Integration of NASA Models and Missions into Agricultural Decision Support

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Center for Climate Systems Research

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Key Questions in Agricultural Climate Change Impacts and Decision Support

- How can we understand how crops will respond to climates that have not been observed?
- What types of changes are most detrimental to different farm systems?
- How certain are projections of these future changes?

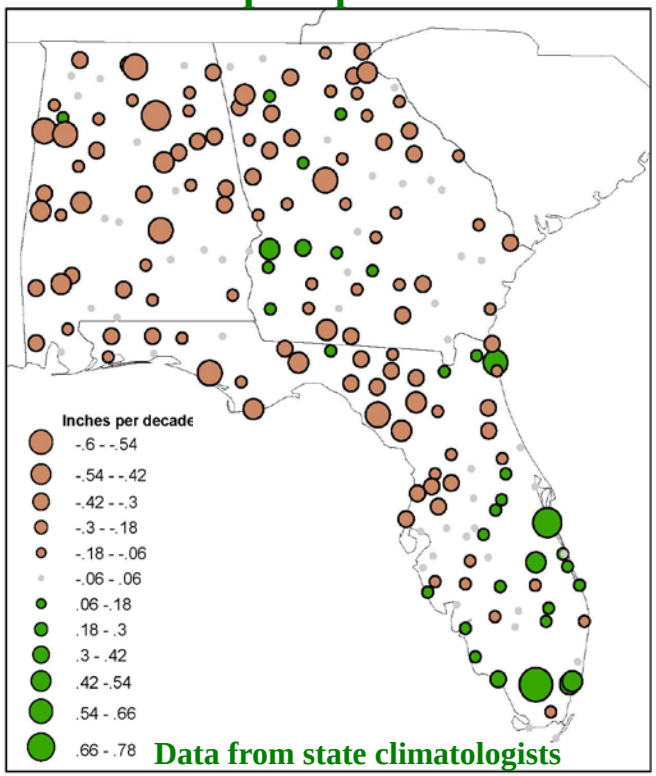
Project Objectives

- Incorporate NASA observational products and climate models into tools for agricultural decision support.
- Link climate information and crop models to conduct a probabilistic assessment of climate vulnerability in the agricultural sector.
- Provide climate scenarios incorporating projected changes in mean climate, interannual variability, and extreme characteristics that allow for adaptation testing and prioritization.

Project Scope

- **Southeastern United States**: partnering with the Southeast Climate Consortium (SECC) and Agroclimate.org
- Central America; partnering with the Regional Center for Hydrologic Resources (CRRH) in Costa Rica and NASA SERVIR's Mesoamerica hub

