



Climate Data Foundations for Post-Secondary Students

Featuring learning resources from ClimateData.ca

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Environment and
Climate Change Canada

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Climate basics

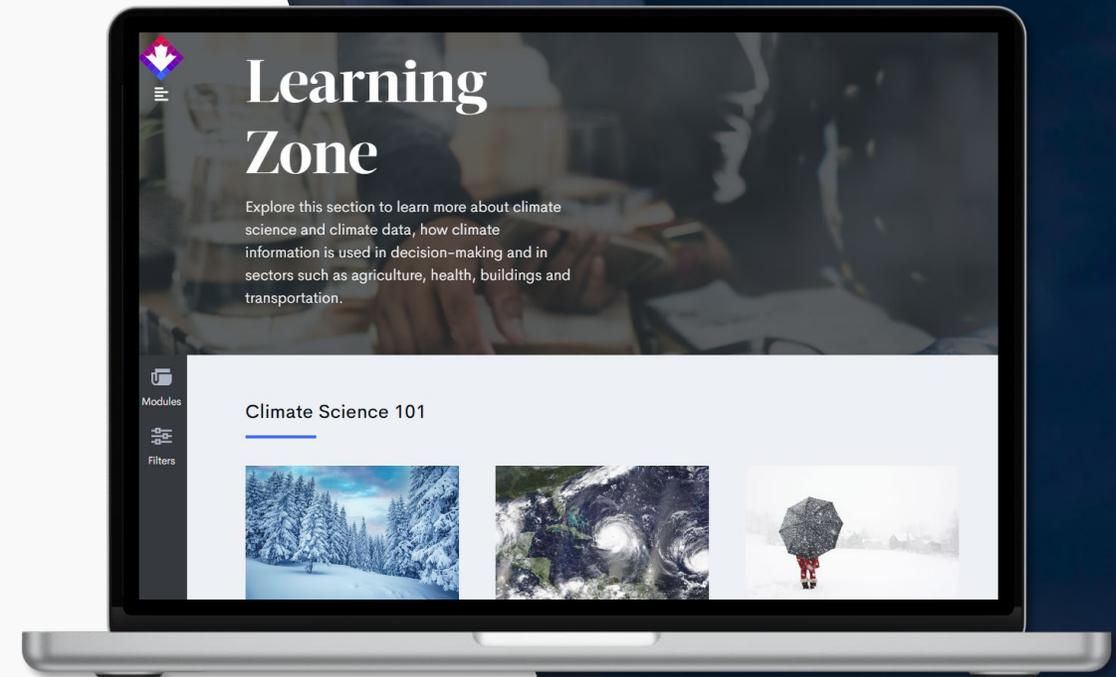
**An introduction to climate
change key concepts**

Climate data for students and researchers



Resources on ClimateData.ca

- Your future is shaped by climate change—now is the time to improve your climate literacy
- Every sector, discipline, and profession in Canada is impacted by climate change, which not only affects averages in temperature and precipitation, but also extremes
- Historical climate data is no longer a good indicator of future climatic conditions because the climate is changing so rapidly

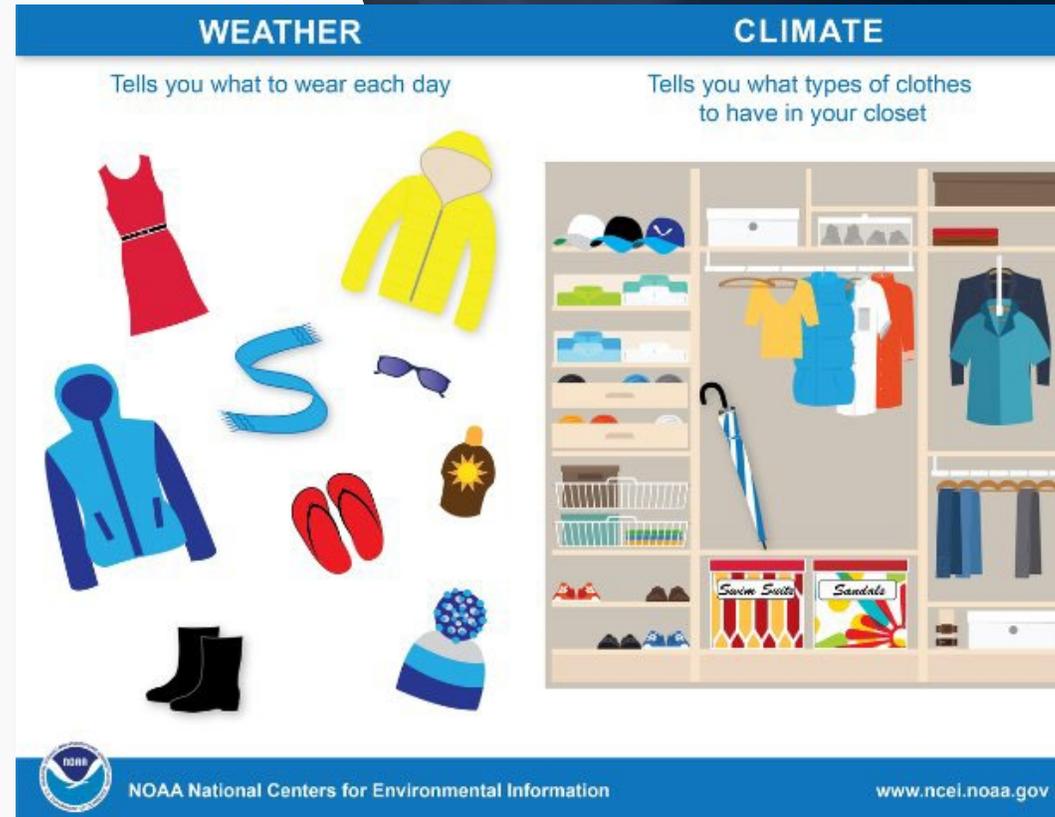


Further learning: “ClimateData.ca Learning Zone”

Climate basics

Climate is the *long-term* statistics of weather

- **Weather** is the specific conditions at a location and time, and these conditions impact the outfit that you will wear on a particular day
- **Climate** determines the rest of the clothes you need in your closet throughout the year
- If climate changes, and we don't adapt our wardrobe, then we run the risk of exposure to environmental conditions we're not prepared for



Further reading: “Weather vs Climate”

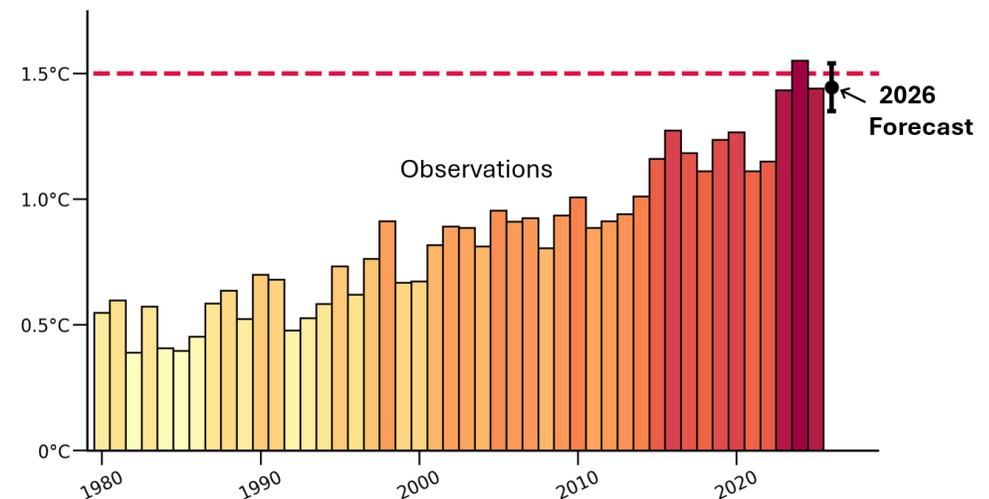
Climate has already changed

Human causes of climate change are dominant

- Human activities and natural climate variations have contributed to observed warming
- However, the human factor is the dominant driver of warming, both globally and in Canada
- Right now, we are experiencing an average annual global temperature that is close to 1.5 degrees warmer than the pre-industrial average



