PACIFIC CLIMATE IMPACTS CONSORTIUM

# PCIC UPDATE April 2023

## PROJECT AND RESEARCH UPDATES

### Correcting CMIP6 Model Output for Downscaling

The data products that PCIC offers rely heavily on downscaled climate output from global climate models (GCMs). By using downscaling methods on GCM data, PCIC's team can infer the sort of high-resolution climate information that is needed for regional assessments. This works well, but the quality of the resulting downscaled product depends, in part, on the quality of the GCM output. PCIC has recently downscaled the output from 26 GCMs that participated in the sixth phase of the Coupled Model Intercomparison Project (CMIP6). Partway through this work, during quality control, PCIC's research team noticed outliers in some of the extreme maximum temperature data. Three participating models[1] were found to have extremely high, sporadically occurring, surface air temperatures at isolated locations during the Northern Hemisphere warm season (May through October) that sometimes exceed 60°C, or came very close to that level, even at high northern latitudes (see Figure 1 for an example). Upon finding the errors, PCIC's research team contacted the modelling group that developed the components that were causing the errors, to confirm the issue.

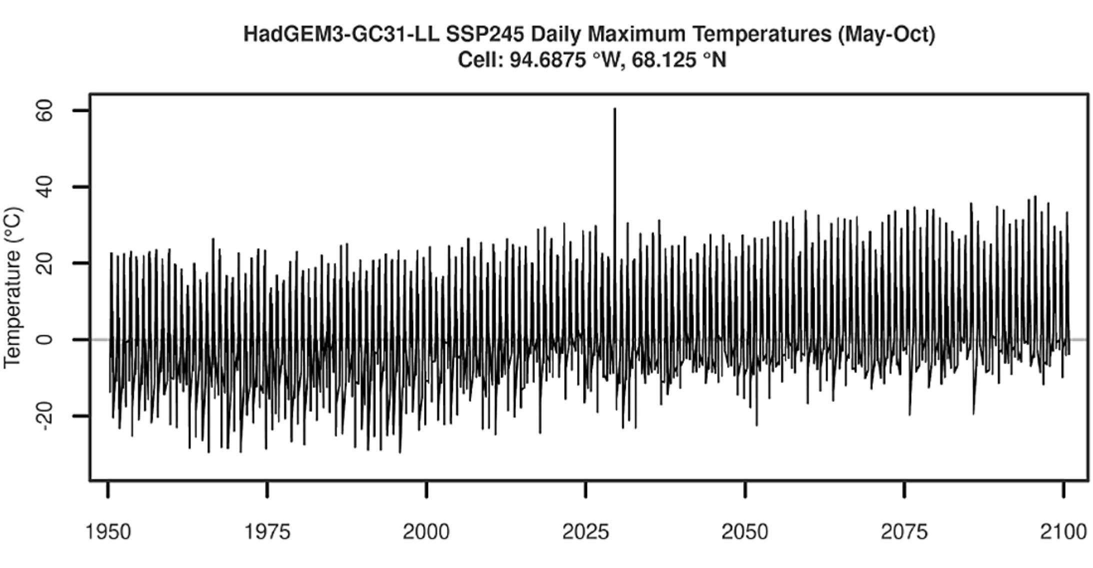


**Figure 1**: This figure shows an example of an area in Nunavut with an anonymously high temperature, in this case from a projection for July 23rd, 2029, in the form of a sharp "spike" that sticks out from the rest of the time series. The projected maximum temperatures shown come from the Hadley Centre Global Environment Model version 3 (HadGEM3) Earth system model, run using a moderate greenhouse gas emissions scenario. This area shows a maximum temperature exceeding 60°C, clearly larger than any other extreme temperature events in the area. This occurred while the surrounding region had an average maximum temperature of 22.5°C.

