scales. ABySS will use the physical connection between ocean surface altimetry and sea floor topography demonstrated in previous altimeter missions, but with two key innovations that will permit resolution of the critical transition to fractal behavior. A delay Doppler altimeter will obtain lower noise levels and reduced sensitivity to wave height; the improvement in surface gravity error amplitude of about a factor of 7 will reveal the transition to fractal scales. The use of a moderate inclination non-repeat orbiter (the International Space Station) will ensure that the resolution is isotropic in azimuth while still covering more than 80% of the oceans.

URL: http://fermi.jhuapl.edu/abyss

OS51D-09 1050h

A Parameterization for Abyssal Tidal Dissipation Based on Non-radiating Drag

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We present results from a high-resolution global numerical simulation of the M2 tide, building upon the work of Jayne and St. Laurent (presented at the last Ocean Sciences meeting). Using a scheme for internal wave drag over mid-ocean rough topography, they brought simulations of tidal elevation and abyssal dissipation closer to altimetric observations. We implement a scheme that differs from theirs in two major ways. First, it is an exact solution even with arbitrary topography as long as the topography is small-amplitude. More importantly for the present application, and following an established line of meteorological research, our scheme changes form based on the nondimensional mountain height NH/U. (Here N is the Brunt-Vaisala frequency, H is the mountain height, and U is the tidal velocity). When NH/U is less than an order unity parameter, drag is proportional to tidal velocity, as in the scheme used by Jayne and St. Laurent. When this parameter is exceeded, radiating waves and linear drag occur only at the tips of seamounts, while the flow below is deflected around the seamount, leading to a non-radiating drag quadratic with the tidal velocity. For typical values of N and U in the mid-ocean, H need only exceed 20 meters for the nondimensional mountain height to exceed unity. This suggests that flow-splitting may indeed be prevelant around mid-ocean topographic features. We examine the sensitivity of our tidal simulations to parameters in the dissipation scheme, and the relative strengths of propagating and non-propagating drag.

OS51D-10 1105h

Long Internal Gravity Waves as a Factor of Large-Scale Transport

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Traditional numerical modeling efforts are focused on quasi-geostrophic (QG) oceanic motions as the main factor of long-term oceanic variability. In particular, horizontal diffusion of scalars, such as heat and biogeochemical quantities, is modeled based on parameterizations of 2D eddy turbulence effects dominated by baroclinic QG motions, and the mean advection is attributed to ocean currents. However, the shallow-water equations also contain high-frequency solutions known as inertia-gravity (IG) waves. The role of the baroclinic (BIG) component of these motions, including internal tides, is the subject of this talk. Our theoretical and experimental studies indicate that these, essentially nonlinear, motions - which we treat as "wave turbulence" - may play an important role in the horizontal transport of tracers, in the spatial variations of tracer concentration, and in the overall energy and momentum balance in some ocean regions. High-latitude regions are affected by this mechanism to a greater extent, for the level of BIG wave turbulence there is comparable to that of QG turbulence. A review of our theoretical and experimental results is presented with an emphasis on accounting for latitudinal variations of BIG wave field properties.

OS51D-11 1120h

Nonlinear Energy Transfer Within the Oceanic Internal Wave Spectrum at Mid and High Latitudes

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In order to examine how the energy supplied by M_2 internal tides cascades through the local internal wave spectrum down to dissipation scales, two sets of numerical experiments are carried out where the quasi-stationary internal wave spectra at 49°(experiment I) and 28°(experiment II), respectively, are first reproduced and then perturbed instantaneously in the form of an energy spike at the lowest vertical wavenumber and M_2 tidal frequency. These experiments attempt to simulate the nonlinear energy transfer within the quasi-stationary internal wave fields over the Aleutian Ridge and the Hawaiian Ridge, respectively, both of which are generation regions of large amplitude M_2 internal tides in the North Pacific. In experiment I, the energy spike stays at the lowest wavenumber where it is embedded and the spectrum remains quasi-stationary after the energy spike is injected. In experiment II, in contrast, the energy level at high horizontal and vertical wavenumbers rapidly increases after the injection of the energy spike, exhibiting strong correlation with the enhancement of high vertical wavenumber near-inertial current shear. This implies that, as the high vertical wavenumber near-inertial current shear is intensified, high horizontal wavenumber internal waves are efficiently Doppler shifted such that the vertical wavenumber rapidly increases and hence enhanced turbulent dissipation takes place. The elevated spectral density at high vertical wavenumber near-inertial frequency band which plays the key role in cascading energy to dissipation scales is thought to be caused by parametric subharmonic instability. In experiment I, in contrast, M_2 tidal frequency is 1.2 times the inertial frequency at 49°so that M_2 internal tide is free from parametric subharmonic instability. Accordingly, even though large amount of M_2 internal tidal energy is available, it cannot be efficiently supplied for the local deep water mixing.

