Asia CliC Workshop
on
Large-scale hydrometeorology of Asian Cryosphere

Abstract

Date: May 17 to 19, 2007

Venue: Yokohama Institute for Earth Science, JAMSTEC, Yokohama, Japan

Organized by (tentative)

IORGC/JAMSTEC

WCRP-CliC Science Steering Group

Japan CliC Committee

China CliC Committee

Workshop Website: http://www.jamstec.go.jp/iorgc/workshop/asiaclic2007/

Conveners Group (tentative)

Tetsuo OHATA (Institute of Observational Research for Global Change, JAMSTEC)
Xin LI (Cold and Arid Regions Environmental and Engineering Research Institute)
Takeshi OHTA (Nagoya University)
Terry PROWSE (University of Victoria & Environment Canada)
Kazuyuki SAITO (International Arctic Research Center, University of Alaska Fairbanks & Frontier Research Center for Global Change, JAMSTEC)
Jinro UKITA (Chiba University)
Daqing YANG (Water and Environmental Research Center, University of Alaska Fairbanks)

Workshop Secretariat

Konosuke SUGIURA (Institute of Observational Research for Global Change, JAMSTEC)
Setsuko ICHIKAWA (Institute of Observational Research for Global Change, JAMSTEC)

Overview of CliC Project

V. Lytle, B. Goodison, V. Ryabinin, and T. Ohata

CliC project

ABSTRACT

The Climate and Cryosphere Project (CliC) is one of the four core projects of the World Climate Research Program (WCRP). CliC's principal goal is to assess and quantify the impacts that climate variability and change have on components of the cryosphere and its overall stability, and the consequences of these impacts for the climate system. CliC is helping to co-ordinate the WCRP role in the International Polar Year (IPY), in particular to insure that a legacy of data management, observational and research capabilities remain after IPY. CliC has also been instrumental in completing the IGOS-cryo theme document. The Theme will create a framework for improved coordination of cryospheric observations conducted by research, long-term scientific monitoring, and operational programs, and to generate the data and information needed for both operational services and research. This presentation will review these and other initiatives and how they relate to Asia-CliC.

An Overview of the ICARPII Cryosphere and Hydrology Research Plan

Terry D. Prowse[1,2)]

1: Climate Impacts on Water Resources, University of Victoria, BC, Canada
2: Climate Impacts on Hydrology and Aquatic Ecosystems, National Water Research Institute, Environment Canada

ABSTRACT

At the Second International Conference on Arctic Research Planning, ICARP II (10-13 November 2005; Copenhagen, Denmark) a series of research plans were presented to guide international science cooperation in the Arctic over the next 10-15 years. One of these plans, developed by a team of circumpolar scientists over a two-year period, focused on "Terrestrial Cryosphere and Hydrologic Systems". Since that time and some subsequent "implementation" workshops, the cryosphere-hydrology plan has become the cornerstone of some international Arctic science plans including: a) one of the central strategic areas for the World Climate and Research Program, Cliamte and the Cryosphere: CliC, and b) the international program Arctic-HYDRA, a focal point of circumpolar hydrologic studies under the International Polar Year (IPY). The final ICARPII cryosphere and hydrology plan can be found at the ICARP http://www.icarp.dk/WGreports/WG7_Final.pdf or World Climate Research Program http://wcrp.wmo.int/pdf/WG7_Final-1.pdf web sites. This presentation outlines the stages in the development of the plan, key short- and long-term science objectives, some current research activities under IPY, as well as the major plan components including ground-based field research, proposed remote sensing initiatives, and requisite upscale modelling.

Snow Cover Data and Variations in Snow Characteristics over the Russian Territory

V. N. Razuvaev, and O. N. Bulygina

All-Russian Research Institute of Hydrometeorological Information - World Data Centre (RIHMI-WDC), 6 Korolev St., Obninsk, Kaluga Reg., 249035, Russian Federation

ABSTRACT

Regular snow cover height measurements on stations were started in Russia in 1902 and modern snow survey observations, including snow water equivalent, in 1966. Time series of snow depth daily data on the extent to which the near-station territory is covered with snow for Russian stations is prepared in RIHMI-WDC. These data and time series of snow survey data on more than 1000 stations were used for investigation of variations in the most important characteristics of snow cover in recent decades.

The snow cover characteristics were analyzed for both the total territory and seven quasi-homogeneous climatic regions of Russia. In the Far East, the increase in the average snow depth is correlated with the winter and autumn precipitation growth.

Data sets with the number of days with different snow depths are derived from daily observations. For the Russian territory, the number of days with the snow depth more than 1.0 cm tends to decrease, in the Urals, Siberia and the Chukot Peninsula in the past decades, while the number of days with the significant snow depth (over 20.0 cm) tends to increase slightly.

For investigation of changes in some useful snow parameters, snow line, for example, it will be necessary to prepare joint data files for Russian, Kazakhstan and other countries. Evidently, one of the problems here will be comparability of the data for the various countries.

Response of River Runoff in Cryolithic Zone of Eastern Siberia (Lena River Basin) to Recent and Future Climate Warming

Georgiadi A.G., Milyukova I. P., and Kashutina E. A.

Institute of Geography, Russian Academy of Sciences, Staromonetny per., 29, 119017 Moscow, Russia

ABSTRACT

During several last decades significant climate warming is observed in permafrost regions of Eastern Siberia. These changes include rise of air temperature as well as precipitation. Changes in regional climate are accompanied with river runoff changes.

Seasonal and long-term changes of river runoff in different parts of the Lena river basin are characterized by significant differences. The main causes of these differences are regional distinctions of climatic conditions, types and properties of permafrost, character of relief, hydrogeological conditions, features of surface and underground water interaction, types and properties of vegetation and soil covers and also regional features of cryogenic processes and phenomena.