The three models that show these spuriously high temperatures employ the same atmospheric and land surface components[2]. These models were sometimes allowing heat from the absorption of sunlight to build up at the land surface, instead of allowing it to be carried away into the model's atmosphere as would occur in the actual Earth system. Crucially, this was only happening in spatially isolated locations, with nearby areas being unaffected by the error, and thus there is the potential to correct these errors prior to statistical downscaling.

The errors were first noticed as a pattern of outliers during quality control of extreme temperature values in downscaled global climate model output. PCIC's team then worked through how best to handle this output. Rather than simply omit the anomalous values from individual locations, which would have left "holes" in the model output that would have propagated into the downscaling process, or throwing away a large amount of simulated climate data because of a relatively small number of anomalous values, PCIC's team developed a method to detect the errors and replace the affected model output with estimates of the correct values for the affected locations. One method to detect these would be simply picking a temperature value and using it as a threshold to classify daily maximum temperatures as being anomalous, such that any temperatures above it would have been considered to be in error. However, this would miss spurious temperatures that are near to, but below the threshold, and events in regions such as northern Canada, where temperatures do not need to be extremely high to be outliers relative to the surrounding values. Instead, PCIC's team developed a two-stage outlier detection method. This involved first identifying temperatures that were well outside the general range of temperatures for a given region, with temperatures above the top quartile (the 75th percentile) being flagged as provisional outliers. These values were then compared, using statistical methods, to daily maximum temperature values from nearby locations. With outliers identified in this way, values from nearby locations can be used to estimate the correct values for locations with errors.

PCIC has now produced two downscaled versions of climate projections from 26 climate models participating in CMIP6 under three different emissions scenarios. One version uses the Bias Correction/Constructed Analogues with Quantile mapping, version 2 (BCCAQv2) downscaling method that PCIC also used to downscale CMIP5 climate change simulations, and the second uses the Multivariate Bias Correction (MBCn) method. The errors discussed here were caught partway through the downscaling project and, because of this, it was possible to correct the erroneous temperatures before downscaling with MBCn. However, their presence had not yet been identified at the time when downscaling was done with BCCAQv2. Because of this, some downscaling results and possibly some derived products were affected. PCIC's team is now producing corrected versions of the affected model runs, which will then be used to replace the old runs and adjust affected products. This corrected data will then be updated on PCIC's Data Portal and will be available to be used for other applications.

1. Two Met Office Hadley Centre (MOHC) models were affected, HadGEM3-GC31-LL and UKESM1-0-LL, as well as one model from the Korean Meteorological Administration (KMA), KACE-1-0-G.

2. Earth System Models (ESMs) have multiple components that represent different parts of the Earth system. These components include three-dimensional models of the atmosphere and ocean, sea ice and basic land surface properties. They generally also include climatically important aspects of the chemistry of the ocean and atmosphere, and some elements of ocean and land ecosystems. Model components can be very complex, including vegetation dynamics and representations of plankton and the interactions between clouds and aerosols. Some models contain active land ice and glaciers. In addition to components that represent the various elements of the Earth system, ESMs also include sophisticated coupling codes that enable the individual components to interact appropriately. For a short overview of climate models, including ESMs, see section 1.5.3 in the first chapter of the Intergovernmental Panel on Climate Change (IPCC) Working Group 1's contribution to the IPCC Sixth Assessment Report.

### Bilingual Design Value Explorer Announcement

The Government of Canada has recently announced the release of the Design Value Explorer (DVE). The DVE was developed by PCIC through support from Infrastructure Canada and the National Research Council of Canada's Climate Resilient Buildings and Core Public Infrastructure initiative, and by the provision of meteorological station data by ECCC's Meteorological Service of Canada.

