
**OS11B MCC: Hall D Monday
0830h**

**Impacts of Air/Sea Exchange on
Biogeochemical Processes in the
Ocean II Posters** (*joint with A, B, GC*)

Presiding: **W M Landing**, Florida
State University; **C Measures**,
University of Hawaii; **G A Cutter**,
Old Dominion University

OS11B-0222 0830h POSTER

**Heat fluxes, overturning, and the uptake
of anthropogenic carbon in the North
Atlantic**

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The influence of the overturning circulation on the anthropogenic carbon sink in the North Atlantic is investigated with a simple box model. The net air-sea flux of anthropogenic carbon is the result of two opposing fluxes: one is uptake caused by the disequilibrium between the rapidly rising atmospheric $p\text{CO}_2$ and the dissolved carbon content in the ocean, depending mainly on the water exchange rate between mixed layer and interior North Atlantic ocean. Superimposed is a second flux, related to the northward transport of heat within the Atlantic basin, that is directed out of the ocean, contrary to conventional wisdom. It is related to cooling and freshening of surface water on its way north, causing a latitudinal gradient in the ratio of seawater alkalinity to total dissolved inorganic carbon. This flux depends strongly on the vertical structure of the upper branch of the overturning circulation and on the distribution of under- and super-saturation of CO_2 in Atlantic surface waters. A data-based estimate of anthropogenic carbon inventory in the North Atlantic is consistent with a dominance of the disequilibrium flux over the heat-flux-related outgassing at the present time, but, in our model, does not place a strong constraint on the net anthropogenic air-sea flux. Stabilization of the atmospheric $p\text{CO}_2$ on a higher level will change the relative role of the two opposing fluxes, making the North Atlantic a source of anthropogenic carbon to the atmosphere.

OS11B-0223 0830h POSTER

**Dry Deposition of Trace Elements to the
Western North Atlantic**

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The concentrations of selected elements, including Al, Fe, Na, Sb, Se, V, and Zn, were determined for bulk aerosol samples collected at Bermuda between 1988 and 1993 as part of the Atmospheric/Ocean Chemistry Experiment (AEROCE). These data were combined with parameterized dry deposition velocities to investigate trace element recycling on atmospheric sea salt. During July and August, which are in the high dust season, > 10% of the monthly mean aerosol Na can be ascribed to crustal sources rather than sea salt, but in general the contribution of mineral dust to Na dry deposition is small (~1%) relative to that from sea salt. In fall and winter, ~10 to 20% of the aerosol Al, a commonly used indicator of mineral dust, is attributable to recycled sea salt, but the dust fluxes then are small, and longer-term averages show a recycling effect of only 1 to 5% on dry deposition. The percentage of recycled Fe appears to be even less than for Al, reaching a maximum of ~5% per month from December to February and averaging only a few percent per day when calculated over the duration of the study. Non-crustal/non-sea salt (NC/NSS) sources account for > 70% of the aerosol Sb, Se, V, and Zn, but differences in the dry deposition velocities for three particle types, which do still need to be verified, strongly affect their air/sea exchange rates. According to the simple model calculations, dust can account for more than half of the new dry deposition inputs of V and Zn, but the amounts of Sb and Se recycled on sea spray approach or exceed their new inputs from dust and the NSS/NC sources.

OS11B-0224 0830h POSTER

The Concentration of Hafnium in Seawater: a Comparison Between the Arctic Ocean and the Northwestern Pacific

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The concentrations and isotopic composition of hafnium in geological samples and ocean sediments have been studied extensively. However, the sources of Hf and its behaviour in the aquatic environment are poorly understood. We established a low blank, high efficiency technique to determine the Hf concentration in seawater. Isotope dilution measurements by multiple collector inductively coupled plasma mass spectrometry (MC-ICPMS) offer a method to obtain accurate concentration measurements from sample volumes of 2 litres.

We will present water column profiles of Hf concentration from two oceanic realms with different hydrographic features and particle concentration (samples from Sea-Bird SBE 9 2000, Swedish AO-01 expedition, 2002 IOC western Pacific cruise). In the Arctic Ocean with its perennial sea ice cover the suspended particle concentration is significantly lower than that of other ocean basins, which is a result of the low dust input and the low productivity. The renewal rate of deep water is slow (isolation ages of 250 to 450 years; Schlosser et al. 1994). In contrast, the Pacific Ocean is exposed to dust input from the Asian deserts and biological productivity at the margin is high. The circulation patterns are controlled by geostrophic forcing and inflowing deep waters from the Southern Ocean.

