Water Research

S U M M E R   2 0 0 9

IP3 — Improved Processes & Parameterisation for Prediction in Cold Regions

IP3 Research Network

IP3 is a research network funded by the Canadian Foundation for Climate and Atmospheric Sciences (CFCAS) for 2006-2010 and supported by partners in all levels of government as well as the private sector. The IP3 network is comprised of several dozen investigators, collaborators, and students from across Canada, the US, and Europe and is headquartered at the University of Saskatchewan's Centre for Hydrology. IP3 is devoted to an improved understanding of the study of water and weather systems in cold regions, particularly Canada's

Snow survey

Rocky Mountains and western Arctic. Data is being collected from several different research areas, where scientists are studying snowpacks, glaciers, lakes, wetlands, permafrost, streamflow, and runoff. Using these data to test water and climate models will lead to improved understanding and predictability of snow accumulation and melt, glacier motion and growth, soil moisture, evaporation, thawing permafrost, and changes in lake levels and streamflow in cold environments. This information is of key importance to applied water management and policy development for communities in planning recreation, sustainable industrial development, and infrastructure as well as environmental conservation in western and northern Canada.

Northern Focus

Northern research locations include permafrost wetlands, taiga woodlands, small lake drainage basins, alpine tundra, and boreal forest. IP3 science in the North has relevance for several key northern issues including permafrost degradation, streamflow and meltwater timing, and flood forecasting. Increased development in the north will continue to exert pressure on northern water resources, and IP3 will contribute directly to improved understanding and prediction of these resources.

Processes

Field observations are being carried out at ten different research locations, each 10 to 200 km² in area, ranging from high altitude mountain sites in the south (Rocky Mountains) and north (Yukon), as well as low elevation sites in the north (Northwest Territories). These different sites were selected to provide varying types of vegetation, natural land features, climate, and precipitation patterns. Field observations include hourly measurement of air temperature, humidity, wind speed, rainfall, snowfall, and snow depth, with glacier surface measurements and streamflow recorded during monthly or annual field campaigns. The goal of collecting data is to move towards a better understanding of the key climate processes as they relate to water systems in cold regions.
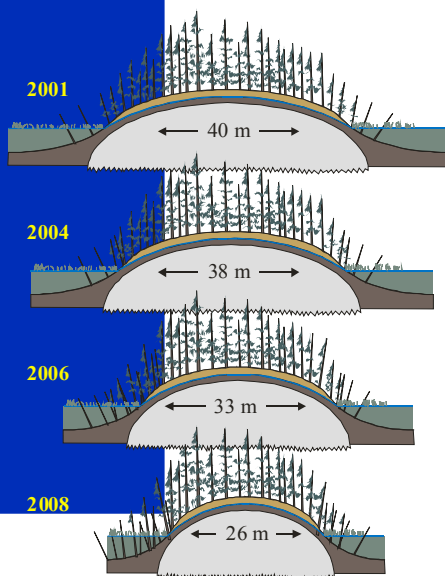
Trail Valley meteorological station

A parameterisation is a means of describing a complex phenomenon in relatively simple mathematical form so that it may be used in a computer simulation

Parameterisation

Parameterisation involves the scaling of specific processes such as snowmelt, blowing snow redistribution, runoff and streamflow, evaporation, and frozen soil infiltration. These land and water processes are described in a mathematical form enabling them to be entered into a computer model. Models with parameterisations are run against models using measured data to allow for comparison and validation of both the parameterisations and the model. One of the modeling tools being developed is the Cold Regions Hydrological Model (CRHM) which is used as a first step in developing mathematical descriptions of the natural world. The model is a proving ground where parameterisations (approximations) can be tested against actual observations to determine how well the model describes various landscape and environmental possibilities.

Prediction

Permafrost loss on a boreal forest peat plateau

2001
← 40 m →

2004
← 38 m →

2006
← 33 m →

2008
← 26 m →

Models can be used for prediction of snowpack levels, lake levels, and streamflow in small watersheds. IP3 is working with several models linking separate water and climate models allowing surface water systems to influence and react to the atmosphere just as weather and water co-exist in the natural world. IP3 science is contributing to a direct improvement in water resource modeling capability of cold region processes such as permafrost, frozen soil, snow sublimation, and snow redistribution by wind and vegetation. Validating and improving models for weather, water, and climate systems leads to better prediction of related atmospheric impacts on water resources and surface climates in cold regions.

