Environment and Climate Change Canada | Environnement et Changement climatique Canada

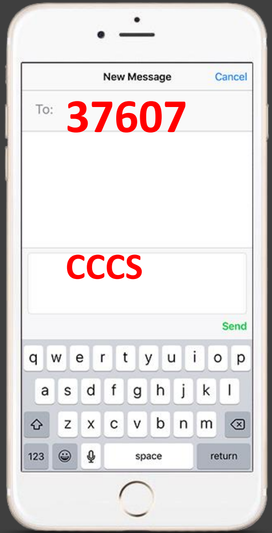
Canada

Leveraging information from climate scenarios for robust infrastructure planning

Trevor Murdock
Canadian Centre for Climate Services

19 July 2023

Interact during the webinar at:



CANADIAN CENTRE FOR CLIMATE SERVICES | CENTRE CANADIEN DES SERVICES CLIMATIQUES

Environment and Climate Change Canada | Environnement et Changement climatique Canada

Canada

Leveraging information from climate scenarios for robust infrastructure planning

Which scenario should I pick?

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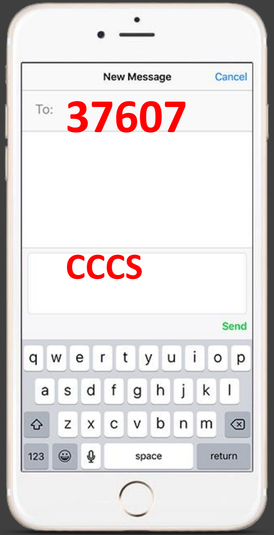

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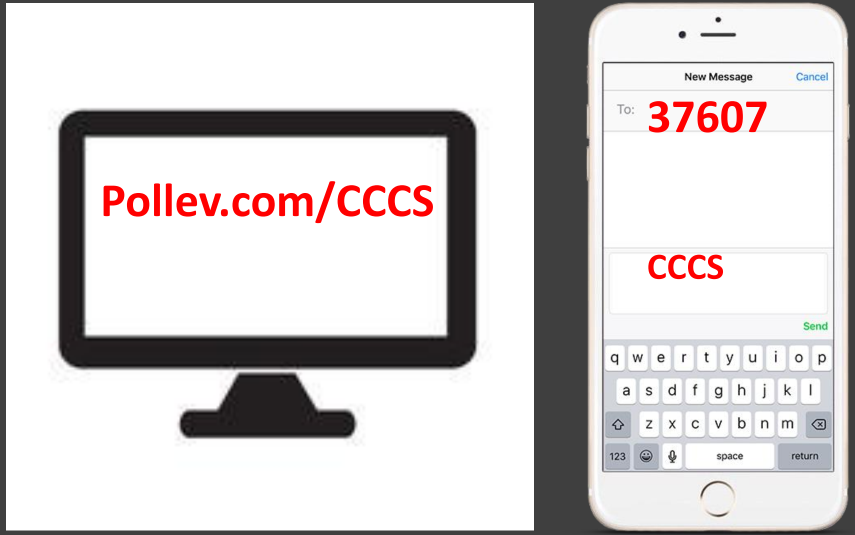
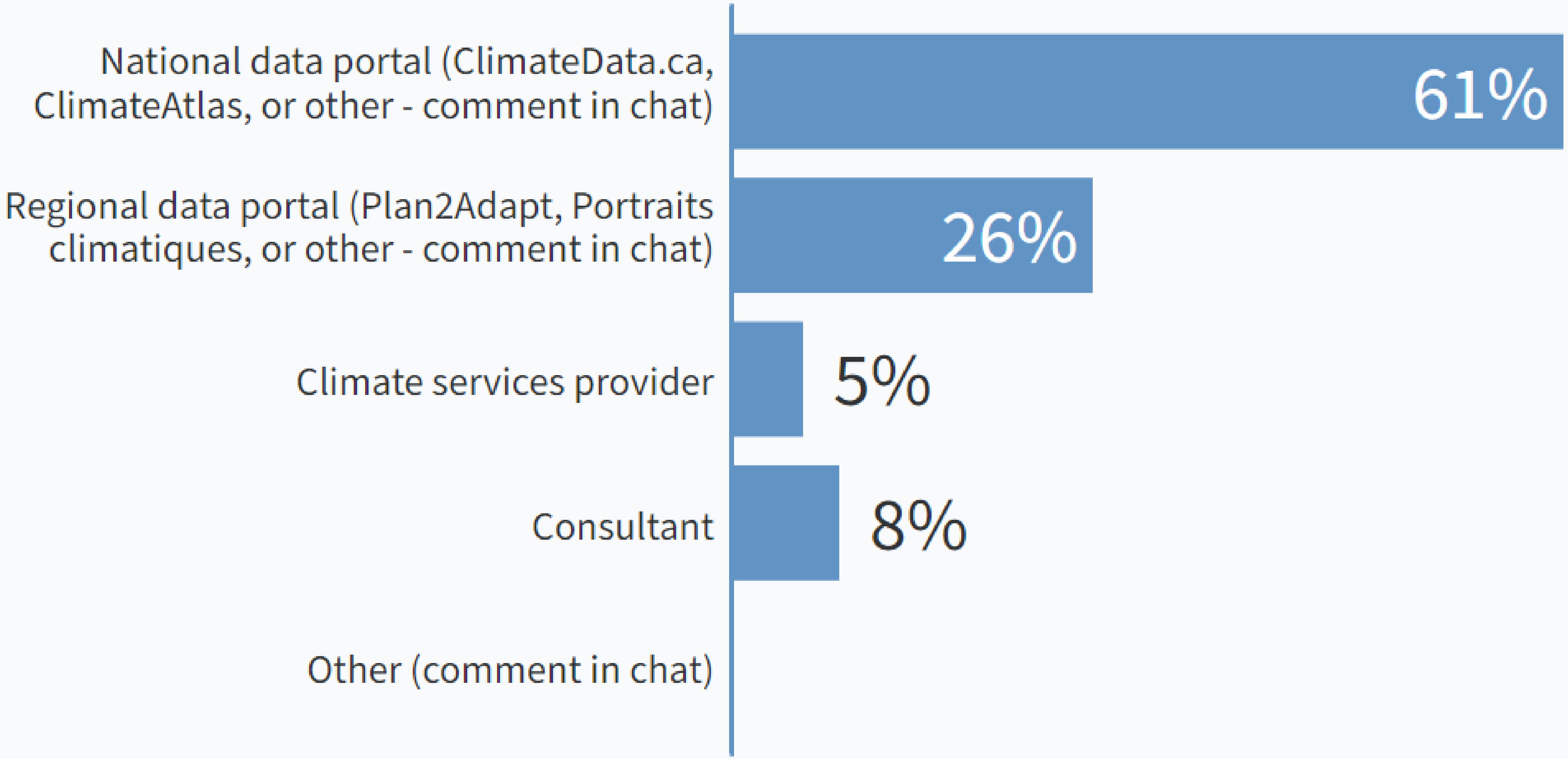
1. Review
   - Role of scenarios in risk assessment
   - Understanding SSPs
   - Uncertainty in Climate Projections
2. Which scenarios to pick?
3. What about GWLs?
4. Discussion

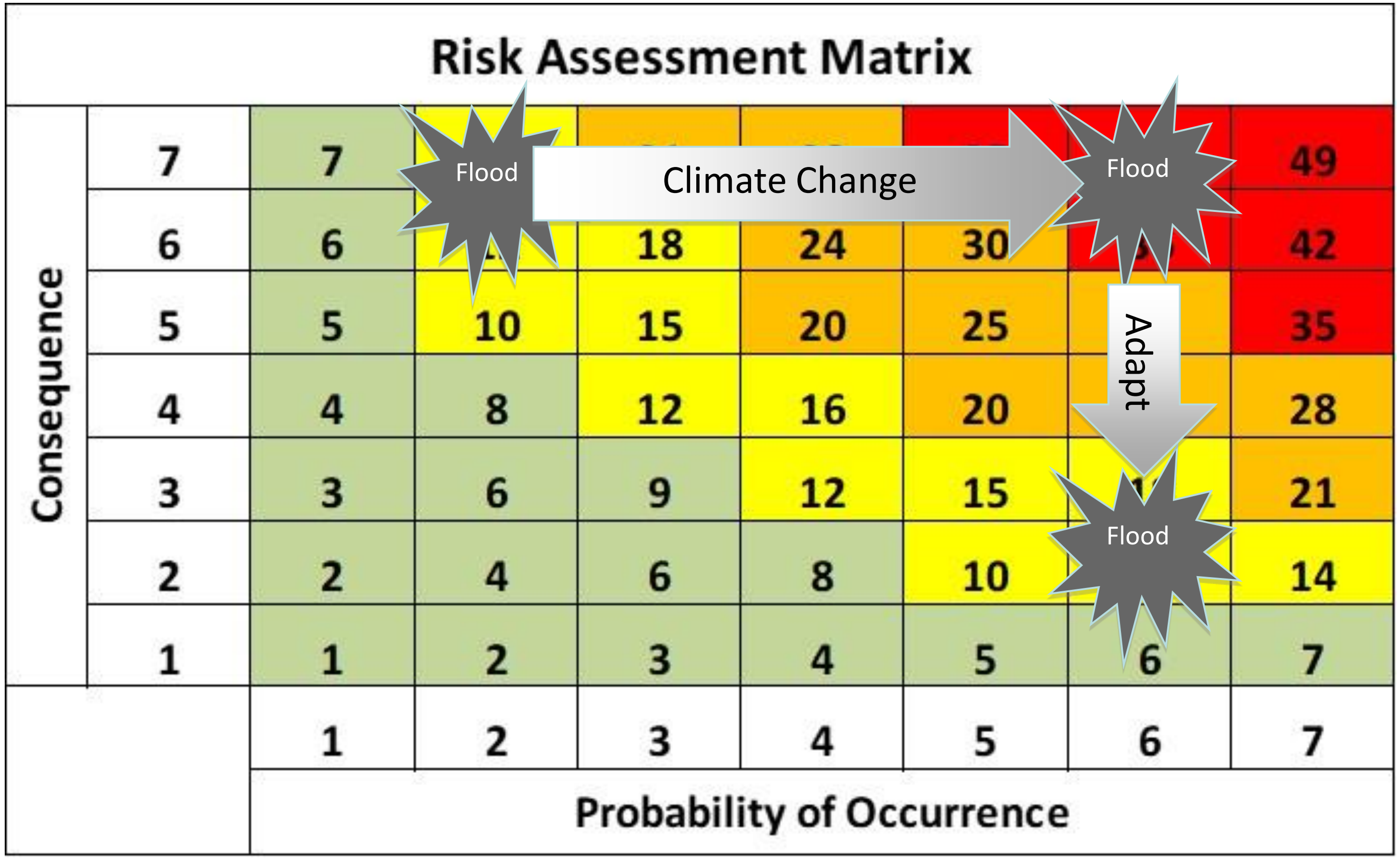
Interact during the webinar at:



Where do you get climate data from for risk assessments?



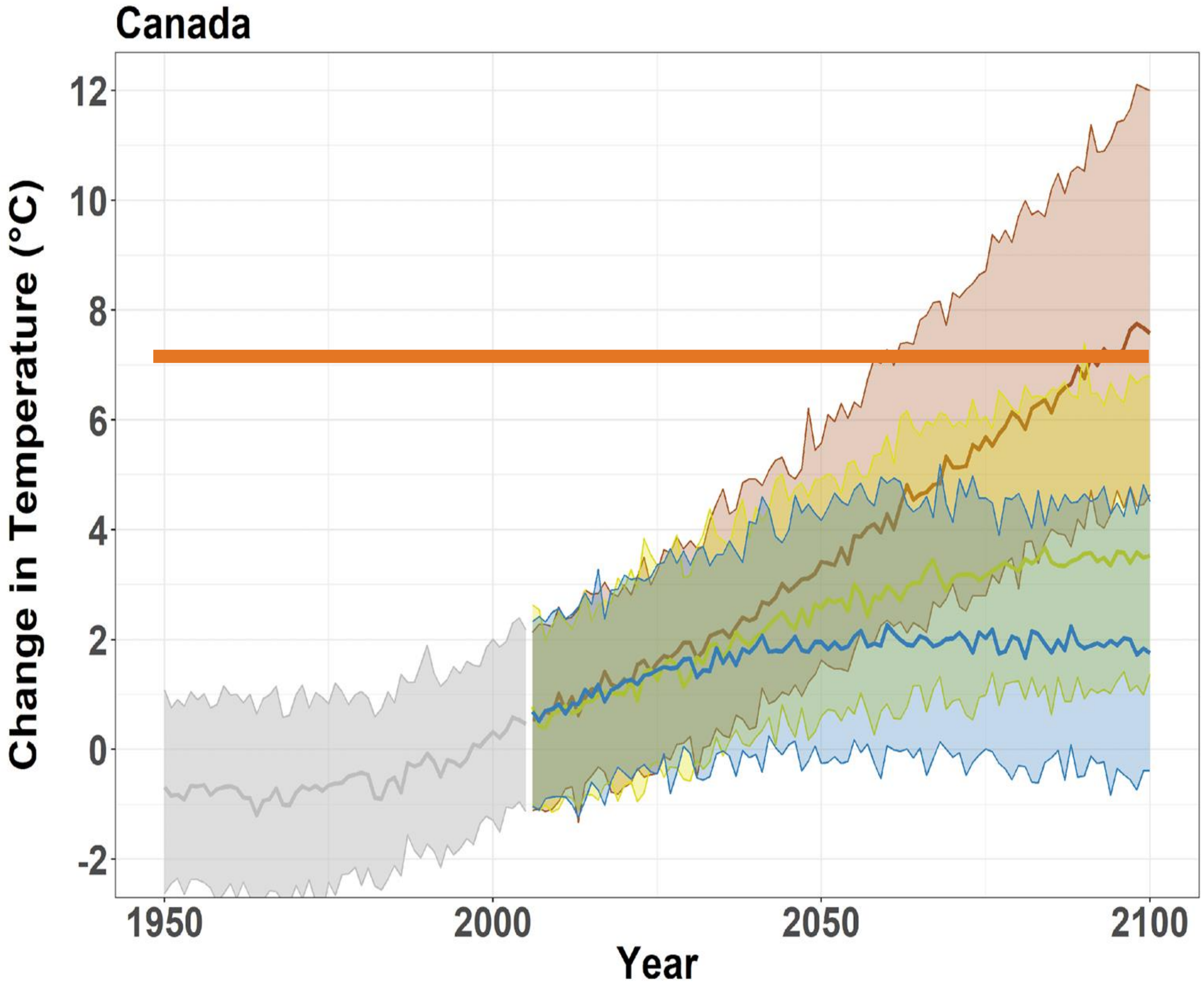
Risk = Likelihood x Consequence



Source: Public Infrastructure Engineering Vulnerability Committee http://www.pievc.ca

