



**CORPORATE
REPORT**

2011-2012



**PACIFIC CLIMATE
IMPACTS CONSORTIUM**

YEAR IN REVIEW 2011-2012

The 2011-2012 PCIC Corporate Report highlights some of PCIC's achievements in providing regional climate services. The report serves as a high-level look at the past year. More detailed information can be found on the PCIC website and specific publications can be found in the PCIC publications library, at: <http://pacificclimate.org/resources/publications>.

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PCIC is a regional climate service centre at the University of Victoria that provides practical information on the physical impacts of climate variability and change in the Pacific and Yukon Region of Canada.

We collaborate with climate researchers and regional stakeholders to produce knowledge and tools in support of long-term planning.



University
of Victoria



PACIFIC CLIMATE
IMPACTS CONSORTIUM

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Renata Kurschner (Vice Chair), BC Hydro

Pierre Baril, Ouranos

Don Barnhardt, University of Victoria

Gayle Gorrill, University of Victoria

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Francis Zwiers (Director, President and CEO), Pacific Climate Impacts Consortium

Cassbrea Dewis (Treasurer), Pacific Climate Impacts Consortium

Jamie Millin (Secretary), University of Victoria

Program Advisory Committee (March 2012)

Thomas White (Chair), BC Ministry of Environment

Daniel Caya, Ouranos

Greg Flato, Environment Canada

Brenda Goehring, BC Hydro

Dirk Nyland, BC Ministry of Transportation and Infrastructure

Stephanie Smith, BC Hydro

Dave Spittlehouse, BC Ministry of Forests, Lands and Natural Resource Operations

Andrew Weaver, University of Victoria

Staff (March 2012)

Francis Zwiers, Director, President and CEO

Andrew Weaver, Senior Scientist

Faron Anslow, Climatologist

David Bronaugh, Programmer/Analyst

Gerd Bürger, Climate Scientist

Alex Cannon, Research Climatologist

Cassbrea Dewis, Lead, Planning & Operations

Hailey Eckstrand, GIS Analyst

James Hiebert, Lead, Computational Support

Hannah Imhof, Research Assistant

Shelley Ma, Administrative Assistant

Trevor Murdock, Lead, Regional Climate Impacts

Paul Nienaber, Programmer/Analyst

David Rodenhuis, Associate Climatologist

Markus Schnorbus, Lead, Hydrologic Impacts

Rajesh Shrestha, Hydrologist

Michael Shumlich, Scientific Information Specialist

Stephen Sobie, Regional Climate Impacts Analyst

Arelia Werner, Hydrologist



MESSAGE FROM THE CHAIR, BOARD OF DIRECTORS, DR. HOWARD BRUNT

At the University of Victoria, addressing real-world problems with practical, state-of-the-art solutions has always been at the very heart of our research mission.

The enclosed corporate report highlights PCIC's success in providing regional climate services to British Columbians and, as the Chair of the Board of Directors, I am delighted to see our staff and management's continued dedication to service excellence. Governance of PCIC is provided by a volunteer board representing a diversity of backgrounds and qualifications. All members of the board are dedicated to the PCIC mission and committed to supporting this unique organization's maintenance of both effectiveness and accountability.

This year PCIC chartered a new, comprehensive path in the PCIC Strategic Plan for 2012-2016: providing user-motivated climate science. Both ambitious and practical, this plan sets corporate priorities for the next five years and outlines PCIC's service objectives to its users, reflecting a mature corporation that understands its capacity and what it takes to deliver state-of-the-science results to users.

Under the leadership of Director Dr. Francis Zwiers, PCIC has established itself as a trailblazer in applied climate science and regional climate service delivery. In 2011, PCIC hosted a workshop on the latter topic and I had the pleasure of opening the meeting and welcoming nearly 100 participants from around the world. An overwhelming success, this meeting brought together climate service providers, researchers and stakeholders—ensuring the continuation of a national discussion on climate services. For example, PCIC was invited to present its vision for regional climate services at the annual Canadian Meteorological and Oceanographic Society congress this past May. PCIC exemplifies applied climate research and its practical application. Given these attributes, I believe that the consortium is a remarkable asset in a province with such a diverse climatology and robust natural resource economy as BC.

We look forward to tackling new ideas, leveraging common goals and even more knowledge transfer and collaborative climate service delivery in the future.

Howard Brunt
Chair, PCIC Board of Directors
Vice-President Research, University of Victoria



PCIC Board of Directors (left to right): Cassbreea Dewis, Francis Zwiers, Pierre Baril, Tom Pedersen, Howard Brunt, Don Barnhardt, Gayle Gorriil, Renata Kurschner and Jamie Millin. (Not pictured: Robert Lipson, James Mack, Asit Mazumder, Terry Prowse and Jim Standen.)



MESSAGE FROM THE CHAIR, PROGRAM ADVISORY COMMITTEE, THOMAS WHITE

It is once again my pleasure to invite you to read about some of the Pacific Climate Impact Consortium's impressive accomplishments over the past year. PCIC's clearly defined applied research program and the service ethic and professionalism of its staff make it indispensable for anyone in British Columbia working to understand and prepare for the impacts of climate change.

Some highlights of this past year include:

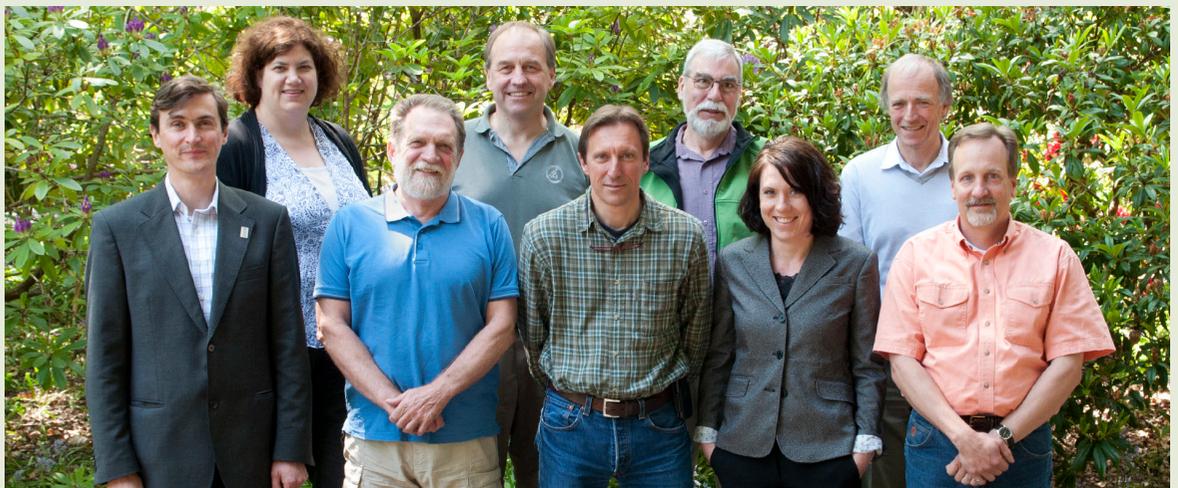
- Completion of a new strategic plan and research plans for each of PCIC's three applied themes - Regional Climate Impacts, Hydrologic Impacts and Climate Analysis and Monitoring. With these in place, PCIC has clearly defined the path to achieving its research goals over the next five years.
- Co-hosting, with Germany's Institute for Coastal Research, an international workshop on Regional Climate Services at the University of Victoria.
- Updating key resources, such as the Plan2Adapt website, and developing new ones, like the Data Portal, that will provide users with access to the extensive meteorological information collected by the province as part of its Climate Related Monitoring Program.
- PCIC staff delivered more than 30 presentations at local, national and international conferences, produced 41 publications, including journal articles and project reports, and collaborated with 34 local governments, provincial ministries and other partners to help them understand climate change in the region, and what it might mean for their business.
- Welcoming new additions to the PCIC team: Faron Anslow, Climatologist, Alex Cannon, Research Climatologist, Shelley Ma, Administrative Assistant and Michael Shumlich, Scientific Information Specialist.

These are but a few examples of the exciting work that has taken place at PCIC over the past year. You will find more details about these and other exciting projects and initiatives in the pages of this Corporate Report 2011-2012. Sincerely,

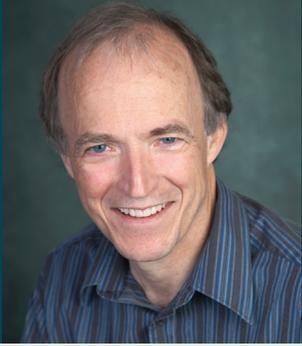
Thomas White

Chair, PCIC Program Advisory Committee

Manager of Science and Adaptation, Climate Action Secretariat, Ministry of Environment



PCIC Program Advisory Committee (left to right): Thomas White, Stephanie Smith, Dave Spittlehouse, Andrew Weaver, Daniel Caya, Dirk Nyland, Cassbreea Dewis (Secretary), Francis Zwiers (Director, President and CEO) and Greg Flato. (Not pictured: Brenda Goehring.)



