Hydrology

H51A MCC: Hall C Friday 0830h

Hydroclimatology of Large Northern Watersheds: From Observation to Modeling I Posters *(joint with B, OS, GC)*

Presiding: **D Yang,** University of Alaska, Fairbanks**; M Serreze,** University of Colorado

H51A-0760 0830h POSTER

Relation Between Carbon-13/Carbon-12 Ratio and Ring Index of Eastern Siberian Trees Changes Under Different Water Conditions

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The relationships between early/latewood width, cellulose carbon-13/carbon-12 ratio (d13C), and soil water content of trees growing on a Larix gmelinii and a Pinus sylvestris stand in Yakutsk, Eastern Siberia were studied. The two sites differed considerably in soil water content, because flooding caused by snowmelt in spring and subsequent drought by dry summer climate provided a marked contrast in soil water condition between early- and latewood formation period. In order to examine whether drought influence d13C - ring width relation, we collected wood samples from eight L.gmelinii and four P.sylvestris trees from the two sites and measured both ring widths and d13C of early- and latewoods formed during 1996-2000. Growth season precipitation correlated well with latewood d13C, and seasonal soil water content change also corresponded to intra-ring d13C. We found negative d13C - latewood width correlation (r = -0.79 for Larix and -0.84 for Pinus, p = 0.005 for both) only at the Pinus site (dry site). Decrease and/or early cessation of latewood growth and increased d13C under water-stressed condition may explain this negative correlation. This signifies the possibility of using the correlation as a drought indicator of trees in this region.

H51A-0761 0830h POSTER

Modeling Active Layer Depth Over Permafrost for the Arctic Drainage Basin and the Comparison to Measurements at CALM Field Sites

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A finite difference model for one-dimensional heat conduction with phase change is applied to investigate soil freezing and thawing processes over the Arctic drainage basin. Calculations are performed on the 25 km x 25 km resolution NSIDC EASE-Grid.
NCEP re-analyzed sigma-0.995 surface temperature with a topography correction, and SSM/I-derived weekly snow height are used as forcing parameters. The importance of using an annual cycle of snow density for different snow classes is emphasized. Soil bulk density and the percentages of silt/clay and sand/gravel are from the SoilData System of the International Geosphere Biosphere Programme. In addition, we parameterize a spatially and vertically variable peat layer and modify soil bulk density and thermal conductivity accordingly. Climatological soil moisture content is from the Permafrost/Water Balance Model (P/WBM) at the University of New Hampshire.
The model domain is divided into 3 layers with distinct thermal properties of frozen and thawed soil, respectively. Calculations are performed on 54 model nodes ranging from a thickness of 10 cm near the surface to 1 m at 15 m depth. Initial temperatures are chosen according to the grid cell's IPA permafrost classification on EASE grid.
Active layer depths, simulated for the summers of 1999 and 2000, compare well to maximal thaw depths measured at about 60 Circumarctic Active Layer Monitoring Network (CALM) field sites. A remaining RMS-error between modeled and measured values is attributed mainly to scale discrepancies (100 m x 100 m vs. 25 km x 25 km) based on differences in the fields of air temperature, snow height, and soil bulk density.
For the whole pan-Arctic land mass and the time period 1980 through 2001, this study shows the regionally highly variable active layer depth, frozen ground depth, lengths of freezing and thawing periods, and the day of year when the maxima are reached.

H51A-0762 0830h POSTER

Using Snow Water Equivalent to Understand the Hydrology of the Arctic Drainage System.

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River discharge is a primary driver of the Arctic Ocean freshwater budget. The timing and magnitude of discharge is strongly allied with cold season snow mass storage and subsequent melt. Snow water equivalent (SWE) from passive microwave is a potentially valuable tool for Arctic hydrologic studies, however, there have been relatively few validation efforts. This study examines depictions of SWE from the Special Sensor Microwave/Imager over the Arctic terrestrial drainage system.

We use SWE derived from passive microwave satellite sensors over the period 1987 - 1999, along with observed precipitation, temperature and river discharge data. Efforts focus on: comparing annual peak SWE with accumulated cold season precipitation, correlation analyses between monthly cold season precipitation and monthly changes in SWE, and assessments of peak SWE against runoff and spring precipitation. Analyses will be conducted using gridded data for the Arctic drainage and aggregations for the major watersheds (the Ob, Yenisey, Lena and Mackenzie basins). Past studies have shown that cold season precipitation, and by implication, SWE, is highly correlated with spring river discharge in the Lena basin. This is due to extensive permafrost, which simplifies the runoff processes. Thus the Lena basin provides an ideal test of the value of the satellite-derived SWE product.

