OS12O HC: 323 A Monday 1330h

Western Pacific Marginal Seas II

Presiding: **S Ramp,** Dept. of Oceanography**; C Lee,** Applied Physics Laboratory

OS12O-01 1330h INVITED

The formation and Circulation of the Intermediate water in the Japan/East Sea

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In order to clarify the formation and circulation of the Japan/East Sea Intermediate Water (JESIW) and the Upper portion of the Japan Sea ProperWater (UJSPW), numerical experiments have been carried out using a 3-D ocean circulation model. The UJSPW is formed in the region southeast off Vladivostok between 41oN and 42oN west of 136oE. Taking the coastal orography near Vladivostok into account, the formation of the UJSPW results from the deep water convection in winter which is generated by the orchestration of fresh water supplied from the Amur River and saline water from the Tsushima Warm Current under very cold conditions. The UJSPW formed is advected by the current at depth near the bottom of the convection and penetrates into the layer below the JESIW. The origin of the JESIW is the low salinity coastal water along the Russian coast originated by the fresh water from the Amur River. The coastal low salinity water is advected by the current system in the northwestern Japan Sea and penetrates into the subsurface below the Tsushima Warm Current region forming a subsurface salinity minimum layer.

OS12O-02 1350h

Evidence of Wintertime Subduction at the Subpolar Front of the Japan/East Sea

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Strong wintertime outbreaks of cold, dry Siberian air produce intense cooling, convective overturning and mechanical mixing at the subpolar front of the Japan/East Sea. These events may also drive instabilities which serve both to sharpen the front and to generate strong downdrafts which sweep cold, northside mixed layer waters into the south-side pycnocline. Four high-resolution towed profiler (SeaSoar) surveys made at the front in January 2000 document the response to three strong atmospheric events. Measurements of upper ocean velocities, temperature, salinity and bio-optical parameters, combined with extensive meteorological observations and remote sensing track the temporal and spatial evolution of the front. The surveys provide evidence of active overturning and subduction. Sections reveal small scale (O(20 km) horizontal, O(20 m) vertical) pycnostads embedded within the pycnocline south of the front. These subsurface features had T-S characteristics and optical properties typical of north-side mixed layers and were found between the 27.0 kg/m^3 and 26.7 kg/m^3 isopycnals (a layer that outcrops on the northern edge of the front) at distances as far as 50 km south of the frontal interface. Moreover, these features often exhibit anticyclonic circulation and negative potential vorticity, a result of the anticyclonic flow and large, negative contributions from the tilting term. These properties are consistent with recent theories of frontogenesis and enhanced subduction rates driven by symmetric and baroclinic instabilities under strong wind and buoyancy forcing.

URL: http://sahale.apl.washington.edu/jes

OS12O-03 1405h

Ekman Frontogenesis: Generation of Negative Potential Vorticity, Subsequent Instability, and Application to the Subpolar Front of the Japan/East Sea.

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North-south sections of density and upper ocean velocity made while crossing the subpolar front of the Japan/East Sea during January 2000 were used to calculate the two dimensional Ertel potential vorticity (PV). In some sections, during cold air outbreaks, the PV in the core of the front above 60 m was negative yet the stratification was stable and the absolute vorticity was positive. The negative PV was attributable to the strong north-south density gradient and vertical shear of the zonal velocity associated with the front. We suggest that the process of Ekman frontogenesis is responsible for generating negative PV of this type. Indeed, as revealed by QuikSCAT scatterometer winds, the location of the subpolar front during cold air outbreaks in this period was in a region of Ekman convergence where conditions are favorable for Ekman frontogenesis.

Using a weakly nonlinear analytic theory and numerical simulations we have shown that convergent Ekman transport can generate fronts with negative PV by intensifying lateral density gradients, steepening isopycnals, and reducing the absolute vorticity. The numerical simulations demonstrate how fronts with negative PV, formed by the process of Ekman frontogenesis, are unstable to symmetric instability, a two dimensional instability characterized by an overturning cell which diverts the Ekman transport down the dense side of the front. The along-front vorticity associated with this overturning cell is driven by the dominance of buoyancy twisting over the tilting of planetary vorticity by the vertical shear of the along-front velocity. For symmetric instability to grow, this imbalance must increase. This is accomplished by the convergent surface flow of the overturning cell, which, through horizontal advection of density, strengthens buoyancy twisting and intensifies the front. Underneath the surface expression of the front, the divergent flow at the base of the overturning cell spreads apart isopycnals and generates anticyclonic vorticity. These signatures of symmetric instability, i.e. thick isopycnal layers and anticyclonic vorticity, were evident in the observations of the subpolar front of the Japan/East Sea for sections where the PV was negative, and suggests that frontal intensification through Ekman convergence and symmetric instability is active in this region.

