abstracts the fast-time-scale processes of small-scale heat conduction, subsidence of melting permafrost and lake-margin collapse. The creation, growth and draining of thaw lakes and associated terrain is modeled in two horizontal dimensions on a grid. In each grid cell, the surface elevation, depth of permafrost and ice content are specified. Lakes are created preferentially where permafrost is undisturbed or has recovered following draining of a lake and grow at a rate determined by lake level, lake size, permafrost depth in surrounding terrain, and climatic factors. Lake level depends on catchment area and precipitation/evaporation balance. Lakes drain, either partially or fully, when their increasing size causes them to intersect a lake, lake basin or river valley lying below their lake level. Ice-rich permafrost recovers at a rate determined by climatic and hydrological factors.

Modeled terrain matches both qualitatively and quantitatively the patterns of intersecting lake basins observed in permafrost lowlands of the Seward Peninsula and Arctic Coastal Plain. The time scale over which modeled lakes evolve and react to perturbations far exceeds that of the fundamental heat conduction, subsidence and erosion processes, and the time scale over which the terrain evolves far exceeds that of lake evolution, suggesting at least two levels of self-organization and associated emergent behavior. The bulk rate at which permafrost melts is sensitive to the climate history of modeled terrain; rates are significantly different for terrain subjected to rapid change from one climate to a second than for terrain developed solely under the second climate regime, for example, suggesting that projections of melt rates must take into account the properties of thaw lake terrain that evolve over millenia, especially morphology.

Supported by Natural Science and Engineering Research Council and the Andrew W. Mellon Foundation.

B12A MCC: Hall C Monday 1330h

Interactions of Permafrost With Climatic, Hydrologic, and Ecosystems Processes IV Posters *(joint with C, H, GC)*

Presiding: **D L Kane,** University of Alaska, Fairbanks**; L D Hinzman,** University of Alaska, Fairbanks

B12A-0773 1330h POSTER

A tool for modeling permafrost and snow in CCSM

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High-latitude terrestrial variables and processes (e.g., permafrost, soil freezing and thawing, snow, moss, lichen, heterogeneity on the micro-scale, interaction of soil moisture and soil temperature states, etc.) have received little systematic study in the context of global climate model simulations. The soil- and snow-components of the hydro-thermodynamic soil vegetation model (HTSVS) that are to be integrated in the NCAR Community Climate System Model will be introduced. These modules among other things describe (1) the insulating effect of snow and its retardation of infiltration, achieved by the inclusion of an explicit snow layer, (2) the heat conduction and water diffusion (including the Richards-equation) within the soil as well as the cross-effects (Ludwig-Soret-effect and Dufour-effect) generally generated by soil moisture and temperature gradients as postulated by the linear thermodynamics of irreversible processes, (3) soil freezing and thawing and the related release and consumption of latent heat, (4) the effects of frozen soil layers on the vertical fluxes of heat and moisture, (5) water vapor fluxes within the soil, (6) water uptake by plants including a vertically variable root distribution, dependent on vegetation-type, (7) a variable ground water depth responding to the previous meteorological conditions. The general performance of the modules and preliminary results will be discussed.

B12A-0774 1330h POSTER

Spatial Variation in Regional CO_2 Exchange for the Kuparuk River Basin, Alaska Over the Summer Growing Season

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Here we describe the spatial and temporal patterns in CO_2 flux for the Kuparuk River Basin during the 1994-95 growing seasons derived from the Regional Arctic CO_2 Exchange Simulator (*RACES*), which uses satellite imagery to scale chamber and tower eddy covariance measurements of net ecosystem CO_2 exchange to the regional scale. CO_2 flux estimates derived from non-linear models were scaled to the Kuparuk Basin using a geographic information system database consisting of the Normalized Difference Vegetation Index (NDVI) maps and dynamic temperature and radiation layers. The spatial and temporal patterns in the NDVI during both growing seasons suggest that ecosystem development occurred 2-4 weeks earlier and was relatively more rapid in the southern portion of the Kuparuk River Basin. Similarly, rates of gross primary production (*GPP*) and whole-ecosystem respiration (R_e) were 2-4 fold higher in the southern basin than along the arctic coastal plain depending on time of year. While *GPP* and R_e showed strong latitudinal trends, spatial and temporal trends in net ecosystem CO_2 exchange (*NEE*) were much more variable. Thus, while rates of carbon gain and loss closely linked, small spatial and temporal differences in these large fluxes (*GPP* and/or R_e) lead to large variations in the regional pattern of *NEE*.

B12A-0775 1330h POSTER

Morphogenesis of Soils Associated With Frost Boils

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Frost boils are a kind of nonsorted circles commonly found in arctic and alpine regions. In early studies of the Northern Alaska Arctic Coastal Plain, frost boils were found more frequently on moist nonacidic tundra (MNT) than on moist acidic tundra (MAT). But a recent study indicates that frost boils are widespread on both land cover types. Although MNT has more frost boils with mineral soils exposed forming an easily recognizable circle that is generally free of vegetation (mud boils). Crossing the transition from MNT to MAT, there is increased vegetation cover on frost boils. In well-developed MAT, vegetation cover masks frost boils. Once the vegetation cover is removed, frost boils are clearly defined by ice ring ridges underneath the inter boil moss layer. These frost boils are active as indicated by chunks of cotton grass (Eriophorum vaginatum) in various stage of decomposition that are found frost churned in along the slopes of the ice ridges toward the upper permafrost. In the lower active layer and the upper permafrost there are concentrations of frost churned organic matter mixed with gleyed mineral horizons. Thus, frost boil process can be regarded as the controlling factor in the sequestration of surface produced organic matter through its incorporation into the upper permafrost for both MNT and MAT.

There are drainage differences due to micro relief across the frost boil sequence. In summer, the elevated center of the frost boil is moderately well drained as compared with the poorly drained inter boil due to its depression position. The active layer depth in the center of the frost boil is generally more than twice that of the inter boil, thus the permafrost table surface forms a nearly perfect bowl shape. The lower active layer has strongly developed reticular cryogenic structure. The upper permafrost is ice-rich, generally containing more than 65% ice (vol.) and has ataxitic cryogenic structure. The thickness of the ice-rich layers in the ridges beneath the inter boil area is much greater than that beneath the boil center. In addition, the cracks and the ice veins are parallel to the slope of the ice ridge. Although there are different theories regarding the initiation of frost boils and different factors are involved in frost boil self-organization, morphological evidence in the field suggests that the thick ice formation under the inter boil causes long-term heave of the frost boil and forms its shape.

B12A-0776 1330h POSTER

Temporal and spatial variability of microclimate and permafrost conditions in Fairbanks region, Alaska.

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Permafrost is a product of cold climate and environment. Its dynamics is strongly affected by changes in climatic characteristics such as: air temperatures, amplitudes of seasonal fluctuations of air temperatures and amount of precipitation. The purpose of this research is to reveal the temporal and spatial variability of microclimate and permafrost conditions in Fairbanks region, Alaska. Our research combines fieldwork, laboratory measurements, analysis and interpretation of data at several study sites in Fairbanks area. The study area is approximately 100x150 km around Fairbanks. All the sites belong to various landscapes with varying permafrost conditions, relief features, slope exposition to solar radiation and amount of precipitation (especially thickness of snow cover during the winter). There are several sites on which measurements were being hold for the period from 1 to 10 years. At study sites vertical temperature profiles in the air, ground surface, active layer and near-surface permafrost have been recorded at hourly intervals, using automatic data loggers. Measurements of snow cover thickness, density and snow surface temperature have been made at selected sites. Measurements and detailed sites descriptions have been made during visits of the sites to obtain information on the snow cover characteristics and the specific features of ground surface morphology and vegetation. Measured data were converted into daily, monthly and annual average temperatures. Depths of the active layer and amplitudes of seasonal variations of ground and air temperature were derived. The processed data were used to assess the effect of climate, especially air temperatures and snow cover characteristics (density and depth) and regional microclimatic factors, particularly vegetation, surface morphology and soil properties (soil composition, water content) on temperature field of the active layer and permafrost. On this basis it is possible to reveal the main factors that rule the permafrost conditions at each particular site. The obtained data will be used for calibration of a numerical model, and as an input data for the forecast of permafrost dynamics.