The preliminary results of samples from the Arctic Ocean show a slight decrease with depth, in contrast to earlier concentration measurements from the Atlantic and Pacific Ocean where Hf concentrations increase with depth (Godfrey et al. 1996, McKelvey and Orians, 1998). The range of our measured concentrations (0.4 to 0.8 pmol/kg) is comparable to earlier results. The higher concentration (0.7 to 0.8 pmol/kg) in the surface waters of the Arctic Ocean are probably a result of reduced scavenging due to low particle concentrations. The Hf concentration data and eventually the Hf isotopic composition of seawater will lead to a better understanding of its suitability as a tracer for past and present ocean circulation and continental weathering.

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OS11B-0225 0830h POSTER

Measurements of Atmospheric Trace Gases Over NW Pacific During IOC 2002 Cruise - Pollutants Transported From East Asia and Biogenic Species Emitted From Ocean

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The R/V Melville cruised from Osaka (Japan) on May 1st to Hawaii on Jun 5th, as a project of Intergovernmental Oceanographic Commission (IOC) 2002. During this cruise, atmospheric trace gases (O₃, CO, DMS, many hydrocarbons, and halocarbons) were measured. It is expected that polluted air as well as Kosa from east Asia is transported to the Pacific in this season. On the west Pacific near from Japan, the concentrations of anthropogenic species were strongly affected by the meteorological condition. And the hydrocarbon concentrations have not very large difference at the east of Japan (about 145°E) and at 170°E in the same latitude.

On 170°E, the ship cruised straight from 50°N to about 20°N, and latitudinal profile of atmospheric species in the Pacific was observed. There are clear concentration decrease from higher latitude to lower latitude for CO, O₃, hydrocarbons, and short lived halocarbons. There is a large gap at around 30°N, since maritime air prevail at lower latitude. The ratios of hydrocarbons and CO give some information about their sources. CO and ethane have similar lifetime in the atmosphere, but the ratio ([ethane]/[CO]) decreased drastically as the distance from the land. CO is supplied by the oxidation of CH₄ and hydrocarbons also on the ocean, in addition to the transportation of anthropogenically generated CO from land. Therefore concentration decrease of CO is smaller than that of hydrocarbons far from the anthropogenic source area.

Biogenically generated species emitted from the ocean (DMS, ethene, propene, isoprene, CH₃Br) were also measured during the cruise. Their trends are totally different from anthropogenic hydrocarbons. Higher concentrations of biogenic generated species were observed at lower latitude, where more activated biogenic activity is expected. Similar trend of ethene, propene, and DMS were observed. Especially, ethene and propene have good correlation. Since these species have relatively high reactivity in the atmosphere, they affect the local chemistry of the atmosphere on the ocean.

OS11B-0226 0830h POSTER

Phytoplankton Community Composition, Growth and Mortality Rates in the North Pacific During May 2002

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The IOC North Pacific expedition of May 2002 from Osaka, Japan to Honolulu, Hawaii, surveyed the region from roughly 22 - 50°N 147°E - 158°W. This survey included nine stations, at which we collected samples for analysis with microscopy and flow cytometry to characterize the abundance and biomass of phytoplankton and microheterotroph populations. We also conducted deckboard-incubated dilution experiments to determine the growth and mortality rates of the phytoplankton community at eight of the nine stations occupied. Preliminary results suggest that the stations studied can be distinguished based on phytoplankton community composition and growth response to macronutrient additions during incubations. Station 1, located in the Kuroshio Current (34°22.76N 147°11.84E), was characterized by a centric diatom bloom (~20°C, surface chlorophyll 0.7 μg l⁻¹) and phytoplankton growth

rates were significantly enhanced after the addition of ammonium and phosphate. Phytoplankton communities at four oligotrophic stations (<0.5 μM nitrate, <0.1 μM phosphate) also exhibited enhanced growth rates after macronutrient additions (Station 6: 30°N 170°E; Station 7: 24°N 170°E; Station 8: 26°N 175°W; and Station 9: 22°45N 158°W). Surface chlorophyll at these stations ranged from 0.05-0.10 μg chlorophyll l⁻¹ with surface temperatures ranging from 22-27°C. The phytoplankton communities at these oligotrophic stations were dominated by picoplankton (*Prochlorococcus* and *Synechococcus*) and small (<5 μm) autotrophs. Finally, no nutrient limitation was observed at three of the stations (Station 2: 44°N 154.6°E; Station 3: 50°N 167°E, and Station 4: 39°N 170°E). Surface chlorophyll at these stations ranged from 0.3 to 0.7 μg l⁻¹ and surface temperatures ranged from 4-13°C. The phytoplankton at these stations were dominated by autotrophs measuring 2-10 μm, including haptophytes and pennate diatoms. In addition, 10-20 μm autotrophic dinoflagellates were common at Station 2. Phytoplankton growth and mortality rates at each of these stations will be discussed.