URL: http://www.ocean.washington.edu/research/gfd/jfm101701.pdf

OS12O-04 1420h

A Comparison of Bio-Optical Characteristics of the Subpolar Front in the Japan/East Sea in Spring and Winter

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The subpolar front of the Japan/East Sea is present throughout the year and is characterized by strong horizontal temperature and salinity gradients in the upper 200 meters of the water column. The front is also characterized by higher phytoplankton abundances as indicated by both chlorophyll fluorescence and inherent optical properties (IOPs, such as beam attenuation and absorption coefficient). During spring and early summer, seasonal heating of the upper layer results in a northward propagating spring bloom. Seasoar mapping of the frontal region shows that subduction processes along the frontal boundary can transport nearsurface water characteristics (low salinity, high oxygen, high chlorophyll fluorescence and IOPs) from north of the front to depths of at least 250 m. During winter, elevated fluorescence and optical absorption at the front result from increased stratification and convergence at the frontal boundary. As in summer, subduction of water transports IOPs downward in the water column. North of the front the IOPs were uniformly mixed to a depth of >120 m and within the front IOPs were highest in the upper 50 m. South of the front, absorption and attenuation spectra show a uniform upper layer from the surface to ~75 m. A subsurface absorption and attenuation maximum from 80 to 110 m is characterized by decreased absorption in the red wavelengths, indicative of the subducted water from north of the front. During winter elevated bio-optical signals were not detected as deeply in subducted water as in summer, but they demonstrated specific spectral changes that would be expected in a subducted phytoplankton population. These results indicate that frontal processes provide a mechanism for significant downward transport of the products of primary production from the upper layer.

OS12O-05 1435h

Apparent Removal of Carbon Tetrachloride in the Thermocline Waters of the East Sea (Sea of Japan)

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Dissolved carbon tetrachloride (CCl4) was measured for the first time in the East Sea (Sea of Japan) throughout the water column in summer 1999 during the HNRO-7 and KH36 expeditions. Seawater samples were collected and stored in flame-sealed glass ampoules for later analysis in the laboratory. The dissolved chlorofluorocarbons (CFCs) CFC-11 and CFC-12 were measured onboard the R/V Roger Revelle (HNRO-7). CCl4, a man-made compound, has been released to the atmosphere since the early 20th century, several decades earlier than CFC-11 and CFC-12. CCl4 has been used in several recent studies as a time-dependent ocean tracer for water mass dating and delineating pathways of newly ventilated deep waters. However, CCl4 has been observed to be removed, presumably by biological activity, in warm upper ocean waters and in anoxic waters. CCl4, CFC-11 and CFC-12 levels were close to equilibrium in surface waters of the East Sea, however CCl4 in the upper 1000 m of the water column had lower saturation levels than those of the other CFCs, especially south of the subpolar front. Evidence of CCl4 removal in thermocline waters is indicated by comparing the profiles of the predicted CFC-11 and CCl4 levels to the measurements,using the pCFC-12 ages and atmospheric source functions and assuming ideal mixing conditions. The observed CFC-11 matches fairly well with the predicted CFC-11, while the observed CCl4 is significantly lower than the predicted CCl4. CCl4 removal rates, calculated by dividing the predicted-observed CCl4 levels by the pCFC apparent age are estimated to be 2-10 % yr-1 in the upper 1000 m waters. Potential biases in estimating the CCl4 removal due to mixing effects and the nonlinear input function of CCl4 will be discussed using a simple box model.

OS12O-06 1450h

Diagnoses of Water Mass Subduction/Formation/Transformation in the Japan/East Sea (JES): Impact of Atmospheric Forcing With Different Time-Space Scales

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The deep/intermediate waters in the Japan/East Sea (JES) are formed by local winter convection/ventilation since all the straits connecting JES to the adjacent oceans are not deep enough (< 200 m) for those dense waters to flow in or out. The area west of 138°E between 40 and 43°N has been proposed as a potential location of water mass formation by Sudo (1986) and Senjyu and Sudo (1996), which has been substantiated by examining the atmospheric conditions (Kawamura and Wu, 1998) and historical hydrographic data (Seung and Yoon, 1995).

