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Particles play the important role that transports energy and substances from the upper ocean to the mesopelagic ocean. It is well known that there is the phytoplankton bloom in spring in the western North Pacific, and be expected that there is large particulate flux associated with the plant plankton production during the spring bloom. We conducted extensive observations for two periods (May 13-15 and 24-28, 1999) during the MR99-K02 cruise of the R/V Mirai. Each period, we conducted the floating sediment trap experiments and measurement of ^{234}Th in water column at two points, one is the low fCO_2 (less than 200 μatm) and high fluorescence blooming point and another is the high fCO_2 (higher than 400 μatm) and low fluorescence one. The vertical profiles of ^{234}Th showed significant deficiency of ^{234}Th to ^{238}U in the top 40 m layer at the blooming points in both periods whereas there was no deficiency at the non-blooming point in the first period. This suggested that there is no net particulate flux at the non-blooming point, however, enormous amount of particles were transported from the upper ocean to the deeper ocean in or just after the blooming. This was confirmed by the results of the sediment trap experiments. At the non-blooming point in the second period, we found the ^{234}Th deficiency which is smaller than one observed at the blooming point, although there was no deficiency at the non-blooming point in the first period. This suggested that the non-blooming point in the first period was in the pre phytoplankton blooming condition and one in the second period was the condition the phytoplankton blooming had already ceased.

OS42D-148 1330h POSTER

Methane cycling in mid-water suspended particle layers, Monterey Bay, California

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The remotely operated vehicle Ventana was used in September 2001 to measure the vertical distribution and the optical characteristics of suspended layers of fine particles along the axis of Monterey Canyon in Monterey Bay, California. A combination of a nephelometer, a transmissometer and a structured light source with high definition video detection was used for these measurements. The particles layers ranged from broad bands extending over several hundred meters of depth to thin, concentrated layers <20 m thick.

Ventana was also used to collect water samples, without the physical disruptions inherent in CTD/rosette-based sampling, within and around the particle layers. Samples were collected from depths of 400 - 1300 m and were analyzed for methane, methane carbon stable isotopes, alkalinity, nutrients and pH. Particle concentration was positively correlated with alkalinity and negatively correlated with δ^{13}C-methane. The latter ranged from -60 per-mil in the most particle-rich water to -30 per-mil in the clearest water; the former is indicative of active biogenic methane production within the particle layers, whereas the latter presumably reflects the effects of the biogenic oxidation of methane diffusing out of the layers. Interestingly, methane concentrations were not correlated with the other parameters, but instead showed a noisy vertical gradient with concentrations ranging from 4 nM at 400 m down to 1 nM at 1250 m (values approximately twice those found in the open ocean at such depths). These observations demonstrate the power of isotopic analysis in studies of methane dynamics in complex systems.

OS42D-149 1330h POSTER

Decoupling of Dissolved Zinc and Silicon in the Upper Water Column of the Subarctic North Pacific

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Total dissolved Zn concentrations are reported for winter and summer along the E-W line P transect and for summer along S-N line Z transect extending from Ocean Station Papa (OSP; 50 °N 145 °W) to the respective shelf waters. Surface water (10m) concentrations ranged from 0.04 nM in the open ocean to 0.9 nM at the Canadian shelf station. A clear gradient is evident, with Zn concentrations decreasing with increasing distance from shore along the E-W transect. Very low concentrations of Zn (0.05-0.07 nM) were observed in near surface water at OSP in winter. However, significant concentrations of Si were observed at all of the open ocean stations in this High Nutrient Low Chlorophyll (HNLC) area. The vertical distribution of dissolved Zn below the surface layer showed a silicon-like vertical profile. There is a significant difference in Zn/Si in the surface water and the nutricline. Dissolved Zn/Si ratios in the upper 200m indicate a trend of decreasing with distance from shore, which infers a decoupling between Zn and Si in the upper ocean. We hypothesise that the silicon-like profile of Zn is a result of recycling from relatively biologically resistant organic particulate phases, that leads to profiles very similar to those of dissolved silicon. The decoupling of Zn and Si cycling and removal in the upper ocean is supported by the reduction in Zn:Si ratios as move offshore from coastal to open ocean waters. Concentrations of the natural organic ligand and the free Zn ion also indicate a change moving offshore. Low concentrations of free Zn ion activity were observed at OSP, which has implications for phytoplankton growth. It is essential to know more about the dissolved and particulate separation and cycling of Zn to fully understand the cycle of this element and implications for speciation and potential influence on primary production.

