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NARCCAP

AGCI Workshop on Advanced Climate Modeling and Decision Making in Support of Climate Services Panel II Comments

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Aspen, CO
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National Center for Atmospheric Research

Outline

- Types of downscaling – important regarding uncertainty
- NARCCAP – for illustrative purposes
- Keeping downscaling in context of other uncertainties – global models and emissions
- Reducing uncertainties vs. creation of false certainty – what uncertainties have we reduced?
- Sample study for comparative evaluation of downscaling

Different Kinds of Downscaling

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- Simple (Giorgi and Mearns, 1991)
  - Adding coarse scale climate changes to higher resolution observations (the delta approach)
  - More sophisticated - interpolation of coarser resolution results (Maurer et al. 2002, 2007)
- Statistical
  - Statistically relating large scale climate features (e.g., 500 mb heights), predictors, to local climate (e.g, daily, monthly temperature at a point), predictands
- Dynamical
  - Application of regional climate model using global climate model boundary conditions – several other types – stretched grid, etc.
- Confusion can arise when the term 'downscaling' is used – could mean any of the above

Statistical Downscaling

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- Various sub-methods
  - Weather classification schemes
  - Regression methods – multiple regression, artificial neural networks, canonical correlation
  - Weather generators

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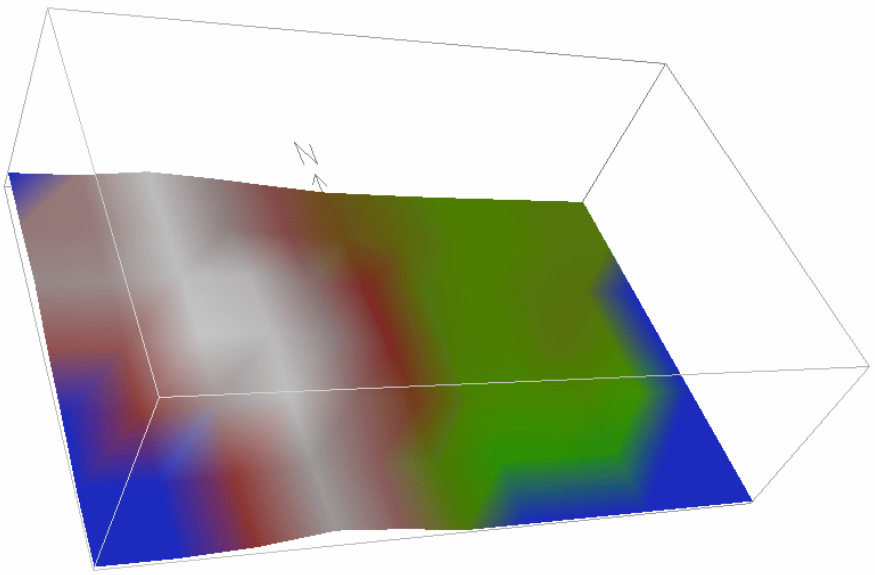
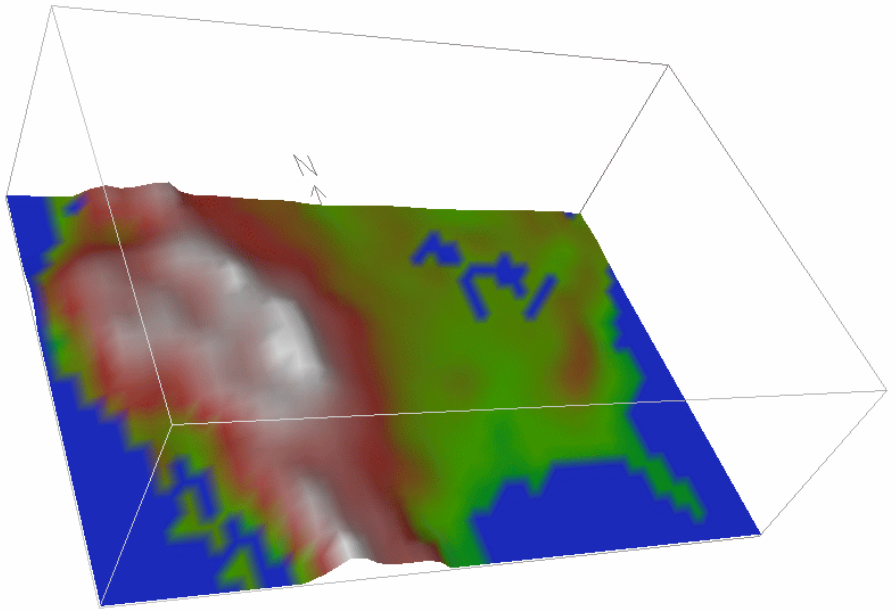
Dynamical Downscaling

Application of
Regional Climate Models
Atmospheric Time-slice Experiments
Stretched Grid Experiments

