PACIFIC CLIMATE IMPACTS CONSORTIUM

PCIC UPDATE February 2025

PROJECT AND RESEARCH UPDATES

Two New Regional Climate Assessments

PCIC recently conducted and released two comprehensive climate assessments for the Regional District of Nanaimo and the Capital Regional District. These assessments highlight PCIC's commitment to create forward-looking, locally relevant data products and guidance to support ongoing planning efforts in specific regions. The reports were co-designed through extensive engagement with each community, ensuring that they were tailored to their specific needs and interests. Both reports feature chapters detailing changes in multiple climate indicators due to expected climate change over the coming decades, such as the growing season length, and warmest and coldest winter days. Each report includes a chapter, co-produced with the respective partner, focused on identifying sector-specific potential future climate impacts in the region, followed by conclusions and recommendations.

New to these assessments, compared to those PCIC previously produced, is additional material designed to help contextualise and interpret the findings and to provide guidance on the use of the data and its limitations. Each partner received a comprehensive data package containing information on dozens of climate variables and indices derived from downscaled, high-resolution scenarios.

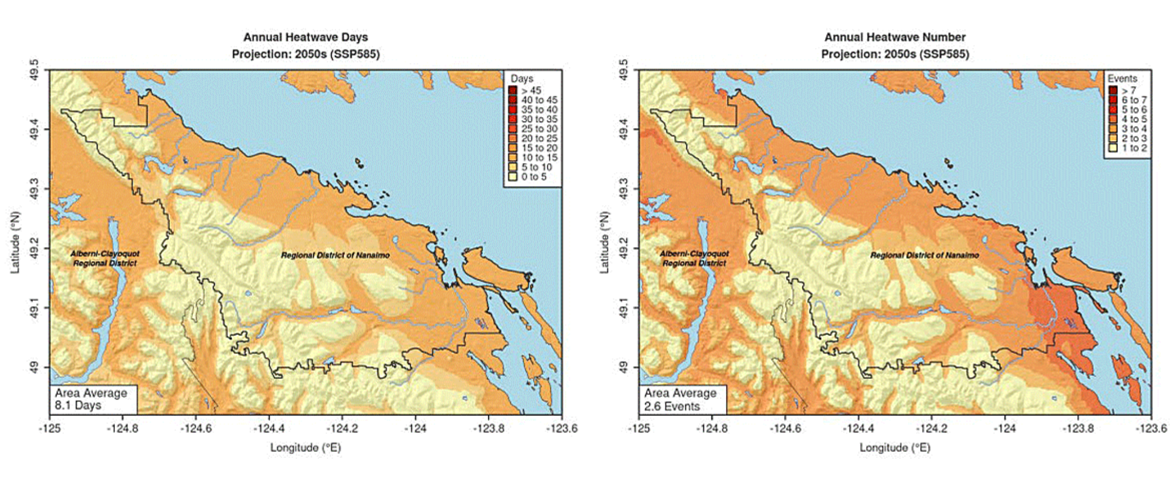

Figure 1: This figure shows the projected annual count of heatwave days (left) and number of annual heatwaves (right) in the 2050s for the Regional District of Nanaimo, assuming a high-emissions scenario. Note the larger values that occur in low-elevation areas. Historically, counts of both heatwave measures are very low (about 1 per year, on average) throughout the region.

Climate projections for the two Districts exhibited strong similarities, with both regions expected to experience warming during every season, a reduction in summer precipitation, and an increase in cool season precipitation, with a higher proportion falling as rain instead of snow. The projected warmer summer temperatures will bring a longer growing season, hotter summer days and warmer nights, and more heatwaves (Figure 1). Fewer frosty days and less extreme cold temperatures will occur in winter.

