OS32G HC: Hall III Wednesday 1330h

Ocean Dynamics and Instabilities I

Presiding: **D E Dietrich,** University of New Mexico**; B Qiu,** University of Hawaii

OS32G-212 1330h POSTER

Validating the GRACE Satellites for Ocean Bottom Pressure

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The GRACE satellites will be launched in March 2001, and will measure the gravity field of the Earth. Each month for 5 years they will produce a monthly-averaged gravity estimate sensitive to mass changes equivalent to a cylinder of water about 500 km in diameter and 1 mm in height (0.001 dbar in pressure). Month to month, the main source of geoid changes is the redistribution of water mass in the hydrosphere. Over the ocean the changes in the mass field are equivalent to changes in the bottom pressure. So the GRACE mission will allow us to generate monthly maps of the ocean bottom pressure. Many corrections, both instrumental and geophysical must be made: for example, the largest secular signal will be post-glacial rebound, which must be modelled out of the data. The issue discussed here is how to compare such GRACE bottom pressure estimates to in-situ bottom pressure recorder (BPR) data for the purposes of calibrating and validating the former.

BPRs historically have been placed on the ocean floor for 1-3 years. In the last decade, they have had accuracies on detided daily averages of order 0.007 to 0.020 dbar, with long term drifts that can be removed (by pre-presurizing the sensors before deployment, or empirically, or both) to a residual accuracy of order 0.010 to 0.020 dbar/yr. The presence of short spatial-scale variability in ocean bottom pressure (estimated from numerical ocean models) requires a certain minimum number of BPRs be deployed in an area so their average achieves an accuracy comparable to 0.001 dbar on monthly scales, but this minimum is regionally dependent. Short time-period variability in ocean bottom pressure brings up an additional issue of aliasing in the GRACE signal, which requires a combination of one month of the gravity data to produce an estimate of the geoid. The expectation of a 5-year mission and the need to retrieve results on a regular basis rather than wait 5 years requires that BPRs be deployed for 5 years with no interruption, but deliver data every year or so: this raises issues about battery life, alternating instruments, acoustic data transmission or data capsule release, and possible satellite transmission versus revisiting the site with ships. Finally, cost is always a concern. We discuss these issues and present possible solutions and configurations.

OS32G-213 1330h POSTER

A Perturbation Model of Radiometric Manifestations of Oceanic Currents

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Modulation of ocean surface roughness by currents provides a "window" for detecting and observing underwater processes with electromagnetic waves. Extracting quantitative oceanographic information from microwave images of the ocean surface requires a physical understanding and an efficient mathematical model of surface wave interaction with currents. In this paper, we consider "weak" currents (with velocities up to few tens of cm/s) and discuss a perturbation approach that leads to numerically efficient models of surface roughness modulation by the current fields with arbitrary dependence on horizontal coordinates and time. With the wave-atmosphere interaction being described within the relaxation approximation, closed-form analytic solutions are obtained to wave action balance equations which describe (a) propagation of individual wave trains and (b) spectral density of surface waves viewed as a random continuum. The hydrodynamic theory is combined with an electromagnetic model based on the small-slope approximation to simulate microwave emission from the ocean surface.

Analysis of the theoretical results demonstrates that physics of surface wave interaction with time-dependent currents, which are inhomogeneous in two spatial dimensions, is more rich and complex than suggested by one-dimensional models considered theoretically in the past. Of particular interest for remote sensing is the finding that realistic, two-dimensionally inhomogeneous currents, unlike their one-dimensional models, can produce perturbations in microwave brightness temperature with spatial scales much larger than that of the current field itself. Our model suggests that microwave brightness temperature measurements should be a sensitive tool of observing and quantitatively evaluating surface currents in the ocean.

