

# WCRP REPORT

World Climate Research Programme



ICSU  
International Council for Science

Asia-CliC Workshop on  
Large-scale Hydrometeorology of Asian Cryosphere  
Yokohama Institute for Earth Science (JAMSTEC)  
Yokohama, Japan  
May 17 to 19, 2007

WCRP Inf. No. 14/2007

October 2007

The World Climate Research Programme is sponsored by the World Meteorological Organization, International Council for Science, and the Intergovernmental Oceanographic Commission of UNESCO.

Climate and Cryosphere (CliC) is a core project of the World Climate Research Programme, cosponsored by the Scientific Committee for Antarctic Research.

Contact information;  
CliC International Project Office  
Norwegian Polar Institute  
The Polar Environmental Centre  
N-9296 Tromsø, Norway  
<http://clic.npolar.no>  
[clic@npolar.no](mailto:clic@npolar.no)  
Tel: +47 77 75 01 46  
Fax: +47 77 75 05 01

#### NOTE

The designations employed and the presentation of material in this publication do not imply the expression of opinion whatsoever on the part of the Secretariat of the World Meteorological Organization concerning the legal status of any country, territory, city or areas of its authorities, or concerning the delimitation of its frontiers or boundaries.

Asia-CliC Workshop on  
Large-scale Hydrometeorology of Asian Cryosphere  
Yokohama Institute for Earth Science (JAMSTEC)

Yokohama, Japan  
May 17 to 19, 2007

WCRP Inf. No. 14/2007  
October 2007



**The Workshop was organized by**  
WCRP-CliC Science Steering Group  
Japan CliC Committee  
China CliC Committee  
IORGC/JAMSTEC

Workshop Website: <http://www.jamstec.go.jp/iorgc/workshop/asiacllic2007/>

**Conveners Group**

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)

## Table of Contents

Summary.....	1
1.0 Outline and Objectives .....	1
2.0 Organization and Support.....	1
3.0 Participants and Presentation.....	1
4.0 Workshop Sessions.....	2
4.1 Opening .....	2
4.2 Scientific and Technical Presentations .....	2
4.3 Round-Table Discussions .....	2
5.0 Report of the Round Table Discussions .....	2
5.1 Northern Eurasian Research Issue.....	2
5.1.1 Northern hydrology system .....	3
5.1.2 Hydrologic and climatic extremes.....	3
5.1.3 Common data sets and products .....	3
5.1.4 Vegetation and river ice.....	3
5.1.5 Lakes/ponds/wetlands.....	3
5.2 South Central Research Issues.....	4
5.3 Continental Research Issue.....	5
5.4 Model.....	5
5.5 Data.....	7
5.5.1 Permafrost data issues .....	7
5.5.2 Seasonal snow-cover data.....	7
5.5.3 River- and lake-ice data.....	8
5.6 Satellite/Observation and Usage.....	8
5.7 Information .....	10
6.0 Next Steps and Actions .....	10
Appendix 1: Agenda	
Appendix 2: List of Participants	
Appendix 3: Acronyms	



## Summary

Forty people participated in the *Asia-CliC Workshop on Large-scale Hydrometeorology of Asian Cryosphere* held at the Yokohama Institute for Earth Science of JAMSTEC on May 17-19, 2007. Among the participants were V. Lytle, the Director of the CliC international Project Office, and T. Prowse and T. Ohata – both members of the CliC Scientific Steering Group. The Director-General of IORG/JAMSTEC, M. Fukasawa, also attended and gave the Welcome Speech. During the first day-and-a-half, thirty-one presentations were made on the various workshop topics, and the remainder of the time was used for discussions.

As a result of the Workshop, members agreed that developing cryosphere datasets –including data rescue– is a high priority for Asia-CliC activities. Within this, the first priority is to develop an Asia-Region *snow-cover data-archive* (land + satellite). Two co-chairs (V. Razuvaev, Russia and T. Zhang, USA) were nominated to develop the *implementation plan* and proceed with the data recovery. *Frozen ground* was identified as second priority, but more discussions are needed before starting activities. *Glacier* data bases were also mentioned, but since only a few researchers interested in glaciers attended, it was decided to discuss this at the 2nd Asia-CliC Symposium to be held at Lanzhou, China in October, 2007, along with the frozen ground issues. It was recognized that these three topics need to be treated in the Symposium.

It was advised that the following projects be pushed and implemented in order to enhance Asia-CliC activities:

- Cryosphere-Atmosphere-Biosphere Interaction (CABIN) presented by A. Sugimoto
- Modeling studies within projects such as Arctic-HYDRA and IHACYs (China core project on High Asia)
- ALOS Glacier inventory studies (improved by broadening the group)
- Hydrometeorology research project in the Heife Region, China, led by Chinese scientists.

## 1.0 Outline and Objectives

The main objectives of this workshop were in-depth discussions of identified scientific issues and to develop implementation plans for Asian Climate and Cryosphere (Asia-CliC) activities. These activities would be a follow-on to the *Working Groups on snow cover and hydrology, frozen ground, large-scale interactions*, as well as part of *satellite and modeling group* which met at the time of 1st Asia-CliC Symposium, April, 2006. We expect to produce a report on the implementation strategy and plans for these issues in the Asian region (roughly the eastern part of Eurasian continent) and the surroundings.

## 2.0 Organization and Support

The Workshop was organized by IORG/JAMSTEC, WCRP-CliC Science Steering Group, Japan CliC Committee, and China CliC Committee. The Conveners Group members are listed on *page iv*. The Workshop Secretariat was run by Konosuke Sugiura (IORG/JAMSTEC), and Setsuko Ichikawa (IORG/JAMSTEC). The event was sponsored by various institutes, generally in the form of travel support.

## 3.0 Participants and Presentation

The meeting was first announced in March 2007 through internet distribution lists such as Cryolist, and on web sites including the Symposium- and CliC web-sites. Forty people

representing nine different countries participated (Canada, China, India, Japan, Mongolia, Norway, Pakistan, Russia and USA). There were 23 oral and 6 poster presentations.

