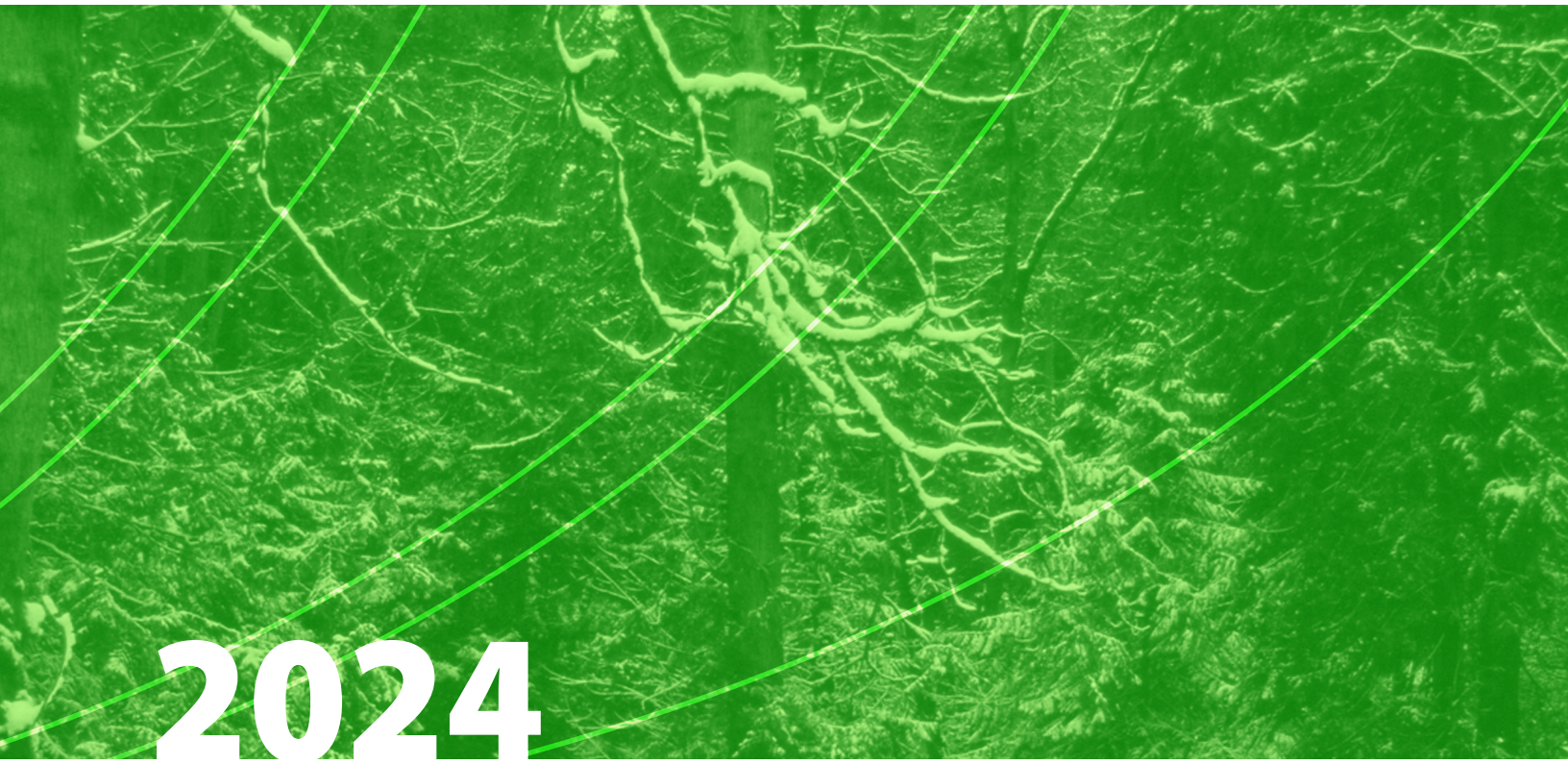

2024

CORPORATE REPORT

2025

PACIFIC CLIMATE IMPACTS CONSORTIUM

Land acknowledgment:

PCIC is situated on the unceded territories of the W̱SÁNEĆ Peoples and of the lək̓ʷəŋən Peoples of the Esquimalt and Songhees Nations. The First Nations of these unceded territories have long been stewards of this land, and their relationships to the land continue to this day. PCIC serves all people of colonially-named British Columbia and is committed to working with the Indigenous Peoples of this region to understand how the climate is changing, the impacts of those changes, and how to suitably adapt.

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2025

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MESSAGE FROM THE DIRECTOR

Over the past fiscal year, working with our partners, PCIC has continued to enhance its suite of climate data, information products, and services—vital tools for planners preparing our province for the impacts of climate change. We recognize this as a time of growing urgency for climate adaptation, marked by challenges that are not only climate-related but also geopolitical and fiscal in nature. At the same time, it is a period of opportunity to support the building of a more resilient province. Climate services are an essential resource in this region, enabling informed and effective adaptation to climate change.

Some highlights from this year's achievements, as detailed in this report, are as follows. We have continued to enhance the Western Arctic Weather Data Portal for Yukon and the Northwest Territories, and the Pacific Climate Dataset (PCDS). These portals are the largest repositories of climate data for these regions and continue to grow. We have also implemented version control for the PCDS, which provides convenient, one-stop access to historical meteorological observations from about 7,000 locations across BC, totaling over one billion observational data records.

This year, we released downscaled CMIP6 products based on the SSP3-7.0 scenario, providing another option to support more fine-grained planning needs. Additionally, PCIC launched the new Salmon Climate Impacts Portal (SCIP), which provides future projections of water temperature in BC's coastal rivers—critical data for those managing fish habitats. We have continued to engage with broader communities.

The ongoing impacts of climate change are reshaping our province. The last decade has been marked by warming and worsening extreme events. In 2024, British Columbia experienced one of its most extreme droughts and wildfire seasons. Prolonged precipitation deficits and record-breaking summer heat extended the historically severe drought of 2023 well into 2025. This multi-year drought affected numerous sectors, with streamflows dropping below critical thresholds and groundwater levels declining. The combination of drought and elevated temperatures created ideal conditions for wildfires. Over one million hectares burned across the province in 2024, on top of the 2.8 million hectares burned in 2023. In comparison, a typical year sees about half a million hectares burned. These drought and wildfire conditions serve as a stark reminder of the growing impacts of climate change on our well-being, our communities, our ecosystems, and our economy—impacts that society must adapt to. This urgent societal need to adapt to a changing climate presents both opportunities and challenges.

There are vital opportunities to expand our services—not only to support our traditional partners by providing more in-depth and precise information for their planning and operations, but also to reach small and underserved communities. These opportunities also allow us to reflect, learn, and elevate the effectiveness of our services. However, they come alongside significant challenges: rising expectations, an ever-increasing sense of urgency, and a rapidly changing geopolitical landscape, compounded by a tightening fiscal environment.

Looking forward, PCIC will work more closely with its partners to navigate the current fiscally challenging environment. By leveraging the unique resources that each partner can provide, we are continuing to extend our services to a broader audience than would be possible for individual partners alone. Together we have developed, and continue to develop, the most extensive set of climate services in our region, to support planners as they work to make our province more resilient.

- Xuebin Zhang

GOVERNANCE AND STAFF

PCIC GOVERNANCE 2024-2025

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Stephanie Tam, Water Management Engineer, BC Ministry of Agriculture, Food and Fisheries

Xuebin Zhang, Director, President & CEO, Pacific Climate Impacts Consortium, University of Victoria

PCIC STAFF AND AFFILIATES 2024-2025

From top to bottom, left to right: Edward Beard, Charles Curry, Abigaïl Dah, Rod Glover, James Hiebert, Samah Larabi, Tong Li, Shelley Ma, Narges Sayah, Markus Schnorbus, Arelia Schoeneberg, Michael Shumlich, Stephen Sobie, Pei-Ling Wang, Xuebin Zhang and Francis Zwiers.

Not pictured: Izzy Farmer, Loni Feffer, Tom Kunkel, Kristyn Lang, Teresa Rush, John Sampson, Quintin Sparks, Kathy Veldhoen, Jingwen Wu, Eric Yvorchuk and Lee Zeman.

