The Abdus Salam
International Centre for Theoretical Physics

United Nations
Educational, Scientific and
Cultural Organization

IAEA
International Atomic Energy Agency

2148-3

Fifth ICTP Workshop on the Theory and Use of Regional Climate Models

31 May - 11 June, 2010

The North American Climate Change Assessment program (NARCCAP): Overview of results

Linda O. Mearns and M. Bukovsky
NCAR
USA

NCAR

The North American Regional Climate Change Assessment Program (NARCCAP)

Linda O. Mearns and Melissa Bukovsky
National Center for Atmospheric Research
and
the NARCCAP Team

ICTP Regional Climate Modeling Workshop

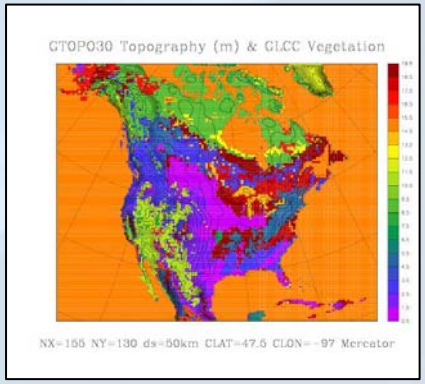
Trieste, Italy
May 31, 2010

National Center for Atmospheric Research

The North American Regional Climate Change Assessment Program (NARCCAP)

NCAR

Initiated in 2006, it is an international program that is exploring multiple uncertainties in regional model and global climate model regional projections.



- **Development of multiple high resolution regional climate scenarios for use in impacts assessments in the United States, Canada, and northern Mexico.**
- **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).**
- **Program has been funded by NOAA-OGP, NSF, DOE, USEPA-ORD – 4 -- year program**

www.narccap.ucar.edu

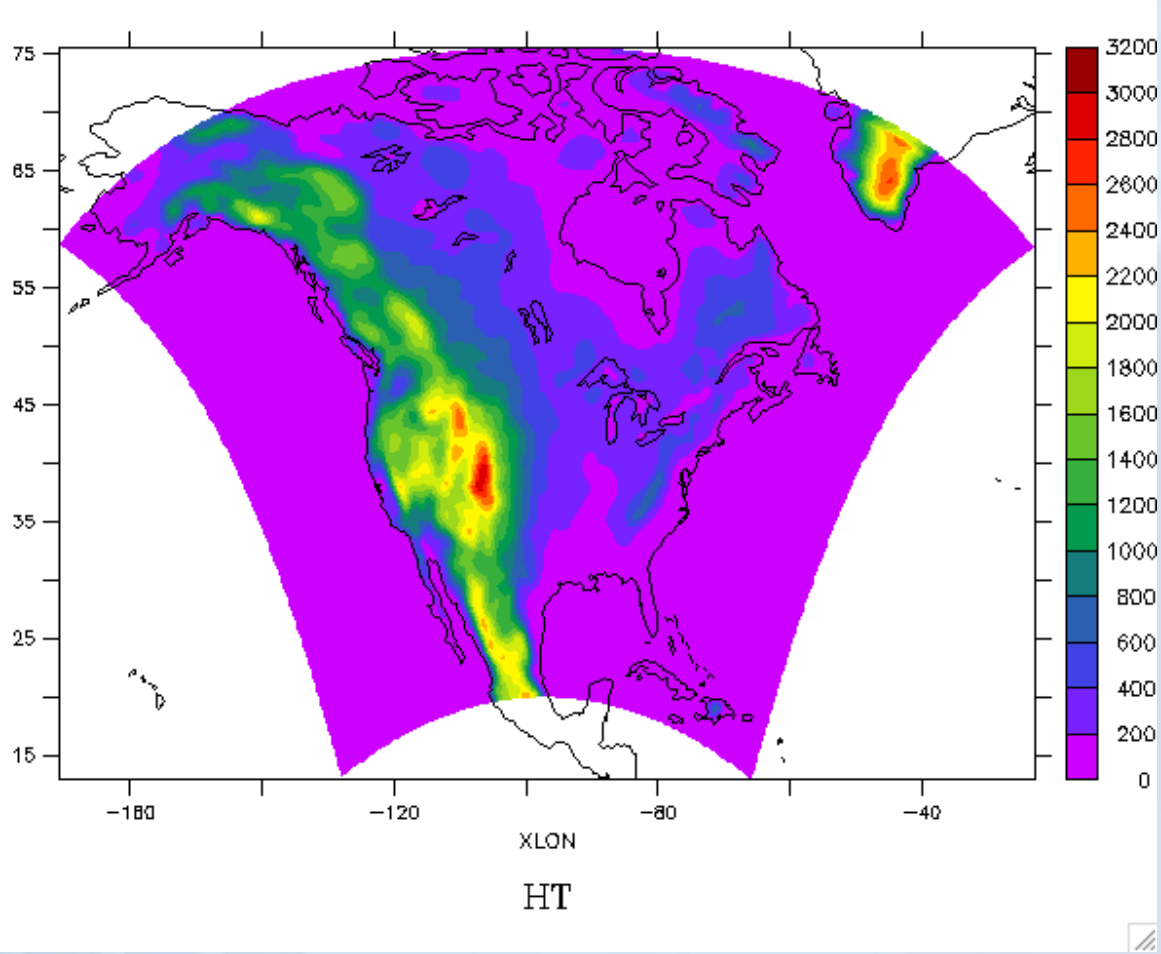
NARCCAP - Team

Linda O. Mearns, NCAR

Ray Arritt, Iowa State; Dave Bader, LLNL - ONL; Melissa Bukovsky, NCAR; Richard Jones, Wilfran Moufouma-Okia, Hadley Centre; Sébastien Biner, Daniel Caya, OURANOS; Phil Duffy, Climate Central; Dave Flory, Iowa State; William Gutowski, Iowa State; Isaac Held, GFDL; Bill Kuo, NCAR; René Laprise, UQAM; Ruby Leung, Yun Qian, PNNL; Larry McDaniel, Seth McGinnis, Don Middleton, NCAR; Ana Nunes, Scripps; Doug Nychka, NCAR, John Roads*, Scripps; Steve Sain, NCAR; Lisa Sloan, Mark Snyder, UC Santa Cruz, Ron Stouffer, GFDL, Gene Takle, Iowa State

* Deceased June 2008

NARCCAP Domain



Organization of Program

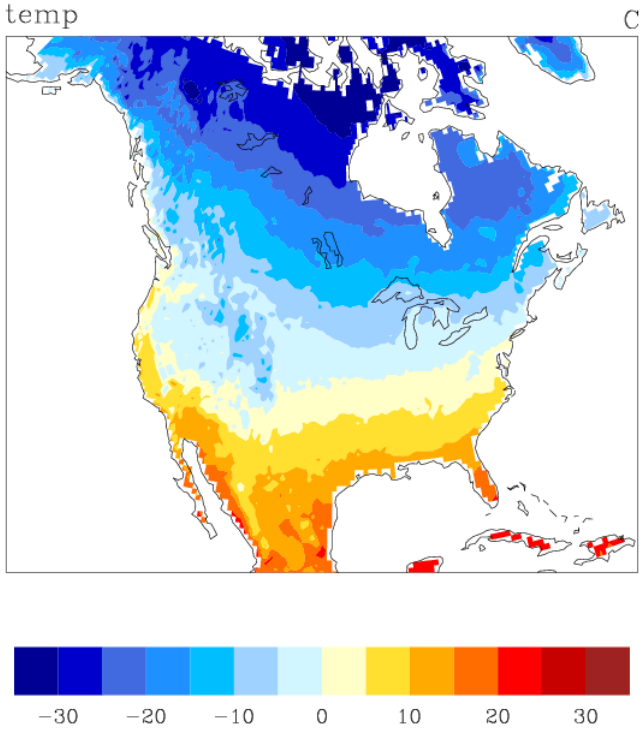
- *Phase I:* 25-year simulations using NCEP-Reanalysis 2 boundary conditions (1979—2004)
- *Phase II*: Climate Change Simulations
  - Phase IIa: RCM runs (50 km res.) nested in AOGCMs current and future
  - Phase IIb: Time-slice experiments at 50 km res. (GFDL AM2.1 and NCAR CAM3) -- for comparison with RCM runs
- Quantification of uncertainty at regional scales – probabilistic approaches
- Scenario formation and provision to impacts community led by NCAR
- Opportunity for double nesting (over specific regions) to include participation of other RCM groups (e.g., for NOAA OGP RISAs, CEC, New York Climate and Health Project, U. Nebraska).

Phase I

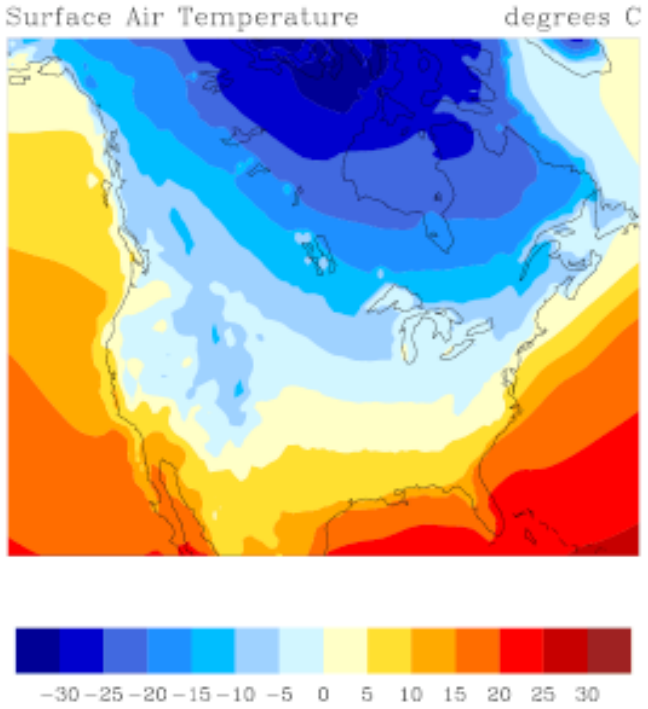
- 6 RCMs: reanalysis-driven runs (RegCM3, WRF, CRCM, ECPC RSM, MM5, HadRM3)
- Results are shown here for 1980-2004 from six RCMs
- Configuration:
  - common North America domain (some differences due to horizontal coordinates)
  - horizontal grid spacing 50 km
  - boundary data from NCEP/DOE Reanalysis 2
  - boundaries, SST and sea ice updated every 6 hours

