

8 days to reduce cloud cover effects, was able to differentiate industrial thermal anomalies from land cover thermal anomalies (e.g., wildfires or agricultural burning) when combined with DMSP stable city lights data. Persistence in thermal anomaly and change in forest cover indicated by normalized difference vegetation index were used to isolate fire disturbance from industrial activities and estimate disturbance severity. ASTER image data was used to verify and quantify the disturbance for a few cases.

B11D-0722 0830h POSTER

Interannual Variation in the Response of Forest Productivity to Elevated Carbon Dioxide

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Photosynthesis and respiration of forests contribute to the regulation of atmospheric carbon dioxide. To determine the capacity of forests to respond to increasing concentrations of atmospheric CO₂, derived from anthropogenic sources, we exposed large replicated plots in a loblolly pine forest to atmospheric plus 20 Pa CO₂ for seven years. While the average growth rate of trees has declined with time, the stimulation caused by elevated CO₂ has remained between 15 and 25 percent. The biomass increment of wood and litterfall, the two major components of net primary production in this forest, also were stimulated by elevated CO₂. A preliminary analysis indicates that net primary production is correlated with growing season precipitation and the rate of nitrogen mineralization, but the magnitude of the stimulation caused by CO₂ is related to temperature. In one year the trees exposed to elevated CO₂ sequestered an additional 174 gC/m² relative to trees under ambient conditions. As trees grow larger more N is immobilized in plant tissues suggesting that the growth response to CO₂ may abate in the future. The stimulation of forest productivity by elevated CO₂, while locally significant, is not likely to reduce the accumulation of C in the atmosphere as the cover of forests continues to decline globally.

URL: <http://www.life.uiuc.edu/delucia/>

B11D-0723 0830h POSTER

Impacts of Forest Management, Climate, and Productivity on Soil CO₂ Efflux from Loblolly Pine (*Pinus taeda* L.) Stands Located on the Virginia piedmont and the South Carolina coastal plain

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Managed loblolly pine (*Pinus taeda* L.) forests occupy over 13 million hectares or nearly 1.5% of the total land area in the United States. Typically, over 70% of stored carbon (C) in forests resides in soils, emphasizing the need to better understand the impact forest management has on belowground processes affecting C storage. We measured soil CO₂ efflux (E_C) from loblolly pine stands located on the Virginia piedmont (VA_P) and SC coastal plain (SC_{CP}) in efforts to quantify soil C loss from sites differing in climate, productivity, and common management practices. VA_P sites were less productive and subjected to a cooler climate than SC_{CP} sites. VA_P sites were burned prior to planting as a form of weed and slash reduction while SC_{CP} sites were bedded to raise planting rows above the water table. E_C

was measured monthly for one year in four replicated age classes (1 to >20 years) on both VA_P and SC_{CP} sites using a closed dynamic chamber. Spatial variability for a given site was accounted for by taking measurements both near the base of the tree and between rows. Concurrent with E_C measurements, soil temperature (top 10 cm), soil moisture (top 10 cm), stand age, and site index were recorded. Empirical models were developed for the VA_P and SC_{CP} sites to assess the relationship between E_C and potential drivers. Soil temperature (top 10 cm) was the major E_C driver on both VA_P and SC_{CP} sites, explaining half or more of the variance. Stand age was positively correlated with E_C on VA_P sites, but we observed no relationship between stand age and E_C on the SC_{CP} sites. Using the empirical models developed from small chamber measurements, we scaled up soil C losses to the stand level for a 20-year rotation. We estimate a total efflux rate of 278.6 Mg C/ha over a 20-year rotation for SC_{CP} and 210.9 Mg C/ha over the same time period for VA_P. The contribution of heterotrophic respiration to E_C was greatest early in the rotation on the SC_{CP} sites, where soils were tilled and organic matter was integrated into the mineral soil. The more minor soil disturbances on VA_P sites had less of an impact on heterotrophic respiration early in the rotation. Our results indicate that management intensity impacts soil C efflux by affecting microbial driven C turnover. In a collaborative effort, empirical models developed from small chamber measurements will be incorporated into process-based models currently being developed to predict net C fluxes in response to a variety of management regimes. Further efforts are ongoing to remote sense input variables.

