in the selected 15-45 E band, is compared between SeaWIFS chlorophyll data and modelled chlorophyll. Similarities and discrepancies are discussed in the light of other physical signals (Sea Surface Temperature, Sea Level Anomalies).

OS12L-03 1415h

Chlorophyll-a Ocean Color Algorithms for the Southern Ocean and their Influence on Satellite Estimates of Primary Production

B. Greg Mitchell[1] (858-534-2687; gmitchell@ucsd.edu); Mati Kahru[1] (858-534-8947; mkahru@ucsd.edu); Rick Reynolds[1] (206-634-9046); John Wieland[1] (858-534-8947; wieland@ucsd.edu); Dariusz Stramski[1] (dstramski@ucsd.edu); Christopher Hewes[1] (858-534-8525; chewes@ucsd.edu); Osmund Holm-Hansen[1] (858-534-2339; oholmhansen@ucsd.edu)

[1]Scripps Institution of Oceanography, University of California, San Diego, 9500 Gilman Drive, Dept 0218, La Jolla, CA 92093-0218, United States

An ocean color chlorophyll-a (chl-a) algorithm for the Southern Ocean (SPGANT) has been developed by combining in situ spectral reflectance and chl-a data obtained during recent cruises to the region. Monthly composites of global Southern Ocean primary production 1997-2001 are calculated from SeaWiFS ocean color data by using either NASAs standard OC4 or our new SPGANT chlorophyll algorithm in the productivity model. Our results are compared to previously published global and Southern Ocean chl-a algorithms and primary production estimates. We used ship-based in situ match-up data for both chl-a and normalized water-leaving radiances (Lwn) to evaluate the efficacy of different algorithms. The SPGANT algorithm minimizes the bias of NASAs OC4 algorithm that underestimates near-surface chl-a for the Southern Ocean by up tot 30-40%. The largest underestimates are in the range of 0.8 3 mg chl m^{-3}. At low chl-a (<0.2) the OC4 algorithm tends to overestimate relative to in situ observations. Evaluation of spectra of Lwn, absorption and backscattering coefficients indicates that differences in Southern Ocean chl-a algorithms compared to low latitude data (e.g. the NASA global data set used for OC4) are attributed to changes in both absorption and backscattering relative to chl-a. SeaWiFS underestimates of chl-a for large regions in the Southern Ocean result in lower estimates of satellite-derived primary production.

OS12L-04 1430h

Air-Sea CO2 Fluxes Inferred From in Situ and Remotely Sensed Parameters in the Southern Ocean

Jacqueline Boutin[1] (33144274971; boutin @ lodyc.jussieu.fr); Yvan Rangama[1] (33144274971; rangama@lodyc.jussieu.fr); Jacqueline Etcheto[1] (33144277071; etcheto@lodyc.jussieu.fr); Liliane Merlivat[1] (33144277072; merlivat@lodyc.jussieu.fr); Taro Takahashi[2] (taka@ldeo.columbia.edu); Bruno Delille[3] (Bruno.Delille@ulg.ac.be); Michel Frankignoulle[3] (Michel.frankignoulle@ulg.ac.be)

[1]LODYC / CNRS University Paris 6, 4 Place Jussieu, Paris 75252, France

[2]Lamont Doherty Earth Observatory, Columbia University, Palisades, NY, United States

