Introduction

This poster displays simulations from the North American Regional Climate Change Assessment Program (NARCCAP) and their ability to reproduce average near-surface conditions from June-September (JJAS) during the North American Monsoon (NAM). This analysis covers major precipitation features, wind and moisture flux fields, the monsoon-related season changes in wind direction, specific humidity, and temperature. Simulations driven by the NCEP-DOE global reanalysis II (NCEP) are the focus of this evaluation. Because the North American Regional Reanalysis (NARR) is used in this model comparison where observations are not available, a comparison of its winds with those observed during the 2004 North American Monsoon Experiment (NAMEX) is also included.

Models & Methods

NARCCAP is producing 50-km horizontal resolution climate simulations over North America by dynamically downscaling 4 different global climate model (GCM) simulations and one reanalysis (NCEP) using 6 different regional climate models (RCMs). All models are shown at their original resolution with their original projections.

Major characteristics of the NARCCAP RCMs:

- **HRM3**
  - **Surfactant time step**: 2.5 s
  - **Surfactant relaxation timescale**: 25.64 s
  - **Temperature**: 23.6°C
  - **Humidity**: 35.18% RH

- **CRCM**
  - **Surfactant time step**: 2.5 s
  - **Surfactant relaxation timescale**: 43.8 s
  - **Temperature**: 24.61°C
  - **Humidity**: 35.18% RH

- **RCM3**
  - **Surfactant time step**: 2.5 s
  - **Surfactant relaxation timescale**: 43.8 s
  - **Temperature**: 24.61°C
  - **Humidity**: 35.18% RH

- **ECP2**
  - **Surfactant time step**: 2.5 s
  - **Surfactant relaxation timescale**: 43.8 s
  - **Temperature**: 24.61°C
  - **Humidity**: 35.18% RH

- **WRFG**
  - **Surfactant time step**: 2.5 s
  - **Surfactant relaxation timescale**: 43.8 s
  - **Temperature**: 24.61°C
  - **Humidity**: 35.18% RH

Observation based datasets and reanalyses:

- **NARR**: North American Regional Reanalysis. 32-km horizontal resolution, 45 layers.
- **UDEL**: University of Delaware air temperature and precipitation analysis, 1/6° resolution, global. (http://www.esrl.noaa.gov/psd/)
- **NAME**: CSU/NAME upper-air and surface gridded analyses version 3.1c. 1° resolution, analysis of data collected during NAME. Uses NARR reanalysis data over data-sparse oceanic regions, but not the Gulf of California. http://tomasco.atmos.colostate.edu/names/products/gridded/index.html

North American Monsoon Highlights

Onshore moisture flow develops during the monsoon season due to a shift in the subtropical high and the development of a thermal low over lowland desert areas. Flux of onshore moisture feeds precipitation along the Mogollon Rim and Sierra Madre Occidental in Mexico. Both are simulated in all of the RCMs, but with errors in magnitude and spatial coverage in most of the models. Precipitation in the CRCM is noisy, several models have a dry bias in AZ, and the RCM3 and ECP2 have high biases along the Sierra Madres compared to UDEL precipitation. Precipitation is dependent on many other processes, so it is important to examine other driving fields in order to gain a better understanding of the models and their simulations of precipitation.

1980-2004 JJAS Average Precipitation Rate

Pretipitation should be present along the Mogollon Rim in AZ and the Sierra Madre Occidental in Mexico. Both are simulated in all of the RCMs, but with errors in magnitude and spatial coverage in most of the models. Precipitation in the CRCM is noisy, several models have a dry bias in AZ, and the RCM3 and ECP2 have high biases along the Sierra Madres compared to UDEL precipitation. Precipitation is dependent on many other processes, so it is important to examine other driving fields in order to gain a better understanding of the models and their simulations of precipitation.

1980-2004 JJAS Average Specific Humidity

All RCMs perform reasonably, except the CRCM. The cause of its unusual high bias in 2-m specific humidity in this area is still unknown.

1980-2004 JJAS Average Moisture Flux

Performance in simulating moisture flux mirrors that of the wind field. Note that the NARR moisture flux is likely too high over the northern part of the Gulf into AZ, as the wind field is too strong here. The magnitude of the CRCM moisture flux appears reasonable, but with inherent error because of the specific humidity bias.

Discussion

When determining the credibility of a model’s simulation, more should be taken into account than just its average precipitation and temperature. While the NARCCAP simulations shown here perform well, for the most part, with these 2 measures, most of them have problems with other fields that indicate how well they are simulating the processes behind the NAM system precipitation. The HRM3 has a warm bias over the Sonoran Desert, which could strengthen its onshore flow and moisturize flux into AZ. The CRCM has an obvious bias in specific humidity in this region. The MM5I and ECP2 do not properly simulate the average monsoon flow in the northern Gulf of California into AZ. The RCM3 has the same problem, but not to the same extent. The only model with no substantial bias in these fields is the WRFG.

This is not to say that this model will not have strong biases in variables/processes in other regions (i.e. do not assume you could get by using just this model for your analysis). This results also do not indicate how any of the models will perform when forced with any of the 4 GCMs being used in NARCCAP. Similarly, they do not yet indicate that any one NARCCAP model simulation of future climate in this region is more credible than another. A process-based analysis of the GCM-driven simulations of current climate and an analysis of the processes driving their projections of future climate will need to be completed first.