B11D-0724 0830h POSTER

Above- and Below-ground Biomass, Net Ecosystem Carbon Exchange, and Soil Respiration in a Poplar *Populus deltoides* Bartr.) stand : Changes after 3 years of Growth under Elevated CO₂

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Stands of cottonwood (*Populus deltoides* Bartr.) trees were grown as a coppiced system under ambient (40 Pa), twice ambient (80 Pa), and three times ambient (120 Pa) partial pressure CO₂ for the past three years in the Intensively-managed Forest Mesocosm (IFM) of the Biosphere 2 Center. Over three years Net Ecosystem CO₂ exchange (NECE) was measured continuously and in the third year, nine whole trees were harvested from each CO₂ treatment over the growing season. Both above- and below-ground parameters were measured. Three years of growth under elevated CO₂ showed the expected stimulation in foliar biomass (8.7, 11.9, and 13.1 kg for the 40, 80, and 120 Pa treatments, respectively). Rates of NECE also followed an expected increase with elevated atmospheric CO₂ concentrations, with maximum CO₂ uptake rates reaching 10.5, 15.6, and 19.6 $\mu\text{moles m}^{-2} \text{s}^{-1}$ in the 40, 80, and 120 Pa treatments, respectively. However, above ground woody biomass and root biomass were not much stimulated beyond 80 Pa CO₂. Wood/foilage and above/below ground biomass ratios reflect this decline. Under conditions of non-limiting nutrients and water, we found consistent increases in the above/below ground biomass ratio and wood to foliage biomass ratios in the 80 compared to the 40 Pa pCO₂. Woody biomass production and the above/below ground biomass ratio were lower under the 120 Pa than any other treatment. Although biomass production did not change appreciably between 80 and 120 Pa CO₂ treatments, both substrate induced and in-situ soil respiration values are also significantly higher in the 120Pa treatment, though no differences were present prior to CO₂ treatments (Murthy et al. 2003). The unique closed-system operation of the IFM allowed for measures of soil CO₂ efflux to be measured at both the soil collar and stand scales using a box model that takes into account all inputs and outputs from the stand. In-situ soil respiration rates increased significantly with increased atmospheric CO₂ concentrations (8.4, 11.8, 14.3 for the 40, 80, and 120 Pa treatments, respectively). Stands of cottonwoods grown at elevated CO₂ concentrations showed expected CO₂ "fertilization" in terms of foliage, wood, and root biomass responses at 80 Pa, but little further response at 120 Pa. Instead, respiration of the plantation soil was greatly stimulated at 120 Pa, suggesting increased carbon secretion to the soil, or respiration associated with more rapid fine root turnover. From a system perspective,

more rapid carbon acquisition in response to elevated CO₂ concentrations appears to saturate, possibly due to more rapid carbon cycling.

URL: <http://www.bio2.edu/Research/agroforestry.htm>

B11E MCC: 3002 Monday 1020h

Molecular Biogeochemical Processes of Terrestrial Environments II (*joint with H, V, MR*)

Presiding: J Cervini-Silva, University of California, Berkeley; J Chorover, University of Arizona

B11E-01 1020h

Probing the Nanoscale Architecture of Mineral Surfaces

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Soil minerals have been shown recently to have an unexpectedly high affinity for certain types of organic molecules including pesticides, explosives and related environmental contaminants. Recent laboratory and field studies, for example, have shown that nitroaromatic compounds are strongly sorbed to certain types of expandable clay minerals. For these compounds, sorption by clay minerals may exceed that of soil organic matter and the molecular mechanisms underlying this preference have been the subject of recent investigation. Expandable clay minerals with a low surface charge density and exchanged with potassium ions have been shown to have the highest affinity for these types of organic solutes. Expandable clay minerals have generally been viewed as hydrophilic materials based on their high affinity for water. Recent evidence, however, has shown that the siloxane surface itself has some hydrophobic character. For exchangeable cations with lower hydration enthalpies, such as potassium, the sorbed organic solutes have an opportunity to interact with both the hydrophilic hydrated cation and with nonpolar regions of the siloxane surface. The combined interaction of these two types of surface sites appears to be important for the sorption of both large and small organic solutes. We have recently combined spectroscopic, structural, and quantum chemical methods with sorption isotherms to examine these types of solute-surface interactions in aqueous media for both specimen and soil clays. Examples of solute-hydrophilic and solute-hydrophobic surface site interactions using different probe molecules will be presented.

