CLIMAtlantic

A Guide to Finding

CLIMATE INFORMATION & DATA

for Atlantic Canada

FEBRUARY 2024

Land Acknowledgement

CLIMAtlantic works throughout Atlantic Canada, all of which is part of the unceded and traditional territories of the Mi'kmaw, Wəlastəkwiyik, Peskotomuhkati, Innu, and Inuit Peoples.

A Guide to Finding Climate Information & Data for Atlantic Canada

CLIMAtlantic.ca

About CLIMAtlantic

Across Atlantic Canada, climate change risks, impacts and vulnerabilities occur with examples including sudden rainfall flooding streets and washing out roads, storm events causing flooding and erosion along coastlines, shifts in species' active ranges, and effecting mental and physical health.

Action on climate change needs to be broad and integrated into all future and current decisions and actions. Collaborative action is needed to prepare communities and natural environments for these changes.

CLIMAtlantic is a climate services organization in Atlantic Canada focused on making climate change adaptation accessible. CLIMAtlantic facilitates access to, and understanding of, climate change and adaptation information, data and tools.

Vision

CLIMAtlantic's vision is that Atlantic Canadians are well-informed and have access to data, information, tools, and supports for appropriate responses to climate change impacts through their plans, decisions, and actions – in ways that meaningfully address the dynamic, persistent, and inequitable nature of climate change.

Partners

CLIMAtlantic is financially supported by Environment and Climate Change Canada and the four Atlantic provinces.

Disclaimer

A Guide to Finding Climate Information & Data for Atlantic Canada represents information available at the time of publication. Climate information and data are constantly being updated with more recent iterations of models as new data are available. The state of our climate is also continually changing as a result of societal decisions and emissions. One of the best ways to stay updated is to refer to ClimateData.ca.

Acknowledgements

Many parts of this Guide were drawn from ClimateWest publications: the Guide to Finding Climate Data, prepared by the Prairie Climate Centre; and the Uncertainty Primer prepared by the Prairie Adaptation Research Collaborative. We gratefully acknowledge ClimateWest's permission to use their materials.

CLIMAtlantic is a free, public resource, here to support access to, and applications of, climate data. For more information, visit CLIMAtlantic.ca, or reach out to our Help Desk at info@climatlantic.ca or 1-506-710-2226.

Who the Guide is for

This is a technical guide intended for those who use climate data for their work. This guide supports users in understanding what climate datasets are available and how projections are developed, as well as what considerations to keep in mind when choosing and applying climate datasets.

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List of Acronyms

BCCAQv2 .... bias correction with constructed analogues and quantile mapping reordering
CCCS .... Canadian Centre for Climate Services
CMIP5 .... Coupled Model Intercomparison Project Phase 5
CMIP6 .... Coupled Model Intercomparison Project Phase 6
GCM .... global climate model
GHG .... greenhouse gas
IDF .... intensity-duration-frequency
ICLEI .... Local Governments for Sustainability
IISD .... International Institute for Sustainable Development
PAVICS .... Power Analytics and Visualization for Climate Science
PCC .... Prairie Climate Centre
PCIC .... Pacific Climate Impacts Consortium
RCM .... regional climate model
RCP .... representative concentration pathway
SSP .... Shared Socioeconomic Pathways

1 Introduction

The climate influences almost all parts of life: food, shelter, health, clothing, transportation, recreation – even culture. And that list is not exhaustive. As such, a wide range of people seek out climate information for a variety of reasons and applications. It is not always easy to find out where the best suited climate information is available, how to access it, and how to interpret it to answer questions about the past, present, and future climate.

CLIMAtlantic is making these steps easier, with a focus on climate information needs within Atlantic Canada. Intended for those who use climate data for their work, this guide supports users in understanding what climate datasets are available and how projections are developed, as well as what considerations to keep in mind when choosing and applying climate datasets.

Section 2 (Key Concepts, Climate Data & Projections) introduces some key concepts, information on climate models, downscaling, emission scenarios, historical climate data and spatial and temporal scales. **Section 3** describes the various climate services with access to downscaled climate projection data and additional climate information applicable to Atlantic Canada. A list of currently available climate indices can be found in **Section 4**, references are listed in **Section 5**, and glossary terms are defined in **Section 6**.

2 Key Concepts, Climate Data & Projections

Difference between climate information and climate data

Climate information, as used in this document, is a broad term encompassing a wide variety of sources including datasets, fact sheets, guides, briefing notes, case studies, research reports, presentations, webinar recordings, and more. In short, anything that seeks to share information about climate change with a basis in scientific evidence can be considered climate information.

In this guide, climate data is a narrower term focused on measures of the observable and projected climate and the indices calculable from these variables, such as temperature and precipitation. Such measures capture biophysical qualities of climate, such as precipitation, the first frost day of the year, and more. Climate data can include:

- observed historical data, collected by weather stations across the country
- simulated historical data, which is data about the past climate generated from climate models
- simulated projected data, which is data about the future climate generated from climate models

Why use climate information?

Climate information and climate data can be used for a variety of purposes. Climate information can help answer questions and prepare for the future, no matter the sector – e.g., education, planning or research – or interest. Many communities across Atlantic Canada already use climate information as the basis for adaptation planning. Observational climate records assist in understanding the historical and current climate, and climate models project how the climate may evolve in the future. The first step in planning for climate change is understanding how the climate is likely to change in the future, and climate information assists with that process.

How is climate model data developed?

Climate models are typically generated at the global scale using Global Climate Models, or GCMs (see section 2.1). Downscaling techniques are used to generate regional climate insights. Downscaling techniques include both dynamical methods, such as Regional Climate Models (RCMs), run at a narrower geographical scale, and statistical methods, which combine observed climate information with climate model simulation outputs to obtain information at a higher spatial resolution. Greater detail about this process is discussed later in section 2.2.

Data derived from GCMs are the best tools available to understand and plan for future projected changes in regional climate conditions. The climate projection data hosted by the Canadian Centre for Climate Services (CCCS), ClimateData.ca, and the Climate Atlas of Canada have been developed using datasets produced by the Pacific Climate Impacts Consortium (PCIC). These datasets are an ensemble of Coupled Model Intercomparison Project, phase 6 (CMIP6, as well as the former CMIP5) GCMs that have been statistically downscaled. This guide provides an overview of where to find statistically downscaled climate projections relevant to Atlantic Canada.

What other types of climate information is available besides data?

While much of this guide is focused on online sources of Atlantic Canada-relevant climate data, organizations that host climate projections also have other climate information available:

- The Canadian Centre for Climate Services maintains a library of historical and future climate resources, featuring projects from across Canada
- ClimateData.ca has sector modules which provide examples of using climate information for different sectors, e.g., adaptation in the health sector
- The Climate Atlas of Canada explores the impacts of climate change through documentary videos, articles, and reports
- ClimateWest offers a curated library of climate change research in the Prairies
- The Pacific Climate Impacts Consortium hosts technical publications, science briefs, research, and tools
- Ouranos provides research along with several reports on their projects in different sectors and communities in Quebec
- CLIMAtlantic offers a curated library of climate change research in Atlantic Canada (in partnership with ICLEI) with a focus on creating a strong network of people and organizations, and generating a wealth of information sharing amongst colleagues, in addition to supporting specific place-based work. CLIMAtlantic also provides a Networking Map to connect individuals and organizations working on climate adaptation, and a Coastal Adaptation Toolkit with associated resources.

