B21E-06 1130h

Molecular Analysis of Endolithic Microbial Communities in Volcanic Glasses

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Terrestrial and marine volcanic glasses become mineralogically and chemically altered, and in many cases this alteration has been attributed to microbial activity. We have used molecular techniques to study the resident microbial communities from three different volcanic environments that may be responsible for this crustal alteration.

Total microbial DNA was extracted from rhyolite glass of the 7 million year old Rattlesnake Tuff in eastern Oregon. The DNA was amplified using the polymerase chain reaction (PCR) with bacterial primers targeting the 16S rRNA gene. This 16S rDNA was cloned and screened with restriction fragment length polymorphism (RFLP). Out of 89 total clones screened, 46 belonged to 13 different clone families containing two or more members, while 43 clones were unique. Sequences of eight clones representing the most dominant clone families in the library were 92 to 97% similar to soil bacterial species.

In a separate study, young pillow basalts (<20 yrs old) from six different sites along the ridge axis at 9°N, East Pacific Rise were examined for microbial life. Total DNA was extracted from the basalt glass and screened for the presence of both bacteria and archaea using the PCR. Repeated attempts with different primer sets yielded no bacterial genes, whereas archaeal genes were quite abundant. A genetic fingerprinting technique, terminal restriction fragment length polymorphism (T-RFLP), was used to compare the archaeal community compositions among the six different basalts. Filtered deep-sea water samples (15 L) were examined in parallel to identify any overlap between rock- and seawater-associated archaea. The six rock community profiles were quite similar to each other, and the background water communities were also similar, respectively. Both the rock and water communities shared the same dominant peak. To identify the T-RFLP peaks corresponding to the individual members of the rock and seawater communities, clone libraries of the archaeal 16S rDNA for one basalt sample (Dive 3718) and its corresponding background water sample were constructed. The most abundant archaeal genes were closely related to uncultured Group I marine Crenarchaeota that have been previously identified from similar deep-sea habitats. These archaeal genes collectively correspond to the dominant T-RFLP peak present in both the rock and water samples.

In a third study, we investigated the microbial community residing in a Hawaiian Scientific Drilling Program core collected near Hilo, Hawaii. Total microbial DNA was extracted from a depth of 1351 m in the drill core (ambient temperature in the drill hole 16°C), where petrographic evidence suggested the presence of microbial alteration. Archaeal 16S rRNA genes were amplified, cloned, and twelve clones representing the most abundant groups were sequenced. Eleven out of the twelve clones were 97 to 99% similar to Group I marine Crenarchaeota, while the remaining clone was 95% similar to Euryarchaeota, based on BLAST searches of the GenBank database.

Our community-level approach to studying microbes living in volcanic glasses has provided a greater understanding of the microbial communities that potentially alter these materials.

B21E-07 1145h

Understanding Microbe-Mineral Reactions Using Synchrotron Radiation Fourier Transform Infrared Spectromicroscopy

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Microorganisms are able to alter their surrounding microenvironment to an extent not predicted by the thermodynamics of the macro-environment chemistry. Microbially induced environmental alterations include weathering, biomineralization and mobilization or immobilization of authegenic metals or contaminants. Microbial colonization of surfaces, followed by biofilm formation, are the first steps in alteration processes. With the exception of iron oxides and iron-reducing bacteria, the fundamentals of how microbes react with various mineral surfaces is not well understood. Synchrotron radiation Fourier transform infrared spectromicroscopy (SR-FTIR) is a non-destructive analytical technique capable of probing, in situ, the microbe-mineral interface. The SR-FTIR beamline 1.4.3, at the Advanced Light Source, Berkeley, CA, has a diffraction-limited spatial resolution of 10 um, is 2-3 orders of magnitude brighter than traditional FTIR, and is not harmful to living samples. Aliquots of pure cultures of *Burkholderia cepacia* G4 were deposited on four individual mineral surfaces (plagioclase, ilmenite, augite and olivine) and spectra were collected within 20-40 min. Reference spectra were collected from the same pure cultures deposited on gold-coated glass slides. Additionally, reference spectra were collected of commercially available biomolecules deposited on the four individual mineral specimens. The spectra of the bacterial cells on gold and the spectra of the separate biomolecules contained all the relevant peaks documented in the literature. However, the spectra collected from the microbe-mineral interfaces were markedly different from the reference spectra and varied between the four mineral surfaces. Bacterial cells in contact with plagioclase exhibited predominantly absorption bands associated with phosphate groups, while the spectra of olivine and bacterial cells were limited to absorption bands associated with bacterial proteins. Spectra of the same bacterial cells in contact with augite indicated a strong peak attributed to amino acids, specifically tyrosine. The results presented here document the changes in the biogeochemistry of the microbial-mineral interface that can occur within minutes when cells react to various mineral surfaces. These results advance the understanding of how microorganisms impact the natural environment.