H51A-0763 0830h POSTER

Interannual variations of vegetation activity and hydrologic cycle observed in Eastern Siberia using stable isotopes of water

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East Siberian taiga is a unique ecosystem, which is established on permafrost. Climate there is extremely dry (about 250mm of annual mean precipitation). Soil moisture, water relating vegetation activities, stable isotope ratios of variety of water (precipitation, soil water, sap water, river water, etc) were observed at Yakutsk, Russia. Large interannual variation was observed in soil moisture and its stable isotopic composition, depending on summer rainfall. Observational results also shows that pulse of spring snowmelt makes seasonal variation in soil moisture, which superimposes on the interannual variation. Although the snow meltwater is not so important for interannual variation of soil moisture, it is extremely important for plant activities, because highest photosynthetic and transpiration activities soon after leaf unfolding are supported by the snow meltwater. Ice meltwater from permafrost is also very important as a direct water source for plants during drought. In other wards, function of soil for water storage stabilizes transpiration. Discrepancy of the period of transpiration by plants (maximum in June) and soil thaw may also derive another time-lag for hydrologic cycle, and water stress in late summer during dry year may also affect the activity of vegetation in the following summer.

H51A-0764 0830h POSTER

Solid Precipitation Measurement Intercomparison in Barrow Alaska, 2001-2002

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An intercomparison experiment of precipitation gauges in high latitude regions of high winds, Barrow, Alaska has continuously carried out since 2000. The Double Fence Intercomparison Reference (DFIR) recommended by the WMO has been installed for measuring true snowfall amount. The Wyoming snow gauge system and several national standard gauges currently used in Arctic regions were installed for test. A snow particle counter system was installed in the observation site for selected blowing snow observations, and the number flux of aeolian snow particles at different particle diameters was measured for investigating the structure of blowing snow within 2.5m above the ground. We also set up an automatic weather station for measuring weather conditions.

Precipitation events of 20-65 were obtained up to the end of March 2001. These event data sometime were total accumulation of several precipitation events. High frequency of trace precipitation was recorded in all gauges. Preliminary mean ratios of the Wyoming gauge system, the Canadian Nipher gauge and the Russian Tretyakov gauge versus the DFIR were 79%, 69%, 66%, respectively. On the other hand, the ratios of the US8" gauge and the Hellmann gauge versus the DFIR were 18% and 10%, respectively. This tendency was similar to the results of the WMO Solid Precipitation Measurement Intercomparison carried out at middle latitudes sites. The blowing snow experiments showed that the number flux of aeolian snow particles at a gauge orifice height verily increased with the occurrence of blowing snow. More precipitation and blowing snow data will be collected at the observation site in the coming winters. They will enable us to carry out further analysis. More efforts are needed to evaluate bias correction procedures suitable for the high latitude regions.

H51A-0765 0830h POSTER

Another Look at Precipitation Recycling With Application to the Arctic

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Research on the atmospheric component of the Arctic hydrologic cycle has become more quantitative over the last decade as a result of enhanced remote sensing

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techniques, improved observational data distribution methods, and the availability of gridded atmospheric fields which are referred to as numerical analyses or reanalyses depending on the production method. The challenge now is in data validation, identification of the processes responsible for producing the observed spatial distributions, understanding how these mechanisms evolve on various time scales, and establishing the linkages with other hydrologic components. A mechanism of current interest over terrestrial land surfaces surrounding the Arctic Basin is known as precipitation recycling. Recycled precipitation is defined as that fraction of moisture that precipitates on a specified region that had previously precipitated in situ, and is contrasted with the advected moisture precipitation component. Recent studies have suggested a substantial or even dominant role for this mechanism for the summer months in high northern latitudes, as evaluated via traditional bulk diagnostic methods. Two fundamental concerns with the application of these methods in the Arctic are (1) the discounting of the precipitable water tendency term, which is known to be large in high latitudes and (2) the assumption that the total flux of atmospheric moisture is represented by the mean, while the transient component of the atmospheric moisture transport is known to be large and even dominant in polar regions. These two issue comprise fundamental characteristics of the Arctic atmospheric hydrologic budget. In this study, atmospheric moisture recycling is computed for in situ and gridded data via traditional methods and a high latitude-specific method. Discrepancies between methods used are identified and the consequences of the above assumptions are presented. Additionally, an evaluation of analyzed atmospheric moisture quantities is performed via comparisons to observational data. In particular, we address the issue of an eastward precipitation gradient over central and eastern Siberia that is found with in situ observational syntheses but not in numerical analyses depictions.

