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A High-Resolution (10-km) Downscaled Regional Climate from NASA GISS AO Model for the Southeastern United States

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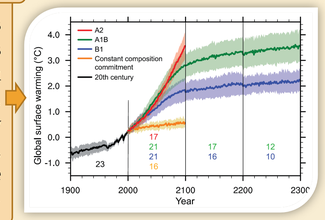
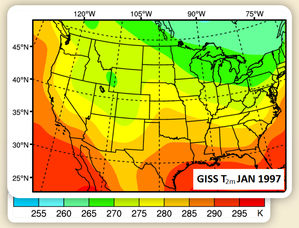
Introduction

IPCC modeling groups have generated projections of future climates with a warming trend in the future. However, they are at very coarse spatial resolution, for example, 3°×4° for the NASA GISS AO model.



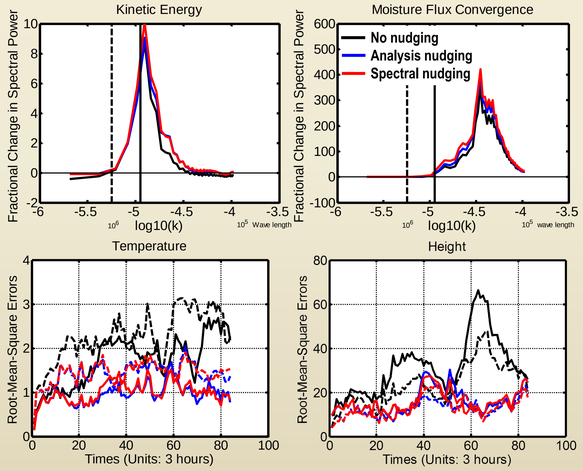


Question: How will regional climates be at reasonably higher spatial resolution that meet the needs of decision-making activities, as well as sustainability management?

One solution: Downscale it!
How? How good it could be?

Downscaling Method Validation

- ❑ Nudging schemes help in retaining large scale information:
  - ✓ Spectral power of long waves maintains at same level.
  - ✓ Root-mean-square difference (RMSD) is smaller with nudging.
- ❑ Dynamical downscaling adds high-resolution information:
  - ✓ Spectral power of short waves increased in WRF outputs.
  - ✓ Small RMSD means not adding too much noises.



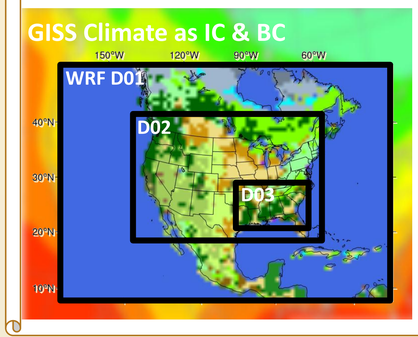
Summary – Take-home Message

- ❖ Generated GISS-WRF downscaled climate (1970-2000) for southeast U.S. (at 10-km) and the contiguous U.S. (at 30-km).
- ❖ The system has the capability to retain large-scale information and to add small-scale features.
- ❖ Correlations of temperature with CRU, NARR, and GISS data are >0.85 for southeast U.S., lowest in Mississippi River Basin.
- ❖ Temperature at 10-km resolution has a cold bias of about 6 °C in both winter and summer, while the 30-km summer has cold biases of about 3 °C in west U.S. and 4°C in east U.S.
- ❖ Precipitation has a wet bias in winter and a dry bias in summer.

Approach

Dynamical Downscaling:

Input the NASA GISS AO model climate to a regional model, here the Weather Research and Forecasting (WRF) model. Allow the regional model to develop localized climate based on its high resolution topography, land use type, soil, etc., while retaining large scale feature of the driving climate.

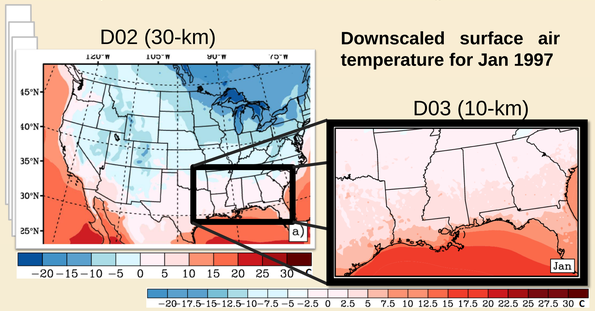


Procedures:

- WRF nested domains D01, D02, and D03
- At 90-, 30-, 10-km resolutions
- Spectral nudging used for D01
- 5~6 days re-initialization
- Hourly output 1970~2000, 2040~2070

Production

Downscaling for 1970~2000 has been completed; 2001~2070 is undergoing. Examples for D02 and D03 (already averaged for the month) are shown below for surface air temperature.