OS32G-214 1330h POSTER

A Theoretical Investigation of Sea State Bias

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Two theoretical formulations of the sea state bias (SSB) by Srokosz (1986; hereafter S86) and Elfouhaily et al.(2000; hereafter E00) are applied to directional ocean wave spectra from WAM and from NDBC moored buoys collocated with Topex altimeter data. S86 SSB computations obtained for WAM with idealised ocean current fields reveal a quasi-linear relationship between the SSB coefficient and the r.m.s. wave slope, which remains valid for a wide range of wind/wave/current conditions. It is shown that the SSB coefficient is parameterised better in terms of slope, than significant wave height and wind speed as is presently used in empirical models.

The theoretical SSB for the buoys 2D wave spectra are compared with estimates from five recent empirical SSB models calculated from the collocated Topex data. The magnitude of the E00 SSB shows a strong sensitivity to the choice of high frequency tail model used to extend the 2D wave spectra, and best agreement with empirical estimates is seen when the influence of short waves is minimal. Similarly, the long-waves-only S86 theory displays better agreement with the empirical SSB models than the E00 theory extended to include short waves effects. Thus, the sea state bias appears to be primarily governed by the slope of long gravity waves, presumably through its well-documented influence on the modulation of short waves.

Given a suitable high frequency tail, the E00 theory can adequately model the radar frequency dependence of the SSB, but at the expense of good quantitative agreement with the empirical SSB models. The E00 theory introduces a new dependence of the SSB on the spectral peak period through its choice of short/long wave discrimination criterion, although no empirical evidence is available at this stage to establish the physical validity of this feature.

OS32G-215 1330h POSTER

Model Validation Using WOCE-SVP Drifters

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Numerous studies have been made comparing output from numerical ocean models to quasi-Lagrangian drifter data. The objectives and methodology of the studies vary, but most entail calculation of derived quantities from time series of both observed and model drifter positions. The success of a model in reproducing properties of the real ocean is then measured by comparing these quantities using a validatory metric. The choice of metric is guided by the questions that model output is expected to answer. The use of ocean models in support of U.S. Navy mine warfare and search and rescue missions suggests that observed and model mixed-layer drifter position data should be useful not only in deriving complex validatory quantities, but also for direct comparison using a positional persistence metric. This metric permits the most basic assessment of model predictive skill in forecasting the advective path of a Lagrangian drifter. A drifter test methodology utilizing the metric is presented and then used with WOCE-SVP drifters to assess a pre-operational ocean model.

OS32G-216 1330h POSTER

Effect of Wave-Current Interaction around Eddy on Wave Field

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The spatial change of current field accompanied by eddy modulates the wave propagating through the eddy. The studies dealing the effect of eddy have been concentrated on ocean waves far away from the eddy. The effect of wave-current interaction in eddy field is studied by using the ray tracing method.

Though the current field of eddy is made by its tangental and radial components, previous studies concentrated to the effect of tangental component. In this study, the effect not only of the tangental component but also of radial component is also analyzed. The eddy model by Mathiesen (1987) is adopted to the profile of both velocity components.

Because of the wave-current interaction, the rays show complicated feature. In the area where the wave propagating direction is same with the current, the rays shows smooth propagation of waves. On the other hand, in the area where the wave propagates against the current, the wave changes its propagating direction and wave number. Some wave components are trapped by the eddy, and such wave components may not develop. Not only the change of propagating direction, but also the change of wave number plays important roll in the modulation of ocean wave. The amplitude distribution shows large spatial change around the eddy. In the area where the current direction is same with wave propagation, the amplitude becomes smaller. In the area where wave propagates against the current, though there are some area the wave cannot propagate, the amplitude becomes large. When wave propagates through the eddy, there are spatial change of amplitude almost parallel with the wave propagation.

Because of the wave-current interaction, the amplitude of a certain wave component changes spatially. The analysis is based on ray tracing method, the effect of wave generation and dumping is not included. However, the tendency of amplitude distribution agrees with the feature of HF backscatter spectra from the area around eddy obtained by HF ocean surface radar. It shows the ray tracing method is valid to analyze when the scale is agree with the 10 km scale phenomena.

