NARCCAP Applications at the Columbia University Center for Climate Systems Research

Southeast Agriculture and Northeast Urban Impacts

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CENTER FOR CLIMATE SYSTEMS RESEARCH
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Introduction

At the Columbia University Center for Climate Systems Research (CCSR), we work closely with the Climate Impacts Group, headed by Dr. Cynthia Rosenzweig at the NASA Goddard Institute for Space Studies, to study the impacts that climate variability and climate change have on human societies. We use global and regional climate models, statistically downscaled products, weather generators and observations to help assess the potential impacts of changes in mean climate, as well as climate variability for stakeholder interests at the regional, national and international level. We also work directly with stakeholders to improve the material we generate and provide guidance on vulnerability assessments and potential adaptation measures. Two of our primary areas of research involve the impacts on agriculture (AgMIP) and the impacts on urban populations and infrastructure (CCRUN).

Consortium on Climate Risk in the Urban Northeast

The Consortium on Climate Risk in the Urban Northeast (CCRUN), part of the NOAA Regional Integrated Sciences and Assessments (RISA) program, focuses on the northeast urban corridor, encompassing the cities of Boston, New York and Philadelphia. Headed by the Climate Impacts Group at NASA Goddard Institute for Space Studies in New York City, it partners with researchers based across the northeast including the University of Massachusetts, Columbia University, the City College of the City University of New York, the Stevens Institute of Technology, and Drexel University. Research focuses on three main areas (water, coastal zones, and health) and seeks to assess impacts and vulnerabilities in these areas, as well as put forth potential solutions and adaptation strategies to reduce future risk.

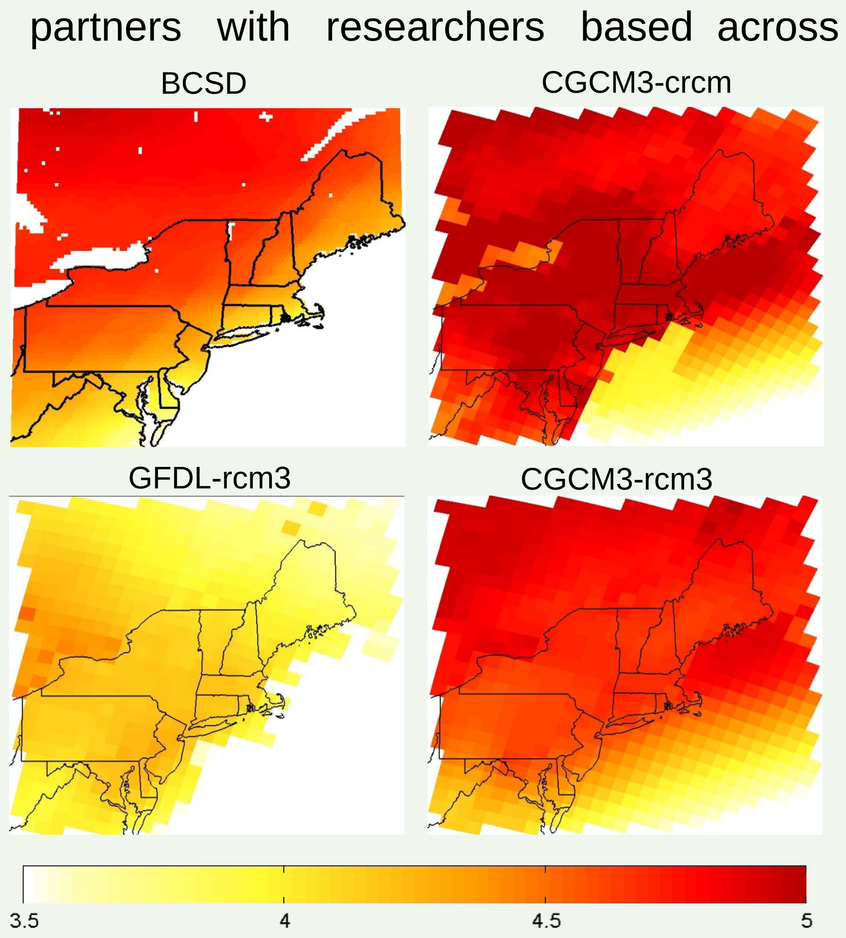

Figure 1
Mean annual temperature changes (°F), 2050s minus 1980s.