B12A-0777 1330h POSTER

Freezing Index as a Measure of Climate Change

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Global warming can be compared in several ways which give insight into magnitude and time extent. One measure of this involves the arctic thermal process of freezing measured by the freezing index or number of degree days below freezing.

Usual visualization of freezing index plotted linearly with time appears as a scatter of data giving difficultly with interpretation. One method developed uses freezing index accumulation as a deviation from the mean, which is a type of differentiation resulting in visible slopes or rates of change. These slopes give a reasonable visualization of warming or cooling trends as related to winter conditions. As opposed to ground temperature measurements, which tend to lag

actual weather, this method gives a more current look at ground temperature trends.

This presentation will discuss this method with application to Fairbanks, Alaska, weather over nearly a 100-year period. Factors affecting results will also be discussed.

B12A-0778 1330h POSTER

Biogeochemistry of Soils Associated With Cryptogamic Crusts on Frost Boils

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Active frost boils in the arctic are observed as circular-organized patterns of disturbed mineral soil at the surface. These features result from annual freeze-thaw cycles physically disrupting the surface soil and deterring the establishment of plants. As climate, microclimate, soil moisture and conditions for soil freeze cycling change, the intensity of physical disturbance changes and these circles of mineral soil can become vegetated. Soil cryptogamic crusts are often observed as the initial stage to revegetation of frost boil centers and persist in patches as revegetation proceeds. Biological, physical and chemical characteristics of surface mineral soils are altered with crust establishment. Influences of cryptogamic crusts on soil properties were studied across a latitudinal gradient in arctic Alaska from 70 to 68.5 degrees N (250 km). Within this latitude range, there is a transition of soil substrates from calcareous and nonacidic in the north to acidic in the south. Characteristics of surface soils from the center circle area of boils were examined at 6 sites across this transect. Soils of bare mineral areas were compared with those from adjacent cryptogamic crusts that were either lichen-moss or lichen-moss-forb cover mats.

Moving from north to south on the study transect, crusts differed with different soil mineral substrates and within study sites crusts differed with soil moisture. Dry boil centers whether nonacid or acid, developed lichen-moss-dryus (nonacid) or lichen-moss (acid) crusts with both having a liverwort component. Cyanobacteria crusts or mats were present on inter tussock areas with acid soil substrates. Biological activity associated with cryptogamic crusts increased soil organic C (OC), producing increased acidity at the surface of sites with nonacid substrates but moderating or buffering acidity of surface soils at sites with acidic substrates. Organic C increases in the crust are associated with increased nutrient holding capacity and available N, P and K as well as establishment of an organic pool of nutrients. Accumulations of OC on the centers of frost boils can result in translocation and sequestration of OC through the formation of organic enriched soil horizons (A-horizons) resulting from leaching and physical processes. Mixing of surface soil and OC results from annual frost heave cracking and from churning of the surface with fall needle-ice formation.

B12A-0779 1330h POSTER

The Moisture Migration of Active Layer in Permafrost Region near Wudaoliang of Tibetan Plateau

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Temperatures and volume moisture contents of active layer were monitored by the means of thermistors and Neutron Moisture Probe respectively in about 8 km south of Wudaoliang along Qinghai-Tibet Highway from 1997 to 1999. The result shows that the characteristics of moisture migration in active layer are quite different within the different stages of freezing-thawing cycle. In summer thawing period, moisture in the thawed layer above freezing front mainly migrates downwards driven by gravity, and which in the frozen layer below freezing front migrates downwards too driven mainly by temperature gradient. In Autumn freezing period, the active layer is freezing bi-directionally from the ground surface downwards and from the bottom of active layer upwards. Soil moisture migrates in contra directions with the freezing processes. The moisture content in unfrozen soils between the upper and lower freezing front was dehydrating during AF. During the winter season (winter cooling period and spring warming period, i.e., WC and SW), moisture migrated upwards driven by temperature gradient. Moisture content in the upper and middle parts of active layer, specially in the middle part, increases obviously.

B12A-0780 1330h POSTER

Methane in Upper Permafrost of Eastern Siberia: Sources and Significance

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Methane contribution to greenhouse effect is significant, so the production and concentrations of methane in great permafrost areas of Eurasia is in important respects analogous to the climate change forecast. Studies of the widespread methane should provide insight into the microbiological activity in permafrost. The total amount of methane trapped in permafrost is poorly studied; methane could disappear in unfrozen deposits, but not in ice-saturated soils. Gas samples were collected directly from upper permafrost of Lena river valley, Eastern Siberia. Frozen alluvial deposits in different landscapes were studied for methane and carbon dioxide content from the depths of up to 5 m. Ice wedges were also investigated. Measurements show different values; highest methane content was found in frozen mineral deposits (up to 6000 ppmv), but some soils almost do not contain methane. Ice wedges contain great amount of carbon dioxide. Ice wedges are presented by two categories: those with high methane content (generally, small wedges often with high mineral content) and those with almost no methane (ice wedges of big thickness). There was no correlation established between the methane content and depth. Average methane content in permafrost could be estimated as 0.05 0.5 ml/kg. Normally, icy permafrost contains more gas. In general, methane and carbon dioxide content increase with water content increase. The older the permafrost, the more methane it contains; this could be an indirect evidence of possible methane generation in the frozen state. Long-term experiments have shown that there is a slow production of methane in different frozen soils at -5°C. The change of methane content occurred according to logarithmical law in samples of modern soils from Alaska, Yakutsk and Hokkaido; the rates of methane production decrease in time, but methane could be produced in significant amounts in frozen soils, taking into account the age of permafrost.

B12A-0781 1330h POSTER

A Twenty Year Time Series of Permafrost Temperatures in Alaska

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There has been a widespread warming of air temperatures in Alaska since 1977 and some warming of permafrost. Constant or cooling permafrost temperatures followed this in the early 1980s, probably due to thin snow covers and a short cooling trend. Permafrost temperatures along a north south transect from Prudhoe Bay to Gulkana and at other sites have generally warmed since the late 1980s, initially in response to thicker snow covers. This warming north of the Brooks Range is comparable in magnitude (2 to 4 °C) to the century long warming there. The trend has not been followed at Eagle and the Yukon River bridge. Warming of the discontinuous permafrost is typically $\frac{1}{2}$ to 1 $\frac{1}{2}$°C. Thin discontinuous permafrost is thawing at the base at a rate of 0.04 m per year at one site. New thermokarst and thawing permafrost have been observed at several sites.

B12A-0782 1330h POSTER

Impact of Seasonal Snow Cover on Surface Heat Fluxes and Active Layer Thickness in the Alaskan Arctic

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The seasonal snow covers the ground surface up to nine months of a year on the Alaskan Arctic. Owing to its high albedo, low thermal conductivity and roughness length, snow cover differs considerably from the soil with respect to properties affecting the radiation budget (albedo) and the turbulent heat fluxes (roughness). The heat fluxes between the atmosphere and the ground also are strongly affected by the presence of snow cover. In this presentation, a surface energy balance approach based one-dimensional finite difference model for freezing and thawing processes and thermal regime of permafrost containing unfrozen water was developed and used to investigate the impact of seasonal snow cover on surface heat fluxes and thermal regime of permafrost. The basic inputs to the model are mean daily air temperature, dew point temperature, solar radiation reaching the snow cover surface (if snow cover is present) or ground surface (if snow cover is absent), wind speed, snow cover thickness, and atmospheric pressure measured at the NWS station, Barrow, Alaska during 1996-1998. A series of sensitivity simulations were conducted by varying snow density and snow thickness. Simulation results indicate that active layer thickness increases with snow thickness increases and decreases with snow density increases, snow surface temperature decreases with snow thickness increases and increases with snow density increases. Changes in snow thickness and snow density also have significant impact on the sensible, latent, and conductive heat fluxes.

B12A-0783 1330h POSTER

Structure and Carbon Distribution of Well- and Poorly-Drained Black Spruce Fire Chronosequences

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The objectives of this study were to: (1) examine structure changes along a boreal black spruce (*Picea mariana* (Mill.) BSP) fire chronosequence in northern Manitoba, Canada; (2) quantify temporal dynamics in C content across the chronosequence; and (3) compare the C distribution for these stands on contrasting soil drainages. The experimental design was a well-drained (dry) and poorly-drained (wet) black spruce fire chronosequences comprised of seven stands that burned between 1998 and 1870.

