within the lower estuaries, which is likely attributed to denitrification within the marsh and/or through local processes. Denitrification was also likely responsible for the downstream NO2- peaks. NH4+ showed two distribution patterns, with one exhibiting high concentrations at both high and low salinity ends, and low in the middle (U-shape), and another having mid to high-salinity peaks (bell shape). Two scenarios alternate between warm (with low river discharge) and cold months (with high river discharge). Such seasonal progression may result from the effect of change in river discharge on nitrification.

For the piedmont river estuaries (Altamaha and Savannah), the accumulation of NO3- disappeared, but net removal processes still existed. NO2- peaks appeared more upstream. Net NO3- removal and NO2- accumulation also likely resulted from denitrification but with less coalition with marsh. The bell shape of NH4+ in Altamaha was evident in winter, but the U-shape did not fully develop in summer. The bell shape of NH4+ persisted year around in Savannah, probably reflecting the combined effect of fast flow rate, anthropogenic pressure, and groundwater input. Inorganic nitrogen in Ogeechee had mixed behaviors since the river had influence from both piedmont and coastal plains.

The difference in river discharge (R) between piedmont and coastal river estuaries apparently resulted in the observed difference in distribution patterns of nitrogen. The model analysis revealed that 1/R was significantly linear-correlated with net maximum NO3- production (Satilla), net maximum NO3- removal (Satilla, Altamaha and Savannah), and net maximum NO2- production (Altamaha and Savannah), all of which indicated that the corresponding net production and removal rates were largely a constant and lack of seasonal variation. The flux estimation showed the NO3- output and estuarine freshwater flushing time (t) was negatively correlated, while the coalition between NO2- output and t showed three continuously-evolving stages: positive, insensitive, and negative for the five systems. These relationships can be interpreted by combing denitrification and changes of flushing time.

OS21P-11 1120h

Spatial Variation in the Stable Nitrogen Isotope Composition of Nitrate, Submersed Aquatic Macrophytes and Periphyton in Four Spring-fed Streams Along Floridas Central Gulf Coast

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Spatial gradients in nutrient concentrations, particularly of nitrate and/or ammonium, are characteristic of estuarine systems and occur as a result of physical mixing processes and also because of uptake and assimilation by phytoplankton and other photoautotrophs. Isotopic fractionation associated with the uptake and assimilation of nitrate and/or ammonium can, in theory, generate strong spatial gradients in the stable nitrogen isotope composition of the residual pool of dissolved inorganic nitrogen that will also be reflected in the isotopic composition of nitrogen sequestered in particulate forms. Stable nitrogen isotopes can serve as in situ tracers of nitrogen as it moves through an estuarine system. Here we present data from four spring-fed and tidally influenced rivers along Floridas central Gulf coast. Each of the four rivers exhibits elevated nitrate concentrations near their headwaters. In two of the rivers, the Chassahowitzka and Homosassa, nitrate concentrations in the surface water declined precipitously with distance downstream. The decline in nitrate in the Chassahowitzka and the Homosassa Rivers coincided with marked spatial gradients in the stable nitrogen isotope composition of submersed macrophytes and their associated periphyton. These findings are consistent with expected patterns and are presumably a consequence of isotopic fractionation during the uptake and assimilation of nitrate. However, in only one river, i.e. the Homosassa, and only during one sampling period, i.e. 1998, were concomitant changes in the stable nitrogen isotope composition of nitrate observed along the established sampling gradients. In two other rivers, i.e. the Weeki Wachee and Crystal River, nitrate concentrations in the surface waters were relatively uniform along the established sampling gradient and as expected there were no strong spatial gradients in the stable nitrogen isotope composition of either submersed plants or their associated periphyton. Differences in the stable nitrogen isotope composition of submersed aquatic plants and associated periphyton in the four coastal rivers are attributed largely to differences in their physical characteristics that, in turn, influence the light environment and the ability of plants and algae to efficiently exploit the available nitrate.

OS21P-12 1135h

The Seasonal Cycles of Nitrate Supply and Potential New Production in the Gulf of Maine and Georges Bank Regions

