

OS42T-09 1550h

**Global patterns of heat storage from TOPEX/POSEIDON**Olga T. Sato<sup>1</sup> (55-12-3945-6484; olga@ltid.inpe.br)Paulo S. Polito<sup>1</sup> (55-12-3945-6484; polito@ltid.inpe.br)

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Global patterns of oceanic heat storage derived from sea surface height anomaly signals from the TOPEX/Poseidon altimeter data are investigated. The height anomaly data spanning the period from 1992 to 2000 are decomposed through 2D finite impulse response filtering. The filtered components are the basin-scale (seasonal, ENSO), westward propagating (Rossby waves), eastward propagating (Kelvin waves), meso-scale eddies, and a small-scale residual. This decomposition results in a set of 316 global maps per component.

To analyze the spatial patterns of each spectral band the correlation between each map and a reference map was calculated. This reference map corresponds to a non-El Nino and a non-La Nina state. That choice avoids most of the predictable biases. Maps that result in a positive correlation are added and maps with a negative correlation are subtracted from the reference map. As a result we obtained a mean pattern for each component. The amplitude and the spatial regularity of these patterns are commensurate with the persistence of the filtered signals. That allows for the detection of areas where the waves are more likely to occur. The tropical instability waves are very intense in eastern tropical Pacific as meridionally coherent signals. Rossby waves patterns are relatively weak in the Atlantic. In all basins they form regular patterns indicating the meridional dependence of their phase speed. The basin-scale signal is dominated by seasonality and clearly shows the presence of the ITCZs.

OS42T-10 1605h

**Deviation of Long Period Tides from Equilibrium: Kinematics and Geostrophy**Gary Egbert<sup>1</sup> (541-737-2947; egbert@coas.oregonstate.edu)Richard D. Ray<sup>2</sup> (301-614-6102; richard.ray@gsfc.nasa.gov)

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New empirical estimates of the long period fortnightly (Mf) tide obtained from TOPEX/Poseidon (T/P) altimeter data confirm significant basin-scale deviations from equilibrium. Elevations in the low-latitude Pacific have reduced amplitude and lag those in the Atlantic by 30 degrees or more. These inter-basin amplitude and phase variations are robust features, which are reproduced by numerical solutions of the shallow water equations, even for a constant-depth ocean with schematic interconnected rectangular basins. A simplified analytical model for co-oscillating connected basins also reproduces the principal features observed in the empirical solutions. This simple model is largely kinematic. Owing to blocking of zonal flow by continents, elevations within a closed basin would be nearly in equilibrium with the gravitational potential, except for a constant offset required to conserve mass. With connected basins these offsets are mostly eliminated by inter-basin mass flux. Because of rotation this flux occurs mostly in a narrow boundary layer across the mouth and at the western edge of each basin, and geostrophic balance in this zone supports small residual offsets (and phase shifts) between basins. The simple model predicts that this effect should decrease roughly linearly with frequency, a result that is confirmed by numerical modeling and empirical T/P estimates of the monthly (Mm) tidal constituent. This model also explains some aspects of the anomalous non-isostatic response of the ocean to atmospheric pressure forcing at periods of around 5 days.

OS42T-11 1620h

**Constant potential vorticity hydraulically controlled flow-complexities from passage shape**

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Velocity, surface height profiles, and volume flux are calculated for critically controlled channel flow of a layer of rotating fluid. A variety of channel cross-stream bottom profiles are considered. The upstream fluid possesses constant potential vorticity. Velocity and surface height distributions, and control criteria are presented for three features that seem to be unique to rotating fluid. These are: sizeable gyres that appear upstream of controlled passages; the existence of more than one critical flow configuration for a single passage (with bottoms of certain special shapes); and strict limits to the value of volume flux for a passage with small bottom slope at right angles to flow direction. In addition, examples are shown of cases in which multiple exits allow flux to exceed a rigorous bound that has been derived for flux out of a passage

OS42T-12 1635h

**Mechanisms and Predictability of Midlatitude SST Anomalies.**Robert B Scott<sup>1,2</sup> (1 609 452 6519; rscott@princeton.edu)Geoffrey K Vallis<sup>1,2</sup> (1 609 452 6528; gkv@princeton.edu)