Understanding Shared Socio-economic Pathways (SSPs)

Learn about the latest set of emissions scenarios, based on Shared Socio-economic Pathways (SSPs). Understand how SSPs differ from RCP scenarios and learn about key

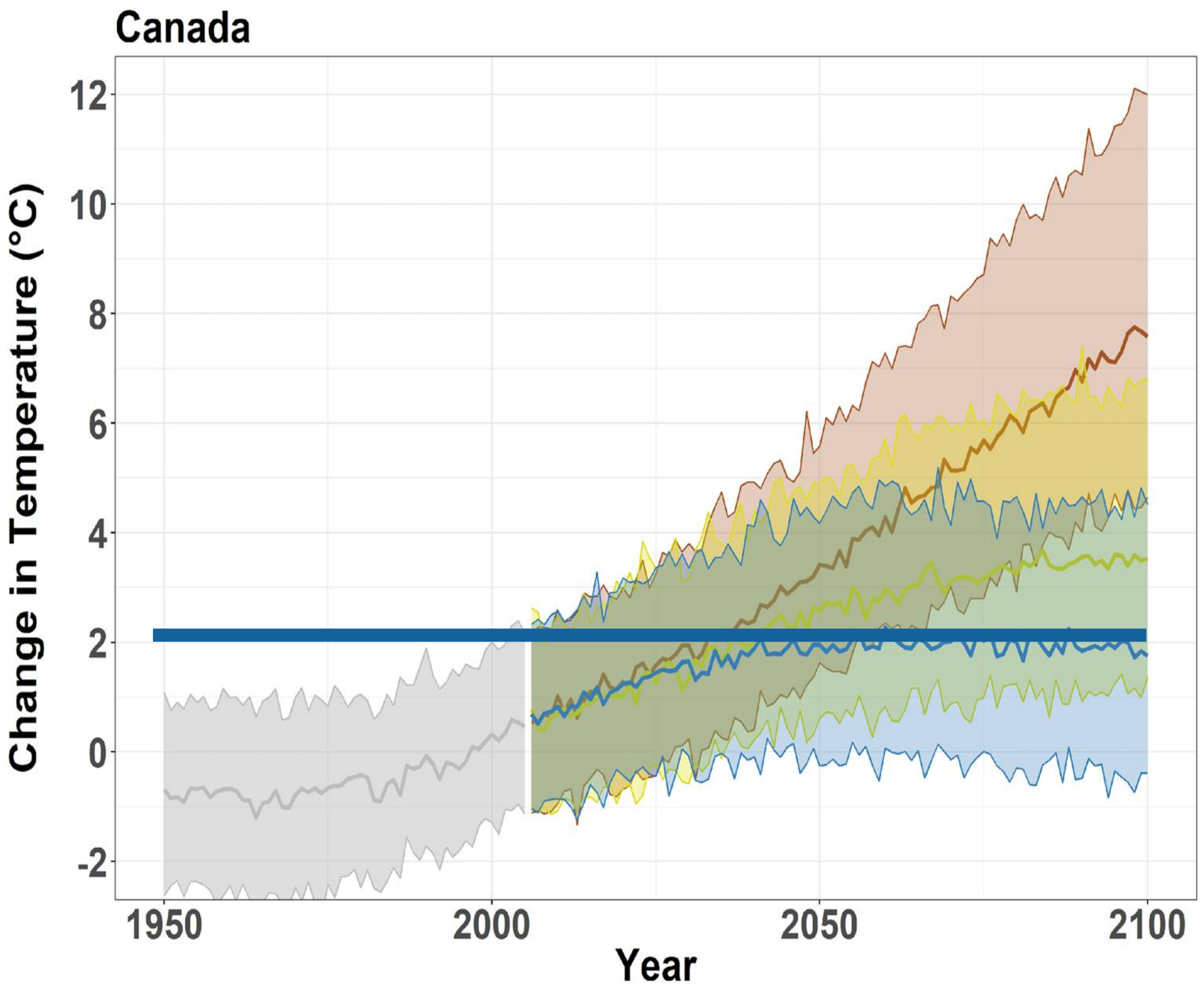


SSP5-8.5

Shared **S**ocioeconomic **P**athway 5: “A high fossil-fuel development world throughout the 21st century.”

UN IPCC AR6

Plot: Canada's Changing Climate Report (2019)

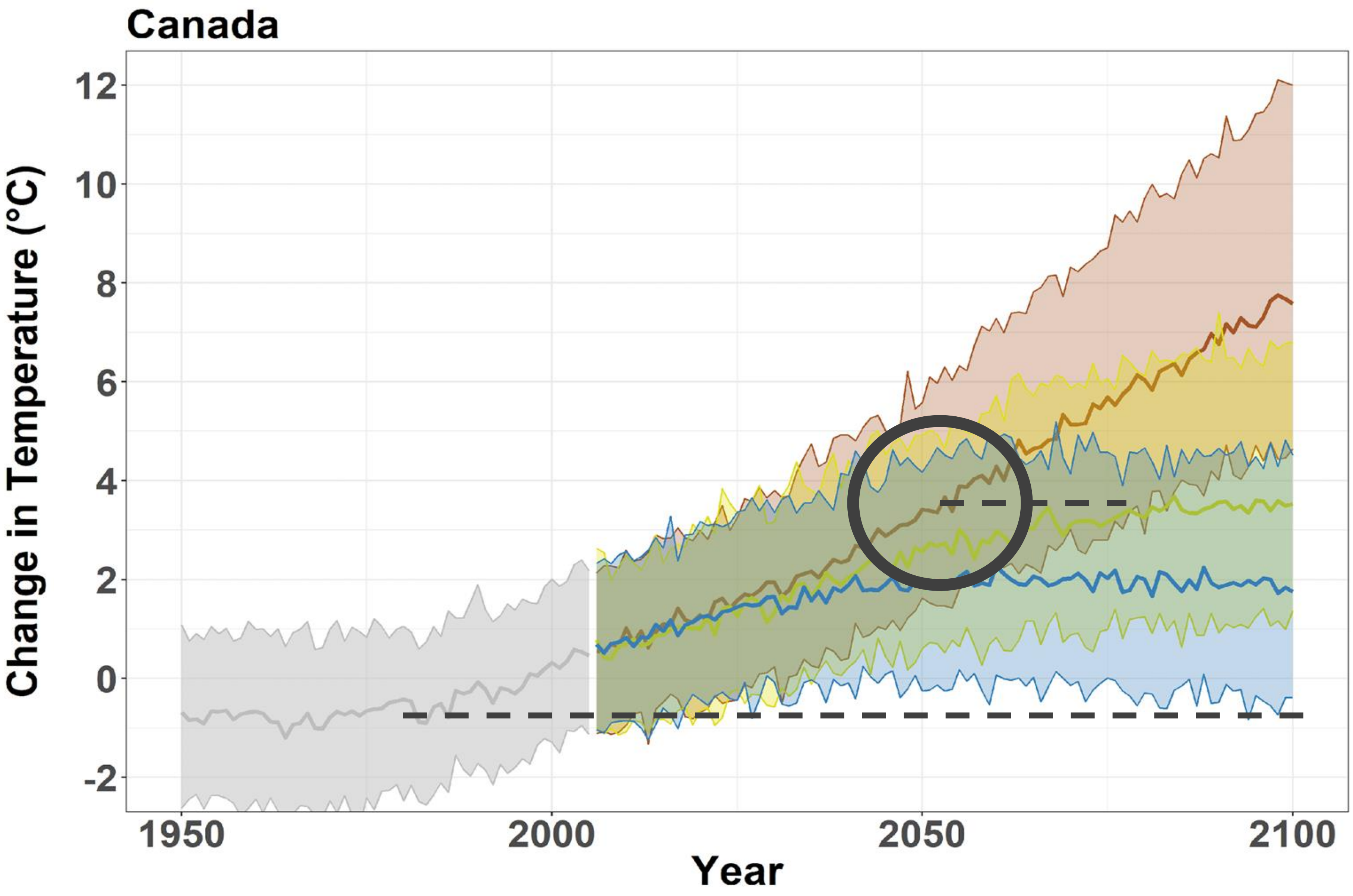


SSP1-2.6

Shared **S**ocioeconomic **P**athway 1: "Consumption is oriented toward low material growth and lower resource and energy intensity."

UN IPCC AR6

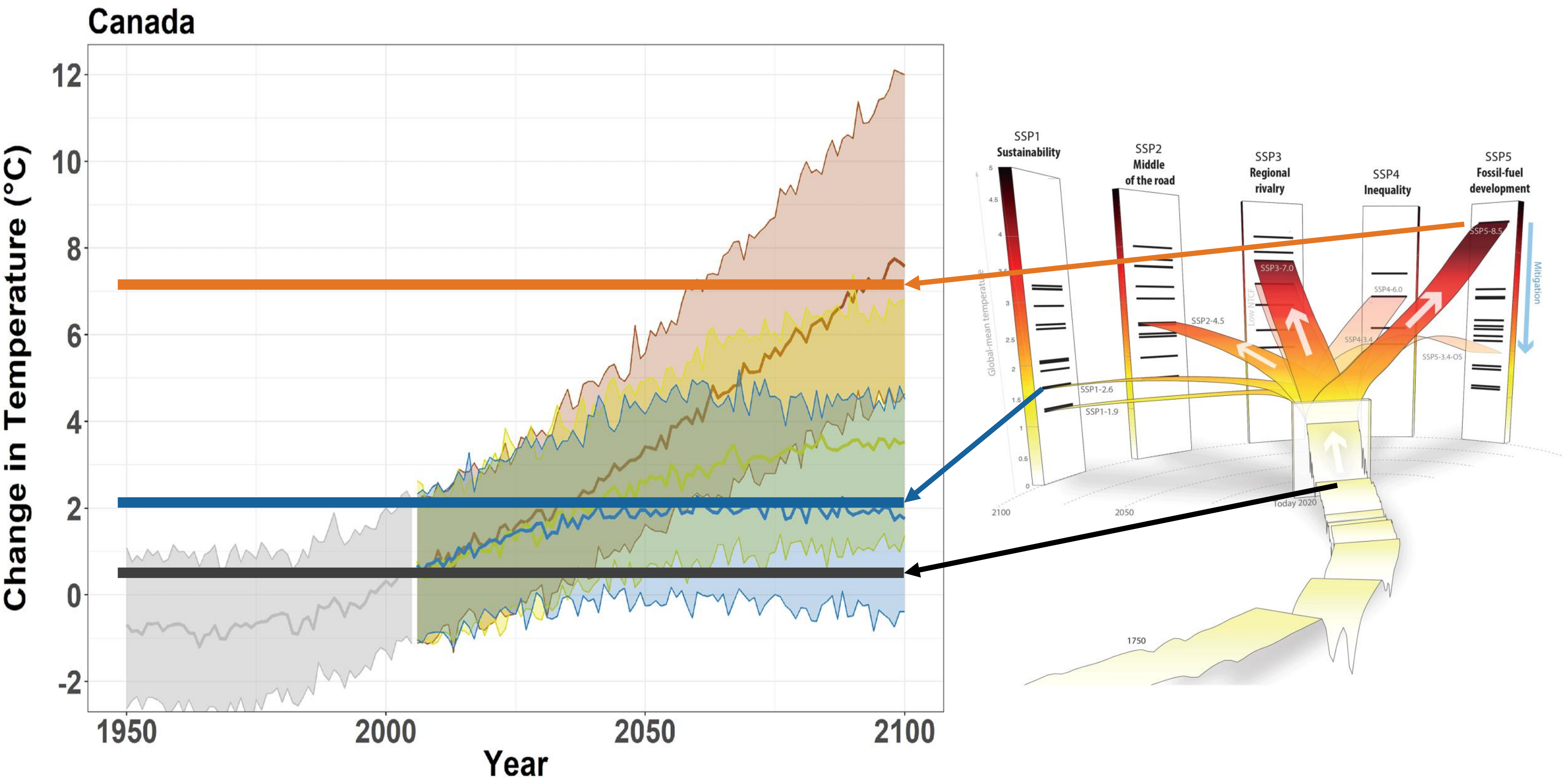
Plot: Canada's Changing Climate Report (2019)