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The Gulf of Maine and Georges Bank are highly productive from the standpoints of primary production and fisheries. However, despite high rates of primary production on Georges Bank, secondary production (zooplankton) is somewhat lower than expected. Competing hypotheses put forth to explain lower secondary production on Georges Bank are advective losses and nitrogen limitation. In order to detect the presence of nitrogen limitation in the region, and to test this hypothesis for Georges Bank, amounts of new and regenerated primary production are estimated using a quantity termed "potential new production" (PNP). PNP is defined as the difference between the total derivative of vertically-integrated nitrate (NO3) contained in the euphotic zone and the vertical flux of NO3 into the euphotic zone assuming only Fickian diffusion, after conversion of all nitrogen to carbon using the Redfield ratio. This paper describes the seasonal cycle of new primary production for each of five, satellite-derived hydrographic provinces contained within the Gulf of Maine and Georges Bank region, using PNP as a proxy for new primary production and the negative correlation between near-surface temperature and vertically-integrated NO3 from the euphotic zone. Maximum recharge rate of NO3 within the euphotic zone occurs during winter, between yeardays 15 and 50 (mid-January to mid-February) for all five provinces, in agreement with the timing of maximum convective and mechanical mixing and formation of MIW in the Gulf of Maine. Maximum utilization rate of NO3 within the euphotic zone occurs within 90 days or less of the date of maximum recharge rate, between yeardays 91 and 120 (April), with little phase difference between provinces, in agreement with the general timing of the spring bloom. However, peak-to-peak amplitudes between maximum NO3 recharge rate and maximum NO3 utilization rates are largest for provinces located within the Gulf of Maine. Wintertime NO3 recharge into the euphotic zone within the Gulf of Maine is largely the result of vertical NO3 flux, except for eastern Gulf of Maine where advective NO3 flux into surface waters is important. However, there still exists a significant deficit for wintertime NO3 recharge within eastern Gulf of Maine waters of approximately 3.8 mmol m-2 d-1 which is not able to be accounted for by either vertical diffusive or horizontal advective NO3 fluxes.

OS21Q HC: 323 A Tuesday 0830h

Western Pacific Marginal Seas III

Presiding: **C N Mooers,** OPEL/RSMAS/Univ. of Miami**; R Watts,** Graduate School of Oceanography

OS21Q-01 0830h INVITED

Monitoring of Transport Through the Korea Strait

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Volume transport of the Tsushima Current flowing into the East (Japan) Sea through the Korea Strait can be estimated by measuring the cable voltage induced across the strait between Pusan, Korea and Hamada, Japan by the current in the geomagnetic field. Correlation between the voltage and the transport based upon direct measurement of the current by either repeated ship-board ADCP section or a series of bottom-mounted ADCP current meters is very high and the voltage can be converted into the transport reliably. Mean transport for a period from March 1998 to October 2001 is 2.5×10^6 m^3 s^{-1}, which is larger than previous estimates. Energy spectrum of the estimated transport has prominent peaks at tidal frequencies and significant fluctuations are also found on synoptic band, monthly and interannual time scales.

URL: http://eastsea.snu.ac.kr

OS21Q-02 0850h

Synoptic Forcing of Korea Strait Transport

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We examine the mechanisms connecting wind stress to transports fluctuations through the Korea Strait on time scales of 2-20 days. Results indicate that the wind stress across the Japan/East Sea off the Korea peninsula is the most influential for forcing the strait transport. An additional area along the shelf break of the East China Sea also is connects wind stress forcing to strait transport variations. The Yellow Sea area is found play a relatively minor role. This is in spite of the shallowness of the Yellow Sea and its large sea level response to wind stress. The mechanism connecting wind stress off the east coast of the Korean peninsula to Korea Strait transport fluctuations is Kelvin waves. Downwelled Kelvin waves propagate southward along the Korea coast to the Korea Strait where sea level across the strait changes and geostrophic transport increases.

Correlations of observed and model transport to time-lagged wind stress fields indicate that wind stress over the Japan/East Sea or wind stress over the Yellow and East China Seas is influential to the strait transport. However, the wind stress field has large spatial correlations. The wind stress in one area may be dynamically connected to the strait transport and thus be strongly correlated, but wind stress in a dynamically disconnected area may indicate a strong correlation only because it is correlated to the wind stress in the dynamically connected area. Thus the wind stress correlation only provides an indication of importance. A time-lagged correlation analysis is conducted using sea level anomaly observed by TOPEX/POSEIDON to observed transports as well as modeled sea level correlation to modeled transport. The results indicate Kelvin waves propagating along the Korea coast to the Korea Strait. An adjoint model analysis provides a direct examination of the transport sensitivity to the wind stress. The adjoint sensitivity indicates that the transport is most sensitive to wind stress across the Japan/East Sea, wind stress along the East China Sea shelf break is an additional forcing for transport, and wind stress across the Yellow and East China Seas is not a large contributor.

OS21Q-03 0905h

The Surface Current of the Japan/East Sea and its Energetics

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In the period of 1995-2001, 44 wind-measuring MINIMETs, 131 SVP and 72 NAVY drifters were deployed in the Japan/East Sea (JES). From these drifters, the mean current field was constructed in 0.5° resolution. The time varying geostrophic currents were estimated from the TP/ERS2 sea level anomaly whose eddy energy had been inter-calibrated with the drifter eddy energy observed by the drifters. The wind-driven current were calculated using QuikSCAT data based on a model of wind-driven currents derived from the MINIMET data. A 1995- 2001 surface current field was derived from the mean, time varying geostrophic and wind-driven currents in every 10 days. The drifter tracks within one day of either side of the ten day mean

computed currents compared very well in magnitude, direction and curvature of the velocity along a three-day long drifter path.