## **4.0 Workshop Sessions**

### **4.1 Opening**

The program began with a welcome speech by M. Fukasawa, the Director-General of Institute of Observational Research for Global Change, JAMSTEC. Dr. T. Ohata presented the objective and goals of the Workshop, followed by introduction of all the participants. An overview of the CliC Project was presented by V. Lytle, Director, CliC International Project Office.

### **4.2 Scientific and Technical Presentations**

General scientific presentations were devoted to the first half of the Workshop. Oral presentations chaired by T. Prowse, T. Ohata, X. Li and K. Saito. Poster presentations were chaired by J. Ukita.

### **4.3 Round-Table Discussions**

The second half of the Workshop was used for more in-depth, round-table discussions of research questions of this region. Topics included:

- (1) Northern Eurasian Research Issue (Leader: D. Yang)
- (2) South Central Research Issue (Leader: X. Li)
- (3) Continental Research Issue (Leader: J. Ukita)
- (4) Model (Leader: T. Ohata)
- (5) Data (Leaders: T. Zhang and V. N. Razuvaev)
- (6) Information (Leader: V. Lytle)

These discussions included ways to address some of the observation and modeling issues unique to this region, and the role of the Asian cryosphere in the global climate system. The topics are summarized in Section 5.

In conclusion, the Workshop participants discussed timing for drafting the Workshop summary, and next steps and actions. The meeting concluded on May 19, at 15:00. The next Asia-CliC activity will be the 2nd Asia-CliC Symposium in Lanzhou, China, October 22-26, 2007, where many of these discussions will continue.

## **5.0 Report of the Round Table Discussions**

### **5.1 Northern Eurasian Research Issue**

The following topics/themes were identified as important components in the northern hydrology-climate systems:

1. Precipitation / Snowfall
2. Snow cover
3. Vegetation
4. Basin hydrology/stream-flow
5. Permafrost/frozen ground
6. Large-scale modeling
7. Lakes/ponds/wet lands
8. River and lake thermal conditions - water temperatures and ice regime
9. Storage volume and variability, soil moisture, ground ice, river ice, and glacier



Presentations given at the workshop covered the aspects of Precipitation / Snowfall, Snow-cover, Vegetation, Basin hydrology and stream-flow, Permafrost and frozen ground, and Large-scale modeling. There were no presentations on Lakes/ponds/wet lands, River and lake thermal conditions, or on Storage volume and variability.

To stimulate the discussions, a major challenge in the northern regions was posted to the group: to understand and explain the regional difference in large river streamflow changes. Recent studies report that discharge from the large Eurasian rivers has increased, but discharge in the NA arctic rivers did not change much, and discharge from rivers in the Hudson Bay region decreased. These differences raised the following major science question:

*Why are stream-flow trends so different among the northern regions, and what caused discharge changes in the Arctic regions and large river basins?*

The discussions focused on this major issue and expanded to cover other important aspects of the northern hydrometeorological systems. The discussions included:

### *5.1.1 Northern hydrology system*

Hydrology is the linkage between atmosphere, land, and ocean. Asia-CliC, given the large research region, has almost no boundaries or limitations. The northern regions are unique, there are major parts of the Arctic with very large rivers, and these large watersheds have changed significantly both due to changing climate and direct human influence. The northern regions also link closely with the “Southern regions”. These linkages and interactions need to be defined and studied.

### *5.1.2 Hydrologic and climatic extremes*

Extreme events can be used to detect the “changes” / “step changes” in the hydrology and climate. Extreme events are indicators and measure of the internal- and seasonal-variability. There is a need to separate extremes from hazardous events.

### *5.1.3 Common data sets and products*

Regional dataset development was discussed. There is lack of sufficient and recent observations to answer questions regarding permafrost degradation and snow cover changes over the high latitude regions. The need for and importance of regional datasets have been recognized, particularly for snow cover and soil temperature data. Observation-model integration at regional scales is also necessary, such as within the project CABIN. Blending and assimilation of observations are also important. Snow sublimation determination requires the estimation of large-scale energy/water budget in cold regions and an understanding of atmosphere/snow characteristics with basin-scale data assimilation. There are uncertainties in the assimilations due to limited numbers of observations.

### *5.1.4 Vegetation and river ice*

Changes in ecotone areas, such as biomass increase and plant species transition, are useful indicators of northern climate and hydrology changes. River ice is a seasonal storage; it affects the stage and timing of discharge relation in the northern regions and basins. Stable isotope data can be used to identify difference and similarity in discharge, for example between the Lena and Yenisei rivers.

### *5.1.5 Lakes/ponds/wetlands*

Due to time limitations, no discussions were made for Lake/ponds/wet lands. These however may be important comments for the northern regions. Discussions of models

and modeling as integrator of observation and physical understanding, including this topic, were carried out in the model session (section 5.4).

## **5.2 South Central Research Issues**

Dr. X. Li led this session, and discussed whether the area in this region is "Japan, China, Korea, Thailand, India, Nepal, Bhutan, Afghanistan and Pakistan" or "higher parts of Himalaya, Karakoram, Qilian and Hindu Kush" or "cryosphere in high Asia". In addition, the following topics/themes were discussed in this session:

- GLOF (Glacier Lake Outburst Floods) are very important in China, India, Pakistan, Nepal and Bhutan
- Water resources in Asian drainage basins
- Regional data set
- Observation or modeling of permafrost mapping, snow mapping and glacier inventories.

The following suggestions were made:

- Snow and glacier mapping is very important for climate studies and water resources.
- Accurate mapping of these parameters is a high priority.
- Eastern and western parts have different characteristics and it needs to be documented.

Other suggestions discussed included:

- Snow-cover mapping from remote sensing datasets and its validation using *in-situ* data
- Documentation of remote sensing products of snow-cover at one point
- Glacier monitoring using RS data
- Orographic effects on precipitation

The GLIMS dataset covering Asian glaciers is not up-to-date and does not include all Asian glaciers. Holding some workshop on glaciers inventory, monitoring etc. was suggested. The satellite sensor ALOS will be launched soon, this will be very useful for glacier monitoring. All Asian countries should request through JAXA access to data from ALOS. Snow- and permafrost-mapping is highly important and should be implemented. This requires close collaboration of various countries and groups.