[3]University of Liege, Institut de Physique 4000 Sart Tilman, Liege, Belgium

Estimates of the air-sea CO2 fluxes in the Southern Ocean made using either atmospheric inversions, ocean biogeochemical models or in situ measurements are still in large disagreement and a large possible sink in the Southern Ocean is still debated. In this paper we study the air-sea CO2 flux south of the North Subtropical Front (NSTF). We combine in situ and satellite measurements to derive estimates of the air-sea CO2 fluxes and of their space and time variability. In a given region, the flux is governed by the CO2 exchange coefficient (K) and the CO2 partial pressure gradient at tha air-sea interface, *P ; it is also strongly dependent on the area of the region. ERS and Quikscat wind speed satellite measurements are used to monitor the magnitude and the space and time variability of K in the Subantarctic and Polar Zones all around the globe, according to the Wanninkhof (1992) K-U relationship. Over all longitudes, due to high wind speeds encountered in this region, a relatively small *P would lead to a significant flux value: a constant *P equal to -10 atm all around the globe between 45°S and 55°S would lead to an absorbing flux of 0.35GtC yr-1. It is thus of prime importance to refine *P determination in that region because: (1) it may be a large sink for anthropogenic CO2 even with relatively small *P, and (2) a small error on *P leads to large error in air-sea flux. The space and time distributions of *P are estimated from existing in situ measurements CO2 partial pressure in the ocean, pCO2, conducted during JGOFS campaigns south of Tasmania and New Zealand. Interpolations of pCO2 are developed based on remotely sensed measurements : SEAWIFS chlorophyll (Chl) and AVHRR satellite sea surface temperature (SST). After removing a climatological seasonal cycle to the observed SST we evidence a change in the pattern of the spatial variability of pCO2 near the isotemperature of 6.5°: south of this isotemperature pCO2 is rather constant whereas north of it, observed pCO2 variations are well correlated to SEAWIFS chlorophyll. Therefore we split the zone south of the NSTF in 2 zones deliminated by an isotemperature of 6.5°C and develop statistical relationships between observed pCO2, SEAWIFS Chl and AVHRR SST. The precision of such derived fits is better than 10 atm. CO2 partial pressure in the atmosphere are derived from CO2 concentrations distributed by Global View corrected for saturated water pressure and for in situ atmospheric pressure derived from ECMWF. Over the zone 135E-165W ; 45S-60S we estimate a flux of 0.08GtC yr-1 , close to Takahashi (2001) estimate. Keeping in mind that this region represents about 1/7 of the area of the Antarctic Ocean, this study supports the hypothesis of a large sink in the Antarctic Ocean.

OS12L-05 1505h INVITED

Carbon Export South of Australia.

Tom Trull (61-3-6226-2988; tom.trull@utas.edu.au)

Antarctic CRC, University of Tasmania, GPO Box-252-80, Hobart, Tas 7001, Australia

Advances in understanding Southern Ocean carbon cycling has come from increasing geographic resolution, first from division into circumpolar zones, and increasingly from consideration of differences among different sectors. This talk will provide an overview of results obtained from the Tasmania- Antarctica WOCE/Clivar SR3 repeat hydrographic section and from process studies in the Subantarctic (SAZ) and Polar Frontal Zones (PFZ) undertaken by the SAZ Project. Interesting results include:1) high levels of organic carbon export to deep ocean sediment traps in both the SAZ and PFZ, despite their HNLC characteristics, similar to the global median in both zones, and to results from AESOPS and other programs, but with differences in the seasonality of export, in particular the existence of a low flux period between spring and summer high flux periods. This "temperate" seasonality may be related to the relatively northward position of the PFZ and SAZ in the Australian sector; 2) larger seasonal nutrient depletions in the SAZ than the PFZ, and evidence that this difference results in part from greater horizontal supply of nutrients to the PFZ. The biological carbon "pump" associated with the seasonal nutrient depletion is the dominant cause of low pCO_2 in the SAZ; 3) lower than Redfield N/P seasonal depletion ratios in the PFZ which appear to derive from diatom uptake stoichiometery. In contrast, the SAZ exhibits Redfield values; 4) similar levels of carbon export to deep sediment traps in the PFZ and SAZ, despite very different algal communities, in particular the dominance of carbonate in the SAZ and silica in the PFZ. This is an unexpected result given recent assessments of the ecosystem control of carbon export, which suggest that diatom-dominated ecosystems such as occur in the PFZ are more likely to export large amounts of organic carbon from surface waters than are ecosystems dominated by smaller non-diatom phytoplankton such as occur in the SAZ. Reconciliation of these results may lie in understanding the efficiency of carbon remineralization in mesopelagic waters. Specifically, it is possible that the silicate-rich particles departing PFZ waters more readily lose their organic carbon at mesopelagic depths than do the carbonate-rich particles exported from the SAZ; 5) a relatively broad and quiescent Antarctic Zone (AZ) between the PFZ and the southern ACC front which is divided into northern and southern portions by a southern branch of the Polar Front. Mixed layer depths are greater in the northern portion, but seasonal phytoplankton biomass accumulation is similar in both portions. This suggests that light limitation is not a major control on algal production. Interestingly the northern "inter-polar-frontal" portion of the AZ exhibits a persistent, relatively deep (>100m) sub-surface chlorophyll maximum, of unclear origin. Comparison of Australian and other sector results is just beginnning, but it is already clear that the differences observed can contribute to a refined synthesis of Southern Ocean carbon cycling.