MESSAGE FROM THE PCIC DIRECTOR, DR. FRANCIS ZWIERS

This annual corporate report, PCIC's 4th, demonstrates just how far the organization has come since being incorporated under the PCIC name in 2008. PCIC, as an organization, has matured and attained a vigorous and healthy steady state. It has a steadily increasing profile as a respected provider of climate information that is backed by significant increases in its depth of expertise and breadth of capabilities. Its unique nature is being recognized within the Province, nationally and also internationally. As an example, I recently gave an invited keynote address on PCIC at Australia's "Climate Adaptation in Action 2012" Conference.

During the past year we have carefully positioned PCIC as an authoritative regional climate service provider with the capacity to undertake applied research where that is needed to facilitate its service delivery objectives. These objectives have been clearly articulated in a new strategic plan, and the investments in applied climate science that are required to achieve those objectives have been succinctly stated in three newly developed research plans covering PCIC's three main themes.

However, we have done much more than planning during the past year. PCIC has delivered climate information to a broad range of users, spanning the gamut across the public sector and including users in the private sector. It has also developed substantial new on-line service delivery capabilities, and it has implemented a system to assure the quality of the products and services that are being delivered. This is achieved through an ongoing process of external peer review and by the publication of PCIC's scientific innovations in the peer-reviewed literature. Indeed, all of the reports and papers that are listed in this report have been subject to this process.

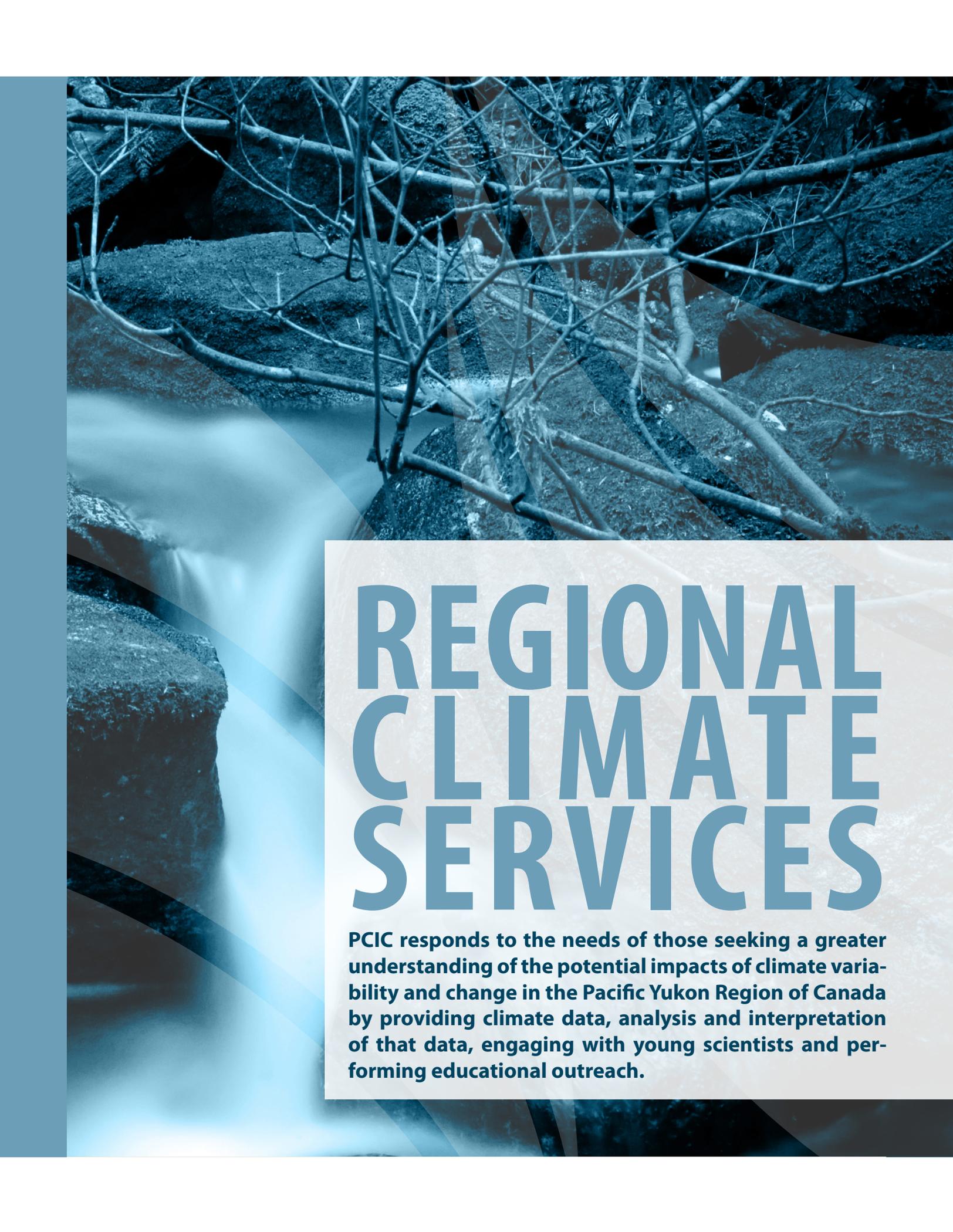
Climate events around the world, including the recent flooding in the Shuswap, North Okanagan and Kootenay regions, underscore the continuing need in the Province for reliable climate information that will help BC adapt to both current and future climate variability and change. PCIC will continue to serve the Province by satisfying that need, and is making strategic investments in capabilities and expertise that will enable us to do so over the long term.

Francis Zwiers

Director,
Pacific Climate Impacts Consortium



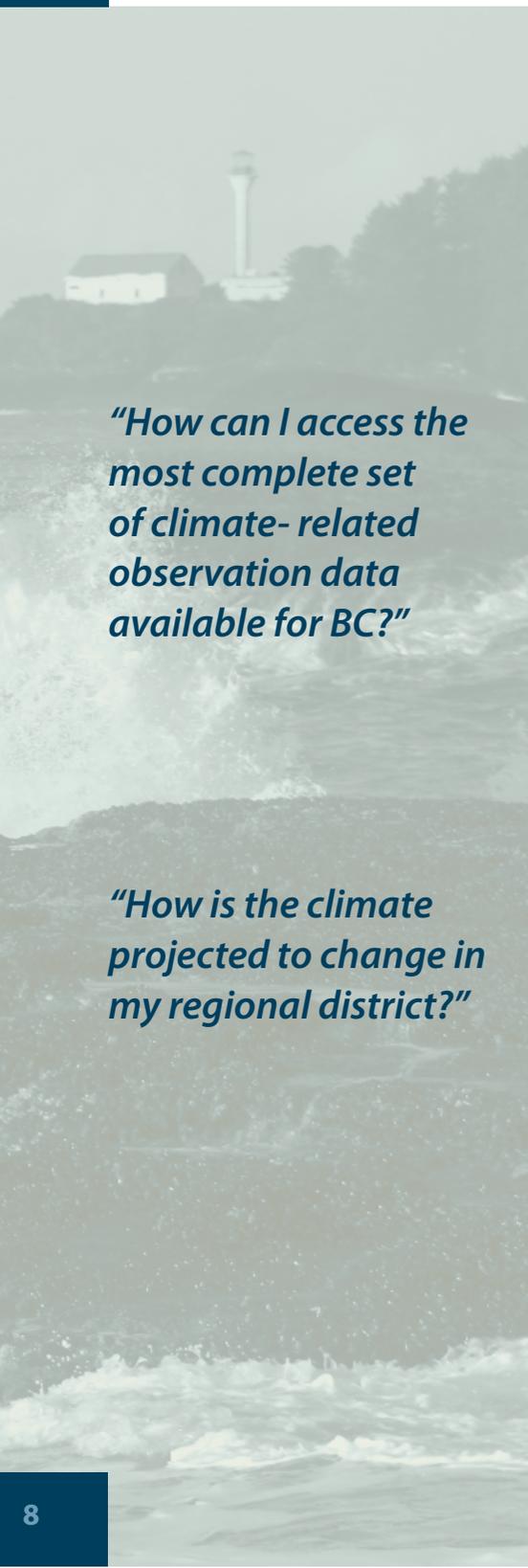
PCIC staff (left to right): Rajesh Shrestha, David Rodenhuis, Francis Zwiers, Trevor Murdock, Faron Anslow, Hailey Eckstrand, David Bronaugh, Stephen Sobie, James Hiebert, Hannah Imhof, Cassbreea Dewis, Paul Nienaber, Shelley Ma, Gerd Bürger, Alex Cannon and Markus Schnorbus. (Not pictured: Michael Shumlich).



