capillary pressures, (2) a wide range of saturation profiles in multi-dimension, and (3) enhanced seepage velocities. Geocentrifuge experiments can be used to generate experimental data to validate mathematical models. However, if an unsaturated flow experiment is performed in the elevated gravity environment of the geocentrifuge, the unsaturated hydraulic properties must first be obtained at the target centrifugal acceleration. This information can be determined from relatively simple, one-dimensional column experiments and will provide the unsaturated hydraulic properties required as input into mathematical models. These one-dimensional column experiments will also provide insight into the influence of gravity on the flow field. In this study, a series of one-dimensional column experiments was performed to obtain the water retention characteristics of a uniform fine sand. Cumulative outflow and temporal changes of capillary pressures were measured during gravity driven drainage. The measured data were used as input data for an inverse analysis using HYDRUS 1-D to obtain unsaturated permeability and saturation-pressure parameters of the tested sand. The geocentrifuge experimental measurements were also compared with data obtained independently from conventional hanging-column tests. The suitability of the centrifuge test method was evaluated by comparing results from the two different experimental methods. In addition, the centrifuge experiments were conducted in different gravity fields to verify the scale similitude of the hydraulic properties in elevated gravity environments.

URL: http://www.inel.gov/env-energyscience/centrifuge/default.shtml

H22A-0909 1330h POSTER

Phase Structure in a Centrifugal Field: Impact of Capillary Heterogeneity and Angular Velocity

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We investigate the evolution of phase structure in a centrifugal field by simulating the simplest of two-phase experiments, the stabilized displacement of a denser wetting phase (e.g., water) by a lighter non-wetting phase (e.g., air) within a heterogeneous porous medium. We model this displacement (drainage) using a Modified Invasion Percolation (MIP) approach that includes both capillary forces and a stabilizing centrifugal force. We generate random fields of spanning pressures to represent capillary heterogeneity. The style of heterogeneity varies from unstructured (uncorrelated) to partially structured (layered system with a random overprint) to fully structured (layered with no random overprint). Drainage is simulated for each layered system twice: once for drainage perpendicular to layers and once for drainage parallel to layers. Our results show that the influence of capillary heterogeneity varies with angular velocity in a centrifugal field. As the angular velocity is increased, non-wetting phase invasion and phase structure become increasingly insensitive to capillary heterogeneity, regardless of its style or orientation. Higher spanning pressure variance, however, increases the sensitivity to capillary heterogeneity and leads to less drainage at a given angular velocity. In general, contact area between the wetting and non-wetting phase increases as the heterogeneity becomes less structured and decreases with increasing angular velocity. Because phase structure critically influences flow processes and petrophysical properties (pressure-saturation, relative permeability, electrical resistivity, etc.), the design of centrifugal experiments must carefully consider this interplay between capillary heterogeneity and centrifugal force.

H22A-0910 1330h POSTER

Runtime and Inversion Impacts on Estimation of Moisture Retention Relations by Centrifuge

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Standard laboratory methods in soil physics for measuring the moisture retention relation (drainage matric potential-volumetric moisture content relation) are each limited to only part of the moisture content range. Centrifuge systems allow intensive accurate measurements across much of the saturation range, and typically require much less time than traditional laboratory methods. An initially liquid-saturated sample is subjected to a stepwise-increasing series of angular velocities while carefully monitoring changes in liquid content. Angular velocity is held constant until the capillary and centrifugal forces equilibrate, forcing liquid flux to zero, and then a final average liquid content is noted. The procedure is repeated after increasing the angular velocity. Centrifuge measurement time is greatly reduced because the centrifugal body force gradient can far exceed the driving forces utilized in standard lab methods. Widely-used in the petroleum industry for decades, centrifuge measurement of moisture retention relations is seldom encountered in the soil physics or vadose hydrology literatures. Yet there is a need to better understand and improve the experimental methodology given the increasing number of centrifuges employed in these fields. Errors in centrifuge measurement of moisture retention relations originate from both experimental protocol and from data inversion. Like standard methods, centrifuge methods assume equilibrium conditions, and so are sensitive to errors introduced by insufficient runtimes. Unlike standard methods, centrifuge experiments require inversion of the angular velocity and average sample moisture content data to a location-specific pair of matric potential and moisture content values, The force balance causes matric potential and moisture content to vary with sample length while the sample is spinning. Numerous data inversion techniques exist, each yielding different moisture retention relations. We present analyses demonstrating the impact of different runtimes and different inversion techniques on estimated moisture retention parameters. Moisture retention data were collected for a number of poorly lithified sands and indurated deformed sands using the UFA centrifuge system (Conca and Wright, 1990). Parameters for the van Genuchten model were estimated for short and long runtimes with one inversion technique. Model parameters were re-estimated for one other inversion technique and a simple averaging approach which does not involve inversion. Our results demonstrate that the averaging approach greatly underestimates the van Genuchten n parameter relative to the inversion techniques. Insufficient runtimes also have a significant impact on estimated parameters. Our analysis indicates a need, barring method standardization, for practitioners to include information about inversion technique and runtime criteria when presenting centrifuge moisture retention results.

