### OS21Q-09 1055h

**A fine resolution numerical modeling on the oceanic circulation of the Japan/East Sea**

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The RIAM Ocean Model (RIAMOM) with a fine resolution of 1/12° is used to investigate the mesoscale eddy variability and its role in water formation and deep circulation in the Japn/East Sea. The RIAMOM is the primitive general ocean circulation model with a free surface, which is originally developed at the Research Institute for Applied Mechnics (RIAM), Kyushu University (Lee and Yoon, 1994; Lee, 1996). The model assumes the Boussinesq, hydrostatic balance and solves the three-dimensional, non-linear, free-surface, primitive equations with the Arakawa B-grid system. In order to prevent the nonlinear instablility which could happen from long term time integration, the generalized Arakawa scheme is used in the horizontal momentum equations. So called the "slant advection" effect is considered in order to represent the vertical advection effect of the horizontal momentum at the bottom topography as possible as correctly (Ishizaki and Motoi, 1999). The model area covers from 126.5 ° E to 142.5 ° E in longitude and from 33 ° N to 52 ° N in latitude. The monthly mean wind stresses and heat flux of ECMWF re-analysis data with horizontal resolution of 0.5625° from 1992 to 2000 are used to force the sea surface. The salt flux at the sea surface is given as a Newtonian type restoring boundary condition. Disscusion will be made on the eddy variability, the energetic deep circulation, and the correlation between mesosclae eddies and the oceanic circulation.

### OS21Q-10 1110h

**Circulation of the East (Japan) Sea Based on POM-ES with Data Assimilation**

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The East (Japan) Sea (hereafter, ES) is drawing keen attentions from international community with various scientific points of views. Particularly, its importance has been recognized as Miniature Ocean so that it provides a unique experimental natural laboratory to investigate the global warming problems, since it is fairly deep (average 1500 meters) compared to horizontal length scale of 1200 km with residence time of around 30 years. POM-ES (Ro, 1999) was developed based on Princeton Ocean Model with realistic bottom topography. Model configuration is designed with grid resolution (1/10 deg), bottom topography, boundary conditions (three open boundaries at Korea, Tsushima, and Soya Strait with 3 (Sv) seasonally varying transport), monthly surface forcings with wind stress and radiation. POM-ES was initially spinned up with monthly GDEM dataset in diagnostic mode for three years and runned for next 30 years in prognostic mode with 3-D T-S nudging scheme. Model is restarted with the final output with data assimilation of satellite SST and T/P SSA. The objectives of the study is to understand 1) seasonal circulation patterns in the East Sea based on the reproduced current patterns with assimilation of climotological dataset of temperature and salinity, 2) characteristics of major current system such as TWC, EKWC, LPC, NKCC and PFJ in terms of current speed and direction, volume transport and water mass 3) processes associated with eddy-current interactions and basin-to-basin water exchange. Model output is investigated in terms of various known features such as general surface circulation pattern with current system of TWC, EKWC, NKCC, LPC and frontal jet, meso-scale eddy generations at recognized locations, counter currents under major current system, volume exchanges between three major basins. All the results of modeling will be presented through animated movie loops.

### OS21Q-11 1125h

**Japan(East)Sea Model-Data Comparisons**

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The Japan (East) Sea (JES) has a complex circulation that varies on atmospheric-synoptic, oceanic-mesoscale, seasonal, interannual, and longer space and time scales. It is of interest to establish how well contemporary numerical circulation models represent the mean and variable circulation in semi-enclosed seas in general, and the JES in particular. As an example, the Princeton Ocean Model (POM) has been implemented for the JES with ca. 10km horizontal resolution and 21 or 26 sigma (terrain-following) level resolution, it has been driven with atmospheric and throughflow forcing of various attributes, and model output has been compared to various observational datasets from the Japanese-Korean-Russian CREAMS Program (1993 through 1997) and the American-Japanese-Korean-Russian CREAMS II Program (1999 through 2001). Here, several examples are provided, including comparison of (1) current spectra from simulation cases with increasingly realistic forcing versus spectra from moored current meter data in the deep Japan Basin, (2) simulated CTD transects versus observed CTD transects, (3) simulated velocities at 800m versus pseudo-Eulerian velocities derived from PALACE Float trajectories, and (4) simulated coastal sea levels versus observed sea levels derived from coastal tide gauges. The results have their pluses-and-minuses and demonstrate the potential for the interplay of models and observations in the JES for evaluating numerical models and, conversely, observing systems.

