Projection of Summer Precipitation over Southeastern U.S.

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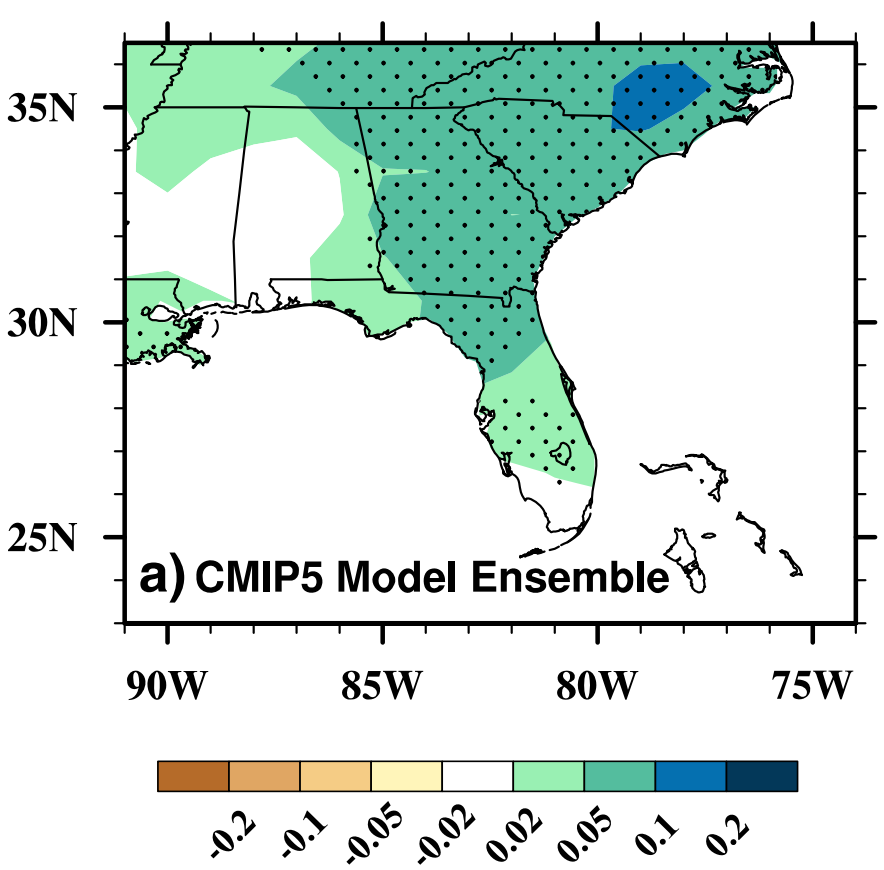
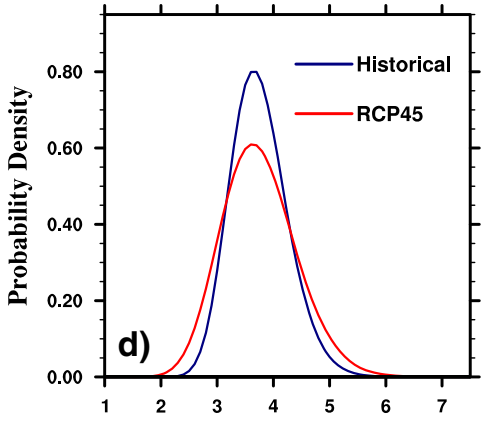
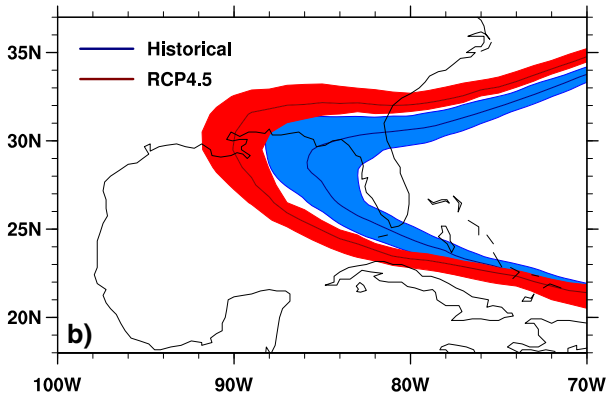
Zhu, X. and C. Stan, 2015: **Projection of Summer Precipitation over Southeastern U.S. in the Super-Parameterized CCSM4**, *Journal of Climate*, accepted.