REGIONAL CLIMATE SERVICES

CONTRIBUTING TO THE BC RISK ASSESSMENT

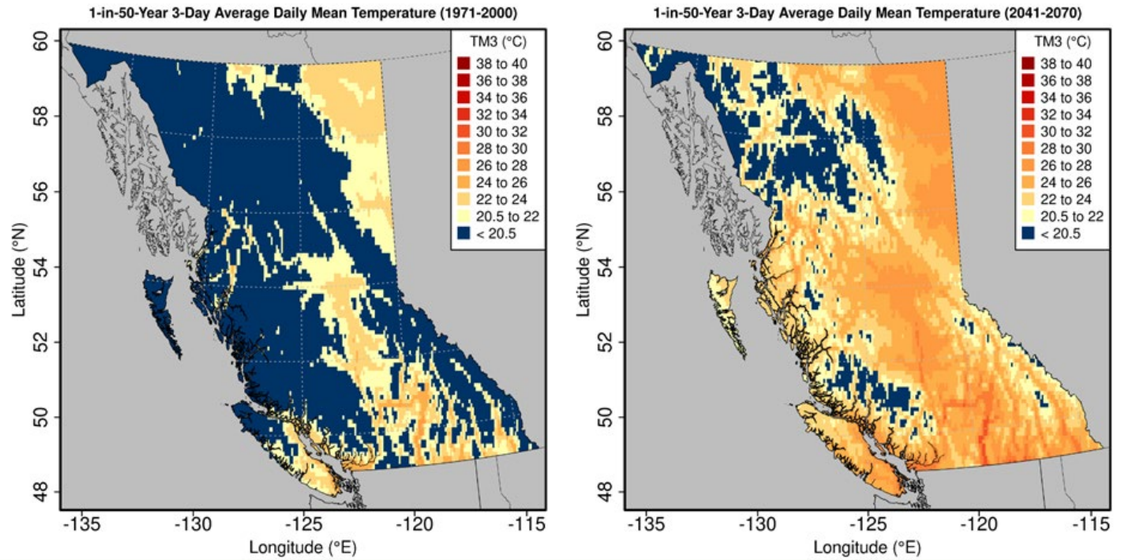


Figure 1: Mean temperature of a 1-in-50 year, 3-day heatwave event in the historical period (1971 – 2000; left), and in the climate projected for the 2050s by an ensemble of downscaled CMIP6 models. Results for the median of model projections are shown.

Partner: British Columbia Ministry of Emergency Management and Climate Readiness

Given its two decades of experience as the leading regional climate services provider for British Columbia, PCIC understands the need to build climate resilience in our province. Recent years have seen multiple extreme weather events strike BC with devastating impacts. These have included flooding that temporarily severed transportation links between the southwestern part of the province and the rest of Canada, unprecedented fire seasons that caused immense damage to BC communities, and an extreme heat event that led to hundreds of deaths in our province. Climate change has made such events more frequent and severe. Adapting to the risks posed by the changing climate is thus critical for BC communities. This requires the subject matter expertise and applied research capacity that PCIC is uniquely positioned to provide.

This year, PCIC continued to support the BC government in its efforts to identify and address climate risks by contributing to the BC Risk Assessment process. PCIC provided expert scientific assessment, knowledge translation, and applied research for the upcoming BC Provincial Overview assessment report. This follows PCIC's contribution to the previous assessment report, released in 2019.

Researchers from PCIC aided in the development of a broad-based provincial climate overview document, contributing their knowledge to this first major phase of the assessment. PCIC also chaired the Climate Change Influence Advisory Working Group, a panel of subject matter experts sharing their knowledge and research experience on the climate hazards of concern. In addition, PCIC's team drew upon their diverse skill sets to provide newly analyzed climate projections of the extreme heat hazard in the province.

Extreme heat poses wide-ranging challenges for adaptation planners, from building and urban design to human health and habitat management. PCIC developed a new climate index describing extreme temperature events lasting three days or more, based on downscaled results from the climate models participating in the sixth phase of the Coupled Model Intercomparison Project (CMIP6). One of these indices captures three-day periods of elevated temperatures so extreme that they occur, on average, only once every 50 years. Estimates of the projected changes in the intensity of such heatwaves between the recent past and the mid-to-late 21st century feature prominently in the draft version of the BC Provincial Overview. These data should serve as a valuable resource for those investigating the increasing impacts of extreme heat across many sectors in the province.

Looking ahead, in anticipation of the regional focus for the next phase of the Risk Assessment, our team is developing an updated series of regional climate summaries spanning the entire province. These summaries provide an overview of the historical and projected future climate in each BC region, using up-to-date and authoritative historical climate data and downscaled climate model results. This allows climate projections to be viewed in the context of the recent past climate for each area, to inform decisions about planning for future impacts.

For these summaries, PCIC's team prepared new fine-scale downscaling calculations for the historical period, using a global reanalysis product extending to 2023 as input. This was important for capturing climatic behaviour in recent years, especially with regard to extremes, and long-term trends up to the present. For the future projections, new fine-scale maps of daily temperature and precipitation were produced from a subset of global climate models that participated in CMIP6, extending to the year 2100. This dataset was used to calculate an extensive set of seasonal and annual indices characterizing the historical and future-projected climate of BC. In addition, a number of new climate indices targeted to meet the particular needs of planners in our province were developed. For example, some of these indices describe characteristics of multi-day heatwaves and extended periods of drought across the province. The analysis for each region will be summarized in a succinct, plain-language document intended to serve as an authoritative reference until at least the next round of CMIP future projections is released (in the late 2020s).

The demand from PCIC's diverse user base for reliable, actionable information on climate-related hazards continues to grow. Through this project and others, PCIC staff have deepened their understanding of the needs of those tasked with planning and decision-making for an uncertain future. Over the two decades in which PCIC has been in operation, our research team has gathered substantial experience working with users on climate impacts and hazards. PCIC scientists are at the forefront of research on climate change and its impacts to our province and are dedicated to using their knowledge to help BC adapt to the changing climate.

TRAINING AND ENGAGEMENT IN THE BC CONTEXT

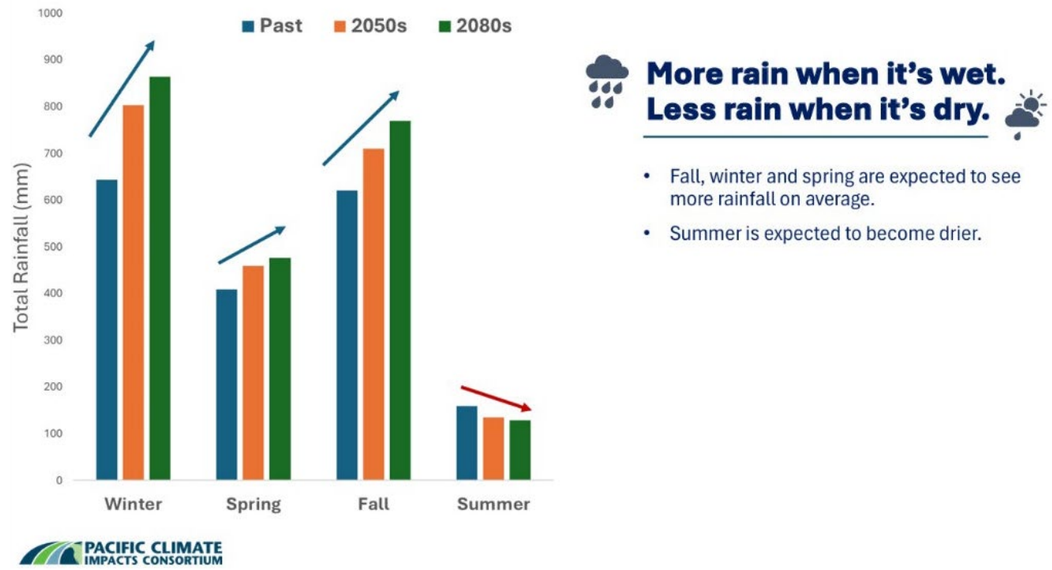


Figure 2: This figure shows a slide from a PCIC training session for the Capital Regional District, displaying seasonal rainfall projections for the region over three time periods.

Partners: Climate Action Secretariat, BC Ministry of Energy and Climate Solutions, Canadian Centre for Climate Services, Environment and Climate Change Canada / Centre canadien des services climatiques, Environnement et Changement climatique Canada

PCIC continues to actively engage with various stakeholders, including local governments, First Nations communities, and emergency management experts. Building on the accumulated knowledge of PCIC's scientific staff, who work at the cutting edge of their fields and have a detailed understanding of the province's climate, PCIC's engagement team deliver targeted training to help users across BC incorporate climate information in their decision making. Training sessions generally include an introduction to climate science, followed by a targeted demonstration of the most relevant analysis tools that PCIC offers, or highlights from a pertinent regional climate assessment. Approaches are tailored to each user group,

but the aim remains to build the capacity of users in BC to find, understand, and apply climate data independently to fulfill their specific planning objectives. These sessions also provide a valuable opportunity for PCIC's team to learn about user needs and for users to gain insight into the current state of knowledge concerning the province's changing climate.

Over the past year, PCIC's team delivered sessions to various groups, from the Royal Architecture Institute of Canada and the Association of Consulting Engineers BC, to the City of Victoria Equity and Climate Community of Practice. We also attended several events to deliver in-person presentations, including the Regional Emergency Management Partnership Forum and the Town of Qualicum Beach and Mid-Island Youth Climate Action Symposium. At the former, our User Engagement Coordinator presented to emergency management coordinators from the Capital Regional District, helping them understand how climate change can be integrated into risk assessments. For the latter, while in the Town of Qualicum Beach delivering a session to councillors, planners, and concerned community members, PCIC staff were invited to the Symposium to educate secondary school students from the Regional District of Nanaimo about climate projections for their region. We are grateful to have the opportunity to share our knowledge and interact with such diverse groups.

