B24A-02 1600h

Microbial Mercury Cycling in San Francisco Bay Sediments: From Regions to the Rhizosphere

Mark C. Marvin-DiPasquale[1] (650-329-4442; mmarvin@usgs.gov)

Jennifer L. Agee[1] (650-329-4434; jlagee@usgs.gov)

Le H. Kieu[1] (650-329-4428; lhkieu@usgs.gov)

Hillary A. Harms[1] (650-329-4442; haharms@usgs.gov)

[1]U.S. Geological Survey, 345 Middlefield Rd. Mail Stop 480, Menlo Park, CA 94025, United States

The San Francisco Bay (SFB) estuary is hydrodynamically diverse ecosystem with extensive mercury contamination associated with historic gold and mercury mining wastes, and in a region with an unprecedented number of wetland restoration projects planned or ongoing. Wetlands are known to be active areas for the microbial transformation of Hg(II) to methylmercury (MeHg), which bioaccumulates in the food web. A better understanding of this microbial process, in these restored wetlands and other sub-habitats, is critical if Hg contamination is to be successfully managed in this system. An examination of MeHg production and degradation in sediments has been conducted at multiple spatial scales throughout the SFB estuary and its tributaries over the past four years. At the regional scale, we will present data from the brackish Bay, the delta, and rivers and reservoirs in tributary watersheds. Within the freshwater delta and river regions, a new project is focusing on emergent marsh, non-vegetated open water, and submerged-macrophyte zones. At the smallest scale, we consider microbial Hg cycling in the root zone (rhizosphere) of dominant wetland plants and propose a conceptual model of the key biogoechemical reactions that may make this transitional zone one of the most important with respect to Hg(II)-methylation.

B24A-03 1615h

Methylation and Release of Mercury From the Solid Phase. What Comes First?

Olof Regnell (46462223781; Olof.Regnell@ecotox.lu.se)

University of Lund, Ecology Building/Chemical Ecology, Solvegatan 37, Lund 223 62, Sweden

It is a well-known fact that methylation leads to a dramatic increase in the bioavailability of mercury (Hg). All recent observations support the notion that Hg methylation is almost exclusively an anaerobic process. According to the reigning paradigm, methylation of Hg takes place in the cytoplasm of anaerobic bacteria, notably sulfate-reducing bacteria. It is believed that certain forms of inorganic divalent Hg (Hg(II)), can readily diffuse across the cell membrane. In addition, a recent study suggested that active uptake may occur when Hg is bound to low weight organic molecules. In the cytoplasm, cobalamin-dependent biochemical pathways, designed to methylate substrates other than Hg(II), are held responsible for the methylation of Hg(II). However, recent results from studies in a Swedish wetland (within the project "Svartsjoprojektet", aiming at understanding Hg dynamics in a Hg-polluted river-lake system) have led us to question whether Hg methylation does occur exclusively within cells. A provocative interpretation of our results is that methylation preceded the release of Hg from the solid phase, e.g. that Hg(II) sorbed to solid surfaces was methylated and subsequently released as methyl Hg to the sulfidic water. I will discuss this possibility in light of existing evidence that Hg methylation is an intra cellular process.

B24A-04 1645h

Mercury methylation in forested uplands; how important is it?

James B Shanley[1] (802-828-4466; jshanley@usgs.gov)

Mark Marvin-DiPasquale[2] (650-329-4442; mmarvin@usgs.gov)

Paul f Schuster[3] (303-541-3052; pschuste@usgs.gov)

Ann Chalmers[1] (802-828-4511; chalmers@usgs.gov)

Michael M Reddy[3] (303-236-5021; mmreddy@usgs.gov)

[1]U.S. Geological Survey, Box 628, Montpelier, VT 05602, United States

[2]U.S. Geological Survey, 345 Middlefield Rd. MS 480, Menlo Park, CA 94025, United States

[3]U.S. Geological Survey, 3215 Marine St. Suite E-127, Boulder, CO 80303, United States

