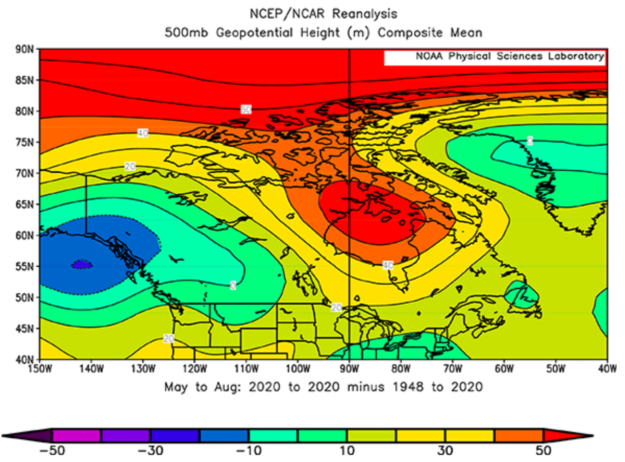
PACIFIC CLIMATE IMPACTS CONSORTIUM

PCIC UPDATE November 2020

PROJECT AND RESEARCH UPDATES

A Preview of Winter? A Record Wet and Cool Spring and Summer in BC



This figure shows the difference in upper air pressure in the May through August period of 2020 as compared to the normal conditions during the same months over the 1948-2020 period. Blue and green colours represent lower than normal pressure, while yellow and red colours indicate higher than normal pressure. Over the May through August period of this year, there was a centre of lower than normal pressure in the gulf of Alaska and over coastal BC while a high pressure centre was situated over Hudson Bay. The pattern helped drive storms across southern and central BC that would otherwise impacted further north. This pattern is typical for summertime La Nina episodes. Data are from the NCEP Reanalysis and the reference period is the full record from 1948 through 2020

Late spring and summer in BC were mostly dreary with cold weather, abundant rain and a continual threat of flood. Local rainfall records were set in Prince Rupert and regional precipitation anomalies yielded summer season records over the northern half of BC. Daily maximum temperatures were very cold yet overnight low temperatures were warmer than normal. All of this rain lead to an extended flood season lasting well into July and ultimately to one of the least active wildfire seasons in BC in the recent record. The weather that the province experienced was driven by atmospheric pressure patterns that were unusual for the period. This article describes what those patterns were, what they led to and how they may be a preview of the coming winter.

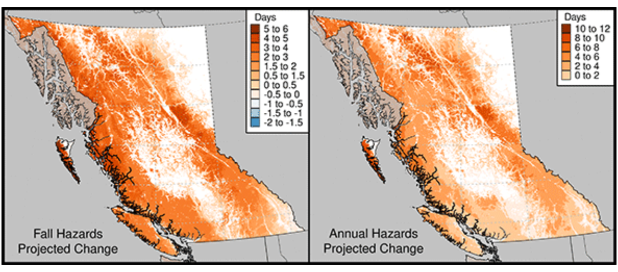
Spring in BC's interior regions marks the transition from dominant modified Arctic air masses to warmer and moister air masses that help the province transition from snow to rain and eventually drier summer weather. On the coast, the transition is from a strong storm track impacting the entire coast to weaker storms tracking more northward impacting the north coast as the North Pacific high pressure centre moves in over the eastern North Pacific just offshore of North America. In May through August, 2020 the transition to warm and moist air in the interior occurred and remained while the North Pacific High failed to build consistently over the south coast of BC. This high typically blocks rain producing lows from tracking over the southern part of the province, so its absence left the door open to a wet and relatively stormy period.

Seasonal variability and deviation from average like this is a part of our climate system. BC has had cool and wet periods like this before and will have them again. But, an interesting aspect of this year's weather patterns was the simultaneous initial growth of La Niña conditions in the tropical Pacific Ocean. At the end of April, ocean surface temperatures cooled in the eastern equatorial Pacific and have continued to do so to present. The transition began what is now 97% likely to become the next episode of La Niña running through winter into spring, 2021, according to the most recent forecast from the the International Research Institute for Climate and Society at Columbia University. La Niña affects numerous regions around the globe and has the strongest linkage with North American weather during winter into spring. Those impacts represent about 20% of the seasonal variability that we experience. Typically there are colder temperatures over the province and more precipitation over the southern half of BC during La Niña events. This translates to deeper than normal snowpacks in winter and often ongoing cool conditions into spring.