REGIONAL CLIMATE SERVICES

PCIC responds to the needs of those seeking a greater understanding of the potential impacts of climate variability and change in the Pacific Yukon Region of Canada by providing climate data, analysis and interpretation of that data, engaging with young scientists and performing educational outreach.

PROVIDING DATA CLIMATE OBSERVATIONS AND FUTURE CLIMATE PROJECTIONS



“How can I access the most complete set of climate-related observation data available for BC?”

“How is the climate projected to change in my regional district?”

PCIC DATA PORTAL AND PROVINCIAL CLIMATE DATA SET

PCIC has developed an easy-to-use internet service, the PCIC Data Portal, that provides access to the Provincial Climate Data Set (PCDS). The PCDS is a collection of station data held in PCIC’s archives. Its development arose from a data sharing agreement between several BC ministries, BC Hydro, Rio Tinto Alcan, and PCIC. The data includes observations of weather variables such as temperature, humidity, precipitation, and wind speed from more than 6,000 locations and spanning more than 140 years in some instances. The portal will be continually updated with data gathered in near real time from Environment Canada and some BC ministries (including the Ministry of Transportation, Ministry of Forests Lands and Natural Resource Operations, and Ministry of Agriculture) thus ensuring that weather observations made in BC will contribute to everyone’s understanding of climate in the province as it continues to evolve.

Data provision is an important PCIC service; this year our hydrologists processed and delivered hydrologic modelling data to various users, including consultants, government researchers and researchers working for other organizations. In the future this data will be available through the PCIC Data Portal.

www.pacificclimate.org/tools-and-data/data-portal

PLAN2ADAPT UPDATE

Plan2Adapt is a tool for assessing regional climate change throughout BC that has been developed by PCIC specifically with the nonspecialist in mind. The recently updated version includes three major upgrades. First, the maps have been improved – users can now zoom and pan the map windows, overlay layers such as parks, and click on the map to see historical and future projected values. Second, the regional districts have been updated to their current boundaries and new region types, such as regional health authorities, have been added. Finally, the impacts tab that provides a list of possible impacts based on the projected climate change for the region of interest has been updated and peer reviewed. This list of impacts is intended to provide a starting point for more detailed local assessments of climate change impacts.

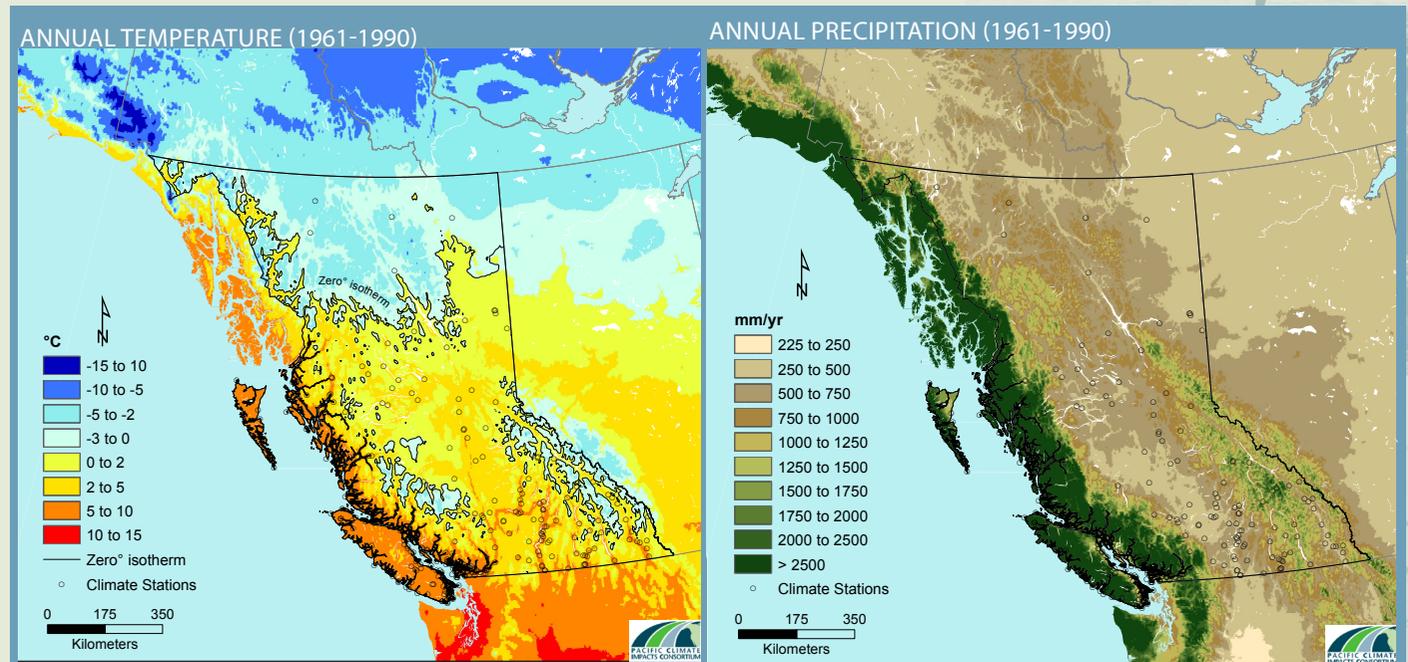
www.pacificclimate.org/tools-and-data/plan2adapt

PACIFIC CLIMATOLOGY

PCIC is mapping the climate of BC at very high resolution using state-of-the-art technology in collaboration with the Pacific Institute for Climate Solutions (PICS), Oregon State University (OSU) and the BC Ministry of Environment. The first major milestones in this project are now complete with the assembly of the necessary data, and with PCIC and OSU establishing the mapping domain and the process for quality controlling station climatologies. The two maps below demonstrate the style of products that will be created, but the new products will be available at a much higher resolution than currently available climate maps for BC. Presently, PCIC is capable of mapping the climatology to a 4 km resolution based on the stations shown in the maps below using the 1961-1990 climatology. The project with OSU will enable us to increase the resolution to 800 metres, based on a larger number of stations from the Provincial Climate Data Set and using an updated climatology (1981-2010). Future work will also produce high resolution maps on a monthly timescale. The new maps will be made available through the PCIC Data Portal.

www.pacificclimate.org/tools-and-data/data-portal

“What is the climate baseline for my area?”



The left map above shows annual temperature averaged over the 1961-1990 period; the right map above shows the annual precipitation averaged over the same period.

PROVIDING ANALYSIS

IMPACTS OF CLIMATE VARIABILITY AND CHANGE ON REGIONAL CLIMATE AND WATER RESOURCES

“What are the future impacts of a changing climate on BC’s Fraser River?”

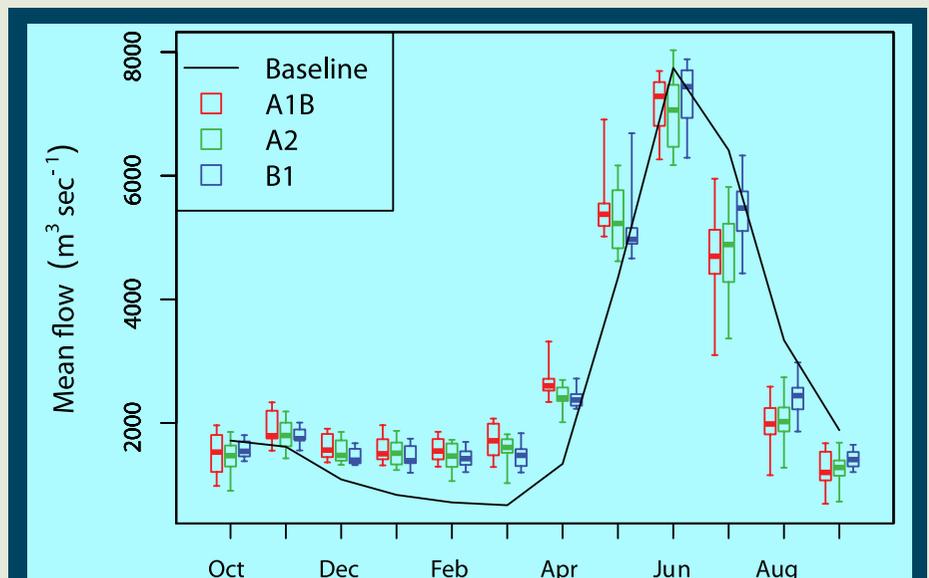
HYDROLOGIC PROJECTIONS FOR THE FRASER RIVER BASIN

The Fraser River Basin is home to about 63% of BC’s population. In basins, such as the Fraser, where the hydrologic regime is dominated by snow accumulation and melt, climate change can have a profound effect on freshwater timing and quantity. This has major implications for water supply, hydro-power generation, public safety and fisheries health. To study the hydrologic regime in the basin, PCIC hydrologists applied a statistical downscaling method on global climate model output, then used this downscaled output to drive a hydrologic model. This work has been published as *Modelling spatial and temporal variability of the hydrologic impacts of climate change in the Fraser River basin, British Columbia, Canada*, in the journal *Hydrological Processes*. PCIC’s analysis suggests that the region could experience earlier onsets of peak discharge, with increased spring and winter flow and decreased summer flow. This is illustrated in the plot of the historic and projected future flows for the Fraser-Hope hydrometric station, below.