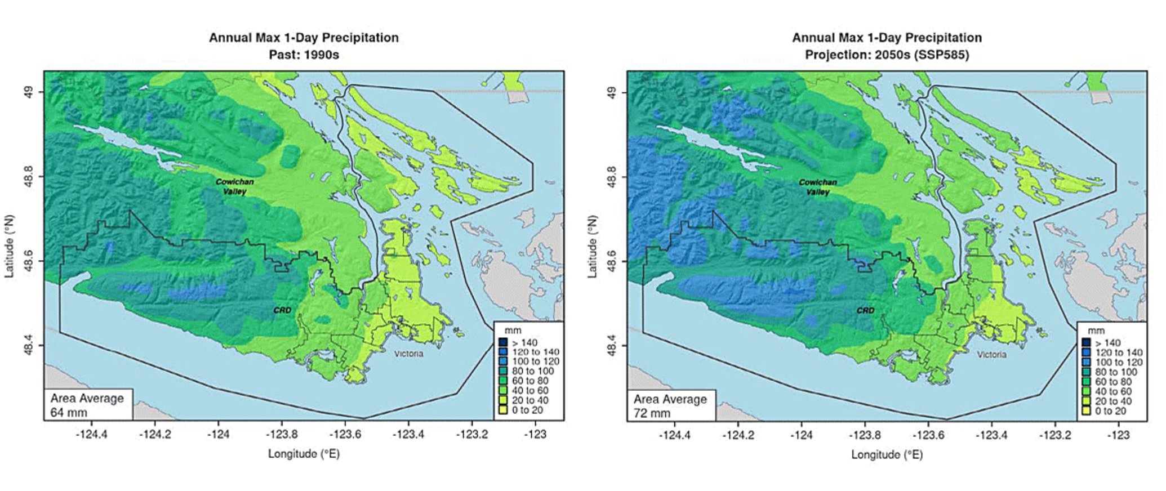

Figure 2: This figure shows the projected annual maximum 1-day precipitation in the 1990s (left) and 2050s (right) for the Capital Regional District, under a high-emissions scenario.

Notably, the amount of rain falling in extreme events, such as over one day (Figure 2) or over consecutive days, is projected to increase more than average rainfall. Recognizing that effective adaptation planning requires more than just broad, large-scale changes, the results were broken down into tables and maps to show the projected changes in geographic detail.

During the creation of these reports, PCIC consulted with local government staff for input on report content and held workshops to better understand how climate change is already impacting their operations. PCIC also led training workshops for both regional districts, providing practical, worked examples tailored to the local government context. Additionally, PCIC researchers presented to the Rainwater Working Group at the Regional District of Nanaimo on the use of the projections for water management, highlighting how these reports could inform future infrastructure planning in these municipalities. The release of the reports also prompted a number of requests for presentations to smaller groups working within the Districts to help them better understand and apply the information PCIC provided. This is an example of added value that PCIC is pleased to provide to our users so that they can make the best use of our products.

Creating a Canada-Wide Mosaic of High-Resolution Climate Maps

In recent years, there has been a growing demand for Canada-wide, high-resolution climatological data and maps for a variety of purposes. This type of information is of interest to a wide range of users, including planners, engineers, consultants and researchers studying historical climate across Canada. Such maps can also be used along with global climate model outputs to derive spatially detailed future projections for fairly small regions.

Over the past few decades, several research groups have produced gridded, station-based datasets covering parts or all of North America. However, this patchwork of high-resolution datasets is difficult to use together and there are some disagreements between the different datasets in areas of overlap (Figure 3). There at least three reasons for this:

- Each dataset uses a different underlying set of stations;
- The products use different ancillary data (for example, digital elevation models) to supplement station information, and;
- Each product uses a different method (and often a different target resolution) to interpolate the station data onto a regular latitude-longitude grid.

With a view toward adding further value to these datasets, PCIC's team has undertaken the ambitious project of weaving them together to create a Canada-wide "mosaic" of climatological maps. This work draws, in part, upon PCIC's extensive experience in developing high-resolution climatologies for BC and the Yukon region, using the Parameter-elevation Regressions on Independent Slopes Model (PRISM).