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The predictability of sea surface temperature (SST) on seasonal to longer timescales is investigated using an idealized, stochastic, climate model and analysis of observational data. It is argued that the crucial factor determining the SST anomaly predictability is the fraction of SST anomaly variance that can be attributed to deterministic forcing. A simple relation is derived to give the predictability in terms of the variance of the stochastic and deterministic portions of the SST anomaly time series. Analysis of observational data of terms in the upper ocean temperature tendency equation, obtained from Bo Qiu of SOEST, was based on a variety of data sources: surface geostrophic currents from the TOPEX/Poseidon altimetry, subsurface data from the Joint Environmental Data Analysis Center, and other surface marine data from the NCEP/NCAR reanalysis project. It was revealed that for the Kuroshio Extension Region, the advection of the time mean temperature gradient by anomalous geostrophic currents is the dominant source of variability. This suggests that the predictability of the anomalous geostrophic currents in the Kuroshio Extension may be the limiting factor determining the SST predictability of that region. This analysis was extended to other regions and different length scales and timescales.

URL: <http://www.gfdl.noaa.gov/~rbs>

**OS42U HC: 323 B Thursday 1330h Suspended Material**

OS42U-01 1330h

**Error model for PUV wave direction and spreading measurements**

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We present a Monte Carlo error simulation for PUV wave direction and directional spreading measurements, and we evaluate the model by comparing wave measurements using an Aquadopp Current Profiler and a Vector Velocimeter. The uncertainties of both direction and spreading depend on the actual wave spreading, plus the signal/noise ratio and the amount of averaging. Three separate wave generation events are apparent in the data. The error model predicts an uncertainty of 0.5° for the computed mean wave direction for each of these events, and the data are consistent with this result.

URL: <http://nortekusa.com/prin-waves.html>

OS42U-02 1345h

**Empirical Light Scattering by Natural, Randomly Shaped Particles from 0.1 to 20 Degrees - Counterpart to Mie Theory**Yogesh C Agrawal<sup>1</sup> (4258672464; yogi@sequoiasci.com)

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There are no known empirical data on the light scattering properties of randomly shaped natural particles in the near-forward region. The most thorough prior work in this context is reviewed and done by Volten et al. (JGR v106, D15, pp17,375-401). They did not address the size-resolved properties, as a counterpart to Mie theory for spheres.

We have obtained the multi-angle scattering properties of narrow size-ranges of particles. Natural particles were separated by hydrodynamic size in a stratified column. This permitted size separation as small as 0.1φ (or 8 per cent), down to a size of a few microns. Multi-angle scattering was observed with the LISST-100 instrument that covers the range 0.1 to 20 degrees. By filtering withdrawn samples, we have established absolute scattering strengths.

The results are intriguing. For particles with *ka* larger than about 200, the main scattering lobe matches Mie predictions. However, beyond the first, no subsequent minima are seen. For finer particles, scattering signatures depart dramatically from Mie predictions, altogether lacking a well-defined minimum of the first diffraction peak.

We shall discuss these observations in light of known theoretical models. Evidently, this strong difference with Mie theory invites questions regarding backscatter properties.

URL: <http://www.sequoiasci.com>

OS42U-03 1400h

**Bottom Boundary Layers and the Jungian Distribution of Particle Sizes Strangers in the Night?**Ole Aarup Mikkelsen<sup>2</sup> (+ 45 35 32 25 00; oam@geogr.ku.dk)Yogesh C Agrawal<sup>1</sup> (425-867-2464 ext 106; yogi@sequoiasci.com)

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The assumption of a Jungian form for the size-distribution of suspended particles in marine boundary layers is common in literature. This power-law form has been employed to infer gross apparent optical properties also. With the large sets of field data on size distribution in bottom boundary layers that have been obtained with the LISST series instruments, the use of a canonical form for the size distribution is called into question. Furthermore, there are fundamental reasons rooted in availability of suspended particles in boundary layers that argue against the likelihood of a canonical form. In this paper, we shall review field measurements in contrast to Jungian forms. When Jungian distributions are fitted to published size distribution data, we find that the Jungian fit can hardly ever be transformed back into the original size distribution without a significant error in including all the suspended volume. The magnitude of the error and its importance for the use of Jungian fits is discussed.