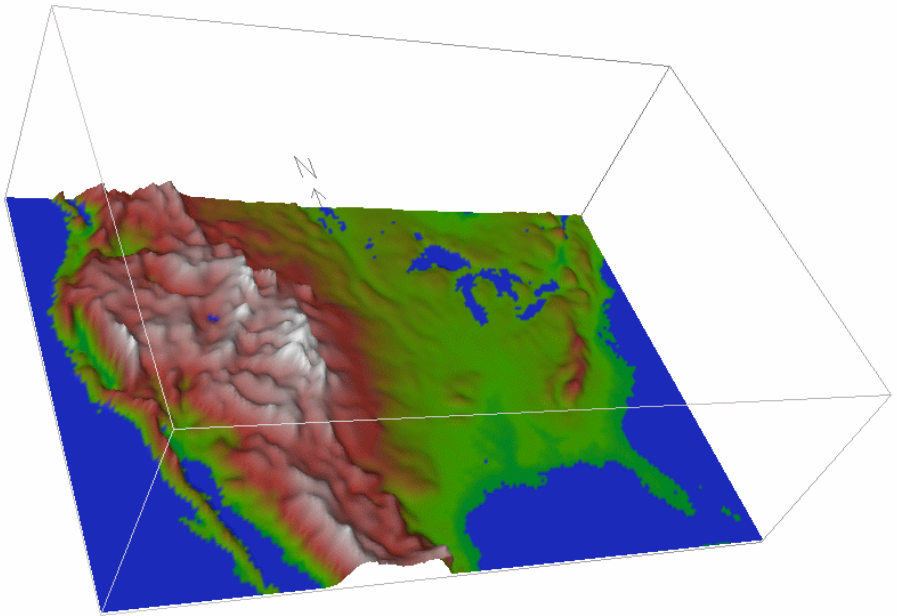
Climate Models



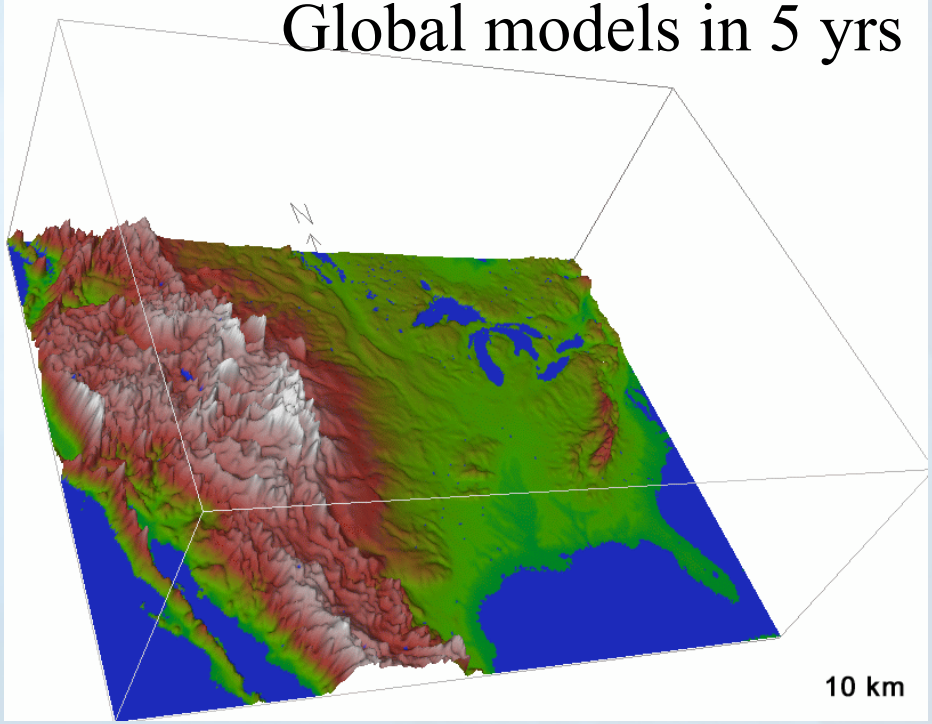
Global forecast models



Regional models



Global models in 5 yrs



The North American Regional Climate Change Assessment Program (NARCCAP)

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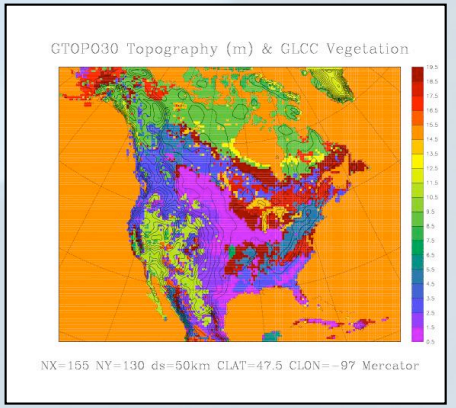
Providing climate scenarios for
the United States, Canada, and northern Mexico

- **Explores multiple uncertainties in regional and global climate model projections.**

  4 global climate models x 6 regional climate models



- **Develops multiple high resolution regional climate scenarios for use in impacts assessments.**

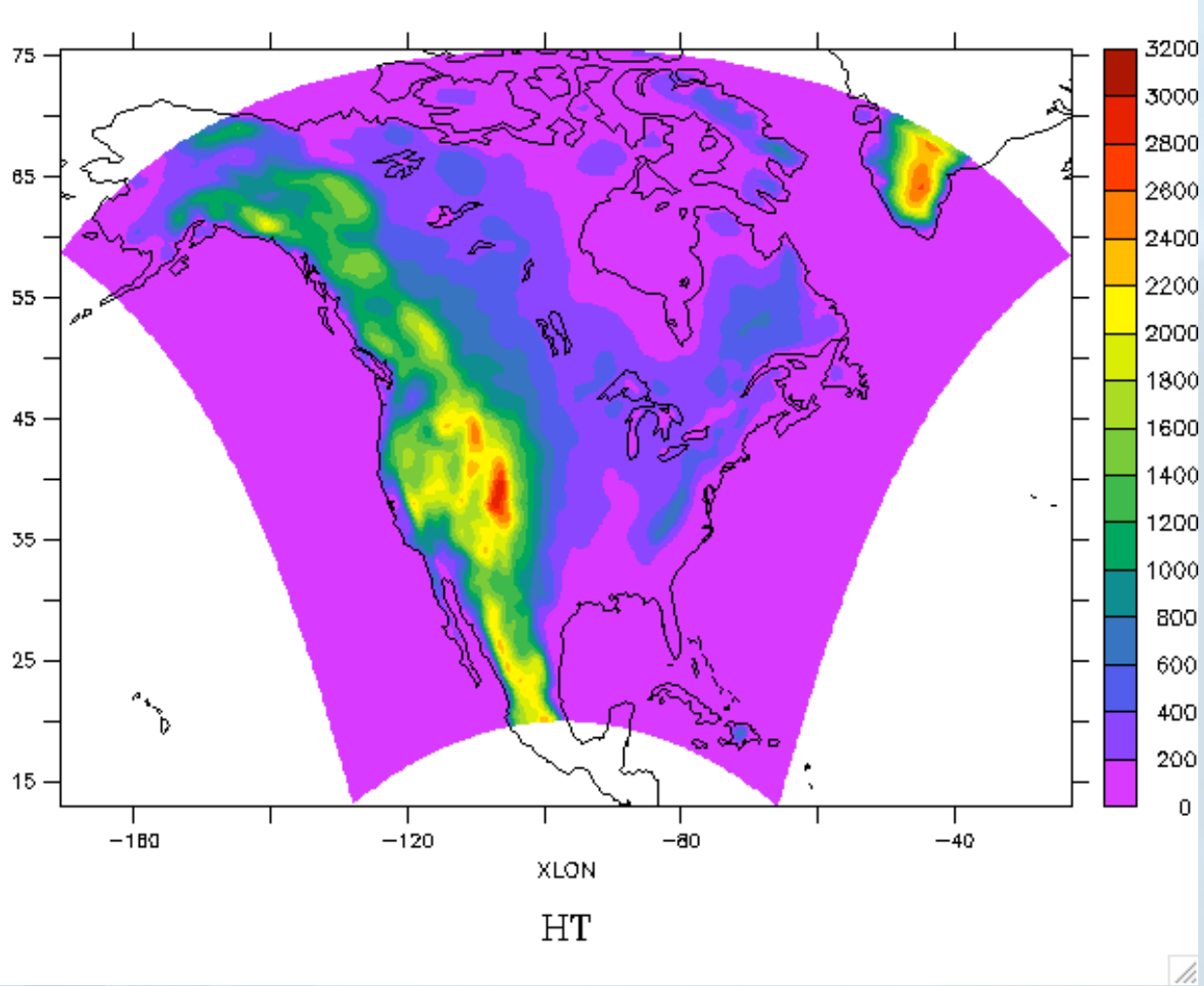
- **Evaluates regional model performance to establish credibility of individual simulations for the future**

- **Participants: Iowa State, PNNL, LNNL, UC Santa Cruz, Ouranos (Canada), UK Hadley Centre, NCAR**