Annual global mean temperature above pre-industrial

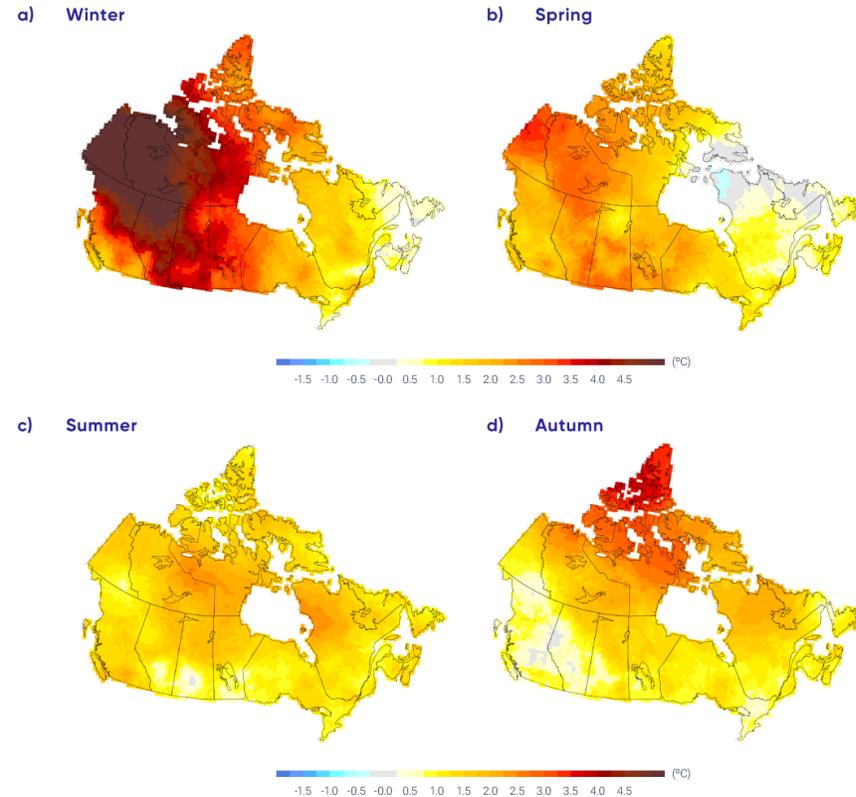


Further reading: “2026 likely to be among the four hottest years on record”

Climate is changing

The extent of warming is not the same everywhere and not uniform by season

- Both past and future warming in Canada is, on average, **about double** the magnitude of global warming
- **Northern Canada** has warmed and will continue to warm at more than double the global rate
- Annual and seasonal mean temperatures across Canada have increased, with the **greatest warming occurring in winter**



Further reading: “Canada’s Changing Climate Report”

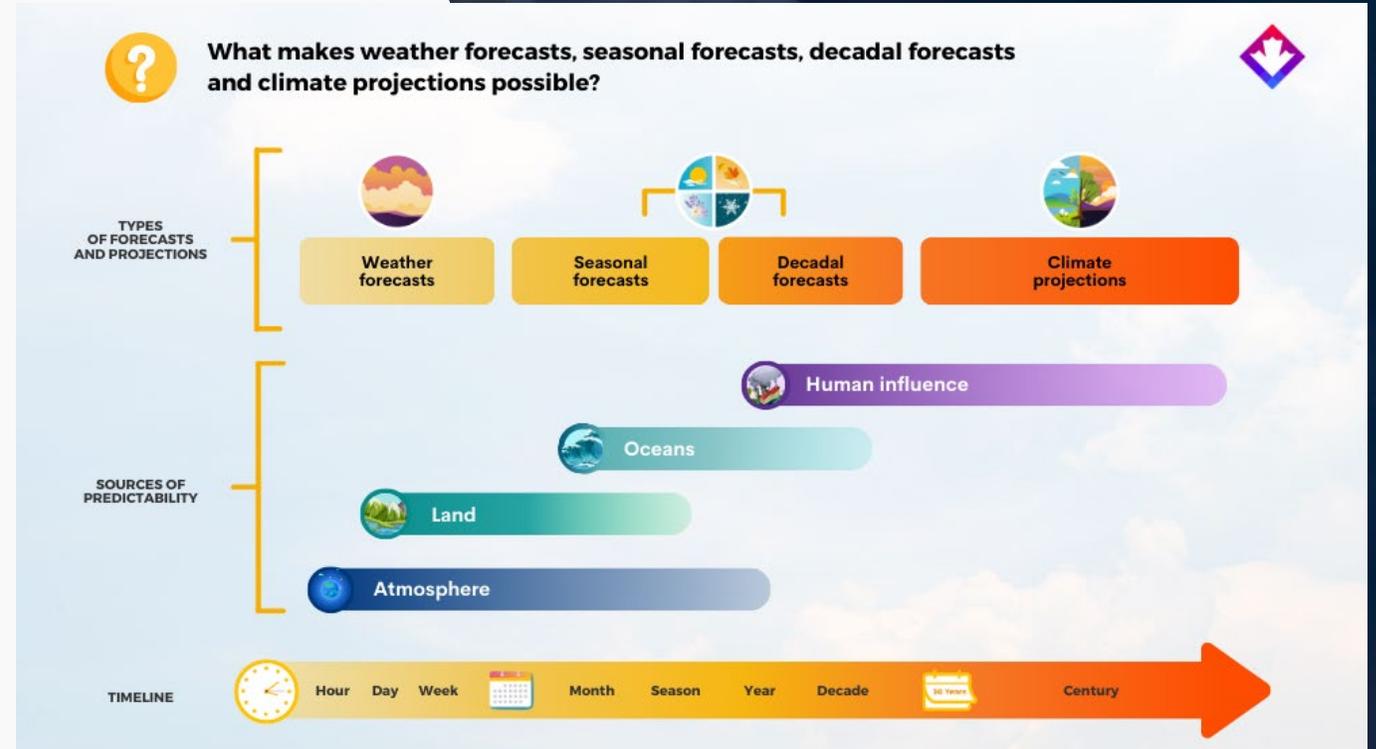
Canada’s Changing Climate Report (2019):
<https://changingclimate.ca/CCCR2019/>

Climate is changing



Climate Variability vs Climate Change

- There are natural phenomena that drive changes in climate over time scales ranging from seasonal to annual to decadal
- Seasonal to decadal fluctuations are influenced by ocean-driven sources of natural variability, such as El Niño
- For longer-term, human-driven climate change, the World Meteorological Organization considers a thirty-year period the minimum needed to define a climate normal and to distinguish underlying trends from natural variability



Further reading: “Natural variability”



Understanding historical data

**Different types of historical
climate data available on
[ClimateData.ca](https://climatedata.ca)**

Historical data

Historical data alone are no longer adequate for future planning or adaptation

- Historical data are useful for establishing baselines against which changes in climate can be evaluated
- ClimateData.ca provides different types of historical data:
 - Observed station data
 - Gridded historical data
 - Modelled historical data
 - Climate normal (average climate conditions of a particular location over a 30-year period)
 - The Adjusted and Homogenized Canadian Climate Data



Historical Climate Datasets available on ClimateData.ca



Further learning: Find and download historical climate data for your community

Which historical data set should you choose?