OS51D-12 1135h

Large Internal Waves in Massachusetts Bay: Modeling generation, propagation and dissipation.

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A comprehensive model to study the generation, propagation and shoaling of large-amplitude internal waves in Massachusetts Bay has been developed, to be used to interpret data collected during the 1998 Massachusetts Bay Internal Wave Experiment. The model solves the Euler equations in a two-dimensional channel with variable depth, mimicking the topography observed in Massachusetts Bay. Six different combinations of tidal forcing and stratification have been considered. Nonlinearity dominates the dynamics during the generation phase over Stellwagen Bank in all cases considered, when a depression forms over the bank during ebb (eastward) tidal flow. As the tidal current slacks and turns westward, the western side of the depression leaves the crest, undergoes an initial smoothing due to the effect of the dropping bottom, until it reaches Stellwagen Basin, where nonlinearity steepens the front until an undular bore develops. Forcing intensity and pycnocline depth are shown to control the release time and smoothing of the initial depression. The shoaling of the undular bore depends on the amplitude of the bore itself, as well as the depth of the pycnocline. If the amplitude of the first wave of the undular bore is such that the pycnocline is displaced deeper than the half-depth mark, a rarefaction wave is generated traveling onshore as the bottom shoals from the basin to the coast, while the flow near the bottom is strongly accelerated and the remaining waves making up the train become unstable and collapse. In this case, the flow becomes again hydraulically controlled. The collapse was observed in all cases except one, characterized by a shallow pycnocline and relatively small waves. In this case, the undular bore was able to reach the shoal area west of the basin with relatively minor transformations, coherent with the dynamics implied by KdV.

OS51E HC: 319 B Friday 0830h

Stratified Coastal and Estuarine Circulation VI

Presiding: **A Valle-Levinson,** Center for Coastal Physical Oceanography Department of Ocean, Earth and Atmospheric Sciences Old Dominion University**; C T Friedrichs,** Virginia Institute of Marine Science

OS51E-01 0830h

Observations of Hypersaline Conditions in Florida Bay by Airborne Remote Sensing.

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Observations of sea surface salinity from an airplane mounted Scanning Low Frequency Microwave Radiometer (SLFMR) have been obtained in a multi-disciplinary study of coastal buoyancy jets. These measurements include overflights of the Florida Bay region in June, 2001. The airborne salinity measurements provide rapid surveys of salinity over the region of the Bay on a time scale of a few hours. Simultaneous in-situ measurements of temperature and salinity were obtained from a coastal research vessel. Salinities in the Florida Bay waters have been observed above 45 psu. Hypersaline conditions in the Bay are due to very shallow depths, which limit circulation and exchange with offshore waters, so that the Bay acts as a hypersaline lagoon. Recent hypersaline conditions are also related to reduced freshwater flow from the Everglades region. SLFMR surveys are used to identify freshwater sources, their regions of influence on surface salinity in the Bay, and regions of limited circulation.

These observations of hypersaline conditions are at salinities above the range of the Klein-Swift model of seawater dielectric constant (used in the inversion of remotely sensed brightness temperature to salinity). At present the model is based on few data points at salinities above 35 psu. Efforts are being made to extend the Klein-Swift model to salinities over 45 psu (at high temperature) to calibrate these observations.

OS51E-02 0845h

Features of Coastal Buoyancy Jets Observed With an Airborne Surface Salinity Mapper

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Beginning in July, 2000, The Scanning Low Frequency Microwave Radiometer (SLFMR) was deployed in an NRL-sponsored multi-disciplinary study of coastal buoyancy jets (CoJet). The radiometer was flown several times over the continental shelves of the US east coast and Gulf of Mexico using a suitably outfitted twin-engine Piper Navajo Chieftain charter aircraft.

Using this system, extensive surveys of sea surface salinity distribution were obtained on a time scale of a few hours. The resulting data were corrected for known environmental influences and field calibrated using sea-truth data from oceanographic research vessels. The

accuracy, precision and spatial resolution of the resulting maps were found to be well-matched to the requirements of coastal ocean studies, particularly in regions characterized by moderate to strong salinity contrasts and a variety of forcing effects that evolve rapidly in time and space. The capability of the salinity mapping system is demonstrated by examples of coastal buoyancy features and transient changes observed over periods of several days.