Episodic fluxes of mercury during high flows at the headwater catchment at the Sleepers River Research Watershed in Vermont indicate that uplands are an important source of total mercury (Hg) to known downstream methylation sites (i.e. large wetlands). Methylmercury (MeHg) behavior in streamwater, soil water, and sediment porewater coupled with high potential methylation rates suggests that forested uplands may be significant source areas for MeHg as well. In a July 2003 incubation, potential Hg methylation rates exceeded potential demethylation rates by factors of 1.6 each in shallow (0-4 cm) swamp and riparian soils and by 19.6 in anoxic stream sediments. The stream sediment had the greatest methylation rate of 7.5 ng/ g of wet sediment / day. However, MeHg concentrations in filtered (0.4 um) porewater at these sites ranged only from 0.07 to 0.37 ng/ L, similar to the range at low-lying wetland sites elsewhere in Vermont (0.06 to 0.56 ng/L). In Sleepers River headwaters as well as larger Vermont rivers, most of the MeHg export occurs during snowmelt and summer / fall storms, with nearly all of the MeHg occurring in the particulate phase. Stream total Hg and MeHg concentrations were consistently correlated, suggesting a common source, probably soil organic matter. The methylation efficiency (ratio MeHg / total Hg) was near 2% in the Sleepers River headwaters, similar to that in Vermont rivers draining large wetland systems, indicating that the methylation process originates in the headwaters.

B24A-05 1700h

Hg Concentrations in Epiphytic Lichens Trace Atmospheric Deposition

Jean Carignan[1] (carignan@crpg.cnrs-nancy.fr)

Luc Marin[1] (lumar@crpg.cnrs-nancy.fr)

[1]CRPG-CNRS, 15 rue Notre Dame des Pauvres, Vandoeuvre 54501, France

Mercury is emitted to the atmosphere by anthropogenic and natural sources, the dominant form being the gaseous elemental Hg^{o}. The residence time in the atmosphere is relatively large, and may reach several months. The rate at which mercury is removed from the atmosphere might be highly variable and depends on environmental conditions. Some authors suggested that the presence of agents such as ozone, OH, NO3 and chorine species may oxidise Hg^{o} leading to an important reduction of its residence time and a significant increase of atmospheric deposition. This study aims to characterise the Hg concentration in lichen samples in order to document the variability of atmospheric fallout. Lichens are of particular interest because their epiphytic character makes them totally dependant of atmospheric nutrients, so that their chemical composition reflects that of atmospheric matter. Lichens hanging on tree branches were sampled in various location of the boreal forest of northern Quebec. The Hg concentrations measured in lichens vary from 2 to 0.2 ppm and decrease systematically from the coast of Hudson Bay towards inland at the scale of hundreds of km. Hg content is highly correlated with halogen elements in lichens. The best correlation is found between mercury and iodine. This suggests that the presence of halogen species are effective for oxidising elemental gaseous Hg in the atmosphere, leading to an increase of total Hg fall out by a factor of 10 in coastal environments relative to continental environments.

B24A-06 1715h

Mercury in the Environment, Global Climate Change and Ozone Depletion Chemistry: Recent Evidence for Multiple Linkages

Victoria A Evans[1] (415-222-8316; victoria.evans@ttemi.com)

Aaron Mann[1] (775-333-8456; aaron.mann@ttemi.com)

Josh Romeis[1] (775.333.8457; josh.romies@ttemi.com)