8.5 – major warming by end of century

4.5 – by 2070s reaches 2050s of 8.5

Historical data only no longer fit for purpose

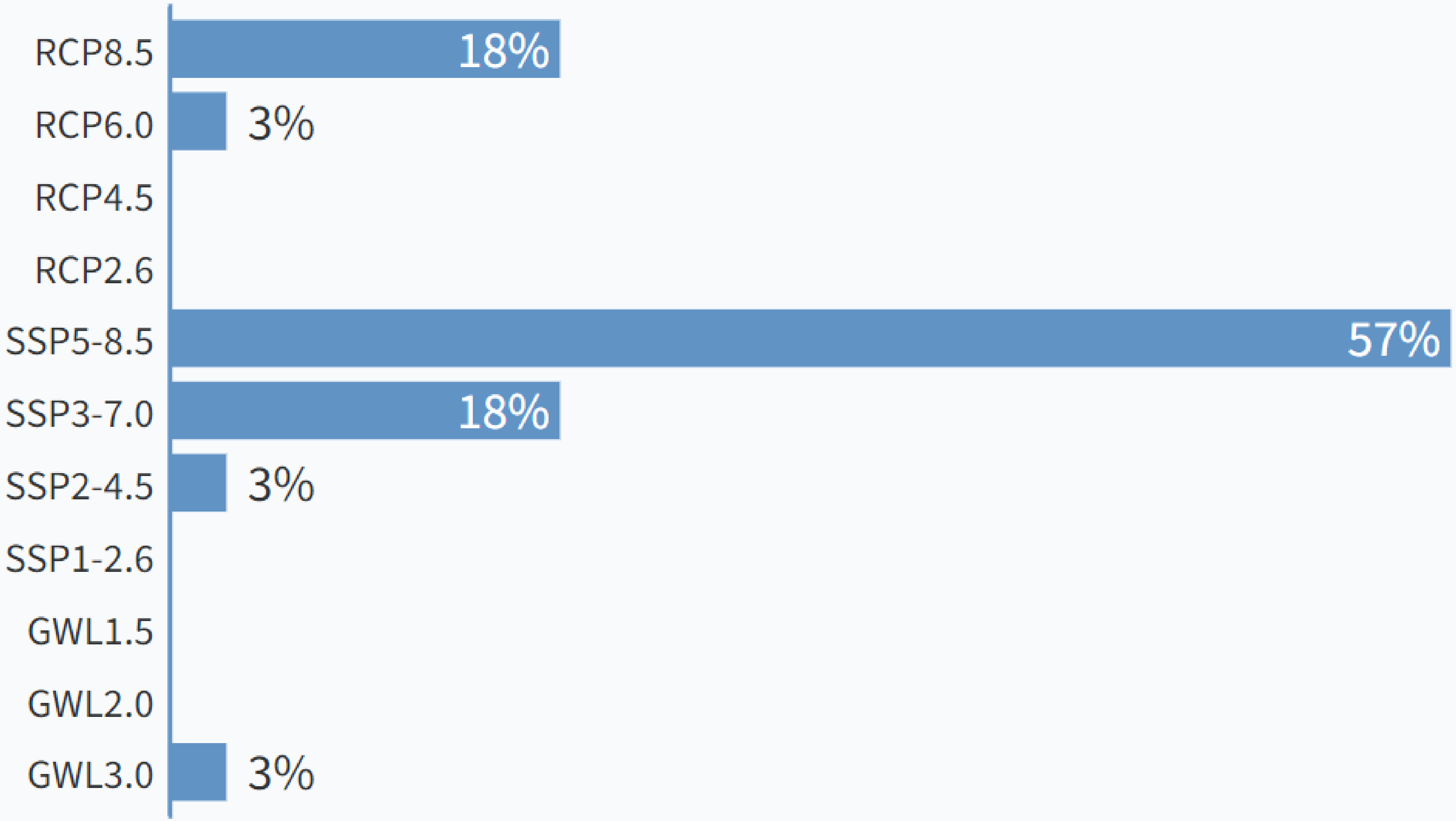


Plots: Canada's Changing Climate Report; Meinshausen et al. (2020)

What to know about SSPs

1. Represent fundamentally different socio-economic assumptions
2. Map out range of plausible future conditions
3. Same radiative forcing levels as RCPs
   - Details are different (e.g., aerosols)
   - Some additional levels (forcing 1.9, 3.4, and 7.0 W/m^2)
4. For new analysis use SSPs (CMIP6/IPCC AR6) but analysis with RCPs (CMIP5/IPCC AR5) remains valid

Which scenario is best for risk assessment?



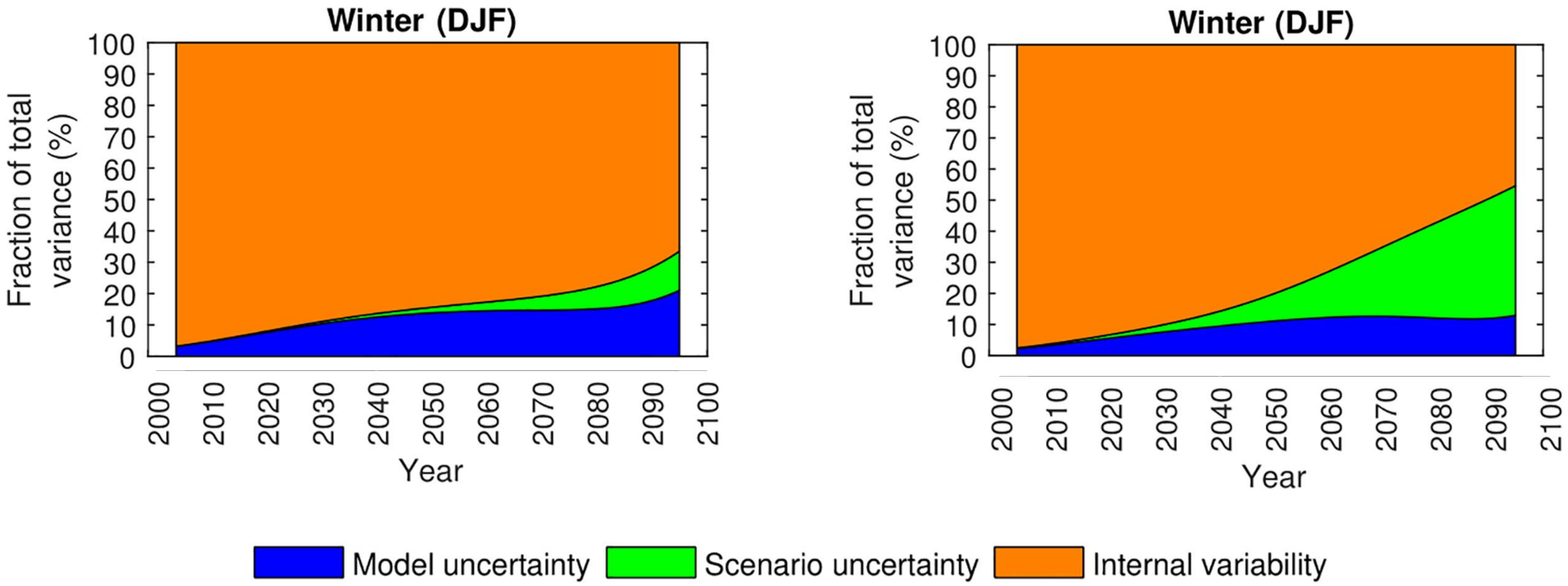
Learning Zone ▸ Topic 3: Understanding Future Projections

Uncertainty in Climate Projections

Adapting to a changing climate requires confronting and dealing effectively with a wide range of uncertainties. Learn about the three main sources of uncertainty in climate projections.

TIME TO COMPLETION 3 min

Scenario uncertainty relative to natural variability

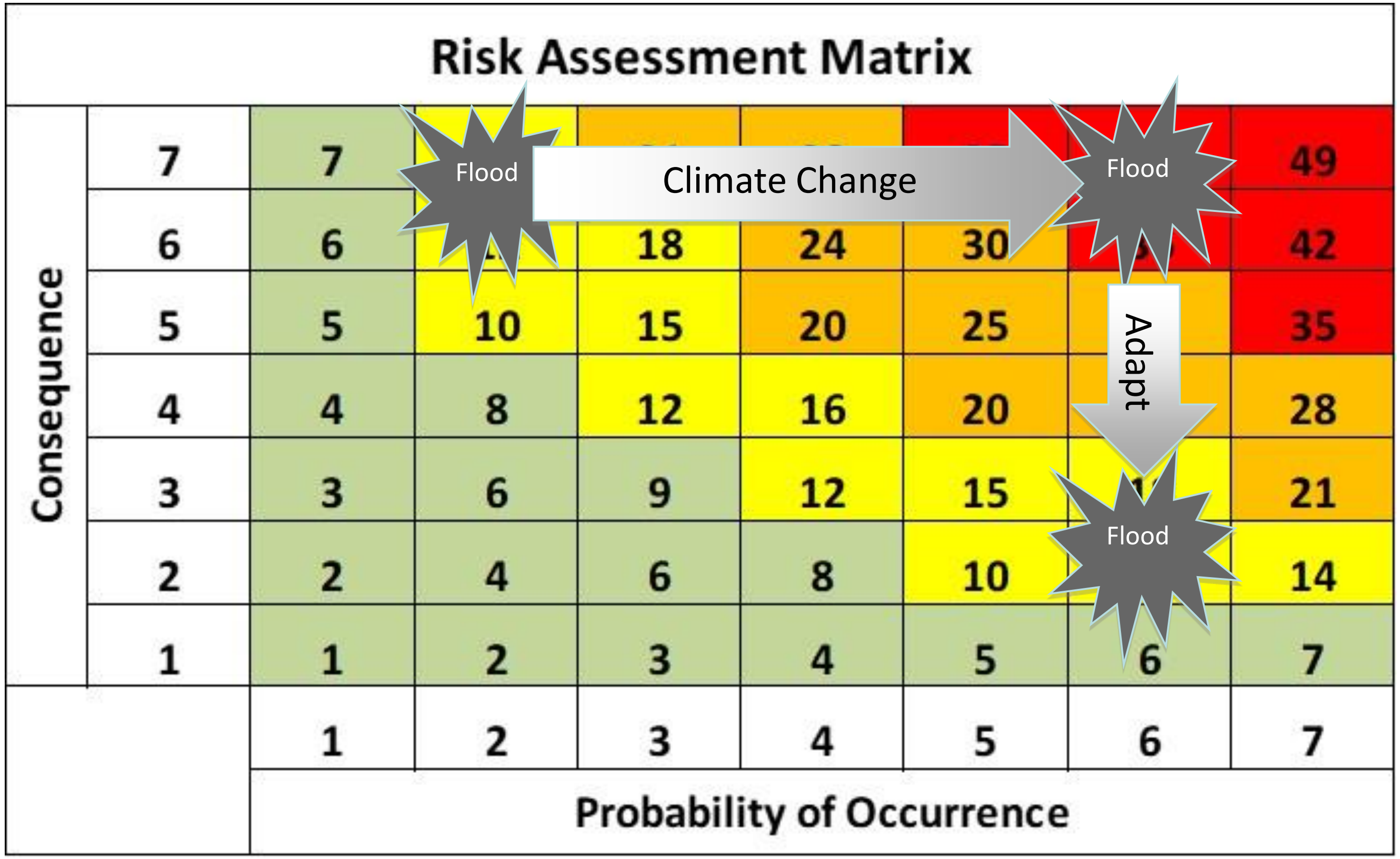


Source: Barrow and Sauchyn 2019

What to know about uncertainty

1. Natural variability
   - is an irreducible component of the climate system that will always be present in future projections
   - is a range that should be explicitly considered
   - is present in historical observations even though not always explicit
2. Scenarios uncertainty
   - depends on human behaviour, policies, and technologies
   - hard to rule out the full range with confidence
   - may not be particularly large in some cases
3. Model uncertainty
   - limited by computing power, understanding; also downscaling method & historical observations if used (all generally improving but slowly)

Risk = Likelihood x Consequence



Source: Public Infrastructure Engineering Vulnerability Committee http://www.pievc.ca

Assigning likelihood scores for events/indices not all hazards' climate projections are equal

- Not available as PROBABILITY
  - **e.g. heat waves, most derived indices/with thresholds**
- Not DIRECTLY available
  - **e.g. flooding, water shortages**
- Not available at all
  - **e.g. contaminated water, air pollution from wildfire**

Likelihood score “bins” are wide

LIKELIHOOD	RATING	CRITERIA FOR DISCRETE CLIMATE-RELATED RISK EVENTS
Almost certain	5	Event is expected to happen about once every two years or more frequently (i.e., annual chance ≥ 50%*).
Likely	4	Event is expected to happen about once every 3 to 10 years (i.e., 10% ≤ annual chance < 50%).
Possible	3	Event is expected to happen about once every 11 to 50 years (i.e., 2% ≤ annual chance < 10%).
Unlikely	2	Event is expected to happen about once every 51 to 100 years (i.e., 1% ≤ annual chance < 2%).
Almost ce not to hap		

*Annual cha

Probability	
Method A	Method B
Negligible Not Applicable	< 0.1 % < 1 in 1,000
Highly Unlikely Improbable	1 % 1 in 100
Remotely Possible	5 % 1 in 20
Possible casional	10 % 1 in 10
what Likely ormal	20 % 1 in 5
ikely equent	40 % 1 in 2.5
obable Often	70 % 1 in 1.4
Probable ing Certainty	> 99 % > 1 in 1.01

Table 1: Data assigned to confidence tiers; tier 1 (green), tier 2 (orange), and tier 3 (red).