In addition to its winter effects, there is a less well known La Niña influence on summer weather patterns over North America. Research shows these impacts mirror what was observed from May through August in the form of predominant low pressure over coastal BC, a stronger than normal jet stream and a storm track impacting much of the province. These same patterns lead to strengthening high pressure over central/eastern Canada and winds from the east over California and southern Oregon. This pattern leads to cool and wet conditions in much of BC and warm and dry conditions over the western US that have been historically associated with the occurrence of large wildfires there. Some of that dryness was observed in southern BC by late August and into September when BC's weather returned to something closer to average. Simultaneously, the western US experienced its worst wildfire season in recorded history, likely due to the combined effects of La Niña weather patterns and warming linked to global climate change.

With the La Niña pattern now well in place, the province stands a greater chance of a colder than normal winter with more precipitation, with the greatest impacts in central and southern BC and into the Pacific Northwest. Environment and Climate Change Canada's seasonal prediction system is calling for a transition from warmer and wetter than normal conditions in the fall to cooler than normal and a slight chance of higher than normal precipitation in southern BC through winter. These averages will be made up of weather that can include periods of sunshine, strong storms, cold air outbreaks and snow.

Studying How Changing Precipitation May Affect Landslides in BC



This figure shows the projected change in the average total number of days with moderate and high landslide hazards for British Columbia during the fall and for the annual average, for the 2041–2070 period as compared to the 1951–2012 period, from an ensemble average of downscaled climate model projections that were driven using the RCP 8.5 emissions scenario.

Recent PCIC research published in the journal *Climatic Change* uses landslide observations, precipitation data, downscaled output from global climate models (GCMs) and a landslide hazard model to develop projections of landslide hazard frequency in British Columbia (BC). The results suggest that, under a high emissions scenario, there may be significant increases in future landslide hazard frequency in BC. The researcher notes that, "[r]isk assessments for regions in [BC] vulnerable to landslides will need to account for increasing hazard due to climate change altered precipitation."

British Columbia experiences more landslides than any other province in Canada and is the location of the two largest landslides in Canadian history. Landslides have been responsible for at least 278 deaths in BC and result in damage costing between 75 million and 200 million dollars, annually. Though landslides can have a variety of causes, most landslides globally are caused by precipitation, which is also true of landslides in BC.

In order to determine how landslides may change in the future in BC, a PCIC researcher utilized a landslide hazard model, along with landslide observations, GCM precipitation that was downscaled using a method developed at PCIC, and precipitation from a PCIC gridded observational data set. The researcher found that the hazard model performed at least as well at classifying observed landslide dates and locations when run with gridded observational data in BC as it does globally, when it is run using satellite precipitation data. The researcher also used downscaled output from GCMs run using the high-emissions Representative Concentration Pathway 8.5 (RCP 8.5) to develop future projections of landslides in BC. These projections suggest that landslide hazards may increase from about 16 days per year in the past (1951-2012) to 21 days per year, a growth of 32%, by the 2050s (2041-2070). The projected increase is greater in those regions that already see the most landslides, such as the west coast and the northern Rocky Mountains, where hazardous days are projected to increase by 50% to 60%.

Sobie, S.R., 2020: Future precipitation caused landslide hazard in British Columbia. *Climatic Change*, doi:10.1007/s10584-020-02788-1.