The above mentioned causes determine non-uniform long-term (since 1930th) response of river runoff changes (its annual amount and its distribution on seasons and role of genetic components) to recent climate changes within the Lena river basin.

Nevertheless results of analysis of river runoff long-term trends in different parts of the Lena river basin show that over the past 10-15 years rather synchronous river runoff increase is observed. But scales of the mentioned increase are different in different parts of this one of the largest river basins of the World.

According to the results of hydrological modeling the expected anthropogenic climate warming in XXI century can bring more significant river runoff increase in the Lena river basin as compared with the recent one.

The hydrology-related consequences of climate warming have been evaluated for the plain part of the Lena river basin basing on a macroscale hydrological model featuring simplified description of processes [Georgiadi, Milyukova, 2000, 2002, 2006].

Challenges in Understanding Arctic Hydrology System Changes

Daqing Yang[1)], Douglas Kane[1)], Sveta Berezovskaya[1)], and Baisheng Ye[2)]

1: Water and Environmental Research Center, University of Alaska Fairbanks, AK 99775, USA
2: Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy of Sciences, Lanzhou, Gansu, 730000, China

ABSTRACT

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 hydrologic changes in the major northern rivers are also important to studies of global change, regional water resources, and distribution of ecosystems.

This presentation will review arctic hydrologic system changes with emphasizes on regional/basin-scale hydro-climatic characteristics and differences. Based on the analyses of long-term records of streamflow, river ice thickness, water temperature over the past 40-60 years, this presentation will discuss the challenges in understanding hydrologic regimes and changes induced by human activities (particularly large reservoirs) and by climate variations/changes over the largest northern watersheds in the Arctic, including the Lena, Yenisei, and Ob rivers.

Our results demonstrate remarkable changes in northern hydrology system. These include changes in streamflow seasonal cycle (such as shifts of snowmelt timing and peak flow, decreases in summer discharge, and increases of winter discharge in the watersheds), thinning of river ice thickness, and warming of stream water temperatures over eastern Siberia. These changes indicate a hydrologic regime shift due to recent climate warming, changes in permafrost conditions, and influence of human activities over the northern regions. Our efforts continue to identify changes in the arctic hydrologic system, and to examine hydrologic responses to climatic change and human impact in the arctic regions as a whole.

Climate Change Impact on Water Resources in Mongolia

G. Davaa

Institute of Meteorology and Hydrology, Juulchin St.-5, Ulaanbaatar-46, Mongolia

ABSTRACT

For assessment of impacts of climate change on the surface water resources have been used climate change scenarios of global and regional climate models.

Scenarios generated by Hadley model (England) show that river runoff will be increased in Pacific Ocean basin and also a little in Arctic Ocean basin by 2040-2070 and while it is expected some increase of river in the Central Asian Closed basin until 2040 and then by 2070-river runoff will decrease. Therefore, generally may conclude that river runoff of Mongolia under climate change effect expected to increase till 2040 (P.Batima, 2002).

Another studies conducted in Great lake depression using "WaterGap" model and (/Water – Global Assessment and Prognosis, Version 2.1; Alcamo et al., 2003, Doll et al., 2002) and also Hadley model shows that river runoff in the Uvs lake basin has increasing tendency and Khayrgas lake basin-will decrease by 2011-2040. Especially, runoff of the Khovd, Buyant Rivers is expected to decrease by 25 percents.

Research studies on evapotranspiration shows that in last 60 years, evapotranspiration is increased by 3.2-10.3 % in steppe and Gobi region and 10.2-15.0 % in mountain and forest-steppe regions (L.Natsagdorj, 2004).

Thermal change of surface water under climate change effect can be estimated using relationship between air and water temperatures. According to greenhouse gas scenario-A2, water temperature is expected to increase by 1.2 ^{o}C in 2020 and by 2.3 ^{o}C and 4.1 ^{o}C in 2050 and 2080, respectively. Such serious change in water temperature will bring much change in aquatic environment as decrease of oxygen concentration and may disappear many aquatic flora and fauna.

Evaporation from open water surface will increase by 66.1-193.4 mm/year during 2020-2080.

Water surface evaporation from the Uvs Lake is expected to increase by 100 mm/year while rainfall only could be increasing by 9 mm in 2020. It shows that outflow component of water balance of lakes will exceed much inflow part. Water level of lakes will be lower by about 1 m within a year and many small lakes may dry out.

Water level of lakes fed by rivers draining from glaciers, has tendency to increase in the beginning and later it will decrease irreversible way. Another results of greenhouse gas scenario-A2 related to future tendency of river runoff indicate 10 mm increase in high mountain region of the Khentei Mts. and 2-5 mm increase in other mountain ranges of Mongolia. River runoff is expected to decrease by 2 mm in intermountain valleys, steppe and Gobi regions. However, such possible increase of river runoff much less than expected potential evaporation increase, about 10 times less. So this shows that river basins will be much dry in near future due to climate change.

Due to continuous increase of air temperature in future, melting of glaciers in Tsambagarav is expected to increase from 131 to 739 cm/year during the 2010-2099.

All the mentioned results show that climate change will much effect on surface water resources and regimes and therefore, it is suggested to take accumulation measures of water resources in high mountain area of the Altai, Khentei, Khangai and Khuvsugul where is runoff formation zone combining with uses of hydropower resources and where evaporation loss is much less than lower basins.