B11E-02 1035h

Surface modification of lattice dynamics in ZnS nanoparticles

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Ligand binding is frequently observed to limit the growth and aggregation of both synthetic and environmental nanoparticles. Surface ligands can have significant consequences on nanoparticle structure, either driving transformations to alternate structures, or modifying the detailed structure relative to the equivalent bulk phase. The shortest interatomic distances in a structure are bond-lengths, accurately measured by extended X-ray absorption fine structure (EXAFS) spectroscopy. Bond-length expansions and contractions have been observed, depending on the choice of ligand. However, a more complete description of nanoparticle

structure is observed with the longer-range distances, obtained from wide-angle X-ray scattering (WAXS). By comparing WAXS data for bulk ZnS and 3 nm ZnS nanoparticles coated with mercaptoethanol, we reveal a structural contraction that becomes more evident at larger distances. Temperature-dependent EXAFS measurements show that this structural modification is associated with a substantial increase in the vibration frequency of the Zn-S bond, relative to bulk ZnS. This pair of observations shows that organic ligands on nanoparticles can cause lattice modification and stiffening, emphasizing that nanoparticles may have surprisingly different materials properties relative to the bulk.

B11E-03 1050h

Effects of Fe on Physicochemical Characteristics of Natural Organic Matter

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Natural organic matter (NOM) is ubiquitous in aquatic and terrestrial environments, and it plays an important role in controlling many biogeochemical processes. NOM molecular weight (MW) is a key property that affects NOM reactivity. Polyvalent metals such as Fe and Al bind strongly to NOM and also can cause its coagulation. Thus, we hypothesized that the presence of Fe would affect NOM MW determinations, even at relatively low Fe and NOM concentrations. This hypothesis was tested by adding increasing amounts of Fe(III) to aqueous solutions of NOM isolate (XAD-8) at pH 5.5, in the dark, and following changes in the NOM MW (measured by size exclusion chromatography), absorbance, and fluorescence. No change in MW was observed to 3 μ M total Fe concentration, but at 10 μ M total Fe concentration, there was a loss of low MW components and an increase in higher MW components. The weight average MW increased from 3661 Da to 3975 Da. Absorbance at 254 nm (typically monitored in water treatment processes) was unchanged by added Fe, but absorbance increase over parts of the visible spectrum (350-600 nm), and decreased in the far UV (200-225 nm), thus altering spectral slope. The two fluorescence maxima observed for this sample (Ex 325, Em 450; Ex 230, Em 435) decreased in intensity with increasing Fe concentration, with no shift in peak location. These results have important implications for our understanding of the concept of 'molecular weight' as applied to NOM, and for NOM reactivity including bioavailability, adsorption, and other processes.

B11E-04 1105h

Fluorapatite as Inorganic Phosphate Source for the Cyanobacterium Anabaena PCC 7120

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We investigated the hypothesis that the cyanobacterium *Anabaena* PCC 7120 is able to use fluorapatite (FAP) as sole phosphate source for growth. In the experimental setup the dissolution of FAP was tested in a phosphate free growth medium in the presence and absence of the *Anabaena*, as well as the cell free supernatant of an *Anabaena* culture. The results were compared with that of an *Anabaena* culture grown without fluorapatite. Parameters measured were pH, dissolved P and Ca, as well as cell density. The FAP grains were analyzed using SEM and XPS. Additionally, the differential expression of secreted proteins in cultures with and without dissolved phosphate was examined. P-limited *Anabaena* cultures tend to aggregate and in the presence of FAP the cells attached themselves to the mineral grains. The cultures benefit from the presence of FAP. The cells have a very effective P-uptake system that is able to take up dissolved phosphate very efficiently and draw the concentrations down to very low levels. Furthermore, the SEM analysis of FAP showed an etching of the mineral grains in the samples from the *Anabaena* cultures. The mechanism of apatite dissolution with and without *Anabaena* will be discussed in terms of these experimental observations.