### OS21Q-12 1140h

**Effects of Winds, Tides, and Storm Surges on Ocean Surface Waves in the Japan/East Sea**

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Ocean surface waves are strongly forced by high wind conditions associated with winter storms in the Japan/East Sea (JES). They are also modulated by tides and storm surges, especially near the coasts. The effects of the variability in the surface wind forcing, tides, and storm surges on the waves are investigated using a wave model, a high-resolution atmospheric mesoscale model, and a hydrodynamic ocean circulation model. We conduct three month-long wave model simulations to examine the sensitivity of ocean waves to various wind forcing fields, tides, and storm surges during January 1997. Comparing with observed mean wave parameters (i.e., significant wave heights and wave periods), our results indicate that the variation in the wave fields is mainly caused by the variability of wind forcing. Tides and storm surges seem to have a significant impact on the waves near shores when mean water depth decreases sharply from a few hundreds of meters to less than 10 m along the west coast of Japan. Improving surface wind forecasts will be crucial for the prediction of surface waves and storm surges in JES, especially near the coastal regions.

## OS21R HC: 316 B Tuesday 0830h

**The North Atlantic Ocean and Its Changing Climate III**

*Presiding:* **B Dickson,** CFEAS, The Laboratory**; T M Joyce,** Woods Hole Oceanographic Institution

### OS21R-01 0830h INVITED

**The General Circulation and Mode Water Formation in Western Subtropical N. Atlantic**

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The circulation of the N. Atlantic subtropics is investigated using observations made by profiling floats. 71 floats were deployed beginning in July, 1997 in the subtropical region of the North Atlantic as a part of the Atlantic Circulation and Climate Experiment. These are subsurface floats that cycle vertically from a depth where they are neutrally buoyant to the sea surface. The floats were programmed to measure temperature and salinity at approximately 100 depths between 1000 m and the sea surface during their periodic ascent at 10-day intervals. The surface and subsurface velocity can be estimated from the drift of the floats.

The geostrophic circulation of the North Atlantic subtropical gyre is estimated using these observations. Traditionally such geostrophic calculations have had the problem of unknown reference velocity, and most previous studies were done assuming a level of no motion at some deep reference level. Since the data collected from the floats consisted of simultaneous hydrography and velocity at a nominal depth of 1000 m, the full absolute geostrophic velocity field above 1000 m can be deduced without a reference level assumption.

The formation and circulation of Subtropical Mode Water (STMW) in the western N. Atlantic (often called 18 degree water) is also investigated. Since the floats produce data at 10-day intervals over the region, nearly synoptic observations are available. Individual events of mixed layer deepening to 500 m in late winter, resulting in STMW renewal, have been detected. The mixed layer deeper than 300 m usually appears in isolated areas and does not last over one 10-day observation cycle. Extensive renewal of STMW was observed during the winter of 2001, while there were only a few deep mixed layer events from during the winters of 1998-2000.

URL: http://flux.ocean.washington.edu

### OS21R-02 0845h

**The Seasonal Hydrography and General Circulation of the Labrador Sea**

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Over 200 neutrally-buoyant subsurface P-ALACE and SOLO floats were deployed between November, 1994 and February, 1998 in the North Atlantic, including the Labrador and Irminger Seas. These floats drift at nominal depths of either 400, 700 or 1500 m, and ascend to the surface every 3.5 to 20 days to communicate with Argos satellites. Upon ascent or descent each float measures a vertical profile of temperature and salinity to a depth of up to 1500 m.

Objective analysis methods were used to estimate the 1997 seasonal-mean, three-dimensional temperature, salinity, density, and geostrophic velocity fields of the Labrador Sea from float drift velocity and profile data. This is the first estimate from direct observations of the basin-wide absolute geostrophic velocity field. The seasonal-mean fields depict the major features of the Labrador Sea circulation, the seasonal water mass transformation, and the spreading of newly-formed Labrador Sea Water.

A sudden surface freshening was observed by some floats in the Labrador Sea in late winter. This freshening is due to floats drifting toward freshwater sources on the continental shelves and in the northern basin. A combined analysis of individual float data and the objectively-analyzed fields suggests that freshwater stored in these regions is gradually transported into the basin by eddy processes.

The impact of the 1997 winter ventilation of Labrador Sea Water on the net heat transport of the North Atlantic was assessed by evaluating the heat budget of the Labrador Sea. Surprisingly, heat storage and net heat transport directly estimated from float data balanced model surface heat fluxes in three of four seasons. The net heat transport of the Labrador Sea accounts for nearly one-quarter of the net heat transport into the northern North Atlantic Ocean.