In addition to these events, PCIC delivered three half-day training workshops to Climate Action Secretariat staff at the BC Ministry of Energy and Climate Solutions. These sessions included an introduction to climate science tailored to the needs of the decision-makers who are working to help our province adapt. These were followed by demonstrations of PCIC's Plan2Adapt tool, which provides high-level climate information from projections spanning the entire province, and a walk-through of ClimateData.ca. Following each session, a feedback survey was circulated to participants, the responses to which we're using to improve future training sessions for those in the provincial government sector.

SUPPORTING NATIONAL CLIMATE SERVICE DELIVERY

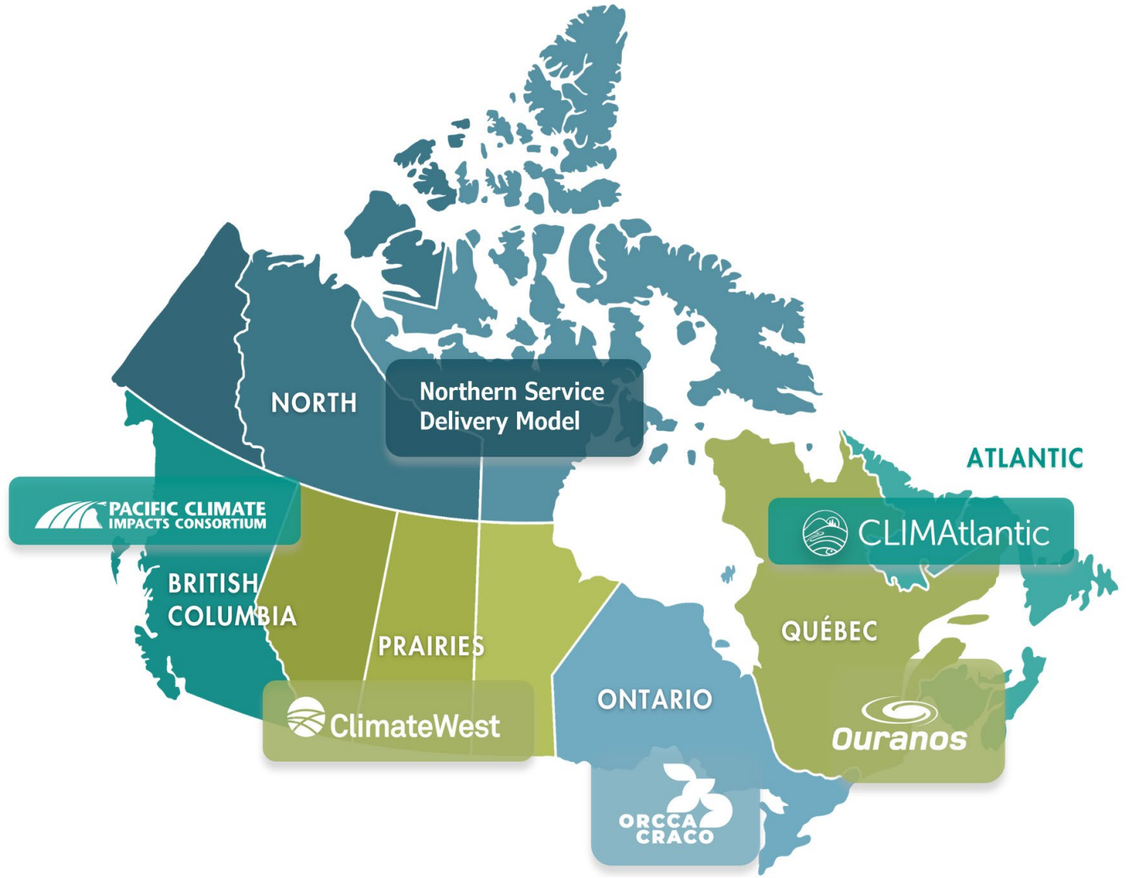


Figure 3: Map showing the primary geographic areas served by regional climate service providers. CCCS plays a key role in supporting and coordinating climate service delivery across Canada. Image credit: Canadian Centre for Climate Services.

Partners: Canadian Centre for Climate Services (CCCS), Environment and Climate Change Canada / Centre canadien des services climatiques, Environnement et Changement climatique Canada, Computer Research Institute of Montréal (CRIM) / Le Centre de Recherche Informatique de Montréal

In partnership with the Canadian Centre for Climate Services, PCIC and other regional climate service providers bring their knowledge and expertise together. We collaborate in streamlining climate service delivery across Canada. This year, PCIC's team continued

to deliver targeted training and aid in the ongoing refinement of a general user training program to educate and guide Canadian planners on incorporating climate information in their decision making.

Over the last fiscal year, PCIC's team contributed to monthly meetings of the ClimateData.ca Content and Engagement Working Group and Regional Climate Centre Training and Engagement. PCIC also participated in the Support Desk, Communications, Data and Product, and Technical Architecture Working Groups, the Program Management Committee, and the Regional Coordinating Committee. Through each of these fora, PCIC shared its expertise while engaging in peer learning and exchanging best practices with other providers to improve the quality of climate service delivery across Canada.

PCIC remains an integral partner in the ongoing development and enhancement of Canada's national climate data portal, ClimateData.ca. A major milestone for the site over the past year was the integration of PCIC's latest Canada-wide downscaled dataset, based on CMIP6 global climate models—the Canadian Downscaled Climate Scenarios–Multivariate dataset (CanDCS-M6)—which now provide the foundational projections information.

This year, PCIC also made numerous contributions to the development of a new version of the ClimateData.ca website, launched in September, 2025. These included assisting in the creation of guidance materials and content for the Marine module and updates to the Transportation sector overview page. In addition, PCIC provided substantive input on aspects of the site design to improve the user experience, such as enhancements to the map interface, user customization options, and expanded data provision and analysis features.

PCIC's researchers also reviewed a new summary page on climatic building design values (based upon data from its own Design Value Explorer tool), along with several Learning Zone articles on seasonal forecasts, climate data for northern Canada, rainfall-driven flooding, extreme snowfall and introductory articles on climate models and downscaling.

In anticipation of providing new information on ClimateData.ca concerning climate extremes, PCIC shared its CanDCS-based return level/period data with CCCS and is providing guidance on how it should be presented on the site. These data can be used to characterise certain types of extremes, such as extreme temperature and precipitation events, and their changing intensity and frequency in a future climate.

Finally, PCIC participated in two workshops exploring the development of a new user assistance feature on the site, specifically one based on artificial intelligence. All of the work in this collaborative project demonstrates PCIC's dedication to improving the quality of climate information and guidance on its use for planners in Canada.

FURTHERING INDIGENOUS ENGAGEMENT

Figure 4: In this photo, Dr. Charles Curry (centre), Lead of PCIC's Regional Climate Impacts theme and Dr. Xuebin Zhang (right), PCIC's Director, deliver a presentation at the BC First Nations Climate Gathering hosted by the First Nations Summit.

Partners: BC Ministry of Energy and Climate Solutions Climate Action Secretariat (CAS); Environment and Climate Change Canada, Canadian Centre for Climate Services (CCCS) / Centre canadien des services climatiques, Environnement et Changement climatique Canada

PCIC remains dedicated to listening, advancing reconciliation and sharing its scientific resources to support to Indigenous communities in their climate adaptation efforts. We do this by collaborating with First Nations, Indigenous communities, and organizations across BC to support community-led climate planning and knowledge sharing.

This year, thanks to ongoing support from a shared contribution agreement with the BC Ministry of Energy and Climate Solutions, PCIC has continued to develop its capacity to engage with Indigenous communities and provide climate information to support their adaptation efforts. This work has involved establishing two-way dialogue, sharing insights about the changing climate and environment, and participating in multiple Indigenous climate events.

These events included the 4th annual Indigenous Climate Resilience Forum, hosted by the BC Ministry of Energy and Climate Solutions' Climate Action Secretariat, and the BC First Nations Climate Gathering, hosted in Musqueam by the First Nations Summit. The Indigenous Climate Resilience Forum featured three days of speakers and discussions connecting Indigenous communities, government, and

climate service providers to discuss the impacts of climate change and fostering resilience. As part of PCIC's contribution, our team presented an introduction to climate projections and demonstrated how climate data tools can support Indigenous resilience work.

The BC First Nations Climate Gathering was a two-day, in-person event that featured a wide range of presentations about climate change impacts and projections affecting future generations. In collaboration with staff from the Canadian Centre for Climate Services, PCIC contributed multiple presentations, beginning with a plenary presentation on past and future climate, followed by sessions on regional climate impacts, wildfire, and sea level rise. We also staffed a booth for conversation and connection with local First Nations and other participants. We are grateful for the invitation to participate in these discussions and for the opportunity to connect around our shared interests in increasing community climate resilience. We learned a great deal through our participation in both events, including the importance of dialogue and relationship-building as key elements in tailoring our services to these communities.