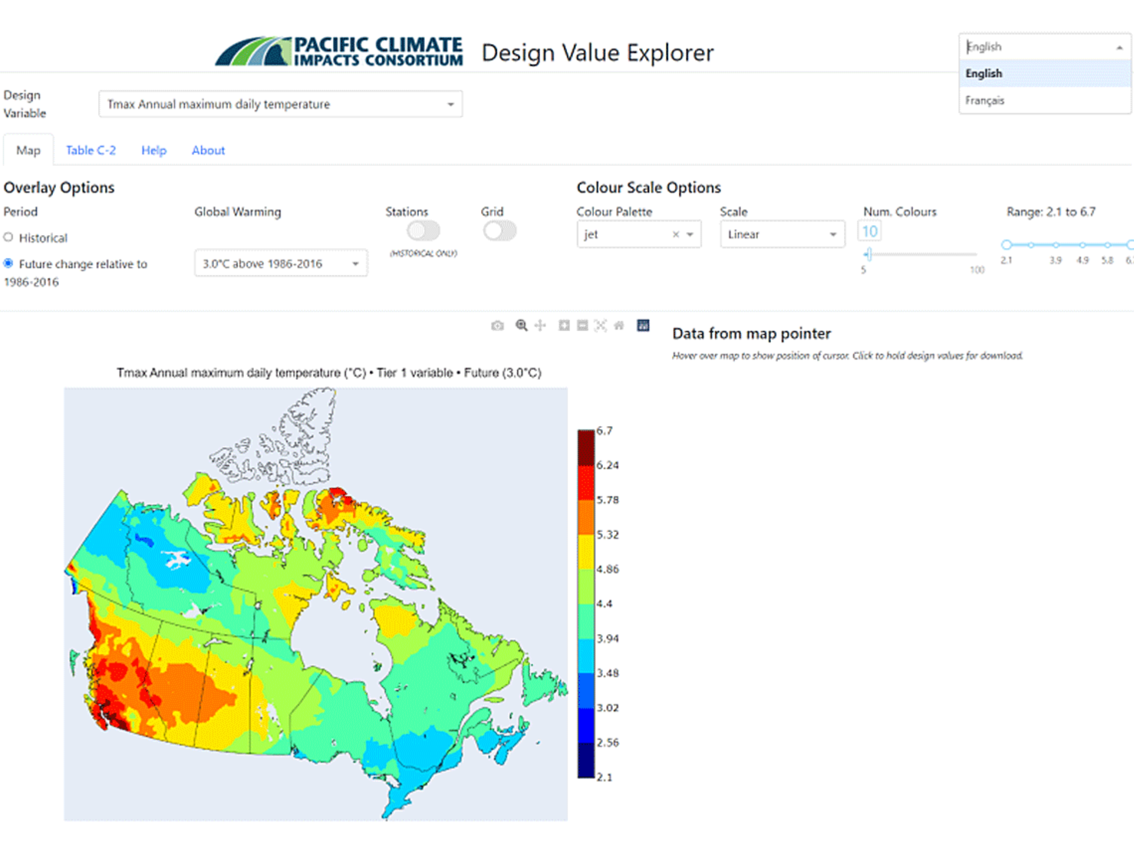


**Figure 2**: This figure shows the user interface for PCIC's Design Value Explorer, with language options in the top right corner.

PCIC's team has developed the DVE such that it is available in both English and French and provides Canada's building professionals with historical and projected future design values for all of Canada. Design values are indices used in building and bridge design that provide information about temperature, wind, precipitation, and moisture. The tool makes these accessible via an interactive map, through which users can zoom in on regions of interest, display and download the values at any location, or access the values in a table of over 600 locations that match those found in the National Building Code of Canada. The tool also uses a novel spatial interpolation method developed by PCIC researchers to estimate values for locations in between weather stations, providing information for projects in regions that are located far from weather stations.

- Read the announcement.
- Use the Design Value Explorer.