### OS21R-03 0900h

## $^{231}$Pa and $^{230}$Th in the Western Atlantic Ocean

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The application of $^{231}$Pa and $^{230}$Th as tracers of present and past changes in deep water age and ocean productivity requires a detailed understanding of their water column distributions. We present measurements of dissolved and particulate $^{231}$Pa and $^{230}$Th collected in 1999 from the Labrador Sea, including a reoccupation of this basin since 1993, and in 1996 from the Equatorial and South Atlantic, for which a preliminary account of $^{231}$Pa and $^{230}$Th results was recently reported [Moran et al., 2001]. Distributions of total $^{231}$Pa and $^{230}$Th indicate the influence of advection, as evidenced by invariant concentrations below ~1000 m in the Labrador Sea and increasing $^{231}$Pa and $^{230}$Th concentrations as deep waters progress southward from northern source regions. Application of a scavenging-mixing model to both tracer distributions indicates a deep water age of 12 years in the Labrador Sea, and a ~60-140 year transit time to the low-latitude stations. We attribute a striking increase in total $^{230}$Th in Labrador Sea intermediate and deep waters from 1993 to 1999 to aging of these waters as a consequence of the cessation in deep convection since 1993. The temporal change in the $^{230}$Th age of these deep waters is consistent with the 6 year time interval between the observations. In addition, the average particulate $^{231}$Pa/$^{230}$Th activity ratio from the Labrador Sea to the Antarctic Polar Front is 0.058, significantly below the $^{231}$Pa/$^{230}$Th production ratio (0.093) and in excellent agreement with excess $^{231}$Pa/$^{230}$Th ratios of 0.060 reported for Holocene sediments north of 50S. These observations further suggest that boundary scavenging is weakly expressed in the Atlantic as a whole. A latitudinal dependence in particle fractionation of these tracers is also evident, with elevated fractionation factors ($F_{Pa/Th}$) observed near the equator and South Atlantic gyre (~11) compared to low values in the Labrador Sea (~3) and Southern Ocean (~1-3). There also exists a depth dependence in $F_{Pa/Th}$, characterized by low values in surface waters, a broad mid-depth maximum, and decreasing values towards the sea-floor. Latitudinal and depth variations in $F_{Pa/Th}$ are suggested to reflect changes in the chemical composition of marine particles.

### OS21R-04 0915h

## Low-Frequency Variability of North Atlantic Subtropical Mode Water

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The hydrographic time series at the Hydrostation "S" near Bermuda has been analyzed to examine the low-frequency variability of North Atlantic Subtropical Mode Water (STMW). The station is situated in the westward return flow of the subtropical gyre and known to reflect the characteristic properties of STMW.

The properties of STMW, often called 18 Degree Water, are known to vary on quasi-decadal time scales. The present consensus on STMW variability (suggested by R. Dickson and his collegues) is that it is driven by the North Atlantic Oscillation (NAO) as a part of the basinwide coordinated change. This view provides a zeroth order understanding consistent with many observations, but is purely passive to the variability in the atmospheric forcing.

Our analysis has revealed that potential vorticity and temperature of STMW have a phase lag that cannot be explained in the context of the current view of the basinwide coordinated change. The maximum correlation was found with potential vorticity leading temperature by 2 years. The time lag between the behavior of potential vorticity and temperature may imply a possible role of oceanic interior dynamics or low-frequency forcing by effects other than NAO.

### OS21R-05 0930h

## Water Mass Transformation Due to Mixed Layer Entrainment in the North Atlantic During WOCE

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The convergence of advective and diffusive buoyancy flux must match the air-sea buoyancy flux between two outcropping isopycnals. This approach (Walin 1982, Garrett et al. 1995, Marshall et al.1999) quantifies the water mass formation in a density class. While the surface air-sea transformation makes an important contribution to water mass formation, mixed layer processes will modify the surface water mass transformation so that the net formation rate below the winter mixed layer depth is different from that given by the convergence of surface air-sea transformation. Garrett and Tandon (1997) considered the role of time-dependence and mixed layer deepening and derived analytical formulae to include the water mass transformation due to mixed layer entrainment fluxes that involve both entrainment parameters and isopycnal geometry. A subsequent analysis of the Marine Light Mixed Layer experiment by Tandon and Zahariev (2001) showed that the water mass transformation due to mixed layer deepening and entrainment is sensitive to inclusion of synoptic events and diurnal cycling.