1970-2000 precipitation trends



Data from state climatologists

http://www.agroclimate.org

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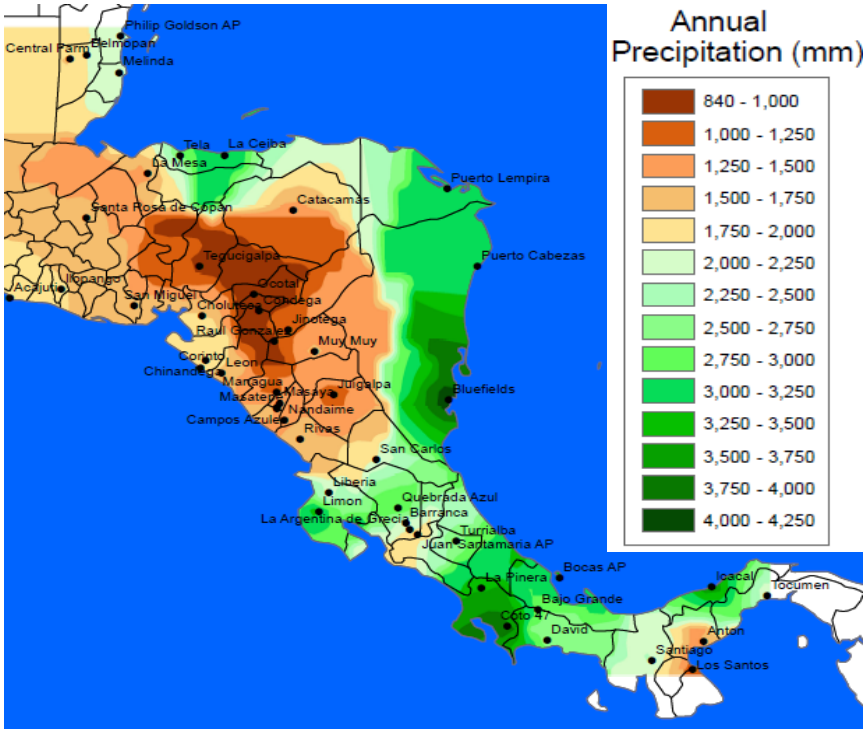
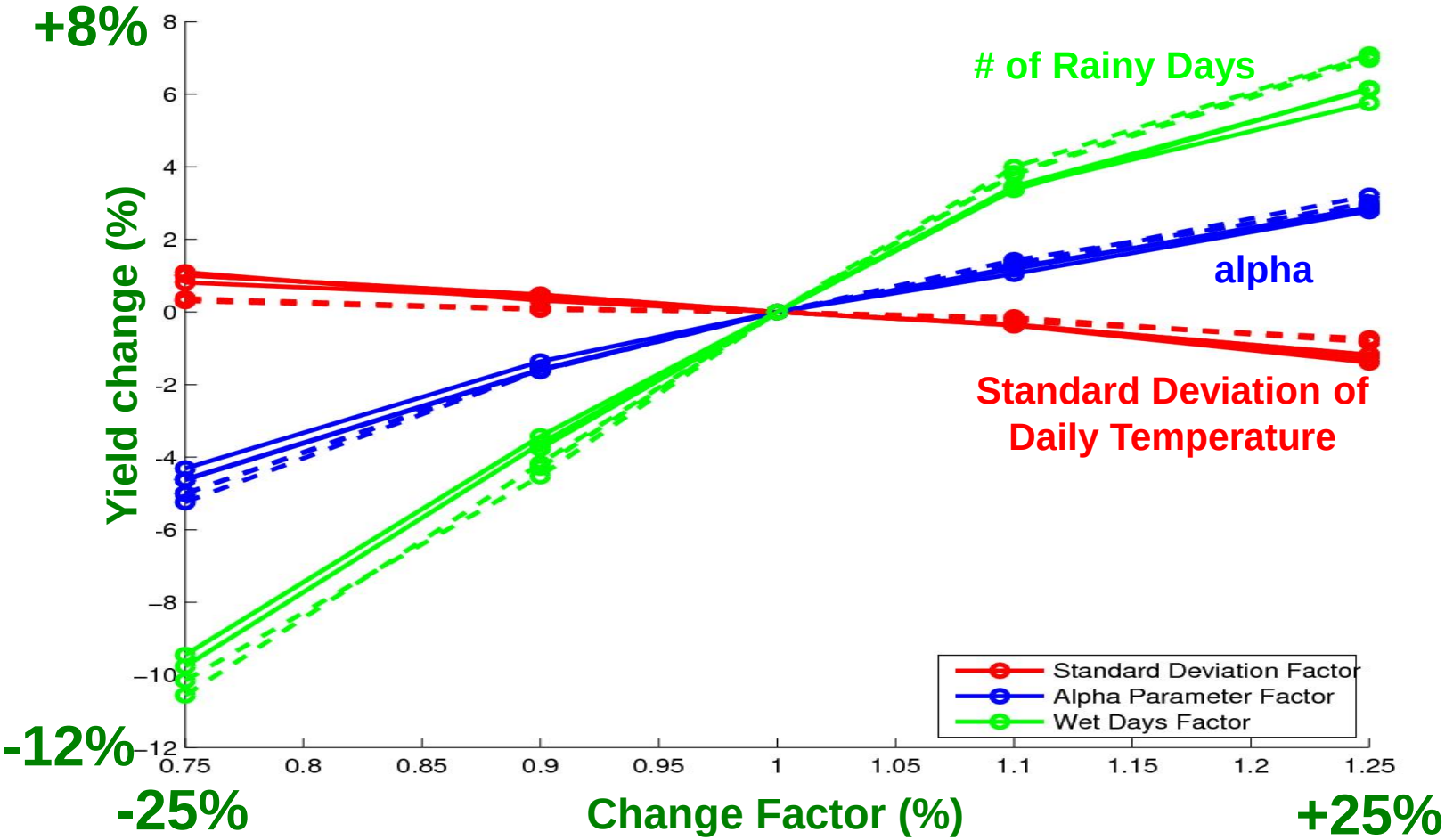
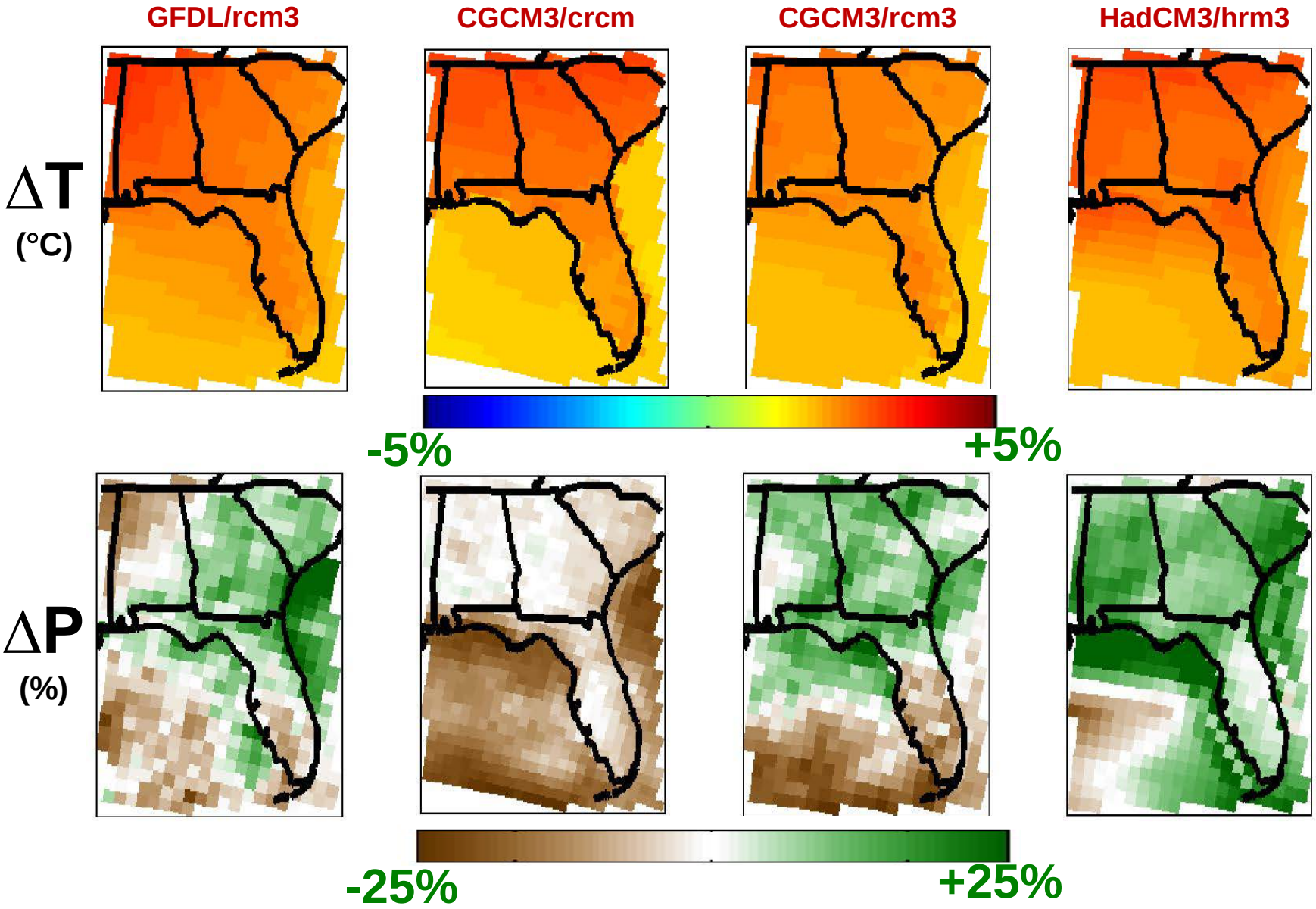


