significant differences in tracer ages and that, in general, tracer ages are not fundamental timescales of the flow. Furthermore, even if ages from two tracers are similar these ages can be very different from the mean (ideal) age or the age of a third tracer. It is also shown that significant temporal variations in tracer ages can occur for steady transport (with only moderate mixing), and that these changes are of similar magnitude to the observed changes in CFC and tritium-helium ages in North Atlantic and North Pacific over the 1980s and 1990s. Accounting for the changes in tracer ages caused by steady transport is necessary before attributing changes in tracer ages to changes in transport. The possibility of using the differences in ages from different tracers to infer information about the age spectra (transport) or the infiltration of unmeasured tracer (e.g., pollutant) into the system is also examined.

OS41F-87 0830h POSTER

Increased Resolution in a Coarse Resolution Global Ocean GCM: Effects on Equilibrium, CFC, and Sequestration Solutions

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We examine the effects of changing horizontal and vertical resolution on the equilibrium and time-dependent solutions of a z-coordinate ocean general circulation model in non-eddy-resolving configurations. Our comparison emphasizes large-scale features relevant to global climate change and carbon sequestration. Since none of our simulations resolve ocean eddies, our results do not address the possible importance of resolving eddies in ocean-climate simulations.

Using a coarse resolution of 4 degrees in longitude by 2 degrees in latitude and a fine resolution of 1 degree in both longitude and latitude, we compare the near-equilibrium solution and solutions of direct injection of fossil-fuel CO_2 and uptake of CFC-11. The large-scale features of the model solutions are very similar at the two resolutions and in many cases are more sensitive to a large difference in horizontal viscosity than to the difference in resolution. There is no persuasive evidence of improvement of large scale results with finer resolution in these non-eddy-resolving simulations. However, when local details are of interest, there is still a need for higher resolution, as we show with calculations of pH change in the direct injection results.

Similar comparisons are made between simulations made with differing vertical resolutions, ranging from 24 to 80 vertical levels, with emphasis on decreasing the layer size of the deepest levels. These simulations all use the coarser 4 degree by 2 degree horizontal resolution. Again, the large scale results are very similar between the different resolution simulations. However, when looking at features that are poorly resolved, such as water masses with large changes in pH, the use of higher vertical resolution can have a significant impact.

OS41F-88 0830h POSTER

A New Mixed Layer Formulation for Isopycnic-Coordinate Ocean General Circulation Modeling

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Implementation of a mixed layer model in isopycnic coordinate general circulation models has been a difficult problem. Existing 1-d mixed layer models assume a continuous density variable, while isopycnic-coordinate models assume a discrete density variable. Attempts to reconcile these differences lead to compromising the integrity of the density variable used as the vertical coordinate of the general circulation model.

A new approach to mixed layer modeling is based on an algorithm for solving the diffusion equation in isopycnic coordinates. This scheme allows vertically adjacent layers to have widely disparate layer diffusivities while maintaining positive layer thicknesses. In particular, a near-surface vertical interval of high diffusivity can overlie deep ocean layers of low diffusivity. The high diffusivity in the upper ocean selects one of the isopycnal layers to occupy the entire vertical interval, creating a "mixed layer", and beneath this selected layer a set very thin layers constitute a sharp pycnocline. The specification of the high diffusivity value and its vertical extent control the dynamics of the mixed layer.

This new algorithm, together with a Kraus-Turner specification of mixed layer depth, was implemented in a three dimensional, isopycnic-coordinate ocean general circulation model. Idealized experiments with a linear meridional gradient of surface buoyancy flux and a cosine wind stress were used to study the role of the mixed layer model in the ocean response. The model ocean develops realistic features, such as a warm, shallow mixed layer in the subtropics and a deep, cold mixed layer in the subpolar region. Seasonal restratification is also represented realistically.

The important role of a realistic representation of the mixed layer is demonstrated by a comparative study of the production of annual Rossby waves in the general circulation model both with and without the mixed layer model.