OS12L-06 1525h INVITED

Organic Carbon Cycling In The Southern Ocean. Case Studies And General Observations

Richard Sempere[1] (33-(0) 4 91 82 90 50; sempere@com.univ-mrs.fr); Christos Panagiotopoulos[1] (33-(0) 4 91 82 90 50; panagiot@com.univ-mrs.fr); Ingrid Obernosterer[2]; Celine Dubreuil[3] (dubreuil@com.univ-mrs.fr); Dominique Lefrevre[3] (lefrevre@com.univ-mrs.fr); Michel Denis[3] (denis@com.univ-mrs.fr); Madeleine Goutx[1] (goutx@com.univ-mrs.fr); France Van Wambeke[1] (wambeke@com.univ-mrs.fr); Sylvie Becquevort[4] (sbecq@ulb.ac.br); Christiane Lancelot[4] (lancelot@ulb.ac.br); Micheline Bianchi[4] (m-bianchi@com.univ-mrs.fr)

[1]LMM, CNRS UMR 6117, Case 907, Campus de Luminy, Marseille 13288, France

[2]Dept. of Biological Oceanography, NIOZ, Den Burg, Texel 1790 AB, Netherlands

[3]LOBE, CNRS UMR 6535, Case 901, Campus de Luminy, Marseille 13288, France

[4]Ecologie des systemes benthiqu, University of Brussels, Brussels B-1050, Belgium

Carbon flux into bacteria can vary from 0 to >100% of the local primary production and produces in turn CO2 through respiration. It is therefore currently admitted that bacteria play a major role on global carbon cycle, although the links between the fate of organic carbon, heterotrophic respiration and marine pCO2 variations are not well established. In addition, numerous uncertainties remain regarding the respective roles of environmental factors such as temperature, UV-B radiations, hydrostatic pressure, predatory pressure by protozoa, viruses, chemical composition of the organic matter available and nutrient stochiometry possibly affecting, the growth efficiency and intensity of bacterial production. For instance, our studies in the Indian sector of the southern Ocean during Antares project indicated that pelagic bacteria are using more rapidly and more efficiently organic carbon leaving the euphotic zone (via sinking particles) in the sub-tropical zone (SZ) than in the polar front zone (PFZ). In such a way, bacteria contribute to an higher accumulation of benthic organic carbon in PFZ than in SZ. This might be partly connected to the drastic variations of the relative abundance of the three main classes of particulate organic matter including amino-acid like compounds, lipids and sugars that we observed between the SZ and the PFZ. In the same area, we also observed significant changes in the rates of bacterial utilization of dissolved organic carbon (DOC) across the Antarctic circumpolar current (ACC). Our results also suggest significant role of the seawater temperature and the UV-B intensity on DOC cycling. A good knowledge of bacterial metabolism may contribute to estimate the quantity of CO2 produced through bacterial respiration from the semi-labile TOC carried within the ACC. In this report, and according to the literature and to our studies undertaken in the Indian Sector of Southern Ocean, we first discuss about the possible small scale links between environmental factors and organic matter cycling through bacterioplankton. We then address the problem of organic matter cycling by bacteria in the Southern Ocean.

