General Introduction to Climate Change Projections

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Arelia Werner & Trevor Murdock
wernera@uvic.ca tmurdock@uvic.ca

PACIFIC CLIMATE IMPACTS CONSORTIUM

University of Victoria
British Columbia • Canada

BC hydro

BRITISH COLUMBIA
Ministry of Environment

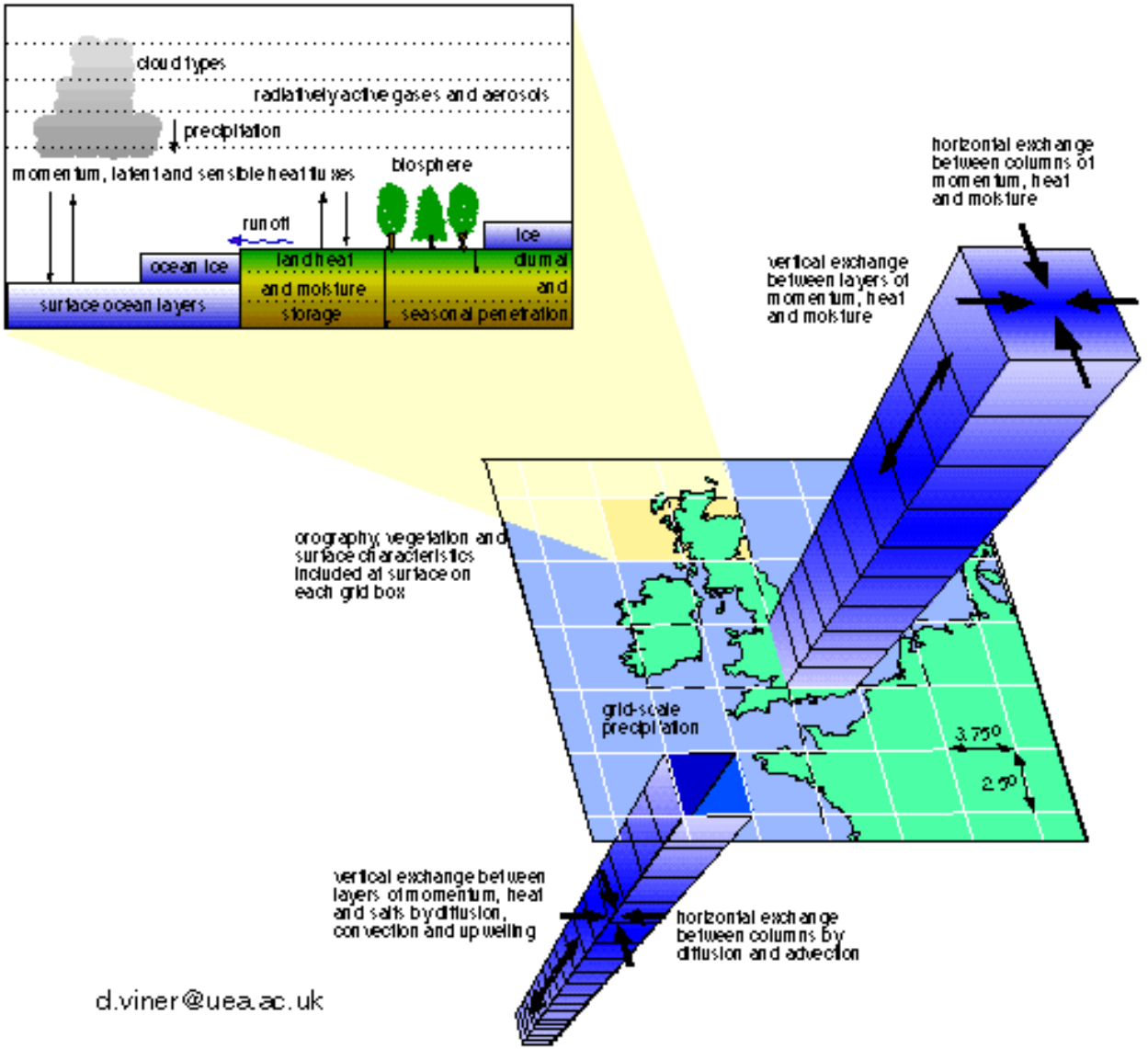
Talk Outline

- Describe GCMs
- Outline sources of uncertainty
- Highlight emission scenarios
- Demonstrate PCIC's online tool
- Present T vs. P projections for Alberta
- Walk through GCM results for BC to define uncertainty
- Discuss uncertainty in the context of temperature and precipitation projections

What are Global Climate Models?

