PACIFIC CLIMATE IMPACTS CONSORTIUM

PCIC UPDATE MARCH 2016

13TH INTERNATIONAL MEETING ON STATISTICAL CLIMATOLOGY

Located in the scenic Bow Valley in the Canadian Rockies, the town of Canmore, Alberta will be the setting for the 13th International Meeting on Statistical Climatology. The meeting will take place between June 6th and 10th, bringing together statisticians, climatologists and atmospheric scientists to discuss and hone the statistical methods that they use in their research.

Statistics is vitally important to scientific practice. It is one of the most important sets of tools by which we determine what our observations and data are trying to tell us. Indeed it is through the methods provided by statistics that we demonstrate that our data is saying anything at all. Statistics is also at the very heart of climate science, in large part because of the discipline's focus on the statistical properties of weather, including extremes, and how they change over time. From gathering observational data and subjecting it to quality control, to analyzing the structure of the data and constructing models to explain it, statistics is used throughout climate science.

The International Meetings on Statistical Climatology began in 1979, with the goal of bringing together scientists and statisticians in order to promote good statistical practice in climate and atmospheric science. The local convenor of this year's meeting is PCIC director Francis Zwiers. This year's meeting is sponsored by the Pacific Climate Impacts Consortium and the World Climate Research Program.

See the official website for more information on the 13th International Meeting on Statistical Climatology, including sessions, registration and submission information, location and accommodations.

2015: YEAR IN REVIEW

We are sixteen years into the twenty-first century and, in terms of global surface temperatures, fifteen of these years are among the sixteen hottest in the instrumental record. Last year, several of the major groups that monitor the Earth's climate, including the National Aeronautics and Space Administration and the National Oceanic and Atmospheric Administration, announced that 2014 was the hottest in the record. Three major climate monitoring groups have reported that 2015 has surpassed 2014 as the hottest year on record. While there is always some uncertainty that must be considered in such rankings, 2015 surpassed 2014 by a wide margin. The anthropogenic global warming trend is reflected in Canada as a whole and in the province of British Columbia, both of which have warmed at roughly double the global average rate since the start of the twentieth century.