Tree species diversity was greater in the younger stands, and by 71 years after fire black spruce comprised >88% and 83% of total basal area for the dry and wet stands, respectively. Feather moss replaced sphagnum during succession in the dry stands, whereas there were no clear patterns in the wet chronosequence. Total vegetation C content (aboveground + belowground) increased with forest succession, ranging from 1.3 to 83.3 t C ha^{-1} for the dry stands and 0.6 to 37.4 t C ha^{-1} for the wet stands. Mean annual aboveground C accumulation rates (ΔC_A) peaked in the 71- and 36-year-old dry and wet stands, respectively. Overstory and live moss C contents increased with stand age. The total root : shoot ratio was fairly consistent (0.235 $\pm$ 0.046) after 37 years following fire. The basal area, vegetation C content, and ΔC_A were significantly greater (α = 0.05) in the dry than wet stands, but the C contents in bryophyte and forest floor were significantly less in the dry stands. Our results emphasize the need to incorporate disturbance and soil drainage in large-scale boreal forest C models.

B12A-0784 1330h POSTER

The Frozen Ground Data Center: New Data for the International Permafrost Community

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Permafrost and seasonally frozen ground regions occupy about 24 percent and 60 percent, respectively, of the exposed land surface in the Northern Hemisphere. Data and information on frozen ground collected over many decades and in the future are critical for fundamental process understanding, environmental change detection and impact assessment, model validation, and engineering application in seasonal frost and

permafrost regions. However, many of these data sets and information remain widely dispersed and relatively unavailable to the national and international science and engineering community, and some are in danger of being lost permanently.

The International Permafrost Association (IPA) has long recognized the inherent and lasting value of data and information and has worked to prioritize and assess permafrost data requirements and to identify critical data sets for scientific and engineering purposes. At the Seventh International Conference on Permafrost in 1998 in Yellowknife, Canada, the first Circumpolar Active-Layer Permafrost System (CAPS) CD-ROM was published and delivered to the Conference delegates.

To continue the IPA strategy for data and information management and to meet the requirements by cold regions science, engineering, and modeling community, the World Data Center (WDC) for Glaciology, Boulder in collaboration with the International Arctic Research Center (IARC) has initiated a new Frozen Ground Data Center (FGDC) as a key node in the IPAs Global Geocryological Data (GGD) system. The FGDC has expanded access to the 1998 CAPS data, is expanding data holdings, and is creating a new version of the CD to be distributed at the July 2003 IPA conference in Zurich.

The FGDC has improved access to existing data through an online search and order system and availability in the Global Change Master Directory. The FGDC has also expanded and updated current holdings with global and regional permafrost, soil temperature, and soil classification maps in a variety of grids and data formats especially geared to aid the permafrost modeling community. The FGDC is working closely with the IPAs Global Terrestrial Network for Permafrost (GTN-P) and its Circumpolar Active Layer Monitoring program to expand and update our data holdings as part of the GGD. We have also continued to update our online permafrost bibliography. We plan to continue acquiring data for the GGD and to produce value-added products such as gridded fields for model validation and analysis.

Identification of additional data and information from all participating countries, organizations, and individuals are requested. The IPA Standing Committee on Data, Information and Communication will continue to coordinate the GGD and CAPS activities. Suggestions on data acquisition, management and distribution are always welcome and encouraged.

URL: http://nsidc.org/frozenground

B12A-0785 1330h POSTER

Fusion of Radarsat SAR interferograms with Other Image and Geological Data Sets to Establish Temporal, Spatial and Physical behaviors of the Active Layer at Sagwon, Alaska

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Regional variations in ground surface parameters are seen, and inferred to be due to areas of differential frost heave, through the application differential interferometric techniques (DINSAR) to Interferometric Synthetic Aperture Radar (SAR) images centered around Sagwon in Alaska's north slope, from scenes covering a two year period from Jan 2000 to March 2002.

Interpretation of the radar images is not straightforward so, several techniques are employed to assist in the interpretation. 1) Comparison with existing surficial geology maps, 2) Time series analysis of the radar dataset using Empirical Orthogonal Function analysis (a temporal equivalent of Principle Component analysis), and 3) Data Fusion between the Radar scenes and optical data sets, and principle component analysis of the Optical data sets.

Comparison with existing surficial geological maps and analysis of radar backscatter images gives an indication of the amount of surface moisture, and its distribution. This correlates with areas of frost heave, wetter area's experiencing a greater degree of heaving. Analysis of the DINSAR images indicates frost heave distribution and shows its susceptibility to the ground lithology, areas such as abandoned riverbeds show less in the way of heave, and active riverbeds and bare rock do not frost heave. The analysis of coherence between radar scenes allows a delineation of area's of acidic tundra, and non acidic tundra.

Optical datasets, from the MODIS and ASTER satellites are also examined to constrain the effects of weather and other shorter-term weather factors. Principle component analysis was performed on individual datasets, which gives an independent (from the radar data set) estimation of area's of acidic and non acidic tundra, and surficial geology.

The combined data set improves characterization of the temporal, spatial and physical behaviors of the active layer in the region.

B12A-0786 1330h POSTER

Thermal Properties of Alaskan North Slope Soils.

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Climatic processes important to permafrost formation, maintenance and degradation have an annual to millennial timescale. The thin active layer, vegetation and snow above the permafrost can exert considerable influence on permafrost stability and react more rapidly than permafrost to climatic shifts. The thermal properties of this layer are thus important for the interpretation of permafrost data. We seek to predict bulk properties of a porous multiphase media based on state variables, bulk material properties and spatial phase densities. In this study, our objectives are: 1) to test thermal diffusivity probes in the field for the assessment of phase density, in particular of volumetric ice content and 2) to corroborate field studies with laboratory determinations of phase density and thermal diffusivity.

We measure thermal properties and phase densities of a range of soils from the Alaskan North Slope, including high organic content and fine-grained mineral soils. Liquid water content is measured using time domain reflectometry to constrain the composition of the multiphase soil. Additional measurements of the soil's state are made using thermistors, heat flux plates and radial heat dissipation probes. The latter are thin films with embedded heat pulse wire and thermopiles to measure the radial thermal gradient response to temperature change. We report changes in thermal conductivity and diffusivity during freezing and thawing, and at different moisture contents and temperatures. The results for thermal conductivity and diffusivity as a function of phase density under field conditions are compared to those measured in the lab and to those calculated using empirical models.

B12A-0787 1330h POSTER

Interactions Among Permafrost, Fire Disturbance, and Moss Cover Near Delta Junction, Alaska

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Near-surface permafrost plays a key role in carbon cycling because of its influence on soil temperature and moisture and their controls on decomposition, fire severity, rooting depth, and moss cover. In sites that are stratified by stand age and presence/absence of permafrost, we measured areal coverage and net primary production (NPP) of 6 dominant moss types. These sites near Delta Junction did not include significant amounts of Sphagnum, perhaps owing to low precipitation or high dust influx. We found that moss cover and cover-weighted moss NPP increased with stand age, but that rates of moss recovery after burning were not statistically different for our permafrost and non-permafrost sites. Total moss NPP ranges from 1 to 40 g OM per square meter over the 140 yr fire sequence, which is consistent with estimates for similar climatic zones. Total moss cover increases with stand age, from 1% to 90% in 140 years. Total moss cover also increases with organic matter thickness. While postburn dead moss and litter layers accumulate after fire, preburn organic layers vary according to fire severity and site history. Therefore stand age and fire severity both play a role in variations we find in live moss cover and moss NPP within the boreal forest.

