4 clades, one cluster, comprised of 3 strains isolated from the air-lock area, tightly aligned with the *B. pumilus* ATCC 7061 type strain (97%). The *gyrB* sequence similarity of this clade was only 91% with the 3 other clades. The genetic relatedness of these strains, as per pulse field gel electrophoresis patterns, will be presented.

The vegetative cells and spores of a number of isolates were tested for their hydrogen peroxide resistance. Cells and spores were separately treated with 5% liquid hydrogen peroxide. After 60 minutes of exposure, the samples were diluted in tryptic soy broth and incubated at 32^{o}C. Vegetative cells of one of the isolates, FO-036b, were the only cells to survive the exposure to hydrogen peroxide. In contrast, spores of several of the isolates survived exposure to hydrogen peroxide. Spores of these isolates do not appear to have any obvious morphological changes. We are in the process of analyzing these hydrogen peroxide resistant spores and comparing them to spores of microbes that are not as hydrogen peroxide resistant. The impact and implications of the identification and recurrence of these hydrogen peroxide microbes, and their spores, will be discussed.

B12D-0150 1330h POSTER

Developing Planetary Protection Technologies: Isolation and Characterization of Novel Microbes from a Spacecraft Assembly Facility

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Systematic detection and classification of cultivable microbes present in the Spacecraft Assembly Facility (SAF) at the Jet Propulsion Laboratory (JPL) were carried out using classical microbial phylogeny and advanced molecular microbial ecology methods. This work is being carried out to understand the microbial diversity in an assembly facility that could potentially contaminate an assembled spacecraft. Contamination of spacecraft surfaces with terrestrial microbes could compromise the interpretation of results from in-situ life detection studies or sample return missions. Fifty samples were collected from various locations of JPL-SAF whose air circulation and humidity are controlled and maintained to the cleanliness of a class 100K clean-room. Sampling locations included both unclassified (entrance floors, shoe-cleaner, air-shower, ante-room, and air-lock), and classified (clean-room floors, clean-room tables and cabinet tops) areas. All samples were analyzed for the incidence of aerobic spore-formers (using Tryptic Soy Agar) and for total aerobic heterotrophs (using R2 Agar). Spore-former incidence ranged from 0 to 3x10^{-1} CFU/25cm^{2}in the unclassified area whereas only 2 out of 25 samples collected in the unclassified areas contained spore-formers. However, the counts of total heterotrophs were about 100 times higher when compared to the spore-formers in the unclassified area and 9 out of 25 samples collected in the classified area contained a range of heterotrophs from 5x10^{1} to 4x10^{2} CFU/25cm^{2} . Representatives of the spore-formers (31 strains) and total heterotrophs (40 strains) were identified by 16S rDNA sequence analysis to determine their phylogenetic relatedness. The spore-formers clustered to 8 known *Bacillus* and *Paenibacillus* species and 6 strains were identified as novel species of the genera *Bacillus* (2), *Paenibacillus* (2), *Ureibacillus* (1), and one new genus. Among the forty heterotrophs, 5 clusters were tightly affiliated with genera, such as *Bacillus* (5), *Staphylococcus* (2), and members of the families actinomycetales (3), streptomyces (1), and micrococcoidaceae (10). However, 19 of the strains isolated clustered to a very distinct clade and formed a relatively close association with the Cytophaga-Flavobacteria-Bacteroides-Taxeobacter (CFBT) group. The physiological novelties of these species such as resistance to hydrogen peroxide, desiccation, etc. will be presented. Isolation of microbes that are resistant to hydrogen peroxide has significant implications in the assembly of spacecraft because vapor hydrogen peroxide is the low-heat sterilization technology of choice for spacecraft hardware.

B12D-0151 1330h POSTER

Development of Planetary Protection Technology: Bacterial Spore Detection using Lanthanide Luminescence

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The core of bacterial spores contains 1 molar dipicolinic acid, DPA, which can be released into bulk solution by inducing germination with L-alanine or by autoclaving the sample. The released DPA binds terbium, Tb, as a tridentate ligand with high affinity, 10e9 M-1, which triggers bright green luminescence under UV excitation that can be correlated to a DPA concentration and subsequently to endospore concentration. Current detection limits of this method are at 10e4 spores per ml. We will present our current efforts to reach single spore per ml detection limits.