In addition to our participation in these gatherings, and again with the support of our partners at CCCS and CAS, PCIC is pleased to contribute to the CoNext Climate Preparedness Hub, a multidisciplinary group supported by Natural Resource Canada's Climate Change Adaptation Program. This free, five-month training program is designed to build climate resilience in small, rural, and remote communities in BC. Specifically, CoNext aims to equip Indigenous and non-Indigenous communities with the skills, tools, and support needed to develop and implement effective climate adaptation strategies.

PCIC provided key support in the form of instructional program development and workshop materials, including the creation of community climate data summaries. PCIC's engagement and training team also facilitated training sessions for the program's first-year cohort and led a dedicated session on 'Ways of Understanding and Communicating Climate Change,' which introduces participants to future climate projections and how they can be best used to inform long-term planning. Over the coming year, our team will continue contributing to this project as it engages with a second cohort of BC communities.

DEVELOPMENT AND NEW APPLICATIONS OF MULTIVARIATE DOWNSCALING

Partner: Environment and Climate Change Canada / Environnement et Changement climatique Canada

This year, PCIC began a new collaboration with scientists at ECCC on an ambitious statistical downscaling exercise that will expand our capabilities in several directions. This work aims to produce high-resolution climate scenarios for all of Canada, with an extended set of variables targeted to myriad applications in hydrology and coastal oceanography. Like our CanDCS scenarios, these data will also be of interest to those working in the impacts and adaptation space.

Building on the successful implementation of a promising multivariate downscaling approach over the Fraser River Basin (reported in last year's corporate report), PCIC scientists performed extensive testing that led to significant improvements in the efficiency of the method. These improvements allow the technique to be applied over a much larger domain, including the Canadian land mass, marginal oceans, and cross-border watersheds shared with the conterminous United States.

The approach, known as the n-dimensional Multivariate Bias Correction (MBCn) scheme, uses known relationships between large- and small-scale phenomena to translate relatively coarse climate model output (i.e., at resolutions of a few hundred km) into smaller-scale information (at resolutions of ~10 km) that is better suited to applications. In the process, MBCn preserves dependencies between climate variables, which is important because many impacts arise from the compounding effect of multiple variables: for example, coincident hot and dry conditions that result in heightened drought and wildfire risk. The result of the downscaling is a set of Canada-wide climate scenarios at a resolution sufficient for regional climate adaptation.

In their effort to improve the efficiency of the downscaling method, PCIC's team focused on the part of the code that uses an iterative process to "nudge" the variables simulated by the input climate model toward gridded observations. They discovered that fewer iterations than originally specified were needed to adjust the model inputs toward the target data. While this seems like a minor improvement, it is highly consequential over the large domain used in this study. Without this change, the downscaling procedure would take months, rather than a few weeks, to complete for an ensemble of climate models. Another impetus for making this change was a difference in the input climate models: instead of the CMIP-class models used for previous downscaling exercises, the current project uses output from the High Resolution Model Intercomparison Project (HighResMIP), whose component models have higher horizontal resolutions (50 km by 50 km or finer), requiring more calculations.

After making the code improvements, PCIC's team applied MBCn to several HighResMIP models, using the Canadian Surface Reanalysis Version 3 (CaSRv3) as the target data set. This dataset, recently devel-

oped by ECCC, also represents an improvement over the target data used in the Fraser Basin study. Preliminary results from these downscaled scenarios are currently being evaluated.

PCIC is grateful for the financial support of Environment and Climate Change Canada which made this project possible. We are proud to support their mandate to provide Canadians with past and future climate change information for climate impact assessments, adaptation planning and mitigation policy development.

HYDROLOGIC MODELLING

DEPLOYMENT OF THE RAVEN MODELLING FRAMEWORK

Partner: BC Hydro

With the support of BC Hydro, PCIC is continuing to enhance its modelling capabilities by adopting the modular Raven hydrological modelling framework. To this end, PCIC scientists have developed a new modelling workflow and deployed Raven to two basins. Raven was chosen in part because of its flexibility. It allows for a wide variety of modelling options and model abstractions. Raven's spatial discretization (how the model divides up space), temporal resolution, and representation of physical processes can be easily tailored for diverse applications.

For example, Figure 5 shows the discretization of the Cheakamus basin using an approach based on sub-basins, lakes, and river reaches, as opposed to the previous approach using a regular grid. Raven's modern codebase and design also enable faster simulation times compared to the previous hydrologic model, the Variable Infiltration Capacity model with glaciers (VIC-GL). This allows for more rapid and efficient deployment over large modelling domains, benefiting not only BC Hydro, but also the communities and organisations that rely on PCIC's hydrologic modelling. Higher resolution projections will now be available to support planning.

Deploying Raven across BC to create these high-resolution streamflow projections is an ambitious goal that has required PCIC scientists to develop a new modelling workflow to meet it. This effort includes exploring optimal model abstraction (how the model divides time and space, and the selection of process algorithms), and developing efficient calibration strategies for large-domain modelling. In particular, PCIC hydrologists have focused on methods for calibrating a coupled glacier model to match changes in glacier area and volume in the basins where it will be applied. PCIC researchers have also been upgrading and incorporating new algorithms into the Raven hydrology library.

As the next step in this work, PCIC's team applied Raven to two new basins, the Cheakamus and Campbell, to evaluate the capabilities of the modelling framework. They confirmed that Raven performed as well as, or better than, VIC-GL. The projections showed expected changes in streamflow seasonality, with higher winter streamflow and lower summer streamflow. In both basins these changes are primarily driven by three factors: (1) increasing winter precipitation, with a greater proportion falling as rain; (2) decreased summer precipitation; and (3) reduced snowpacks. In the Cheakamus basin, decreased summer flows are also attributed to shrinking glacier area and reduced glacier runoff.

This work has only been possible thanks to the support of BC Hydro, PCIC's oldest partner. Over the two decades following PCIC's inception in 2005, this ambitious partnership has been foundational to the Hydrologic Impacts program. BC Hydro's support has been instrumental in developing and maintaining PCIC's core hydrologic modelling capabilities and enabling substantial research on the future climate and hydrology across most of the province's watersheds. This work has produced the largest and most comprehensive set of hydrologic impacts data of its kind for our province.

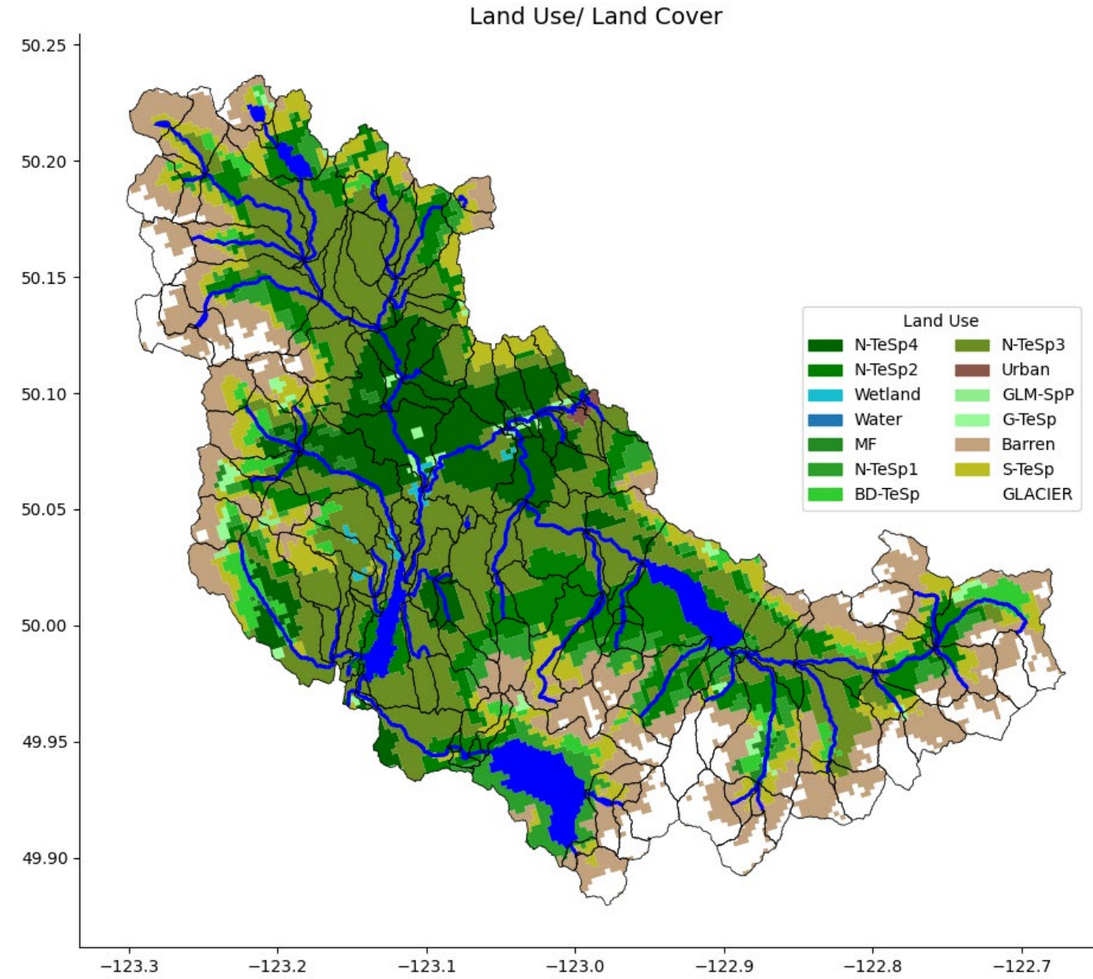


Figure 5: This figure shows the vector-based spatial discretization and representation of the Cheakamus River above Daisy Lake Dam, where the domain is divided into individual sub-basins (black outlines) based on river reaches, and lakes.