www.servir.net

Sensitivity of Southeastern US Corn to Variability Change Factors



Uncertainty in Downscaled Climate Scenarios: NARCCAP A2 2050s-1980s



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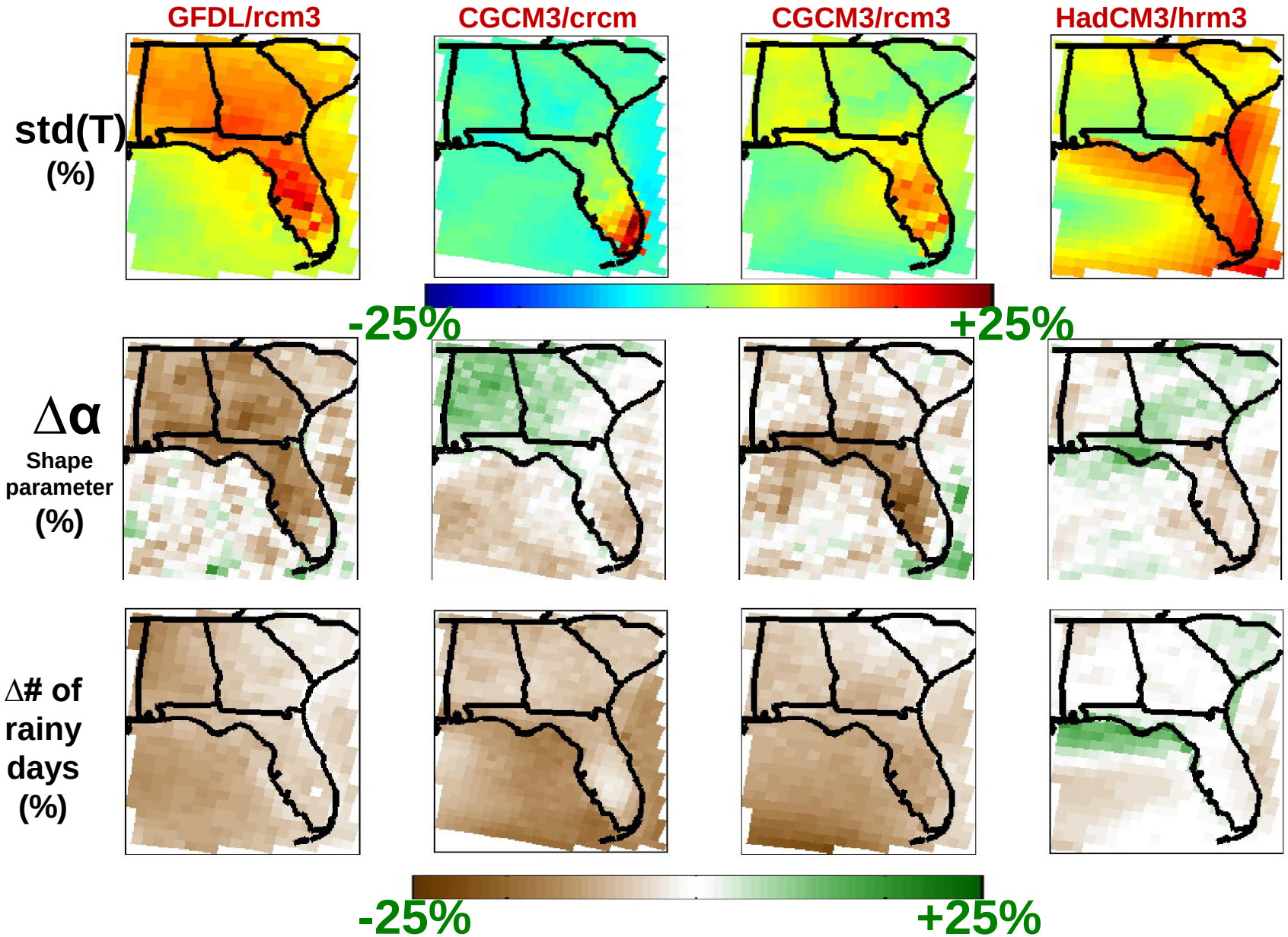
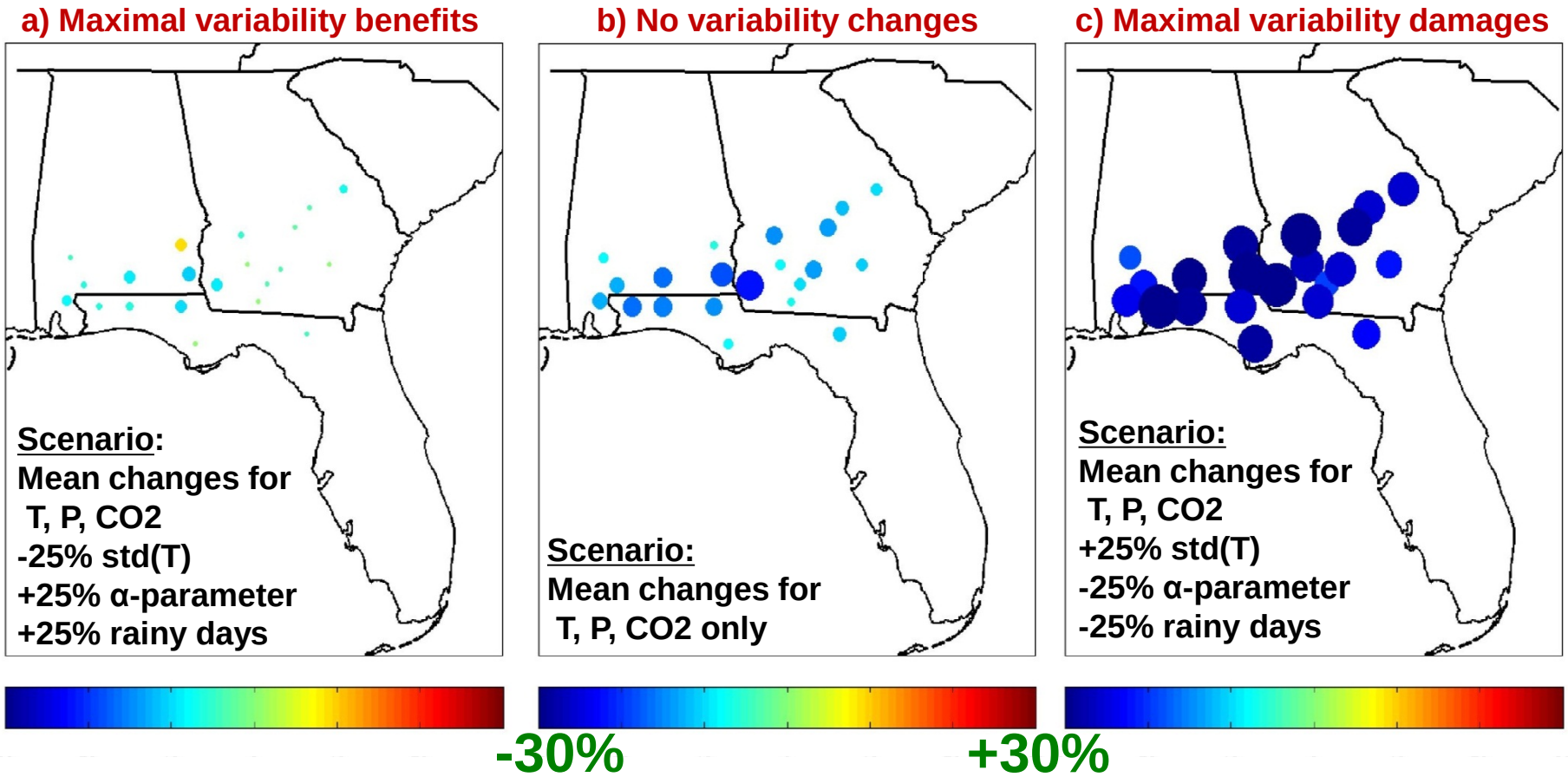
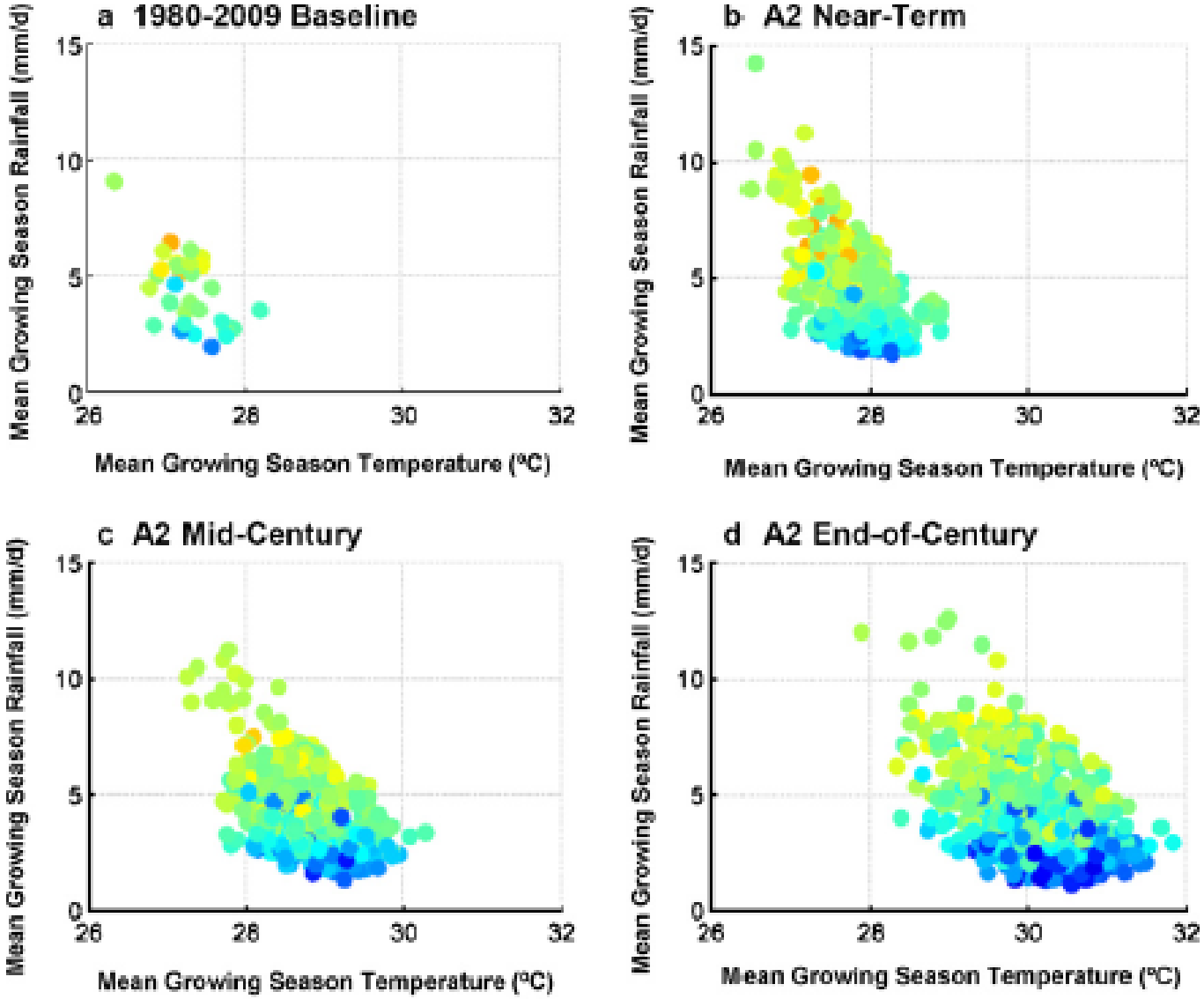