OS41F-89 0830h POSTER

Atmospherically Forced Mesoscale Motions: Influence of Scales on the Relationship Between Wind Stress Curl and Barotropic Currents

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The surface wind stress is now well established as an important source of energy for mid-latitude barotropic mesoscale motions at periods of days to months. Depending on the time and space scales of the forcing and the degree of scattering by rough topography, the ocean's response will be evanescent in space or as freely-propagating Rossby waves with a wide range of relative vorticities. At large time scales the local balance between the wind stress curl and the ocean's response can be expected to approximate the Sverdrup balance. Simple theoretical considerations and previous modeling studies suggest that the Sverdrup balance will be generally observable only after substantial horizontal averaging of point observations of currents has removed the smaller scale waves carrying most of the relative vorticity. However, there have been occasional and unexpected observations of a Sverdrup balance at free wave periods as short as 10 days. Using observations of barotropic currents obtained during the Barotropic Electromagnetic and Pressure Experiment (BEMPEX), the presence of atmospherically forced mesoscale variability, including evanescent oscillations at periods shorter than a few days and free Rossby waves at longer periods to six months, is confirmed. By averaging the BEMPEX current observations over a succession of increasingly larger spatial domains, it is shown that at large scales the ocean approaches a topographic Sverdrup balance, per the modeling expectations, even though the Sverdrup balance is only sporadically indicated at similar periods at the individual mooring sites.

OS41F-90 0830h POSTER

Confirmation and Quantification of Strong, Deep Poleward Boundary Flow off Chile, a Major Branch of the Pacific Mid-depth Outflow

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From hydrographic data, deep poleward boundary flow off Chile was identified by Warren in the 1970's and found by Reid in the 1980's to carry a large part of a net southward flow leaving the Pacific Ocean at mid depths (about 1000 - 3000 m). Recent analyses of WOCE sections across the South Pacific in the 1990's paint a mixed picture of the boundary flow off Chile and its role in the Pacific Mid-depth Outflow. For the last ten years we have maintained a recording current meter mooring near 30°S at a deep ocean site (water depth 4300 m) about 150 km off the Chilean coast and about 70 km seaward of the Peru-Chile trench. During the last eight years of this period, current meters at 2450 m and 3750 m registered mean southward flow of 0.6 and 0.1 cm s^{-1}, respectively. Upon this mean flow was superimposed significant interannual variability with strongest southward flow (about 1.5 and 0.7 cm s^{-1}, respectively) during the 1997-1998 ENSO event and northward flow (about 0.5 and 0.5 cm s^{-1}, respectively) during 1994-1995. This result implies that, ideally, 5-10 year long current observations should be used in this region for referencing geostrophic estimates of mean circulation. We used our direct current observations, together with heat balance constraints on the inflow into the deep Chile and Peru basins, to reference geostrophic flow estimates from the WOCE P6 line hydrographic data (along 32°S) between the coast of Chile and the East Pacific Rise (112°W). We find a mean southward, mid-depth transport of about 10 Sv within 1500 km of the Chile coast and a northward, mid-depth transport of about 3 Sv east of the East Pacific Rise. This flow pattern agrees well with deep property distributions, for example, of dissolved oxygen, silicate and carbon 14. The implied net southward flow of about 7 Sv represents at least half of current transport estimates of the Pacific Mid-Depth Outflow. This flow structure is unexpected in terms of the simplest application of Stommel-Arons dynamics of deep ocean flow and is not found in state-of-the-art Ocean General Circulation Models. We suggest that large horizontal variations in diapycnal mixing and, perhaps, in geothermal heating in the region may need to be considered to capture this observed flow structure in ocean models.

OS41F-91 0830h POSTER

Testing an Empirical Flux Model For Convective Mixing in Lake Biwa

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Microstructure experiment was conducted to study nighttime cooling convection, on August 30-31 1999 in Lake Biwa, Japan. We made 131 vertical profiles at 10 minutes interval using a newly developed microstructure profiler TurboMAP (Turbulence Ocean Microstructure Acquisition Profiler). The instrument measures a horizontal velocity shear component, temperature, conductivity, turbidity, and pressure.