Activities in the Tibetan Plateau were introduced. Three Automatic Weather Stations (AWS) and 20 Isotope Monitoring Stations have been installed, and a new AWS is planned. The new approach of using GPS and GPR for glacier movement monitoring is used, and the land surface observation project is proceeding. Isotope data will be opened gradually.

Snow-cover estimation from remote-sensing datasets was introduced. This estimation focuses on cloud, shadow, sub-pixel classification using visible sensors on MODIS and NOAA to analyze time series of snowmelt runoff and perform scenario analysis. *In-situ* measurements for snow-cover estimation are sparse. There are only a few continuous stations for monitoring snow cover since 1951. But the data is unfortunately not available. Formation of a group to map the snow cover in the Asian area to improve and validate the accuracy of remote sensing snow cover products was suggested. Lakes in the area also should be mapped. Development of a database for precipitation in this region is also important.

### **Summary:**

Why is there so little attention paid to this very important region for snow cover, glaciers and permafrost?

Data-product development and data sharing should be initiated and accelerated.

### **5.3 Continental Research Issue**

Dr. J. Ukita led this session by presenting a talk titled “Continental processes – Large scale”. He argued that if we are concerned about climatic processes over Eurasia, it is necessary to take into account impacts of prominent climate modes such as the North Atlantic Oscillation (NAO), Arctic Oscillation (AO), ENSO, and monsoon. To support his argument, he presented empirical evidence that (1) Climate variations in sea ice and atmospheric circulation in high-latitudes are related to SST variability in the tropical Pacific (ENSO signals); (2) ENSO significantly modulates atmospheric circulation at both surface and upper level (250 hPa); and (3) The magnitude of ENSO has increased in recent decades, which coincided with a modulation of the ENSO-monsoon relationship. From these pieces of evidence, he suggested that overarching science questions for Asia-CliC must address, (but is not limited to) the following question:

*In what way do the NAO, ENSO and monsoon collectively affect the water cycle, energy balance of Eurasia through modulation of the oceanic and atmospheric states and their circulation patterns?*

Essential to this question is a realization that Eurasia is a crossroad of those prominent climate modes.

Discussions followed, mostly focusing on issues related to snow cover and monsoon. It was pointed out that model studies are generally inconclusive as to a possible link between anomalous snow cover and monsoon variability. From a synthesis viewpoint, it may be more natural to focus on what brings about the variations in snow cover and monsoons and how they are related, rather than focusing on surface hydro-meteorological conditions. For the snow cover, atmospheric circulation and large-scale moisture budget are critical factors, whereas for monsoon, ENSO impacts cannot be ignored. Given this, priorities must be given to processes affecting continental scale climate variability, especially forcings from the regions outside Eurasia, namely the Euro-Atlantic (upstream) region and the tropical Pacific.

### **5.4 Model**

To begin the Model discussion session, results of the Model split-session from the April 2006 Symposium were first presented. Unfortunately, because many modeling experts did not attend this meeting, it was difficult to extend the discussions made in April 2006. Subsequent discussion therefore focused primarily on the summary results of the previous meeting. Important points identified during the discussion included:

1. It was recognized that models are integrators of a variety of coupled atmospheric and hydrologic processes and there was a general consensus that they are critical for advancing CliC studies.
2. Recognizing that the cryosphere is influenced by the climate system and visa versa, there is a need to improve current land-surface models to reflect such feedback processes as well as other changing surface characteristics, such as vegetation.
3. “What land surface/sub-surface observations are required to validate and improve Global Climate Models?” was one question posed. Sensitivity studies should be conducted to determine the most important observations which are missing.
4. The necessity to improve models of frozen ground and permafrost were noted.
5. Data assimilation systems using inverse methods were mentioned by Chinese participants as being important to develop.

6. Based on the ICARP-II Cryosphere and Hydrology Research Plan and subsequent Arctic-HYDRA discussions, Terry Prowse introduced the following directions for modeling studies for atmospheric and hydrological models:
  - i. To explain historical changes in flow regimes, there is a need to conduct hindcast evaluations. Employing the best-available atmospheric-hydrologic models for use in cold-regions systems, a focus should be placed on multi-factor modelling rather than single-factor analyses previously conducted. Factors for ensemble consideration include, for example, vegetation, snow cover/precipitation, permafrost, land use and fire effects. There may also be as yet unidentified or “missing factors”.
  - ii. An assessment needs to be undertaken to evaluate how well current GCM/RCM models replicate existing arctic hydrology, observed and predicted. This was also identified as an area of interest by Arctic-HYDRA and is one area of interest that Canada (Environment Canada: National Water Research Institute) would like to collaborate with Japan and other Asia-CliC countries. There may be a possibility to use the Mackenzie and Lena as comparative test basins. One period of specific interest is the spring snowmelt runoff that also determines the major period of runoff in these basins and the most extreme flood events because of the compounding effect of ice covers. Additional collaboration on this issue is being planned between Canada and the State Hydrologic Institute, St. Petersburg in June 2007 with a follow-up workshop in February 2008. The intensively monitored research basins near Lanzhou, China offer another site at which such model testing could be undertaken. An international effort on this front could form a useful focus for Asia-CliC and form a major component for the CliC Theme 1 - *Terrestrial Cryosphere and Hydrometeorology of Cold Regions* - overall.
7. Development of improved snow-melt runoff simulation models was stressed.
8. Water-temperature modeling was noted as being an important variable to include in future modeling efforts. The analysis of isotopes in atmospheric and hydrologic systems and processes was acknowledged as having significant benefit in coupled model development.
9. Difficulties in downscaling from GCM/RCMs were noted as being especially important in alpine areas such as found in extensive high-elevation areas of Asia.
10. Given the special cryospheric characteristics of Asia, models (Integrated runoff /water cycle) for Northern Large Basins should be a primary focus. As well, there should be others that include important aspects of snow cover, frozen ground, glaciers, etc., that need to be identified and developed specifically for Asia.
11. Improved GCM representation of the Asian Cryosphere (extent of snow cover, glaciers, permafrost, etc.) should be an important focus. Comparison with current updated observations needs to be considered. For this, assembly of high-quality and spatially representative observational data sets is required. There is a need for improved data archive systems in modeling activities related to, for example, snow and frozen ground.
12. Modeling activities that generate information about “extreme events” and important to “water-resource management” are especially needed.
13. Although perhaps a general statement, it is still important to stress that there is a need when coupling models to ensure integration and continuity of spatial scales.
14. To improve the GCM model, the representation of frozen ground and structural characteristics of the permafrost regions need to be considered. Often these topics tend not be of interest to scientists working on permafrost, and the two communities need to work together.

