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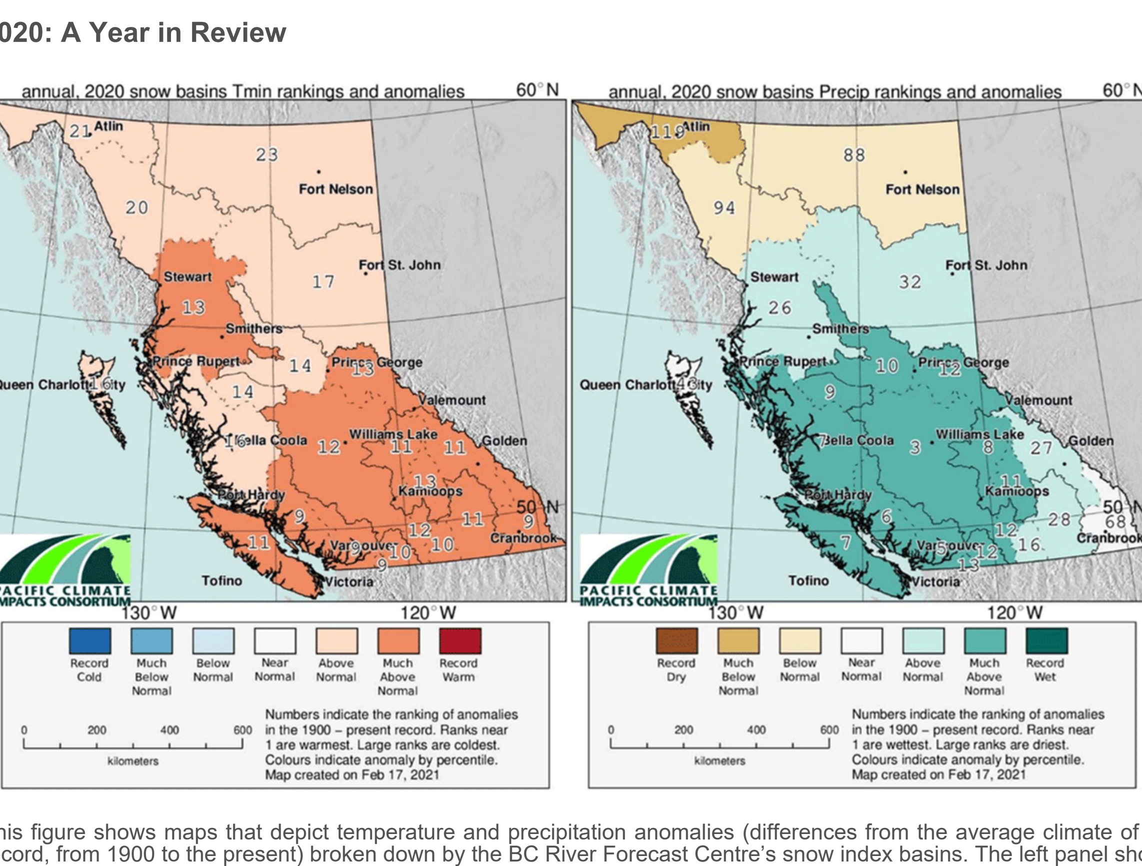
PCIC UPDATE March 2021

PROJECT AND RESEARCH UPDATES

2020: A Year in Review



This figure shows maps that depict temperature and precipitation anomalies (differences from the average climate of the record, from 1900 to the present) broken down by the BC River Forecast Centre's snow index basins. The left panel shows the anomaly in annual average of daily minimum temperature in terms of quantile ranking. This panel shows much above normal conditions across southern BC and above normal temperature in northern BC. The right panel shows the anomaly in annual total precipitation in terms of quantile ranking This panel shows much above normal conditions in central and southwest BC while below and much below normal conditions existed in northern BC. In all cases, the shading for "record" measurements represent the 0th or 100th percentiles, "much above/below normal" represents measurements that fall in between the 0th to 10th or the 90th to 100th percentiles, above/below normal refers to measurements that fall within the 10th to 33rd or the 66th to 90th percentiles and "near normal" refers to measurements within the 33rd to 66th percentiles.

As a whole, 2020 in British Columbia was warmer and wetter than normal, when compared to the average over the 1981–2010 climate normal period as well as the long term 1900–2020 record. Breaking down daily maximum and minimum temperatures reveals that much of the warmth arose from higher than normal daily minimum temperatures, which were 0.5 °C warmer than the average. The year in the province also saw an average of daily maximum temperature that was the coolest since 2012, with a temperature of 0.2 °C below the 1981–2010 normal. Precipitation came in essentially average at just 2% wetter than normal over the year. Late spring and summer were the most extreme, with record precipitation totals. The most anomalous precipitation fell across northern BC north of Prince George and over southwest BC over Vancouver Island and the lower Fraser River (not shown). The large amount of precipitation and ongoing snowmelt produced flooding in southern BC well into July. Flooding also occurred in northeastern BC due to unseasonal warmth in spring leading to rapid break-up of river ice.