Trail Valley Creek

Tundra monitoring site winter

The Trail Valley Creek watershed is a shrub and tundra site draining into the Arctic Ocean through the Eskimo Lakes system. Research in this watershed is focused on monitoring links between snow cover, blowing snow redistribution, permafrost active layer depth, and water runoff.

Tundra monitoring site summer

Havikpak Creek

Havikpak Creek flows into the Mackenzie River near the Mackenzie Delta. The basin is primarily open taiga woodland, with some open wetlands and shrub tundra underlain by continuous permafrost. Data is collected from two meteorological stations and one streamflow monitoring station located near the Inuvik Meteorological Services of Canada weather station. Snowmelt and runoff processes are being studied for better understanding and input to models.

Forest meteorological station

Wolf Creek

Alpine meteorological station

Wolf Creek research basin is located near Whitehorse and represents a sub-arctic mountain environment with both lowland forest and alpine tundra represented at the research site. Meteorological stations are located at three elevations; forested, brush, and alpine. Stream gauges in the watershed allow the study of the snowmelt-driven water cycle and the influence of frozen ground on this process. Snow redistribution modeling done at Wolf Creek is being used to build models for use at other northern sites.

Baker Creek

Baker Creek includes a series of interconnected lakes draining a watershed north of Great Slave Lake. The landscape is taiga woodland and boreal forest. The basin has three meteorological stations and one streamflow gauging station. This site represents extreme landscape diversity with exposed rock, soil and peat underlain by permafrost, as well as both large and small lakes —all give a different response to water runoff. Lake connectivity relationships during runoff are being modeled to explore water storage patterns and runoff response.

Streamflow measurement

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IP3 contributes to better weather and climate prediction, to estimation of streamflow from un-gauged basins, to calculating freshwater inputs to the Arctic Ocean, and to sustainable manage-ment of mountain and northern water resources. Study of snowmelt modeling, water storage, and streamflow are essential for a better understand-ing of how climate change affects our freshwater resources. IP3 is working to involve the water resource management community in the sharing of knowledge gained through this research.

To learn more about IP3 visit our website at
http://www.usask.ca/ip3/

Canadian Foundation for Climate and Atmospheric Sciences (CFCAS)
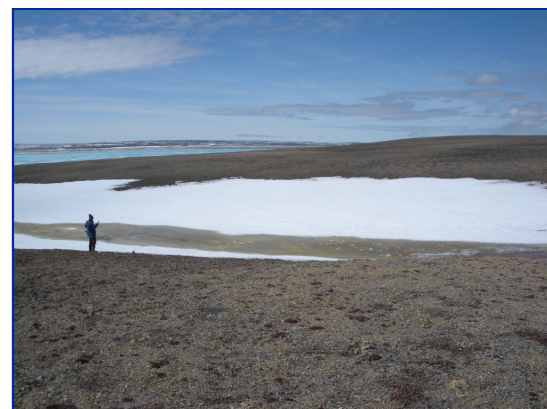Fondation canadienne pour les sciences du climat et de l'atmosphère (FCSCA)

Scotty Creek

Scotty Creek represents a flat region of boreal forest with wetlands and low-lying bogs in a zone of discontinuous permafrost. Study of soil thaw and runoff on peat plateaus is the focus of this research site located roughly 50 km south of the confluence of the Liard and Mackenzie Rivers. Runoff occurs mostly through the subsurface rather than over ground requiring an improved understanding of frost table depth as it relates to runoff. Permafrost in this region is undergoing change with peat plateaus underlain by permafrost being converted to bogs and wetlands through permafrost thaw. Permafrost thaw leads to changes in drainage for wetlands and complicates model development in representing these changing conditions.

Shifting permafrost boundaries

Polar Bear Pass

Polar Bear Pass is located on Bathurst Island, Nunavut, 120km northwest of Resolute. This arctic wetlands research site is an important national wildlife area, underlain by continuous permafrost with a polar desert-type climate. While winter snowpack is one of the most important water re-sources for Arctic ecosystems, ongoing research is looking at the impor-tance of rainfall in continuous streamflows. Hillslope creeks are important for recharging wetlands; however, after snowmelt, flows require substan-tial rainwater input for continuous streamflow to sustain these wetlands.

Drifting snowpack

Photos, diagrams and research provided
by IP3 network members