W E D

OS32G-217 1330h POSTER

The Growth and Decay of Meanders in a Spin-Down Isopycnic Channel Model Initialized with Gulf Stream Data

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A 6-layer version of the Miami Isopycnic Coordinate Ocean Model (MICOM) configured in a 1000 × 2000 km periodic channel with 5 km horizontal resolution is used to study the nonlinear instability of the Gulf Stream system. The model is initialized with isopycnal surfaces derived from Halkin and Rossby's 1985 analysis of the mean Gulf Stream structure at 73° W. The model is run for two years in a cyclic spin-down configuration. The model configuration excludes surface winds, topographic effects, and thermodynamic forcing, in order to study the meander development solely due to the internal dynamics of the flow during initial meander development and the evolution of the meandering spectrum toward a turbulent equilibrium state.

The model jet spontaneously develops meanders that share several characteristics of Gulf Stream meanders: the model meander phase speeds decrease as the meander wavelengths increase; they develop a pronounced westward axial tilt as they evolve; and warm and cold core rings form that interact strongly with the jet. Meander phase speeds measured from direct injection of known-wavelength EKE into the cyclic spin-down configuration compare favorably with measured Gulf Stream dispersion curves, as do temporal growth rates determined from the basin-averaged EKE and EKE conversions.

Basin-average energetics reveal an initial baroclinic release of eddy kinetic energy. The model's growth of EKE is controlled at finite amplitude by the reverse barotropic conversion of EKE to mean kinetic energy, consistent with the "barotropic governor" mechanism of James and Gray (1986).

Subsequent development of meanders is influenced by a "closed-loop" energy cycle involving the production of EKE at 300 km by the baroclinic conversion, followed by the shifting of the EKE wavelengths to between 500-1000 km through the enstrophy cascade. The reverse barotropic conversion depletes the long wavelength EKE by converting it to mean kinetic energy.

The excess MKE is restored to the pool of available potential energy, where the process repeats.

OS32G-218 1330h POSTER

Duo-Resolution North Atlantic Ocean/Gulf of Mexico Model

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A duo-resolution North Atlantic/Gulf of Mexico model is developed and applied using two fully coupled grids: a high resolution grid west of 60 deg west and low resolution grid east of 60 deg west. This facilitates efficient resolution of the Florida straits and passages between the Caribbean Sea and North Atlantic ocean, and the strong currents and eddy fields from South America to the Grand Banks.

New surface and lateral boundary conditions are applied which eliminate siginificant errors and physical inconsistencies compared to models using conventional surface restoring and latitudinal sponge layers. By design, the ensemble average of the model annual cycles tracks annual cycle surface climatological data precisely, with no phase lag or amplitude errors. The model is fully fourth-order-accurate, with low numerical dissipation and dispersion.

URL: http://www.ssc.erc.msstate.edu/DieCAST

OS32G-219 1330h POSTER

Investigation of Sea Surface Temperature Tendencies During 1985-1999 Using NOAA/NASA Satellite AVHRR Oceans Pathfinder Data Set

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The NOAA/NASA 9-km satellite AVHRR Oceans Pathfinder Sea Surface Temperature Data Set is used to investigate the global distribution of sea surface temperature (SST) tendencies during the 1985-1999 period. The advantages of using this vastly improved data set are its virtual global coverage and high resolution not provided by any *in situ* observations which have been used extensively for studying climate change. Our preliminary results reveal interesting global patterns during the period of study, such as pronounced warming in the eastern equatorial Pacific Ocean, northern/northeastern North Pacific Ocean, and eastern Atlantic Ocean but neutral or even cooling in regions of the western equatorial Pacific Ocean. These tendencies are examined for their statistical significance and the results discussed in the context of studies based on the *in situ* records, which span a longer time period but have less spatial coverage. The major ENSO event of 1997-1998 is shown to have a significant contribution to SST warming tendencies in low-latitude regions and poses the question of how to include major ENSO event years in an examination of SST tendency.