2.1 Global Climate Models

Global climate models (GCMs) are complex computational and numerical models representative of the interactions between different components of the Earth, including the atmosphere, ocean, land surface, as well as frozen components such as sea ice, glaciers, and permafrost (Taylor et al., 2012). By representing these processes, GCMs are a tool for climate scientists to better understand the Earth's climate system. GCMs are also used to create climate projections of how the Earth's climate system may change and are used to understand how climate change may impact different systems and sectors, such as water availability (Kienzle et al., 2012), ecosystems (Thorpe, 2011), and agriculture (Carew et al., 2017).

GCMs also simulate key physical processes to approximate the global climate system (Taylor et al., 2012). To model the effects of greenhouse gases (GHG) on regional climate variables, GCM simulations have been conducted under different emission scenarios (Moss et al., 2010; Taylor et al., 2012).

The Canadian Downscaled Climate Scenarios – Univariate (CMIP5), or CanDCS-U5 for short, was constructed from 27 Global Climate Models (GCMs) and three Representative Concentration Pathways (RCPs – RCP2.6, RCP4.5 and RCP8.5), using the BCCAQv2 downscaling method described below. Scenarios can be selected from any combination of models, RCPs, and time period.

The CMIP6 GCMs downscaled scenarios were constructed from 26 GCMs and three Shared Socioeconomic Pathways (SSPs - SSP1-2.6, SSP2-4.5 and SSP5-8.5) using the BCCAQv2 downscaling method described below. This data set is now referred to as Canadian Downscaled Climate Scenarios – Univariate (CMIP6), or CanDCS-U6 for short.

How is the ensemble of GCMs represented?

The climate information websites outlined in this guide (ClimateData.ca, Climate Atlas of Canada, PCIC Climate Explorer, and PAVICS) present data from an ensemble of 24 to 27 GCMs in different ways. It is standard practice to utilize data from several GCMs, rather than relying on a single GCM, to represent differences between the projections of different climate models. Using the GCM ensemble means being prepared for a range of plausible outcomes, leading to more robust planning. How to treat uncertainty within the ensemble of GCMs is explored in further detail in the ClimateData.ca Learning Zone.

Different methods of representing the GCM ensemble may be best suited for specific needs, whereas other methods may not. Resources may use different summary statistics to represent the ensemble, such as the median and the 10th and 90th percentiles, to indicate the range of climate model projections. For many purposes, this is adequate; however, for more detailed assessments, accessing climate projections from specific, individual GCMs, may be best. For cases where a smaller number of models are being used, PCIC has a list of models that are a representative subgroup of models for both Canada as a whole and for Eastern Canada.

2.2 Downscaling

GCMs provide climate projections for grid cells, with dimensions measuring hundreds of kilometres. Downscaling helps to translate large-scale information to a more local scale for increased relevance to communities. Several, constantly evolving techniques are used for downscaling, and can be categorized as either statistical or dynamic. Bias Correction with Constructed Analogues with Quantile Mapping Rendering (BCCAQv2) is an example of statistical downscaling while RCMs are dynamic.

BCCAQv2 is a method, developed at PCIC, that combines bias correction constructed analogues, and quantile delta mapping (Cannon et al., 2015). This method downscales daily projections of temperature and precipitation, while also incorporating extreme indices. It is important to have a representative gridded reference for this dataset. BCCAQv2 is used for future climate projections on ClimateData.ca and the Climate Atlas of Canada. It is also available on the PCIC Climate Explorer and Power Analytics and Visualization for Climate Science (PAVICS).

RCMs have a finer resolution, and therefore represent climate processes and topography with more detailed characteristics. Ouranos also has a regional climate model that contributes to the Coordinated Regional Climate Downscaling Experiment (CORDEX). CORDEX-North America groups regional models of North America from different modelling centres, instead of the global models CMIP uses. Currently, the CORDEX datasets can be accessed through the Earth System Grid Federation (ESGF) and viewed on the Intergovernmental Panel on Climate Change (IPCC) Atlas.

2.3 Emissions scenarios

Emissions scenarios describe plausible future releases of GHGs, aerosols and other anthropogenic gases into the atmosphere. Emissions scenarios are based on coherent and internally consistent assumptions about driving sources, such as technological change, demographic and socioeconomic development, and their key interactions.

What are the differences between SSPs and RCPs?

In contrast to Representative Concentration Pathways (RCP) scenarios, the Shared Socio-economic Pathways (SSP) based scenarios, which have been in use since 2021, provide economic and social factors for the associated emission pathways and changes in land use.

SSP based scenarios further refine the previous GHG concentration scenarios (known as RCPs), explicitly designed for the exploration of the effects of different emissions trajectories or concentrations by the climate modelling community. GHG concentration scenarios result in various radiative forcing values, which is in essence the difference between the incoming and outgoing radiation. The socioeconomic characteristics used to define RCPs were not standardized, making it difficult to map societal changes, like population, education, and government policies, to climate targets, such as keeping global warming well below 2°C. SSPs address this by defining how societal choices can lead to changes in Radiative Forcing by the end of the century.

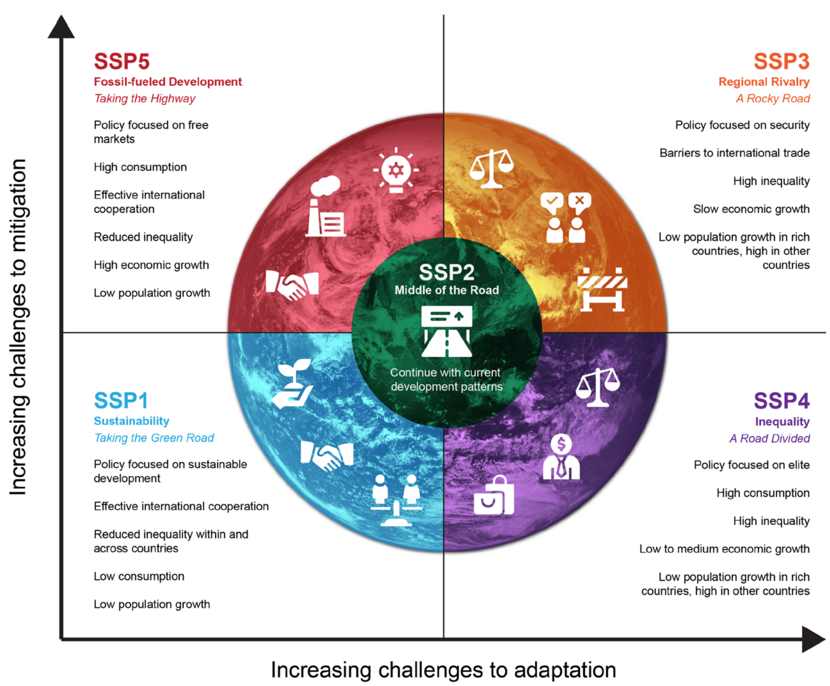

Figure 1 The five "families" of scenarios. Source: ClimateData.ca.
Enlarge this image in your browser.

