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Linking Global Climate Models to Protected Area Research: Ideas and Approaches

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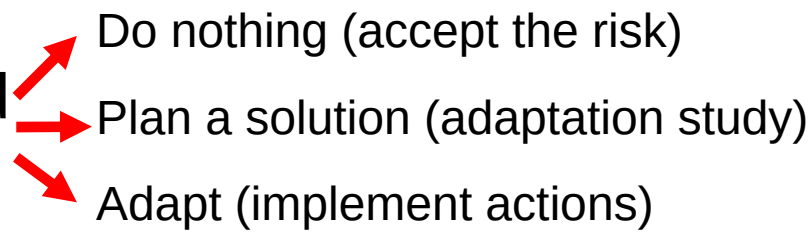
4 November 2010

Simplified Steps
Responding to Climate Change

- Define the where, when and by how much temperature, precipitation and other climate variables (indices) have changed in the past, and will change in the future
- Identify current vulnerabilities locally

- Assuming projections, how will the impacts and vulnerabilities then change?

- Given the risk associated



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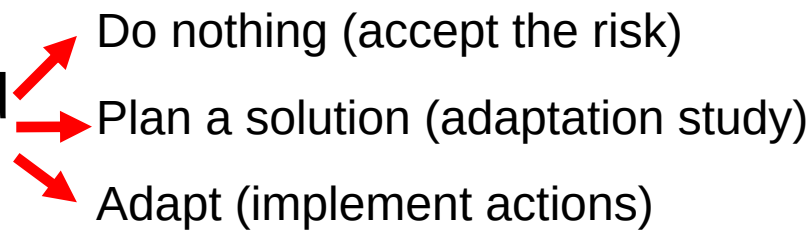
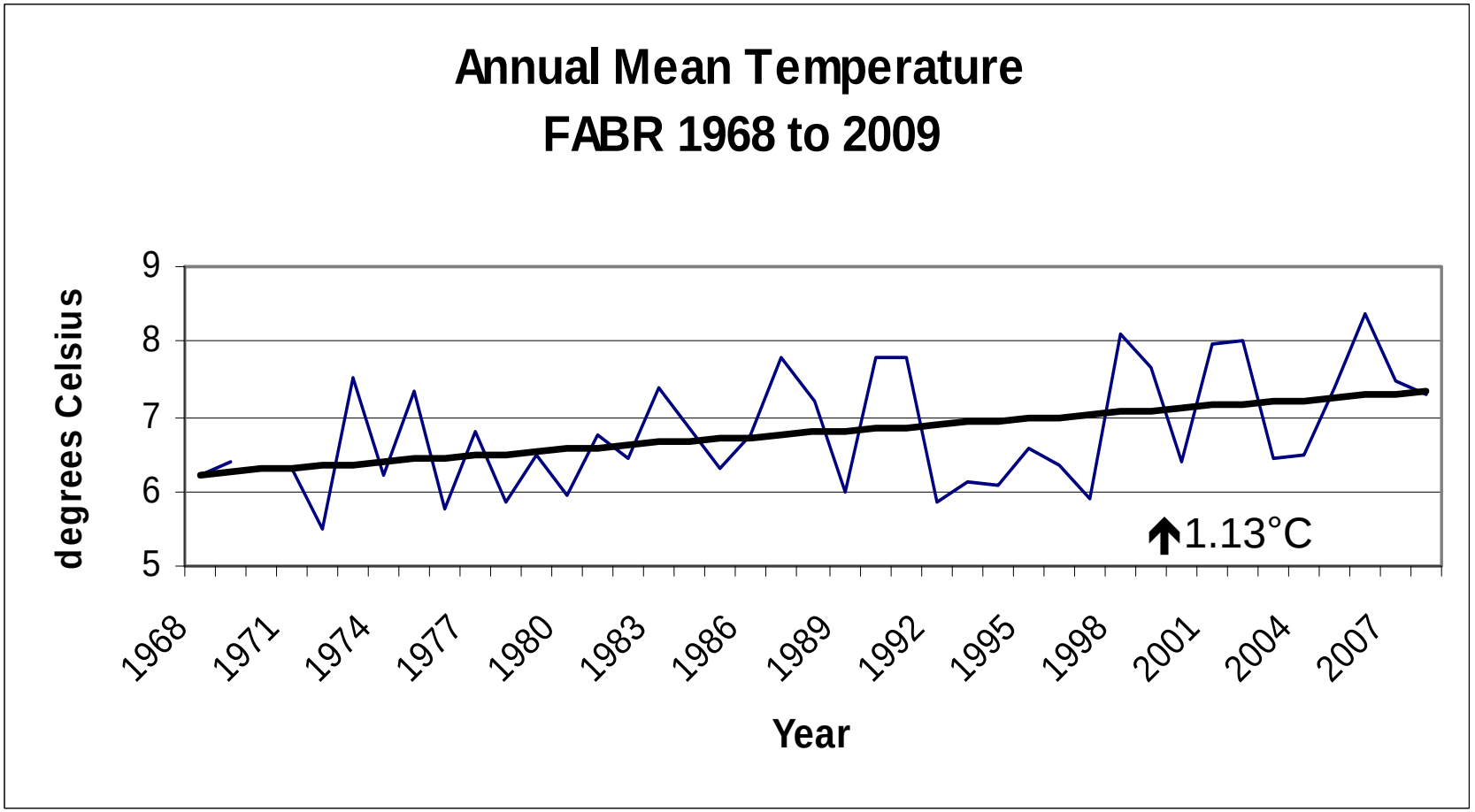


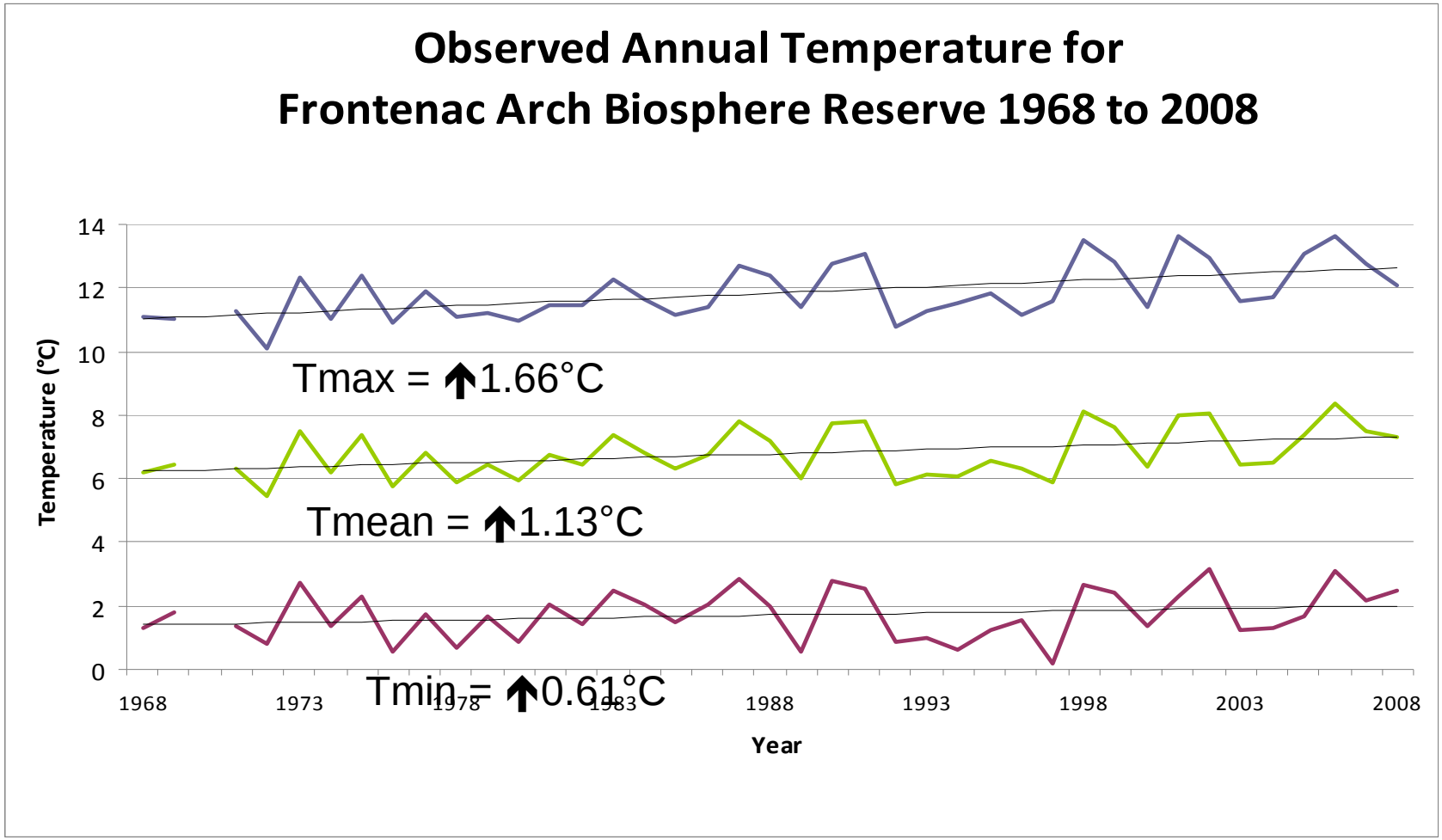
Establish how climate has changed in the past

- Length of record (30+ years of data)
- Continuous records
- Up to present?
- Is the station representative?
- How often have extreme events happened in the past?