Motivation







- Under the RCP4.5 scenario summer precipitation variability will intensify
- Westward migration of NASH

Li et al. 2013, *JGR*

Motivation

Representation of convective processes and model horizontal resolution affect the relationship between land-surface properties and precipitation

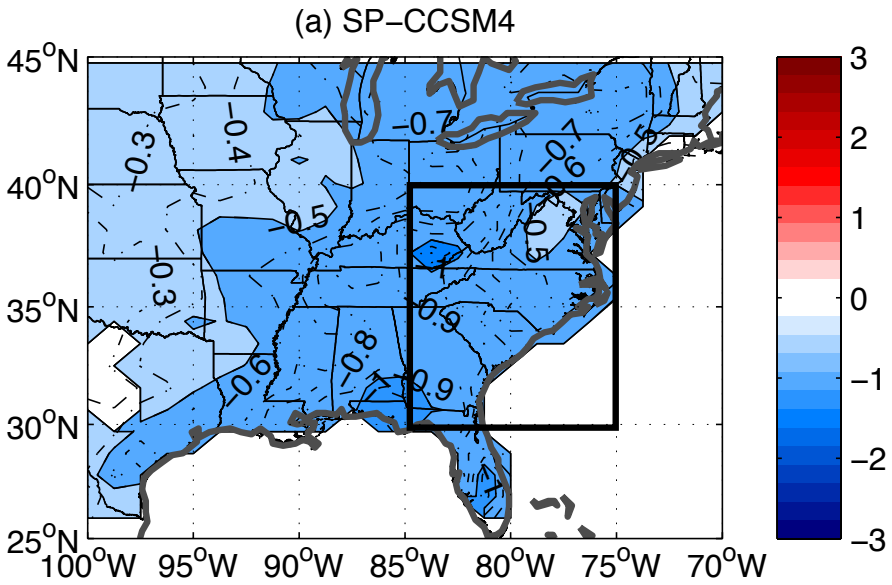
- Hohenegger et al. 2009:
  - In the Alpine region the ***positive*** soil-moisture precipitation feedback simulated by a low-resolution, ***parameterized convection*** model became ***negative*** in the high-resolution***, resolved convection*** version of the model
- Taylor et al., 2013:
  - Low-resolution models with parameterized convection tend to be biased towards a positive soil-moisture precipitation feedback and the increase in resolution does not change the biases