Variability Impacts Can be Substantial



Mean percentage changes (A2 2050s vs. 1980s baseline) in corn yield a) when variability adjustments maximize yield; b) with no variability adjustments; and c) when variability adjustments minimize yield. Note that only the mean shifts from the GFDL 2.1, CGCM3, and HadCM3 GCM were examined.

Baseline and Future Analysis of Growing Climate Uncertainty via Agricultural Impacts

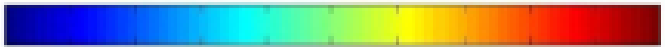


Maize Simulations in Los Santos, Panama

Each dot represents a particular season

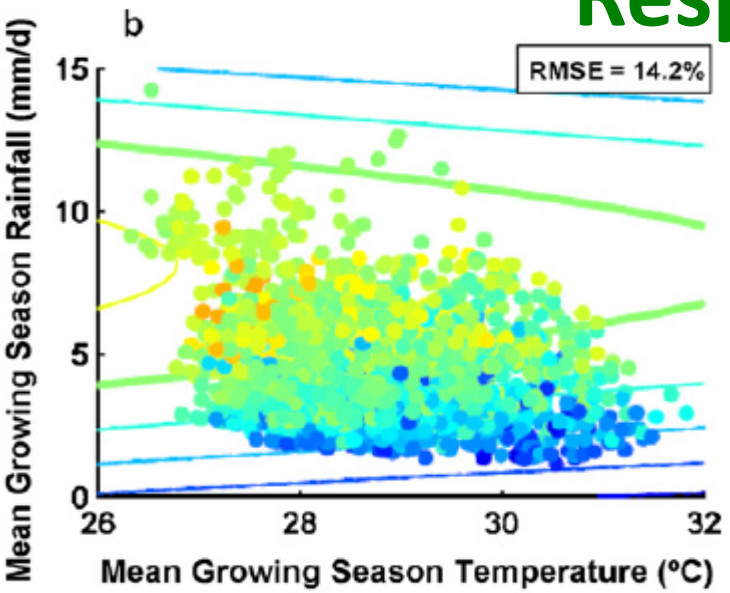
Spread shows climate uncertainty across CMIP3

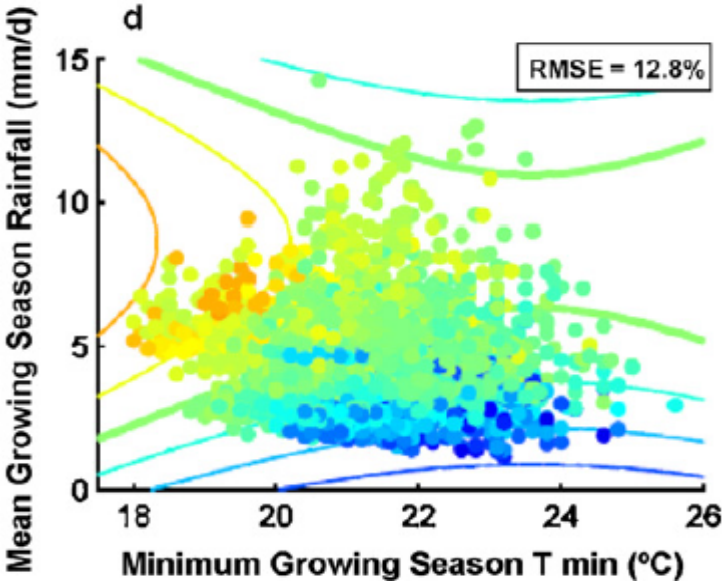
Color shows change in crop yields (compared to baseline)

-100%  **+100%**

Ruane et al., 2011

Climate Sensitivity Scenarios Impacts Response Surfaces





Crop model simulations can help identify critical sensitivities to address with adaptation

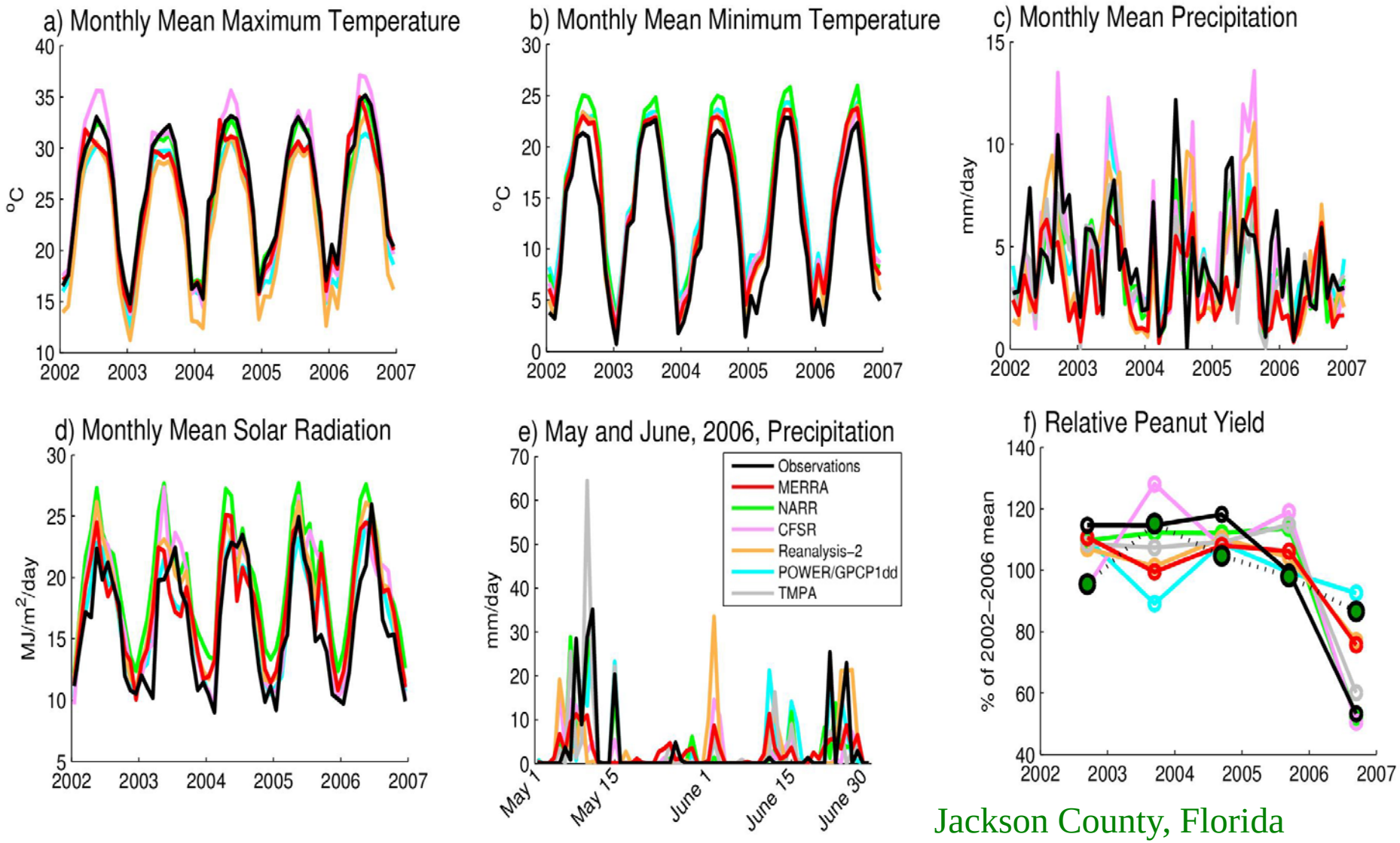
- Crop model simulations in Los Santos respond particularly to:
  - growing season rainfall
  - minimum temperatures in December (correlated with weather pattern associated with particularly bad end-of-season drought)