## 5.5 Data

In this session, **data- policy, -archive, -distribution and -sharing issues**, were discussed, among others. Several colleagues raised the issue of what data are needed to realize the main projects of the Asia-CliC Program, what data products are available, and the frustration of existing but unavailable data products as well as what parameters need further measurements. Actions needed to make things happen were also discussed.

It was agreed that Asia-CliC should focus on shallow soil temperature/soil freeze-thaw data, soil hydro-thermal properties, leaving deep permafrost data for the International Permafrost Association (IPA); i.e., the International Polar Year project on *Thermal State of Permafrost (TSP)*. On the subject of Central Asian permafrost mapping, Asia-CliC should work closely with the IPA mapping working group. Unifying data distribution, sharing and management policies should be developed.

Asia-CliC should form data working groups for the various sections of the cryosphere. A snow-data working group was temporarily established, which included one or two members from each contributing country. Other data working groups should be formed as required; i.e., frozen ground-, precipitation-, glacier inventory-, and river- and lake-ice groups.

A Eurasian-wide *glacier inventory* was proposed. Historical lake/river ice data sets from various Asian countries should be rescued and archived—especially those in high latitudes and the Tibetan Plateau. Glacier data issues will be discussed in more detail at the next workshop—probably in March 2008.

Data on *Soil moisture and temperature data; Meteorological data* (air temperature, precipitation, vegetation, soil type, DEM data); *Data management, Data policy, and Data sharing* were discussed. The following data issues were discussed in detail:

### 5.5.1 Permafrost data issues

- Expand and update Russian historical soil temperature data sets to 2008/09 (IPY), digitize soil temperature data from Mongolia, China, former USSR Republics, and other Asian countries.
- Archive and update IPA CALM (Circumpolar Active Layer Monitoring) and deep borehole permafrost temperature data (IPA/IPY TSP), and other related data sets.
- Obtain daily soil temperature to force models for talik studies.
- Digitize data sets of the timing and duration of soil freeze/thaw period, including active-layer freeze-up dates.
- Obtain detailed local and regional maps of permafrost and ground ice distribution.
- Compile mountain permafrost distribution over the central Asian regions.
- Collect soil type, organic content, soil moisture, snow cover, vegetation, and high resolution DEM data.

### 5.5.2 Seasonal snow-cover data

Special attention was paid to snow cover as an important climate change parameter. For effective investigation of snow cover changes over the Asian region, an improved snow-cover data set should be created. This dataset should include snow-cover data from all countries in the region. For this purpose, it is necessary to:

- Expand and update historical Russian snow cover data products, further expand to Mongolia, China, India, Pakistan, and former USSR republics
- Make available “state of the ground” data set from Russia

Problems of integration and blending satellite remote sensing products with *in-situ* observations were discussed.

A special workshop or session on snow should be included in the agenda for the Asia-CliC Science meeting in October 2007, in Lanzhou.

#### 5.5.2.1 Working group on snow-cover data

A working group on Snow-Cover Data was established, and the preliminary objectives for the group were noted (these need further refinement):

- Coordinate snow-cover data collection, archival, and distribution from relevant countries.
- Ask each member to conduct an inventory of snow data, and submit a policy for sharing for each country.
- Make a proposal to create a joint snow-cover data set and discuss result in the special session in the 2nd Asia-CliC Symposium
- Report to CliC SSG for approval and support.
- Report progress at CliC or other related meetings.

The group consists of the following individuals (others will be identified as required):

Tingjun Zhang, the National Snow and Ice Data Center, University of Colorado at Boulder, USA, Co-Leader

Vyacheslav Razuvaev, All-Russian Research Institute of Hydrometeorological Information - World Data Center (RIHMI-WDC), Russia, Co-Leader

Xin Li, Cold and Arid Regions Environmental and Engineering Research Institute (CAREERI), Chinese Academy of Sciences, and the World Data Center for Glaciology (WDC), Lanzhou, China

Jian Wang, Cold and Arid Regions Environmental and Engineering Research Institute (CAREERI), Chinese Academy of Sciences, and the World Data Center for Glaciology (WDC), Lanzhou, China

Bashir Ahmad, Water Resources Research Institute (WRRI), National Agriculture Research Center (NARC), Islamabad, Pakistan

Davaa Gombo, Hydrological Section, Institute of Meteorology and Hydrology, Ulaanbaatar, Mongolia

Ramesh P. Singh, Indian Institute of Technology, Kanpur, India

Daqing Yang, Water and Environmental Research Institute, University of Alaska Fairbanks, USA

Konosuke Sugiura, JAMSTEC, Japan

Tetsuo Ohata, Asia-CliC

Victoria Lytle, CliC International Project Office

#### 5.5.3 River- and lake-ice data

- Collect and archive river- and lake-ice data over the Eurasian Arctic regions, including the Tibetan Plateau regions.
- Expand the current monitoring sites.

### 5.6 **Satellite/Observation and Usage**

Dr. R. Singh led a session on Satellite Data/Observational Data and Usage. Questions discussed were :

1. Do we have sufficient data to meet the need of the community?
2. Do we have sufficient spatial and temporal resolution?
3. Do we have free access to remote sensing data?
4. Do we have reliable remote sensing data?
5. Do we have validated global data?

The application of remote sensing data to GCM was also addressed, including the necessity of improvements in measuring LAI. Research results using satellites observations were presented. Key satellite products include Snow & Ice information from AMSR/AMSR-E, AVHRR, ESMR/SSMR, GLAS/ICESat, MODIS/Aqua, MODIS/Terra, SAR (RADARSAT), SSM/I, Landsat, SMOS and ALOS. Major data sources for these are National Snow and Ice Data Center (NSIDC) (<http://nsidc.org>) and EOS data gateway (<http://edcimswww.cr.usgs.gov/>).