NCAR

UDEL obs., DJF seasonal avg, 1980-2004

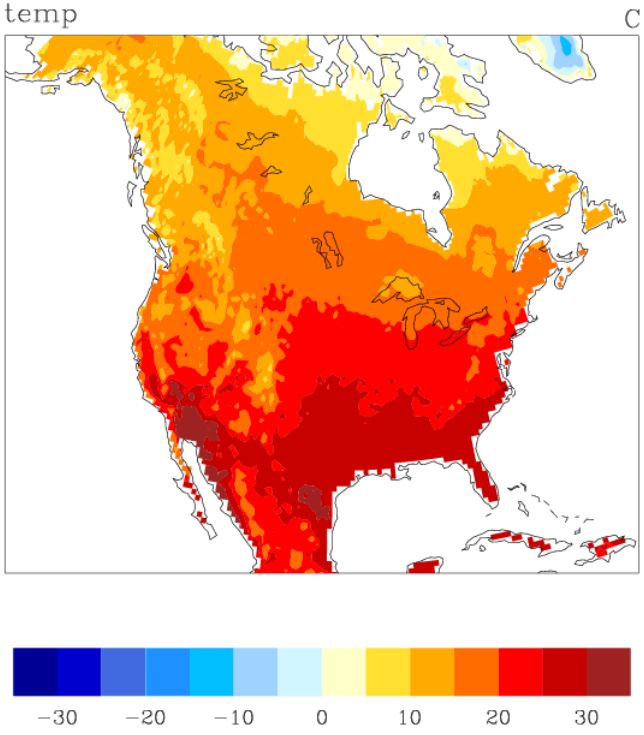


MM5I+NCEP, DJF seasonal avg, 1980-2004

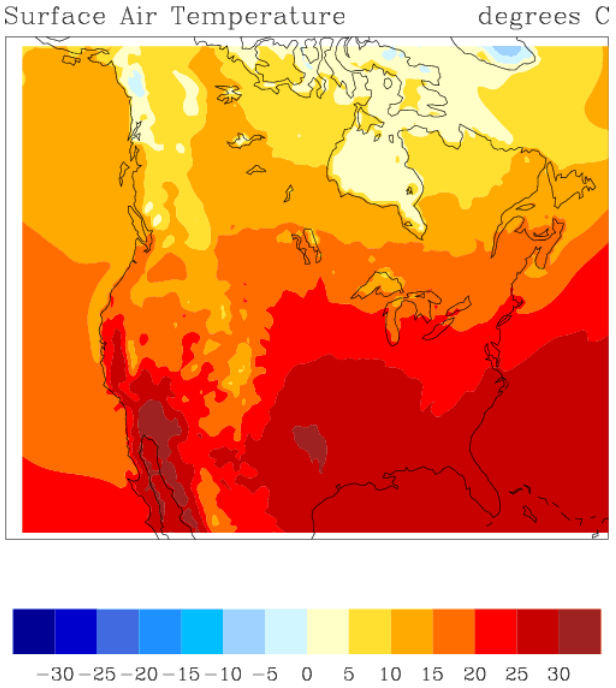


NCAR

UDEL obs., JJA seasonal avg, 1980-2004

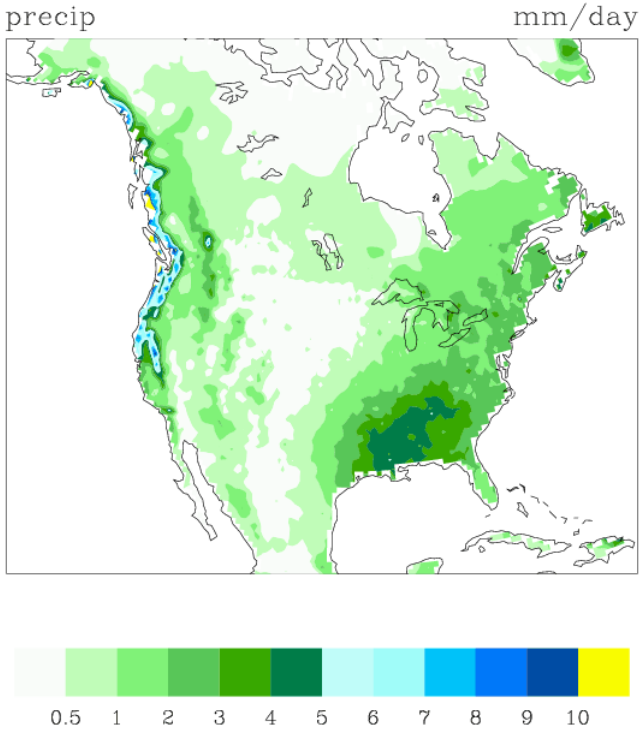


CRCM+NCEP, JJA seasonal avg, 1980-2004

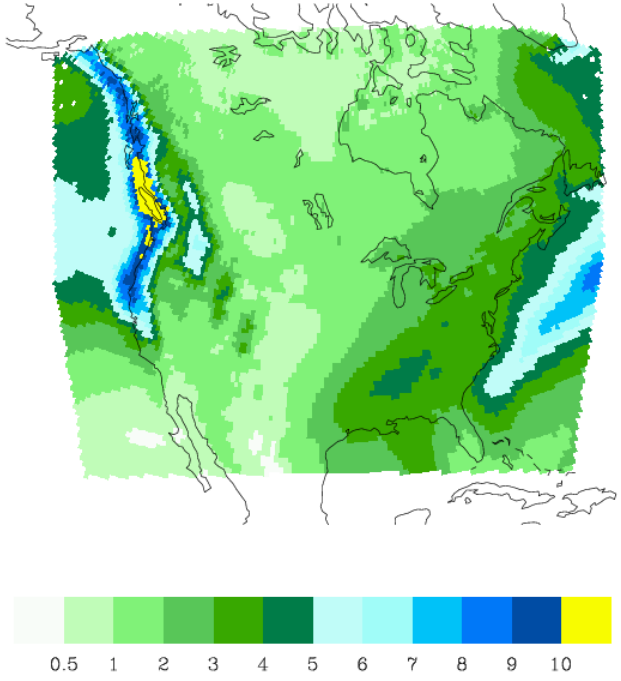


NCAR

UDEL obs., DJF seasonal avg, 1980-2004

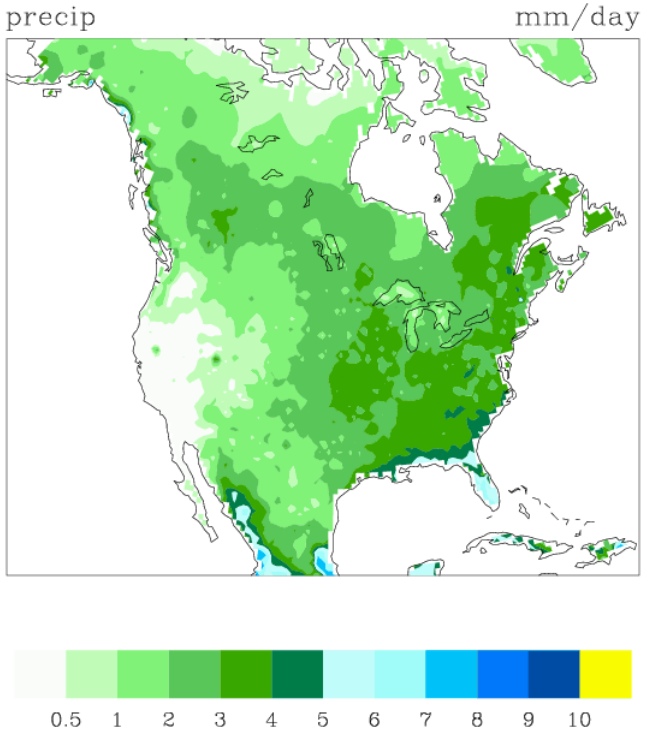


Winter Precip ECP2 Regrided .5 degree

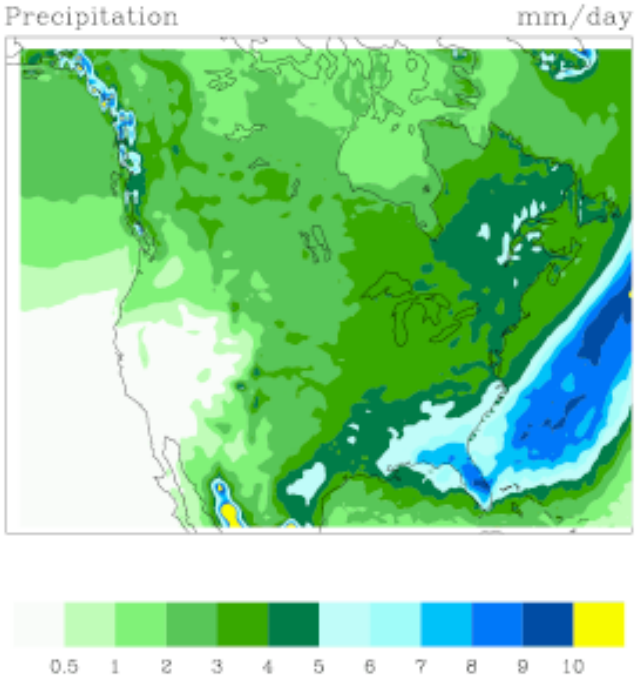


NCAR

UDEL obs., JJA seasonal avg, 1980-2004



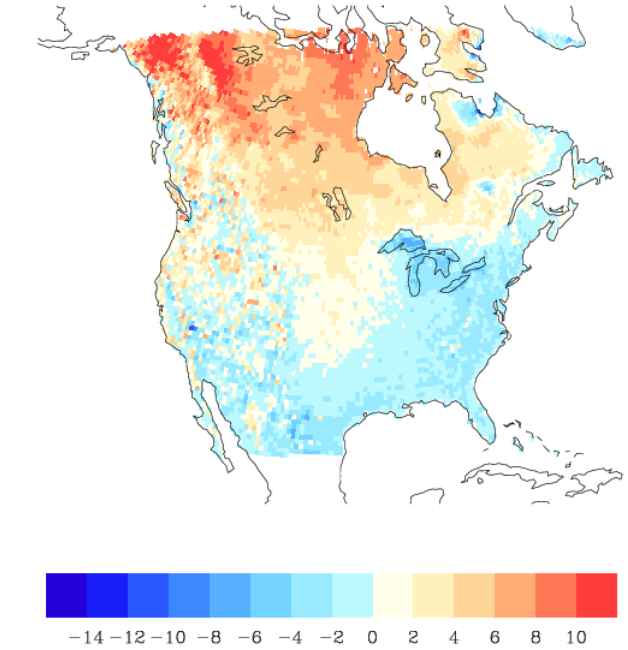
RCM3+NCEP, JJA seasonal avg, 1980-2004

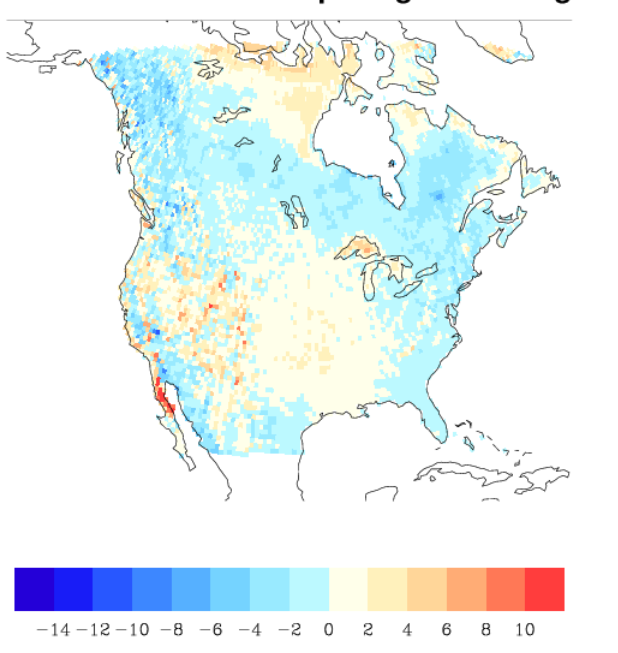


Temperature Biases

NCAR

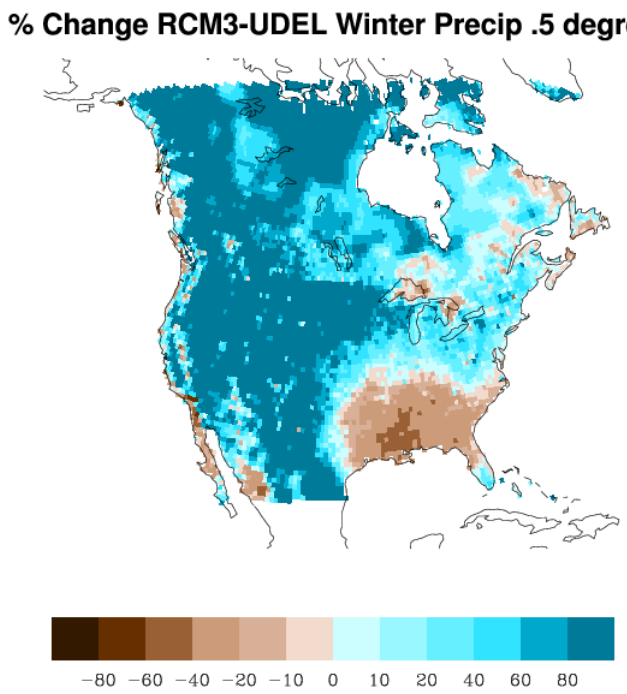
RegCM3

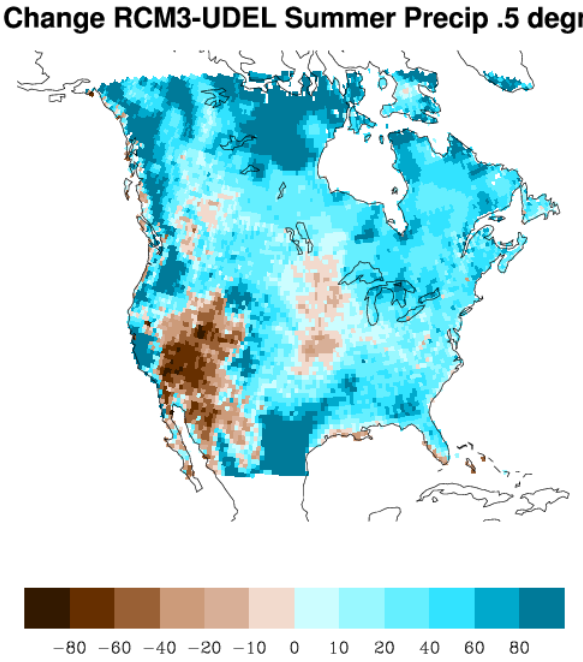




Precipitation Biases

RegCM3





RMSE Temperature - NA

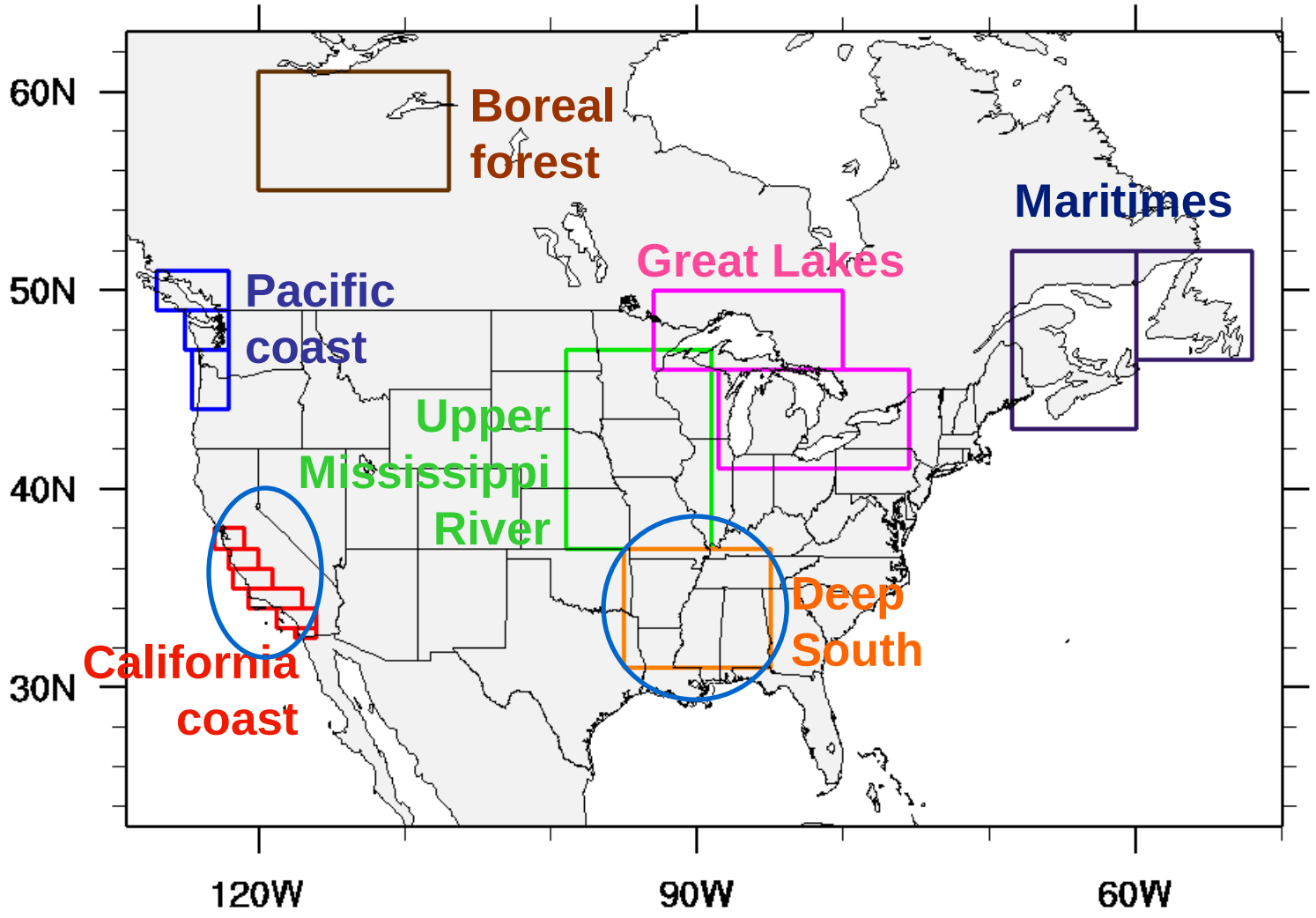
RCM	Winter	Spring	Summer	Fall
CRCM	3.1	3.0	2.4	2.5
ECP2	3.6	2.4	2.2	1.9
HadRM3	5.9	3.9	3.6	3.1
MM5	2.8	2.4	2.3	2.9
RegCM3	4.5	3.4	2.1	1.9
WRF(G)	3.6	4.0	2.3	2.9
ENS	2.8	2.4	1.8	1.8

RMSE Precipitation - NA

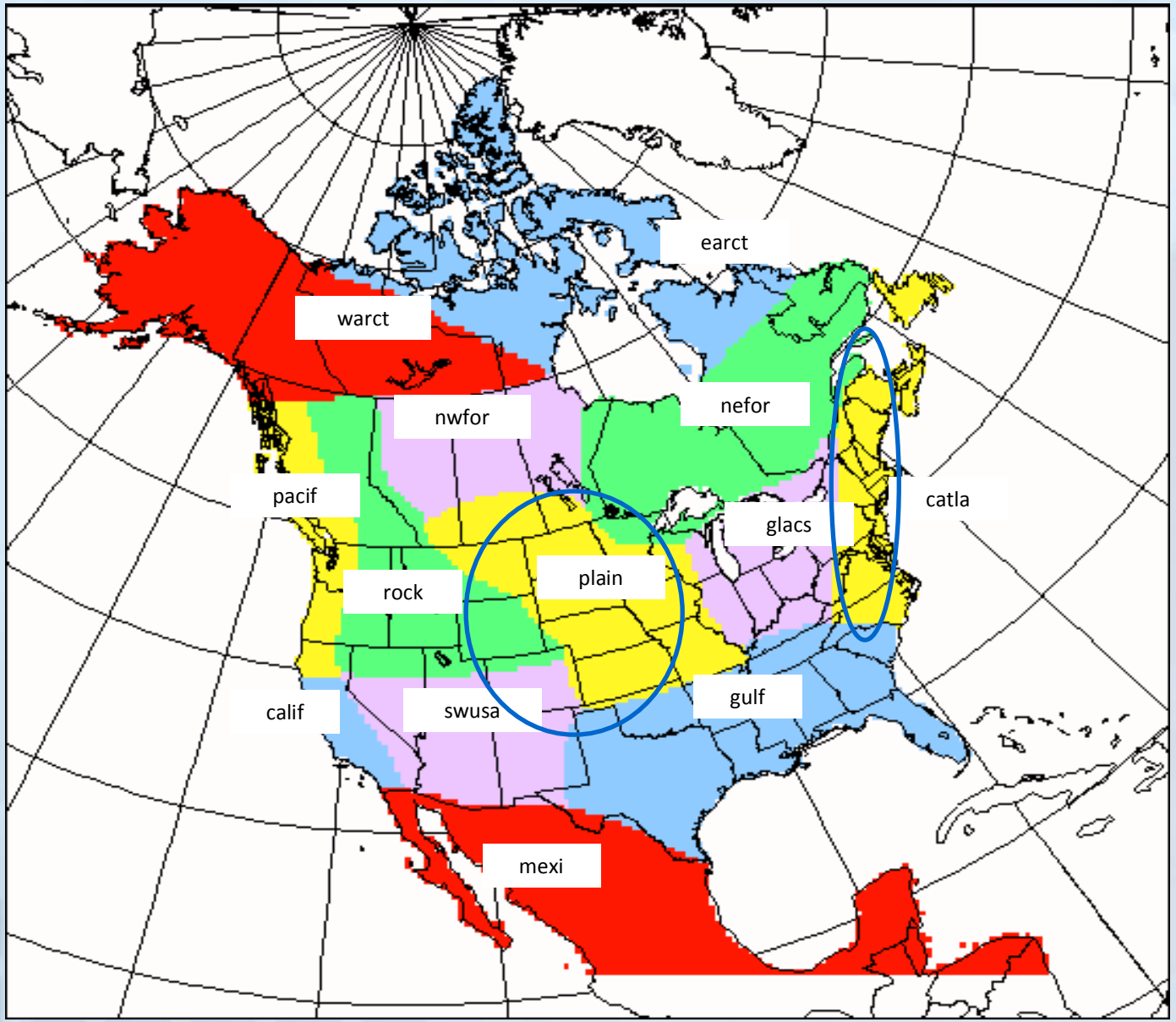
RCM	Winter	Spring	Summer	Fall
CRCM	.86	.66	.70	.82
ECP2	1.06	1.12	.80	.89
HadRM3	1.35	1.01	.60	1.22
MM5	1.09	.84	.60	.97
RegCM3	1.19	1.12	1.10	1.15
WRF(G)	.94	.69	.77	.87
ENS	.93	.82	.57	.85

