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# The Importance of Stealth: Recent Findings with the Eye-in-the-Sea Deep-Sea Observatory

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N fertilization experiment in two salt marshes in the northeastern USA. In each marsh 4 replicate plots were treated with 4 different Si:N ratios (ambient, 2x Si:N, 0.5x Si:N, and N only). Algal community composition and biomass (determined by cell counts, chlorophyll, and CN analysis) were altered by fertilization and changes to the Si:N ratio. We also report changes in the Si and N content of the periphyton following the treatments. While ecological effects of altered Si:N have received attention in open waters of estuaries, similar alterations can change the periphyton and may affect the lower food web of salt marshes.

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#### CONSOLIDATION AND EROSION ACROSS A MUD-SAND GRADIENT

Sand-mud transitions are a common feature of many continental shelves. Accompanying this transition is a fundamental change in bed erodibility. Here we present field and laboratory measurements of erosion rates and related sediment properties across a gradient in the mud-sand content of the bed. The field measurements were made along a cross-shelf transect in the Gulf of Lions, NW Mediterranean, and included grain size of bed and suspended sediment, bed porosity, and erodibility measured using a Gust erosion chamber. Laboratory measurements are being made on clay-sand mixtures that consolidate for varying lengths of time, with a focus on clay fractions associated with the transition from cohesive to non-cohesive erosion behavior (~7.5%). The field measurements show a distinct difference in sediment mass eroded vs. shear stress relationship for predominantly muddy beds compared to higher-sand/lower-clay content beds, consistent with expectations for cohesive and noncohesive beds. The laboratory measurements are designed to better resolve this difference and its dependence on clay fraction. The results will be useful for sediment transport modeling and for understanding the processes associated with mud-sand transitions on the shelf.

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#### THE IMPACT OF SENSOR RETRIEVAL ERRORS AND DIURNAL WARMING ON THE ACCURACY OF BLENDED MULTI-SENSOR SEA SURFACE TEMPERATURE PRODUCTS

The blending of complementary retrievals from infrared and microwave sensors provides the potential for enhancing the accuracy and sampling of sea surface temperature (SST) products. To achieve these improvements in accuracy, however, differing uncertainties in the products and diurnal warming effects must be carefully accounted for. Previous research has revealed uncertainties in each individual SST product dependent on different environmental parameters. In this work, the impact of incorporating the uncertainties and diurnal warming corrections in blended multi-sensor SST products is evaluated. The bias and variability of individual infrared and microwave SST retrievals from multiple sensors are derived from collocations with in situ measurements from moored and drifting buoys. The accuracy of blended SST products relative to independent buoy measurements is compared with and without compensation for the individual retrieval bias and variability. Identified biases are directly subtracted from the retrievals. Differing variability of the retrievals is accounted for in the relative weighting applied to each retrieval. Compensation for the estimated amount of diurnal warming present in daytime observations is explored based on the application of simplified look-up tables derived from detailed numerical models. The merged products considered include both direct weighted pixel averages and a simplified optimal interpolation product.

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#### THE IMPORTANCE OF STEALTH: RECENT FINDINGS WITH THE EYE-IN-THE-SEA DEEP-SEA OBSERVATORY

The Eye-in-the-Sea (EITS) observatory was designed to be acoustically quiet and to use far-red illumination to observe deep-sea animals unobtrusively. The EITS has clearly demonstrated the critical importance of stealth in research ocean observatories. Its use has revealed both animals and behaviors never seen before. Additionally recordings of animal activity under different lighting conditions and in the presence or absence of different sound-producing vehicles (ROVs and submersibles) have revealed to what extent tools for exploration bias observations. Recent recordings made during a 2007 NOAA Ocean Exploration mission to deep waters around the Bahamas provide excellent additional examples of the importance of stealth. During three 36 hr deployments, at 487, 548 and 694 m, at least nine species of deep-sea shark were recorded. A clear diurnal rhythm was apparent with smaller sharks such as *Squalus cubensis* seen during the day and larger sharks such as *Hexanchus griseus* at night. Examples of recordings made of unusual behaviors will be shown including bottom-rooting by six-gill sharks and different swimming behaviors of barracudinas (Paralepididae) under red light as compared to white light.

