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Interactions Between Zooplankton and Karenia brevis in the Gulf of Mexico.

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ECOSYSTEM DYNAMICS IN MASSACHUSETTS BAY AND MONTEREY BAY: BIOGEOCHEMICAL AND BIOGEOCHEMICAL-PHYSICAL BALANCES

Biogeochemical and biogeochemical-physical balances are investigated for coastal ecosystems. Using dominant balances, i.e. approximate mathematical relationships among different terms/processes, is common in physics but less common in biology. Presently, such balances are investigated using data assimilation, i.e. combining data and models. The assimilation scheme is four-dimensional and multivariate, biological/physical data influence biological/physical fields. Massachusetts Bay during August-September 1998 and Monterey Bay in August 2003 are discussed as examples. Zeroth-order biogeochemical balances are introduced and utilized to initialize biogeochemical fields and uncertainties, and to calibrate model parameters. The predictive capability and predictability limits of the ecosystems are evaluated using uncertainty predictions. For Massachusetts Bay, evidence of Chl-a patchiness is provided, sub-mesoscale dynamics is found to be important, and effects of ecreasing light levels and of increasing storms and sub-mesoscale to mesoscale variability are highlighted. Different sub-regions of trophic enrichment and accumulation are synthesized. Preliminary results are presented for Monterey Bay, focusing on differences between the upwelling and relaxation states. Finally, suggestions for model improvements and adaptive sampling, i.e. predicting the most useful data, are provided.

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TROPHIC ECOLOGY OF ESTUARINE MEIOFAUNA: RELATIONSHIP BETWEEN BENTHIC FORAMINIFERA AND FOOD RESOURCES IN SOUTH SAN FRANCISCO BAY, CA, U.S.A

Water column parameters (chlorophyll concentration) and sediment parameters (chlorophyll, total organic carbon, nitrogen, amino acids, bacterial abundance) were measured, and benthic foraminiferal population size and biovolume was counted and calculated monthly from November 1999, through November 2001 from one site in South San Francisco Bay. Water column chlorophyll peaked in the spring of 2000 and 2001 and the fall of 2000, with sediment parameters peaking one to three months later. The benthic foraminiferal population peaked during the spring of both study years, and showed a large peak in the fall of 2001 dominated by the small sized foraminifer, Fursenkoina pontoni. The data strongly suggest that benthic foraminifera increase in numbers following phytoplankton blooms when many kinds of sediment organic matter also increase. Foraminiferal biovolume and standing crop generally increase when sediment C:N ratio increases, suggesting that benthic foraminiferal populations in South San Francisco Bay are exploiting a detrital food source. Thus, foraminifera are probably quick to exploit sediment organic matter, and may be important reminieralizers of nutrients in this system.

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REAL-TIME ERROR FORECASTING, DATA ASSIMILATION AND ADAPTIVE SAMPLING IN MONTEREY BAY DURING AOSN-II USING THE ERROR SUBSPACE STATISTICAL ESTIMATION SYSTEM

During the August 2003 AOSN-II experiment, the Error Subspace Statistical Estimation (ESSE) system was utilized in real-time to forecast physical fields and uncertainties, assimilate various data (ships, AUVs, gliders, aircraft, satellites) provide suggestions for adaptive sampling and guide dynamical investigations. ESSE aims to capture, forecast and reduce the largest uncertainties i.e error subspace. It is currently based on a singular value decomposition of the minimum error variance update and on an adaptive ensemble scheme to forecast the largest errors. Each ensemble member was a sample path of the HOPS primitive equation model forced stochastically to represent model errors. Using a total of 4323 ensemble members, 10 sets of ESSE error forecasts assimilation outputs, adaptive sampling recommendations and dynamical interpretations were issued and posted on the web. Scientific and operational results will be presented, including: dynamical findings in Monterey Bay and California Current region focusing on different stages of the upwelling and relaxation states; ensemble properties (convergence, mean, most probable forecast (co)-variances and singular vectors); forecast skills; and subjective/quantitative adaptive sampling based on field, error and data forecasts.

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INTERACTIONS BETWEEN ZOOPLANKTON AND KARENIA BREVIS IN THE GULF OF MEXICO

Blooms of the toxic dinoflagellate K. brevis are common in the Gulf of Mexico, yet no in situ studies of the interactions between zooplankton and K. brevis in the Gulf of Mexico have been conducted. Zooplankton numerical abundance, biomass and taxonomic composition of non-bloom and K. brevis bloom stations within the ECOHAB study area were compared. At non-bloom stations, the most important determinant species were Parvolcalanus crassirostris, Oithona colcarva and Paracalanus quasimodo at the 5-m isobath and P. quasimodo, O. colcarva and Oikopleura dioka at the 25-m isobath. There was considerable overlap between the 5 and 25-m isobaths, with 9 species contributing to the top 90% of numerical abundance at both isobaths. Within K. brevis blooms Acartia tonsa, Centropages velificatus, Temora turbinata, Evadne tergestina, O. colcarva, O. dioika, and P. crassirostris were consistently dominant. Variations between non-bloom and bloom assemblages were evident, including variations in numerical abundance and biomass and the reduction in numerical abundance of 3 key species. Calculated grazing pressure proved insufficient to terminate K. brevis blooms, despite occasional grazing hot spots.

