

hemisphere. Dominant positive correlations and regressions indicate that when Aleutian low is strong accompanied by negative NPIs, northward (southward) winds generally prevail in the lower (upper) troposphere in the off-equatorial tropics. For the Walker circulation, correlation and regression are calculated between the wintertime NPI and zonal wind speeds meridionally-averaged between 10S and 10N. High correlations and regressions are located in the middle of the troposphere over the western equatorial Pacific.

The present results indicate that the BDO influences the Hadley and Walker circulations substantially. The correlations of stream functions prevailing over both the northern and southern hemispheres have significant implications on the inter-hemispheric distribution of the BDO.

OS21C-12 1145h

The Southern Ocean's Grip on the Northward Meridional Flow

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Recently, a quasi-island approach for examining the meridional flux of warm and intermediate water from the Southern Ocean into the South Atlantic, the South Pacific and the Indian Ocean was proposed. The method considers the continents to be pseudo islands in the sense that they are entirely surrounded by water but have no circulation around them. The method employs an integration of the linearized momentum equations along a closed contour containing the continents. This allows one to compute the meridional transport into these oceans without finding the detailed solution to the complete wind-thermohaline problem.

The solution gives one expected and one unexpected result. It shows that, as expected, about 9 Sv of upper and intermediate water enter the South Atlantic from the Southern Ocean. It also shows, however, the unexpected result that the Pacific-Indian Ocean system should contain a shallow meridional overturning cell carrying 18 Sv. By shallow it is meant here that the cell does not extend all the way to the bottom (as it does in the Atlantic) but is terminated at mid-depth. (This reflects the fact that there is no bottom water formation in the Pacific.) Both of these calculations rely on the observation that there is almost no flow through the Bering Strait and on the assumption that there is a negligible pressure torque on the Bering Straits sill.

Here, we present a new and different approach which does not rely on the above two conditions regarding the Bering Strait and yet gives essentially the same result. The approach does not involve any quasi-island calculation but rather employs an integration of the linearized zonal momentum equation along a closed open-water latitudinal belt connecting the tips of South Africa and South America. The integration relies on the existence of a belt (corridor) where the linearized general circulation equations are valid. It allows for a net northward mass flux through either the Sverdrup interior or the western boundary currents. It is found that the belt-corridor approach gives 29 Sv for the total meridional flux of surface and intermediate water from the Southern Ocean. This agrees very well with the above-mentioned quasi-island calculations which give a total northward flux of 27 Sv. Given the spacing between the continents and the small variability of the southern winds with longitude, one may assume that out of the 29 Sv, 9 Sv enter the Atlantic and 20 Sv enter the combined Pacific-Indian Ocean system which is also in agreement with the quasi-island calculation. These agreements indicate that the assumptions made in the earlier studies regarding the Bering Strait are probably valid.

OS21D MCC: 104 Tuesday 0830h

Dynamic Processes Governing Estuaries I (joint with B, H)

Presiding: F O Nitsche,

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OS21D-01 0830h

Sonar Investigation of Sediment Deposition Patterns in the Delaware River Estuary

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Sedimentation in the Delaware River Estuary is influenced by natural hydrographic properties and engineering practices such as channel dredging and shoreline bulkheading, which influence sediment transport among its subenvironments. To better understand the regional sediment dynamics of this estuary, bottom sediments and morphologies were mapped using 300 miles of dual-frequency side-scan and Chirp sonar data between Trenton, NJ and New Castle, DE, a highly urbanized region. Sediment grabs (188) and cores (48) were collected to groundtruth the sonar data. Sonar imagery and grain size analysis reveal a sediment textural pattern that, in general, parallels the longitudinal salinity gradient of the estuary. In the northern extent of the study area (0-1 PSU), fluvial sands grade down estuary to muddy sands of possible marine origin in the southern extent (1-5 PSU). At the head of the salinity intrusion, three distinct locations of low acoustic backscatter are present within a larger area of higher backscatter. The low backscatter bottom corresponds to seasonally active mud deposits, whereas the high backscatter characterizes a dense mud bottom, mantled by a mobile veneer of sand and gravel. The zones of active deposition compose merely 8% of the total area of study, yet they contain a significant fraction of the suspended sediment inventory. The depositional zones are interpreted to reflect localized suspended sediment trapping, likely due to flocculation, as well as other processes that maintain the estuary turbidity maximum. The new sonar imagery has provided important insight into sediment budgetary and contaminant transport issues in the Delaware River Estuary; timeseries measurements of sediment transport are needed to elucidate the physical processes responsible for sediment trapping and deposition in the turbidity maximum region.