URL: http://www.uaf.edu/water/projects/NorthSlope/northslope.html

H51A-0766 0830h INVITED POSTER

Soil Moisture Response to a Changing Climate in Arctic Regions

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Soil moisture is the land surface hydrologic variable that most strongly affects land-atmosphere moisture and energy fluxes. In Arctic regions, these interactions are complicated by the role of permafrost. Especially in northern regions, soil moisture therefore is important not only as a hydrological storage component, also as a result of its strong influence on the hydrological cycle through controls on energy fluxes such as evaporative heat flux, phase change in thawing of permafrost, and effects on thermal conductivity. With projected increases in surface temperature and decreases in surface moisture levels that may be associated with global warming, it is likely that the active layer thickness will increase, leading to subtle but predictable ecosystem responses such as vegetation changes.

Field measurements of soil moisture have been collected on the North Slope of Alaska, with emphasis upon establishing macro and micro-topographic influences. Sites were installed in the foothill regions and on the coastal plain of the Kuparuk River basin. Spatially distributed model simulations are being conducted across a range of scales. Preliminary results indicate macro-topographic gradients greatly impact the importance of lateral versus vertical fluxes. Microtopographic differences affect the small spatial scale differences in soil moisture, but have less impact upon flux direction. Permafrost in arctic regions exerts a significant influence on soil moisture through controls on vegetation and drainage. In relatively flat areas where the frozen layer is near the surface, the soil moisture contents are usually quite high. These areas have relatively high evapotranspiration and sensible heat transfer, but quite low conductive heat transfers due to the insulative properties of thick organic soils. As in more temperate regions, watershed morphology exerts strong controls on hydrological processes; however unique to arctic watersheds are complications arising from the short-term active layer dynamics and longer-term permafrost dynamics. As the active layer becomes thicker throughout the summer, it has a greater capacity to store water, resulting in a time-varying basin response to storm events. As the season progresses, the stream recession rates increase as more hillslope water flows through the soil rather than as overland flow. Peak flows are also more attenuated as the active layer increases in thickness or as permafrost areal extent decreases.

H51A-0767 0830h POSTER

Snow ablation process in the southern mountainous taiga of eastern Siberia, during an early spring

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The southern mountain taiga region is the water source of the Lena and Bikal basins. Ma et al. (2000) showed that most of the water in these rivers flows from south-eastern Siberia, which has heavy rain, especially in the summer. From August 2000 to May 2002, we made long-term observations of the water, energy, and carbon cycles on a catchment scale. This paper presents results of an intensive observation on snowmelt, sublimation and energy balance during a spring in 2002. The Mogot experimental watershed is located in the southern mountain region of eastern Siberia (55.5°N, 124.7°E) approximately 60 km north of Tynda, in the Amur region, Russia. The observation site is the catchment of the Nelka River. The basin is about 12 km long and 2.5 km wide, with a total area of approximately 30.8 km2; the slopes are exposed to the northeast and southwest. In this basin, altitudes range from approximately 580 to 1150 m. The land surface is predominantly covered by larch forest, but birch forest partly covers the ridge area and higher elevations are covered by pine forest. Three sites with typical surface conditions were selected to observe meteorological elements. Two sites, LF (Larch forest, 610m) and OP (grassland, 608m) were at the bottom of the valley, and another site ES (Larch forest, 635m) was located in an east slope. Snowmelt begun from 4 April 2002 and snow disappearance date was 7 May 2002. There was large difference of air temperature and relative humidity between Site OP or LF and ES in March 2002, but difference of air temperature and relative humidity between Site OP and LF was not significant. The difference of altitude between OP or LF and ES was approximately 30 m. Thus, this demonstrated that strong inversion layer existed above the snow surface. As season has gone on, then inversion layer was getting weak. Monthly mean evaporation was 0.26 mm/day in March. We also observed evaporation pan observation. The amount of evaporation was 0.24 mm/day so both observational values for evaporation from snowpack were similar. Furthermore, evaporation of site LF was greater than that of site ES. The most important energy to evaporation was soil heat flux during an early spring. Soil heat flux of site LF also was greater than that of site ES. Thus, different soil heat flux made the differences in evaporation. During early spring, strong inversion layer occurred at the atmospheric surface layer above the snow surface. There was good positive correlation between soil heat flux and strength of atmospheric inversion. The strength of atmospheric inversion increased the soil surface flux into a snowpack and we think that soil heat flux contributed the latent heat flux during March because the most of net radiation was negative and sensible heat flux was not significant. Therefore, strong atmospheric inversion caused the energy for latent heat flux and spatial variation of evaporation during early spring.