- Sensitivity of agriculture can be compared to uncertainty of climate projections

-100% Yield (% of baseline mean) **+100%**

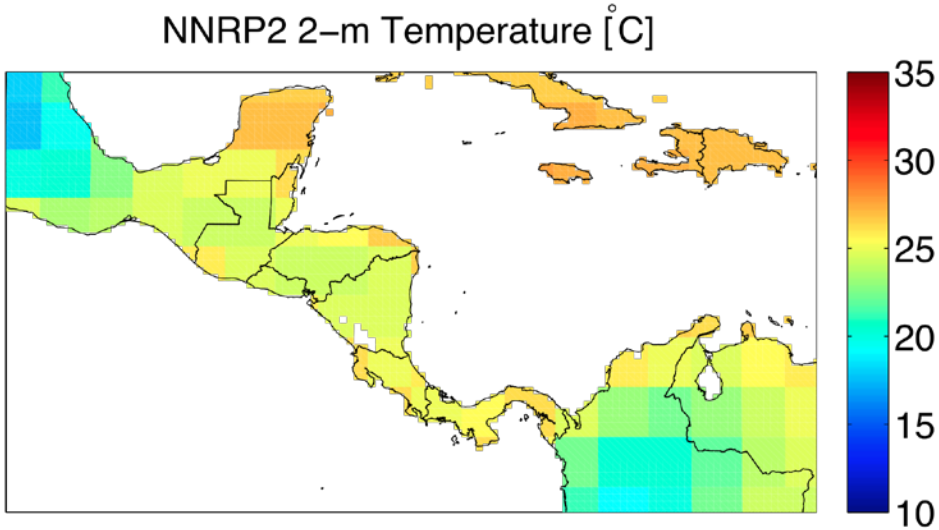
Ruane et al., 2011

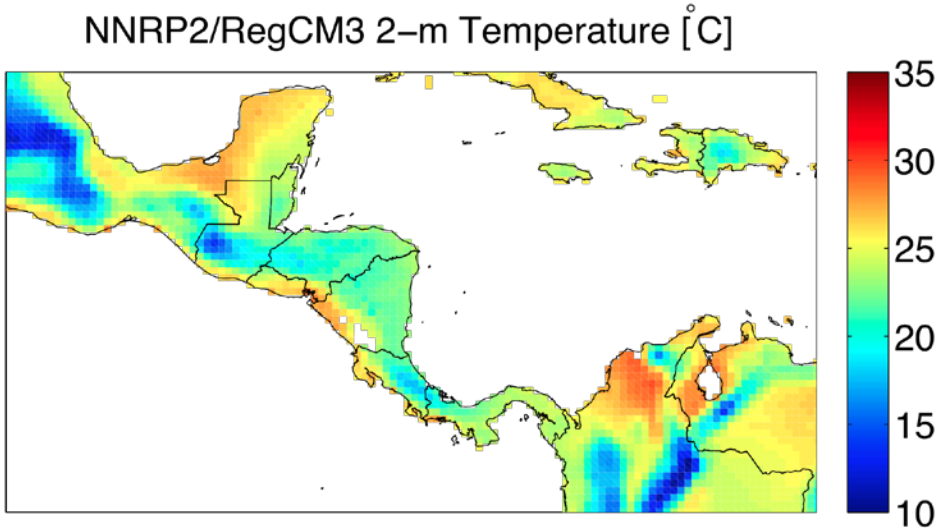
Diverse Climate Datasets Pick Up Different Features