OS32G-220 1330h POSTER

Interannual Variability of the Brazil-Malvinas Confluence

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Altimetry data from 8 years of the TOPEX/POSEIDON mission are analyzed to study the variability in the Southwestern Atlantic Ocean, with a focus on the Brazil Malvinas Confluence (BMC) region. This frontal zone formed by the merging of the southward flowing Brazil Current and the northward flowing Malvinas Current is one of the most energetic regions in the world oceans and varies on a wide range of spatial and temporal scales. The interannual variability in the BMC is characterized by a 2-3 year oscillation between an enlongated state and a contracted state. In the enlongated state, the Brazil offshore extension has a relatively high kinetic energy and a greater zonal penetration to the east. In the contracted state, the kinetic energy maximum reaches its southermost position and the high kinetic energy tongue along the subtropical front contracts. An empirical orthogonal function (EOF) analysis of the ssh anomaly data indicates an increase of the mean zonal ssh gradient across the BMC during the contracted states, particularly in 1995/1996 and 1999/2000. It suggests an anomalously strong southward flow in the BMC region during this state. One possible forcing mechanism for this low-frequency variability is the direct response of the BMC region to the wind-driven subtropical gyre. The subtropical gyre intensity is anomalously stronger during the years when the BMC is in its contracted state.

OS32G-221 1330h POSTER

Observing the Agulhas and Madagascar Retroflections

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The oceans around South Africa contain two important retroflecting current systems the Agulhas Retroflection to the south of South Africa and a smaller system to the south of Madagascar. Both are rapidly evolving, with considerable change in the position of the currents, and the shedding of eddies. To understand the evolution of these systems we examine data from three different spaceborne sensing systems ATSR (Along-Track Scanning Radiometer), TMI (TRMM Microwave Imager) and SeaWiFS. ATSR is an infrared radiometer providing sea surface temperature (SST) at high spatial resolution; the problem of cloud cover means that short-period composites are often far from complete. TMI determines SST from microwave emissions; this affords a view through most clouds, but the spatial resolution is much poorer. SeaWiFS uses visible wavelengths to provide ocean colour images related to chlorophyll content; it suffers from similar cloud problems to ATSR. None of these sensors provide a direct measurement of currents, but give an indication of coherent flow features.

The TMI SST data, though limited latitudinally, show westward progradation of the Agulhas Retroflection (associated with ring shedding) about eight times per year in the period 1997-1999. This agrees with previous estimates. However, this behaviour is seen to change in the 2000-2001 period, with the Agulhas Retroflection occurring further to the east. Another new observation from the TMI data is that, although the first northward meander of the Agulhas Return Current is constrained by bathymetry, its position does vary intermittently, remaining fixed in a given location for up to six months at a time.

OS32G-222 1330h POSTER

A Simulation for Deployment of Argo Floats

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An international project named Argo started in 2000. In this project, approximately 3000 profiling floats will be deployed in the world ocean to build a real-time monitoring system of the upper and middle layers of the ocean. Argo floats drift at a specified depth (usually 2000m), and rise up to the sea surface every specified period (usually ten days) measuring temperature, salinity, and pressure with the CTD sensor. They stay at the sea surface for a half day transmitting the CTD data to ARGOS satellites, and then return to 2000 m depth.

Japan will deploy approximately 400 Argo floats in the western part of the North Pacific and a part of the tropical Indian Ocean. In order to deploy floats over these areas as efficiently and uniformly as possible using limited cruises available, the Frontier Observational Research System for Global Change and the Japan Marine Science and Technology Center (JAMSTEC), the main organizations to implement the Japan ARGO project, are performing a numerical simulation for float deployment using velocity data of the JAMSTEC High-Resolution OGCM. Method and application of this simulation are presented.