SSP based scenarios are labelled in formats with SSP, a number for the family, and a number for the radiative forcing (e.g., SSP5-8.5). "SSP5" represented the Shared Socioeconomic Pathway representing a fossil fuel intensive world – in this case, a world dominated by mitigation challenges (Figure 1, p. 11). Within a single SSP "family" (see Figure 1) there can be multiple emissions scenarios that lead to different levels of radiative forcing. Different assumptions about ambitions to mitigate climate change can result in differing emissions within the same general socio-economic narrative. For example, SSP1-1.9 and SSP1-2.6 both stem from the same socio-economic family of scenarios, SSP1 (Sustainability: Taking the Green Road). However, these scenarios have different emissions, resulting in different Radiative Forcing values (1.9 vs 2.6) as a result of the applied mitigation actions. Figure 2 shows illustrative temperature levels relative to pre-industrial levels with historical temperatures (front light-yellow band), current (2020) temperatures (white block in the middle), and the branching of the respective scenarios over the 21st century along the different socio-economic SSP families.

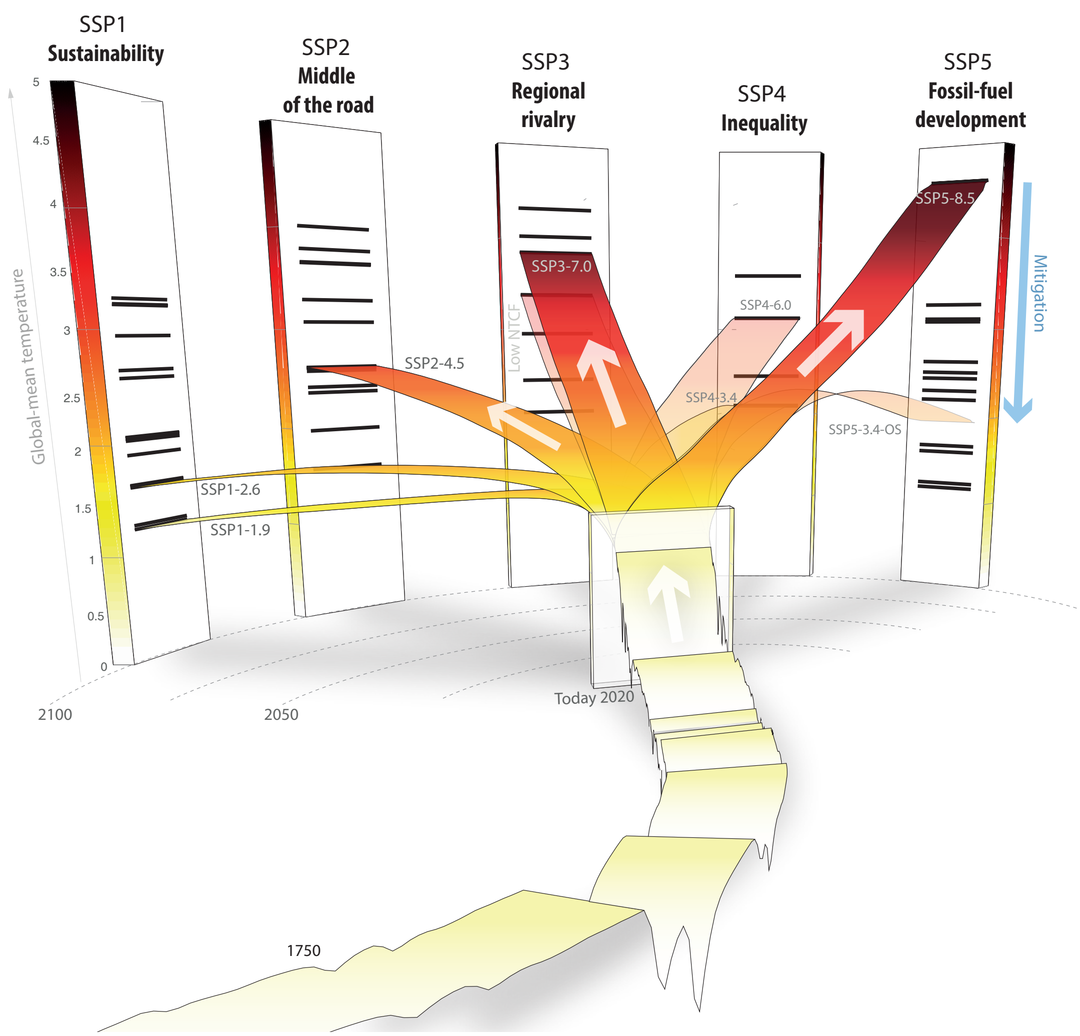

Figure 2 The SSP scenarios and their five socio-economic SSP families.
Source: Meinshausen et al., 2020. Enlarge this image in your browser.

ClimateData.ca currently has projections available based on three scenarios (SSP1-2.6, SSP2-4.5, and SSP5-8.5), highlighted in Figure 3. These scenarios span a wide range of possible future climates, have associated projections available from many different climate models, and have levels of Radiative Forcing similar to three commonly used RCPs (high [RCP8.5], medium [RCP4.5] and low [RCP2.6]) previously used by ClimateData.ca.

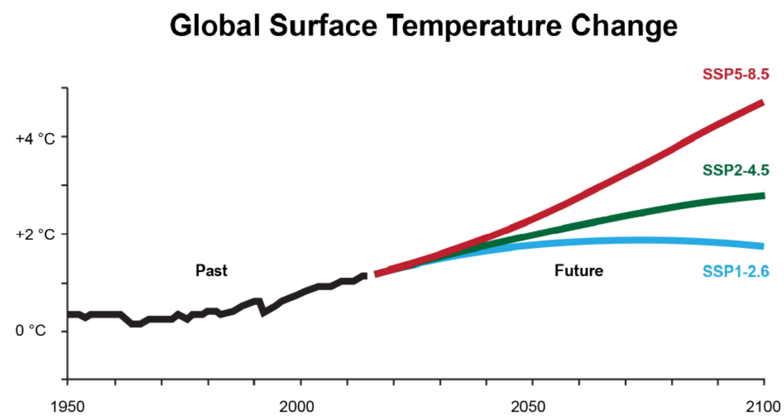

Figure 3 Global surface temperature changes (relative to pre-industrial levels) under three SSP based emissions scenarios found on ClimateData.ca. Source: ClimateData.ca. Enlarge this image in your browser.

Which SSP should be considered?

This question will always arise when using future climate data. When using projections to assess the planning, siting, and construction of a high-risk and long-lasting project, such as a hospital, for example, it makes sense to use a high scenario, such as SSP5-8.5. In the case of projects with a short life span or that will be easy to upgrade in the future, and have less associated risks, it makes sense to use a lower scenario.