mm/day

Regions Analyzed

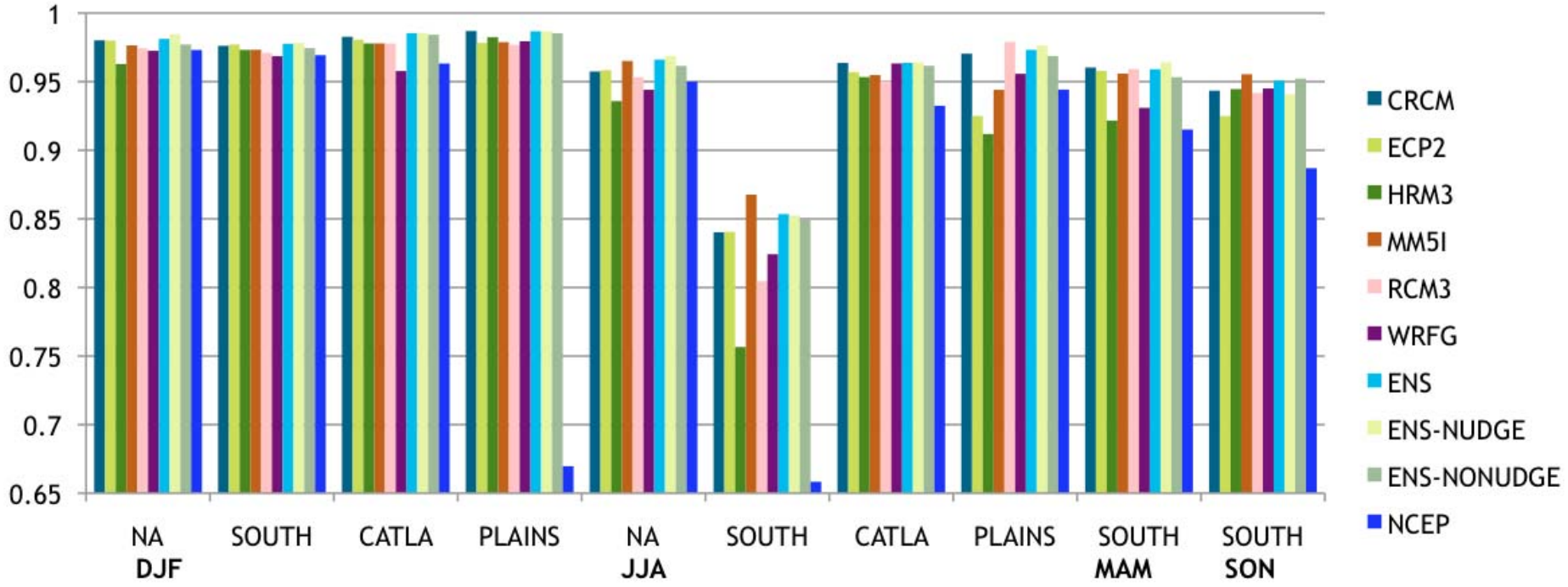


Regions


earct
warct
nefor
nwfor
pacif
catla
glacs
plain
rock
gulf
calif
swusa
mexi

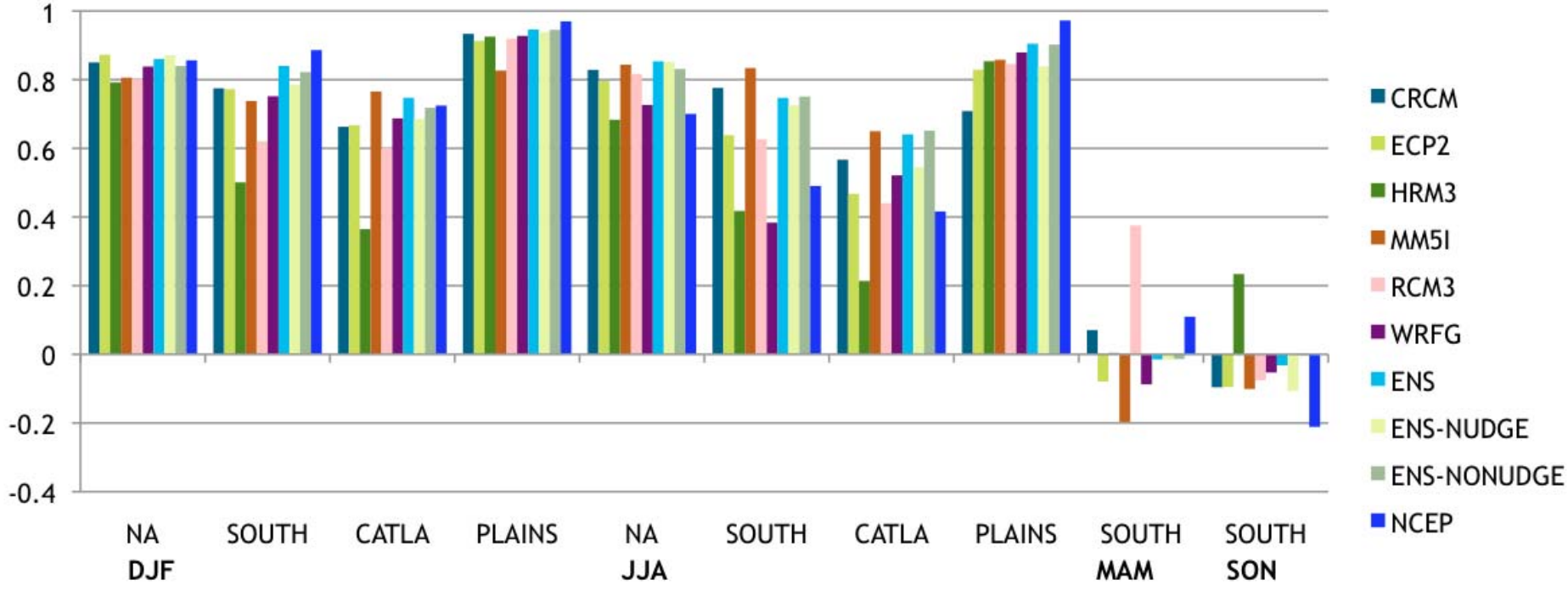
NCAR

2m Temperature: Pattern Correlation



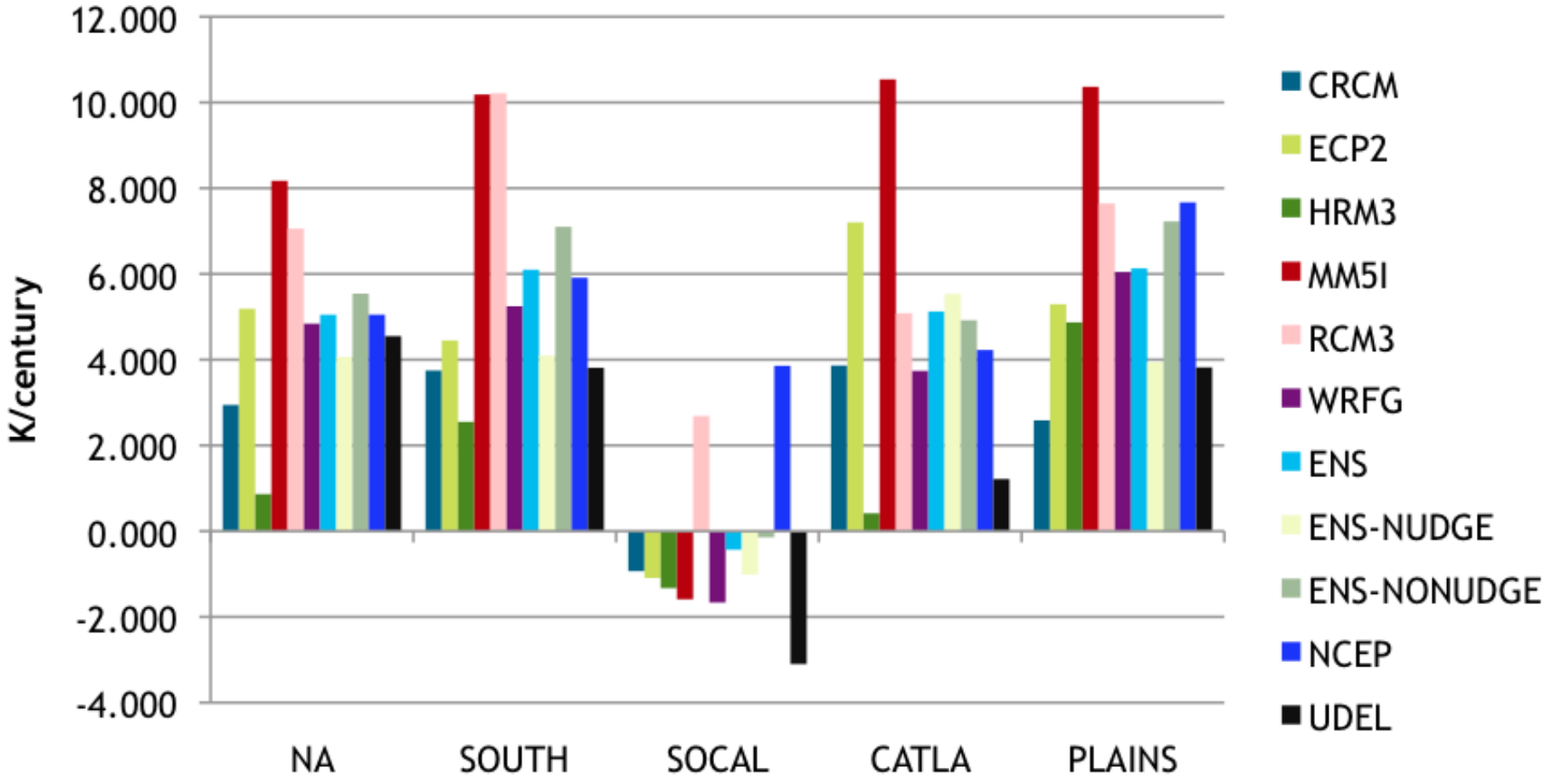
NCAR

Precipitation: Pattern Correlation



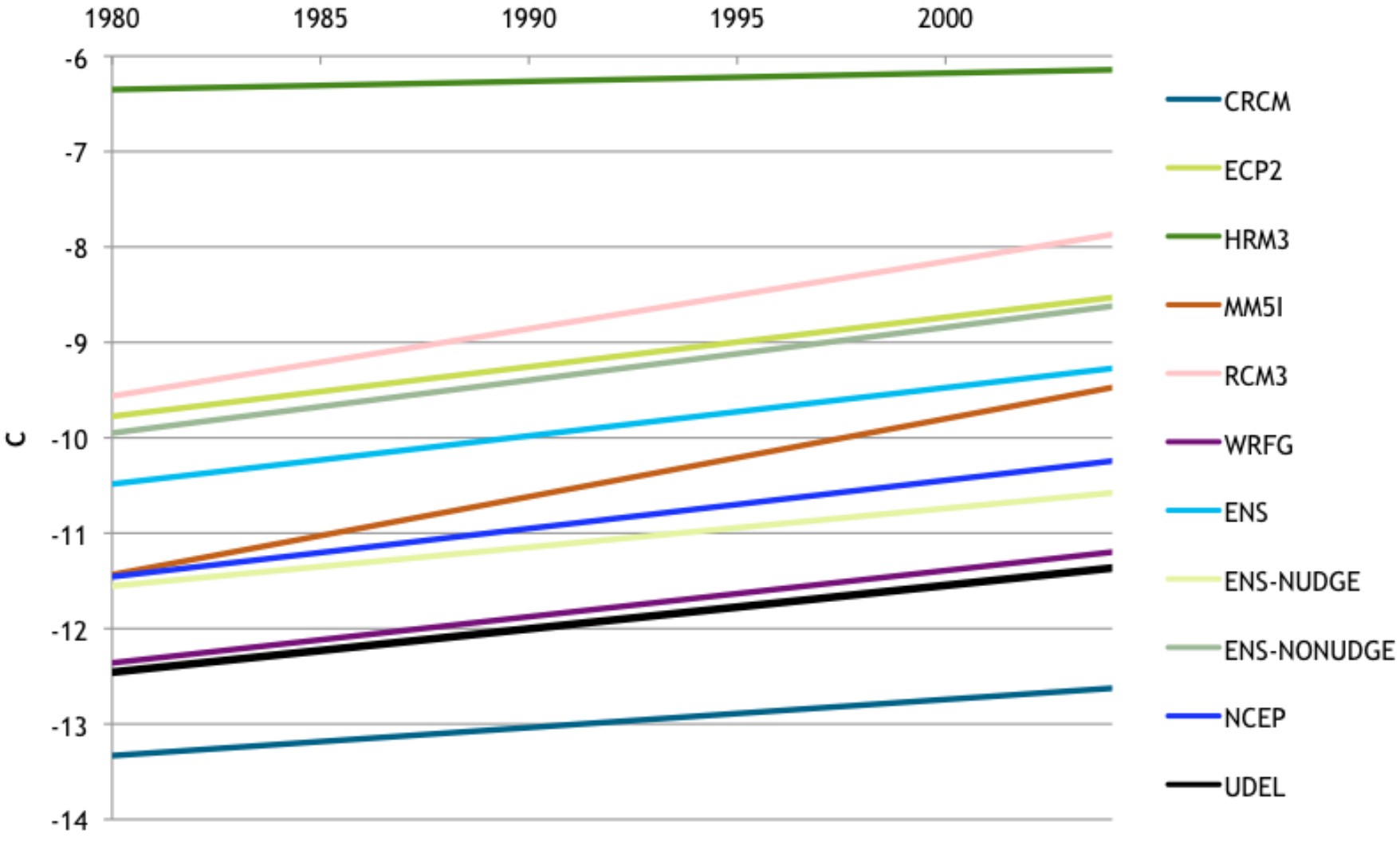
NCAR

DJF 2m Temperature Trends



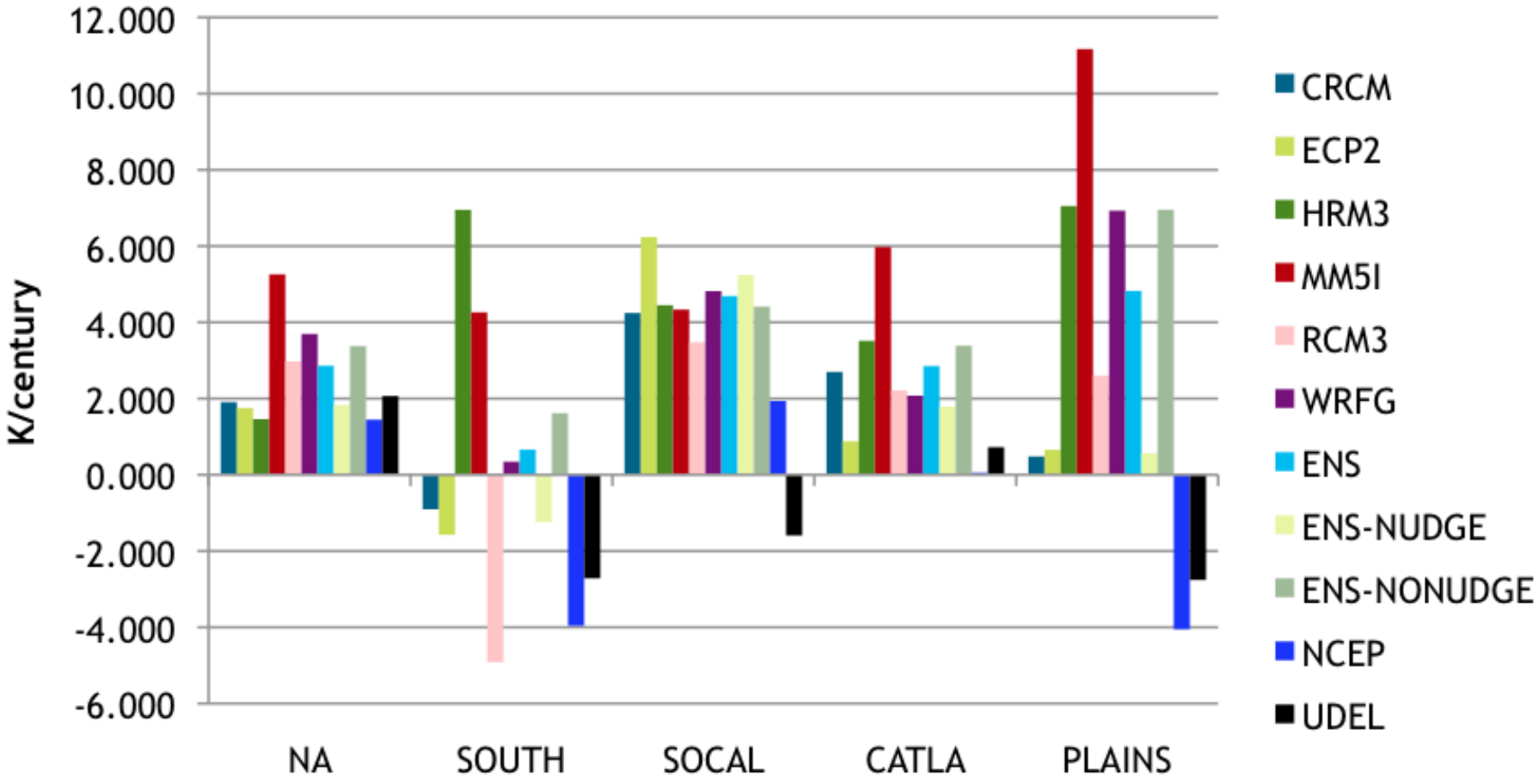
NCAR

DJF 2m Temperature Trends

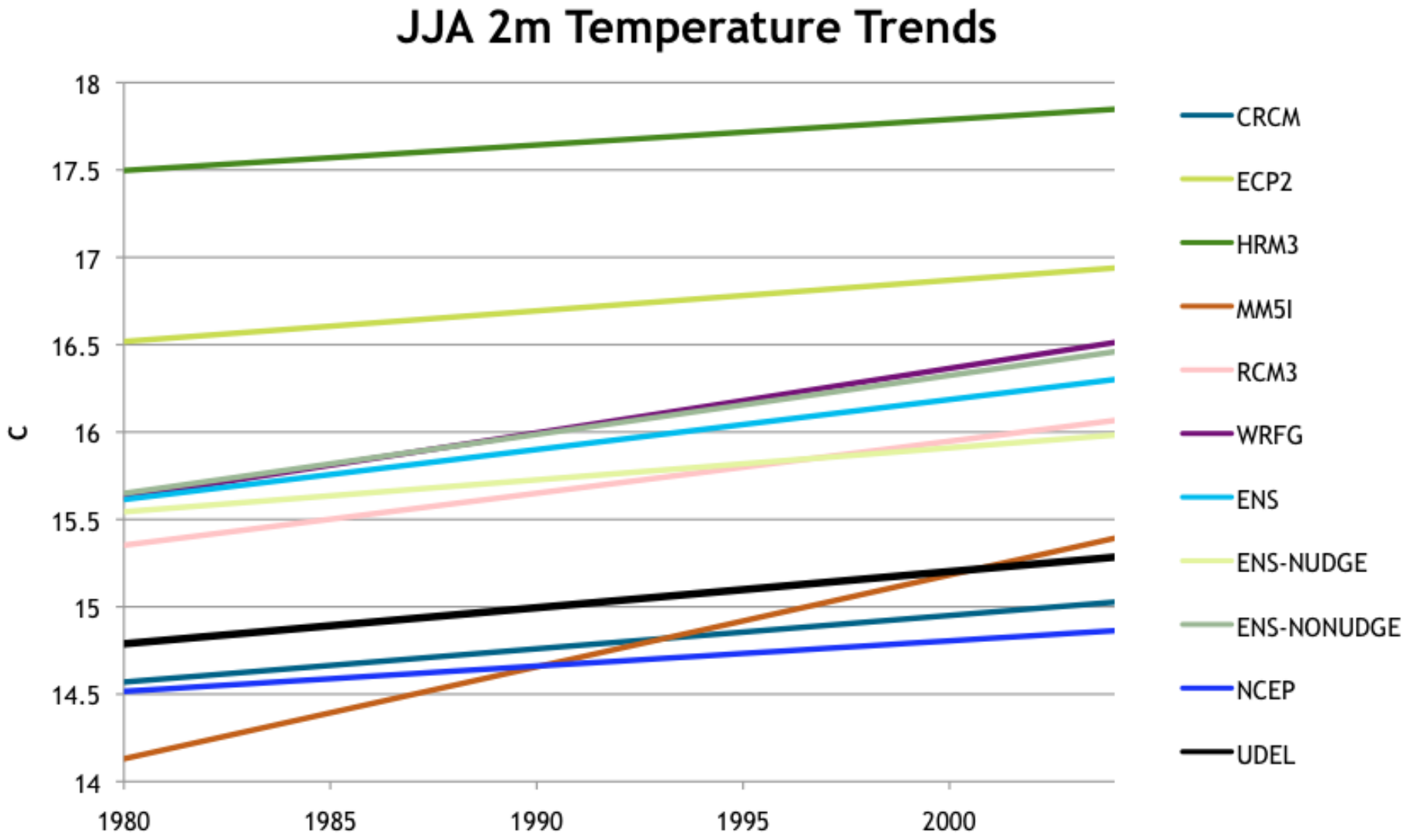


NCAR

JJA 2m Temperature Trends