H22A-0911 1330h POSTER

Accelerated simulation of the migration of solutes in sandy soils amended by sewage sludge: Transport and retardation

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A common way to dispose of sewage sludge is to spead it on agricultural land because of its high nutrient (P, N) and org C contents. However, in addition to these beneficial components, sewage sludge can contain toxic chemicals such as heavy metals. This farming technique is relatively recent (several decades, at most) and there is still a need for information concerning the processes controlling the fate of the heavy metals in the sludge. To study how fast they migrate in the soil profile, the transfer of water and associated solutes in both unsaturated and unsaturated conditions can be accelerated by centrifugation according to the equation: tsimulated = treal * g2. (t: time). In a lysimeter study (diameter 30 cm, depth 60 cm) carried out using the CEA-CESTA Silat 265 centrifuge, we simulated, at 20 g, several months of percolation in one day. Experiments were done on cores of sandy forest soil (podzol) to which various sewage sludges (containing 2 to 12 mg/kg Cd, 20 to 120 mg/kg Ni, 50 to 465 mg/kg Pb) and simulated rain were applied. Major ions migrated at an estimated rate of 6-8.5 mm/simulated day (2-3 m/simulated year), while heavy metals (Cd, Ni, Pb) were retarded by a factor of 1.5 to 2. The retention of these heavy metals is associated with the organic C content of the soil profile (rich in the upper horizon).

H22B MCC: Level 2 Tuesday 1330h

Observations and Modeling of Land Surface Hydrological Processes IV Posters *(joint with A, B, C)*

Presiding: **V Lakshmi,** University of South Carolina**; A Cahill,** Texas A&M University

H22B-0912 1330h POSTER

Assimilation of Observed Discharge Records Into a Lumped Hydrological Model Using an Extended Kalman Filter

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The objective of this research is to investigate the possibility to improve discharge forecasts from a lumped hydrological model (TOPLATS) through the continuous assimilation of discharge observations. An extended Kalman filter is used as assimilation algorithm. Model simulations are performed over the Zwalm catchment in Belgium at an hourly time step from 1994 through 1998. A simple online routing scheme is applied to the modeled discharge values in order to allow the assimilation of the observed discharge records at every time step. The modeled soil moisture contents and water table levels are updated through the Kalman filtering procedure. The overall improvement in the modeled discharge peaks is quantified. The assimilation scheme is also run in a flood forecasting mode. In this mode, a two-month spin-up period, in which all available discharge data are assimilated, proceeds the forecasting period. The improvement in the forecasted discharge peaks, as a consequence of the data assimilation during the model spin-up, is assessed. This research is expected to lead to a framework to improve flood forecasts from lumped hydrological models, through the continuous assimilation of operational discharge observations.

H22B-0913 1330h POSTER

A 85-year Retrospective Hydrologic Analysis for the Western U.S.

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The National Climatic Data Center (NCDC) has recently created digital archives of daily climatological data (primarily precipitation and daily temperature maxima and minima) for the continental U.S. going back to the beginning of the instrumental records. Previous electronic archives were typically available only back to about 1948, with a few stations digitized back to the 1930's. We have used these data to extend our previous 50-year retrospective analysis back to 1916

and forward to 2002, a period for which adequate station density exists to perform hydrologic simulations with the Variable Infiltration Capacity (VIC) model. A particular advantage of this 85-year period is that it includes the drought of the 1930s, which allows comparative evaluation of the severity of more recent events. Several important technical issues are addressed, including development of a method, based on the carefully quality controlled HCN (Historical Climatology Network) stations to control for drift in the gridded data that otherwise results from changes in the stations included over time. The resulting long gridded climate records, and associated hydrologic simulations (e.g., of soil moisture, snow water storage, and runoff) derived from them make possible a better understanding of hydrologic variability in the 20th century. We perform exploratory evaluations of the new data set over the Columbia River basin to evaluate the severity of the 2001 hydrologic drought, and over the interior of the western U.S. to evaluate the severity of the ongoing three-year agricultural drought.

H22B-0914 1330h POSTER

Effects of Global Warming on Drought Frequency and Duration in the Northeast United States

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Over the past century, the northeast United States experienced several major droughts, with great economic damage as a consequence. Drought indices, such as the widely used Palmer Drought Severity Index, have been use to detect and monitor droughts with limited success. Here we use a relatively new index, the Standardized Precipitation Index, to study the change of drought conditions in the northeast United States, using observations and simulations from eight state-of-the-art general circulation models for the period 1901 to 2050. We separated the droughts into two different time scales, 3 months and 12 months, and three different severities, moderate, severe, and extreme. We found that, while the models behave quite differently from each other, the ensemble averages of the model simulations showed decreases in the frequencies of droughts in the future. The models project the frequencies of 3-month moderate, severe, and extreme droughts to decrease by about 12%, 4% and 6%, respectively, in the future compared with the 20th century; and those of 12-month duration to decrease by 16%, 7% and 8%. The only significant changes projected to occur in the duration of droughts is a decrease in extreme events.