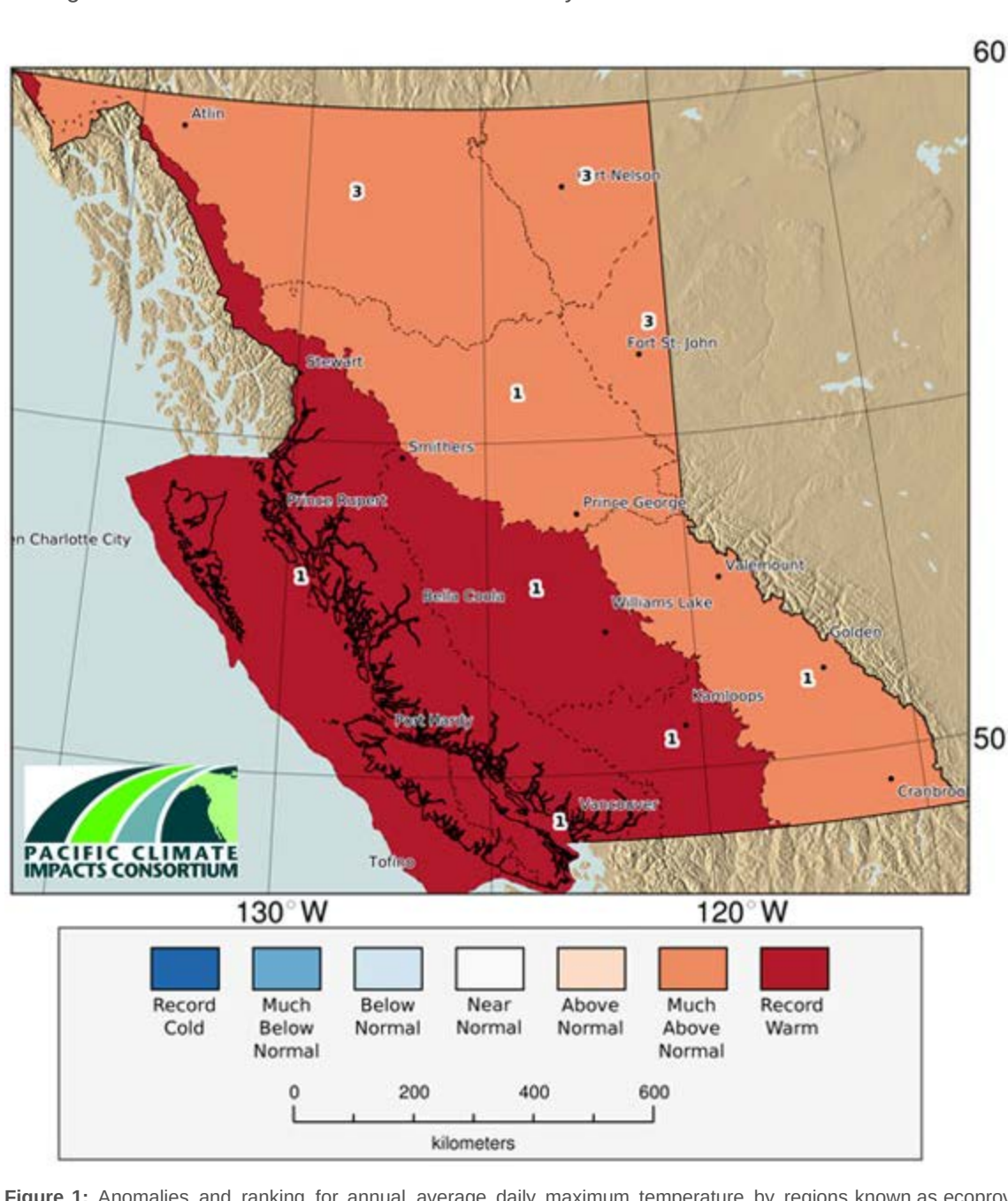

Figure 1: Anomalies and ranking for annual average daily maximum temperature by regions known as ecoprovinces. Bold numbers with white outlines in each map indicate the ranking of average temperatures in each region relative to the 116 year period from 1900 through 2016. A value of 1 indicates record warmth.

In many respects, 2015 was a record year for British Columbia, too, both seasonally and for the year as a whole. To help us place last year's conditions in BC into a historical and global context, PCIC Climatologist Dr. Faron Anslow offers his perspective on 2015. In brief, the warm winter saw records for daily maximum and minimum temperature broken in the southwest and this warmth continued into the spring, with the warmest minimum temperatures ever recorded in western and central BC and maximum temperature records broken in the north. While the summer and fall reverted to more typical conditions, the year overall remained exceptionally warm for the province (Figures 1 and 2).

