predatory copepod must tailor its feeding current to minimize the perceptible fluid disturbance, while maximizing its encounter rate with prey. In this study, we document the use of mechanoreception by the calanoid *Skistodiaptomus oregonensis* as it attacks and captures remotely located artificial prey entrained in the feeding current. Published hydrodynamic models are utilized to support the hypotheses that these calanoids utilize an expansive feeding current and directed swimming to reduce risk of detection by prey, and use wake capture while sinking to increase the volume searched.

Mechanoperception of remotely located prey entrained in a far-reaching feeding current is an energy efficient strategy compared to chemoperception. However, while an expansive feeding current is effective in non-turbulent regimes, in turbulent environments, a far-reaching, low velocity feeding current should be effective only if coupled with behaviors that quickly minimize separation distances once prey is detected. The results of this study show how copepod swimming and sinking behavior, coupled with a low velocity feeding current, not only can increase copepod encounter rates by increasing direct contact rates, but also can increase the probability of detecting and capturing prey in turbulent and non-turbulent environments.

OS31K-06 1035h

The Effect of Autotroph Geometry on C:N Ratios.

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Perhaps the simplest biophysical factor affecting an autotrophs is its dimensionality i.e. whether it is a 3-D particle, or forms a 2-D surface. The C:N ratio of unicellular algae is consistently 6.625 (the Redfield ratio), while macroalgae and seagrass (which obtain nutrients through a 2-D surface) have a C:N ratio which is 1 to 9 times the Redfield ratio, with a median of 2.8. Simple calculations are presented of the physically-limited supply rates under highly light- and N-limiting conditions of light and N to unicellular algae and benthic plants. These calculations predict that the light:N supply rate ratio to benthic plants is $\sim$ 4 times that to unicellular algae. More thorough calculations shed light on the variability of C:N ratios of macroalgae. Contrasting geometric properties may exert a significant evolutionary pressure on the elemental composition of unicellular algae and benthic plants.

OS31K-07 1050h

Fluid Mechanics Produces Conflicting Constraints During Olfactory Navigation: The Effect of Drag

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Animals foraging in turbulent odor plumes not only must acquire appropriate information from the chemical signal, but must respond to fluid forces imposed on their body. Drag forces experienced by animals will affect the cost of locomotion, but magnitude of this effect varies with both fluid velocity and the drag coefficient. We measured the drag on blue crab specimens oriented at angles ranging from 0 deg (facing the flow) to 90 deg (facing to the side) using a simple force transducer. At 0 deg. the long axis of the animal is normal to the flow resulting in a large drag coefficient (Cd =1.1). As the body angle rotates to a position of 90 deg, the drag coefficient decreases by a factor of 2. Blue crabs attempting to minimize drag during locomotion therefore would be expected to adopt a body angle of 90 deg. This was tested by examining the body angle of animals navigating in a chemical plume of metabolites released from freshly dead flesh. At low flow speeds (ca. 5 cm/s) crabs searching for odor sources orient at an angle of roughly 45 deg relative to the flow direction. However, at higher flow speeds (ca. 10 cm/s) animals assume the drag minimizing posture of 90 deg. Animals also may alter their body posture with distance to the source, and this will be discussed as well. The failure of blue crabs to adopt a drag-minimizing posture in slow flows suggests an additional constraint that also mediates their response to flow, but which opposes the drag effect, i.e. the deleterious consequences are maximal at 90 deg and minimal at 0 deg. The fact that crabs do indeed orient at 90 deg when flows are swift, and hence the overall drag force is increased, suggests that they tradeoff these two constraints to strike an optimal balance between the positive and negative consequences inherent in assuming a particular body angle. Our hypothesis is that postures that result in drag minimization are accompanied by a decrease in the ability to effectively acquire chemosensory information necessary to navigate in chemical plumes. The companion abstract by Webster et al. details the chemical signal structure impinging on olfactory appendages as a function of body angle. Quantification of chemical signals using a variety of techniques suggests that drag minimization is indeed inversely related to the ability to extract chemical information from turbulent plumes.