B21E-08 1200h

Probing the biomolecule-mineral interface: Molecular biogeochemical techniques in force microscopy

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Molecular level force measurements have great potential to provide unique insight into the biomolecule-mineral interface. Several recent advances in atomic and chemical force microscopy (AFM/CFM), biomembrane force microscopy, and biological force microscopy and laser trapping have allowed force measurements of biomolecules interacting with minerals, inorganic surfaces and cells at the picoNewton force scale. Tip and probe activation schemes have been successful allowing biomolecules to be attached to force sensors while still retaining activity. When probed against a mineral surface, the biomolecule response (e.g., a conformation change or adhesion) to the surface is readily detected and can provide valuable information on sorption/desorption reactions, surface complex formation, biomolecule or ligand assisted dissolution mechanisms, or surface associated redox processes. One example includes a recent CFM experiment we completed with the ferric iron specific ligand azotobactin. Like other siderophores, azotobactin has demonstrated the ability to extract Fe from mineral surfaces. However, the dissolution mechanism by which this relatively high molecular weight ligand operates is unknown. Observation of comparatively large adhesion forces between goethite (FeOOH) and azotobactin, and plateau features in the retraction portion of the force curves suggest that a surface complex is a likely possibility in the mechanism. Additional AFM studies will examine dissolution features associated with the siderophore to further assess the nature of its extraction of Fe contained on mineral surfaces. This presentation will provide an overview of how biomolecules interacting with minerals can be studied using force measurements, as well as current results from our ongoing force experiments with organic ligands and Fe and Al oxides.

B22A MCC: Hall C Tuesday 1330h

The Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) II Posters *(joint with A, H)*

Presiding: **C Nobre,** Centro de Previsão de Tempo e Estuidos Climáticos (CPTEC)**; M Keller,** University of New Hampshire

B22A-0733 1330h POSTER

Understanding Global Teleconnections of Climate to Regional Model Estimates of Amazon Ecosystem Carbon Fluxes

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Our LBA-ECO research team is investigating global teleconnections of ocean climate to regional satellite-driven observations for Amazon ecosystem production, mainly in the form of monthly predictions of net carbon exchange over the period 1982-1999 from the NASA-CASA (Carnegie-Ames-Stanford) Biosphere model. This model is driven by observed surface climate and monthly estimates of vegetation leaf area index (LAI) and fraction of absorbed PAR (FPAR) generated from the NOAA satellite Advanced Very High Resolution Radiometer (AVHRR). Land surface AVHRR data processing using modified MODIS (Moderate-resolution Imaging Spectroradiometer) radiative transfer algorithms includes improved calibration for intra- and inter-sensor variations, partial atmospheric correction for gaseous absorption and scattering, and correction for stratospheric aerosol effects associated with volcanic eruptions. Results from our analysis suggest that anomalies of net primary production (NPP) and net ecosystem production (NEP) predicted from the NASA-CASA model over large areas of the Amazon region east of 60 degrees W longitude are strongly (and positively) correlated with the Southern Oscillation Index (SOI). Certain areas of the south central Amazon show strong linkages of the NASA-CASA anomaly record to the Arctic Oscillation (AO) index. Geophysical processes are investigated for these global teleconnections of ocean climate to Amazon ecosystem carbon fluxes and land surface climate.

URL: http://geo.arc.nasa.gov/sge/casa/

B22A-0734 1330h POSTER

Automated Chamber Measurements of Soil-Atmosphere Carbon Dioxide Flux in Undisturbed Forest at the Tapajos National Forest, Brazil

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In forests, the respiration of roots and soil dwelling organisms accounts for a large part of ecosystem respiration. We installed an automated chamber system for measurement of the soil-atmosphere flux of carbon dioxide (CO_2) in the Tapajos National Forest, Para, Brazil in April 2001. This is a mature forest site that is relatively undisturbed. Soils are clay textured oxisols. Mean annual temperature is 25°C and mean annual precipitation is 2000 mm per year. Eighteen aluminum chambers were installed in a 0.5 ha area close to the flux tower at the km 67 LBA site. Vegetation was excluded from the chambers. Eight of these chambers are closed individually and sampled for approximately 21 minutes about 5 times per day (closed 7% of the day). The other 10 chambers are sampled individually approximately once per day (closed 1.5% of the day). We measured CO_2 concentration with an IRGA (LiCor 6262). We found that during the late wet season (April-June 2001) CO_2 fluxes for the 8 frequently sampled chambers averaged about 3.2 μmol CO_2 m^{-2} s^{-1}. Fluxes decreased slowly from the end of the wet season in June through the end of the dry season (November-December) when CO_2 flux averaged was about 2.2 μmol CO_2 m^{-2} s^{-1}. With the onset of the rain in January 2002, fluxes increased rapidly to approximately 3.0 μmol CO_2 m^{-2} s^{-1}. Both soil temperature and soil moisture exert strong controls on soil-atmosphere CO_2 flux. As we would expect, soil CO_2 flux is positively correlated with both soil temperature and soil moisture content. Because soil temperature and soil moisture are negatively correlated with one another, one effect tends to mask the other.