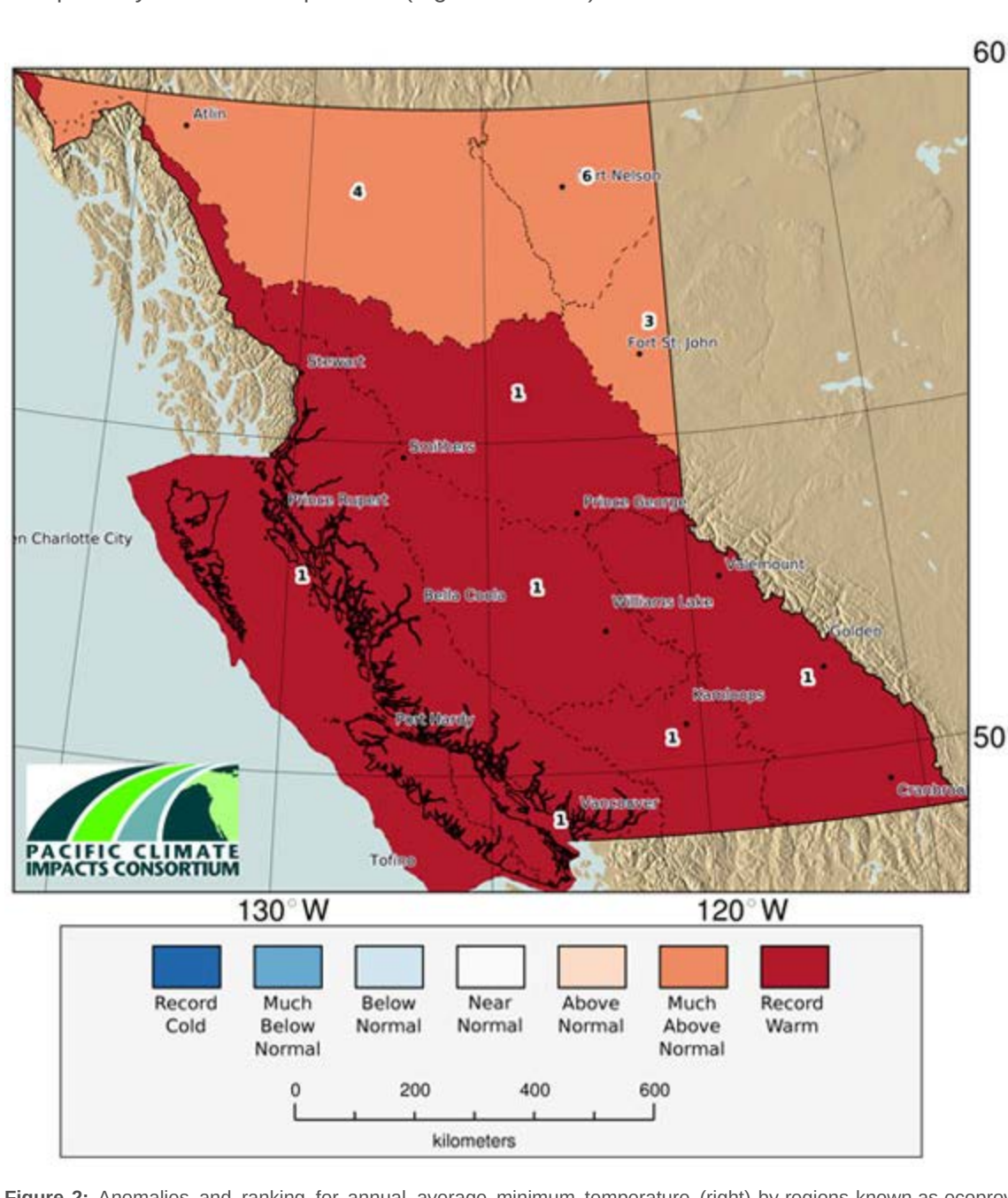

Figure 2: Anomalies and ranking for annual average minimum temperature (right) by regions known as ecoprovinces. Bold numbers with white outlines in each map indicate the ranking of average temperatures in each region relative to the 116 year period from 1900 through 2016. A value of 1 indicates record warmth.

Read Faron's 2015: A Year in Review for an in-depth analysis of the seasonal weather anomalies and some meteorological events in our province over the last year, some of their climatological underpinnings and how these conditions fit into historical and global contexts.

THE COP21 PARIS AGREEMENT

PARIS2015 UN CLIMATE CHANGE CONFERENCE COP21·CMP11

The Earth's climate continues to change, with the lion's share of the increase in global temperature since the 1950s being attributable to anthropogenic greenhouse gas emissions. The effects of climate change can be seen in the Earth's physical systems, including the warming atmosphere, shrinking glaciers and rising oceans, and in myriad individual shifts in biological systems, from the distribution of plants, to changes in species interactions and shifts in the timing of migrations and flowering. The Intergovernmental Panel on Climate Change (IPCC) states in its Fifth Assessment Report that, "changes in climate have caused impacts on natural and human systems on all continents and across the oceans." The projected impacts of anthropogenic climate change vary with the magnitude of the change, with less warming associated with lower risk. These impacts have the potential to be quite widespread and far reaching, affecting global weather, ecosystems, infrastructure, food production and freshwater availability. For more information on these impacts, see the contribution of Working Group II to the IPCC's Fifth Assessment Report.