OS31K-08 1105h

Fluid Mechanics Produces Conflicting Constraints During Olfactory Navigation: Effects on Chemical Signal Acquisition

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In the companion abstract, Weissburg et al. document that for blue crabs, a body angle of 90 deg results in the lowest drag coefficient (Cd). However, crabs searching in chemical plumes only orient at this angle when flows are rapid, and in slow flows show an angle of ca. 45 deg. Our working hypothesis is that differing body angles have dramatic consequences for the chemical signal impinging on the sensory organs, and that drag minimization has the consequence of decreasing the ability to acquire chemical signals necessary for olfactory navigation. Flow visualization and laser-induced fluorescence measurements revealed variation in odor plume dynamics around the crab body for different orientations. When the appendages are in the turbulent wake of the claw or body, the plume is mixed and homogeneous relative to the unobstructed plume. This arrangement commonly occurs at higher body angles, where the cephalic appendages and the legs on the downstream side receive signals within the turbulent wake of the claw or body. The effect of postural angle was investigated further using a minute (10 mm dia) chemical microprobe positioned close to the sensory appendages. When at 0 deg, the antennae and legs experience a virtually unobstructed plume composed of intense peaks of odor concentration, which are intermittent at the antennae and much more uniform at the legs (which are lower in the boundary layer). Signal strength declines with increasing angle, and at 90 deg the antennules receive only very dilute odor. At the legs, intermittence increases with increasing angle and is greatest at 90 deg. Additionally, at this angle the downstream legs receive only dilute odor concentrations. The reduction of peak concentration at the antennae may inhibit identification of appropriate odors, whereas the increase in intermittence at the legs, and the reduced concentrations impinging on the downstream side, make bilateral comparisons difficult. Since efficient plume tracking depends on both of these factors, a drag-minimizing posture (i.e. 90 deg) will inhibit olfactory navigation. Blue crabs respond to these conflicting demands by weighting the degree of drag minimization in proportion to the potential magnitude of the drag effect. Increased flow velocity magnifies the locomotory cost of a high drag posture, thus in swift flows crabs turn to the side in order to minimize drag and sacrifice their ability to acquire olfactory cues.

OS31K-09 1120h

Modeling of Nutrient Uptake and Signal Release by Benthic Bacteria

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Substantial theoretical efforts have argued that unattached bacteria are too small to improve nutrient uptake directly by moving through fluid or from turbulence because their low Reynolds numbers preclude a thinning of the diffusive boundary layer. Conversely, plush biofilms comprised of many layers of bacteria attached to a surface have been shown theoretically and empirically to increase nutrient uptake with flow over the surface. Comparatively little work has focused on interactions between solitary or sparsely populated attached bacteria and the fluid environment. Furthermore, scant theory has addressed the diffusive release of compounds from bacteria, a topic of increasing relevance due to recent discoveries of 'quorum sensing,' or chemical communication among microbes. This work uses a theoretical electrical analog for diffusive mass transfer to model nutrient uptake by bacteria attached to surfaces, showing that sparse populations of bacteria (less than a monolayer coverage) can benefit from flow over the surface. Signal release from single cells is modeled with published reaction kinetcs, standard diffusion equations, and careful consideration of boundary conditions and their physiological interpretation. Premliminary models suggest that signal dynamics are dependent on the proximity of cells to one another, a result that supports published observations.

OS31K-10 1135h

Flow sensing in dinoflagellates at small temporal scales: Studies in developing Couette flow reveal sensory tuning.

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Many marine dinoflagellates are bioluminescent, emitting bright flashes of light from single cells in response to mechanical stimulation. This extremely rapid behavior is believed to serve a defensive function by deterring grazing. The time scale of the response is much faster than the time scale at which macroscopic flows can be fully developed. Therefore it is appropriate to characterize the time-dependent response to quantifiable developing flow. In order to study what parameters of flow development are important in determining the bioluminescent response of dinoflagellates we have constructed small-scale Couette (concentric cylinder) flow chambers to allow measurement of the full response over time of a defined population of cells during flow development. The gap between the outer and inner cylinders of the Couette devices was kept small so that the flow could develop rapidly across the gap. The bioluminescent response of the dinoflagellate *Lingulodinium polyedrum* was observed while the outer cylinder was accelerated using a computer-controlled servo-motor at a rate proportional to the time scale for diffusion of the velocity gradient across the gap. The developing phase of the flow was numerically modeled to determine velocity and shear versus radial position in the gap over time. There were surprising differences in the sensitivity and kinetics of flow-stimulated bioluminescence between different strains of *L. polyedrum*. For a given strain the response threshold measured in developing Couette flow was very similar to that observed in converging flow (another developing flow) and to that previously reported in fully developed Couette and pipe flows. However, at above threshold shear levels the response was strongly dependent on the rate of flow development. This indicates that dinoflagellate mechanotransduction may display rapid adaptation similar to that observed in known mechanosensory cells of many metazoans.

