that the many conflicting conclusions regarding desert shrub responses to rainfall are explained by the lack of sufficient field data and by several key nonlinear plant-soil-atmosphere couplings.

B31C-09 1120h

Potential Changes to Fire Patterns in Amazonia

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Fires are major disturbances for ecosystems in Amazonia. They affect vegetation succession, change nutrients and carbon cycling, and modify atmosphere composition. Fires in Amazonia are strongly related to land-use, land-cover and climate conditions. Because these factors are expect to change in the future, models are needed to evaluate the consequences of potentially different conditions. Here we present a new fire model developed by relating satellite fire information to corresponding statistics on climate, land-use and land-cover. The model is able to reproduce the main features of the fire behavior in Amazonia. To evaluate potential changes in fire patterns in the future, we applied the model under different scenarios of climate conditions and future development of the region. The results show that in response to these scenarios, there maybe substantial changes in the frequency and patterns of fires in the future. The implications of these results will be discussed in terms of the carbon cycle, forest coverage, and atmospheric fluxes.

B31C-10 1135h

Nitrogen deposition and sensitive ecosystems: a case study from the San Francisco Bay Area

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Nitrogen deposition from urban smog can greatly affect local ecosystems. This paper examines a complex situation in the Santa Clara Valley, CA where N-deposition from existing, new, and proposed developments threatens an ecosystem supporting numerous rare, threatened, and endangered species. Grasslands on nutrient-poor serpentinitic soils are being invaded by nutrient-demanding introduced annual grasses, driven by dry N-deposition of about 10 kg ha-1 yr-1. These grass invasions threaten the native biodiversity of the serpentinitic grasslands, including the federally-protected Bay checkerspot butterfly. Additional NOx and NH3 sources planned for the region include a 600 MW natural gas fired power plant, industrial parks that may eventually draw 20,000 to 50,000 additional cars per day, 25,000 housing units, and associated highway improvements. Ongoing mitigation proposals include purchase and long-term management of hundreds of hectares of habitat.

The situation is a model for understanding N-deposition from a scientific and policy viewpoint. Fundamental biogeochemical questions include: 1) What are the relative contributions of NOx and NH3 to increased N-deposition? NH3 slip from power plant NOx scrubbers can release more reactive nitrogen than is removed as NOx, and modern automobiles release NH3 in addition to NOx. 2) How are N-emissions transported, chemically modified, and deposited on the local ecosystems, and are these processes adequately captured in regulatory models? How do point sources differ from line sources such as a heavily traveled freeway? 3) What are the effects of chronic N-deposition on the ecosystem, and is there a critical load or a steady cumulative effect? 4) What are the effects of management such as fire, grazing, mowing on N-cycling and plant composition? Policy issues include: 1) What are the incremental impacts of individual projects relative to high background deposition, 2) What margin of safety should be built into modeling and impact assessment? and 3) What are the most effective mitigation options?

B32A MC: Hall D Wednesday 1330h

Soil Biogeochemistry

Presiding: J Kimble, USDA-NRCS-NSSC

B32A-0106 1330h POSTER

The Use of EMI and Electrical Instruments for Estimating Soil Properties to Help in Mapping

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Electromagnetic induction (EMI) is a very rapid and relatively inexpensive means for delineating soils and soil properties at a variety of scales. Ground-level measurements of four different EMI devices (EM38, EM31, Dualem-2 and Dualem-4 meters) and an electrical resistivity implement (Veris 3100) were compared and used to assess the depth to sand and gravel within an area mapped as predominantly as Warsaw but with inclusions and also small areas of other soils (fine-loamy over sandy or sandy skeletal, mixed superactive, mesic Typic Argiudolls). All five tools produced similar spatial patterns of apparent conductivity. Within the study site, measured depths to sand and gravel averaged 0.96 m and ranged from 0.33 to 1.85 m. Depths to sand and gravel were most strongly correlated with measurements obtained with the EM31meter in the vertical dipole (r = 0.811, 0.002 level) orientations, and the Dualem-4 meter in the horizontal coplanar (r = 0.765, 0.005 level) geometry. Lack of stronger correlations was attributed to variations in soil properties and the depth and volume of soil materials sounded with each instrument. Variations in the degree of correlation between apparent conductivity and depth to sand and gravel demonstrate the importance of selecting an instrument and dipole orientation that provide the maximum response within the depth of interest.