OS42D-150 1330h POSTER

Biological and Physical Controls on Export Fluxes at two Contrasting Continental Margins.

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Continental margins are dynamic systems where production and export of particles results from a complex interplay of physical and biological forcing. In this paper we compare two continental margins that differ in their characteristics. The Goban Spur, in the Celtic Sea, has topographically driven shelf-edge upwelling and a broad, gradual slope whereas at the north Iberian Margin strong, periodic wind-driven upwelling drives pelagic production, and a narrow shelf drops more steeply to the abyssal plain. Export fluxes at mid-water depths below the winter mixed layer, from sediment trap moorings, show strong differences but also commonality between these systems. In this paper we use bulk (dry weight, POC, opal, carbonate) and detailed marker (algal pigments, organic biomarkers, TEP, radionuclides, microscopy) analyses on sedimenting particles to reconstruct processes at the surface leading to flux. Whereas seasonality in production and flux are evident at the Goban Spur, the Iberian Margin situation is strongly dependant on short-term fluctuations in upwelling intensity; rapid and periodic destabilization of the upper water column leads to pulses of organic matter sedimentation. Based on empirical relationships, fluxes from the shelf to the abyssal plain are calculated in the water column and at the sediments. The spatial distribution of water column and benthic fluxes reflect topographic differences between the Goban Spur and Iberian Margin and are used to estimate particulate export from the continental margin to below the depth of winter mixing. This is a crucial factor in the ability of the margins to sequester atmospheric CO_2.

OS42D-151 1330h POSTER

Effects of El Niño 1997-98 on Particle Fluxes from two Coastal Upwelling Areas: Northern Chile and Southern California

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We compare daily fluxes of siliceous phytoplankton, biogenic silica, organic carbon, calcium carbonate, and lithogenic particles at two mooring sites deployed in boundary current systems of the Pacific Ocean. Both moorings are influenced by strong seasonal and interannual variability that allows to evaluate the effect of physical forcing on particle fluxes under non-El Niño and El Niño conditions. The SBB trap, deployed in the Santa Barbara Basin, off southern California (34°N, 120°W), collected particulates from August 1993 to April 1998. The CH trap, off Central Chile (30°S, 73°W), was deployed between June 1993 and May 1995, and from February 1997 to June 1998. Lithogenic components dominate the flux at the SSB site; their contribution largely increased under El Niño conditions, presumably reflecting higher rainfall and runoff into the basin. Flux of biogenic opal, the second most important bulk component, decreased under El Niño conditions, and was accompanied by major changes in the composition of the siliceous microplankton assemblage and increased diversity. Tropical species invaded the basin while representatives of upwelling conditions diminished sharply (*e.g.* spores and vegetative cells of the diatom genus *Chaetoceros*) Thus, the "normal" scenario of high biogenic opal and organic carbon fluxes in boreal spring (upwelling period) and low fluxes in boreal fall-winter was altered during the 1997-98 El Niño event. Particle flux off northern Chile, on the other hand, is strongly dominated by calcium carbonate, with lithogenic particles and biogenic opal as secondary contributors. Export fluxes were markedly lower during the 1997-98 El Niño: total mass flux diminished by 60%, probably due to poorly mixed subsurface waters and reduced intensity of coastal upwelling. However, the seasonal pattern of particle export at the CH site varied little under non-El Niño and El Niño conditions. Upwelling in austral winter determined the maximum export production pattern of bulk components and siliceous microorganisms. Biogenic opal and siliceous plankton fluxes depict almost unimodal pattern of downward transport, attaining their annual maximum within 3-5 weeks in late austral winter, in coincidence with highest pigment concentrations in surface waters. Major components of the diatom flora maintained much of their regular seasonal cycle of flux maxima and minima during both sampling periods: resting spores of *Chaetoceros* dominated the diatom flux, and the occurrence of pelagic diatoms reflected the intermingling of warmer waters of the Subtropical Gyre into the coastal upwelling system.