WED

OS31L HC: 314 Wednesday 0830h

Coupling of Biogeochemical Processes Between the Upper and Mesopelagic Ocean I

Presiding: **R B Rivkin,** Memorial University of Newfoundland**; L Legendre,** Laboratoire d"Ocanographie de Villefranche

OS31L-01 0830h INVITED

Maximum Resiliency as a Food web Organizing Construct: Export Production and Microbial Composition of a Pelagic Ecosystem

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A pelagic food web model was formulated with the goal of developing a quantitative understanding of the relationship between total production, export production, and environmental variables in marine ecosystems. The model assumes that primary production is partitioned through both large and small phytoplankton and that the food web adjusts to changes in the rate of allochthonous nutrient inputs in a way that maximizes resiliency, i.e., the ability of the system to return to steady state following a perturbation. The results of the modeling exercise indicate that ef ratios, defined as new production/total production = export production/total production, are relatively insensitive to total production rates at temperatures greater than 25^{o}C and lie in the range 0.1-0.2. At moderate to high

total production rates, ef ratios are insensitive to total production and negatively correlated with temperature. The maximum ef ratios are 0.67 at high rates of production and temperatures of 0^o-10^oC. At temperatures less than 20^oC, there is a transition from low ef ratios to relatively high ef ratios as total production increases from low to moderate values. This transition accounts for the hyperbolic relationship often presumed to exist between ef ratios and total production. The model predicts that the ratio of heterotrophic bacterial biomass to phytoplankton biomass will be greatest under oligotrophic conditions. This prediction is in accord with the results of several field studies. Under eutrophic conditions, model results indicate that the same ratio will be positively correlated with temperature, and that microbial biomass will be dominated by phytoplankton at low temperatures and high production rates. The predictions of the model are in excellent agreement with results reported from the Joint Global Ocean Flux Study (JGOFS) and from other fieldwork. In these studies, there is virtually no correlation between total production and ef ratios, but temperature alone accounts for 86% of the variance in the ef ratios. Model predictions of the absolute and relative abundance of autotrophic and heterotrophic microorganisms are in excellent agreement with data reported from field studies. Combining the ef ratio model with estimates of ocean temperature and photosynthetic rates derived from satellite data indicates that export production on a global scale is 20% of net photosynthesis. Because of the short generation time of marine microbes, pelagic food web behavior that is determined primarily by the activity of these organisms may tend to display characteristics expected of the mature stages of ecological succession. Maximum resiliency, a characteristic expected of such mature stages, may therefore prove to be a useful construct in modeling the response of pelagic food webs to environmental change. The results of the model have important implications for the impact of climate change on export production, particularly with respect to temperature effects.

OS31L-02 0850h

Variability in the Ratio of Carbon to Nitrogen Uptake by Phytoplankton in the Pacific

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Production estimates made using different chemical tracers are typically related to one another by assuming a constant elemental uptake ratio by the plankton (e.g. Redfield C:N = 6.6). Further, it is common to compare f-ratios, the ratio of new to total production, that are derived through different measures of total production, and to assume f-ratios calculated from integrated production are representative of regional values. Here, we use data from the Tropical and Subarctic Pacific to show these practices neglect a great deal of the spatial and temporal complexity in pelagic ecosystem production, and may result in significant errors in biogeochemical flux estimates.