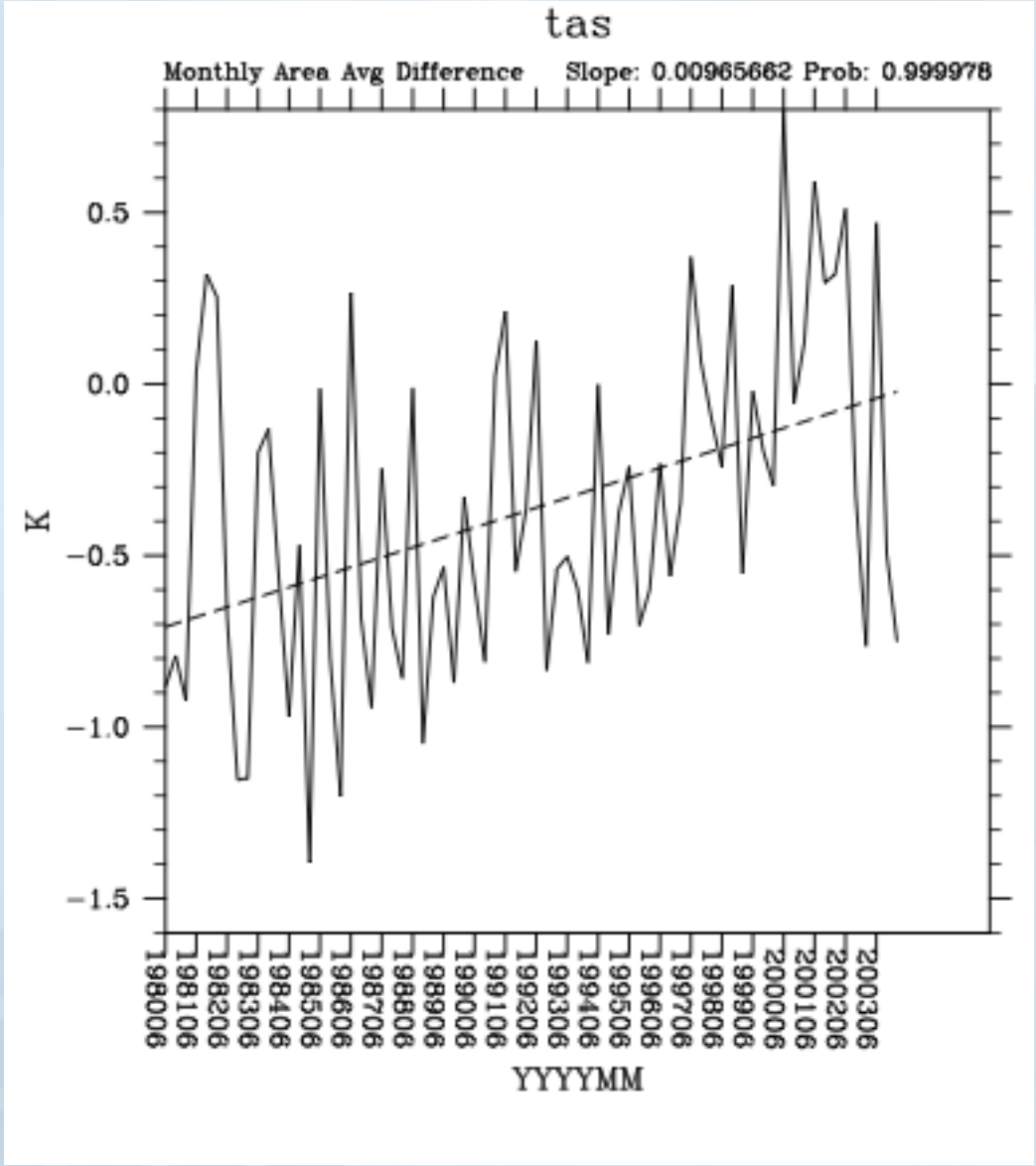


NCAR


JJA 2m Temperature Trends
C
18
17.5
17
16.5
16
15.5
15
14.5
14
1980
1985
1990
1995
2000
CRCM
ECP2
HRM3
MM5I
RCM3
WRFG
ENS
ENS-NUDGE
ENS-NONUDGE
NCEP
UDEL

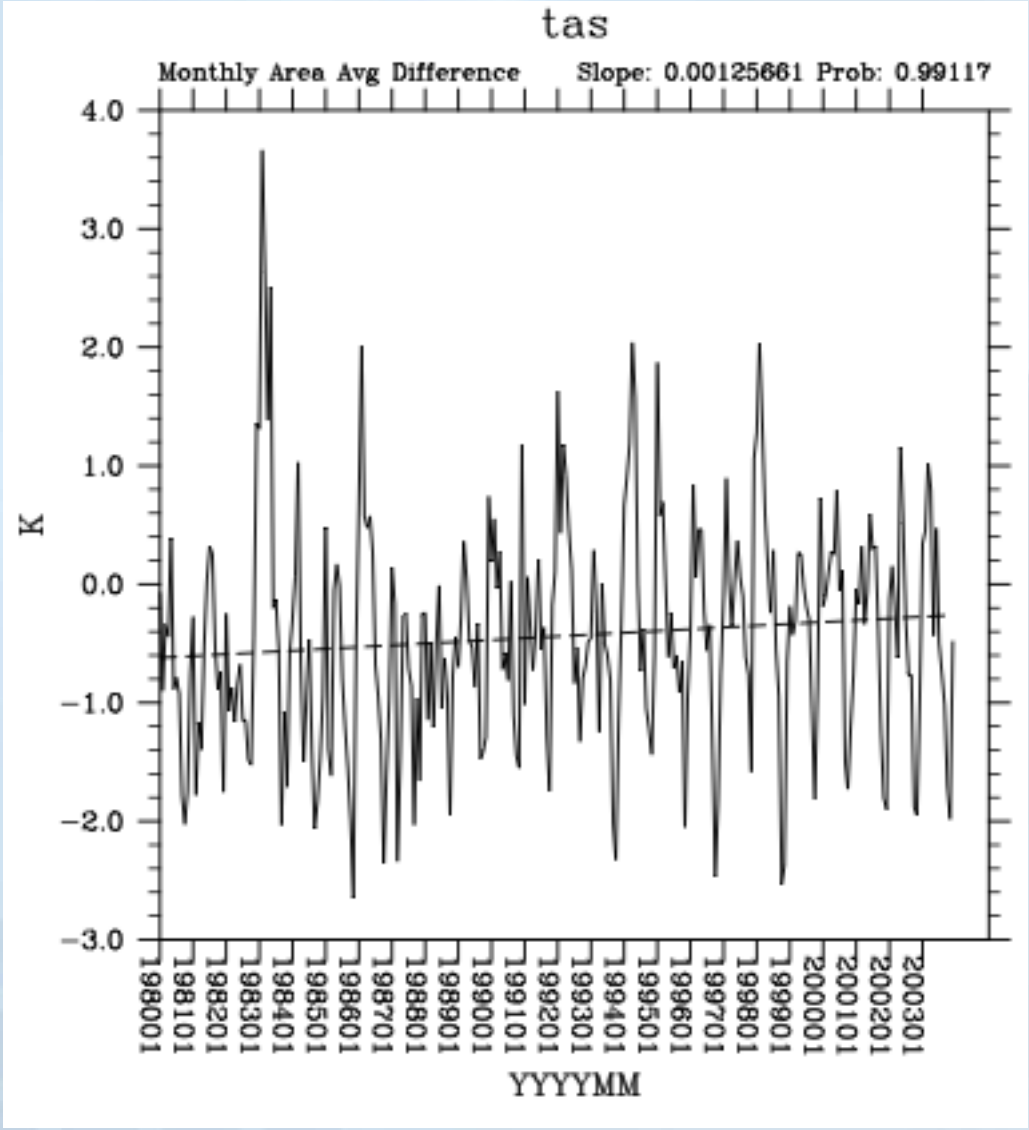
MM5I(ncep driven) – NCEP DJF 1980-2003 Monthly Area Avg Difference (~Model Bias Trend w/ Time) in 2m Temperature

NCAR



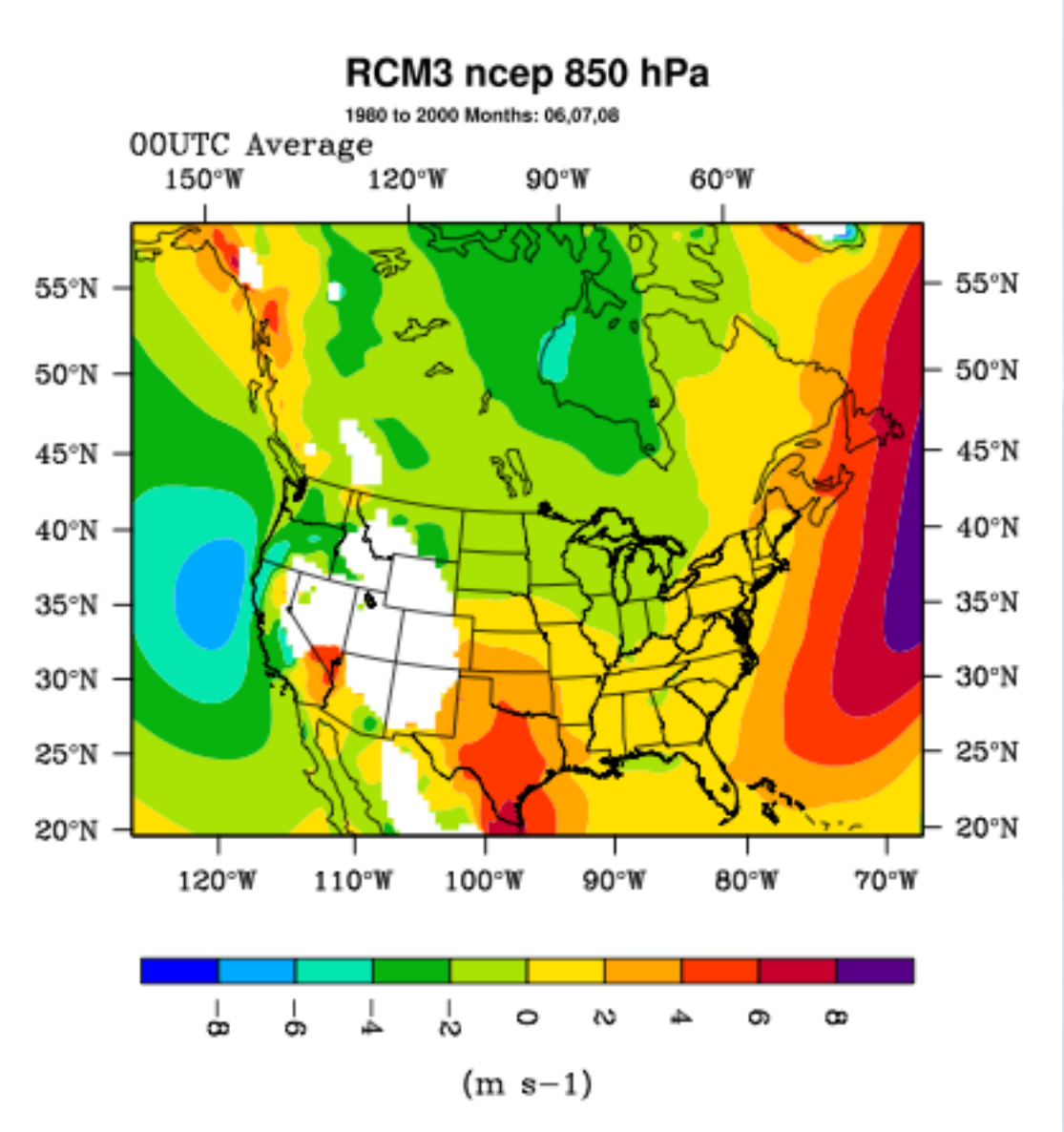
MM5I(ncep driven) – NCEP All Season 1980-2003 Monthly Area Avg Difference (~Model Bias Trend w/ Time) in 2m Temperature