B12D-0152 1330h POSTER

Developing Planetary Protection Technology: New Capabilities and Facilities at JPL

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In order to meet planetary protection microbial reduction requirements, in situ life detection and sample return missions will be required to reduce the bioburden levels of their spacecraft to specified levels and then validate that these levels have been met. Use of modern materials and sophisticated electronics and sensors in todays spacecraft dictate the need for cleaning and sterilization technologies capable of reducing bioburden levels while at the same time maintaining material and subassembly integrity. Numerous cleaning and sterilization technologies exist, but their ability to provide biological decontamination on spaceflight hardware needs to be better understood. New laboratory technologies and facilities to support planetary protection are under development at the Jet Propulsion Laboratory. These laboratory capabilities will provide new tools for cleaning, sterilization, and detection and characterization of bioburden on spacecraft. The goal of these activities is to provide new methods to establish and maintain the cleanliness and sterility of NASA hardware before flight. This development combines research in environmental microbiological studies of spacecraft assembly facilities and the development of practical methods for the cleaning and sterilization of hardware. A variety of modern molecular biology, biochemistry, and microscopy approaches are used to evaluate to effectiveness of various methods of cleaning and sterilization.

B12E MC: Hall D Monday 1330h

Geophysiology: The Influence of Organisms on Their Geophysical Environment I

Presiding: **J Neff,** U.S. Geological Survey**; G N Cameron,** University of Cincinnati

B12E-0153 1330h POSTER

Distribution of Dimethylsulfide andDimethylsulfoniopropionate in Arctic Shelf Region

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Dimethylsulfide (DMS) is the most abundant biogenic sulfur-bearing compounds emitted from ocean to the atmosphere. DMS is oxidized in the atmosphere and condensed as aerosols, which affect the radiative balance of the Earth directly or indirectly. Ice algae are known to accumulate high amount of dimethylsulfoniopropionate (DMSP; precursor of DMS) in their cell for the purpose of cryoprotection. Therefore, the sulfur compound has potential significance in the Arctic climate. Observations in the Arctic Ocean were carried out in September, 1999 and from August to October, 2000. The concentrations of dissolved DMS, dissolved DMSP and particulate DMSP were determined for seawater samples collected at 7-9 water depths within 200 m from the surface at the 21 stations along the Beaufort shelf. Mean concentration of DMS in surface water was about 1.4 nmol/l (Range 0.2 17.5 nmol/l) . This suggests that the flux of DMS from this region to the atmosphere is moderate in the observed period. DMS and DMSP appeared within the upper 20 m of the water column, at most of the stations. Concentrations of particulate DMSP were relatively high, though that of dissolved DMSP and DMSP were low. This suggests the bacterial consumption of dissolved DMSP and DMS may active in summer. Relatively high concentrations of DMS and DMSP were found at the stations along Barrow Canyon, where the warm water mass was observed. Since the warm water mass in Barrow Canyon is believed to have originated from North Bering Sea, that indicates the Pacific water mass could affect the production of those sulfur compounds. High concentrations of particulate DMSP (maximum 30 nmol/l) were also found at the stations influenced by ice melt water rather than river water. That indicates ice algae are significant producer of DMSP and DMS in Arctic Ocean.

B12E-0154 1330h POSTER

Biological albedo reduction of snow and ice on glaciers in Alaska.

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Biogenic contaminants in snow and ice and its effect on surface albedo were investigated on five glaciers in Alaska. Several species of snow algae and dark colored organic material were found in the snow and ice of all of the glaciers. The surface albedo was significantly reduced by red-colored algae (Chlamydomonas nivalis) on snow area of the glaciers, and by dark colored material (cryoconite) on ice area. The amounts of snow algae and other biogenic material were different between glaciers: larger amounts of algae and material existed on inland glacier compared to south costal glaciers of Alaska. The measured surface albedo was lower on the inland glacier than on the south costal glaciers, consistent with the amount of the biogenic material. Results suggest that the effect of biological activity on surface albedo is more significant on the inland glacier than the south costal glaciers in Alaska.

URL: http://www.frontier.iarc.uaf.edu:8080/~nozomu/

B12E-0155 1330h POSTER

Biological Control on Mineral Transformation in Soils ?

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Weathering of primary minerals is commonly linked to biological processes through the production of carbonic and organic acids. Plants can also play a role in weathering by removing soluble constituents and enhancing diffusion gradients within the soil. Here we investigate the synthesis of secondary minerals and the role of plants in removing elements that act as building blocks for these minerals. In order to minimize losses from leaching, we have sampled a chronosequence of soils forming on lava flows on Hawaii Island that receive about 200 mm of rain annually and have never been subjected to high levels of rainfall. The P concentration in the soils drops from almost 3000 mg/kg on a 1.5 ky lava flow to around 1000 mg/kg on a 350