We found that integrated total production and f-ratios vary by about 30%, depending on what sources of dissolved nitrogen are taken into account, and estimates derived from nitrogen uptake measurements can vary by more than an order of magnitude from those derived from carbon uptake measurements. C:N uptake does not always occur at the Redfield value, and varies by geographic location, time of day, and depth in the water column. There is a general trend of decreasing C:N uptake with depth, from roughly 10 near the surface to less than 5 below 100m, with many instances where C:N uptake is greater than 20. The highest C:N uptake ratios occur almost exclusively where f-ratios are at their lowest values. The highest nitrogen uptake often occurs deeper in the water column, between the 1% and 0.1% light levels. This deep production can be significant, suggesting that areal production estimates may need to account for it. C:N uptake ratios are also often higher in the afternoon incubation versus first light, and both C:N and f-ratios show considerable day to day variability during the two time series at the equator.

These data suggest that carbon and nitrogen uptake may not occur at the same location in upper ocean ecosystems, and that understanding the source of this variability is critical to our understanding of ecosystem function, and to accurate predictions of new and total production. To that end, we suggest several hypotheses and point to future research directions than may help resolve these observations.

OS31L-03 0905h

Stoichiometry of Upper Ocean Carbon Fluxes in the Atlantic Ocean

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The annually averaged ratio of organic carbon (POC): inorganic carbon (PIC) of particles sampled with particle interceptor traps in the Atlantic ocean in the 1990ies can be described by an exponential function with depth (POC:PIC = 64.3 * $Z^{-0.56}$; r^2=0.69). The validity of this function is evaluated by means of comparision with independent estimates of (a) the POC:PIC ratio of export, (b) the vertical change in the PIC flux and (c) the POC:PIC ratio of remineralisation. The POC:PIC flux function is combined with recently estimated empirical relationships between the flux of particulate organic matter, primary production and depth to estimate the effective carbon flux (J_{eff}) in the Atlantic ocean. Basin scale (65°N to 65°S) integrals of export production from this approach vary between 0.9 and 2.9 GT C yr^{-1}. Shallow remineralisation within the winter mixed layer account for 11-17% of export production and CaCO3 sequestration from the winter mixed layer further reduces the carbon flux by 13 - 16%. The effective carbon export, J_{eff}, of the Atlantic ocean is estimated to range between 0.64 and 2.2 GT C yr^{-1}. Data from this study suggest that the sequestration of calcium carbonate is the dominate process in modulating the effective carbon export in the tropics while POC remineralisation in the winter mixed layer dominates in temperate and polar waters. The sensitivity of the effective calcium carbonate sequestration flux to assumptions regarding the ratio of released CO_2: precipitated $CaCO_3$ an the POC:PIC export ratio is discussed.

OS31L-04 0920h

Natural Diets of Vertically Migrating Zooplankton in the Sargasso Sea

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Diel vertically migrant zooplankton contribute to carbon export from the upper ocean by producing sinking fecal pellets, released during the night spent feeding in surface waters, and by respiring, excreting and defecating surface-ingested carbon below the mixed layer. A recent study at the Bermuda Atlantic Time-series Study (BATS) site showed that particulate organic carbon actively transported in animal guts and defecated at depth can significantly contribute to carbon export. What migrators consume in the surface waters impacts the amount, composition, and quality of the particulate organic matter that is exported, yet few studies have focused on feeding habits of migrant zooplankton. The natural diets of three abundant migrant species at BATS, copepods *Pleuromamma xiphias* and *Euchirella messinensis*, and the euphausiid *Thysanopoda aequalis*, were investigated during 1999 and 2000. Gut content analysis using epifluorescence microscopy showed that all three species consumed a wide variety of plants, animals and detritus. Changes in gut content usually reflected seasonal trends in phytoplankton community structure (determined by HPLC analysis) in the Sargasso Sea. A notable exception was that all three species consumed diatoms more than other phytoplankton taxa, despite that diatoms are small contributors to the phytoplankton community at BATS. The animals migrators preyed foremost upon were protozoans and crustaceans, but other metazoans such as chaetognaths and cnidarians were also consumed. Marine snow was an important component of migrator diets with typically > 50 %, and rarely < 20 % of the guts containing olive-green debris. Large cyanobacteria (> 4 micrometer in diameter) found in guts were likely consumed with marine snow. Species-specific feeding preferences and differences in the degree of feeding selectivity between the migrators were evident, and in general agreement with feeding habits predicted from our analysis of migrator mouth parts (using light microscopy). The euphausiid *T. aequalis* fed more equally on phytoplankton, heterotrophic prey and detritus compared to both copepod species. The copepod *P. xiphias* consumed a diverse assemblage of phytoplankton from late winter until summer and supplemented its diet by carnivorous feeding in autumn and early winter. *E. messinensis* showed the highest feeding specialization with a strong preference for pennate diatoms during winter and spring, and for coccolithophorids during late summer and fall. The differences in migrator diets suggest that an individual species approach is important in determining how feeding habits affect the structure of pelagic food webs and carbon flux in the sea.