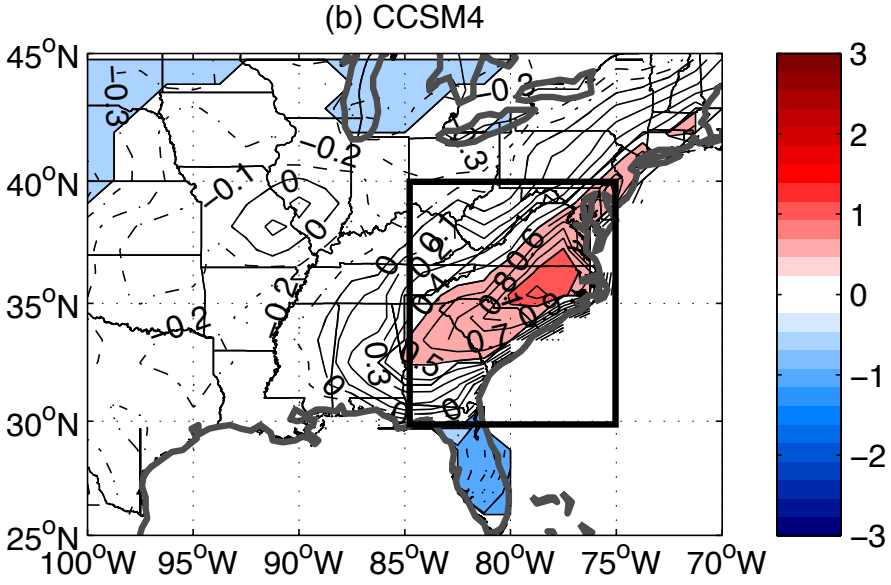
Objectives

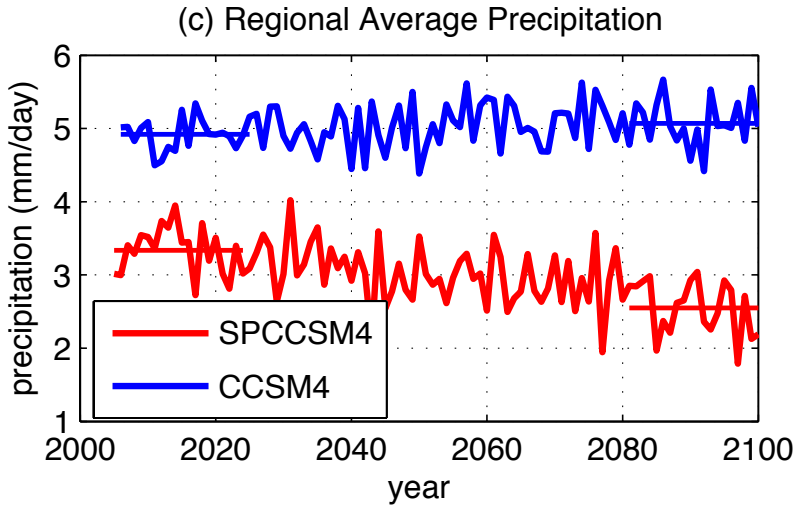
- Evaluate the change in precipitation at the end of 21st century projected by SP-CCSM4 under the RCP8.5 scenario

- Compare the SP-CCSM4 projection to the conventionally-parameterized CCSM4

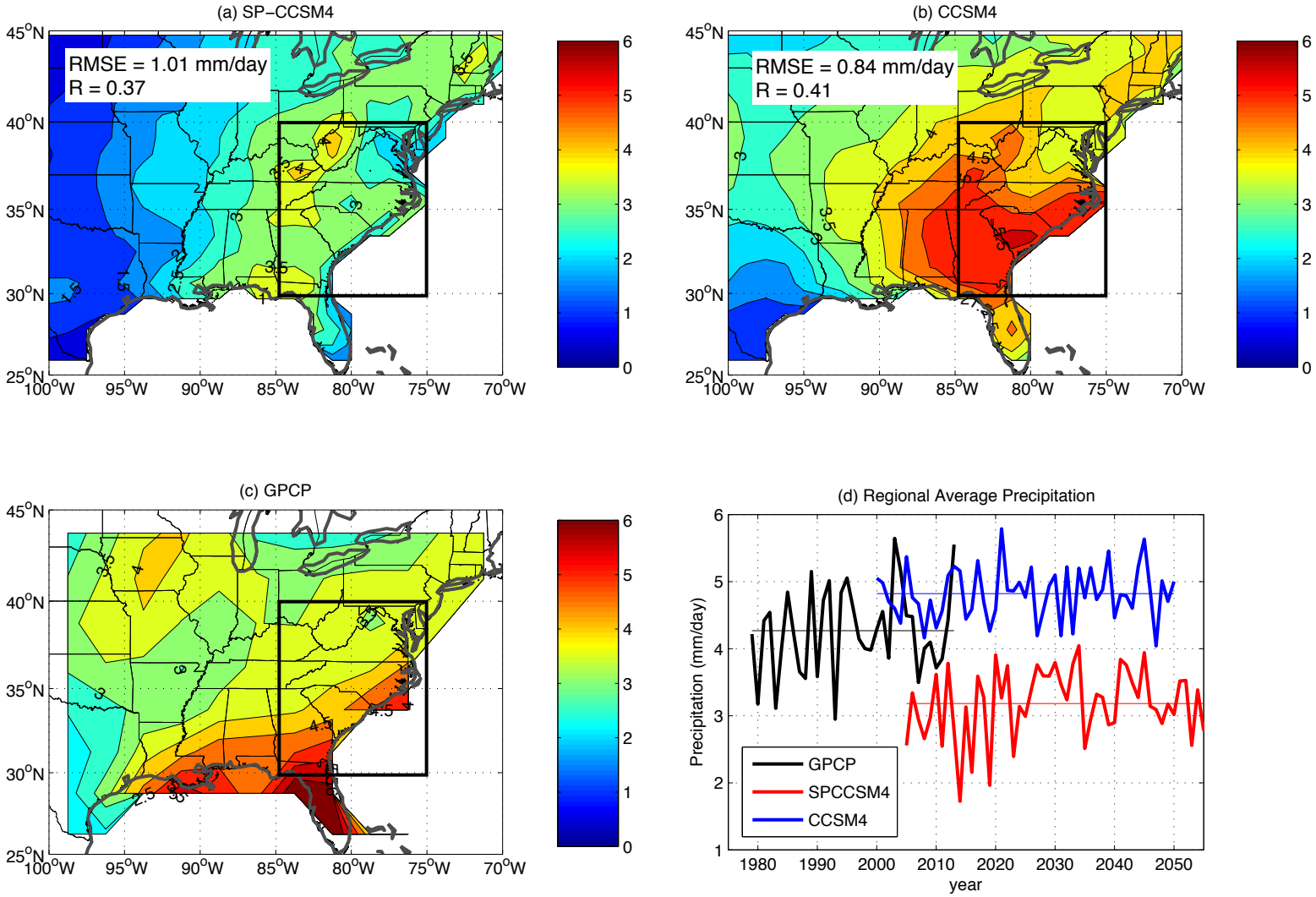
The change in JJA climatology at the end of 21st century, RCP8.5 scenario