Past Climate



Past Climate



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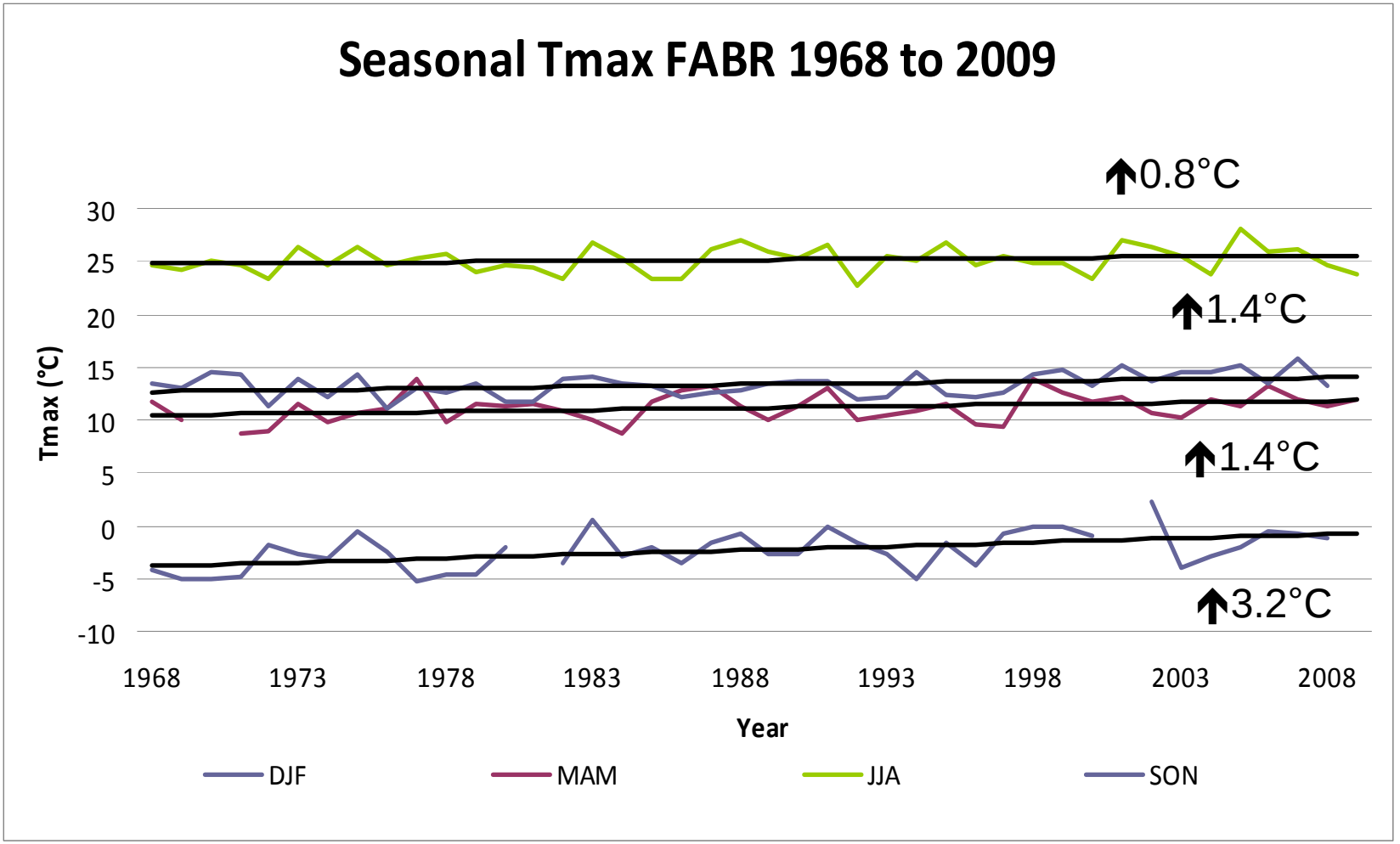

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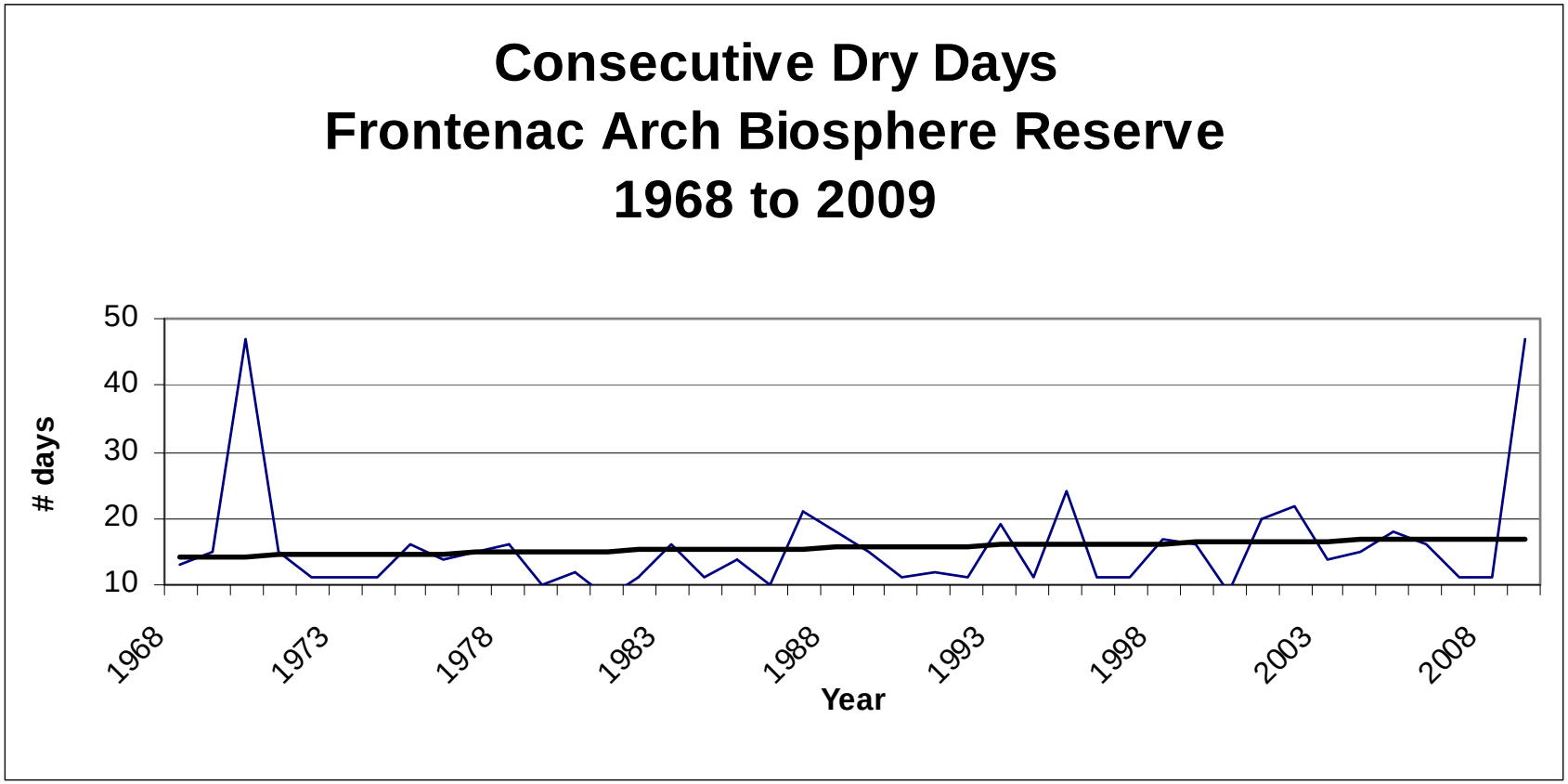

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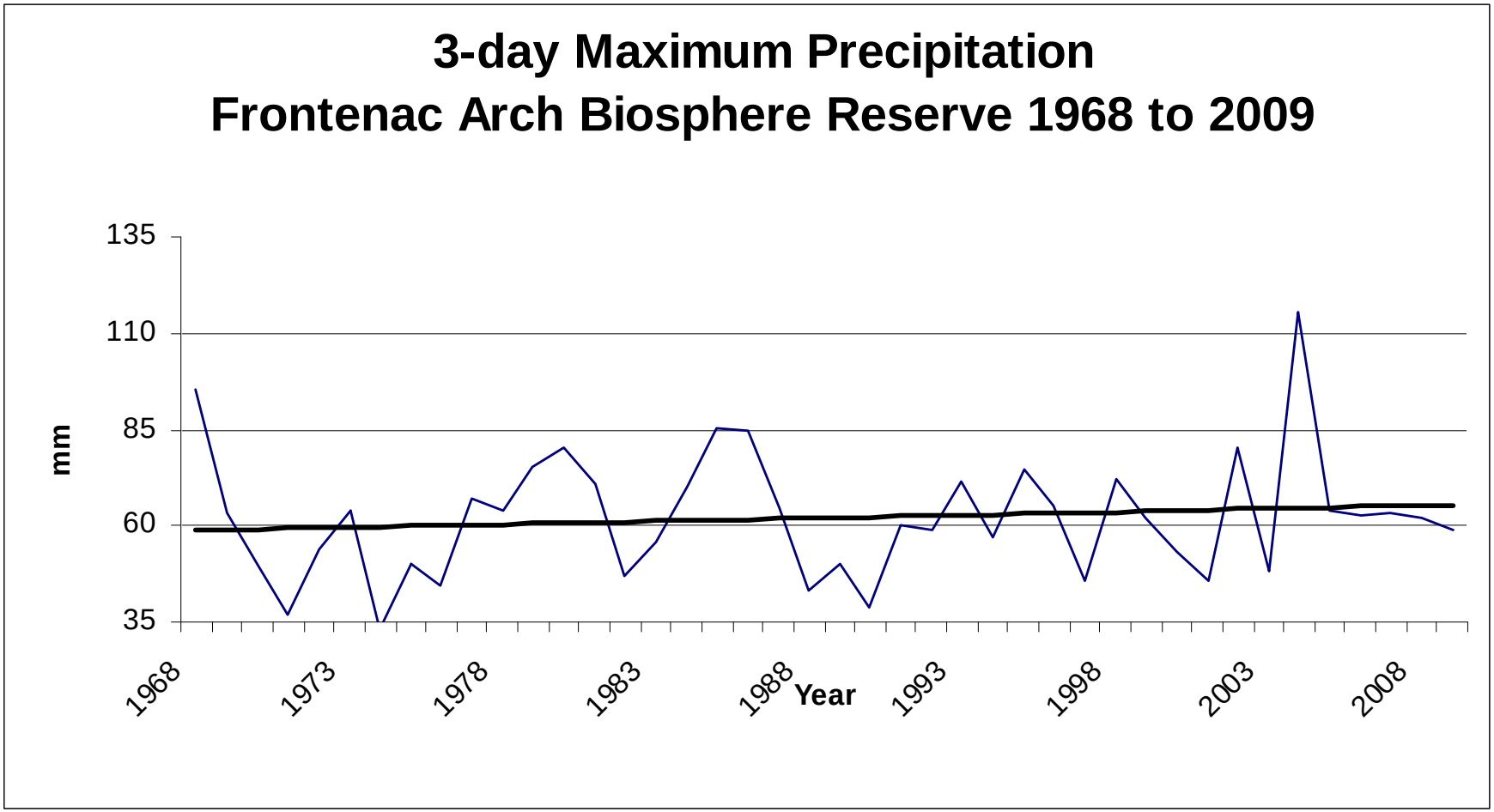
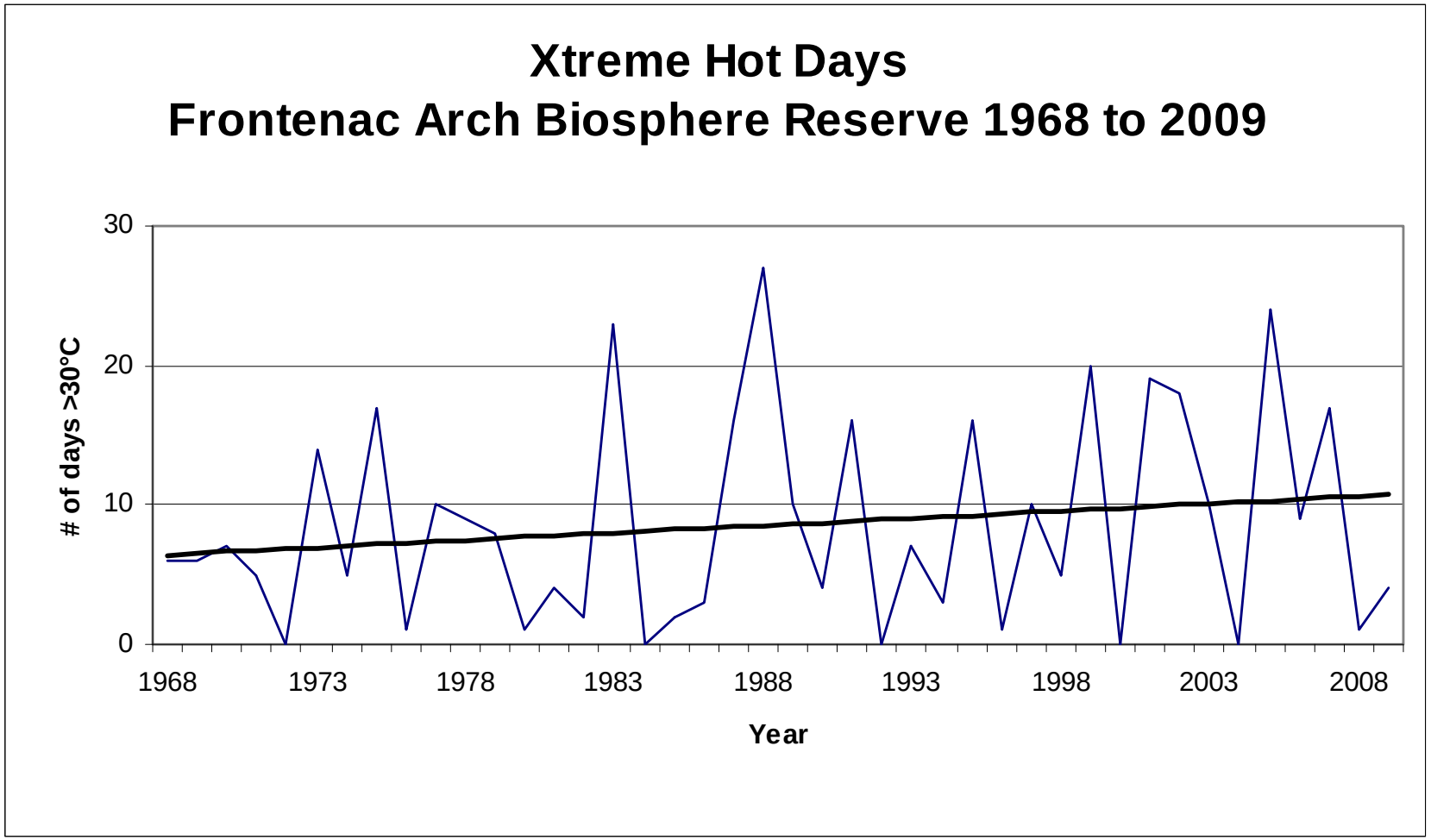