OS21D-02 0845h

Sediment Dynamics Derived From Historic Bathymetry Data of the Hudson River

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Sediment dynamics of estuaries are complex consisting of a mixture of fluvial, marine and estuarine specific processes. The location and strength of these processes change from spring to neap tide, from wet to dry season, and due to occasional extreme flooding events. For example in the area of the estuarine turbidity maximum sediment is eroded, deposited and re-suspended during tidal cycles. Therefore, it is difficult to determine between present short-term sediment dynamics as part of these cycles and long-term deposition and erosion. Such long-term changes are likely to result in bathymetric changes. Comparing actual and historic bathymetric data can reveal areas where the bathymetry has changed over time and lead to the identification of areas of deposition and erosion. We present the results of a comparison of historical nautical charts, old NOAA bathymetry data and recently collected bathymetry from the lower Hudson River Estuary extending from 1865 to 2001. The different data sets have been loaded and compared using a geographic information system (GIS). Although several problems like unknown datum level of the historical maps make it difficult to obtain absolute amounts of changes, relative differences in bathymetry can be imaged. The analyzed 50 km of the Hudson River between the Tappan Zee to the Battery does not show evidence of significant changes of the general shape of the river for the last 140 y. But some local changes are observed. Several are clearly the results of human activities like shoreline infilling, pier construction, and bridge building. Evidence for a deposit 5 km north of the modern turbidity maximum is observed.

OS21D-03 0900h

Infilling of the Hudson River Estuary During the Late Holocene (3000ka to Present): Implications for Estuarine Stratigraphic Models

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Estuaries are widely preserved in the geologic record and the estuarine fill, contained between non-marine

sediment, provides an excellent temporal marker for continental margin studies. Estuarine stratigraphic models have provided a framework within which to interpret the estuarine fill. However, estuarine systems differ greatly in the shape of their valleys, the tectonic boundaries they cross, and in sediment supply so that their position in the geologic record may be out of sequence with that predicted by the models. New insights into estuarine systems and models are provided by the Hudson River Estuary (HRE; New York State) based on >150 cores and grab sediment samples and acoustic images documenting in great detail how the HRE filled its earlier excavated valley during the latest Holocene (3ka to present).

Radiocarbon and 137-Cs radioisotope ages, borehole, and core data document the sedimentation patterns of the estuary. Diatom assemblages provide estimates of the shallowing-upwards of the estuary as its basin filled with sediments. The three areas of the stratigraphic model present in the HRE, include zones formed within inner fluvial and outer marine areas, (containing coarse-grained, sands and gravels), and a central area (containing fine-grained, silts and clays), that are nearly filled with little room for sediments to accumulate at or near sea-level. This has resulted in sedimentary bypass for almost the entire length of the estuary. South of Kingston, fine-grained sediments have ceased accumulating when the bottom approaches wave base. Upstream from Kingston, final filling occurs as sediments fill in the remaining accommodation, forming islands. This should result in the export of sediment to the coastal zone. Instead, localized areas of sediment trapping still exist, which are related to the Hudson Valley Highlands and to the location of the estuarine turbidity maximum that hold large volumes of sediment. As a result minor volumes of Recent sediment are accumulating in coastal bays (Sandy Hook, New Jersey) and on the inner shelf, and sediment export to the Hudson Shelf Valley on the mid-shelf is nearly non-existent, with sediments dated at 14ka from 14-C on the outer shelf. Additionally, anthropogenic activities (construction of bridges and dredging) alter sedimentation patterns in the estuary leading to continued localized erosion and deposition. For example, sediment export onto the shelf is taking place, not by natural processes but by dredging. The variability documented for the HRE indicates that although estuarine and stratigraphic models provide a framework for continental margin studies, the models need to be interpreted, taking into consideration these factors.