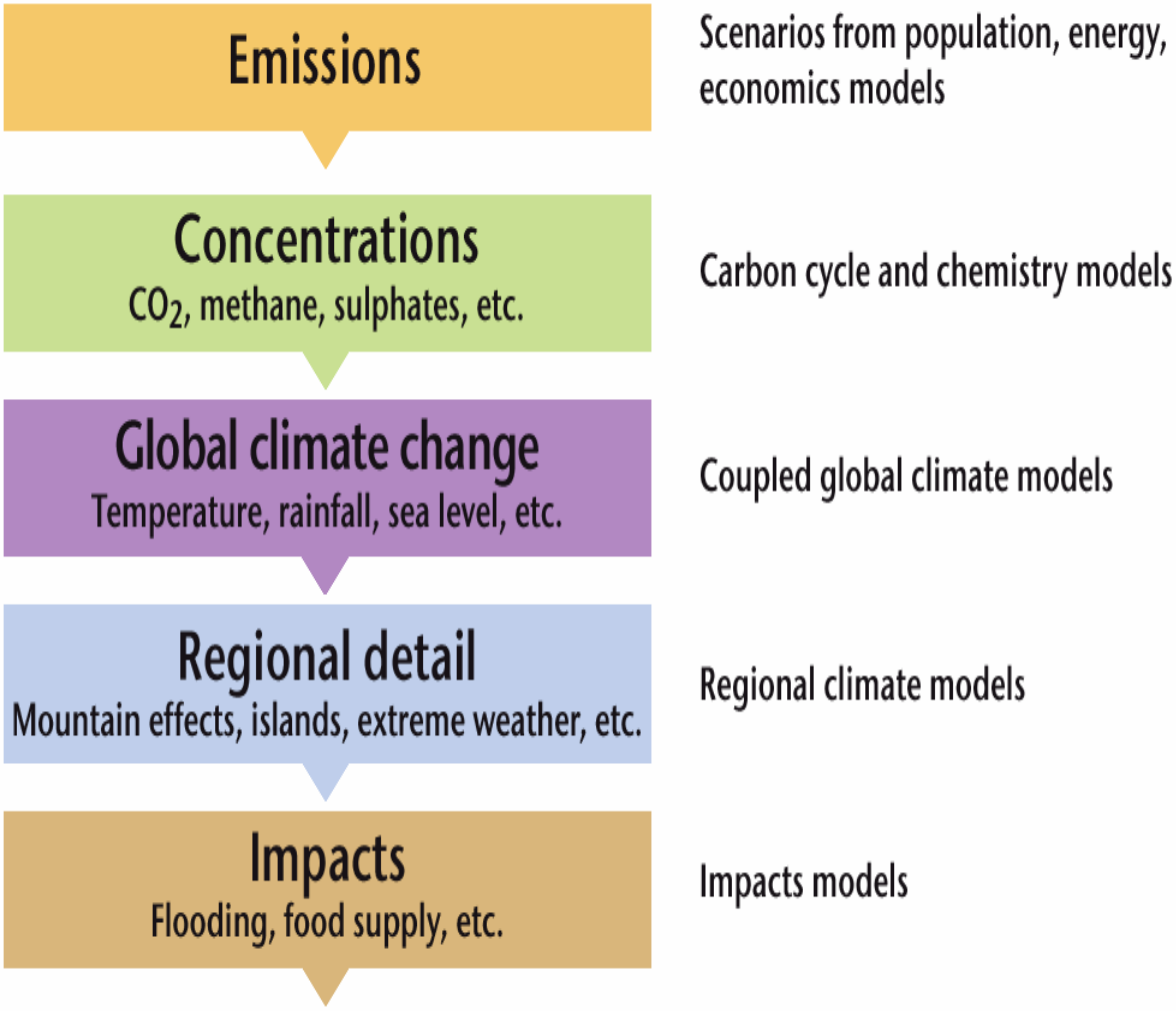
- **GCMs compute global weather patterns several times per day projected over the next century**

- **GCMs are the "…only credible tools currently available for simulating the physical processes that determine global climate..." [IPCC]**