During the experiment, moderate west-southwest winds varied between 1 5 m/s. The net upward heat flux in nighttime from surface of the lake, J_b^0, is calculated from an empirical formulation, and the value was about 10^{-7} [W/kg]. After sunset, the diurnal mixed layer started to deepen, forming homogeneous warm water layer that was more than 27.2 [$^\circ C$] near the surface. Just before the dawn in early morning the diurnal mixed layer reached approximately 10 m depth. We observed relatively high dissipation rate ($\epsilon \sim 10^{-7}$ [W/kg]) in the deepening diurnal mixed layer. In the seasonal thermocline, dissipation rate up to 10^{-8} [W/kg] was also observed.

The dissipation rate to surface heat flux ratio:ϵ / J_b^0 was about 0.4 on average. This value is smaller than previous measurements being 0.6. We examined an empirical relationship obtained by Kantha (1980) for flux ratio, R, and bulk Richardson number, Ri. Our field data are consistent with the empirically established relationship from a laboratory experiment.

OS41G HC: 318 A Thursday 0830h

Biogeochemical Evolution of the Phanerozoic Ocean II

Presiding: **E Gaidos,** University of Hawaii at Manoa**; F Mackenzie,** University of Hawaii at Manoa

OS41G-01 0830h

Uranium-Series and Radiocarbon Geochronology of Deep-Sea Corals: Implications for Southern Ocean Ventilation Rates and the Oceanic Carbon Cycle

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We present new uranium-series and radiocarbon measurements for deep-sea corals from the Southern Ocean. These data are used to reconstruct ventilation ages, both at present and at the end of the last glacial period approximately 16,500 years ago. We apply an improved two-component mixing approach to correct uranium-series dates for contaminant thorium and protactinium present in oxide coatings. Calculated seawater radiocarbon values for contemporary samples decrease with depth in the water column and agree with direct seawater radiocarbon measurements for this area. This indicates that deep-sea corals can accurately record seawater radiocarbon distributions. Two of three glacial samples experienced open system uranium-series systematics, however, a third sample from the Drake Passage yields concordant thorium and protactinium dates as well as seawater values for initial $^{234}U/^{238}U$. This coral yields a ventilation age that is approximately 20-40% greater than modern values for its location. This increase is consistent with published deep-sea coral and calibrated planktonic-benthic foraminifera radiocarbon data, suggesting that the glacial oceans as a whole may have been substantially less ventilated, presumably due to decreased formation of North Atlantic Deep Water. An overall decrease in oceanic mixing rates could have contributed to lower dissolved carbon in surface ocean water and lower atmospheric pCO_2 during the past glacial period.

OS41G-02 0845h

Reconstruction of the Silica Cycle Over the Phanerozoic from the Silicon Isotopic Composition of Sponges

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Sponges, by virtue of the considerable span of their presence in the fossil record, offer a tremendous opportunity for the study of the silica cycle and its impact on silica biomineralization and the evolution of diatoms, radiolarians, and sponges over the Phanerozoic. Large qualitative changes in the silica cycle have previously been inferred from the occurrence of cherts and biogenic silica sediments in the geologic record. More precise reconstruction of variations in the silica cycle might be made from the silicon isotopic composition of fossil sponge material.

Variations in the stable isotopic ratios of silicon in opal are a powerful tool for studying silica cycling, but have been largely restricted in use to diatomaceous materials. Diatoms have only been around for 100-200 million years and grow only in surface waters, providing a record restricted in space and time relative to the record available from sponges, which grow on the seafloor at all depths and have been around since the late Proterozoic.

Presented here are the first data on silicon isotope fractionation by sponges, including estimates for both hexactinellid and demosponges. Fractionation factors range from 0.995 to 0.998, and averaging around 0.996, suggesting that the $\delta^{30}Si$ of sponge silica is offset from dissolved silicon in seawater by -2.1 $^{o}/_{oo}$to -5 $^{o}/_{oo}$. These are the largest fractionation factors measured to date for silicon isotopes in materials produced on Earth. The range of variation in fractionation factors suggests that care must be taken during the reconstruction of the silicon isotopic composition of deep water from fossil sponges. The first silicon isotope-based reconstruction of the long term silica cycle will be presented here.

