# NARCCAP

# NARCCAP: Overview and Sample Results

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## INTRODUCTION

The North American Regional Climate Change Assessment Program (NARCCAP) is an international program to produce high resolution climate change scenarios and investigate uncertainties in regional scale projections of future climate by nesting multiple regional climate models (RCMs) within multiple atmosphere-ocean general circulation models (AOGCMs) forced with the A2 SRES scenario and with historical data over a domain covering the conterminous United States and most of Canada and Northern Mexico.

The resulting 60+ terabytes of data are being archived for distributed storage and made available to climate analysis and global change impacts researchers worldwide via the Earth System Grid (ESG). To ensure that the final product is usable by the impacts community, GIS practitioners, climate analysts, modelers, policy-makers, and other end users, data is stored in CF-compliant NetCDF format, making it fully compatible with many popular analysis programs, including ArcGIS, Matlab, IDL, and R. Tools are also available for converting data to plain text.

## GOALS

- Exploration of multiple uncertainties in regional model and global climate model regional projections.
- Development of multiple high resolution regional climate scenarios for use in impacts assessments.
- Further evaluation of regional model performance over North America.
- Exploration of some remaining uncertainties in regional climate modeling (e.g., importance of compatibility of physics in nesting and nested models).
- Quantification of uncertainty across all models.
- Creation of greater collaboration between US and Canadian climate modeling groups, as well as with the European modeling community.

## NARCCAP AT A GLANCE

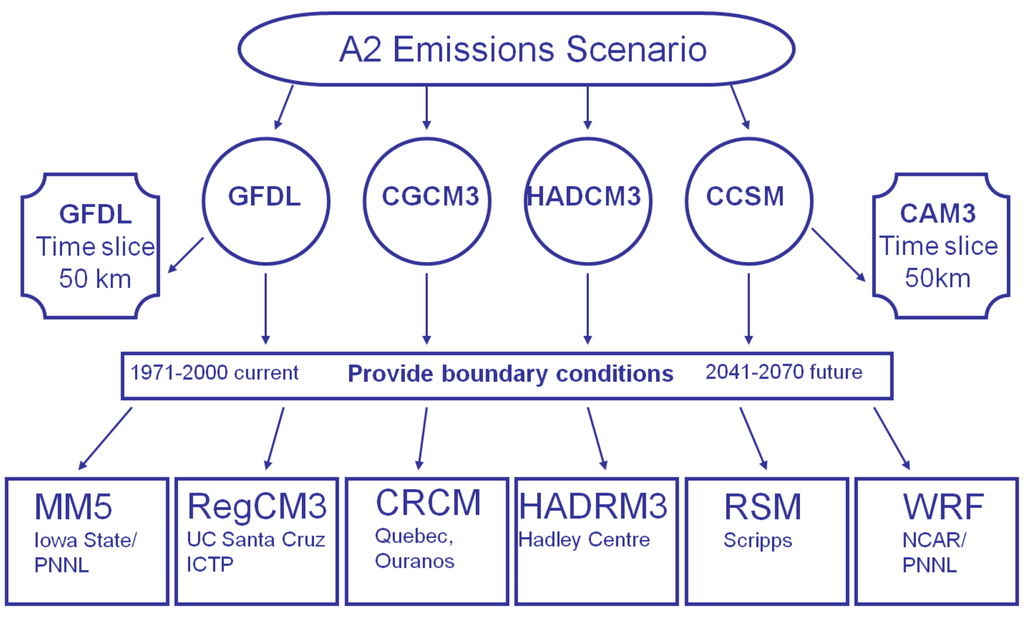
- 4 different AOGCMs driving 6 different RCMs
- 50 km spatial resolution
- 3 hourly temporal resolution
- 52 output variables
- 2 high-resolution AGCM timeslice experiments
- Future emissions scenario: SRES A2

*Phase I:* RCMs are driven by historical (1979-2004) observed (NCEP2 Reanalysis) data

*Phase II:* Each RCM is driven by 2 GCMs for current (1971-2000) and future (2041-2070) periods. GCM/RCM pairings are chosen for maximum value in statistical analysis.

*Timeslices:* Atmospheric components of the GFDL & CCSM global models are run at 50 km resolution using observed SST data (offset in the future scenario) instead of a coupled ocean.

## NARCCAP PLAN – Phase II




## EXPERIMENTAL DESIGN

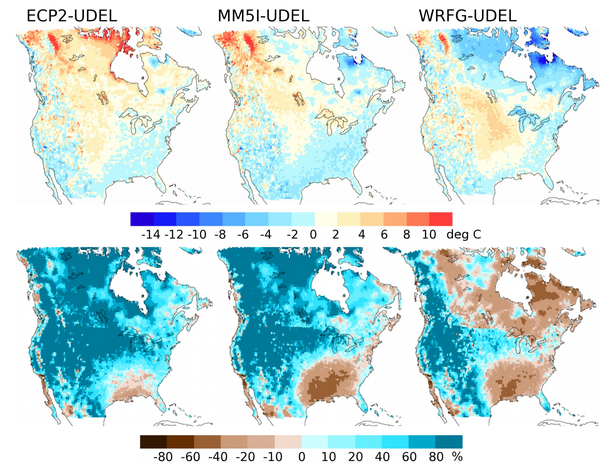
NARCCAP uses a fractional factorial design to manage funding limitations. Each RCM is paired with two GCMs. Timeslice experiments are also performed for two of the GCMs (CCSM & GFDL). Each RCM is paired with one of the two timeslice GCMs. '1st' or '2nd' indicates order of simulation.