Past Climate



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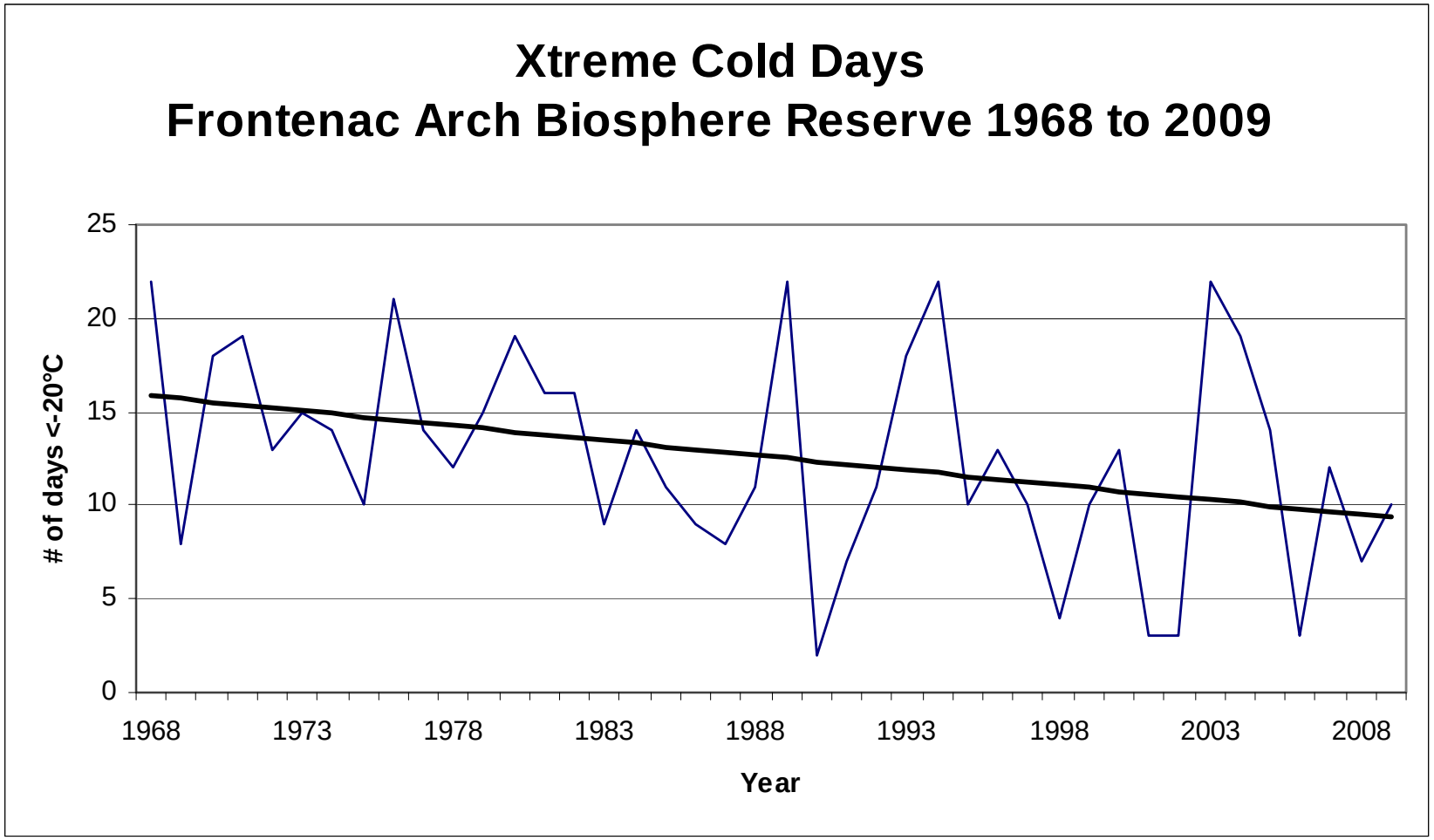

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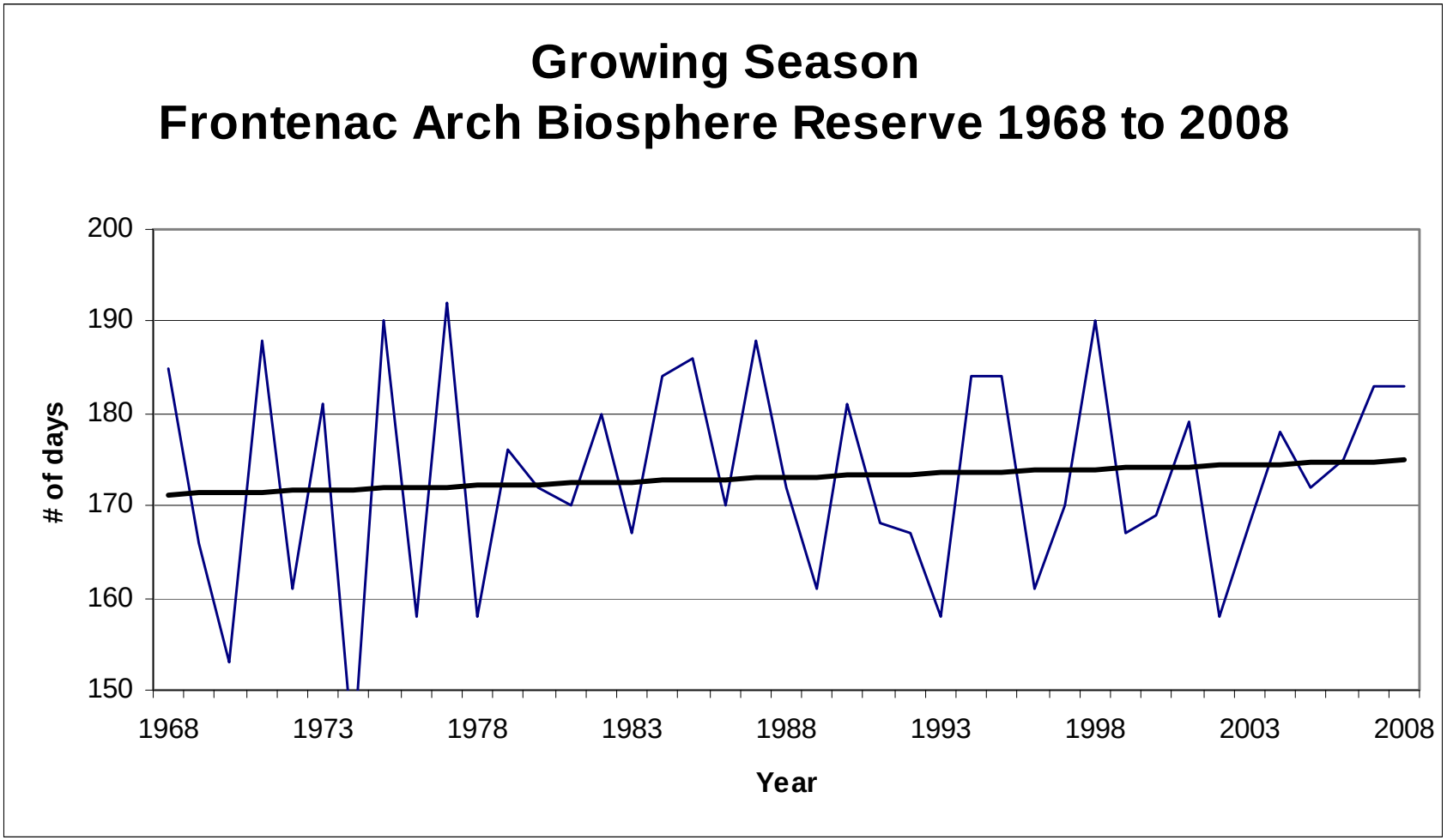