OS41G-03 0900h

Changes of Sea Level and Poleward Ocean Heat Transport as Potential Causes for the Late Ordovician Glaciation

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Two stages of the Late Ordovician climate were simulated using an atmospheric general circulation model (AGCM; GENESIS v2.0). The goal of numerical experiments was to determine the role of paleogeographic changes in global cooling and its potential impact within a range of pCO_2 on the End Ordovician glaciation. Different shoreline positions based on high and low sea levels were evaluated to assess possible cooling effect of a lower sea level. Furthermore, some of the runs were performed with a lower poleward ocean heat transport to evaluate its impact on global cooling. A 3–dimensional ice sheet model was then added to the atmosphere model to investigate the role of the cryosphere. The results indicate that the paleogeographic changes coupled with an ice–induced albedo feedback might have been only preconditioning events rather than direct cause of glaciation. For all pCO_2 levels above 12x pre–industrial atmospheric level (PAL), the Caradocian (∼454 Ma) experiments yielded higher annual mean temperatures than Ashgillian (∼446 Ma) experiments. Below pCO_2 levels of 12x PAL extensive permanent sea ice and snow cover exists in both the Northern and Southern Hemispheres. Nevertheless, Caradocian and Ashgillian simulations with high sea level yielded no ice sheets; the ice sheets formed only in the Ashgillian simulations with pCO_2 level of 8x PAL, low sea level, as well as in the simulation with high sea level and with a reduced poleward heat transport. The pCO2 threshold for the onset of glaciation for Ashgillian paleogeography is 8x PAL with a low sea level (exposed shelfs) and/or reduced poleward ocean heat transport. The increase in upwelling indicated in simulations, could have caused the reduction of pCO_2 due to increased organic matter burial causing further cooling of the global climate. However, in this model the paleogeography and pCO_2 change alone are not sufficient to cause glaciation if the sea level stayed high (even with pCO_2 as low as 8x PAL). Therefore, sea level changes and/or poleward ocean heat transport are the factors that might have been crucial for strong observed global cooling during the Late Ordovician. New results using coupled GENESIS and MOM 2 ocean-atmospheric model may shed additional light on this problem.

OS41G-04 0915h

Carbon Cycle Changes and Glaciation in the Late Ordovician.

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The Late Ordovician glaciation and mass extinction was a major climatic change marked by positive shifts in $\delta^{13}C$ and $\delta^{18}O$. We examine the implied change in carbon cycling using simplified box models and an Ocean General Circulation Model (OGCM).

The oceanic carbon cycle is examined for overturning circulations related to the non-glacial and glacial periods through signatures of $\delta^{13}C$ and atmospheric pCO_2 drawdown. We hypothesise that the ocean interior is partly ventilated by the formation of dense water, cooled over shallow, high latitude shelves. We demonstrate that the strength of meridional overturning is then altered by the extent of the shallow shelves: The overturning is typically reduced from 15Sv to 10Sv when sealevel is lowered by 200m. Limiting cases are investigated for a circulation (i) with dense water formation on shallow shelves and (ii) with no shallow shelves. The implications for nutrient supply and primary productivity are explored.

For non-glacial conditions, we find the ocean circulation has a deep thermal mode with anoxia confined to isolated regions and a shallower circulation for the glacial period (Hirnantian), related to reduced shallow shelf area. Shifts in $\delta^{13}C$ and atmospheric pCO_2 consistent with the geologic record are obtained without the need for enhanced biological productivity or changes in nutrient concentrations. These results contrast with the widely held assumption of a shallow non-glacial circulation with deep, global anoxia.