d.viner@uea.ac.uk

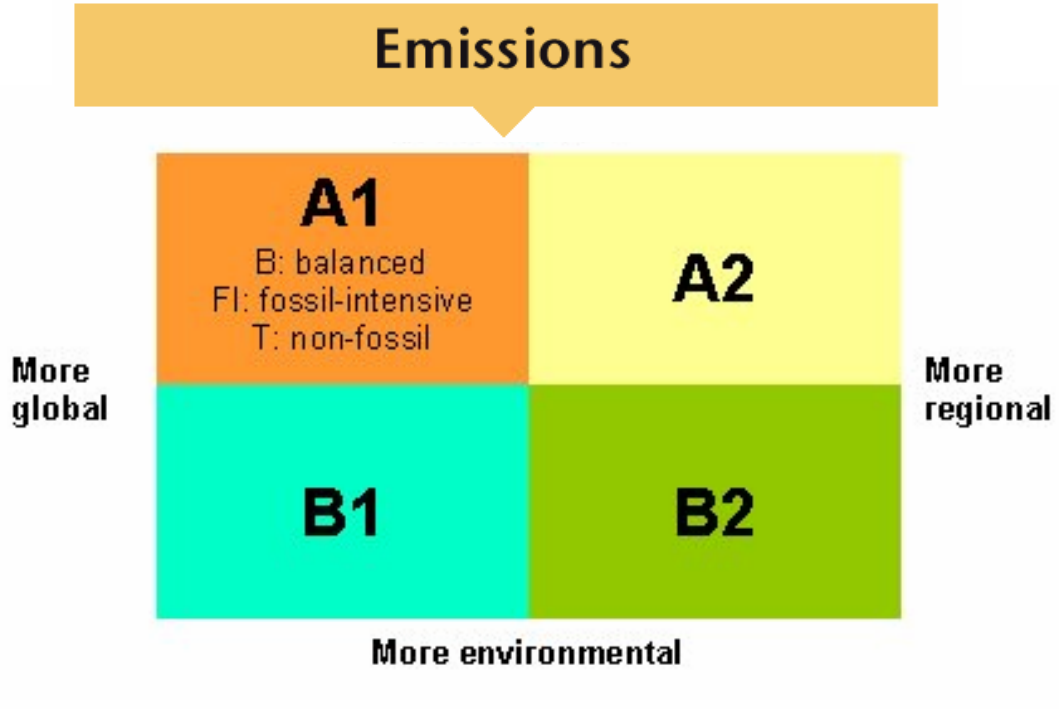
Sources of Uncertainty

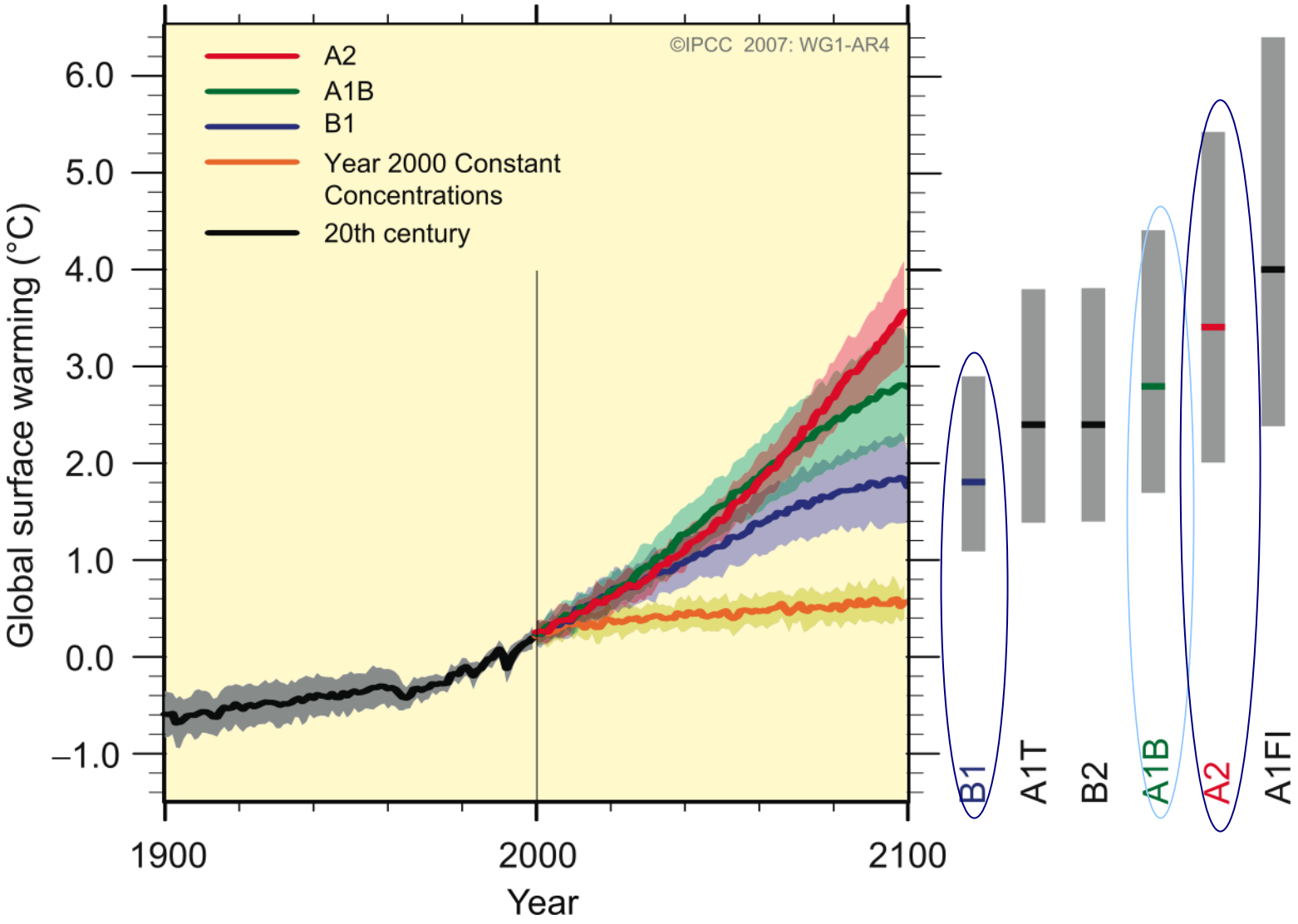


[Source: Hadley Centre for Climate Prediction and Research, UK Met. Office]

SRES Emissions Scenarios

- Emissions scenarios based on different assumptions about how the global economy will evolve and emit fossil fuels over the next century





IPCC AR4 Figure SPM.5

GCMs

Each GCM has different parameterizations of physics of the Atmosphere, Ocean, Cryosphere & Biosphere

Ensembles were provided with 15 GCMs with one projection following each of the A2 and B1 emission scenarios (30 projections in total).