OS31L-05 0935h

The Role of Vertical Mesozooplankton Migration in Coupling the Upper Ocean and Mesopelagic Zone: a Modelling Study of the Northeast Subarctic Pacific

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In modelling the ecosystem dynamics of the planktonic nitrogen cycle in the Northeast Subarctic Pacific, establishing a balance between the upper and mesopelagic ocean is, to say the least, a complicated matter. The physics, through local atmospheric conditions and large scale circulation patterns, largely controls the entrainment of deep water inorganic nitrate, while primary production and grazing, which are, in general, locally defined processes, lead to an eventual return particulate flux. To further develop this simple picture, we superimpose the life-cycle patterns of ontogenetic migrants, the copepods *Neoclanus plumchrus* and *N. flemingeri*, which certainly respond to environmental conditions of the plankton yet which also carry "histories" of a mesopelagic origin and, thus, explicitly couple the two regimes.

Our vertically resolved, dynamic ecosystem model of Ocean Station Papa (OSP) consists of prognostic equations for the following nitrogen pools: two phytoplankton (< 5 μm phytoplankton and > 10 μm diatoms), two zooplankton (microzooplankton flagellates and mesozooplankton copepods), two particulate organic (suspended and sinking), and two inorganic (nitrate and ammonium+urea). Vertical mixing of the biological pools and physical properties is modelled by the KPP oceanic boundary layer scheme [Large, McWilliams and Doney; Reviews of Geophysics; November 1994]. Phytoplankton groups are differentiated by their light, nutrient and micronutrient (iron) affinities, sinking rates and predators, while zooplankton pools have distinct predation roles: microzooplankton heterotrophs versus copepod omnivores. In addition we model copepod life-cycle dynamics including migration of early stage copepodites to the upper ocean, weight dependent growth and excretion, maturation, and return to the deep ocean. We assess the impact of variations in the mesozooplankton life cycle on the nitrogen pools of the upper ocean and mesopelagic zone with emphasis on shifts in the recycled and loss pathways of the upper ocean, the partitioning of planktonic biomass, and copepod development.

OS31L-06 0950h INVITED

Physical Controls on the Export of Dissolved and Particulate Organic Matter

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In a steady state, the export of organic matter must be compensated by a supply of nutrients to the light-lit upper ocean. This nutrient supply can be simulated with considerable accuracy by a high-resolution ecosystem-circulation model of the North Atlantic. The model results are used to examine physical processes that govern the transport of nutrients into the euphotic zone and the export of organic matter leaving it. Illustrated is the requirement for a rigid definition of the surface across which export production or nutrient supply are computed. Possible choices for this surface include a fixed depth level, the varying depth of the euphotic zone, and the depth of the winter mixed layer. Implications of the different choices are discussed with respect to the associated re-emergence timescales of an exported biogeochemical tracer flux. The basin-scale model is then used to investigate the climate sensitivity of organic matter export across the various depth surfaces. A corrolary of this study is that in the North Atlantic the export of dissolved organic matter to depths below the winter mixed layer is very small compared to that of particulate organic matter.