OS41G-05 0930h

Comparative Evolution of Plastid Genomes in Eukaryotic Algae

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In contrast to terrestrial ecosystems, we know very little about the evolution of marine phytoplankton and how the evolutionary history is related to the structure of contemporary marine planktonic food webs. To understand some of the genomic differences in the eukaryotic photoautotrophs and their respective ecological successes we analysed plastid genomes from the major eukaryotic algal taxa. Chloroplasts of all eukaryotic algae and higher plants appear to have been derived from a single common ancestor through one or more endosymbiotic events. Assuming that the original plastid was similar to extant cyanobacteria, our analysis suggests that over 90% of the symbionts genes were lost in the first endosymbiotic association, but a core set of genes has been retained in all plastids. This core set encodes for the ATPase, photosystems and photosynthetic electron transport components, and 70 S ribosomes. There are fundamental differences however in the plastid genome composition between two major algal lineages, the green one (Chlorophytes) and the red one (Chromophytes): red plastids retain a complementary set of genes that potentially confer greater physiological independence from the host. We hypothesize that specific gene losses in the primary endosymbiotic green plastid, especially the transfer of the small subunit of ribulose 1,5-bis-phosphate carboxylase/oxygenase (RuBisCO) to the host nucleus, reduced the fitness of green plastids as a portable genetic entity for subsequent symbiotic associations. Secondary endosymbiotic plastids descending from the primary red alga lineage were appropriated by numerous, unrelated phagotrophic host cells, leading to the radiation and rise to ecological prominence of the chromophytic classes of phytoplankton in the Mesozoic and Cenozoic periods. Associated with the diversification in the red algal lineages was a shift in oceanic dominance from green algae to the red plastid lineage which continue to dominate the oceans today.

URL: http://marine.rutgers.edu/ebme/index.html

THU

OS41G-06 0945h

Reconstructing the Early Paleozoic Ocean-Atmosphere, One Isotope at a Time

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Reconstruction of the physical and chemical conditions of pre-Cretaceous oceans has proven to be challenging due to the incompleteness of the stratigraphic record, limited temporal control, and diagenetic overprinting. Advances in our understanding of specific isotope systems and analytical technology (e.g., dating of sedimentary minerals, microsampling, sample pretreatments, coupled laser ablation and MC-IPC-MS) have led to the development of high-resolution records of the stable and radiogenic isotope composition of pre-Cretaceous oceans. In this presentation, we will focus on newly developed, coupled Sr and C isotope curves for the Cambrian, a period characterized by major and possibly anomalously rapid continental reorganization, significant changes in climatic and oceanic conditions, and the explosion of metazoan life.

Seawater $^{87}Sr/^{86}Sr$ values exhibit a long-term nonlinear rise throughout the Early to Middle Cambrian and reach the highest seawater $^{87}Sr/^{86}Sr$ values (0.7093) over the past 2 b.y. in the earliest Late Cambrian. Significantly, the magnitude and rate of increase in seawater $^{87}Sr/^{86}Sr$ values during the Cambrian (0.00004 to 0.00005/m.y.) overlap to exceed the Tertiary rise in seawater $^{87}Sr/^{86}Sr$ values over the last 40 m.y.. The nonlinearity of the Cambrian rise likely records changes in tectonic style throughout the Pan-African Orogeny. The potentially unprecedented rapid rates of increase in seawater $^{87}Sr/^{86}Sr$ values may indicate that this orogenic event was of greater

magnitude than subsequent major Phanerozoic orogenies. The coupled carbonate carbon isotope record defines a dynamic evolution of seawater $\delta^{13}C$ throughout the late Early to Late Cambrian, including a large-magnitude negative excursion ($4^o/_{oo}$) at the Early-Middle Cambrian boundary interval. Superimposed high-frequency, large-magnitude (2 to $4^o/_{oo}$) fluctuations in $\delta^{13}C_{org}$ and $\Delta^{13}C$ values record major perturbation in global carbon cycling during this period. Temporal trends in the magnitude and frequency of these C isotope fluctuations, coupled with trends in faunal diversity and distribution, indicate that rapid (10s to 100s ky) and repeated fluctuation in marine primary productivity, seawater CO_2 concentration, and biogeochemical cycling was intimately associated with Early-Middle Cambrian trilobite extinction and radiation.

OS41G-07 1020h INVITED

Chemoautotrophy at oxic-anoxic interfaces: The implications of ocean anoxia in the Phanerozoic

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An enormous amount of interest and studies have focused on the evolution of the biogeochemical sulfur cycle over geologic time. By and large, the emphasis has been on the reductive portion of the oceanic sulfur cycle. This includes studies aimed at determining past sulfate levels, the effect of biota on total sulfate, and the consequences of widespread bottom ocean anoxia. We rely heavily on isotopic analyses (S, C, O) in order to interpret conditions and past Earth events, often based on analogies made with modern marine processes (eg., S-fractionation associated with biological sulfate reduction). However, it is important to recognize that there is another side to the oceanic biogeochemical sulfur cycle that involves biological processes and has ramifications among multiple isotopic systems: sulfide oxidation. I will discuss sulfide oxidation, the potential effects of sulfide oxidation on various isotopic systems, and the implications these processes may have during past ocean anoxia.