[1]Tetra Tech EM Inc., 135 Main Street Suite 1800, San Francisco, CA 95403

This synthesis paper provides a discussion of recent scientific evidence documenting multiple linkages between atmospheric mercury cycling, global climate change factors (GCC) and ozone depletion chemistry. Previously researchers have hypothesized that GCC could enhance the mobilization and bioaccumulation of mercury in ways that could increase the risk of human exposure. Recent scientific research focused upon mercury emissions and mercury cycling in the environment has yielded an improved understanding of biogeochemical processes. These studies provide insights from both field and laboratory measurements and from all of the environmental compartments involved in mercury cycling. Taken together, the results of these scientific studies document multiple relationships between mercury cycling, GCC factors and ozone depletion chemistry. These complex relationships promote the cycling of mercury in the environment, i.e., increasing the mobilization and bioavailability of mercury in the environment. First, recent findings demonstrate that the rate of oxidation of elemental mercury to reactive gaseous mercury increases with increased solar radiation, in turn elevating the level of mercury released from soils, substrate and polar snow pack. The increased rate of the oxidation of elemental mercury is documented to be contemporaneous with tropospheric ozone depletion events in polar studies. Second, an increase in the release of mercury from substrate occurs with increased temperature as demonstrated during forest fires and in mercuriferous geology. Third, mercury bioaccumulation in fish has been closely linked to the production of dissolved organic carbon, with an increase in bioaccumulation levels possible with increased water temperature. As a result, this paper suggests a new term, the "Muir Effect" for describing multiple linkages that occur in complex environmental cycles. The Muir Effect is named after well-known American naturalist, John Muir.

B31A CC: 220 C-E Wednesday 0830h

Multitemporal Remote Sensing of Vegetation II Posters

Presiding: **C Song,** University of North Carolina at Chapel Hill**; W B Cohen,** USDA Forest Service

B31A-01 0830h POSTER

Monitoring Forest Succession Using Multitemporal Landsat Images: Factors of Uncertainties

Conghe Song (csong@email.unc.edu)

University of North Carolina, Deparment of Georgarphy CB# 3220, Chapel Hill, NC 27599, United States

This study evaluates uncertainty factors in using multitemporal Landsat images for subtle change detection, including atmosphere, topography, phenology, sun and view angles. The study is based on monitoring forest succession with a set of multiple Landsat TM/ETM+ images spanning 15 years over the H. J. Andrews Experimental Forest in the Western Cascades of Oregon. The algorithms for removing atmospheric effects from remotely sensed images evaluated include a new version of dark object subtraction (DOS3) method, the dense dark vegetation (DDV) method, the path radiance (PARA) approach, and the 6S radiative transfer codes. We found that the DOS3 approach undercorrects the image, and the recently developed DDV and PARA approaches can produce surface reflectance values closely matching those produced by 6S using in situ measurements of atmospheric aerosol optical depth. Atmospheric effects reduce NDVI and Greenness, and increase Brightness and Wetness. Topography modifies Brightness and Greenness, but has minimal effects on NDVI and Wetness, and it interacts with sun angle. Forest stands at late successional stages are more sensitive to topography than younger stands. Though the study areas are covered predominantly by evergreen needle leaf forests, phenological effect is significant. Sun angle effects are confounded with phenology, and reflectance values for stands at different successional stages are related to sun angles nonlinearly. Though Landsat has a small field of view angle, the view angle effects from overlapping Landsat scenes for a mountainous forested landscape may not be ignored when monitoring forest succession with multitemporal images.

B31A-02 0830h POSTER

Trace metal content and micromorphology as proxies for bleaching in the modern coral *Porites divaricata*

Sande A. Burr ((607)255-9608; sab45@cornell.edu)

Dept. of Earth and Atmospheric Sciences, Snee Hall Cornell University, Ithaca, NY 14853

Morphology and trace metal content of scleractinian corals have previously been used as proxies for past environmental conditions, but no proxy for the health of ancient corals currently exists. Skeletal material associated with bleached and non-bleached tissue from Recent *Porites divaricata* was analyzed with SEM and ICPAES. Differences in both morphology and trace metal content were found in samples associated with bleached and non-bleached tissue. SEM analysis showed skeletal corallites associated with unbleached tissue have well-defined septal denticles. Skeletal corallites associated

with bleached tissue have weakly-defined septal denticles, many appearing rudimentary. Significanly higher trace metal/Ca ratios were found with ICPAES for Ag, As, Cd, and Co between skeletal material associated with bleached and non-bleached tissue. The presence of these differences suggests the processes of skeletogenesis and the uptake and deposition of trace metals in the scleractinian skeleton are affected by bleaching. Such indicators might be observed in the fossil record as indicators of past environmental stress and bleaching in scleractinian corals.