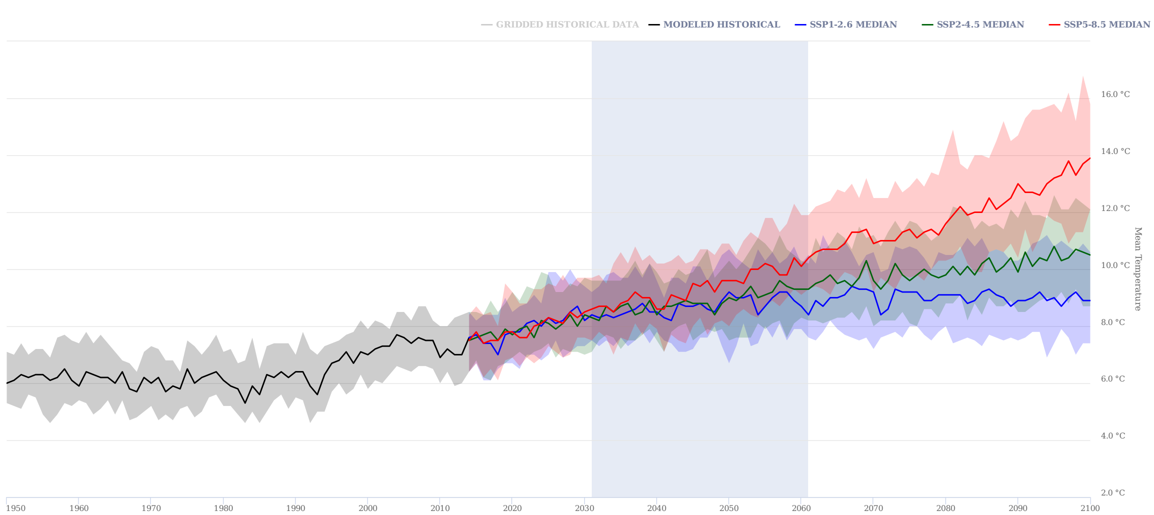

Figure 4 Example of temperature divergence after mid-century depending on emission scenarios. Source: ClimateData.ca. Enlarge this image in your browser.

Determining the future climate poses challenges due to the intricate nature of the climate system, climate models, and human factors. While it is certain that the climate will differ from the past and present, predicting exact changes is challenging. Despite the imperative for action to mitigate climate change, a certain level of warming is already 'locked-in,' leading to ongoing climatic effects. Even the most conservative scenario indicates a temperature increase (Figure 4, p. 13). By considering multiple potential futures, planners and decision-makers can enhance preparedness for a spectrum of potential outcomes.

TABLE 1 Emissions scenarios available on each website.

	ClimateData.ca	Climate Atlas of Canada	PCIC Climate Explorer
RCP 2.6	✓		✓
RCP 4.5	✓	✓	✓
RCP 8.5	✓	✓	✓
SSP1-2.6	✓		✓
SSP2-4.5	✓		✓
SSP5-8.5	✓		✓

2.4 Uncertainty

Future climate projections have three associated types of uncertainty.

1. The first is the emission scenarios. Different SSP scenarios exist because many societal choices will be made in the coming decades that we cannot know in advance.
2. The second type of uncertainty is climate model uncertainty. Climate models are computer simulations of earth processes, and each climate model is built slightly differently. With these different simulations of the climate, we get a better picture of the range of possibilities.
3. The third type of uncertainty is that the climate has natural variability. Some years are warmer than average and some years are colder. Patterns such as El Niño-Southern Oscillation and the North Atlantic Oscillation are examples of natural variability.

For more information on uncertainty in climate projections, see Sauchyn et al., 2022.

2.5 Historical climate data

Why is there a range of historical climate values?

To simulate the past climate from 1850 to 2014, GCMs are run under observed atmospheric composition. From 2014 onward, they are run under levels of GHG emissions corresponding to different SSPs, which on ClimateData.ca are SSP1-2.6, SSP2-4.5, and SSP5-8.5. Therefore, the range of historical climate values within the GCM ensemble represents the values range of a given year modeled by the different individual GCMs. Figure 5 shows a grey band of GCM historical simulations and coloured bands of GCM simulations for the future under different SSPs.

The Canadian Centre for Climate Services, ClimateData.ca, the Climate Atlas of Canada, and PCIC Climate Explorer all have simulated historical climate data on their sites.

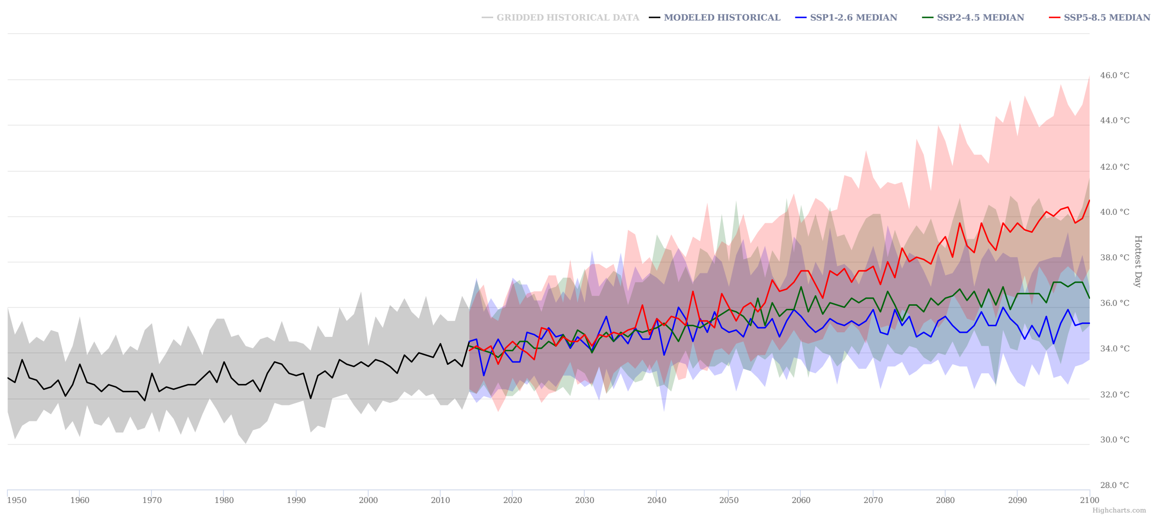

Figure 5 ClimateData.ca figure for the hottest day for Fredericton, New Brunswick. Source: ClimateData.ca. Enlarge this image in your browser.

Where can I find historical observations?

Environment and Climate Change Canada has a variety of historical climate record products derived from long-term climate station observational data (Historical Climate Data). Products include:

- Historical data
- Historical radar
- Canadian Climate Normals
- Monthly climate summaries
- Almanac averages and extremes
- Engineering climate datasets

Historical station records are also available in the station format on ClimateData.ca. Historical climate data are useful in evaluating historical climate conditions or trends in a region.

Figure 6 displays the 30-year climate data averages (called Climate Normals) for the period 1991-2020. Climate Normals are updated every 10 years.

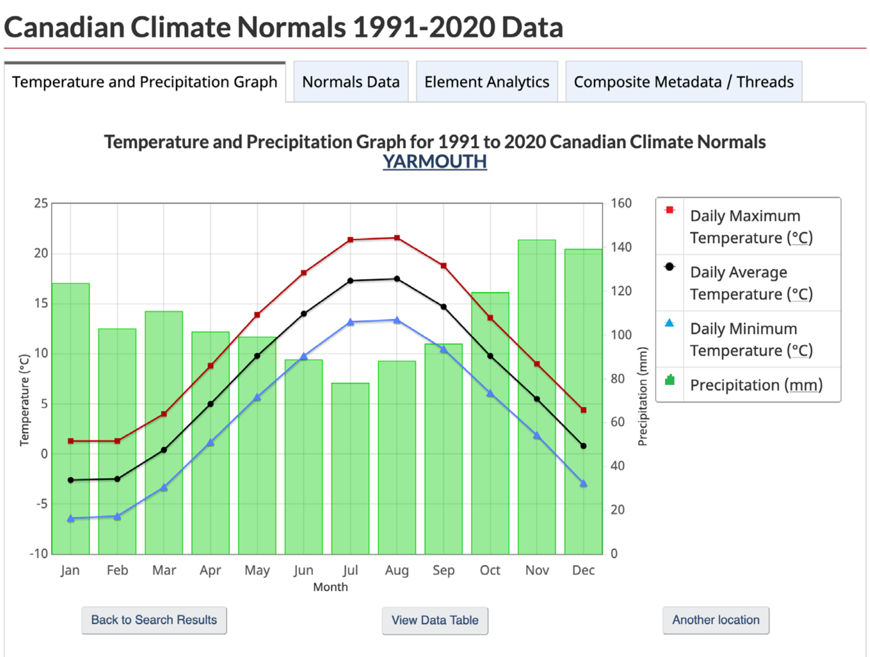

Figure 6 Climate Normals for the Yarmouth climate station, 1991-2020.
Source: Government of Canada, 2023. Enlarge this image in your browser.