Temperature	Precipitation	Ice and Snow	Wind
Max. mean daily air temperature	Annual total precipitation	Ice accretion thickness (1/20)	Hourly wind pressures (1/10)
Min. mean daily air temperature	Annual rain	Permafrost extent	Hourly wind pressures (1/25)
Annual mean air temperature	15 min rain (1/10)	Rain load (1/50)	Hourly wind pressures (1/50)
Design temperatures January 1%	One day rain (1/50)	Snow load (1/50)	Hourly wind pressures (1/100)
Design temperatures January 2.5%	Relative humidity		Driving rain wind pressure (1/5)
Design temperatures July 2.5% dry			
Design temperatures July 2.5% wet			
Degree days below 18°C			

Climate-Resilient Buildings and Core Public Infrastructure Initiative

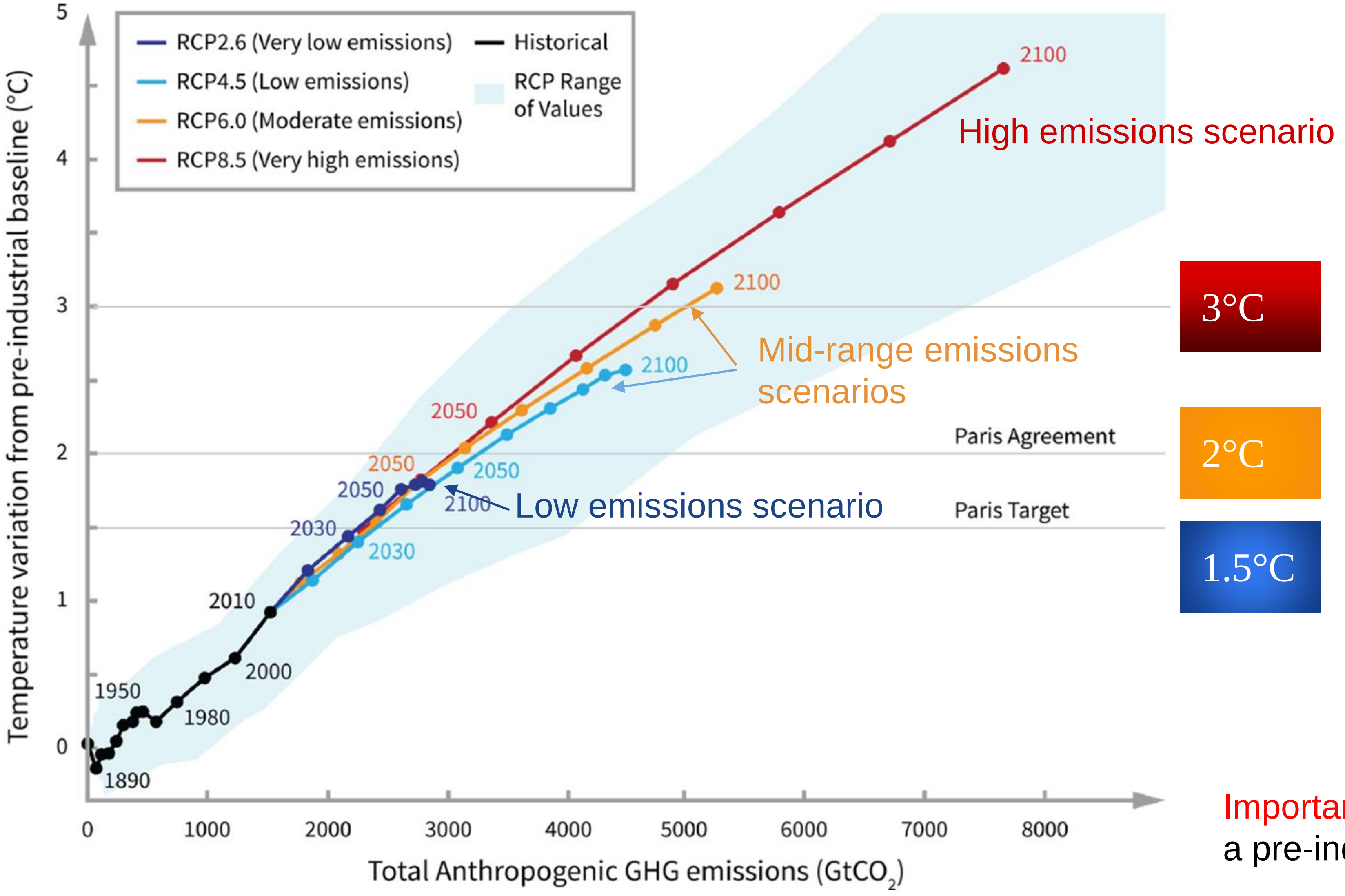
- Even qualitative findings can estimate *change* in likelihood
- Show your work: record the levels of confidence & other caveats
- Remember: purpose of a risk assessment is to surface risks and then have a conversation on risk tolerance for design

Which tool is best for building a house?

So which scenario? Use professional judgement

1. For risk assessment, currently 8.5 is most commonly used
   - Engineering conservative, allows for comparison to other work
   - Note that even more conservative options are possible and sometimes used (e.g., 90th percentile across ensemble of runs)
   - In some cases (subject to availability) 4.5, 6.0, 7.0 is used in addition or instead
2. For design *consider* multiple scenarios spanning wide range and use risk tolerance to make choices for design
3. Most importantly: state your assumptions & show your work
4. The climate system responds to total forcing so it is possible to re-examine an assessment or analysis done with a specific scenario in light of new information by adjusting how interpretation of risk tolerance and/or time

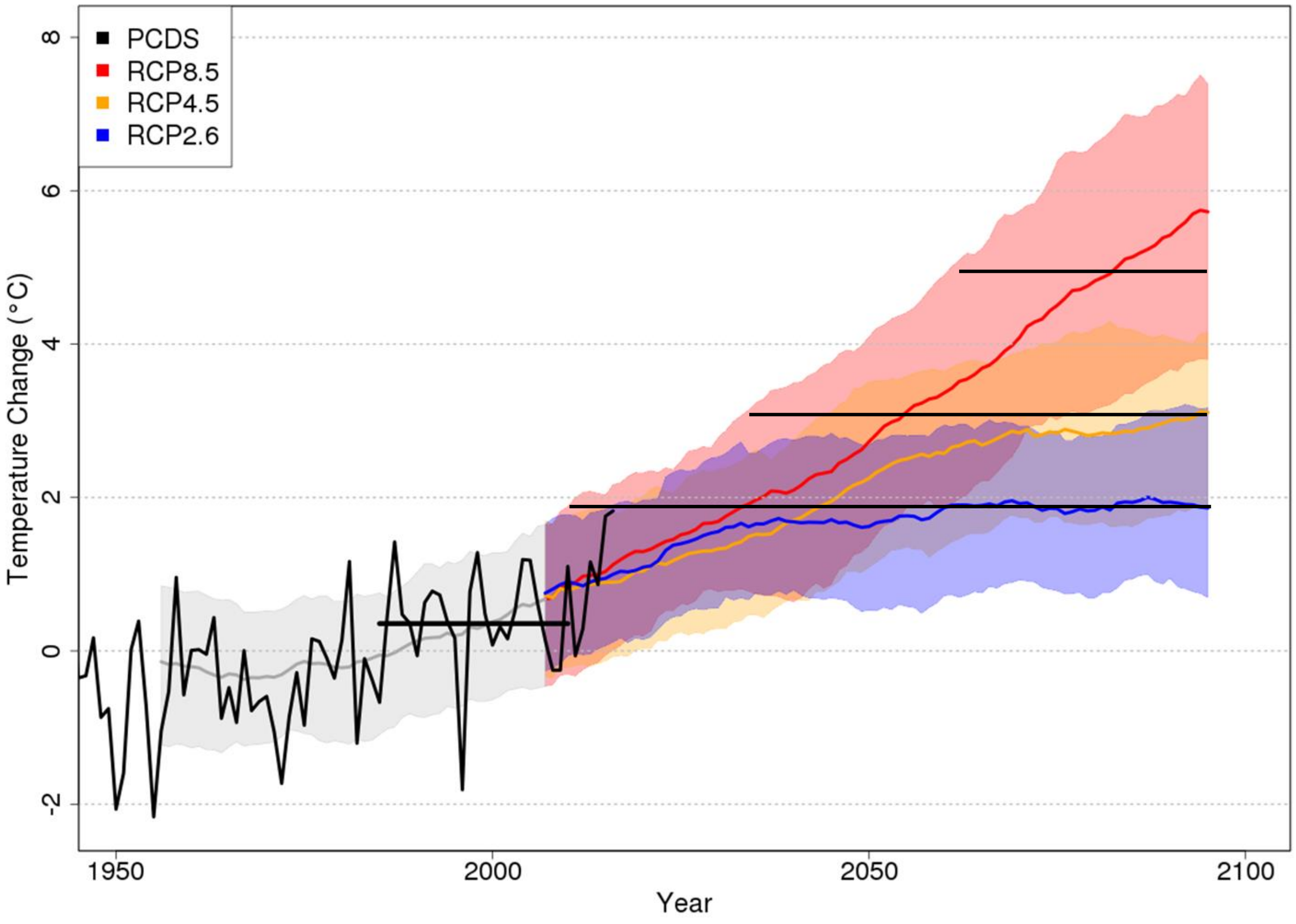
Future Warming - Global Warming Levels



For a given GWL, it is more a question of *when* a scenario exceeds that warming, not if

Important: These are GWLs compared to a pre-industrial baseline (1850-1900)

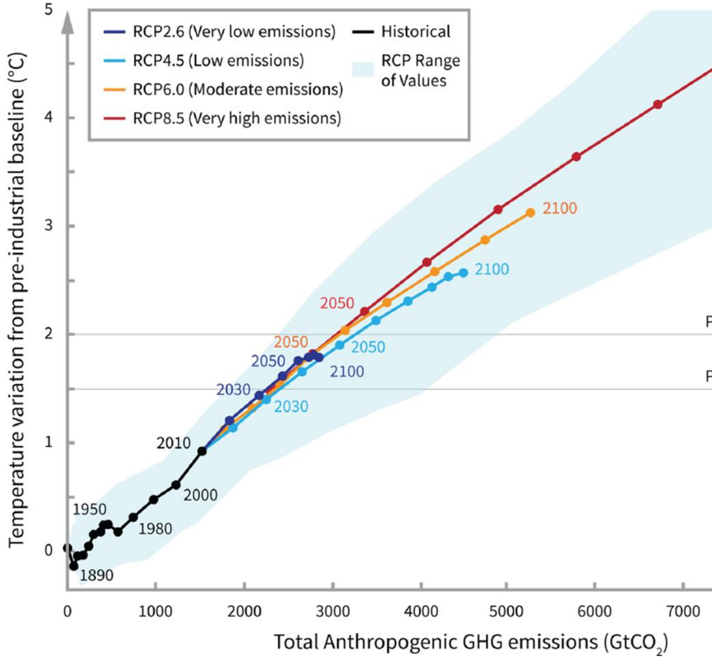
Future Warming - Global Warming Levels



3.5 °C

2 °C

1.5°C



What to know about levels of global warming

1. Complementary / convenient way to look at risk
   - allows assessment of risk / designing for fixed amount of warming
2. Not a silver bullet
   - need to choose risk tolerance remains but moves from “which scenario” → “when will this GWL occur”
   - need to choose multiple scenarios in design remains but moves from “multiple scenarios” → “multiple GWLs for a given time period”
   - uncertainty remains but moves from wide range of projected change → range of possible timing of occurence
3. Can enable use of “Single Model Large Ensembles”
   - as in the use of CanRCM-LE for Appendix C-2 building code parameters

Open discussion questions

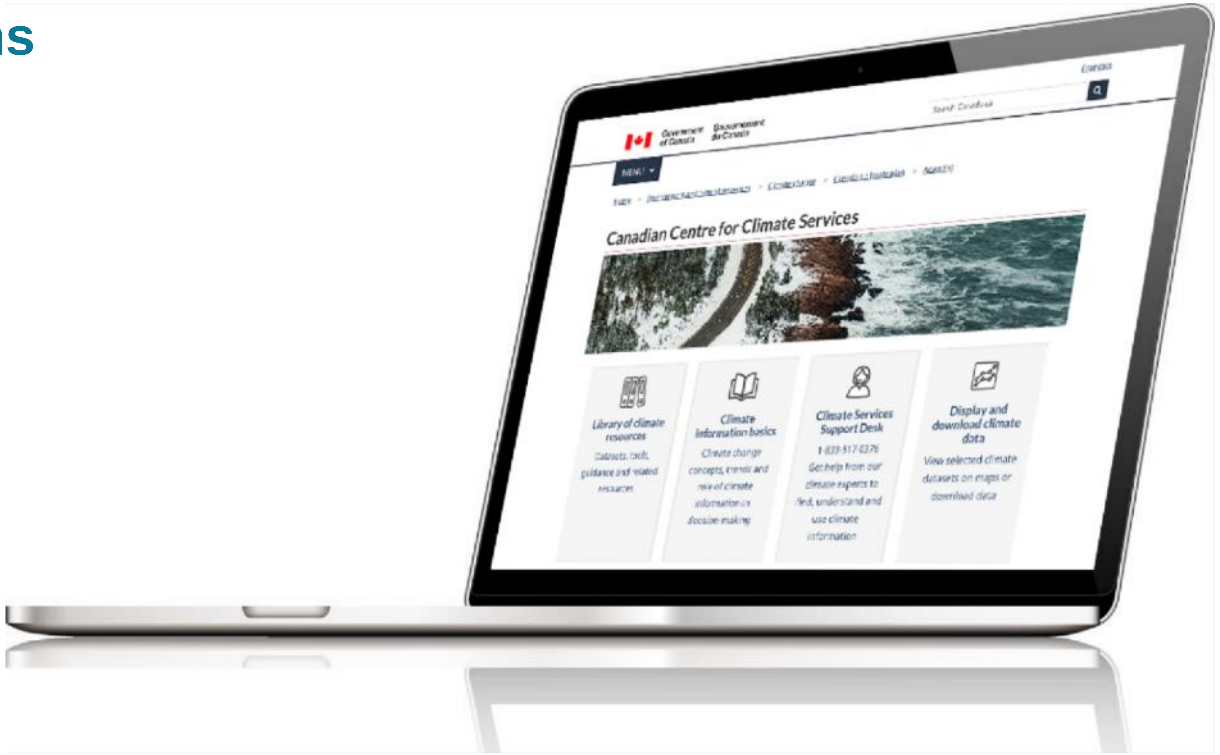
1. Did you have any key insights?