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WETLAND PROXIMITY AFFECTS METHYLMERCURY IN THE AQUATIC FOOD WEB OF CHEQUAMEGON BAY (LAKE SUPERIOR)

We examined the influence of wetlands and tributaries on concentrations of methylmercury (MeHg) in the food web of Chequamegon Bay, a 167 km<sup>2</sup> embayment on the south shore of Lake Superior. Concentrations of MeHg in seston (1.8-11.4 ng/g), benthic macroinvertebrates (15-109 ng/g), and zooplankton (22-66 ng/g) were generally greater than those typically observed in open water sites of Lake Superior, but less than those in inland lakes of the region--a pattern also observed in small planktivorous (yellow perch) and benthivorous fish (Eurasian ruffe and johnny darter). Within the Bay, concentrations of MeHg in surficial sediment, zooplankton, and fish were highest in tributary- and wetland-influenced sites. Spatially, the concentration of MeHg in benthic macroinvertebrates increased concomitantly with increased exposure to organic matter from allochthonous (wetland and riverine) sources, as inferred from isotopic analysis of carbon. These results indicate that Chequamegon Bay is a transitional zone, where the entry of MeHg into the aquatic food web is strongly influenced by proximity to terrestrial landscape features, particularly wetland environments.

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#### SEASONAL VARIABILITY OF BIOGEOCHEMICAL PROPERTIES AND WATER QUALITY WITHIN A COUPLED MODEL OF CHESAPEAKE BAY

Seasonal variability of biological and chemical properties of Chesapeake Bay is studied through application of a numerical ocean general circulation model with a fully coupled ecosystem. The physical model applied here is the Regional Ocean Modeling System (ROMS). The ecosystem model has been modified from the standard Fasham-type formulation packaged as part of the ROMS distribution to include components that explicitly simulate the impact of river borne sediments, inorganic nutrients and dissolved organic matter. Wet and dry deposition of atmospheric nitrogen, spatio-temporal variation in phosphorus limitation and sediment resuspension have also been incorporated. Finally, dissolved oxygen is explicitly tracked, which allows for resolving the seasonal transition to denitrification within the water column and underlying benthos. In this initial application of the biogeochemical version of Chesapeake Bay ROMS (ChesROMS), results for 1999 are presented and characterized with respect to available in situ observations obtained by the Chesapeake Bay Program. Through a series of sensitivity studies, the relative contributions made by each of the included leading order processes toward successfully realizing the Bay's seasonal biogeochemical evolution are assessed.

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#### THE INTERANNUAL VARIABILITY OF THE INDONESIAN THROUGHFLOW

Twenty years of sustained repeat XBT measurements in the Indonesian Throughflow region are used to delineate the interannual variability of the Pacific to Indian ocean exchange. Geostrophic (relative to 700m) plus Ekman transports are examined across 3 independent XBT lines. Interannual variability is greater than 5Sv and a large component is strongly correlated to remote wind forcing in the equatorial Indian and Pacific Ocean. The velocity response to Indian wind changes is very different compared to that for Pacific wind changes. Transports shall also be compared to those derived from the 3 years of direct velocity measurement attained through the INSTANT project.

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#### NUTRIENT SUPPLY TO THE WESTERN AUSTRALIAN SHELF

Recent estimates of nutrient supply to the continental shelf off Western Australia indicate that terrestrial and atmospheric inputs are small (<1%) compared to preliminary estimates of nitrogen derived from Leeuwin Current advection and eddy activity (8%) and seasonal upwelling along the shelf (7%). By closure the budget suggested that 84% of primary production was recycled on the shelf, thus, even considering the uncertainties in the offshore input estimates, the continental shelf off the west coast is primarily a recycling system. Elsewhere in the world similarly narrow shelves are typically export systems, however our preliminary budget suggests that just 7% of the shelf productivity is transported offshore and 5% exported to the deep ocean. Ongoing fieldwork is focusing on the benthic pelagic coupling of the shelf to help constrain a 3D biogeochemical model of the system. Model skill is assessed against satellite and in-situ observations and the model is used to quantify the spatial and temporal dynamics of the continental shelf carbon and nitrogen biogeochemistry.