In creating climate projections, we use several different approaches including a delta method consisting of a 16 global climate model (GCM) ensemble with 3 SRES scenarios (A2, B1 and A1B), a Bias-Corrected Spatially Disaggregation (BCSD) product (BCSD; Maurer, et al. 2007, based on Wood et al. 2002, 2004, and Maurer 2007), as well as NARCCAP (Figure 1). In addition to studying mean changes, we have also looked to NARCCAP for changes in future interannual and intraannual variability for both temperature (Figure 2) and precipitation.

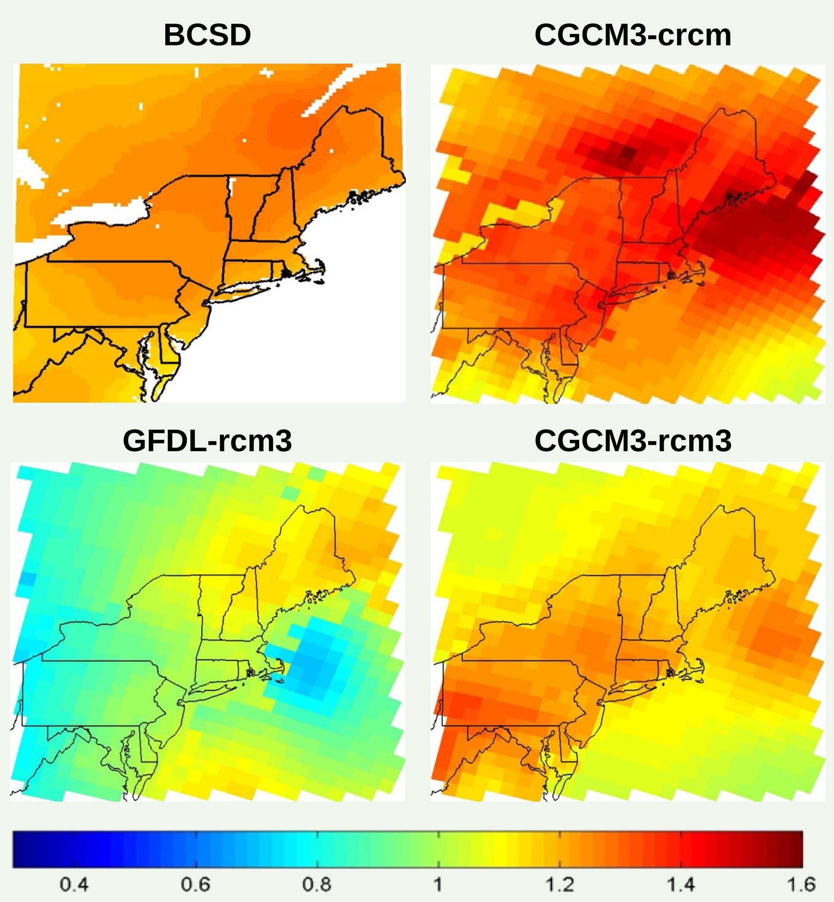

Figure 2
Change in standard deviation of annual temperature, 2050s divided by 1980s.

While large scale climate projections may be useful at the national and regional scales, urban planners and managers require projections on much smaller spatial scales and are concerned with certain climate thresholds that are particularly relevant to urban areas such as the number of days below 32°F (transportation sector), the number of days above 90°F (energy and health sectors), and the number of intense precipitation events (e.g., more than ½ inch of rainfall per day (Figure 3); water management sector). Utilizing NARCCAP model output, we are able to use the ensemble of regional climate models (RCMs) to help quantify the uncertainty in future rainfall variability.