B31A-03 0830h POSTER

Potential of MODIS Ocean Bands for Estimating CO2 Flux from Terrestrial Vegetation: A Novel Approach

Abdullah F Rahman[1] (765-285-1172; faiz@bsu.edu)

Vicente D Cordova[1] (vdcordova@bsu.edu)

John A Gamon[2] (jgamon@calstatela.edu)

Hans P Schmid[3] (hschmid@indiana.edu)

Daniel A Sims[1] (dasims@bsu.edu)

[1]Ball State University, Geography Department Room # CL-425, Muncie, IN 47306, United States

[2]California State University Los Angeles (CSULA), Dept. of Biology 5151 State Univ. Dr., Los Angeles, CA 90032, United States

[3]Indiana University, Geography Department, Bloomington, IN 47405, United States

A physiologically-driven spectral index calculated using two ocean-color bands of MODIS satellite sensor (bands 11 and 12) showed great potential to track seasonally changing photosynthetic light use efficiency (LUE) and stress-induced reduction in net primary productivity (NPP) of terrestrial vegetation. Consequently, we developed a simple model solely based on remotely sensed spectral data, which resulted in a dynamic, per-pixel 'continuous field' approach that could explain 88 percent of variability in flux-tower based daily NPP. These findings highlight the unexplored potential of narrow-band satellite sensors to improve estimates of spatial and temporal distribution in terrestrial carbon flux.

B31A-04 0830h POSTER

Residual Cloud Screening On MODIS LAI Products

mingzhen chen[1] (416-946-7715; chenm@geog.utoronto.ca)

Jing M Chen[1] (416-978-7085; chenj@geog.utoronto.ca)

Feng Deng[1] (416-946-7715; dengf@geog.utoronto.ca)

[1]Dept. of Geography, Univ. of Toronto, 100 St. George St. Room 5047, Toronto, ON M5S 3G3, Canada

Leaf area index (LAI) is a key variable in many ecosystem models and in global models of climate, hydrology, biogeochemistry and ecology, which need to describe the exchange of fluxes of energy and mass (e.g., water and CO2), and momentum between the surface and the atmosphere. The MODIS sensor onboard of Terra has been producing daily global coverages, from which 'cloud-free' composite images every 8 days are being produced. MOD15 is the LAI product of MODIS using the 8-day composite images. In order to use the data series for monitoring and modeling terrestrial ecosystems, additional quality control is necessary. A series of LAI maps of MOD15 over the entire China's landmass are processed. The most challenging issue in using the MOD15 product is the data quality related to the accuracy of LAI in all pixels labeled as 'cloud-free' and the screening of residual clouds. Test pixels of each land cover type are analyzed. The cloud-contaminated pixels labeled in MOD15 as 'significant clouds were present' and 'mixed cloud present on pixel' are excluded from further analysis. Cloudless pixels generally show LAI values in plausible ranges, except those of croplands and grasslands (from the Pack 3 algorithms) which appear to be abnormally high (larger than 6 in many cases). However, the main problem is the large LAI variations among remaining 'cloudless' dates for individual pixels. These are mostly residual cloud effects or errors in atmospheric corrections. Based on the seasonal trajectory of LAI, a cubic spline smoothing and interpolation technique is developed for residual cloud screening through analyzing the temporal variation patterns of a seasonal LAI series. The time series is first fitted using cubic spline smoothing with a curve smoothness controlling parameter, and abnormally low values in the time series are identified and replaced with fitted values. This procedure is repeated until the upper envelope is found. Once the final curve is determined, it is used to interpolate between final selected points to reconstruct the seasonal LAI variation. This approach has been applied to MOD 15 product in the whole year of 2001 over China to demonstrate its effectiveness.