B12A-0788 1330h POSTER

Modeling of spectral characteristics of post-fire forest floors in east Siberian taiga for satellite data interpretation

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The relationship between boreal forest and global climate is an important issue today. East Siberian taiga ecosystem can be characterized as an occurrence of permafrost that has become unstable in warming environment after the Last Glacial Maximum. A Recent increase of Siberian forest fire induces permafrost degradation and forest destruction where forest recovery is prevented by salt accumulation or by changes of the ground thermal regime. Positive feedback effects of boreal forest destruction especially east Siberian taiga on global warming have been pointed out, and further investigations on the relationship between boreal forest and global climate are requested. Remote sensing technique is necessary as a tool for monitoring boreal forest functions and changes including forest fire influences. There are many radiative transfer models of vegetation canopies. On the contrary, field measurements of spectrum of boreal forest elements were shown only in studies in BOREAS Project in Canada and others. This is one of the reasons why we can hardly apply radiative transfer models to interpret satellite data. In this research, we measured spectral characteristics of forest floors of matured*Larix cajanderi*, matured *Pinus sylvestris* and nineteen years*Betula papyrifera* communities and a grassland that passed six years after the last forest fire in east Siberian taiga zone and constructed a forest floor model as a submodel of a radiative transfer model of east Siberian forest for satellite data interpretation.

B12A-0789 1330h POSTER

Mitigation of Drought Limitation in Photosynthesis of Larix gmelinii Saplings by Clear-cutting in East-Siberian Taiga

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Although Larix gmelinii forest ecosystem on permafrost is frequently disturbed by human activity like logging, regeneration system is not developed because of little understanding of the eco-physiological process. In the east-Siberian ecosystem, water cycle plays an important role in the regeneration, namely the annual precipitation is only 200-250mm approximately, and the melting of permafrost after the logging changes forest to wet land called as Alas where regeneration of tree is impossible. Thus we focus the drought stress in CO2 assimilation rate in the regenerated L. gmelinii sapling under canopy, and the effects of clear-cutting. In order to evaluate the drought limitation in the CO2 assimilation rate, in this study, irrigation treatment was conduced for 10 days in understory and clear-cut area. The clear-cutting was carried out in 2000, and this experiment was carried out in 2002. The light saturated CO2 assimilation rate (Amax) was measured in the morning and the afternoon. Volumetric soil moisture content at the 15 cm of the depth was approximately 10% under canopy and 30% in clear-cut area. The midday depression of Amax was larger in understory than that in clear-cut area, especially the understoried Amax was near 0 μmol m-2 s-1. During the irrigation treatment, i.e. 10 days, the volumetric soil moisture content was kept over 30% in the both areas. After the irrigation, the Amax increased to 3.2-fold in understoried and 1.3-fold in clear-cut area in morning. The Amax in afternoon increased to 50-fold in understory and 2.5-fold in clear-cut area after the irrigation. Thus the drought

limitation of Amax was larger in understory than clear-cutting area. These results suggest that (1) drought stress is major factor to limit the CO2 assimilation of the regenerated L. gmelinii saplings under canopy, and (2) clear-cutting mitigates the drought limitation in the CO2 assimilation rate during the early stage of the disturbance of clear-cutting.

B12A-0790 1330h POSTER

Midday Depression of CO2 Assimilation Rate during Summer within a Larix gmelinii Canopy on Permafrost in Eastern Siberia

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Synthesis of carbon cycle in east-Siberian Larix forest on permafrost is less understood, although the forest ecosystem plays an important role for carbon storage, and the ecosystem is predicted to be sensitive to global warming. In this study, midday depression of CO2 assimilation rate within a canopy is focused as a limiting process of the carbon uptake in Larix gmelinii forest. Our objectives are (1) to confirm strong midday depression of CO2 assimilation rate in July as a previous study, and (2) to understand the environmental factors to limit the CO2 assimilation rate. According to the experiments by intact method, the midday depression started after 9:00 approximately. After 14:00, the CO2 assimilation rate decreased to below approximately 10% of the maximum, at that time, leaf temperature was 25 to 30°C and leaf to air water vapor pressure deficit (VpdL) was 3 kPa. The tendency of the midday depression was similar between dominance (20 to 19 m tree height) and co-dominance (19 to 18.5 m tree height). According to the experiments by detached method, the CO2 assimilation rate decreased to approximately 80% of the maximum at 30°C of leaf temperature, humid air condition (VpdL = 1-2 kPa), light saturated condition (PPFD > 1000 μmol m-2 s-1, ambient CO2 concentration and adequate water supply. Furthermore, the CO2 assimilation rate decreased to 80% of the maximum when VpdL increased from 1 to 3 kPa at 30°C. Thus the high temperature and the high VpdL conditions decrease the CO2 assimilation rate to approximately 64% of the maximum. In order to examine an effect of the long duration of high temperature and high VpdL, the CO2 assimilation rate was measured for 5 hours at 30°C and 3 kPa conditions. The CO2 assimilation rate decreased to 83% of the maximum after the 5 hours treatments. Thus the influence of 30°C, 3 kPa and their long duration decreased the CO2 assimilation rate to approximately 50% of the maximum. In conclusion, the midday depression of CO2 assimilation rate is major factor limits the CO2 uptake within the canopy. The half contribution in the midday depression of CO2 assimilation rate is high temperature, dry air conditions and their long duration.

B12A-0791 1330h POSTER

Climate on Abnormal Occurrence of Wildland Fires in Siberia and Mongolia

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A great many wildland fires occurred in Siberia and Mongolia in 2002. Especially in Mongolia, the Prime Minister declared that the whole area should ready for civil defense to assist fighting the wildfires from August 16. Generally speaking, the wildfires are caused by extreme hot and dry conditions, but few analyzed climatic data can be found as the reason. Then we began to analyze climatic data compiled by National Climatic Data Center. For example, in Ulaanbaatar, the capital of Mongolia, it rained only 10mm (it rains 68mm in normal years) in July, 2002; the monthly mean temperature was 21.7 degreeC (the average is 17.7 degreeC). We can see the similar phenomenon was happened in 1998 recently, and we suspect that it will occur once in some years. The authors investigate the causes of the many wildland fires from the extreme climatic factors: such as hotter temperature, less rainfall, drier humidity, and so on. We also analyze the synoptic distribution of the atmospheric pressure, wind speed and wind direction calculated by ECMWF. At first, the climate average synoptic charts were made with each factor. After that, we are trying the comprehensive analysis. A lot of wildland fires occurred abnormally last summer, and the main reason will be assigned by the monthly climate. Now we are analyzing further by daily meteorological data.

B12A-0792 1330h POSTER

The Controversy Over Economic Development Within The Arctic National Wildlife Refuge (ANWR)

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In the future the demand for oil and gas will increase. Development within ANWR is a real possibility and any potential economic expansion should be executed in a manner that leaves the least impact on the overall ecosystem. In 1960, 8.9 million acres (3.6 million hectares) of pristine wilderness located in NE Alaska was set aside as one of Americas largest refuge areas the Arctic Wildlife Range, later renamed the Arctic National Wildlife Refuge (ANWR). The coastal plain portion of ANWR was excluded from wilderness designation so that economic development, specifically oil and gas, could be considered. More than 20 years later, economic development in the refuge area continues to be hotly debated. The nearby Prudhoe Bay oil field is located on the northern fringe of the arctic coastal plain and has produced billions of barrels of oil since the 1970s. Research has shown that the wildlife population adapted and continues to co-exist with the industrial development. What are the real implications of drilling in this fragile region? The key to understanding the consequences of commercial development is to identify all of the facts, opinions and related issues. All viewpoints need to be considered, but these need to be based on science and all available data, and not dictated by extreme points of view. Attention must be given to changing cultural mores, societal needs and the prevailing political climate at the time. In the future, when there is a perceived shortage of oil, the pressure to explore for hydrocarbons will increase, and the top priority will be to ensure that the environmental footprint is minimized.

B12A-0793 1330h POSTER

Simulated Soil Moisture Dynamics and Hydrologic Processes in Discontinuous Permafrost

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The soil moisture regime in the sub-arctic environment plays an important role in a number of processes related to climate change including soil respiration, permafrost distribution, and the frequency and severity of wildfires. In order to understand and predict ecosystem response to a changing climate and resulting feedbacks, it is critical to quantify the interaction of soil moisture and meteorology as a function of climatic processes, landscape type, and vegetation.