H51A-0768 0830h POSTER

Climate, Surface Energy Balance and Ground Thermal Regime at Three Arctic Sites (Spitsbergen, Siberia, Alaska)

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We examine differences between three study sites located on Spitsbergen, in Alaska and in Siberia with respect to climate (air temperature, snow cover, net radiation), surface energy balance (evaporation, ground heat flux), surface characteristics and parent material. By comparing surface energy balance components of these three sites, the control mechanisms at the local scale (such as surface characteristics) are examined relative to the larger scale factors (such as climate).

At all these sites, stations are installed on patterned ground: frost boils on Spitsbergen, low-centered polygons in Siberia and tussock tundra in Alaska. In addition to differences in surface characteristics and soil material, climatic conditions at the three sites are also different. The Lena Delta has the most continental climate (coldest winter air temperature and lowest precipitation), while Spitsbergen has a mild, maritime winter climate due to the influence of the Atlantic current.

Continuous permafrost underlies all these sites. Though the sites on Spitsbergen and Alaska have different climates, the annual temperature at the top of the permafrost is similar (−3°C) however, the Alaskan summer is much warmer and the winter is much colder than Spitsbergen. The site in Siberia is underlain by cold permafrost with an annual surface permafrost temperature of −10°C. These climatic differences introduce important differences in the surface energy balance and ground thermal regime. Preliminary results of energy balance modeling show differences in snow ablation. Net radiation provides the major energy input for snow melt in Spitsbergen, while the snow ablation at Ivotuk is governed by atmospheric sensible heat. Almost 50 % of the total available energy during the snow ablation period at the Siberian site is lost to sublimation.

H51A-0769 0830h POSTER

Climatic change and river ice regime in the Lena River during the last 16 years

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Lena River, one of the four largest rivers flowing into the Arctic Ocean, freezes over completely from early December to late April. The process of river-ice formation is affected by regional thermal and climatic conditions. Even though flooding occurs in the Lena River basin by snowmelt and ice jams each spring. However, there were three catastrophic floods occurred in 1998, 1999 and 2001 during the preceding 30 years. Especially, the flood in 2001 is the worst for over 100 years. In order to determine the cause of the formation of flooding, a data analysis and modeling of breakup date based on meteorological data was carried out in this study. The length of data set was 16 years, 9 years (from 1986 to 1994) coming from GAME-Siberia Committee and 6 years (after 1994) from NOAA/NCDC. From the meteorological data, the amount of precipitation in winter season (From October to April) shows increasing with an interannual variation. A decrease in winter temperature could be found during 1988-2000 and minimum temperature of winter occurred in 2000. The winter temperature in 2001 will likely be near or above the long-term average value. In this study, a simple accumulated degree-day method was used to estimate the river ice breakup date and a model calibration was done in the period of 1986-1988. Here, six river sections (Zhigansk, Yakutsk, Isit, Olekmink, Vitim and Kirensk) along the Lena River were selected and a long-term simulation was carried out for estimating breakup date and river ice thickness. The results show: 1) ice breakup date depends on local climate condition for each section; 2) the difference in breakup dates between upstream (Kirensk) and midstream (Yakutsk) ranges from several days to about 70 days for the previous 16 years; 3) the winter temperature of 2000 has led to a maximum in the thickness of river ice for the last 16 years.

