Summertime in the NARCCAP Regional Climate Simulations

P417

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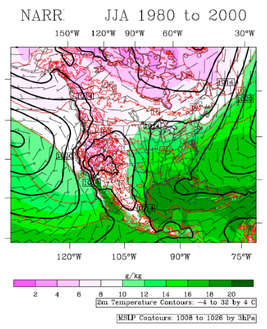
NCAR/IMAGe

Introduction

The North American Regional Climate Change Assessment Program (NARCCAP) is producing high-resolution climate simulations in order to generate regional climate change scenarios for impacts research and to investigate uncertainties in the projection of future climate. NARCCAP simulations are produced by 6 regional climate models (RCMs) given conditions from 4 different global climate models (GCMs) and one reanalysis.

This particular study investigates the performance of the different regional models as driven by the NCEP Reanalysis II for June-August (JJA) from roughly 1980-2000, with a focus on central U.S. precipitation. The North American Regional Reanalysis is used for comparison to present day conditions. Also included is a brief assessment of changes in precipitation between 1971-2000 and 2041-2070 from 3 of the NARCCAP RCMs driven by 3 GCMs: the United Kingdom Hadley Centre Climate Model version 3 (HADCM), the Geophysical Fluid Dynamics Laboratory Climate Model version 2.1 (GFDL), and the Canadian Global Climate Model version 3 (CGCM). All GCMs have been forced with the SRES A2 emissions scenario for the 21st century.

More information on NARCCAP can be found at www.narccap.ucar.edu.



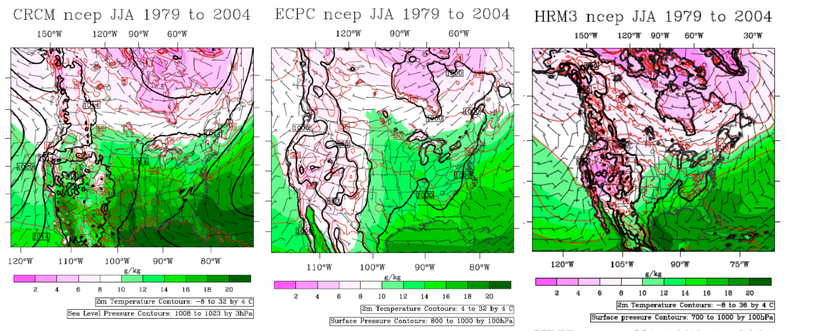
1980-2000 JJA Average Surface Conditions

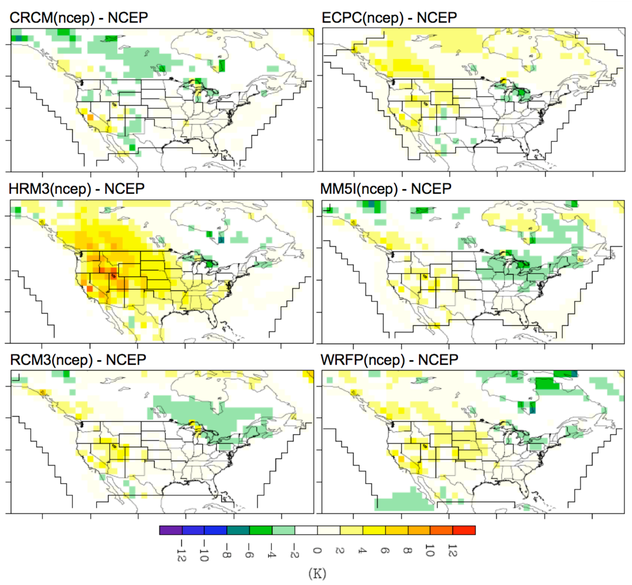
2m Temperature (red lines, deg C)

2m Specific Humidity (color fill, g/kg)

Mean Sea Level Pressure -**OR-** Surface Pressure (black lines, hPa)

10m Winds (barbs, half barb = 5kts, full barb = 10kts)





2m Surface Temperature Difference

1979-2004 JJA Average

Difference between RCM NCEP Reanalysis II driven run and the NCEP Reanalysis II (RCM Driver).

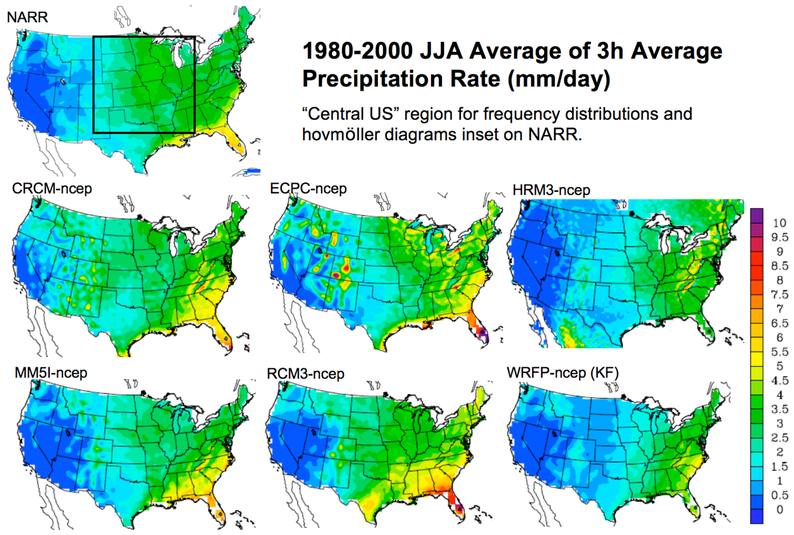
RCM re-gridded to reanalysis resolution.