2. Was anything surprising?

3. What is still confusing?

Canadian Centre for Climate Services

Provides Canadians with information and support to consider climate change in their decisions



1-833-517-0376

ccsc-cccs@ec.gc.ca

Canada.ca/climate-services

Thank you

Website

English:
canada.ca/climate-services

Français:
canada.ca/services-climatiques

Climate Services Support Desk

1-833-517-0376

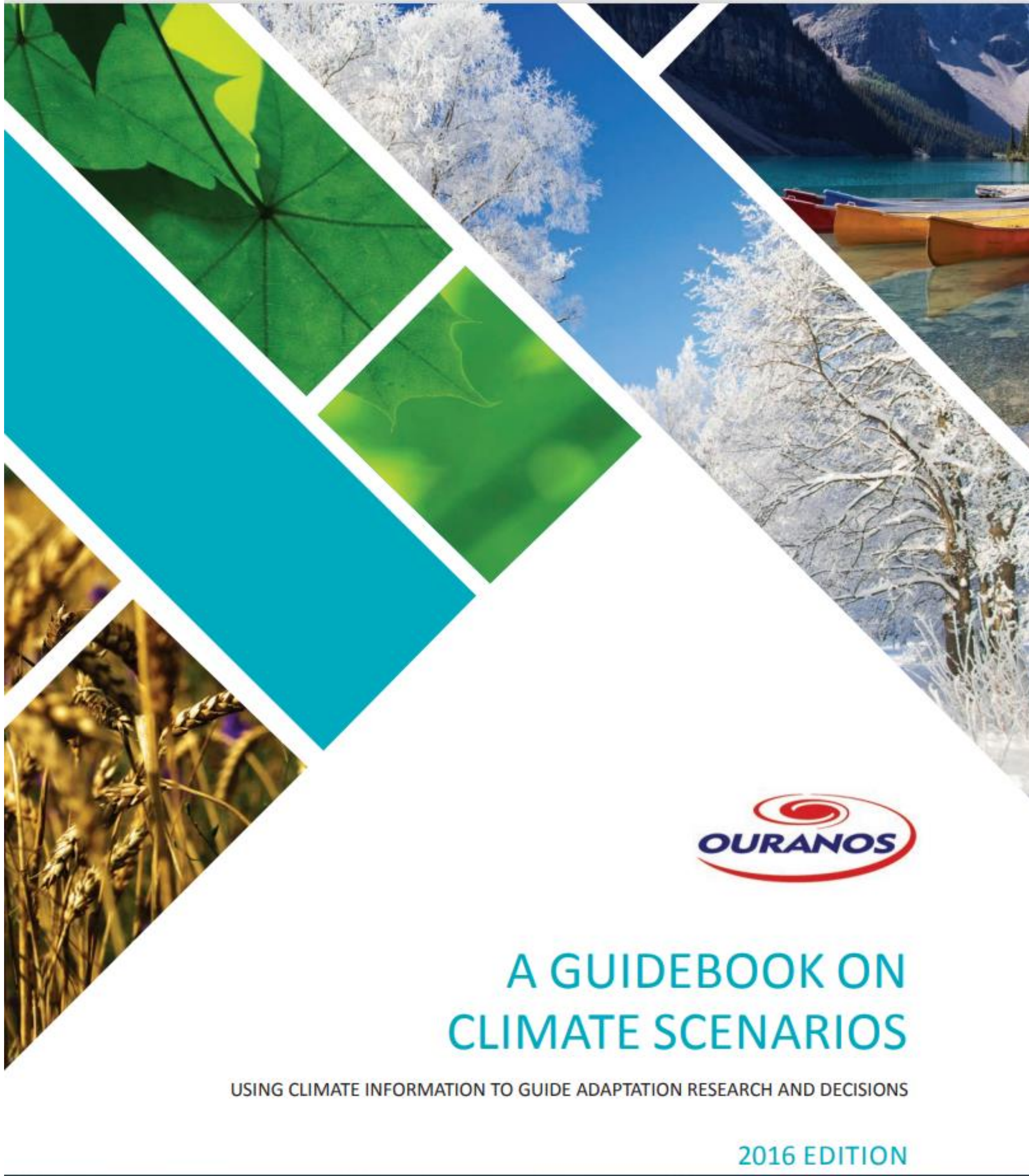
ccsc-cccs@ec.gc.ca

Acknowledgments – thanks to Laura VanVliet & Ken Chow for figures

Resources

Guidebook on climate scenarios

- Current version is a 2016 update to previous guidance
- Newer recommendations in development



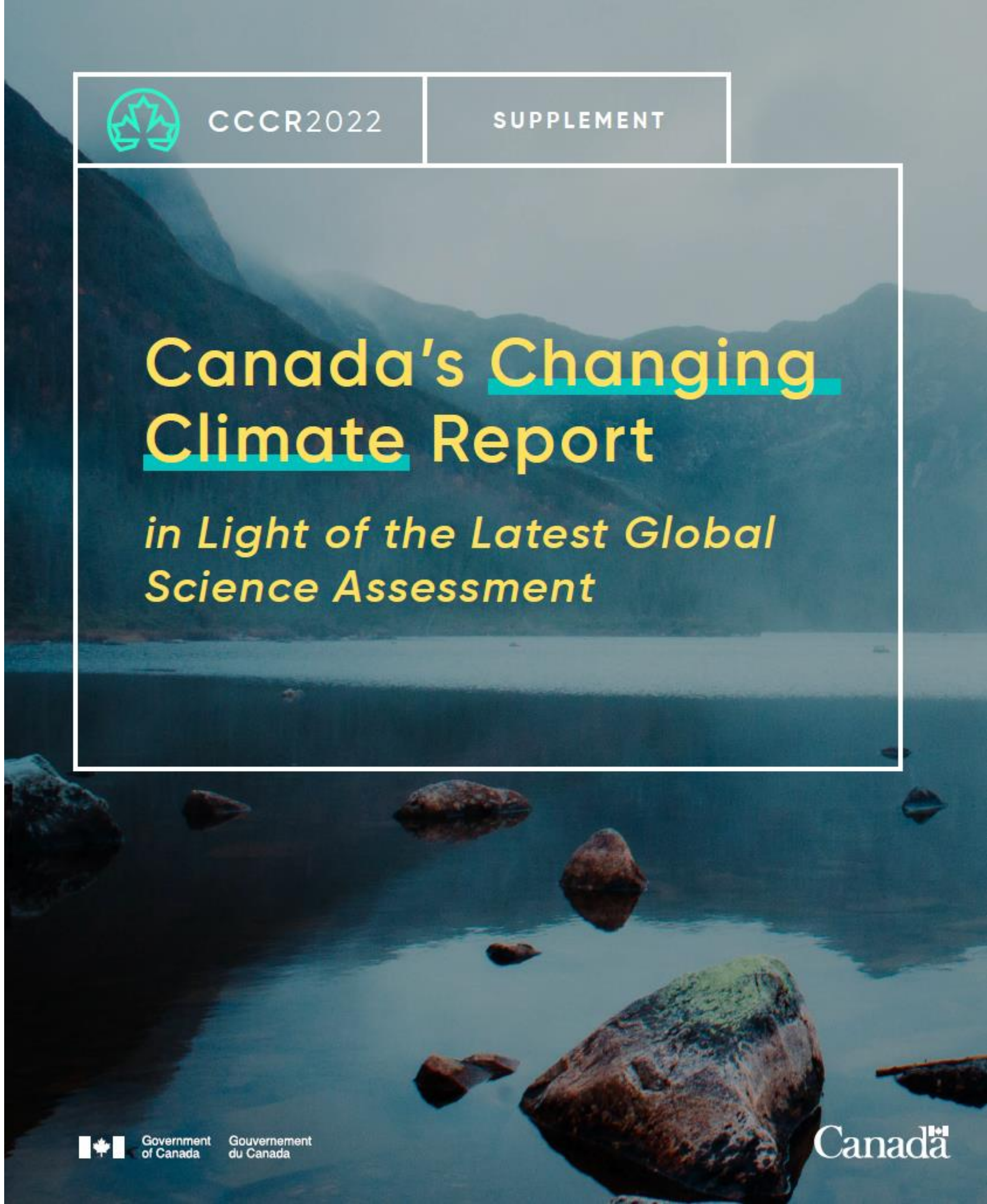
CCCR2022

The latest science and information on climate change in Canada. Available at ChangingClimate.ca

SSP – Shared Socio-economic Pathways

- SSP1-2.6 – emissions decline to net zero around or after 2050
- SSP5-8.5 – emissions roughly double from current levels by 2050

Guidance on the new scenarios and data available at www.ClimateData.ca/Learn (~June 2022)



TAC-CCCS Training

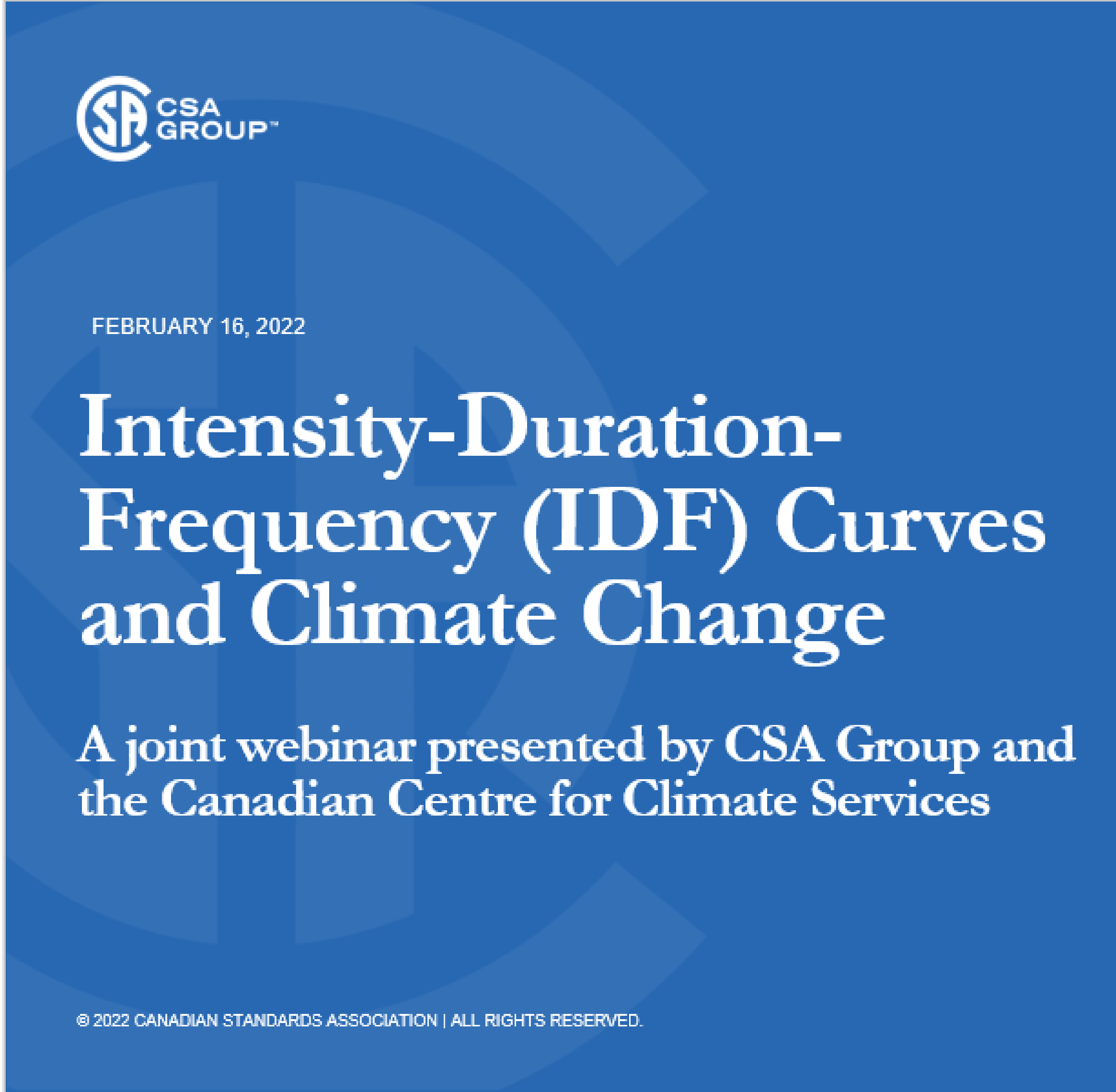
- The CCCS, Transport Canada, and the Pacific Climate Impacts Consortium (PCIC) ran a three-part training series with the Transportation Association of Canada (TAC) on using climate information in the Transportation sector
  - Part 1: Introduction to climate information for decision making
    - Overview of key climate information concepts
    - Climate change impacts
    - Risk assessments
    - Historical datasets and future climate projections
  - Part 2: Finding and accessing climate data
    - Overview of key sources of climate information including ClimateData.ca, the Climate Atlas of Canada, and PCIC's Climate Explorer
  - Part 3: Assessing risk – A learning exercise
    - Learning exercise to understand key climate change impacts for infrastructure projects or asset management planning

Video - more in depth on risk

- [Presentation] at University of Toronto Centre for Climate Science and Engineering
  - What is climate change risk
  - How to bring climate change risk into engineering work
  - Why do to so – including professional responsibility and duty of care

CSA-CCCS webinar

- Why no longer appropriate to use IDF curves based on historical information alone?
- Best practices
- Details on a specific “scaling” approach used by Environment and Climate Change Canada and outlined in CSA PLUS 4013 to account for climate change, and coming to ClimateData.ca



Recorded CCCS presentations

Français

Government of Canada | Gouvernement du Canada

Search ECCC

MENU

Canada.ca › Environment and natural resources › Climate change › Canada's climate plan › Adapting › Canadian Centre for Climate Services