From these surface current fields, variability and energetics of surface circulation in the JES were computed. The eddy energy showed weak eddy activities in the northern JES but large eddy activities in the southern JES. Unlike in published numerical model solutions, the bottom topography played little role in the shape and intensity of the observed eddy field. Using these data the exchange of mechanical eddy energy at the surface with the meanflow and the role of the wind in energy input are calculated and discussed.

OS21Q-04 0920h

Mean flow and variability in the southwestern East Sea

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The Ulleung Basin is one of three deep basins that are contained within the East/Japan Sea. Four current meter have been maintained in this basin beginning in 1996. With supporting hydrographic data and help from a high-resolution numerical model the data from these moorings provide important clues to the thermohaline and wind-driven circulation within the southwestern part of the East Sea. As the connections of the East Sea are all quite shallow the mechanisms for formation and circulation of the deeper water masses (principally East Sea Intermediate Water and East Sea Proper Water) are of special interest. Their distribution, circulation patterns and variability are discussed in the context of the regional and larger scale oceanography. In particular, the bottom water within the Ulleung Basin, which must enter through a constricted passage from the north, is found to circulate cyclonically within the basin - a pattern that seems prevalent throughout the East Sea.

OS21Q-05 0935h

Shallow and Deep Current Variability in the Southwestern Japan/East Sea

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For the two years, June-1999 to July-2001, data have been recorded from a two-dimensional array of 23 pressure-gage-equipped inverted echo sounders (PIES) and 12 deep recording current meters (RCM) at depths of 1–2.6 km throughout the Ulleung Basin. These current measurements augmented a set of 4 moorings deployed by the Korean Ocean Research and Development Institute and an additional mooring installed by Kyushu University – RIAM, all coinciding in time. The goal of this study is to understand the physics of the circulation and energetic mesoscale eddy variability observed there. The array spanned roughly a 250-km square between Korea and Japan. The PIESs measure vertical acoustic travel time τ from the sea floor to the surface and bottom pressure P_{bot}. The deep circulation from the RCMs is used to level the pressure measurements, by applying the geostrophic assumption to the weak temporal mean deep currents. A method of Gravest Empirical Mode (GEM) analysis of historical data from the Ulleung Basin, combined with NRL's Modular Ocean Data Assimilation System (static MODAS), is applied to estimate from τ the profiles of temperature $T(p)$, specific volume anomaly $\delta(p)$, and other variables at each site. These combined instruments (23 PIESs and 17 RCMs) provide two-year time series of geopotential height profiles $\phi(p)$, vertical shear (baroclinic), and deep current fields (barotropic reference), which may be combined to generate daily maps of the absolute upper and deep current structure and temperature field. Two companion papers in this session (Mitchell *et al.*,, and Wimbush *et al.*) report repectively on the upper layer circulation and on the barotropic tides observed. In this presentation an overview will be given of the slowly varying mean fields in the upper and lower layers, their interannual differences, and relationship to the regional climatology. A preliminary case study will be presented of the joint spinup of energetic meanders of the upper baroclinic front together with energetic deep eddies. An immediate result from the array of P_{bot} sensors is that the sea surface height (SSH) in the Ulleung Basin exhibits leading-order departure ($\mathcal{O}$(10–20) cm) from inverted barometer response to atmospheric pressure. This is because the Japan Sea is a relatively small closed basin, subject to strong wind stress forcing and pressure-gradient forcing, both with concomitant SSH setup. This SSH setup exhibits seasonal (monsoonal) and synoptic atmospheric time scales.

OS21Q-06 0950h

Tides of the Southwest Japan/East Sea Determined From an Array of 23 Bottom Pressure Recorders

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Between June 1999 and June 2001, an array of 23 Pressure-gauge-equipped Inverted Echo Sounders (PIES) was operating on the floor of the Ulleung Basin (UB) of the Japan/East Sea, in a 250 × 220 km region at depths of 1–2.6 km. Throughout this two year deployment period, near-bottom pressure was measured once an hour, on each PIES, with a Paros Digiquartz sensor. The resulting pressure data were analyzed by the response method, and maps drawn of the cotidal lines (phase and amplitude) for the eight major constituents (Q_1, O_1, P_1, K_1, N_2, M_2, S_2, K_2).

