

Cold Regions Hydrology in the International Polar Year

-Report from ICSIH-

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There are substantial hydrology activities in the International Polar Year (2007-2008), driven by the need for a better understanding of hydrology in the Polar Regions. This need is made urgent by the ungauged or poorly-gauged nature of much of the Arctic and Antarctic drainage basins and by the importance of melt in governing the balance between terrestrial snow and ice and streamflow. Freshwater inputs can modify ocean currents, particularly those in the North Atlantic which currently warm Europe. The impacts of a warming Arctic are already raising serious concerns about the stability of the sensitive balance between climate conditions, freshwater input, oceanic circulation and the state of cryospheric components.

In the International Polar Year cold regions hydrology activities are mainly organised around the Arctic-Hydra Project lead by Árni Snorrason of Iceland, <http://arcticportal.org/arctichydra>. The Arctic-HYDRA project consists of a network for the observation of the Arctic Hydrological Cycle (AHC) coupled with a suite of intensive, focussed process studies that are based on in-depth measurements and modelling of the individual components of the AHC. Furthermore, hydrological models and data assimilation techniques will be developed to generate a comprehensive, integrated description of the AHC including the feedbacks between the atmosphere, cryosphere and the oceans. The main scientific goals of the Arctic HYDRA project are to i) characterize variability in the AHC, ii) examine linkages between atmospheric forcing and continental discharge to the oceans, iii) assess the historical response of the Arctic Ocean to variations in freshwater input from rivers and net precipitation over the ocean, iv) attribute to specific elements of the AHC or to external forcing the sources of observed spatial temporal variability in the land-ocean- ice-atmosphere system, v) detect emerging changes in the contemporary state of the AHC in near real time and to place such changes into a broader historical context.

Two major activities relating to the IPY and linked to Arctic-Hydra are the Russian national programme for hydrology in IPY and the Canadian IP3 Network (Improved Processes and Parameterisations for Prediction in Cold Regions) both of which recently have had important meetings. The format and results of these meetings are briefly described below.

Russian hydrology activities related to IPY

The scientific program for Russian participation in IPY was adopted in 2006 by the Russian National Committee for IPY 2007-2008

(http://www.ipyrus.aari.ru/orgcom_comp.html; in Russian language only) under the support of the Government of the Russian Federation. Russian IPY 2007–2008 activities assemble researchers from the Federal Service for Hydrometeorology and Environmental

Monitoring, Russian Academy of Sciences, Moscow State University, institutes of the government ministries and some non-government organizations. A total of 164 projects have been endorsed by the Russian National Committee for IPY 2007-2008. These projects have an interdisciplinary emphasis and address seven branches of research. The first branch is particularly devoted to the hydrological processes in the Arctic region. The main objectives of the hydrological section are the estimation of the current and the future changes in hydrological and ice regime of the rivers and lakes, and snow processes in the Russian arctic regions under the climate changes. Within the framework of these objectives, the projects are directed to

- (1) collecting a broad-ranging set of hydrometeorological data which will be made available worldwide,
- (2) developing a strategy to account for climate change impacts on arctic rivers,
- (3) assessing the probable changes in the large river runoff under the changing climate and adapting existing water resources systems to these changes, and
- (4) estimating the spatial-temporal variability of snow processes and their sensitivity to climate change.

On 3-9 October 2007 in Sochi, the Russian National Committee for IPY 2007-2008 organized a conference where the first results of these studies were discussed. The conference was hosted by the Scientific Centre of the Russian Academy of Science (RAS) and opened with a plenary talk from academician of RAS Vladimir M. Kotlyakov, Chairman of the Scientific Council of Arctic and Antarctic Research. Over 100 people attended the conference and presented 92 oral and poster reports from which thirteen were focused on the hydrological topics listed above. These hydrological reports were presented by researchers from the Water Problems Institute of RAS, the Institute of Geography of RAS, the Institute of Atmospheric Physics of RAS, and Moscow State University. Different approaches to modelling river runoff generation in the permafrost regions, river ice-cover dynamics and ice jam flooding, and seasonal snowcover processes as well as to estimating the current changes in water and chemical flow of the large Siberian rivers into the Arctic Ocean, and the physical properties of snow cover were developed and reported by these researchers. The conference closed with a discussion on integration, in the framework of IPY, of the Russian IPY hydrological activity with the international community of cold region hydrology.