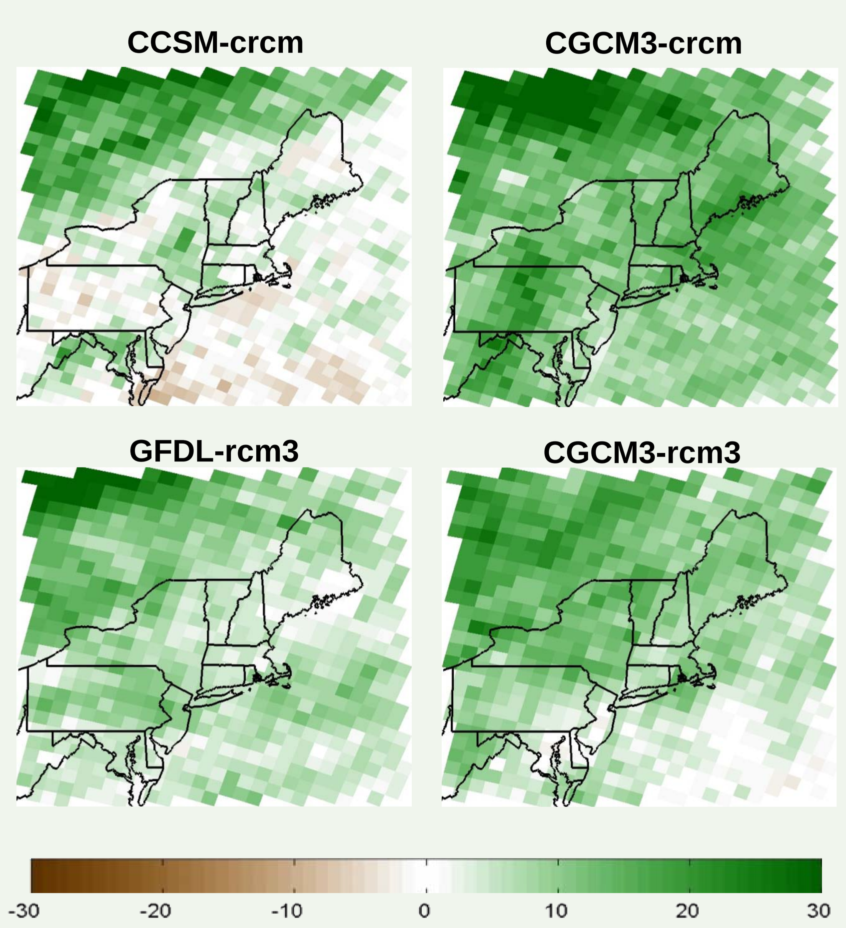

Figure 3
Percent change in number of days with greater than ½ inch of rainfall, 2050s divided by 1980s.

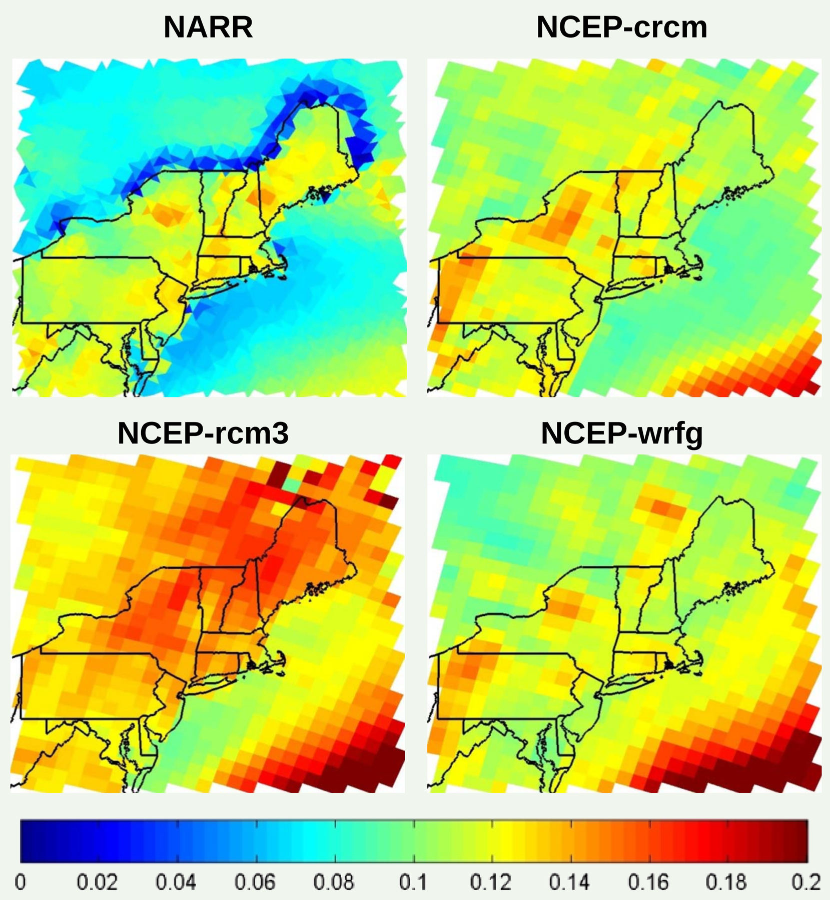

Figure 4
Mean annual precipitation (inches per day), 1990 – 1999,

We have also compared the NARCCAP outputs with direct observations from weather stations (for single grid box analyses; e.g., New York City) as well as with gridded reanalysis such as the North American Regional Reanalysis (NARR) to help ground our research to reality (Figure 4). In addition to comparing results with observations and gridded reanalysis, we also compare the NCEP driven RCM runs to the hindcast runs of the GCM driven RCMs to help quantify model biases (not shown).