BC Hydro supplies power to 95% of the province and has a strong need for the best hydrologic modelling available, to ensure future water resource availability. This ongoing and sustained partnership benefits both organisations and, ultimately, all British Columbians. PCIC hydrologists are developing and applying cutting-edge tools to deliver this modelling and make the results accessible to planners at BC Hydro and across the province. In addition to financial support, BC Hydro provides data from its stations to the Climate Related Monitoring Program. PCIC is committed to supporting BC Hydro through the application of climate insights and direct, applied research.

IMPROVED MODELLING OF BC'S SALMON HABITATS

Partner: British Columbia Salmon Restoration and Innovation Fund, Fisheries and Oceans Canada, Pacific Region / Fonds de restauration et d'innovation pour le saumon de la Colombie-Britannique, Pêches et Océans Canada, region du pacifique

Understanding how climate change will alter the dynamics of freshwater systems is critical for protecting and preserving healthy fish populations. Many fish species will be affected by changes in discharge and water quality. To address this need, PCIC is producing a set of high-resolution modelling runs for streamflow, water temperature, and saturated dissolved oxygen at very high resolution, and is working to make the results available through a new data portal (discussed in the next story). These data will provide vital information to support ecosystem management in the watersheds of British Columbia, which are habitat to a large and diverse number of species, including different species of salmon.

To develop these high-resolution projections, PCIC hydrologists created and refined a multi-step modelling workflow. This workflow uses existing output from VIC-GL, which is then downscaled and routed through Raven's high-resolution, vector-based streamflow and lake network. Using VIC-GL alone, streamflow can only be derived for areas larger than a single grid cell in the hydrologic model, about 25 km^2. However, by using VIC-GL to drive the Raven model (see previous story), the resolution can be improved by about a factor of five.

To produce future water temperature projections in these watersheds, PCIC hydrologists also implemented a thermal wrapper and an improved lake temperature model within the Raven framework. This allows temperature simulations such as those seen in Figure 6. The thermal wrapper represents

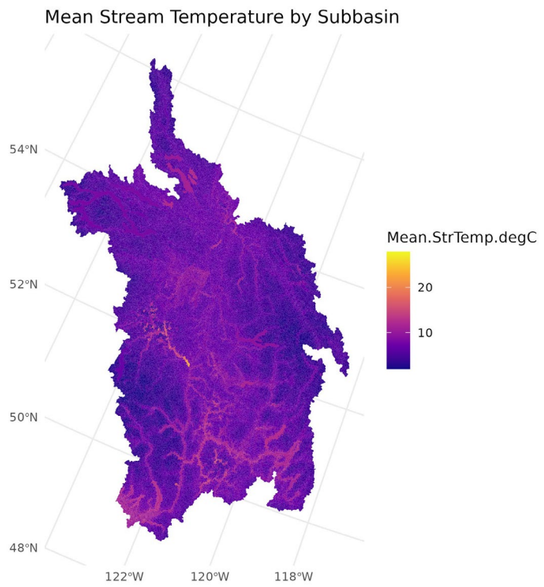


Figure 6: This figure shows the mean water temperature for lakes and rivers in the Fraser River basin.

heat transfer processes and accounts for incoming and outgoing radiation, evaporation, and heat exchange with the ground and air. The model uses two layers to represent heat in the water column: the top layer exchanges heat with the atmosphere, while heat transfer between the top and bottom layers occurs via conduction and convection. PCIC researchers have also implemented an oxygen model to estimate the saturation concentration of dissolved oxygen in hydrologic simulations, which is the maximum amount of dissolved oxygen that water can hold, based on factors such as temperature and atmospheric pressure.

With the modelling workflow established, PCIC's hydrologists have now deployed it across BC's entire coastal domain, including the Fraser Basin, covering a combined area of about 405,000 km^2. This model will be used to downscale VIC-GL projections based on climate model output from CMIP6. This work is near completion, and the resulting high-resolution vector-based output will be supported by a new data portal.

This is an example of how PCIC is able to pool resources from its collaborators to develop a wide range of tools for multiple users. The foundation of this work relies on basic hydrologic modelling capabilities funded by BC Hydro, which in turn allows for research on an expanded set of variables. This broader research is supported by funding from the BC Salmon Restoration and Innovation Fund

A NEW PORTAL TO SUPPORT PLANNING IN BC'S SALMON HABITATS

Partner: British Columbia Salmon Restoration and Innovation Fund, Fisheries and Oceans Canada, Pacific Region / Fonds de restauration et d'innovation pour le saumon de la Colombie-Britannique, Pêches et Océans Canada, region du pacifique

As discussed in the previous story, PCIC is developing a new data portal to provide high-resolution projections of streamflow, temperature, and dissolved oxygen for BC's entire coastal domain. This new data portal is now at the prototype stage and being reviewed. This information is needed to support engineers, ecosystem managers, and planners in their decision making.

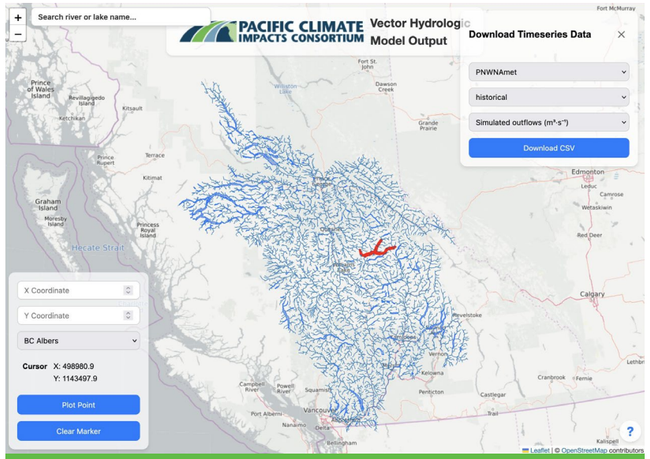


Figure 7: This figure shows the interface for the forthcoming online vector-based data portal, currently under development. This will allow users to visualise and download projections of streamflow, water temperature and dissolved oxygen at the level of individual stream reaches and lakes using an easy point-and-click interface.

With the new data portal, users will have access to high-resolution, vector-based representations of their basins and stream channels, matching the geography of the modelled domain with much higher precision than previous data products. This is made possible via the adoption of the Raven Hydrologic Modelling framework, discussed in the previous story, which is used to generate the very high-resolution vector products. The previous gridded modelling output was challenging for some users, both in terms of identifying their locations of interest and interpreting the coarsely gridded results. The new data portal will make it much easier for users to locate and match output for their regions and specific locations of interest.

This tool will complement the Salmon Climate Impacts Portal (SCIP) featured in last year's Corporate Report. Work also continued to expand the spatial domain of the tool to include indicators for the entire BC coastal drainage area.

This work is the culmination of dedicated efforts by PCIC hydrologists and computer scientists. The hydrologists developed the high-resolution modelling pipeline, incorporated lake and stream temperature into their models, and implemented dissolved oxygen saturation. PCIC's computer scientists developed the software for the data portal that makes the model output easy to visualise and access.

PROVIDING CLIMATE DATA AND DEVELOPING COMPUTATIONAL RESOURCES

STATION DATA PORTALS DEVELOPMENT

Partners: British Columbia Ministry of Emergency Management and Climate Readiness and Climate Related Monitoring Program Partners: British Columbia Ministry of Environment and Parks, British Columbia Ministry of Agriculture and Food, British Columbia Ministry of Forests, British Columbia Ministry of Transportation and Transit, BC Hydro, Rio Tinto, Environment and Climate Change Canada, Metro Vancouver, The Capital Regional District, The Pacific Climate Impacts Consortium

PCIC's team have continued to expand our station data portals as new observations become available and also improved the resilience of the portals. These portals serve a vital function as the general repository for climate data for BC and Yukon. This year, 51.3 million new observations were added to the BC Provincial Climate Data Set (PCDS) and 11.1 million new observations were added to the Data Portal for Canada's Western Arctic, most of these via an automated ingestion pipeline.

In addition, PCIC's team developed and deployed a version control system within the PCDS that automatically tracks changes made by data source providers and/or PCIC staff to weather station observations and their associated metadata. This is an important milestone in our ongoing effort to improve the integrity and usability of climate monitoring data in British Columbia. If a station relocates or metadata is corrected, the system now ensures that updates are recorded, and history is tracked consistently and transparently across the dataset.