GCMs include the following:

CGCM3	**Canadian Centre for Climate Modelling and Analysis Global Coupled Model 3**
HadCM3	**Hadley Centre Coupled Model 3**
NCAR CCSM 3.0	**National Centre for Atmospheric Research Coupled Model 3**
GFDL CM2.0 & GFDL CM2.1	**Global Fluid Dynamics Laboratory Coupled Model 2**

AR4 versus TAR

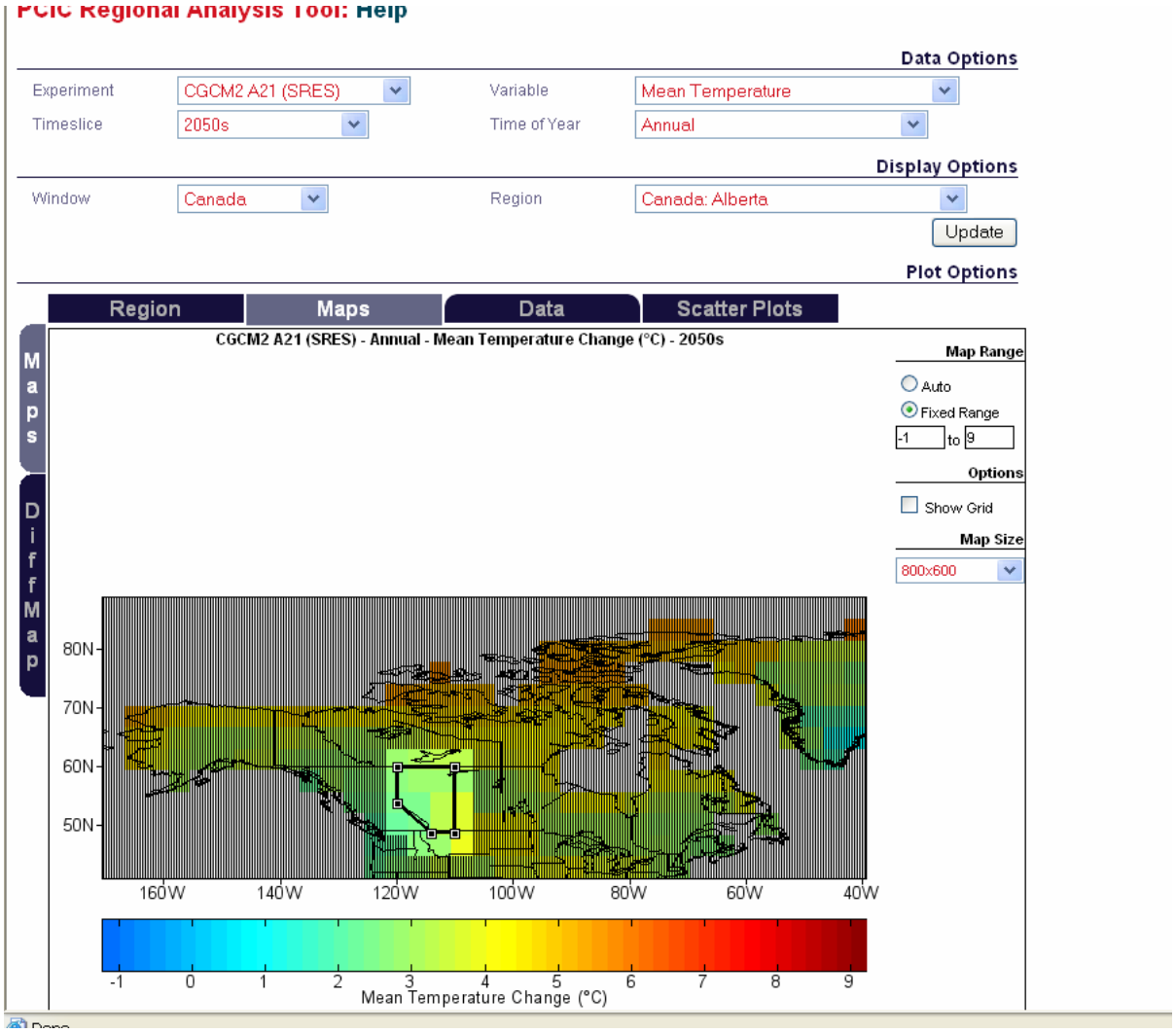
- AR4 less warming than the TAR, particularly at the upper end of the range
- Differences are due to:
  - Emission scenarios are evenly represented in AR4 (i.e. 15 from A2 and 15 from B1)
  - Disproportionate number of projections with high emissions in the TAR resulted in warmer projections
  - More GCMs are included in AR4
  - AR4 includes the most recent version of the GCMs (version 3 instead of 2 for the CGCM)

