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PCIC UPDATE SEPTEMBER 2016

IMPROVING THE AVAILABILITY AND QUALITY OF CLIMATE DATA FOR BC

Planners and climate researchers alike require credible, high-quality observational climate data of their regions of interest. These help us to determine what the climate was like in the past, how it is changing today and provide a baseline for projected future changes. However, observational data sets can contain errors and biases that arise as the area surrounding a station changes, or as equipment fails, is moved or replaced. PCIC researchers have recently undertaken a project aimed at tackling these challenges for data sets in BC.

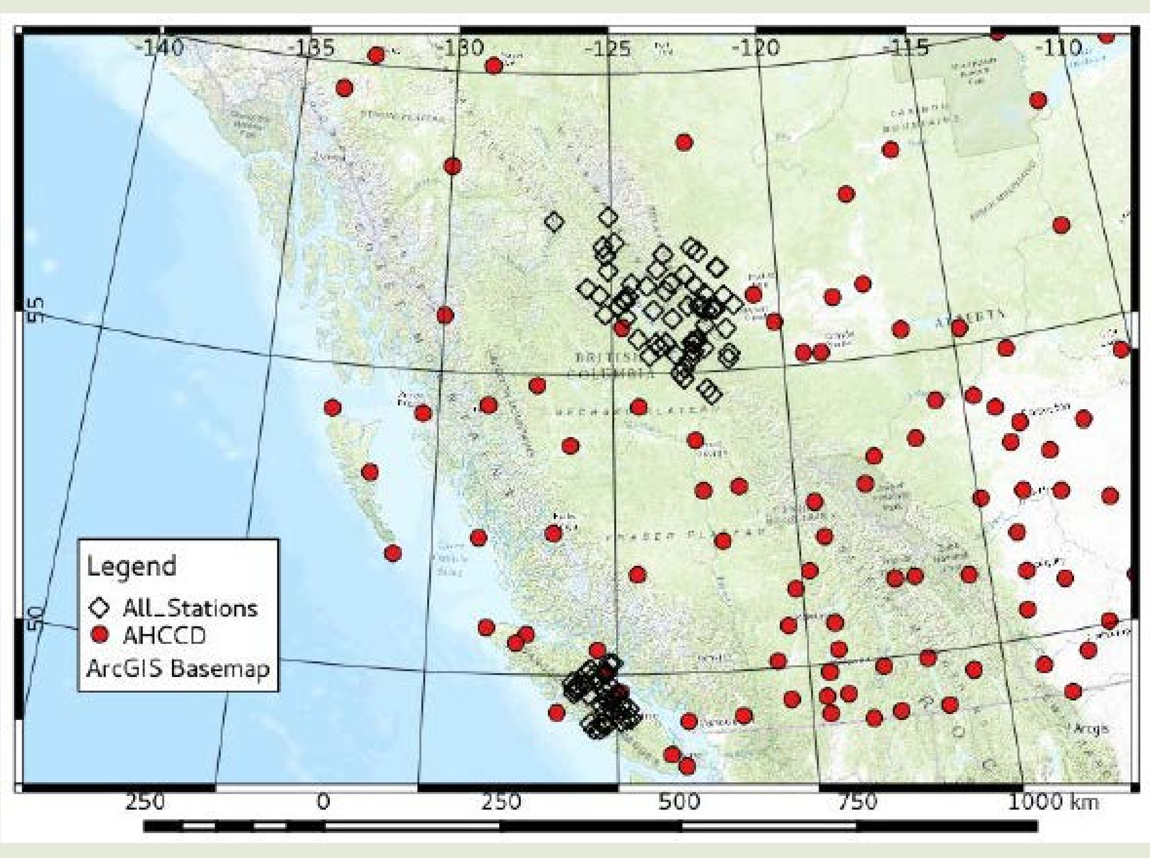

Figure 1: This figure shows the locations of stations with observational data available in and near BC from the Adjusted Homogenized Canadian Climate Datasets (red circles) and those used by PCIC researchers in the recent pilot project (diamonds).

One of the main high-quality sources of data for the province is the Adjusted Homogenized Canadian Climate Dataset (AHCCD), which was created and is regularly updated by scientists at Environment and Climate Change Canada. While these records are of very good quality and are generally quite long, they are also somewhat sparse. The stations in the set tend to be clustered around large population centres and transportation corridors leaving large parts of British Columbia without a nearby station. However, there are other sources of station data available for the province. PCIC, working with BC Hydro, Rio Tinto ALCAN and the Ministries of Environment, Transportation and Infrastructure, Forests Lands and Natural Resource Operations, and Agriculture have compiled a data set using observations from thousands of stations in the province. This Provincial Climate Data Set (PCDS) contains valuable data that can help to "fill in" some of the regions that are sparse in the AHCCD (see the red dots in Figure 1). However, in order to do this, the PCDS data must first undergo quality control and homogenization.