Participants discussed the need for integration of model outputs and satellite data to build a framework of data assimilation strategy for Asia-CliC. The importance of improving the algorithms and the need for an overall strategy to implement new algorithm development was discussed. This should include the validation for basin- and regional-scale hydrology. The session discussed the issue of how to effectively deal with a wide range of resolutions that we encounter in cryospheric remote sensing, including the topic of multiple approaches for different products depending of varying resolution requirements.

Japanese activities concerning the glacier inventory of Eurasia using a new Japanese satellite ALOS (Advanced Land Observation System) were introduced. The satellite carries three types of sensors, PRISM – panchromatic radiometer (0.52-0.77mm) with 2.5 m resolution and 75km/35km (nadir/triplet only) swath, which is ideal for digital elevation model (DEM) and surface mapping, AVNIR-2 – advanced visible and near IR radiometers in 4 bands (0.42-0.89mm) with 10m resolution and 75km swath, and PALSAR – L-band SAR with 7-44m, 14-88m and 100m resolution (single, dual, polarimetric) and 40-70km and 250-350km (single and ScanSAR) swath in 4 sensor modes. A combination of those sensors would provide needed high-resolution imageries with a DEM capacity. A core project team which is aiming to building the glacier inventory for High Asia based on this new satellite has submitted a proposal to JAXA (later approved). Outstanding issues discussed included validation, optimization of observation windows affected by the presence of monsoon, compatibility and possible overlaps with GLIMS, data policy especially concerning the use of DEM and future continuity of data .

The results on snow impurities and snow grain distribution products using ADEOS-II/GLI were presented. The importance of satellite Cal/Val experiments and a snow pit network as a reference were mentioned. Planned activities on ground-based snow observations at Tuul river basin (Mongolia), Yakutsk (Russia) and Hokkaido (Japan) in the winter of 2007 were reported. An experiment on snow pack conditions at several Asian countries in the winter of 2007/08 was suggested. It was also mentioned that the resolution of satellite data was coarse and estimates using satellites data were less reliable, especially in high mountains, and snow surveys in mountainous area are needed.

World Data Centre D. Summarized two projects, China LDAS and downscaling WATER project (airborne RS experiment). Information on the development of data assimilation systems for basin-scale hydrometeorological observations was provided. In addition, information concerning a new project on Asian glacier inventory using ALOS were presented.

## 5.7 Information

V. Lytle led this session where the following topics were presented and discussed: *WCRP has several cross-cutting topics* - CliC is leading the sea level rise cross-cut, and the International Polar Year cross-cut. Future research should consider how they may be able to contribute to these initiatives.

*The IGOS-Cryo theme* report has been completed, and includes several recommendations specifically targeting hydrometeorology. This document lays out a framework for improved coordination of cryospheric observations. Future work within Asia-CliC and the broader CliC community should use this report as needed to help improve observational networks. Future work within CliC will help with the implementation of this Cryosphere observing system (CryOS).

Everyone at the meeting was encouraged to register at the *CliC Specialists* database: <http://clic.npolar.no/specialists>. This register is used to help nominate panel and committee members, and to find people who can respond to requests. Everyone is also asked to help update national program activities on the CliC website, please send any updates to [clic@npolar.no](mailto:clic@npolar.no). The CliC website also contains lists of future cryosphere-related meetings, and links to other groups.

## 6.0 Next Steps and Actions

**Priority topics** with actions:

- *Snow-cover data-archive mapping* - Vyacheslav Razuvaev and Zhang Tinjun will lead this topic, in addition to a group of specialist. Discussions will continue during the *2nd Asia-CliC Symposium, Lanzhou*, with the formation of a proposed detail plan and half day meeting.
- *Frozen ground*- This topic is under consideration, and will be discuss in Lanzhou
- *Glacier mapping* - This topic is under consideration, and will be discuss in Lanzhou and Glacier Workshop.
- *Hydrometeorological data* – e.g., precipitation especially solid precipitation.

**Advised topics:**

- Initiate Process Research project advised: CABIN (Japan core project), to be more detail and finalize
- Model related activities: Arctic-HYDRA
- IHACYs (China core project)
- ALOS Glacier inventory (broaden group)
- Chinese hydro-meteorology research project

**Follow-up and CliC Meetings:**

- 2nd Asia-CliC Symposium, Lanzhou, China, October 22-26, 2007, (XIE Aihong)
- Asia-CliC WS on Glacier related issues. 2008, place TBD. China CliC Committee will take the lead
- CliC SSG November 19-21, Geneva, Switzerland

**Related Meetings**

- IUGG (International Union of Geodesy and Geophysics): IUGG2007, Perugia, Italy, July 2-13, 2007. Related sessions are Cold Region Land System, Permafrost and Hydrology, and Asian Glaciers
- Northern Research Basin Meeting
- AGU (American Geophysical Union); 2007 Fall Meeting will be held in San Francisco, USA, December 10–14, 2007
- AOGS (Asia Oceania Geosciences Society); AOGS2008 will be held in Busan, Korea, 2008.



## **APPENDICES**



## Appendix 1

# A G E N D A

May 17, 2007 (Thursday)

**10:00**            **Entrance and Registration**

**10:30-11:30**    **Welcome Speech and Introduction**

Fukasawa, M., Welcome Speech  
All participants, Self Introduction  
Ohata, T., Objectives and Target of the Workshop  
Lytle, V., Overview of CliC Project (O-1)

*Workshop Photograph and Coffee Break*

**12:00-12:30**    **Plenary Session (Oral Presentation, Prowse, T.)**

Prowse, T., An Overview of the ICARPII Cryosphere and Hydrology Research Plan (O-2)  
Ukita, J., An Overview of the IGOS-P Cryosphere Theme Report and Asian Contributions (O-3)

*Lunch Break (Meeting of the Conveners)*

**13:30- 15:30**    **Plenary Session (Open Session, Ohata, T.)**

Yang, D., Challenges in Understanding Arctic Hydrology System Changes (O-6)  
Davaa, G., Climate Change Impact on Water Resources in Mongolia (O-7)  
Li, X., Cryospheric Change in China (O-8)  
Singh, R.P., Effect of Dust Storms on the North West Himalayan Snow-Covered Region (O-9)