Cryospheric Change in China

Xin Li, Guodong Cheng, Huijun Jin, Ersi Kang, Tao Che, Rui Jin, Li Zongwu, Zhuotong Nan, Jian Wang, and Yongping Shen

Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy of Sciences
World Data Center for Glaciology and Geocryology in Lanzhou

ABSTRACT

This paper provides an overview of the current status of the cryosphere in China and its change. Up-to-date statistics of the cryosphere in China are summarized based on the latest available data. There are 46,377 glaciers in China, covering an area of 59,425 km^2. The glacier ice reserve is estimated to be about 5600 km^3 and the annual glacier runoff is about 61.6×109 m^3. The steady snow cover extent in China is about 3.5×106 km^2 and the maximum water equivalent is 95.9×109 m^3. The permafrost area in China is about 2.2×106 km^2. The total ground ice reserve on the Qinghai-Tibet Plateau is estimated to be about 10,923 km^3. Recent investigations indicate that the glacier areas in China have shrunk by about 2~10 % in different regions over the past 45 years. As a total, glacier area recession is about 5.5 %. Snow mass has a slight increase. The permafrost is in conspicuous degradation, raised as indicated by shrinking, areas of permafrost elevated lower limit of permafrost, raised ground temperature, deeper active layer, and thinner seasonal frost depth. Some model predictions snow that the glacier area shrinkage could be by up to 26.7 % in 2050, but glacier runoff will increase until reaching its maximum in about 2030. The snow might show a increase trend in western China but a decrease trend in eastern China, with increasing interannual fluctuations. The degradation of permafrost is likely to continue, with 1/3 to half of the permafrost on the Qinghai-Tibetan Plateau to be lost. Most of the high-temperature permafrost will disappear. The permafrost in northeastern China would retreat further northwards.

Effect of Dust Storms on the North West Himalayan Snow Covered Region

Ramesh P. Singh, Senthil Kumar, and Anup K. Prasad

Department of Civil Engineering, Indian Institute of Technology, Kanpur – 208 016, India, E-mail rpalka425@gmail.com

ABSTRACT

During the pre-monsoon period (April – June), dust storms are common over the Indo-Gangetic plains in general, in particular in the north west part of Indian region. Detailed analysis of the NOAA HYSPILT back trajectories have shown that these dust storms are mainly originated from the Arabia peninsula, Afghanistan, Pakistan and Thar desert of India and travel at a large distances. These dust storms reach to the Himalayan region. The ground studies of snow samples have shown the mineralogical composition of dust which are found to be variable depending on the source region of these dusts. We have carried out detailed analysis of multi sensor data (TOMS, MODIS, AIRS, SSM/I) and have studied the various snow covered parameters (albedo, emissivity, brightness temperature) and also the aerosol parameters of the atmosphere during 1979-2006 over the snow covered region bounded by Latitude 30-38.50 N and Longitude 71-80 E. The detailed analysis of snow parameters show sharp decrease in albedo, emissivity and brightness temperature of the snow cover which is also complemented from the increase in the aerosol optical depth during dust storm period. The analysis of AIRS data show significant changes in the meteorological parameters in the snow covered region of the Himalayan region associated with the dust storms. Changes in the meteorological conditions due to dust storms also change the microphysical parameters of the cloud. The impact of the multi parameters of the snow deduced from the multi sensor data will be discussed in view of the observed inter-annual variability of the snow cover of the North West of the Himalayan region.

Hydrological Response to Changes in Permafrost Conditions over Russian Arctic Drainage Basins

Tingjun Zhang[1)], and Daqing Yang[2)]

1: National Snow and Ice Data Center, CIRES, University of Colorado at Boulder, USA

2: Water and Environmental Research Center, University of Alaska Fairbanks, USA

ABSTRACT

Recent studies indicate that runoff over the Siberian Arctic drainage basins has increased substantially over the past several decades. The source of water causing the runoff increase is unknown. In this study, we hypothesize that changes in the active layer and permafrost dynamics play a role in the recent changes in the Arctic hydrological regime. We document (i) permafrost and ground ice distribution; (ii) changes in permafrost temperature, active layer thickness, and length of thaw season over the past few decades, and (iii) their impact on the hydrologic cycle over three Siberian river basins: the Ob, the Yenisey, and the Lena. Permafrost underlies approximately 4 to 10 % of the total area of the Ob basin, the least among the three large river basins, 36 to 55 % in the Yenisey basin, and 78 to 93 % in the Lena basin. Consequently, total volume of the excess ground ice varies from approximately 302 to 854 km^3 in the Ob, 1,699 to 2,462 km^3 in the Yenisey, and 3,523 to 4,227 km^3 in the Lena basin. According to ground-based measurements, mean annual soil temperature at 40 cm depth has increased about 1.3 ^oC in the Ob, 0.8 ^oC in the Yenisey, and 1.6 ^oC in the Lena river basin for the period from 1930 through 1990. The increase is more pronounced from the mid 1960s to 1990. An increase in the near-surface soil temperature leads to lateral thawing of permafrost and thickening of the active layer. Long-term soil temperature measurements indicate that permafrost has been degrading during the past several decades. Active layer thickness has increased about 30 cm from the mid 1950 to 1990 over the Lena river basin. Thawing index has increased substantially over all three river basins from the 1950s to 1990s, implying that the increase in active layer thickness is a widespread phenomenon over the Russian Arctic drainage basin during the past few decades. Changes in active layer thickness of 15 cm produce a runoff equivalent of about 0.9 to 2.4 mm in the Ob, about 7.8 to 11.3 mm in the Yenisey, and about 15.3 to 19.4 mm in the Lena. An anti-correlation of changes in active layer thickness and runoff may exist due to possibly high evaporation and storage in the thickened active layer. There might be a time lag between changes in active layer thickness and runoff. Late freeze-up of the active layer may also contribute to the increase in the winter runoff. Overall, changes in permafrost conditions in the Ob basin have a minimum impact on runoff. Lateral thawing of permafrost and thickening of the active layer may account for the significant increase in runoff over the Yenisey river basin. Melting of the excess ground ice through thickening of the active layer might be one of the major sources of runoff in the Lena river basin. Further work will include better understanding of the rate of lateral thawing and spatial permafrost distribution of discontinuous, sporadic, and isolated permafrost.