The Princeton Ocean Model was implemented for JES (JES-POM) to simulate interannual, seasonal, and mesoscale variations in velocity and hydrographic fields for five year from 1993 to 1997. It reproduced the general features of the JES circulation.

From simulations, there are three areas (Area V: 41-43°N west of 137°E, Area K: 36-38°N west of 132°E, and Area KB: near Korea Bay) with a local maximum subduction rate (> 500 m/yr). The "flux center" off Vladivostok is identified as the primary subduction area, though the positions and values of the localized maximum subduction rate are different year-to-year.

OS12O-07 1525h

Studies of Deep Convection Processes Using a Numerical Ocean Model: The Japan (East) Sea

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The Japan (East) Sea is an area of intense interaction between the atmosphere and the ocean during winter. Cold Siberian airmasses are advected past a relatively warm ocean by prevailing westerlies, a situation analogous to winter-time cold air outbreaks off the east coast of the US. In addition, the cold air masses are funneled through gaps in the coastal range, for example off Vladivostok. The subpolar front that separates the East Korea Warm Current masses from the relatively cold ambient water masses of the Japan Basin is home to one of the most intense mesoscale activity observed in the global oceans; the region abounds in eddies and meanders that span a wide spectrum of scales. Off Vladivostok, during winter, strong very cold winds get channeled through gaps in the mountain range onto JES and this may cause deep mixing and at least Intermediate Water (if not Deep Water) formation. Most often, some preconditioning of the underlying ocean is essential for deep convection and Deep Water formation. In this study we focus on the deep convection processes in the JES through the use of a three-dimensional ocean model. The three-dimensional ocean model used for this research is the University of Colorado version of the Princeton sigma-coordinate model, which contains a second moment closure turbulence mixed layer model. The 3-D circulation model is run at a fine vertical resolution (10 m in the upper layer, less than 1 m near the surface) to resolve the mixed layer, a necessary step for the intricate surface layer of the JES. Horizontal resolution is 1/24 degree. Surface fluxes are provided by ECMWF model analyses.

The focus of this research is on wintertime intense wind forcing, deep convection events and the formation of intermediate water/deep water and its variability during the June 1999 May 2000 time period. During this time a comprehensive observational program was initiated by the ONR. The in situ data is used for initializing the model and for determination of locations where deep convection is occurring. Regions off the Siberian coast are examined for deep mixing episodes during strong cold-air outbreaks. The simulations of the model show the sensitivity of the ocean in these cases to the surface forcing. The influence of the 3-D processes, such as the circulation patterns and their mesoscale variability on the deep convection events and subsequent formation of Intermediate/Deep Water in JES will be shown.

OS12O-08 1540h

Winter Convection and Brine Rejection in the Japan/East Sea

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The Japan/East Sea (JES) is well-ventilated to the bottom (3500 m depth), and is much better ventilated than the adjacent North Pacific at the same depth and density. Winter data from 1999 and 2000 show that the JES is one of the few sites in the world with deep winter convection, and that convection in the JES has many similarities to convection in the Mediterranean. It has been shown previously that deep oxygen in the JES has been declining over many decades, suggesting that ventilation was more vigorous early in the 20th century than in recent decades. Nevertheless, the presence of significant oxygen and chlorofluorocarbons to the JES bottom suggests ongoing ventilation. In winter, 1999, a first late-winter survey of the northern JES included one hydrographic station with evidence of open-ocean convection to about 1100 meters in the cold air outbreak region south of Vladivostok, and weak evidence of brine rejection under ice formation in Peter the Great Bay (shelf near Vladivostok). Topography and the presence of a semi-permanent anticyclonic eddy and the subpolar front delineate the convection region, which is in the path of strong northerly winter winds.

Because of persistent cold conditions at the beginning of the next winter, including Vladivostok air temperatures colder than any other year since 1976 and SST -2C below normal in the northern Japan Sea, a second winter survey was conducted in late February 2000. Evidence of convection deeper than 1200 m was much more widespread than in the previous, warmer winter. Shelf water subjected to brine rejection in Peter the Great Bay had also created significant amounts of bottom water along the base of the continental slope just south of Vladivostok.