As we move forward in our work, we are looking to analyze daily distributions of temperature and precipitation, and to look at three dimensional dynamic processes. Additionally , we also hope to explore the idea of interpolating NARCCAP RCMs to a common grid for comparisons.

Agricultural Model Intercomparison and Improvement Project

The Agricultural Model Intercomparison and Improvement Project (AgMIP; Rosenzweig et al 2012) is an international effort to assess the impacts of future changes in climate on agriculture, including economic and trade implications, and uncertainty estimates. To achieve this, we will generate a myriad of future climate change scenarios with which to force crop and economic models, which we will use to analyze uncertainty in climate information across space, time, GCMs, RCMs, emission scenarios, and methodological choices. NARCCAP is primarily being used to generate variability changes for AgMIP studies within the United States.

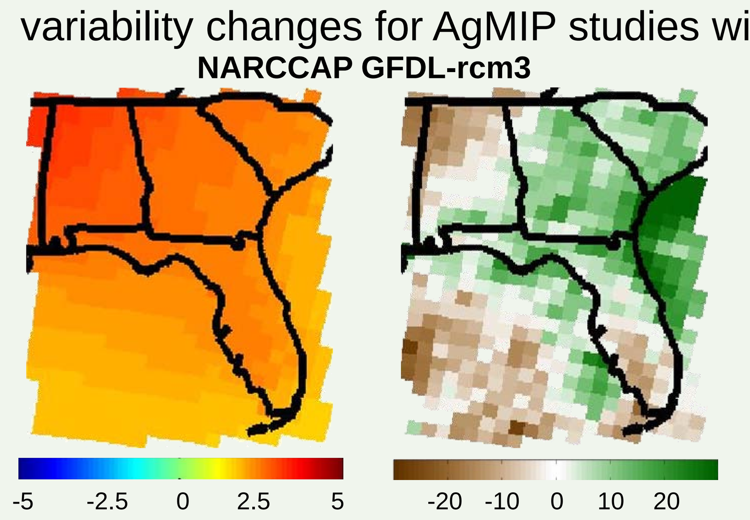

Figure 4
Mean change in temperature in degrees Celsius (left), and percentage change in mean rainfall (right), 2050s – 1980s.

As a pilot for AgMIP, we are using NARCCAP to analyze agricultural responses in the Southeast US. Here, the effects of changing climate variability and extreme events are being analyzed using NARCCAP output. In this limited pilot sample, changes are more consistent when using the same RCM (Figure 6; columns 1 and 3) than when using the same driving GCM (Figure 6; columns 2 and 3), underscoring the need for an ensemble approach utilizing multiple RCMs.

Though all RCMs have biases, we are attempting to gain a better understanding of how these biases interact and amplify biases found in GCMs. As AgMIP moves forward, the ensemble of NARCCAP RCMs will provide variability changes for studies across North America and ultimately help us place uncertainty into context for the overarching impacts assessment process. Working with NARCCAP is helping us prepare for global applications with CORDEX (Giorgi et al. 2009).