B32A-0107 1330h POSTER

Soil organic radiocarbon and mineralogy at two coastal California sites

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As the atmospheric carbon dioxide concentration rises it becomes increasingly important to understand the mechanisms that control carbon sequestration in carbon pools such as soils and ocean sediments. Mineralogy and soil grain size have both been hypothesized to regulate soil carbon storage. On volcanic soils, carbon storage correlates best with a mineralogical property, amorphous mineral content. However, volcanic soils are relatively uncommon and weather to unusually high concentrations of amorphous minerals.

Two chronosequences of soil terraces occurring along the coast of California provide the opportunity to study the relationship between a range of mineral types, soil carbon content, soil radiocarbon age, and grain size on more common Alfisol soils. One site is located close to the mouth of the Mattole River, near Eureka, CA, and the second site is located close to Santa Cruz, CA. Both series of chronosequences formed on similar parent material, although the Mattole site receives approximately twice the rainfall of the Santa Cruz site. Through analysis of relationships between soil mineralogical properties, organic matter content, and soil radiocarbon age, we examine potential controls on soil carbon turnover.

B32A-0108 1330h POSTER

Fingerprinting of Soil Organic Matter in the Arctic to Help Predict Carbon Dioxide Flux

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It is estimated that a doubling of atmospheric carbon would result in a temperature increase at the high latitudes of 4 degrees C in summer and 17 degrees C in winter. The resultant warming and drying of Northern soils could result in an increase in the decomposition rate of soil organic matter (SOM) and increase in carbon dioxide flux to the atmosphere. Based on a recent study on SOM in the Kuparuk River basin, the age of SOM in the upper permafrost layers ranges from 6000-8000 yrs B.P., with some older than 12,000 yrs. B.P. Some readily degradable SOM is preserved because of frozen conditions while other matter is preserved due to its inherent biological recalcitrance. As such, not all SOM would be equally susceptible to biodegradation in a warmer climate.

Fingerprinting of organic matter by pyrolysis-GC/MS was used to compare the relative distribution of specific classes of organic compounds in soil samples. The relative susceptibility of the SOM in each soil sample to microbial degradation was compared based on correlations between pyrolysis fingerprints and carbon dioxide evolution. Pyrolysis-GC/MS fingerprinting was then performed on more than 100 soils sampled from the Kuparuk River basin, the western Alaska transect, Canada, Norway and Siberia.

Charts were prepared showing the characteristics of SOM in soils with the greatest and least propensity to contribute carbon dioxide to the atmosphere under conditions of substrate-limited biological decomposition. The calibration and use of pyrolysis-GC/MS make it practical to analyze hundreds of samples in the time it presently takes to analyze a single sample by laboratory or field incubation techniques.

B32A-0109 1330h POSTER

Do anaerobic microsites control soil methane flux?

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Understanding the exchange of methane between soils and the atmosphere remains one of the highest priorities for climate change research. To explain the biophysical basis of soil methane flux, we have tested the hypothesis that soil methane emissions are controlled by the distribution of anaerobic micro-sites in soils. Examination of this hypothesis depends on separating productive and consumptive processes within natural soils. We applied a new $^{13}CH_4$-isotope pool dilution technique to natural gradients in soil moisture in both tropical and temperate ecosystems. We observed a highly nonlinear response of methane flux to increasing soil moisture driven primarily by a stepwise increase in variance of methane production in wetter soils. Neither methane consumption nor carbon supply could explain the observed variations in methane emissions across the moisture gradients. Instead, we found soils to have a highly variable mixture of methanogenic and non-methanogenic paths of energy flow, and that the development of soil micro-sites appears critical for controlling this mixture. We conclude that only a small fraction of mineralization must proceed through methanogenic pathways before soils have positive net methane flux.

B32A-0110 1330h POSTER

Soil Organic Carbon Redistribution by Geomorphic Processes in an Undisturbed Zero Order Annual Grassland Watershed, California

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Despite the crucial role of soils in global carbon cycle, the sizes of soil organic carbon (SOC) pools and relevant fluxes are still in debate. We studied the extent which topography regulates SOC pools and fluxes through geomorphic processes (erosion, deposition, and episodic hollow evacuation) in an undisturbed zero order annual grassland watershed of Tennessee Valley California (site area: 100m×70m, MAP:760mm, MAT:16°C). We systematically measured soil thickness, bulk density, texture, carbon and nitrogen content to the depth of bedrock contact for 69 soil pits (and plant C inputs at 44 aboveground 25×25 cm quadrats) along diverging slopes (average slope: 28%) and in the adjacent hollow. We performed a high resolution (<1m) topographic survey of the area using a total laser station with centimeter scale accuracy. Survey data was used to create a topo map and calculate the 2 dimensional slope curvature using Kriging method. Over the diverging slope, in general, soil thickness (5 to 92cm) and SOC storage (3.8 to 17.0 kgC/m^2) tend to increase downslope despite their significant variations with local topographic curvature. Hollow soils are thicker (71 to 270cm) and have higher SOC storage (17.5 to 28.6 kgC/m^2). However aboveground plant C inputs in the upper hollow (75 to 187 gC/m^2/yr) were not higher than those of diverging slope (42 to 336 gC/m^2/yr), suggesting the importance of the burial and reduced decomposition rate of SOC eroded from adjacent slopes. By combining a diffusion soil transport law (which is a function of topographic curvature and soil thickness) and a carbon decomposition model, we determined the rate of SOC erosion losses from divergent slopes and reconstructed SOC storage in the hollow over time scale of 10k years. This empirically constrained model provides the mechanistic explanation of the observed topographic pattern of SOC storage.