- If you are solely interested in understanding past conditions, and if your location of interest is near a weather station, you would use the station data observations
- If you are interested in understanding the trends in past conditions at specific locations, you should use a dataset called Adjusted and Homogenized Canadian Climate Data (AHCCD)
- If you are interested in understanding past conditions in areas away from stations, the gridded, ANUSPLIN data could be used
- If you want to compare future projections with past conditions, you should use modelled historical data



Further reading: “Which Historical Data Set Should I Use?”



Understanding future climate projections

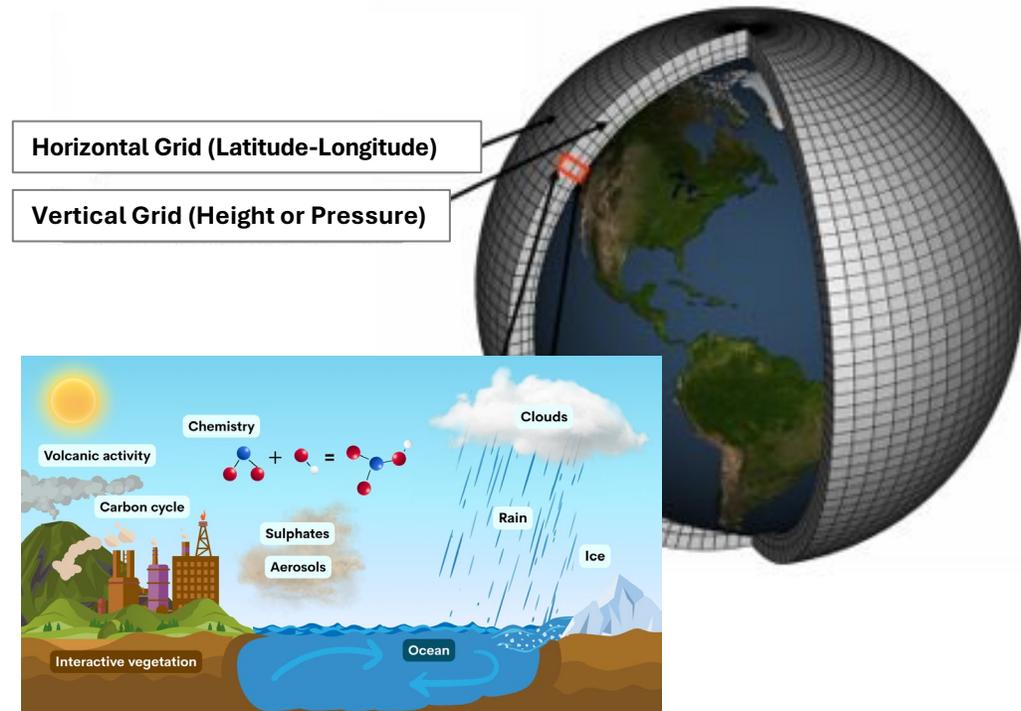
**Climate models and how to
manage uncertainty in
climate model projections**

Climate models



Mathematical representations of the global climate system

- Climate models break down the world into small cubes or 'grid cells'
- Mathematical relationships are used to represent the various components of the climate system, the atmosphere, ocean, land surface and cryosphere
- By adjusting factors such as greenhouse gas concentrations, climate scientists can use climate models to test the impact of human activities on the climate



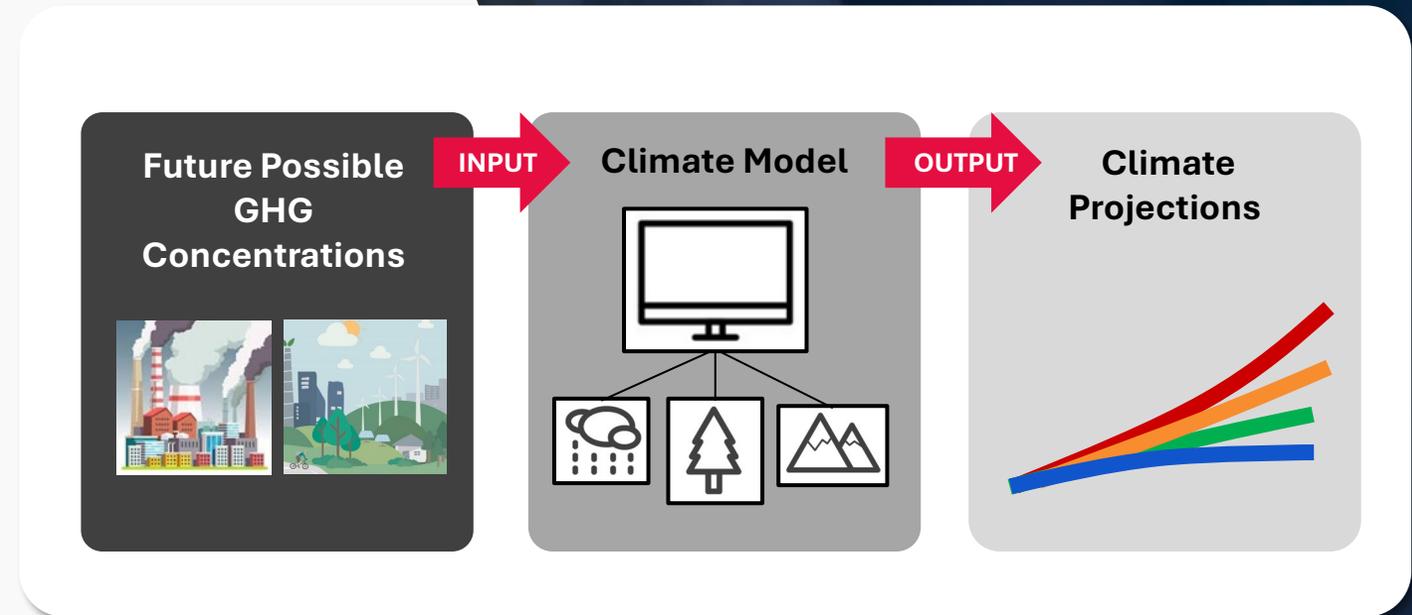
Further learning: “Understanding Ranges in Climate Projections” video

Uncertainties in climate projections



Adapting to a changing climate requires confronting and dealing with uncertainties

- **Natural internal climate variability:** Our climate varies due to natural fluctuations, including semi-cyclical phenomena like El Niño, as well as other influences that are less predictable and vary from year to year.
- **Model uncertainty:** Climate models represent the climate system in different ways and are continually refined as science and technology advances, which leads to some variation in their projections.
- **Emissions scenario uncertainty:** Because future emissions depend on socioeconomic and technological choices, models use different emissions trajectories to represent a range of possible futures.