OS11B-0227 0830h POSTER

Mercury cycling over the North Pacific Ocean: Influence of South East Asia dust deposition.

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Mercury in the marine environment was investigated as part of a comprehensive study of its biogeochemical cycle in the North Pacific Ocean on the 2002 IOC cruise. The impact of dust deposition on the concentration of mercury in surface water was assessed using measurements in the water column (total and gaseous dissolved species) as well as in the marine boundary layer. Incubation experiments were performed in order to investigate the role of photochemistry in the air-sea exchange of mercury. In addition we will present a comparative study of mercury cycling between the Pacific Ocean and the Atlantic Ocean.

OS11B-0228 0830h POSTER

Observations of Near-Surface Thermal Structure and Turbulence Parameters

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Turbulent transport in the upper few meters of the ocean is one of the major factors controlling air-sea heat, momentum, and mass exchange. A number of issues related to this exchange are poorly understood. For example, in low wind speed regimes, near-surface stratification can significantly affect turbulent processes. However, under more energetic conditions, processes affecting near-surface layer turbulence and thus air-sea exchange are not well quantified.

Here we present observations in the near-surface layer from an experiment in Wellington Harbor, New Zealand. Continuous measurements were made from local time 1200-1700, during which time the wind dropped from 14 to 0 ms⁻¹. During this period the air was 4 °C colder than the water. The primary results were derived using the cycling autonomous profiler SkinDeEP. Additional turbulence data were recorded using a SCAMP temperature gradient microstructure profiler and a VECTOR acoustic velocimeter. A microwave radar quantified the white-capping percentage. The data showed: (i) the turbulent albeit inhomogeneous nature of the near-surface fluid and (ii) the change in temperature structure as the wind forcing eases. A comparison is also made with neutral conditions where the air and sea were at comparable temperatures.

OS11B-0229 0830h POSTER

Silver in the North Pacific

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Water data gathered in the North Pacific (May 2002) during the fourth International Oceanographic Commission cruise (IOC IV) are offering new insights into the biogeochemical cycling of Ag in the worlds oceans. Ag concentrations in surface waters and from nine vertical profiles will greatly supplement the limited data set of Ag measurements in the Pacific Ocean, which at present consist of one site in the South Pacific [1], two sites in the eastern North Pacific [2], and three sites near Japan [3]. Natural biogeochemical processes govern the distribution of Ag, as is clear from its nutrient-type distribution in oceanic vertical profiles, with depletion in surface waters and enrichment at depth. Ag has previously been shown to positively correlate with Si [2-6], and that trend will again be examined in these samples. Any deviations from this trend can be used as an indicator of anthropogenic Ag contamination.

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OS11B-0230 0830h POSTER

The Atmospheric Dust Concentration and the Fractional Solubility of Atmospheric Al in seawater

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In order to determine the atmospheric dust concentration and the fractional solubility of atmospheric aluminum (Al), aerosol samples were collected weekly on the windward side of Oahu, Hawaii between February and June 2002. Sampling was conducted using an automatic sector controlled aerosol sampling system to prevent pumping during times when winds would bring dust from nearby islands and local sources to the sampler. Aerosols were collected on 10 replicate acid cleaned Millipore 47 mm Polycarbonate filters with a pore size 0.4 μm at a mean pumping rate of 80 L/min.

Microwave acid digestion of a complete set of filters and their aerosol load followed determination of Al by flow injection analysis (FIA) yielded a precision (1 σ) of 11% for the entire sampling and analysis process. Partial dissolution of the aerosols was determined by suspending a replicate filter in 60 mL of 0.2 μm filtered surface seawater at pH 8.3. 10 mL of this solution was then filtered (0.2 μm) and the amount of dissolvable Al was determined. In order to see changes in Al solubility with respect to time, samples were analyzed for Al at 24 hour intervals for 4 successive days. Another replicate filter sample was analyzed for major ions including Na^+ , K^+ , Mg^{2+} , Ca^{2+} , Cl^- , NO_3^- and SO_4^{2-} .

During the sampling period, the atmospheric Al concentrations and atmospheric mineral dust concentrations observed above Hawaii were 1.2-56.1 (ng/m^3) and 15-700 (ng/m^3), respectively, assuming mineral aerosols are 8% Al by mass. Atmospheric dust concentrations at Hawaii increased shortly after an intense dust outbreak was observed in Mongolia in late March. Al fractional solubility varied from 0.087-14.3% with a

mean value of 4.6%. Within the first 24 hours, Al in the aerosol samples appeared to dissolve relatively quickly (first mode). It then continued to dissolve slowly over the next three days (second mode). The total dissolvable Al (1st plus 2nd mode) as well as the total charge of dissolvable non sea salt (nss) K^+ , Mg^{2+} and Ca^{2+} was well correlated with the total charge of NO_3^- and nss SO_4^{2-} ($R^2=0.78$, $R^2=0.84$). These results indicate that the abundance of atmospheric ($\text{NO}_3^- + \text{nss SO}_4^{2-}$) acids is one of the major factors controlling the fractional solubility of atmospheric dust.