NCAR



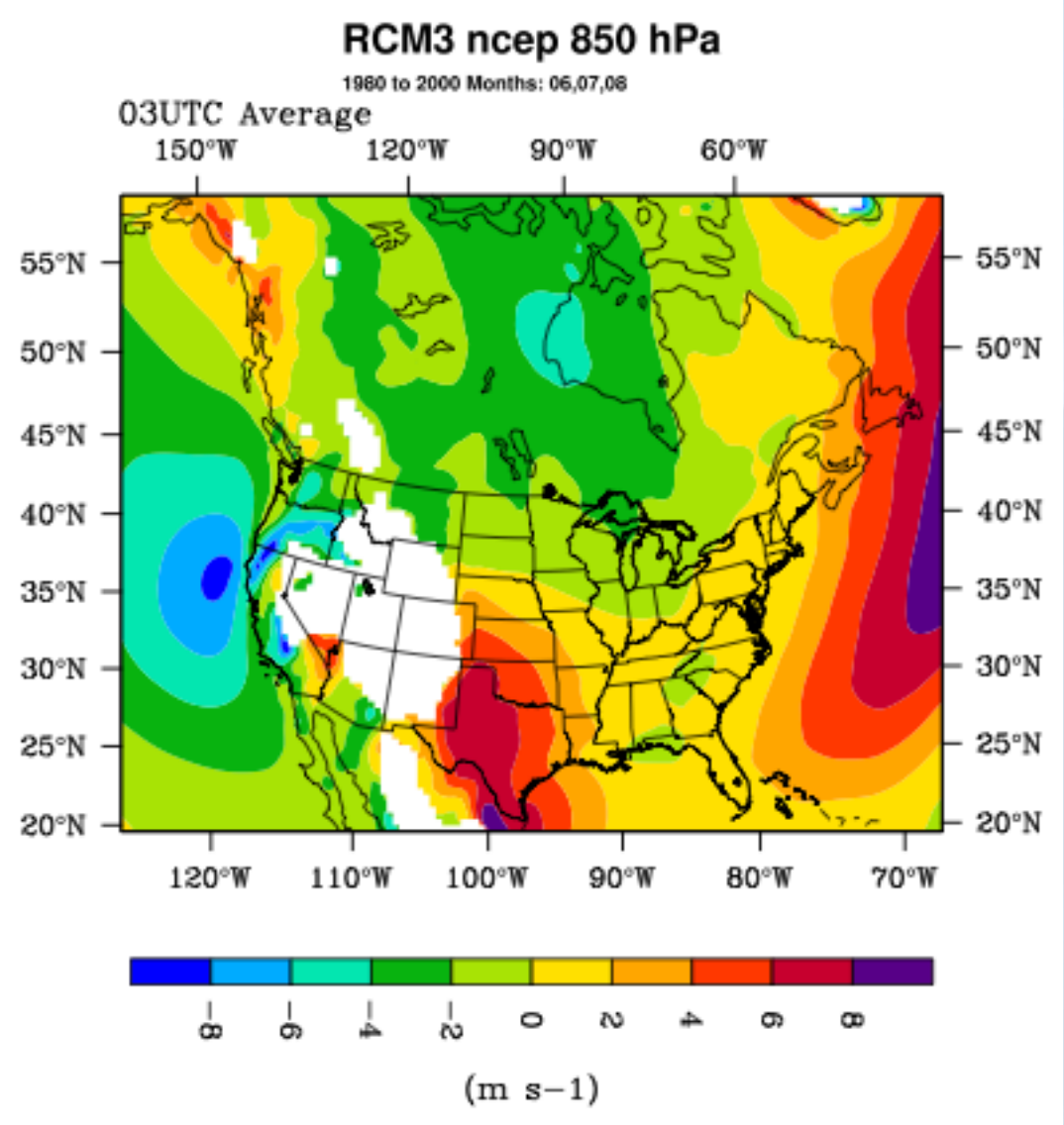
1980-2000 JJA Average VAS (North-South) 850 mb Wind Component at 00UTC (7pm Central)

NCAR



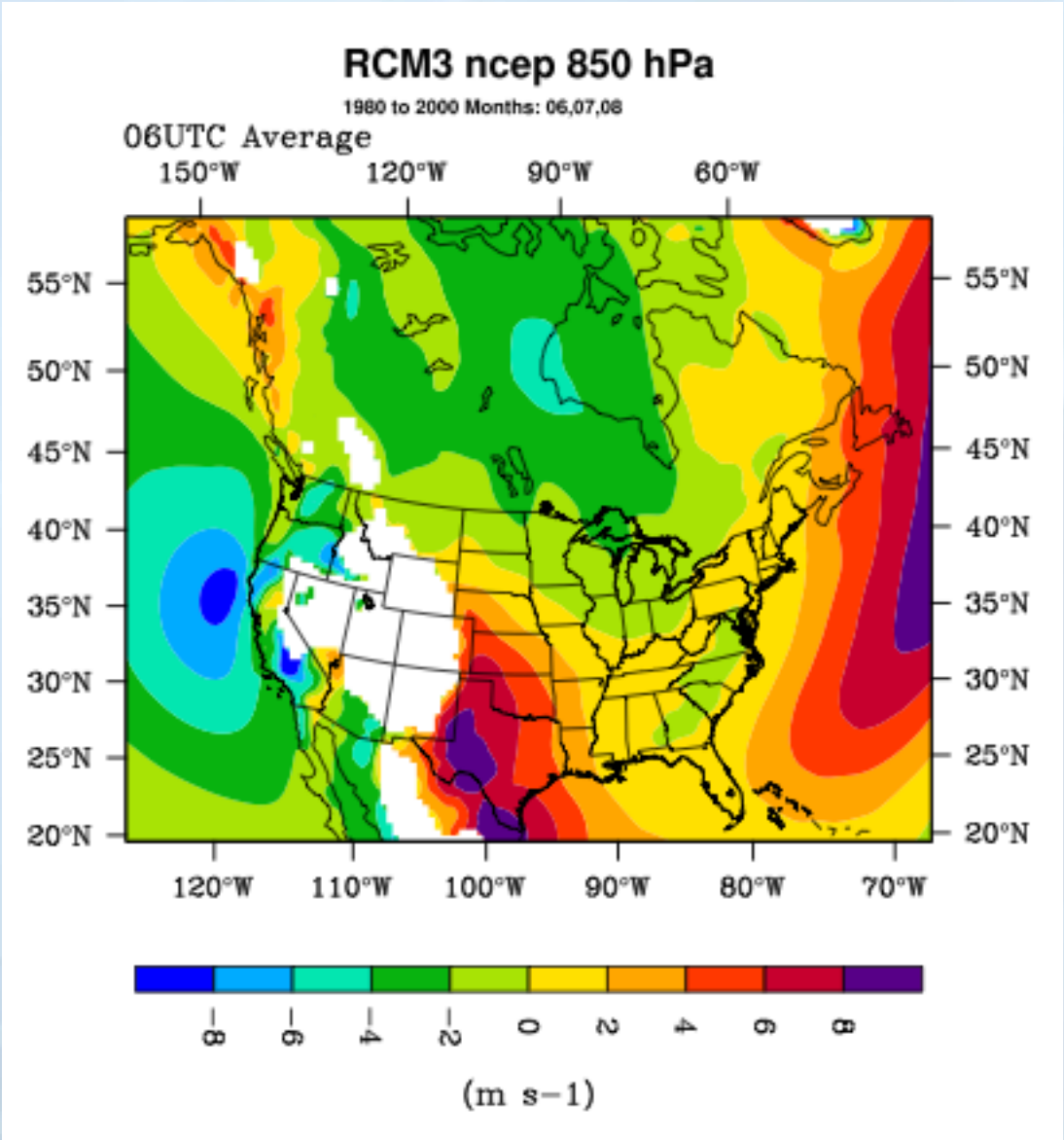
1980-2000 JJA Average VAS (North-South) 850 mb Wind Component at 03UTC (10pm Central)

NCAR



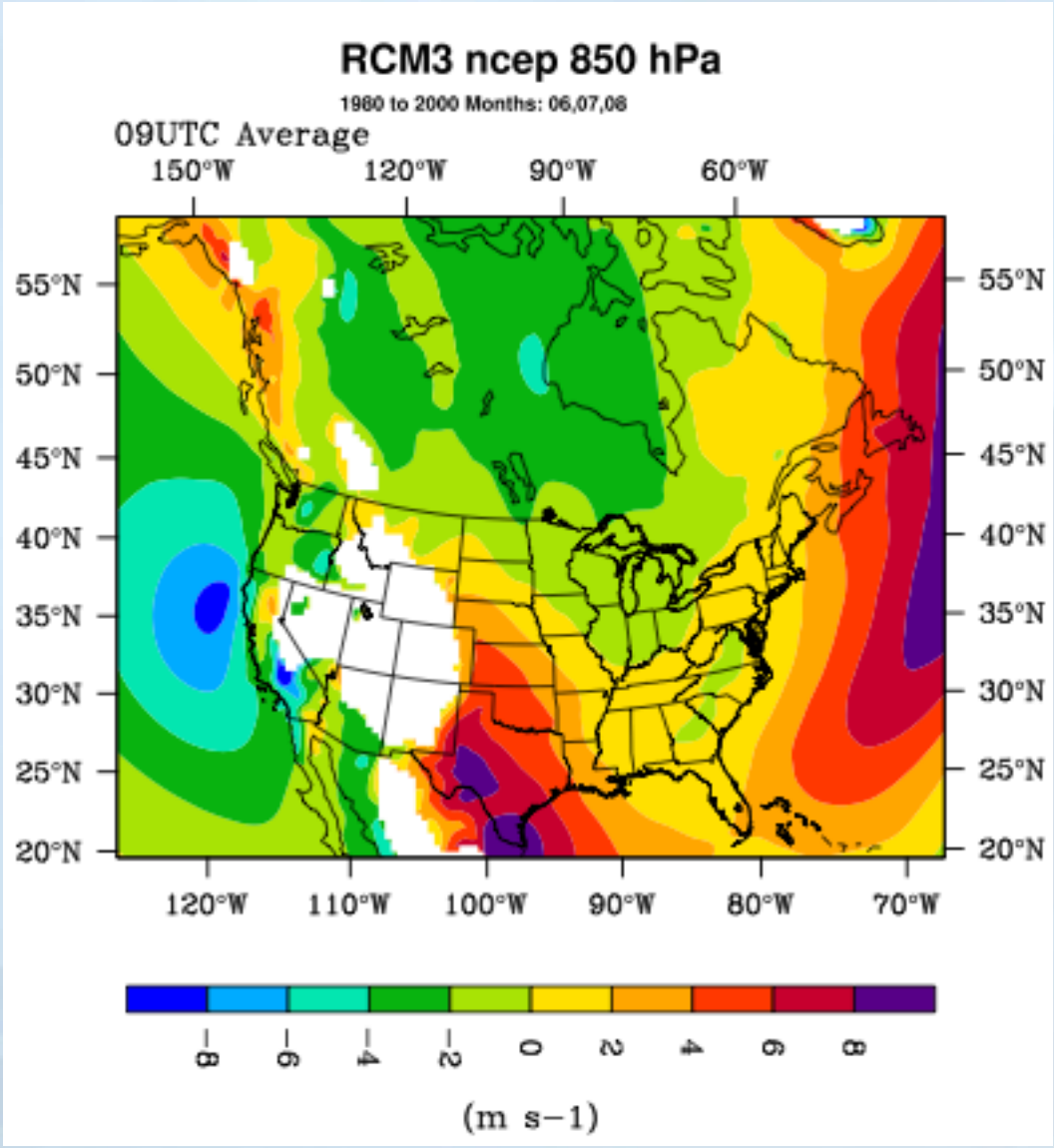
1980-2000 JJA Average VAS (North-South) 850 mb Wind Component at 06UTC (1am Central)

NCAR



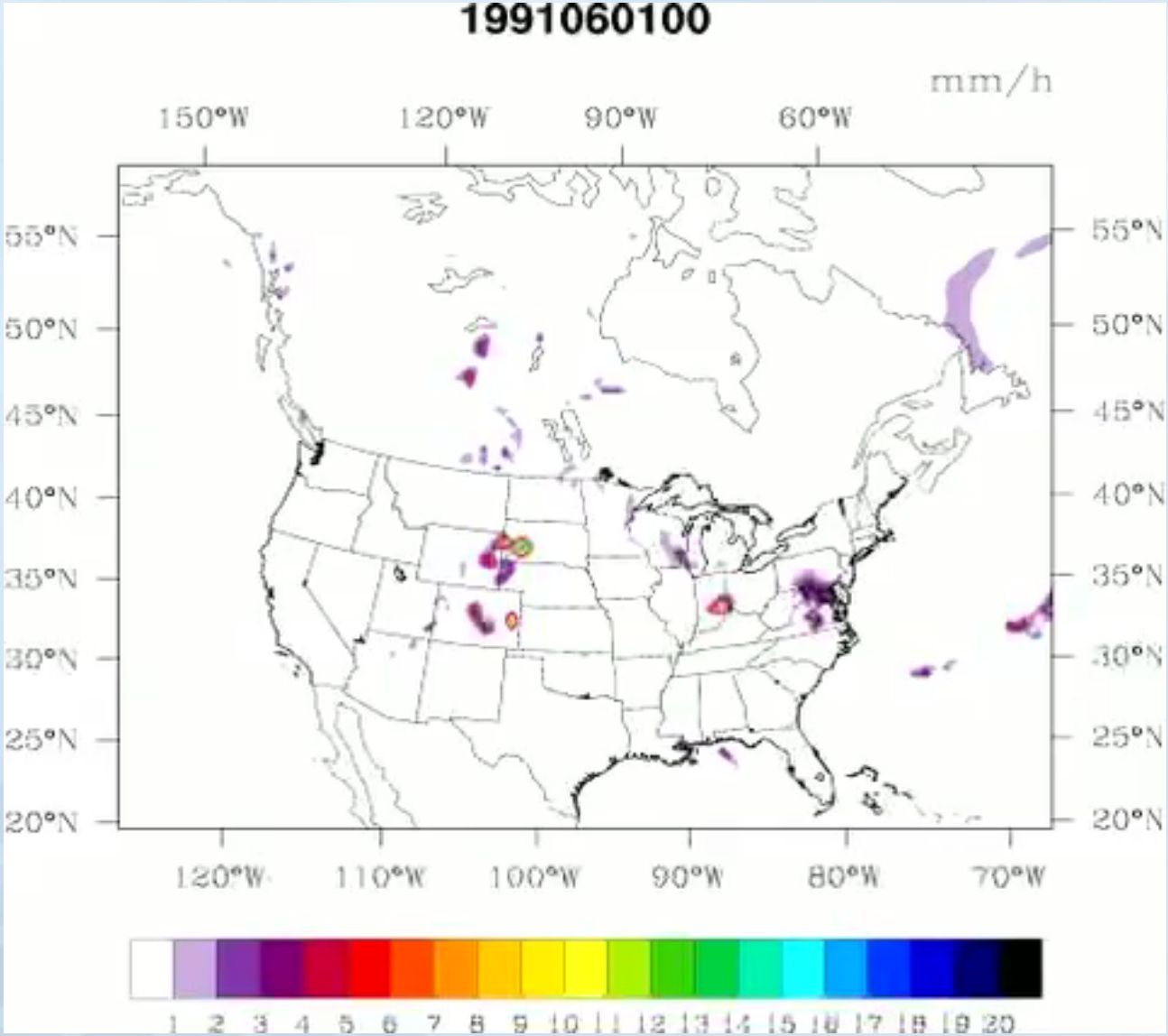
1980-2000 JJA Average VAS (North-South) 850 mb Wind Component at 09UTC (4am Central)