This method had been employed previously to assess the projected climate-induced hydrologic changes in the Colombia, Campbell and Peace River Basins. PCIC hydrologists are now preparing to apply the same method to additional river basins in the Pacific and Yukon Region of Canada.

To meet the growing demand for information on extreme events, PCIC hydrologists undertook an analysis of projected changes in streamflow extremes (annual peak) at various locations throughout the Fraser Basin. The analysis suggests that there will be a decrease in the magnitude of peak-flows for most locations in the Fraser Basin in the future.

www.pacificclimate.org/resources/publications



The hydrograph box plot above shows the baseline (1970s) and future (2050s, for three emissions scenarios) flow response for the Fraser-Hope hydrometric station. Winter and spring flow are projected to increase while summer flow is projected to decrease and the mean annual peak flow is projected to occur earlier in the season. The box plot is set up such that the band in the middle of the box is at the median (50th percentile) value of mean flow, the top and bottom are at the 75th and 25th percentile, respectively, and the ends of the whiskers are at the upper and lower limits for the 30-year means of the GCM ensembles.

DOWNSCALING INTERCOMPARISON

As a regional climate service centre, PCIC must tackle the challenge of downscaling large-scale global climate models to provide future climate projections that are relevant at the local scale and suitable for driving PCIC's hydrologic model. Two years ago, PCIC climate scientists set out to test several different methods for their accuracy in particular locations throughout BC. This project, which evaluated the skill of downscaling techniques in simulating climate extremes, found that: (1) most of the techniques tested show some skill at representing past climate extremes, and (2) the two main downscaling techniques used by PCIC showed the best performance. This research has been published in the *Journal of Climate* as *Downscaling extremes - an intercomparison of multiple statistical methods for present climate*. In addition to validating skill based on historical climate, several methods were used to project climate change and extremes into the future as well. Most of the techniques tested produced consistent future climate projections. The findings of this second phase of the project have also been submitted to the *Journal of Climate*.

www.pacificclimate.org/resources/publications

PUBLICATION OF HYDROLOGICAL IMPACTS WORK

A substantial amount of effort during the 2011/12 period was spent in the preparation and completion of various publications documenting the methods, analysis and results of three major projects that formed the basis of the Hydrologic Impacts program: Hydrologic Modelling, Regional Climate Modelling Diagnostics, and Synthesis. These papers dealt with the use of the Variable Infiltration Capacity (VIC) hydrologic model to assess effects of projected climate change within the Peace, Campbell and upper Columbia River watersheds, based on global climate projections used in the IPCC 4th Assessment Report. Work during this period also saw the completion of a high-level summary report of the results of the Hydrologic Impacts program.

www.pacificclimate.org/resources/publications

ANALYSING CLIMATE EXTREMES

PCIC undertook and completed its first two regional analyses of climate extremes, an important step in the provision of knowledge and tools to serve community planning needs. Climate scientists used Regional Climate Models (RCMs) from the North American Regional Climate Change Assessment Program for this purposes. The first analysis focused on the Canadian Columbia Basin. The RCM historical simulations were evaluated and changes in indicators of climate extremes were analysed for the region. Another analysis of climate extremes was undertaken for the Georgia Basin region. Some of the details of these analyses are discussed on page 12.

“Are the downscaling methods that PCIC uses skilful when compared against other methods?”

“How will climate change affect hydrology and water resources in BC?”

“Can PCIC help me understand future potential climate extremes in my region?”

PROVIDING INTERPRETATION REGIONAL CLIMATE INFORMATION SPECIFIC TO USER NEEDS

“How will climate extremes change in the Columbia Basin?”

“Where can I find information on climate extremes for my local adaptation planning project?”

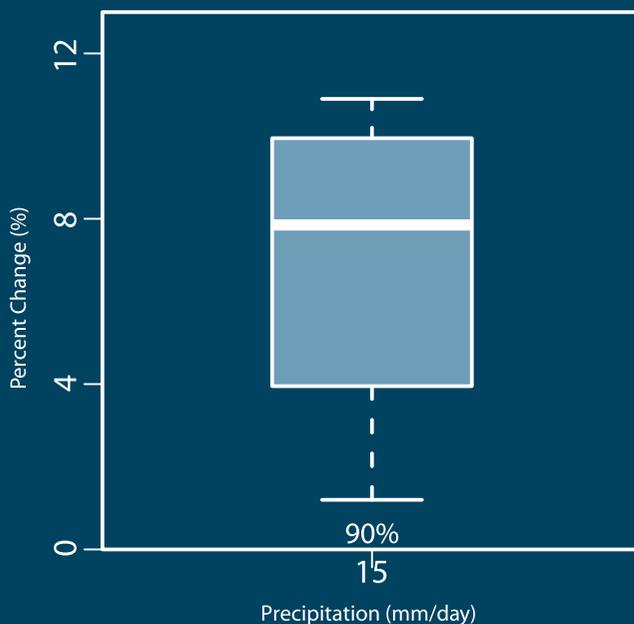
EXTREMES IN THE COLUMBIA BASIN

PCIC and the Columbia Basin Trust (CBT) have a long collaborative relationship. This year, PCIC provided the CBT with its most ambitious interpretive report to date—an analysis of climate extremes for the Columbia River Basin region. To ensure relevance to regional decision-making, PCIC solicited input from a team of CBT parties working on the CBT adaptation project through a series of webinars. This iterative and consultative approach was used so that the information provided would be useful to decision makers in the Basin.

www.pacificclimate.org/resources/publications

GEORGIA BASIN ANALYSIS OF EXTREMES

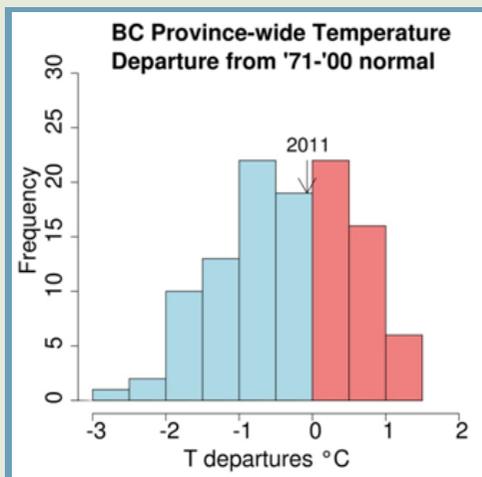
In the past, PCIC has worked directly with individual local governments to provide climate analysis in support of adaptation planning. This year, PCIC coordinated an innovative four-way partnership between PCIC, Natural Resource Canada, ICLEI-Local Governments for Sustainability, and several Georgia Basin Municipalities: the City of Victoria, the Capital Regional District, the City of North Vancouver, the City of Vancouver, the Corporation of Delta, the City of Surrey, and the Metro Vancouver Regional District. This project focused on a few selected indices of extremes, complemented by an analysis of historical climate at selected locations. Projections for the Georgia Basin indicate an increase in temperature, winter precipitation, precipitation extremes (as seen in the plot below) and those extremes associated with warm weather, and a decrease in summer precipitation and extremes associated with cold weather.



As part of the Georgia Basin Analysis of Extremes, PCIC climatologists looked at the future projections for the total precipitation from extreme weather events. This figure shows the results for rainfall from the North American Regional Climate Change Assessment Program model ensemble, for the Capital Regional District. This one box-and-whiskers plot shows changes in precipitation above the 90th percentile of rainfall as compared to the period of 1971-2000. The millimetre per day (mm/day) equivalent, as measured at the Victoria Airport, is also given. The box in the box-and-whiskers plots shows the range of the middle half of the data. The line in the middle of the box is the median value of the data and the whiskers extend to the largest and smallest data values. Future projections show a notable increase in the extreme precipitation events (greater than 15 mm/day or the 90th percentile).