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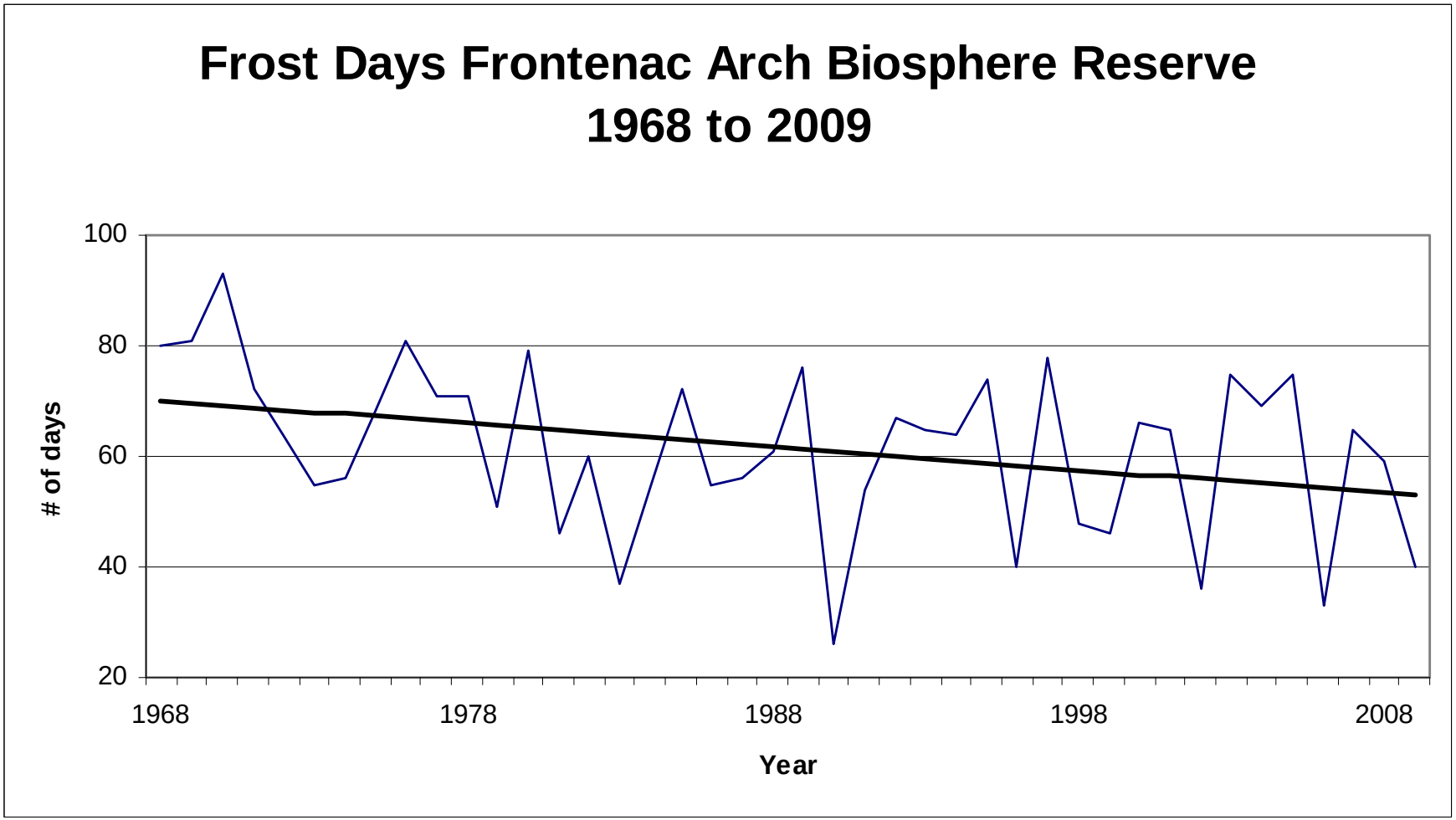

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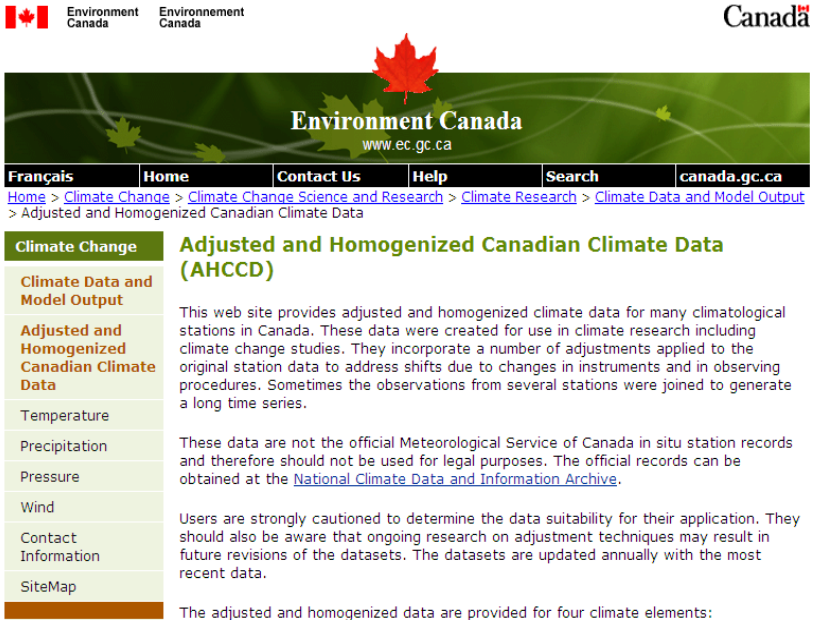
Where to get local data in Canada

Observed historical climate data

(weatheroffice.com)

Observed long-term climate data (Adjusted/Homogenized)

(ec.gc.ca/dccha-ahccd/)



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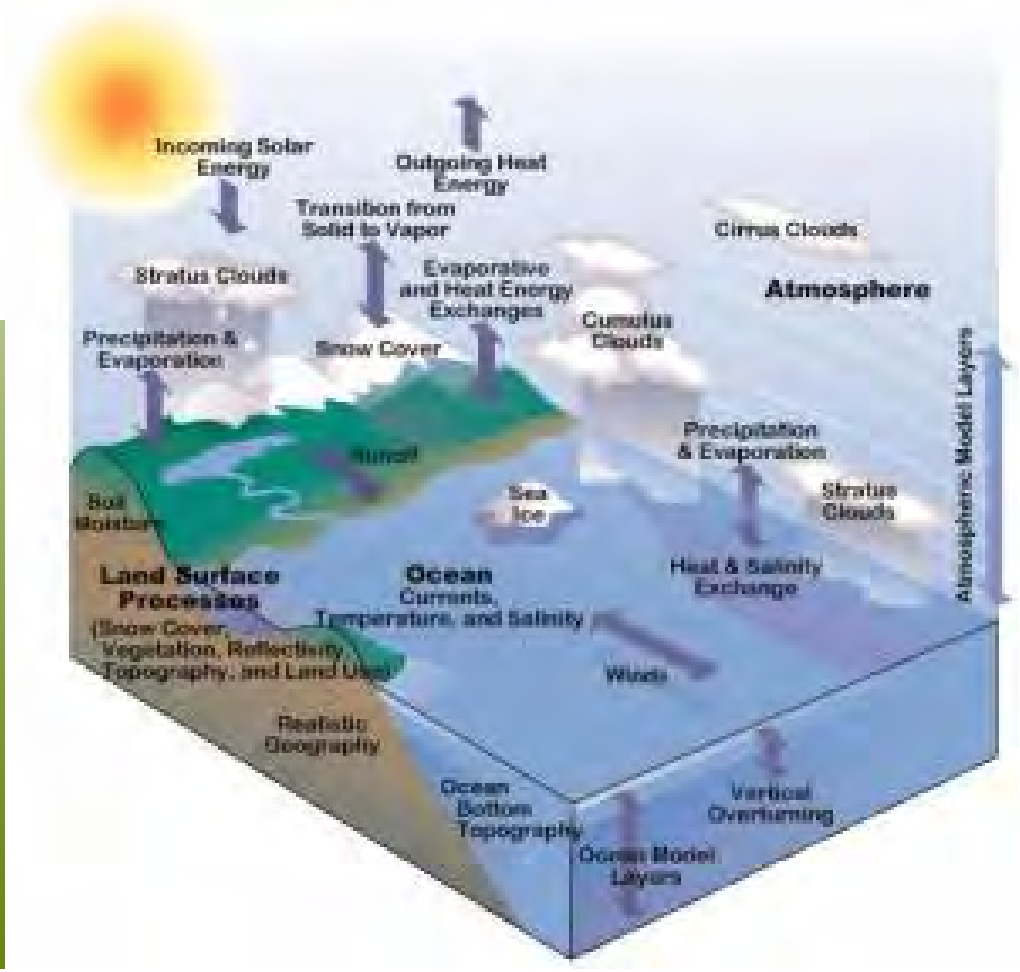
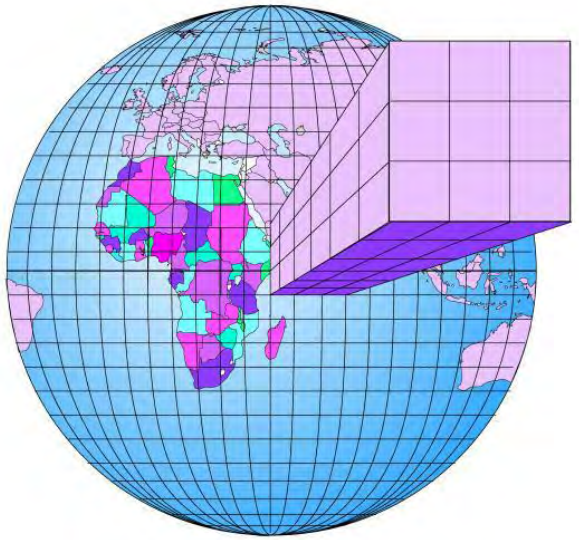
Future Climate Projections Using Global Climate Models (GCMs)



- mathematical models
- been around 35 years



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24 Models Used in IPCC 4AR (2007)

CENTRE	MODEL
Bjerknes Centre for Climate, Norway	BCM2.0
Canadian Centre for Climate Modelling and Analysis (CCCma), Canada	CGCM3T47
Canadian Centre for Climate Modelling and Analysis (CCCma), Canada	CGCM3T63
Centre National de Recherches Meteorologiques, France	CNRMCM3
Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia	CSIROMk3.0
Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia	CSIROMk3.5
Max Planck Institute für Meteorologie, Germany	ECHAM5OM
Meteorological Institute, University of Bonn Meteorological Research Institute, Germany	ECHO-G
Institute of Atmospheric Physics, Chinese Academy of Sciences, China	FGOALS-g1.0
Geophysical Fluid Dynamics Laboratory (GFDL), USA	GFDLCM2.0
Geophysical Fluid Dynamics Laboratory (GFDL), USA	GFDLCM2.1
Goddard Institute for Space Studies (GISS), USA	GISSAOM
Goddard Institute for Space Studies (GISS), USA	GISSE-H
Goddard Institute for Space Studies (GISS), USA	GISSE-R
UK Meteorological Office, United Kingdom	HADCM3
UK Meteorological Office, United Kingdom	HADGEM1
National Institute of Geophysics and Volcanology, Italy	INGV-SXG
Institute for Numerical Mathematics, Russia	INMCM3.0
Institute Pierre Simon Laplace, France	IPSLCM4
National Institute for Environmental Studies, Japan	MIROC3.2 hires
National Institute for Environmental Studies, Japan	MIROC3.2 medres
Meteorological Research Institute, Japan Meteorological Agency, Japan	MRI-CGCM2.3.2
National Center for Atmospheric Research (NCAR), USA	NCARPCM
National Center for Atmospheric Research (NCAR), USA	NCARCCSM3