PCIC researchers recently undertook a pilot project to examine the feasibility and value of homogenizing the PCDS by examining temperature records from two small regions within BC: the Campbell River region on Vancouver Island and the Williston Basin region of northeastern BC. PCIC researchers employed quality control measures designed to detect spurious values (such as "statistical outliers" which lie far outside the normal range of the data). This included statistical testing and the review of unusual measurements in order to determine whether such measurements represented genuine meteorological conditions. The researchers then made monthly averages from the quality-controlled temperature records and applied homogenization methods to adjust the data, removing the estimates of changes due to non-climatic factors.

The results showed that about half of the temperature records are affected by such changes, but that the data were overall of quite high quality. The researchers also found that the overall project of creating a province-wide homogenized temperature and precipitation data set from the PCDS is achievable. As a result of this exploratory work, a second round of funding was awarded to PCIC to help us realize this objective.

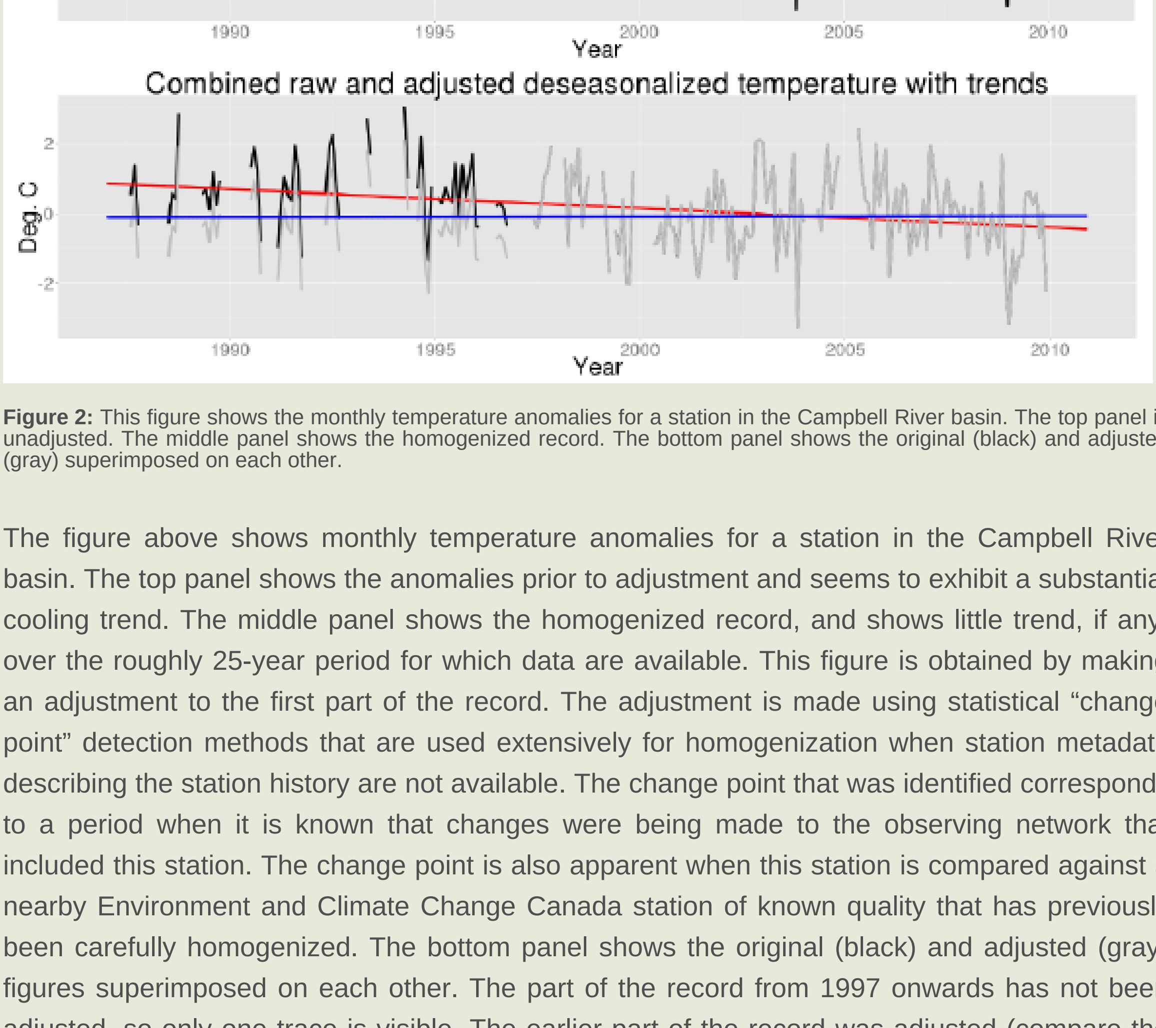

Figure 2: This figure shows the monthly temperature anomalies for a station in the Campbell River basin. The top panel is unadjusted. The middle panel shows the homogenized record. The bottom panel shows the original (black) and adjusted (gray) superimposed on each other.

The figure above shows monthly temperature anomalies for a station in the Campbell River basin. The top panel shows the anomalies prior to adjustment and seems to exhibit a substantial cooling trend. The middle panel shows the homogenized record, and shows little trend, if any, over the roughly 25-year period for which data are available. This figure is obtained by making an adjustment to the first part of the record. The adjustment is made using statistical "change point" detection methods that are used extensively for homogenization when station metadata describing the station history are not