PCIC SEASONAL CLIMATE REVIEWS

The PCIC Seasonal Climate Reviews provide information on seasonal weather variations. In what will eventually be a quarterly product, PCIC climatologists initiated the project this year focussing on temperature anomalies. “Why was this spring and early summer so cold in BC?,” published in Fall 2011, addressed the 2011 spring and summer cold weather anomaly and the perception that these seasons seemed much colder than average. In the *PCIC Update, Spring 2012*, PCIC Climatologists looked at the entire 2011 period and compared it with the past climate. A chart from this update, showing how 2011 compares to the past 111 years, appears below. Although the year was near normal in terms of annual mean daily temperature, a number of extreme and anomalous events occurred including record breaking precipitation in the northeast. The Seasonal Climate Reviews are published on the PCIC website.



The figure to the left is a histogram of annually averaged, province-wide temperature relative to the average period (1901-2011). The 2011 anomaly (shown with an arrow) indicates that 2011 would be considered a normal year, slightly on the warm side, compared to temperatures observed in other years between 1901-2011.

“How can I better understand the climate of British Columbia?”

“How do we apply projections of future climate to our adaptation project?”

PRESENTATIONS AND USER CONSULTATIONS

Successful transfer of knowledge about climate to users involves continuous dialogue between the users of climate information and climate scientists.

This year, PCIC scientists made over 20 presentations to user groups. Notably, PCIC presented to the BC Ministry of Environment, the BC Ministry of Transportation and Infrastructure, and to the City of Victoria and other regional partners. The presentations, geared directly at the user-specific audience, facilitate the interpretation of climate science for users’ needs.

Through our dialogue-based approach to climate service provision, PCIC works directly with a variety of stakeholders from government to private industry to provide the type of interpretation that they need for future planning. PCIC scientists always make the effort to be available to users to answer questions and provide advice.

COMMUNICATION AND EDUCATION

PCIC is committed to promoting a deeper societal understanding of applied climate science and engaging with young academics.

ENGAGING YOUNG SCIENTISTS

In the past year PCIC was lucky enough to have three promising young scientists spend time at the PCIC offices as visiting scientist and interns.

Ester Salimun, a PhD student at the National University of Malaysia, was a guest at PCIC for two and a half months. Her research examining sea surface temperature influences on climate variability in Malaysia was aided by the opportunity to make use of PCIC resources and those of the nearby Canadian Centre for Climate Modelling and Analysis (CCCma).

Oliver Krüger, a PhD student from the Institute for Coastal Research, Helmholtz-Zentrum Geesthacht in Germany, spent four months at PCIC further developing his research on the evaluation of the use of air pressure based proxies, such as geostrophic wind statistics, for describing past storm activity.

Hanna Imhof joined PCIC for a ten week internship after completing her BSc in Meteorology at the University of Munich. Her project at PCIC was to quality control and correct precipitation data in the Provincial Climate Data Set. After leaving PCIC, Hannah entered a Master's program in meteorology at the Karlsruhe Institute of Technology.

Through engaging with young scientists, PCIC staff have the opportunity to both share and gain valuable insights into the analysis of the climate system.

COMMUNICATING CLIMATE SCIENCE

PCIC stepped outside the box this year, working closely with PICS on an online course designed to help public servants and others understand the scientific causes of climate change. The first module of the course "Climate Science Basics", was unveiled in the summer of 2011 and followed by "Climate Insights: Bite Size," short videos that summarize the lessons of the course.

The concept for the online courses was born out of the realization that communicating the basic elements of climate science in a clear way, free of value statements is a necessary element of climate service provision. PCIC explored the role of climate service provision further by organizing a workshop on the topic in the autumn of 2011. The workshop focused on regional scale climate services and the challenge of communicating and applying climate science to real world problems.

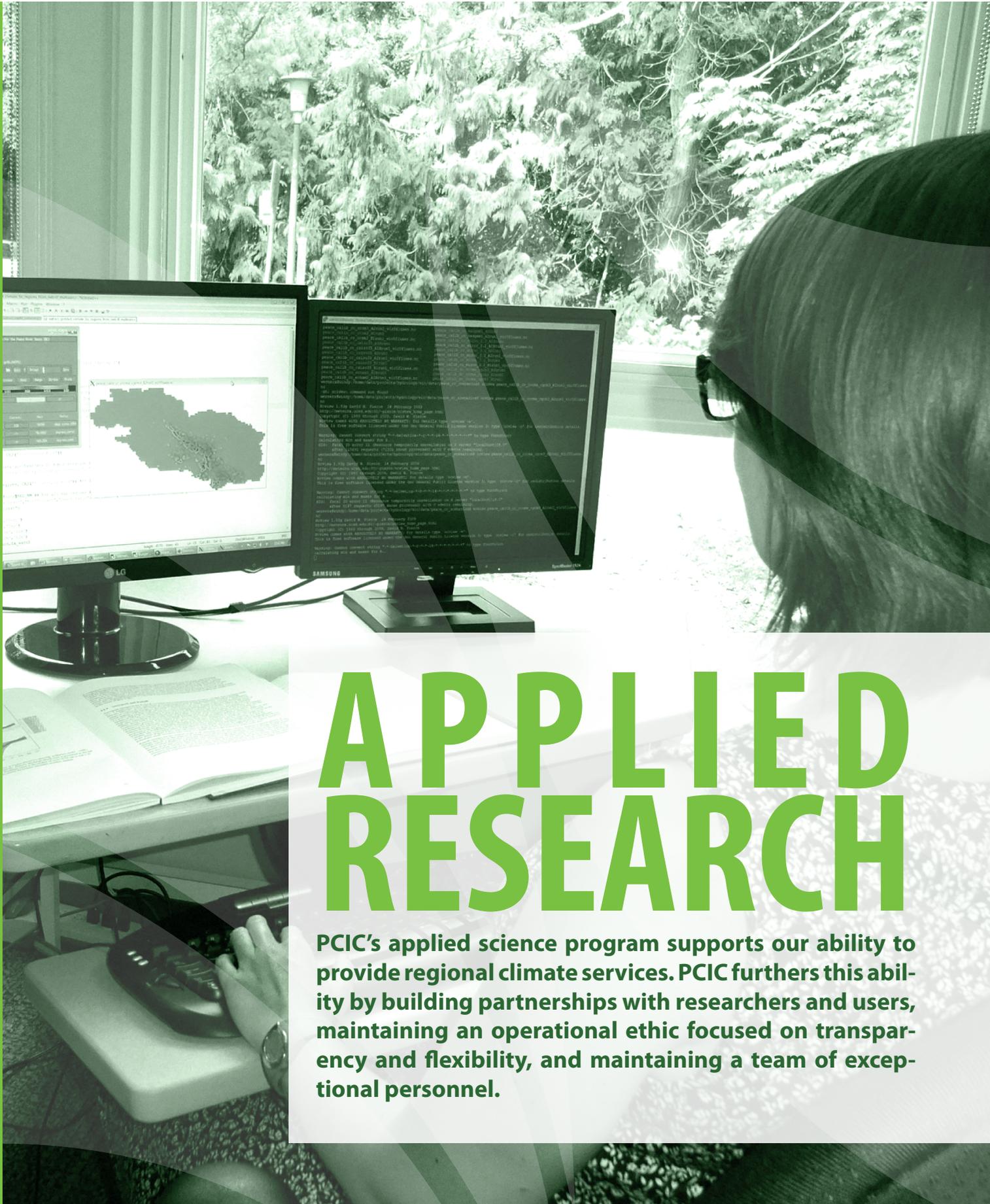
IdeaFest 2012

PCIC and PICS co-hosted a public lecture at the first annual UVic IdeaFest, an event designed to celebrate UVic research, scholarship and creativity. The lecture, "Climate Change and Food Security," was co-presented by Francis Zwiers, PCIC Director, and Dr. Aleck Ostry, UVic Professor in the department of Geography. The lecture explored how BC's climate has changed over the past century and how future changes likely to occur will relate to future of food security in BC.

Pacific Climate Seminar Series

PCIC and PICS continued our successful joint seminar series, the Pacific Climate Seminar Series. The monthly lectures are an opportunity to bring together climate researchers, stakeholders and members of the University community to hear about the latest in climate research from a broad-ranging list of speakers. Notable speakers from the past year included Dr. Dianna Allen, Simon Fraser University; Dr. Bill Crawford, Fisheries and Oceans Canada; Dr. Hans von Storch, Institute of Coastal Research, and Dr. Alan Hamlet, University of Washington.

<http://pacificclimate.org/seminars>



APPLIED RESEARCH

PCIC's applied science program supports our ability to provide regional climate services. PCIC furthers this ability by building partnerships with researchers and users, maintaining an operational ethic focused on transparency and flexibility, and maintaining a team of exceptional personnel.