OS12L-07 1545h

Using Ocean Oxygen Measurements to Constrain Carbon Fluxes in the Southern Ocean

Melissa B Hendricks[1] (609-258-2756; mhendric@princeton.edu)

Bruce A Barnett[1] (bbarnett@princeton.edu)

Michael L Bender[1] (bender@princeton.edu)

Paul G Falkowski[2] (falko@imcs.rutgers.edu)

[1]Department of Geosciences, Princeton University, Guyot Hall, Princeton, NJ 08544, United States

[2]Department of Marine and Coastal Science, Rutgers University, 71 Dudley Road, New Brunswick, NJ 08901, United States

We have experimentally characterized net O_2 production, gross O_2 production, and net/gross ratios, in the Southern Ocean in 3 summer/fall transects to the ice edge and a crossing of the Drake Passage, from measurements of the concentration of O_2, the concentration of Ar, and the triple isotope composition of O_2 ($^{18}O/^{17}O/^{16}O$). $\Delta^{17}O$ ($\delta^{17}O$ - 0.52 * $\delta^{18}O$) of O_2 is a bioactive tracer that gives a precise measure of the fraction of dissolved O_2 deriving from gross photosynthesis ($\Delta^{17}O = 0.249\ ^{o}/_{oo}$) rather than the dissolution of atmospheric O_2 ($\Delta^{17}O = 0.015^{o}/_{oo}$). $\Delta^{17}O$ values from these cruises range from $0.015^{o}/_{oo}$ to $0.080^{o}/_{oo}$. Ar gives a measure of the contribution of physical processes to O_2 supersaturation, and windspeed allows one to estimate gas exchange rates across the air-sea interface. Thus, from oxygen and argon measurements and estimates of windspeed, we calculate ratios of net to gross production, net O_2 production and gross O_2 production.

The agreement between gross production and scaled primary production from satellite estimates is good for the Dec. 1999 transect from Christchurch to the ice edge, where satellite and O isotope estimates of production are both $\sim$ 110 mmol m^{-2} day^{-1}. Both satellite estimates and O isotope estimates of production in the Drake Passage were much lower (<60 mmol m^{-2} day^{-1}) later in the season, during March 2000.

O_2/Ar ratios north of the Polar Front during Dec. 1999 ranged from 2% undersaturated to 3% supersaturated. We tentatively attribute the biological undersaturation to net heterotrophy at the end of the bloom. Waters south of the Polar Front during Dec. 1999 had biological supersaturations up to 3% and net/gross O_2 production ratios of $\sim$0 to 0.4, averaging about 0.2. These scale to values of net C production/^{14}C production averaging about 0.4. During Dec. 2000, waters north and south of the Polar Front had net/gross O_2 production ratios of 0.05 to 0.4, averaging about 0.15. Waters farther south of the Polar Front during Jan. 2001 had lower biological supersaturations (<1%) and net/gross O_2 production ratios less than 0.1. These waters appear to be weakly net autotrophic in the waning stage of the bloom. The small $\Delta^{17}O$ values of O_2 in all sampled regions produce uncertainties in the net/gross O_2 production ratios of approximately 0.05.

OS12L-08 1600h

Non-Redfield N/P Nutrient Utilization Ratios in the Polar Frontal Zone of the Southern Ocean, a Model and Data Synthesis Study

Xiujun Wang[1,2] ((831) 632 4481; wwang@mlml.calstate.edu)

Richard J Matear[1,3] (61 3 6232 5243; richard.matear@marine.csiro.au)

Thomas W Trull[1] (61 3 6226 2988; Tom.Trull@utas.edu.au)

[1]Antarctic CRC University of Tasmania, GPO Box 252-80, Hobart, TAS 7001, Australia

[2]Institute of Antarctic and Southern Ocean Studies, University of Tasmania, GPO Box 252-77, Hobart, TAS 7001, Australia