Supporting BC Salmon Management

The British Columbia Salmon Restoration and Innovation Fund (BCSRIF) is jointly funded by the Government of Canada and the Province of British Columbia and supports wild fish stocks for fisheries in the province. As one of 14 projects announced in September of 2019, PCIC researchers are working on a project under BCSRIF to inform and support evidence-based fisheries management. PCIC's efforts will assist managers as they focus on the restoration, protection and maintenance of healthy and diverse salmon populations and their habitats in the province. PCIC is using its strength in climate impacts assessment and online tool development to determine what potential impacts salmon populations may face in their freshwater habitats as a result of the changing climate and provide online tools to support planning that takes climate change into consideration. The expected products of this work are now under active development. They will include hydrologic projections of potential changes in water quantity, annual flow regimes and water temperature, maps of climate change induced risk to key life history events and software tools for conducting salmon and vulnerability assessments at the level of watersheds. PCIC researchers have recently developed the input files that are needed to run their hydrologic models and, as a first step, have prepared the models to simulate the Skeena and Somass drainage basins. PCIC has also just taken aboard a post-doctoral researcher to work on risk assessment and planning for the requirements and design of the online tools is also now underway. These will enhance the effectiveness of fisheries management decision-making processes in the context of a changing climate.

PCIC Corporate Report Released

PCIC is proud to announce the release of its *Corporate Report 2019-2020*. The report covers the wide variety of research activities conducted at PCIC and the increases to the climate services that PCIC has provided over the past year. Some of the highlights include PCIC's continued engagement with the engineering community, work to support decision making in agriculture and water management and the continued growth of PCIC's climate data offerings and online tools. In addition, the report discusses PCIC's continuing work on hydrologic modelling, research on climate extremes and its many partnerships, including those with BC Hydro, BCSRIF and the Canadian Centre for Climate Services.

Read the report.

Vancouver Island Agricultural Planning Report Released

The ninth adaptation plan in a series for BC's agricultural regions with the BC Agriculture and Food Climate Action Initiative has been released. The new plan focuses on Vancouver Island. This series of adaptation plans has been developed to support BC's agricultural sector in planning and adaptation efforts that account for projected changes to BC's climate.

The agriculture that a region can support is determined, in part, by the climate of that region. Therefore changes to a region's climate can have impacts on agricultural production and having credible climate information and projections, such as those found in these adaptation plans, is useful to aid in planning. The plans include descriptions of the projected changes to climate, the impacts that these changes may bring and potential strategies for addressing these impacts.

The projections indicate that Vancouver Island will warm during all seasons, with intense warmth increasing and intense cold events decreasing. Hot extremes are expected to increase, with the projections showing hot and dry summers in the future. The projections also show an increase in extreme precipitation. Taken together, these changes present several potential impacts for agriculture on the island, among them, summer water demand issues, increased wildfire risk, possible flooding impacts, and changes to insect populations. Some of the adaptation strategies covered include increasing water storage, wildfire preparedness, climate knowledge and the availability of agricultural decision-making support tools.

These reports were developed in partnership with the BC Agriculture and Food Climate Action Initiative, local agricultural organizations, local governments and the provincial government.

Read the new adaptation plan, here.

Access all of the adaptation plans, here.

STAFF PROFILE: DR. MD. SHAHABUL ALAM

Dr. Md. Shahabul Alam joined PCIC as a Postdoctoral Research Hydrologist this past winter. His work, supported by the British Columbia Salmon Restoration and Innovation Fund (BCSRIF), focuses on the impacts of climate change on the freshwater environments of a set of coastal watersheds in British Columbia, and on salmon productivity. Dr. Alam investigates this by coupling hydrologic models, which simulate water flow in the watersheds, to models that simulate water temperature in the rivers. He explains, "As an end product, my research will help development of software tools for the watershed and fisheries managers of BC coastal region." This work will result in detailed streamflow and water temperature data, analysis, and software tools to access hydrologic model output and salmon risk maps, as well as a tool that will allow biologists or regional stream-keepers to assess potential impacts on the salmon in a given area. PCIC wishes to congratulate Dr. Alam on his recent, successful PhD defense. He earned his PhD in Civil Engineering from the University of Saskatchewan, following an MSc degree in the same field, from the same university. Dr. Alam also holds an MSc degree in Water Resources Engineering jointly from the Katholieke Universiteit Leuven and Vrije Universiteit Brussels, and an engineering degree in Civil Engineering from Bangladesh University of Engineering and Technology. Talking about completing his PhD during the pandemic, Dr. Alam says, "It feels great to finish my PhD, although the defense was done remotely due to the reality of COVID-19. I am disappointed that I could not celebrate my accomplishment with my supervisors, friends, and families during this difficult time. But it is absolutely relieving that I can now focus solely on my research at PCIC."