available. The change point that was identified corresponds to a period when it is known that changes were being made to the observing network that included this station. The change point is also apparent when this station is compared against a nearby Environment and Climate Change Canada station of known quality that has previously been carefully homogenized. The bottom panel shows the original (black) and adjusted (gray) figures superimposed on each other. The part of the record from 1997 onwards has not been adjusted, so only one trace is visible. The earlier part of the record was adjusted (compare the original in black with the adjusted in gray). It is normal practice to adjust earlier parts of a record relative to the most recent part of the record since more is usually known about the recent history of the observing station, such as its siting and management and the characteristics of its instruments.

PCIC CORPORATE REPORT 2015-2016

During the past year, PCIC has developed new data products, upgraded the hydrologic model we use, improved and publicly released our in-house downscaling procedure for research purposes and completed a number of research projects to help stakeholders in BC adapt to the changing climate. PCIC has also welcomed new researchers to our group. Our 2015-2016 Corporate Report outlines these and other achievements in a series of stories, giving an overview of our research and the products we are developing for the users we serve.

Read our Corporate Report.

MODELLING CHANGES IN ANNUAL MAXIMUM PEAK FLOWS ON THE FRASER RIVER

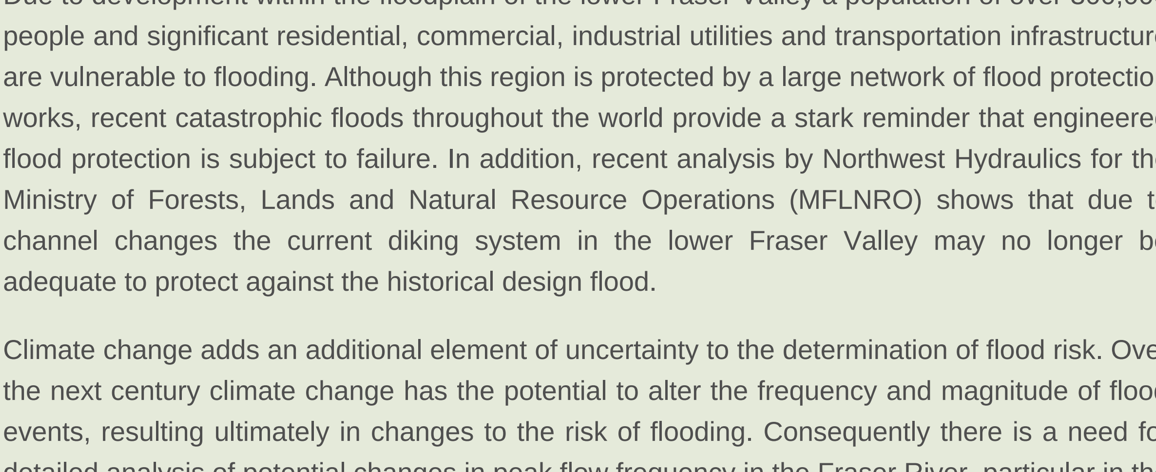

Figure 3: This figure shows projected changes in 10-year (Q10), 50-year (Q50) and 100-year (Q100) peak flow return levels for the Fraser River at Hope for three periods (2011-2040, 2041-2070 and 2071-2100) and three RCP emissions scenarios. Projected flows are given as box-plots summarizing the results for an ensemble of CMIP5 projections, with ensemble sizes of 45, 56 and 56, for RCP 2.6, 4.5 and 8.5, respectively. The dashed line indicates the average VIC-simulated 10-year, 50-year and 100-year peak flows for the 1961-1990 baseline period.