The observed coastal plume features are described and interpreted in the light of supporting oceanographic and meteorological data, and the overall capability and utility of the system are briefly evaluated.

OS51E-03 0900h

Variability of Surface Salinity in the Northern Gulf of Mexico as a Consequence of the Seasonal Redistribution of River-Discharged Fresh Water

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The Navy Coastal Ocean Model is used to investigate the fate of freshwater discharged by large rivers in the northern Gulf of Mexico. For example, the wind-driven transport of buoyant river water in the vicinity of the Mississippi River delta shows a strong annual cycle. Model results indicate that during the fall and winter the Mississippi River plume is directed westward along the Louisiana-Texas shelf and remains insulated from the deep water as it is trapped to the coast. Conversely, during the spring and summer the buoyant river plume spreads over deeper water to the east of the delta where it is influenced by offshore circulation. For instance, mesoscale eddies associated with the Loop Current can entrain this water and transport it considerable distances. The variability of the surface salinity field in the northern Gulf of Mexico as a consequence of seasonal patterns in the redistribution of river-discharged fresh water is described from model results and compared with historical observations.

OS51E-04 0915h

Flow Patterns and Depositional Processes of the Ba Lat River Plume, Red River Delta, Vietnam.

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Nearshore oceanographic studies were undertaken in February-March and July-August 2000 on the intrusion of the Ba Lat river plume in the Gulf of Tonkin, for analysis of its freshwater and sediment transport. Observations in the river mouth and adjacent coastal zone were made using an ADCP and a CTD with attached OBS. These measurements reveal the vertical and horizontal structure of the river plume. The surface waters in the coastal zone were observed to be brackish and strongly stratified during the larger part of the wet season, caused by low mixing rates of river plumes with ambient water. The sediment concentration within the river plume is high, concentrations up to 600 mg/l were observed during a discharge with a one-year recurrence interval.

The flow pattern of the buoyant surface layer diverged strongly from the underlying and more or less shore-parallel tidal currents. The direction of this surface current is dominantly southward due to Coriolis forcing and the prevailing wind pattern. This southward geostrophic current is well developed due to the fresh water influx of other Red River tributaries, and the low degree of mixing. The buoyant surface layer is very sensitive to wind drag, and even during low relative wind speed the direction could be reversed to the north.

The dominant flow direction of the coastal current is opposite to that of the tidal currents during outflow of the turbid plume, which results in little advection of the river plume. The settling rate of suspended sediments is high, and the plume has lost most of its sediment within several hours. Deposition of plume sediments therefore takes place within a short distance of the river mouth.

URL: http://coast.geog.uu.nl/vietnam.htm

OS51E-05 0930h

Idealized numerical simulations of river plumes

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A series of numerical model runs are performed in an idealized domain to examine the formation and fate of a river plume. In regard to the formation of the river plume, effects of numerical resolution and advection scheme are considered, as well as parameterizations of estuarine circulation. The fate of the river plume is shown to be dependent on the inclusion of wind. In particular, an oscillatory wind stress (spatially uniform with zero time-mean) increases the along-shore dispersion of fresh water.

OS51E-06 0945h

Horizontal and Vertical Shear of Current Velocity Within the Plume Turning Region of the Chesapeake Bay Outflow

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A High Frequency (HF) radar system was deployed to map surface currents over the inner-shelf during the Chesapeake Bay Outfall Plume Experiments in the fall of 1996 (COPE-1) and 1997 (COPE-3). There were two ADCP moorings within the HF radar measurement domain during COPE-1 and five during COPE-3. The HF radar observed the bulk-averaged surface currents over the upper 1.5 m of the water column at 20-minute intervals. The horizontal bin size was 1 km2 over an area of approximately 30 km x 44 km. The HF radar observed currents agreed very well with the near-surface bins of the ADCPs. The most energetic component of the currents in the region was the barotropic M2 tide with the major axes of the tidal ellipses aligned with the Chesapeake Bay mouth. During COPE-3 ADCP moorings within the main shipping channels into the bay mouth revealed a baroclinic response with a large phase difference between a (0-5 m) deep surface layer and the bottom layer. The low-pass velocity fields were sensitive to the outflow from the estuary and the direct wind forcing. Morlet wavelet decomposition revealed several events with an energetic response of the surface velocities in the 30-50 hour period scale that were centered on the outflow channels. A similar analysis of the ADCP observed velocity profiles revealed that the energy was initially confined to the upper 5-m but spread downward with time. These high-energy events were forced by the local wind forcing and were linked to the presence and horizontal scales of the Chesapeake Bay outfall plume.