H22B-0915 1330h POSTER

Modeling Irrigation's Influence on Precipitation in Texas

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Irrigation in the Texas High Plains represents an enormous hydrologic disturbance in central North America, with over 6 x 10^9 m^3 of irrigation water applied annually to an area of 16,000 km^2. Previous research has estimated that a 6% to 18% enhancement of summer precipitation is attributable to irrigation. This phenomenon can be explained by the increase in instability and latent heat flux caused by the irrigation water; the contrasting wet and dry surfaces initiate mesoscale convective complexes and result in rainfall. Here we test this influence quantitatively through the use of a mesoscale model (RAMS). Simulations of precipitation produce spatial rainfall patterns and amounts similar to observation. We examine what threshold in irrigation is necessary to significantly influence precipitation patterns by employing a series of simulations using various amounts of irrigation water applied at the surface. Preliminary results from seasonal simulations are also presented.

H22B-0916 1330h POSTER

Combined Analysis Using River Flow and Leaf Area Index in an Evaluation of a Spatially-Distributed Hydro-Ecologic Model for Semi-Arid Shrubland Watersheds

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Distributed hydro-ecologic models which link seasonal streamflow, soil moisture and evapotranspiration patterns with spatial patterns of vegetation are important tools for understanding the sensitivity of Mediterranean shrubland ecosystems to future climate and land use change. Applying spatially distributed process based models to investigate these interactions, however, must address issues of parameter uncertainty and calibration. Monte-carlo based approaches that evaluate metrics of observed and modeled streamflow correspondence are commonly used to constrain parameter space. In these ecosystems, however, the strong coupling between vegetation biomass and soil moisture patterns can be used to provide an additional constraint on hydrologic model parameters and further data for model evaluation. In particular, examining the sensitivity of modeled spatial patterns of LAI (leaf area index) across parameter space and comparison between modeled and observed patterns of LAI derived from remote sensing data can provide important information about the ability of a model to predict spatial patterns in addition to aggregate responses such as streamflow. We examine these issues using RHESSys (Regional hydro-ecologic simulation system) for several small watersheds near Santa Barbara, California. Results indicate model parameter space can be more tightly constrained by examining the sensitivity of LAI to parameters that control hydraulic conductivity and soil depth. However, significant deviation between modeled and remote sensing derived LAI across parameter space indicate the limitations of current model assumptions about the key process that control the spatial distribution of soil moisture in these watersheds. Implications for examining the sensitivity of these semi-arid ecosystems to climate change are discussed.

H22B-0917 1330h POSTER

Variability of United States Runoff and its Climate Teleconnections

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Understanding the space-time variability of runoff has important implications for climate because of the linkage of runoff and evapotranspiration, as well as practical implications for the prediction of drought and floods. In contrast to climate variables like precipitation and temperature, there has to date been relatively little work evaluating climate teleconnections of runoff, in part because of the absence of data sets that lend themselves to commonly used techniques in climate analysis like principal components analysis (PCA). We examine the space-time variability of runoff over North America between latitudes 25 and 53 degrees north, which is the spatial domain of the North American Land Data Assimilation System (N-LDAS) for which a 50-year retrospective data set of runoff and other land surface water cycle variables has been produced at 1/8 degree latitude-longitude spatial resolution. Past efforts to investigate spatial patterns of runoff variability in the United States have utilized streamflow observations, which have three important drawbacks: first, the location of the observations is highly non-uniform, second, routing effects associated with the conversion of runoff to streamflow confound the interpretation of the observed variables, and third, river impoundments and diversions affect the observations by varying amounts. By using derived spatially distributed runoff which represents natural (no effects of routing, or diversions or impoundments) conditions, we are able to avoid these shortcomings. Using the 50-year 1/8 degree data set, accumulated to monthly amounts, we determine climatic teleconnections using common climate indices (such as Niño3.4 and NAO), by season for lead times of months to a year. High and low values of climatic indices are evaluated separately, which allows independent interpretation of the telconnections of different climatic anomalies to the runoff variability. We identify patterns of runoff variability that are not revealed with observed datasets, especially where observations are sparse. A greater number of significant climate-runoff relationships are exhibited for runoff patterns on the east and west coasts and southern interior, with fewer for Northern interior runoff patterns in the Upper Mississippi and Missouri river regions. Rarely do both the positive and negative phases of any climatic index show significant teleconnection with a particular pattern of runoff variability, lead time and season.

H22B-0918 1330h POSTER

Water Balance of Shrinking Thermkorst Ponds near Council, Alaska

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Water balances were conducted on a wetland complex near Council, Alaska on the Seward Peninsula during the 2001 and 2002 summers in order to investigate the possibility of groundwater drainage through open taliks. This study is a product of the Arctic Transition in the Land-Atmosphere System (ATLAS) initiation within the Land Atmosphere Ice Interactions (LAII) flux program, created to understand the feedbacks within the land-atmosphere system in arctic regions and to predict reasonable scenarios resulting from future global climate change. The majority of ponds in the Council area are displaying a decreased surface area when compared with aerial photographs from the 1950's, and because the long-term temperature and precipitation data from Nome does not reveal any conclusive trends, the cause of this change is hypothesized to be related to the local permafrost and thermokarst conditions. From permafrost boring data, DC electrical sounding studies, and ground penetrating radar (GPR) surveys, the permafrost in the area is typically 20 to 60 meters thick, and underneath the shrinking thermokarst ponds are large thawed regions (taliks), most of which extend through the local permafrost (open taliks). Downward vertical gradients have been identified in the open taliks, indicating the downward migration of water from the ponds to the subpermafrost groundwater. It was hypothesized that this water loss mechanism is significant in the hydrologic dynamics of the ponds and is related to the recent drying of the ponds. The results of this two-year study, however, demonstrate that evapotranspiration and lateral drainage are capable of accounting for 100% of the observed storage changes.