OS31L-07 1030h INVITED

Influence of Mesopelagic Respiration on Biogenic Carbon Cycling. 1. Conceptual Development

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Most of the biogenic carbon (BC) that is exported (E) from the euphotic zone is remineralized to CO2 (i.e. respiration, R) in the underlying mesopelagic layer (or twilight zone), which in most oceans extends to the permanent pynocline (typically ca. 1000 m). A significant part of this remineralized CO2 is ventilated back to the surface layer on decadal time scales, where it equilibrates with the atmosphere. Only the BC that is remineralized or buried below the permanent pycnocline is isolated from the atmosphere long enough to be of significance to the global climate (i.e.. sequestration, S). Current estimates of E and S for the World Ocean are ca. 7 to 12 and 1 to 2 Gt C/year, respectively. The main biological mechanisms that control R in the mesopelagic layer are the size structure, sinking velocity and chemical composition of E. The interactions among these factors are nonlinear. Because the changing climate will modify both R and the downward propagation of characteristics of the surface ocean (e.g. heat, storm mixing), these will influence S, which will in turn feedback to the climate.

OS31L-08 1050h INVITED

Influence of Mesopelagic Respiration on Biogenic Carbon Cycling.2. Rates and Patterns.

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Relatively little is known about processes occurring in the mesopelagic layer (i.e. twilight zone; 100 to 1000 m). Trap studies suggest that about 90 percent of the settling particulate organic carbon (POC) is remineralized between 100 and 1000 m, but remineralization of dissolved organic carbon (DOC) is largely uncharacterised. The biogenic carbon (BC) that is transferred or buried below the permanent pycnocline (i.e. sequestration, S) is isolated from the atmosphere for long periods (e.g. millennia) and is therefore of significance to global climate change. The sequestration of BC can be computed from euphotic zone export (E) and its subsequent mesopelagic remineralization (R; S = E - R). Because there are very few direct measurements of R, we estimated this property, at the global scale, from a meta-analysis of the distributions of physical, chemical and bacterial properties in the mesopelagic layer. We computed heterotrophic respiration from empirical relationships among temperature, DOC, and bacterial production and growth efficiency. Preliminary estimates of R are 11 to 35 (mean = 22) Gt C/year for the World Ocean. These values are 28 to 88 percent of the computed upper ocean respiration of ca. 40 Gt C/y. These data suggest that global dissolved and particulate primary production may be >75 Gt/y.

OS31L-09 1105h INVITED

Respiration and organic carbon inputs to the mesopelagic ocean

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Respiration in the mesopelagic ocean has been traditionally considered to play a small role in the global oxidation of organic matter in the ocean. Recent evidence, however, suggests that mesopelagic respiration is likely to be comparable in magnitude to respiration in the euphotic zone. In this presentation we synthesize information on the mechanisms of transport, transformation and the rate of respiration of organic matter in the mesopelagic ocean. Finally, a respiratory carbon budget will be produced for the mesopelagic ocean, to be compared with estimates of vertical and lateral inputs of organic matter.

OS31L-10 1125h

A 1 D Size-resolved Model of Particle Dynamics below the Mixed Layer.

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Marine particle size structure and dynamics in the mixed layer have been intensively studied and several models including phytoplankton growth, sinking, coagulation, bacterial degradation and zooplankton grazing have been proposed. Considerably less is known in the deeper layers due to the lack of observations; in particular of particle size structure. Sediment traps data have shown that large aggregates may be a major component of POM vertical flux. Particle aggregation by coagulation and zooplankton feeding and defecation may be important. To address the question of mid-water particle transformation, we formulated a 1D model with size specific equations describing particle sinking, coagulation, disaggregation and bacterial and zooplankton consumption. The model is forced at 100 m depth by observed particle size spectra; the modeled particle size spectra are compared with observations between 100 and 1000 m depth. We use data obtained at a quasi-oceanic site for a four years time series in the NW Mediterranean Sea. The model can describe as much as 60% of the variance in particle size spectra. Inferred vertical fluxes are also compared to the vertical flux measured at 1000 m depth.

OS31L-11 1140h INVITED

Does Mesoscale Hydrodynamics Affect the Spatial Distribution of Large Particulate Matter?