THU

OS42E HC: Hall III Thursday 1330h

Bentho-Pelagic Coupling at High Latitudes III

Presiding: **C Smith,** University of Hawaii at Manoa**; A R Baco,** University of Hawaii

OS42E-152 1330h POSTER

The Lipid Pool in Holothurians From the Antarctic Shelf and the Porcupine Abyssal Plan, Northeast Atlantic, and its Relationship to Food Availability

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Seasonal fluxes of organic matter (OM) to the deep sea following blooms in surface waters have been widely reported over the last 20 years (Deuser and Ross, 1980; Rice et al., 1986). Bacteria and other microorganisms can respond in a matter of hours or days to the arrival of fresh OM (Lochte and Turley, 1990; Gooday and Turley, 1990), but much less is known about the response of larger organisms in the deep ocean. In the present study, the pools of lipids of holothurians; from two oceanic regions that experience a seasonal pulse of phytodetritus (the Porcupine Abyssal Plain; PAP, Northeast Atlantic ∼5000 m water depth and the Peninsula Shelf; PS; Antarctica; ∼600 m) have been examined and compared in relation to their food availability. The approach involved analysis of the lipid of body tissues of 8 species (Amperima rosea, Oneirophanta mutabilis, Psychropotes longicauda, Pseudostichopus villosus, Paroriza prouhoi, Molpadia blakei, Deima validum and Pseudostichopus spp.) fr om PAP and 4 species (Peniagoni sp., Molpadia musculus, Scotoplanes globosa and Benthuria sp.) from PS. Fatty acid (FA) distributions are similar for all species from both sites. That indicates that metabolism of these compounds and processes involved in the food uptake for them are similar. On the other hand, FA's are significantly more abundant in animals from the PS, which probably reflects the high quantity of phytodetritus at the PS seafloor, relative to the PAP. Distributions of sterols, on the other hand, are more variable; although there are intra-site differences between species, the inter-site distributional differences are greater. These differences likely reflect different food sources present at the PAP and PS and the feeding strategies adopted by individual species.

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URL: http://www.pcweb.liv.ac.uk/ocean/org_geochem/index.html

OS42E-153 1330h POSTER

Preliminary Findings of the Reproductive Processes of Deep Water Actinarians from the Western Antarctic Shelf

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During five western Antarctic FOODBANCS cruises (PSO Craig Smith), between March 2000 and March 2001, a variety of actinarian species were recovered. A number of individuals of each of the anthozoans Capnia georgiana, Bolocera kerguelensis, Sisyonis sp. and the commensal anemone Isosicyonis alba (on the shells of a species of Provacator gastropod) were examined to determine gametogenic pattern and seasonality.

Initial results show each of these anemone species to have different reproductive patterns. Observations show Capnea georgiana to have no reproductive structures during the both the March samples analysed. Bolocera kerguelensis is a highly fecund anemone, with large previtellogenic (249.62microns mean) and vitellogenic (623.58microns mean) oocytes, suggesting no seasonality. Only one female of the Sisyonis sp. anemone was found within the two months samples. This anemone had large previtellogenic (177.91microns mean) and vitellogenic (482.06microns mean) oocytes and shows the possibility of a third cohort. Isosicyonis alba has small oocytes (69.18microns mean) all of the same stage, suggesting seasonality of reproduction. The variability in the gametogenic pattern of the different species is examined in relation to the flux of organic matter from surface production.