On Saturday, December 12th, the representatives from 195 nations who had gathered in Paris for the 21st session of the Conference of Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC) negotiated and agreed to a plan to curb the effects of anthropogenic climate change. This plan, known as the Paris Agreement, aims to keep the global average temperature "well below" two degrees Celsius above the pre-industrial (i.e. 1850-1900) average and to make efforts to keep the warming below 1.5 degrees Celsius. If met, such a target would reduce the additional risks that we face due to anthropogenic climate change. The agreement is set to be delivered to the UN in New York and open for signature in April of 2016. The agreement will be in effect once 55 countries that account for at least 55% of global emissions have ratified it.

Some portions of the Paris Agreement will be legally binding within the UN framework, such as regular five-year reviews of each nation's progress toward meeting its emissions targets, and some portions will not be binding, such as the emissions targets themselves. While the agreement does not detail any specific changes to global energy production, agriculture or transportation, it provides a foundation and framework for work on emissions reduction. If ratified, the agreement will take effect in 2020. In the meantime, the parties agreed to a further decision that includes actions before 2020, such as a report from the Intergovernmental Panel on Climate Change on emissions trajectories to keep global warming to under 1.5 degrees Celsius above pre-industrial levels.

What does this mean for Canada? While Canadian greenhouse gas emissions are only about 2% of global emissions. Canada is one of the top-20 largest per-capita emitters, owing largely to our resource-based economy, the physical size of our country and energy demand for heating. Two of Canada's largest sectors in terms of greenhouse gas emissions are transportation and oil and natural gas production, which are responsible for about a quarter of emissions and a little over 20% of emissions, respectively. The transport sector has relatively stable in terms of absolute emissions since 2005, while emissions from oil and natural gas production have risen by about 10%. The stability of emissions In the transportation sector has been largely a result of fuel efficient vehicles offsetting the effect of increased driving distances and vehicle numbers. In the oil and natural gas producing sector, the increasing emissions are due to a mix of reduced emissions from conventional natural gas and oil, which is being offset by generally increasing emissions from the oil sands. The other large sources of Canadian emissions, each responsible for roughly or just over 10% of emissions are: agriculture, buildings, emissions-intensive industries such as mining and cement, and energy for electricity.

While the federal government has not yet detailed its plan or emissions targets in light of the Paris Agreement, Environment Minister Catherine McKenna has stated that such a plan will include a price on carbon. The federal government has also scheduled a meeting of aboriginal leaders and premiers for March of this year to develop a national climate strategy.

Read the Paris Agreement at the UNFCCC's online library.

UPCOMING TALK: CHANGING EXTREMES—IS IT REAL, OR JUST IMAGINED?

Today's electronic and print media are replete with stories about extreme weather and climate events from all over the world. These stories draw our attention because of their immediacy and the devastating impacts of these events, which often result in deaths and are costly in terms of the damage caused.

In the aftermath of such devastation, media raise questions over whether extreme events are more frequent and intense than in the past, whether human activity is a driving force behind long-term changes, and almost inevitably, if the particular event just passed was caused by human influence on the climate. On March 30th at 3 p.m. join PCIC Director Dr. Francis Zwiers in the Haro Room of UVic's Cadboro Commons for a discussion of all three of these questions. Dr. Zwiers will also provide an overview on the latest answers that climate science can provide.

See the event page for a more information and a map of the campus.

PCIC AT UVIC'S IDEAFEST: HOTTER, DRIER SUMMERS? IMPLICATIONS AND ADAPTATIONS FOR B.C.

Figure 3: The audience and presenters for the Hotter Drier Summers? Implications for BC event at the recent UVic Ideafest.