B22A-0735 1330h POSTER

Spatial Variability of Stem Wood and Soil Respiration in Tropical Forests

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It is commonly accepted that stem wood respiration and soil surface/atmosphere trace gases fluxes are spatially highly variable. However there are few studies that attempt to quantify this variability. Manual measurements of soil and stem wood CO2 fluxes can be useful in determining spatial heterogeneity. During the periods of March 14 to 16 and June 7 to 13 we measured stem wood respiration from a wet tropical forest in La Selva, Costa Rica; and between July 16 and 27, 2002 we measured soil CO_2 exchanges in a tropical forest located near Santarem, Para, Brazil. Measurements were obtained using manual chamber systems. Fluxes were measured in chamber headspace air using a pump and an open path infrared gas analyzer. Generally, fluxes ranged between 2 and 6 μmol m^{-2} s^{-1} for soil and 0.13 and 6.4 mol m^{-2} s^{-1} for stem wood during the sampling periods. The average flux of all points was 4.6 $\pm$1.7 μmol $m^{-2}s^{-1}$ for soil and 1.8 $\pm$1.14μmol $m^{-2}s^{-1}$ for stem wood. Existent automated systems installed at these sites have showed a range of soil CO_2 flux values between 1.5 and 6 μmol m^{-2} s^{-1} in Santarem site, and 0.001 and 8.95 μmol m^{-2} s^{-1} for stem wood respiration in La Selva site for the same period of year.

B22A-0736 1330h POSTER

Automated crown detection algorithm: an analysis of two tropical Amazonian forests

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Spatial analysis of crowns in high-resolution images can improve the estimate of carbon stocks on regional and local scales, aid in demographic studies on the stand level, begin to analyze tree structural properties at the landscape level, and aid in forestry efforts. Radiative inverse transfer models, gap models, and cohort models may be parameterized with the spatial analysis of crowns and subsequently derived forest structural characteristics. We developed an algorithm to automatically detect tree crowns in two tropical Amazonian forests. IKONOS panchromatic images were used from two Amazonian forests in Para, Brazil: the Tapajos National Forest, (3.08°S, 54.94°W) and the Fazenda Cauaxi, (3.75°S, 48.37°W). Analysis was conducted on undisturbed forests from both sites. Our method combines local maximum filtering and local minima value finding methods with analysis of extracted transect data from the local maxima. We use a derivative threshold that ends the transect. Once all pixels of a given brightness value are analyzed, an iterative step examines the next lower brightness value. Pixels where crowns have been delineated are taken out of further analysis. Our method allows for overlap of crowns, gaps between crowns, and complex and noisy canopies to be analyzed. A sensitivity analysis was run on the derivative threshold and the minimum local maximum value to seed the transect analysis. Least-squares goodness of fit is conducted to examine parameterization from the sensitivity analysis. The best fit for the derivative threshold is found set at -8. The sensitivity analysis finds that the minimum local maxima is related to the difference between the maximum brightness value and brightness value with the highest frequency. Mean, minimum and maximum crown widths for field data are (mean 9.0 m +/- 1.6 S.D., min 1.0 m, max 40.7 m) and automated estimation are (mean 11.9 m +/- 5.0 S.D., min 2.0 m, max 34.0 m). The Kolmogorov-Smirov test for difference between distributions indicates a statistical difference (alpha = 0.05) between field measured tree crowns with automated estimates. Based on allometric equations, estimated tree size class distribution appears promising, but with an overestimation of middle size classes. Mean DBH for field data is 30 cm +/- 3.4 S.D. and for automated routine is 51.0 cm +/- 16.7 S.D. The biomass for the automated method is 281 Mg ha^{-1} and the field data is 203 Mg ha^{-1} > 20 cm DBH. Stem density is 137 ha^{-1} > 20 cm DBH and 74 ha^{-1} > 35 cm DBH for field data and is 89 ha^{-1} for the automated routine. Validation of the automated crown detection algorithm was conducted at Tapajos and is currently being compared to biometric data.

B22A-0737 1330h POSTER

Variation in forest structure and carbon dynamics in tropical rain forests of Amazonia

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A better understanding of the variations in the dynamics and structure of trees in tropical forests is necessary for predicting the potential for these ecosystems to lose or store carbon. Data from forest inventory plotsshow large differences in forest structure, biomass, and tree growth rates among plots in three location. The number of stems (g.t. 10cm diameter)per hectare is higher in the Manaus site (626 ha^{-1}) than in the Rio Branco (466 ha^{-1}) or Santrem (460 ha^{-1}) sites. Stocks of C in above-ground biomass in the three areas were 180.1 (Manaus), 122.1 (Rio Branco), and 140.6 (Santarem) MgC ha^{-1}. Estimates of mean annual accumulation of C in living trees based on monthly dendrometer band measurements ranged from 1.6 (Manaus), 2.5 (Rio Branco), to 2.8 (Santarem) MgC ha^{-1} yr^{-1}. Our results showed marked seasonality to growth, with highest growth rates in the wet and lowest rates in the dry season. This effect was most pronounced for trees with diameter g. t. 50cm. Comparing the three areas investigated suggests that forests experiencing a longer dry season have larger annual diameter growth increments for individual trees, and more of the forest biomass in the largest trees.