[3]CSIRO Division of Marine Research, GPO Box 1538, Hobart, TAS 7001, Australia

Summer observations in the Polar Frontal Zone (PFZ) of the Southern Ocean suggest that the biological N/P depletion ratio in the mixed layer is less than the classical Redfield value of 16. To investigate this issue we simulated the seasonal nitrate, phosphate and silicate cycle in the upper ocean with a biophysical model. Total phytoplankton biomass was prescribed from SeaWiFS estimates and we included two phytoplankton types, diatoms and non-diatoms. We set the non diatoms N/P utilization ratio to 16 while the diatoms N/P and N/Si utilization ratios were determined by fitting the observed seasonal nitrate, phosphate and silicate cycle in the mixed layer.

Our tuned reference model reproduced the observed seasonal phosphate and silicate cycles but was unable to satisfy the seasonal nitrate cycle. The best model fit to the observations required an N/P utilization ratio of 13.3 but still overestimated the nitrate utilization during the summer. We considered three mechanisms for improving the simulated nitrate cycle: 1) seasonal variations in the N/P ratio of the horizontal nutrient supply to the PFZ, 2) different remineralization length scales for particulate organic nitrogen (PON) and particulate organic phosphorus (POP) and 3) the seasonal accumulation and decomposition of labile dissolved organic matter(DOM).

The observed seasonal variability in the horizontal gradient of N/P in the PFZ is weak, 14.5 in the winter and 16 in the late summer. The reference model used a

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.

Michael J Lutz[1] (6560 906 3444; lutz@pangea.stanford.edu)

Robert B Dunbar[1] ((650) 725-6830; dunbar@stanford.edu)

[1]Stanford University, Department of Geological and Environmental Sciences Building 320, Stanford, Ca 94305-2115, United States

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.

Martin Lourey[1] (61-3-6226-7546; mlourey@utas.edu.au)

Tom Trull[1] (61-3-6226-2988; tom.trull@utas.edu.au)

Daniel Sigman[2] (sigman@princeton.edu)

[1]Antarctic CRC, University of Tasmania, GPO Box 252-80, Hobart, Tas 7001, Australia

[2]Dept of Geosciences, Guyot Hall, Princeton University, Princeton, NJ, United States

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

Birgit Schneider[1] (bschneider@awi-bremerhaven.de)

Reiner Schlitzer[1] (rschlitzer@awi-bremerhaven.de)

Gerhard Fischer[2] (gerhard.fischer@uni-bremen.de)

Eva Noethig[1] (enoethig@awi-bremerhaven.de)

[1]Alfred-Wegener-Institute, P.O. 120161, Bremerhaven 27515, Germany

[2]Fachbereich 5, University of Bremen, Klagenfurter Strasse, Bremen 28359, Germany

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

Tommy D Dickey (805 893-7354; tommy.dickey@opl.ucsb.edu)

University of California, Santa Barbara, Ocean Physics Laboratory University of California, Santa Barbara Univ. of Calif., Santa Barbara, Santa Barbara, CA 93117, United States

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

Charles C. Eriksen (206-543-6528; charlie@ocean.washington.edu)

School of Oceanography University of Washington, Box 355351, Seattle, WA 98195-5351, United States

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

Philip S Bogden[1] (Bogden@GoMOOS.org); Kate Beard (beard@spatial.maine.edu); Lew Incze (lincze@bigelow.org); Jim Irish (jirish@whoi.edu); Vijay Panchang (vijay.panchang@noaa.gov); Will Perrie (perrie@mar.dfo-mpo.gc.ca); Josie Quintrell (josie.quintrell@state.me.us); Collin Roesler (croesler@bigelow.org); David Townsend (davidt@maine.edu); Andy Thomas (thomas@maine.edu); Huijie Xue (hxue@maine.edu)

[1]GoMOOS, PO Box 4919, Portland, ME 04112-4919, United States

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