Tidal amplitudes in the UB are small, typically 4 cm for O_1, K_1 and M_2, and less than 1.5 cm for the other constituents. Diurnal constituents are strongest in the southeast corner, while semidiurnal constituents are strongest in the northwest corner of the UB. Maximum amplitudes observed are 6–7 cm for O_1, K_1, and M_2; 1.5–1.8 cm for S_2, P_1, N_2, and Q_1; and 0.5 cm for K_2. Minimum amplitude in the southwestern part of the UB suggests a zero-amplitude point in that region for all the constituents. The co-phase lines in each case show a counter-clockwise-rotating amphidrome with the zero-amplitude "amphidromic point" typically just outside the UB, in the direction of the Korea/Tsushima Strait to the south. Except for S_2 and K_2, none of these amphidromic points appears to be within our instrumented area, but extrapolation of our maps suggests the positions of these points are slightly different than previous estimates. For example, *Odamaki* [1989] gives the position of the local M_2 amphidromic point as 35°40′N, 131°15′E, but from our *in situ* measurements it appears the actual longitude is about a degree further west.

Reference: Odamaki, M., Tides and tidal currents in the Tusima Strait, *J. Oceanog. Soc. Japan, 45*, 65–82, 1989.

OS21Q-07 1025h

Daily Maps of Temperature, Salinity, and Velocity in the Southwestern Japan/East Sea

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A two-dimensional array of 23 pressure-gauge-equipped inverted echo sounders (PIES) was recovered in July 2001 after a two year deployment in the Ulleung Basin (UB). The PIESs measure two important quantities, bottom pressure and vertical acoustic echo time (τ) between the instrument and the surface. Using the τ records referenced to a common pressure level, a new gravest empirical mode (GEM) technique incorporating the Naval Research Laboratories Modular Ocean Data Assimilation System (MODAS) static climatology is applied to generate a two-dimensional (p,t) time series of temperature (T), salinity (S), and specific volume anomaly (δ) at each PIES site. Daily OI maps of T, S, and δ are then generated for any desired pressure level. Through the geostrophic method, velocites are calculated from the δ profiles. The Subpolar Front is a persistent feature that changes character between Year 1 and Year 2 of the deployment. During Year 1 it maintains a relatively steady position near 38°N and periodically sheds cold core eddies that follow a southwestward trajectory east of Ulleung Island. During Year 2, the front shifts southward 50-100 km and develops a steep trough that sheds cold core eddies southeast of Ulleung Island. The eddies exhibit two distinct types of behavior. The first type is stationary and exists for a short period before being reabsorbed by the trough. The second type propagates westward then turns north along the Korean coast before being reabsorbed by the Subpolar Front northwest of Ulleung Island. The Ulleung Eddy is a highly variable warm feature approximately 150 km in diameter. The eddy formed when a large meander of the Second (Offshore) Branch of the Tsushima Warm Current pinched off in December 1999, after which the Second Branch diminished. This eddy, centered near 37°N, 131°W, persisted until November 2000, when it was reabsorbed by the reemergence of the Second Branch. The eddy pinched off and the Second Branch diminished again in February 2001, but this time the Ulleung Eddy shifted northwestward (∼100 km) while a steep cold meander trough of the Subpolar Front filled the eastern UB. The confluence of the East Korean Warm Current and the North Korean Cold Current is a robust feature that dominates the eastern edge of the UB. During times of low volume transport of the Tsushima Current (measured by colleagues using ADCPs and cable), the confluence extends southward to a latitude of 36°N and appears to suppress the Second Branch. During times of high volume transport it is confined to latitudes above 37.5°N.

OS21Q-08 1040h

Characterization of the Zooplankton Community and Size Composition and Abundance in Relation to Hydrography and Circulation in the Sea of Japan

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The Japan/East Sea (JES) may be thought of as a model or microcosm of larger oceanic systems where biogeographic boundaries juxtapose at highly dynamic boundaries. The northern and southern Japan/East Sea are hydrographically and biologically distinct, with the southern portion being more tropical/oligotrophic and the northern portion being more boreal/eutrophic. The plankton of the Japan Sea remains poorly understood, particularly with regard to high-resolution description of the distribution of planktonic taxa and environmental conditions. The taxonomic and size composition of the zooplankton community and associated hydrography in the upper 80 m of the JES were described during the summer of 1999 using the Video Plankton Recorder (VPR), surveying over both the northern and southern regions, the Subpolar Front between, and the Ulleung Basin. Plankton also were collected at 15 selected stations using a ring net for silhouette analysis of taxa and size. Distributions of backscatter intensity from a shipboard acoustic Doppler current profiler from three cruises conducted in spring-summer 1999 and winter 2000 were analyzed as a proxy for plankton abundance. Dramatically different plankton compositions were observed in the various hydrographic regions. Plankton taxonomic and size composition and abundance were associated with particular water mass types. Seasonal changes in the plankton distribution and abundance and associations of plankton with hydrographic features from ADCP backscatter intensity also will be discussed.

TUE

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.