B22A-0738 1330h POSTER

Deposition and Loss of Cations and Anions in a Lowland Forest on Highly Weathered Soils in the Amazon

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In ecosystems with highly developed soils, weathering of parent material no longer provides nutrient inputs. In these systems atmospheric deposition, even at low levels, helps maintain adequate supplies of essential nutrients, but nutrient losses also play an important role in determining nutrient availability over time. We examined the patterns of nutrient deposition in rainfall, changes in nutrient concentrations in canopy throughfall and export of nutrients in the soil solution at 20 and 100 cm depths. The amount of nutrients in the rainfall at our site varied 10 fold across the wet season with maximum values found at the onset of the dry season (August and October). Throughfall concentrations showed the same patterns as rainfall but nutrients were 2 to 10 fold more concentrated in throughfall than in the rainfall suggesting that precipitation collects nutrients in the canopy. No significant difference in nutrient concentrations was found when we compared our site on sandy soil with that on clay soils despite significant differences in soil nutrient pools. Compared to throughfall, K and PO4 were found in significantly lower concentrations in the soil solution at 20 cm while NO3 and SO4 were found in higher concentrations. Soil solutions in the clays contained significantly less NO3, Ca and Mg as compared to sands. These patterns suggest that PO4 and K are more highly conserved than NO3 in clays as compared to sands and that the clays have lower leaching losses of NO3, Ca and Mg than do the sands. Retention within the ecosystem can be related to either biological uptake or geochemical sequestration especially for PO4. Nutrient concentrations at 100 cm depth were similar to those at 20 cm with significant reductions in concentrations found only for NH4 and NO3. Nitrogen in the rainfall was composed of approximately 37 % organic forms. In the through fall this fraction increased to 67 % and in the soil solution this fraction was reduced to 29 % in the clays and 25 % in the sands. Overall, these data suggest that differing soil texture plays an important role in the overall soil fertility of tropical ecosystems through regulation of leaching losses.

B22A-0739 1330h POSTER

Modeled Optical Properties of Aerosols from Biomass Burning in the Amazon Region

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Optical properties of aerosols from biomass burning in the Amazon region were calculated in the solar spectrum range: single scattering albedo, asymmetry factor, extinction coefficient, scattering and

back-scattering coefficients, and absorption coefficient. Aerosol properties vary with loading or atmospheric conditions, and we decided to describe these variabilities as a function of aerosol optical thickness, developing a dynamical model. We defined 12 ranges of aerosol optical thickness, for which we calculated the spectral optical properties. The calculations were made using an algorithm based on the Mie Theory, using as input a constant complex refractive index (average of all data) and the average size distribution of aerosols for each range of aerosol optical thickness. These data were retrieved from measurements made with the sunphotometers from AERONET installed in 2 sites, Abracos Hill (lat=-10.760, long=-62.358, alt=200m) and Alta Floresta (lat=-9.917, long=-56.017, alt = 175m) during the dry seasons of 1999, 2000 and 2001. Both forest sites have strong anthropogenic impacts from deforestation and fires, and the measurements made at this time of the year characterize the aerosol regional plume, with similar physical and chemical properties at a given aerosol optical thickness. The dynamic model has substantial differences in the aerosol optical properties if compared with a static model, and it is well described at an aerosol optical thickness varying from 0.0-1.6.

B22A-0740 1330h POSTER

Atmospheric Attenuation Of Total Solar Flux By Clouds At Six Amazonian Sites: 1999-2001

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In Brazil, we now have a data set of pyranometer measurements at several sites distributed across the Amazon basin, with a record spanning more than 3 years at some locations. This network represents one of the few such long-term flux data bases available for this region, and provides an opportunity to characterize the nature of atmospheric effects on surface, broadband irradiance. Sufficient data are now available to assess trends in cloud attenuation on a range of timescales (diurnally, seasonally, and interannually).

Cloud-induced fractional and absolute total flux reductions at the surface were evaluated for all years and sites. The fractional reduction, fB was computed as the ratio of received irradiance to the modeled clear-sky irradiance for background (low) aerosol conditions. A distinct difference was found between cloud attenuation in the wet and dry seasons, particularly in the southern Amazon.

Histograms of fB for typical wet season months reveal a bi-modal distribution with a reduction peak (when the solar beam is obstructed) and an enhancement peak (produced by edge reflections from broken cloud cover). This phenomenon has been noted previously at the Abracos Hill sites during a 2 month study in 1999 (Gu et al., 2001). Our multi-year, multi-site data now suggest this is a fairly consistent feature of wet season months in the southern sites in Rondonia and northern Mato Grosso, and of most or all months at the equatorial sites (Balbina, Belterra) in Para and Amazonas.

B22A-0741 1330h POSTER

Biogenic aerosol over the Amazon Basin

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Biogenic particles form the major component of the atmospheric aerosol above and within the vast Amazonian tropical rainforest under non-polluted "background" conditions. We have employed a variety of different analytical techniques in order to try to better characterise the composition and temporal variation of this aerosol fraction. Microscopic examination reveals that many different types of biological particles are present, including fungal and fern spores, pollen grains, microbes, plant debris and insect parts. These forest-derived particles, and the elements, ions and compounds associated with them, are abundant in both the coarse and fine aerosol fractions, with the highest mass concentrations generally in the coarse fraction. There is a distinct increase in their concentrations at ground level at night. This is probably due to the formation of a shallow nocturnal inversion, which reduces dispersion of the aerosol, whilst convective mixing during the day leads to efficient dilution with air from aloft. Preferential nighttime emission of some types of biogenic particles may also contribute to the observed day-night variation.