*Coffee Break*

**15:45- 18:00**    **Plenary Session (Oral Presentation, Li, X.)**

Zhang, T., Hydrological Response to Changes in Permafrost Conditions over Russian Arctic Drainage Basins (O-10)  
Spektor, V., Influence of Climate on Ground Temperatures in Yakutia (O-11)  
Sugimoto, A., Importance of Soil Moisture as a Controlling Factor for Permafrost Ecosystem (O-12)  
Wang, J., Effect of Climatic Change on Snowmelt Runoffs in Mountainous Regions of Inland Rivers in Northwestern China (O-13)  
Zhang, F., Effect of Climate Change on Runoff in Three Mountain Permafrost Watersheds, Northwest China (O-14)  
Yu, Q., Sino-German Cooperative Research on the Degradation of Permafrost on the Qinghai-Tibet Plateau (O-15)  
Ueno, K., Function of Snow Covers in the Tibetan Plateau in Winter and Spring (O-16)  
Wang, S., Evolution of the High-Elevation Inlakes in Tibetan Plateau over Recent Decades (O-17)

**18:00- 18:15**    **Plenary Session**

Discussion item and Targets

**18:30-20:00**    **Icebreaker (Japanese style pub)**

## Appendix 1

**May 18, 2007 (Friday)**

**09:00 Entrance**

**09:30- 12:00 Plenary Session (Oral Presentation, Saito, K.)**

Razuvaev, V., Snow Cover Data and Variations in Snow Characteristics over the Russian Territory (O-4)

Zheleznyak, M., Development of the North-East Asia Permafrost Monitoring Network (O-19)

Ishikawa, M., Global Significance of Frozen Grounds Discontinuously Distributed in Eurasian Eco-tone, Mongolia (O-20)

Saito, K., Hydro-Thermal Regimes in the Circum-Arctic Basins Simulated by a High-Resolution CGCM for 1900-2100 (O-21)

Suzuki, R., Importance of Forest Floor Information for Vegetation Remote Sensing over Boreal Forest (O-22)

Yang, D., Development of Bias-Corrected Precipitation Database and Climatology for the High Latitude Regions (O-23)

Asanuma, J., RAISE Surface Flux Results and Future Plan of RAISE Group (O-24)

***Coffee Break***

Rikiishi, K., Implications of the Recent Reduction of Snow Cover in the Himalaya Mountains and Tibetan Plateau Region (O-25)

Ahmad, B., Process, Causes and Future of Water Cycle of Indus River Basin (O-18)

**12:00-17:30 Round Table Discussions (including Introduction of Poster Presentation chaired by Ukita, J., Coffee Break and Lunch Break)**

Northern Eurasian Research Issue

Sugimoto, A., Ohata, T.: CABIN

Short presentations

South Central Research Issue

Short presentations

Continental Research Issue

Short presentations

## Appendix 1

**May 19, 2007 (Saturday)**

**09:00           Entrance**

**09:30-14:30   Round Table Discussions (including Coffee Break & Lunch Break)**

Model

Short presentations

Data

Short presentations

Satellite/Observation Usage

Short presentations

Information

Short presentations

**14:30-15:00   Plenary Session**

Summary

Next Steps and Actions

Close of the Workshop

\*\*\*\*\*

### **Poster Presentations (May 17-19)\***

**Suzuki, K.**, *A Review of Snow Processes in the Forested Area (P-1)*

**Zhang, Y.**, *Trends and Variability in the Hydro-Meteorological Regime of the Tuul River Basin, Mongolia in Recent Decades (P-2)*

**Tian, L.**, *Isotopic Variation in the Lake Water Balance at the Yamdruk-tso Basin, Southern Tibetan Plateau (P-3)*

**Xie, A.**, *Mount Everest Meteorological Observations in 2005 (P-4)*

**Sugiura, K.**, *Time Series of Snow Pack Profiles Observed at Sapporo for 2003/04-2006/07 Winter Seasons (P-5)*

**Georgiadi, A.G.**, *Response of River Runoff in Cryolithic Zone of Eastern Siberia (Lena River Basin) to Recent and Future Climate Warming (O-5)*

\* Only first author listed.

## Appendix 2

### List of Participants

Bashir Ahmad  
Water Resources Research Institute (WRRI)  
National Agriculture Research Center (NARC)  
P.O. NIH, Park Road, Islamabad, Pakistan  
bashirad@hotmail.com  
Phone/Fax: +92-333-5487506/ +92-51-9255074

Jun Asanuma  
Terrestrial Environment Research Center  
Tsukuba University  
Ten-nohdai 1-1-1, Tsukuba, Ibaraki, Japan  
asanuma@suii.tsukuba.ac.jp  
Phone/Fax: +81-29-853-6704

Masao Fukasawa  
Institute of Observational Research for Global Change (IORGC), JAMSTEC  
2-15, Natsushima-cho, Yokosuka, 237-0061, Japan  
fksw@jamstec.go.jp  
Phone/Fax: +81-46-867-9400

Davaa Gombo  
Hydrology Section, Institute of Meteorology and Hydrology  
Juulchin St.-5, Ulaanbaatar-46, Mongolia  
watersect@yahoo.com  
Phone/Fax: +976-11-312765/ +976-11-326614

Yoshihiro Iijima  
Institute of Observational Research for Global Change (IORGC), JAMSTEC  
2-15 Natsushima-cho, Yokosuka-city, Kanakawa, 237-0061, Japan  
yijima@jamstec.go.jp  
Phone/Fax: +81-46-867-9274/ +81-46-867-9255

Reiichiro Ishii  
Frontier Research Center for Global Change (FRCGC), JAMSTEC  
3173-25 Showa-machi, Kanazawa-ku, Yokohama-shi, Kanagawa, 236-0001, Japan  
r.ishii@jamstec.go.jp  
Phone/Fax: +81-45-778-5674/ +81-45-778-5706

Mamoru Ishikawa  
Graduate School of Environmental Earth Science, Hokkaido University  
Kita-10, Nishi-5, Kita-ku, Sapporo, 060-0810, Japan  
mishi@ees.hokudai.ac.jp  
Phone/Fax: +81-11-706-2221