OS42U-04 1415h

**The Impact of Higher Tidal Ranges on Assessing Marsh Surface Condition Using Thematic Mapper Data**Michael S. Kearney<sup>1</sup> (301-405-4057; mk11@umail.umd.edu)

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The rapid degradation and loss of coastal marshes in many areas of the US Atlantic and Gulf Coasts calls

for new approaches for updating coast-wide information on marsh condition, especially in light of forecasts predicting a significant increase in the rate of global sea level rise. Conventional aerial photographic techniques can be expensive and, more importantly, do not lend themselves to timely regional assessments of changes in coastal marshes. Landsat Thematic Mapper, with its relatively high spatial resolution, satisfactory spectral characteristics, and frequency of observations, provides a potentially useful tool for making regional appraisals of changes in marsh surface condition. We have developed a three-component spectral mixing model that classifies marsh substrates into one of four categories, ranging from substrates that lack of any evidence of degradation to those where complete deterioration heralds imminent loss. Using this methodology in Chesapeake Bay and Delaware Bay, we documented large scale marsh degradation (70% of mapped marshes) between 1984-1993, a period corresponding to exceptionally high rates of sea level rise along the US middle Atlantic Coast. The model has since been applied to the whole Atlantic Coast as well as the Gulf Coast. Though extensive validation has confirmed the accuracy of model results for microtidal coasts like Chesapeake Bay, mesotidal and macrotidal areas present problems that reflect the influence of higher tidal ranges on the model characterization of marsh substrate condition. Mesocosm experiments with a spectroradiometer show that, although the shapes of spectral curves largely remain the same as the marsh surface is more completely inundated at high tide in higher tidal ranges, spectral response from 680 to 720 nm is considerably dampened. This dampening tends to bias classification toward greater levels of substrate degradation than may be present. Multi-temporal analyses across the tidal cycle for these coasts are planned to determine the impact of higher tidal ranges on the model.

URL: <http://www.glc.f.umd.edu>

#### OS42U-05 1450h

##### Selecting Hyperspectral and Multispectral Image Processing Routines for Coral Reef Substrate Discrimination

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The Great Barrier Reef (GBR) is the worlds largest living structure, yet its sheer magnitude renders it virtually impossible to conduct fieldwork over the entire region, and many reefs are fragile and difficult to access. Therefore, remote sensing remains the only way to obtain synoptic data about many coral reef ecosystems. Subsequent to image acquisition, the multitude of processing techniques often makes selection of the most appropriate method unclear, and standard procedures are yet to be developed for reef environments. In coral reef ecosystems, substrate complexity, water column attenuation and georectification difficulties make field campaigns for accuracy assessment challenging. Thus assessing image processing routines for their own merits becomes difficult if knowledge of true pixel content is uncertain. Hence, the aim of this project was to develop an approach using synthetic images to identify optimal processing routines to discriminate coral reef substrate types. Preliminary results were obtained from synthetically generated images, whereby each pixel in the synthetic image contains hyperspectral reflectance data obtained in situ on Heron Reef (23°27'S, 151°55'E) southern GBR, Australia from three types of target substrates: corals (n=167); algae (n=42); and sediment (n=34). Additional pixels were synthesized to contain the average spectral profile of these features and simulated linear mixtures. The resultant synthetic "reference-image" contains a series of pixels with a gradation from 100% of one target substrate to 100% of the next, with 10% increments of each target substrate. Synthetic image generation allows visual analysis of colour composites, where variations in reflectance between image pixels (with known sub-pixel scale composition of target features) are easier to visually interpret than standard spectral profiles. By using this approach, standard image processing techniques can be applied and classification techniques assessed with 100% confidence of the pixel content. Using the synthetic reference-image (including reflectance and first and second derivative information), several image enhancement and classification routines were assessed for their substrate discrimination accuracy. The spectra were also resampled to simulate the multispectral response of Landsat ETM and IKONOS sensors to determine the optimal processing techniques for both hyperspectral and multispectral data at this scale. Our results have proved promising for substrate discrimination and analysis of field spectra and will now be applied to data over larger spatial scales. Through this research we highlight the relative strengths and weaknesses of image processing procedures for coral reef substrate discrimination, enabling selection of the most ap-

propriate routine for individual applications. This procedure for image processing evaluation is applicable not only for coral reef ecosystems, but in all environments where remote sensing image analysis is performed.