Influence of Climate on Ground Temperatures in Yakutia

Valentin Spektor, Vladimir Rusakov, and Mikhail Zheleznyak

Melnikov Permafrost Institute Saberian Branch Russian academy of Scinces

ABSTRACT

Presently, there are two monitoring sites in Yakutia (at Yakutsk and Tiksi) where ground temperature observations have been made during the last 10 years at three hour intervals. In Central Yakutia, geothermal monitoring has been conducted over 30 years in various terrain types at a frequency of 4 times a year. There are also several boreholes in Yakutia where temperature measurements were taken at random intervals ranging from 5 to 15 years.

In Central Yakutia, largest positive temperature trends (0.012-0.019°C/yr) have been observed at the 20-40 m depth. However, there were periods (4-5 years) with different trend signs at this depth interval.

In Tiksi, northern Yakutia, ground temperatures have been steadily decreasing (0.01-0,019 °C/yr) at the 3-20 m depth interval. At the 30 m depth, temperatures have increased over the last 12 years, at an average rate of 0.027 °C/yr.

Analysis of ground temperature data obtained at a depth of 20 m in various terrain units in Central Yakutia indicates no or little change (either an increase or decrease) in mean annual ground temperatures within the depth of zero annual amplitude for the last 30 years.

In mountainous areas of southern Yakutia, the ground thermal regime remains stable in spite of the increasing trend in air temperature. In some terrain types, however, ground temperatures have increased.

The fact that there have generally been no pronounced changes in ground temperature in response to the air temperature rise is explained by the snow cover dynamics and the processes occurring in the active layer.

Importance of Soil Moisture as a Controlling Factor for Permafrost Ecosystem

Atsuko Sugimoto[1)], Akira Kagawa[2)], and Trofim C. Maximov[3)]

1: Hokkaido University
2: Forestry, Forest Products Research Institute
Institute for Biological Problems of Cryolithsphere, Russian Academy of Science

ABSTRACT

Soil moisture is expected to be an important factor controlling various phenomena such as runoff, evapotranspiration, carbon fixation, and biogeochemical cycles in eastern Siberia where climate is extremely dry. Pulse of precipitation drives variation in soil moisture as usually observed in other region, however, precipitation is not representative for available water in the system in this region. In such region covered by permafrost as eastern Siberia, variation in soil moisture is not in accordance with that in precipitation, because of water storage function of permafrost and slow rate of evapotranspiration. Therefore, dataset of soil moisture is essential for various analyses, and precipitation cannot be a good proxy for it. Previous results of our analysis on tree-ring indicate the possibility to estimate past soil moisture with isotope signals in tree-ring.

Reconstruction of past soil moisture is quite important for comprehensive understanding of the carbon, water, and biogeochemical cycles in the permafrost ecosystem in eastern Siberia. Strategy for the estimation and understanding of the system will be discussed.

Effect of Climatic Change on Snowmelt Runoffs in Mountainous Regions of Inland Rivers in Northwestern China

Jian Wang[1)], and Shuo Li[2)]

1: Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy of Sciences
2: College of Geography, Nanjing Normal University, Nanjing 210097, China

ABSTRACT

Climatic change has significant impacts on snow cover in mid-latitude mountainous regions, In the meantime, spatial and temporal changes of snow cover and snowmelt runoffs are considered as sensitive indicators of climatic change. In this study, the upper Heihe Watershed in Qilian Mountains was chosen as a typical area affected by snow cover and snowmelt runoffs in northwestern China. The changes in air temperatures, precipitation, snowfall and spring snowmelt runoffs were analyzed for the period from 1956 to 2001. The results indicate that climatic warming was apparent, particularly in January and February, but precipitation just fluctuated without a clear trend. The possible changes of snowmelt runoffs in the upper Heihe watershed in response to a warming of 4 ^{o}C were simulated using Snowmelt Runoff Model (SRM) based on the degree-day factor algorithm. The results of the simulation indicate that a forward shifting of snow melting season, an increase in water flows in earlier melting season, and a decline in flows in later melting season would occur under a 4 ^{o}C warming scenario.

Effect of Climate Change on Runoff in Three Mountain Permafrost Watersheds, Northwest China

Fei Zhang[1)], Jingshi Liu[1)], Yuying Huang[2)], and Jie Li[2)]

1: Institute of Tibetan Plateau Research, Chinese Academy of Sciences, Beijing 100085, China
2: Water Resources Survey and Hydrology Bureau of Xinjiang Uygur Autonomous Region, Urumqi 840000, Xinjiang, China

ABSTRACT

Trends and variability in basin hydrological regime and climate were analyzed for three mountain permafrost watersheds from Altay, Tianshan and western Kunlun Mountains in northwest China for the period 1957-2004. The Mann–Kendall non- parametric test was used to detect trends and the Trend Free Pre-Whitening (TFPW) approach was employed to correct the time-series data for autocorrelation. A total of 39 annual and monthly hydrological and meteorological variables for each watershed were examined for 48 years. Statistically significant trends included strong increases in winter air temperatures and monthly flows in winter (December to March) as well as in the annual minimum flow, and weak decreases in summer flow and in the mean annual flow. However, change-point analyses revealed that much of the apparently long-term trend was actually due to abrupt changes in the variables that mainly occurred in the late-1980s and early-1990s. It is found that there are reliable positive correlations between October-November temperature and the following monthly discharges during October to February, it suggests that both temperature rising and discharge increasing at the frost beginning can greatly increase drainage of the subsurface water in January when the maximum variability occurred and the annual minimum flow has shifted into February from January as being reliable evidence, and the total increases in winter flow are increasing as a function of time. The onset of spring snowmelt is occurring earlier in the three watersheds.