OS51E-07 1020h

A Modeling Study of the Three-Dimensional Continental Shelf Circulation off Oregon

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Sixty-day simulations of the sub-inertial continental shelf circulation off Oregon are performed for a hindcast study of summer 1999. Model results are compared with in situ currents, HF-radar derived surface currents and hydrographic measurements obtained from an array of moored instruments and field surveys. The correlations between observed and modeled alongshore currents and temperatures in water depths of 50 m are in excess of 0.8. The modeled three-dimensional, time-varying circulation and dynamical balances are analyzed, providing a detailed synoptic description of the continental shelf circulation off Oregon for summer 1999. In the region of the coast where the alongshore topographic variability is small the upwelling circulation is consistent with standard conceptual models for two-dimensional across-shore circulation. In the regions where the alongshore topographic variations are greater the upwelling circulation is highly three-dimensional. Over Heceta Bank the upwelling circulation is complicated, with weaker direct coupling to the wind forcing over most of the shelf. It is demonstrated that the upwelled water that is found over the mid-shelf off Newport is upwelled to the north and is advected to the south. During upwelling favorable winds the tendency of the alongshore depth-averaged velocity in the coastal jet is large and is driven by the difference between the southward surface stress and the bottom stress. Inshore of the coastal jet, the tendency is small and is driven by the difference between the surface stress and a negative alongshore pressure gradient. When the wind stress decreases, the tendency inshore of the jet is primarily balanced by a negative alongshore pressure gradient and a northward flow is generated. Subsequently, the alongshore pressure gradient decreases, the flow becomes geostrophic, and the northward flow persists until the next significant event. A region to the south of Newport over the inner-shelf is identified as the region where the northward momentum is initially generated.

OS51E-08 1035h

A Modeling Study of the Flow Instabilities Associated With the Coastal Upwelling Front.

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A three-dimensional, sigma-coordinate, primitive equation model (ROMS) is used to explore the dynamics of instabilities associated with the coastal upwelling front and determine the role these instabilities play in across-shelf exchange processes. A collection of experiments are performed to both gain insight into the processes and understand their potential significance in the real ocean. Simulations are first performed with alongshore-uniform bathymetry and steady upwelling favorable winds applied to an ocean initially at rest to illuminate the development of the instabilities. A sixty-day-record of real wind forcing is then applied over this same domain to examine the response over multiple upwelling events. One advantage of this domain is that it allows analysis of alongshore averaged fields for comparison with two-dimensional upwelling simulations which do not exhibit the instabilities. The role of alongshore variations in bathymetry is then considered with both the steady and real wind forcing in a periodic domain with topography representative of the Oregon Shelf. With steady winds and alongshore uniform bathymetry an oscillatory pattern on a scale of approximately 8 kilometers is visible along the upwelling front by day 5. As the upwelling progesses, the small-scale peaks and troughs of this pattern coalesce to form a growing disturbance on the front of increasingly greater wavelength. The simulation with multiple wind events shows that these small scale oscillations reappear superimposed on the pre-existing patterns within several days of each strong upwelling favorable wind event. Comparison of the time and alongshore-averaged density sections from this run with identical two-dimensional simulations without the instabilities, reveal that the frontal disturbances lead to the presence of significantly higher density water in the surface boundary layer farther offshore. The rate of development of the instabilities is sensitive to the local shelf bottom bathymetry. Consequently, the simulations with variation in alongshore bathymetry reveal regions along the coast that are particularly conducive to the development of the frontal disturbances and show the subsequent variations in instability growth associated with advection of disturbances into regions with different shelf topography.

FRI

OS51E-09 1050h

The Influence of Topography on Shelfbreak Frontal Currents

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Flow instabilities of shelfbreak frontal currents can provide significant temporal and spatial variability of the front, which can lead to the mixing of coastal and open ocean waters. Our recent study of the shelfbreak current in the Middle Atlantic Bight found the current to be highly unstable (with growth rates on the order of one day) over a wide range of background conditions. To test the applicability of these results to other shelfbreak frontal currents, we have assessed the degree to which topography influences the nature and strength of the instability of a baroclinic shelfbreak frontal current. To characterize the frontal instabilities, a linearized primitive equation stability model is employed to determine the three-dimensional propagation of perturbations superposed on a two-dimensional mean flow field, which varies continuously across the stream and with depth. The role of topography in destabilizing or stabilizing the flow is investigated for both retrograde and prograde jets. Additionally, the role of stratification in establishing the stability characteristics for retrograde and prograde jets is investigated.