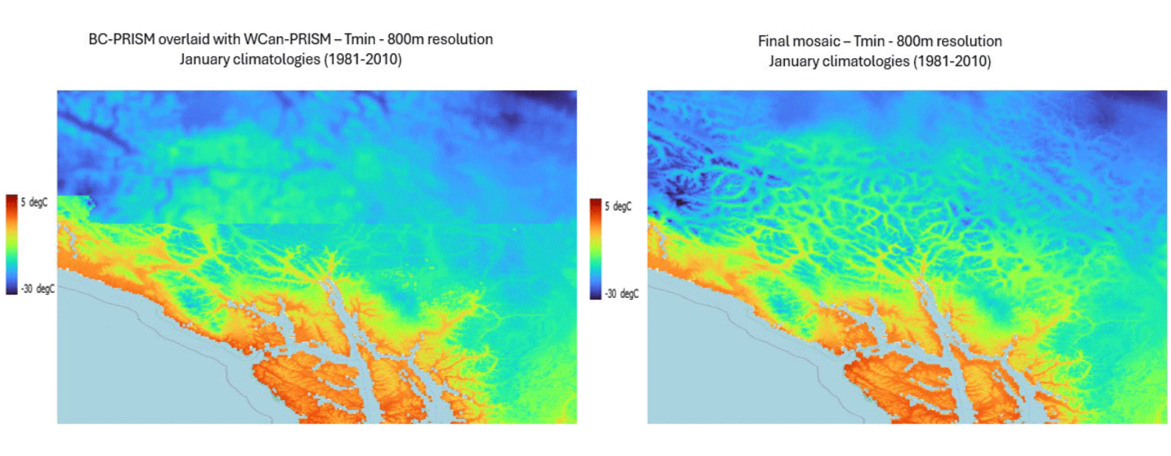

Figure 3: The left panel shows an area of Alaska, Yukon, and northern BC with the colours representing January mean minimum daily (i.e. nighttime) temperature in two gridded data products: Western Canada PRISM (visible in the upper portion of the left panel) and BC PRISM (in the lower portion of the panel). The discrepancy between temperatures along the boundary between the two datasets is evident. The right panel shows the result of the two-step procedure that uses smoothed backgrounds from the PRISM products along with fine-scale anomalies from a third product, Daymet, to achieve a smooth blending between the products in the region where they overlap.

In the initial phase of this project, supported by the British Columbia Ministry of Forests, PCIC's researchers brought together existing PRISM climatologies for the 1981-2010 period to create a continuous map stretching from Alaska, through BC, to the coterminous U.S. They also identified significant technical challenges in extending the mosaic to incorporate additional datasets. Now in the second phase, supported by Environment and Climate Change Canada, PCIC's team is extending the mosaic eastward within Canada, with the goal of spanning the entire country.

Creating these larger maps necessitates dealing with the aforementioned discrepancies between datasets in the areas where they overlap (Figure 3). To handle this, PCIC's team developed new methods to merge the individual maps at their boundaries while maintaining consistency with our understanding of the regional-scale climate. The main method involves separating each monthly map into two layers: a coarse-resolution, smoothed background field and a fine-scale anomaly field, created by subtracting the smoothed field from the original data. The fine-scale anomalies often reflect how the local climate varies with topography, while differences in the smoothed maps in the same region reflect different background levels (biases) in the underlying products. By blending the coarse- and fine-scale fields separately across the regions of overlap and then combining the resulting maps, reasonably smooth climatological maps for the areas spanned by multiple products were produced.

The resulting maps will be of interest to the wide range of users already mentioned, while the methodology will be made available for other researchers to use and build upon. In addition, PCIC will be integrating these maps into our on-demand "climate imprint" downscaling tool, which is under development and currently operates only over BC. By developing a national mosaic of climatologies at a roughly one-kilometre resolution, the eventual goal is to enable interested users to perform customized downscaling of various climate variables and extreme climate indices, providing fine-scale information that is more suitable for planning and adaptation efforts.