OS42E-154 1330h POSTER

Benthic Community Composition and Biomass Distribution: Viral, Bacterial, and Infaunal Associations from the Gulf of Alaska to the Canadian Archipelago

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As part of a US-Canada scientific collaboration during the St. Roch II Voyage of Rediscovery, benthic sediment and water column samples were taken along the continental shelf from the Gulf of Alaska, the Bering, Chukchi and Beaufort Seas, and within the Canadian Archipelago (C.A.) as far east as Spence Bay, Nunavut. Goals of this cruise included study of possible correlations between spatially related infaunal and microbial abundances.

Bivalves dominated infaunal biomass from the Gulf of Alaska to the Chukchi Sea: *Yoldia sp.* in the Gulf of Alaska, and *Nuculana radiata, Nucula belloti,* and *M. calcarea* in the Bering Strait region. In addition, ampeliscid amphipods dominated the northern Bering Sea stations. By comparison, sternaspid polychaetes and ampeliscid amphipods were dominant in the Beaufort Sea samples and at stations entering the C.A. At Hat Island in the C.A., bivalves again dominated, particularly the families Astartidae and Hiatellidae, while a siliceous sponge dominated the most northeasterly station. Benthic biomass ranged from 57.8 gC/m^2 in the southern Chukchi Sea to 0.2 gC/m^2 in the C.A. Infaunal "hot spots" were observed at Hat Island (43.8 gC/m^2) and Whale Bluff (21.8 gC/m^2) in the C.A., comparable to the Bering Strait biomass measurements.

Water column virus-like particles (VLP) ranged from $2.3x10^8$ ml^{-1} in the Gulf of Alaska to 5.6×10^6 ml^{-1} in the C.A.; bacterial counts ranged from 1.3×10^6 ml^{-1} in the Gulf of Alaska to 4.6×10^4 ml^{-1} in the C.A. Integrated water column VLP and bacterial distributions correlated significantly with integrated chl *a*; discrete water column VLP and bacterial distribution correlated most significantly with chl *a* and temperature, but also with other water column characteristics. Integrated water column VLP and bacteria also correlated with sediment chl *a*, VLP and bacteria abundances. Sediment bacterial counts ranged from 3.2×10^8 per g (dry weight) in the Bering Sea to 1.7×10^6 per g in the C.A. VLP counts ranged from 1.1×10^9 per g in the St Lawrence Island region of the Bering Sea to 2.1×10^7 in the C.A., however at one C.A. station the VLP was observed at 1.2×10^9 per g.

The high VLP and bacterial abundance data associated with high infaunal benthic biomass suggest that biomass accumulation in these sediments may be influenced by microbial activity.

OS42E-155 1330h POSTER

Feeding and Pellet Production of the Copepod Calanus finmarchicus on Auto- and Heterotrophic Prey

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The calanoid copepod Calanus finmarchicus is one of the dominant grazers of large phytoplankton in the north Atlantic, contributing significantly to the downward flux of organic matter by production of large fast sinking faecal pellets. We investigated the feeding and pellet production of C. finmarchicus using auto- and heterotrophic diets, to reveal its food preferences and the effect of diet on pellet production and therefore on the potential importance of pellets for vertical carbon flux. The filtration, ingestion and pellet production rates of late copepodite stages of C. finmarchicus, collected from a north Norwegian fjord, were measured with the diatom Thalassiosira weissflogii, the heterotrophic dinoflagellate Oxyrrhis marina and the ciliate Strombidium sulcatum, offered alone or in 1:1 mixtures. In addition, copepod feeding and pellet production was measured in natural seawater, during and after the spring bloom. Copepods fed on all the food species, but the filtration, ingestion and pellet production rates were significantly higher on T. weissflogii than on O. marina and S. sulcatum. In mixtures with T. weissflogii and O. marina, copepods fed on both species, but preferred T. weissflogii. The pellet production was directly related to the ingestion, and not affected by the food quality. We conclude that C. finmarchicus copepodites feed both on auto- and heterotrophic food, but prefer diatoms to microzooplankton. Further, the quality of the copepod's diet affects pellet production only through its effect on the ingestion rate.