- **Initiated in 2006, funded by NOAA-OGP, NSF, DOE, USEPA-ORD – 4-year program**

www.narccap.ucar.edu

NARCCAP Domain



Organization of Program

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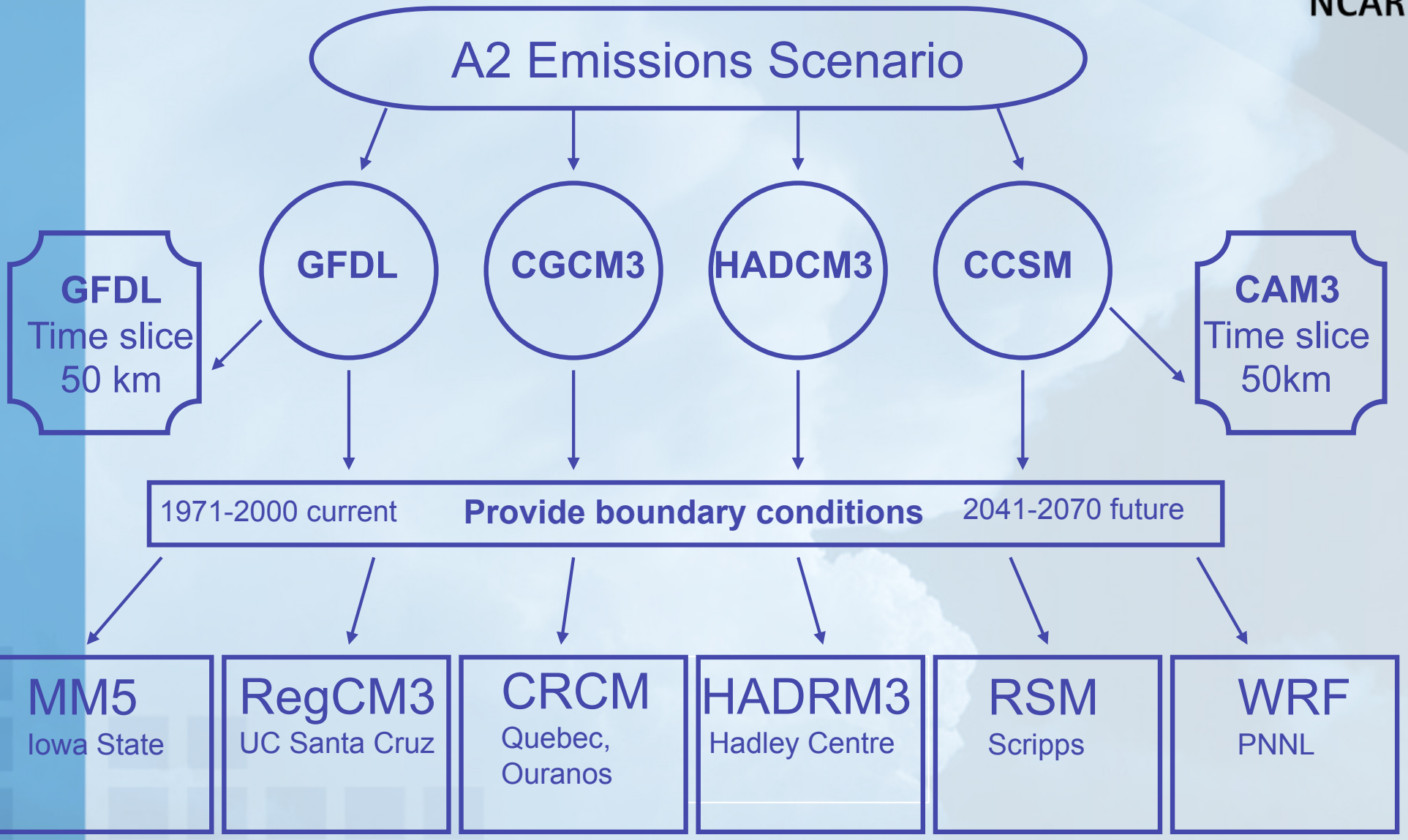
- Phase I: 25-year simulations using NCEP/DOE-Reanalysis 2 boundary conditions (1979—2004)
- Phase II: Climate Change Simulations
  - Regional model runs (50 km res.) nested in global model current and future
- Quantification of uncertainty at regional scales – probabilistic approaches
- Scenario formation and provision to impacts community led by NCAR.

NARCCAP PLAN – Phase II



GCM-RCM Matrix

AOGCMS

RCMs	GFDL	CGCM3	HADCM3	CCSM
MM5			X	X1
RegCM	X1**	X		
CRCM		X1**		X
HADRM	X		X1**	
RSM	X1		X	
WRF		X		X1
*CAM3				X
*GFDL	X**			

1 = chosen first GCM
*= time slice experiments
Red = run completed
** = data loaded

Change in Winter Precip Canadian Models

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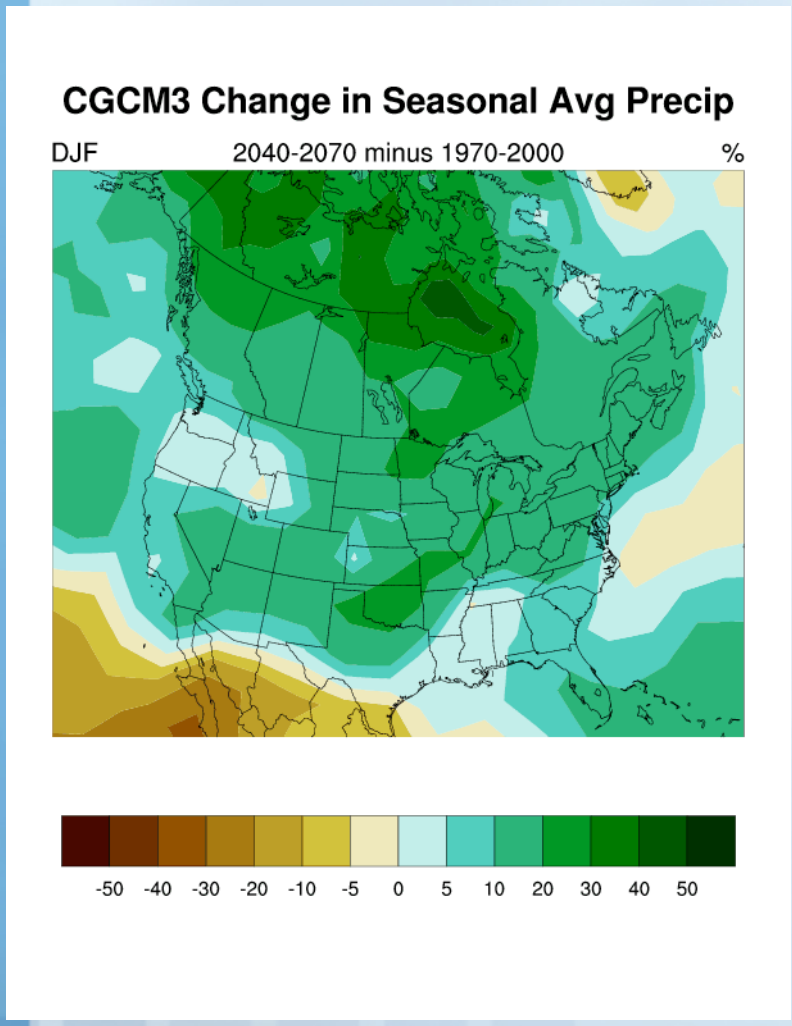