One of the applications is a hypothetical experiment to examine the characteristics of drift of Argo floats in the western part of the tropical and North Pacific. In the experiment, a number of floats were initially distributed uniformly over the whole area, and their movements were computed using the model velocities at the sea surface and at 2000 m depth alternately for the respective periods equal to the realistic ones. In the long term, the floats drift mainly southwestward at $20^\circ S - 0^\circ$ and northwestward at $0^\circ - 25^\circ N$ in the tropics, and southeastward at $30^\circ - 50^\circ N$ in midlatitude. These are quite similar to the directions of currents at the sea surface. The deployment of Argo floats is relatively easy in mid-latitude, because the floats launched just east of Japan are drifted eastward and spread over the area. It is more difficult in the tropics where the floats are drifted westward and hence need to be launched in the eastern part of the area which is far from Japan. The deployment is particularly difficult near the equator where the floats diverge poleward and need to be supplemented regularly.

URL: http://www.jamstec.go.jp/J-ARGO/

OS32G-223 1330h POSTER

Propagation of 4-6 Days Variations of Sea Level South of Japan and its Impact on the Kuroshio Path

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Sea level variations on the south coast of Japan were analyzed in terms of variations of Kuroshio path using the frequency domain empirical orthogonal function (FDEOF) and the extended EOF (EEOF). The Kuroshio south of Japan has two types of current path, large-meander (LM) and non-large-meander (NLM) paths. In the transition stage from NLM to LM (i.e., the formation stage of large meander), a small meander of the Kuroshio occurs southeast of Kyushu, propagates eastward, and grows to the large meander. Small meander occurs frequently, about twice a year. Most of them decay during a propagation and cannot develop to the large meander. Existence of small meander is well monitored by the third mode of FDEOF of sea level for periods of 20-80 days. Another prominent feature of sea levels is westward propagation of variations with periods of 4-6 days. We analyzed this propagation in detail with EEOF and examined a relation of the sea level disturbance to an occurrence of small meander.

For the sea level variations for periods of 4-6 days, the first to sixth modes of EEOF account for 51% of the total variance. The first and second EEOFs are almost in phase south of Japan, while the third to sixth EEOFs are in phase east of the Boso Peninsula and propagate westward from the peninsula. Phase speed of the third and forth modes is 2.3 and 4.4 m/s to the east and west of the Kii Peninsula, respectively. That of the fifth and sixth modes is 1.6 m/s throughout the south coast of Japan.

Disturbance in sea level at south of Kyushu formed by the westward propagation seems to be related with generation of small meander in case of large velocity of the Kuroshio south of Kyushu; a small meander generates about 50 days after the disturbance develops largely. This takes place for about 50% of the occurrence of significant disturbance. Such a disturbance may play a role of trigger for generation of a small meander when the Kuroshio velocity is large.

OS32G-224 1330h POSTER

Variability of the North Pacific Subtropical Mode Water simulated by an Ocean General Circulation Model

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Mechanisms of the variability of the North Pacific Subtropical Mode Water (NPSTMW) are examined using an ocean general circulation model. The wind stress and the surface heat flux over the formation area locally force the thermal structure of the NPSTMW in the interannual time scale rather than the decadal time scale. In the decadal time scale, the change in the NPSTMW temperature is mainly influenced by that in the background bowl structure of the thermocline due to dynamical adjustment of the subtropical gyre to the basin-wide wind stress change. That is, the warm (cold) NPSTMW results from the deep (shallow) bowl structure of the thermocline. Moreover, changes in the Kuroshio transport and the NPSTMW temperature simultaneously occur. These results are not in agreement with the previous study that the heat advection by the Kuroshio affects the NPSTMW temperature with time lag of 2 years.

OS32G-225 1330h POSTER

Eddies in the South of the Subtropical Gyre of the South Pacific Ocean

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The objective of this study is to investigate the occurrence of eddies in the Southern part of the South Pacific Subtropical Gyre in French Polynesia using satellite altimetric and Acoustic Doppler Current Profiler (ADCP)data for the purpose of fisheries. The altimetric data show eddies with diameter of 100-400 km with a lifetime of at least 2 to 3 months in the latitude interval 15-35S, that is, centred several degrees north of the subtropical convergence. These eddies, located around the Austral islands and seamount chain, seem stationary. The stationary state is perturbed during an El Nino year. ADCP data obtained from two cruises in the South of French Polynesia are consistent with TOPEX/Poseidon altimetric data. The better spatial resolution of the ADCP shows that eddies in the South of French Polynesia smaller than 100 km could also exist. The origins of the eddies will be discussed.