B32B MC: Hall D Wednesday 1330h

Metals in Soil and the Environment

(joint with H)

Presiding: **K Dawson,** University of Alabama

B32B-0111 1330h POSTER

Conditional Sampling for Measuring Mercury Vapor Fluxes

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Surface to atmosphere mercury fluxes are difficult to measure accurately. Current techniques include dynamic flux chambers and micrometeorological gradient and aerodynamic approaches, all of which have a number of intrinsic problems associated with them. We have adapted conditional sampling, a micrometeorological technique commonly used to measure other trace gas fluxes, to measure surface to air mercury fluxes. Our initial flux measurement campaign over an agricultural soil consisted of two one-week measurement periods, and was longer in duration than any previously reported measurement period. Fluxes during both measurement periods ranged between 105.25 ng m^{-2} h^{-1} (evolution) and 34.95 ng m^{-2} h^{-1} (deposition) with an average evolution of 6.6 ng m^{-2} h^{-1}. The data showed significant diurnal trends, weakly correlated with shallow soil temperatures and solar radiation. Poor conditions for micrometeorological techniques plagued the system throughout the measurement period, and increased uncertainty in the data collected. However, this initial trial run indicates that conditional sampling has much promise for the accurate quantification of both short and long-term mercury fluxes.

B32B-0112 1330h POSTER

Heavy Metals Concentrations in top Soils of Urban Areas (Naples Southern Italy) as an Indicator of Anthropogenic Origin.

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Heavy metals pollution, which mainly originates from automobile exhausts and industry, is a serious danger for human health. The source and extension of heavy metals pollution in the top soils has been studied extensively in the past 30 years. The role of the soil processes in accumulating or mobilising metals is very important in environmental science due to the central position of the soil in the hydrological cycle and ecosystem. Concentrations of heavy metals in top soils, collected in green areas and public parks in metropolitan Naples area have been determined to provide information on specific emission sources. In addition to toxic metals, such as Pb, As, Cd, Cr and others, we have investigated the top soils as well for Pt group elements (PGEs), because since 1993 it is mandatory within EC for all new petrol driven motor vehicles to be equipped with Pt/Pd/Rh catalytic converter. In Italy this law has come into effect in 1998, but still is allowed to old vehicles use lead gasoline, though now the big majority of cars is equipped with Pt/Pd/Rh catalytic converters. Emission of abraded fragments of catalytic converters in vehicle exhausts will certainly determine environmental contamination with Pt group elements (PGEs), since many Pt complexes are highly cytotoxic and, in small dose, are strong allergens and potent sensitiser. The metropolitan area of Naples due to intense human activities and vehicles traffic is an interesting area to be monitored in order to check the pollution state of the soils. The geology of the area is prevalently represented by volcanics, erupted from the Upper Pleistocene to Recent by Mt. Somma-Vesuvius on the east and the Campi Flegrei fields on the west. To compile multi-element geochemical maps baseline we have sampled in situ and transported top soil for a total of 200 samples. The survey have been carried at about 200 sites covering an area of about 120 Km2, with a grid of 0.5 x 0.5 km in the highly urbanised area and 1 km x 1 km in the sub urban areas. In each sampled site has been determined the pH (5.93- 8.21); and measured partial and total radioactivity (U, Th, K) using a portable scintillometer. All soil samples were analysed for 40 elements by ICP-MS and AES. The data for some of the harmful metals (as mg Kg-1) range as follows: Cd from 0.03 to 6.9, Cr from 0.8 to 189, Ni from 0.8 to 67, Pb from 17 to 2052, Co from 3 to 37, Hg from 0.01 to 2.6, Pt from 0.001 to 0.1, Pd from 0.002 to 0.052. The geochemical data, have been processed by means of GIS to compile geochemical single element distribution, R-mode factor analysis element associations and risk maps. The latter in particular, are useful to enhance areas potentially at risk for residential/recreational and commercial/industrial land use, following intervention criteria fixed by Italian