The version control system also lays the groundwork for future improvements. It enables PCIC to make documented and reversible adjustments to climate data and to build high-quality datasets for climate monitoring, research, and decision-making. These adjustments might include correcting inaccurate station locations or elevations, accounting for observational biases caused by changing instrumentation over time, or identifying and removing erroneous data caused by instrument failure or, in older records, observer error. It also enables careful tracking of how observational networks that are operated by multiple partners of the provincial Climate-Related Monitoring Program (CRMP) evolve over time. In this way, actual changes in weather and climate can be distinguished from artifacts caused by changes to weather stations.

This work is part of PCIC's broader commitment to building resilient climate data systems, often developed alongside our core responsibilities. Support from users, partners, and funders helps multiply the impact of this work. We are grateful to the BC Ministry of Emergency Management and Climate Readiness, who supported this development.

MAKING HIGH-RESOLUTION CLIMATE SCENARIOS MORE ACCESSIBLE

Partners: Environment and Climate Change Canada, Canadian Centre for Climate Services / Centre canadien des services climatiques and DACCS partners: Canada Foundation for Innovation/ Fondation Canadienne pour l'innovation, British Columbia Knowledge Development Fund, University of Toronto, Computer Research Institute of Montréal / Le Centre de Recherche Informatique de Montréal, McGill University, University of Victoria, Ouranos, Concordia University

The landscape of BC is characterized by complex topography, where climatic conditions can vary over short distances. This creates a need for high-resolution climate information to support planning and adaptation efforts across the province. To meet this demand, PCIC is developing a new online tool to allow users to generate their own kilometre-scale projections for the regions of BC that are of interest to them.

The tool was originally implemented in a format known as a Jupyter Notebook, an interactive document that combines live code, visualizations, and narrative text that is more suited to users with an intermediate level of technical ability. Behind this front-end interface, the engine of the tool is a Web Processing Service that enables users to efficiently generate downscaled climate variables for their areas of interest using PCIC's data and computational resources.

Recently, PCIC's team redeveloped the front end into a more user-friendly, point-and-click interface to make it accessible to a broader range of users—essentially placing fine-scale climate data at their fingertips. In addition to improving the interface, several other upgrades were made. These upgrades include: implementing a user authentication process to guard against unauthorized use; designing a queuing system to manage multiple simultaneous users and processes; placing time limits on stored data to manage storage constraints; and providing real-time progress updates while the tool is running.

PCIC's team have taken the tool from a limited-access prototype to production-quality climate software, now in beta-testing and being prepared for deployment on our site in the 2025-2026 fiscal year.

As described in last year's Corporate Report, the tool's engine leverages software technology developed through the Data-Analytics for Canadian Climate Services (DACCS) project, which brings computational resources close to vast amount of data in data storage for efficient climate data product generation. As a future addition to PCIC's Data Portal, it represents a major step forward in climate service provision to our wide community of climate data users.

MAINTAINING AND UPGRADING PCIC'S COMPUTATIONAL INFRASTRUCTURE

PCIC relies on various computing resources to generate climate information and deliver its services. This year, PCIC continued to improve and expand its computational infrastructure, doubling its research storage capacity and preparing to increase its computing power. A new blade chassis was added. This hardware enclosure can host additional servers, expanding the space and compute capacity available for the vast climate and hydrologic datasets that PCIC scientists use in their modelling and analysis.

These improvements not only support more research and faster turnaround of results, they also make PCIC more resilient. When one of the large national computing clusters that PCIC relies on experienced a service interruption, our researchers were able to continue their work by pivoting to internal systems. Having both in-house and external resources ensures that critical research continues uninterrupted, while still benefiting from the scale and shared capacity that national computing clusters provide.

PCIC's partnership with UVic Research Computing Services allows us to securely host our computational infrastructure in a local, Canadian-owned, professional facility with seismic-isolated racks, ensuring protection from earthquakes while gaining high-speed network connectivity, and reliable power and cooling.

Together, these upgrades mean that PCIC can deliver climate service more reliably to its partners and users. By balancing internal capacity with ongoing use of external computing resources, PCIC ensures both efficiency and resilience in meeting the growing demand for climate information.

ENHANCING FEATURES OF PCIC'S TOOLS AND INCORPORATING NEW CLIMATE PROJECTIONS

Partners: Environment and Climate Change Canada / Environnement et Changement climatique Canada, British Columbia Ministry of Emergency Management and Climate Readiness

PCIC offers a wide variety of tools that provide data from across our province for planners, researchers and engineers. These tools are continually being improved, developed and updated with the best available information to enhance their overall usefulness. Adding information to these tools has been fast and efficient, thanks to a framework that standardizes both data addition and software development. Key improvements to PCIC's tools this year included an update to the CMIP6 downscaled data used in PCIC's Climate Explorer tool, shifting from the previous univariate downscaling method to the multivariate MBCn technique, which is reported in more detail in the earlier story, *Development and New Applications of Multivariate Downscaling*. These new projections will be particularly useful for applications that require consistency between related variables, such as in hydrologic modelling.

The Weather Files Data Portal, which provides engineers with future-shifted weather files that represents what typical weather conditions might look like in the future for building design, has been upgraded to use climate model output from CMIP6. This update incorporates the most recent data from the latest generation of global climate models.

In addition, new statistically-downscaled output from climate model runs using the SSP3-7.0 scenario has been added. SSP3-7.0 is a high-emissions scenario that lies between the moderate SSP2-4.5 scenario and the more extreme SSP5-8.5 scenario. It can be used to study how approximately 3.5 °C to 4.0 °C of global warming by the end of the century might affect regions in Canada. This addition provides PCIC's users with a more diverse selection of emissions scenarios for their planning and research needs.

OTHER ACTIVITIES

A NEW STANDARD FOR ESTIMATING EXTREME PRECIPITATION IN A FUTURE CONTEXT

Partner: Canadian Standards Association, operating as CSA Group (CSA)

In mid-2023, PCIC was asked by the CSA to serve on a committee to develop a national standard on the estimation of extreme rainfall information for engineering design. This includes estimating how the intensity and frequency of extreme rainfall may change in the future. The purpose of this standard is to support engineers in their design processes as they work to make the built environment more resilient to future climate impacts.

Three members of PCIC's staff joined the Technical Committee for CSA W231, "Developing and Interpreting Intensity-Duration-Frequency (IDF) Information Under a Changing Climate," serving alongside other subject matter experts from across Canada. The work built on a 2019 CSA guidance document to which PCIC also contributed (CSA PLUS 4013), which summarized the then-current IDF curve methodology and the status of future-projected extreme rainfall from climate model simulations.

Unlike the previous guidance, a national standard employs normative language that prescribes how users must perform the calculations to set design parameters for engineering applications, including critical infrastructure. In developing the standard, the technical committee evaluated methods in the context of current scientific understanding, held a series of meetings to reach consensus amongst committee members, formulated several drafts, and made final revisions in response to public review. The result is the CSA W231:25 standard, published in early 2025. It is anticipated to serve the relevant professional communities until at least 2030. The CSA periodically reviews and updates its standards, and it is likely that an update to W231:25 to reflect further developments in our understanding of how extreme rainfall will change in the future will start in 2028.

An important insight from the previous guidance was that, despite ongoing advances, directly simulated precipitation from global climate models is not yet suitable for use in engineering design. Instead, the standard employs the known relationship between the annual mean temperature change and the maximum water content of the atmosphere to estimate the magnitude of extreme daily and subdaily rainfall at the local scale. This rather simple "temperature-scaling" relationship provides a straightforward way for practitioners to estimate future heavy-rainfall amounts. Available climate modelling research indicates that so-called "thermodynamic" processes dominate projected change in extreme precipitation in Canada, supporting the use of temperature scaling as a conservative approach for estimating future intensity. Changes in atmospheric circulation (so-called "dynamic" processes) may also influence future extreme rainfall, but available research suggests they play a less important role in Canada than in some other parts of the world. Scientific consensus on the potential impact of circulation changes at different scales is not yet strong

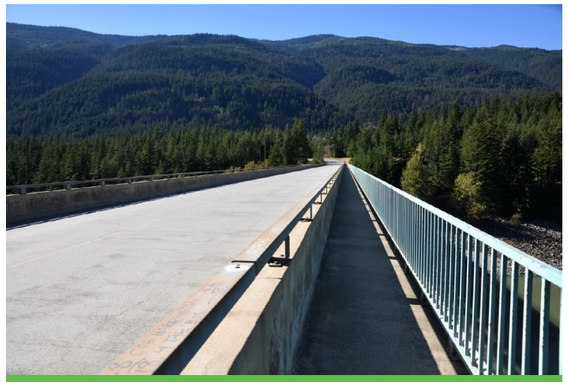


Figure 8: This photo shows the Cog Harrington Bridge that crosses the Fraser between Boston Bar and North Bend. Photo credit: Dr. Francis Zwiers.

life of the infrastructure or system being designed, the nature of the hazards to which it may be exposed, and the consequences of exposures to extreme levels of those hazards.

enough to advise the engineering community on whether such changes can confidently be taken into account in a future version of the standard. However, ongoing research using very high-resolution weather and climate models aims to achieve this goal. PCIC helps the continued development of the W231:25 standard by synthesizing the evolving scientific literature on how extreme rainfall intensity will change with the climate.