H22B-0919 1330h POSTER

Long-Term Warm-Season Stream Temperature Variations and Changes Over Siberian Lena River

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Stream temperature is an important environmental variable that has considerable significance in regional hydrology, climate, and ecology systems. Few investigations on long-term stream temperature variations in Arctic regions have been undertaken. This research examined and analyzed long-term (1950-1992) stream temperature data collected at dozens of stations in the Lena River basin during (open water) warm seasons. Preliminary results show that: (1) the stream temperature across the whole basin shows a significant positive trend during early warm season, which may indicate a response of early snowmelt due to climate warming in the winter and spring seasons; (2) over the Aldan tributary, stream temperatures collected at elevated locations are much lower than those at low valley stations; (3) in the Upper Lena river, stream temperatures have very strong negative trend in late July to early August, which imply certain climatic factors is affecting the stream temperature regime during this period; and, (4) in the Vilui subbasin, stream temperatures are strongly affected by reservoir regulations, for instance, extremely strong positive and negative trends appear at the station close to reservoir in early and middle warm season, respectively. The research has defined

stream temperature regime and identified its long-term changes/variations over Lena river basin. Our future work will examine the impacts of climate change on river thermal condition. We will also study the effects of local environmental settings to stream temperatures and aquatic life.

H22B-0920 1330h POSTER

Land surface model evaluation using a new soil moisture and hydrology data set from Boissy-le-Châtel, France

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Soil moisture is a very important component of the climate system, regulating both energy and water fluxes on local and regional scales. To obtain accurate climatological and meteorological forecasts we therefore need to obtain accurate predictions of soil moisture from land surface models. Actual in situ measurements are crucial for testing and developing these models. It is to this end that we have obtained a new soil moisture dataset from the Boissy-le-Châtel hydrological station in the Orgeval catchment in France. This dataset has a time span of over 5 years, from late 1996 to early 2003. It includes soil moisture measurements for 11 layers, as well as meteorological observations which can be used to force a land surface model. The data will be made available to the public via the Rutgers University Center for Environmental Prediction Global Soil Moisture Data Bank. We force the NOAH land surface model with the meteorology observations, and evaluate the resulting soil moisture, sensible and latent heat fluxes, and runoff using the Boissy-le-Châtel data. This experiment can serve as a prototype for other models to conduct their own evaluations, in the spirit of PILPS Phase 2.

H22B-0921 1330h POSTER

A 50-yr Global Dataset of Land Surface Fluxes and States

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Model simulations of large scale water and energy balances are useful for the study of climate change and variability, and in some cases can act as surrogates for observations that are sparse or nonexistent. We describe a global, 50-yr sub-daily, 1.0 degree terrestrial dataset of water and energy fluxes and states using observation based forcings and a state of the art land surface model. The forcing dataset is constructed from a combination of global monthly precipitation and temperature data disaggregated to subdaily time steps using the NCEP/NCAR Reanalysis. Known biases in the Reanalysis precipitation and near-surface meteorology are corrected using observations where available. Corrections are made to the wet-dry day statistics of the reanalysis precipitation which have been found to exhibit a spurious wave-like pattern in the high-latitude winter. Wind-induced undercatch of solid precipitation is corrected using the results from the World Meteorological Organization (WMO) Solid Precipitation Measurement Intercomparison. Underestimation of precipitation in mountainous regions is corrected using a hydrologic water balance approach based on watershed runoff ratios and historical discharge data. This version of the dataset is available at daily and 2 degree resolution. A second version has been created at 3-hourly and 1.0 degree resolution to capture the finer temporal and spatial variability of land surface fluxes and states. This dataset is obtained by disaggregating the 2 degree precipitation by statistical downscaling using relationships developed with the 0.5 degree GPCP daily 1997-present dataset. Temporal disaggregation from daily to 3-hourly also uses statistical downscaling but with the TRMM 1/4 deg 3-hourly dataset (Feb 2002 - Jan 2003). The forcing dataset is used to drive the Variable Infiltration Capacity (VIC) land surface model to produce fields of land surface water and energy fluxes and states. Calibration of the model is achieved through the use of a multi-objective and multi-seasonal calibration strategy which uses representative sampling techniques and geostatistical interpolation to reduce the computational overhead. The final product provides a long-term, globally-consistent dataset of land surface water and energy fluxes and states that are useful for the study of seasonal and inter-annual variability and for the evaluation of coupled models and other land surface prediction schemes.