The weather anomalies in BC were set within the context of a global average temperature that either tied (GISSTEMP) or was a close second (HadCRU, NCEI) the instrumental record for the warmest year. This was remarkable, because the previous high was set during a very strong El Niño year, which tends to raise global surface temperatures. In contrast, 2020 began as neutral El Niño year and transitioned to the cool La Niña phase. This transition began in May and was confirmed by global monitoring organizations as early as August. Although La Niña isn't typically initiated in spring, our previous newsletter noted that late-spring conditions in BC were very similar to patterns associated with La Niña. This La Niña phase persisted into the fall and winter, and continues into 2021.

BC's ongoing winter and spring weather will be partially governed by La Niña as it eventually transitions back to neutral conditions. These La Niña conditions make it more likely that BC will experience cool temperatures and deeper than normal snow packs leading into the summer.

Two New Birds Join the DACCS Birdhouse

One challenge that arises in working with global climate model data is the amount of time, network capacity, and local data storage resources that are required to assemble climate data in one place before it is analyzed. PCIC has partnered with the University of Toronto, the Computer Research Institute of Montréal (CRIM), Ouranos and others to develop a network of climate data storage systems with associated dedicated computing resources that enable analysis to take place without moving the data from where it is stored. The system, which will be the end result of the Data Analytics for Canadian Climate Services (DACCS) project, is developing a network of these nodes, including one at PCIC, and the software needed to use the network. The software will allow users to perform climate analyses on climate data wherever it resides on the network, without first having to gather and organize the data. Users will do this by preparing a Python/Jupyter notebook that describes the analysis methods and data to be used in a standardized way, submitting their analysis requests via a web interface and then receiving the end product. A key part of this project is to develop a collection of prepackaged analysis tools, called birds, that can be used as building blocks in a user's Python scripts. As well as implementing a DACCS node at PCIC, a key aspect of our work is to package a number of PCIC's analysis tools as birds so that they can be used throughout the DACCS network.

We have recently developed two new birds, one named Chickadee, which does downscaling—including the Bias Correction Constructed Analogs with Quantile mapping method developed at PCIC—and one named Quail, which computes climate extremes using the climdex.pcic software package. These two tools join the three other birds that we developed previously: Thunderbird, which is the PCIC Climate Explorer back-end, Osprey, which performs the river routing used for the Variable Infiltration Capacity hydrologic model, and Sandpiper, the Plan2Adapt climate impacts rule engine. PCIC is excited about being able to share these analysis tools with the broader community to make climate analysis more accessible and increase the efficiency and ease with which climate data analytics can be performed.

This work is supported by the Canadian Cyber Infrastructure Fund of the Canadian Foundation for Innovation and the BC Knowledge Development Fund.

New Climate-Resilient Buildings and Core Public Infrastructure Report

PCIC is pleased to announce that a report contributing to the federal government's Climate-Resilient Buildings and Core Public Infrastructure initiative has just been released. The report was developed by Environment and Climate Change Canada's Climate Research Division, in partnership with PCIC and supported by the National Research Council, as part of a five-year initiative within the Pan Canadian Framework on Clean Growth and Climate Change. Canada's changing climate is altering the environmental conditions that buildings and infrastructure are being exposed to. This report provides an assessment of how climatic design data relevant to the National Building Code of Canada and the Canadian Highway Bridge Design Code are projected to change in the future.

The report discusses the changes in Canada's climate that have been observed and projected future changes, as well as some considerations for the use of climate data, such as noting that confidence in climate projections generally decreases at smaller spatial scales. The report breaks down the climate design variables that it analyses into three tiers by confidence in future projections. Tier 1 variables are those variables for which there is high, or very high confidence, such as those related to temperature, and tier 3 variables being those with low or very low confidence, such as snow load, changes to wind pressure and annual mean relative humidity. The report also discusses some of the future directions of climate change research that may lead to more robust future projections for climate change assessments, such as sampling regional climate model uncertainty and using convection-permitting models.

Read the report.

Upcoming Talk in the Pacific Climate Seminar Series

The 2021 Pacific Climate Seminar Series started up on Wednesday, February 28th with a talk by Dr. Liese Coulter, *Imagining the Unprecedented: Developing Climate Risk Storylines*. Her presentation covered the development of climate storylines, and she explained how storylines and adaptation pathways are complimentary and support scientists and decision makers.

The next talk in this series will be delivered by PCIC researcher and Acting Lead, Regional Climate Impacts, Dr. Charles Curry on March 31st at 3 p.m. Pacific Time. Charles's talk is titled, *Leveraging expert knowledge of weather extremes, climate models, and future change to inform infrastructure design standards in Canada*. This will be followed on April 28th by a talk delivered by PCIC Post-Doctoral Hydrologic Scientist, Dr. Kai Tsuruta. Kai's talk is titled, *Exploring the effects of climate change and glacier loss on streamflow predictability*. Details for Kai's talk will be available, soon.