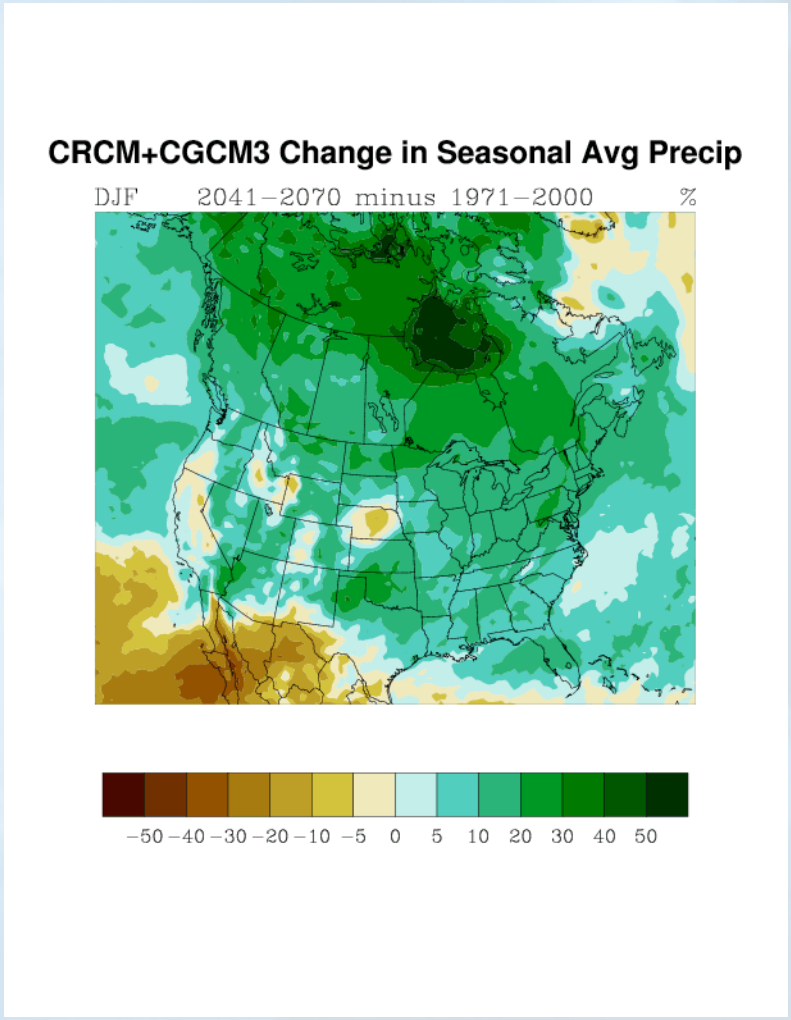

Why quantification of uncertainty is important

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- Because many uncertainties are not going away any time soon
- Because we need to make decisions under conditions of uncertainty
- Because many resource managers need this information (but doesn't have to be probabilistic information – can be a range of scenarios)

Quantification of Uncertainty

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- The four GCM simulations already ‘situated’ probabilistically based on earlier work (Tebaldi et al., 2004)
- RCM results nested in particular GCM would be represented by a probabilistic model (derived assuming probabilistic context of GCM simulation)
- Use of performance metrics to differentially weight the various model results

Probabilistic Information on Climate Change for Colorado

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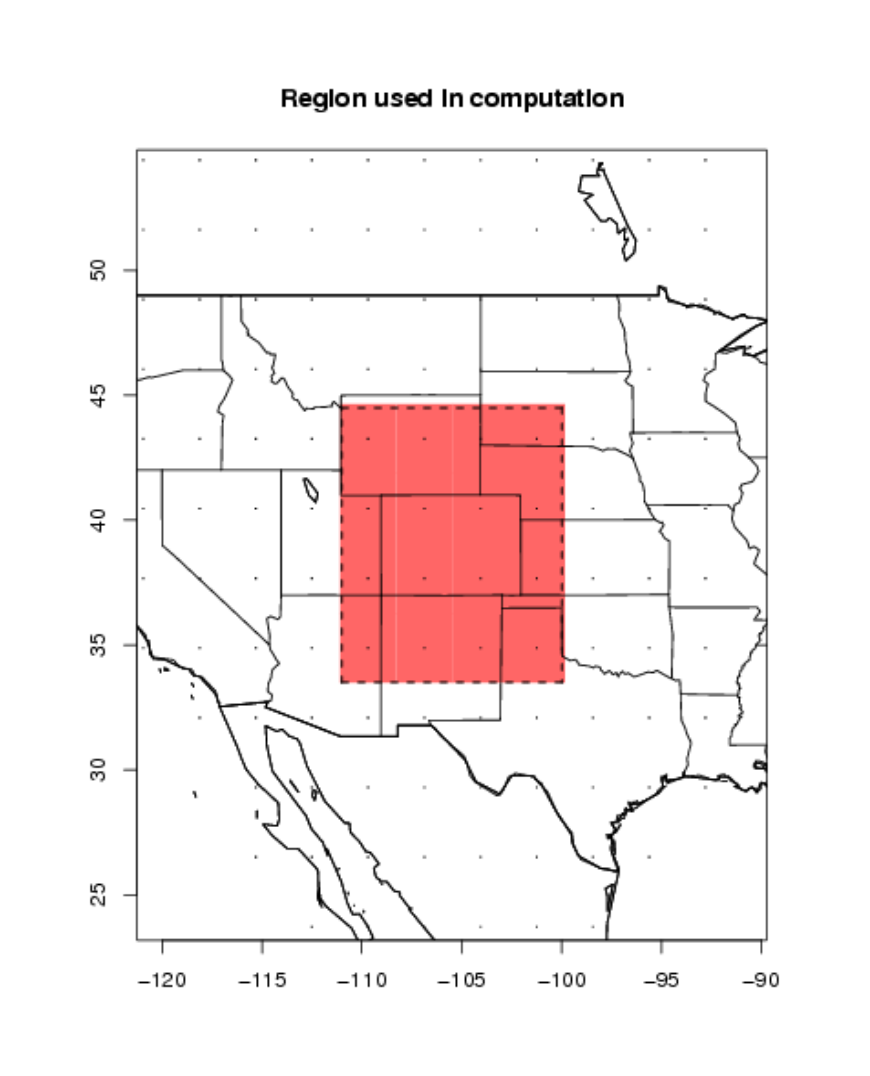
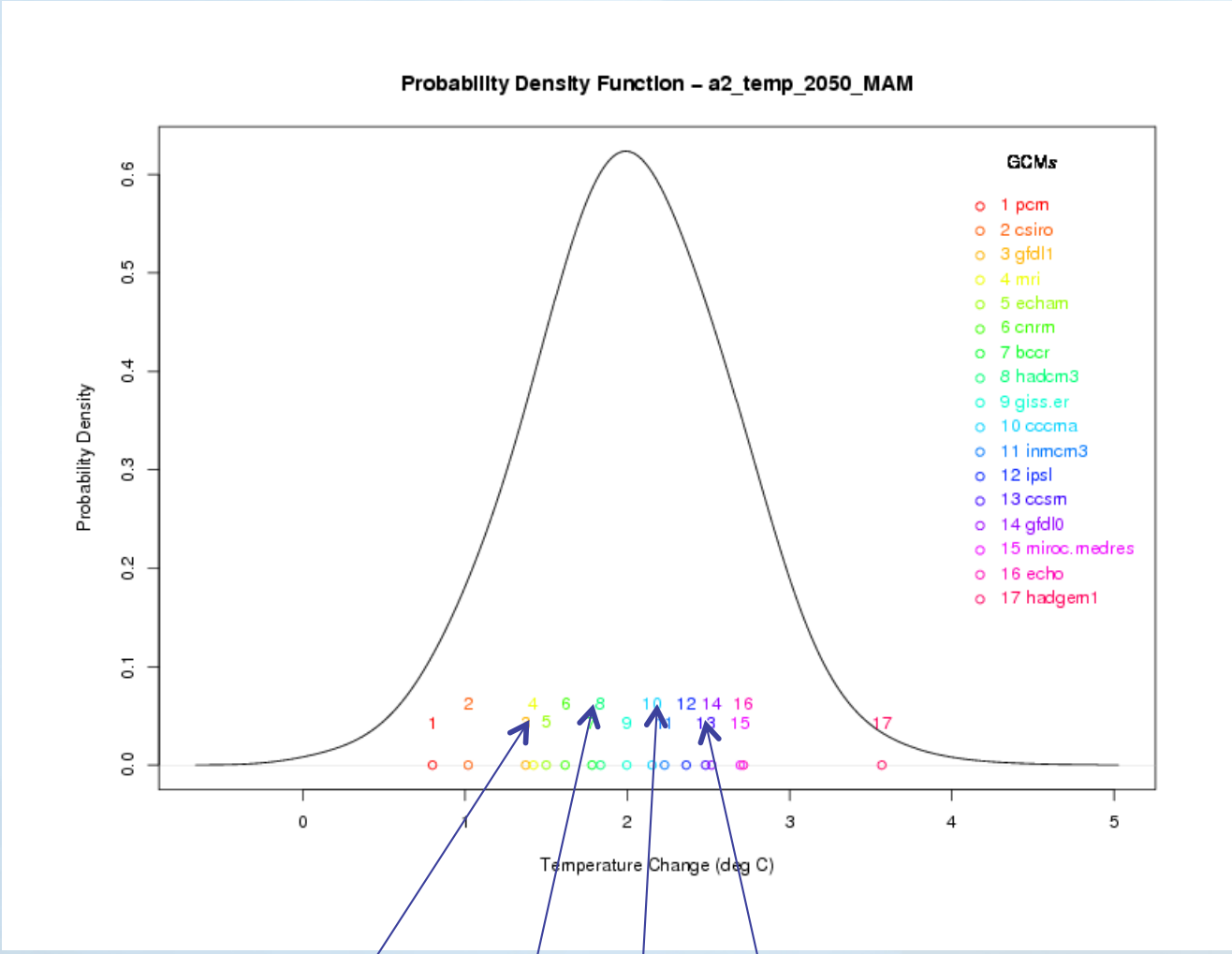
For 2040-2060 compared to current 1971-2000