Sino-German Cooperative Research on the Degradation of Permafrost on the Qinghai-Tibet Plateau

Qihao Yu[1)], Kurt Roth[2)], Huijun Jin[1)], Xichai Pan[1)], Philip Schiwek[2)], Yu Shen[1)], Zhi Wei[1)], and Jichun Wu[1)]

1: State Key Laboratory of Frozen Soil Engineering, CAREERI, CAS, Lanzhou Gansu 730000, China
2: Institute of Environmental Physics, University of Heidelberg, D-69120 Heidelberg, Germany

ABSTRACT

The Sino-German joint team from the Cold and Arid Regions Environmental and Engineering Research Institute (CAREERI), Chinese Academy of Sciences (CAS), and Institute of Environmental Physics, University of Heidelberg, conducted field investigations and preliminary research on the degradation of permafrost on the Qinghai-Tibet Plateau (QTP) and its environmental impacts in the source regions of the Yangtze, Yellow and Lancang-Mekong Rivers in the interior of and on eastern QTP as well as in the Tianshuihai region in the Western Kunlun Mountains on western QTP. Three long-term monitoring stations were established along the access road from Yushu to Budongquan, Qinghai Province, on eastern QTP. In addition to conventional exploratory methods such as hand pits, water and soil sampling, in situ measurements of soil moistures and temperatures, and surface surveys, new multi-channel ground penetrating radar (GPR) was applied for investigating structures of the active layer, permafrost, cryogenic phenomena and vegetation differentiations, distribution of ground water tables and soil moistures, and migration of salts. The preliminary studies show that characteristics of surface landscapes have important influences on heat and mass transfer in soils. Major differences between cold (< -4 ^{o}C) permafrost in the Tianshuihai region and warm (> -1 ^{o}C) permafrost on interior and eastern QTP lie in their geology and ground ice development, as well as ground temperatures. The ecological environments in the Tianshuihai region have changed greatly during the past 30 years: large areas of vegetation have degenerated or vanished, with considerable surface soil salinization. In the Tianshuihai area, small pingos, unsorted circles, sand wedges and polygons, and other periglacial phenomena were identified. GPR survey indicates that topography, vegetation, and surface moisture conditions have substantial impacts on the permafrost table and ground ice.

Function of Snow Covers in the Tibetan Plateau in Winter and Spring

Keniichi Ueno[1)], and Nozomu Hirose[2)]

1: Life and geoenvironmental sciences, Univ. Tsukuba

2: JST

ABSTRACT

Seasonal transition of the land-atmosphere interactions over the Tibetan Plateau was analyzed in 2004 winter and spring seasons, by using in-situ, objective, and satellite data. Development of convective boundary layer and function of snow covers were diagnosed by WRF model simulation. In the winter, plateau surface heating induced shallow PBL development with evident diurnal changes of surface wind over the thin and patch snow cover. But, strong sub-tropical jet stream prevented dibatic heating (Q1) of the atmosphere over the plateau. On the other side, diurnal change of Q1 was clearly diagnosed in the tendency term in spring season when the sub-tropical jet activity became weak. MUCH-snow experiment by the WRF model depressed this Q1, and advection term of Q1 due to sub-tropical jet activity was enhanced. Namely, snow covers in the synoptic condition of weak sub-tropical jet, such as in late March to April, have evident effects for the synoptic flows around the Tibetan plateau.

Evolution of the High-Elevation Inlakes in Tibetan Plateau over Recent Decades

Siyuan Wang[1,2)], Jingshi Liu[2)], Gong Tongliangc[2)], and Yu Shumei[2)]

1: Institute of Electronics, Chinese Academy of Sciences
2: Institute of Tibetan Plateau Research, Chinese Academy of Science
3: Hydrology and Water Resources Bureau of Tibet, Lhasa 850000, Tibet, China

ABSTRACT

This study analyses satellite images, long term climate change and streamflow records to examine hydrological response of six high-elevation inland lakes (>4 500 m a.s.l.) in the Tibetan plateau over the last 30 years. The results show the lake areas greatly extended a maximum 27.1 % in recent decade comparing with that in the 1970s, which is associated with the annual precipitation increased by 75 mm (18.6 %), annual mean and winter mean temperature risen by 1.1~2.0 ^{o}C and annual runoff increased by 20% and thinned by 30 cm in seasonal depth of soil forst, respectively. These changes enlarged the lake area up to 55 km^2 (23.4 %) since 1998. The change point of annual precipitation, annual mean temperature and annual runoff occurred in 1993, 1983 and 1997, respectively. The timing of lake growth corresponds with both the abrupt increasing of annual precipitation and runoff since the mid-1990s. This study suggests a strong positive water balance in cold seasons and permafrost degradation.

Process, Causes and Future of Water Cycle of Indus River Basin

Bashir Ahmad

Water Resources Research Institute (WRRI), National Agriculture Research Center (NARC), Park Road, Islamabad, Pakistan

ABSTRACT

Assessment of water resources in the Indus Basin, its related process, causes and future of water cycle has been discussed here. Indus Basin River System drains one of the largest river basins in Asia. Its main tributary, Indus River, originates in Tibet in the northern Himalayas, snakes through Himalayan mountain ranges before appearing on the plains of Punjab in Pakistan. Indus River and its tributaries (Jhelum, Chenab, Ravi, Sutlaj and Beas Rivers and Kabul River) which drain an area of 364,700 sq miles (944,569 sq.km), are the main source of water in Pakistan, which bring an average of 187 BCM of water annually. This includes 143.18 MAF (173.63 BCM) from the Western rivers (Indus, Kabul, Chenab and Jhelum) and 8.40 MAF (10.37 BCM) from the Eastern rivers (Ravi and Sutlej). The average contribution from the flows generated within Pakistan is about 3.99 MAF (4.92 BCM). Allowing for a potential reduction in inflows from the Eastern rivers through increased utilization by India, the total surface water availability in the Indus Basin is estimated at 147.17 MAF (181.55 BCM). There are a number of barrages and several major dams constructed on this river system, which provides the backbone to one of the largest irrigation systems of the world.