OS41G-08 1035h

Relations Between Long Term Sea-level change, Shelf-Ocean Exchange and Shelf Burial of Organic Material

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Although the present shelf environment represent only 10% of the oceans' area, close to 50% of organic material buried in the marine environment is buried in the shelf and slope sediments. Despite the fact that shelves dominate burial, as much as 80% of the nutrients delivered to the shelf environment to support primary production are supplied from the open ocean. These observations imply that changes in the long term eustatic sea-level and the physical shelf-ocean exchange are of primary importance in modulating the shelf burial and thereby the global carbon and nutrient cycling.

With a simple biogeochemical ocean model and different shelf-ocean exchange parameterizations we explore the relations between long term sea-level changes since the Mesozoic and the global carbon and nutrients cycles. Water column respiration of export production from the surface layer is prescribed as a power function, and burial is taken as proportional to the material reaching the sea-floor. In the simplest shelf parameterization we assume export production is uniform over the ocean and use a global mean hypsographic curve for calculating the carbon and phosphate burial at different depths. The present hypsographic curve is modified above sea-level to be in better accordance with the observed non marine area during the Cretaceous.

With sea-level 200m above present we calculate a ∼20% increase in the shelf-slope burial. Because nutrient input have been kept constant, the mean ocean phosphate concentration decrease by ∼30% and deep ocean burial decrease by ∼40%. The model predicted inverse relation between sea-level and deep ocean phosphate burial is contrary to what is observed. This suggest that changes in shelf-ocean exchange, weathering or other causes probably overwhelmed the influence of sea-level on organic matter burial. Results from a more elaborate shelf-ocean exchange sub-model will be presented and discussed in the context of observations.

OS41G-09 1050h

The Evolution and Radiation of Eucaryotic Phytoplankton Taxa (EREUPT)

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The EREUPT research team, representing a group of 21 scientists from numerous institutions, is focused on understanding the historical origins and environmental conditions that led to selection and radiation of the major eucaryotic phytoplankton taxa, and the ecological processes that contribute to their continued success in the contemporary ocean. The proposed research utilizes a combination of geological, molecular biological, ecological, and models. Our primary goal is to develop the first quantitative models of eucaryotic phytoplankton community structure in the contemporary oceans based on paleoecological and evolutionary inference. The proposed research seeks to test a set of three related hypotheses, from which we will develop a conceptual model for evolution and ecological success (dominance) of key phytoplankton taxa in the contemporary ocean. The central hypotheses are: 1) The three dominant phytoplankton taxa in the contemporary ocean evolved in shallow shelf-seas in the Mesozoic Era in response to changes in the ocean environment, such as anoxia, changes in sea level, or tectonic processes that excluded ecological advantages previously afforded to chlorophytes. 2) Once established, these groups radiated rapidly. The rapid tempo of evolution was a consequence of high mutation frequencies relative to reversion and sexual recombination, resulting in high genetic potential and DNA content relative to genetic expression in the three taxa. The rapid tempo of evolution in the three taxa has permitted rapid radiation and adaptation to changing oceanic conditions throughout the Mesozoic. This rapid tempo continues to the present time. 3) The ecological dominance of the three major eucaryotic phytoplankton taxa is a consequence of pan-division traits that permit individual species within each group to rapidly accommodate large variations in oceanic conditions. These traits include the evolution of cell walls and vacuoles that respectively provide protection from predation while simultaneously optimizing the exploitation of pulsed nutrient supplies. A corollary of this hypothesis is that the structure of marine food webs in the contemporary ocean is primarily a consequence of the tempo of evolution of the three major taxa of eucaryotic phytoplankton, which itself is a consequence of continuous changes in oceanic regimes.