Daily climate records of weather station data of temperature and precipitation variables are viewable on the interactive Climate Data Viewer. Figure 7 displays weather station locations from which temperature and precipitation data can be viewed.

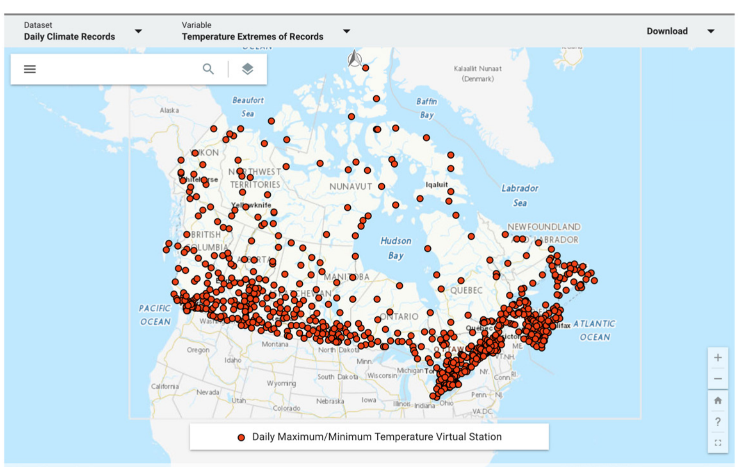

Figure 7 Interactive Climate Data Viewer. Enlarge this image in your browser.

2.6 Spatial and temporal scales

Spatial resolution of the climate data

By using the BCCAQv2 statistical downscaling method, PCIC has downscaled GCM data to a 1/12 (~ 6 km x 10 km) grid covering all of Canada. The various climate information websites (ClimateData.ca, Climate Atlas of Canada, PCIC Climate Explorer, and PAVICS) have chosen to display this information at different resolutions or over relevant boundaries using spatial averaging.

TABLE 2 Spatial resolution of the climate data on each website.

Resolution	**ClimateData.ca**	**Climate Atlas of Canada**	**PCIC Climate Explorer**	**PAVICS**
~ 6 x 10 km	✓	✓*	✓	✓
30 x 30 km		✓		
100 x 100 km		✓		
Other	Health regions, census subdivisions, and watersheds. Data can be downloaded for multiple grid cells in the Analyze tool	Large grid, Small grid, Provinces & Territories, Cities & Municipalities, Indigenous communities	User-defined custom regions	User-defined custom regions

*6 x 10 km data on the Climate Atlas of Canada is only available for select cities.

Temporal resolution of the climate data

Downscaled climate projections are available at a variety of time steps, such as daily, monthly, seasonal and annual.

TABLE 3 Temporal resolution of the climate data on each website.

	ClimateData.ca	Climate Atlas of Canada	PCIC Climate Explorer	PAVICS
Daily	✓		✓*	✓
Monthly	✓	✓	✓	✓
Seasonal	✓	✓	✓	✓
Annual	✓	✓	✓	✓

*PCIC has daily data available through the Statistically Downscaled Climate Scenarios data portal.

2.7 Data file formats

Climate data is available in a variety of file formats. In general, it is likely most appropriate to access climate data in a familiar file format, depending on what is required.

TABLE 4 File formats available for download from each website.

	ClimateData.ca	Climate Atlas of Canada	PCIC Climate Explorer	PAVICS*
CSV	✓	✓	✓	✓
GeoTIFF	✓	✓	✓	
GeoJSON	✓	✓	✓	
ASCII	✓	✓	✓	
Arc/Inf ASCII Grid	✓	✓	✓	
NetCDF	✓	✓	✓	✓

Note: Not all information is available in all formats (e.g., not all information on ClimateData.ca is available in CSV format).

*Data on PAVICS is reliant on NetCDF format but with the use of the python programming language and environment can be exported into most other formats.

2.8 Other types of data and analysis tools

Besides GCM projections, several other types of data and analysis tools are available on the climate information websites.

TABLE 5 Overview of other historical and future data and analysis tools available on each website.

	Canadian Centre for Climate Services	ClimateData.ca	Climate Atlas of Canada	PCIC Climate Explorer
Historical climate products	• Adjusted and Homogenized Climate Data (AHCCD); • Canadian Gridded Temperature and Precipitation Anomalies (CANGRD); • Regional Deterministic Precipitation Analysis (RDPA); • Canadian Seasonal to Inter-annual Prediction System (CanSIPS); • Daily climate records; • LongTerm Climate Extremes (LTCE)	IDF curves, both Historical and Future; 1981-2017; climate Normals; observed climate station data.		Gridded meteorological datasets: PBCmet2010 (nationwide) and NWNAmet2015
Future climate products	Anomaly values; coarse GCM outputs		Anomaly values; multiple climate data graphs	Numerous climate data graphs
Analytical tools		Custom analysis tool		R packages for climate data

2.9 Guidance and training materials

Each of the climate information websites provide further guidance for finding information. Some climate information websites also provide additional learning resources that range from introductory materials on climate change to items such as robust guidance on IDF curves.

TABLE 6 Website documentation and educational resources available on each website.

	Canadian Centre for Climate Services	ClimateData.ca	Climate Atlas of Canada	PCIC Climate Explorer
Website Document-ation	Written technical documentation	Explanatory videos in the Learning Zone	Guidebook on using the website	Video tutorial and FAQs
Educational Resources	Explanatory articles	Learning Zone videos and articles	Introductory articles	Science briefs

2.10 Web resources, climate data and projections

Climate projections can be used to understand and plan for future climate changes and to assess different sector risks. The planned use for climate projections will help in determining which climate information website best suits your needs. For example, one website may be better suited for a project than another based on the specifications of the climate model data required (e.g., grid size, emission scenarios, or whether individual GCM data is needed), the usability of the website, and/or additional climate information resources available.

The Canadian Centre for Climate Services and its partners offer three main data portals to access climate data with increasing degrees of complexity as follows:

1. The Climate Atlas of Canada portal: learn about climate change in Canada through mapping and storytelling
2. The ClimateData.ca portal: explore case studies and downloading greater details of location-based climate data by climate variable or sector
3. The PAVICS portal: an advanced tool for academia, practitioners, and other expert users

In general, considering 30-year time frames and using multiple climate models is standard practice when using climate model data. Further information and direction on using climate projections is provided in the ClimateData.ca Learning Zone.

The climate information websites are places to examine a variety of future projected changes of climate indices in communities under different GHG emission levels (see Section 4 for a full list of climate indices). Several climate information websites also provide reports, publications, articles, and documentary videos that describe current climate change adaptation strategies within various communities and sectors. These stories and technical reports provide a picture of how people across Canada are responding to climate change and building resilience and can be an informative resource to better understand climate change at the local level.