The irrigation system of Pakistan is the largest integrated irrigation network in the world, serving 17 million hectares of contiguous land. There are four main reservoirs, 15 barrages in the whole of the Indus Basin Irrigation System (IBIS) and 45 main canals with discharge capacities ranging from 15 m^3/sec to 425 m^3/sec. A number of major Pakistani cities and several rural communities are established along its banks. River system is mainly snow-fed but during monsoons carries major floods. Fatalities due to flooding are also common. A number of flood control measures have been adopted to relieve the flood impact of the river.

From the perspective of groundwater use, it is estimated that about 41.6 MAF (51.3 BCM) of groundwater is abstracted for irrigation use and for urban and rural drinking water supplies. Groundwater use is nearing the upper limit of the resource in most parts of Pakistan. The groundwater table in most of the fresh water areas is declining and therefore the potential of further groundwater exploitation is very limited.

Total water resources available are 237 MAF (187 MAF from river inflows and rainfall, 50 MAF from groundwater). Future water requirement by the year 2025 would rise to 271 MAF. If we sustain the present 237 MAF, a shortage of 34 MAF would have to be faced.

Development of the North-East Asia Permafrost Monitoring Network

Mikhail Zheleznyak

Melnikov Permafrost Institute Saberian Branch Russian academy of Scinces

ABSTRACT

Permafrost responds in different ways to periodic and episodic climate variations on Earth. The response depends on the duration of change and the resulting surface energy exchange conditions. In order to obtain reliable predictions of environmental change which are important for land-use planning, the regional patterns of permafrost response to climate change should be understood. Ground temperature measurements provide a means of assessing permafrost reaction, as well as a basis for paleoenvironmental reconstruction.

In East Siberia, permafrost investigations were begun in the early 20th century. In this huge region with an area of 6 mln sq. km, however, ground temperature monitoring is being conducted only in central Yakutia (vicinity of Yakutsk), Tiksi, Chersky and, occasionally, in southern Yakutia (Chulman).

In 2006-2007, geothermal monitoring sites were established in Igarka, Chernyshevsky and Magadan as part of the TSP and Asia CliC projects. Presently, 8 new sites are at the stage of preparation (Lensk, Olekminsk, Batagai, Aldan, Tynda, Chara, Zhigansk and Khandyga) where measurements will be started later this year.

It is planned to establish 10 more sites during the year of 2008. In total, there will be 22 monitoring sites in East Siberia by 2008, regularly distributed over the region.

The permafrost monitoring program includes measurements of air temperature, snow cover and ground temperatures to a depth of 30 m, as well as observations of frozen ground phenomena.

Global Significance of Frozen Grounds Discontinuously Distributed in Eurasian Eco-tone, Mongolia

Mamoru Ishikawa[1,2)]

1: Hokkaido Univ.
2: IORGC

ABSTRACT

Hydro-meteorological and ecological processes occurring on the cold land regions are clearly influenced by the presence of frozen grounds, because frozen grounds define the movement of subsurface water and nutrition. It is crucially important to understand energy processes of frozen ground for many scientific branches of cold regions, although they have only implicitly considered. The roles of frozen grounds might be more delineated at the region with the mosaic-likely distributed frozen ground regions, in which comparable observations are possible even within the small areas. In this context we have been observing interactive behavior between land surface hydro-meteorological and frozen ground processes on the southern boundary of Eurasian permafrost region, Mongolia. Our five years observational studies have been shown some aspect of frozen ground of the region, involving (1) hydro-thermal characteristics of dry active layer, and (2) thermal symbiotic system of permafrost and forests, both of which were found through the analysis of state-of-the-arts measurements of soil and atmospheric heat flux components at the several representative sites.

Hydro-Thermal Regimes in the Circum-Arctic Basins Simulated by a High-Resolution CGCM for 1900-2100

Kazuyuki Saito[1,2)]

1: International Arctic Research Center, University of Alaska Fairbanks
2: Frontier Research Center for Global Change, Japan Agency for Marine-Earth Science and Technology

ABSTRACT

Contributing to the IPCC AR4, a 200-year integration for the period 1900 to 2100 was carried out using a high-resolution coupled Atmosphere-Ocean global climate model (CGCM) developed by CCSR/NIES/FRCGC. One of the strength of the CGCM is explicit implementation of soil thaw/freeze processes down to 4 m, and river routing process, which enables quantitative assessments of possible climatic changes in the subterranean hydro-thermal regimes, soil water storage, and freshwater discharge to the focused oceans.

The analysis showed the overall increase in hydrological cycles in the circum-Arctic basins, of which Lena river alone accounts for more than 10 % of the current annual discharge. Simulated precipitation increased steadily at a higher rate in the 21st century. Evapotranspiration and runoff shared almost equally the increase in water inflow. The model also projected increase in the maximum depth of active layer by more than 1 m, and melting of ground ice by more than the half, on average. Snow accumulation decreased during the integration period, whereas soil water storage increased slightly.

