Water peaks

Dr Stephen Déry explains his research, which examines hydrometeorological processes in British Columbia's mountains; systems that have an impact on the supply of freshwater within Canada

How would you outline the activities of the Northern Hydrometeorology Group?

The Northern Hydrometeorology Group (NHG) investigates the role of climate variability and climate change on the high-latitude and alpine water cycle. Thus, our research is focused on hydrometeorological processes and their impacts on the surface energy and water budgets. We use field observations, reanalysis datasets, remote sensing data, and numerical modelling to investigate these processes at scales from one metre to many kilometres. With growing demands for freshwater resources in a rapidly changing climate, there is an urgent need to better understand the hydrometeorology of mountainous, northern watersheds.

What are NHG's chief accomplishments? How does it contribute to ongoing research?

NHG has expertise in the fundamentals of hydrometeorology and hydrometeorological monitoring. These include the deployment of automatic weather stations in remote locations and harsh environments. We also study snow physics, particularly redistribution of snow by wind and remote sensing of snow covers, as well as river discharge in western Canada and the Arctic, its links to large-scale forcing, and the impact of local conditions. Finally, we examine the influence of forests on snow cover, snow melt, hydrology and micro-meteorology.

Could you describe the Cariboo Alpine Mesonet, constructed by NHG, and explain its latest observations, activities, and contributions to research?

The Cariboo Alpine Mesonet (CAMnet) now consists of a network of nine automatic weather stations deployed southeast of Prince George in the Cariboo Mountains since 2006. They are located at elevations ranging from 744-2105 metres, providing important information on the air temperature, precipitation, and snow depth gradients in this mountainous region. CAMnet thus provides continued long-term monitoring of the Quesnel and upper Fraser watersheds and yields a substantial database suitable for climate and climate change studies. CAMnet comprises some of the highest, long-term meteorological stations in Canada. Of particular note, two of the meteorological stations are situated near Castle Creek Glacier, where ongoing glaciological and sediment transport studies are also underway.

Looking ahead, what are the potential implications of your research?

This research advances our knowledge of the role of climate variability and change on the mountains of western Canada. Evaluating the past, current and possible future contribution of snow, ice, and glaciers to the hydrological cycle is of primary importance for water resources management, as well as recreational and commercial activities in British Columbia and elsewhere in Canada. The continued development of CAMnet provides guidance on making sensible choices for deploying instrumentation in remote terrain. Better information on mountain climate change and downstream impacts also has important ramifications for engineers, water resource managers, ecosystem scientists and policy makers. Our research will answer some of the most pressing questions that Canadian society will face in the 21st Century; will we have sufficient water for our needs, and where will it come from?

Changing scenery

A team from the **University of Northern British Columbia** is investigating the shifts in mountainous climate and its impact on the people and ecology of Canada in the face of global climate change

CANADA'S MOUNTAINS ARE often referred to as its 'water towers' – providing freshwater storage due to seasonal snowpack and glaciers and meltwater which joins numerous streams. However, climate change in the North American Cordillera may be affecting these stores, altering the amount and duration of precipitation which the mountains receive. A team at the University of Northern British Columbia is studying the way these changes could be affecting a shift in the timing of the spring freshet. Given that these melts feed many streams and rivers in western Canada, supplying the growing demand for freshwater, alterations in supply are serious. In the rapidly changing climate, it is important for research to be conducted so that the hydrometeorology of the mountains can be understood. By focusing on the water towers which feed the Quesnel River Basin, which drains an area of 12,000 km^2, with much of the water traveling from the Cariboo Mountains through deep fjord lakes to enter the river, the team is gaining results that will yield benefits across western Canada.

Dr Stephen Déry, who is leading the project, is focused on gaining tangible results: "The overarching goal of our research is to achieve a better understanding of northern hydrometeorological processes and their impacts on the surface energy and water budgets." Working on subjects including long- term climate variability, as well as the current, unprecedented degree of climate change, there is a real need for empirical research in these areas. This will begin to demonstrate the way in which snow and ice contribute to both the stocks and fluxes of freshwater, providing critical information in this rapidly changing environment.

FOREST LOSS

The team has also uncovered a threat to Canada's great old-growth trees, which include species like cedars and hemlocks, both of which can attain ages in excess of 1,000 years. These trees are prevalent in the Canadian Interior Wetbelt, which is the focus of measurements and modelling to predict changes in the weather, which have yielded worrying results, as Déry explains: "Our results show the Interior Wetbelt will generally receive more precipitation in the future; however this additional precipitation will occur during autumn and winter, while growing season precipitation will decline." As a consequence, old-growth trees may not benefit from the increased water presence, and in fact they may well face droughts in the summer months. It is predicted that this will cause an environmental shift north and to higher elevations, meaning that many areas will become inhospitable, causing forest thinning.

STATIONS AND SATELLITES

Due to the importance of their work, the team has had to confront a great number of challenges. Chief amongst these is maintaining their network of meteorological stations, which cover vast areas of remote terrain and severely inhospitable conditions. The difficulty of organising this work has now been somewhat alleviated by the superb imaging which can now be conducted using satellite-borne instrumentation. Investing in moderate resolution imaging spectroradiometry means that the researchers are able to gather data with fewer difficult and dangerous trips to stations in the mountains. From the turn of the millennium onwards, snowcover data for the Quesnel River region has been collected by satellite imaging, providing them with data about the changes being experienced.

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WIDER ISSUES

Such changes are driven by numerous wider effects, including shifts in air temperature, alterations in large climate teleconnections, such as the El Niño-Southern Oscillation and retreating glaciers. Déry is keeping these broad phenomena in mind when completing the work: "As the climate continues to warm, greater variability in annual streamflow, and hence in hydrological extremes, may influence ecological processes and human usage throughout Fraser River Basin in the 21st Century". The multitude of ecological processes being studied by Déry and his team will have a significant impact on Canada, from spawning salmon to water supplies for homes, and help to safeguard this invaluable resource for the future.

INTELLIGENCE

NORTHERN HYDROMETEOROLOGY

OBJECTIVES

To investigate the consequences of the temperature rise on the water cycle (hydrometeorology) of northern Canada, where it is projected to affect a large proportion of Canada's landmass, and to contribute to an improved understanding of hydrometeorological processes in this region. In addition, the work aims to establish possible consequences of climate change on ecological processes and habitats, as well as their social implications.

PARTNERS

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DR STEPHEN DÉRY has three degrees in Atmospheric Science: a BSc and MSc from York University and a PhD from McGill University. He joined UNBC in 2005 as Canada Research Chair in Northern Hydrometeorology, focusing on how rising temperatures affect the water cycle. Prior to this appointment, Déry was a researcher at the Lamont-Doherty Earth Observatory of Columbia University outside New York City and also held a Visiting Research Scientist position at Princeton University in New Jersey. In addition to this Canada Research Chair position, he has appointments in the Chemistry, Environmental Science and Environmental Engineering undergraduate and Natural Resources and Environmental Studies graduate programmes at UNBC. He teaches senior-level courses in Atmospheric Science and has developed a new course simply entitled 'Snow and Ice'.

Northern Hydrometeorology Group

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