### IPCC Summary for Policy Makers on Synthesis Report

The Intergovernmental Panel on Climate Change (IPCC) has released the *Summary for Policymakers* and *Longer Report* for its upcoming *Synthesis Report* of its *Sixth Assessment Report* (AR6). The *Summary for Policymakers* opens with a high-level summary that brings together key points from the IPCC's three working groups, which examine: (1) the physical climate science, (2) adaptation and vulnerability, and (3) mitigation. With each successive report, the IPCC's confidence in the attribution of observed climate change and its ensuing impacts to increasing greenhouse gas concentrations from the use of fossil fuels has grown, as has its confidence in its assessment of the need for, and benefits of, strong mitigation and adaptation measures to avoid the worst of the projected future impacts. The *Longer Report* goes into these in greater detail.

The reports highlight the most important messages from the three *Working Group Assessment Reports* and three *Special Reports* that they draw upon. They explain that human activities are responsible for the current warming (about 1.1 degrees compared to the 1850-1900 period) and associated widespread changes and impacts, including effects on weather and climate extremes. They also share projections for what the future may hold, dependent on emissions pathways, with increased warming following continued emissions and bringing with it impacts that escalate as warming increases. This warming will also be greater in high-latitude regions, such as our province. The reports indicate that, while adaptation and mitigation measures have expanded over time, these still fall short of what will be needed to meet the challenges that climate change presents. But the reports also share the wealth of opportunities available to address climate change across multiple areas and how these will reduce the costs of climate change and provide co-benefits.

- Read the new *Summary for Policymakers* for the AR6 Synthesis Report.
- Read the *Longer Report* for the AR6 Synthesis Report.
- Visit the page for the new report to access the report, headlines statements and more.

### The Pacific Climate Seminar Series

The Pacific Climate Seminar Series continued into 2023, starting on January 25th, with PCIC Director Dr. Francis Zwiers delivering a talk on Climate change, extreme precipitation events and some implications for risk analysis. This was followed by two talks on using emergent constraints to reduce the uncertainty in climate projections, on the same theme as the one given by Dr. Yonxiao Liang on December 9th, *Constraining Climate Model Projections of 21st Century Global and Regional Warming* that was discussed in the last *PCIC Update*. The first of this year's talks was delivered on February 15th by Dr. Aurélien Ribes from Météo France, when he spoke on, *An observational constraint to reduce uncertainty on global and regional climate change*. The second of these was given by Dr. Chad Thackeray from the University of California, Los Angeles, on March 29th. His talk was titled, *Reducing uncertainty surrounding climate change using emergent constraints*. Following these talks, Dr. William Merryfield, from Environment and Climate Change Canada discussed *Decadal Prediction at CCCma*, on April 26th. We will be announcing the topic and speaker for the May talk in the Pacific Climate Seminar Series, which is scheduled for 3 p.m. on the 24th, shortly.

- Watch Dr. Liang's presentation.
- Watch Dr. Zwiers's presentation.
- Watch Dr. Ribes's presentation.
- Watch Dr. Thackeray's presentation.
- Watch Dr. Merryfield's presentation.

In addition to the Seminar Series, PCIC is pleased to announce an interactive climate change training session on PCIC's newest web-based tool, the Design Value Explorer (DVE) that will be held on June 8th from 10:30 a.m. to 12 p.m., Pacific Time. This session will be delivered jointly with our partners at the Canadian Centre for Climate Services (CCCS) and Engineers and Geoscientists British Columbia.

- Learn more about the DVE training session.

## STAFF PROFILE: NINA NICHOLS

Nina Nichols joined PCIC in September of 2022 as PCIC's Indigenous Communities Climate Adaptation Coordinator, a new role with the user engagement and training team. Nina spent her first six months focused on increasing her understanding of where organizations and First Nations are in their climate work and where PCIC might best support this work. Her role is to increase PCIC's capacity to support the climate work of BC First Nations, and this has so far has been centered on relationship building and better understanding the priorities of First Nations as they relate to climate data.