B11E-05 1120h

Catalytic Interactions Involving Cerium, Catecholate, and Oxygen may be Pivotal to Phosphorus Bioavailability and Humic Acid Production

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Highly insoluble cerium phosphate minerals form as the result of weathering of apatite and are important phosphorous repositories in soils. Prior studies have documented solubilization of these secondary phosphate phases in soils under some conditions, but the mechanisms are poorly understood. Here we report results of batch dissolution experiments under oxic and anoxic conditions, XRD, ATR-FTIR, and XPS analysis that suggest that catecholate catalyzes the oxidation of surface Ce³⁺ ions, resulting in formation of CeO₂, a strong oxidant. The CeO₂ then causes the decarboxylation of catecholate to form CO₂, humic compounds, and soluble organic acids. The organic byproducts can further promote CePO₄ dissolution by complexing with dissolved lanthanide ions. These processes may exert key controls on phosphate and organic carbon cycles in soils.

B11E-06 1135h

Light Induced Dissolution of Iron Oxides in the Presence of Siderophores

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Iron is a micronutrient that is essential for a range of important enzymatic processes in most organisms. Iron deficiency is thought to be limiting the primary productivity in marine High Nutrient Low Chlorophyll (HNLC) regions which has a significant effect on global carbon cycling. Important iron sources in HNLC regions are upwelling and atmospheric dust inputs. However, the iron bioavailability from atmospheric dust is limited by the low solubility and slow dissolution kinetics of iron bearing minerals. Marine bacteria are known to facilitate weathering reactions by exudation of substances such as low molecular weight organic ligands including siderophores. We investigated if siderophore promoted photoreductive dissolution constitutes an important pathway for increasing the bioavailability of iron oxides. We used the microbial siderophores aerobactin and desferrioxamine-B (DFO-B). Aerobactin and desferrioxamines are excreted by marine and terrestrial bacteria. Aerobactin is a dihydroxamate siderophore containing the potentially photoreactive group alpha-hydroxy carboxylate. DFO-B is a trihydroxamate siderophore which forms soluble iron complexes that are not photoreactive (BARBEAU et al., 2003). Despite the structural differences, both siderophores accelerate iron oxide dissolution in irradiated suspensions compared to dissolution rates in the dark. This suggests that both siderophores are not involved in a light induced ligand to metal charge transfer reaction, but rather accelerate other photoreductive dissolution mechanisms. Similarly it was observed that both ligands accelerate light induced dissolution of iron oxides in the presence of oxalate as a chromophore. The observations suggest that light induced dissolution of iron oxides in the presence of siderophores is an important pathway for bacterial iron acquisition. However, the formation of Fe(II) by this mechanism may also lead to an increase of the availability of iron to phytoplankton that generally does not produce siderophores or take up iron(III)siderophore complexes (BARBEAU et al., 2001). References Barbeau K., Rue E. L., Bruland K. W., and Butler A. (2001) Photochemical cycling of iron in the surface ocean mediated by microbial iron(III)-binding ligands. *Nature* 413(6854), 409-413. Barbeau K., Rue E. L., Trick C. G., Bruland K. T., and Butler A. (2003) Photochemical reactivity of siderophores produced by marine heterotrophic bacteria and cyanobacteria based on characteristic Fe(III) binding groups. *Limnology and Oceanography* 48(3), 1069-1078.

B11E-07 1150h

Mechanism of Non-Steady State Dissolution of Goethite in the Presence of Siderophores