B22A-0742 1330h POSTER

Two Preliminary SRTM DEMs Within the Amazon Basin

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Digital topography provides important measures, such as hillslope lengths and flow path networks, for understanding hydrologic and geomorphic processes (e.g., runoff response to land use change and floodplain inundation volume). Two preliminary Shuttle Radar Topography Mission digital elevation models of Manaus (1S to 5S and 59W to 63W) and Rondonia (9S to 12S and 61W to 64W) were received from NASA JPL in August 2002. The PI Processor produced these initial DEM segments and we are using them to assess the initial accuracy of the interferometrically derived heights and for hydrologic research. The preliminary SRTM derived absolute elevations across the Amazon floodplain in the Cabaliana region generally range from 5 to 15 m with reported errors of 1 to 3 m. This region also includes some preliminary elevations that are erroneously negative. However, topographic contours on 1:100,000 scale quadrangles of 1978 to 1980 vintage indicate elevations of 20 to 30 m. Because double-bounce travel paths are possible over the sparsely vegetated and very-flat 2400 sq-km water surface of the Balbina reservoir near Manaus, it serves to identify the relative accuracy of the SRTM heights. Here, cell-to-cell height changes are generally 0 to 1 m and changes across a 100 km transect rarely exceed 3 m. Reported errors throughout the transect range from 1 to 2 m with some errors up to 5 m. Deforestation in Rondonia is remarkably clear in the C-band DEM where elevations are recorded from the canopy rather than bare earth. Here, elevation changes are 30 m (with reported 1 to 2 m errors) across clear-cut areas. Field derived canopy heights are in agreement with this change. Presently, we are deriving stream networks in the Amazon floodplain for comparison with our previous network extraction from JERS-1 SAR mosaics and for hydrologic modeling.

URL: http://www.icess.ucsb.edu

B22A-0743 1330h POSTER

Effects of Experimental Drought on Trace Gas Emissions from a Tropical Forest Soil

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Deforestation and global climatic change could result in significant reduction in precipitation in the Amazon Basin. Attendant changes in soil water content may affect emissions of trace gases from soils. A throughfall exclusion experiment was initiated in 2000 at the Tapajos National Forest to investigate the responses of forest biogeochemical processes to simulated reduced rainfall. Two 1-ha plots have been trenched to 1.5 m depth around the perimeter. Plastic panels placed below the canopy divert about 60% of the throughfall away from the treatment plot. The other plot remains as a control with natural rainfall. We have measured emissions of CO_2, N_2O, NO, and CH_4 four or five times per year since 1999. At each date, 18 chamber measurements are made in each plot. During the pre-treatment calibration period, differences in emissions of CO_2, N_2O, and CH_4 between the two plots were not significant. One plot had consistently higher emissions of NO than the other plot, due to unknown sources of spatial variation. Emissions of CO_2 and N_2O were highest in the wet season; NO emissions were highest in the dry season. Net consumption of CH_4 usually occurred, but some CH_4 production was observed during the wet season. After placement of the throughfall exclusion panels, no consistent change has been observed for CO_2 and NO emissions. In contrast, mean emissions of N_2O and CH_4 have diverged in these two plots. Wet season increases in N_2O emissions that occur in the control plot are diminished in the exclusion plot. Rates of net uptake of CH_4 observed during the dry season continued into the wet season in the exclusion plots, while consumption rates declined and net production of CH_4 was observed during wet seasons in the control plots. Depth profiles of concentrations of CO_2, N_2O, and CH_4 have also been measured. Combining profiles of gas concentrations, soil water content, and bulk density permits estimation of the depths where each gas is predominantly produced. In summary, the first two years of experimental drought have decreased emissions of N_2O and CH_4 from wet soils and increased CH_4 consumption.

B22A-0744 1330h POSTER

The Effect of Experimentally Induced Root Mortality on Trace Gas Exchange

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Soil-atmosphere exchange of carbon dioxide (CO_2), nitric oxide (NO), nitrous oxide (N_2O) and methane (CH_4) was measured following a root exclusion experiment in the Tapajos National Forest near Santarem, Para, Brazil. The sampling period (June 4 - August 14, 2000) coincided with the beginning of the dry season. The experiment was set up as a randomized complete block design with 5 pairs of 2.5 x 2.5 m plots in both sand and clay soils. Trenches were dug around one plot in each pair for screen installation.

Trace gas fluxes were measured weekly for ten weeks following the trenching. Duplicate flux measurements were made for each of the trenched and non-trenched plots. Enclosures made of 0.25 m diameter PVC pipe were placed on a base imbedded in the soil. Dynamic measurements using a portable backpack system equipped with an NO_2 chemiluminescent detector for NO and an infrared gas analyzer for CO_2 were completed in the field. CH_4 and N_2O fluxes were measured through a static enclosure method. Syringe samples of the enclosure headspace were analyzed by GC-FID (CH_4) and ECD (N_2O) the following day. Daily average fluxes ranged between -0.01 and 60.3 ng-N cm^{-2} hr^{-1} for N_2O. NO fluxes ranged between 0.58 and 8.74 ng-N cm^{-2} hr^{-1}. CH_4 fluxes varied between net consumption and production from -1.73 to 0.912 mg m^{-2} d^{-1}. Soil respiration ranged from 1.34 to 5.12 umoles

CO_2 m^{-2} s^{-1}. Significant differences were seen between trenched and non-trenched plots in both clay and sand soils for N_2O emissions only.

Hourly field standardization of the NO_2 chemiluminescent analyzer resulted in lower variability than the traditional method of standardization which is completed at the beginning and end of the measurement day. Frequent field standardization of the analyzer is necessary to reduce measurement error due to intra-day variability.

