Towards Establishing NARCCAP Regional Model Credibility Through Process-Based Analysis

Melissa S. Bukovsky and Linda Mearns
NCAR/IMAGe
Anji Seth and Jeanne Thibeault
UCONN

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Introduction

• Examine credibility of an ensemble of RCM simulations and their projections for warm-season precipitation over the Southwest*, Central U.S., and Northeast U.S.

• Establish the differential credibility of the RCM/GCM combinations.

• Extend analysis beyond temperature and precipitation and the use of basic metrics.

  – Establish whether or not the processes responsible for the precipitation are credibly simulated.

• Identify bias in related processes and establish the potential impact of that bias on projections.
North American Regional Climate Change Assessment Program

• 6 RCMs downscaling 4 GCMs (with 12 combinations planned)
  – Future: 2041-2070 (2069)

• RCMs are also being used to dynamically downscale the NCEP/DOE Reanalysis 2
  – 1980-2004

• 50-km horizontal resolution over most of North America

• Plus, 2 global 50-km timeslices (GFDL and CAM).

www.narccap.ucar.edu
Other Datasets

• CMIP3 and CMIP5 AOGCMs

• For comparison:
  – **NARR** (North American Regional Reanalysis), 32-km horizontal resolution.
  – **UDEL** (University of Delaware), $\frac{1}{2}$ degree resolution, gridded observations, for land only.
  – **NAME** (North American Monsoon Experiment), 1 degree resolution, gridded observations from a special observing period during July 2004
  – 20$^{th}$ Century Reanalysis. 2 degree horizontal resolution, 1871-2012.
1980-2004 JJAS Average Precipitation Rate: NCEP-driven
1980-2004 JJAS Average Near-Surface Moisture Flux: NCEP-driven Simulations
1980-2004 5-day Average Precipitation Climatology
NCEP-Driven Simulations
GCM-driven 5-day Average Precipitation Climatology

Current Climate: 1971-1999

Graph showing daily precipitation climatology from 1 January to 31 December for various models including CRCM-cgcm, CRCM-ccsm, HRM3-hadcm3, MM5I-ccsm, RCM3-gfdl, WRFG-ccsm, WRFG-cgcm, HRM3-gfdl, RCM3-cgcm, CCSM-slice, NARR, ECP2-gfdl, and GFDL-slice_current.
5-day Average Precipitation Climatology
5-day Average Precipitation Climatology
5-day or Monthly Average GCM Precipitation Climatology
JJAS NARCCAP 13-Model Ensemble Mean Change

a) 2-m Temperature
b) Precipitation

In b): Vertical color scale indicates model agreement on the sign of change. Hatching indicates where more than 50% of the models show change that is significant at the 0.10 level and where more than 75% of the models agree on the sign of change.
Impact of Bias on Precipitation Change

Left: mean change
Below: change in frequency of 3-hourly precipitation events by percentile.

<table>
<thead>
<tr>
<th>NAM Region</th>
<th>% Change</th>
<th>Absolute Change (mm/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ensemble Average</td>
<td>-15.10</td>
<td>-0.13</td>
</tr>
<tr>
<td>CCSM-driven</td>
<td>-28.20</td>
<td>-0.15</td>
</tr>
<tr>
<td>CGCM-driven</td>
<td>-25.89</td>
<td>-0.22</td>
</tr>
<tr>
<td>GFDL-driven</td>
<td>-4.28</td>
<td>-0.09</td>
</tr>
<tr>
<td>HADCM-driven</td>
<td>-0.05</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Below: change in frequency of 3-hourly precipitation events by percentile.
A Brief Example for the Northeast

Top Left: 1981-2000 to 2051-2070 JJA precipitation change (mm/day) from the HADCM3.

Top Right: 1981-2000 monthly average precipitation for the Northeast (inset box to left).


RCM simulations driven by the HADCM3 may inherit similar errors.
Final Comments

• Work in Progress!
  – More to come on the processes driving changes in the Southwest, model credibility in the Northeast, and the start of the analysis in the Central U.S.

• The ability of the models to capture monsoon system rainfall is heavily determined by driving GCM. Whether or not this applies in the Northeast is still under investigation.
  – Good argument for continued improvement of AOGCMs!

• Projections for precipitation change in the Southwest are influenced by model bias, with the largest negative changes in the simulations with the poorest verifications.