Regional climate service providers supply links to the projections, and offer regionally relevant information, training, and tools.

- Pacific Climate Impacts Consortium (PCIC) in Pacific Canada and Yukon
- ClimateWest in the Prairies
- Ontario Resource Centre for Climate Adaptation (ORCCA) in Ontario
- Ouranos in Quebec
- CLIMAtlantic in Atlantic Canada

3 Online Climate Data and Projections

This section of the guide focuses on the growing network of government and non-profit climate service providers with a common mandate to make reliable climate information and climate data more widely accessible. The information and data provided by these climate services organizations adhere to high standards of scientific credibility. The climate data portals and climate services organizations include:

National climate service provider

- The Canadian Centre for Climate Services, part of Environment Climate Change Canada, Government of Canada

National-level climate data portals

- ClimateData.ca
  - A high-resolution climate data platform for decision makers looking to build a more resilient Canada. Users can explore case studies and download location-based climate data by variable or sector.
- The Climate Atlas of Canada
  - Climate science, mapping, and storytelling are combined to increase Canadians' awareness of climate change. This interactive tool is designed to inspire local, regional, and national action for moving away from risk resilience.
  - For citizens, researchers, businesses, and community and political leaders.
- Power Analytics and Visualization for Climate Science (PAVICS)
  - A virtual laboratory facilitating climate data analysis by providing access to several data collections ranging from observations, climate projections and reanalyses.
  - Provides a Python programming environment for users to analyze data without downloading it and is constantly updated with the most efficient libraries for climate data analysis, in addition to ensuring quality control on the provided data and associated metadata.
  - PAVICS provides options to directly access several types of climate and weather datasets, analyze and visualize climate data, and run hydrologic models through the Raven hydrologic modelling framework. More information on the analytical tools and datasets available through PAVICS can be found on its website.

This section of *A Guide to Finding Climate Information & Data for Atlantic Canada* provides an overview of information available from the resources listed above; except for PAVICS which provides a greater ability to analyze data than the other sites described in this document and is targeted towards a highly technical user base familiar with climate data and a Python programming environment.

A wide range of climate model data and adaptation resources are available for Canada. Sources of climate information for Atlantic Canada consist of national and regional climate information websites.

3.1 ClimateData.ca

ClimateData.ca is a national climate data portal with access to high-resolution climate model data through mapping and location-based summaries for several climate variables and indices. Observed climate normals, observed station data, intensity-duration-frequency (IDF) curves, and climate model data for several climate variables and indices are also available for download.

Available Resources

- Sector modules connect climate model data and applications in various sectors, including health, agriculture, transportation, and buildings
- Training materials in the Learning Zone provide background information on climate science and the use of climate information
- Graphs display climate projections for three emission scenarios allowing for comparisons of projections under the different scenarios
- Historical climate station data and historical and future IDF curves
- Analysis tool with the option to define custom thresholds for various climate indices
- National downscaled climate projections available for viewing or download for comparisons of projections under the different scenarios
- Historical climate station data and historical and future IDF curves
- Analysis tool with the option to define custom thresholds for various climate indices
- National downscaled climate projections available for viewing or download

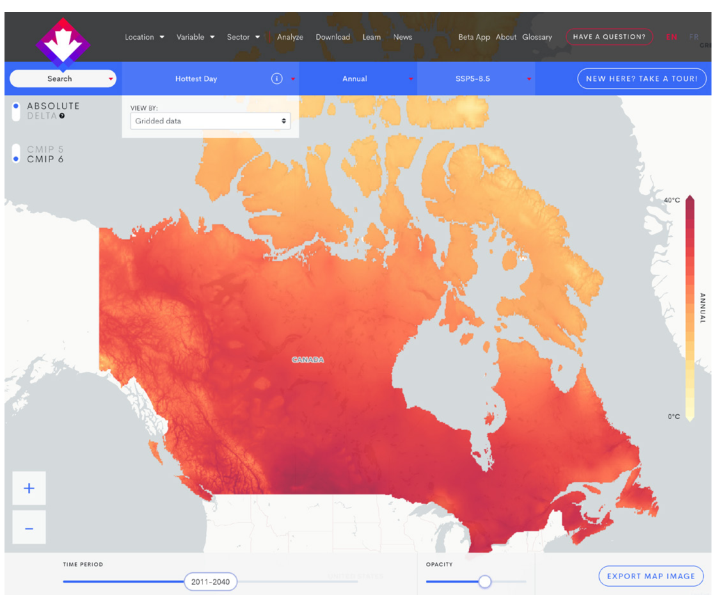

Figure 8 Typical gridded depiction of climate indices on ClimateData.ca.
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3.2 Climate Atlas of Canada

The Climate Atlas of Canada is a national data portal and interactive tool that combines climate science, nationwide mapping, and storytelling with Indigenous Knowledges and community-based research and videos to inspire awareness and action. It features nationwide mapping of climate model data (Figure 9) and users can explore projected climate changes for many variables and indices. Climate model data can be accessed through downloadable graphs and maps or as location-specific climate reports.

Available Resources

- Topic pages explore the impacts of climate change, adaptation strategies, and perspectives across Canada for a variety of subjects, including agriculture, cities, forests, and health
- Articles, reports, and documentary videos use storytelling to convey the impacts of climate change and how people across Canada are adapting
- National climate projections are available for viewing through an interactive map or for download

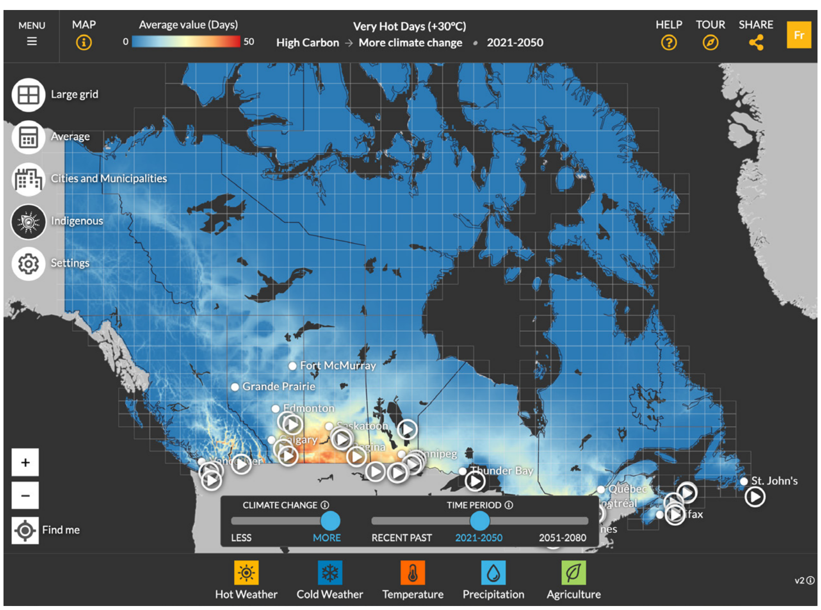

Figure 9 Typical interactive map view on the Climate Atlas of Canada.
Enlarge this image in your browser.

3.3 Pacific Climate Impacts Consortium

The Pacific Climate Impacts Consortium (PCIC) is a regional, data-driven climate services provider, focused on Pacific Canada and Yukon. PCIC conducts research related to hydrologic impacts, regional climate impacts, and climate analysis and monitoring.