NCAR



RegCM3 Precipitation June-August 1991

NCAR



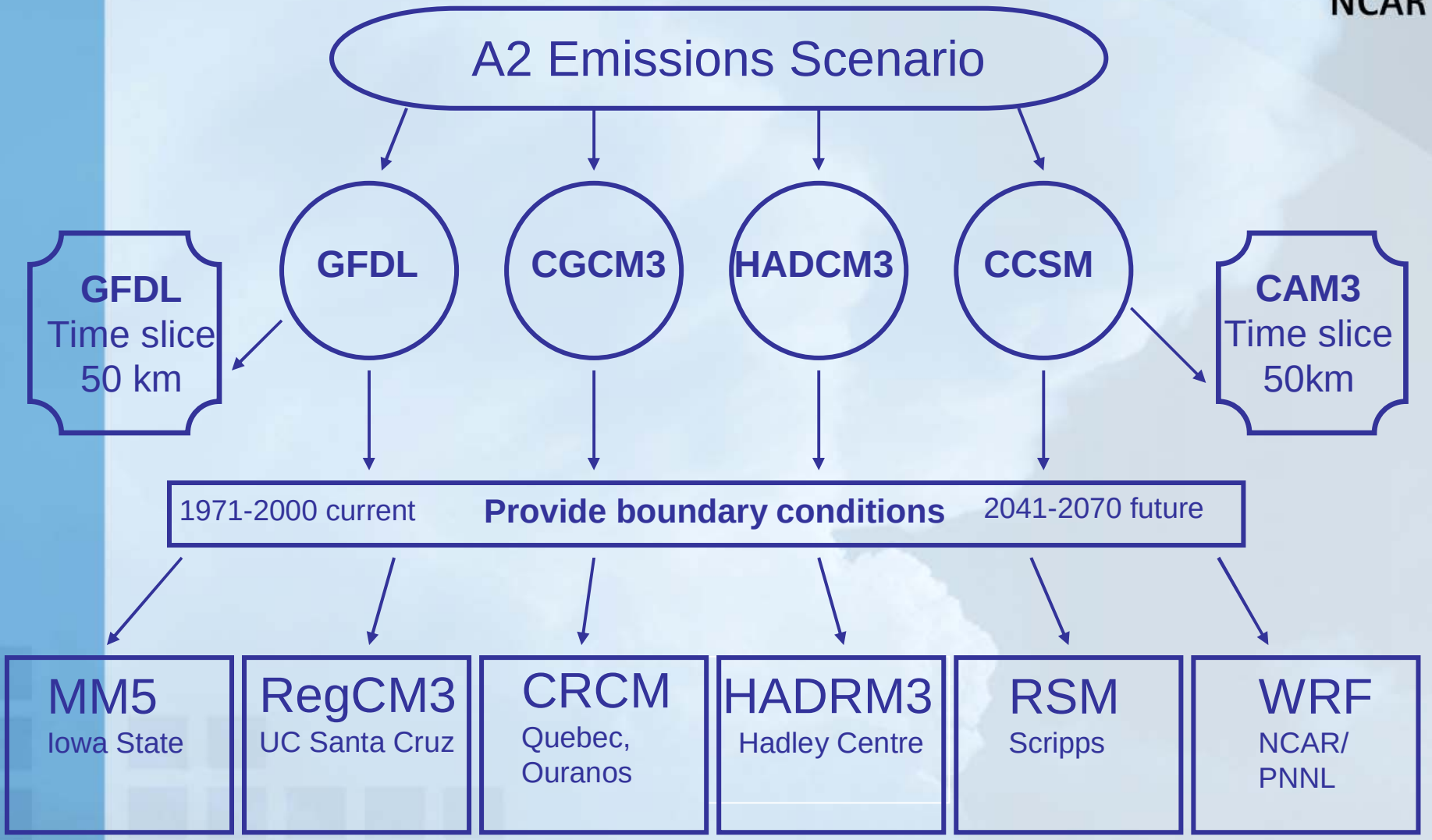
mm/h

movie

NCAR

Phase II
Climate Change

NARCCAP PLAN – Phase II



GCM-RCM Matrix

NCAR

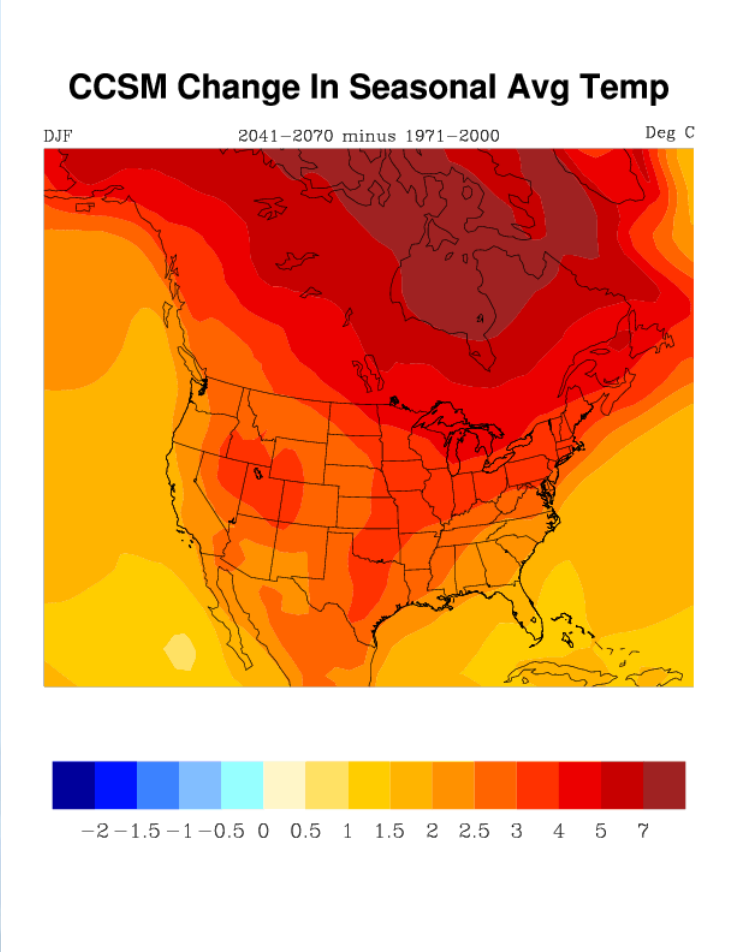
AOGCMS

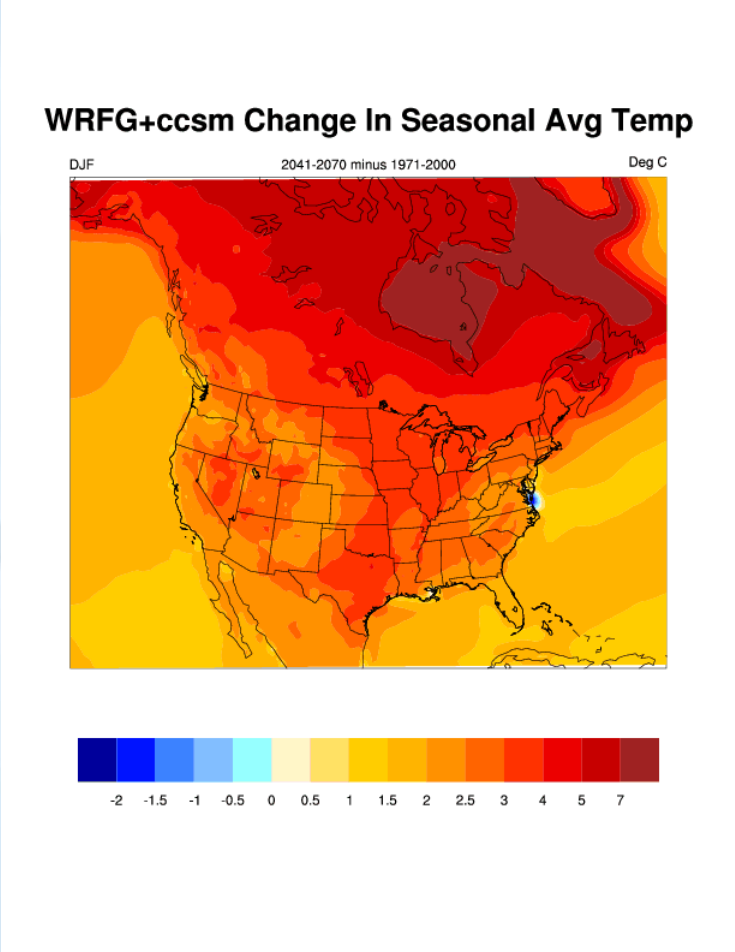
RCMs	GFDL	CGCM3	HADCM3	CCSM
MM5			X	X1
RegCM	X1**	X**		
CRCM		X1**		X
HadRM	X		X1**	
RSM	X1		X	
WRF		X		X1**
*CAM3				X
*GFDL	X**			