URL: http://marine.rutgers.edu/ebme/html_docs/project_Biocomplex.html

OS41G-10 1105h

Dynamical Analysis of a Network Model of Phosphorus for the Phanerozoic Earth

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We present a dynamical model of the global biogeochemical cycling of phosphorus. The primary parameters of the model are seafloor spreading rate, eustacy, efficiency of thermohaline circulation, and the ratio of primary biological productivity between the oceans and land. The first three can be measured or estimated from the geologic record of Phanerozoic time. The last depends on biological innovation and climate limitations. The water column is modeled as euphotic zone and deep water omponents that exchange at a rate given by the THC parameter. High-temperature hydrothermal systems also strip P from the deep ocean at a rate proportional to the rate of seafloor spreading. Phosphorus is removed from the euphotic zone by sinking in organic particles at a rate that is proportional to primary productivity. Remineralization of the organic particulate matter and release of P in the deep ocean is a sensitive function of the oxygen content of the water column. We assume that the amount of particulate organic matter buried in ocean sediments is stochiometrically related to the amount of net respiration of organics and oxidative weathering of minerals on land. Remaining organic matter reaches benthic sediments, where it can be slowly released into pore water upon diagenesis. The sediments are subducted at the rate of sea-floor spreading. Phosphorus is also sequestered on continental shelves: Marine regressions result in weathering and release of this P. Surface waters receive P both from riverine input and from aerial transport of soil-derived dust particles. These fluxes depend on the rate of weathering. A major difference between this model and previous efforts is that an explicit temperature-dependence to weathering is not included: Although laboratory experiments support an Ahrrenius-like temperature dependence of mineral weathering rates, this has not been supported by basin-scale measurements and terrestrial biological activity has probably been a more important factor on the Phanerozoic Earth. We explore the dynamics of this model and examine the system's response to slow changes in parameters as well as sudden perturbations (e.g., impacts or eruption of large igneous provinces). We also determine the long-term trend of total biologically available phosphorus, a potential determinant of global biodiversity.

OS41G-11 1120h

Simulation of Coastal Upwelling Circulation and Nitrogen Isotopic Fractionation With a Coupled Physical Biogeochemical Model

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A coupled physical-biogeochemical model is used to simulate the evolution of the sedimentary nitrogen isotopic signal during the last glacial-interglacial transition in coastal upwelling systems. The biological model is a simple nitrogen-based trophic chain model, which also computes the nitrogen isotopes fractionation. Photosynthesis and zooplankton excretion fractionations influence the detrital nitrogen isotopic signal, which is compared to the sedimentary data. The 2D physical primitive equation model simulates the coastal upwelling circulation.

This coupled model is applied for different sea level situations to reproduce the sedimentary $\delta^{15}N$ and organic nitrogen flux signals, and we reconstruct some palaeoceanographic scenarios. Offshore Cap Blanc, Mauritania, the effect of the sea-level rise, inducing the shelf immersion, is the main factor to explain the organic nitrogen flux and isotopic signal variations along the last deglaciation. Between 15 and 5.5 kyrs, 60 % of the sedimentary isotopic signal could be explained by this local shelf immersion effect. Any sedimentary diagenetic process or any nitrogen loss/gain budget occurring in other ocean areas and affecting the nutrient isotopic signature would account only for 40 % on these local sedimentary isotopic signal variations. We thus conclude that the global oceanic fixed nitrogen budget during the last glacial-interglacial transition may have been more balanced and stable than previously assumed. This effect is modulated by an upwelling seasonality that may have been much longer at the Last Glacial Maximum, around 10 months instead of 5-6 months at present. This model has been also successfully applied to the upwelling system of Benguela (South West Africa) to study some recycling processes.

OS41H HC: 318 B Thursday 0830h

Molecular Ecology of Carbon and Nitrogen Cycles in Ocean Margins I

Presiding: **F Wilkerson,** San Francisco State University**; J Paul,** University of South Florida

OS41H-01 0830h

High Density Sampling in the Coastal Ocean.

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The oceanographic community is gaining a better understanding about the population dynamics of bacterioplankton communities on different spatial and temporal scales. The use of molecular techniques targeted