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Iron is an essential micronutrient for almost all known organisms. Bacteria, fungi, and graminaceous plants are capable of exuding siderophores as part of an iron acquisition strategy. The production of these strong iron chelating ligands is induced by iron limited conditions. Grasses under iron stress, for example, exude phytosiderophores into the rhizosphere in a special diurnal rhythm (Roemheld and Marschner 1986). A few hours after sunrise the exudation starts, culminates around noon and is shut down again until about 4 hours after noon. The phytosiderophores diffuse into the rhizosphere (Marschner et al. 1986) and are passively back transported to the plants by advective flow induced by high transpiration around noon. Despite a fairly short residence time of the phytosiderophores in the rhizosphere, it is a very effective strategy for iron acquisition. To investigate the effect of such pulse inputs of siderophores on iron acquisition, we studied the dissolution mechanism of goethite (alpha-FeOOH), a mineral phase common in soils, under non-steady state conditions. In consideration of the chemical complexity of the rhizosphere, we also investigated the effect of other organic ligands commonly found in the rhizosphere (e. g. oxalate) on the dissolution kinetics. The dissolution experiments were conducted in batch reactors with a constant goethite solids concentration of 2.5 g/l, an ionic strength of 0.01 M, a pH of 6 and 100 μ M oxalate. To induce non-steady state conditions, 3 mM phytosiderophores were added to a batch after the goethite-oxalate suspension reacted for a certain time period. Before the siderophore was added to the goethite-oxalate suspension, no dissolution of iron was observed. But, with the addition of the siderophore, a high rate was observed for the iron mobilization under these non-steady state conditions that subsequently was followed by a slow steady state dissolution rate. The results of these non-steady state experiments are very reproducible and the magnitude of dissolved iron corresponds to the reaction time of goethite with oxalate. Analogous non-steady state experiments were conducted, but with two other siderophores or citrate to induce non-steady state conditions: 40 μ M of the bacterial siderophore desferrioxamine B (DFO-B), 40 μ M of the fungal siderophore Ferrichrome, and 3 mM of citrate. Fast dissolution of iron was observed as a response to non-steady state. We also substituted the non-siderophore ligand oxalate by 500 μ M citrate or 750 μ M malonate and again observed fast dissolution after the non-steady state siderophore additions. Independent of the type of the ligands, a reproducible fast dissolution of iron followed by steady state dissolution was observed after the addition of the non-steady state ligand concentrations. Thus it can be said that the reproducible fast dissolution of iron under non-steady state conditions represents a general geochemical mechanism and an important process in the context of biological iron acquisition in natural systems. References Marschner, H., Roemheld, V. et al. (1986). "Different Strategies in Higher-Plants in Mobilization and Uptake of Iron". *Journal of Plant Nutrition* 9(3-7): 695-713. Roemheld, V. and Marschner, H. (1986). "Evidence for a Specific Uptake System for Iron Phytosiderophore in Roots of Grasses". *Plant Physiology* 80(1): 175-180.

B11E-08 1205h

Connecting the Molecular- With the Macro-scale: Evidence for the Stepwave Dissolution Model

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A general crystal dissolution model by Lasaga and Lutttge (2001, 2003) has shown promise in furthering our understanding of nanoscale dissolution processes at crystal surfaces. The model predicts trains of steps ("stepwaves") generated at the outskirts of etch pits radiating across the crystal surface. Each step will lower the crystal surface causing surface normal retreat and thus control the overall dissolution rate. This model is fundamentally based on a modified Gibbs-Thomson equation. It utilizes Monte Carlo techniques to explore the behavior of crystal dissolution (and precipita-

tion) including aluminosilicates, carbonates, and sulfates. Here, we test some key model predictions using the sulfate mineral barite (BaSO_4). Atomic force microscopy (AFM) and vertical scanning interferometry (VSI) were used to look at the (001) surfaces of freshly cleaved samples. Experiments were conducted in a flow-through cell that allowed monitoring the evolution of the sample surface with AFM. Results show that etch pits appear within minutes and indeed generate steps at their outskirts that radiate away from the growing pit. Complementary investigations were conducted with VSI. This technique has a much larger field of view than the AFM, typically up to mm^2 , but provides comparably high vertical resolution of up to 0.7 angstroms. VSI measurements show that the entire barite surface retreats during the dissolution process as predicted by the theoretical model. Within the last ten years biologically produced chelating agents have been discovered naturally occurring in the environment. The computer model is used to determine the effects of chelating agents and our experiments using VSI also show a marked, as much as two orders of magnitude, increase in dissolution rate of barite due to the presence of chelating agents. Our presentation will discuss a quantitative attempt to directly link molecular-scale processes with observations at the nano-, micro- and macro-scale to better understand dissolution kinetics of crystalline matter.