Nina's background includes a Bachelor of Science from the University of California, Davis, in environmental science and biology, and a Masters in Resource and Environmental Management from Simon Fraser University with the Pacific Water Resource Centre. "After my masters I worked with the First Nations Fisheries Council of BC and as an environmental consultant," Nina explains, providing some background on her work with BC's Indigenous communities. While there she focused on advancing First Nations priorities in marine management and fisheries policy. This work allows Nina to bring valuable experience to her role: "While working directly with climate data is new to me, I am bringing to PCIC the understanding of what climate impacts look like to communities on the land, and the importance of relationship building and systems thinking to advance adaptation planning."

"I am looking forward to seeing how the role evolves and supporting PCIC's growth to support First Nations communities," Nina reflects. "I believe this is an important direction of growth as many First Nations are disproportionately impacted from climate change due to impacts from colonial policies," she explains, providing the example of reserve lands being situated in flood plains. First Nations peoples hold significant knowledge on climate adaptation and climate impacts, and this role will ideally complement the work communities are already doing, by bringing forward climate data as a tool to support other forms of knowledge and planning.

## PCIC STAFF NEWS

This spring, PCIC said a fond farewell to Dr. Travis Tai. Dr. Tai joined PCIC in September 2020 to work on salmon population risk assessments as part of the BC Salmon Restoration and Innovation Fund. PCIC is grateful for Dr. Tai's work that centered on developing a climate change risk assessment framework for salmon species across BC and we wish him the best in his future endeavours. PCIC is also pleased to welcome Ameneh Mollasharifi as a Data Analyst (Co-op). Ameneh's work at PCIC will be focused on deriving streamflow and water temperature hazard exposure indicators from hydrologic simulations and conducting analyses to help PCIC researchers better understand the impacts of future climate change on the habitat of salmon in BC's rivers.

## PUBLICATIONS

**Anslow F.** and **Sobie S.**, 2022: Land temperature and hydrological conditions in 2021 as a chapter in *State of the Physical, Biological and Selected Fishery Resources of Pacific Canadian Marine Ecosystems* in 2021, Boldt, J., Joyce, E., Tucker, T. and Gauthier, S., eds., *Canadian Technical Report of Fisheries and Aquatic Sciences*, 3482.

Diaconescu, E., H. Sankare, K. Chow, **T.Q. Murdock** and A.J. Cannon, 2023: A short note on the use of daily climate data to calculate Humidex heat-stress indices. *International Journal of Climatology*, 43, 2, 837– 849, doi: 10.1002/joc.7833.

**Lao, I.R.**, C. Abraham, E. Wiebe, and A.H. Monahan, 2022: Temporal and Spatial Structure of Nocturnal Warming Events in a Midlatitude Coastal City. *Journal of Applied Meteorology and Climatology*, **61**, 9, doi:10.1175/JAMC-D-21-0205.1.

Philip, S. Y., S.F. Kew, G.J. van Oldenborgh, **F.S. Anslow**, S.I. Seneviratne, R. Vautard, D. Coumou, K.L. Ebi, J. Arrighi, R. Singh, M. van Aalst, C. Pereira Marghidan, M. Wehner, W. Yang, S. Li, D.L. Schumacher, M. Hauser, R. Bonnet, L.N. Luu, F. Lehner, N. Gillett, J.S. Tradowsky, G.A. Vecchi, C. Rodell, R.B. Stull, R. Howard and F.E. Otto, 2022: Rapid attribution analysis of the extraordinary heat wave on the Pacific coast of the US and Canada in June 2021, *Earth System Dynamics*, **13**, 1689–1713, doi:10.5194/esd-13-1689-2022.

**Tsuruta, K.** and **M. A. Schnorbus**, 2022: Assessing the influence of calibration methodology and model structure on glacio-hydrological simulations in the Cheakamus River Basin, British Columbia, Canada. *Journal of Hydrology X*, **17**, 100144, doi:10.1016/j.hydroa.2022.100144.

**Zwiers, F.W.**, 2021: On the role of science in informing adaptation policy. In *Statistics, Science and Public Policy XXIV*, Edited by A.M. Herzberg, Queen's University, in press.





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