B31B CC: 524 A Wednesday 0830h

Dissolved Organic Carbon in the Biogeochemical Functioning of Systems I *(joint with H, GC)*

Presiding: **T Moore,** McGill University**; K Bishop,** Swedish University of Agricultural Sciences

B31B-01 0830h INVITED

How Does the Changing Environment Affect Concentrations, Fluxes and Properties of Dissolved Organic Matter in Soils?

Karsten Kalbitz (49-921-555624; karsten.kalbitz@bitoek.uni-bayreuth.de)

Dept. of Soil Ecology, Bayreuth Institute for Terrestrial Ecosystem Research (BITOEK), University of Bayreuth, Dr.-Hans-Frisch-Str. 1-3, Bayreuth D-95440, Germany

Environmental conditions influencing the release and fate of dissolved organic matter (DOM) in terrestrial and aquatic ecosystems have changed in the past and continue to change in the future. I studied effects of declining acidic deposition on concentrations and fluxes of dissolved organic carbon (DOC) using long-term soil solution data of two forest sites. The response of DOM to increased decomposition of soil organic matter caused by land use change (clear-cutting) and subsequently increased temperature will be examined at one forest site. Effects of an increased or decreased productivity of forests on DOM were studied by experimental manipulation of litter input to two forest soils. The central idea of all experiments carried out in the field was the response of DOM as a key driver in terrestrial and aquatic ecosystems to the changing environment. From the results of these experiments I conclude that accelerated decomposition of organic matter caused by temperature rise or land use changes should result in increasing concentrations and fluxes of DOC from soils into aquatic ecosystems. The larger stability of this additional DOM increases the importance of DOM for C sequestration in soils. The expected increased productivity of forest ecosystems should also result in increased DOC fluxes from soils. On the other hand, declining acidic deposition might result in smaller DOC fluxes into aquatic ecosystem if water passes through well developed soils with the capacity to sorb DOC.

B31B-02 0850h

Responses of Watershed DOC Export to Climatic Fluctuations: Mechanisms and Predictions

Ji-Hyung Park[1] (480-965-8165; jhp@asu.edu)

Myron J. Mitchell[2] (mitchell@mailbox.syr.edu)

[1]Arizona State University, School of Life Sciences, PO Box 874501, Tempe, AZ 85287, United States

[2]SUNY-College of Environmental Science and Forestry, Faculty of Environ. & Forest Biology, Syracuse, NY 13210, United States

Although various biogeochemical processes in forested watersheds have been linked to climatic fluctuations including warming, freezing, and drought, we still lack mechanistic understanding of responses of dissolved organic carbon (DOC) in soils and surface waters to climatic change and their implications for other biogeochemical cycles. We investigated responses of DOC export from a forested watershed in the Adirondack Mountains to climatic fluctuations during winter and spring snowmelt periods using intensive biogeochemical data and the PnET-BGC model. DOC concentrations in stream water draining the watershed showed positive responses to temperature rises and subsequent increases in runoff during snowmelt events from December through April. Concentrations of dissolved organic nitrogen (DON) showed a similar response pattern, while NO3 concentrations peaked before and tapered off during major spring snowmelt. Increased DOC concentrations during snowmelt events usually coincided with decreases in pH, consistent with the idea that DOC could offset increases in surface water pH caused by decreasing acidic deposition. The positive response of DOC and DON concentrations to increases in both temperature and runoff, along with concurrent decreases in ground snow depth, suggested that snowmelt responses to temperature fluctuations during winter and early spring might play a key role in interannual variations in watershed DOC export, as observed for NO3 export from the same watershed. No significant increases in precipitation are projected for this site in the entire 21st century compared to a constant warming trend projected. However, PnET-BGC simulations of runoff and DOC concentrations in steam water showed increases in both parameters from January through April, probably due to significant warming trend for this period. These results highlight the importance of winter and spring snowmelt events in hydrologically mediated responses of watershed DOC export to temperature fluctuations.