PCIC Regional Analysis Tool

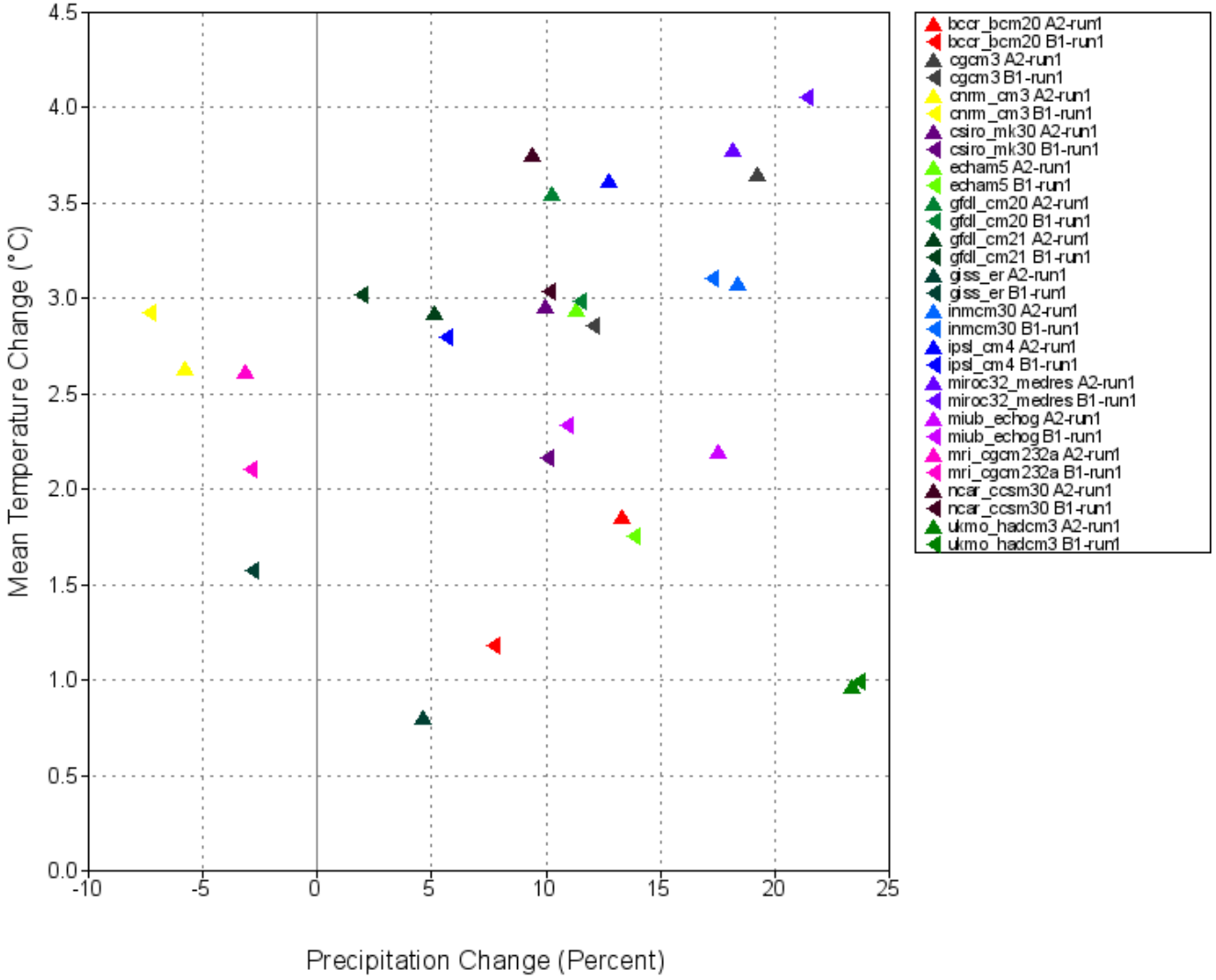
www.PacificClimate.org/tools/

- Similar to the CCCSN Environment Canada tool, but regionally focus
- Predefined regions or create by clicking on map
- Control panel interface (rather than steps)
- Dynamic map creation allows for user customization of many features (legend, decimal places, grid, etc.)
- Meta-information about full map and region (min, max, median, area-weighted mean, stddev)