Expanded Streamflow Analysis for BC River Basins

PCIC scientists continue to expand our work on streamflow modelling and projections in BC. Our hydrologic impacts team recently produced a new streamflow analysis for BC river basins, based upon climate projections through 2100, to support plans to make our province's transportation networks more resilient to the impacts of climate change. The serious nature of the impacts that weather and climate extremes can have on BC's transportation infrastructure was brought into stark focus by the rainfall-driven flooding and landslides of November 2021 that cut southwestern British Columbia off from the rest of Canada by land.

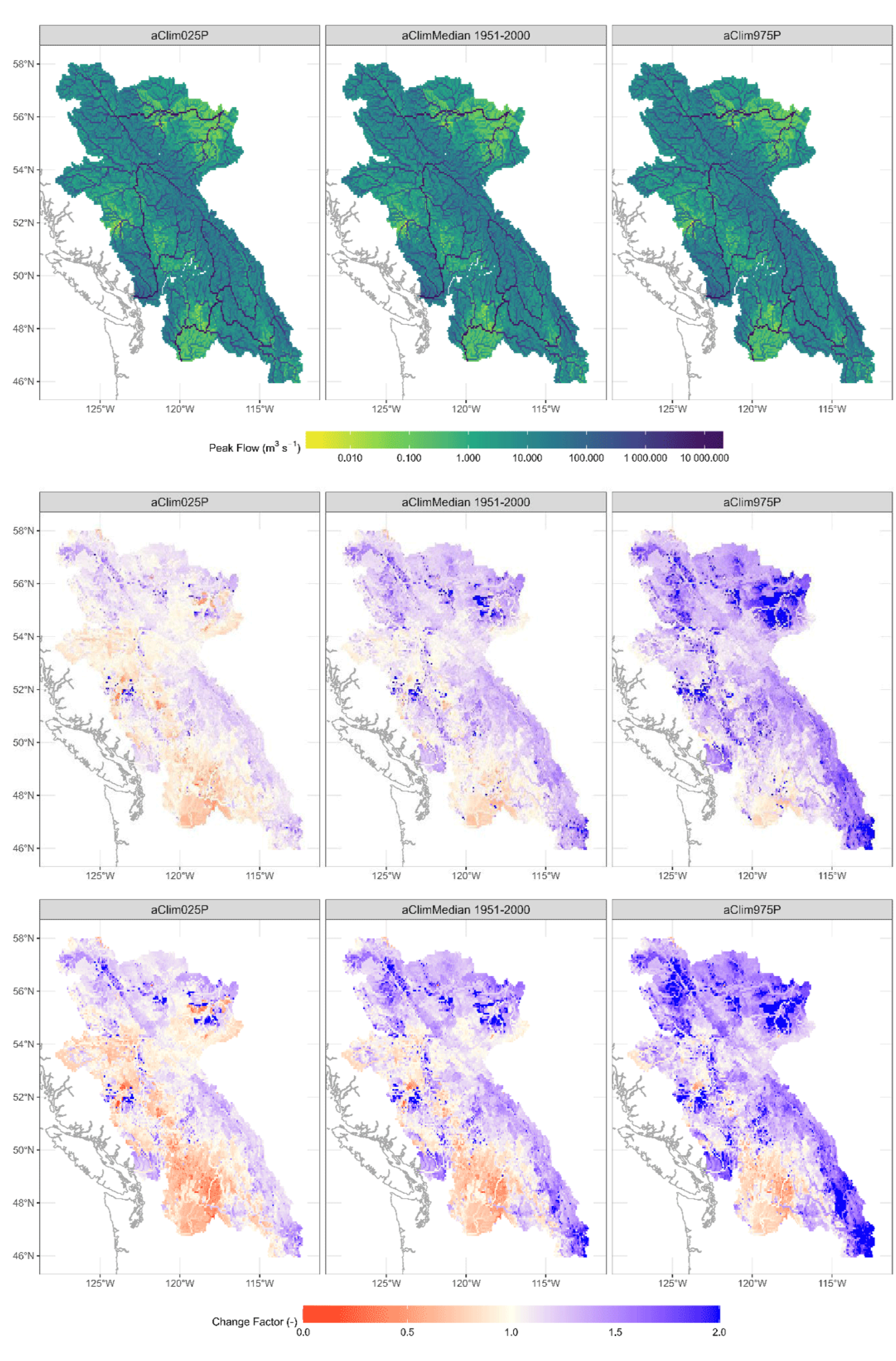

Figure 4: This figure shows the absolute value of annual peak flow during the 1951-2000 period (top row) and change factors in annual peak flow magnitude for 100-year return period events for 2041-2070 (middle row) and 2071-2100 (bottom row) compared to a baseline period (1951-2000). The maps cover the Peace, Fraser and Upper Columbia basins.

Partnering with the British Columbia Ministry of Transportation and Infrastructure (BC MoTI), PCIC researchers quantified design flood values (for 2-, 20-, 50-, 100- and 200-year events) for historical and future periods over a region including the Peace, Fraser and Upper Columbia basins (Figure 4), and made these values accessible as a gridded product via our online Climate Explorer tool. PCIC's research team also completed a pilot study to explore and develop metrics to describe extreme low river flow in the Nicola Basin. This work is intended to allow engineers to incorporate climate change considerations into their infrastructure design process.

The design flood values were developed using simulations conducted with the Variable Infiltration Capacity model with glaciers (VIC-GL). This hydrologic model was driven by statistically downscaled climate model output from the Canadian Earth System Model (version 2) 50-member large ensemble (CanESM2-LE), which allows the direct counting of rare, extreme high-streamflow events, from which return periods can be estimated. Design flood values for each high-resolution grid cell (an area of approximately 30 km^2) are based on streamflow that enters from the area upstream of the selected cell. This means the size of areas ranges from one grid cell to the full 665,000 km^2 of the catchment. These flood design values were provided for discrete 30-year windows from 2015 to 2085 (for example, from 2041-2020 and from 2071-2100; Figure 4).