Available Resources

- Publication, reports and software library developed by PCIC
- National climate projections for individual GCMs are available for download at the daily scale (statistically downscaled climate scenarios) or for viewing and download through the interactive Climate Explorer tool (Figure 10)
- Statistically downscaled climate scenarios from both CMIP5 and CMIP6
- The Design Value Explorer provides access to historical climatic design variables across Canada in either map or table form and allows users to examine projected future change in design variables, and download maps and tables.
- Gridded model outputs from a VIC-GL hydrologic model driven by six GCMs under two Representative Concentration Pathways (RCPs), RCP 4.5 and RCP 8.5. Model outputs include evapotranspiration, surface runoff, glacier area, and others.

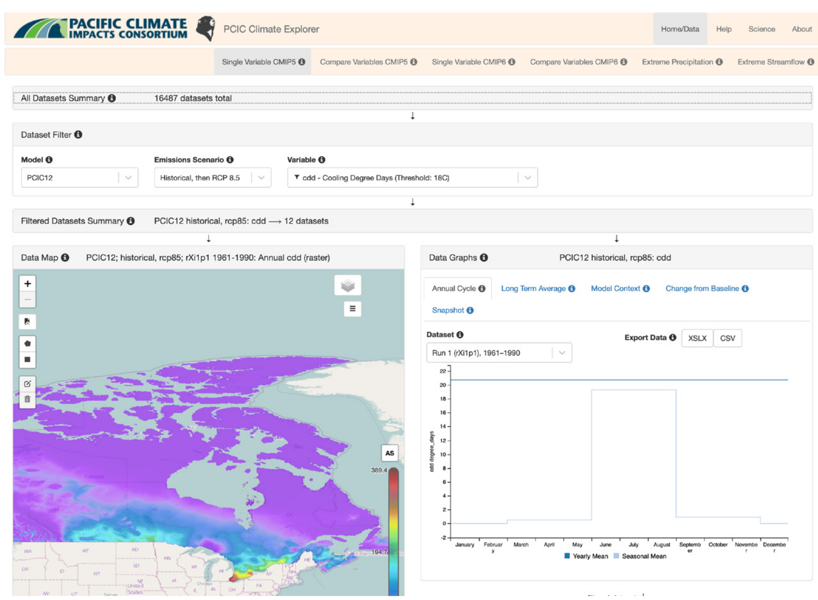

Figure 10 PCIC Climate Explorer interactive interface allowing viewing and download of downscaled climate indices for any selected user selected area. Enlarge this image in your browser.

3.4 Ouranos

Ouranos is a consortium focused on regional climatology and climate change adaptation in Quebec which conducts programs and research in several areas, including agriculture, energy, northern environment, water management, and tourism. An extensive library of their past work, including technical reports on climate change, with a regional focus on climate change knowledge and adaptation in Quebec is available.

Available Resources

- A library of publications and reports on sectoral climate impacts and adaptation strategies
- Resource for ClimateData.ca/PAVICS portal

4 Climate Indices Available Online

Climate indices	Description	Climate Data.ca	Climate Atlas of Canada	PCIC Climate Explorer	PAVICS*
Mean temperature, Tmean	Average temperature for a given time period (average of Tmin and Tmax each day)	✓	✓		
Minimum temperature, Tmin	The daily minimum temperature	✓	✓	✓	✓
Maximum temperature, Tmax	The daily maximum temperature	✓	✓	✓	✓
Total precipitation	Total precipitation for a given time period	✓	✓	✓	✓
Relative sea level change	The change in ocean height relative to land and is the apparent sea-level change experienced by coastal communities and ecosystems	✓			
MSC Climate Normals 1981-2010	Climate Normals describe the average climate conditions of a particular location over a 30-year period	✓			

*Most climate indices in Section 4 are calculated with minimum temperature, maximum temperature, and precipitation, therefore are available in PAVICS through analysis.

HOT WEATHER

Climate indices	Description	Climate Data.ca	Climate Atlas of Canada	PCIC Climate Explorer
Hottest day or highest Tmax	Highest maximum temperature value	✓	✓	✓
Tropical nights (days with Tmin > 18°C)	Number of days with minimum temperature > 18°C	✓		
Tropical nights (days with Tmin > 20°C)	Number of days with minimum temperature > 20°C	✓	✓	✓
Tropical nights (days with Tmin > 22°C)	Number of days with minimum temperature > 22°C	✓		
Cooling degree days	Indicator of air conditioning requirements. Degree days when mean temperature exceeds 18°C	✓	✓	✓
Number of heatwaves	The average number of heat waves per year		✓	
Average length of heat waves	The average length of a heat wave where a heat wave occurs when at least three days in a row reach or exceed 30°C		✓	
Longest spell of +30°C	The maximum number of days in a row with temperatures 30°C or higher		✓	
Hot (+30°C) season	The length of the season when maximum temperatures above 30°C can be expected		✓	
Days with Tmax > 25°C or Summer Days	Number of days with maximum temperature > 25°C	✓	✓	✓
Days with Tmax > 27°C	Number of days with maximum temperature > 27°C	✓		
Days with Tmax > 29°C	Number of days with maximum temperature > 29°C	✓		

HOT WEATHER continued				
Climate indices	**Description**	**Climate Data.ca**	**Climate Atlas of Canada**	**PCIC Climate Explorer**
Days with Tmax > 30°C	Number of days with maximum temperature > 30°C	✓	✓	
Days with Tmax > 32°C	Number of days with maximum temperature > 32°C	✓	✓	
Extremely hot days (+34°C)	Number of days with maximum temperature > 34°C		✓	
Warm spell duration index	Number of days with at least six consecutive days with maximum temperature > 90th percentile			✓
Percentage of days with Tmax < 10th percentile	Percentage of days with maximum temperature < 10th percentile			✓
Percentage of days with Tmax > 90th percentile	Percentage of days with minimum temperature > 90th percentile			✓
Lowest Tmax	Minimum maximum temperature over a given time period			✓
Mean diurnal temperature range	Average difference between daily minimum temperature and maximum temperature			✓
5-, 20-, and 50-year annual maximum temperature	Annual maximum daily maximum temperature with a return period of 5, 20 or 50 years			✓
Days with Humidex > 30	Number of days with a maximum Humidex (HX) over 30	✓		
Days with Humidex > 35	Number of days with a maximum Humidex (HX) over 35	✓		
Days with Humidex > 40	Number of days with a maximum Humidex (HX) over 40	✓		

COLD WEATHER

Climate indices	Description	Climate Data.ca	Climate Atlas of Canada	PCIC Climate Explorer
Very cold days (-30°C)	Total number of days per year when minimum temperature drops to -30°C or below		✓	
Freeze-thaw cycles	Total number of days per year when temperatures fluctuate between freezing and non-freezing (Tmax > 0°C and Tmin ≤ -1°C)	✓	✓	
Frost days	Number of days with minimum temperature < 0°C	✓	✓	✓
Ice days	Number of days when daily maximum temperature does not exceed 0°C	✓	✓	✓
Coldest day or lowest Tmin	Lowest minimum temperature over a given time period	✓	✓	✓
Heating degree days (18°C)	Annual sum of the number of degrees Celsius when the Tmean for a given day is below 18°C; gives an indication of the amount of space heating (e.g., from a gas boiler/furnace, baseboard electric heating or fireplace) that may be required to maintain comfortable conditions inside a building during cooler months	✓	✓	✓
Freezing degree days	Annual sum of the number of degrees Celsius that each day's mean temperature is below 0°C		✓	✓
Cumulative degree-days above 0°C	Degree days with mean temperature > 0°C	✓		
Mild winter days (-5°C)	Number of days when minimum temperature is less than or equal to -5°C		✓	
Days with Tmin < -15°C	Number of days with minimum temperature < -15°C	✓	✓	