This study focuses on extending the above calculations to the North Atlantic for 1990-1998 during the WOCE period. Employing a large number of gridded one dimensional mixed layer models forced by NCEP reanalysis air-sea fluxes (daily/six-hourly) to calculate the local entrainment parameters, and Levitus monthly data to determine isopycnal geometry, we calculate the water mass transformation due to mixed layer entrainment. To get a closed annual cycle in the mixed layer depth, we ascribe any net annual heat flux to advective processes. Thus the synoptic frequencies in the NCEP forcing are unperturbed. Our preliminary results show that monthly average of computed SST is close to Levitus at the grid points. These estimates of water mass formation due to mixed layer process will be useful for inverse box models of the North Atlantic.

### OS21R-06 0945h

## Basin-wide Changes in Heat Transports at 48°N in the Atlantic Ocean during WOCE in Relation to the NAO Index

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Observed rapid changes of meridional transport estimates for seven repeats of the WOCE section A2/AR19 at 48°N in the Atlantic Ocean during WOCE and later, and for selected other previous times, are compared with results from models. Models show a quasi-instantaneous barotropic response, baroclinic changes lag changes in surface heat fluxes some 7 years. Observed changes of the absolute meridional transports, though, follow changes in the NAO index after 18 months. The northern North Atlantic shows significant changes in the hydrography on interannual to decadal time scales. Changes in atmospheric forcing, summarised by the NAO index, are largely responsible for these rapid transport changes.

From October 1999 to May 2000, i.e. the reduction of the heat transport by ca. 30% can only explained by the propagation of long baroclinic Rossby waves. The line of the zero-windstress curl closely follows changes in the NAO index. During the last 30 years the line of zero-windstress curl has moved, for periods of a positive NAO index, northward across the entire ocean. Only since 1997 this northward movement is confined to the Newfoundland Basin, whereas in the West-European Basin the line remains at its southernmost position. This partition seems to excite Rossby waves at the Mid-Atlantic Ridge that in superposition create an intense meso-scale variability in the central Newfoundland Basin, resulting in strong meandering of the North Atlantic Current. We argue that this mechanism is responsible for the rapid and large changes in meridional transports.

URL: http://www.bsh.de/Oceanography/Climate/Clivar/DecadalChange.html

### OS21R-07 1000h

## Labrador Sea Water Formation Rates from Observations and Model

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Since Labrador Sea Water (LSW) is part of the cold tongue of the global meridional overturning of the ocean, LSW formation rates and their variability might affect the meridional oceanic heat transport in the North Atlantic. Here we present LSW formation rates derived from observed CFC inventories. A high resolution model of the North Atlantic is used to examine the CFC inventory method and compare it against the classical volumetric calculation. While the simulated CFC inventory and its geographical distribution in 1997 is fairly similar to observations, the model indicates pronounced variations in the histroy of CFC uptake, reflecting pulsations in LSW formation between 0 and 11 Sv. The model CFC based estimate of the mean LSW formation rate is 3.5-4.4 Sv, in good agreement to the formation rate according to the classical volumetric definition (4.3 Sv).

### OS21R-08 1035h

## Long-term changes in sensitivity of Eastern US and Sargasso Sea Climate to the NAO

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Interannual anomalies of climate variability in the Eastern US for the past 100+ years have been studied for their spatial EOF structure, long-term changes, and the co-variability with several climate indices: the Southern Oscillation Index (SOI), North Pacific Index (NPI) and North Atlantic Oscillation (NAO) index. Especially for air temperature, wintertime (Dec.-Feb.) variability is much more pronounced than summertime (Jun.-Aug.). The leading principal component (PC) of wintertime air temperature, which explains 70 percent of the interannual variance, is significantly correlated with the NAO, while the leading PC of wintertime precipitation correlates with the SOI. The spatial structure of the leading EOFs have a similar spatial character when compared to the correlation between the data and the climate indices, suggesting that the EOFs can be thought of as proxies for mapping the effects of climate indices upon the Eastern US. The effects of the SOI and NPI are generally the same, however these two climate indices are not independent. The long-term sensitivity of Eastern US climate to the Pacific indices seems only weakly dependent with time, whereas the NAO has grown considerably in importance with time since the beginning of the 20th century. This will be the focus of the presentation. Surrogate temperature data from New Haven and SST data from the Sargasso Sea have been used to extend this 100+ year analysis back into the previous century and the apparent long-term trend in the sensitivity to the NAO completely disappeared in the latter part of the 19th century, when the NAO again appears as an important agent in Eastern US and Sargasso Sea winter temperatures. If a measure of potential predictability is the degree to which interannual atmospheric and oceanic climate co-varies with these climate indices, the recent period (post 1960) may overestimate this predictability based on the long-term changes observed in sensitivity to the NAO.