Recorded presentations from the Canadian Centre for Climate Services

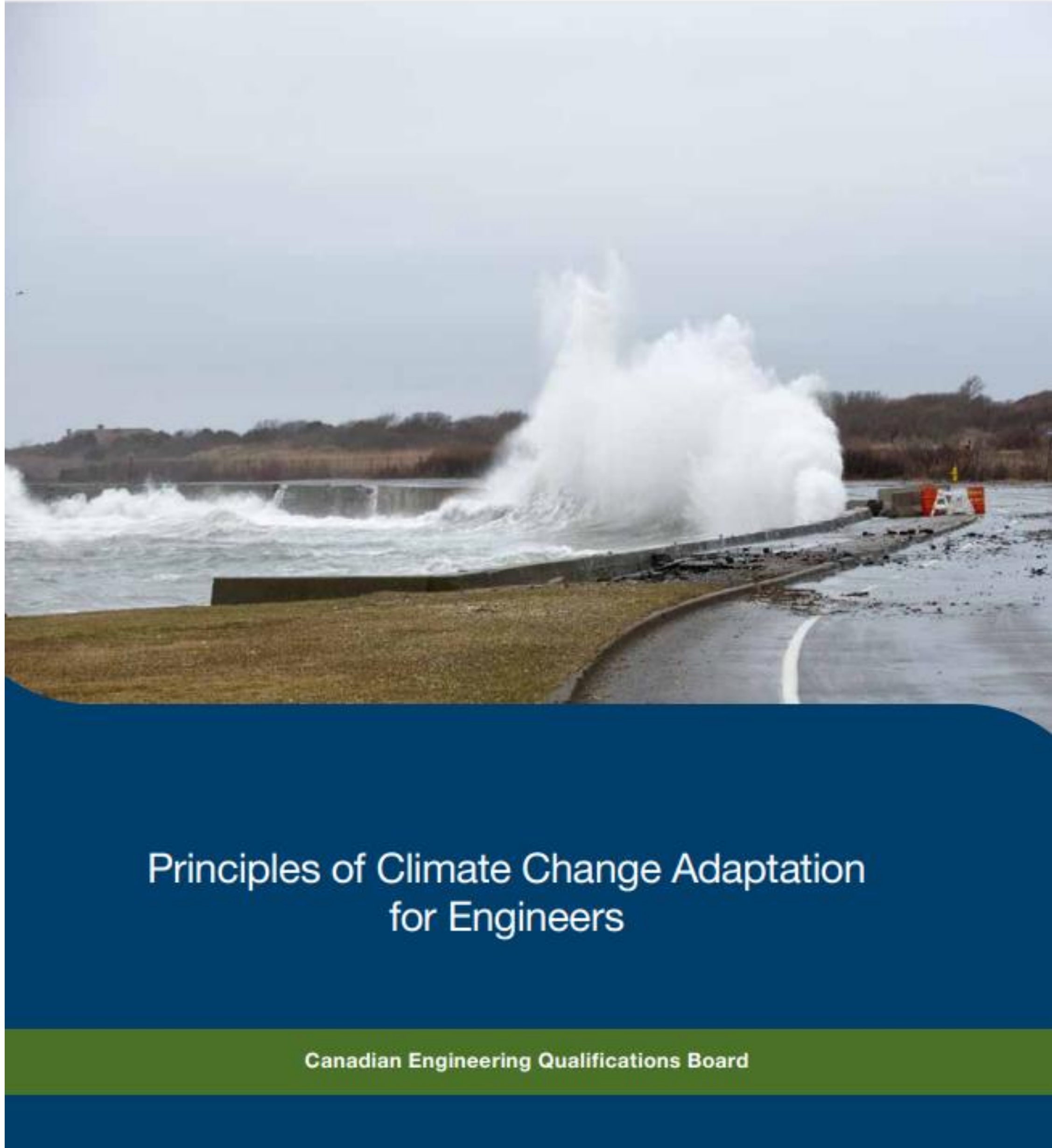
The list of presentations below is organized from most to least recent.

Please contact the Climate Services Support Desk if you have questions or wish to request a presentation for your organization.

engineerscanada
ingénieurscanada

Engineers Canada

- Engineers cannot assume that the future will be similar to the past.
- Goal of report: that engineers consider the implications of climate change in their professional practice and that they create a clear record of the outcomes of those considerations.
- Nine principles that constitute the scope of professional practice for Engineers to initiate climate change adaptation actions



National Research Council

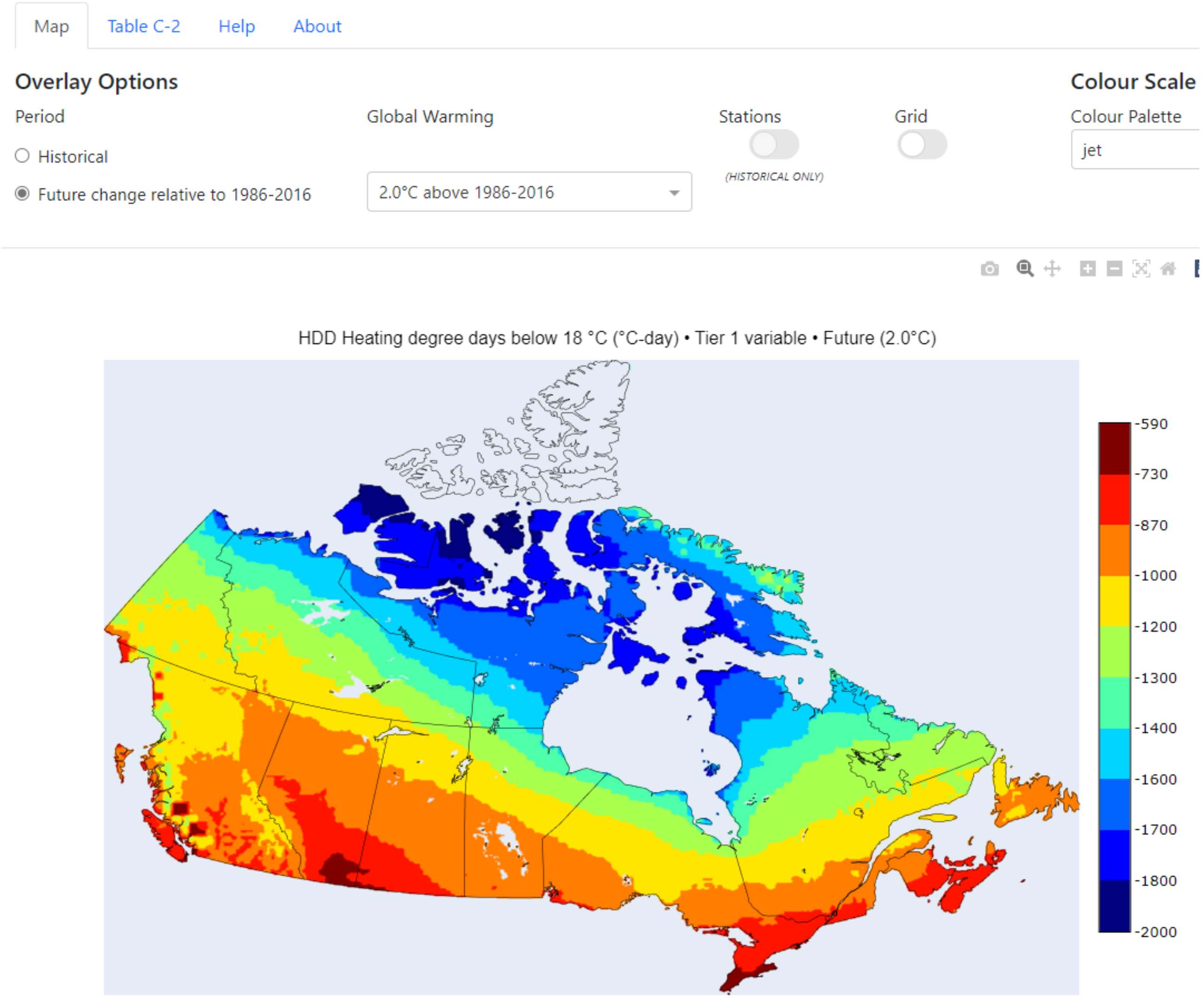
- NRC's [Climate Resilient Buildings and Core Public Infrastructure Initiative](#)(CRBCPI)
  - Partnership with Infrastructure Canada
  - **Enabling Canada to design and build for the future:** Integrating climate resiliency into national codes, standards and guidance for buildings and infrastructure.
  - Significantly advanced the field of climate change adaptation for buildings and infrastructure, and is at the leading edge of this effort internationally
  - Developed a suite of evidence-based guidance documents on how to adapt

PCIC’s Newest Analysis Tool: **Design Value Explorer**

The DVE is tailored to users who consult the **National Building Code of Canada** and the **Canadian Highway Bridge Design Code** as part of their work.

The DVE allows users to:

- View historical design values maps over Canada;
- Display design values at an arbitrary location indicated on the map;
- View future-projected change maps for any design value;
- Download customizable maps in PNG format and tables in CSV format.
- And more!



Questions?

Stacey O’Sullivan - sosullivan@uvic.ca
Technical questions: Charles Curry – cc@uvic.ca

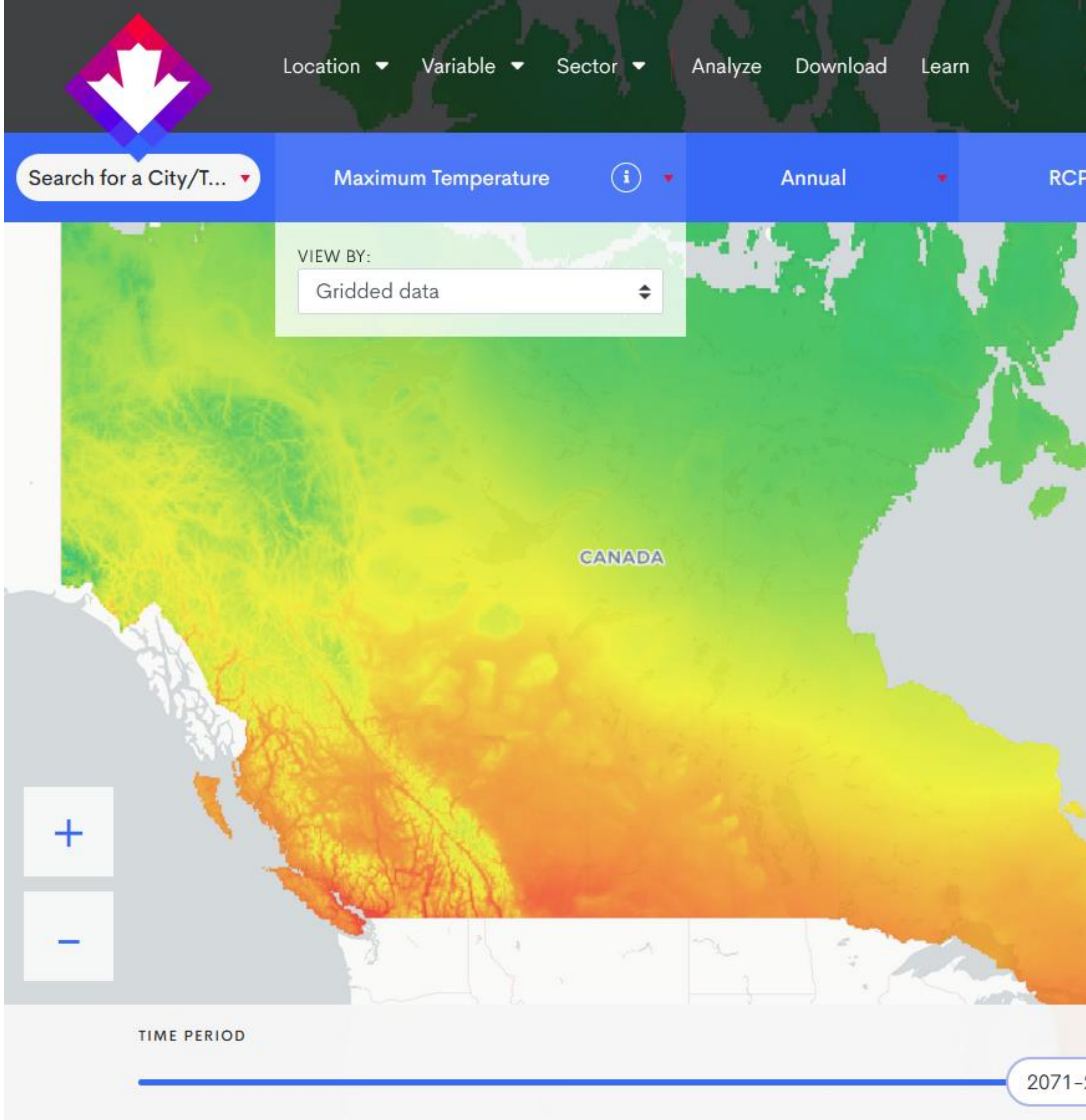
ClimateData.ca

Climate Data

- Climate Data
- High resolution climate data
- Temperature and precipitation variables and climate indices
- Sea level rise
- Observed climate normals and daily data download
- Intensity Duration Frequency (IDF) curves
- Local and national scale charts and maps
- Ability to compare emission scenarios
- Customizable tools to analyze and extract data

Helpful Resources

- Sector modules with tailored case studies
- Learning Zone

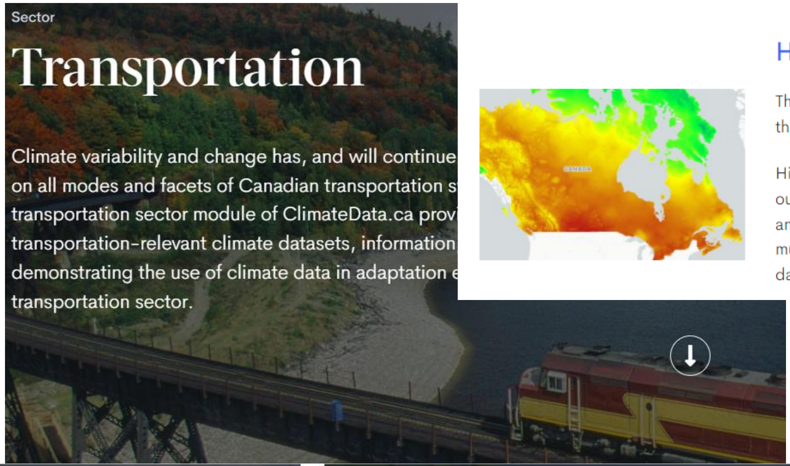


Transportation Module

- How climate change impacts transportation systems
- Transportation-specific case studies
- Sector resources
- Related variables
- And more

Related Variables

Explore variables to learn about how data was used to impact climate related decisions in specific contexts.