PCIC is also continuing its engagement with the CSA by assisting in the development of an initial "Climate Change Framework," document that aims to provide all CSA committees with a common information basis as they address the challenge of adapting standards to account for future climate change impacts. The framework will also propose a basic thought process, organized as a flow chart, that design practitioners can use to guide their thinking when considering future climate conditions. This structured process is expected to take into account the anticipated service

CONTRIBUTIONS TO CANADA'S NATIONAL ASSESSMENT

Partner: Environment and Climate Change Canada / Environnement et Changement climatique Canada

Over the past year, PCIC has continued to support the development of the upcoming national climate assessment, Canada's Changing Climate Report 2026 (CCCR2026). This report will provide a comprehensive overview of current knowledge on past climate changes and future projections for Canada, including their physical impacts. Its thoroughness—featuring contributions from leading climate experts across government and academia—closely resembles the approach taken by the Intergovernmental Panel on Climate Change (IPCC).

Like the IPCC's assessments, the CCCR2026 involves a rigorous assessment of peer-reviewed literature on Canada's climate and related aspects. Successive drafts have undergone intense scrutiny, line by line, through multiple rounds of external reviews. The CCCR2026 emphasizes the Canadian context, focusing on the climate and associated processes that are particularly important for our region. Due to the sheer amount of work involved, these reports are only produced every five years or so, with the previous edition released in 2019 (to which PCIC also contributed).

While the new report focuses solely on the physical aspects of climate change, it covers a broader scope of phenomena. It will serve as a key reference for understanding how and why Canada's climate is changing, and what the future may look like.

PCIC scientists contributed targeted research and analysis, and assessment. They served in multiple roles, including coordinating lead author, contributing author and reviewer across several chapters. Of the ten chapters, PCIC scientists contributed to three. Drawing on their expertise in historical climate data collection and analysis, they led the chapter on observed changes in Canada's climate. Similarly, using their extensive experience in analysing climate projections, and also in the study of climate extremes, other PCIC authors contributed to the chapters on future climate change and extremes. Additionally, Dr. Xuebin Zhang, PCIC's Director, serves on the report's advisory panel, sharing his extensive expertise as a leading climate scientist.

The main findings from the CCCR2026 will be featured in next year's corporate report.

CONSTRAINING CLIMATE PROJECTIONS

Partner: Environment and Climate Change Canada / Environnement et Changement climatique Canada

One of the more interesting and consequential areas of research at PCIC over the past year has focused on new methods to reduce the uncertainty range in future climate model projections. The range of projected values for many climate variables increases the further one looks into the future. This wide range of potential outcomes can pose a substantial hindrance to planning and decision-making: it is difficult to plan when there is substantial uncertainty about what you're planning for.

In a series of peer-reviewed research papers, PCIC authors and collaborators have succeeded in using observations to constrain estimates of past and future warming for Canada at both national and regional scales, including British Columbia. Using a similar technique, they have refined projections of global mean surface temperature and other climate variables to better support climate change adaptation planning worldwide.

The methodology used by PCIC's team, known as "emergent constraints," begins with identifying empirical relationships between variables in the historical climate and variables in future projections. These relationships, which emerge from analyzing a large set of climate model simulations, along with past observations can then be used to narrow the range of model estimates for past and future climate changes. Among other benefits, this helps planners improve climate resilience in their projects.

PCIC researchers applied the emergent constraints method to revisit both the historically simulated and future projected warming in Canada. This work used both global and Canadian national mean temperature observations over 1948-2023 (when station observations are available in northern Canada) to constrain output from an ensemble of models participating in CMIP6 (Figure 9).

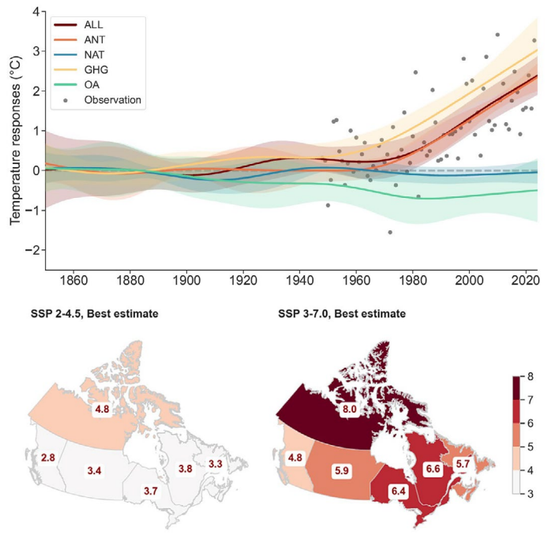


Figure 9: The top panel shows observationally constrained estimates of changes in annual mean temperature in Canada due to: all forcings (ALL), anthropogenic forcing (ANT), natural forcing (NAT), greenhouse gas forcing (GHG), and other anthropogenic forcings (dominated by aerosols, OA). Temperature responses to various forcings, along with their 5-95% uncertainty ranges, are shown in color, while observations are plotted as gray dots. Observed and constrained temperatures in this figure are given as differences from the 1850-1900 mean. The bottom panels show the best estimate of the constrained projection for Canadian sub-regions at the end of the 21st century (2081-2100) under the moderate SSP2-4.5 scenario (left) and the higher-emissions SSP3-7.0 scenario (right).

Their results suggest that human influence has warmed Canada's climate by about 2°C from the 1850-1900 pre-industrial period to the recent 2015-2024 decade. Future warming is projected to range from around 5.0°C to 6.5°C above pre-industrial levels by the end of this century, depending on the chosen emissions scenario.

Importantly, applying the observational constraints narrows the uncertainty range in future projections substantially, by up to roughly 50% by the end of the century, again depending on the scenario and region. This published study is informing two chapters of the upcoming CCCR2026 (see previous story).

Moving to the global context, PCIC's researchers applied a related method to climate model output to evaluate the skill of projected temperature changes with lead times of 20 and 50 years. The research team demonstrated that the technique greatly reduces the bias and spread in model projections under both the high- and low-emissions scenarios. As a result, these constrained projections should be considered as credible predictions rather than mere projections, given their measurable prediction skill and the clear understanding of its origin.

COMMUNICATIONS

UPDATING PCIC'S WEBSITE

Partners: University of Victoria (UVic) Communications and Marketing, UVic Library Services

Over the past year, with the support of UVic, PCIC transitioned to a new website. While the site retains much of the previous content, including the same data, tools, and other information, its integration with UVic's content management system allowed several key improvements. First, the design is responsive, allowing elements to adapt to multiple screen resolutions. Second, a tiered structure improves the organisation of pages containing extensive technical information, presenting a lower density of text at first glance. Third, the user interface was streamlined by placing PCIC's highest-demand products front-and-centre.

Developed with UVic's Communications and Marketing team, the new site integrates the front end of PCIC's web offerings into UVic's system, leveraging the university's expertise in information technology, storage, and security. As a steward of large volumes of data, PCIC places high importance on safeguarding these resources. Hosting the site within UVic's security perimeter enables PCIC to benefit from multiple layers of protection across the digital campus, along with regular hardware and software updates that uphold the highest standards of network security.

As part of the website transition, PCIC's Publications Library has been added to UVic's online repository, UVicSpace. This makes our work more accessible to users while enabling us to draw on the expertise and resources of UVic's library team. In addition, PCIC now uses UVic's event management platform, LiveWhale, which automatically displays PCIC events and seminars in the UVic calendar.