H22B-0922 1330h POSTER

Monitoring forest-atmosphere exchanges with remote sensing

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In this study the microwave land surface emissivity (MLSE) has been retrieved by combining surface observations and coincident SSM/I radiance over the heavily forested area, Harvard Forest, for two growing seasons of 1999 and 2000. Decoupled from the soil moisture underneath the forest, plant water amount indicated by MLSE shows an increasing trend of moisture after the leaf emergence. The increase in plant water amount over Harvard Forest during the growing season may contribute to the decrease in surface albedos in the near infrared (NIR) wavelengths and total shortwave. Diurnal variation of MLSE decreases significantly as the growing season proceeds, due to the acceleration of evapotranspiration process. Further, the emissivity difference between 19 GHz and 37 GHz correlates well with the canopy resistance, as well as albedos of total shortwave and PAR. It demonstrates the potential of multi-platform/multi-spectrum remote sensing for monitoring evapotranspiration and CO2 uptake.

H22B-0923 1330h POSTER

Spatial Correlation Structure of Soil Moisture from Aircraft to Satellite Footprint Scales During SGP97 and SGP99

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The Spatial correlation structure of soil moisture content from aircraft to satellite remote sensing footprint scale is presented using in situ and remotely sensed data from the SGP'97 and SGP'99 experiments. At the aircraft footprint scale, the correlation scale of moderately wet fields decreases from approximately 75 m to 7 m as the drying period progresses, without significant change in semi-variance. At the satellite footprint scale, the remotely sensed region is partitioned to remove the large scale trend of soil moisture variability created by precipitation, based on the antecedent rainfall data. Persistent spatial correlation features of soil moisture are observed over both the wet and dry regions, with correlation lengths from 15 to 30 km. The factors affecting the spatial features of the soil moisture distribution are discussed by analyzing the spatial statistics of ancillary data such as soil texture, vegetation water content, topography, and precipitation.

H22B-0924 1330h POSTER

Streamflow Response to Seasonal Snowcover Extent Changes in Large Siberian Watersheds

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This study uses remotely sensed long-term (1966-1999) weekly snowcover extent data to investigate snowmelt runoff response to seasonal snowcover change in the large Siberian watersheds (the Ob, Yenisei and Lena basins). It quantified the seasonal cycles and variations of snowcover extent and river streamflow, and identified a clear correspondence of river streamflow to seasonal snowcover extent change, i.e. an association of low streamflow with high snowcover extent during the cold season, and an increase in discharge associated with a decrease of snowcover extent during the melt periods. This study also examined and compared the weekly mean streamflow with the weekly basin snowcover extent for the study period. The results revealed a very strong linkage between the streamflow and snowcover extent change during the spring melt season over the large Siberian watersheds, and developed a statistically significant weekly runoff - snowcover relation. This relation suggests a practical procedure of using remotely sensed snowcover information for snowmelt runoff forecasting over the large northern watersheds. Analyses of extreme (high/low) streamflow cases (years) and the associated snowcover conditions indicate an association of high (low) flood peak with late (early) snowmelt in the Ob and Yenisei basins. Comparisons of snowmelt timing with peak flow show different associations between these two variables among the large Siberian rivers. These results demonstrate that the NOAA weekly snowcover extent data are useful for understanding and predicting streamflow changes in the arctic regions. Snowcover water equivalent data/products obtained by remote sensing technology and in-situ snow observations are currently being examined for what we expect will eventually improve hydrologic forecasts over the large northern watersheds.

URL: http://www.uaf.edu/water; http://climate.rutgers.edu/snowcover/

H22B-0925 1330h POSTER

Natural Spatial and Temporal Variation in Hydrometeorology Over the Eurasian Arctic Drainage Basin in the 20th Century Based on Observational Records

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Significant increases in the fresh water discharge to the Arctic Ocean from Eurasia with an average annual rate of 2.0+-0.7 km3/year have been found for the last 60 years by Peterson et. al.(2002). The reason for this increase, whether natural variability, global change or both, is unclear. But we do need to identify the primary sources of these changes. Using an update of the R-ArcticNET database (http://www.R-ArcticNET.sr.unh.edu) along with newly developed human impact data sets (irrigation lands, reservoirs, population and water use) we identify the long-term observational gauges with minimal upstream human influence. We use this gauge subset to identify seasonal and annual variations of the hydrometeorological elements (e.g. river runoff, precipitation, air temperature) for the natural watersheds. This regionalization of the Eurasian Arctic drainage allows us to map out the dominant causes of change and provide insight in the variability of the hydrological cycle. This preliminary analysis has shown three general tendencies in hydrometeorology change across the Eurasian Arctic Ocean drainage basin: 1) increases in annual runoff up to 25% due primarily to a rise in precipitation in European North and Western Siberia; 2) significant winter increases (5-50%) in runoff for all regions due to a shorter cold period (increasing air temperature) and rising ground water storage; 3) decrease in annual and especially spring runoff (10-30%) in the Southern regions of the Ob and Yenisey basins as a result of winter precipitation decline and earlier snow melt.