Control Run
JJA Climatology



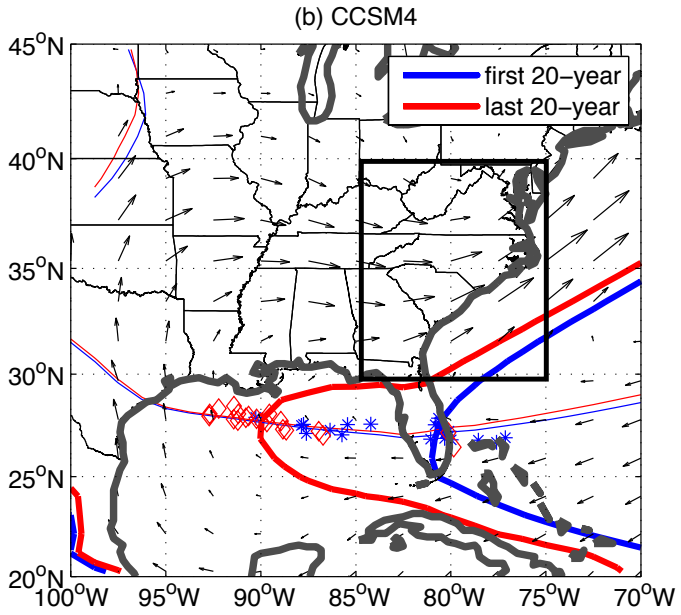
Factors influencing the precipitation climatology

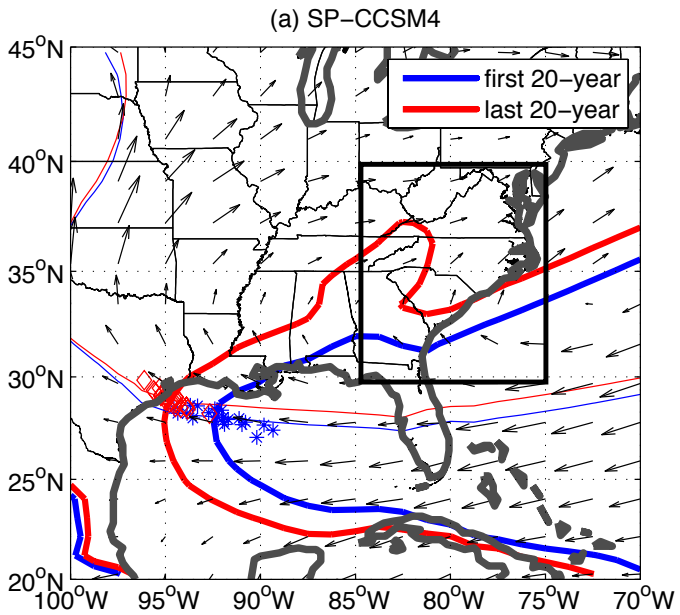
- ✓ The position of the North Atlantic subtropical high
- ✓ Local land-atmosphere interactions
- ✓ Synoptic-scale convective activity, landfalling tropical cyclones
- ✓ Southerly flow from the Gulf of Mexico