Further learning: Uncertainty in Climate Projections

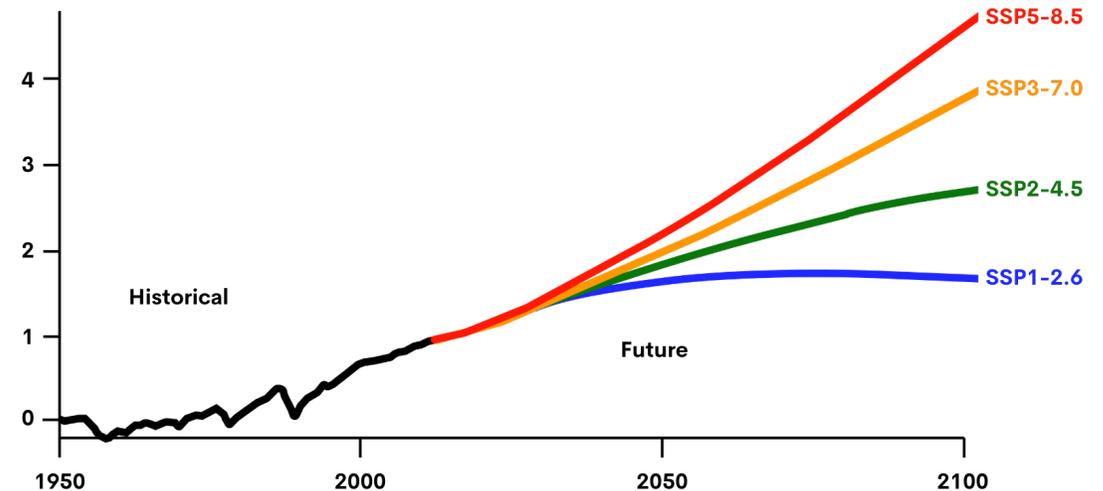
Emission scenario uncertainty

How much the climate will change in the future will be determined by greenhouse gas emissions

- Today, the scenarios used to characterize possible future development pathways for human societies are known as Shared Socio-economic Pathways (SSPs)
- It is important to know about these scenarios – how they are defined and the key differences between them – prior to using future climate data
- ClimateData.ca hosts climate model projections based on four SSP scenarios: SSP1-2.6, SSP2-4.5, SSP3-7.0 and SSP5-8.5



Global Mean Surface Temperature Change (°C)



Further reading: “Understanding Shared Socio-economic Pathways (SSPs)”

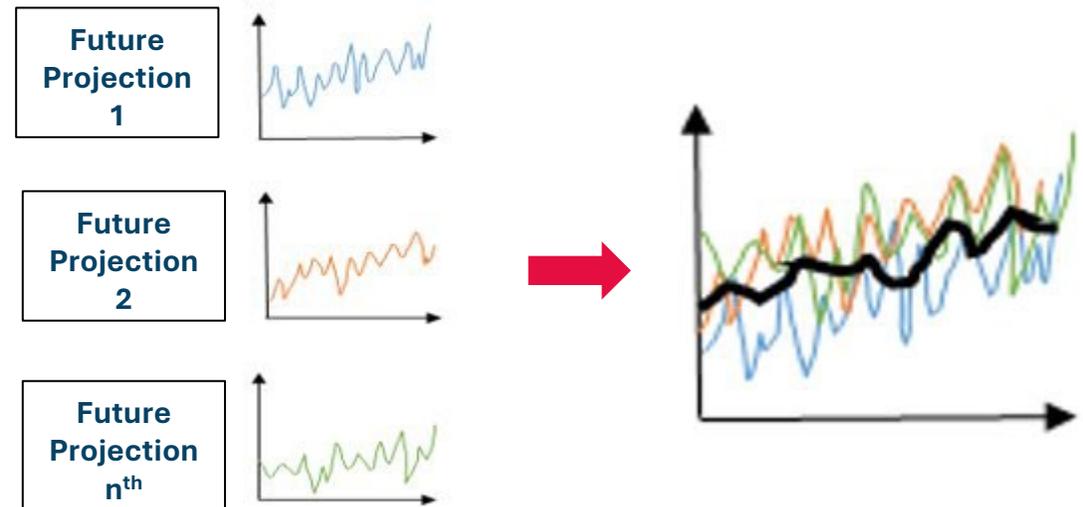
Model uncertainty



Understanding inter-model differences

- While all climate models use well-established principles to simulate the climate, each model uses slightly different approaches, which produce inter-model differences
- Each model has different strengths and weaknesses. For example, models may use different spatial scales, which affect how well they represent topography. There is also variation in model parameters (e.g., how clouds are represented in the model)
- It is recommended that multiple models, known as an ensemble, be used to get a better grasp of what the future may look like

Multi-model ensemble



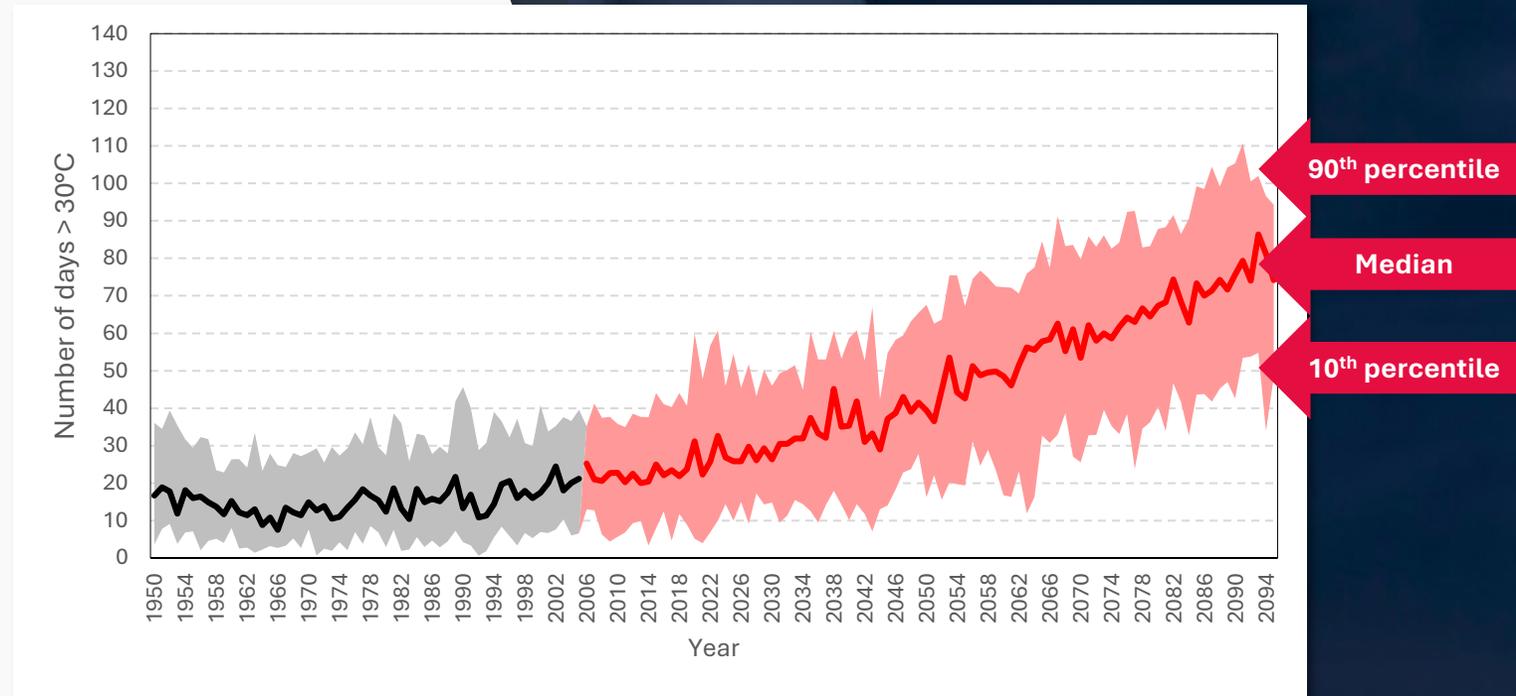
Further reading: “Understanding Multi-Model Ensembles”