OS21D-04 0915h

Estuarine Processes and Fluctuations in Oyster Presence Within the Hudson River Estuary During the Holocene

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Estuarine ecosystems provide abundant and diverse food resources and have long been exploited by humans. Within the Hudson River estuary, human impacts began with extensive harvesting of oysters (*Crassostrea virginica*) by Archaic era populations 7000 yrs ago. The size of the oysters recovered by the indigenous populations varied over time and a distinct hiatus appears in the archeological record. These changes have been attributed both to over exploitation and to fluctuations in the estuarine environment.

Geophysical and sampling data from the Hudson River estuary in the Tappan Zee region, 20 miles north of the Battery, reveal ancient oyster beds preserved in the river bottom sediments which match the history of human harvesting. Side-scan sonar and Chirp sub-bottom data reveal shallow oyster beds exposed on the river bed and buried by up to 3 m of sediment with ages of 1000-2000 yrs bp which cover 25% of the river bottom. When active, these beds would have represented an abundant resource in this part of river. Several 10-m long sediment cores reveal older shell layers (6300-6400 yrs bp). No oyster shells are recovered between these basal oysters and the shallow oyster beds. Sub-bottom and sampling data also reveal a changing depositional regime in response to rising sea level which is linked to the oyster chronology. The oyster phases of the lower Hudson valley are observed elsewhere along the Atlantic seaboard, and coincide with cool-warm cycles of the mid-to late Holocene. Oysters within the Tappan Zee flourished during the mid-Holocene Hypsithermal period, disappearing during the period of cooler and wetter conditions which followed at 4500 yrs bp, and returning with warmer conditions at 2000 yrs bp. We conclude that changes in oyster presence preserved within the estuarine sediments of the lower

Hudson reflect changing environmental conditions associated with these Holocene climate cycles and do not reflect overexploitation by local native populations.

## OS21D-05 0930h

### Paleoenvironmental History of Long Island Sound, CT, USA

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Western Long Island Sound (LIS) is an urban estuary heavily impacted by waste water effluents from CT and New York city. The estuary has suffered seasonal hypoxia since the 1970s, and in 1999 lobsters suffered > 90% mortality. We used short sediment cores that cover the last several 100 years to reconstruct the temperature/salinity history of LIS, as well as its history of hypoxic episodes. We measured oxygen and carbon isotopic compositions and Mg/Ca and Sr/Ca in calcite tests of the benthic foraminifer *Elphidium excavatum*, collected alive (Rose Bengal stained) in grab samples and in core samples, as proxies for bottom water temperature and salinity. The level of bottom water oxygenation is derived from the carbon isotope values in foraminifer calcite, after correction for paleosalinity. The strong seasonal temperature fluctuation in Long Island Sound bottom waters (about 20°C) and the long livespan of the foraminifer make precise paleotemperature estimates difficult. The oxygen isotope data (in vivo effect 1.1 ‰) of the foraminifer tests were recalculated at constant mean-annual water temperature (12.5°C) into paleosalinities, ranging between 18 and 33 ‰. The oxygen and carbon isotope ratios of river water, Long Island Sound water and dissolved inorganic carbon were used to construct a mixing model for the Sound. From calculated paleosalinities and the modern mixing model we derived expected carbon isotope ratios, which were subtracted from the observed values. We argue that the residuals (excess carbon isotope values) are proportional to the amount of organic carbon that was oxidized in these waters, and as such represent a proxy for paleohypoxia. Data from nine cores show no long term trends in salinity over the last 1000 years, but show more pronounced variations over the last 100 years. Several low salinity events could be correlated with wet climate periods documented in Southern New England. The excess carbon isotope values were between 0 and -1 ‰ for most of the last millennium but became much more negative in the mid 18<sup>th</sup> to 19<sup>th</sup> century, with strong variability in the 20<sup>th</sup> century. The low salinity events of the last 100 years correlate strongly with strongly negative excess carbon isotope values, suggesting a linkage between the wet periods and oxidation of organic matter on the bottom of the Sound (algal blooms, warm periods?). This linkage between low salinity events and strongly negative excess carbon isotope values did not occur prior to 1900 AD. More detailed dating (<sup>210</sup>Pb, <sup>137</sup>Cs) will improve the time resolution and correlation between cores of the various documented events.