B22A-0745 1330h POSTER

Root Decomposition and Trace Gas Dynamics in Two Moist Tropical Forest Soils

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Roots represent a large potential carbon source to tropical forest soils, and influence biogeochemistry through exudation, uptake, and interactions with microbial communities in the rhizosphere. Disturbance to aboveground plant biomass often results in belowground mortality and can alter rates of decomposition. Root decomposition rates are not well characterized in moist tropical forests, and less is known about their role in key biogeochemical processes. In this study we used trench plots to measure rates of *in situ* fine root decomposition, trace gas fluxes, and N pools over one year on two soil types (sand and clay) in the Tapajos National Forest in Brazil. Root decomposition was faster in clay soils (k = 0.96 yr^{-1}) than in sands (k = 0.61 yr^{-1}). Approximately 60 days after removal of the aboveground vegetation, CO_2 fluxes in the clay trench plots began to decline and remained on average 26 % lower than the clay control plots for the rest of the experiment. Trenching and associated root mortality increased soil moisture in the sands, and increased soil NO_3 pools in both sand and clays. Nitrous oxide fluxes were approximately doubled in the trenched plots relative to the controls. Root mortality and decomposition increased NO fluxes in the sands, and net CH_4 fluxes in the clays. Our results show that root mortality, decomposition, and associated changes in soil C, N, and moisture can strongly influence trace gas production and emissions. Our findings also show differential effects with regard to soil texture, with strong textural controls on C and N dynamics.

B22A-0746 1330h POSTER

From patterns to process: effects of Land use/cover on the biogeochemistry of surface waters in Western Amazonia (Rondnia, Brazil)

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To comprehend how land use change is affecting river biogeochemistry, it is necessary to identify the structural and functional alterations of the landscape configuration and composition, key attributes to understand how river biogeochemical signals are generated, maintained and altered by human intervention. Here we present the results of an integrated landscape analysis of the meso-scale Ji-Parana river basin (western Amazonia) based on landscape patterns, including soil properties, river network, topography and land use/cover. Our main objective was to understand what are the relationships between basin attributes and surface water chemistry. In terms of the consequences for river biogeochemistry, the heterogeneous spatial distribution of deforestation and soil properties along the basin translate into different signals. Sectors of the river with poorer soils also had waters with lower ionic content, whereas richer soils relate to waters with higher concentrations of salts. The percentage of the basin area covered by pasture was a good predictor for the concentrations of K+, Ca2+, Mg2+, electrical conductivity and pCO2. These results could be an indication that not only the soils cation content are determinants of river water quality, but also, that there are intensive cation losses by soil erosion resulting from inadequate pasture management. Concentrations of these elements increased constantly as the river drains areas dominated mainly by pasture. The statistical analysis shows that pasture cover explains 99% of the variance observed in theconcentrations of these elements in the river. The highest values were found at the central part of the basin, where pasture areas are maximum. Based on the patterns of pasture establishment observed in this study it is not likely that deforestation will occur in the head waters of the basin, due to soils characteristics of that region. Environmental concern about deforestation should focus, instead, on the lower reaches of the river, where forests occupy potentially agricultural areas. In terms of consequences for the river biogeochemistry, little changes, resulting from forest to pasture conversion, should be expected in the head waters, due to limitations of soils properties. Simultaneously, if areas located in the lower reaches of the river were deforested and converted into pasture, we would expect changes in river water composition similar to those observed in the central part of the basin.

B22A-0747 1330h POSTER

Scaling Forest Properties Derived from High-resolution Imagery to the Amazon Basin

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We present results of a spatial extrapolation analysis of forest canopy characteristcs using IKONOS 1-m panchromatic data and MODIS reflectances. Canopy properties such as crown width and gap fraction distributions are estimated within a number of 800 m moving windows using a logic-based algorithm, for two logged and unlogged regions of the Brazilian Amazon. The output of the algorithm is evaluated across sites, and statistically related to the reflectance observations which are available at a similar spatial scale. The 1000m resolution MODIS data includes 7 bands in the visible, near-infrared, and shortwave-infrared wavelengths, but we also consider commonly used vegetation indices (EVI and NDVI). Detailed canopy measurements like those obtainable from IKONOS are needed for basin-wide research, but crossing such a large gap in scale leads to a number of uncertainties. These uncertainties and prospects for the future will be discussed. An initial analysis is encouraging.

B22A-0748 1330h POSTER

Modeling the Effects of Hydrogeology and Land Cover Conversion on Runoff Processes and Rates in Rondônia, Brazil

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Hydrologic records in the state of Rondônia, Brazil are still too sparse and short, and the extent of deforestation too small and transient for recognition of deforestation signals in runoff from mesoscale river basins (100s -1000s of km^2). Large changes in soil recharge are known to result from deforestation at a point, but the response of river flow to such changes is complicated by subsurface transfer of this water, transient subsurface storage, and increases in the amount of overland flow. These influences depend in turn on the topographic ruggedness and hydrogeologic properties of a basin.