OS12O-09 1555h

Japan/East Sea Bottom Water Renewal in Winter 2001

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To study process of the Japan/East Sea ventilation in winter the ship CTD and chemical observations were implemented in 3 consecutive cruises in the western part of deep Japan Basin by r/v Professor Khromov in February-March and r/v Professor Gagarinskiy in April and May-June of 2001. As a result of extremely severe winter new bottom water (NBW) formation was observed in February at a few stations located close to continental slope. It was a layer of 200-800 m thick overlaying the bottom (2700-3200 m) with water of high oxygen content (235-247 uM/kg) and negative potential temperature anomaly of 0.02-0.18 C. Other 30 stations taken in February cruise down south to 40 N did not show NBW signal. Surprisingly, the April and May-June cruises revealed spreading of NBW over the whole central and southern part of the deep Japan Basin down to 40-15 N. Estimation of this bottom water flow from the continental slope zone suggests a flow speed of 4-6 cm/s which is quite realistic.

Comparison with our observations of April 1999 and March 2000 shows that such intense ventilation of bottom water was never observed in previous years. Peculiarity of winter 2001 conditions was not only more frequent cold air outbreaks with lower air temperature resulted in SST anomaly up to 2.0-2.5 C but also higher salinity in the area off Peter the Great Bay. Integration of these factors caused intense dense water formation at the shelf area of Primorye and ventilation of bottom layer of the entire Japan Basin. It seems that such process was never observed since the 50-th. However an evidence of bottom water anomalies observed off the slope of Peter the Great Bay in April 1999 suggests that weak ventilation process might took place in other years.

OS12O-10 1610h

Formation and Propagation of Bottom Water Anomaly in the Japan/East Sea

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Appearance of new bottom water (NBW) was observed in the Northwestern Japan/East Sea in winter, 2001. Process of formation and distribution of this water of lower temperature and higher density over the deep Japan Basin during February-June period is analyzed using hydrographic and chemical observations implemented in 3 successive cruises and satellite data. Two modifications NBW were observed in February: NBW1 found at the slope of Peter the Great Bay had negative salinity anomaly of 0.003 psu, while NBW2 observed to the east had positive salinity anomaly of 0.004-0.005 psu. This suggests different areas or conditions of this water formation.

Oxygen concentration in anomalous waters as well as concentrations of nutrients, pH, methane are in good correlation with potential density. Correlation fields for depths below 2800 m corresponding to NBW are straight lines. This can be interpreted as a mixing line of two water masses: cold surface one characterized by high oxygen, low nutrient and surface concentrations of other parameters like methane, and deep saline one with normal potential temperature, and rich in nutrients, which is typical for Japan Sea proper water. Good approximation by the straight line proves the fact of mixing of only two source waters and permits to constrain and estimate preform nutrient concentrations for second mode water as well as end member concentrations of methane and all other properties of both mixing water sources.

Spatial distribution of NBW thickness, depth of location and anomalies of water characteristics is very inhomogeneous. Most of NBW thickness observed was about 150 - 300 m. The strongest anomaly of about 700 m was found at only one station and was not caught in vicinity of 10 miles around. This can be interpreted as a center of lens like anticyclonic eddy. Following Nof, 1982 one can expect its propagation alone fixed isobaths. If we assume the NBW formation by slope convection off Primorye and westward translation by the eddies, this would explain apparent patchiness of NBW characteristics observed over Japan Basin. Satellite infrared data for April demonstrate existence of mesoscale eddy situated over the location of maximal pronounced anomaly which possibly can be associated with propagation of NBW.

OS12O-11 1625h

CFCs Indicating Renewal of the Bottom Water in the Winter of 2001 in the Japan Sea and Providing Evidence on the Continental Shelf Pump

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Based on the results obtained in the East China Sea, Tsunogai et al. (1999) have proposed a concept, continental shelf pump (CSP), for the transport of C from the shelf zone to the pelagic ocean.

The CSP starts with more cooling of the shelf surface water than that of the open sea surface water, which forms the denser shelf water and accelerates the absorption of atmospheric CO2 in the shelf zone. Rivers flowing into the zone bring fresh water and nutrients. The fresh water reduces the fugacity of CO2, f(CO2), of the mixed water, and the nutrients and those supplied from other sources also lower the f(CO2) making organic C. The organic C is decomposed largely at

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the shallow bottom and the water containing regenerated CO2 as well as directly dissolved CO2 is mixed into the deeper subsurface layer of the open sea by isopycnal diffusion and advection. The isopycnal mixing still continue under the pycnocline, even in the warming season. In the high latitudes, the formation of sea ice amplifies the pump activity. In the low latitudes, the evaporation of water from the surface also performs as a starter.