Multi-model ensembles



Visualizing inter-model differences

- Percentiles are used to show us where the majority of individual model results fall within the ensemble
- Three ensemble statistics are available on ClimateData.ca: the 10th, 50th, and 90th percentiles
- Most model results fall between the 10th and 90th percentiles. The 50th percentile (the median) represents the midpoint of the distribution, with half of the model results above and half below



Further reading: “Understanding Multi-Model Ensembles”

Global Warming Levels (GWLs)



- GWLs can be used to explore and compare changes in climate at specified levels of global warming, including the limits on global temperature increase committed to in the Paris Agreement
- The GWL approach shifts the uncertainty in regional climate projections from the magnitude of the change associated with different emissions scenarios to the time when specific GWLs will be reached
- The GWL approach makes it easier to relate global warming targets to regional impacts and is a useful complement to the emissions scenario approach for presenting climate change projections.

Global warming level (°C)	SSP1-2.6	SSP2-4.5	SSP3-7.0	SSP5-8.5
1.5	2023-2042	2021-2040	2021-2040	2018-2037
2.0	n.c.	2043-2062	2037-2056	2032-2051
3.0	n.c.	n.c.	2066-2085	2055-2074
4.0	n.c.	n.c.	n.c.	2075-2094

The first 20-year period during which the average global surface temperature change (°C) exceeds the specified global warming level relative to the pre-industrial period (1850-1900) is shown. An “n.c.” indicates that the global warming level is not crossed during the period 2021-2100. [Source: Adapted from [IPCC Cross-Section box TS.1](#)]



Further reading: “Introduction to Global Warming Levels”



Learning Zone “Deep Dive Topics”

**A focus on different topics,
datasets, and regions**



Seasonal to decadal forecasts

- ClimateData.ca offers forecasts that cover rolling 3-month periods over the next 12 months
- Seasonal forecasts describe the probability of a variable (e.g., mean temperature) being above, near, or below normal
- When making decisions using seasonal forecasts, it is important to consider both the probable conditions and the performance of the seasonal prediction system for the season, variable, and location of interest



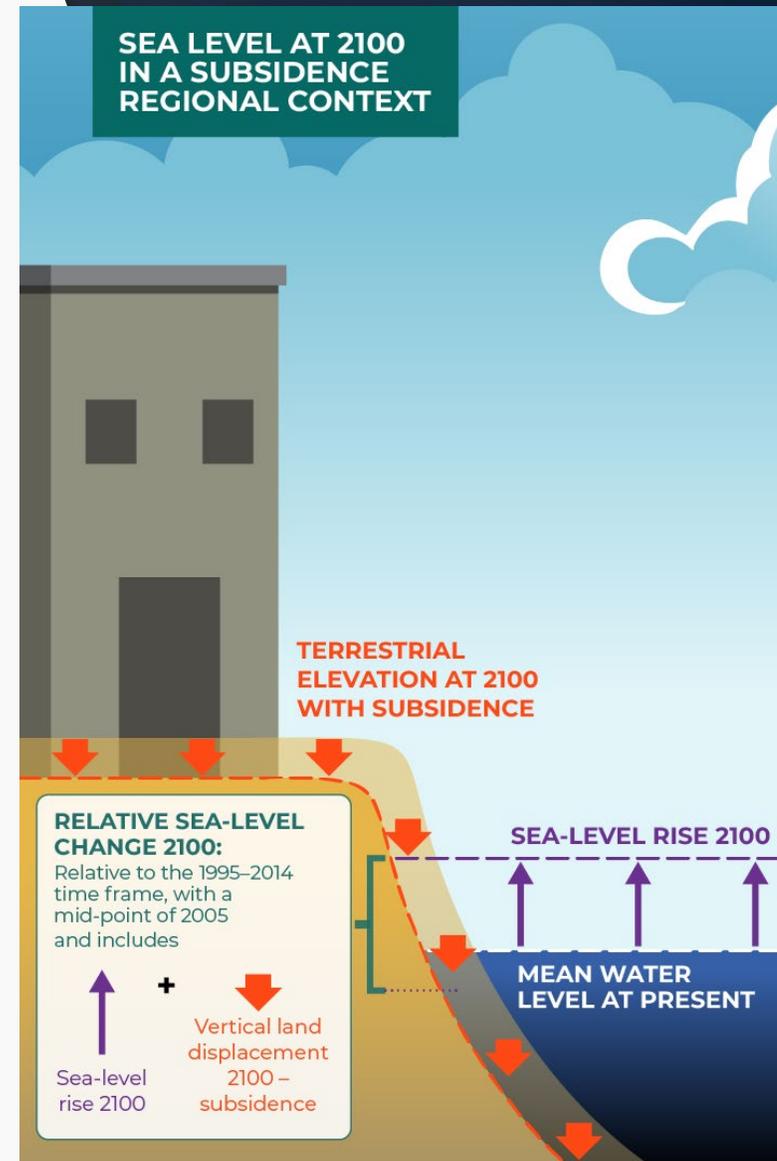
Further reading: “Seasonal to Decadal Forecasts Module”

Marine climate data

- **Relative Sea-Level Change** integrates global sea-level rise projections with local vertical land motion data. This data captures how the land is slowly rising or sinking in response to the retreat of massive ice sheets from the last ice age. The results are high-resolution estimates of relative sea-level change along Canada's coastlines
- **Vertical Allowance** data provides recommended elevations to be added to infrastructure design based on historical and projected future water levels, integrating relative sea-level change projections, local tide and storm surge characteristics, and associated uncertainties to support flood risk assessments and infrastructure resilience planning



Further learning: "Marine and Future Climate Module"

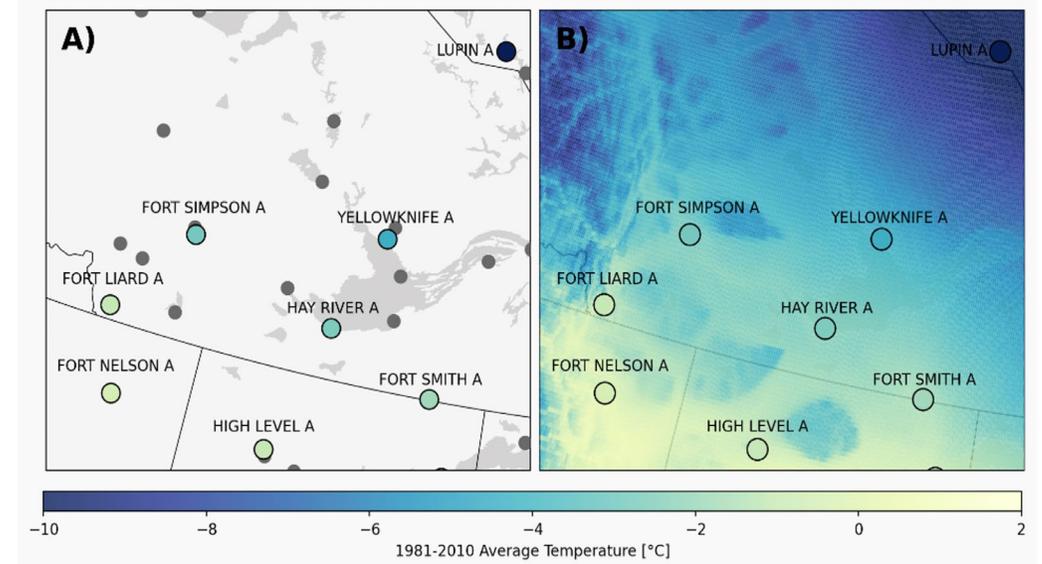


Northern climate data resources



Reliable climate data for northern Canada

- Northern Canada is warming three times as fast as the global average, and the global Arctic is warming nearly four times as quickly
- A variety of Western science-based climate data types are available to support climate-smart decision-making in northern Canada, including observation-based datasets as well as historical and future climate model data
- Indigenous Science, historical climate data and future climate data should be used together to inform adaptation decisions