OS42E-156 1330h POSTER

Radiocarbon Dates Based on Organic Matter in Diatom Frustules

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Calcareous fossils are often rare in the opal-rich sediments that accumulate at high southern latitudes. Dates obtained from total organic carbon (TOC) are often inconsistent with expectations, and it can be difficult to establish accurate chronologies for sediment cores. Compound-class radiocarbon analyses (CCRA) of sterols and fatty acids offer a promising alternative approach but require relatively large amounts of material, generally 30 g or more, and are based on materials with potentially different histories of sedimentation. To provide a further alternative, we are exploring the possibility of dating the organic material naturally present in diatom frustules. The process involves cleaning one to three grams of siliceous sediment by heating it under pressure with concentrated nitric acid at temperatures up to 200°C. Carbon dioxide obtained from combustion of the cleaned sediment provides the sample for analysis of radiocarbon. Concentrations of organic carbon remaining after cleaning are typically 0.01% but the resulting ages are clearly more accurate than those based on TOC. In a core in which the planktonic forams, *Neogloboquadrina pachyderma* and *Globigerina bulloides* have also been dated, the diatom-based ages are typically 1600 years younger than those based on TOC and in rough agreement with the foram ages (Δ = 10, 40 years for *N. pachyderma* and 1120, 590, 170 years for *G. bulloides.*) Further comparisons, including CCRA vs. forams vs. diatoms, will be available by the time of the conference. Further refinement and validation of this technique may yield reliable ages for previously undateable cores using an order of magnitude less sample than comparable methodologies.

OS42E-157 1330h POSTER

Coupling Between Walrus and Bivalves in a Fjord in High-Arctic NE Greenland

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Predation of adult male walruses (*Odobenus rosmarus*) on bivalves was studied during July-August 2001 by direct observations in Young Sound (74°18N; 20°20W), NE Greenland. Underwater film and photos taken by scuba divers documented walrus feeding behaviour at 6-25 m depth. After each feeding session the divers marked the feeding location with a specially designed buoy. During a typical feeding session the walrus made several distinct pits when excavating bivalves from the soft-bottom sediments. Direct observations confirmed that a walrus sucks out the soft parts of the bivalves and leaves the shells on the seafloor. Therefore, the number of bivalves eaten per dive could be estimated by collecting the empty shells left after each dive. All shells from the marked feeding location was collected within 1 h of predation and the species and individual

size of the consumed bivalves were subsequently identified from the shells. Only shells with fresh remains of soft tissues were considered to represent the observed foraging dive. Three species of bivalves (*Mya truncata, Hiatella arctica* and *Serripes groenlandicus*) were consumed. The number of bivalves eaten during 10 dives made by 5 different walruses averaged 53 ± 5 (mean ± SE, all species pooled) per dive which lasted 5-7 min. This corresponds to 150 ± 19 g shell free dry weight per dive.

OS42E-158 1330h POSTER

Feeding Ecology and Migration Characteristics of a Northern Population of Arctic Charr, Salvelinus Alpinus (L.) in N.E. Greenland