DEVELOPING SCIENTIFIC AND INFORMATION RESOURCES

PCIC's applied science program supports our service objectives. Structured around the three PCIC themes, staff scientists, analysts, and programmers develop PCIC's scientific and information resources to ensure that PCIC is able to provide climate information using the most up to date techniques. PCIC's applied science work is held to the test of peer review through presentations, scientific congresses and publishing in journals.

PUBLISHING APPLIED RESULTS

PCIC published the results from its applied research extensively over the past year both in scholarly journals and other venues. PCIC staff published 29 journal articles and 12 PCIC reports. PCIC publications are available through the PCIC website and listed in the publications section of this report.

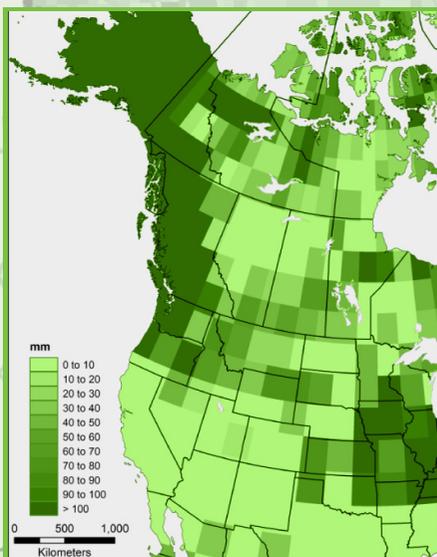
PCIC scientists delivered over 40 presentations at over 20 conferences and workshops locally, nationally and internationally.

VALIDATING CLIMATE INDICES

Understanding, analysing and attributing climate extremes is becoming increasingly important as stakeholders need to plan for extreme weather events and request more information on climatological extremes. The climate modelling community uses a standard suite of 27 indices formulated by the Expert Team on Climate Change Detection and Indices (ETCCDI) to describe and evaluate climate extremes. In collaboration with Environment Canada, PCIC programmer/analysts have completed an independent implementation and validation of an existing program used to compute the ETCCDI indices. PCIC's implementation has enabled these computationally intensive indices to be inexpensively computed across the entire globe. It has also furthered the community's understanding of the robustness, strengths and weaknesses of the ETCCDI indices. In the future PCIC's ETCCDI indices computations will aid in the interpretation of extremes within the context of the fifth phase of the international Coupled Model Intercomparison Project (CMIP5).

HIGH RESOLUTION HYDROLOGIC MODELLING

PCIC hydrologists explored the use of a new hydrologic model, the Water Flow and Balance Simulation Model developed by the Eidgenössische Technische Hochschule in Zürich (WaSIM-ETH), as a possible alternative, or complement, to the Variable Infiltration Capacity Macroscale Hydrologic Model (VIC model), which is used extensively at PCIC. The WaSIM-ETH hydrologic model was used to assess the effects of climate change in the upper Columbia headwaters (Columbia River at Donald). This model is capable of operating at significantly higher spatial resolution than the VIC model, and it has the capability to explicitly model glacier mass balance. However, the model's capabilities are very computationally intensive. For PCIC, this means the model is useful for case studies of individual basins in BC but too resource-intensive to run over the entire Pacific Yukon Region of Canada.



As part of PCIC's ongoing work to analyse climate extremes, PCIC climatologists examined future projections of precipitation extremes from the CanESM2 climate model. The map above indicates the annual total precipitation from those days on which precipitation exceeds the 99th percentile for wet days.

SEASONAL FORECASTING

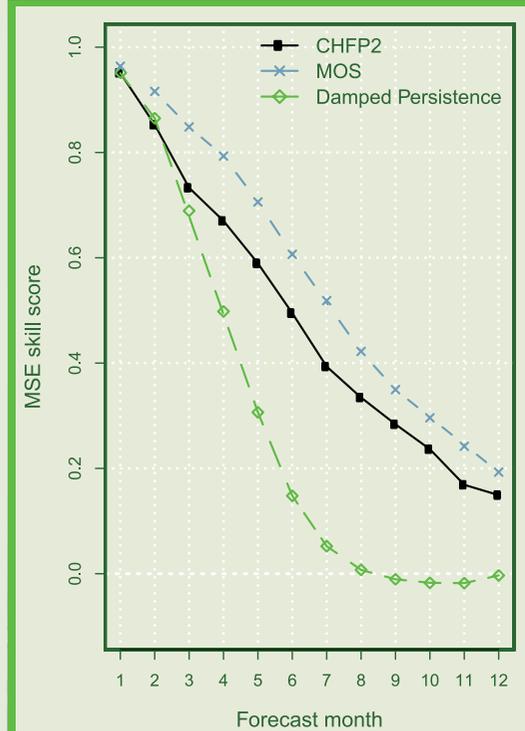
PCIC initiated the project “Predicting Climate Extremes on Seasonal to Decadal Time Scales” supported by a Contribution Agreement with Environment Canada’s Canadian Centre for Climate Modelling and Analysis (CCCma) during this year. The main goal of this project is to assess the skill of seasonal-to-decadal predictions of climate and hydrological extremes based on coupled model outputs from the CCCma, including those from the second Coupled Historical Forecast Project and CMIP5. A plot of hindcasts and observations from this assessment project, of forecast skill for sea surface temperature anomalies in the Niño 3.4 region of the Pacific Ocean is shown on the right.

In terms of seasonal hydrological predictions, work will focus on the creation of an experimental streamflow hindcast database. This database will include outputs needed to assess the sensitivity of the VIC model prediction system to downscaling methods, hydrological model calibration, and hydrological model initialization. Additional research into nonstationary extreme value analysis and related statistical and machine learning methods for post-processing coupled GCM outputs to estimate hydroclimatic extremes is also planned.

PROVIDING GUIDANCE ON CLIMATE SCENARIOS

The PCIC report, *Selecting and Using Climate Change Scenarios for British Columbia* is intended to assist those engaged in climate change impact, vulnerability and adaptation analyses by providing guidelines on how to choose climate scenarios, including the choice of appropriate spatial and temporal scales of the data and methods to use.

Although the focus is on BC, much of the material is applicable to regional climate change scenarios in other regions and it builds upon the Intergovernmental Panel on Climate Change’s (IPCC) guidelines for use of scenarios. The report discusses scenarios from the IPCC Fourth Assessment and includes descriptions of tools for data access that are readily available in BC.



The plot above shows that PCIC’s bias correction techniques can improve the skill of El Niño forecasts made with a state-of-the-art climate model. Because seasonal forecast skill in BC is dependent on our ability to predict El Niño events, improvements in seasonal El Niño prediction should translate into improvements in the forecast skill of climate variables here in BC.

Shown in the above figure is a measure of forecast ability called the Mean Squared Error skill score, for Pacific Ocean surface temperature anomalies in the Niño 3.4 region, located in the equatorial Pacific Ocean. Higher skill scores indicate a better forecast. The benchmark forecast is damped persistence (in which the current Niño 3.4 temperature anomaly is “damped” toward long-term average values). CHFP2 is an ensemble mean of forecasts made with a climate model participating in the Coupled Historical Forecasting Project’s second phase, and MOS is PCIC’s contribution, the model output statistics post-processing of CHFP2, which serves as a form of bias correction for the model output.

BUILDING PARTNERSHIPS

PCIC is committed to building partnerships that enable service delivery and support our applied science program. This includes partnering with users of our information and fostering a two-way dialogue. Equally important is leveraging research partnerships; exchanging expertise, data, climate model output, joint authorship on papers and reports and shared supervisory responsibilities for students and post doctoral researchers.

PACIFIC CLIMATE IMPACTS CONSORTIUM
Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung

Exploring Regional Climate Services: Meeting Stakeholder Needs for Practical Climate Information

November 21-23, 2011

University of Victoria
Michelle Pajot Room,
Student Union Building
Victoria, BC Canada

Pacific Institute for Climate Solutions
University of Victoria
KlimaCampus

REGIONAL CLIMATE SERVICES WORKSHOP 2011

REGIONAL CLIMATE SERVICES WORKSHOP 2011

The workshop “Exploring Regional Climate Services: Meeting Stakeholder Needs for Practical Climate Information” was held at the University of Victoria, on November 21-23, 2011. Its purpose was to stimulate discussion among climate scientists, climate service providers, communicators and regional climate stakeholders on the various ways in which climate information is communicated. Particular focus was placed on the role played by regional climate service providers like PCIC in mediating the transfer of knowledge from climate researchers to stakeholders.

In addition to over 30 presentations, workshop attendees took part in a collective authorship exercise whereby each was assigned to one of five writing groups tasked with exploring a workshop session theme. The purpose of these groups was to initiate the development of a draft workshop paper on regional climate service delivery for eventual submission to a peer-reviewed publication.