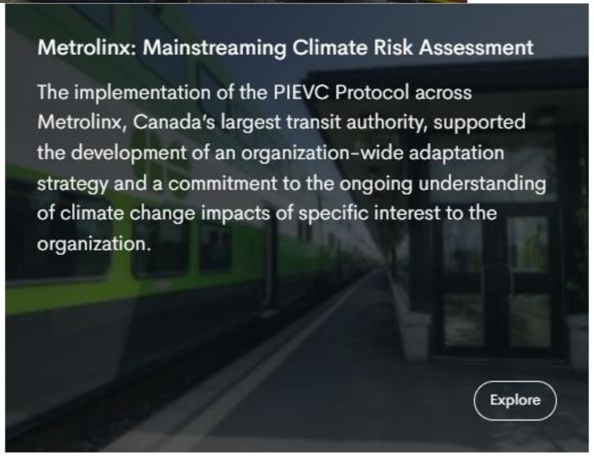


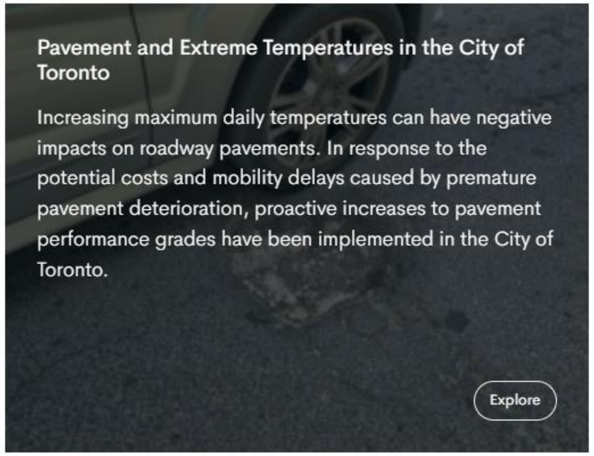
Hottest Day

The *Hottest Day* describes the warmest daytime temperature in the selected time period. In general, the hottest day of the year occurs during the summer months.

High temperatures are important. They determine if plants and animals can thrive, they limit or enable outdoor activities, define how we design our buildings and vehicles, and shape our transportation and energy use. However, when temperatures are very hot, people – especially the elderly – are much more likely to suffer from heat exhaustion and heat stroke. Many outdoor activities become dangerous or impossible in very high temperatures.

Case Studies

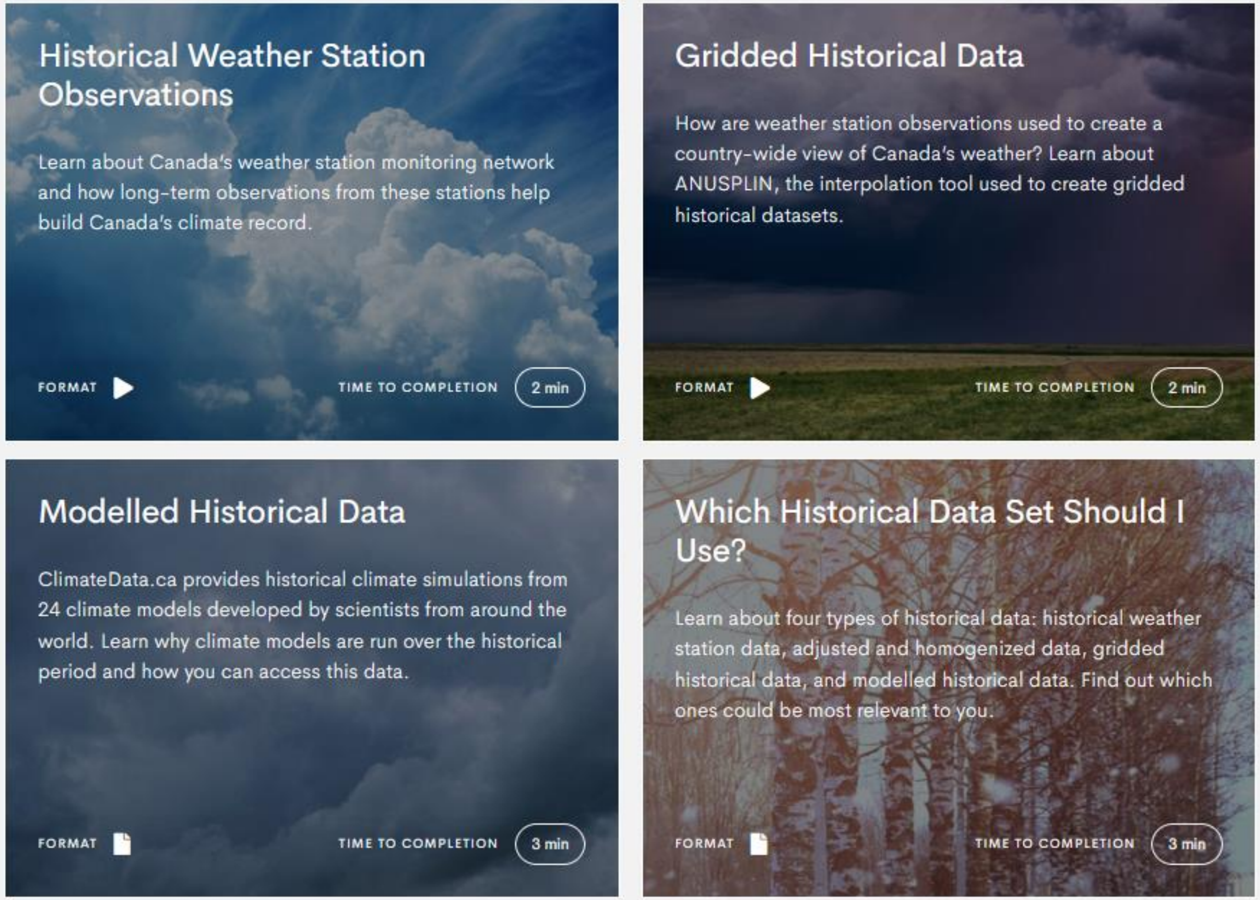




ClimateData.ca Learning Zone

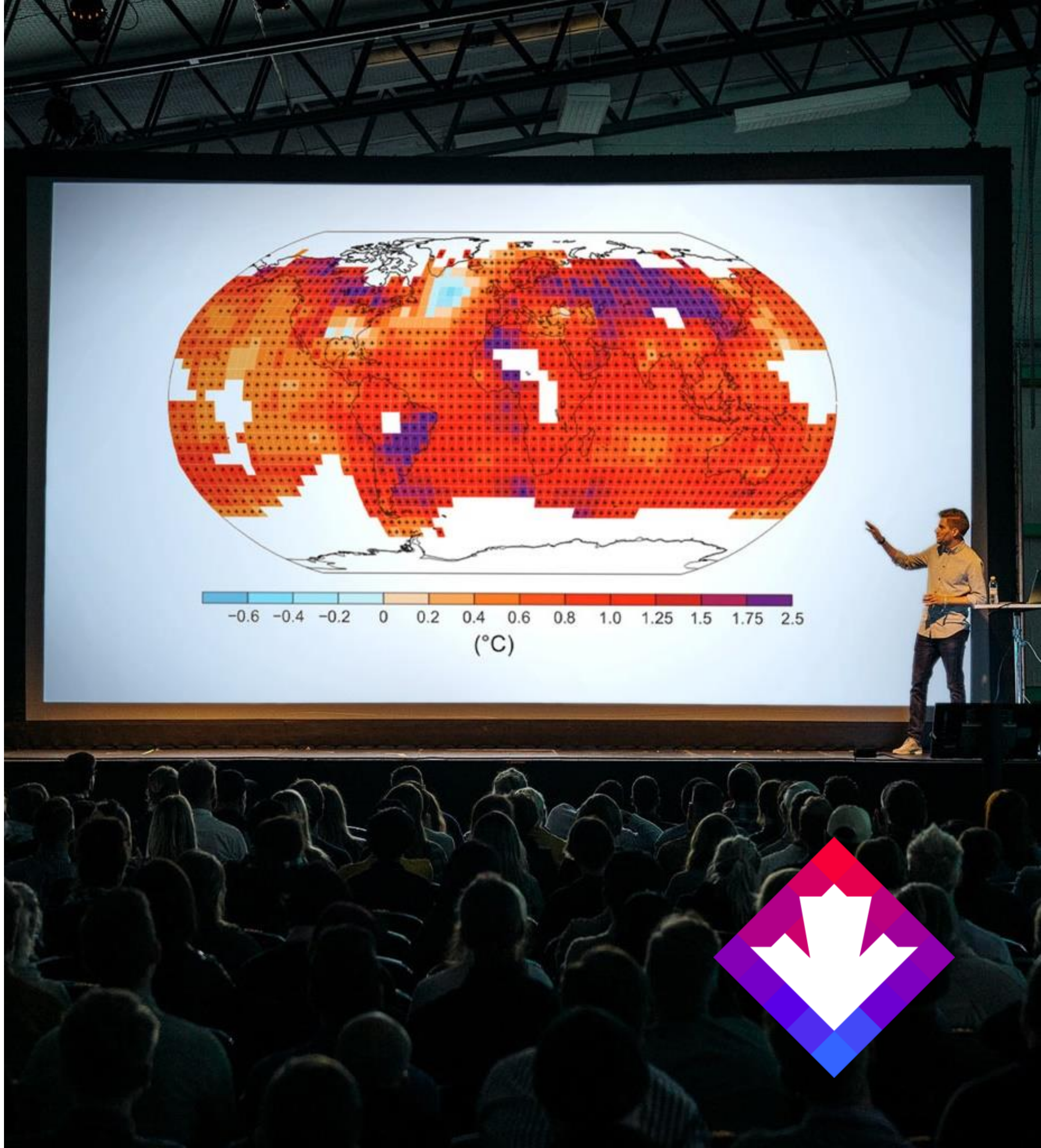
ClimateData.ca/learn/

- Introduction to climate information for decision making
- Understanding historical data
- How to use ClimateData.ca
- Downloadable training materials
- *More coming soon!*



Training Materials

- Understand the importance of considering climate change in decision-making
- Be more familiar with key concepts regarding historical climate trends and future climate
- Understand the basics of climate projections and emissions scenarios
- Understand there is a range of possible climate futures
- Be aware of possible applications of climate information
- Know where to find climate information



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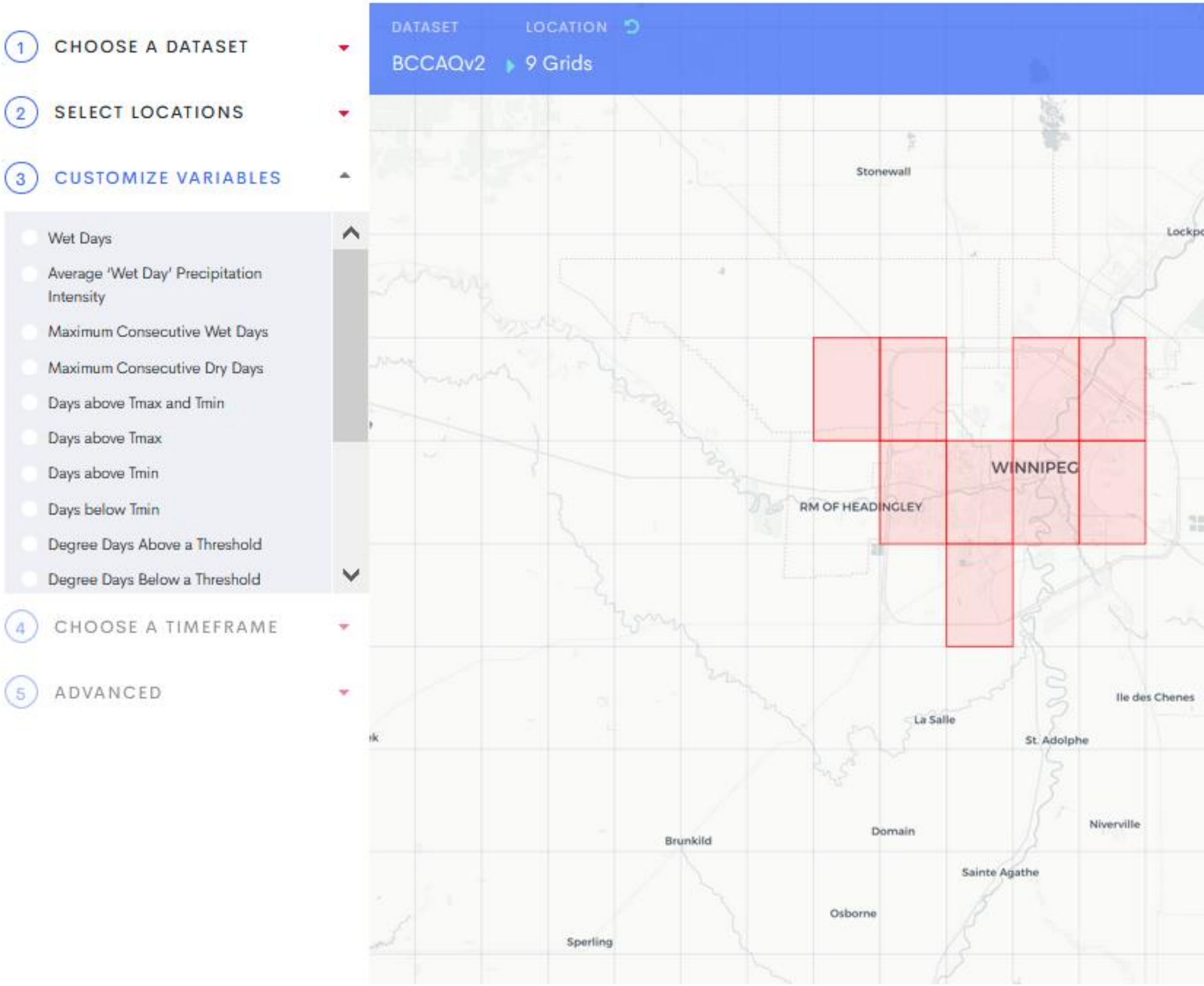
ClimateData.ca
Analysis Page