## Appendix 2

Hideyuki Kamimera  
Institute of Observational Research for Global Change (IORGC), JAMSTEC  
2-15 Natsushima-cho, Yokosuka-city, Kanakawa, 237-0061, Japan  
kamimera@jamstec.go.jp  
Phone/Fax: +81-46-867-9278/ +81-46-867-9255

Yuji Kodama  
Institute of Low Temperature Science, Hokkaido University  
Sapporo, 060-0819 Japan  
kod@pop.lowtem.hokudai.ac.jp  
Phone/Fax: +81-11-706-5509/ +81-11-706-5509

Keiko Konnya  
Institute of Observational Research for Global Change (IORGC), JAMSTEC  
2-15 Natsushima-cho, Yokosuka-city, Kanakawa, 237-0061, Japan  
conya@jamstec.go.jp  
Phone/Fax: +81-46-867-9271/ +81-46-867-9255

Xin Li  
Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy  
of Sciences, World Data Center for Glaciology and Geocryology in Lanzhou  
320 West Donggang Road, Lanzhou, 730000, China  
lixin@lzb.ac.cn  
Phone/Fax: +86-931-4967249/ +86-931-8279161

Victoria Lytle  
CliC Project Office  
Polar Environmental Center, Norwegian Polar Institute, Tromsø, 9296, Norway  
Victoria.lytle@npolar.no; clic@npolar.no  
Phone/Fax: +47 95089598, +47 77750145/ +47 77750501

Xieyao Ma  
Frontier Research Center for Global Change (FRCGC), JAMSTEC  
3173-25 Showa-machi, Kanazawa-ku, Yokohama-shi, Kanagawa, 236-0001, Japan  
xyma@jamstec.go.jp  
Phone/Fax: +81-45-778-5546/ +81-45-778-5706

Kouichi Masuda  
Frontier Research Center for Global Change (FRCGC), JAMSTEC, JAMSTEC  
3173-25 Showa-machi, Kanazawa-ku, Yokohama-shi, Kanagawa, 236-0001, Japan  
masuda@jamstec.go.jp  
Phone/Fax: +81-45-778-5538/ +81-45-778-5706

Tetsuo Ohata  
Institute of Observational Research for Global Change (IORGC), Japan Agency for Marine-  
Earth Science and Technology (JAMSTEC)  
2-15, Natsushima-cho, Yokosuka, 237-006, Japan  
ohatat@jamstec.go.jp  
Phone/Fax: +81-46-867-9250/ +81-46-867-9255

## Appendix 2

Takeshi Ohta

Graduate School of Bioagricultural Sciences, Nagoya University

Furo-cho, Chikusa Ward, Nagoya 464-8601, Japan

takeshi@agr.nagoya-u.ac.jp

Phone/Fax: +81-52-789-40589

Hoteak Park

Institute of Observational Research for Global Change (IORGC), JAMSTEC

2-15 Natsushima-cho, Yokosuka-city, Kanakawa, 237-0061, Japan

park@jamstec.go.jp

Phone/Fax: +81-46-867-9292/ +81-46-867-9255

Terry Prowse

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

Water & Climate Impacts Research Centre, University of Victoria, PO Box 1700 STN CSC, Victoria, BC, Canada V8W 2Y2

Terry.Prowse@ec.gc.ca

Phone/Fax: +1-250-472-5169/ +1-250-472-5167

Vyacheslav N. Razuvaev

All-Russian Research Institute of Hydrometeorological Information

World Data Centre (RIHMI-WDC)

6 Korolev St., Obninsk, Kaluga Reg., 249035, Russian Federation

razuvaev@meteo.ru

Phone/Fax: +7-495-255-21-94/ +7-495-255-22-25

Kunio Rikiishi

Department of Earth and Environmental Sciences, Hirosaki University

Bunkyo-cho 3, Hirosaki City, Aomori Prefecture, 036-8561, Japan

rikiishi@cc.hirosaki-u.ac.jp

Phone/Fax: +81-172-39-3605

Kazuyuki Saito

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

1): 930 Koyukuk Dr., 408B, PO Box 757340, Fairbanks, AK, 99775-7340, USA, 2): 3173-25 Syowa-machi, Kanazawa-ku, Yokohama, Kanagawa, 236-0001, Japan

1): ksaito@iarc.uaf.edu, 2): ksaito@jamstec.go.jp

Phone/Fax: +1-907-474-5813/ +1-907-474-2691

Ramesh P. Singh

Indian Institute of Technology, Kanpur, India

Department of Civil Engineering, Indian Institute of Technology, Kanpur – 208 016, India

rpalka425@gmail.com

Phone/Fax: +91-512-2597295/ +91-512-2597395



## Appendix 2

Valentin Spektor  
Permafrost Institute SB RAS, Yakutsk  
Mezlotnaya st, 36, 677010 Yakutsk, Russia  
fe@mpi.ysn.ru  
Phone/Fax: +7-4112-334689/ +7-4112-334476

Atsuko Sugimoto  
Faculty of Environmental Earth Science, Hokkaido University  
Kita 10 Nishi 5, Kitaku, Sapporo, 060-0810, Japan  
sugimoto@star.dti2.ne.jp  
Phone/Fax: +81-11-706-2233/ +81-11-706-4867

Konosuke Sugiura  
Institute of Observational Research for Global Change (IORGC), Japan Agency for Marine-  
Earth Science and Technology (JAMSTEC)  
2-15, Natsushima-cho, Yokosuka, 237-0061, Japan  
sugiura@jamstec.go.jp  
Phone/Fax: +81-46-867-9279/ +81-46-867-9255

Kazuyoshi Suzuki  
Institute of Observational Research for Global Change (IORGC), JAMSTEC  
2-15, Natsushima-cho, Yokosuka-city, Kanagawa, 237-0061, Japan  
skazu@jamstec.go.jp  
Phone/Fax: +81-46-867-9276/ +81-46-867-9255

Rikie Suzuki  
Frontier Research Center for Global Change (FRCGC), Japan Agency for Marine-Earth  
Science and Technology  
3173-25, Showamachi, Kanazawa-ku, Yokohama, Kanagawa, 236-0001, Japan  
rikie@jamstec.go.jp  
Phone/Fax: +81-45-778-5541/ +81-45-778-5706