The primary of goal of our research is to develop/modify a numerical model, which is able to describe, simulate, and predict soil moisture dynamics and all other hydrologic processes everywhere throughout a sub-arctic watershed. This model will be used as a tool to better understand the effects of vegetation and soil type, presence of permafrost, amount and timing of precipitation, and disturbance (such as wildfire) on soil moisture dynamics. The area selected for this research is the Caribou-Poker Creeks Research Watershed (CPCRW), located 48 km north of Fairbanks, Alaska (65°10'N, 147°30'W) and encompasses and area of 101.5 km^2. Permafrost in CPCRW is discontinuous, generally found along north facing slopes and valley bottoms. Three small sub-basins of CPCRW, which are underlain with approximately 3, 19, and 53% permafrost, are simulated to explore differences in permafrost vs. non-permafrost dominated areas.

The Arctic Hydrological and Thermal Process Model (ARHYTHM) is a process based, physically distributed numeric model will be modified to simulate the hydrologic processes throughout a watershed underlain by discontinuous permafrost. The model can be used as a tool to simulate spatially distributed processes, such as soil moisture dynamics or snowmelt, as well as point measurements such as streamflow at any point within the model domain. ARHYTHM was developed to simulate energy and mass transfer processes in the Alaskan arctic regions. Modifications made to the ARHYTHM model will be made to reflect the differences between the sub-arctic and arctic environments. Changes to the model will include the representation of discontinuous permafrost, distributed vegetation types, and the incorporation of a deep groundwater component. The model domain is based upon a 100-meter digital elevation model (DEM) that encompasses CPCRW. Parameters such as soil type and depth, vegetation type, and permafrost distribution (as well as their hydrologic properties) will be spatially distributed throughout the model domain. Meteorologic data (radiation components, relative humidity, air and ground temperature, precipitation, and wind speed) are used to drive the model. This paper will present up-to-date results of this on-going research.

B12A-0794 1330h POSTER

Modeling Runoff in Basins Containing Continuous and Discontinuous Permafrost, Seward Peninsula, Alaska

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Preliminary runoff modeling results are presented for four basins on the Seward Peninsula. Mauze Gulch (4.9 km^2), and Niagara Creek (6.5 km^2), located near Kougarok, Alaska and Melsing Creek (80 km^2), and Clydes Gulch (0.7 km^2), located near Council, Alaska. These watersheds have been studied extensively as part of the NSF Arctic Transitions in the Land-Atmosphere System (ATLAS) study. These watersheds demonstrate a progression from a continental subarctic to a marine moderated subarctic environment. Each contain varying proportions of permafrost. Mauze Gulch and Niagara Creek are underlain by continuous, warm, thin permafrost (~15 m thick). A significant difference between the two watersheds near Kougarok is that Niagara Creek has been disturbed by a recent tundra fire (1997), potentially having an impact on the thickness of the active layer. Melsing Creek and Clydes Gulch are underlain by discontinuous permafrost. Clydes Gulch is fed by a small spring and it flows into Melsing Creek. Melsing Creek has several springs that contribute to flow.

The Swedish HBV model was applied to these watersheds due to its simplicity and repeated success simulating stream discharge in arctic regions. The model requires minimal input of meteorological data (temperature and precipitation) to simulate accurate hydrographs. Two consecutive years of data were used to calibrate the model and a third year was used to independently test it. Snow water-equivalent, potential evaporation and stream discharge are also used to calibrate the model. Frozen ground can be represented in the model by defining the subsurface layers in the model. By changing parameters, such as field capacity and the thickness of layers representing permafrost, we would expect to quantify the physical differences between watersheds. Preliminary runs of the model have produced reasonable agreement between measured and simulated hydrographs. Modeling watersheds across a climatic gradient to see if model parameters relate to physical differences will help us better understand the impacts a warming climate may have on hydrological systems.

B12A-0795 1330h POSTER

JERS-1 SAR Mosaics of the North American Boreal Forests

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The National Space Development Agency of Japan (NASDA) initiated the Global Boreal Forest Mapping (GBFM) project in the mid-1990s, in collaboration with NASAs Jet Propulsion Laboratory (JPL), the European Commissions Joint Research Center (JRC), the Alaska SAR Facility (ASF), and a team of investigators from around the world. The objective of this project was to use the Japanese Earth Resources Satellite (JERS-1) Synthetic Aperture Radar (SAR) to image at high resolution the Earths Boreal forests. Since SAR can obtain imagery independent of solar illumination and cloud conditions, it was possible to image these regions during the winter, as well as the summer.

Within the receiving station mask of ASF (which covers Alaska and much of Western Canada), particularly good temporal diversity was obtained since direct downlinks to ASF were possible. Outside of the ASF mask the data were recorded and then retransmitted later to receiving stations, which limited the data acquisitions. However, it was still possible to produce winter and summer mosaics of most of boreal North America (within three month temporal windows).

The mosaics were produced at 100 m resolution, and are sensitive to land cover structural and moisture properties including forest structure, freeze/thaw state, and forest inundation. The methods used to mosaic the imagery were also used for mapping South America in the Global Rain Forest Mapping (GRFM) project, and similar to techniques applied by the NASA Shuttle Radar Topography Mission (STRM).

Mosaicking and co-registering the North American data set were particularly difficult due to the large number of scenes (14,000), the large geo-location corrections that were required, and the convergence of the image swaths at the far northern latitudes. The mosaics will be distributed freely on DVD media for scientific and educational purposes. The techniques developed for this task will be useful for mosaicking imagery from the SAR on-board the NASDA Advanced Land Observing Satellite (ALOS), scheduled for launch in mid-2004.

The research described in this publication was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

B12A-0796 1330h POSTER

Mapping Wetlands of Alaska and Western Canada from Satellite Radar Imagery

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Boreal wetlands have an important function in processing methane, carbon dioxide, nitrogen, and sulfur as well as in sequestering carbon. The type and extent of high latitude wetlands are important indicators of methane source areas, while upland forests in the taiga are important methane-consuming sinks. Wetlands regulate biogeochemical processes such as methane production, and fix and store organic matter in the long run. The extent and complexity of wetland ecosystems are still quite uncertain partly because it is difficult to discriminate wetlands on a global scale using widely available optical remote sensing data and techniques, which are not able to detect standing water conditions under most vegetation. The accurate assessment of areal and temporal distributions of wetlands can have a large impact in improving the estimates of the global net carbon exchange. Synthetic Aperture Radar (SAR) sensors are well suited to monitoring wetlands because of their ability to detect various combinations of standing water and vegetation structure and moisture conditions. SARs also penetrate cloud cover and do not require solar illumination, allowing the collection of frequent seasonal data.

Multifrequency, multipolarization SAR data needed to classify various wetlands types have been available for several years from airborne systems. Although existing spaceborne SAR data are limited to single frequency and single polarization configurations, combining data from different SAR satellites can emulate a space-based multifrequency multipolarization capability. No large-scale wetlands mapping efforts have been carried out thus far due unavailability of appropriate SAR data sets. However, with the recent availability of the JERS-1 north American boreal mosaic augmented by the partial ERS-2 overlapping data, it is now possible to generate maps of wetland extent, as well as set the stage for performing time-series analysis with future planned SAR satellite systems.

We present a first-ever large-scale wetlands map covering Alaska and western Canada, generated using a classification algorithm applied to coregistered JERS-1 (L-band HH polarization) and ERS-2 (C-band VV polarization) SAR mosaics. The former exists for almost the entire area of Alaska and Canada, whereas currently we have access to the latter only for Alaska and Western Canada. The classification method is based on a rule-based decision-tree algorithm, and recognizes five wetland classes of fens, bogs, swamps, marshes, and open water. These classes are defined based on distinctive abiotic parameters such as hydrology, water chemistry, or mineral material, which interact with the biota to form characteristic vegetation cover, and in some classes, peat. This wetlands product is compared to existing local-scale maps to the extent currently possible. More extensive validations are planned in cooperation with various wetlands research groups. We are also working towards producing the wetlands map of the remainder (eastern part) of Canada as more C-band satellite SAR data are assembled for that region.