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The relationship between mesoscale hydrodynamics and the distribution of Large Particulate Matter (LPM, particles larger than 200 m) in the first 1000 m of the western Mediterranean basin was studied with a microprocessor-driven CTD-video package, the Underwater Video Profiler (UVP). Observations made during the last decade showed that in late spring and summer LPM concentration was high in the coastal part of the W Mediterranean basin at the shelf break and near the continental slope (computed maximum: 149 microgC.l-1 between 0 and 100 m near the Spanish coast of the Gibraltar Strait). LPM concentration decreased further offshore into the central Mediterranean Sea where, below 100 m, it remained uniformly low, ranging from 2 to 5 microgC.l-1. However, a strong variability was observed in the different mesoscale structures such as the Almeria-Oran jet in the Alboran sea or the Algerian eddies. LPM concentration was up to five times higher in fronts and eddies than in the adjacent oligotrophic Mediterranean waters (i.e. 35 vs. 8 microgC.l-1 in the Alboran Sea or 16 vs. 3 microgC.l-1 in a small shear cyclonic eddy).

Our observations suggest that LPM spatial heterogeneity generated by the upper layer mesoscale hydrodynamics extends into deeper layers. Consequently, the superficial mesoscale dynamics may significantly contribute to the biogeochemical cycling between the upper and meso-pelagic layers.

OS31M HC: 315 Wednesday 0830h

Equatorial Oceanography I

Presiding: **D Moore,** NOAA /PMEL; **J P McCreary,** IPRC

OS31M-01 0830h INVITED

Dynamics of the Pacific Subsurface Countercurrents

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A hierarchy of models, varying from $2\,{}^1/_2$-layer to 4% $^1/_2$-layer systems, is used to explore the dynamics of the Pacific Subsurface Countercurrents, commonly referred to as Tsuchiya Jets (TJs). The TJs are eastward currents located on either side of the equator at depths from 200 m to 500 m and at latitudes varying from about 2° to 7° north and south of the equator, and they carry about 14 Sv of lower-thermocline (upper-intermediate) water throughout the tropical Pacific. Solutions are found in idealized and realistic basins, and are obtained both analytically and numerically. They are forced by winds and by a prescribed Pacific interocean circulation (IOC) with transport M (usually 10 Sv), representing the outflow of water in the Indonesian passages and a compensating inflow from the Antarctic Circumpolar Current.

Analytic solutions to the $2\,{}^1/_2$-layer model suggest that the TJs are geostrophic currents along arrested fronts. Such fronts are generated when Rossby-wave characteristics, carrying information about oceanic density structure away from boundaries, converge or intersect in the interior ocean. They indicate that the southern and northern TJs are driven by upwelling along the South American coast and in the ITCZ band, respectively, that the northern TJ is strengthened by a recirculation gyre that extends across the basin, and that TJ pathways are sensitive to stratification parameters. Numerical solutions to the $2\,{}^1/_2$% -layer and $4\,{}^1/_2$-layer models confirm the analytic results, demonstrate that the northern TJ is strengthened considerably by unstable waves along the eastward branch of the recirculation gyre, show that the TJs are an important branch of the Pacific IOC, and illustrate the sensitivity of TJ pathways to vertical-mixing parameterizations and the structure of the driving wind.

In a solution to the $2\,{}^1/_2$-layer model with $M = 0$, the southern TJ vanishes but the northern one remains, being maintained by the unstable waves. In contrast, both TJs vanish in the $M = 0$ solution to the 4% $^1/_2$-layer model, apparently because wave energy can radiate into a deeper layer (*i.e.*, layer 4). In the $4\,{}^1/_2$% -model, then, the TJs are in fact driven by the Indonesian Throughflow, a remarkable example of remote forcing on a basin-wide scale.

OS31M-02 0855h

Equatorial currents in nested high-resolution tropical Pacific simulations during 1992-1997.

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Using a 1/3 $^\circ$ resolution model of the tropical Pacific Ocean, we investigate the structure of the surface layers (0-400 m) in the equatorial Pacific Ocean from 1992 to 1997. The model has open boundaries at 26°N, 26°S and in the Indonesian Throughflow. Boundaries conditions are prescribed from a low-resolution global model (ECCO project) which assimilates altimetry data from TOPEX/Poseidon, ERS1 and ERS2 satellites as well as monthly temperature and salinity climatologies. To study the impact of the forcing on the quality of the results, the model is driven by forcing fields estimated by the ECCO model or by the NCEP forcing files, respectively. When using the ECCO forcing, the currents at 110°W and 140°W of longitude along the equator are in a remarkably good agreement with the TOGA-TAO measurements. As a prerequisite

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