Based on global model results from the IPCC archive (about 21 models)

Based on Tebaldi et al. 2005



Probability of temperature change for Colorado, Spring- A2 scenario



Change in Temperature Spring

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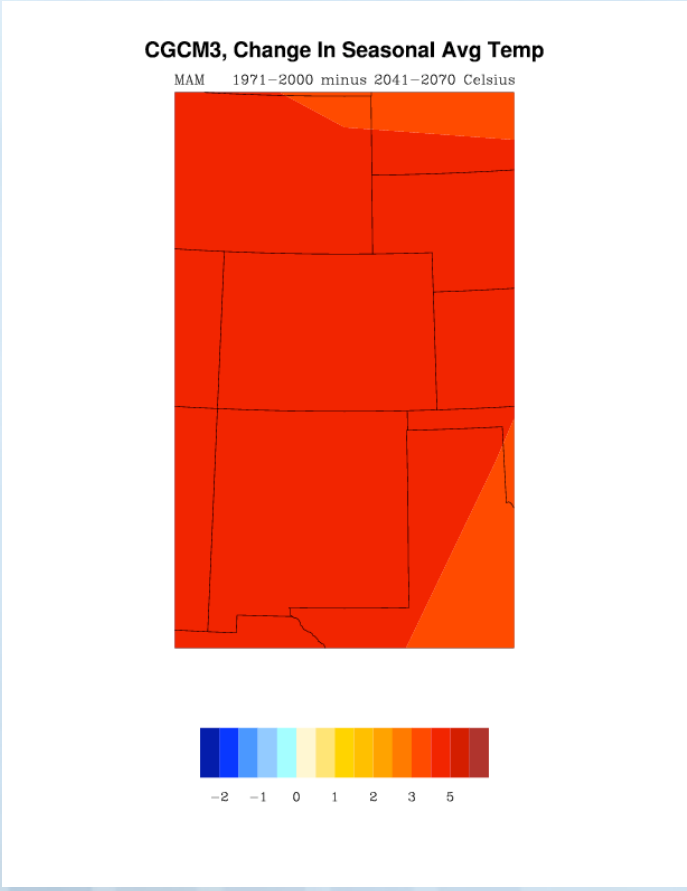
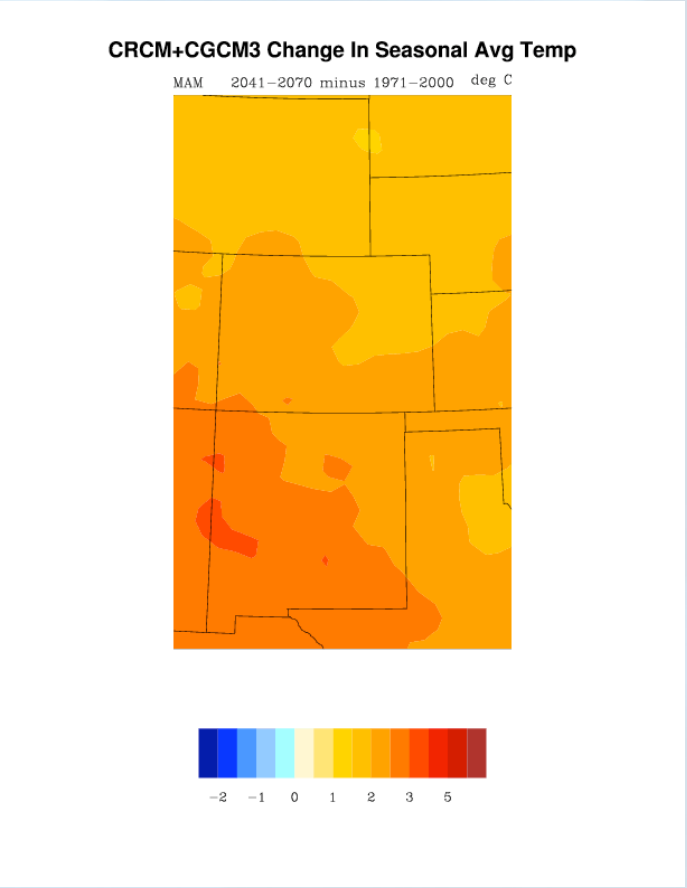
Canadian Global Model