This work was performed in part at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

B12A-0797 1330h POSTER

Fire severity impacts trajectories of vegetative regrowth and δ^{13}C in organic pools and fluxes in Siberian/Alaskan forests

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Stable carbon isotope ratios of carbon dioxide and leaf organic matter were measured in boreal forests of varying age and fire severity in Siberia and Alaska. This study focused on moderate and extreme severity burn sites in neighboring Alaskan forests ranging from 2 years to 160 years and Siberian forests ranging from 1 year to 200 years. The Alaskan forests were composed primarily of black spruce (*Picea Mariana*) and quaking aspen (*Populus tremuloides*) with a shift in species dominance from aspen to spruce approximately 50 years after fire disturbance. The Siberian forests were composed of Dahurian larch (*Larix gmelinii*). The understory species are the same in both Siberia and Alaska: dwarf birch (*Betula nana*), willow (*Salix alaxensis*), blueberry (*Vaccinium ovalifolium*), cranberry (*Vaccinium vitis-idaea*), and various moss and lichen species. Our aim was to determine how disturbance influenced local and regional carbon isotopic ratios in organic pools and fluxes. Samples of organic δ^{13}C in whole leaf tissue were collected from the dominant species of each forest. $\delta^{13}CO_2$ and $[CO_2]$ were measured on soil cuvette- and canopy-CO_2 to determine the isotopic ratio of soil and ecosystem respiration, respectively. Plant functional type primarily controlled the organic δ^{13}C composition, and changes in abundance of different plant functional types with time since fire lead to patterns of ^{13}C-enrichment with increased forest age. Successional stage and species composition trajectory dictated the composition of heterotrophic respiration with more ^{13}C-enriched values found in dry/cold coniferous areas. Burn severity and successional state largely determined the distribution and abundance of plant functional types which dictated the δ^{13}C values of organic pools and fluxes in the ecosystems. These results suggest that fire severity and frequency changes the carbon isotope composition of ecosystems and biosphere-atmosphere fluxes in ways that are predictable at local and regional scales by changing species composition and regrowth patterns.

B12A-0798 1330h POSTER

Permafrost in the Fox Permafrost Tunnel

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Geology, engineering geology, and paleo-geography of the Fox permafrost tunnel have been thoroughly studied (Sellmann, 1967, 1972; Hamilton and others, 1988, Huang, 1985, Johansen and others 1981, 1982,). Permafrost specific information from previous studies is very limited and controversial. We applied 3D mapping and a cryo-facial analysis to identify genesis and structure of permafrost and distinguish between original syngenetic permafrost and later alternations of soil and massive ice. By mapping the tunnel in a 3D framework, features which occur on both walls of the tunnel and at its ceiling can be connected. For example, ice wedge continuity can be seen along with the nature of their disruption patterns. Mapping is particularly useful for determining the history of syngenetic ice-wedges modification, which show most visually the timing patterns and nature of the events that transpired in modification of the original permafrost conditions. Main principals of the cryo-facial analysis (Katasonov, 1960) are based on dependence of shape and size of ice inclusions in permafrost on facial type of soil and consequently on morphological conditions in which soil was deposited and frozen such floodplain, slope, etc. Quaternary permafrost deposits have different ice content depending on its genesis and facial type. We analyzed the permafrost cryogenic structure and soil water content to distinguish between original syngetetic permafrost and soil altered later.

In previous studies two layers of silt with a subhorizontal thermal unconformity between them and two types of massive ice (ice-wedges and buried ice) have been identified. Our study contradicts to such descriptions. Ice, which was described previously as buried pond or aufeis, we identified as thermokarst-cave ice, which was formed inside permafrost in channels made by running water. Such thermokarst caves occur mainly in ice-wedges and seldom in ice-rich soil. Both situations take place in the Fox permafrost tunnel. The thermokarst-cave ice is often confused with ice of different genesis.

There is no a thermal unconformity boundary which is parallel to soil surface. The permafrost exposed in the tunnel was greatly altered by destruction of ice-wedges and their surroundings with formation of ice-wedge casts (pseudomorphs). Instead of one subhorizontal thermal unconformity, we found numerous sub-vertical unconformities. A few ice-wedges exposed in the walls of the tunnel continue through the tunnel ceiling, whereas the others ice-wedges were partly or completely destroyed and replaced by pseudomorphs. Some pseudomorphs can be easily recognized from surrounding soil by difference in material. In case of same material, a pseudomorph can be distinguished from surrounding soil by difference in cryogenic structures and properties.

Our classification of pseudomorphs is based on soil in ice-wedge cast and surrounding soil The classification includes following types: gravel in gravel, silt in gravel, gravel in silt, silt in silt, ice in silt, silt in ice and complex: gravel and silt in silt, ice and silt in silt. An ice in silt pseudomorph would be formed when ice-wedge is replaced by thermokarst cave ice. Existing ice-wedges do not penetrate into gravel, but several pseudomorphs in gravel have been found.

Comprehensive description of permafrost and restoration of the permafrost history at the tunnel require more detailed investigations. Our study has been partly funded by the University of Alaska EPSCOR program.

B12A-0799 1330h POSTER

Response Characteristics of Dissolved Organic Carbon Flushing in a Subarctic Alpine Catchment

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Dissolved organic carbon (DOC) is an important part of ecosystem-scale carbon balances and in the transport of contaminants as it interacts with other dissolved substances including trace metals. It also can be used as a surrogate hydrological tracer in permafrost regions as near-surface waters are often DOC enriched due to the presence of thick organic soils. In a small subarctic alpine catchment within the Wolf Creek Research Basin, Yukon, Canada, DOC was studied in the summer of 2001 and spring of 2002 to determine the role frost (both permanent and seasonal), snowmelt and summer storms on DOC flushing. Peak DOC concentrations occurred during the snowmelt period, approximately one week prior to peak discharge. However, peak discharge took place several weeks after snow on south facing exposures had melted. Within the hillslopes, DOC concentrations were three to five times greater in wells underlain with permafrost compared with seasonal frost. Groundwater DOC concentrations declined during snowmelt, yet remained at levels above the streamflow. After peaking, streamflow DOC concentrations declined exponentially suggesting a simple

flushing mechanism, however there did not appear to be a relation between DOC and topographic position. Following melt, permafrost underlain slopes had near-surface water tables and retained elevated levels of DOC, whereas slopes without permafrost had rapidly declining water tables at upslope locations with low DOC concentrations at all positions except near-stream riparian zones. The influence of summer rainstorms on DOC was monitored on three occasions. In each case DOC peaked on the ascending limb of the runoff hydrograph and declined exponentially on the receding limb and hysteretic behavior occurred between discharge and DOC during all events. Patterns of DOC within the hillslopes and streams suggest that runoff from permafrost-underlain slopes control DOC flushing within the stream during both snowmelt and summer periods. This flushing mechanism conforms with conceptual models of runoff generation in discontinuous permafrost catchments whereby water tables within permafrost-underlain slopes rise into porous organic-layers, whereupon DOC is leached into the water and rapidly conveyed to the stream.

B12A-0800 1330h POSTER

3D Numerical Simulation of the Geothermal Field of Permafrost at Salluit in Nunavik, Québec, in Response to Climate Warming. Research in Progress.

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The village of Salluit is located in the continuous permafrost zone in Nunavik, Québec. This Inuit community of about 1100 people is characterized by a fast population growth. The village lies in the bottom of a restricted valley flanked by steep rock walls. Most village infrastructures are built on frozen saline and ice-rich marine silts creating problematic ground conditions for infrastructures construction. For satisfying the fast population growth, a housing program is in progress but the available terrain with proper ground conditions for stable foundation is scarce and little is known on the permafrost conditions in the valley.

During the construction of the airport of Salluit, a thermistor cable has been permanently buried in a rock outcrop. Regular temperature measurements have been carried out from 1987 and 1994, and from 2001 until now. During the first measurement interval, the permafrost temperature decreased steadily from -8 to -8.5 °C at a depth of 8 m. According to Environment Canada, the climate in that region of Canada was slowly cooling. However, this trend was reversed around 1997-1998 and some important warming recently occurred. In August 2001, the temperature measurements showed an increase of about 1.9 °C at the same depth. Moreover, a major active layer detachment failure occurred in the valley uphill in 1998 forcing the moving of twenty houses recently built. This landslide was probably triggered by the climate warming. Proper assessment of available terrain for the village expansion is therefore a major concern for the Inuit community of Salluit.