### OS21R-09 1050h

## Interannual Variability in Labrador Sea Water Formation: How is it Related to the Atmospheric Forcing?

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Considerable interannual to decadal variability has been observed in the properties and volume of Labrador Sea Water (LSW) formed in the subpolar North Atlantic. So far, most attempts to explain this hypothesize a direct correlation to the atmospheric forcing and, in particular, the North Atlantic Oscillation (the dominant wintertime atmospheric mode of variability in the region). This assumes there are no feedbacks within the deep convection process that are able to modify the surface-imprinted variability. In principle a number of internal oceanic mechanisms can cause the convective response to be more complex. One likely feedback involves the preconditioning of the water column, whereby the remnant of convected waters from one year affects the amount of dense water formed the following year. We investigate the role of preconditioning in modulating the variability of convection by coupling two simple models. The first model, driven by realistic surfaces fluxes from 1950 to the present, relates the amount of dense water formed at a given site to the atmospheric forcing as well as the conditions prior to the onset of convection. The second model determines the subsequent spreading and export of LSW, which in turn represents the next input to the first model. The results of this coupled simulation show how preconditioning modifies the response of the convective process on timescales comparable to the basin's memory. Comparison to a timeseries of LSW properties in the Labrador basin shows substantial improvement in the prediction of the observed LSW variability.

### OS21R-10 1105h

## The Gulf Stream System and the North Atlantic Oscillation: A synergistic perspective with wind-driven and thermohaline responses

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The low-frequency impact of North Atlantic Oscillation on the Gulf Stream system is discussed from a multi-scale perspective. Specifically, the impact of NAO on the Gulf Stream system is described in terms of its basin-scale gyre-specific components: the azores high centered on the subtropical gyre; and the Islandic Low centered on the subpolar gyre.

The Gulf Stream system can be described as a four-component system: (i) the western boundary current regime; (ii) the separation regime (75-70w), (iii) the meandering northeastward flow regime (70-60W); and (iv) the freely flowing eastern regime (60-45W). Evidence presented herein suggests that the behavior of the Gulf Stream system can be described as a combination of responses of different segments to different components of NAO. Specifically, the boundary current and the separation regime is primarily driven by the integrated wind-stress forced baroclinic Rossby waves, whereas the eastern segments are more sensitive to Labrador Slope water influx into the Slope water region. It is thus possible that the wind-driven response from predominantly high-NAO periods during last 30 years (1966-96) was the primary contributor for the relatively northward position of the Gulf Stream System; while the predominantly low NAO periods might have forced the overall Gulf Stream System to maintain a southerly position prior to 1966 and after 1997 due to large scale advection of Labrador Sea and Slope water to the north of the Stream.

### OS21R-11 1120h

## Long-term Variability of the Deep North Atlantic Basin

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An assessment of the ocean's role in our global climate requires a determination of how climate signals, acquired at the sea surface, are expressed at depth in the ocean. Toward this end, historical hydrographic data from the National Oceanic Data Center are used to examine the pattern of climate change in the deep North Atlantic. Motivated by a recent study that has shown significant volume-averaged warming in the North Atlantic over the past fifty years, we will discuss the certainty with which we can identify climate changes and patterns on density surfaces that span the deep North Atlantic. Preliminary results indicate significant cooling and freshening of the isopycnals below the thermocline. Such changes are compatible with the previously reported volume-averaged warming since the subthermocline isopycnals also exhibit a long-term deepening. This basin-wide deepening, on the order of 1-2 meters/year over the past fifty years, is consistent with the changes noted from repeated hydrographic sections in the North Atlantic basin.

### OS21R-12 1135h

## Interannual-to-Interdecadal Variability of Temperature and Salinity in the Labrador Sea

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Observations obtained across the Labrador Sea during the 1990s reveal exceptionally high cooling of the upper 2000 m during the early part of the decade followed by steady warming. The major cause of the noted cooling was a series of extremely cold winters in the of the Labrador Sea, which led to year-to-year deepening of convective mixing and creation of very dense and cold version of the Labrador Sea Water (LSW) filling the basin down to 2300 m. During the milder years following 1994 most of this LSW was mixed into the boundary currents and slowly drained away from the Labrador Sea to other regions of the North Atlantic Ocean while the remaining portion increased in temperature (T) and salinity (S) as the higher T-S waters bordering the sea were mixed toward the centre. The loss of the LSW led to a restratification of the upper waters across the sea, expressed in significant increases in T and S as well as a decrease in density. This tendency was interrupted in 2000 when the relatively cold winter caused the convective mixing down to 1500 m. At the present time (2001), the newer and shallower and less dense formation of LSW (2000) co-resides in the Labrador Sea with the relics of the deep LSW (1994).