The University of Victoria's sixth Ideafest was held between March 7th and 12th, showcasing the work of some of Canada's best researchers. As a part of this event, the Pacific Climate Impacts Consortium (PCIC) and the Pacific Institute for Climate Solutions (PICS) presented a panel discussion on hydro-climatic change in BC. Titled, *Hotter, Drier Summers? Implications and Adaptations for BC*. The discussion began with PCIC scientists Faron Anslow and Trevor Murdock discussing how 2015 fits into the context of the historical climate and what projections suggest the future may hold for the province. They explained that, while 2015 was a hot and dry year compared to the historical record, it would be cool and wet year if compared to the projected climate in 2100. The talk then featured topical presentations by experts in agriculture, fisheries, water supply and forestry followed by a group panel discussion, in which they discussed the climate impacts in their sectors. The evening ended with a general discussion on how our knowledge informs adaptation and solutions strategies for B.C. The event was well attended, including the Lieutenant Governor, Judith Guichon and is available online.

The panel discussion was moderated by PICS Executive Director, Dr. Sybil Seitzinger. Watch a recording of the talk online.

PACIFIC CLIMATE DATA SET GATHERS ITS HALF-BILLIONTH OBSERVATION

At a little after three o'clock in the afternoon on December 12th, British Columbia's Climate Related Monitoring Program (CRMP) hit a major milestone, gathering its 500,000,000th data point. The CRMP is a collaborative project and data sharing agreement between several private and public sector groups. This agreement brings together data from each group's meteorological networks as well as what is termed "metadata," information about the stations themselves and how the data has been processed. Through the CRMP, weather observations and climate data from more than 6000 stations in the province, some of which extend back to 1872, are available to researchers, engineers, industry and the general public. The data itself is held in a database maintained by PCIC, as a component of PCIC's Climate Analysis and Monitoring Theme. These weather and climate variables are redistributed through an easy to use web interface on PCIC's BC Station Data Portal.

The CRMP is made possible through the continued efforts of the groups in its partnership: the British Columbia Ministries of Environment, Transportation and Infrastructure, Natural Resource Operations, Forests and Agriculture, BC Hydro, Rio Tinto Alcan and PCIC's Climate Analysis and Monitoring Theme.

PCIC AT THE AMERICAN GEOPHYSICAL UNION'S 48TH ANNUAL FALL MEETING

Approximately 24,000 Earth and space scientists made their way to San Francisco in December, for one of the largest annual scientific conferences in the world. Spanning disciplines ranging from geology and climate science to planetary science and solar physics, the American Geophysical Union's Fall Meeting offers a unique opportunity for scientists to explore the cutting edge of research in Earth, planetary and solar sciences.

Since its inception PCIC (and PCIC's predecessor organization, the Canadian Institute for Climate Studies) has sent teams of scientists to the AGU Fall Meeting to present their work, network and learn from other researchers pushing back the boundaries of human knowledge in their disciplines. This year, five PCIC researchers attended the meeting. PCIC's Hydroclimate Variability Scientist, Dr. Najafi, shares his experience, below.

"Francis and I (along with Richard Lawford from Morgan State University and Paul Houser from George Mason University) co-organized a session entitled "Integrated Observations/Modeling of Water Cycle Extremes and Attribution of Changes in the Components of the Hydrological Cycle to Human Influences" which brought together about 27 presentations, including eight oral talks and 19 posters.

"I presented our (co-authors: Francis Zwiers and Nathan Gillett) recent study on the detection and attribution of changes in April 1st snow water equivalent (SWE) and summer runoff in four river basins located in British Columbia (the poster is attached).

"We are currently drafting a paper on these findings to submit to a peer reviewed journal in continuation of our efforts to understand the anthropogenic influence on Arctic climate and its hydrology.

"The AGU meeting also provided the opportunity to meet and interact with researchers from different parts of the world and attend interesting talks related to hydroclimatic extremes, regional droughts (particularly in California), detection and attribution, seasonal forecasting, uncertainty quantification in hydrologic modeling, etc."

Some of the talks from the AGU Fall Meeting are available from the AGU's YouTube channel and a larger selection are available from AGU On-Demand (registration is free).