URL: <http://www.geosp.uq.edu.au/brg>

#### OS42U-06 1505h

##### Transmissometer POC – Bottles versus Pumps

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The distribution of particulate organic carbon (POC) can be quantified rapidly from transmissometer profiles of beam attenuation if accurate measurements of POC in the water can be obtained for calibration. The two standard means of determining POC concentrations are to filter samples from water bottles or by in-situ filtration with later analysis of the filtrate. However, the concentrations measured by these two methods can differ by a factor of 2 to 200. A third, independent method of determining POC is to calculate the difference between total organic carbon in filtered and unfiltered water using high temperature combustion (HTC) methods. In the Ross Sea the ratio of bottle POC to HTC POC was 1.44 during cruise NBP 96-4A and 1.87 during cruise NBP 97-1, but the ratios are upper estimates because of undersampling of large particles in samples of 0.1 ml for HTC. The ratio of bottle POC to pump POC ranged between 20 and 200 on NBP 96-4A and between 5 and 50 on NBP 97-1. In the Antarctic Polar Front the ratio ranged between 2 and 25 on cruise RR Kiwi 7. The bottle POC values are closest to the independent method of measuring POC (i.e. by HTC), whereas pump POC values are low. Other evidence suggests that at POC concentrations below 2  $\mu\text{M/l}$ , bottle POC may be high due to adsorption of DOC onto filters. After considering possible reasons for the bottle/pump differences for  $\text{POC} > 2 \mu\text{M/l}$ , and based on filtration tests and correlations, we conclude that the most likely cause for the low in-situ pump POC values results from high pressure differentials across the filter during in-situ filtration, resulting in carbon being sucked through the fibers. Obviously this has important ramifications for any program based on POC measurements.

#### OS42U-07 1520h

##### Physical Dynamics and Optical Character of the Hudson River Outflow Plume

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Under pressure and density forcing, river outflow plumes turn in an anticyclonic path and become trapped by Coriolis and topographic constraints against adjacent coastlines. The resulting freshwater plumes can extend for along-coast distances of over 100 km from their sources, with an offshore scale of 5-15 km. Downwelling favorable winds confine the plumes and amplify the alongshore currents within them. When winds turn to an upwelling favorable state, the plumes are rapidly mixed into the interior of the continental shelf. The plumes are biologically and optically important contributors to interior shelf waters due to high loads of CDOM, chlorophyll particulates and sediments. In this study, we examine the results of a mooring array and shipboard survey along the coast of New Jersey during July, 2001. Using ac-9 (wetlabs) and other optical instruments, calibrated against filter pad measurements, we describe the distribution of optically important materials in the plume and adjacent waters, and relate the dynamics of the plume (depth and temperature/salinity arrays) to the inherent optical property distribution, an important foundation for interpretation of color satellite images.

#### OS51A HC: 318 B Friday 0830h

##### Physics and Biology of Antarctic Continental Shelf Waters III

**Presiding:** K L Daly, University of

South Florida, College of Marine Science; D P Costa, Ecology Evolutionary Biology

#### OS51A-01 0830h

##### Feeding and energy budget of Antarctic krill *Euphausia superba* at the onset of winter in the Lazarev Sea (juveniles, adults, furcilia III larvae)

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Overwintering success of *Euphausia superba* is a key factor dictating population size, but there is uncertainty over how they cope with the scarcity of pelagic food. Both non-feeding strategies (reduced metabolism, lipid utilisation or shrinkage in size) or switching to other foods (carnivory, ice algae or detritus) have been suggested for adult krill, while for larvae it is assumed that they have to feed during winter, because of their low lipid reserves and continuous development in the field. We examined these strategies in the SW Lazarev Sea in autumn (April 1999), when sea ice was forming and phytoplankton was at winter concentrations (0.6-0.9 microgram Chl a L<sup>-1</sup>). Both juveniles and adults had very high lipid content (36% and 44% of dry mass respectively). However their low O:N ratios suggested that these reserves were not being utilised. Results from gut contents analysis and large volume incubations agreed that juveniles fed mainly on phytoplankton and adults fed on small copepods (smaller than 3mm). The feeding methods also concurred that feeding rates were low compared to summer. Even when acclimated to high food concentrations, clearance and ingestion rates were lower than 30% of summer rates. Respiration and ammonium excretion rates of freshly caught krill were 60-80% of those in summer. These findings suggest both switch feeding and energy conservation strategies, with a trend of reduced and more carnivorous feeding with ontogeny. In contrast to juveniles and adults, the most abundant furcilia III larvae, showed low lipid content (12% of dry mass) and their high O:N ratio of 72 suggest a high lipid turnover. Gut content analysis of freshly caught larvae demonstrated that they fed exclusively on phytoplankton. The larvae did not reduce their metabolism and were able to utilise high food concentration when it was available. The study shows that during periods of low food supply in the water column, larvae have to exploit ice algae to cover their metabolic demands.

#### OS51A-02 0845h

##### Winter Growth and Condition of Ice Krill (*Euphausia crystallorophias*) off East Antarctica

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In Austral winter (July/August) 1999 we conducted a study into krill growth rates in the Mertz Glacier