## OS21D-06 0945h

### Fate and Impact of Contaminants in Sediments of the NE United States

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Estuaries and coastal sediments may be the ultimate sink for particle-reactive contaminants and excess

nutrients. Their distribution in these sediments of the northeastern United States is a function of the location and magnitude of contaminant sources, which are correlated with population distribution and the history of land use, and of the dynamic physical and geochemical processes that occur in the sediments and on the sea floor. New York Bight, Long Island Sound, Massachusetts Bay, and the coastal regions of the Gulf of Maine have heterogeneous geology and bathymetry, variable currents, and each encompasses areas of both increasing and decreasing human impact. Chemical and geophysical mapping indicates that contaminants introduced into the environment during the past 250 years of population growth and industrial activity are present in muddy deposits up to 2 m thick, and are dispersed with fine-grained sediment throughout the region. Lower concentrations of regulated contaminants (e.g., metals such as Hg, Pb, and Cu) in the most recently deposited sediments verify the effectiveness of source reduction. Decreases in sediment metal concentrations, however, are not always accompanied by a decrease in sewage tracers and nutrient loading because of continuous population growth. Bottom currents focus and remobilize sediments periodically, creating complex patterns of habitat and sedimentation, large gradients in contaminant distributions, and non-steady state geochemical conditions. Results from analysis of over 200 sediment cores in coastal waters of the Northeast identify areas where contaminated sediments have accumulated in the last few centuries. Benthic populations in some of these areas have been impacted by local substrate changes, toxicity, hypoxia, and anoxia. The existing contaminant pool is often mobile. A multidisciplinary approach, including predictive models that include changing sources and physical, chemical, and biological transport processes, is required to estimate the long-term fate and effect of the large inventory of pollutants currently in coastal sediments.

## OS21D-07 1020h

### Biogeochemistry of Sedimentary Carbon, Phosphorus and Redox-Sensitive Trace Metals in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary

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The San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta) is a highly modified estuarine wetland that has experienced decades of water diversion, agriculture and urbanization. It is not fully understood how these anthropogenic impacts have influenced processes such as carbon cycling, nutrient fluxes and redox potential. This study was conducted for the purpose of characterizing organic carbon, sedimentary forms of phosphorus and redox sensitive trace metal concentrations at sites with differing depositional environments and salinity. Surface sediment samples (0 - 6 cm) were cored at five sites on a transect from the freshwater Consumes River to the boundary of the San Francisco Bay, encompassing a salinity range of ~0 - 28. Saltwater regimes are often characterized by lower rates of carbon accumulation than are neighboring freshwater regimes because sulfate reduction accelerates organic carbon decomposition and thus decreases net accumulation rates. In this study, organic carbon contents in sediments were found to increase with increasing salinity (study range: ~1 - 29 weight % C). Molar ratios of *C<sub>organic</sub>* to *P<sub>organic</sub>* also increased seaward, from ~12 at the Consumes River site up to ~600 at Sherman Island. Reactive phosphorus (bioavailable P) concentrations decreased seaward (study range: ~1 - 19 μmoles g sediment<sup>-1</sup>), showing the opposite trend to that of organic carbon. Detrital phosphorus concentrations (unavailable P) did not show a consistent trend with salinity (study range: ~0.1 - 17 μmoles g<sup>-1</sup>). Uranium concentrations (study range: ~10 - 32 nmoles g<sup>-1</sup>) increased with salinity, consistent with increasingly suboxic sedimentary conditions associated with higher organic carbon contents. Manganese and barium concentrations (study range: ~6 - 12 and ~2 - 4 μmoles g<sup>-1</sup>, respectively) did not show a consistent trend along the site transect. The complexity of the Bay-Delta system makes biogeochemical studies challenging, but, given the heterogeneity of this system and of wetlands in general, and their potential sink capacity, it is important to investigate local effects on carbon accumulation such as nutrient cycling and redox state. This study represents a first step in characterizing carbon burial, sedimentary phosphorus and redox conditions in an important estuarine system.