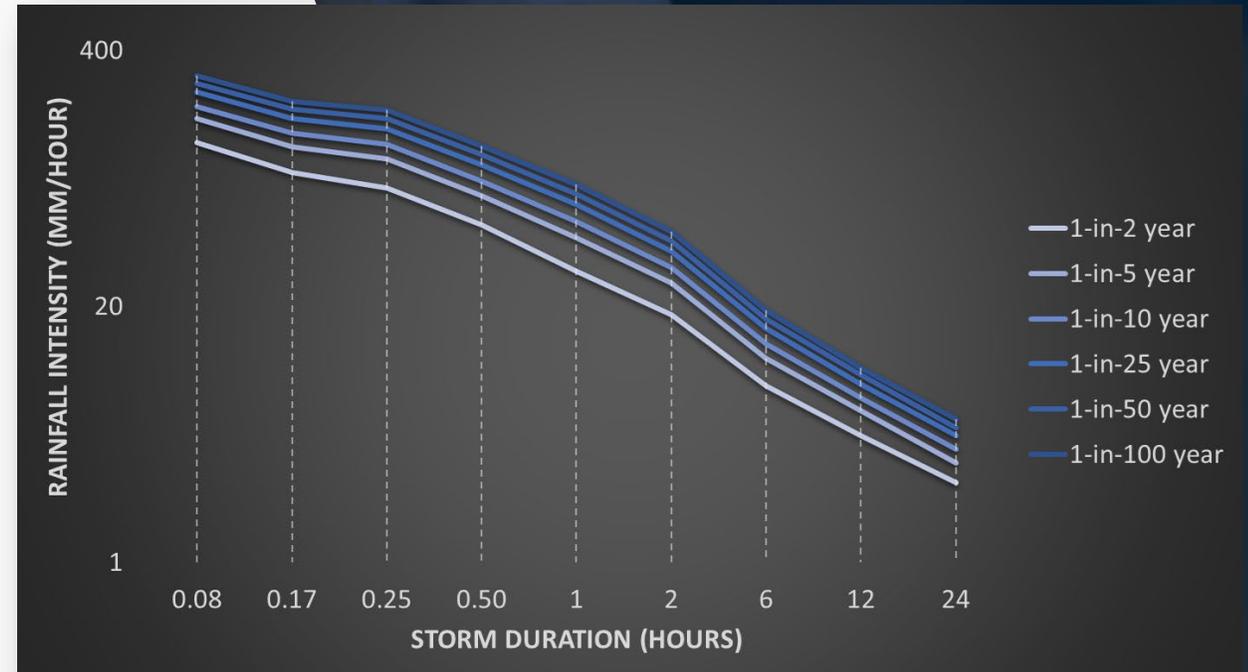
Illustrative example, around Yellowknife, of how weather station data can be interpolated, to transform station data into gridded data. A) AHCCD stations noted in grey circles, with the average temperature from 1981-2010 shown in coloured circles where available. B) The historical gridded data (NRCANmet) based on station data.



Further reading: “Northern Climate Data Resources Module”

Intensity-Duration-Frequency (IDF) data

- IDF curves relate short-duration rainfall intensity with its frequency of occurrence, important for decision-making about the **risks of extreme precipitation**
- IDF data based on historical observations alone are not appropriate for long-term decision-making
- Temperature scaling provides a simple way to update IDF curves for climate change
- Climate change-scaled IDF data is available for all IDF stations on [ClimateData.ca](https://climatedata.ca)

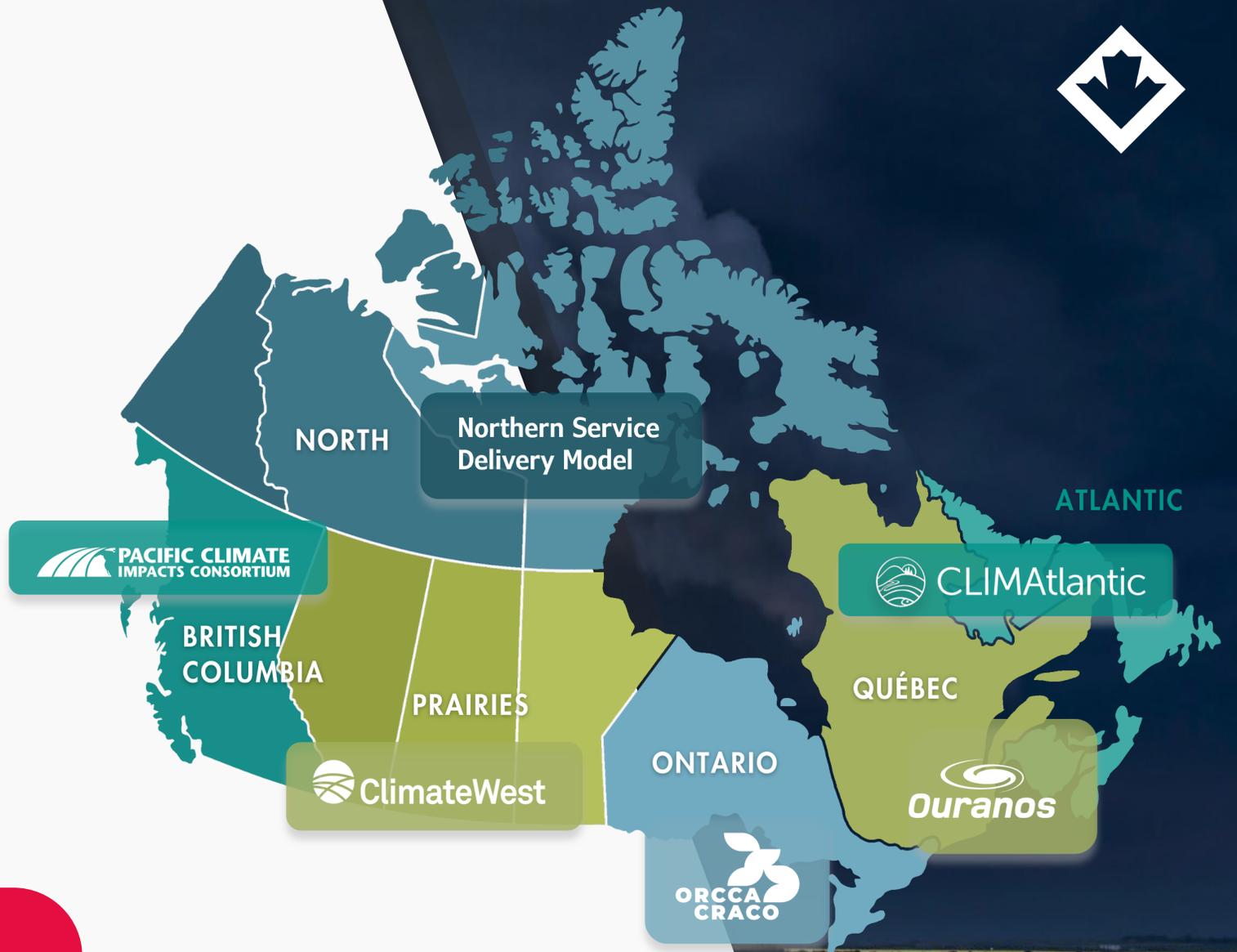


Further reading: “Intensity-Duration-Frequency (IDF) Curves Module”