This analysis gives a basic sense of model bias. Most of the RCMS have a warm bias in the Plains in JJA and during the rest of the year.

Model Descriptions (note: all RCMs have a 50km horizontal resolution)

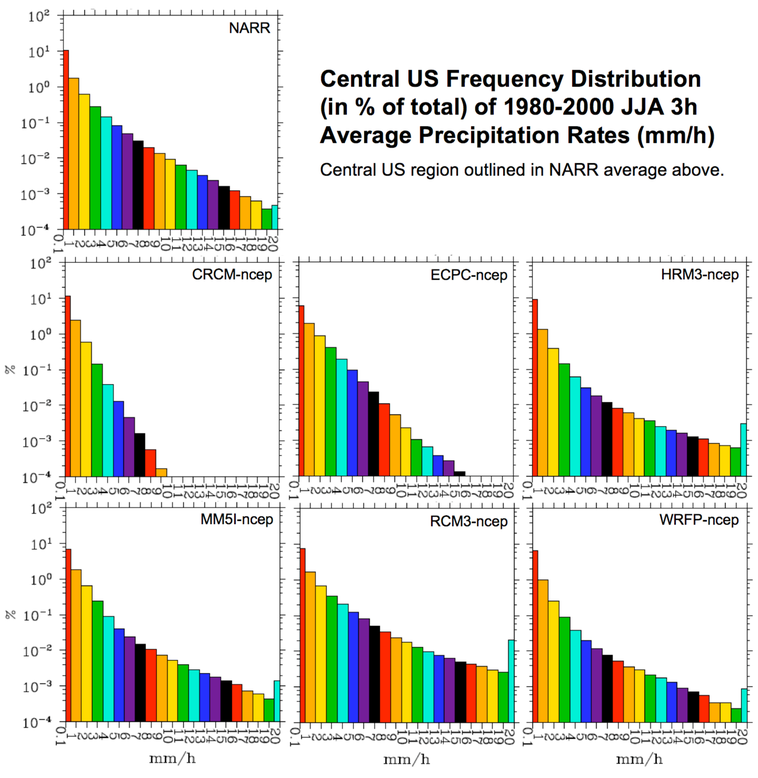
Model	Investigators	Dynamics	Lateral Boundary Treatment	Land Surface	TWL*	Vegetation Types	Boundary Layer	Explicit Moist Physics	Cumulus Parameterization
CRCM	D. Caya S. Biner R. Laprise	Nonhydrostatic, Compressible	9 points (Davies 1976); spectral nudging of horizontal wind.	CLASS	3/3	21 vegetation classes	Local K, gradient Richardson number formulation	Removal of supersaturation	Mass flux
HRM3	R. Jones E. Buonomo W. Moufouma-Okia	Hydrostatic, Incompressible	4 points (Davies and Turner 1977)	MOSES	4/4	53 classes (Wilson and Henderson-Sellers 1985)	First order turbulent mixing	Prognostic cloud liquid and ice; liquid potential temperature	Mass flux, including downdraft
MM5	R. Arritt W. Gutowski E. Takle C. Anderson R. Leung Y. Qian	Nonhydrostatic, Compressible	4 points (linear relaxation)	NOAH	4/4	16 classes from USGS SiB model	Hong-Pan (MRF) countergradient, non-local K	Dudhia simple ice	Kain-Fritsch2 mass flux
RCM3	L. Sloan J. Bell J. Pal	Hydrostatic, Compressible	12 points (exponential relaxation)	BATS	1/3	19 classes	Non-local K, countergradient flux	SUBEX, prognostic cloud water	Grell with Fritsch-Chappell closure
ECPC	J. Roads A. Nunes	Hydrostatic, Incompressible	Perturbations relaxed at boundaries; spectral filter	NOAH	4/4	13 classes	Hong-Pan non-local K	Removal of supersaturation	Simplified Arawaka-Schubert
WRF	R. Leung B. Kuo J. Done	Nonhydrostatic, Compressible	15 grid points (exponential relaxation)	NOAH	4/4	24 classes from USGS	Yonsei Univ. (explicit entrainment)	Prognostic cloud liquid and ice, rain, snow	Kain-Fritsch2 mass flux