Importance of Forest Floor Information for Vegetation Remote Sensing over Boreal Forest

Rikie Suzuki[1)], Hideki Kobayashi[1)], Nicolas Delbart[1)], Tetsuya Hiyama[2)], and Jun Asanuma[3)]

1: Frontier Research Center for Global Change, Japan Agency for Marine-Earth Science and Technology
2: Hydrospheric Atmospheric Research Center, Nagoya University
3: Terrestrial Environment Research Center, University of Tsukuba

ABSTRACT

Regarding the satellite remote sensing of forest vegetation, the Normalized Difference Vegetation Index (NDVI) reflects the total greenness of the forest canopy and the forest floor. This feature is considerable especially for sparse forests like Siberian taiga. This paper discusses the greenness of the forest canopy and floor based on the aerial spectral reflectance data and aerial video image which were observed near Yakutsk from spring to summer in 2000. Base on the video images, forest conditions were classified into 4 types: (1) no-green canopy and snow floor, (2) green canopy and snow floor, (3) no-green canopy and no-snow floor, and (4) green canopy and no-snow floor. Mean NDVIs for (1), (2), (3), and (4) were -0.03, 0.17, 0.43, and 0.76, respectively. As for (2), although there was the green canopy, the NDVI was rather small because the large background reflectance from the snow floor. By contrast, the NDVI of (3), which had no greenness on forest canopy, is considerably large due to forest floor greenness. The case of (4) indicated the largest NDVI due to the green canopy and green floor. Thus, it was revealed that NDVI considerably depends on the forest floor greenness and the snow cover.

Development of Bias-Corrected Precipitation Database and Climatology for the High Latitude Regions

Daqing Yang[1)], Douglas Kane[1)], Barry Goodison[2)], and David Legates[3)]

1: Water and Environmental Research Center, University of Alaska Fairbanks, AK 99775, USA;
ffdy@uaf.edu
2: Meteorological Service of Canada, Downsview, Ontario M3H 5T4, Canada
3: Center for Climatic Research, University of Delaware, Newark, DE 19716, USA

ABSTRACT

Precipitation is one of the key components in hydrological modeling and process studies. It is also the most important variable in global change analyses, as change of precipitation will have a major impact on hydrology, climate and ecosystems. It has been recognized that significant (up to 100 %) systematic errors (biases) exist in the gauge-measured precipitation records and these biases must be documented and corrected in order to obtain a compatible, accurate data set for large-scale hydrological and climatic investigations. The climate of the high latitudes is characterized by low temperature, generally low precipitation and high winds. Because of the special condition in the high latitudes, the biases in precipitation gauge observations are enhanced and need special attention.

This presentation directly addresses the problem of biases of precipitation measurements in the high latitude regions. This work has been based on the extensive research experiments, particularly on the WMO Solid Precipitation Measurement Intercomparison Project. It defines the accuracy of precipitation measurements, implements the consistent bias-correction methodologies for the high latitude regions (Alaska, northern Canada, Siberia, northern Europe, Greenland, and the Arctic Ocean), and develops the unbiased and compatible precipitation database (including grid products) and climatology for the pan-Arctic. This research is particularly relevant to studies of climate change and fresh water cycle in high latitude regions, such as the WCRP/CLIC, GEWEX and the SEARCH. The results of this study will improve our understanding of the spatial and temporal variability of precipitation and its contribution to the freshwater balance of the high-latitude land and ocean systems. They will also be useful to analyses of global climate change and validation of the GCM/RCM.

RAISE Surface Flux Results and Future Plan of RAISE Group

Jun Asanuma

Terrestrial Environment Research Center, Tsukuba University

ABSTRACT

RAISE, the rangeland atmosphere-hydrosphere-biosphere Interaction, Study Experiment in Northeastern Asia, was conducted during 2001-2006 with its intensive observation in the central mongolia in 2003. The presentation summarizes the major findings of RAISE surface flux group as well as explains the future plan of the RAISE groups

Implications of the Recent Reduction of Snow Cover in the Himalaya Mountains and Tibetan Plateau Region

Kunio Rikiishi and Risa Obama

Department of Earth and Environmental Sciences
Hirosaki University, Japan

ABSTRACT

The Himalaya Mountains and Tibetan Plateau region is the source area of water for many major rivers including Yellow, Yangtze, Mekong, Salween, Ganges, and Indus Rivers. At the same time, the Tibetan Plateau is unique in that it works as a heat source in summer and a heat sink in winter for the middle stratosphere. For this reason, the cryospheric condition in the Himalaya/Tibet region is very important from the point of view of both water supply and climate change in the 21st century. According to Rikiishi and Nakasato (2006), the annual mean snow-covered area in the Himalaya/Tibet region is decreasing at a rate of 1 % per year, mainly caused by earlier snowmelt in the spring and summer seasons.

To confirm the above results, we have analyzed the satellite observations of clear sky upward and downward solar fluxes for the periods 1948 – 2005. It has been found that the upward solar flux varies considerably depending on whether the earth's surface is covered with snow or not, while the downward solar flux is rather stable throughout the observational period. As for the Himalaya/Tibet region, the albedo (ratio of upward flux to downward flux) in the melting season is generally decreasing at the rate of 0.002 – 0.004 per year. Obviously, this could be explained by the earlier snowmelt or earlier snow cover disappearance in the Himalaya/Tibet region. It is very important to note that the reduced albedo may be a result of earlier snowmelt on the one hand and may accelerate the snowmelt by absorbing more solar flux on the other. In other words, it is possible that the recent global warming is, not a cause of, but a result from reduced snow cover (or cryosphere).

A review of Snow Processes in the Forested Area

Kazuyoshi Suzuki, Takeshi Yamazaki, and Takeshi Ohta

Cold Region Hydrological Cycle Group, Hydrological Cycle Observational Research Program, Institute of Observational Research for Global Change, JAMSTEC

ABSTRACT

About 1/3 on the land of the earth is covered with the forest, and the forest area that is the biggest in those forests is tropical and boreal forests. The snow and forest strongly influence each other because the boreal forest existed in the seasonally snow covered region, and the boreal forest of winter influences the temperature formation of the northern hemisphere. In this review, the focus was to review the snow processes of the forest located in the seasonal snow covered area, especially the snow accumulation and melt processes, and the research in Japan was brought together.