Emission Scenarios

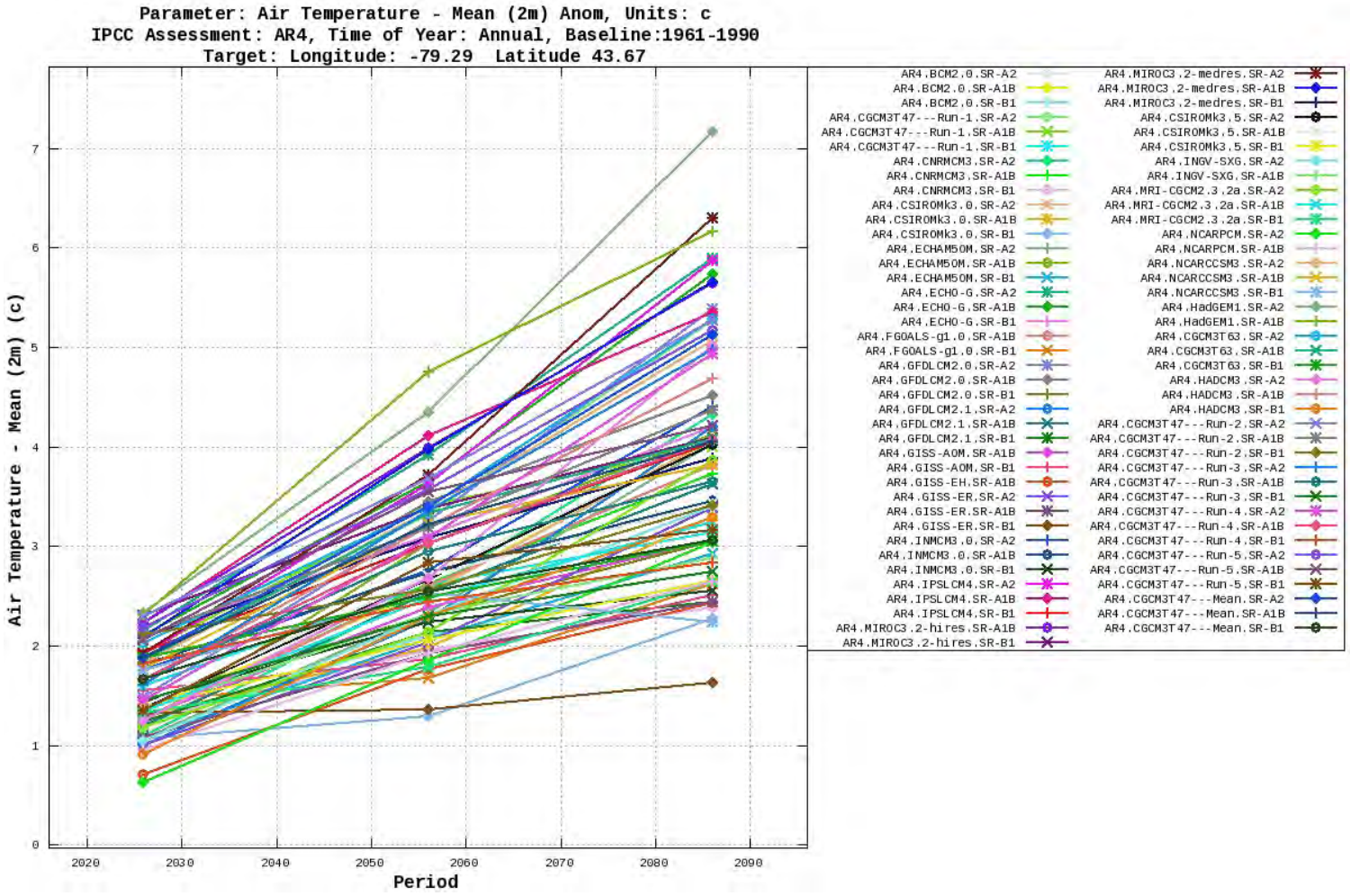
3 primary GHG indicators
- Human population
- Global economy type
- Energy type

A1 - The A1 scenarios are of a more integrated world. The A1 family of scenarios is characterized by:rapid economic growth; a global population that reaches 9 billion in 2050 and then gradually declines; the quick spread of new and efficient technologies; a convergent world – income and way of life converge between regions; and extensive social and cultural interactions worldwide. There are subsets to the A1 family based on their technological emphasis: A1FI - an emphasis on fossil-fuels; A1B - A balanced emphasis on all energy sources; and A1T - emphasis on non-fossil energy sources.

A2 - The A2 scenarios are of a more divided world. The A2 family of scenarios is characterized by:a world of independently operating, self-reliant nations; continuously increasing population; regionally oriented economic development; and slower and more fragmented technological changes and improvements to per capita income.

B1 - The B1 scenarios are of a world more integrated, and more ecologically friendly. The B1 scenarios are characterized by: rapid economic growth as in A1, but with rapid changes towards a service and information economy; population rising to 9 billion in 2050 and then declining as in A1; reductions in material intensity and the introduction of clean and resource efficient technologies; and an emphasis on global solutions to economic, social and environmental stability.

Annual Mean Temperature Change at Toronto, Ontario 2020s, 2050s, 2080s



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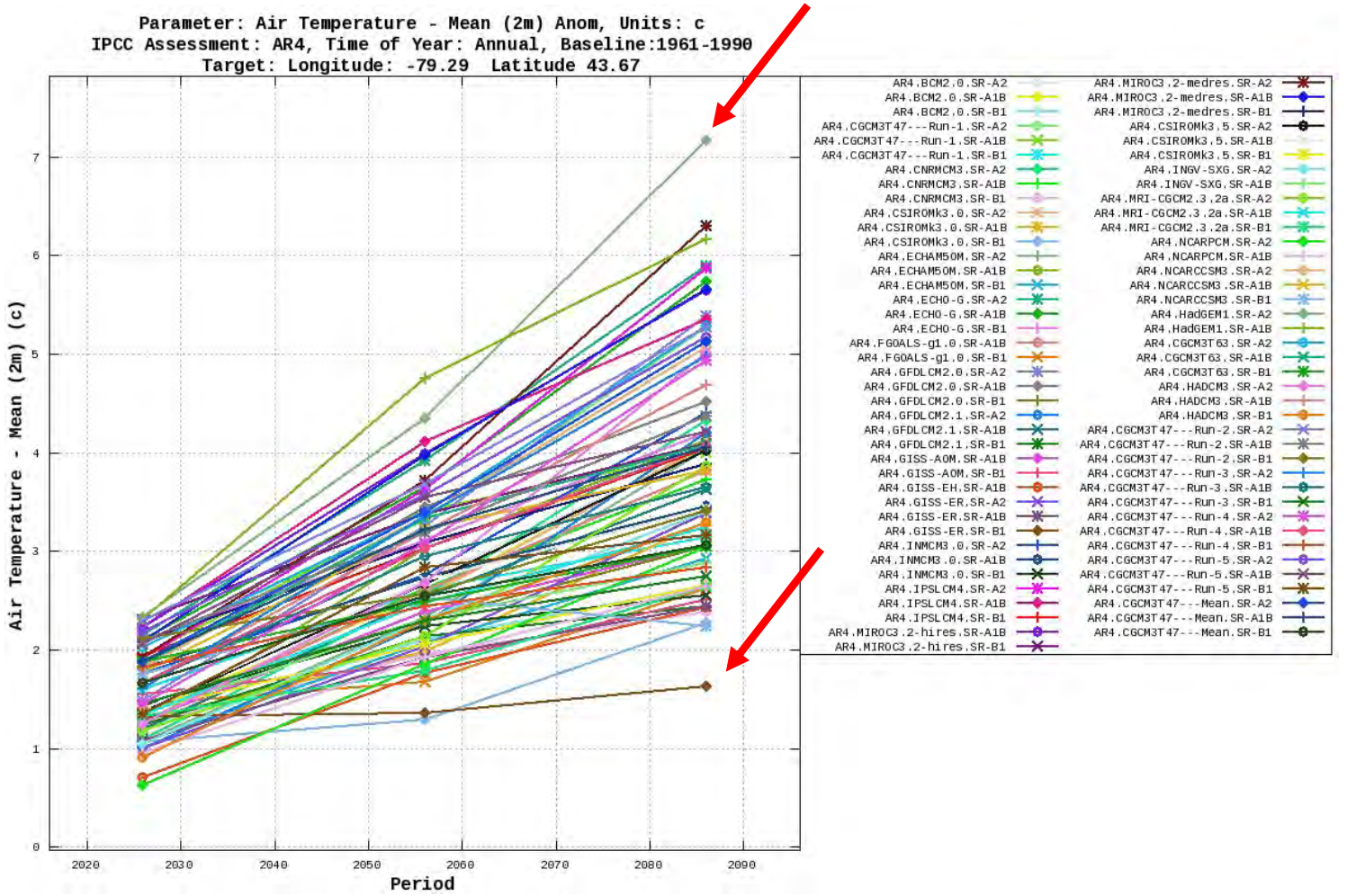
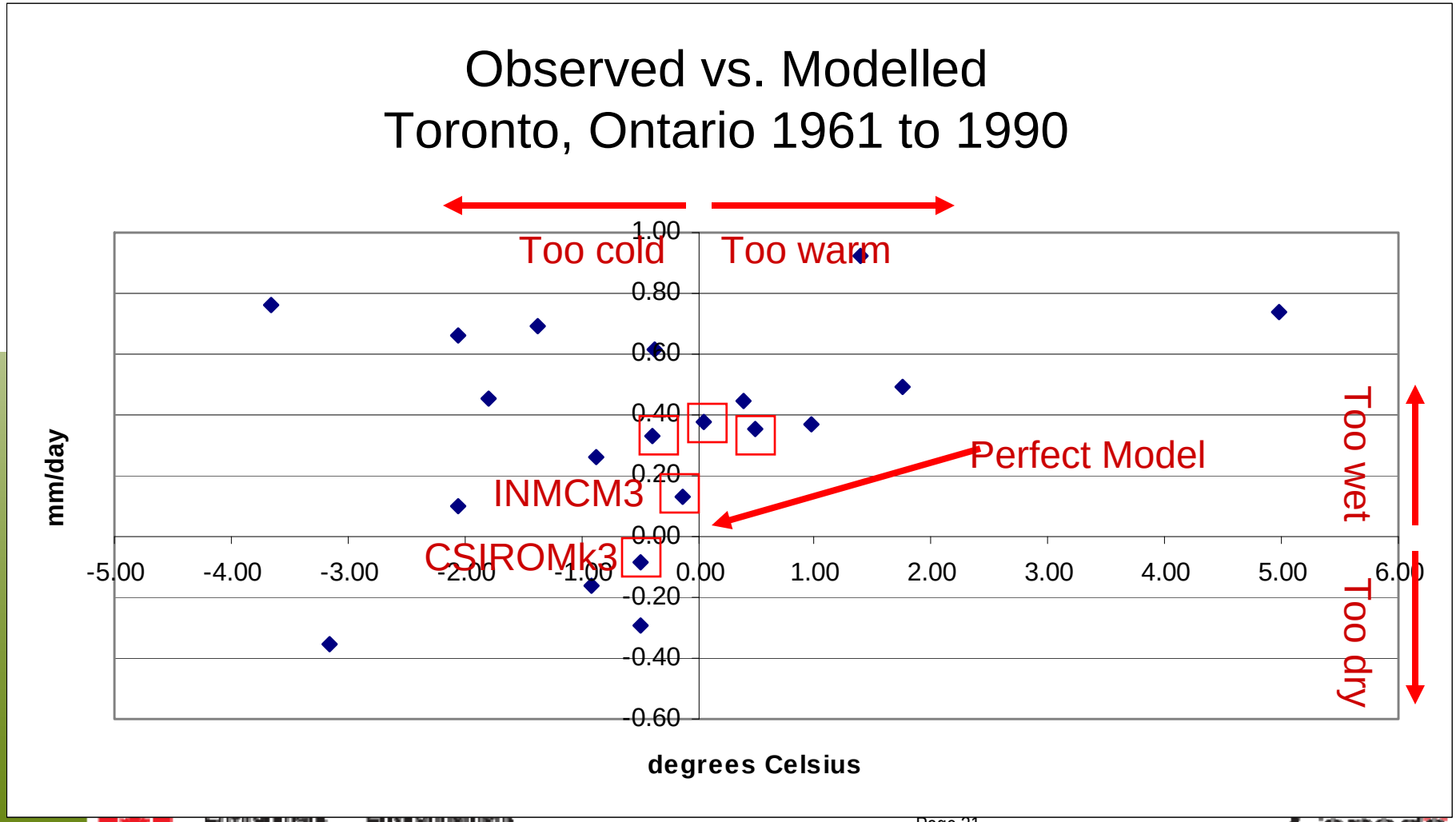
How do we select a model(s)