Due to development within the floodplain of the lower Fraser Valley a population of over 300,000 people and significant residential, commercial, industrial utilities and transportation infrastructure are vulnerable to flooding. Although this region is protected by a large network of flood protection works, recent catastrophic floods throughout the world provide a stark reminder that engineered flood protection is subject to failure. In addition, recent analysis by Northwest Hydraulics for the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) shows that due to channel changes the current diking system in the lower Fraser Valley may no longer be adequate to protect against the historical design flood.

Climate change adds an additional element of uncertainty to the determination of flood risk. Over the next century climate change has the potential to alter the frequency and magnitude of flood events, resulting ultimately in changes to the risk of flooding. Consequently there is a need for detailed analysis of potential changes in peak flow frequency in the Fraser River, particular in the lower Mainland where the risk of catastrophic flooding is highest. On behalf of MFLNRO, PCIC scientists have recently investigated the effects of climate change on annual maximum peak flows on the Fraser River. The outcome was a better understanding of peak flow changes for the Fraser River at a location corresponding to the hydrometric gauge at Hope, BC. The research employed a statistical approach that leverages streamflow simulation from the VIC hydrology model and seasonal temperature and precipitation from CMIP3 climate forcings to predict peak flow changes for a large ensemble of latest-generation CMIP5 climate experiments. Results show that small peak flow events (e.g. 2-year return period) are projected to decrease in magnitude whereas large peak flow events (e.g. those with more than a 100-year return period) may increase in magnitude (see Figure).

NEW DOWNSCALING PACKAGE

The impacts of climate change are felt at the scale of communities. However, global climate models generally have a resolution on the order of a hundred kilometres, which makes their raw output too coarse to be used for planning and research at the community scale. To help planners, stakeholders and researchers in BC better understand the impacts of climate change on these scales, PCIC has developed a statistical downscaling method called Bias Correction/Constructed Analogues with Quantile mapping reordering, or BCCAQ, which is now available as a configurable package capable of running on super computers and laptops alike. This package, called ClimDown, uses a second version of BCCAQ that corrects for the tendency of many statistical downscaling methods to project changes in extremes that are too large, and is highly computationally efficient, being five-to-eight times faster than the first version of the method.

NEWSWORTHY SCIENCE

PCIC's latest Science Brief highlights articles two recent research papers that focus on extreme weather events that affect coastal British Columbia. The first paper, by Soontiens et al. (2016) examines storm surges in the Strait of Georgia. The authors find that the model they use does well at reproducing the magnitude of storm surges and that the primary contribution to such events in the region are sea surface height anomalies from the Pacific. The second paper, by Hagos et al. (2016) examines changes to atmospheric river events over western North America, assuming a business-as-usual anthropogenic greenhouse gas emissions. Their projections show an increase of about 35% in days on which atmospheric rivers make landfall and an increase of about 28% in extreme precipitation days by the end of the 21st century.

Read the latest Science Brief.