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ASSESSING PHYTOPLANKTON BIOMASS AND PHYSIOLOGICAL VARIABILITY AT STATION ALOHA (22 45’N; 158 00’W) USING RADIANCE REFLECTANCE PROFILES

Nearly monthly deployments of a Profiling Reflectance Radiometer (PRR) have been made at Station ALOHA (22 45’N, 158 W) as part of the Hawaii Ocean Time-series program since February 1998. Profiles of chlorophyll a (chl a) concentration and yellow substance absorption at 440 nm have been derived from downwelling irradiance measurements at three wavebands. In addition, upwelling radiance at 683 nm measured by the PRR allows the quantification of chl a passive fluorescence. Based on these measurements we derive vertical profiles of fluorescence quantum yield for the phytoplankton assemblage and analyze their seasonal and interannual variability in the context of other HOT core measurements. Furthermore, we compare this variability with that derived from primary production estimated by 14C in situ uptake and Fast Repetition Rate fluorometry (FRRf). Preliminary results suggest that fluorescence quantum yield in the study area does not vary significantly over time, with the exception of periods when summer phytoplankton blooms are observed. We will discuss possible causes of the apparent uncoupling between the observed variability in the fluorescence quantum yield, 14C derived Primary Production, and FRRf derived photosynthetic parameters.

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SERIES: INFLUENCE OF IRON FERTILISATION ON DIMETHYLSULFIDE (DMS) AND DIMETHYLSULFONIOPROPIONATE (DMSP) DISTRIBUTION IN THE EASTERN SUBARCTIC PACIFIC

The response of dimethylsulfide (DMS) and dimethylsulfoniopropionate (DMSP) to the iron fertilisation of a 64 km2 area in the North-East Pacific conducted in July 2002 is presented. Previous iron enrichment have shown none to 3-fold increase in DMS concentrations. When observed, the increase in DMS coincided with the peaks in biomass and diatoms but was attributed to the grazing of the early iron-induced haptophyte bloom. This experiment generated a haptophyte bloom followed by a massive diatom bloom. The haptophyte bloom coincided with a marked increase in DMSPp concentrations, but DMS levels remained similar outside and inside the iron patch. An increase in microzooplankton grazing caused a rapid decline of the abundance of haptophytes. The crash of the haptophyte bloom (and DMSP) was accompanied by a drastic decrease in DMS which persisted during the following diatom bloom. This unexpected DMS deficit in the upper mixed layer DMS burden indicates a rapid microbial re-cycling of the DMSP with little conversion into DMS. The influence of iron fertilisation on oceanic DMS production is thus more variable than previously reported.

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VERTICAL DISTRIBUTION OF METHANOGEN COMMUNITIES IN ORGANIC-RICH SUBSURFACE SEDIMENTS OF THE PERU TRENCH

Sediment cores were collected from three deep boreholes (0-267 mbsf) during Ocean Drilling Program Leg 201 in February 2002. We examined the distribution of methanogens (methane-producing Archaea) and methanogen communities along geochemical profiles (incl. sulfate, methane, acetate, ethane) to determine shifts in community composition related to porewater chemistry. Specific focus was on hydrate-containing samples as well as the sulfate-methane transition zone. We phylogenetically analyzed communities by PCR-amplification of the methyl-coenzyme M reductase gene (mcrA), a key enzyme in methanogenesis and present in all known methanogens. Preliminary results indicate that methanogens were present throughout most of the sulfate reduction zone and that diverse communities of methanogens extended to depths of >200 mbsf.

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BIODIVERSITY AND FUNCTION IN MARINE SEDIMENTS: A MUDDLE OR A SOLVABLE MYSTERY?

Among scientists working in both shallow and deep-sea sediments, there has been a traditional separation of the 'bug counters' who generate diversity data and the ecosystem scientists who generate bulk measurements of processes and functions such as respiration, production and carbon burial. The few studies that have attempted to link diversity and function in marine sediments have yielded inconclusive results, and we are left to infer relationships largely from studies designed for other purposes. We will explore the forms of macrofaunal diversity that are most likely to influence sediment ecosystem function, highlight