Report on Wind and Power Outages Released

High winds are the main cause of tree- and weather-related power outages in the Pacific Northwest. These occur primarily in the winter and spring seasons and are often caused by extratropical cyclones as they make landfall along the coast. In order to better understand the connection between wind and power outages, PCIC researchers combined weather station data, reported power outages, climate indices and developed a simple empirical model of power outage occurrences. This research resulted in the creation of a new dataset of wind and power outages over 2005-2017. The researchers found that, over this period, the frequency of outages is strongly influenced by surface winds near the coast. In addition, while outages increase slowly with weak and moderate winds, outages occur much more quickly during strong wind conditions, when wind speeds are over 50 kilometres per hour. While the time period used for the study is too short to reliably quantify the effect of low-frequency climate variability, the data shows that there may be some connection between the Northern Oscillation Index and outage frequency. The model that the researchers developed also shows some skill in hindcasting the subseasonal to interannual frequency of tree- and weather-related outages.

Read the report.

Introducing ClimateWest

PCIC is pleased to welcome ClimateWest as the newest member of the network of regional climate service providers that are partnering with the Canadian Center for Climate Services (CCCS). PCIC and Ouranos are both already members of this network, and the CCCS continues to work to expand the network to include other parts of Canada. ClimateWest will provide climate data, interpretation, training, tools and guidance on adaptation to the Prairie Provinces of Manitoba, Saskatchewan and Alberta. They will support climate-related decision making from the scale of municipal governments to small businesses. In doing this, they will serve a similar function in the Prairies as PCIC does in BC and Ouranos does in Quebec.

Visit ClimateWest.

STAFF PROFILE: CHARLOTTE BALLANTYNE

This issue's staff profile covers the work of Climate Data Analyst, Charlotte Ballantyne, a member of the Climate Analysis and Monitoring theme whose work at PCIC includes acquiring and ingesting data into PCIC's databases, and analysing and performing quality control on data. Two of the primary projects that she has been focused on while at PCIC have been updating climatic design values that are used for infrastructure design as part of PCIC's project with the National Research Council Canada (NRC) and working on the climate maps that PCIC provides using the Parameter-elevation Regressions on Independent Slopes Model (PRISM). She is also improving the climate data that PCIC stores by adding additional observations into our database in order to fill in gaps in our existing data.

For the NRC project, Charlotte developed the methodology for combining climate stations to create composite stations with long enough timeseries for extreme value analysis, generated maps comparing the updated design values with their previous values, and applied extreme value analysis to a variety of different climate variables. Charlotte's work on the PRISM maps includes removing noise and generating monthly precipitation from precipitation gauge data, creating monthly climatologies for a variety of variables and station networks, and updating the PRISM code itself to better handle data. Commenting on this, she says, "Something I find interesting is the variety of methods for improving model accuracy in areas with sparse climate station data or for variables such as snow water equivalent that are tricky to measure using conventional methods." She provides a few examples that give some of the flavour of bringing together data for climate services: combining multiple nearby stations with short records into a single station with a record long enough to be suitable for creating climatologies, using emerging technologies such as drone mapping and machine learning, and integrating expert knowledge on regional climate.

Charlotte found herself drawn to the field almost immediately, "The courses I took on climatology and hydrology during my undergraduate degree at UVic were among my favourites, in particular, a course on mountain meteorology which solidified my interest in the subject of climatology." She spent a co-op term working as a weather station technician for the Ministry of Forests, Lands and Natural Resource Operations and Rural Development at the Kalmalka Forestry Centre in Vernon, BC. She reflects on this period of travelling around the province collecting climate data, and working with PRISM climate data, "being able to experience the diversity of climate in BC and the drivers that contribute to it furthered my interest in modelling climate in complex terrain."

This work is important because having updated design values allows for planners and engineers to develop infrastructure projects that take projections of the future climate into consideration. Creating accurate, high-resolution climate maps is important for decision making in fields ranging from forestry and agriculture to transportation, and they can be a useful tool for establishing baselines when it comes to future climate projections.

PCIC STAFF NEWS

PCIC wishes to welcome co-op student Stacey O'Sullivan, who has just joined PCIC as a Content Development and User Engagement Assistant with the Regional Climate Impacts Theme.

PUBLICATIONS

Ben Alaya, M.A., F.W. Zwiers and X. Zhang, 2020: A bivariate approach to estimating the probability of very extreme precipitation events. *Weather and Climate Extremes*, **30**, 100290,10.1016/j.wace.2020.100290.

Kim, J., S. Park, J. Kwon, Y. Lim and H-S. Oh, 2021: Estimation of spatio-temporal extreme distribution using a quantile factor model. *Extremes*, **24**, 177–195, doi:10.1007/s10687-020-00404-0.

Mahmoudi, M.H., M.R. Najafi, H. Singh and M. Schnorbus, 2021: Spatial and temporal changes in climate extremes over northwestern North America: the influence of internal climate variability and external forcing. *Climatic Change*, **165**, 14, doi:10.1007/s10584-021-03037-9.

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Our website | Follow us on Facebook

Our address is:
Pacific Climate Impacts Consortium
University House 1
2489 Sinclair Road
University of Victoria
Victoria, British Columbia
Canada V8N 6M2