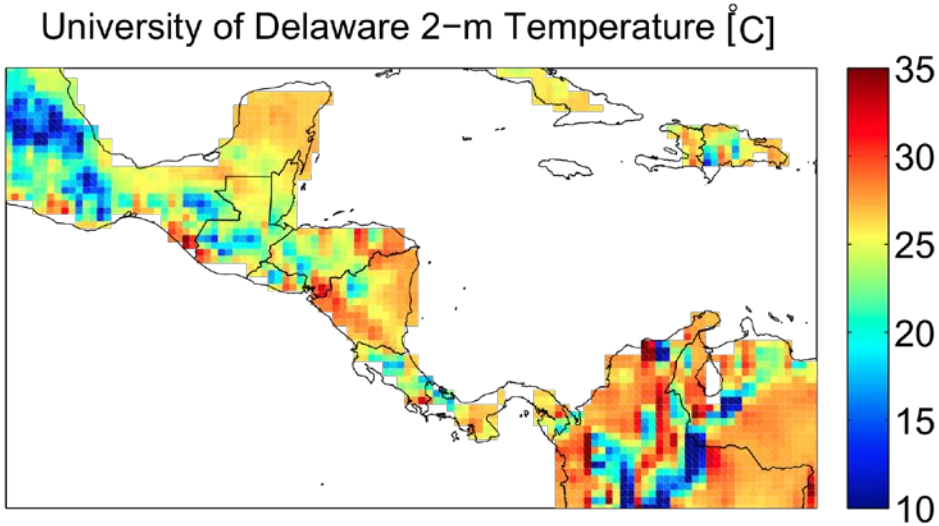


Jackson County, Florida

More Accurate Representation of Local Climate in RCM



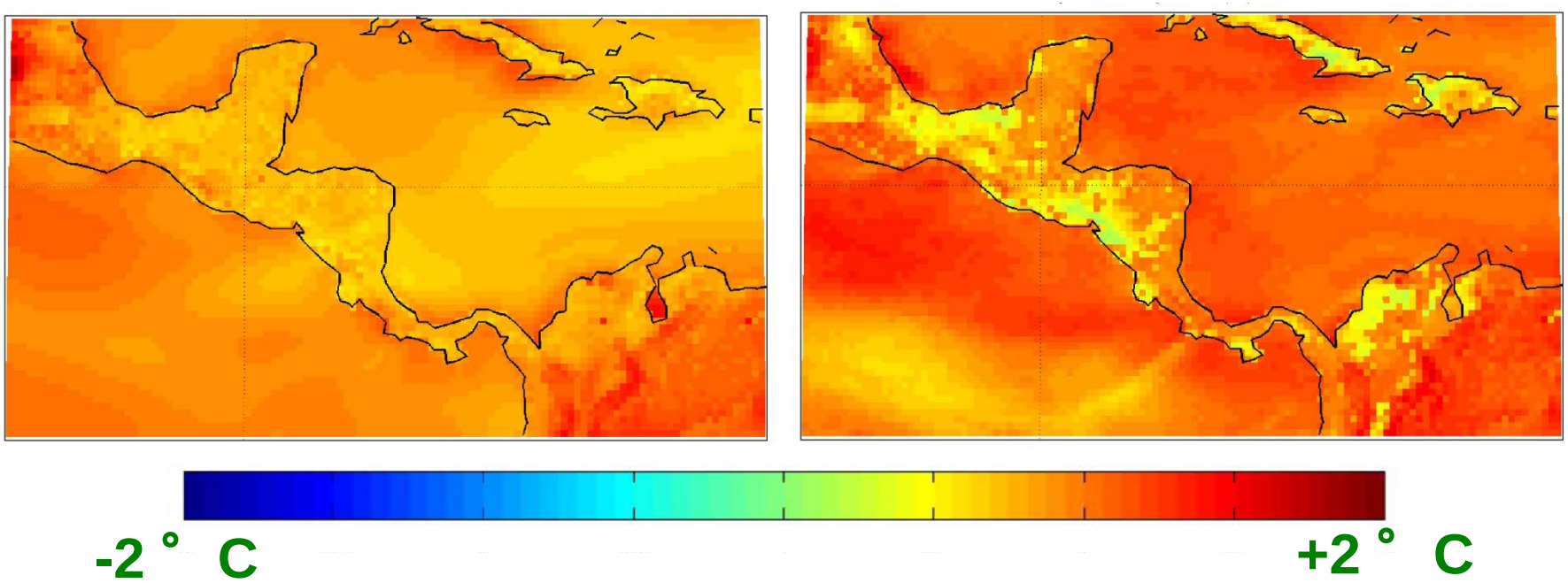




Comparison of 1980-2010 mean annual temperature from NCEP/DOE Reanalysis-2 at its native resolution (~200 km) and downscaled by the RegCM3 regional climate model (30 km).

The downscaled outputs do a superior job of capturing climates around the complex coastlines and topography of Central America, as seen in a comparison to the University of Delaware observational product.

Extreme Temperatures Shift More than Mean Temperatures



Change in 99th percentile temperatures vs. mean change (CCSM/WRF simulations)

Key Findings and Plans

- **Lessons Learned**
  - Magnitude of climate variability change impacts (particularly the number of rainy days) on Southeastern corn are similar in magnitude to mean climate changes
  - Among climate factors, the large interannual variations in Panamanian rainfall continue to be the most dominant factor in maize yield into the coming decades.
  - The sensitivity of baseline yields to farm-level characteristics and management options (planting date, fallow period length, soils, the maize cultivar, and fertilizers) is greater than the sensitivity to projected climate changes.
- **Impacts**
  - Demonstrated utility of NASA climate products and regional climate models (including NARCCAP results) for agricultural impacts assessment.
  - Provided cutting-edge evaluation of uncertainties in climate, soils, and farm-level management factors.
- **Upcoming Plans**
  - One-year NCE to complete GISS ModelE simulations and further RCM experiments, provide projections of climate metrics to SECC for agricultural planning in the Southeastern U.S. (e.g., chill hours, infection indices, growing degree days) and Central America via SERVIR, analyze statistics for CMIP3 and CMIP5 GCMs, assess agricultural impacts driven by data from multiple observational products and CMIP5 climate models outputs, and link to AgMIP

The Agricultural Model Intercomparison and Improvement Project (AgMIP)

Cynthia Rosenzweig[1], Jim Jones[2], Jerry Hatfield[3]