PCIC WELCOMES NEW RESEARCH CLIMATOLOGIST

PCIC is very pleased to announce that Dr. Christian Seiler moved into his new role as PCIC's Research Climatologist in February. Prior to this, Christian was a Post-doctoral fellow and Research Associate at PCIC, investigating model simulations of coastal storms for the Marine Environmental Observation Prediction and Response Network (MEOPAR). In his new role, Christian is working alongside PCIC's scientific and computational support staff to further our understanding of the impacts of climate change and its implications for adaptation in PCIC's study area and more broadly. His expertise in storms and their representation in climate models will help PCIC meet a user need to better understand storm changes and their impacts.

Christian holds a PhD in Earth System Science from Wageningen University, in the Netherlands.

PCIC CLIMATOLOGIST INTERVIEWED BY CBC ON BC GLACIERS AND THE BLOB

Dr. Faron Anslow discusses the record-breaking ocean temperatures in the North Pacific Ocean. Image: the Canadian Broadcasting Corporation.

Over the period in which records have been kept, most of the Earth's glaciers have been shrinking. This pattern is reflected in the changes we see to the mass of British Columbia's glaciers, which currently cover about three percent of the province and have been steadily retreating and thinning since at least the 1950s. Over the last few years, this reduction in glacier mass has accelerated, catching the attention of the scientific community and the general public. As one of the scientists interviewed by CBC's The National, PCIC Climatologist Dr. Faron Anslow discusses the the role that persistant warm ocean surface temperatures in the north-east Pacific Ocean dubbed, "the blob," might have played in this accelerated loss of glacier mass.

Watch this segment on the CBC's website.

TALKS FROM THE PACIFIC CLIMATE SEMINAR SERIES

The last three talks from the Pacific Climate Seminar Series were delivered by the founding director of UVic's minor in the Human Dimensions of Climate Change, Dr. Robert Gifford, Canadian Centre for Climate Modelling and Analysis senior research scientist, Dr. John Fyfe, and PCIC Post-Doctoral Fellow, Dr. Megan Kirchmeier-Young.

Dr. John Fyfe begins his talk on the warming hiatus.

Speaking in September, Professor Gifford discussed the gap between climate change concern and climate change action, the psychological barriers that prevent people from adopting climate-friendly habits and choices. This was followed in October by Dr. Fyfe's discussion of the so-called "hiatus" in warming, the mechanisms underlying it, how it will likely end and lessons in science communication resulting from discussions of the hiatus. In November, Dr. Kirchmeier-Young delivered seminar on extreme event verification for probabilistic downscaling. In this talk she discussed the need for developing both a methodology for the verification of probabilistic climate data sets and also, metrics that describe user-relevant climate characteristics. She outlined her current efforts toward these goals.

NEW PCIC SCIENCE BRIEFS

PCIC has recently released two Science Briefs. The first cover a review paper by Westra et al. on future changes to short-duration extreme rainfall. Their work, published in the journal *Reviews of Geophysics*, summarizes current research on the analysis of future changes to the intensity, duration and frequency of short-duration extreme rainfall. They find that in some locations short-duration extreme precipitation does not simply scale with the ability of the atmosphere to hold moisture as given by the Clausius-Clapeyron relation, but instead increases more strongly with warming between 12 and 24 °C, in part due to an increase in convective rainfall. It also appears to weaken at these locations above 24 °C. The authors also discuss the current state of observations of sub-daily rainfall and the ability of models to simulate them. One implication of the authors' findings is that it will be some time before it will be possible to make credible projections of sub-daily rainfall events.

Read this Science Brief.

The second Science Brief covers two recent papers by Beedle et al. (2015) and Clarke et al. (2015) examining changes to glaciers in western Canada. Publishing in the journal The Cryosphere, Beedle et al. use photographic methods to quantify changes to 33 glaciers in the Cariboo Mountains. They find that all of the glaciers receded over the 1952-2005 period, with an average loss in surface area of about 0.19% per year. Clarke et al.'s work is published in Nature Geoscience and uses a regional glaciation model driven by global climate model output to examine possible future changes to glaciers in western Canada. Their projections show a reduction of about 70% in glacier volume by the year 2100 compared to 2005, with the largest losses occurring around 2020 to 2040.

Read this Science Brief.

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RECENT PAPERS AUTHORED BY PCIC STAFF

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