Using data from topographic and geologic maps, seasonal extreme water-table depths, and hydrogeologic properties (both measured in situ and back-calculated from streamflow), we have modeled runoff responses to deforestation that should be expected from typical hillslopes in gauged river basins of Rondônia. The hillslopes vary in length and gradient, and in degree of rockiness, all of which we have measured for a number of gauged basins. The computations show that although complete deforestation should increase total runoff by about 40%, the partitioning of the runoff into subsurface and surface paths and the proportion of the flow reaching the river as quickflow should be affected by the interaction of these increased volumes of runoff with the hydrogeology and geometry of the basin. Steeper sloping basins, such as the Rio Massangana are predicted to generate larger amounts of quickflow than low-gradient topography such as that of the Rio Jacundá. However, when low-gradient hillslopes are deforested in the model, the increased runoff is partitioned mainly into quickflow through an increase in saturation overland flow.

B22A-0749 1330h POSTER

Soil Water Repellency in Amazonian Pastures

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Conversion of forest to pastures represents the largest land use change in the Brazilian Amazon. Soil water repellency (hydrophobicity) impacts water, carbon, and nutrient pathways on millions of hectares worldwide and has been shown to result from fire. However, the extent and severity of soil water repellency and its impact on tropical agroecosystems remains an important knowledge gap. Water repellent soils were identified in pastures in Northwest Mato Grosso. The intensity and spatial variability of soil water repellency were determined in situ at the mineral soil surface at both micro- (mm<) and meso-scales (m<) following several weeks without rainfall. Measurements were made using the Molarity of an Ethanol Droplet (MED) test in pastures of various lengths of time since burning. Drops of increasing ethanol molarity were applied until the surface tension of the solution was sufficiently small to overcome the hydrophobic repulsion of the soil. Soils of recently burned pastures exhibited extreme water repellency (MED > 3.5 N). Soil water repellency of pastures was found to be significantly correlated to the length of time since the pasture was last burned (R2=0.38; p=0.02). Pastures that had not been burned for over a year were found to be strongly water repellent (MED > 2 N), with 7 years without burning required for pastures to become hydrophilic (MED <1 N). High MED values following pasture fires may indicate the role of water repellency in pasture degradation. The areal coverage of Brachiaria brizantha grass tufts was measured as a proxy for net primary productivity of pastures under varying grazing pressures, and was also found to be correlated with hydrophobicity (R2=0.38; p=0.06). Surprisingly, soil water repellency was found to increase for increases in B. brizantha coverage. This may be due to the increased hydrophobicity-inducing potential of a pasture with greater biomass. While pasture soils were found to be generally compacted with bulk density (0-5 cm) ranging from 1.31 to 1.52, the relationship between hydrophobicity and surface soil compaction is non-significant. Spatial variability of soil water repellency was high at both meso- and micro-scales, with hydrophilic point measurements (MED < 1.0 N) scattered through generally hydrophobic soil. Dissipation over time of soil water repellency is consistent with hydrophobicity theory.

B22A-0750 1330h POSTER

Micrometeorology of a Tropical Rainforest Before and After Selective Logging

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We are using long-term eddy covariance to directly measure the effects of selective logging on the energy and trace gas exchange of a tropical forest, as a component of the Large Scale Biosphere-Atmosphere Experiment in Amazonia (LBA). We began measurements in June 2000 from a 65 m tall tower in a primary evergreen stand in the Tapajos National Forest (km 83), Para, Brazil, that was selectively logged during the fall of 2001. In addition to the core flux measurements of carbon dioxide, water vapor, momentum, and heat, sensors have been installed to measure vertical profiles CO2, H2O, wind velocity, and temperature within and above the forest, to aid in understanding the complex micrometeorology that determines the transfer between the forest and the atmosphere. In addition, after the logging a second 65 m tall tower was installed in a large gap created by the logging, and similarly instrumented. Here, we address the micrometeorology of the forest, both before and after the logging.

B22A-0751 1330h POSTER

Effects of Interannual Climate Variability in Secondary Forests and Crops Under Traditional and Alternative Shifting Cultivation

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Regenerating forests play an important role in long-term carbon sequestration and sustainable landuse as they act as potentially important carbon and nutrient sinks during the shifting agriculture fallow period. The long-term functioning of secondary forests (capoeira) is increasingly threatened by a shortening fallow period during shifting cultivation due to demographic pressures and associated increased vulnerability to severe climatic events. Declining productivity and functioning of fallow forests of shifting cultivation combined with progressive loss of nutrients by successive burning and cropping activities has resulted in declining agricultural productivity. In addition to the effects of intense land use practices, droughts associated with El Nio events are becoming more frequent and severe in moist tropical forests and negative effects on capoeira productivity could be considerable. In Igarape-Acu (near Belem, Para), we hypothesize that experimental alternative landuse/clearing practices (mulching and fallow vegetation improvement by planting with fast-growing leguminous tree species) may make capoeira and crops more resilient to the effects of agricultural pressures and drought through 1) increased biomass, soil organic matter and associated increase in soil water storage, and nutrient retention and 2) greater rooting depth of trees planted for fallow improvement. This experimental practice (mechanized chop-and-mulch with fallow improvement) has resulted in increased soil moisture during the cropping phase, reduced loss of nutrients and organic matter, and higher rates of secondary-forest biomass accumulation. We present preliminary data on water relations during the dry season of 2001 in capoeira and crops for both traditional slash-and-burn and alternative chop-and-mulch practices. These data will be used to test IKONOS data for the detection of moisture status differences. The principal goal of the research is to determine the extent to which capoeira and agricultural fields are susceptible to extreme climate events (drought) under contrasting landuse/clearing practices.