H22B-0926 1330h POSTER

Evaluation of predicted soil frost and snow metamorphism by means of WINTEX and LAPP data

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Snow cover and soil frost are important conditions affecting atmospheric humidity, and temperature in high latitudes. The hydro-thermodynamic soil-vegetation scheme (HTSVS) among other processes considers soil frost and snow-metamorphism. Using observed meteorological data collected during the WINTEX and LAPP program for two stations i.e. Sodanklya (Finland) and Marsta (Finland), HTSVS is evaluated. HTSVS was initialized by observed snow and soil temperature. Observed short-wave downward radiation, air temperature, precipitation, wind, and pressure data as well as parameterized long-wave downward radiation were used to force HTSVS. The model was run from March 12 thru May 30, 1997. Sensitivity analysis was carried out by varying various parameters and using different parameterization of long wave downward radiation alternatively. In the first month, snow height was slightly underpredicated, while towards the end of the snow season the model tends to slightly overestimate snow height. The results show that the model is sensitive to the parameterization of long-wave downward radiation. The offline evaluation of the modified HTSVS by using WINTEX and LAPP is still ongoing. More stations will be evaluated to gain better insight to models deficits and for model improvement in the future.

H22B-0927 1330h POSTER

The Carbon Cycle and the Northern Hemisphere Annular Mode: Relationships and Associated Mechanisms

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Atmospheric inversion studies as well as most land ecosystem models show that a substantial fraction of the interannual variability observed in atmospheric carbon dioxide is associated with changes in the net exchange of carbon dioxide between the atmosphere and the land biosphere. Through published work exploring the relationship of the El Nino - Southern Oscillation (ENSO) and the carbon cycle, it is well accepted that these changes in the net exchange of carbon dioxide in the tropics are strongly linked to ENSO variability. In that same manner, our analysis explores the relationship between these changes in the extratropics and the Northern Hemisphere Annular Mode/Arctic Oscillation (NAM/AO). Recent work has shown that high NAM/AO index periods are characterized by stronger than normal zonal flow along 55 - 60 degrees north latitudes, which results in the advection of relatively warm, moist air masses over northern land masses. In addition, in recent decades the NAM/AO has exhibited a trend toward high polarity in the winter months. Using Normalized Difference Vegetation Indices (NDVI) developed from over 20 years of AVHRR (Advanced Very High Resolution Radiometer) data, NCEP Reanalysis climate data from NOAA/NCAR and SiB2.5, the Simple Biosphere land surface model, we have analyzed the variations in key components of the carbon cycle with respect to high and low index variability in the NAM/AO. We see a statistically significant correlation between wintertime NAM/AO indices and Leaf Area Index and Fraction of Photosynthetically Active Radiation during the past two decades. In addition, we see soil temperature and moisture anomalies associated with wintertime NAM/AO indices are related to respiration anomalies later in the year.

URL: http://biocycle.atmos.colostate.edu

H22B-0928 1330h POSTER

Analyzing model uncertainty in predicted surface fluxes resulting from prescribed soil and vegetation parameters

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The atmosphere and land-surface continuously interact, for which the surface affects current weather and climate. The biosphere-soil system plays an important role because it is the media in those interactions. The processes that describe those interactions are the exchange of momentuum, heat, water vapor, and matter. To include these processes at the soil-biosphere-atmosphere interface in atmospheric models they have to be parameterized. The different vegetation and soil types are realized by prescribed plant physiological and soil physical parameters (e.g. soil hydraulic conductivity, soil thermal conductivity, porosity, pore-size distribution index, leaf area index, albedo and emissivity of the foliage and soil, minimum stomatal resistance, canopy height, etc.) in these parameterizations. The parameters can vary even among the same soil or plant type. The order of magnitude of those variations can be as much as the mean values of the parameters themselves. In order to improve weather prediction the model uncertainty, caused by the necessity to prescribe parameters, has to be minimized. To asses the errors uncertainty analysis with respect to the prescribed parameters is carried out using the Gaussian Error Propagation method. We use the PennState/NCAR mesoscale meteorological model MM5 coupled with the Oregon State University land surface model (OSULSM) as the test-platform. The Gaussian Error Propagation technique provides error bars for the fluxes simulated by MM5. Moreover, the technique can point out which parameters contribute the most to the error, and should be replaced in future model development. Our preliminary results show that throughout the domain errors were at low or moderate levels. The highest errors predicted appear to be associated with scarcely vegetated, sandy clay loam areas and areas covered by ice and snow.

H22B-0929 1330h POSTER

Characterizing the Influence of Permafrost on Hydrological Processes through a Spatially Distributed Model

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In the sub-arctic environment, the presence or absence of permafrost is a strong factor in controlling both soil moisture dynamics and hydrology. Soil moisture, which displays a high spatial and temporal variability, is an important variable in understanding and predicting a large number of processes including land-atmosphere interactions, permafrost aggradation/degradation, and fire frequency and severity. 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 goal of our research is to describe, simulate, and predict soil moisture dynamics and all other hydrologic processes everywhere throughout a sub-arctic watershed. The model we are developing will be used as a tool to better understand the effects of vegetation and soil type, presence or absence of permafrost, the amount and timing of precipitation, and disturbance (such as wildfire) on soil moisture dynamics. Three small subbasins of the Caribou-Poker Creeks Research Watershed (CPCRW), located 48 km north of Fairbanks, Alaska (65°10'N, 147°30'W), are the areas selected for study. These small sub-basins, which are underlain with approximately 3, 19, and 53% permafrost, are simulated using the TopoFlow hydrologic model to explore differences in permafrost versus non-permafrost areas. The TopoFlow model is a process based, spatially distributed numeric model developed to simulate soil moisture dynamics and other hydrologic processes. This model can be used to simulate spatially distributed processes, such as soil moisture dynamics or snowmelt, as well as point measurements such as stream flow within the model domain. Simulation results reflect many characteristics of the sub-arctic environment, including the representation of discontinuous permafrost, distributed vegetation types, and a groundwater flow.