1. Range of Projections
2. Validation
3. Ensemble

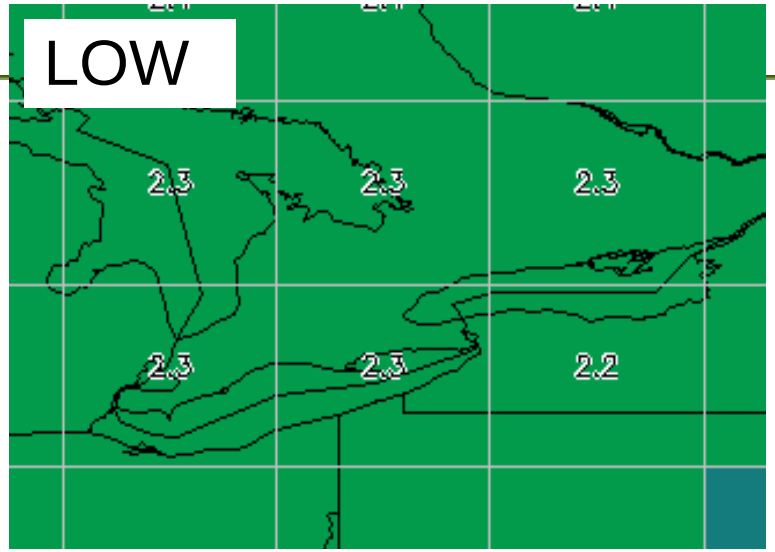
Range of Models

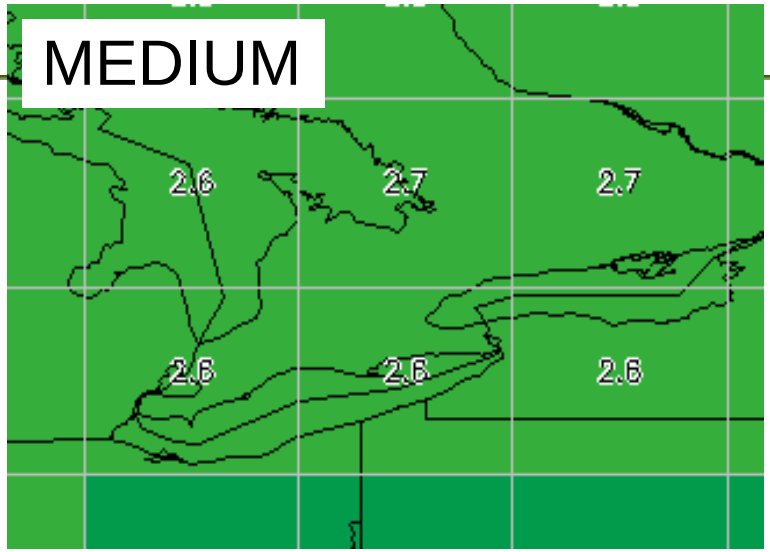


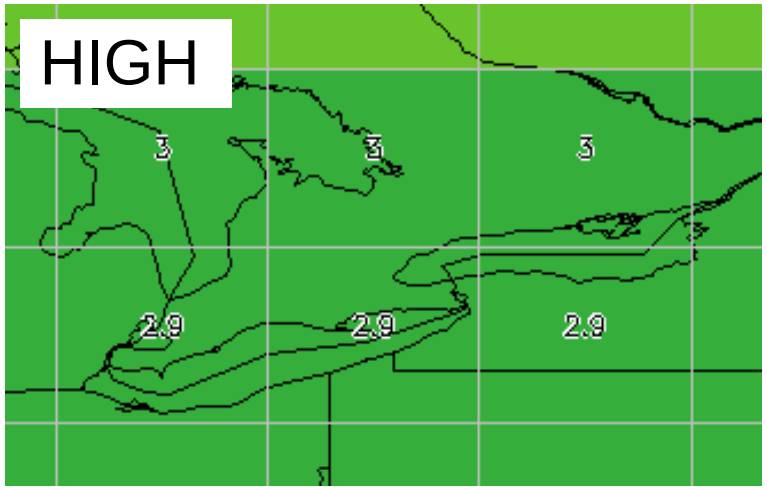
Validating Models

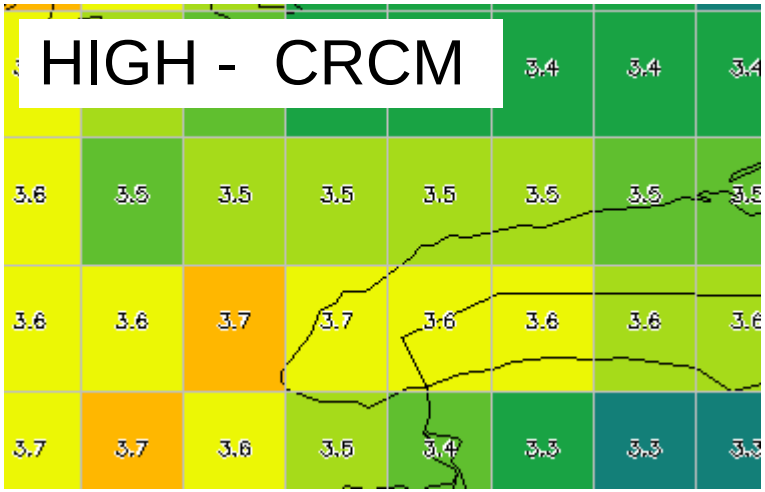


Ensemble – Annual Mean Temperature Change in 2050s









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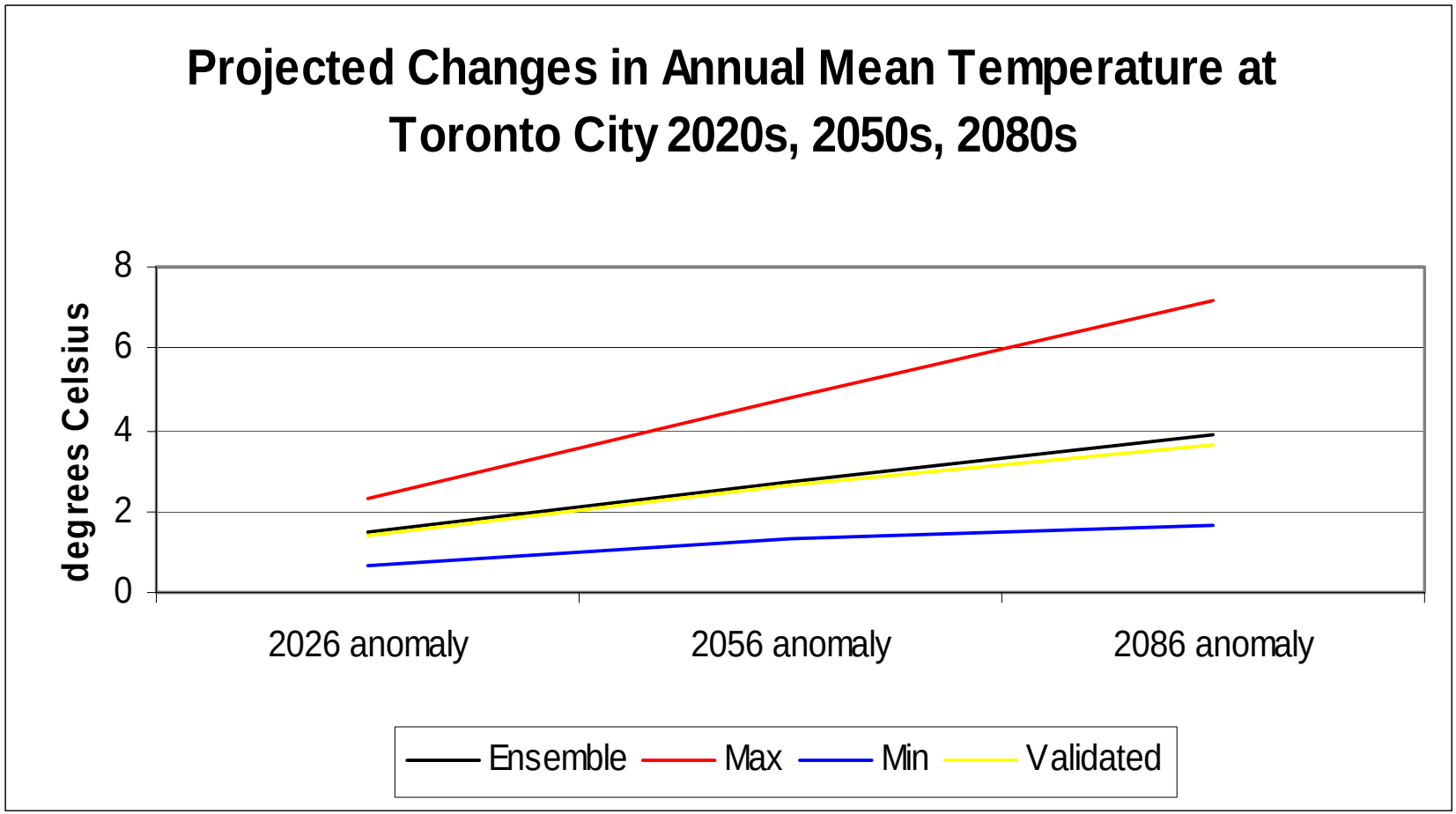
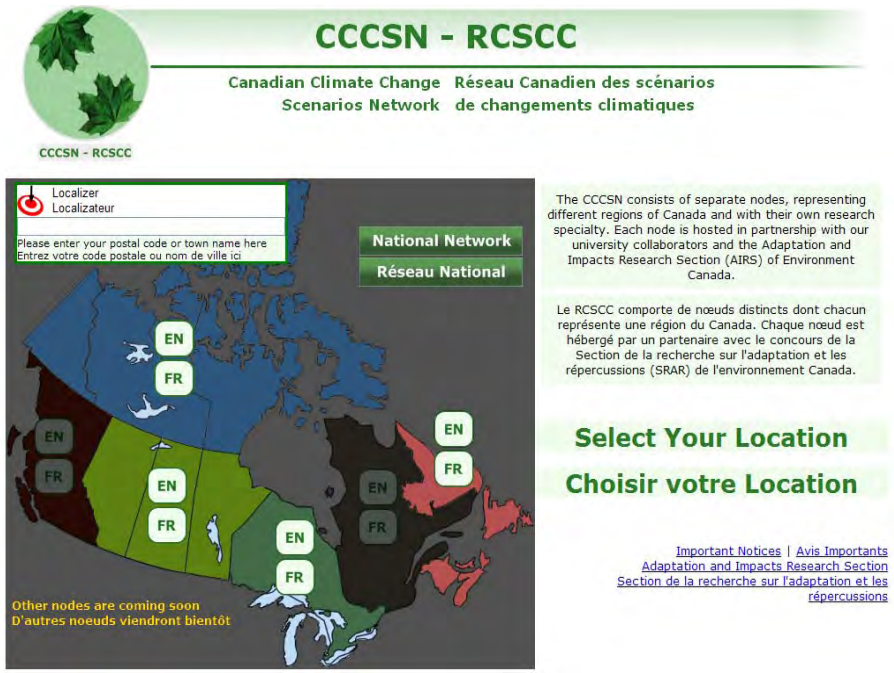
Projected Changes in Annual Mean Temperature