The CSP is functioning more strongly in Funka Bay in the northern Japan (Nakayama et al. 2000) and in the Okhotsk Sea (Tsunogai et al., 2001). Here we present the results obtained in the Japan Sea.

In the last 50 years, dissolved oxygen contents decreased year by year and it is considered that its deep water was not formed. The Japan Sea is connected to the Pacific and the Okhotsk Sea through 4 straits, but their sill depths are shallower than 140 m. Thus, its deep and bottom waters are produced within the sea. We studied their formation process using CFCs. The observations were carried out twice in 2000 and 2001 and obtained interesting results.

In 2000, the CFC-11 concentrations decreased almost exponentially with depth from 6 pmol/kg at 500 m depth to 0.3 pmol/kg or less at the bottom, 3500 m depth at 3 stations (40 – 41 E<N, 132 – 133 E<E) a few hundred km off Vladivostok. In 2001, they first decreased similarly to the year 2000, but they increased up to 2 pmol/kg in the bottom water. The concentrations of dissolved oxygen also increased in the bottom water in 2001. On the other hand, at a station (42.0 E<N, 136.5 E<E) apart about 500 km to the ENE, we did not find the increase in the bottom water in 2001. Furthermore, the increase in the layer between 500 – 1500 m layer varied widely from station to station. This variation may be due to the spatially different cooling and the different topography in the shelf and slope zones.

OS12O-12 1640h

Could China's Development Lead to Bottom Water Formation in the Japan/East Sea?

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Using hydrographic data and box models and a comparison between the cooling of the Mediterranean and the Japan/East Sea, it is shown that the presently discussed diversion of rivers such as the Yellow or the Yangtze for agricultural use is likely to cause the renewal of Bottom Water formation in the Sea of Japan. Such formation was common (near the Siberian coast) in the 1930s, 40s and 50s but subsided since that time due to a warming trend (accompanied by a decreased salinity due to the melting of ice). Since a diversion of fresh water is analogous to evaporation, a (diversion-induced) increase of salinity is expected and the increase is large enough to allow Bottom Water formation even at the present-day cooling rates. Even a modest diversion of merely 3000 cubic meters per second (which is 10 percent of the total fresh water flux) will probably cause Bottom Water formation at a rate of roughly 750,000 cubic meters per second. This is the first known case where anthropogenic effects can easily reverse an existing vertical structure.

OS12P HC: 316 B Monday 1330h

The North Atlantic Ocean and Its Changing Climate II

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

OS12P-01 1330h INVITED

Tracking Hydrographic Change Through the Deep Western Boundary Current System

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In recent decades, a notable infusion of fresh water in the Northern North Atlantic and an extreme fluctuation of surface wind patterns together precipitated major shifts in the character and production of deep waters in the Nordic Seas and Labrador Basin – the headwaters of the global thermohaline circulation (THC). The consequences of this high latitude THC variability are now recognizable downstream in the subtropical and tropical deep circulation as conspicuous shifts in temperature-salinity characteristics, atmospheric tracer gas concentrations, and vertical density structure in the deep western boundary current (DWBC). Hydrographic changes are quite prominent near the two principle cores of DWBC flow– the Upper and Lower North Atlantic Deep Water – directly reflecting recent freshening and ventilation history at their respective sources. The DWBC velocity structure is exhibiting attendant modifications: a weakening of the deeper core of Overflow Waters and an apparent strengthening of the upper core of Labrador Sea Water (LSW). In the 1990's, these signals moved progressively through the subtropical circulation and have now entered the tropics enroute to the equator. By year 2000, just 10-12 years following dramatic events in the Labrador Sea, a plume of anomalously cold, fresh, dense, and highly ventilated LSW had advanced down the boundary to 10°N. Its strength and continuity along the tropical DWBC signify a thermohaline anomaly that is building in intensity and transiting large distances without being mixed away by eddies or diffusion into the adjacent interior. Simultaneous alterations of the DWBC vertical density structure, including the development of a potential vorticity anomaly, suggest a tropical expression that has dynamical implications for the deep circulation. These anomalous signatures are providing an opportunity to directly measure the speed with which ocean signals propagate from the high latitudes to the tropics and beyond via the DWBC, and to assess the dynamical response of the deep limb of the THC to high latitude climate fluctuations.