Canadian Regional Model



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Spring Temperature Change
2041-2070 compared to 1971-2000

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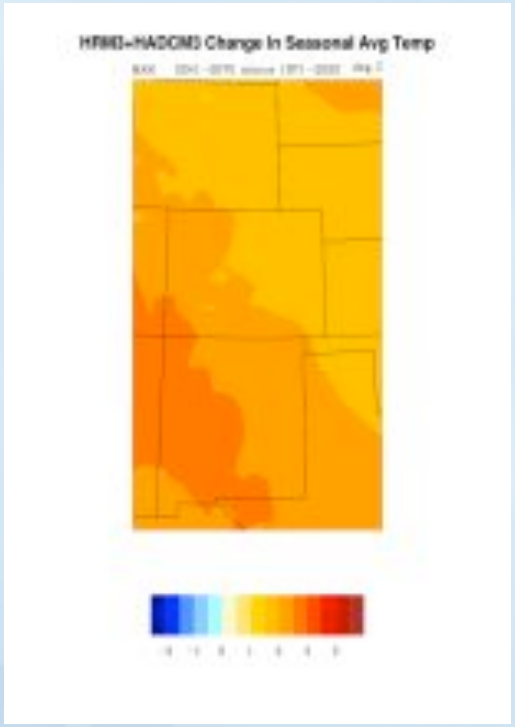
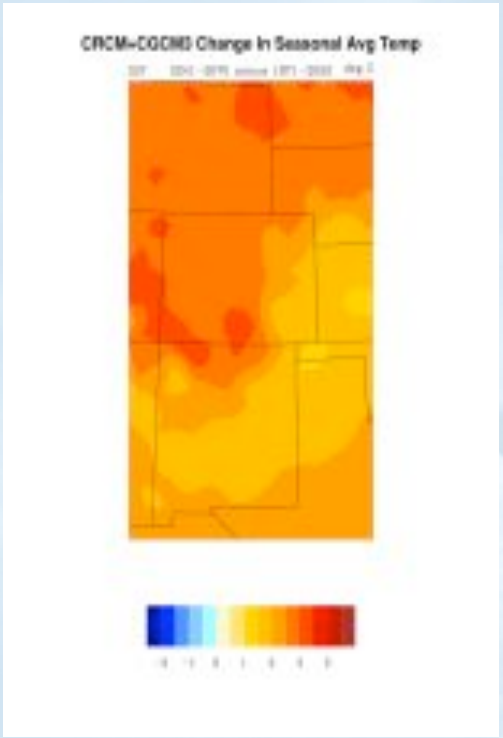
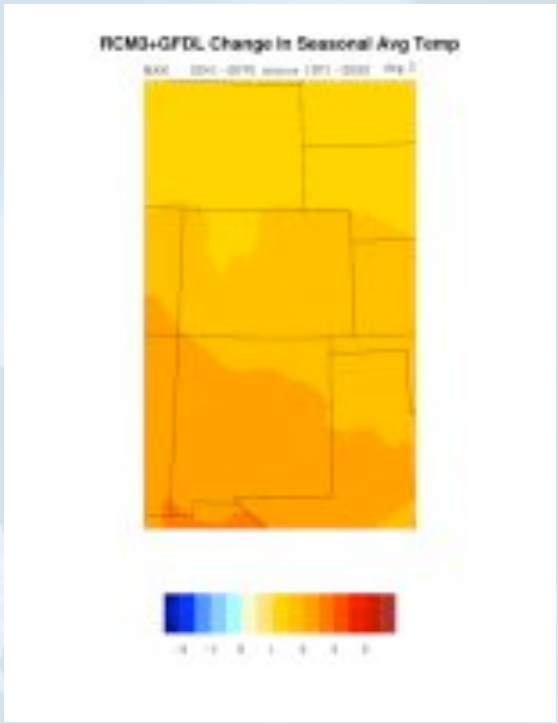
HadRM3 in HadCM3



CRCM in CGCM3



RegCM3 in GFDL



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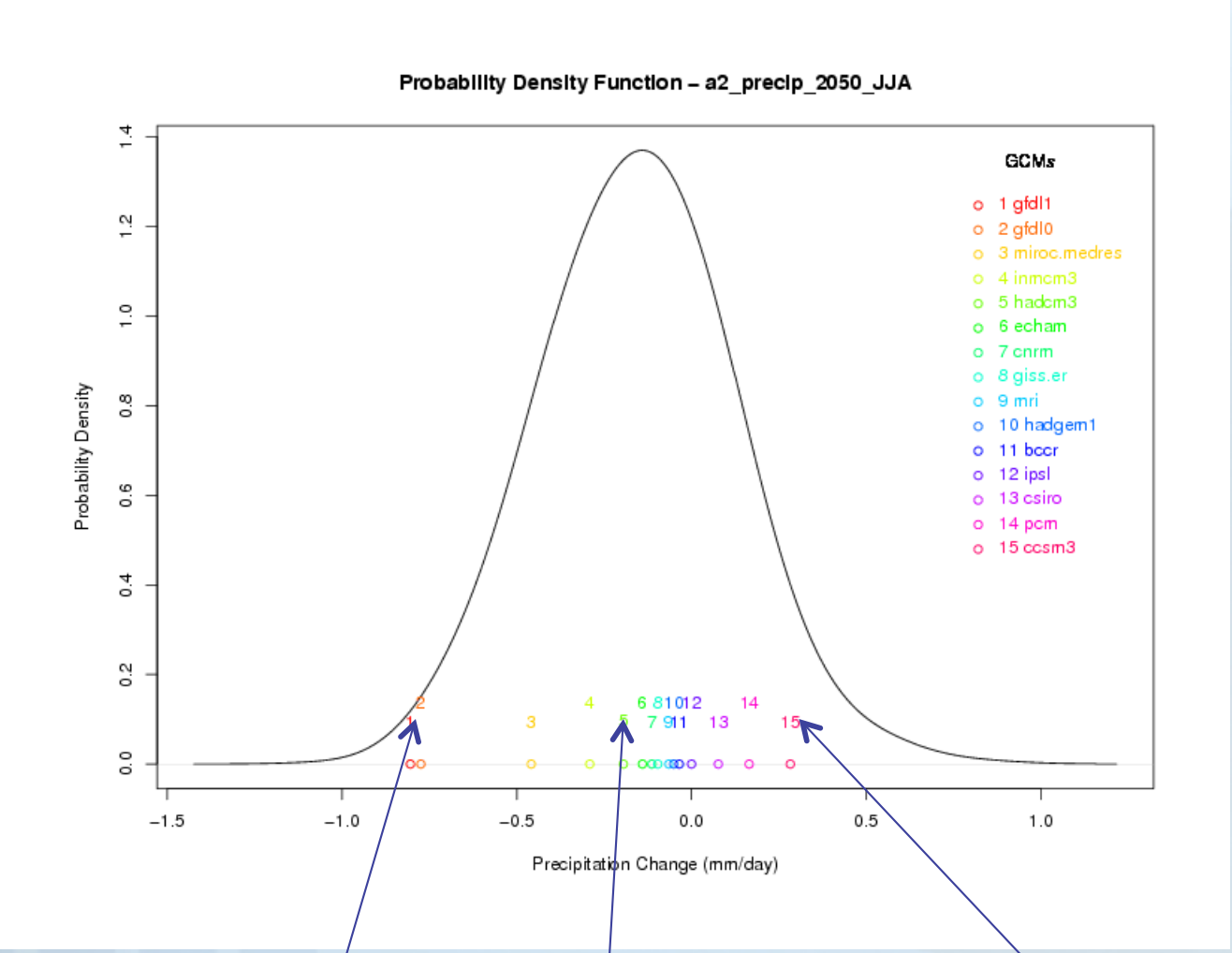
Probability of Change in Precipitation – A2 Scenario