H51A-0770 0830h POSTER

Increasing Arctic River Discharge: Responses and Feedbacks to Global Climate Change

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The Eurasian Arctic contains some of the largest rivers on Earth. Our synthesis of river monitoring data reveals that the average annual discharge of freshwater from the six largest Eurasian rivers (Yenisey, Lena, Ob', Kolyma, Pechora, S. Dvina) to the Arctic Ocean increased about 7% from 1936 through 1999. Correspondence between discharge from these Eurasian arctic rivers and the North Atlantic Oscillation (NAO) suggests that variations in discharge are coupled to hemispheric climate patterns. Increases in discharge also correspond to increases in global, pan-Arctic, and Eurasian arctic temperatures. If the increasing river discharge is a response to global warming, the quantity of extra water delivered to the Arctic Ocean within the next century could approach that predicted by climate models to significantly impact the Atlantic thermohaline circulation.

H51A-0771 0830h POSTER

Changes in Lena River Streamflow Hydrology: Human Impacts vs. Natural Variations

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This study systematically analyzes long-term (1942-1990) monthly discharge records for the major subbasins within the Lena River watershed in order to document significant streamflow hydrology changes induced by human activities (particularly reservoirs) and by natural variations/changes. The results show that, the upper streams of the watershed, without much human impact, experience a runoff increase in winter, spring and (particularly) summer seasons, and a discharge decrease in fall season. These changes in seasonal streamflow characteristics indicate a hydrologic regime shift toward early snowmelt and higher summer streamflow perhaps due to regional climate warming and permafrost degradation in the southern parts of Siberia. The results also demonstrate that the reservoir regulation has significantly altered the monthly discharge regime in the lower parts of Lena river basin. Because of a large dam in west Lena river, peak discharge in the Vului valley has been reduced by 10-80% in the summer season and low flow has been increased by 7-120 times during the cold months. These alternations, plus a remarkable streamflow increase in May and a decrease in June over the Lower Lena basin, lead to a streamflow regime shift toward early peak flow at the Lena basin outlet. Due to reservoir regulations, discharge records observed at the Lena basin outlet do not always represent natural changes and variations, they tend to underestimate the natural runoff trends in summer and overestimate the trends in winter and fall seasons. Therefore, cold season discharge increase identified at the mouth of the Lena basin is not all natural-caused, but the combined effect of reservoir regulation and natural runoff changes in the unregulated upper sub-basins. This study clearly illustrates the importance of human activities in regional and global environment changes, and points to a need to examine human impacts in other large high-latitude watersheds.

H51A-0772 0830h POSTER

Contemporary Changes in Eurasian pan-Arctic River Discharge

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Increases in the fresh water discharge to the Arctic Ocean from Eurasia have been observed for two decades. We seek to identify the major sources of this increase (natural variability, global warming or direct human causes) for the 10 largest Eurasian watersheds in the pan-Arctic. Using an updated R-ArcticNET database (http://www.R-ArcticNET.sr.unh.edu) along with gridded fields of precipitation and air temperature, mean watershed time series were calculated. All river basins show increasing the air temperature over the last 30 years. The greatest runoff increase is observed for the large European rivers (Severnaya Dvina, Pechora) where it is related to rising precipitation. The largest Siberian rivers, Yenisey and Lena, which have a large permafrost extent, show the increasing annual runoff despite a decline in precipitation. This is possibly due to permafrost melt but we feel the current data sets are insufficient to confirm this result.

Seasonal trends in river discharge show winter values increasing by 85% on the Yenisey, 39% on the Lena, 16% on the Ob, and 10% on the Severnaya Dvina over the last 12 years. We now believe that it is no longer possible to use the down stream gauges of these large basins for seasonal change analysis because of the impoundments within these basins. While at first the reservoirs appear small, their impact during low flow (winter) could be significant. Therefore, we look at 97 smaller drainage basins (5 000 to 100 000 km2) with at least 50 years of record and minimal human impact. We find that since the mid-70s significant increases (10-30%) in winter and summer-autumn runoff are observed on rivers located on the north slope of the European Russia. Winter runoff has increased 40-60% in Irtysh basin and in the Lake Baikal region and 15-35% in northern part of Siberia.

This preliminary analysis has shown two general tendencies in river runoff across the Arctic Ocean drainage basin: 1) increases in annual runoff due primarily to a rise in precipitation, permafrost melting and faster spring snowmelt (increasing air temperature); 2) large winter increases in runoff due to shorter cold period (increasing air temperature), rising ground water storage and earlier spring snow melt. We also discuss the deterioration in observational capability and data quality for the last 15 years and how it may affects reliability of river discharge estimates.