The workshop was jointly organized by PCIC and the Institute for Coastal Research, Helmholtz-Zentrum Geesthacht in Germany, with co-sponsors the Pacific Institute for Climate Solutions, the University of Victoria and KlimaCampus Hamburg.

SUPPORT FOR BC HYDRO

PCIC and BC Hydro signed a new four-year collaborative agreement to continue PCIC’s research efforts in support of the crown corporation’s long-term climate change adaptation plans.

This is the second agreement of its kind between the two partners. Between 2006 and 2010, PCIC’s Hydrologic Impacts group collaborated with BC Hydro on a set of projects aimed at better understanding the effects of climate variability and change on future streamflow for three major BC watersheds: the Upper Columbia River, Campbell River and Peace River. PCIC has since continued this work, publishing results in peer-reviewed journals, thus exposing them to careful scientific review.

PCIC has also extended the impacts analysis to include the Fraser River Basin and improved the capabilities of our hydrological modelling tools with the objective of adding a glacier component. In addition, PCIC provides BC Hydro staff with support and responds to requests for information and analysis, and will increasingly assist the corporation on broader adaptation issues, such as the potential for changes in forest fire risk, which has implications for the BC Hydro transmission system.



PRISM CLIMATE GROUP, OREGON STATE UNIVERSITY

This past year was the first full year of the three-year collaborative agreement between PCIC and the PRISM group at Oregon State University (OSU). The purpose of the collaboration is to transfer expert knowledge and technology from OSU to PCIC. The PRISM software transfer will ultimately result in PCIC's ability to produce high resolution climatological maps of precipitation and the maximum, minimum and mean temperatures for all of BC. Significant progress was made this year, gathering, organizing and reformatting data, conducting initial quality controls on the data and developing station averages. The project is now ready to begin initial production of new climatological maps.

PREPARING FOR THE FIFTH PHASE OF THE COUPLED MODEL INTERCOMPARISON PROJECT

PCIC has completed three research plans that guide the theme research programs. The research plans set a solid course for the next five-year period. We look forward to working with the results from the recent CMIP5 climate modelling experiments. The results from the experiments will be put to use, and applied to improving PCIC products.

To this end, PCIC is working closely with colleagues at Environment Canada in the Climate Research Division, and at the Canadian Centre for Climate Modelling and Analysis on the UVic campus.

OUTREACH AT GLOBE 2012

PCIC and our sister organization, the Pacific Institute for Climate Solutions (PICS), exhibited at the GLOBE 2012 Trade Fair in March. GLOBE 2012 was an opportunity for the two groups to promote the spectrum of insights that we offer, from educational short courses and research support (PICS) to regionally downscaled future climate projections and data provision (PCIC). Hundreds of GLOBE delegates visited the PCIC/PICS exhibit including national and international leaders in business and the environment.



MEOPAR

The Government of Canada announced funding awards to three new Networks of Centres of Excellence (NCE). The Marine Environmental Observation, Predication and Response Network (MEOPAR), one of the three, is based at Dalhousie University but brings together over 40 researchers from research universities across the country—including several University of Victoria scientists. MEOPAR will receive \$25 million over five years to carry out its mandate to address critical issues related to human activity in the marine environment and the impact of marine hazards in coastal regions.

PCIC Director Dr. Francis Zwiers was heavily involved in the successful MEOPAR NCE proposal. His research expertise in climate analysis and extreme event statistics will be combined with a suite of multidisciplinary partners with expertise in global and regional climate modelling, risk assessment, ocean modelling and data assimilation. A core project of the NCE, "Climate Change and Extreme Events in the Marine Environment" will address, among other questions, how the frequency and magnitude of extreme events are expected to change in coastal regions as climate changes.

This will eventually help to bolster PCIC's program of work, allowing a stronger focus on the BC coast.

A PhD student and postdoc are expected to take on aspects of the project under the supervision of Dr. Zwiers.

OPERATIONS AND FINANCES

As a not-for-profit corporation, PCIC is accountable to its Board of Directors, its stakeholders and the general public. We maintain a high degree of accountability in pursuit of operational excellence.

PCIC's ongoing focus on recruiting and retaining exceptional personnel, while maintaining operational flexibility and engaging with our professional communities is key to PCIC's success.

MAINTAINING LEADING EDGE EXPERTISE

At PCIC, we have a highly qualified staff of professionals, climate scientists, statisticians, hydrologists, computer programmers, communicators, and administrators. Our success rests on maintaining a critical mass of scientific expertise in order to be able to provide our users with authoritative and trustworthy climate information. This means that recruitment and retention of exceptional personnel while recognizing the need to maintain operational and programmatic flexibility is a key component to achieving operational excellence. This year we welcomed four new team members: Faron Anslow, Climatologist; Alex Cannon, Research Climatologist; Shelley Ma, Administrative Assistant and Michael Shumlich, Scientific Information Specialist.

PCIC's applied research relies heavily upon engaging with our professional communities. Occasionally, in pursuit of engagement, greater understanding and professional development, our staff members participate in professional workshops. Staff use the opportunity to promote PCIC's services and engage partners in the professional and research communities in areas of expertise such as specialized scientific computing and visualizations, statistical and dynamical climate downscaling, climate variability and analysis, and hydrologic modelling.

NEW LOCATION

Many months of planning and construction came to fruition on June 6, 2011, as PCIC and PICS moved into their new offices in University House 1. The building, formerly the Alumni House, was once the residence of the university president. It has been newly renovated, incorporating energy efficiency features, such as heat pumps, LED lighting and conservation-minded plumbing features.

Sharing the same building provides PCIC and PICS with even more opportunities to work closely together on climate-related projects of mutual interest.



MAINTAINING A LONG-TERM BUDGETARY OUTLOOK

Treasurer's Report 2012

-Cassbreea Dewis, Lead Planning and Operations

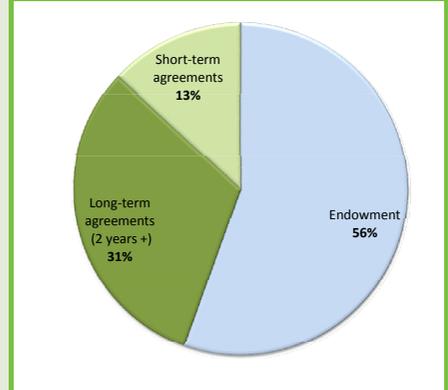
The financial results for the fiscal period 2011-2012 mirror the story told in the pages of this annual report. PCIC is successfully accomplishing innovative applied climate science that is motivated by user needs. New projects brought on this year, both long term and short term, support the diversification of PCIC's funding envelope and speak to PCIC's growing reputation as a reliable source for practical climate information. PCIC management maintains modest expenditures, an important element of a not-for-profit corporation. We focus nearly all our resources towards our most important asset, our professional staff. Partnerships with large research centres, stakeholder groups and government agencies allow PCIC to leverage our funding.

PCIC maintains a long-term budgetary outlook, anticipating a similar environment to that which has prevailed since 2008 when an endowment was granted to UVic to support PCIC and PICS. This includes continued funding to PCIC from the endowment, financial engagement by major stakeholders, strategic partnerships with other climate research organizations and climate information providers, and institutional support from UVic.

Within the assumed funding environment, PCIC plans to achieve its fiscal targets by leveraging the endowment revenue through strategic partnerships, fulfilling commitments of long-term agreements while remaining flexible and engaging in new opportunities, and continued to take on user-commissioned projects.

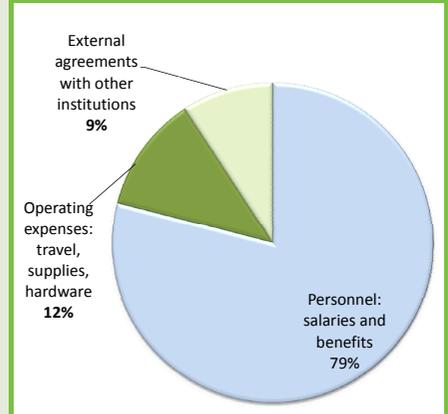
The recently published PCIC Strategic Plan lays out the next five years of service and operational excellence. One of PCIC's great strengths is that it has always been equally committed to both.

Revenue (2011/2012)



The figure above summarizes the proportion of revenue PCIC received through short term agreements, long term (over two years) agreements, and from a proportion of an endowment granted to UVic in 2008 to support PCIC and PICS.

Expenses (2011/2012)



The figure above shows proportional expenditures during 2011-2012.