H22B-0930 1330h POSTER

Tests of scalar heat flux - roughness scale relationships from the SGS-2002 data sets

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This study addresses relationships between sensible heat flux and dimensionless roughness scale, based on measurements at several time and length scales. The data were obtained in the summer of 2002 over the homogenous flat terrain of the Utah salt flats. The instrumentation consisted of 16 sonic anemometers arranged into a vertical 4 by 4 grid allowing for spatial resolution of 0.5 m. The temporal resolution of the data is 20 Hz. Supporting meteorological measurements including the relative humidity, latent heat flux, net radiation, soil heat flux, and skin surface temperature were also obtained. Using these data we measure the sensible heat flux and compare to predictions from a model by Brutsaert, and from a more recent improvement proposed by Cahill et al. (1997). The variability of contributing meteorological variables such as the Latent heat flux (H),the friction velocity (u*) and the Obukhov length (L) will be characterized as a function of averaging time, as well as spatial filtering scale. Thus the effects of coarse-graining in space and time upon the validity of the various models is ascertained.

H22B-0931 1330h POSTER

The Atmospheric Boundary Layer at the Aletsch Glacier (3600 m - Switzerland)

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Observations of the atmospheric boundary layer (ABL) were obtained during the unusually warm period of April through to August 2003 at the Jungfraujoch Observatory -3580 m. Sonic anemometers were deployed at the Aletsch Glacier to evaluate the turbulent fluxes of momentum and heat. Aerosol optical properties and water vapor profiles were also measured with EPFL Lidar systems. Three typical cases of PBL height were identified over the Swiss plateau: low (under 3600m), medium (reaching 3600m) and high PBL (above 3600m). We present observations of the exceptionally high altitude daytime ABL (5000 m) and the persistence of the nocturnal residual layer. These results are supported also by local (meteorology at Jungfraujoch) and regional (close European meteorological soundings) as complementary measurements.

H22B-0932 1330h POSTER

Validation of the Community Land Model (CLM) using data collected during the Soil Moisture Experiment 2003 (SMEX03)

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The Community Land Model (CLM) can be used to examine the physical, chemical, and biological processes through which terrestrial ecosystems affect and are affected by climate. CLM simulates the hydrological cycle and surface energy budgets using water and energy balance approaches. CLM's outputs include soil moisture, latent and sensible heat fluxes, and surface temperature. The Soil Moisture Experiment 2003 (SMEX03) was conducted to provide validation data satellite and aircraft based microwave remote sensing instruments. As part of the SMEX03 experiment, soil moisture, surface temperature, and vegetation data were collected in the Little River watershed, GA. Eddy flux stations measured energy fluxes at three sites with distinct vegetation characteristics. This study compares the CLM's biogeophysical and hydrological outputs to measured soil moisture and energy flux data.

H22B-0933 1330h POSTER

The effect of land-cover misclassification on predicted impervious surface

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If land-cover data are available for a study area, a coefficient-based impervious surface modeling approach is relatively straightforward and quick to implement. Impervious-surface estimates developed by using this approach, however, may be biased or imprecise for several reasons, including land-cover misclassification. Data collected as part of a U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program study in New England were used to assess whether impervious-surface model predictions were improved by explicit adjustment of National Land Cover Data (NLCD) land-cover values to account for misclassification. Adjustments were based on a user probability matrix derived from published accuracy-assessment information. NLCD and field-measured impervious-surface values at 55 New England study sites were used to assess models for predicting impervious surface. Four models were distinguished by land-cover resolution (Level I and Level II) and whether land-cover data were adjusted. The relatively poor classification accuracy of the NLCD developed-land class (74% for Level I developed land and 40-61% for Level II developed categories) generally results in adjustments that decrease the amount of developed land. These downward adjustments begin when relatively low amounts of developed land are present in a study site. Because developed-land impervious-surface coefficients have a high value, decreases in the amount of developed land will lower predicted impervious-surface values relative to those in models using unadjusted NLCD data. The results of the investigation are mixed as to whether impervious-surface models that account for land classification error rates result in meaningful improvements in impervious-surface predictions over models that do not make these modifications. The model-verification results suggest that NLCD Level I land-cover data, adjusted for land-cover misclassification, is preferable to other land-cover options for use in models predicting impervious surface. There was no significant difference between paired observations of observed and predicted impervious-surface values when the adjusted Level I data were used. Significant differences between paired observed and predicted impervious-surface values occurred in the other three models. Overall, the sensitivity of the models to land-cover classification errors and adjustments for these errors was small; the difference between predicted impervious surface from a model using unadjusted land-cover and simulated values from an adjusted model ranged from 1-2%.