H51A-0773 0830h POSTER

Historical and Satellite Observations of Spring Ice Breakup, Mackenzie River, Canada

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The process of river ice breakup plays an important role in shaping adjacent physical, biological, and human systems on major arctic rivers. The spring flood and associated ice breakup represents the most important event of the year, playing a large role in sediment transport, replenishment of perched ecosystems, and damage to bridges and riverbank structures. Breakup is also important from a climatic perspective, since the timing of breakup can be a useful index of regional climate change. A large body of literature exists which exploits observations of ice breakup as a proxy for climate change. However, the potential for using remotely sensed imagery to study the timing and spatial dynamics of ice breakup is less well documented. In order to better understand the breakup process, the present study uses synthetic aperture radar (SAR) and AVHRR imagery from the last ten years to examine breakup and spring flood dynamics on the Mackenzie River. AVHRR imagery allows examination of breakup along the entire course of the river at a high temporal resolution, while SAR imagery allows the detailed examination of breakup at a much greater spatial resolution as well as through clouds. These data are compared with point observations from stations along the Mackenzie to infer differences in breakup regime over the last half century.

H51A-0774 0830h POSTER

Streamflow Regime and Change in the Large Northern Watersheds

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Observational records show significant climate change in the high latitude regions over the past several decades. Hydrologic response of the large northern watersheds to climate change and variation is one of the key issues in understanding atmosphere-land interactions in the northern regions. Examination and documentation of changes in the major northern rivers are also important to studies of global change, regional water resources and distribution of ecosystems. This study systematically analyzes the long-term monthly streamflow records over the past 40-50 years for the large northern watersheds, such as the Lena, Yenisei, Ob rivers, Yukon and Mackenzie basins. The objectives are to describe the seasonal regime of river streamflow, and to document significant streamflow hydrology changes induced by human activities (particularly reservoirs) and by natural variations/changes. The results of this study show significant changes in streamflow characteristics. These include amount and timing of snowmelt runoff, summer season discharge, and an increase of winter discharge over most of the watersheds. These changes identified may indicate a hydrologic regime shift due to recent climate warming over the northern regions. They may also be related to changes in permafrost conditions and influenced by human activities. Our efforts continue to identify the changes in streamflow hydrology in different sub-basins of the large watersheds, to examine the inter-annual variation of monthly discharge and their responses to variations in climate conditions, and to quantify the human impact to regional hydrologic changes.

URL: http://www.uaf.edu/water

H51A-0775 0830h POSTER

Sensitivity of the Precipitation Gauge Correction for the Estimation of Global and Continental Water Balance

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GSWP-I was an intercomparison project of eleven LSMs to evaluate their results and to discuss problems among them. Runoff observations at 250 stations had been collected for 1987 and 1988, and were compared with the LSM results. It was found that land surface models (LSMs) could estimate annual runoff fairly well in general, but, all of the models tend to underestimate the annual runoff in the high latitudes. It was suggested that the underestimation is caused by the observational bias of forcing data, especially for solid precipitation. The aim of this study to investigate the sensitivity of the precipitation gauge correction for the estimation of the global water balance by LSMs, based on a compensated global precipitation dataset. According to the correction, the precipitation increases by 100mm and the runoff increases by 50mm on average in the high latitude of the northern hemisphere. It is found that:

1. The runoff underestimation in the high latitude, which was found in the previous GSWP experiment, was reduced by the gauge correction.

2. After the compensation, global precipitation increased approximately 100 mm/yr and global runoff increase was 40 to 50 mm/yr.

3. Global precipitation and runoff and those on continental basin scale were reasonable from the atmospheric water balance.

The bias of runoff underestimation in a high-latitude became smaller than that of the previous GSWP experiment, however, the variance of error didn't become smaller yet. This fact shows that the direction of compensation is proper but it needs still

more improvement in estimating more realistic runoff amount.

H51A-0776 0830h POSTER

Biogeochemical Tracers in Arctic Rivers: Linking the Pan-Arctic Watershed to the Arctic Ocean (the PARTNERS project)