Regional climate hubs

Profiles featuring climate data hubs from across Canada

- Learn more about each of the regional climate data partners who partner together on ClimateData.ca
- Each partner focuses on a different region of the country



Further reading: “Finding Regional Climate Information”

ClimateData.ca podcast



Audio learning tools about climate data and climate adaptation experiences

- The ClimateData.ca podcast “From Here to There” explores the perspectives of Canadian professionals and their climate adaptation stories

Listen to recent podcast episodes:

- Episode 1: Toronto’s Streets
- Episode 2: Climate Data and Climate Risk Assessments
- Episode 3: Municipal Regulation for Adaptation (fr)
- *Episode 4: Agriculture-focused episode coming soon*



From *here*
to *there*



Further reading: “Podcast pilot launch” with links to three pilot episodes



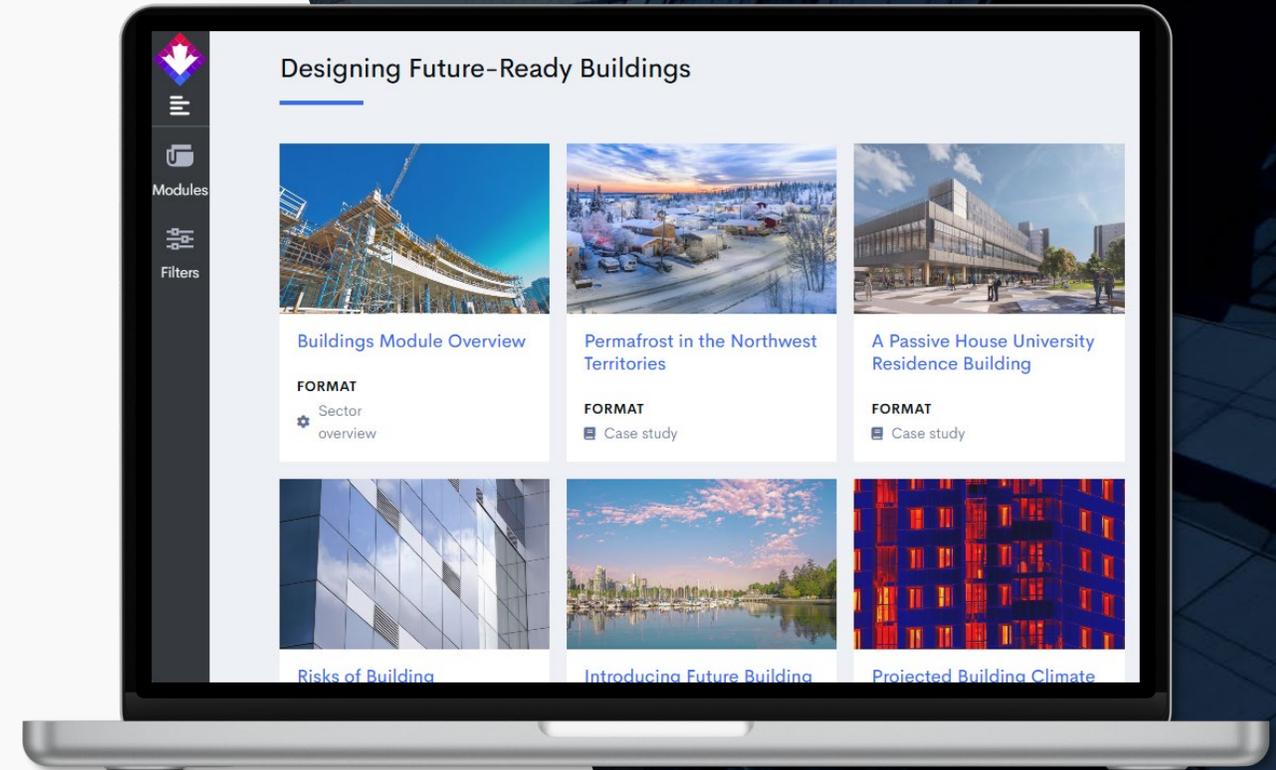
Sector-specific learning modules

**Climate data resources
for your discipline**

Designing future-ready buildings

Explore applications for engineering and infrastructure-related sectors

- Learn about resources currently available to help improve the climate resilience of buildings in the face of a changing climate
- Access Future-Shifted Weather Files, Future Building Design Value Summaries and Future Building Climate Zones
- Explore case studies with practical examples of the integration of climate change information into building planning, design, and operations



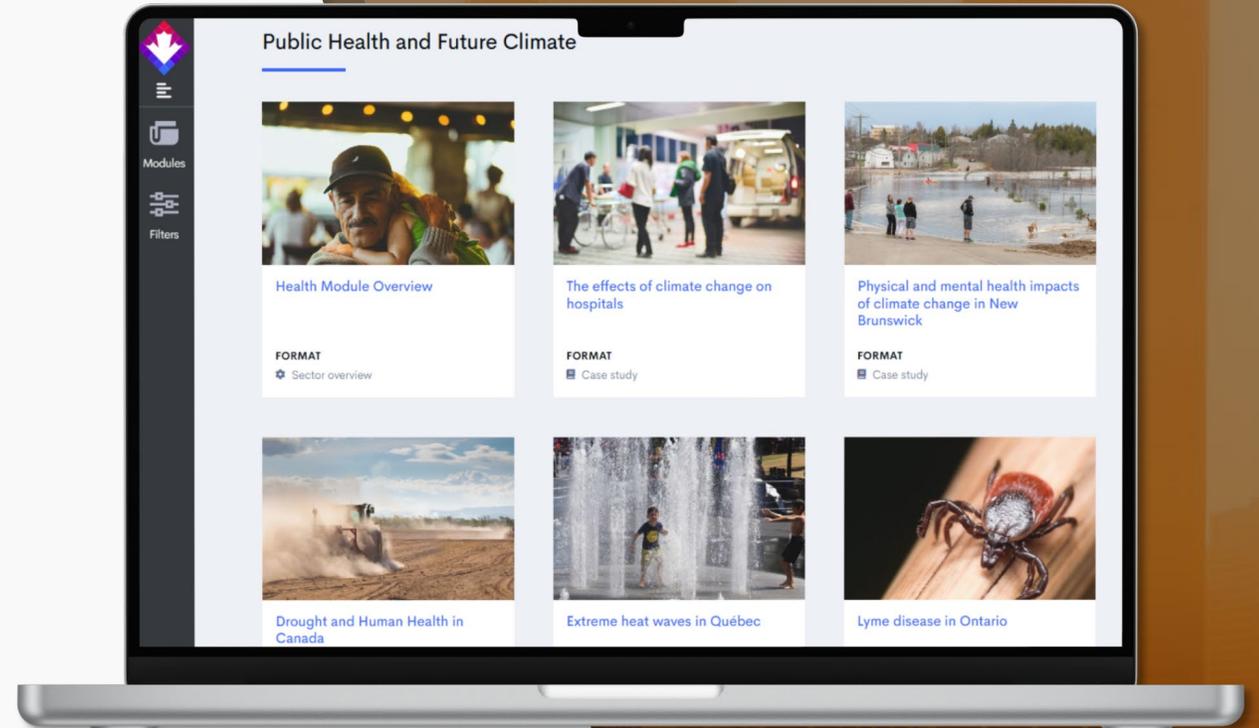
Further reading: “Designing Future-Ready Buildings Module”