Change in Precipitation in Spring (%)

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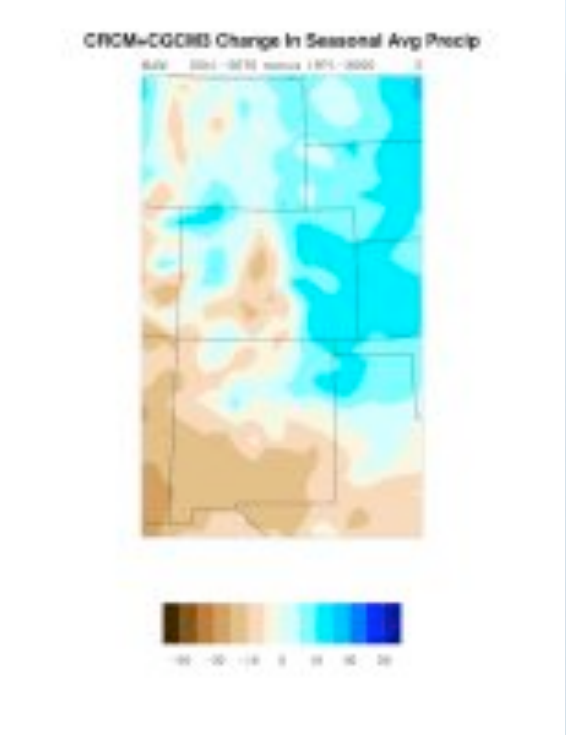
Canadian global model

Canadian regional model



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Change in Precipitation in Spring Regional Models

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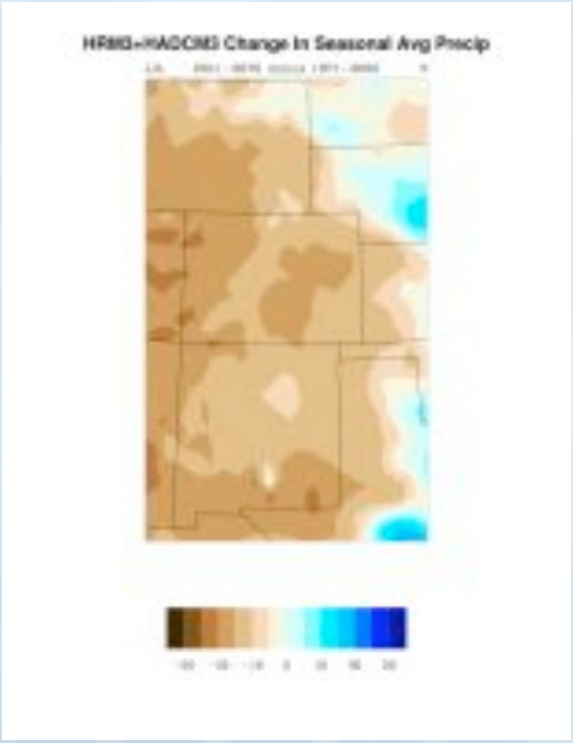
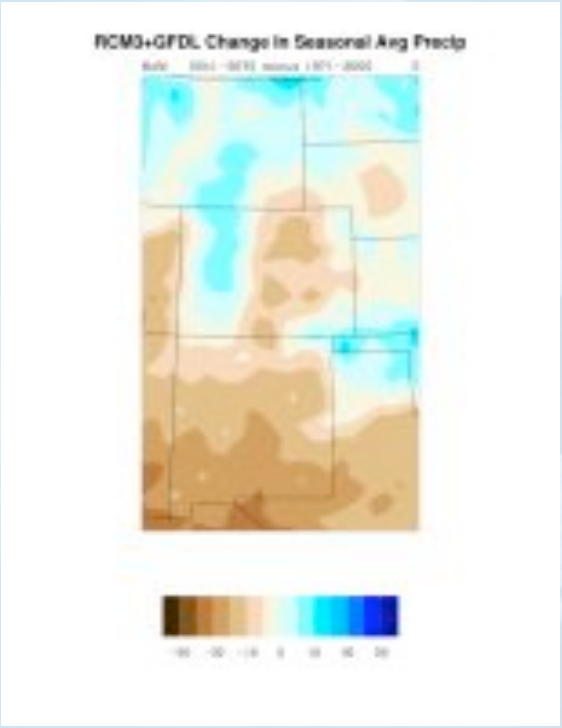
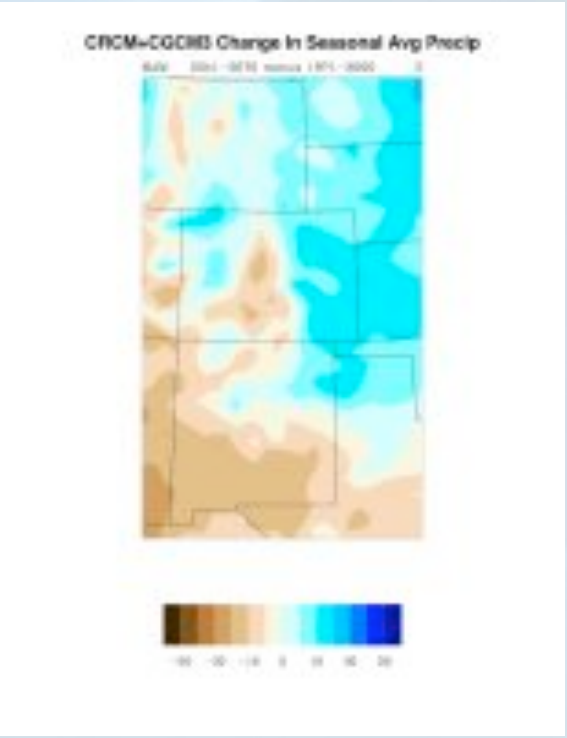
HadRM3 in HadCM3



RegCM3 in GFDL



CRCM in CGCM3



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The NARCCAP User Community

Three user groups:

- Further dynamical or statistical downscaling
- Regional analysis of NARCCAP results
- Use results as scenarios for impacts studies

www.narccap.ucar.edu

To sign up as user, go to web site – contact Seth McGinnis,

mcginnis@ucar.edu

Reducing Uncertainty?