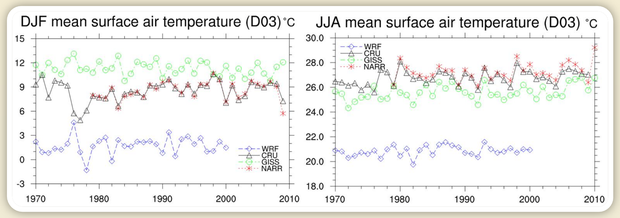


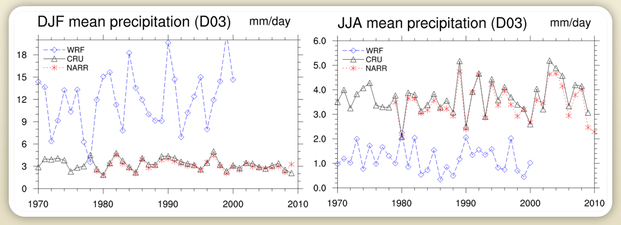
Downscaled surface air temperature for Jan 1997

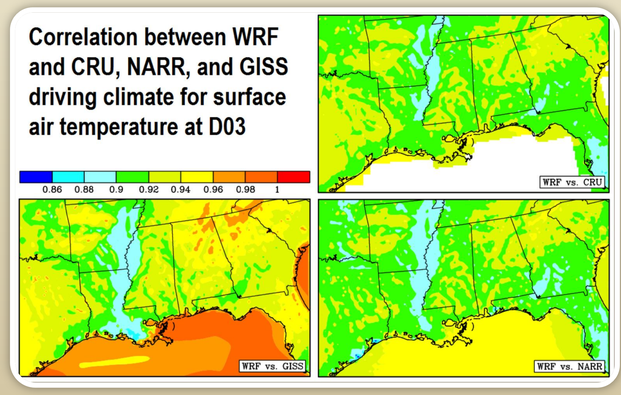
Additional post-processed products:

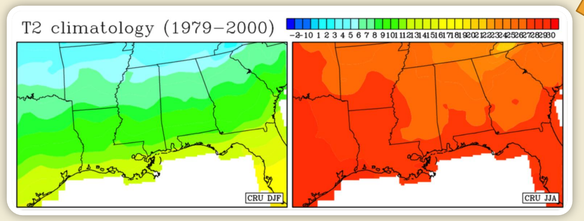
Three-hourly data files are archived, with the accumulated variables including precipitation. Monthly mean, maximum, and minimum fields are also calculated for climate analysis, as well as for other applications, such as ecosystem modeling.

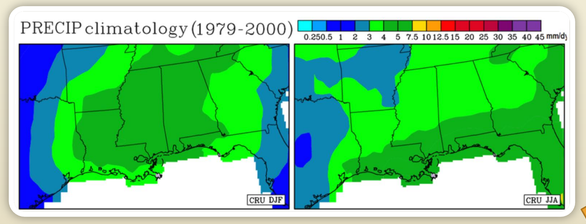
Verification with CRU, NARR, and GISS Data

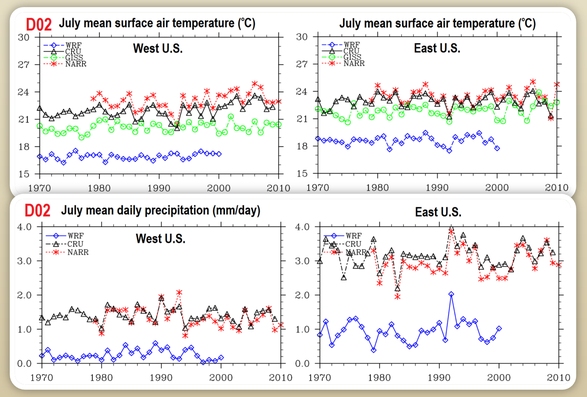




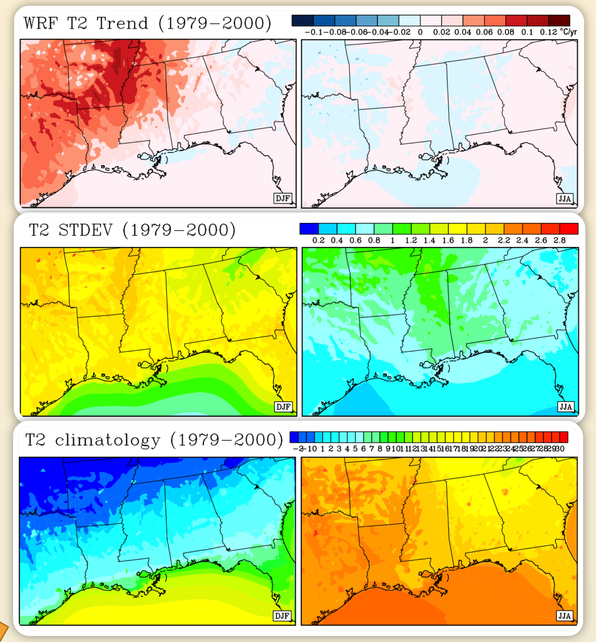








Downscaled Climate & Its Change for SE U.S.



Acknowledgements

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