*TWL = Thermal / Water Layers



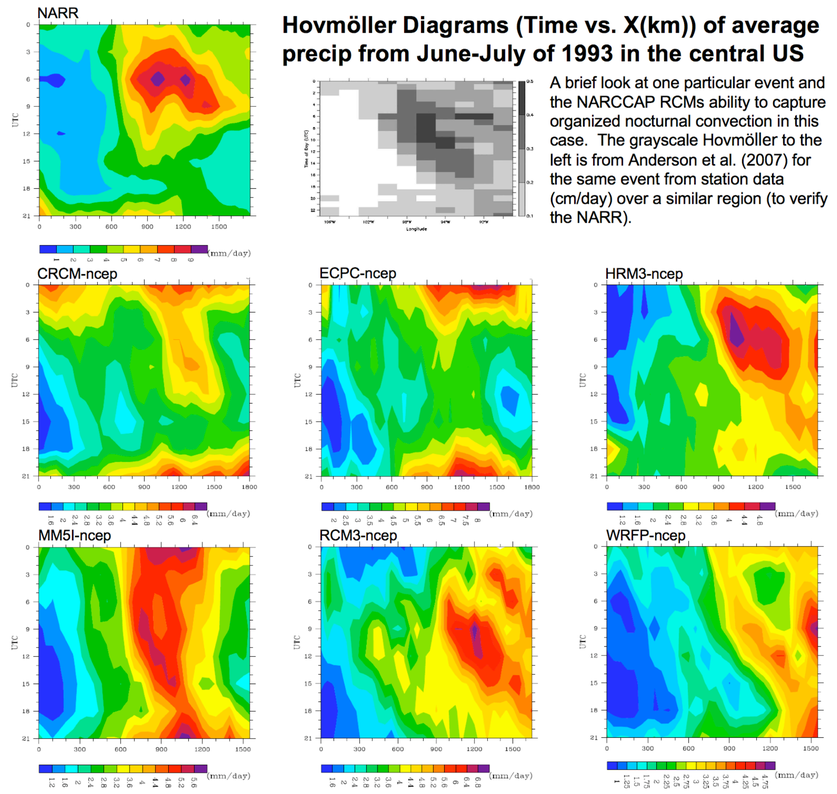
1980-2000 JJA Average of 3h Average Precipitation Rate (mm/day)

"Central US" region for frequency distributions and hovmöller diagrams inset on NARR.



Central US Frequency Distribution (in % of total) of 1980-2000 JJA 3h Average Precipitation Rates (mm/h)

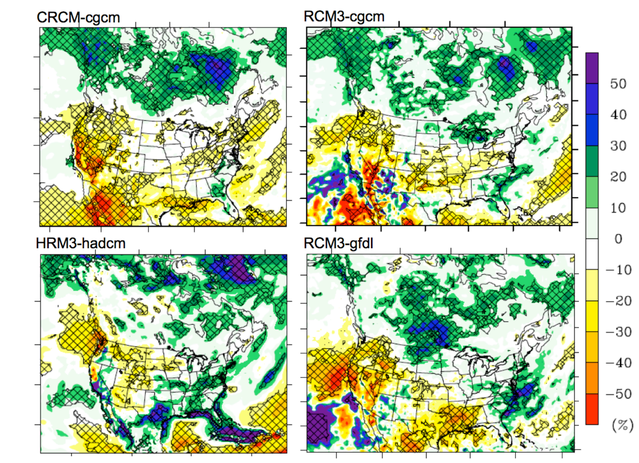
Central US region outlined in NARR average above.



Hovmöller Diagrams (Time vs. X(km)) of average precip from June-July of 1993 in the central US

A brief look at one particular event and the NARCCAP RCMs ability to capture organized nocturnal convection in this case. The grayscale Hovmöller to the left is from Anderson et al. (2007) for the same event from station data (cm/day) over a similar region (to verify the NARR).

Percent Change in Average JJA Precipitation 1971-2000 vs. 2041-2070

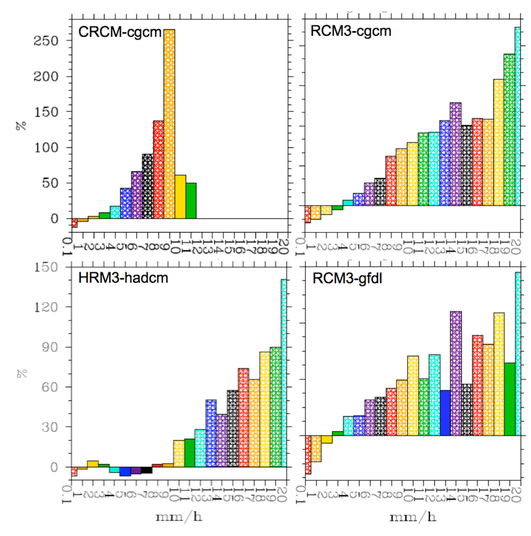


3 Different RCMs driven by 3 different GCMs.

Hatching indicates statistical significance at the 0.1 level (via bootstrapping with bias correction and acceleration) here and below.

Percent Change in Central US Frequency Distribution

1971-2000 vs. 2041-2070



References

Anderson, C.J., R.W. Arritt, and J.S. Kain, 2007. An alternative mass flux profile in the Kain-Fritsch Convective Parameterization and its effects in seasonal precipitation. J. Hydrometeorology, 8, 1128-1140.

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