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Anadromous arctic charr, Salvelinus alpinus (L.) are salmonids that adopt a migrant life history strategy to take advantage of access to marine environments and richer feeding areas during the short but intense summer season of the colder high latitude regions. If the migrant charr population is large and consumption rates are high then Arctic charr may have a significant impact on various trophic levels within a local region. In an attempt to increase our understanding of their potential regulating role in a local marine environment the feeding ecology and migration characteristics of an anadromous arctic charr population was studied in Young Sound, N.E. Greenland (74°18'N; 20°15'W). Results from 290 stomachs (charr lengths; 16-69cm) sampled in 1997 and 2000 showed a variable selection of prey items according to seasonal and annual changes in prey availability. Amphipods (54% occurrence and 40% weight) and mysids (55% occurrence and 33% weight) along with fish (40% occurrence and 21% weight) constituted the dominant prey in 1997, whereas pelagic snails (90% occurrence and 60% weight) and to a lesser extent crustaceans and fish were the dominant prey in 2000. The small size group (< 40cm) tended to feed almost exclusively on crustaceans suggesting ontogenic changes in diet. Seasonal changes in diets reflected a feeding pattern according to the Optimal Foraging Theory as charr chose a broader variety of food items during the early part of the summer when prey was scarce and fewer types of prey in the latter part of summer when food was more abundant. The median length of charr migrating upstream decreased significantly during the migration period as a comparatively greater proportion of smaller individuals ascended the river during the latter part of the summer. Charr in this population first migrated to the sea from the age of 6 years (overall age; 6-22 years). Peak abundance of returning charr in the latter part of the study period corresponded well with increases in river discharge and highest daily tide levels. The potential role of anadromous arctic charr within the marine food web is discussed in relation to ongoing studies of changes in marine arctic production in Young Sound. (http://www.dmu.dk/LakeandEstuarineEcology/CAMP/).

OS42E-159 1330h POSTER

Ice-Associated Organic Carbon in the Bering Sea Water Column During Winter

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Algae growing on the under-surface of fast ice or pack ice can be important to foodwebs in the upper water column, and to providing inoculum for spring blooms as the ice edge recedes. Much of this algal carbon may be released in dissolved form. However, seldom have there been measurements of dissolved and total organic carbon (DOC, TOC) underneath pack ice in winter to evaluate the importance of ice algal contributions throughout the water column. During the unique winter of 2001, pack ice in the Bering Sea had receded north of St. Lawrence Island (65°N) by 15 February, but by 15 March had advanced again to 62°N. In our sampling during March, this variable pack allowed us to examine effects of ice cover on DOC and TOC at surface, middle, and bottom depths in water ranging from 50-90 m deep, over an area of about 900 km^2. The Bering Sea ice pack advects southward at a highly variable rate of about 15 km/day. In March 2001, newly-formed pack ice less than 1-2 weeks old rapidly developed ice algal communities. Sample stations covered by pack ice (n = 23) had higher levels of TOC at surface (P = 0.023) and middle depths (P = 0.019) than did stations with open water or newly-formed pancake ice (n = 14). In contrast, DOC concentrations did not differ between ice cover types (P > 0.474), suggesting that a baseline concentration of DOC was augmented by particulate carbon derived from ice algae. Our findings indicate that even new pack ice can rapidly develop ice algae capable of contributing significant organic carbon throughout the water column long before onset of the spring bloom.

OS42F HC: Hall III Thursday 1330h

Biophysical Factors Affecting the Growth and Survival of Aquatic Organisms IV

Presiding: **J Ackerman,** University of Northern British Colombia

OS42F-160 1330h POSTER

The Effect of Small-Scale Turbulence on the Morphology and Growth Rate of *Eucampia zodiacus* Ehernberg (Bacillariophyceae)

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The role of size and shape in the ecology of planktonic diatoms has been debated since the latter part of the 19th century. Elaborate shapes have been hypothesized to influence flotation, orientation of the particle within the water column, or to confer protection from grazers. More recently, it has been argued that differences in shape could interact with small-scale mixing processes to increase the flow of nutrients to the cell surface, thus enhancing growth rate. In order to explore potential biological-physical interactions, we examined the effect of small-scale turbulence on the morphology, size and growth rate of the diatom *Eucampia zodiacus* Ehrenberg. Colonies were grown in 20 L batch cultures, in 5 levels of turbulence (quantified with an ADV), and compared to a quiescent control. The resulting colony length was directly related to the level of turbulence under which E. zodiacus was grown. Helical colonies up to 4 mm in length, each composed of hundreds of cells, were formed at epsilon values $\sim 10^{-8}$ to 10^{-7} m^2 sec^{-3}. Only short fragments of colonies were formed at epsilon of $\sim 10^{-6}$ to 10^{-5} m^2 sec^{-3}. At epsilon $\sim 10^{-4}$ to 10^{-3} m^2 sec^{-3}, colonies were not formed at all: only single cells and pairs of cells occurred. Some turbulence was necessary in order for *E. zodiacus* to form morphologically normal colonies. In the non-stirred control tank, many colonies were abnormally twisted. If formed, helices were often irregularly coiled. *Eucampia* also modified its shape in response to turbulence. Over the range of epsilon values where colonies were formed, the pitch of the helix decreased with increasing turbulence. Differing levels of turbulence also led *E. zodiacus* to alter the mechanical strength of the connection between cells. The silicon processes that connect adjacent cells in a colony were largest under the conditions that led to the formation of the longest colonies. We did not observe statistically significant changes in growth rate amongst the different turbulence treatments. Changes in morphology, but not in growth rate, indicate that this diatom adapts to the level of turbulence under which it is grown, but that the changes may be related to altering the mechanical strength of the colony, rather than modification of nutrient uptake dynamics.