http://www.cics.uvic.ca/scenarios/



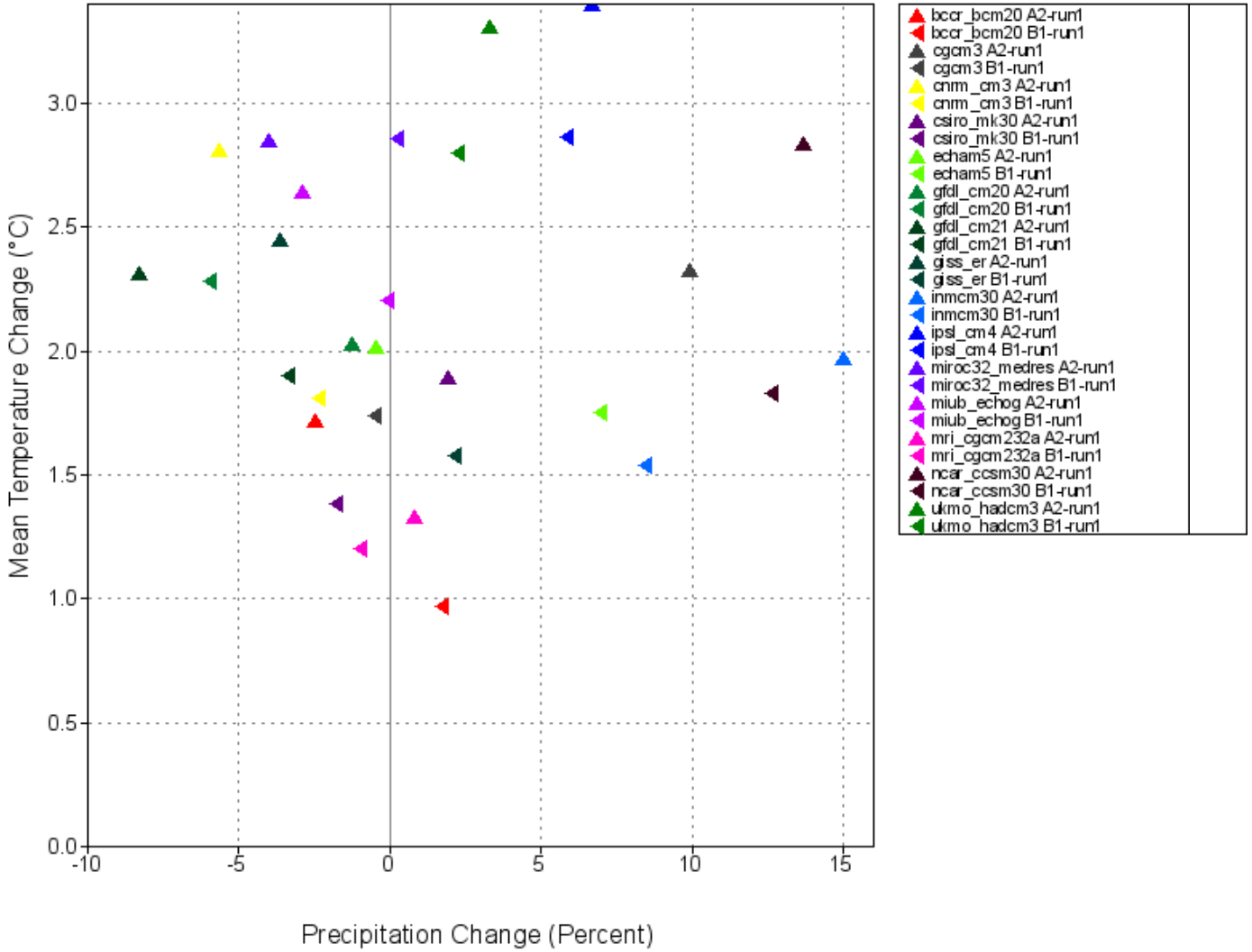
Winter Mean Temperature versus Precipitation Change Across Alberta for the 2050s



Winter - DJF - 2050s - Mean Temperature Change vs Precipitation Change - All experiments - Canada Alberta

(BETA) Prepared by PCIC

Summer Mean Temperature versus Precipitation Change Across Alberta for the 2050s



Summer - JJA - 2050s - Mean Temperature Change vs Precipitation Change - All experiments - Canada Alberta

(BETA) Prepared by PCIC PCIC

GCM ensembles - BC average 2050s projections

Emissions Scenario	Min	10th percentile	25th percentile	Average	50th percentile (median)	75th percentile	90th percentile	Max
B1	0.6	1.2	1.3	**1.6**	1.6	1.8	2.1	2.9
A1B	1.3	1.3	1.5	2.0	2.1	2.5	2.8	3.1
A2	1.0	**1.2**	1.5	**1.9**	1.9	2.3	**2.5**	2.6
B1,A2	0.6	**1.2**	1.4	**1.7**	1.7	2.0	**2.5**	2.9
B1,A2	**1.1**	**1.6**	**1.8**	**2.2**	**2.2**	**2.4**	**3.0**	**3.3**
B1,A1B,A2	0.6	1.3	1.4	1.8	1.8	2.2	2.6	3.1

Alberta

Table 4.1.3a – BC 2050s (2041-2070) annual temperature anomalies (°C) from (1961-1990) model baseline. Range from 15 GCMs for each of 1, 2, or 3 emissions scenarios. Min = minimum, max = maximum. Source: LLNL data.