OS32G-226 1330h POSTER

A Statistical Model for Time-Varying Wind-Driven Currents Based on Altimeter and Pacific Drifter data.

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Ralph and Niiler (JPO 1999) analyzed long-term mean ageostrophic circulation measured by WOCE drifters at 15m depth in the tropical Pacific. Their best statistical model had both the amplitude of the current and its vertical scale proportional to wind speed and inversely proportional to the square root of the Coriolis parameter. The 15m ageostrophic current vectors were optimally described by an angle to the wind and a magnitude proportional to the wind speed. We have repeated this analysis with 2-day averaged (i.e. time dependent) drifter data.

This allows us to explore the latitude variability of the angle between the wind and the 15m velocity, the proportionality of wind-driven current to wind speed, and optimal horizontal smoothing scale for computing geostrophic currents from the altimeter-derived SSH fields. Altimetry products (both along-track SSH and 2-D mapped fields) were used to estimate and remove the geostrophic velocity, reducing the variance of the observations by up to 70%. Wind model parameters were optimized on the residuals, reducing their variance by up to 30%. Winds from both NCEP and Atlas (Atlas, et al., JGR 1999) products were compared for efficacy in terms of variance explained.

OS32G-227 1330h POSTER

Regime shifts found in the Northern Hemisphere SST field

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A 'regime shift' is characterized by an abrupt transition from one quasi-steady climatic state to another, and its transition period is much shorter than the lengths of the individual epochs of each climatic state. In the present study, we investigate when regime shifts occurred and what was the difference in climatic states before and after the shifts, using the wintertime sea surface temperature (SST) field in the Northern Hemisphere. The relationship between changes in the SST field and those in the atmospheric circulation is also investigated.

In order to detect organized patterns of the SST variations, we adopt an empirical orthogonal function (EOF) analysis. As the results, the first mode is identical to El Nino/Southern Oscillation (ENSO) and so-called Pacific Decadal Oscillation (PDO), and corresponds to the Pacific/North American (PNA) pattern. The second mode, which relates to the Arctic Oscillation (AO), has a zonally elongated signal in both the North Atlantic and the North Pacific. EOF analyses to each oceanic basin are made separately and the robustness of these modes is confirmed.

In the present study, we define the regime shifts as the 'significant' and 'systematic' changes between the two quasi-steady states continuing more than 5-year. Then, in order to identify the years when regime shifts occurred in the SST field, we carefully inspect the time series of original gridded SST data and those of the EOF modes. As a result, six regime shifts are detected in the study period from the 1910s to the 1990s: 1925/26, 1945/46, 1957/58, 1970/71, 1976/77 and 1988/89. It is ascertained that the shifts at almost all grids are completed within one year. All regime shifts having similar SST and atmospheric circulation pattern including the changes in an intensity of the Aleutian Low (AL) and the corresponding SST changes in the central North Pacific. All regime shifts can be described well by the combination of the first and the second EOF modes. Duration between each regime shift is about 10 years, which are identical to the PDO. The simultaneous shifts in the first and the second EOF modes imply that the change in the AL activity associated with the PNA pattern might have some connection with that of the AO.