H22B-0934 1330h POSTER

Global Soil Moisture Estimates from a Long-Term Hydrometeorological Forcing Data Set

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Offline land surface modeling simulations require meteorological forcing with consistent spatial and temporal resolutions. Although reanalysis products present an attractive data source for these types of applications bias to many of the reanalysis fields limits their use for hydrological modeling. In this study we develop a global 0.5 degree forcing data set for the time period 1979-1993 on a 6-hourly time step through application of a bias correction scheme to reanalysis products. We then use this forcing data to drive a land surface model for global estimation of soil moisture and other hydrological states and fluxes. The simulated soil moisture estimates are compared to in-situ, satellite observations and to the modeled estimates of Nijssen et al. [2001]. In general, there is good agreement between anomalies in modeled and observed root zone soil moisture (top one meter). Similarly for the surface soil wetness state, modeled estimates and satellite observations are also in general statistical agreement, however, correlations decline with increasing sub-grid variability and vegetation amount. Comparisons to the data set of Nijssen et al., [2001] also demonstrates that both simulations present complimentary estimates of wet and dry root zone soil moisture anomalies, despite being derived from different land surface models, using different data sources for meteorological forcing, and with different specifications of the land surfaces properties. Results of this study demonstrate that reanalysis products corrected to observations can be used within a land surface model to produce soil moisture estimates in general agreement with surface and root zone observations.

H22B-0935 1330h POSTER

The Greening of the McGill Paleoclimate Model. Part I: Improved Land Surface Scheme With Vegetation Dynamics

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The formulation of a new land surface scheme with vegetation dynamics for coupling to the McGill Paleoclimate Model (MPM) is presented. The new land surface component incorporates significant improvements over the old version used in the MPM, which can be summarized as follows: (i) Parameterization of deciduous and evergreen forests by using the model's climatology and the output of the dynamic global vegetation model: VECODE, developed by Brovkin et al.; (ii) Parameterization of leaf budburst and drop by using the model's climatology and plant function type dependent threshold values for these quantities; (iii) Parameterization of the seasonality of leaf area index by using time-dependent growth; (iv) Calculation of land surface albedo by using vegetation-related parameters, snow depth and the model's climatology. The results show considerable improvement of the model's simulation of the present-day climate. In particular, the strong seasonality of terrestrial vegetation and the associated land surface albedo variation are in good agreement with several satellite observational datasets. The first application of this new version of the MPM to Holocene millennial-scale climate variability is described in a companion paper, Part II.

H22B-0936 1330h POSTER

Comparison of Seasonal and Spatial Variations of LAI/FPAR From MODIS and Common Land Model

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This paper compares by land cover type seasonal and spatial variations of MODIS leaf area index (LAI) and fraction of photosynthetically active radiation (0.4 - 0.7 μm) absorbed by vegetation (FPAR) from two and half years with those from the Common Land Model (CLM) and investigates possible reasons for notable differences. The FPAR value is mainly determined by LAI in MODIS and both LAI and stem area index (SAI) in CLM. On average, the model underestimates FPAR in the Southern Hemisphere and overestimates FPAR over most areas in the Northern Hemisphere compared to MODIS observations during all seasons except northern middle latitude summer. Such overestimation is most significant in winter over northern high latitudes. The MODIS LAI is generally consistent with the model during the snow-free periods but may be underestimated in the presence of snow, especially for evergreen trees. The positive FPAR bias is mainly attributed to CLM SAI of deciduous canopy and higher LAI than MODIS for evergreen canopy as well. The negative FPAR bias results from several factors including differences in LAI and soil albedo between CLM and MODIS or limitations of the geometric optics scheme used in the model. Therefore, the MODIS algorithm needs to better represent the winter LAI retrievals while the model needs to better quantify LAI and SAI. Since stems will not have the same single scattering albedo as green leaves, it may be inappropriate for the model to treat LAI and SAI the same in the FPAR and albedo parameterizations. If so, the role of SAI in these parameterizations needs reformulation.

H22C MCC: Level 2 Tuesday 1330h

Hydrogeophysics: Characterization and Monitoring of Soil Properties and Processes in the Laboratory III Posters *(joint with NG, MR)*

Presiding: **D Lesmes,** George Washington University**; S Vega,** Stanford University

H22C-0937 1330h POSTER

Experimental Rock-on-Rock Abrasive Wear Under Aqueous Conditions: its Role in Subglacial Abrasion

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We have determined experimentally the rate of abrasive wear of rock on rock for a range of rock types as a function of normal stress and shear displacement. Unlike abrasive wear in fault zones, where wear products accumulate as a thickening gouge zone, in our experiments wear particles were removed by flowing water. The experiments are thus directly pertinent to one of the most important processes in subglacial erosion, and to some extent in river incision. Wear was produced between rotating discs machined from rock samples and measured from the progressive approach of the disc axes towards each other under various levels of normal load. Shear displacements of several km were produced. Optical and scanning electron microscopy