	T GCM range	T A2-B1	P GCM range	P A2-B1
2050s	**1.3**	**0.3**	10%	0%
2080s	2.0	1.2	13%	3.5%

Temperature (°C) and Precipitation (% of 1961-1990 model baseline) uncertainty estimates from GCMs and emissions scenarios

Ratio of Emission Scenarios for Ensemble Average Temperature Anomalies for 2050s vs. 2080s

	B1	A1B	A2
2050s	1	1.25	1.15
2080s	1	1.37	1.55

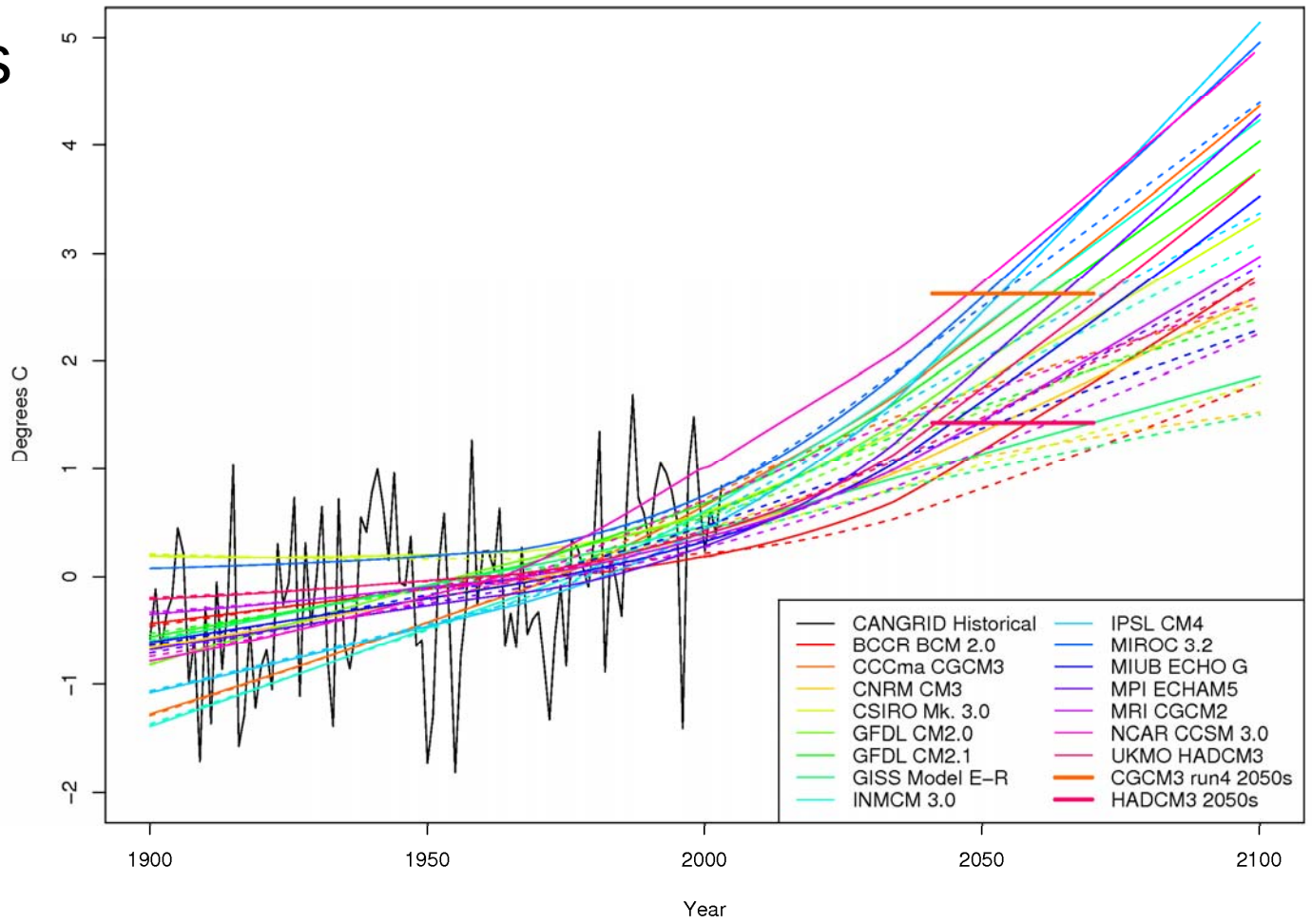
CGCM3 - BC average 2050s projections

Projection (run #)	Temperature anomaly (°C)			Precipitation anomaly (%)		
	Winter	Summer	Annual	Winter	Summer	Annual
1	3.0	2.0	2.3	15	2	11
2	3.1	2.5	2.5	17	7	15
3	3.1	2.3	2.3	13	6	15
4	**3.2**	**2.2**	**2.6**	**15**	**6**	**14**
5	4.0	2.2	2.5	29	3	16
Average	3.3	2.2	2.4	18	5	14
Run 1-4 range (max-min)	0.2	0.5	0.3	4	5	4
Range (max-min)	1.0	0.5	0.3	16	5	5

Table 4.1.2 – BC 2050s (2041-2070) anomalies from (1961-1990) model baseline for 5 CGCM3 runs following A2. Run 1 is used in ensembles (section 4.1). Run 4 is used for single GCM results in section 4.1 and to force downscaling results (sections 4.2 and 4.3). Source: LLNL data.