Other changes include a new mailing list, offering more options for tailored communications, and ac-

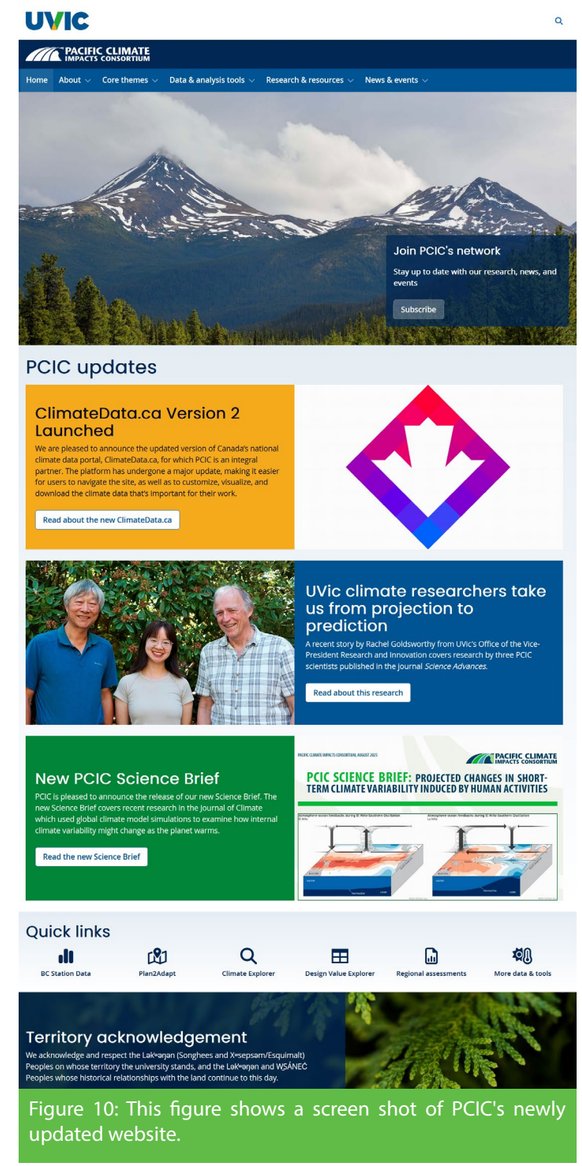


Figure 10: This figure shows a screen shot of PCIC's newly updated website.

cess to site analytics that will guide user-focused updates and improvements in the future. Overall, the new website enhances PCIC's ability to deliver an improved user experience while allowing our staff to focus their efforts on applied research and engagement. We are grateful for the support of our UVic colleagues, whose efforts ensured a smooth transition and, in the process, strengthened our connection with the UVic community.

COMMUNICATIONS

PCIC's communication channels take many forms. We regularly share important news and updates on our research programs, tools and new data products with our users through the PCIC Update newsletter. Similarly, our Science Briefs highlight key findings from the climate research literature when they have implications for our service region. In addition to the outreach and engagement efforts discussed in previous stories, PCIC scientists publish in peer-reviewed literature and frequently present their work at conferences and seminars.

Over the 2023-2024 fiscal year, PCIC staff presented on a wide array of topics including the detection of human influence on precipitation in Canada, changing climate risks to infrastructure, multi-model ensemble projections utilizing machine learning, and reducing the uncertainty of projected changes in extreme precipitation.

PCIC also hosted seven speakers as part of its Pacific Climate Seminar Series. The talks covered a wide variety of topics ranging from quantifying future freshwater hazard exposure for salmon in BC to decadal prediction and novel implementations of observational constraints for understanding climate change. The speakers included PCIC scientists, Canadian researchers and international experts, from Switzerland, England and the United States—each presenting on topics of pressing relevance for PCIC's users.

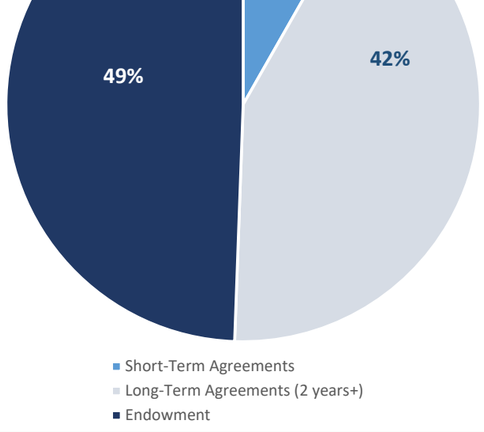
This fiscal year, PCIC published two Science Briefs, plain language summaries of recent research, relevant to PCIC's regional stakeholders and presented with context sufficient to understand the findings. These Science Briefs were on the topics of: "Climate Model Genealogy and its Relationship to Modelled Climate Properties," and "On Anthropogenic Changes in Interannual-to-Decadal Climate Variability in CMIP6 Simulations."

OPERATIONS AND FINANCE

OPERATIONS AND FINANCE

PCIC obtains revenue from three primary sources: an endowment that was placed at UVic by the BC Government in 2008, long-term agreements with key partners, and short-term contracts with users who have specific requirements. Sustained funding from the endowment continued to provide us with leveraging opportunities, with users and stakeholders providing 51% of 2024-2025 revenue under 13 agreements. Investment in our talented team of 25 staff comprised 93% of our expense budget, with the remaining 7% supporting operational expenses such as computing resources, staff professional development, project-related travel and financial accounting and auditing services. As a not-for-profit corporation, PCIC carefully manages its expenditures to stay within its funding envelope and ensure that all its funding supports its programs and service delivery.

2024-2025 REVENUE



2024-2025 EXPENSES

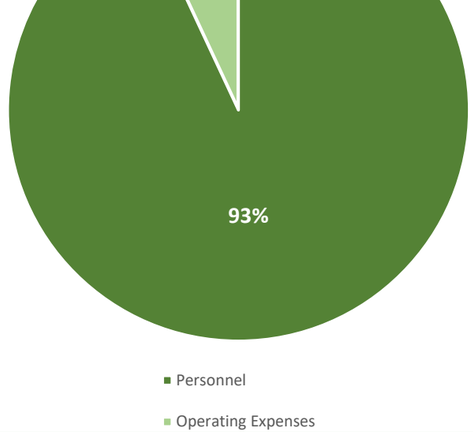


Figure 11: This figure shows a breakdown of PCIC's revenue (left) and expenses (right) for the 2024-2025 fiscal year.

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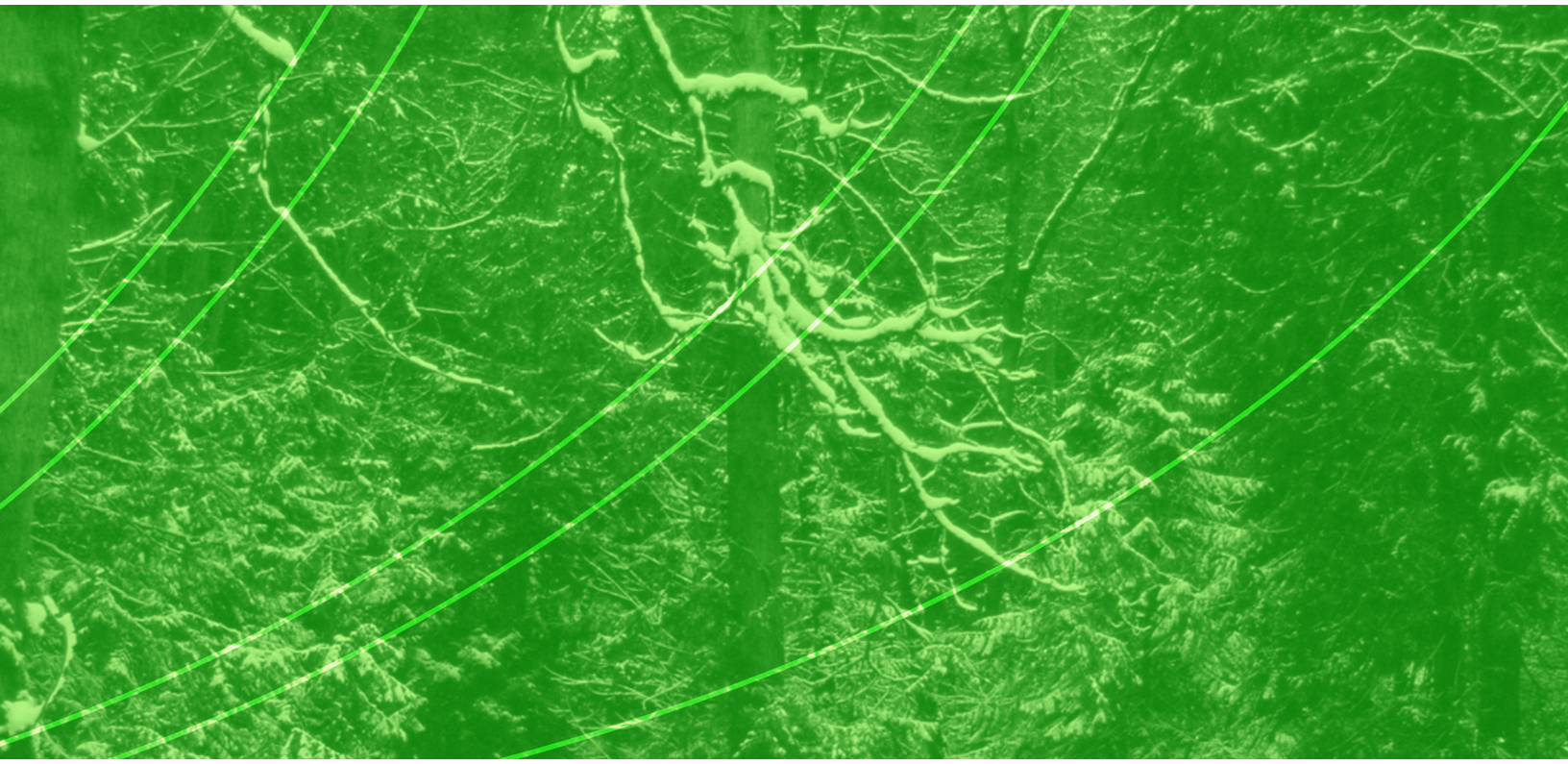

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