B32B-0113 1330h POSTER

Arsenite Oxidation by Anaerobic Bacteria in Mono Lake, California

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Mono Lake, California is a meromictic soda lake (pH = 9.8; salinity = 70-90 g/L) with exceptionally high arsenic content (200 μM) derived from hydrothermal sources. Previous work has shown that arsenic speciation changes from arsenate [As(V)] to the more reduced arsenite [As(III)] with vertical transition from the lake's surface oxic waters to its unmixed, anoxic bottom waters and that dissimilatory reduction is responsible for the observed change in arsenic speciation (Oremland et al., 2000). Depth profiles of arsenic speciation indicate that a small amount of As(V) exists in the anoxic bottom waters, suggesting a constant resupply by microbial oxidation of As(III). Anaerobic microbial oxidation of As(III) to As(V) was first noted in arsenate-enriched anoxic bottom water amended with nitrate, where nitrate addition caused a rapid microbial re-oxidation of arsenite to arsenate (Hoeft et al. 2001). In following, we conducted time course experiments with As(III)-amended bottom waters supplemented with either 5 mM nitrate, Fe(III)-NTA or nitrite. Nitrate-amended waters formed As(V), while killed controls did not form significant amounts and 5 mM nitrate was completely reduced to 5 mM nitrite by the end of the incubation. Live samples amended with 5mM Fe(III)-NTA produced As(V) that exceeded production of As(V) in killed controls, while nitrite-amended waters formed As(V) in excess of killed controls after an initial lag. We isolated a pure culture, strain MLHE-1, that grows in minimal salts media by oxidation of As(III) to As(V) with the reduction of equivalent quantities of nitrate to nitrite. Strain MLHE-1 appears to be a chemoautotroph. These results demonstrate that the cycling of As(V) and As(III) can be sustained in the absence of oxygen. This has implications not only for the recycling of As(V) in Mono Lake's bottom waters, but also for the mobility of arsenic in aquifers as well.

Oremland, R.S. et al. 2000. Geochim. Cosmochim. Acta 64: 3073-3084. Hoeft, S.E. et al. 2001. Geomicrobiol. In press.

B32B-0114 1330h POSTER

Zinc Adsorption on Fe(II)/Fe(III) Substates Produced by Microbial Reduction of High-Surface-Area Goethite, Medium-Surface-Area Goethite and Lepidocrocite

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A series of experiments were performed to investigate the influence of bacterial reduction on Zn^{2+} adsorption by Fe(III) oxyhydroxides. Lepidocrocite, high-surface-area (HSA) goethite, and medium-surface-area (MSA) goethite were synthesized with measured BET surface-areas of 75^2/g, 225m^2/g and 48 m^2/g, respectively. Zinc adsorption isotherms were determined for the unreduced mineral phases at aerobic conditions from pH 5.5 to 7.5 in a matrix of artificial groundwater (AGW). The isotherm data for zinc adsorption onto HSA goethite were pH-independent over the studied pH range, with <5% variation in zinc adsorption. Isotherm data for lepidocrocite and MSA goethite showed pH-dependence with up to 65% variation in zinc adsorption over the pH and concentration range used.

Incubation experiments were performed in which lepidocrocite, HSA goethite or MSA goethite served as the electron acceptor for the dissimilatory iron reducing bacterium (DIRB) *Shewanella alga* in a matrix of AGW under anaerobic conditions. The incubation bottles were sampled at various time intervals to establish the effects of progressive iron reduction on the zinc adsorption capacity of the solid material. Batch experiments were then conducted equilibrating AGW solutions of zinc with incubation experiment substrates to produce adsorption isotherms at various stages of reduction. The results of these experiments showed a decrease of about 10 to 15% in the adsorption capacity of the reduced substrate compared to the original HSA goethite. Incubation experiments for lepidocrocite only produced <1% reduction of Fe(III) after a period of several months. *S. alga* incubations containing MSA goethite have produced 4% reduction in Fe(III) after a period of approximately 5 months. Experiments are currently underway to determine the effects of bacterial reduction of the MSA goethite on Zn^{2+} adsorption. The data produced from these experiments will then be fit using the Freundlich and Langmiur adsorption models to predict the effect of bacterial reduction on the adsorption capacity of Fe(III) oxyhydroxides. The results of these experiments will improve our understanding of the biogeochemical processes that affect the mobility of metals in anaerobic groundwater systems.