OS12P-02 1345h

Rapid Freshening of the Deep North Atlantic Over the Past Four Decades.

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The overflow and descent of cold dense water from the sills of the Denmark Strait and Faroe-Shetland Channel is the principal means by which the deep ocean is ventilated and so is a key element of the global thermohaline circulation (THC). Most projections of greenhouse gas induced climate change anticipate a weakening of the THC in the North Atlantic in response to increased freshening and warming in the subpolar seas and the supposition is that this climate signal will be transferred to the deep ocean via the two overflows. Nevertheless, these simulations do not yet deal adequately with many of the mechanisms believed to control the THC, and our observations cannot yet detect whether the rate of the oceans overturning circulation is changing. Here, complementing recent evidence that overflow transport may be slackening, we show that the entire system of overflow and entrainment that ventilates the deep Atlantic has steadily changed in character over the past four decades, resulting in a sustained freshening of the deep and abyssal waters of the Northern North Atlantic — the headwaters of the global thermohaline circulation.

OS12P-03 1400h

^{129}I Ventilation Ages for Denmark Strait Overflow Water in the Labrador Sea

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^{129}I (half-life = 16 million y) discharged from nuclear facilities in France and the UK is transported through the North Sea into the Norwegian/Greenland Seas in 1-2 years. Deep mixing and convection in the Greenland Sea injects tracer ^{129}I into intermediate waters that overflow the sills between Greenland, Iceland and Scotland and ventilate the deep North Atlantic. ^{129}I is well suited to determining ventilation ages for North Atlantic Deep Water (NADW), because it has a direct pathway for injection into NADW source regions and provides an excellent comparison with ventilation tracers such as CFCs. An ^{129}I section measured across the Labrador Sea in 1997 showed decreasing levels with increasing water depth in Labrador Sea Water, with the lowest values (3-4 x 10^7 atoms/l) measured at 1800 m, close to the deepest historical extent of convection. The highest ^{129}I levels (> 15 x 10^7 atoms/l) were measured in Denmark Strait Overflow Water (DSOW), below 3000 m. From a comparison of ^{129}I/CFC ratios measured in DSOW with the Greenland Sea input function, a ventilation age of 2-3 y was estimated for DSOW. An ^{129}I section measured in 1999 showed that the ^{129}I concentration in DSOW increased by about 50% between 1997 and 1999. This is consistent with a predicted 50% increase in the Greenland Sea ^{129}I input function between 1995-1997 and a 2-3 year transit time to the Labrador Sea.

OS12P-04 1415h

FISHES 2001 and Vivaldi 1996; Two Recent Surveys of the Subpolar Northeast Atlantic

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Many detailed surveys have been made in the subpolar North Atlantic during the past decade. However, descriptions of the circulation vary in their pattern and magnitude. Satellite studies and eddy resolving ocean models indicate that eddies may dominate mean currents in some regions, effectively aliasing traditional basin scale ocean observations. However the region is important climatically and biologically. It is an area of cooling and deep winter mixing. Zooplankton distributions (specifically Calanus finmarchicus) are heavily constrained by the circulation. Thus it is an important area to understand dynamically.

Surveys made in the subpolar North Atlantic in 1996 and 2001 were designed to investigate the pathways of the North Atlantic Current and distinguish areas of eddy activity, particularly in the region between Iceland and Scotland. An upper ocean SeaSoar survey (0-400 m) with scattered full depth CTD casts was made in Oct - Nov 1996 (Vivaldi'96). Extending from west of Ireland and Scotland to East Greenland it showed clear current paths of warm stratified water flowing into the region and deep winter mixed subpolar mode water to the east and in the north Iceland Basin. However the vertical extent of mode water was greater than the SeaSoar could survey. Thus a second survey using full depth CTD casts was made in May-June 2001 to investigate the end of winter distribution of mode water. FISHES 2001 (Faroe - Iceland - Scotland Hydrographic and Environmental Survey) concentrated on the region between Iceland, the Faroes and Scotland. Results showed a large area of weakly stratified water extending 500-600 m vertically and spreading westwards from the Scottish shelf edge between the Rockall - Hatton and Faroe Plateaux out into the Iceland Basin. Circulation was weak and no clear current paths were apparent, but topography clearly influenced the distribution of mode water. Here we will discuss the circulation observed in the two surveys five years apart, contrast the distribution of mode water and investigate the factors affecting them.

OS12P-05 1430h

First Direct Thickness Observations of the Denmark Strait Overflow

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