THE PACIFIC CLIMATE SEMINAR SERIES RESUMES

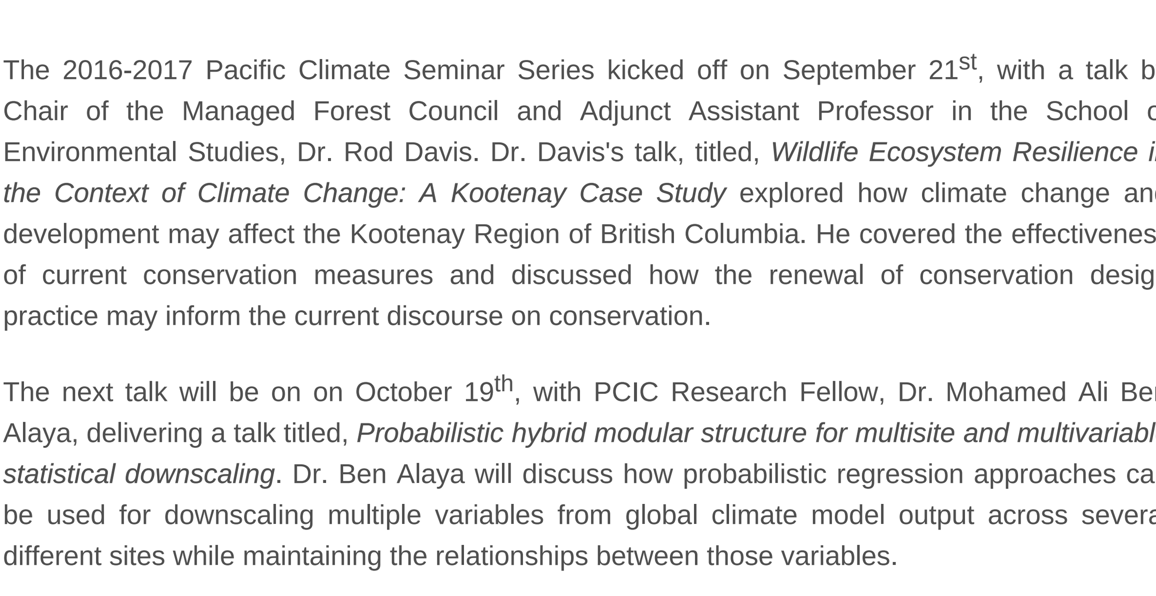

Figure 4: Rod Davis speaking at the Pacific Climate Seminar Series on September 21st.

The 2016-2017 Pacific Climate Seminar Series kicked off on September 21st, with a talk by Chair of the Managed Forest Council and Adjunct Assistant Professor in the School of Environmental Studies, Dr. Rod Davis. Dr. Davis's talk, titled, *Wildlife Ecosystem Resilience in the Context of Climate Change: A Kootenay Case Study* explored how climate change and development may affect the Kootenay Region of British Columbia. He covered the effectiveness of current conservation measures and discussed how the renewal of conservation design practice may inform the current discourse on conservation.

The next talk will be on on October 19th, with PCIC Research Fellow, Dr. Mohamed Ali Ben Alaya, delivering a talk titled, *Probabilistic hybrid modular structure for multisite and multivariable statistical downscaling*. Dr. Ben Alaya will discuss how probabilistic regression approaches can be used for downscaling multiple variables from global climate model output across several different sites while maintaining the relationships between those variables.

More information about Dr. Davis's talk can be found on the the event's page at the Pacific Institute for Climate Solutions.
More information on Dr. Ben Alaya's talk in October, can be found on the event's page.

PCIC STAFF CHANGES

In the late summer PCIC welcomed new Research Associate Chao Li. Chao Li is a hydroclimatology scientist who joined PCIC following a post-doctoral position at the Carnegie Institution for Science at Stanford University. He holds a PhD in Hydrology and Water Resources from Texas A&M University and his research at PCIC will focus on developing more reliable ways to estimate the characteristics of precipitation extremes that are relevant to the engineering community. PCIC also extends a warm welcome to Carl Masri, a fourth-year Computer Science student from UVic whose studies focus on computer communications. Carl will be working with PCIC's Computational Support Group, utilizing his knowledge of user experience design and development skills to ensure that the data portal is useful to researchers for many years to come.

PCIC also said a fond farewell to its former Geospatial Programmer and Analyst, Basil Veerman and volunteer intern Laurine Pironti. Basil's expertise in geospatial programming was integral to the development of several new and updated tools that PCIC will be offering in the near future. Basil received a coveted PCIC mug to take with him to his new position in Seattle. Laurine is a 4th year student in Water Science and Technology at Polytech Montpellier in France. She worked with the Hydrologic Impacts theme for two months this summer, helping to prepare the VIC model for operational deployment. She has now returned to France to complete her studies.

RECENT PAPERS AUTHORED BY PCIC STAFF

Daines, J.T., A.H. Monahan, and **C.L. Curry**, 2016: Model-Based Projections and Uncertainties of Near-Surface Wind Climate in Western Canada. *Journal of Applied Meteorology and Climatology* (accepted).

Teufel, B., G.T. Diro, K. Whan, S.M. Milrad, D.I. Jeong, A. Ganji, O. Huziy, K. Winger, E. Montero, J.R. Gyakum, R. de Elia, **F.W. Zwiers**, L. Sushama, 2016: Investigation of the 2013 Alberta Floodfrom a weather/climate perspective. *Climate Dynamics*, doi:0.1007/s00382-016-3239-8.

Weller, D., S.-K. Min, W. Cai, **F.W. Zwiers** and D. Lee, 2015: Human-caused Indo-Pacific warm pool expansion. *Science Advances*, doi: 10.1126/sciadv.1501719.

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