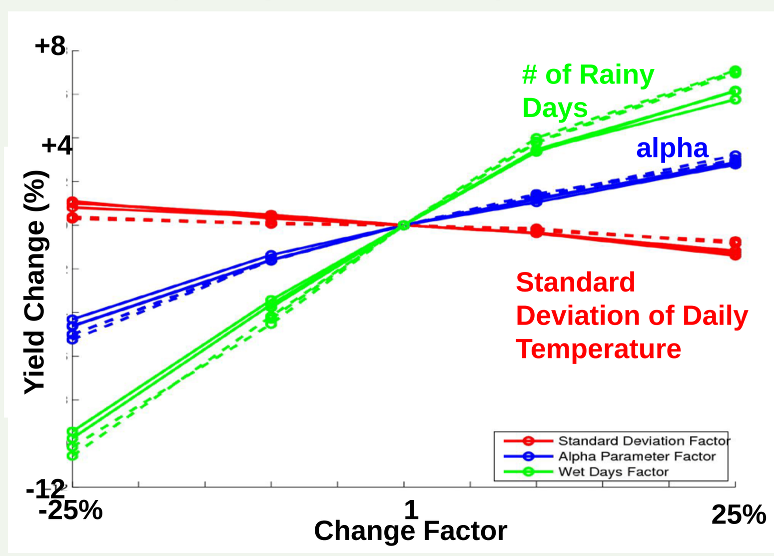

Figure 5
Sensitivity of Simulated Corn Yield in the Southeast US to Variability Change Factors; variability changes only (dashed lines), variability and mean T, p, and CO_2 changes (solid line).

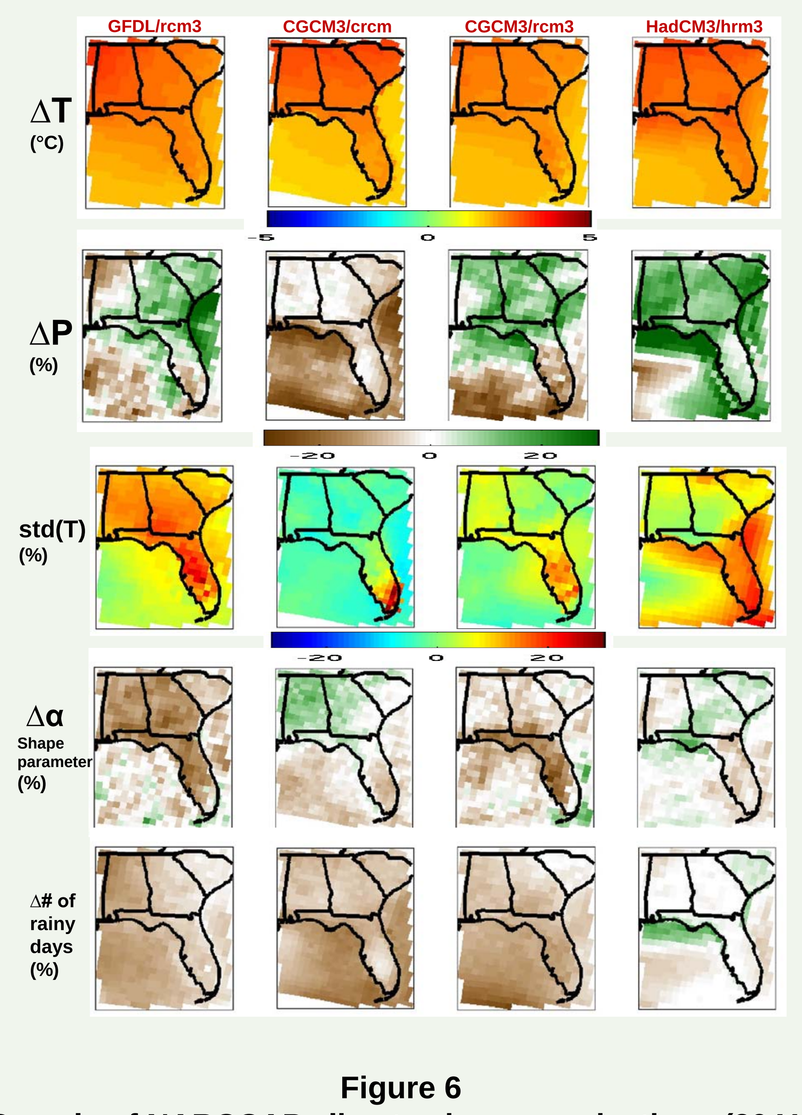

Figure 6
Sample of NARCCAP climate change projections (2041-2070 vs. 1971-2000). std(T) = Standard deviation of temperature

References

Mearns, L.O., et al., 2007, updated 2011. The North American Regional Climate Change Assessment Program dataset, National Center for Atmospheric Research Earth System Grid data portal, Boulder, CO. Data downloaded [February 2011].

Rosenzweig, C, et al., 2012. The Agricultural Model Intercomparison and Improvement Project (AgMIP): Protocols and Pilot Studies. *Ag. For. Meteor.*

Giorgi, F., Jones, C., Asrar, G., 2009. Addressing climate information needs at the regional level: the CORDEX framework. WMO Bulletin. 58(3), 175-183.

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