B22B MCC: Hall C Tuesday 1330h

Biogeochemical Cycling of Carbon, Nitrogen, and Heavy Metals: Implications for Ecosystem Restoration and Global Cycles II Posters *(joint with OS)*

Presiding: **J O Sickman,** California Department of Water Resources**; A B Mller-Solger,** California Department of Water Resources

B22B-0752 1330h POSTER

Estimating Global Terrestrial Carbon Turnover Times Using Data Assimilation

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We estimated carbon turnover times for various terrestrial ecosystems by assimilating estimated CO2 fluxes into the Simple Biosphere Model, Version 2 (SiB2). CO2 fluxes for TRANSCOM3 regions were estimated by inversion of flask measurements using a transport model. We simulated the terrestrial NEE using SiB2 for 1983 to 1993 on a global, 1° by 1° latitude/longitude grid with a 10-minute time step. We iterated for optimal turnover times for 11 ecosystem types using the inverse Hessian assimilation technique. Since the SiB2 response to turnover time is grossly nonlinear, we first optimized the linear correlation between the measured and simulated NEE as a first guess to the inverse Hessian technique. The results are reasonable estimates for those carbon pools with relatively short turnover times that are most sensitive to inter-annual variations in climate. Tropical forests and grasslands have shorter turnover times and mid- and high-latitude forests and tundra have longer turnover times.

B22B-0753 1330h POSTER

Nitorgen Deposition Impacts on a Sensitive Grassland Ecosystem: Conservation, Management, and Restoration

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Humans have greatly increased the flux of reactive nitrogen in the biosphere, altering many terrestrial and aquatic ecosystems. In the San Francisco Bay Area, CA, grasslands on nutrient-poor serpentinitic soils are being invaded by nutrient-demanding introduced annual grasses, driven by dry N-deposition on the order of 10 kg ha-1 yr-1. These grass invasions threaten the rich native biodiversity of the serpentinitic grasslands, including the federally-protected Bay checkerspot butterfly and several endemic plant species.

A passive monitoring network for reactive nitrogen gases (NOx, NO2, NH3, HNO3, and O3) has been set up to investigate regional and local N-deposition gradients. The regional gradient extends from clean coastal areas to inland valleys downwind of the highly urbanized Santa Clara Valley, driven by prevailing NW winds. A local gradient extends upwind and downwind of an 8-lane freeway carrying 100,000 cars/day, located in a relatively clean near-coastal area.

Plant surveys at the clean-air site bisected by the freeway show greater grass invasion closer to the freeway, but only on the downwind side (controlling for soil depth, the other main factor affecting grass density). Grassed-over areas build up thatch that suppresses native plants. Restoration experiments include mowing, goat grazing, and prescribed fire. Carefully-timed mowing appears to be an effective treatment for small areas. Removal of cuttings removes 5-8 kg-N/ha, the same order of magnitude as the estimated N-inputs from the freeway.

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. Mitigation proposals include purchase and long-term management of hundreds of hectares of habitat. Management of the larger areas necessitates continued moderate cattle grazing. Cattle selectively crop nitrogen-rich annual grasses, and remove N from the system, while redistributing N within the system as feces and urine. This case study highlights the complexities of habitat management in the face of N-deposition and invasive species.

B22B-0754 1330h POSTER

Nitrogen Gas Fluxes in Northeastern Temperate Forests

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Nitrogen gas fluxes are a poorly quantified component of the nitrogen (N) cycle of forest ecosystems and are important to water quality, atmospheric chemistry and forest health. We measured fluxes of nitric oxide (NO), nitrous oxide (N_2O) and dinitrogen (N_2) in oak and maple stands in the Catskill mountains of New York State. Fluxes of NO and N_2O were measured using in situ chambers and N_2 flux was measured in intact cores incubated in a helium-oxygen atmosphere closed recirculation system in the laboratory. Fluxes of NO and N_2O were higher in maple than in oak stands, which is consistent with previous work showing higher rates of N cycling under maple than oak. NO fluxes averaged 1.7 mg N m^{-2} d^{-1} in maple and 0.2 in oak. N_2O fluxes averaged 0.10 mg N m^{-2} d^{-1} in maple and 0.004 in oak. However, N_2 fluxes were higher in oak (2.3 mg N m^{-2} d^{-1}) than maple (0.15), a surprising result that was supported by independent measurements of denitrification potential. There was marked variability in fluxes between replicate plots that was linked to the presence of understory vegetation and physical characteristics of the forest floor. Results suggest that N gas fluxes in northeastern temperate forests may be more important than previously thought and may be an important regulator of export of N to coastal waters, N-related atmospheric chemistry and forest N saturation.

B22B-0755 1330h POSTER

Modeling Temporal and Spatial Characteristics of Nitrogen dry Deposition in the Phoenix Metropolitan Area

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Annual fluxes of NO_x-derived dry deposition in the Phoenix metropolitan area, along with its temporal and spatial characteristics, were predicted using a diagnostic model as well as the Community Multiscale Air Quality Model (Models-3/CMAQ). Input data for