## OS21D-08 1035h

### Field Observations of Hydrodynamics, Sediment Transport, and Water and Sediment Quality in the Hudson-Raritan Estuary

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The New York-New Jersey Harbor estuary system is of enormous ecological and economic importance to the region. The presence of toxic chemicals in the water and sediments results in reduced water quality, fisheries restrictions/advisories, and general adverse impacts to the estuarine ecosystem. The Port of New York and New Jersey is central to the economy of the region. However, in recent years, problems associated with the management of contaminated dredged material, including high costs and the lack of suitable disposal/use alternatives, have threatened to impact the volume of shipping in the Harbor. Sources of contaminants include atmospheric deposition, municipal and industrial wastewater treatment facilities, combined sewer and stormwater outfalls, and rainfall-induced runoff (non-point sources). In addition, Harbor sediments can act as a continuing source as they are re-suspended and moved throughout the system by both natural and man-made means. As part of the New Jersey Toxics Reduction Workshop, Stevens Institute of Technology and Rutgers University are conducting hydrodynamic, sediment transport, and water and suspended sediment quality measurements in Newark Bay, the Arthur Kill and the Kill van Kull. The goals of the project include: (1) collection of high resolution (event-driven and long-term) hydrodynamic, sediment transport and water and suspended sediment quality measurements for use in the assessment of the dominant physics of the system and in the development of a combined hydrodynamic-sediment transport-water/sediment quality model for the region. (2) identification of those tributaries to NY-NJ Harbor that are significant sources of the chemicals of concern, and evaluation of the importance of non-point sources and existing contaminated bottom sediments as sources of the chemicals of concern. (3) identification of point discharges that represent significant sources of the chemicals of concern.

Observations were obtained over a two-year period, during 21 tributary flow events, each having an approximate duration of 1 week. The measurement program included 3 fixed mooring stations and 5 ship-board locations. Each mooring consisted of an acoustic Doppler current profiler; a high-resolution pressure sensor; an OBS; a CTD; and a laser-based scatterometer. The ship-board measurements included vertical current profiles using a towed acoustic Doppler current profiler; CTD measurements; OBS measurements; suspended sediment concentration and particle size spectrum using a laser-based scatterometer; and chemical characterization of water and suspended sediment samples. The water and sediment quality measurements were obtained using a specially designed Trace Organics Platform Sampler. This sampler allowed for the measurement of low-level concentrations of PCBs (108 congeners), dioxins/furans, Pesticides, PAHs and metals (Hg, Cd, Pb). Preliminary analysis of the data has improved our understanding of the circulation and sediment transport patterns in this region of the estuary, including the influence of extreme tributary flow events, local winds, and anthropogenic effects such as port structures, vessels, and the navigation channels, and has identified the most highly contaminated reaches of the tributaries.