OS11B-0231 0830h POSTER

Halocarbon Production by Pelagic, Sea-Ice and Snow Communities of Micro-organisms - A Source for Halogens in the Arctic Troposphere

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Volatile halocarbons are trace constituents of the oceans and the atmosphere, and they contribute significantly to atmospheric chemistry and the biogeochemical cycling of the elements chlorine, bromine and iodine in the environment. The trace gases and their degradation products contribute to the atmospheric destruction of ozone. An inverse correlation between bromine and ozone in the troposphere has been reported from certain areas, such as the Arctic region.

Previous observations suggest that there is a major release of brominated substances into the troposphere during early spring in the Arctic Ocean. Therefore, we participated in an expedition during April and May 2002 to the Greenland Sea with I/B Oden to identify the origin of halocarbon production with emphasis on brominated compounds.

Incubation experiments were performed with micro-organisms from different habitats, seawater, brine and snow. The aim was to measure the magnitude of halocarbon production and relate this to the micro-organisms in the different habitats. It has been suggested that the formation of organo-bromine compounds in snow in spring conditions may be due to the formation of reactive bromine species such as HOBr. However, tests of the brominating activity in seawater, brine and melted snow suggested no significant production of HOBr. Instead our results indicate that snow and ice communities contribute to a larger extent to the total production of halocarbons (e.g. bromoform) than previously assumed. We also found that the production was higher with increasing salinity in the brine.

URL: <http://www.amc.chalmers.se>

OS11B-0232 0830h POSTER

Colloidal Iron, Aluminum, and DOC/DON in Surface Waters of the Northwest Pacific: Results from the 2002 NSF/IOC Cruise

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Over 70 surface seawater samples were collected on the 2002 NSF/IOC cruise between Japan and Hawaii using a towed fish peristaltic pump trace-metals clean sampling system. Samples for total dissolved Fe and AL were filtered using 0.2 μm cartridge filters. Colloidal Fe and Al were isolated using a Millipore Prep-Scale 1 kDa regenerated cellulose tangential flow ultrafiltration device. Concentration factors were 8-10. Aluminum concentrations were measured using the lumogallion fluorometric technique; Fe concentrations were measured by Fe-57 isotope dilution with a Finnegan Element high-resolution magnetic sector ICPMS.

Total dissolved Fe concentrations ranged from 0.2 to 0.6 nM and were weakly correlated with atmospheric Fe

deposition (calculated from aerosol Fe concentrations). Colloidal Fe ranged from 10-60 percent of the total dissolved Fe and appeared to be related to atmospheric input and biological activity. We will discuss the relationships between the concentrations of particulate, dissolved and colloidal Fe, Al, and DOC/DON and the intertwined effects of atmospheric input, complexation by natural ligands, and physical dilution into the mixed layer.

OS11B-0233 0830h POSTER

Atmospheric Deposition and Upper Ocean Cycling of Iron and Aluminum in the Gulf of Mexico: Results from the SWISS project

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Three cruises have been conducted in the Gulf of Mexico for the Surface Water Iron Speciation Study (SWISS). Our goal is to investigate the processes that lead from aerosol Fe solubilization to stabilization in the water column and eventually to uptake by phytoplankton. One cruise was conducted during the low dust, high river runoff period (spring 2001); two cruises occurred during the high dust, low runoff period (late summer 2001 and 2002). Surface seawater samples were collected using a clean towed batwing pump system and separated into particulate, total dissolved, colloidal, and truly dissolved fractions using cartridge filters and tangential flow ultrafiltration. Colloidal Fe concentrations ranged from 20-80 percent of the total soluble Fe, and were generally lower in the open Gulf waters. Aerosol samples were collected for 12-24 hour intervals onto 47 mm, 0.45 μm filters using a sector-controlled system to avoid stack exhaust. The solubilities of aerosol Fe and Al were assessed by rinsing the filters with surface seawater or ultrapure water. The leach solutions were analyzed for trace elements and major ions. The concentrations of total aerosol Fe ranged from 5-30 nmol/m³ and correlated strongly with Al. The total soluble Fe ranged from 2-19 percent and averaged 9 percent. The soluble Fe(II) ranged from 1-60 percent of the total soluble Fe (average 17 percent). The data from the third cruise (Sep. 2002) will be discussed in context with what we have learned from the first two cruises.