and the International AgMIP Community

[1]NASA GISS, [2]University of Florida, [3]USDA-Ames

AgMIP The Agricultural Model Intercomparison and Improvement Project

USDA

UKaid from the Department for International Development

NASA

AgMIP International Workshops

1st Global

Wheat

Rice

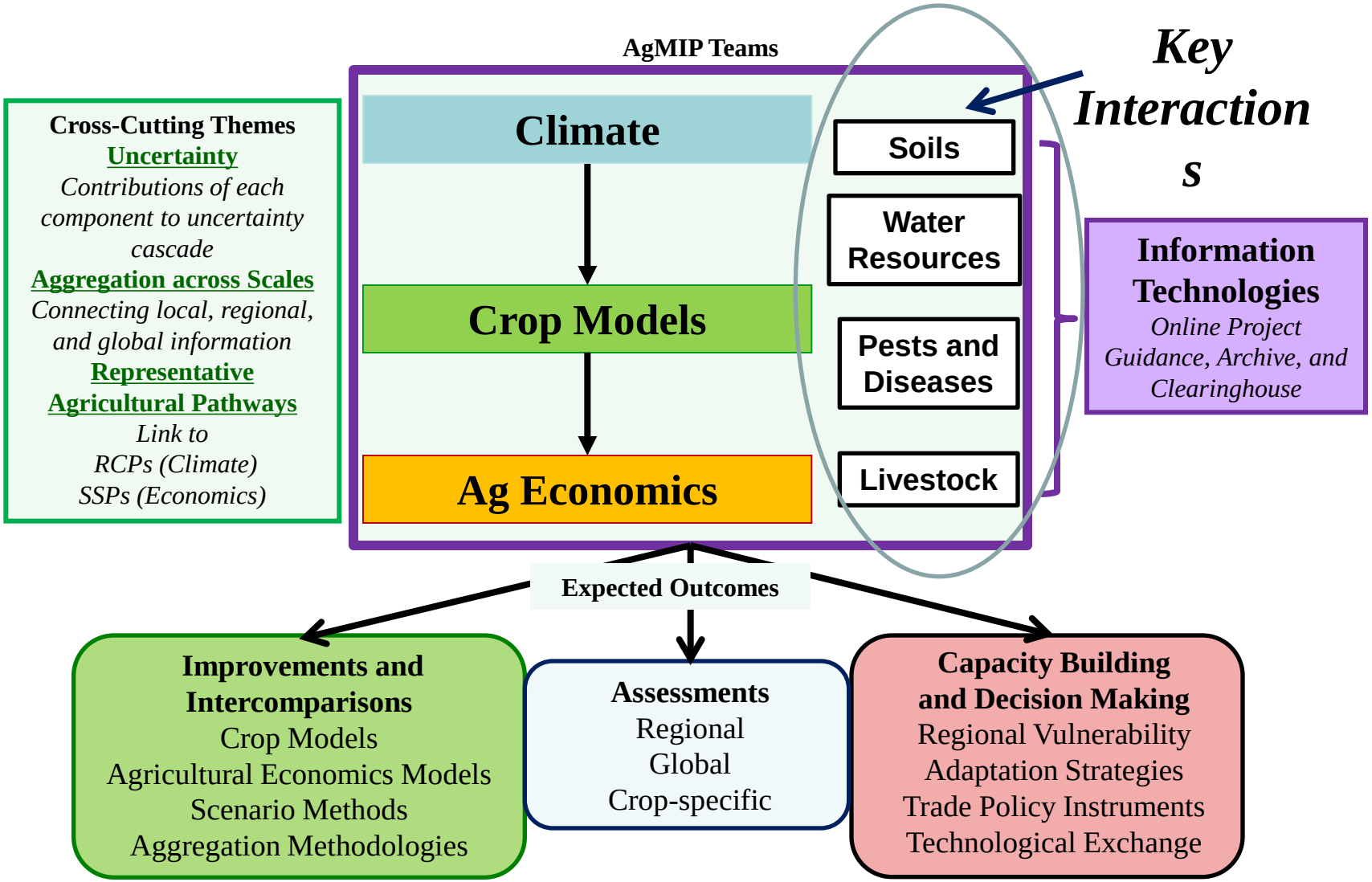
2nd Global

South America

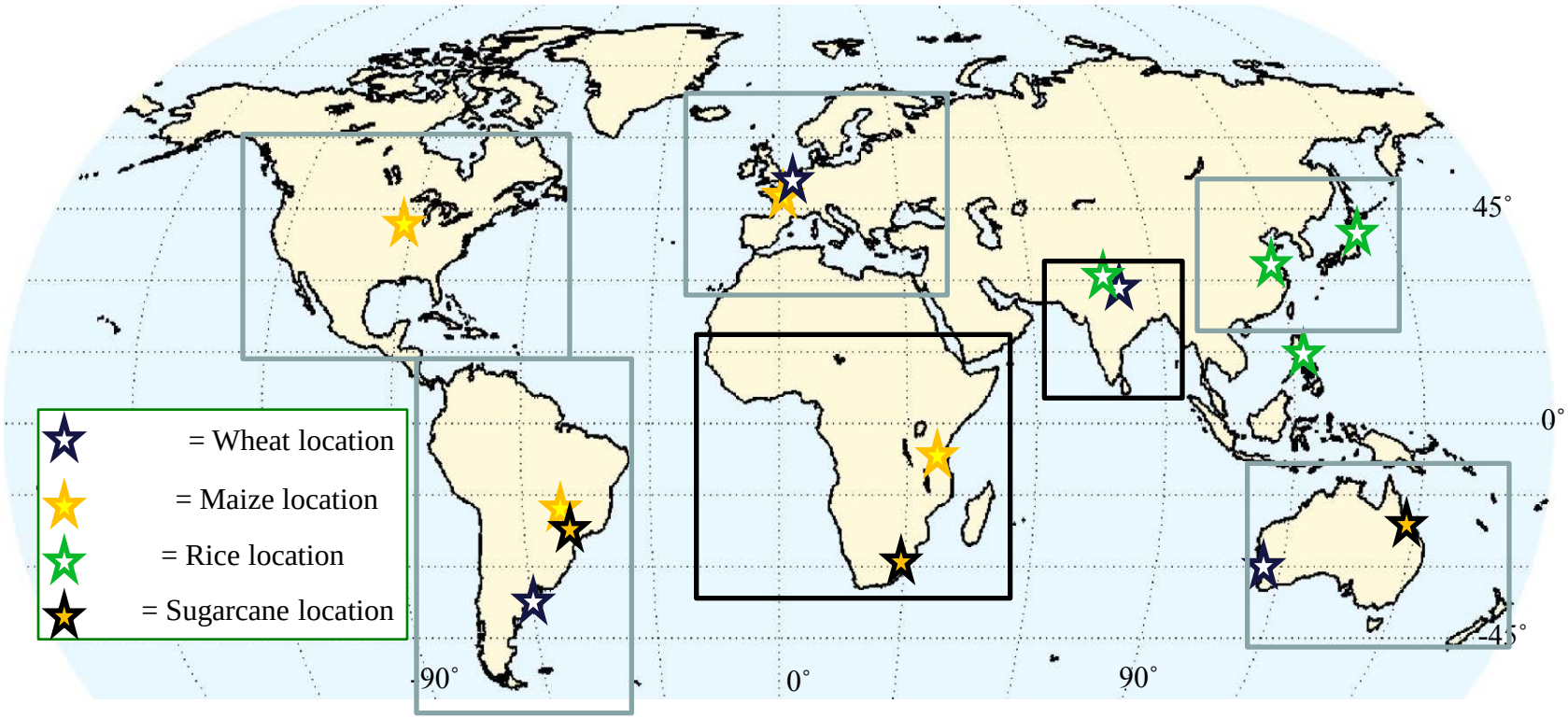
Sub-Saharan Africa

South Asia

AgMIP Teams, Linkages, and Outcomes



AgMIP Regions and Crop Model Intercomparison Pilot Studies



- Wheat (27 models), Maize (~20), and Rice Model (~15) Pilots underway
- Pilots under development for sugarcane, millet/sorghum, soybean, groundnut, potato, and livestock

AgMIP The Agricultural Model Intercomparison and Improvement Project

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For Protocols, up-to-date events, and news, visit

www.agmip.org

Contacts

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