## OS21D-09 1050h

### Controls on the Efficiency of Estuarine Particle Trapping: Ecosystem Implications

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Comparisons between the Columbia and Fraser river estuaries suggest several important controls on retention of suspended particulate matter (SPM) in estuarine turbidity maxima (ETM). Observations were carried out in spring 1997 and 1999 in the Columbia under moderate to high-flow conditions. Because of flow regulation, flow levels were 60% of their natural values, considerably increasing the salinity intrusion length and efficiency of particle trapping. Observations in the Fraser were made under extreme high-flow conditions (1999) and under normal spring conditions (2000). Concentrations of coarse material (sand and flocs landward of salinity intrusion, primarily large aggregates within the salt-water mass) were inferred from acoustic backscatter (ABS). Concentrations of silt and clay were estimated from optical backscatter (OBS). Both were calibrated through gravimetric analysis of pump samples and Owen tube results. The very high flows in the Fraser prevented efficient SPM retention for several reasons, and no permanent ETM was observed. First, the salinity intrusion was forced out of the estuary mouth on every greater ebb, exposing the bed to high bedstress levels. Moreover, the estuary was so short that individual silt particles could not settle to the bed before being exported by the river flow. Finally, aggregation appeared to be rate-limited, such that fluvial particles were unable to form into large aggregates during their rapid transit through the estuary. Aggregation occurred instead in the buoyant plume outside the estuary. Thus, the time scale for particle retention in the Fraser was <1 day. Conditions for ETM particle trapping were more favorable in the Columbia, because salt was never totally expelled from the system, and the fronts at the upstream limit of salinity intrusion were never forced back to the plume lift-off zone at the mouth. Also, near-surface waters required most of a tide to transit the length of salinity intrusion, allowing formation, settling and retention of aggregates in a distinct ETM. Strong SPM export occurred primarily on spring tides, rather than on every greater ebb. Thus, the time scale for SPM particle retention was about 15 days, much longer than in the Fraser. ETM ecosystem conditions reflected physical processes. Land-Margin Ecosystem Research (LMER) studies found that epibenthic zooplankton standing stocks were much higher in the Columbia than in the Fraser. This result likely reflects both better feeding conditions in and reduced export from the Columbia ETM. Comparison of the two systems also has important implications for historic changes in estuarine productivity in the highly altered Columbia. The unregulated Fraser provides an indication of pre-dam conditions in the Columbia (with 11 mainstem dams). Historic salinity data suggest that, if the 1997 Columbia spring freshet had not been regulated by dams, salt would be pushed seaward of the tidal delta on every greater ebb. Thus, despite higher sediment concentrations in the fluvial source water, estuarine SPM levels in the Columbia ETM would likely not have been higher before dam construction than they are now; SPM residence times would certainly have been lower. Thus, reduced flows may have actually increased ETM secondary productivity in the Columbia during the spring freshet. Because of the link between secondary productivity and organic matter supplied in fluvial SPM, however, productivity integrated over the entire spring and summer may have been higher before flow regulation.

URL: <http://www.ese.ogi.edu/~jaylab>

OS21D-10 1105h

Two-Layer Flow and Tidal Trapping in the Hudson Estuary: Model Simulations of a Large-Scale Tracer Release

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A numerical model is used to simulate the fate and transport of a tracer released into the Hudson Estuary. The model is based on the three-dimensional, time-variable, estuarine and coastal circulation modeling framework (ECOM), and consists of over 10,000 mass balance segments with a 600 m horizontal and

1 m vertical resolution in the study area. The data set used in this study was obtained from a large-scale SF6 tracer release experiment conducted during July/August 2001. It consists of over 2,000 measurements with a typical resolution of 400 meters. The modeled and measured longitudinal tracer concentration profiles (plumes) are different from the ideal Gaussian curve in two ways. (1) On a large scale the plume is asymmetric, with the downstream end stretching out farther than the upstream end. (2) Small-scale (1-2 km) peaks are present at the upstream and downstream ends of the plume. A sensitivity analysis on the model is used to understand the processes responsible for these features. The model forcing functions (e.g., freshwater forcing, gas transfer velocity, salinity boundary conditions, geometry) are modified systematically and the resulting tracer profiles are compared to the base case. It is demonstrated that the large-scale asymmetry is due to salinity intrusion, which sets up a two-layer circulation. This effectively reduces the area available for freshwater transport, causing larger net downstream velocities in the freshwater layer above the salt wedge. Since the salinity intrusion is confined to the downstream end of the tracer plume, only that part of the plume is subject to the larger velocities. The downstream end of the plume is advected faster than the upstream end, which leads to the large-scale asymmetry. The small-scale peaks are due to tidal trapping. Small embayments trap water masses and tracer as the plume passes by in the main channel. At a later time, when the plume in the main channel has passed, the tracer is released, causing a secondary peak in the longitudinal profile.

OS21D-11 1120h

Variation in Surface Turbulence and the Gas Transfer Velocity in a Macro-Tidal Estuary

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Measurements of the gas transfer velocity (*k*) by the gradient flux method and new observational techniques that probe turbulence in the aqueous surface boundary layer were conducted in the Plum Island Sound, MA. Efforts were aimed at testing new methods in an estuarine system and determining if turbulence created by tidal velocity can be responsible for the short-term variability in *k*. Measurements were made during low to moderately high wind speeds at a site with tidal excursions of 2.7 m and a range in tidal velocity of nearly 1 m s<sup>-1</sup>. Estimates of *k* using the gradient flux method were made simultaneously with the Controlled Flux Technique (CFT), infrared imagery, and high-resolution turbulence measurements, which measure the surface renewal rate, turbulent scales, and the turbulent dissipation rate, respectively. All measurements were conducted from a small mobile catamaran that eliminates nearly all air- and water-side flow distortions.