B11F MCC: 3014 Monday 1020h

The Impact of Dust Emission and Deposition on Biogeochemical Cycling and Ecosystem Function II (*joint with A, H, OS, PP*)

Presiding: G S Okin, University of Virginia; N Mahowald, National Center for Atmospheric Research

B11F-01 1020h INVITED

The Biogeochemical Influences of Dust Deposition in a Global Ocean Ecosystem Simulation

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Global ocean simulations of ocean biogeochemistry are driven with model estimates of atmospheric dust transport and deposition as a key source of iron to the upper ocean. The coupled Biogeochemistry/Ecosystem/Circulation (BEC) model includes explicit phytoplankton functional groups that compete for available light and several potentially growth-limiting nutrients - nitrogen, phosphorus, silicon, and iron. Diatoms, coccolithophores, picoplankton, and nitrogen fixing diazotrophs are represented in the model. These different classes of phytoplankton experience differential grazing pressure and other loss terms in the model. Global scale patterns in nutrient limitation, primary production, carbon export out of surface waters, and nitrogen fixation are all sensitive to variations in atmospheric dust deposition. Dust deposition also significantly influences the competition between phytoplankton groups (diatom vs. non-diatoms, n-fixers vs. picoplankton). The potential impacts of climate driven variations in dust deposition to the oceans will be discussed.

URL: <http://www.ess.uci.edu/~jkmoore/>

B11F-02 1040h

Temporal Variability of Iron in the Upper Ocean at Hawaii Ocean Time-series Station ALOHA

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Trace metal clean techniques were used to sample Hawaii Ocean Time-series (HOT) station ALOHA on seven occasions between Nov. 1998 and Oct. 2002. On three occasions, full water column profile samples were obtained; on the other four occasions, surface and near-surface euphotic zone profiles were obtained. Together with three published samplings (Rue and Bruland, 1995; Johnson et al., 2003), this site may have been monitored for "dissolved" (<0.4 or <0.2 m) Fe more frequently than any other deep-sea site in the

world. Low Fe concentrations are seen in the lower euphotic zone (<0.1 nmol/kg). Significant temporal variability is seen in near surface Fe concentrations (ranging from 0.2 - 0.7 nmol/kg); we attribute these surface Fe fluctuations to variable dust deposition and biological uptake. This variability can only occur if the surface layer Fe residence time is less than a few years. Given that residence time and typical values of Fe at HOT (0.4 nmol/kg from June through November), a higher percentage of the total aerosol Fe must be released typically from North Pacific aerosols compared to North Atlantic aerosols (as was also surmised by Johnson et al., 2003 for a single dust storm in April 2001).

B11F-03 1055h

Establishing a Functional Link Between African Dust and Region-wide Coral Reef Decline

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For nearly thirty years, coral reefs in the Western Atlantic and Caribbean basin have experienced historically unprecedented declines. Algal blooms, mass coral bleaching, disease outbreaks and shifts in the dominance of benthic coral-competitors were first documented in the 1970s and have increased in frequency, intensity, variety and range over the past two decades. Recent studies of decreasing coral cover document regional losses averaging nearly 80% over this period. Here, we provide experimental evidence that increased supplies of iron-rich eolian dust from Africa to typically iron-poor marine environments throughout the region could have played a key role in these profound changes. Atmospheric inputs of "new" micronutrients, especially iron, have the potential to overcome limitations to the growth of opportunistic coral-competitors and the virulence of coral pathogens. Microcosm and mesocosm experiments with a putative bacterial pathogen of stony corals, *Aurantimonas corallicida*, and a temperate stony coral, *Oculina arbuscula*, provide a means to test the functional relationship between iron availability, microbial growth and coral health. Iron limitation of *A. corallicida* growth rates is readily induced by the addition of synthetic chelators such as 2,2'-Dipyridyl to bacterial cultures at relatively low concentrations (e.g. 10 μM). This growth limitation is reversed by 100 nM over-enrichments of pure reagent-grade iron as well as iron-rich "synthetic dust" derived from African lakebed sediments. The Chrome-azuroil S assay demonstrates that *A. corallicida* also synthesizes high-affinity iron-capture mechanisms (i.e. siderophores) that may serve as critical determinants of virulence. Finally, our experimental mesocosms are based on oligotrophic Mediterranean seawater and permit controlled experimentation under relatively low iron (~ 5 nM) conditions. Using this system, denaturing gradient gel electrophoresis (DGGE) analysis of PCR-amplified ribosomal DNA fragments is used to study changes in the bacterial community associated with corals incubated under Fe-replete and Fe-deplete conditions. Observations of marked variability in coral bacterial profiles suggest that certain bacterial species on coral surfaces are responsive to shifts in environmental iron levels. These experiments begin to provide a mechanistic understanding of how dust, and in particular, environmental iron, might affect survival and competition in the coral reef community. This novel, model-based experimental approach can be further extended to virulence bioassays and may be useful for other process studies of coral-microbe interactions as well.