Where to Get Future Climate Projections

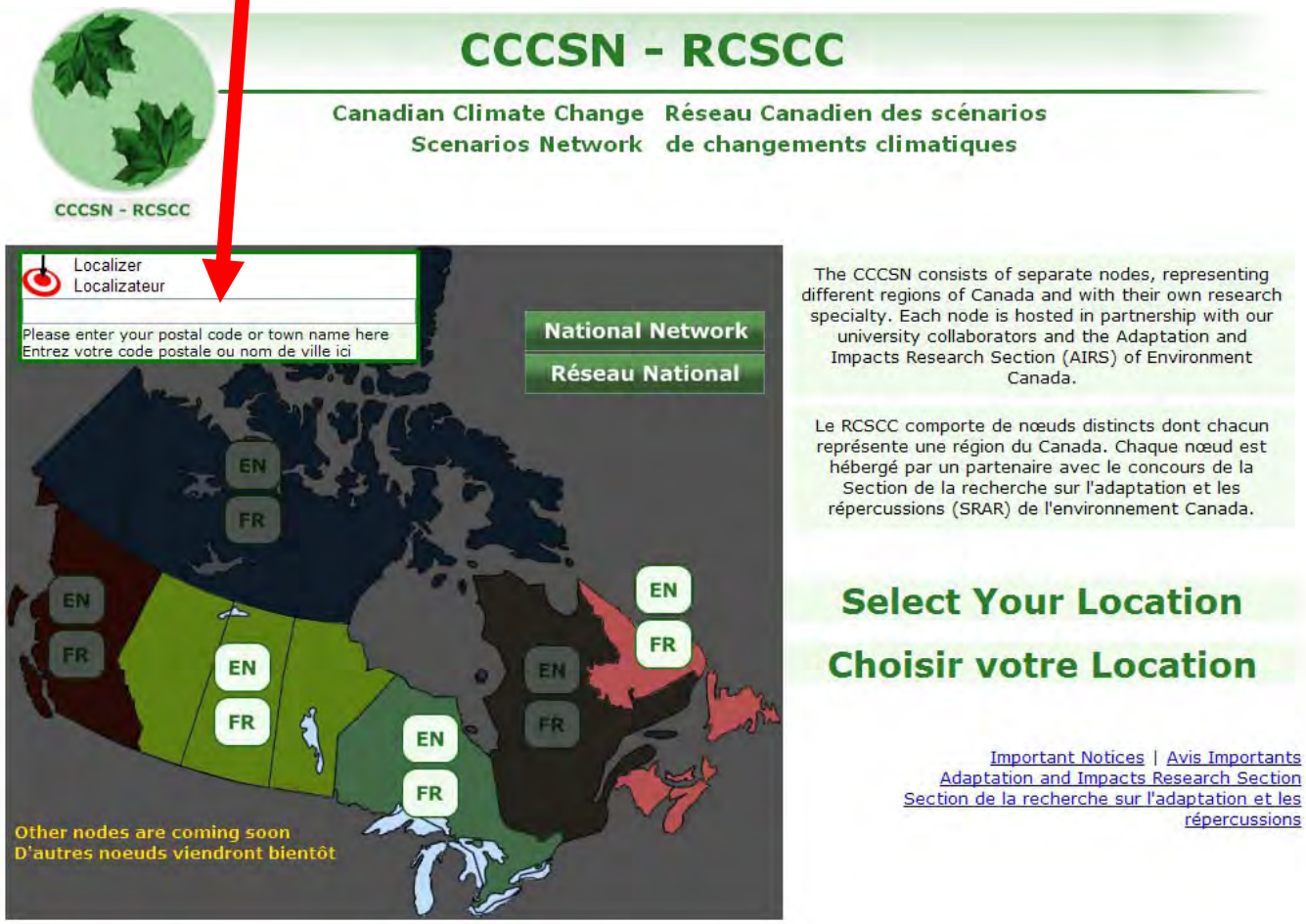
The Canadian Climate Change Scenarios Network (CCCSN.CA)
(www.cccsn.ca)



- University Partnership
- GCM and RCM data, tools
- Added-value 'Bioclimate profiles' on degree days, frost/freeze, water budget, temperature exceedances, etc.
- ENSEMBLE results – an average of ALL GCM models for temperature and precipitation so no decision on which models to use
- NEW design of site to better reflect regional research

NEW – Making it local the 'Localizer'

For a customized summary report on climate change projections for your location, simply enter your town name here



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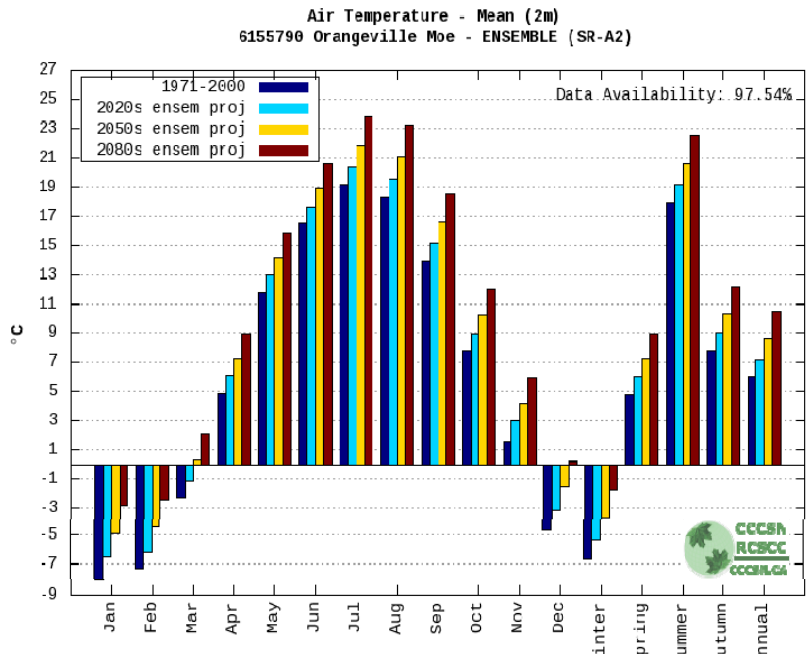
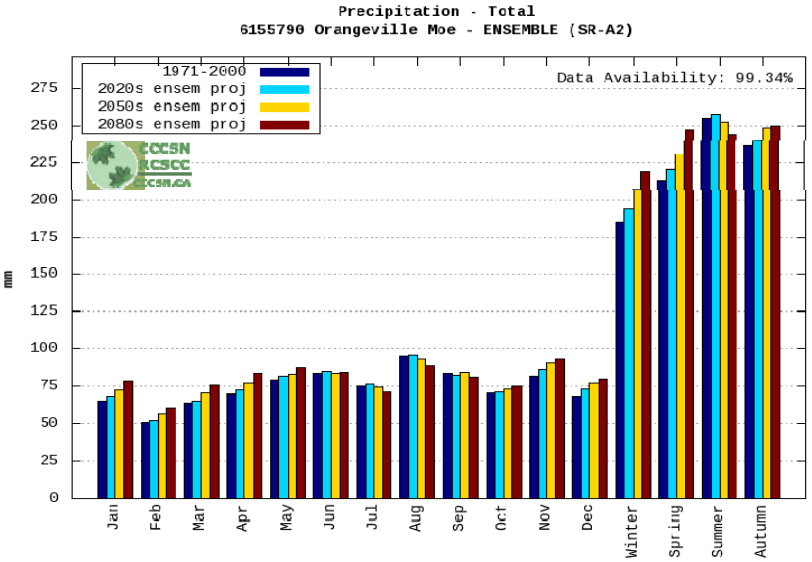
What the ‘Localizer’ offers:

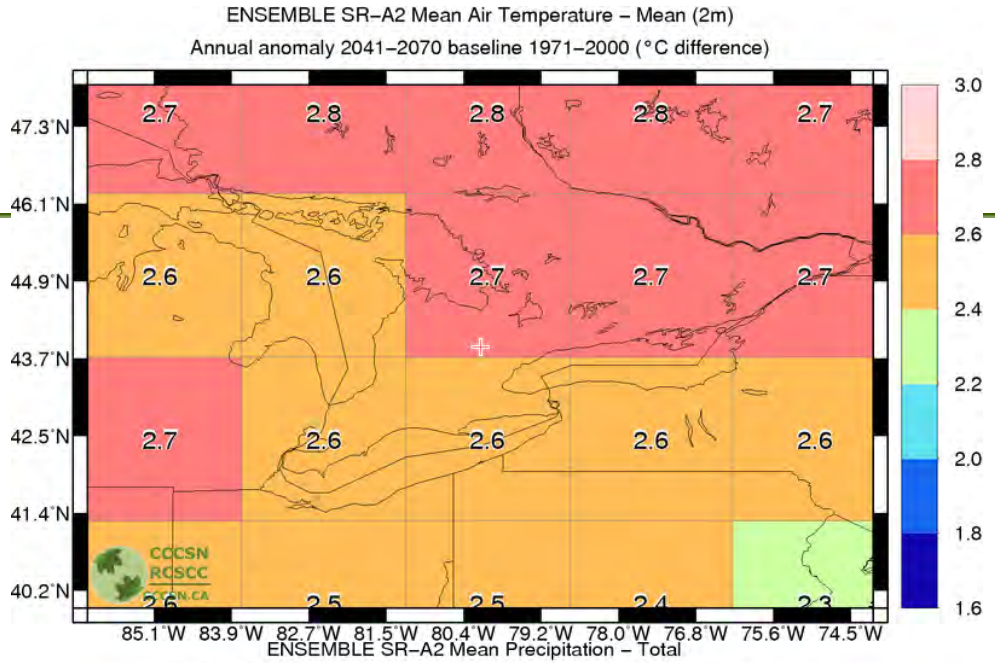
A quick and easy overview of projected <u>local</u> climate change