Since conditions of hydrologic drought are also of interest, PCIC's hydrologists also conducted a low-flow frequency analysis of the Nicola Basin in south-central BC. This pilot study estimated low-flow metrics based on annual minima of seven-day average flow for return periods of 2-, 5-, 10-, 20-, 50-, and 100-years. Again, the use of the downscaled CanESM2 large ensemble permits the counting of rare, extreme low-flow events within the same future periods. The results of the analysis show that the response of extreme low flow to climate change varies between locations and between return periods. Much of this variability is due to the occurrence and relative importance of different types of low flow events, which can occur in both winter (low runoff due to precipitation stored as snow) and summer (low runoff due to low rainfall).

Supporting Climate Preparedness in Small BC Communities

PCIC is pleased to announce its partnership in the CONEXT Climate Preparedness Hub. CONEXT is a climate adaptation training program designed to empower community leaders in small, rural, and remote communities across British Columbia. These communities are aware of their exposure to current and projected future climate change impacts, but often possess extremely limited resources to prepare and adapt. CONEXT aims to build an understanding of potential climate impacts in these communities and also to translate this knowledge into actions than can be taken to help build climate resilience.

PCIC has provided key support to the CONEXT project by way of curriculum development and workshop materials, including a resource hub accessible to all of the communities, and by facilitating training sessions for the first-year cohort in the program. PCIC's engagement and training team is the lead facilitator for a dedicated session on *Ways of Understanding and Communicating Climate Change*, which introduces participants to future climate projections and how they can be used with other sources of information to inform long-term planning. Over the coming year, our team will continue its contributions to this project as it engages with a second cohort of BC communities.