The IP3 Research Network: Enhancing Understanding of Water Resources in Canada's Cold Regions as part of IPY

IP3, *Improved Processes and Parameterisation for Prediction in Cold Regions*, is a research network funded by the Canadian Foundation for Climate and Atmospheric Sciences (CFCAS) for 2006-2010. The Network, which is comprised of about 80 Investigators, Collaborators, postgraduate students, and postdoctoral fellows from across Canada, the US, and Europe, is devoted to an improved understanding of surface water and weather systems in cold regions, particularly Canada's Rocky Mountains and western Arctic. IP3 makes a contribution to better weather and climate prediction, to estimation of streamflow from ungauged basins, to predicting changes in Rocky Mountain snow and water supplies, to calculating freshwater inputs to the Arctic Ocean, and to sustainable management of mountain and northern water resources.

IP3 has three goals: understanding the key climate system **Processes** relating to the hydrometeorology of cold regions; **Parameterising** land surface hydrology processes that control the coupled atmospheric-hydrological system in cold regions; and validating and improving models for weather, water, and climate systems leading to better **Prediction** and simulation of related atmospheric impacts on water resources and surface climates in cold regions. The first of these goals is being addressed through intense field campaigns along a transect of eight highly instrumented, small (10-200 km²) research basins that characterize the range of Canada's cold regions. Field investigations are focused on snowpacks (based on land, glaciers, and lake ice), open water (primarily small lakes), and runoff generation over frozen ground, glacierized areas, and permafrost. To address the other two goals, the Network members are pursuing a new generation of process hydrology and coupled atmospheric-hydrological models. Recent advances in understanding are being parameterised and integrated into numerical models to improve the predictive capabilities for complex land-atmosphere systems in cold regions.

IP3 held its Second Annual Network Workshop at the Cold Regions Research Centre of Wilfrid Laurier University in Waterloo, Ontario, Canada, 8-10 November 2007. Approximately 90 people attended the Workshop, including 27 students from across Canada and the UK. The event was also the launch of the Canadian component of the International Polar Year (IPY) aspect of IP3 and related studies of Arctic-Hydra. The Workshop provided the first link between the IPY and the PUB (IAHS Predictions in Ungauged Basins) Decade.

Dr. Gordon Young, President-elect of IAHS, provided a plenary talk on "Cold Regions Hydrology and its Relevance to Canada and the World". Dr. John Pomeroy, IP3 Principal Investigator, gave an overview of the Network and its goals. This was followed by 27 scientific reports from Investigators and Collaborators highlighting cold regions hydrological processes, parameterization of these processes into models, and prediction using a range of modelling strategies which encompassed small-scale process hydrology models through larger scale coupled atmosphere-land surface hydrology models. The third day of the Workshop focussed on IP3's international and national collaborations. The Network contributes to PUB as Working Group 16 and has established linkages with the Western Canadian Cryospheric Network, a related CFCAS-funded glaciological research network. Dr. Fred Wrona, Acting Director General of the Water Science and Technology Directorate of Environment Canada, spoke on behalf of the Canadian government and highlighted its links to IP3 in *Freshwater Systems: Hydrology and Ecology*, a Canadian Arctic IPY initiative.

The IP3 Users' Advisory Committee, chaired by Bob Reid, held its first in-person meeting as part of the IP3 workshop with plenary presentations from Ian Church, Science Advisor to the Government of the Yukon, on "The User's Perspective from the North" and from Bob Sandford, Executive Director of the Western Watersheds Climate Research Collaborative and prolific Alberta-based author, on "A Tower of North American Babel: Making Climate Science Intelligible To Leaders, Policy Makers, and the Public." These presentations were followed by a round table discussion on water resource and ecohydrology users' needs from IP3.

In the closing session, Dr. Hok Woo, Chair of the IP3 Board of Directors, summarized the good progress IP3 has made in its 16 months of existence. Since the

workshop, IP3 has been accepted as a project of CliC (the Climate and Cryosphere Project) of the World Climate Research Programme.

Next Meetings

The Nordic Hydrological Conference will be held in Reykjavík on 11-13 August 2008 where Arctic-Hydra and ICSIH will sponsor sessions relating to climate modelling in the Arctic, hydrological measurements and modelling in the Arctic, glaciological measurements and modelling in the Arctic, and climate impacts on Arctic water resources and hydroeco-systems. <http://www.nhc2008.com>. There will also be further Russian and Canadian meetings dealing with their IPY studies, including the next IP3 workshop in Whitehorse, Yukon Territory in November, 2008.