Kumiko Takata  
Frontier Research Center for Global Change (FRCGC), JAMSTEC  
3173-25 Showa-machi, Kanazawa-ku, Yokohama-shi, Kanagawa, 236-0001, Japan  
takata@jamstec.go.jp  
Phone/Fax: +81-45-778-5544/ +81-45-778-5706

Lide Tian  
Institute of Tibetan Plateau Research, Chinese Academy of Sciences  
P. B. 2871, 18 Shuangqing Rd., Haidian Dist., Beijing 100085, China  
ldt@itpcas.ac.cn  
Phone/Fax: +86-10-62849390/ +86-10-62849886

Kenichi Ueno  
University of Tsukuba  
Tenno-dai 1-1-1, Tsukuba, Ibaraki, Japan  
kenueno@sakura.tsukuba.ac.jp  
Phone/Fax: +81-29-853-4399

## Appendix 2

Jinro Ukita  
Chiba University  
1-33, Yayoi-cho, Inage-ku, Chiba, 263-8522  
jukita@faculty.chiba-u.jp  
Phone/Fax:

Jian Wang  
Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy of Sciences, World Data Center for Glaciology and Geocryology in Lanzhou  
320 West Donggang Road, Lanzhou, 730000, China  
wjian@lzb.ac.cn  
Phone/Fax: +86-931-4967234/ +86-931-4967235

Siyuan Wang  
Institute of Electronics, Chinese Academy of Sciences  
No.19 BeiShiHuan XiLu, Haidian District, Beijing 100080, P.R.China  
w\_siyuan@126.com  
Phone/Fax:

Aihong Xie  
Joined Key Laboratory of Cryosphere and Environment, Cold and Arid Regions, Environmental and Engineering Research Institute, Chinese Academy of Sciences  
320 Donggang Xiroad, Lanzhou 730000, China  
xieaih@lzb.ac.cn  
Phone/Fax: +86-931-4967338/ +86-931-8277094

Hiroyuki Yabuki  
Institute of Observational Research for Global Change (IORGC), JAMSTEC  
2-15 Natsushima-cho, Yokosuka-city, Kanakawa, 237-0061, Japan  
yabuki@jamstec.go.jp  
Phone/Fax: +81-46-867-9268/ +81-46-867-9255

Daqing Yang  
Water and Environmental Research Center, University of Alaska Fairbanks  
AK, 99775, USA  
ffdy@uaf.edu  
Phone/Fax: +1-907-474-2468/ +1-907-474-7979

Qihao Yu  
State Key Laboratory of Frozen Soil Engineering, CAREERI, CAS  
Lanzhou Gansu 730000, China  
yuqh@ns.lzb.ac.cn  
Phone/Fax:

Fei Zhang  
Institute of Tibetan Plateau Research, Chinese Academy of Sciences  
18 Shuangqing Rd. Haidian District, Beijing 100085, China  
zhangfei@itpcas.ac.cn  
Phone/Fax: +86-10-62849373

## Appendix 2

Tingjun Zhang

National Snow and Ice Data Center, USA

1540 30th Street, NSIDC/CIRES, 449 UCB, University of Colorado, Boulder, Colorado

80309-0449, USA

tzhang@nsidc.org

Phone/Fax: +1-303-492-5236/ +1-303-492-2468

Yinsheng Zhang

Institute of Observational Research for Global Change (IORGC), JAMSTEC

2-15 Natsushima-cho, Yokosuka-city, Kanakawa, 237-0061, Japan

yszhang@jamstec.go.jp

Phone/Fax: +81-46-867-9273/ +81-46-867-9255

## Appendix 2

### Acronyms Used in this Publication

ADEOS-II/GLI	Advanced Earth Observing Satellite/Global Imager
ALOS	Advanced Land Observing Satellite (Japan)
AMSR	Advanced Microwave Scanning Radiometer
AO	Arctic Oscillation
AVHRR	Advanced Very High Resolution Radiometry
AVNIR-2	Advance Visible sensor (one of three different types on ALOS)
AWS	Automatic Weather Stations
CABIN	Cryosphere-Atmosphere-Biosphere Interaction
CALM	Circumpolar Active Layer Modeling (IPA)
CAREERI	Cold and Arid Regions Environmental and Engineering Research Institute (China)
CLiC	Climate and Cryosphere
DEM	Digital Elevation Model
ENSO	El Niño/Southern Oscillation
EOS	Earth Observing System (NASA/Europe/Japan)
ESMR	Electrically Scanning Microwave Radiometer
GCM	Global Circular Model
GLAS	Geoscience Laser Altimeter System
GLIMS	Global Land Ice Measurements from Space
GLOF	Glacier Lake Outburst Floods
GPR	Global Penetrating Radar
GPS	Global Positioning System
ICARP	International Conference for Arctic Research Planning
ICESat	Ice, Cloud and land Elevation Satellite (NASA)
IHACY	International High Asia Cryosphere Year (China core projects on High Asia)
IORGC	Institute of Observational Research for Global Change (JAMSTEC)
IPA	International Permafrost Association
IPY	International Polar Year
JAMSTEC	Japan Agency for Marine-Earth Science and Technology
JAXA	Japan Aerospace Exploration Agency
LAI	Leaf Area Index
LDAS	Land Data Assimilation System (China)
MODIS	Moderate Resolution Imaging Spectroradiometer

## Appendix 2

NAO	North Atlantic Oscillation
NSIDC	National Snow and Ice Data Center
PALSAR	L-band SAR sensor on ALOS (one of three different types)
PRISM	Panchromatic Radiometer sensor on ALOS satellite (one of three different types)
RCM	Reaction Control Module
RIHMI-WDC	Research Institute of Hydrometeorological Information–World Data Center (Russia)
RS data	Radio Sonde data sets
SAR	Spaceborne Synthetic Aperture Radar
SMOS	Soil Moisture and Ocean Salinity (ESA)
SSM/I	Special Sensor Microwave/Image
SSMR	Scanning multichannel Microwave Radiometer
SST	Sea Surface Temperature
TSP	Thermal State of Permafrost
WCRP	World Climate Research Programme
WDC	World Data Center