ky lava flow. This loss of P can only be ascribed to P-uptake by plants with subsequent removal through the loss of above ground biomass through fire and/or wind removal. Over the same time frame the amount of plagioclase in the soils drops from around 22% of the <2 mm soil fraction on the youngest lava flow to virtually 0% on the 350 ky flow, suggesting a substantial release of Si. Elevated silicon in arid, basaltic soil environments often leads to formation of smectite, a feature not observed along the chronosequence. In fact, plagioclase is replaced by the kaolin mineral halloysite with allophane as an apparent precursor. Kaolin minerals are associated with moderate to intense leaching environments rather than the mild leaching conditions that influence these soils. We selected an intermediate age soil profile (170 ky lava flow) to conduct an in-depth investigation of the soil mineral composition. We detected a strong dominance of halloysite, the presence of gibbsite, but no smectite. Secondary halloysite formation is preferred over smectite formation when Si activities are relatively low, and the pH is acidic rather than alkaline. Although this mineral assemblage seems to imply formation under a wetter climatic regime, the oxygen isotopic composition of the halloysite suggests formation under soil environmental conditions similar to the present. The Si concentration in grass and tree leaves in the vicinity of the soil contain between 3 and 8% Si. Loss of these leaves to the nearby ocean (either as dried or burned residue) could be responsible for considerable Si removal in a manner similar to the P-removal. The resulting Si-deficient soil-water favors the formation of halloysite over smectite as is demonstrated by construction of mineral stability diagrams using the soil-water data from the soils along the chronosequence.

B12F MC: 122 Monday 1330h

Carbon, Climate Change, and Disturbance in Northern Forest Ecosystems I *(joint with GC)*

Presiding: **M Apps,** Natural Resources Canada**; A D McGuire,** University of Alaska Fairbanks**; J Caspersen,** Princeton University

B12F-01 1330h INVITED

Environmental Variation, Vegetation Distribution, and Carbon Dynamics in High Latitudes

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In this study, we evaluated how vegetation distribution and carbon dynamics are related to environmental variation spanned by the network of the IGBP high latitude transects. While the most notable feature of the high latitude transects is that they generally span temperature gradients from southern to northern latitudes, there are substantial differences in temperature among the transects. Also, along each transect temperature co-varies with precipitation and photosynthetically active radiation, which are also variable among the transects. Although there are similar sequences of vegetation transitions along these gradients, there is variance in climatic associations with vegetation transitions among the transects. Both climate and disturbance interact to influence latitudinal patterns of vegetation and soil carbon storage among the transects. The analyses in this study have taken an important step toward coordination of global change studies among the high latitude transects. Coordinated studies have the potential to substantially improve understanding of controls over vegetation dynamics and carbon dynamics in high latitudes in ways that will further clarify the role of high latitude ecosystems in the earth system.

B12F-02 1350h INVITED

Climate Change, Forest Fires and Carbon in Northern Forests

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Fire is a key ecological process that to a large extent is responsible for the present composition and structure of northern forests. Biodiversity, energy flows and biogeochemical cycling are greatly influenced by the fire regime. Fire activity is directly related to climate and weather. Simulations of future weather using two coupled Global Circulation Models suggest that conditions will be significantly more conducive to fire occurrence and fire spread over most of North America. Other factors such as ignition agents, fuel characteristics, fire season length and human activities will also influence the future fire regime. An altered fire regime will have significant repercussions on the vegetation and the carbon balance of northern forests.

Fire is the disturbance of most significance for the carbon cycle. Carbon is released directly from flaming and smouldering combustion. In Canada, these direct emissions have been estimated to be on average about 20% of recent annual fossil fuel emissions. In addition to combustion, carbon is lost through decomposition of fire-killed vegetation and the carbon sink strength of the regenerating forest is usually less than that of the previous mature forest. Direct carbon flux measurements suggest that it may take up to 20-30 years for a site to return to its pre-fire state in terms of daytime carbon flux in the Canadian boreal forest, although some stands may recover in about ten years.

B12F-03 1410h INVITED

Estimating Forest Carbon Stock Dynamics from Forest Inventories, Disturbance Data and Simulation Models: An Integrated Analysis for British Columbia

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Forest inventories and growth and yield projection systems are an integral part of modern forest management. This information is commonly used for the long-term planning of annual allowable cuts and timber supply analysis. A strategy for the use of such information in a comprehensive, regional carbon budget model was developed and implemented for British Columbia, Canada.