B31B-03 0905h

Effects of Catchment Characteristics and Disturbances on Storage and Export of Dissolved Organic Carbon in a Boreal Headwater Stream

Graham R. Hillman[1] (1-780-435-7260; ghillman@nrcan.gc.ca)

Joseph C. Feng[2] (1-780-436-9916)

Cecilia C. Feng[1] (1-780-435-7310; cfeng@nrcan.gc.ca)

Yonghe Wang[1] (1-780-435-7237; ywang@nrcan.gc.ca)

[1]Natural Resources Canada, Northern Forestry Centre 5320 - 122 Street, Edmonton, AB T6H 3S5, Canada

[2]Canadian Forest Service, 6303 - 125 Street, Edmonton, AB T6H 3V8, Canada

The transportation of large amounts of dissolved organic carbon (DOC) down a stream within a 15.51-km2 catchment in Alberta, Canada, related directly to events, such as high rainfall and beaver dam failures, that created major disturbances. A 2.3-km section of the stream was drastically altered in June 1994 when a flood wave resulting from a breached beaver dam deposited large amounts of debris and sediment within the section. Results from stream DOC storage analyses, in which a difference method was used, suggest that the organic debris dams created by the failed dam event served as both sources and sinks for DOC. Discharge and DOC measurements at hydrometric stations located at intervals along the stream indicated that storage of DOC in the stream was strongly influenced by the presence of wetlands and beaver (Castor canadensis). Disturbances occurring during periods totalling 28 days in 1994 and 17 days in 1995 accounted for 94% (1374 kgkm-2) and 84% (204 kgkm-2), respectively, of the amount of DOC exported from the catchment during the May-September period. DOC concentrations in the stream were greatest (77.0 mgL-1) near the top of the catchment where a 2-km2 fen served as the primary source of DOC. Stream DOC concentrations decreased progressively downstream to the catchment outlet where the mean concentration was 23.3 mgL-1.

B31B-04 0920h

Landscape Control of Dissolved Organic Matter Concentration and Chemistry in a Northern Michigan Watershed

Scott D. Bridgham[1] (bridgham@uoregon.edu); Paul C. Frost[2] (pfrost@nd.edu); James H. Larson[2] (jlarson1@nd.edu); Carol A. Johnston[3] (CAROL_JOHNSTON@SDSTATE.EDU); Katherine C. Young[4] (kdochert@nd.edu); Christine T. Cherrier[1] (cherrier@uoregon.edu); Gary A. Lamberti[2] (Gary.A.Lamberti.1@nd.edu); Patricia A. Maurice[4] (Patricia.A.Maurice.3@nd.edu); David M. Lodge[2] (Patricia.A.Maurice.3@nd.edu)

[1]University of Oregon, Center for Ecology and Evolutionary Biology, Eugene, OR 974035289, United States

[2]University of Notre Dame, Department of Biological Sciences, Notre Dame, IN 46556, United States

[3]South Dakota State University, Center for Biocomplexity Studies, Brookings, SD 57007, United States

[4]University of Notre Dame, Department of Civil Engineering and Geological Sciences, Notre Dame, IN 46556, United States

Dissolved organic matter (DOM) concentration, average molecular weight (M_w), and molar absorptivity were measured for 60 streams in the Ontonagon River watershed on the upper peninsula of Michigan in September 2002. Thirty-five of these streams have been sampled about every 2 months since. DOC concentration ranged from ~4 to 35 mg C L^{-1} across streams. DOM M_w and molar absorptivity also showed considerable variation among streams and seasons. Drainage density was the best single predictor of stream water DOC concentration ($r = 0.62$) of the landscape features (% of watershed in agriculture, evergreen forest, lake, woody wetland, and herbaceous wetland) and