Infrared imagery showed considerable variability in the turbulent scales that affect air-water gas exchange. These measurements were consistent with variation in the surface renewal rate (range 0.02 to 2 s<sup>-1</sup>), the turbulent dissipation rate (range 10<sup>-7</sup> to 10<sup>-5</sup> W kg<sup>-1</sup>) and *k* (range 2.2 to 12.3 cm hr<sup>-1</sup>). During low wind conditions, all variables were shown to correlate with tidal speed. At moderately high wind speeds, however, the turbulent regime appears to transition from tidally- to wind-driven turbulence since the turbulent dissipation rates remain nearly constant as tidal speed increases. Furthermore, moderately high wind speeds did not ensure the highest dissipation rates; dissipation rates reached levels produced by moderately high winds when tidal velocities reached maximum values under low wind conditions. Taken collectively our results indicate the promise of these methods for determining short-term variability in gas transfer and near surface turbulence in estuaries and that turbulent transport associated with both tidal velocity and wind speed are important factors with respect to gas exchange in coastal systems.

OS21D-12 1135h

Simulations of Altered Freshwater Flow Into Tampa Bay and Impact on Salinity

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The salinity in the far northeast portion of Tampa Bay is shown to respond to changes in freshwater inflow due to withdrawal of freshwater from the inflowing Palm River in a three-dimensional circulation model of Tampa Bay. The model contains realistic geometry and bathymetry, and is driven by observed surface wind stress, tidal forcing, evaporation, precipitation, runoff, and river inflows. Two model scenarios are compared: 1) no freshwater withdrawal; 2) full permitted freshwater withdrawal. While salinity differences between scenarios of nearly 4 ppt occasionally occur in the surface of the Palm River, more typical values are ≤ 2 ppt, with this value declining with distance from the withdrawal site, though the differences can propagate at these levels even into East Bay. Generally the time periods of low total flow show little salinity difference between scenarios. At higher flow rates the salinity difference increases, but will decrease at extremely high rates such as might be found following a large storm. The salinity in the first scenario is generally lower than in the second, except for occasional high salinity intrusions near the bottom of East Bay due to alterations in the gravitational residual circulation that can last for several days. The changes in residual circulation are driven by the altered horizontal salinity gradient. These changes in residual circulation lead to alterations in estuarine residence time, which has implications for water quality and larval retention.

URL: <http://ompl.marine.usf.edu/TBmodel>

OS22A MCC: Hall D Tuesday 1330h

Ocean-Atmosphere Interaction and Climate Variability III Posters (joint with A, GC)

Presiding: C Wang, NOAA Atlantic Oceanographic and Meteorological Laboratory; S Xie, University of Hawaii

OS22A-0219 1330h POSTER

A Thick, Grounded ice Shelf in the Northwind Ridge Region, Western Arctic Ocean?

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As a general rule, ice rafting in presently or formerly glaciated oceans leaves laterally extensive layers of ice rafted debris (IRD) of roughly the same composition: the concept of the "Heinrich layers". This holds true for the North Atlantic, the Norwegian-Greenland Sea, the Fram Strait, and most of the Arctic Ocean, but not in the westernmost part of the Arctic Ocean, the Northwind Ridge region. There, cores from the same geographic area show very different types of IRD. This area is also the only part of the Arctic that became abiotic at times. For these reasons, a straightforward interpretation of the paleo-climate has thus far been impossible. But the recent discovery of glacial bedforms on the Northwind Ridge changed all that. We now suggest that a large ice sheet once grew on Northwest Alaska and extended as a floating ice shelf into the Arctic Ocean, producing a sediment layer with fine-grained clastic sedimentary rocks and coal from NW Alaska. This material must have dropped from the underside of the floating ice mass and was not widely dispersed in the Arctic Ocean. Reconstructions of the dynamics of this ice shelf and similar ice structures in the Canadian Arctic could provide valuable insights into the future behaviour of some of earth's present ice shelves.