B11F-04 1110h INVITED

The global dispersion of microorganisms and pollutants in clouds of desert dust

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A current estimate of the quantity of dust that is transported some distance in Earth's atmosphere each year is approximately two billion metric tons. Whereas various research projects have been undertaken to understand this planetary process, little has been done to address public and ecosystem health issues. Our research group is currently investigating

long-range transport of microorganisms associated with desert dust clouds at various points on the globe via the integration of remote sensing, modeling and microbiological assays. Using a suite of molecular biology techniques, we are identifying cultivable bacteria and fungi and enumerating total bacteria and viruses. Research results indicate that approximately 30% of the microorganisms found in Earth's atmosphere during African dust events' are species of bacteria or fungi that have previously been identified as disease causing agents in terrestrial plants, trees, and animals. This presentation will cover historical research in this field and the implications of microbial and pollutant *metals, pesticides, etc.* transport to downwind ecosystems.

URL: http://coastal.er.usgs.gov/african_dust/

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The Biogeochemical Impact of Global and Local Dust on Hawaiian Ecosystems

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Hawaii is distant from continental sources of dust, yet there is abundant evidence that continental dust accumulates in soils on stable land surfaces. The physical evidence for dust accumulation is a dark grayish purple horizon that resides just below the O horizon; it is evident to a trained eye in 20 ky soils but becomes quite obvious in 150 ky soils. The continental dust contains about 20% quartz and a greater amount of mica, minerals that are not found in the local basalt and tephra. Thus presence of quartz and mica in Hawaiian soils identifies present, and in the case of buried horizons, past stable surfaces. In older soils near surface soil horizons can contain up to 30% quartz after 150 ky of accumulation. Soils on older lava flows do not necessarily contain greater amounts of dust because chemical and physical erosion removes variable amounts from different landscape positions. In soils older than 20 ky there is a progressive increase in the quartz to mica ratio suggesting that mica is preferentially weathered in locations where physical erosion is limited. In addition to mineralogy, the isotopes of Sr and Nd provide distinctive indications of dust contribution to soil profiles because the mantle-derived lavas have different isotopic signatures that the more highly evolved continental components. In horizons greatly impacted by dust the basaltic derived Sr and Nd signatures are nearly completely overprinted by continental signatures. Strontium concentrations are highly depleted due to leaching whereas Nd is less labile. Using quartz and Nd as tracers of continental dust we calculate a minimum long-term dust accumulation rate of 125 mg/cm²/ky. Dust has a profound effect on the budgets of elements that are susceptible to leaching losses and becomes the dominant source of labile nutrients, Si and P in the oldest, most intensely weathered soils. We calculate a dust-derived P input flux of 0.8 mg/cm²/ky and a dust-derived Si input flux of 35 mg/cm²/ky. Leaching losses of Si and P are high in young soils but decline to values that balance the dust input in the oldest soils. Extremely refractory elements, such as Nb, that are concentrated by residual enrichment are much less readily impacted by dust additions. For example, 150 ky soils show strong continental dust signatures when considering mineralogy, or Sr and Nd isotopes, but dust can have contributed less than 4% of the Nb in the profile. Calcium and Sr, labile elements in humid soils are little impacted by dust additions because far greater quantities of these ions are dissolved in rainwater.