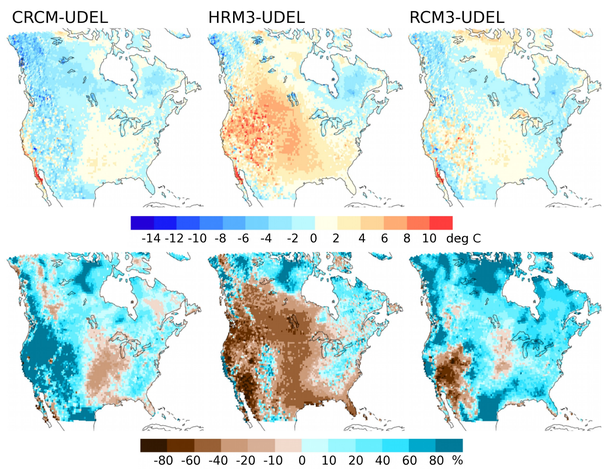
| GCM / RCM | Phase I | Phase II | | | |
|---|---|---|---|---|---|
| | **NCEP** | **GFDL** | **CGCM3** | **HADCM3** | **CCSM** |
| **CRCM** | DONE | | 1st | | 2nd |
| **ECPC** | DONE | 1st | | 2nd | |
| **HRM3** | DONE | 2nd | | 1st | |
| **MM5I** | DONE | | | 2nd | 1st |
| **RCM3** | DONE | 1st | 2nd | | |
| **WRFP** | DONE | | 2nd | | 1st |

## SAMPLE PHASE I RESULTS

At right, winter temperature and precipitation bias relative to the U. Delaware observational dataset is shown for three of the NCEP-driven simulations. ECP2 and MM5I exhibit similar warm biases in central Canada, while the WRFG warm bias is mainly centered in the US and Canadian plains.

The dry bias in the south-central US is due to a secondary maximum in winter precipitation that most of the models have difficulty simulating. CRCM (not shown) and ECP2 perform best in this regard, perhaps because they use spectral nudging, and this precipitation feature is driven by larger-scale dynamic processes.



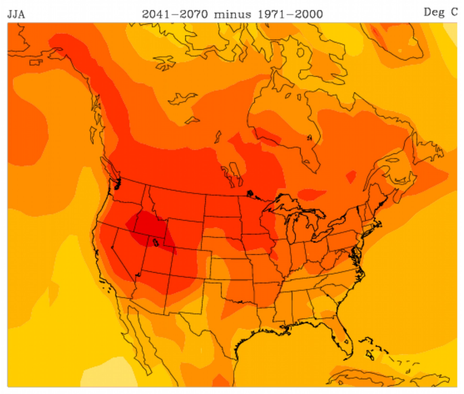




Shown at left is summer temperature and precipitation bias for the three models not shown above. CRCM and RCM3 simulate temperature well, while HRM3 exhibits a warm bias over most of North America. All models have a slight warm bias in the Plains.

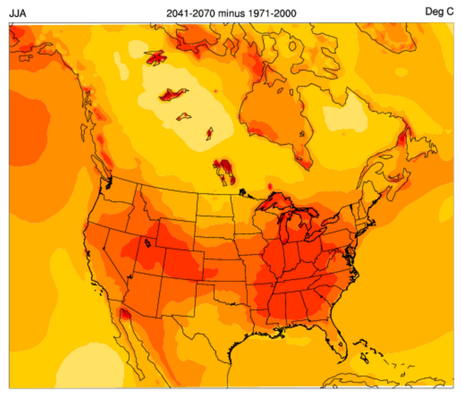
Precipitation bias varies, but all models have a dry bias in the Midwest. The secondary maximum here is difficult for models to capture using convective parameterization; RCM3 and CRCM come closest. In the southwest US, there is a strong dry bias in all models except CRCM related to the simulation of the North American Monsoon.

## SAMPLE PHASE II RESULTS

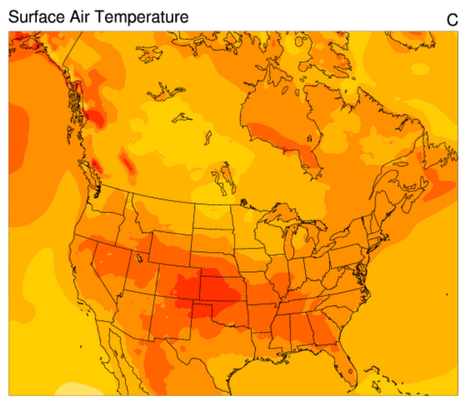
**CCSM Change In Seasonal Avg Temp**



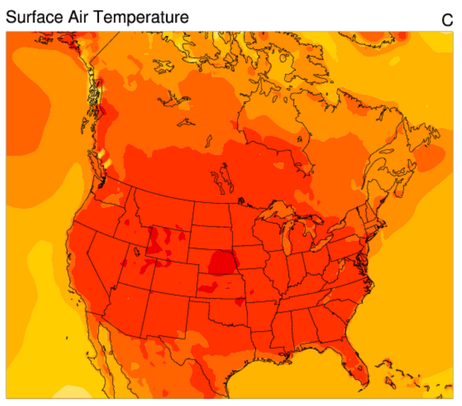

**WRFG+ccsm Change In Seasonal Avg Temp**




**MM5I+CCSM Change in JJA Avg Temp**




**CRCM+CCSM Change in JJA Avg Temp**





**Comparison of Change in Summer Temperature: Global vs Regional Model Results**

Patterns of temperature change can differ substantially between the global and regional models.

This is the case for the CCSM and the 3 regional models driven by it. Higher temperature changes are found in the CCSM (top left), particularly in the western part of North America, and higher still in the CRCM driven by the CCSM (bottom right) over a large swath of North America.

The WRF (top right) and MM5 (bottom left) driven by the CCSM, on the other hand, project strikingly lower changes in temperature through most of central Canada.