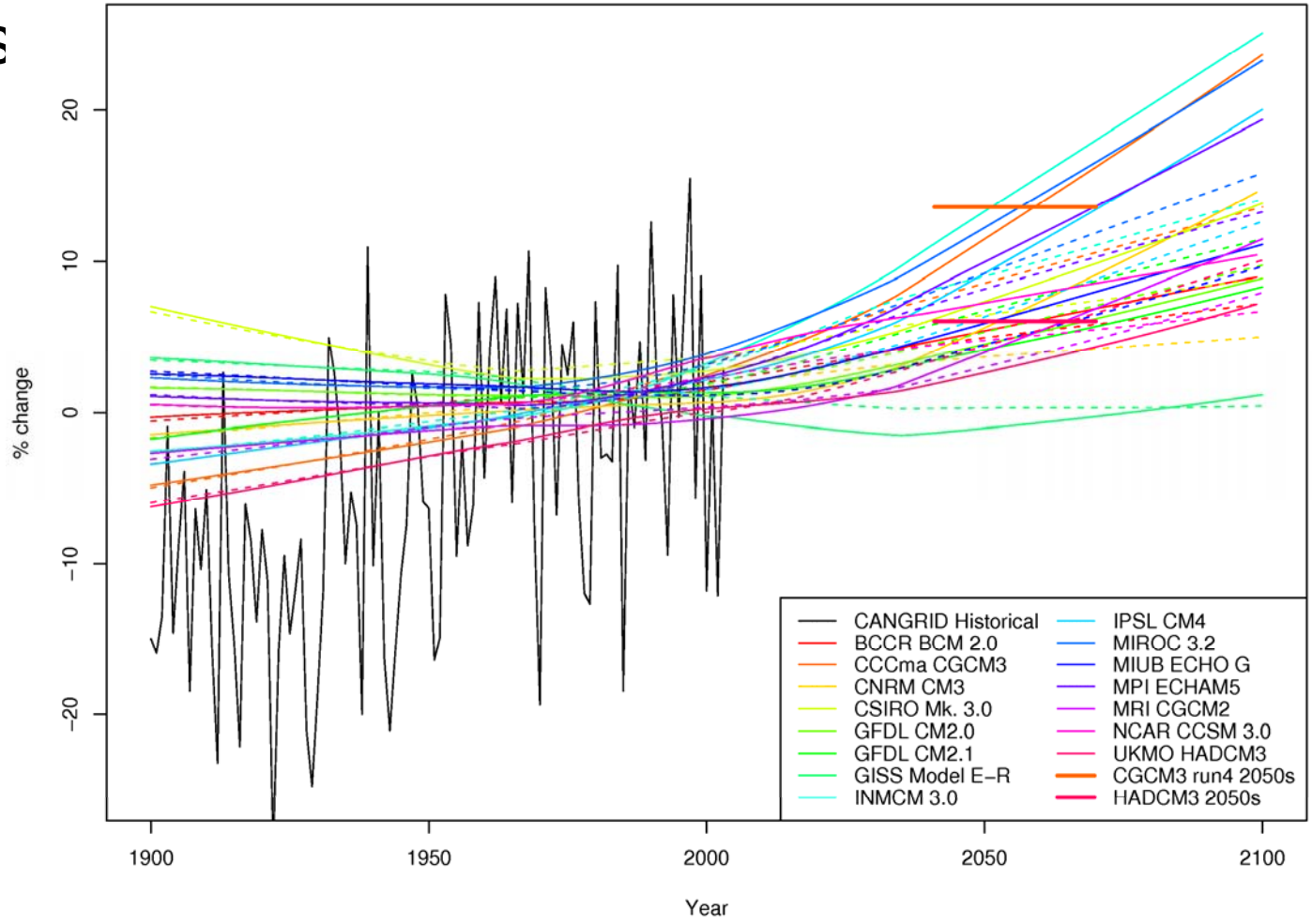
BC Temperature Projections

- Anomalies from 1961-1990
- 15 GCMs
- solid A2, dash B1



BC Precipitation Projections

- Anomalies from 1961-1990
- 15 GCMs
- solid A2, dash B1



IPCC Projections for North America by end of the 21st Century

1. The annual mean temperature is likely to exceed global changes
2. Seasonal changes are likely to be largest in the winter in the north
3. Annual precipitation is very likely to increase in Canada
4. Winter and spring precipitation is likely to increase but summer precipitation to decrease in southern Canada

Summary

- GCMs have imperfect physics which result in uncertainties
- Precipitation is more uncertain than temperature because of the difficulty of representing microphysical processes and larger variability
- However, they still provide meaningful projections of the directions climate will change in the future
- Furthermore, this uncertainty can be estimated by evaluating a ensemble of models and used to place error bounds on projections

Thank you

For more information

www.PacificClimate.org

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