Examination of T and S time series over the past 53 years showed that the pattern of T and S variations noted in the LSW during the recent years were very similar to those observed in the 1950s and 1960s. However, the magnitudes of annual T and S changes associated with the build-up and decline of LSW in the 1990s are twice or more higher than the estimates for similar events in the 1950s and 1960s.

The time series of the Northeast Atlantic Deep Water (NEADW) and Denmark Strait Overflow Water (DSOW) show rapid increases of T and S in the early 1960s with slow declines into the 1990s except for 5-year oscillations in the DSOW over the past 15 years.

The noted changes led to significant variations in the steric heights over 5 decades with highest level in late 1960 and the lowest in 1994, with the difference between these decades greater than 10 cm.

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# OS21S HC: 317 A Tuesday 0830h

## Coastal Circulation and Transport

*Presiding:* **J K Lewis,** Scientific Solutions, Inc.**; N Garfield,** San Francisco State University

### OS21S-01 0830h

## Kinematics of the Middle and Outer Shelf of the South Atlantic Bight: A Comparison of Moored Observations

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Moored instrumentation was deployed on the continental shelf at two sites in Onslow Bay, North Carolina. One site was mid-shelf and the other was at the shelf break. We report on one years data collection at mid-shelf and 3 months at the shelf break. The instrumentation measured water column profiles of current and temperature at two discrete depths. Detailed comparisons between the two moorings are made in terms of characteristics of the flow fields and temperature variability. The mid-shelf site was dominated by M2 tidal fluctuations in the velocity and seasonal variability in temperature. The shelf break site was dominated by synoptic scale events in the flow and 2-7 day fluctuations in temperature.

URL: http://www.fredbingham.com/cormp

### OS21S-02 0845h

## Spatial and Temporal Variability of Circulation Patterns at Offshore Shoals on the Eastern Florida Continental Shelf

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Circulation patterns were observed over a potential sand resource area on the inner continental shelf offshore Sebastian Inlet, Florida to document the physical processes potentially impacted by sand mining within identified borrow sites. ADCP surveys were conducted for a 26-hour period in spring and fall 2001. The survey transect lines were designed to capture the spatial variation of flow across Thomas shoal with a minimum water depth of 10 m. The survey pattern was repeated approximately every four hours, duplicating the center survey line every 2 hours. The data indicate flow regimes within the study area are dependent upon wind-forcing, water level elevations, and seafloor topography. Current magnitudes vary from less than 20 cm/s in the spring to more than 100 cm/s (2 knots) in the fall, primarily flowing along the axis of the shoal. Observations were combined with regional historical data to describe circulation patterns on the inner continental shelf between Port Canaveral and Sebastian Inlet, Florida, including major forcing influences, time scales of variability, and the magnitude of resulting currents. Measurements compiled and analyzed will be used to estimate sediment transport patterns adjacent to potential borrow sites. This information, combined with wave analysis and historical shoreline and bathymetric change data sets, provides estimates of potential alterations to sediment transport processes along the shoreline and in the nearshore as a result of dredging at these offshore borrow sites.

### OS21S-03 0900h

## Hydrography off Bodega, CA, During June 2000 and 2001 COoP/WEST Survey Cruises

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The NSF sponsored CoOP (Coastal Ocean Processes) WEST (Wind Events in Shelf Transport) experiment investigates the shelf upwelling paradox that while eastern boundary shelves are characterized by high productivity due to upward fluxes of nutrients into the euphotic zone, wind forcing also represents negative physical and biological controls via offshore transport and deep (light-limiting) mixing of primary producers. Specifically, upwelling ecosystems along mid-latitude eastern boundaries of the ocean are well-known for wind forcing and high productivity at lower trophic levels, with concomitant transport of near-surface plankton offshore.

This program has now has conducted two month-long spring cruises, June 2000 and June 2001, centered on the region west of Bodega, CA. Conditions could not have been more different for the two cruises. The June 2000 cruise period experienced abnormally calm