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ESTUARINE TYPOLOGY: PERTURBATIONS AND EUTROPHICATION RESPONSES

NOAA and US estuarine science and management communities have recognized that the 1999 National Estuarine Eutrophication Assessment (NEEA), while useful, needs modification and updating. This would best be accomplished by a progression from (1) classification of estuaries into functional types that respond differently to perturbation, through (2) characterization of the nature and degree of perturbation, to (3) identification and prediction of responses. Each step requires objective assessments based on quantitative data, and depends on comparisons among many estuaries. We describe a physically based approach to classification of coastal waters. This includes development of classification tools (e.g. geospatial clustering such as DISCO) and supporting infrastructure (web-based access to tools, databases, and outcomes). This will enable community input to and participation in the development of a typology that will provide a rigorous yet flexible basis for the NEEA update and for management actions at the estuary level.

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DIFFERENTIAL MIXING IN SHEAR-DRIVEN OVERTURNS

We investigate mixing due to shear instability in a doubly diffusive fluid via linear stability analysis and direct numerical simulation. Breaking Kelvin-Helmholtz billows are studied in three stratification regimes: (1) diffusively stable, (2) unstable to salt fingers and (3) unstable to diffusive convection. The resulting flows combine turbulence, gravity waves and double diffusive phenomena. Analyses focus on property fluxes, turbulent diffusivities and mixing efficiencies. Variance and covariance budgets, including codissipation terms, are computed. Results are compared with the balances proposed by DeSzoeke (1998, J. Phys. Oc. 28, 2064) for stationary turbulence and with ocean observations.

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TEMPORAL AND SPATIAL PERSISTENCE OF ICHTHYOPLANKTON ASSEMBLAGES: THE ROLES OF ADVECTION, DIFFUSION AND BEHAVIOR

To determine whether ichthyoplankton occur as persistent communities over scales of days to weeks, we repeated detailed bongo grid surveys three times in Trinity Bay Newfoundland over a 10-day period during June of 2001. We hypothesized that circulation would largely dissipate spatial patterns that were observed during the first survey, and that changes would reflect a combination of advection and diffusion that could be modeled reasonably well with a coastal circulation model and without invoking active behavior. Preliminary analysis of ichthyoplankton data indicates that patterns were variable over time periods of days, and that particular assemblages were not maintained in consistent areas of the bay. This result suggests that ichthyoplankton occur as poorly defined assemblages rather than persistent communities in specific water masses, and that their spatial patterns are more influenced by physical transport and dispersal than by behaviour. Observed patterns in ichthyoplankton will be used to seed the circulation model and determine whether the model output is consistent with the observed changes in distribution and community assemblages.

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REMOTE SENSING REFLECTANCE AND THE OPTICAL PROPERTIES OF THE COASTAL AND ESTUARINE WATERS OF LEO-15 DURING JULY 2001

The near-shore waters of LEO-15, and adjacent estuarine environments of Great Bay and Barnegat Bay, New Jersey, were remotely surveyed at 1-2 meter spatial resolution with the PHILLS-1 optical-nir hyperspectral sensor between 23 July and 2 August, 2001. Within this period, a series of ground truth measurements were made by our group and we report here on 15 stations for which a complete set of in-water data is available for cross-check and comparison. Measurements include at surface Remote Sensing Reflectance (Rrs), HPLC pigment, total suspend sediment (organic and inorganic fraction), particle size, and depth profiles of water absorption (both filtered and unfiltered), attenuation and backscatter coefficients. These measurements are used to quantify the water properties of LEO-15 during this time period and to note how the estuarine environment compares to that off-shore. Near-simultaneous PHILLS-1 measurements are available for 5 of the stations. A comparison of PHILLS-1, above water surface measured and HYDROLIGHT modeled Rrs shows generally good agreement with comparable variations noted between any two sets of measurements.