Public health and future climate



Communicate and plan for a changing climate

- Explore the impact of climate change on Canada's health system
- Find blogs about climate adaptation written in partnership with Health Canada
- Connect the dots between global warming and the spread of vector-borne diseases
- Understand how drought and extreme weather are already impacting communities



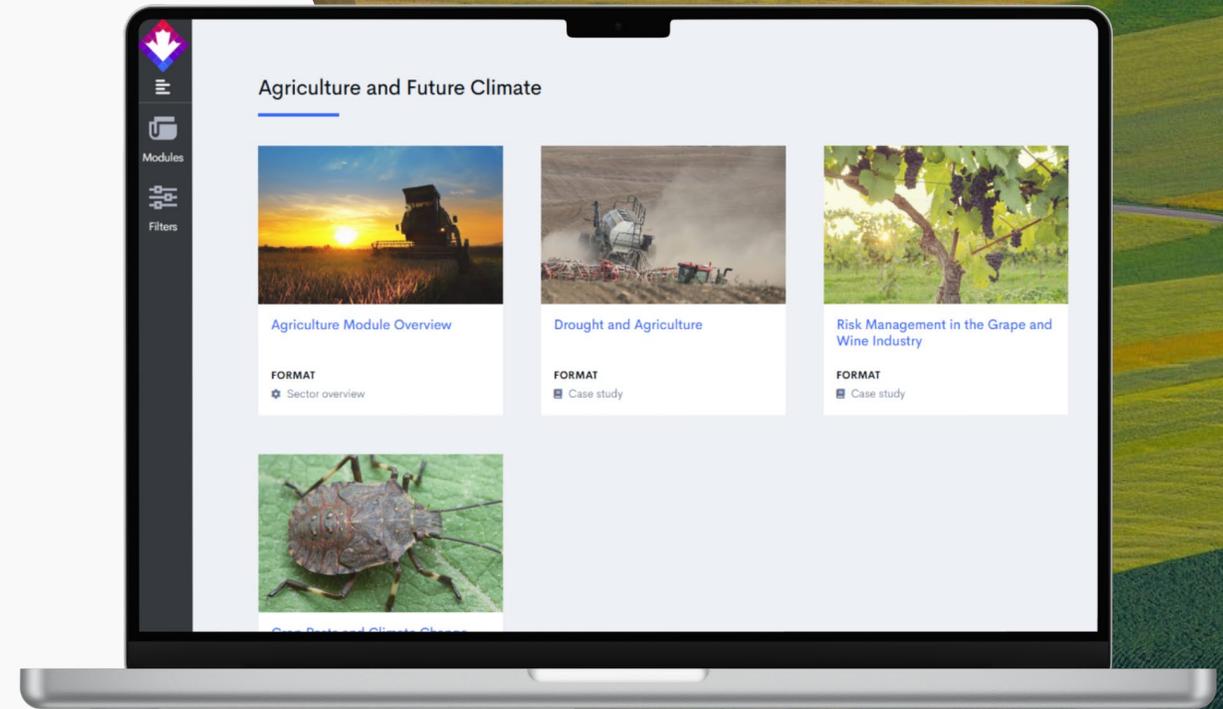
Further reading: “Public Health and Future Climate Module”

Agriculture and future climate



Deepen understanding about how climate change impacts the agricultural sector

- Explore how climate information can be used in agricultural decision-making
- Connect the dots between global warming and the length and timing of growing seasons
- Understand how drought and extreme weather are already impacting communities

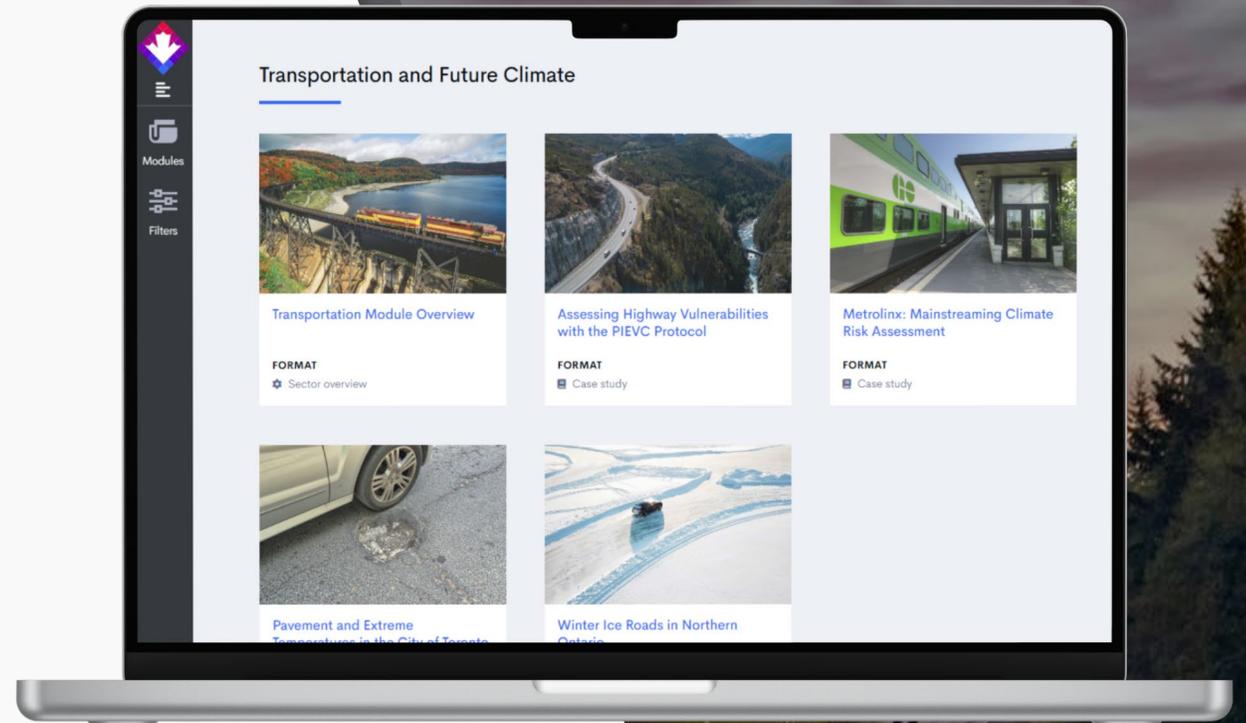


Further reading: “Agriculture and Future Climate”

Transportation and future climate

Adapting transportation infrastructure and operations

- Explore climate data applications for pavement and ice roads
- Understand how changes in freeze-thaw cycles, temperature, and precipitation can impact infrastructure planning
- Learn about codes, protocols, and risk frameworks related to transportation and climate



Further reading: "Transportation and Future Climate"



Thank you for taking this self-guided tour of the climate literacy resources on ClimateData.ca!

Reach out with any questions to ccsc-cccs@ec.gc.ca

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