OS51E-10 1105h INVITED

Preliminary Results of a New Dye Tracer Experiment at a Shelfbreak Front

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A pilot cruise to study the coupling of the circulation, mixing and productivity at the shelfbreak front on the New England shelf was conducted July 9-18, 2001. This was the first of 3 cruises of an interdisciplinary collaborative project involving Houghton and Marra (LDEO), Prater and Herbert (URI), and Hales (OSU). An objective was to test the hypothesis that nutrient rich water from the bottom boundary layer that detaches at the shelfbreak upwells along the front and sustains the summertime chlorophyll maximum at the base of the euphotic zone. A dye tracer and COOL floats were deployed to define a Lagrangian reference frame of the upwelling water while a pumping SeaSoar was used to monitor the nutrient and bio-optical properties of this water. Presented here are very preliminary results of only the dye tracer portion of the experiment.

Due to unanticipated technical limitations the tracer, Fluorescein, was injected into the outer edge of the cold pool at 50 m depth inshore of the front instead of near the base of the shelfbreak front as intended. In this region the isopycnal surfaces, virtually horizontal, have density compensating cross-shelf temperature and salinity gradients. The dye patch moved westward along the shelfbreak with a mean speed of 0.17 m/s. No significant upwelling or downwelling was detected. The dye patch moved slightly offshore through the T/S gradient on the isopycnal perhaps 2 km in 4 and a half days. Vertical shear in the flow produced profiles with multiple dye peaks and contributed to the lateral dispersion of the dye patch. From the rate of the variance increase of the dye patch we estimate a vertical diffusivitiy of 3×10^{-5} m^2/s in a region where the buoyancy frequency is 9×10^{-3} rad/s, i.e., period of 11 minutes. Cross-shelf and along-shelf diffusivities are estimated to be 0.3 and 6 m^2/s respectively.

OS51E-11 1120h

The Onset of Seasonal Stratification in the Southern Middle Atlantic Bight

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The Ocean Margins Program was a multidisciplinary exploration of processes leading to the transformation, retention, and export of biogenic materials on and from the broad continental shelf between Cape Hatteras and Chesapeake Bay. As this area forms the terminus of the equatorward coastal current, it was expected to exhibit maximal cross-shelf transports. The field effort took place from late winter through mid-summer. During this seasonal progression, the hydrographic structure undergoes a major transformation from unstratified winter conditions, to strongly stratified summer conditions. This change has a major impact on the chemical and biological processes in the area. This presentation describes how the hydrographic transformation takes place in an area where five water masses vie locally for dominance and are subject to strong wind stress, heat flux, and offshore forcing. A total of eight hydrographic cruises made repeated cross- and alongshelf transects in the area providing snapshots of conditions. In 1996, the shipboard hydrographic measurements were augmented by an array of 26 moorings, supporting 126 temperature and 118 salinity sensors. The mooring data has been optimally interpolated to provide a detailed, three-dimensional time history of the seasonal hydrographic evolution. The results show that the region is subject to large-scale intrusions from north and south, both of which materially affect the timing and development of stratified conditions. Intrusions from the north are wind driven and provide cold, moderate salinity, unstratifed water, delaying the development of stratified conditions. Intrusions from the south of warmer, generally more saline waters, driven into the area by alongshore winds from the South Atlantic Bight, and/or intrusions of Gulf Stream waters pushed shoreward by frontal eddies, tend to promote stratification. In 1996, an intrusion of saline water from the south, combined with decreased winds from the north, slowed the southward flow of cold Middle Atlantic Bight water, and subsequently caused low salinity Virginia Coastal Waters to spread from the coastal plume, out over the denser water from the north. With the reduced alongshelf flow, solar insolation and sensible heat fluxes were then able to warm the surface waters, providing an initial stratification, which was then further augmented by an outflow of low salinity coastal waters.