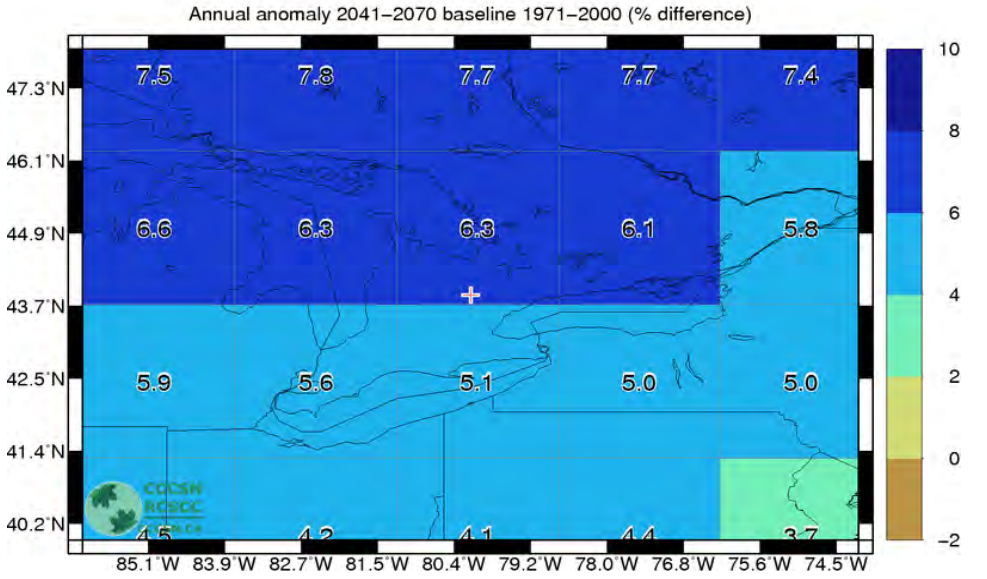
- No guesswork about which models of the 2 dozen available from the IPCC to select – the average of all is calculated
- For the standard 3 emission scenarios (A2-high,A1B-middle and B1-low)
- The standard deviation for each month is shown to give an idea of model uncertainty
- Monthly change in temperature and precipitation for the 2020s, 2050s and 2080s from the closest long-term EC observation station
- Tabular format with historical (1971-2000) observations as the baseline and projected change
- Uses GCM data – NOT Regional models

PARTIAL SAMPLE OUTPUT









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Using ‘BIOCLIMATE PROFILES’ other details are available for the same locations as LOCALIZER

Temperature: Mean, Max and Min	
Heating & Cooling Degree Days	
Daily Corn Heat Units	
Daily Growing Degree Days	
Monthly Growing Degree Days	
Daily Frost	
Water Balance	
Frequency of Precipitation	
Maximum Temperature Above Threshold	>25C, >30C, >35C
Maximum Temperature Below Threshold	<0C, <-10C, <-20C
Freeze-Thaw Cycles	
Accumulated Precipitation	

Not available for ensemble model – you must select a model to apply

Climate Change Projections: Can we answer everything?

- Some events we cannot determine from climate model projections and likely never will

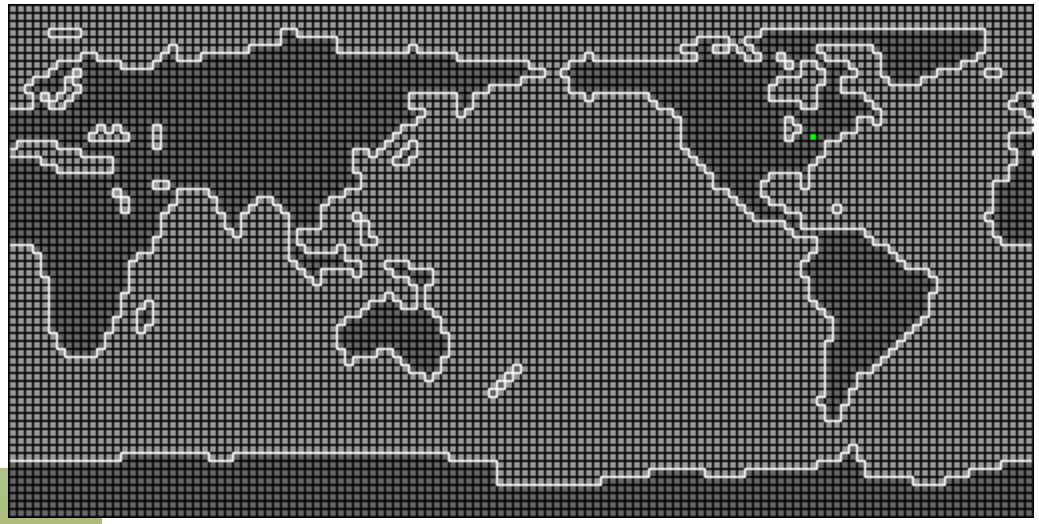
  - too fine a spatial scale AND temporal scale

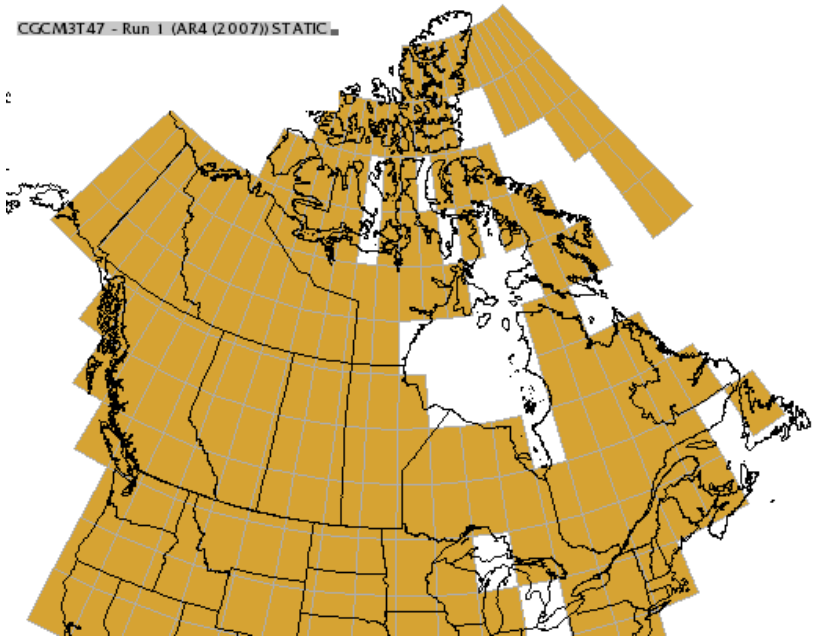
  A good example: tornado occurrence

- Statistical downscaling can help with some extremes, but requires some operational expertise not available to all

- Sometimes all we have are historical trends…

Resolution of GCMs?





What about downscaling GCMs?

- Downscaling = obtaining finer resolution scenarios of climate change from the coarser resolution GCM output
- no 'standard' approach to downscaling
- Dynamical downscaling = regional climate models (RCMs) where a finer resolution model is “nested” within the GCM
- Statistical downscaling = obtain local-scale surface weather from regional-scale atmospheric variables that are provided by GCMs

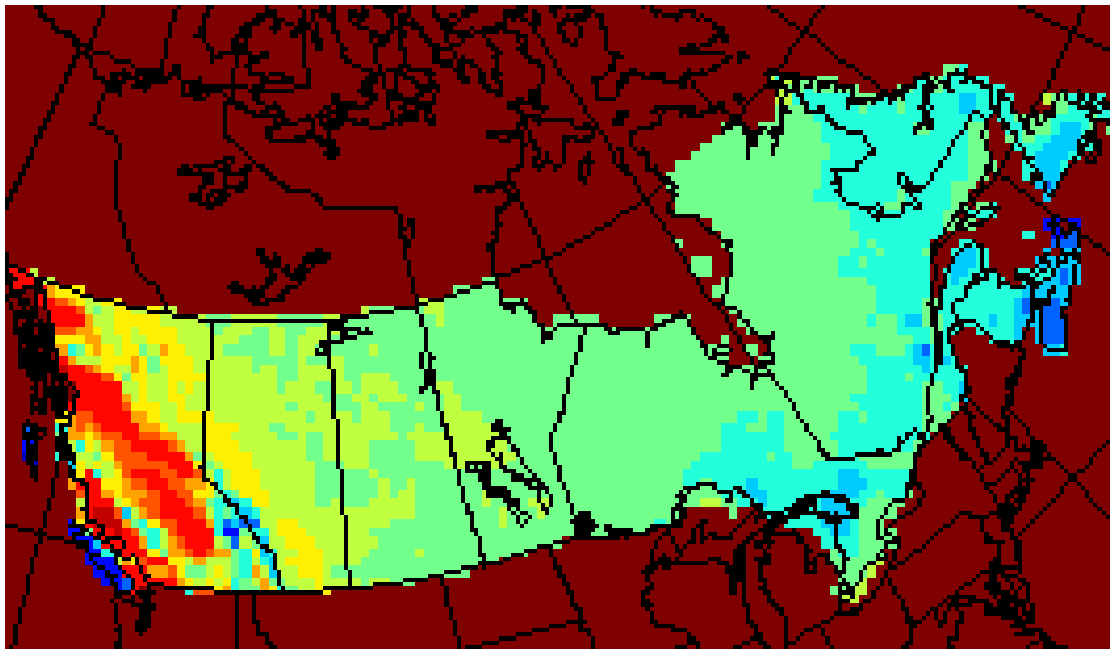
RCMs and Mean Precipitation:

MEAN - Accumulated Daily Precipitation (PCP) in mm/day

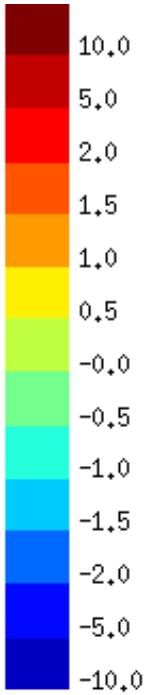
30-yr Winter (Dec-Jan-Feb) Climatology (1971-2000)

RCMs simulate more PCP in BC (up to 2-5 mm/d), and less PCP along eastern and south-eastern Canada

CRCM4.2.3 driven by ERA-40



BIAS:



Statistical Downscaling

- 2 major freeware
- ***SDSM***, a Statistical DownScaling Model, uses multiple linear regression techniques

  sdsm.org.uk/

- ***LARS-WG***, a stochastic weather generator where a statistical model is used to simulate daily weather data based on the observed statistical characteristics of weather at a single site

  rothamsted.bbsrc.ac.uk/mas-models/larswg.php

What EC can offer

- Advice on climate change impact assessment
- Training on how to obtain, organize, QA/QC climate observations for understanding past climate
- Training on use of CCCSN.CA website for obtaining future climate projections
- Training on statistical downscaling techniques

Contact: adam.fenech@ec.gc.ca