OS32G-228 1330h POSTER

Interaction between Island and Ventilated Thermocline: Implication for the Hawaiian Lee Countercurrent

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The interaction between an island and the wind driven subtropical circulation is investigated using a $2^1/_2$-layer ventilated thermocline model. The island is located in mid gyre and equatorward of the gyre center in order to simulate the Hawaiian Islands. The presence of the island creates three new dynamic regimes west and southwest of the island: one where the 2nd layer is at rest (the island shadow zone), one where the 2nd layer potential vorticity (pv) is determined by the western boundary current (wbc) outflow conditions at the northern tip of the island, and one where the pv is determined by the wbc outflow conditions at the southern tip. Each of the above regimes affects the baroclinic structure of the zonal jet extending westward from the southern tip of the island. We investigate the impact of the model on the Hawaiian Lee Countercurrent (HLCC), an eastward current crossing the western Pacific at the latitude of the southern tip of Hawaii (18°–20°N). We show that the HLCC is determined not only by the anomalous Ekman pumping generated by the presence of the islands, but also by the effect of the islands on the broader-scale Sverdup flow east of the island. In particular, the model predicts a zonally varying baroclinic structure in the HLCC which is consistent with observations.

OS32G-229 1330h POSTER

Interannual to Interdecadal Upper Ocean Variability in the Northeast Pacific

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Low frequency variability over the northeast Pacific is examined in terms of the one-dimensional response to local Ekman pumping according to the Hasselmann (1976) stochastic climate model. The model is forced with monthly wind stress curl anomalies derived from the NCEP reanalysis for the period 1948-2000. An empirical orthogonal function (eof) analysis shows that the leading mode of the response bears the signature of the Pacific Decadal Oscillation, and that the associated principal component captures the 'regime shift' of 1976/77. Comparisons between hindcast anomalies and in situ observations of pycnocline depth anomalies at Station P (215E, 50N) yield a correlation coefficient of 0.77 over the 43 year period 1957-1999. A further comparison with sea surface height anomalies derived from over 8 years of T/P altimetry data is presented. This shows good agreement in the spatial and temporal structure of the leading eofs between the model and observations. Overall, the results indicate that variability in upper layer thickness on interannual to interdecadal time scales over the northeast Pacific occurs largely as an integrated response to local Ekman pumping.

OS32G-230 1330h POSTER

Coastal Promontories and Associated Processes in the Coastal Ocean

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Coastal promontories or headlands are found along the coast of the world. Their shapes and sizes vary and so the hydrodynamic conditions around the promontories. In tide-dominated environment strong tidal mixing tends to lower the surface water temperature near the promontory, and the tidal front may develop between stratified offshore water and well-mixed coastal water. Strong current velocity is also found around the tip of the promontory and it is associated with the sea level depression. The maximum sea level depression is found at the minimum radius of curvature. Eddies may also develop due to the velocity shear caused by vorticity generation. Park and Wang (2000) suggested that the topographic vorticty tendency is responsible for the strong vorticity generation. Acceleration and deceleration of currents together with velocity shear result in net sediment movement around the coastal promontory. It has been shown that the promontory normal to the tidal stream is unstable and it tends to rotate cyclonically from the axis normal to the tidal stream. This study shows some examples of processes associated with coastal promontories and discusses the mechanisms responsible for those.

Park, M.-J. and D.-P. Wang 2000 Tidal vorticity around a coastal promontory, Journal of Oceanography, 56:261-273.

OS32H HC: 318 A Wednesday 1330h

WED

Air-Sea Exchange I

Presiding: **R Feely,** NOAA Pacific Marine Environmental Laboratory**; W McGillis,** Woods Hole Oceanographic Institution

OS32H-01 1330h

Equatorial Pacific Direct Air-Sea Carbon Dioxide Fluxes

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CO_2 exchange across the air-sea interface is an important mechanism in modulating global climate and the absorption of anthropogenically produced CO_2. Depending on the time of year, different regions of the ocean can be sources or sinks for atmospheric CO_2. Currently, it is estimated that the ocean as a whole acts as a sink for CO_2, taking up about 2 gigatons per year of the approximately 5.5 gigatons of carbon dioxide produced by industrial and agricultural activity. However, there is significant uncertainty in this estimate, largely because the kinetics of ocean-air CO_2 transfer are not well understood.

In February, 2001, the GasEx-2001 study took place aboard the NOAA Research Vessel Ronald H. Brown in the Eastern Equatorial Pacific near 3°S 125°W. The