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

Change in Temperature -DJF

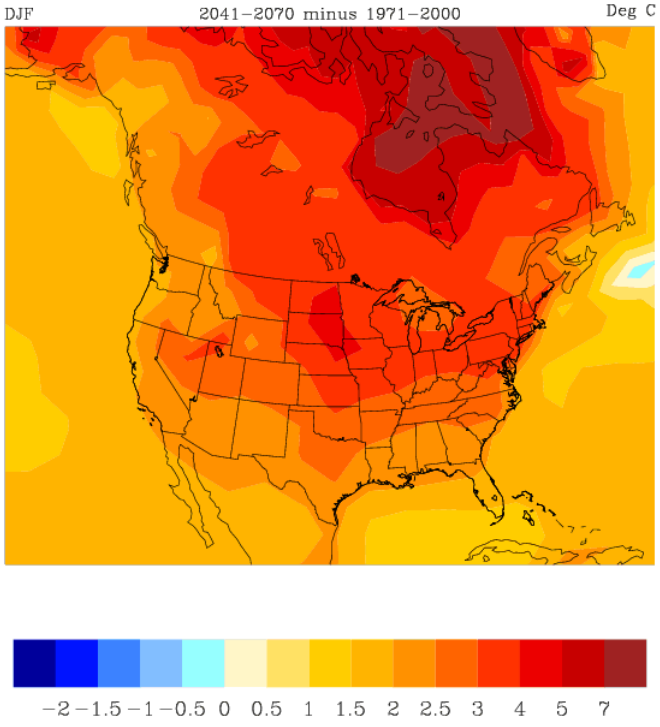
NCAR

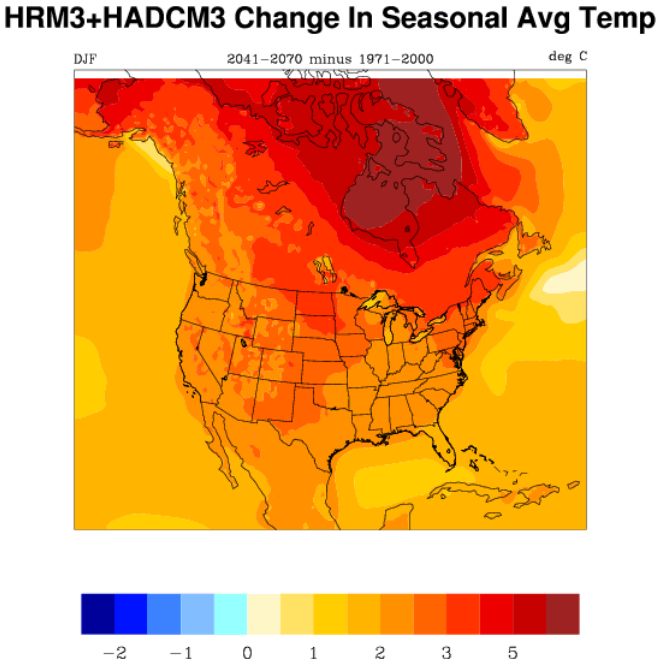




Change in Winter Temperature UK Models

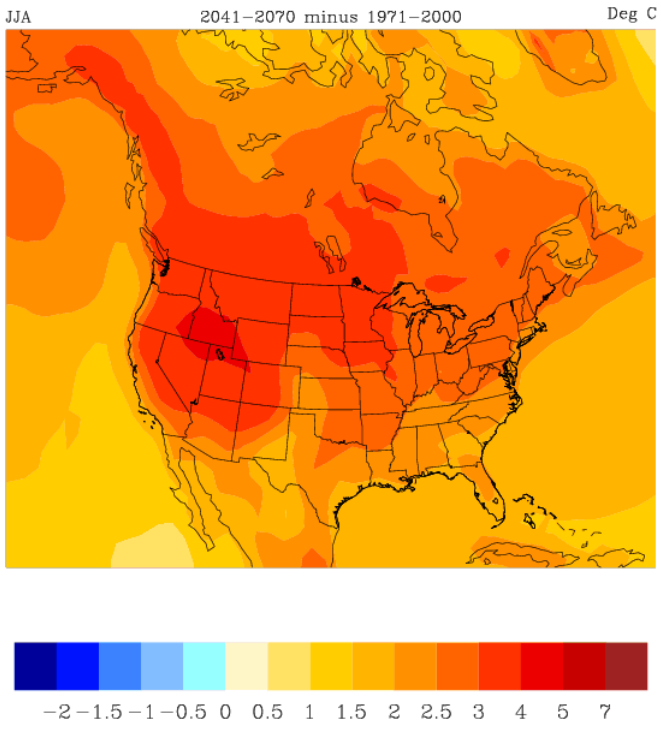
NCAR

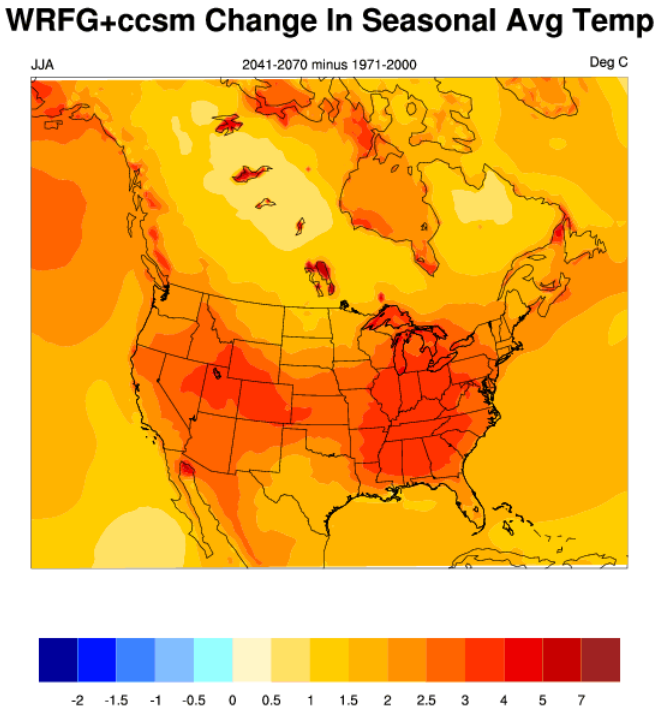




Change in Temperature - JJA

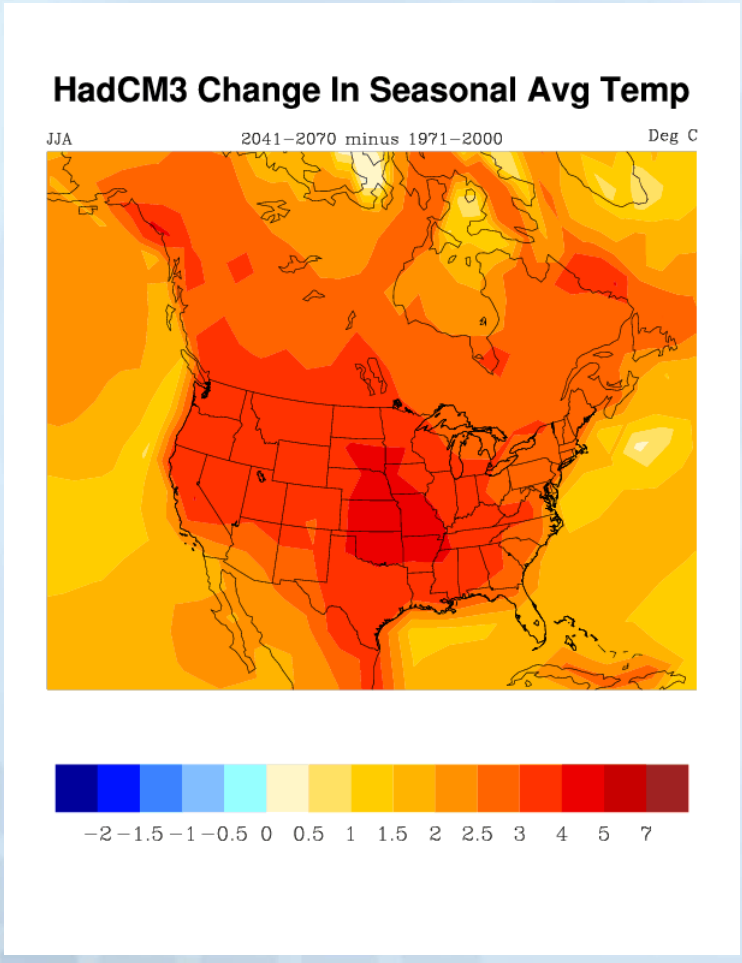
NCAR

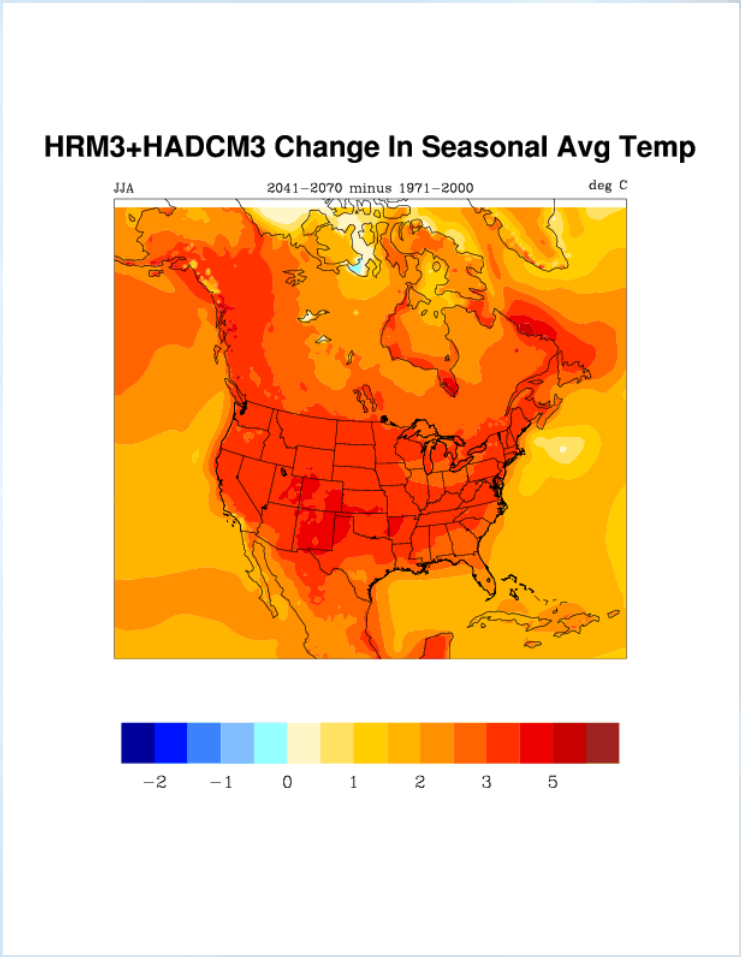




Change in Summer Temperature UK Models

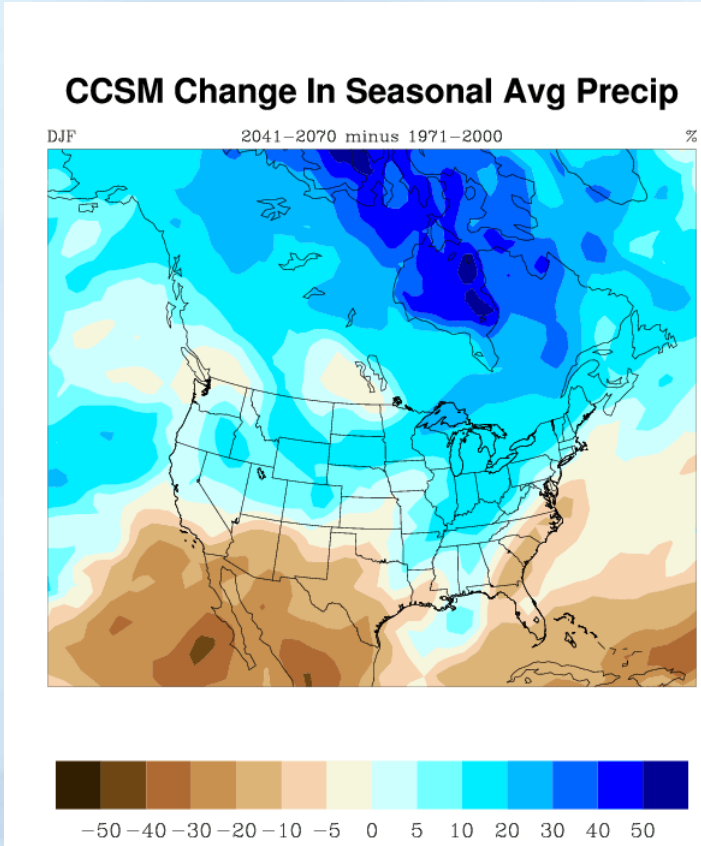
NCAR

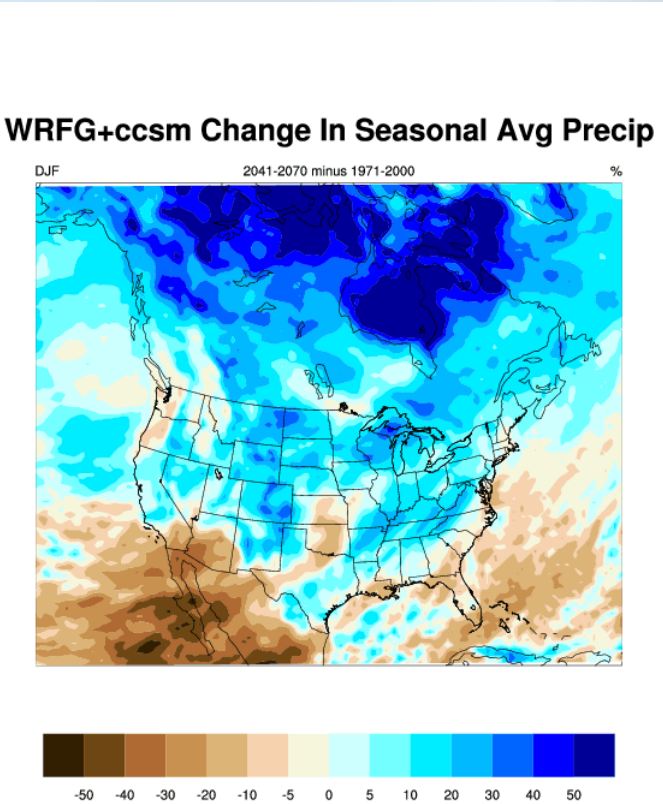




Change (%) Winter Precip

NCAR

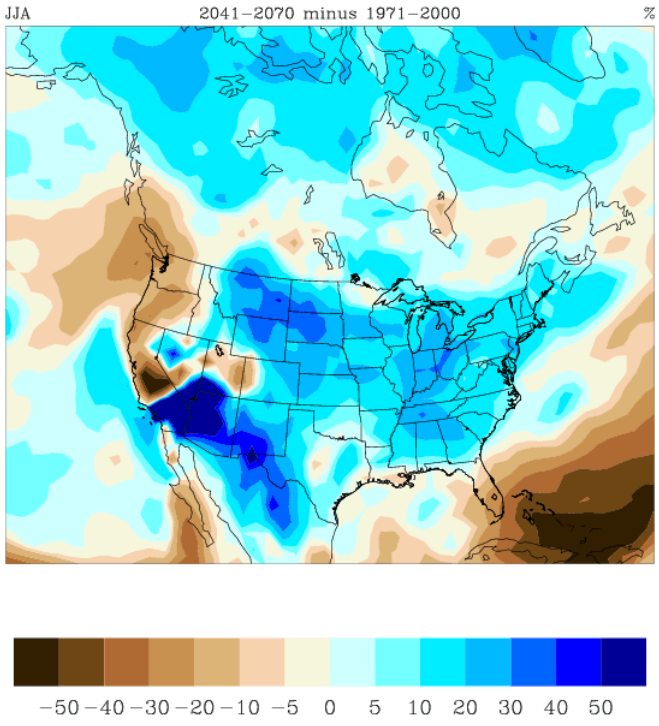




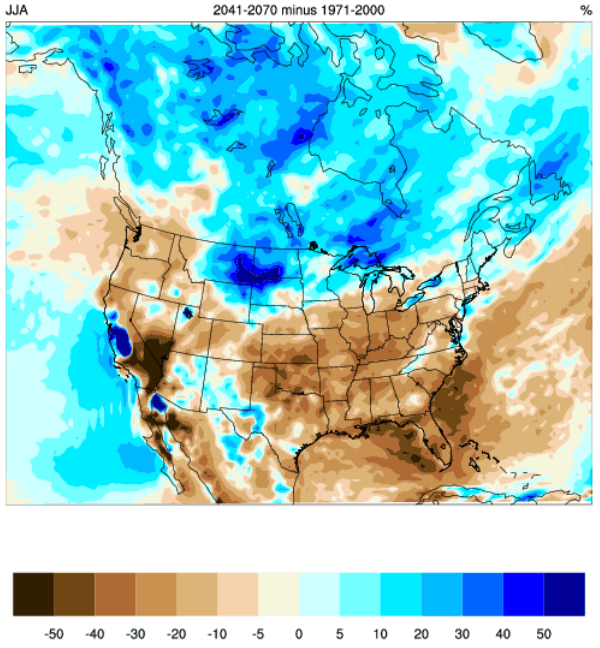
Change (%) Summer Precip

NCAR

CCSM Change In Seasonal Avg Precip



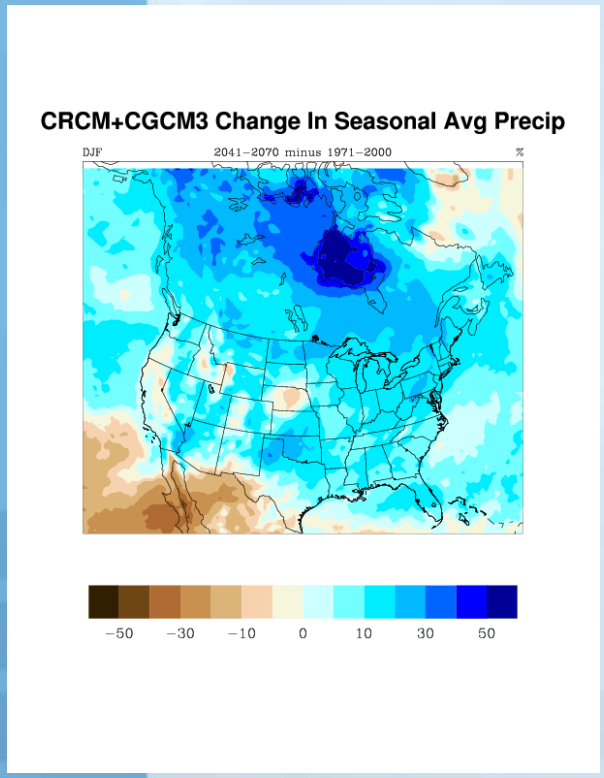
WRFG+ccsm Change In Seasonal Avg Precip



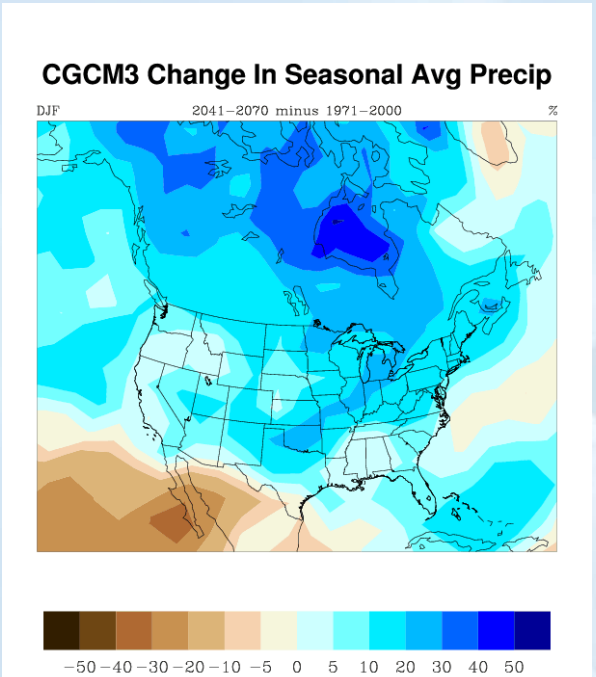
Uncertainty across two RCMs nested in same GCM for % Change in Winter Precipitation

NCAR

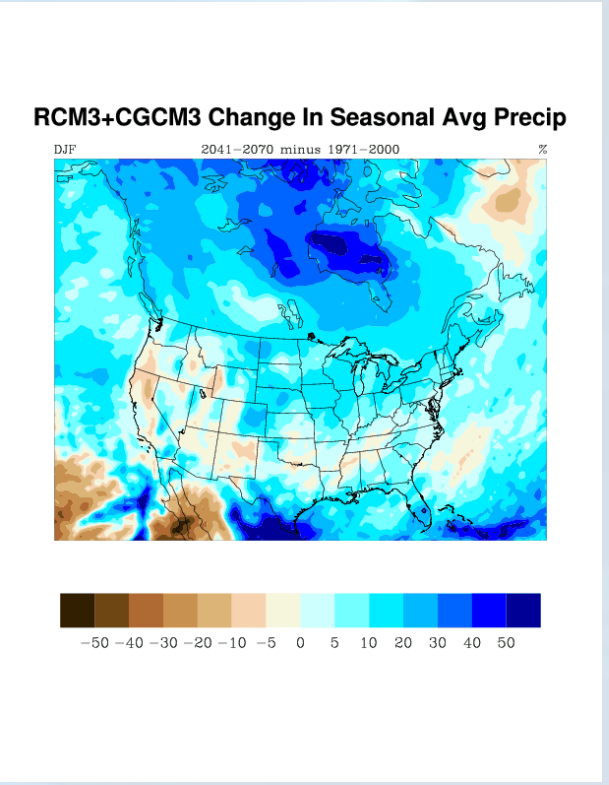
Regional Model 1



Global Model



Regional Model 2

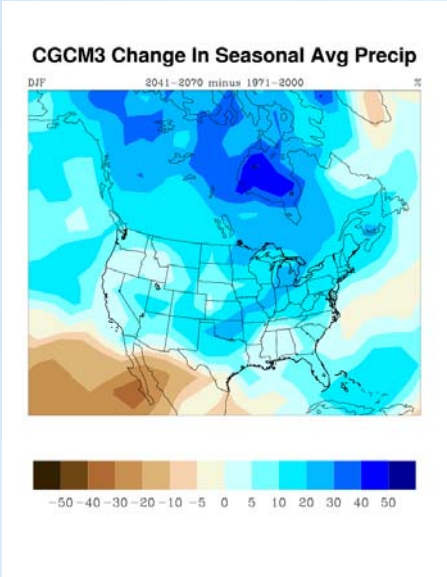


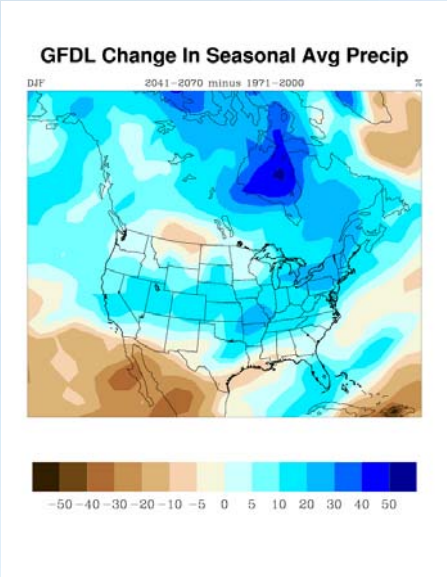
Effect of two different GCMs driving one RCM – % change in winter precipitation