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The Arctic is undergoing unusual and apparently progressive changes in the land, ocean, and atmospheric components of the hydrologic cycle that could have long-term consequences for both local and global climate. Understanding sources and fates of river discharge is important because rivers make an enormous contribution to the freshwater budget of the Arctic Ocean, presently accounting for 50 to 60 percent of all freshwater inputs. The overall objective of the PARTNERS project is to use river water chemistry as a means to study the origins and fates of continental runoff. Through a collaboration among Russian, Canadian, Germany, and U.S. scientists, we have compiled and evaluated existing biogeochemical data sets for large arctic rivers. Our synthesis of nutrient and sediment data sets has revealed large gaps and uncertainties in biogeochemical fluxes, so in the next phase of the project we will be collecting and analyzing new samples from the six largest arctic rivers (Yenisey, Lena, Ob', Mackenzie, Yukon, Kolyma). Samples will be analyzed for a wide range of constituents, focusing on compounds that can be used as tracers of river water in the Arctic Ocean or that give clues about watershed sources or processes. Sampling will occur several times per year for four years (2003-2007). This multinational, multidisciplinary project will greatly improve our understanding of land-ocean linkage in the pan-Arctic watershed.

H51A-0777 0830h POSTER

Atmospheric processes responsible for the interannual seesaw-like summer dry and wet regimes in Northern Eurasia

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In northern Eurasia, interannual variability of summer (June–August) precipitation has a marked signature with east-west seesaw-like interchange of dry and wet extremes across Siberia. For example, an out-of-phase relationship with nearly 6–8-year cycle in the basin-scale precipitation for the Ob and Lena River and associated replacement of Siberian wet and dry regimes appear from 1970s through 1980s. (Fukutomi et al. 2002, submitted to JHM). We further investigate the atmospheric conditions for these regimes based on the NCEP reanalysis and precipitation products (PLEC/L).

A singular value decomposition (SVD) analysis is applied to 500hPa Northern Hemisphere geopotential height and the Siberian precipitation for 30 summers 1972-2001. The leading mode of coupled variability (SVD1) is characterized by an east-west dipole structure of Eurasian quasi-stationary wave and precipitation anomalies. When eastern Siberia is wet, a low-height anomalies accompanied by lower-tropospheric cold-air anomalies are formed, while a high-height anomalies with warm-air anomalies are produced over western Siberia; the reverse situation is established at eastern Siberian dry case. Three sets of eastern Siberian wet (dry)–western Siberian dry (wet) extremes are selected to examine the physical processes in detail.

The seasonal variances of daily 2–6-day (synoptic scale) filtered sea level pressure fields are enhanced in the wet and low-height anomalies while reduced in the dry and high-height anomalies at each extreme phase, which indicates that remarkable interannual changes in the location of genesis and tracks of synoptic-scale disturbances occur in association with these specific regimes. The analysis with eddy statistics demonstrates an impact of synoptic-scale eddy activities on the maintenance of the Eurasian quasi-stationary wave structure at the extreme phases of dipole rainfall anomalies. An eddy vorticity flux convergence (divergence) is concentrated in the low- (high-) height anomalies in the upper troposphere, and eddy heat flux convergence (divergence) is also superimposed on the low- (high-) height anomalies in the lower troposphere. These features suggest that the barotropic feedback induced by synoptic-scale eddies acts to reinforce the Eurasian quasi-stationary waves, and the baroclinic feedback acts to dissipate the thermal structure of these wave anomalies.

H51A-0778 0830h POSTER

Dynamic Observations of Ground Water Flow Through Discontinuous Permafrost Zones and Varied Alluvial Media

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The site-specific ground water regime affiliated with a permafrost environment has not yet received investigative emphasis commensurate to its level of importance. We are studying this hydrological regime in Fairbanks AK through a series of integrated studies that characterize ground water flow by deploying a series of ground water flow systems to continuously monitor flow rates and directions within the suprapermafrost aquifer, taliks, thaw channels, subpermafrost aquifer and areas proximal to the nearby Chena River. Ground water hydrology in a permafrost environment is complicated not only by water flowing through varied surficial materials, but also by factors unique to the permafrost environment. Changes in ground ice and the active layer can alter the water budget in a manner which is hard to quantify, as it adds and removes water according to short-term seasonal and long-term climatic temperature variations. These conditions may impose temporal changes on ground water flow as it moves along already complex pathways constrained by the irregularly shaped impermeable masses of permafrost. We observed variations in flow rates and directions coincident with what would be expected based on local permafrost configuration. Melting snow pack and river ice can both serve as sources of aquifer recharge, although the magnitude of that recharge can vary spatially depending on available recharge and infiltration potential. Areal recharge can displace portions of the ground water reservoir through the river banks, manifested as ground water reversals in wells proximal to the river. Conversely, melting river ice during spring break-up imposed ground water reversals where pulses of river water were emitted to the ground water aquifer. These observations of local ground water flow rates and directions, contribute to a holistic understanding of ground water flow in permafrost environments, especially when taken in the larger context of other related geophysical and modeling studies aimed to understand permafrost.

