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PACIFIC CLIMATE IMPACTS CONSORTIUM

PCIC UPDATE DECEMBER 2017

PROJECT AND RESEARCH UPDATES

Project Spotlight: Rivers Climate Change Indicators

In August of 2017, interactive maps that show changes to the timing and volume of river flow, using data from analysis performed at PCIC, were published. These accompany updates to a British Columbia (BC) Ministry of Environment and Climate Change Strategy (MoECCS) report on climate indicators in BC, to which PCIC has also contributed. Rivers and the ecosystems that they support provide a variety of services to communities in the province. Changes to river flow can result in impacts, such as floods, that affect these services.

Seventeen stations—places where river flow data is recorded using gauges—were suitable for trend analysis, six with records extending back for about 100 years and 11 with records for about the last 50 years. Most stations showed significant increases in minimum daily flow and insignificant decreases in maximum daily flow over 1912-2012, while the magnitude and direction of change in mean annual and seasonal flow varied by river basin. Changes in river flow depends on a basin’s location, size, elevation, and flow regime. Changes in flow volume for the 55-year period, 1958-2012, were similar to those for the 1912-2012 period except that, in the latter period, decreases in mean and minimum summer flows occurred at all stations. Finally, the date by which half of the annual water volume has passed the gauging point came earlier by about a week at the majority of locations over both periods.

The updated report contains some discussion of factors that influence river flow and projected future changes to key rivers in BC. In particular, projections suggest that the annual flow volume of the Fraser, Peace and Upper Columbia Rivers may increase by the 2050s. Projections suggest seasonal changes that vary in their details between rivers, but all four of the rivers that the researchers examined, the Campbell, Fraser, Peace and Upper Columbia, show increased winter flows and decreased summer flows.

The results of this analysis are now available in an interactive online map at Environmental Reporting BC, and as a section in an updated report on climate change indicators in BC from the MoECCS. This update, and other climate indicator updates to which PCIC contributed in 2015 and 2016, can be found in the report below.

Visit the website.
Read the report.

Engineering Design Values

Providing site-specific data and analysis allows for the evaluation of how climate change may affect specific engineering projects. PCIC researchers have recently worked on projects having to do with building construction, providing building code parameters, extremes indices and guidance for Island Health, and providing “weather files” to assist engineers with energy modelling.

For the first project, PCIC partnered with Island Health, who undertook a Public Infrastructure Engineering Vulnerability Committee (PIEVC) climate vulnerability assessment and are planning two construction projects for the Nanaimo Regional General Hospital where using future climate information could affect the design. In addition to building code parameters and projections of extreme indices, PCIC provided guidance on the use of this data. This project is the first in which a user has commissioned future climate projections specifically for use in an active building design. This has led to considerable interest in the project, with the work being presented at the 2017 Engineers and Geoscientists BC Annual General Meeting, BC Hydro’s semi-annual community manager’s conference and the BC Climate Action Secretariat’s annual Public Sector Organization climate change symposium.

This work also sparked interest in a complementary project that has been recently completed, in which PCIC has partnered with engineers at UBC and their consulting engineers to incorporate future climate projections in building design values by providing future “weather files” for energy modelling. While this area is nascent, this project has shown the feasibility of producing such files and it has led to further discussions with BC Housing, BC Hydro, UBC and Island Health about energy efficient buildings.

Continued Progress on the Climate Tool for Engineers

Ensuring that engineers can easily and efficiently access and explore the climate data that they need is one of PCIC’s priorities. To this end, PCIC has been developing a climate tool with the support of the BC Ministry of Transportation and Infrastructure that will display engineering-relevant data in the form of maps and timeseries plots, and allow users to download data for their regions of interest with an easy to use web interface. A beta version of the tool is expected to be released early in the next fiscal year.

New Partnerships

The Blueberry Council of BC has signed a service agreement with PCIC to support regional adaptation work in the agricultural sector in the Fraser Valley. This project follows from a series of regional assessments for the agriculture sector co-produced by PCIC and the BC Agriculture and Food Climate Action Initiative.

The Comox Valley Regional District has partnered with PCIC for work related to climate change impacts on hydrology for the Comox Lake Watershed.

Paper on Hotter Summers Published

Increased summer temperatures can have impacts on human health, water quality and increase energy needs for cooling. Recent research on extremely warm summers, led by PCIC research associate Chao Li and co-authored by PCIC Director Francis Zwiers suggests that by the middle of the century, current record-breaking temperatures will be the norm. The work has been published in Earth’s Future and featured on both CBC News and UVic News, as well as local Victoria media.