Following the request of the provincial government, a thorough study for mapping the permafrost conditions and assessing the impacts of climate warming on permafrost conditions has been undertaken in 2002. The surveys carried out included deep sampling of permafrost, seismic reflection and ground penetrating radar profiling, and surface mapping supported by a detailed photo interpretation. The survey aims at providing information on the geological and geotechnical characteristics of permafrost. Thermistor cables in deep boreholes, meteorological stations, dataloggers for the measurement of surface temperature, and thermal probes have been also installed in the valley. Air photographs will be used to produce a digital terrain model of the valley. This integrated multi-technique approach is essential for properly assessing the permafrost conditions in the valley.

The study will provide the data needed for the development of a 3D model of permafrost conditions in the valley. A 3D numerical simulation of the geothermal field of permafrost in the valley will be then undertaken. This simulation is a major challenge giving the size of the thermal field and the variability in permafrost conditions. The impacts of climate warming on the thermal field of permafrost will be simulated and predicted by forcing the surface temperature to increase following different scenarios of climate warming.

It is planned to combine the geotechnical properties and the simulation of the geothermal field of permafrost in order to define threshold values of permafrost strength and slope instability and set a prewarning scheme of permafrost temperature in case of further warming in the coming years. The monitoring of permafrost temperature will be continued in the future. If the scheme is reached, actions can be then undertaken to mitigate the impacts of climate warming on the infrastructures and protect the population of Salluit.

B12A-0801 1330h POSTER

The Thermal Regime of Steep Alpine Rock Faces

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Disturbances in the sub-surface temperature distribution of perennially frozen rock faces can affect their stability due to the destabilization of ice-filled rock-joints close to 0 degrees Celsius and changing ground water systems. These thermal and possibly geotechnical alterations can be induced by glacier retreat and climatic change on a time scale of years to decades. As an immediate response, a thickening active layer will affect shallow depths, while a long term adjustment and a rise of the permafrost base will affect depths of several meters to 10s or 100s of meters. For research as well as the assessments of potential geotechnical hazards, knowledge on the spatial distribution and thermal characteristics of affected rock walls as well as corresponding modelling tools are needed.

In 2001, more than 20 data loggers have been placed in near-vertical Alpine rock faces to record near-surface rock temperatures at differently exposed sites between 2000 and 4500 m a.s.l. As surface temperatures largely govern the temperature distribution at depth, this is sufficient as a database for spatial models. The absence of snow cover and the direct coupling of atmosphere and subsurface without a mixed-media active layer is expected to provide a good predictability as compared to existing models (statistical and energy balance) employed on more moderate surfaces. Mean annual air temperature together with direct short-wave solar radiation can explain much of the spatial variability observed in mean annual (near-) surface temperatures.

First results from the recent data set obtained in the autumn of 2002 are presented together with a case study on large rock-fall events.

B12A-0802 1330h POSTER

Carbon and Nitrogen Storage in Aboveground Biomass and Organic Layer in Natural Larix Stands in Eastern Siberia

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To evaluate the carbon storage capacity of natural Larix stands in eastern Siberia, aboveground biomass, carbon and nitrogen storage in the biomass and organic layer of soil, and net primary production (NPP) were estimated in relation to stand age. Stands studied were from young to mature growth stage. The aboveground biomass and carbon storage in the biomass increased sigmoidally with stand age. The asymptotes of the biomass and carbon storage were 104 t· ha-1 and 52 tC· ha-1, respectively. The carbon storage capacity of the aboveground biomass was considered not to be small depending on the long period during which a large biomass close to the asymptote is retained, while the annual increment of the biomass is small. Also, carbon sink efficiency of the biomass changed with stand age. NPP of the stands was small comparing with those of temperate and boreal stands. Estimated net ecosystem production was positive even in a mature stand. Siberian Larix stands studied were carbon sink irrespective of stand age. The carbon storage in organic layer of soil accounted for 80-100 % of that in the aboveground biomass and was a significant carbon sink. Nitrogen was considered as a limited nutrient for the production of the stands from its allocation pattern to aboveground tree organs and storage pattern in soil. Furthermore, the decomposition rate of litter was small and affects the accumulation of organic materials.

B12A-0803 1330h POSTER

Unprecedented Occurrence of Wildland Fires Near Yakutsk (East Siberia) in 2002

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In 2002, a large number of wildland fires occurred near Yakutsk, the eastern part of the Russian Federation. Wildland fires started from early May, 2002 and continued even into September. The number and burnt area of the wildland fires were appears very big and they will become historical records. The authors approach an investigation of the causesfrom various angles to establish the causes of the abnormal wildland fires in 2002. Weather conditions such as temperature, rainfall, humidity, wind direction and so on were analyzed by comparingaverage values. Daily satellite images for the area around Yakutsk were processed to show how the wildland fires spread in the Yakutsk wildland region. The first author joined a Japanese field research team (CREST) and investigated vegetation near Yakutsk. Combustible materials of wildland near Yakutsk were collected and analyzed. The amount of fuels such as small twigs, fallen leaves and so on wasmeasured in several different kinds forests. The wildland fires were also observed from helicopter. The results of this comprehensive analysis show how the wildland fires near Yakutsk in 2002 were abnormal. The fire phenomenon at Yakutsk in 2002 may becaused by the ongoing so-called global warming.

B12A-0804 1330h POSTER

Correlation of Changing Annual Air and Permafrost Temperatures in Northern Alaska

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Temperatures, generally taken on a weekly basis, were obtained to depths of as much as 30 meters into the permafrost in the vicinity of Barrow, Alaska during the 1950s. The sites studied had different surface covers, including well-drained gravels, well-drained and vegetated polygonal areas, marshlands and a recently-drained shallow lake bed, all having similar air temperatures, summer precipitation and wind conditions. Permafrost temperatures also were obtained during the early 1980s, to depths as great as 700 meters, on the coastal plain of northern Alaska.

Weather Bureau records for Barrow indicate an overall minor warming in air temperatures from 1924 to 2001, broken into a period of warming between 1924 and 1950, a cooling period from 1950 to 1975 and warming again from 1975 to 2000, with the majority of that warming occurring during the 1990s, followed by two years of cooler temperatures. Most of the warming was occasioned by milder winter temperatures. The decadal average annual degree days of thaw of the 1920s was not exceeded until the decade of the 1990s.

The permafrost temperatures, -7 to −11°C at depth of zero annual amplitude, at the sites in the vicinity of Barrow indicate similar patterns of minor warming in the early 1950s, followed by a period of cooling during the mid and late 1950s. The deeper permafrost temperatures obtained during the early 1980s show the effects of an apparent warming in the upper 100 meters of the wells except at a site where the sand dune, sparsely-vegetated original environment would not appear to be favorable for changes in moisture entrapment/retention. The permafrost data suggest that the widely-circulated reports about permafrost deterioration endangering the oil facilities at Prudhoe Bay are totally without merit.

KEYWORDS: Permafrost, temperature, climatic change, Northern Alaska

B12A-0805 1330h POSTER

The Influence of Physical Breakdown and Solute Transport on Chemical Properties of Permafrost Soils: Insights From Radiogenic (Sr and Nd) and Elemental Composition.

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This study in a continuous permafrost region investigated the influence of cold temperatures on soil formation, weathering, and solute transport by determination of radiogenic Sr and Nd isotopes in solid, labile, and dissolved reservoirs in the soil-vegetation system. The site is located in Caledonian belt of northeast Greenland with soils developed on glacial and colluvial deposits of metamorphic rocks of the Paleoproterozoic basement complex. Soils are well-drained Arctic Browns (Typic Haploturbels) characterized by an overall higher content of fines in upper soil horizons and accumulation of clay minerals in the B-horizon.

The Sr and Nd isotope ratios and element composition of bulk soil and grain size separates indicate enrichment of biotite, amphibole, and the accessory minerals apatite, garnet, and zircon in fine fraction of upper soil horizons. The higher abundance of these minerals in dark striae of gneiss suggests a higher susceptibility of mafic layers to physical break down that is enhanced in upper soil layers. Accumulation of biotite and its weathering products in the clay fraction of B-horizons is documented in high Sr isotope ratios. Lower Nd isotope ratios in B than A-horizons suggest that clay accumulation is related to mechanical rather than in situ weathering. The overall change in mineralogy decouples the chemical evolution of upper soil layers from lower soil layers.