Data readily accessible from forest information systems include the area, stratification and attributes (including merchantable volume) of forests. Growth and yield tables or empirical models provide the required information on stand dynamics. Disturbance statistics (harvest, fire, insects) describe the dynamics of the forest area. Temporary and permanent sample plots provide millions of tree measurements that were used in the conversion of volume to biomass estimates. Methods previously developed for the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS2) were used to calculate belowground biomass and to establish the various dead organic matter pools. Inventory data are nearly complete, except for a small portion of the total forest area. Land-use change statistics are available for forest roads, but not yet for other causes of land-use change.

A modified version of the CBM-CFS2 was used to calculate C stocks and stock changes for the period 2000 to 2032. Results indicate that ecosystem C stocks in the timber harvest land base are changing very little, with between-year variability of - 20 to + 20 Tg C / year. In contrast, ecosystem C stocks in the non-timber harvest land base are increasing at a rate of about 100 Tg C / year, largely because of the absence of harvesting and the assumed rates of future fire and insect disturbances, which could be the result of protection efforts. Actual disturbance rates, observed in future years, could have large impacts on C stock changes.

Annual changes in C stocks will also be influenced by climate variability. Growth and yield models predict periodic annual increment based on observations averaged over multi-year periods and are currently not responsive to climate variability. Future research needs to address climate-related sources of interannual variability in both biomass and dead organic matter C stocks.

The methods and tools used in this analysis are readily transferable to other regions and forest management units with good forest inventory information and where large-scale disturbances play an important role. Such analyses will help forest managers understand and assess the implications of alternative management strategies on future forest C stocks.

B12F-04 1430h INVITED

Uncertainties in high-latitude net CO_2 fluxes, seasonality and interannual variability from a Bayesian inversion

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Atmospheric inversions are useful tools for estimating surface fluxes of CO_2, however the literature shows a broad range of results for net annual fluxes. We will present a conceptual (and non-mathematical) model of how the Bayesian style of inversion works, and then describe a number of reasons why the inversions produce different answers, such as sparcity of data, difficulty in observing the tropical flux signal because of the nature of the atmospheric transport, the assumptions made regarding the spatial distribution of fluxes within a region, aggregation error and atmospheric transport error. All these factors (and several others) make estimating net fluxes a difficult task. However, the inversions can make much more robust estimates of monthly fluxes and inter-annual variability as the signals associated with these two features are considerably larger. In particular, in the northern high-latitudes the observing networks allow solutions of the amplitude and phase of the seasonal cycle of the surface fluxes with some useful uncertainty estimates. We present a study where CO_2 flux estimates from four terrestrial biosphere carbon models from the Carbon Cycle Model Linkage Project were used as priors for a Bayesian atmospheric inversion. In this set up, the inversion is essentially used to test the biosphere models, to see if the process-based carbon flux estimates are consistent with the observations of CO_2 in the atmosphere. If the fluxes are not consistent the inversion produces estimates of what phase and amplitude are required, and from this we can gain insight into what processes in the biosphere models need to be addressed. We see this method as a valuable tool for combining the information and understanding available from the inversion and process-based methods.

B12F-05 1450h

The Role of Snow and Surface Organic Layer in Permafrost Stability in the Alaskan Northern Forest Ecosystems

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Permafrost is a prominent feature of the Alaskan boreal forest. Discontinuous permafrost underlies practically the entire area of the boreal forest in Alaska. Only the northernmost part in the southern foothills of the Brooks Range is within the continuous permafrost zone. This makes the permafrost conditions of the boreal forest in Alaska very different compared to the East Siberian boreal forest, most of which lays within the continuous permafrost zone, or to the West Siberian and Russian European North taiga where permafrost is absent in the major part of the area. The stability of permafrost is very important for the stability of northern forest ecosystems, for which permafrost serves as a foundation. As soon as permafrost starts to degrade by natural or human imposed causes, significant changes in northern ecosystems should be expected, especially if permafrost is ice-rich. Permafrost temperature is the most important indicator of permafrost stability. The closer the temperature is to 0°C, the more susceptible permafrost is to climate warming or surface disturbances. In the Alaskan boreal forest region, these temperatures are within the 0 to - 4°C range and typically warmer than -2°C. The main reason why permafrost temperatures here are so high is that the mean annual air temperatures in this region are typically within the range of -2°C to -5°C on a long-term average. However, not only air temperatures are responsible for the permafrost temperature regime. Probably the most important other natural factors are the thickness, thermal properties, and duration of the snow cover and the presence and properties of the surface organic layer. Our data show that at the permafrost sites within the Alaskan boreal forest zone, the mean annual ground surface temperatures are usually 3 to 6°C warmer than the mean annual air temperatures with the most common figures between 4 and 5°C. Most of this difference is due to the warming effect of snow cover. As a result, the mean annual ground surface temperatures in