ClimateData.ca/analyze/

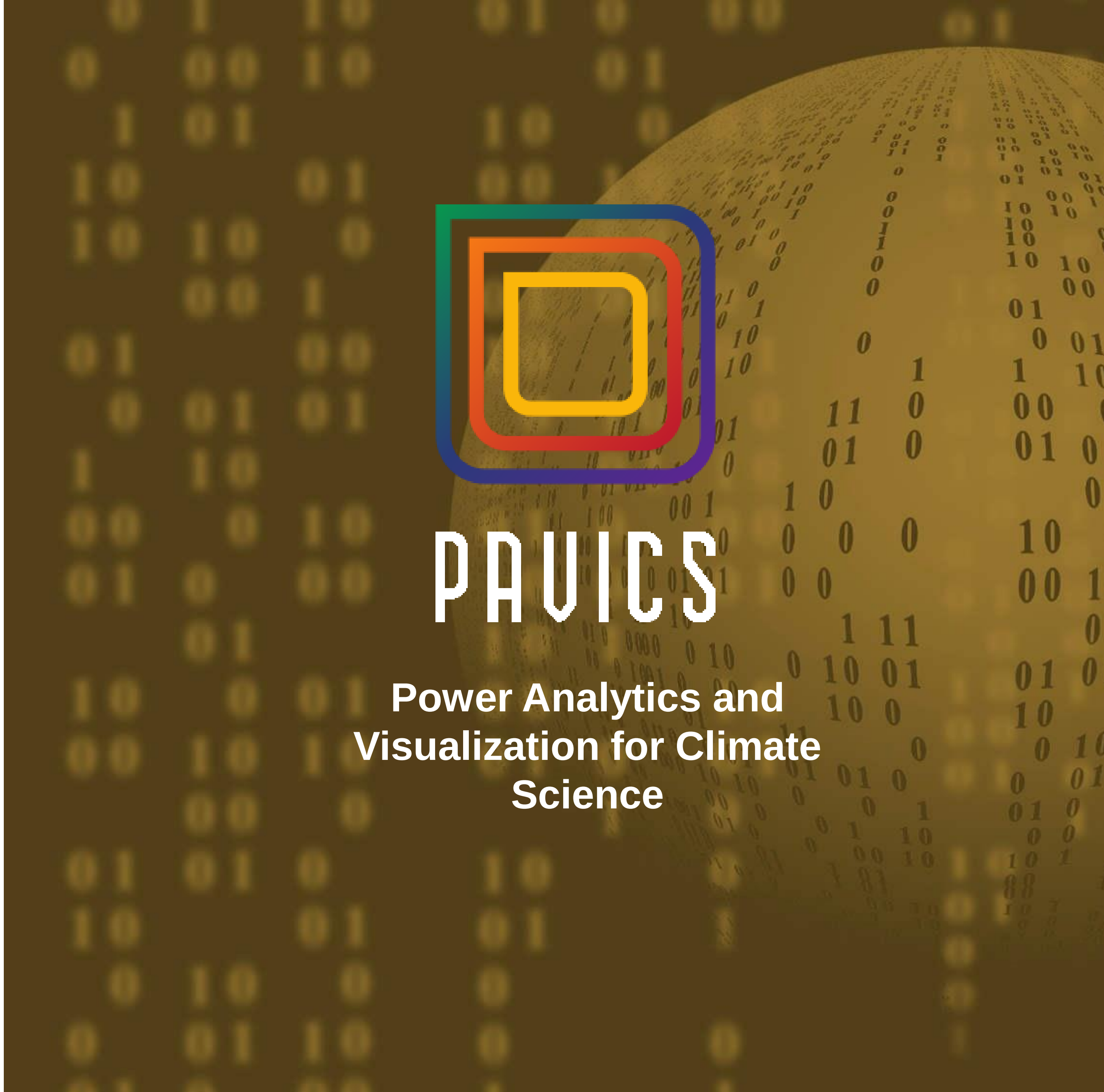
- Choose data set
- Select locations
- Customize variables
- Choose a timeframe
- Select advanced options
- *More coming soon!*



PAVICS

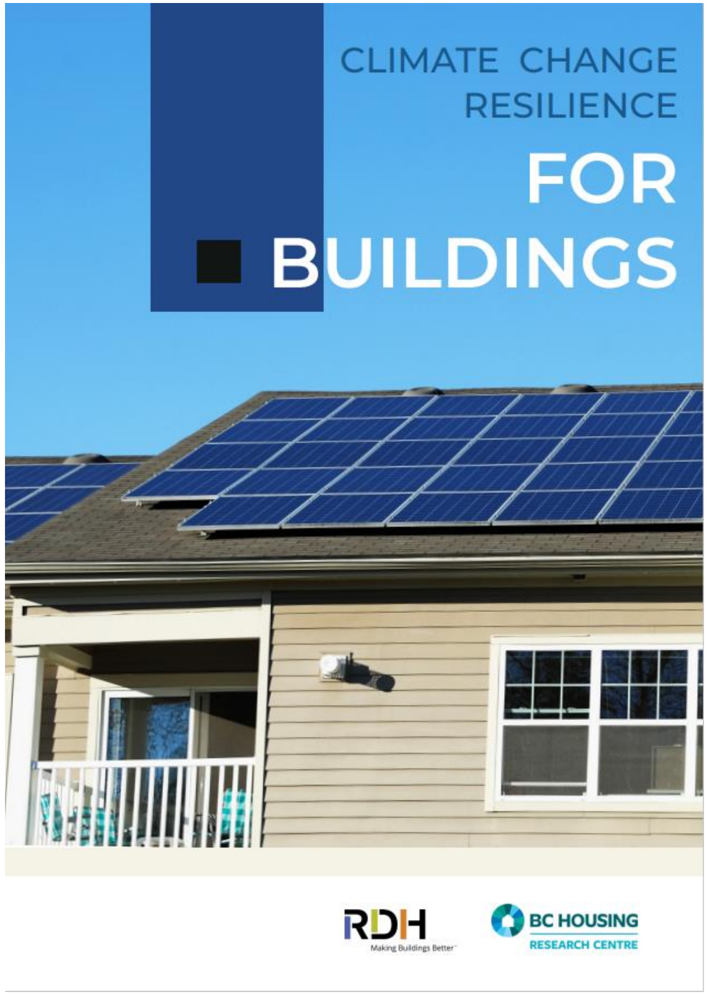
Pavics.Ouranos.ca

- Virtual laboratory facilitating the analysis of climate data
- Access observations, climate projections and reanalysis datasets
- Use a Python programming environment to analyze data without downloading it



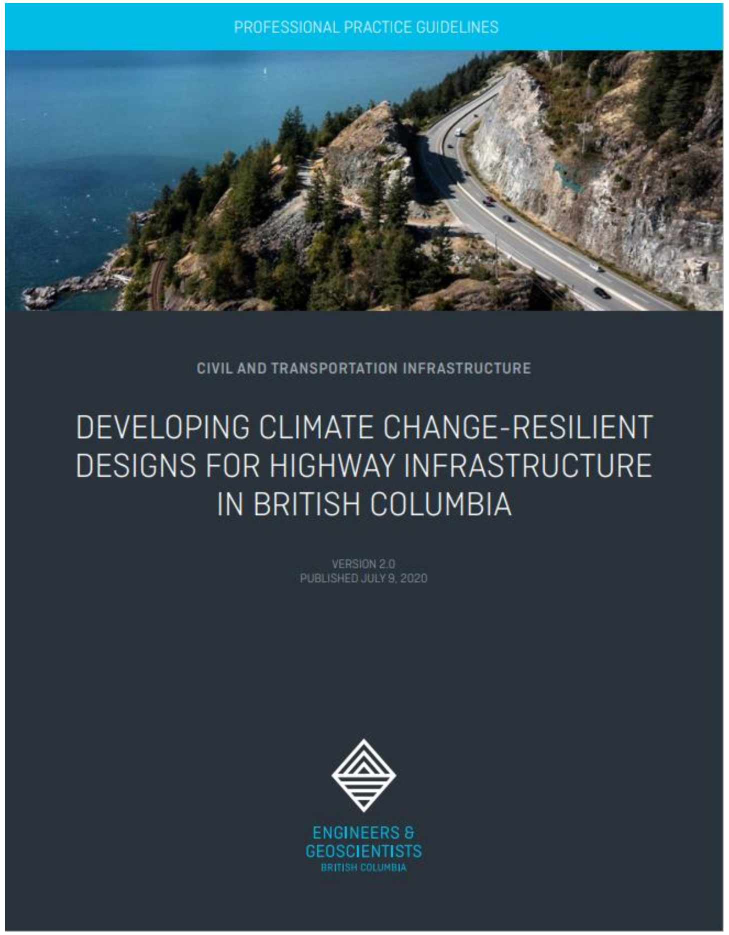
Climate Change Resilience for Buildings

- Understand the causes of climate change and future projections within the context of the built environment.
- Recognize climate hazards for buildings in specific locations and prioritize vulnerabilities.
- Understand the LCR (Low Carbon Resilience) approach and its application to buildings.
- Access tools and processes to start planning LCR for new and existing buildings



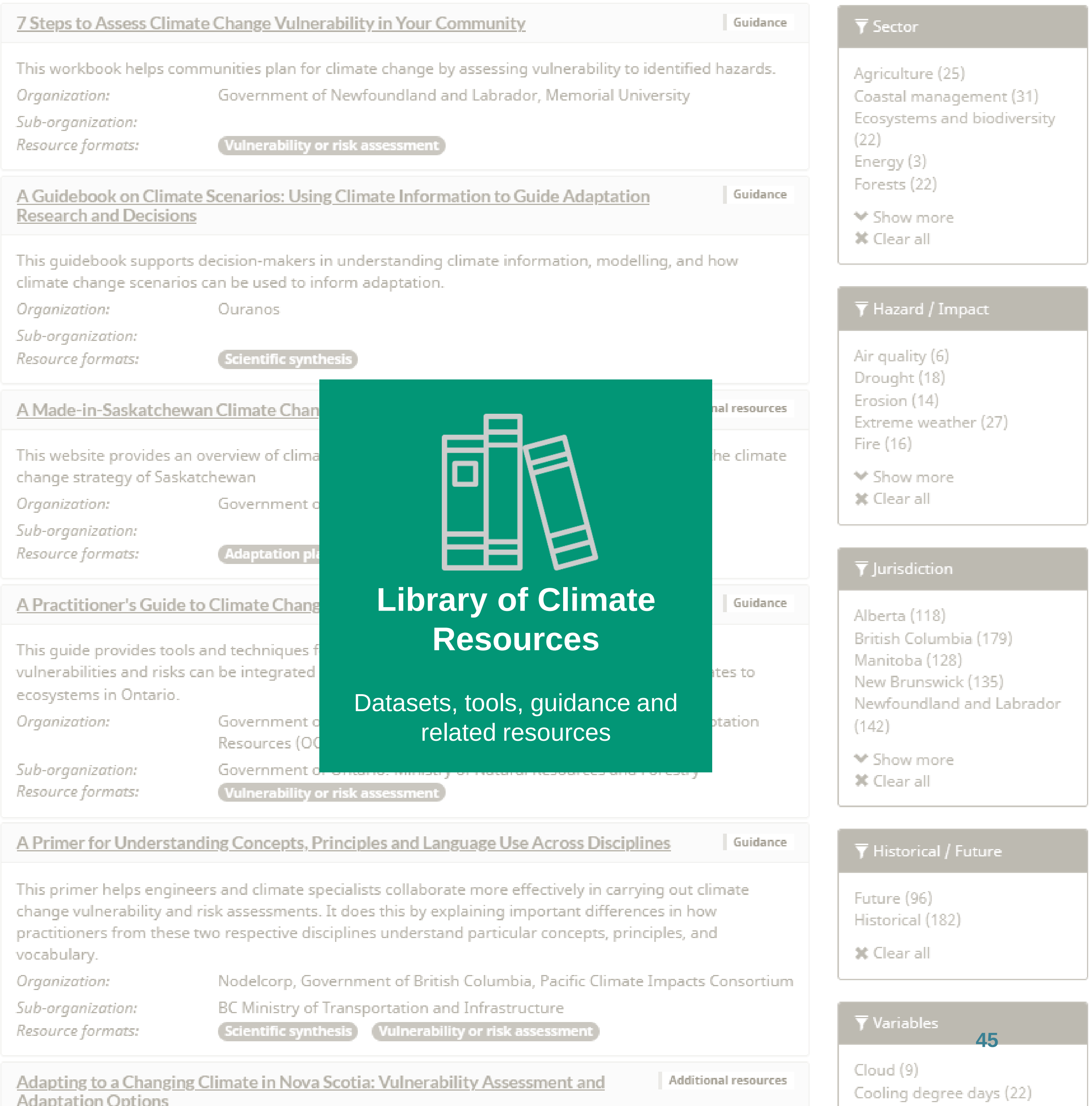
Climate-resilient Designs for Highway Infrastructure

- Guidance on professional practice for Engineering/Geoscience Professionals who carry out a range of activities related to Climate Change-Resilient Design for Highway Infrastructure
- For Qualified Professional who complete Climate Change Risk Assessments



Library of Climate Resources

- **300+** links to climate datasets, tools, guidance and related resources
- Collection of **climate resilient standards**
- Useful for impact, vulnerability and risk **assessments**, and for adaptation **planning**
- **Search** using filters or keywords



Network of Regional Climate Service Providers

CCCS **supports** and **fosters** the development of regional climate organizations to provide localized services

NATIONAL CLIMATE SERVICES PROVIDER

Canadian Centre for Climate Services
www.canada.ca/climate-services

Government of Canada | Gouvernement du Canada

NATIONAL TOOLS

Climate Atlas of Canada
www.climateatlas.ca

Canadian Climate Data
www.ClimateData.ca

Power Analytics & Visualization for Climate Science (PAVICS)
https://pavics.ouranos.ca/

REGIONAL CLIMATE SERVICES PROVIDERS

Ouranos
www.ouranos.ca
(region: mostly Quebec)

Pacific Climate Impacts Consortium
www.pacificclimate.org
(region: mostly Pacific NW)

ClimateWest
www.climatewest.ca
(region: Prairies)

CLIMAtlantic
www.climatlantic.ca
(region: Atlantic)

Climate Services Support Desk

ccsc-cccs@ec.gc.ca

- Helps users find the **right datasets** and **information**
- Provides **guidance** for understanding and using data
- Draws on a **network of experts** to respond to inquiries

Feedback

Your feedback is welcome. Leave us your comments and suggestions.

Inquiry

Get help from our climate experts to find, understand, and use climate information.