To determine sources of dissolved materials and solute transport we measured Sr isotope ratios in the exchangeable complex (ammonium-acetate) and soil water collected with suction cups, and calculated the intercept of regressing Sr isotopes ratios versus Al/Sr ratios of bulk upper soil horizons. Exchangeable Sr isotope ratios are uniform for each soil profile, higher than in bulk soil, and match isotope ratios in vegetation. They document that solutes extracted with this method give the composition of the plant available nutrient reservoir and indicates the strong influence of biotite. In contrast, Sr isotope ratios calculated from regression analyses are rather uniform and lower than observed in soil/exchange solution. The agreement with isotope composition of soil water indicates that this approach yields the longer-term Sr isotope signature of solutes that are exported by percolating water.

The difference in the isotope composition in these reservoirs point to different sources and limited exchange between both reservoirs. The accumulation of clay enriched in biotite and its weathering products in B-horizons may provide a preferential source for vegetation. A good correlation between organic carbon content and cation exchange capacity indicates that biomass cycling stabilizes the high Sr isotope signature. Lower Sr isotope ratios are observed in Na-rich feldspar, amphibole, and apatite that are abundant in sand and silt fraction of soils. Seeking these minerals as primary sources for Sr isotope ratio in percolating water suggest more rapid release of solutes to water. The difference between Sr isotope ratios of both solute reservoirs diminishes when soils are less well drained providing longer time for isotope equilibration.

B12A-0806 1330h POSTER

Landscape-Component Modeling of Permafrost Temperatures in Central Alaska

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Monitoring from 1997 to 2001 revealed that mean annual soil temperatures varied widely within a mountainous region in central Alaska, both at 5 cm below the soil surface (-2.6 to 3.3°C) and at 100 cm depth (-4.0 to 2.7°C). This variation was due primarily to differences in winter soil temperature among sites, which in turn were attributed mainly to the effect of elevation on winter air temperature. Thawing n-factors, which are ratios of soil temperatures to air temperatures, were similar among most landscape units (combinations of physiography and vegetation structure), in contrast, freezing n-factors were substantially lower in upland areas than in riverine or lowland areas. There was substantial variability in freezing n-factors was among years, with the lowest values occurring in winter 1999-2001, when snow depths were greatest. Regression analyses indicated that successional stage, elevation, drainage, and snow depth all contributed to the variation in freezing n-factors. A spatially explicit model to simulate deep soil temperatures was developed based on regional climate, topography, vegetation, and soil properties. The model used climatic factors (air temperatures, snow cover) and n-factors to couple soil temperatures to atmospheric conditions, and thermal conductivity ratios of frozen and unfrozen soils to calculate temperatures at the base of the active layer. Model simulations indicate that 32% of the area has permafrost. Field verification revealed the model was highly accurate (84%) at predicting permafrost distribution and most (70%) predicted mean annual temperatures were within 1°C of measured temperatures.

B12A-0807 1330h POSTER

Modeling of Permafrost and Gas Hydrate Stability Zone Dynamics within Alaskan Arctic Shelves and Continental Margins

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A two-dimensional finite difference model was developed to simulate the influence of climate and sea level variations on the thermal regime of permafrost and gas hydrate stability zone (GHSZ) dynamics within the Alaskan Arctic Shelf. Unlike previous models, this model takes into consideration latent heat associated with formation (decomposition) not only permafrost but also the hydrates of natural gases. It employs the thermo-baric conditions where the hydrostatic pressure changes with depth and sea level. As a first step, to assess the importance of interaction between permafrost and GHSZ, we compared our results of simulations with previous model results, where latent heat associated with gas hydrates was neglected.

Calculations were carried out for the last glaciation - interglaciation cycle (120 Kyrs). Two sites were studied: Lonely and Prudhoe Bay. As upper boundary conditions we took paleotemperature curve developed by Romanovsky and Maximova and applied it with some adjustments to our sites. Also in this model we took into consideration sea level fluctuations during last 120 Kyrs. Temperature of water assumed to be constant (-1.5 C). Properties of rocks assumed to be constant along the entire cross section (one-layer structure) and the values of thermal conductivity and heat capacity were taken from literature. We assumed fine-grained soil structure for Lonely site. For Prudhoe Bay we took into account both possible cases: fine-grained and coarse-grained soils.

As a result of our investigation we found that permafrost thickness at Lonely in the model with gas hydrate latent heat included is at least 10% smaller than in the model without this latent heat. The differences in the gas hydrate stability zone (GHSZ) volume can be even more (15%) with the thickness of the zone larger in the model without hydrates. For Prudhoe Bay, we obtained a difference of 9% in permafrost thickness and GHSZ for coarse-grained soil and 14% for fine-grained soil. Also, analysis of GHSZ dynamics during the last 120 Kyrs was carried out. It shows that the most significant changes in GHSZ volume was related to the largest sea transgression rates. The investigation also shows the presence of a gas hydrate stability zone on the continental slope underneath the seabed. The potential presence of gas hydrates on the slope may help to explain some slope processes that take place in this region.

B12B MCC: Hall C Monday 1330h

Water, Energy, and Carbon Exchange in Forest Systems IV Posters *(joint with A, H, GC)*

Presiding: **B Law,** Oregon State University**; P Thornton,** National Center for Atmospheric Research**; D Baldocchi,** University of California, Berkeley

B12B-0808 1330h POSTER

Optimizing field methods for measuring C cycling in forests: A pilot test in the Delaware River Basin

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Recent work has demonstrated the utility of USDA Forest Service Forest Inventory and Analysis (FIA) data in large-scale assessment of forest C cycling rates. These FIA-based estimates have also been used to provide valuable large-scale comparison data for ecosystem process model predictions. However, the inventory-based techniques were not designed specifically to measure carbon stocks or NPP. Adaptation of FIA data is based on allometric relationships that predict biomass from tree dimensions such as height and diameter, and ecosystem models that predict NPP and other ecosystem carbon pools. The tree biomass component of forest C may be estimated with reasonable accuracy, but estimates of biomass increment, other ecosystem carbon variables, and NPP require measurements that are not made by FIA and may not be compatible with the FIA sampling design.

We are developing new sampling and measurement techniques for comprehensive monitoring of forest NPP in the Delaware River Basin (DRB), USA. Our methods for NPP estimation include development of an efficient sampling design and protocol, techniques for short-term measurement of tree diameter increment and litterfall production, and application of new generalized allometric equations for tree biomass that were designed for application at the continental scale. In order to estimate forest NEP, we will model coarse woody debris (CWD) dynamics and develop an approach to monitor soil CO2 flux over large areas. Since 2000, we have installed 30 forest C monitoring plots at sites throughout the DRB and 13 independent validation plots. Measurement of C cycling rates is ongoing, though analysis of preliminary data suggests that NPP at our plots is consistent with expectations based on the literature.

B12B-0809 1330h POSTER

Estimating Canopy Leaf Area with Indirect Measurements: Comparison of Instruments and a Sensitivity Analysis in Alaskan Boreal Forest Stands

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Leaf area index (LAI) is a widely used variable for estimating a number of different processes associated with vegetation canopies, including light and precipitation interception, photosynthetic capacity, transpiration, and so on. LAI can be measured directly, but the process is tedious, expensive, and impractical over large areas. There are several methods for indirectly estimating LAI using methods that invert simple canopy models based on measurements of canopy light interception. These methods are useful because they allow efficient sampling of large areas, and relatively rapid and inexpensive data collection. We studied boreal forest stands in interior Alaska, at a range of successional stages, using two different instruments designed to estimate canopy LAI. A Decagon AccuPar Ceptometer and a Li-Cor LAI-2000 Plant Canopy Analyzer were used to provide unique measurements of canopy light interception, and then applied using specific theoretical inversions to estimate LAI. We tested both instruments' sensitivity to measurement conditions, and were able to estimate the uncertainty in the measurement based on the range of conditions allowed within our