OS42F-161 1330h POSTER

Bioconvection in Oceans and Lakes

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It has been recently stated that bioconvection is a feedback mechanism from the biology to the physics that requires investigation in an oceanographic context. Bioconvection has previously been studied with regards to experiments of shallow suspensions of motile micro-organisms. It describes the mechanism by which upward-swimming organisms aggregate near the surface, causing an overturning instability because the surrounding water has a lower density than the organisms. When viewed from above, a variety of patterns can be seen.

Here, we consider the potential for an alternative form of bioconvection to occur. Subsurface chlorophyll maxima are commonly-observed aquatic features. Models show that, under the right circumstances, a chlorophyll-rich layer of water can become heated more than the water above it, creating an unstable situation. We model such a scenario to investigate the potential for creating scaled-up versions of the bioconvection patterns observed in the small-scale experiments (albeit by a different process).

Our model consists of the full Navier-Stokes equations, plus equations for phytoplankton biomass, irradiance (which is modified by the phytoplankton), water temperature (which is modified by the irradiance) and water density (which is modified by the temperature). The resulting convection can advect the phytoplankton, and thus could be a mechanism for creating horizontal patches of phytoplankton in lakes and oceans.

URL: http://www.chebucto.ns.ca/~english

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Chaos or Critters?: Distinguishing Turbulence from Zooplankton in Acoustic Profiles of Turbulent Environments

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Recent work has shown that zooplankton feeding is improved when the animals are exposed to certain levels of turbulence and that some species may seek preferred levels of turbulence in the mixed layer. Acoustic backscatter is a common tool to study zooplankton distributions. In turbulent regions it may be difficult to identify the source of acoustic backscatter because both turbulent microstructure and zooplankton scatter sound. Multiple frequency sounding is helpful because turbulence and plankton have different spectral signatures, but there remains a pressing need to verify the models of backscatter with in situ measurements of turbulence and zooplankton, so that plankton density can be unambiguously related to turbulence.

We made simultaneous measurements of turbulent microstructure and fine-scale zooplankton distribution in a local fjord (with sill-generated turbulence) by mounting forward looking sounders (44 and 307 kHz) and a video recorder on a towed vehicle designed for taking velocity and temperature microstructure measurements. The footprint of these sounders is small (radius less than 2 m at the maximum range of 20 m) and the approach of reflectors can be tracked to within 2 m of the turbulence sensors at the front of the towed vehicle.

In turbulent areas, the sounders on the towed body showed mostly large-scale, diffuse scatter (likely turbulence) that was punctuated by the occasional strong, discreet target when a zooplankter (or group) passed by. The ship-board sounders (12, 40, 100 and 200 kHz), on the other hand, have a broad footprint at the range of interest, and only show diffuse backscatter in turbulent regions with no evidence for scatter from plankton. The zooplankton layers (visible in low-turbulence regions away from the sill) appear to be dispersed near the sill, making the zooplankton density too low to be detected with the ship-board sounders.

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