H51B MCC: Hall C Friday 0830h

Surface Water Hydrology and Water Resources Posters

Presiding: **J Jacob,** University of Florida

H51B-0779 0830h POSTER

Operating Water Resources Systems Under Climate Change Scenarios

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Population and industrial growth has resulted in intense demands on the quantity and quality of water resources worldwide. Moreover, climate change/variability is making a growing percentage of the earth's population vulnerable to extreme weather events (drought and flood). The 1996 Saguenay flood, 1997 Red River flood, the 1998 ice storm, and recent droughts in prairies are few examples of extreme weather events in Canada. Rising economic prosperity, growth in urban population, aging infrastructure, and a changing climate are increasing the vulnerability of Canadians to even more serious impacts. This growing threat can seriously undermine the social and economic viability of the country. Our ability to understand the impacts of climate change/variability on water quantity, quality, and its distribution in time and space can prepare us for sustainable management of this precious resource. The sustainability of water resources, over the medium to long-term, is critically dependent on the ability to manage (plan and operate) water resource systems under a more variable and perhaps warmer future climate.

Studying the impacts of climate change/variability on water resources is complex and challenging. It is further complicated by the fact that impacts vary with time and are different at different locations. This study deals with the impacts of climate change/variability on water resources in a portion of the Red River Basin in Canada, both in terms of change in quantity and spatial-temporal distribution.

A System Dynamics model is developed to describe the operation of the Shellmouth Reservoir located on the Red River in Canada. The climate data from Canadian Global Coupled Model, CGCM1 is used. The spatial system dynamics approach, based on distributed parameter control theory, is used to model the impacts of climate change/variability on water resources in time and space. A decision support system is developed to help reservoir operators and decision makers in sustainable management of water resources. The decision support system helps in analyzing the impacts of different reservoir operation scenarios, under changing climate conditions, by exploring multiple- what-if- scenarios. Canadian study areas and data sets are used for the research. However, the proposed approach provides a general framework that can be used in other parts of the world.

H51B-0780 0830h POSTER

The Impact of a Flood Retarding Structure on Watershed Runoff Under Dry, Average, and Wet Climatic States

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Flood damage to agricultural lands during the late 1930s and early 1940s prompted passage of the Federal Flood Control Act of 1944 (P.L. 78-534) and the Watershed Protection and Flood Prevention Act (P.L. 83-566) of 1953. As a result of these flood abatement programs, the USDA SCS constructed about 2,500 flood retarding structures (FRSs) in the State of Oklahoma to control runoff from about 22,000 km2. One of the pilot projects implemented in the flood abatement programs was the treatment of tributaries in the Washita River Basin in southwestern Oklahoma. The Little Washita River Experimental Watershed (LWREW) represents one such tributary that was instrumented during the 1960s to determine the downstream hydrologic impacts of the SCS flood retarding structures. Previous studies have investigated the impacts of FRSs on water yield, peak reduction, and flow frequency for tributaries in the Washita River Basin. Implicit in these investigations was the assumption that changes in measured runoff characteristics before and after construction of the FRSs were due only to the construction of these structures. Even though decade-long climate variations during the 1961-1990 period were recognized, they were not explicitly considered in previous analyses and resulted in difficult interpretation of results. Furthermore, flood frequency studies were limited by the short period of record before and after the installation of the FRSs. Computer simulation of watershed response provides the opportunity to determine the impacts of FRSs on runoff characteristics without the confusing effect of climate variations. The objective of this study is to determine the effect of a FRS on the flow regime and peak flows of subwatershed 442 within the Little Washita River Experimental Watershed in southwestern Oklahoma. Observed precipitation and streamflow data are complemented by computer simulations to overcome many of the shortcomings in previous analyses. Climate generation techniques are employed to assess of the magnitude of the impacts of the FRS relative to changes in watershed response due to decade-long climate variations. The results of this study provide a better estimation of the beneficial impacts of FRSs on downstream flow regime and the reduction of downstream flood risk under dry, average, and wet climatic conditions.

H51B-0781 0830h POSTER

Water Level Fluctuations in the Plata Basin (South America) From Topex/Poseidon Satellite Altimetry

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