NCAR

GCMs

CGCM3

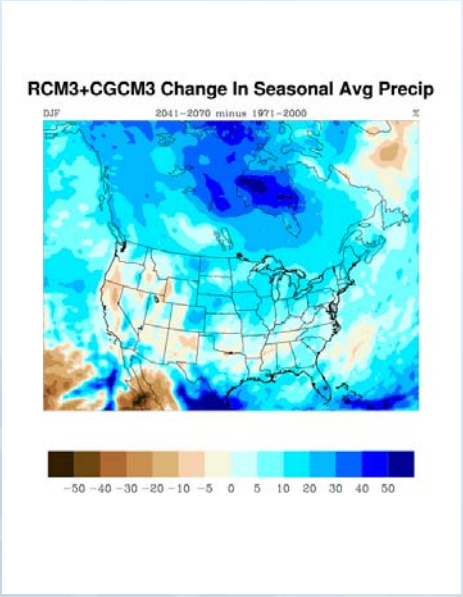


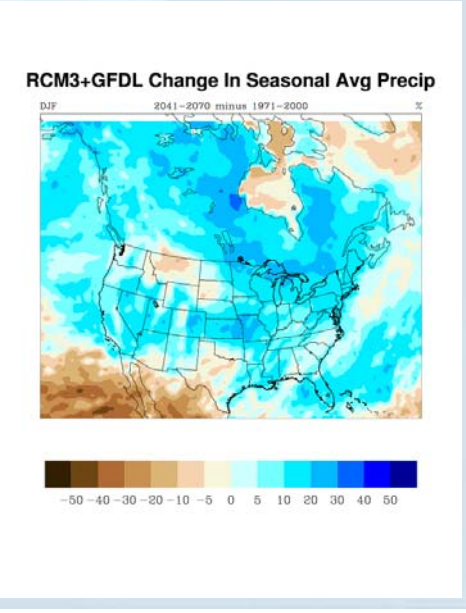


GFDL

RCM

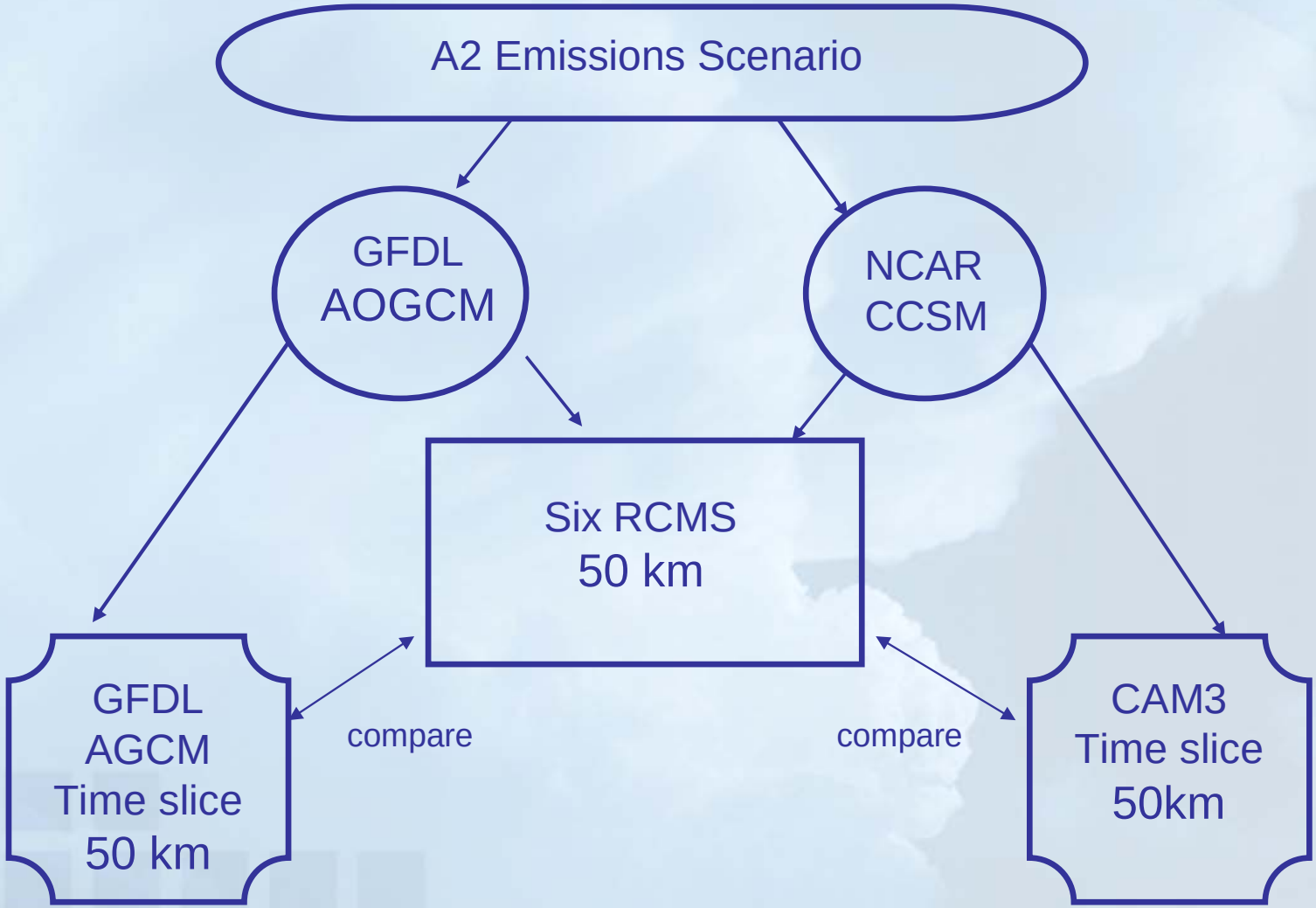
RegCM3

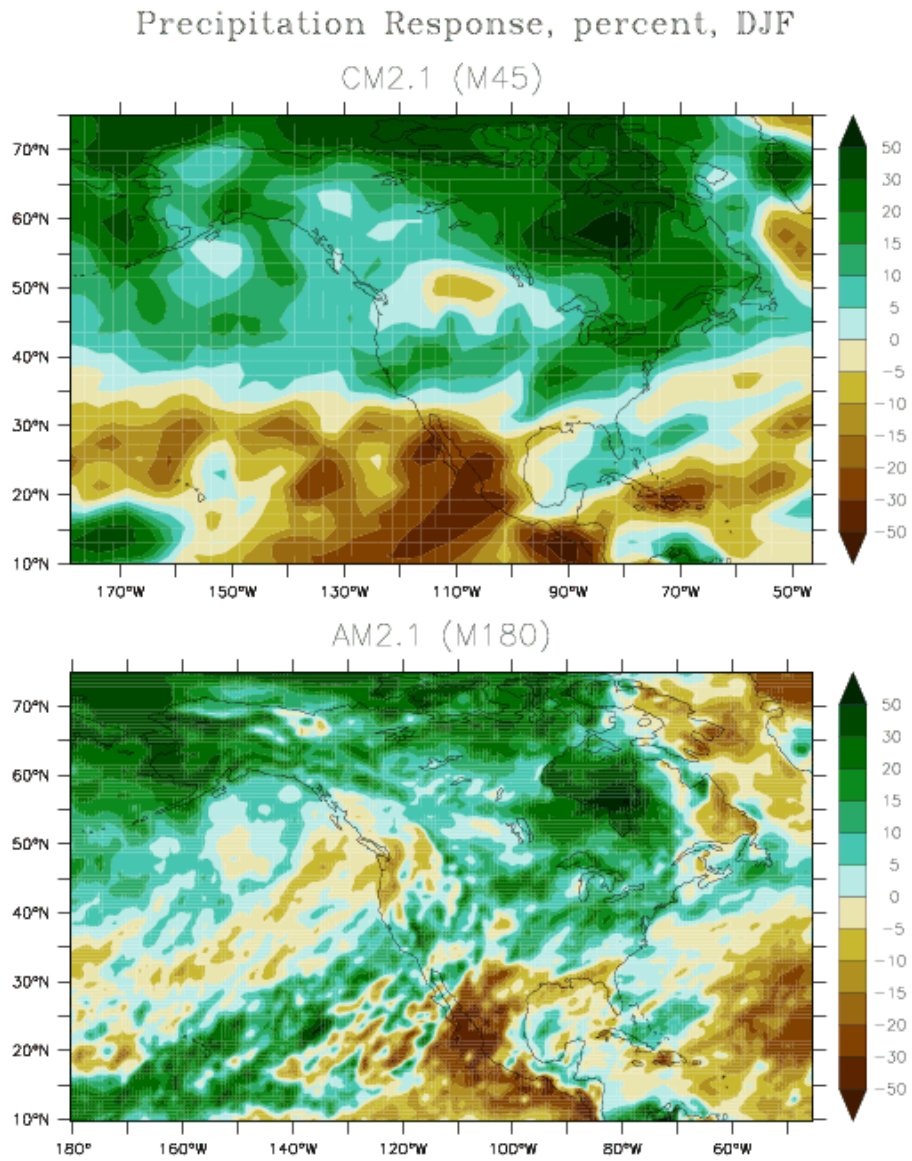




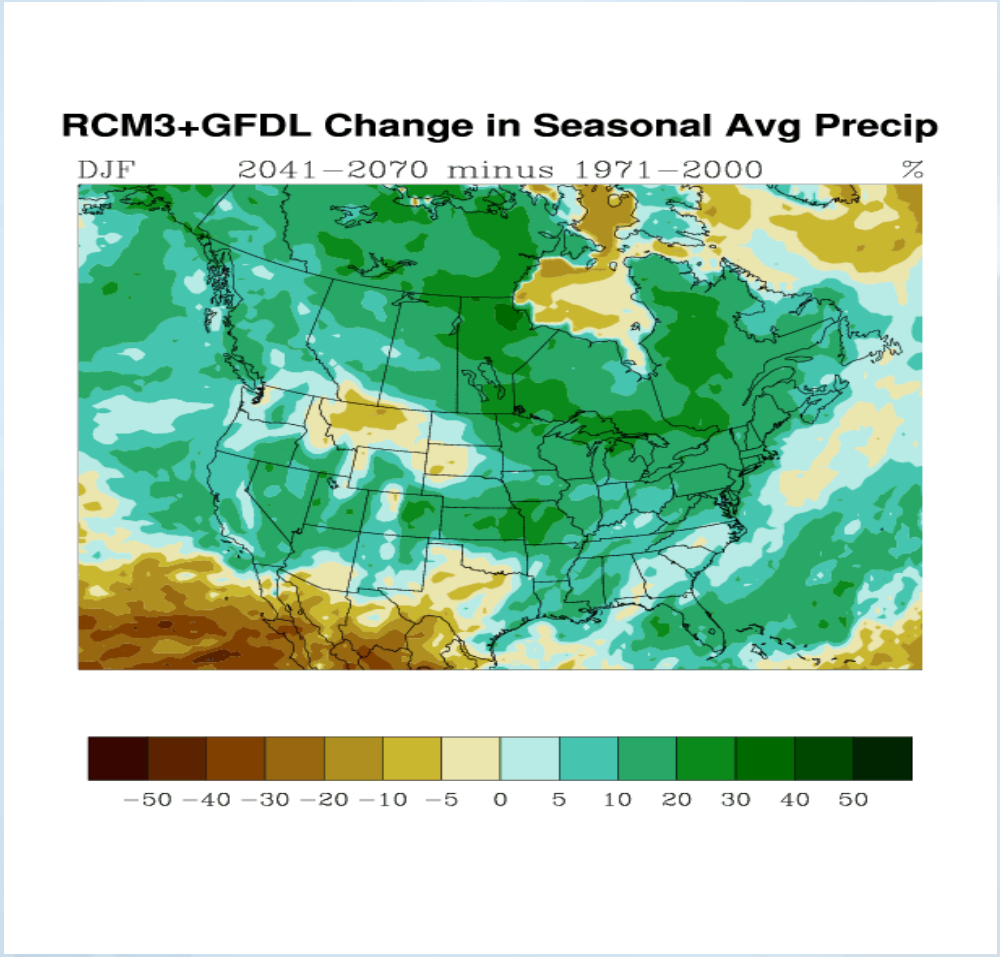
Global Time Slice / RCM Comparison

at same resolution (50km)




Precipitation Response, percent, DJF
CM2.1 (M45)
70°N
60°N
50°N
40°N
30°N
20°N
10°N
170°W
150°W
130°W
110°W
90°W
70°W
50°W
50
30
20
15
10
5
0
−5
−10
−15
−20
−30
−50
AM2.1 (M180)
70°N
60°N
50°N
40°N
30°N
20°N
10°N
180°
160°W
140°W
120°W
100°W
80°W
60°W
50
30
20
15
10
5
0
−5
−10
−15
−20
−30
−50

RegCM3 in GFDL
% Change Precip - Winter

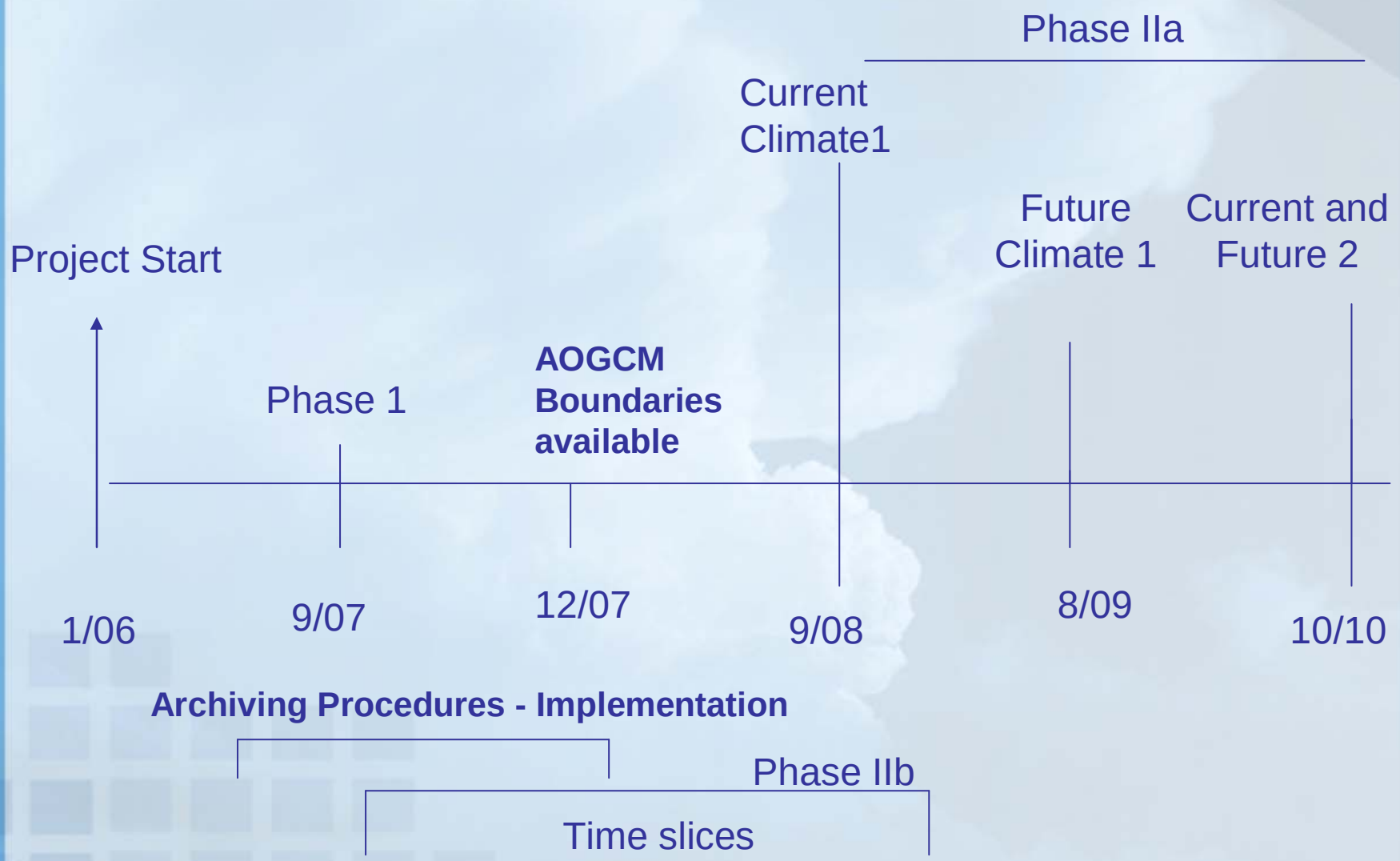


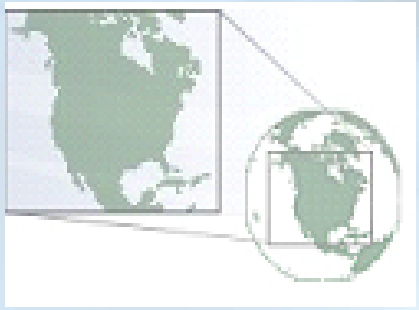
Quantification of Uncertainty

NCAR

- The four GCM simulations already ‘situated’ probabilistically based on earlier work (Tebaldi et al., 2004, 2005)
- 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 – will use different metrics – including process level expert judgment - determine sensitivity of final pdfs to various methods

NARCCAP Project Timeline





NCAR

The NARCCAP User Community

Three user groups:

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

www.narccap.ucar.edu

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

Close to 300 users registered

mcginnis@ucar.edu

End