Trends and Variability in the Hydro-Meteorological Regime of the Tuul River Basin, Mongolia in Recent Decades

Yinsheng Zhang[1)], G. Davaa[2)], and T. Ohata[1)]

1: Institute of Observational Research for Global Change, Japan
2: Institute of Meteorology and Hydrology, Ulan Bator, Mongolia

ABSTRACT

This study analyzes long-term hydro-meteorological data within the Tuul River watershed in order to document Trends and variability in the hydro-meteorological regime induced by reservoir regulations and by natural variations/changes. The target basin is locating in at the edge of the Eurasian cryosphere, it is economically most important river basin in Mongolia. The study area is in between latitudes of 46°50'N and 48°57'N and the longitudes of the 103°50'E and 108°18'E in Central Mongolia, Northeast Asia. In general, we restrict our analyses to the period 1945 to 2004. The hydrological components from observation and estimation using in situ meteorological data, including precipitation, discharge, snow cover, soil moisture and NDVI will be analyzed by link of water budget of the river basin. The results indicated that several hydrological variables exhibit a greater number of significant trends than are expected to occur by chance. Annual flow series are remarkably and basin average precipitation are slightly increasing in river basins where degrades forest and vegetation cover due to wild fire, wood cut and overgrazing.

Isotopic Variation in the Lake Water Balance at the Yamdruk-tso Basin, Southern Tibetan Plateau

Tian Lide[1,2)], Liu Zhongfang[1)], Gong Tongliang[3)], Yin Changliang[2)], Yu Wusheng[1)], and Yao Tandong[1,2)]

1: Laboratory of Land Surface Processes Monitoring and Research, Institute of Tibetan Plateau Research, Chinese Academy of Sciences, Beijing 100085

2: Key Laboratory of Cryosphere and Environment, Cold and Arid Region Environmental and Engineering Research Institute, CAS, Lanzhou 730000

3: Tibet Institute of Water Resource Survey Planning Design and Research, Lhasa 850000

ABSTRACT

Stable isotope is a practical tool in the study of the lake water budget. This is an alternative way to study the hydrological cycle in the large numbers of in-land lakes on the Tibetan Plateau, in which the isotope record of the sediment is believed to reflect the climatic and environmental changes. A monitoring of stable isotope of the precipitation, river and lake waters during 2004 in the in-land Yamdruk-tso Basin, southern Tibetan Plateau, reveal the lake water $\delta^{18}O$ is over 10‰ higher than the local precipitation. This high difference indicates strong isotope enrichment due to lake water evaporation. The simulated results based on the isotope technique shows that the present lake water $\delta^{18}O$ level is corresponding to an average relative humidity of around 54-58 % during evaporation, very close to the instrumental observation. The simulated result also shows that the in-land lakes on the Tibetan Plateau have a strong adjustability to the isotope shift of input water $\delta^{18}O$. On average condition, the isotope component in the in-land lake water is much controlled by the local relative humidity, and can also be impacted by the shift of local precipitation isotope component. This is probably responsible for the large consistence of isotope component in the extensive in-land lakes on the Tibetan Plateau.

Mount Everest Meteorological Observations in 2005

Xie Aihong, Qin Dahe, Ren Jiawen, Qin Xiang, Xiao Cunde, and Kang Shichang

Joined Key Laboratory of Cryosphere and Environment, Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy of Sciences

ABSTRACT

Mount Everest, the highest point on Earth, is often referred to as the earth's third pole, As such the place is relatively inaccessible and little is known about its meteorology. In April 2005, an automatic weather station was installed at the mountain's North Col (6523 m a.s.l.). According to the observation, the meteorological characteristics were analyzed. All the meteorological elements displayed obvious diurnal variation. During May 1 to July 22 2005, long-wave radiation, temperature, relative humidity and pressure all increased, short-wave radiation and wind speed decreased, net radiation changed little, and wind direction turned from north to south.

The monthly variation of daily meteorological elements on Mount Everest coincided with that on Dingri, the closest routine meteorological station, with the high correlation coefficient of 0.928, 0.877, 0.682, 0.755, 0.826 and 0.676 ($N = 83$, $P < 0.001$) for mean temperature, minimum temperature, maximum temperature, relative humidity, pressure and wind speed, respectively. Furthermore, the vertical mean gradient of temperature was above 0.6 ^{o}C/100m, especially for the daily maximum temperature. Most weather events on Mount Everest prominently appeared at the same day as those on Dingri, especially those from daily mean pressure, temperature and relative humidity with the cross-correlation coefficient of 0.673, 0.485 and 0.487 ($N = 83$, $P < 0.001$), respectively. Some other weather events on Mount Everest lagged one-day behind those on Dingri. Furthermore, forecasting weather events on Mount Everest from pressure on Dingri was more reliable than those from the other meteorological elements. The conclusions are much important for research on meteorology and climate change in the region.

Time Series of Snow Pack Profiles Observed at Sapporo for 2003/04-2006/07 Winter Seasons

Sugiura, K.[1)], Aoki, Te.[2)], Motoyoshi, H.[3)], Kodama, Y.[4)], and Yasunari, T.J.[4)]

1: IORGC/JAMSTEC

2: Meteorological Research Institute

3: The Graduate University for Advanced Studies

4: Hokkaido University

ABSTRACT

Frequent snow cover study for snow type, size, density, hardness, depth, water equivalent and mass concentration of snow impurities has been carried out at Sapporo, Japan, during four winter seasons from 2003/04 to 2006/07. The maximum snow depth was beyond 1m, except for the 2006/07 winter, and was 109 cm on March 1, 2005. The maximum snow water equivalent was 39 cm on March 5, 2004. The average date of the maximum snow water equivalent in all winter seasons was later than that of the maximum snow depth, that is a time lag between the maximum snow depth and snow water equivalent was confirmed. The average snow cover density increased gradually, and reached about 400 kg/m^3 at the end of winter. This presentation also introduces the effect of snow impurities to snow cover.