Their research examines historical and projected changes to summer mean wet bulb globe temperatures (WBGT), an indicator that takes into account both air temperature and humidity, and is often used as a measure of potential heat stress on people. The authors’ results suggest that, at least half of all summers may exceed the current maximum summer average WBGT on record by the 2030s and by mid-century 95% of all summers may surpass it. In addition, they examine a number of regions comprising most of the Northern Hemisphere over the 1973-2012 period and find that the changes in summer mean WBGT cannot be explained by natural influences alone.

Read the CBC story.
Read the UVic News story.
Read the original paper.

CMOS Bulletin Article by PCIC Post-Doc Summarizes Research on Wildfire Risk

With just over 700 members and subscribers, the Canadian Meteorological and Oceanographic Society, CMOS, is Canada’s national society of scientists, individuals and organizations involved in meteorology, oceanography and related fields. Recently, PCIC Post-Doctoral Fellow Megan Kirchmeier-Young wrote an article featured in the CMOS Bulletin, the society’s bi-monthly newsletter that contains both technical articles and reporting on professional meetings.

In her article, Dr. Kirchmeier-Young summarizes recent research that she led on extreme wildfire in the Fort McMurray area that was motivated by the 2016 Fort McMurray fire and on which PCIC Director Francis Zwiers is a co-author. The article covers the authors’ methods and main findings as well as the choice of metrics and thresholds that they used to indicate extreme events. One of their key findings is that the risk for extreme fire risk events in this region has become roughly 1.5 to 6 times as likely due to anthropogenic forcings. Work is ongoing to extend this analysis to British Columbia’s severe fire season of 2017.

Read the article in the CMOS Bulletin.
Read the original paper.

STAFF PROFILE: DR. GILDAS DAYON

Dr. Gildas Dayon is a Hydroclimate Scientist whose work focuses on the impacts of internal climate variability on the hydrological cycle of British Columbia and streamflow temperature modeling.

Prior to his position at PCIC, Dr. Dayon completed his PhD at Cerfacs, the European Centre for Research and Advanced Training in Scientific Computing, in Toulouse, France. While there, he developed a statistical downscaling method for precipitation, proposed a framework to assess the suitability of downscaling methods for the future climate and created a new set of hydrological projections. One of the main objectives was to quantify the uncertainties associated with these hydrological projections, which arise from different emissions scenarios, the use of climate and hydrological models, and internal climate variability. Dr. Dayon explains, "Internal climate variability is the intrinsic variability of the climate system. Even in the absence of a global energy imbalance, the climate system varies around a state of reference, mainly due to interactions between the different components of the system." The magnitude of this internal variability can be important at the time scale of decades and will no doubt affect how the climate changes in the coming decades. It is important to assess this uncertainty for PCIC's users, especially in the adaptation context.

To this end, Dr. Dayon’s research at PCIC is largely focused on the role and the quantification of internal climate variability, as well as its impacts on the hydrological cycle in Western Canada. To do this, a large number of simulations from the same global climate model are used, with each simulation differing only in terms of the initial conditions that the model starts with. These simulations are then downscaled with a statistical method developed at PCIC, in order to drive a hydrological model. Then the output of this model is analyzed.

In addition, Dr. Dayon is working on the development of a stream temperature model. "It is a challenging topic," Dr. Dayon comments, "as we only have a few observations, which makes it difficult to evaluate our model." At the same time, because stream temperature is closely related to water quality, both for BC communities and for wildlife, having a model that will allow researchers to better understand changes in streamflow temperature and make projections of future changes would be valuable.

PACIFIC CLIMATE SEMINAR SERIES

The Pacific Climate Seminar Series, jointly hosted by PCIC and the Pacific Institute for Climate Solutions, continued this fall with talks by PCIC's Dr. Dhouha Ouali and Deborah Carlson from West Coast Environmental Law. Dr. Ouali spoke on October 25th about the use of regional frequency analysis to provide estimates of hydro-meteorological extreme events. Deborah Carlson spoke on NOvember 22nd about the legal risks, opportunities and responsibilities that professionals who work in areas affected by climate change face.

Read the abstract for Dr. Ouali's talk.
Read the abstract for Deborah Carlson's talk.

The series will resume in the new year. The next speaker will be announced in January.

STAFF CHANGES

PCIC recently welcomed Yaheng Tan into its research community. Yaheng is a PhD student studying the relationship between atmospheric rivers and extreme precipitation in the future climate. She will be joining PCIC for the next year and is co-supervised by PCIC Director Francis Zwiers and Professor Song Yang from the School of Atmospheric Sciences at Sun Yat-sen University.

PUBLICATIONS

Release of PCIC's 2016-2017 Corporate Report

PCIC's last fiscal year (April 2016 to March 2017) was a period of intense activity that saw the completion of an updated hydrologic model, continued engagement with the engineering community on infrastructure projects, improvements to the data that PCIC provides and the Data Portal that provides access to it, and the ongoing development of a new online tool. In addition, PCIC continued to provide new projections and analyses for various regions in BC and to communicate the latest scientific findings as they relate to the needs of the regional stakeholders whom PCIC serves.