OS51E-12 1135h

On vertical advection truncation errors in terrain following numerical models: Comparison to a laboratory model for upwelling over submarine canyons

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Submarine canyons which indent the continental shelf are frequently regions of steep (up to 45 degrees), three-dimensional topography. Recent observations have delineated the flow over several submarine canyons during 2-4 day long upwelling episodes. Thus upwelling episodes over submarine canyons provide an excellent flow regime for evaluating numerical and physical models. Here we compare a physical and numerical model simulation of an upwelling event over a simplified submarine canyon. The numerical model being evaluated is a version of the S-Coordinate Rutgers University Model (SCRUM). Careful matching between the models is necessary for a stringent comparison. Results show a poor comparison for the homogeneous case due to non-hydrostatic effects in the laboratory model. Results for the stratified case are better but show a systematic difference between the numerical results and laboratory results. This difference is shown not to be due to non-hydrostatic effects. Rather, the difference is due to truncation errors in the calculation of the vertical advection of density in the numerical model. The calculation is inaccurate due to the terrain following coordinates combined with a strong vertical gradient in density, vertical shear in the horizontal velocity and topography with strong curvature.

OS51E-13 1150h

Observations of Current Driven Upwelling About the Separation Point of the East Australian Current.

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A multidisciplinary experimental program was undertaken during the 1998 − 1999 Austral Summer to investigate upwelling processes on the continental shelf of New South Wales (NSW) Australia. The observational program was conducted in the vicinity of the separation point of the East Australian Current (EAC), which is generally between Port Stephens and Coffs Harbour. Oceanographic time series data was obtained from two shore-normal arrays of current meters and thermistors moored across the continental shelf at Smoky Cape (30°55′S) and Diamond Head (31°44′S) for a 2 month period. Two intensive hydrographic surveys were also conducted aboard the RV Franklin during mooring deployment and retrieval.

The observations show that the EAC dominates the physical processes across the narrow continental shelf at Smoky Cape. It is responsible for driving colder nutrient rich water through the bottom boundary layer from the continental slope north of Smoky Cape into the near surface waters in the coastal region south of Smoky Cape. Furthermore, current driven upwelling occurs on a more massive scale than that driven by local wind forcing by an order of magnitude. North of the separation point the EAC is the dominant cause of upwelling, whereas south of the separation point local wind forcing also plays a role.

The findings of this study have implications for the prediction and possible management of algal blooms which can occur as a response to substantial nutrient enrichment events.

OS51F HC: 317 A Friday 0830h

The Science and Human Dimensions of Purposeful Ocean Carbon Sequestration

Presiding: **K Caldeira,** DOE Center for Research on Ocean Carbon Sequestration**; L J Hansen,** World Wildlife Fund

OS51F-01 0830h

Comparing pH impacts of oceanic CO_2 injection and atmospheric CO_2 release

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Direct injection of CO_2 into the ocean has been proposed as a means of diminishing the climate effects of fossil-fuel burning. The release of CO_2 to the atmosphere from the burning of fossil fuels increases atmospheric CO_2 content and warms the planet.

Direct injection of CO_2 into the ocean could produce significant reductions in deep ocean pH. However, the release of CO_2 to the atmosphere also drives a CO_2 flux into the ocean, thereby also decreasing ocean pH.

We have performed simulations of direct CO_2 injection and atmospheric CO_2 release using an ocean general circulation model. We have computed the volumes of ocean subject to pH perturbation as a function of the magnitude of pH perturbation. We find that the long-term, far-field effects of direct CO_2 injection are similar to the long-term, far-field effects of an equivalent atmospheric CO_2 release. However, direct CO_2 injection produces a region in the vicinity of the injection site with a pH change greater than that produced from atmospheric release. This is because atmospheric release results in CO_2 ingassing over the entire ocean surface, thus diluting the CO_2 impact on ocean chemistry.

To a first approximation, CO_2 released to the ocean or atmosphere ultimately adds the same amount of hydrogen ions to the ocean. Atmospheric CO_2 release introduces these hydrogen ions to the ocean over time and spreads out them out spatially across the entire ocean surface. Direct CO_2 injection introduces them to the ocean immediately and in a smaller initial volume of water. The advantage of direct injection is that it avoids most of the climatic effects of atmospheric CO_2 release.

Direct CO_2 injection can be engineered to minimize near-field pH consequences. If the far-field consequences of direct CO_2 injection are unacceptable, then atmospheric CO_2 release is likely to be similarly unacceptable. Methods have been proposed to diminish adverse impacts of CO_2 dispersal in the ocean, including the dissolution of calcium carbonate. Nevertheless, ocean CO_2 sequestration probably makes most sense within the context of the evolution towards a carbon-emission free economy.