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PHOSPHORUS ACQUISITION IN TRICHODESMIUM AND OTHER NITROGEN FIXERS IN THE SUBTROPICAL NORTH ATLANTIC AND PACIFIC

The oligotrophic open oceans are generally considered to be nitrogen limited. However, nitrogen fixing organisms such as the filamentous cyanobacterium Trichodesmium and cyanobacterial symbionts of diatoms, which can be important contributors to the nitrogen cycle in these areas, are inherently not nitrogen limited. Phosphorus acquisition therefore is an important process to these organisms, as P may be their limiting nutrient. Phosphate uptake rates by diazotrophs were measured using P-33 in April and May 2003 in the tropical Atlantic and August 2003 in the Pacific. Trichodesmium phosphate uptake was found to be independent of light, but did exhibit a diel pattern, increasing before the middle of the day and then decreasing. Vmax in Trichodesmium ranged from 0.8-12.2 pmol per colony per hr, while Ks ranged from 0.024-0.287 micromolar PO4. On four days in the Pacific when alkaline phosphatase activity in Trichodesmium was measured, the rate of PO4 cleavage from a fluorescent substrate was always higher than ambient PO4 uptake rates and sometimes higher than Vmax.

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STOCK IDENTIFICATION OF CHUM SALMON (ONCORHYNCHUS KETA) USING MICROCHEMISTRY OF OTOLITH

The chemical analysis of trace elements was conducted to reveal the depository relationship between otolith and ambient water and to develop the ways to distinguish fish stocks. The ambient water and otoliths of hatchery-reared chum salmon fry were collected from three major hatcheries (Yangyang, Samchuk and Uljin of Korea) each spring from 2001 to 2003. Trace elements in the otoliths and water were analyzed using inductively coupled plasma mass spectrometry (ICP-MS). Composition of trace elements of the ambient water did not significantly vary during the three years and some trace elements/Ca ratios such as Sr/Ca and Ba/Ca in the ambient water seemed to be well reflected in the otoliths of salmon fry. These two elements might be indicators in distinguishing hatcheries which have different chemical environments. Discriminant analysis with 8 element/Ca ratios (Na/Ca, Mg/Ca, Al/Ca, Cu/Ca, Sr/Ca, Ba/Ca, Mn/Ca, and Zn/Ca) represented a distinct separation in accordance with the natality of stocks.

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DYNAMICS OF BIOACTIVE TRACE METALS DURING THE SUBARCTIC PACIFIC IRON EXPERIMENT FOR ECOSYSTEM DYNAMICS STUDY (SEEDS2001)

During the first Fe-enrichment experiment in the northwest subarctic Pacific (SEEDS2001), the dynamics of dissolved and acid dissolvable trace metals were studied. Immediately after sampling, seawater for dissolved species was filtered and acidified to pH 2.2. Seawater for acid dissolvable species was acidified to pH 2.2 without filtration and stored for 20 months at an ambient temperature until the chelating column extraction and determination by ICP-MS. Before the Fe enrichment, the dissolved Fe in the surface mixed layer was <0.13 nM and the acid dissolvable Fe was 4.7 nM. The difference was a labile particulate fraction, which was not easily available to phytoplankton, since the photochemical quantum efficiency of photosystem II was low. After the Fe enrichment, acid dissolvable Fe in the patch decreased exponentially from 9.6 nM on day 2 to 4.6 nM on day 13, which was still ~3 nM higher than the outside concentration. Dissolved Fe decreased from 1.4 nM to <0.13 nM. Although the acid dissolvable concentrations for Mn, Co, Ni, Cu, Zn and Cd did not change significantly, the dissolved concentrations decreased exponentially.

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THE BALTIC ENVIRONMENTAL DATABASE AND TOOLS FOR DATA ANALYSIS

The Baltic Environmental Database is a database comprising hydrographic and chemical observations from the Baltic Sea since 1900 (243412 stations); gridded bathymetry, inputs from the drainage basin, weather data, atmospheric nitrogen inputs and sea level variations. The database is under frequent updating thanks to the contributions of over 100 laboratories and Institutions from all countries around the Baltic Sea. Several of computer programs were developed to analyze data from the database in different ways. DAS (Data Assimilation System) requests data from the database to construct 3D gridded data and allows the users to analyze spatial distribution of variables (horizontal surfaces, vertical transects) and perform different calculations. NetStations is used to analyze temporal variation of the parameters for a selected region of the Baltic. The database is also used in the program NEST — an information environment of a decision support system for developing and testing cost-effective