Speaking of his earlier studies, he says, "In my PhD and MSc research, I always tried to study how climate change is going to impact various aspects of our environment by altering the availability of water, because climate change is a reality globally and particularly in my home country." The importance of the climatic influence was clear in Dr. Alam's earlier research, in which he evaluated the long-term hydrological performances of oil sands mine reclamation covers under climate change in northern Alberta. He explains, "For reclamation covers, climate seems to play a vital role," and the changes that he saw were likely to result in accelerated flushing of constituents contained within the mine waste, but also create larger water yields to surface water bodies and downstream receptors. "These changes suggest that the design of reclamation covers at oil sands mine sites should consider these changes," Dr. Alam says. "I am very happy that I was able to do something to protect the environment and this project has prepared me to do more wherever it required. "

Before arriving at PCIC, Dr. Alam also worked as an Assistant/Sub-Divisional Engineer with Bangladesh Water Development Board for more than 10 years, where he was involved in the projects related to flood control, riverbank protection and drainage improvement, to promote flood-free environments and socio-economic development throughout the country.

PCIC STAFF NEWS

This fall, PCIC is pleased to have welcomed three new staff members. Dr. Travis Tai joined PCIC's Hydrologic Impacts theme as a Post-Doctoral Scientist who is doing salmon-population risk assessment for the British Columbia Salmon Restoration and Innovation Fund. Jessie Booker has joined PCIC's Regional Climate Impacts theme as a Content Developer and User Engagement Assistant, in partnership with the Canadian Centre for Climate Services. Cairo Sanders has joined PCIC's Computational Support Group as an Assistant Programmer. She is working on the Data Analytics for Canadian Climate Services (DACCS) project, supported by the Canada Foundation for Innovation.

PEER-REVIEWED PUBLICATIONS

Ben Alaya, M.A., C. Ternynck, S. Dabo-Niang, F. Chebana and T.B.M.J. Ouarda, 2020: Change point detection of flood events using a functional data framework. *Advances in Water Resources*, **137**, 103522, doi:10.1016/j.advwatres.2020.103522.

Ben Alaya, M.A., **F.W. Zwiers** and X. Zhang, 2020: A bivariate approach to estimating the probability of very extreme precipitation events. Accepted, *Weather and Climate Extremes*.

Cannon, A.J., D. Il Jeong, X. Zhang and **F.W. Zwiers**, 2020: An assessment of how climate change might alter climatic design values in Canada. In press, *Environment and Climate Change Canada*

Meshesha, T.W., J. Wang and **N. Demelash Melaku**, 2020: A modified hydrological model for assessing effect of pH on fate and transport of Escherichia coli in the Athabasca River basin. *Journal of Hydrology*, **582**, 124513, doi:10.1016/j.jhydrol.2019.124513.

Paik, S., S.K. Min, X. Zhang, M.G. Donat, A.D. King and **Q. Sun**, 2020: Determining the Anthropogenic Greenhouse Gas Contribution to the Observed Intensification of Extreme Precipitation. *Geophysical Research Letters*, **47**, 12, e2019GL086875, doi:10.1029/2019GL086875.

Sobie, S.R., 2020: Future changes in precipitation-caused landslide frequency in British Columbia. *Climatic Change*, doi:10.1007/s10584-020-02788-1.

Sun, Q., X. Zhang, **F. W. Zwiers**, S. Westra, and L.V. Alexander, 2020: A global, continental and regional analysis of changes in extreme precipitation. *Journal of Climate*, advanced online view, doi: 10.1175/JCLI-D-19-0892.1.

Williamson, S.N., C. Zdanowicz, **F.S. Anslow**, G.K. Clarke. L. Copland, R.K. Danby, G.E. Flowers, G. Holdsworth, A.H. Jarosch, and D.S. Hik, 2020: Evidence for Elevation-Dependent Warming in the St. Elias Mountains, Yukon, Canada. *Journal of Climate*, **33**, 3253–3269, doi:10.1175/JCLI-D-19-0405.1.

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