PCIC PUBLICATIONS

PCIC publications are available from the PCIC Publications Library:
www.pacificclimate.org/resources/publications

- Anslow, F. S.**, 2012: Climate Analysis and Monitoring, Research Plan for 2012-2016. Pacific Climate Impacts Consortium.
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- Rodenhuis, D.**, B. Music, M. Braun and D. Caya, 2011: Climate Diagnostics of Future Water Resources in BC Watersheds. Regional Climate Modelling Diagnostics Project Final Report.
- Moore, R. D., G. Jost, G. K. C. Clarke, **F. Anslow**, V. Radic, B. Menounos, R. Wheate, **A. T. Werner**, and **T. Q. Murdock**, 2010: Glacier and Streamflow Response to Future Climate Scenarios, Mica Basin, British Columbia, Final Report Prepared for BC Hydro.
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- Pacific Climate Impacts Consortium**, 2011: PCIC Corporate Report 2010-2011.
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- Pacific Climate Impacts Consortium**, 2011: PCIC Update, Volume 4, Number 3.
- Pacific Climate Impacts Consortium**, 2012: Downscaling Intercomparison Project: Summary Report.
- Pacific Climate Impacts Consortium**, 2012: PCIC Strategic Plan 2012-2016.
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- Picketts, I.M., **A. T. Werner**, **T.Q. Murdock**, J. Curry, S.J. Déry, and D. Dyer, 2012: Planning for climate change adaptation. Pacific Climate Impacts Consortium, 2012: PCIC Update, Volume 5, Number 2.
- Schnorbus, M.**, K. Bennett, **A. Werner** and **A. Berland**, 2011: Hydrologic Impacts of Climate Change in the Peace, Campbell and Columbia Watersheds, British Columbia, Canada. Hydrologic Modelling Project Final Report (Part II).
- Shrestha, R. R.**, **A. J. Berland**, **M. A. Schnorbus**, and **A.T. Werner**, 2011: Climate Change Impacts on Hydro-Climatic Regimes in the Peace and Columbia Watersheds, British Columbia, Canada. Pacific Climate Impacts Consortium.
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- Schnorbus, M.**, 2012: Hydrologic Impacts, Research Plan for 2012-2016. Pacific Climate Impacts Consortium.
- Werner, A. T.**, 2011: BCSD Downscaled Transient Climate Projections for Eight Select GCMs over British Columbia, Canada.
- Werner, A. T.**, 2011: BCSD Downscaled Transient Climate Projections for Eight Select GCMs over British Columbia, Canada. Hydrologic Modelling Project Final Report (Part II).
- Zwiers, F.**, **M. Schnorbus**, and **G. Maruszeczka**, 2011: Hydrologic Impacts of Climate Change on BC Water Resources: Summary Report for the Campbell, Columbia and Peace River Watersheds.

PUBLICATIONS IN PEER-REVIEWED JOURNALS

Below is a list of the peer-reviewed publications from PCIC staff members for 2011-2012:

- Bürger, G.**, J. Schulla and **A.T. Werner**, 2011: Estimates of future flow, including extremes, of the Columbia River headwaters. *Water Resources Research*, 47 (W10520), 1-18.
- Cannon, A. J.**, 2012: Köppen versus the computer: comparing Köppen-Geiger and multivariate regression tree climate classifications in terms of climate homogeneity, *Hydrology and Earth System Sciences*, 16, 217-229.
- Cannon, A. J.**, 2012: Neural networks for probabilistic environmental prediction: Conditional Density Estimation Network Creation & Evaluation (CaDENCE) in R. *Computers & Geosciences*, 41, 126-135.
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- Curry, C. L., **D. van der Kamp**, and A. H. Monahan, 2012: Statistical Downscaling of Historical Monthly Mean Winds Over a Coastal Region of Complex Terrain: I. Predicting Wind Speed. *Climate Dynamics*, 38, 1281-1299.
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- Dibike, Y. B., T. P. Prowse, **R. R. Shrestha**, and R. Ahmed, 2012: Observed trends and future projections of the hydroclimatic regime of the Lake Winnipeg watershed. *Journal of Great Lake Research*, 38, 72-82.
- Hegerl, G.C., P.A. Stott, S. Solomon and **F.W. Zwiers**, 2011: Comment on Climate Science and the Uncertainty Monster by J. A. Curry and P. J. Webster. *Bulletin of the American Meteorological Society*, 92 (12), 1683-1685.
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- Hoegh-Guldberg, O., G. Hegerl, T. Root, **F. W. Zwiers**, P. Stott, D. Pierce, and M. Allen, 2011: Reply to: "Overstretching attribution" by Parmesan et al. (2011). *Nature Climate Change*, 1.
- Jenkner, J., W. W. Hsieh, and **A. J. Cannon**, 2011: Seasonal modulations of the active MJO cycle characterized by nonlinear principal component analysis. *Monthly Weather Review*, 139 (7), 2259-2275.
- Lane, O., S. Cohen and **T. Q. Murdock**, 2011: Climate Change Impacts and Adaptation in the Canadian Columbia River Basin: A Literature Review, University of British Columbia / Environment Canada.
- Min, S. K., X. Zhang, **F. W. Zwiers**, and G. C. Hegerl, 2011: Human contribution to more intense precipitation events. *Nature*, 470, 378-381.
- Pellatt, M. G., S. Goring, K. M. Bodtker, and **A. J. Cannon**, 2012: Using a down-scaled bioclimate envelope model to determine long-term temporal connectivity of Garry oak (*Quercus garryana*) habitat in western North America: implications for protected area planning. *Environmental Management*, 49 (4), 802-815.

PUBLICATIONS IN PEER-REVIEWED JOURNALS, CONTINUED

- Picketts, I. M., **A. T. Werner**, **T. Q. Murdock**, J. Curry, S. J. Dery and D. Dyer, 2012: Planning for climate change adaptation: lessons learned from a community-based workshop. *Environmental Science & Policy*, 17, 82-93.
- Rasouli, K., W. W. Hsieh, and **A. J. Cannon**, 2012: Daily streamflow forecasting by machine learning methods with weather and climate inputs. *Journal of Hydrology*, 414-415, 284-293.
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- Shrestha, R. R.**, Y. B. Dibike, and T. P. Prowse, 2012: Modelling climate induced hydrologic changes in the Lake Winnipeg Watershed. *Journal of Great Lake Research* 38, 83-94.
- Shrestha, R. R.**, **M. A. Schnorbus**, **A. T. Werner**, and **A. J. Berland**, 2012: Modelling spatial and temporal variability of hydrologic impacts of climate change in the Fraser River basin, British Columbia, Canada. *Hydrological Processes* 26, 1840-1860.
- Sobie, S. R.**, and **A. J. Weaver**, 2012: Downscaling of Precipitation over Vancouver Island using a Synoptic Typing Approach. *Atmosphere-Ocean*, 50 (2), 176-196.
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- Wang, X.L., H. Wan, **F. W. Zwiers**, V.R. Swail, G.P. Compo, R.J. Allan, R.S. Vose, S. Jourdain, X. Yin, 2011: Trends and low-frequency variability of storminess over western Europe, 1878-2007. *Climate Dynamics*, 37, 2355-2371.
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- Zhang, X., J. Wang, **F. W. Zwiers**, and P. Ya Groisman, 2010: The influence of large scale climate variability on winter maximum daily precipitation over North America. *Journal of Climate*, 23, 2902-2915.
- Zwiers, F.W.**, X. Zhang, and J. Feng, 2011: Anthropogenic influence on extreme daily temperatures at regional scales. *Journal of Climate*, 24, 881-892.

PARTNERS

Below is a list of some of the groups that PCIC worked with over the 2011-2012 period:

BC Hydro

BC Ministry of Environment

BC Ministry of Forests, Lands and Natural Resources

BC Ministry of Transportation and Infrastructure

Canadian Centre for Climate Modelling and Analysis (CCCma), Climate Data and Analysis Section, Environment Canada

Capital Regional District

City of North Vancouver

City of Surrey

City of Vancouver

City of Victoria

Corporation of Delta

Columbia Basin Trust

Environment Canada

Fraser Basin Trust

Future Forests Ecosystem Scientific Counsel

ICLEI Canada

Institute for Coastal Research (Germany)

Island's Trust

Living Rivers Society

Lorax Environmental Services Ltd.

Metro Vancouver Regional District

Natural Resources Canada

Ouranos Scientific Symposium

Pacific Institute for Climate Solutions (PICS)

ACKNOWLEDGEMENT OF REVIEWERS

Pacific Climate Impacts Consortium publishes 'PCIC Publications.' These are project reports that are often direct outcomes of stakeholder driven projects. Each 'PCIC Publication' is peer reviewed through a blind peer review process similar to those undertaken by scientific journals. To those scientists and researchers that agree to review PCIC's applied research, we are deeply indebted. We recognize and gratefully acknowledge the contribution of the many peer-reviewers whose efforts were instrumental in maintaining the high quality of our research.





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