Two PCIC Scientists Again Recognized as Highly-Cited Researchers

PCIC scientists continue to make significant contributions to their fields of study. Recently, PCIC Director Dr. Xuebin Zhang and PCIC Scientist Emeritus Dr. Francis Zwiers were again recognized by Clarivate for the significance and influence of their research.

Each year the Institute for Scientific Information at Clarivate compiles a list that honours the top researchers in their domains, as determined by citations of their work over the past decade, qualitative analysis by the Clarivate team and expert judgement. This exercise focuses on those researchers who have contributed work that has had significant impact both within their fields and across disciplines. Clarivate characterizes the researchers that they recognise as, "one in one-thousand." This marks Dr. Zwier's seventh year on the list and Dr. Zhang's fourth.

In addition, Dr. Zhang was recently inducted as a Fellow of the American Meteorological Society (AMS). New Fellows are elected annually by the AMS Council from a slate submitted by the Fellows Committee and are only eligible after making an outstanding contribution to their fields over a substantial period of years.

STAFF PROFILE: LONI FEFFER

Loni Feffer joined PCIC as our new Indigenous Communities Climate Knowledge Translator in August of last year. She brings her experience in supporting Indigenous language revitalization at the First Peoples' Cultural Council to this role. Reflecting on this experience, she says, "I learned a lot while there. All of my coworkers were linguists and I enjoyed hearing about the diversity of languages that we have in the region." With a BA in environmental studies and anthropology, Loni is interested in the ways that both western science and local and Indigenous Knowledge systems fit together to address climate change.

As a member of PCIC's user engagement and training team, Loni has been contributing to the CONEXT project (described in the story above), and has been busy making connections with Indigenous organizations and First Nations in BC, and also their partners in government, to discover how PCIC might best support their needs for climate-related expertise. By building these relationships, we hope to facilitate the two-way exchange of environmental knowledge and thereby learn how PCIC can best assist Indigenous communities. Asked what her favourite parts of this work are, Loni replied with, "finding all the commonalities folks share in terms of goals, vision for the future and community. Also, hearing about the good work that people are already doing and seeing where we can fill in each other's gaps in knowledge, skills and capacity."

THE PACIFIC CLIMATE SEMINAR SERIES

The Pacific Climate Seminar series resumed on October 23rd, with a presentation by Dr. Mike Flannigan from Thompson Rivers University who spoke on, *Climate change and wildfires in BC– a hot and smoky future?* This was followed by a seminar by Dr. Duo Chan from the University of Southhampton, who delivered his talk, *Improved Homogenisation of Observations Shows Steadier and Faster Historical Global Warming* on November 27th.

This year's seminar series began with a presentation by Dr. Alex Cannon from Environment and Climate Change Canada on January 29th, titled, *Towards thunderstorm projections for Canada using machine learning and HighResMIP climate model simulations*. This will be followed by a seminar at the end of February by PCIC's Dr. Tong Li on the topic of constrained projections. At the end of March, Dr. Nathan Lenssen from the Colorado School of Mines will speak about multi-year ENSO predictability, while Dr. Stephan Gruber will close the series at the end of May by sharing his work on Canadian and global permafrost. More information on these will be provided through our site and mailing list in the coming weeks.

- Read more about Dr. Cannon's talk.
- Read more about Dr. Flannigan's talk and watch it online.
- Read more about Dr. Chan's talk and watch it online.

PCIC STAFF NEWS

With our Content Development and User Engagement Coordinator, Izzy Farmer, starting maternity leave in December, we were happy to welcome Ed Beard into that role. Working as part of the Regional Climate Impacts team, Ed is focused on developing effective and innovative ways of sharing climate insights from PCIC and beyond with our extremely diverse climate service audience. He brings his recent experience working in environmental research and policy at the national and regional levels of government in the UK to his new role at PCIC.

In December of 2024, PCIC said a bittersweet goodbye to our Administrative Assistant Teresa Rush. Teresa joined us in 2021 and was vital in the facilitation of PCIC's day-to-day operations. We wish Teresa all the best in her retirement.

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