COLD WEATHER continued				
Climate indices	**Description**	**Climate Data.ca**	**Climate Atlas of Canada**	**PCIC Climate Explorer**
Days with Tmin < -25°C	Number of days with minimum temperature < -25°C	✓		
Cold spell duration index	Number of days with at least six consecutive days with minimum temperature < 10th percentile			✓
Percentage of days with Tmin < 10th percentile	Percentage of days with minimum temperature < 10th percentile			✓
Percentage of days with Tmin > 90th percentile	Percentage of days with minimum temperature > 90th percentile			✓
Highest Tmin	Maximum minimum temperature over a given time period			✓
5-, 20-, and 50-year annual minimum temperature	Annual minimum daily minimum temperature with a return period of 5, 20 or 50 years			✓

PRECIPITATION				
Climate indices	**Description**	**Climate Data.ca**	**Climate Atlas of Canada**	**PCIC Climate Explorer**
Precipitation as snow	Total precipitation when mean daily temperature is below freezing			✓
Wet days >= 1mm	Number of days with precipitation > 1 mm	✓		✓
Wet days >= 10mm	Number of days with precipitation > 10 mm	✓	✓	✓
Wet days >= 20mm	Number of days with precipitation > 20 mm	✓	✓	✓
Wet days	Number of days in a year with 0.2 mm or more of rain or snow		✓	
Dry days	Number of days in a year with less than 0.2 mm of rain or snow		✓	
Maximum length of wet spell	Maximum number of consecutive days with precipitation > 1 mm			✓
Maximum length of dry spell or maximum number of consecutive dry days	Maximum number of consecutive days with precipitation < 1 mm	✓		✓
Number of periods with five or more consecutive dry days	The number of occurrences of five or more consecutive dry days (precipitation < 1 mm)	✓		
Maximum 1-day total precipitation	Largest single day precipitation event	✓	✓	✓
Max 3-day precipitation	Maximum precipitation in a 3-day consecutive period		✓	
Max 5-day precipitation	Maximum precipitation in a 5-day consecutive period	✓	✓	✓

PRECIPITATION continued				
Climate indices	**Description**	**Climate Data.ca**	**Climate Atlas of Canada**	**PCIC Climate Explorer**
Simple precipitation intensity index	Daily precipitation amount on days with precipitation > 1mm divided by the number of wet days (precipitation > 1 mm)			✓
Precipitation > 95th percentile	Total precipitation when daily precipitation > 95th percentile			✓
Precipitation > 99th percentile	Total precipitation when daily precipitation > 99th percentile			✓
5-, 20-, and 50- year annual maximum 1-day precipitation	Annual maximum 1-day precipitation with a return period of 5, 20 or 50 years			✓
Short-duration Intensity Duration Frequency (IDF)	IDF curves relate short-duration rainfall intensity with its frequency of occurrence and are often used for flood forecasting and urban drainage design	✓		

OTHER VARIABLES

Climate indices	Description	Climate Data.ca	Climate Atlas of Canada	PCIC Climate Explorer
Growing season length	Interval between the first six days with daily mean temperature > 5 °C and the first span after July 1 of six days with mean temperature < 5 °C			✓
Frost free season	Approximate length of the growing season where there are no freezing temperatures to kill or damage frost-sensitive plants	✓	✓	
First fall frost	Marks the approximate end of the growing season for frost-sensitive crops and plants	✓	✓	
Last spring frost	Marks the approximate beginning of the growing season for frost-sensitive crops and plants	✓	✓	
Corn heat units	Temperature index used to indicate whether there are sufficient heat units in a region to permit growing corn		✓	
Growing degree days (5°C)	Growing degree days (GDD) are a measure of whether climate conditions are warm enough to support plant and insect growth	✓	✓	✓
Growing degree days (10°C)			✓	
Growing degree days (15°C)			✓	
Growing degree days (4°C)			✓	
Standardized precipitation evapotranspiration index (3-months)	A drought index based on the difference between precipitation and potential evapotranspiration; Negative (positive) values indicate water deficit (surplus)	✓		
Standardized precipitation evapotranspiration index (12-months)		✓		

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6 Glossary

Adaptation: Actions taken to prepare for the effects of climate change, including those to maximize the potential to take advantage of new opportunities and actions to minimize the consequences of risks.

Coupled model intercomparison project, phase 6 (CMIP6): A coordinated climate modelling exercise involving over 20 climate modelling groups from around the world, which has produced a standard experimental protocol for studying the output of many different global climate models.

Downscaling: A process of translating large-scale climate model outputs to a higher spatial resolution. Downscaling techniques include both dynamical methods, such as RCMs run at a finer scale, and statistical methods, which combine observed climate information with climate model simulation outputs.

Emission scenario: Because future emission levels are unknown, climate models are run under different potential levels of future emissions, based on plausible long-term socioeconomic trends, including land use patterns and energy consumption.

Ensemble: Many different climate models exist and take various approaches. Because no one model can be considered the best, it is standard practice in climate change studies to use the outputs of many models when studying projected future climate changes. This provides a plausible range of outcomes for analysis and decision-making. The group of models that contribute to any such aggregate result is called the ensemble of models.

Global climate model (GCM): GCMs use powerful computers to model the planet's climate using equations and parameters to describe patterns, processes, and interactions in the atmosphere and oceans and to project future climate changes under different carbon emission scenarios.

Greenhouse gases (GHGs): Gases that can absorb and emit thermal infrared (heat) energy, including water vapour, carbon dioxide, methane, nitrous oxide and ozone. Too high of a concentration of GHGs in the atmosphere can result in planetary warming.

Historical data: Data about the past climate, including that collected by weather stations across the country (observed historical data) or generated from climate models (simulated historical data).

Mitigation: Actions taken to reduce GHG emissions or enhance sequestration of GHGs, thereby reducing the long-term severity of climate change.

Percentile: Used to indicate where a value falls in a dataset. For example, the median represents the 50 per cent value, the 90th percentile represents the value below which 90 per cent of the data falls.

Projection: In climate science, projections are the simulated outputs of climate models run under different scenarios representing potential future levels of GHG emissions.

Radiative forcing: The change in the balance of incoming and outgoing energy in Earth's climate system resulting from a change in a driver of climate change, measured in Watts per square meter. Positive radiative forcing increases the energy of the climate system and thereby the temperature of the planet.

Regional climate model (RCM): High-resolution climate models driven by the boundary conditions from a GCM through a process known as dynamical downscaling. The regional focus of these models produces climate projections at a smaller spatial scale (10 to 50 kilometres) compared with that of the GCMs (hundreds of kilometres).

Representative concentration pathways: Standard scenarios used in CMIP5 to simulate how the climate might change in response to different levels of human activity. In effect, these scenarios represent possible trajectories of GHG concentrations. Four RCP scenarios were used in CMIP5 to guide climate research, each leading to a different degree of radiative forcing (indicated by the number given to each RCP).

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