Read about these stories and more in our Corporate Report.

PCIC Science Brief: The Evolution of Snowmelt and Drought

The new PCIC Science Brief covers two recent papers by Musselman et al. (2017) and Herrera-Estrada et al. (2017) that examine two elements of the hydrologic cycle: how the rate of snowmelt in western North America may change as the Earth's climate changes, and how droughts can evolve and move over time.

Read the latest Science Brief.

CVRD Report Published: Climate Change Projections for the Cowichan Valley Regional District

A climate impacts assessment commissioned by the Cowichan Valley Regional District (CVRD) and co-produced with PCIC and Pinna Sustainability has recently been published. This work follows from an earlier climate impacts assessment completed for the Capital Regional District and uses a new, user-led collaborative development approach. To create the report, the partners co-developed the assessment through an ongoing dialogue, ensuring that the end product is tailored to the needs of the regional stakeholders for whom it was developed. Assuming business-as-usual emissions scenario, the climate projections suggest that the area will see warming during all seasons. Precipitation is projected to increase during the fall, winter and spring, but summers may be drier on average.

For more details about the projections, read the report.

State of the Physical, Biological and Selected Fishery Resources of Pacific Canadian Marine Ecosystems in 2016

Fisheries and Oceans Canada has recently published the above titled technical report on fisheries and aquatic sciences, to which PCIC contributed. Part of an ongoing annual series that was established in 1999, the report presents the most recent state of the region, as determined by observations, and projected future conditions. These in turn are used to help determine important changes to the ocean that may potentially impact British Columbians. PCIC contributed an overview of the hydroclimatological conditions in the province, with a few of the key findings being that 2016 was warm and wet, with new daily average and daily minimum high air-temperature records, and above normal precipitation throughout most of the province, but especially over southern regions, in part due to the El Niño of 2015 and 2016.

For more information, read the report. .

PEER-REVIEWED PUBLICATIONS

Gagné, M.-È., **M.C. Kirchmeier-Young**, N.P. Gillett, and J.C. Fyfe, 2017: Arctic sea ice response to the eruptions of Agung, El Chichón, and Pinatubo. *Journal of Geophysical Research: Atmospheres*, **122**, 15, 8071–8078, doi:10.1002/2017JD027038.

Kirchmeier-Young, M., **F.W. Zwiers**, N.P. Gillett and A.J. Cannon, 2017: Attributing Extreme Fire Risk in Western Canada to Human Influences. *Climatic Change*, **144**, 2, 365–379, doi:10.1007/s10584-017-2030-0.

Li, C., X. Zhang, **F.W. Zwiers**, Y. Fang, A.M. Michalak, 2017: Recent very hot summers in northern hemispheric land areas measured by wet bulb globe temperature will be the norm within 20 years. Accepted, *Earth's Future*, doi: doi:10.1002/2017EF000639.

Najafi, M.R., **F.W. Zwiers** and N.P. Gillett, 2016: Attribution of Observed Streamflow Changes in key British Columbia Drainage Basins. *Geophysical Research Letters*, **44**, 21, 11,012–11,020, doi:10.1002/2017GL075016.

Ouali, D., F. Chebana, and T.B.M.J. Ouarda, 2017: Fully nonlinear statistical and machine-learning approaches for hydrological frequency estimation at ungauged sites. *Journal of Advances in Modeling Earth Systems*, **9**, 2, 1292-1306, doi:10.1002/2016MS000830.

Pingree-Shippee, K., **F.W. Zwiers** and D. Atkinson, 2017: Representation of Canadian Coastal Storm Activity by Six Global Reanalyses. *International Journal of Climatology*, Early Online View, doi: 10.1002/joc.5235.

Shrestha, R., A.J. Cannon, **M.A. Schnorbus** and **F.W. Zwiers**, 2017: Projecting future nonstationary extreme streamflow for the Fraser River, Canada. *Climatic Change*, **145**, 3–4, 289–303, doi: 10.1007/s10584-017-2098-6.

Sillmann, J., T.L. Thoranisdottir, N. Schaller, L. Alexander, G.C. Hegerl, S.I. Seneviratne, R. Vautard, X. Zhang and **F.W. Zwiers**, 2017: Understanding, modeling and predicting weather and climate extremes: Challenges and opportunities. In press, *Weather and Climate Extremes*, doi: 10.1016/j.wace.2017.10.003.

Stott, P.A., D.J. Karoly and **F.W. Zwiers**, 2017: Is the choice of statistical paradigm critical in extreme event attribution studies? *Climatic Change*, **144**, 2, 143-150, doi:10.1007/s10584-017-2049-2.

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