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- Example of reduced uncertainty
  - It is very likely that current trends in climate are due to anthropogenic effects – statement has become stronger over IPCC volumes
- But reducing vs. false certainty
  - E.g., using very high resolution to downscale only one global model

Likelihoods of Climate Change

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Summer temperature change:

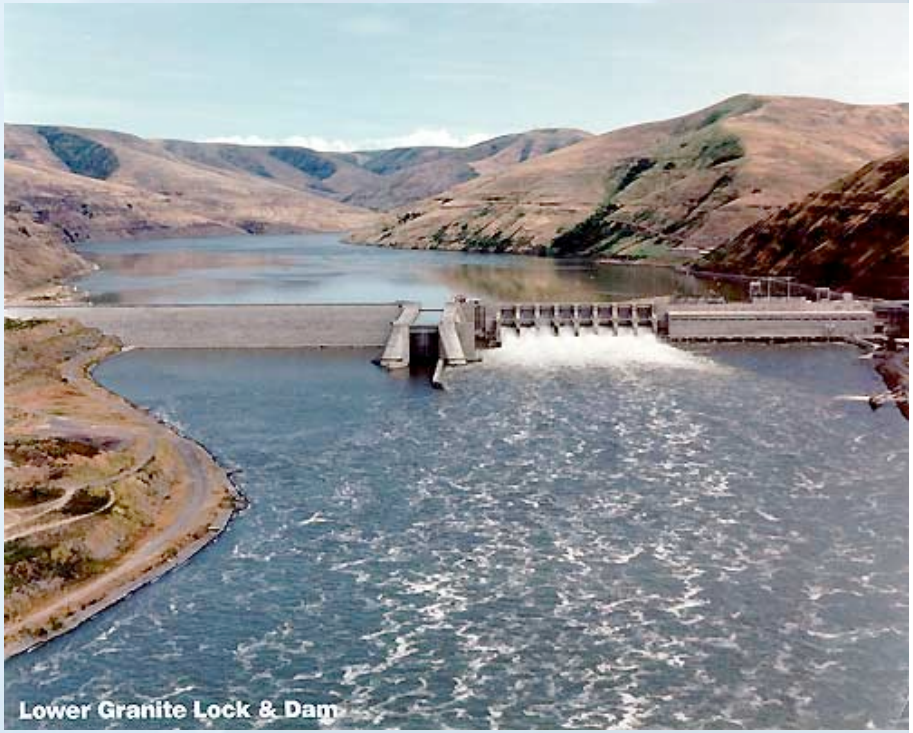
	Quantiles				
	5th	25th	50th	75th	95th
°C	1.5	2.1	2.5	2.9	3.5

Summer precipitation change:

% change	-27	-15	-7	+ 1	+12

Adaptation Planning for Water Resources

- Develop adaptation plans for Colorado River water resources with stakeholders
- Use NARCCAP scenarios, simple DS, statistical DS
- Determine value of different types of higher resolution scenarios for adaptation plans
- NCAR, B. Reclamation, and Western Water Assessment

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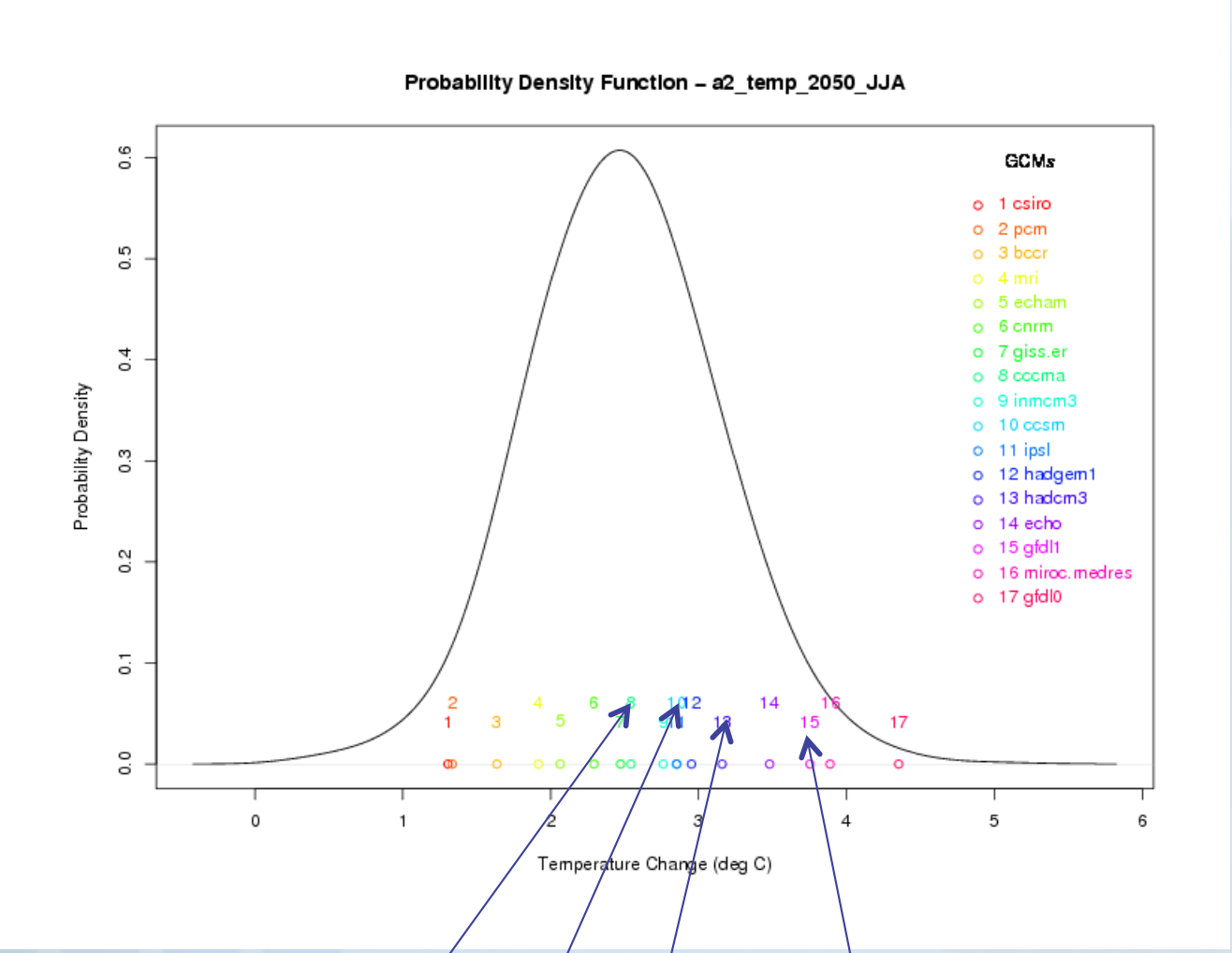
End

Probability of temperature change for Colorado - A2 scenario



The 'Mismatch' of Scale Issue

"Most GCMs neither incorporate nor provide information on scales smaller than a few hundred kilometers. The effective size or scale of the ecosystem on which climatic impacts actually occur is usually much smaller than this. We are therefore faced with the problem of estimating climate changes on a local scale from the essentially large-scale results of a GCM."

Gates (1985)

"One major problem faced in applying GCM projections to regional impact assessments is the coarse spatial scale of the estimates."

Carter et al. (1994)

'downscaling techniques are commonly used to address the scale mismatch between coarse resolution GCMs … and the local catchment scales required for … hydrologic modeling'

Fowler and Wilby (2007)