Factors influencing the Southeast U.S. precipitation summer climatology

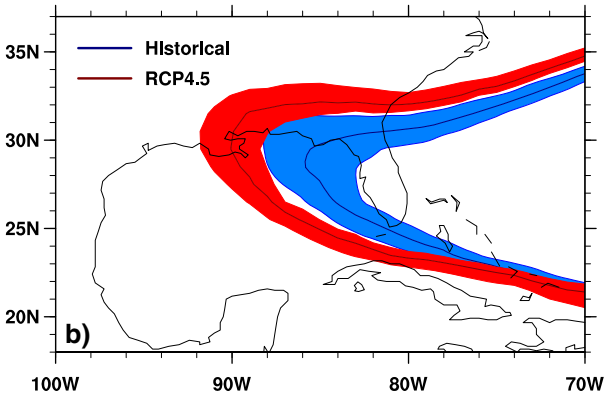
- ✓ The position of the North Atlantic subtropical high
- ✓ Local land-atmosphere interactions
- ✓ Synoptic-scale convective activity, landfalling tropical cyclones
- ✓ Southerly flow from the Gulf of Mexico

Position of the North Atlantic subtropical high (1020 hPa)





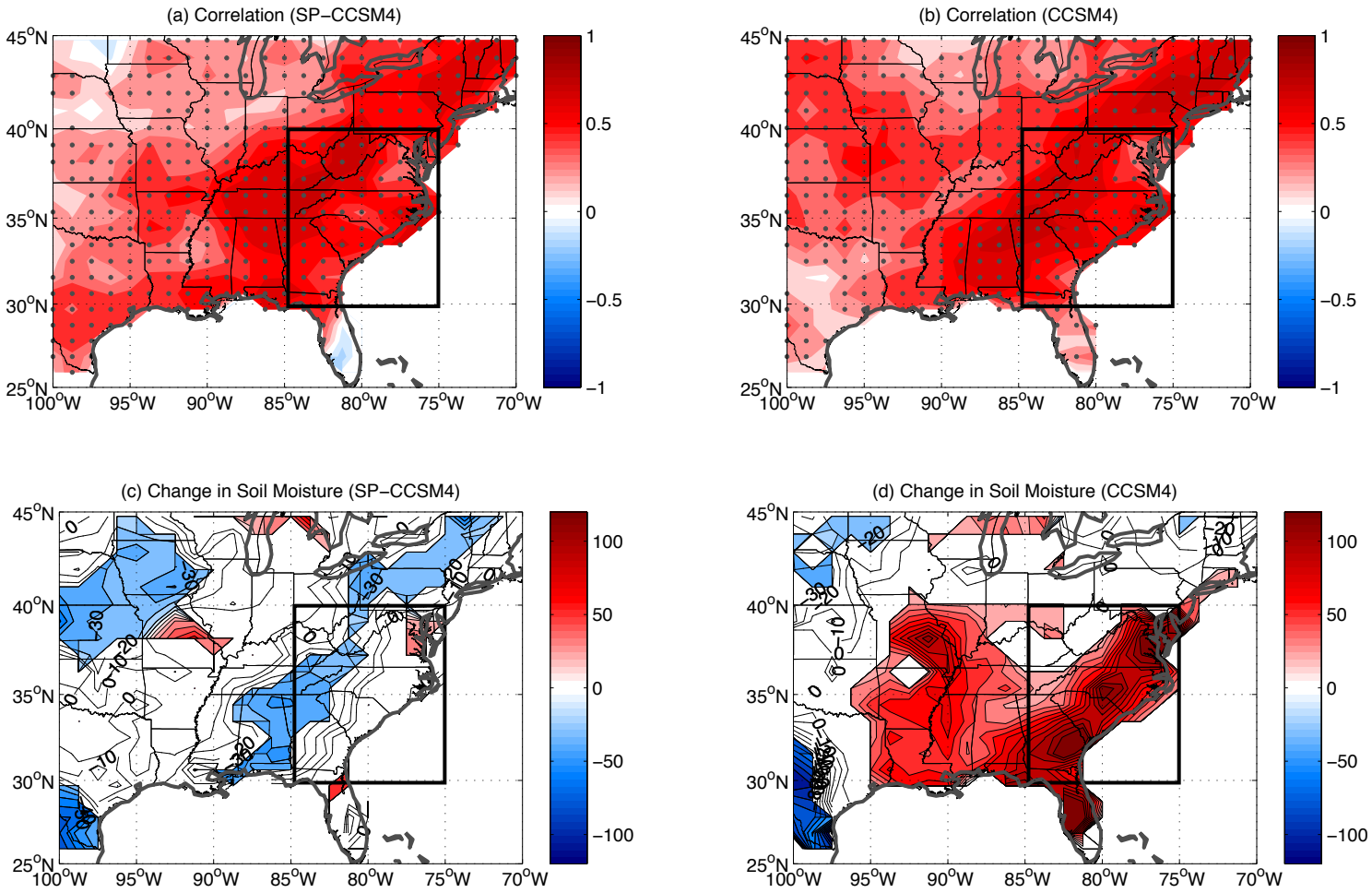
CMIP5 Model Ensemble



Li et al. 2013, *JGR*

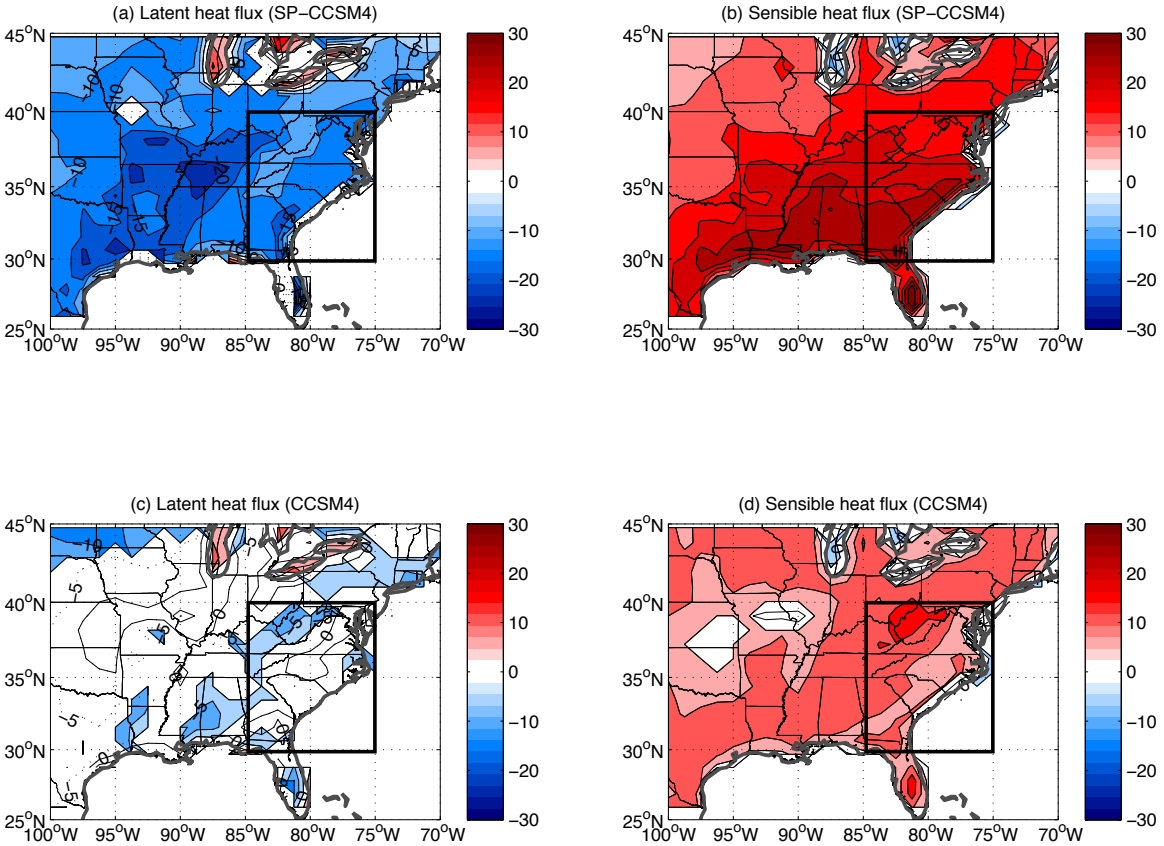
Land-atmosphere interactions

Precipitation and Soil Moisture Content, RCP8.5



Land-atmosphere interactions

Changes in surface fluxes, RCP8.5

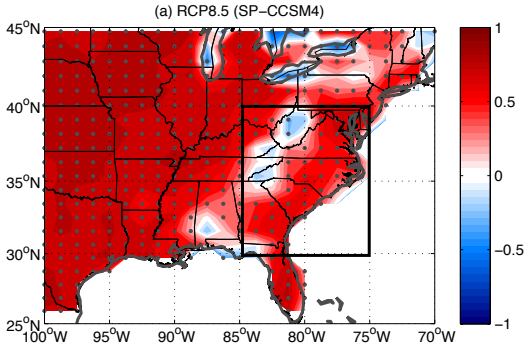


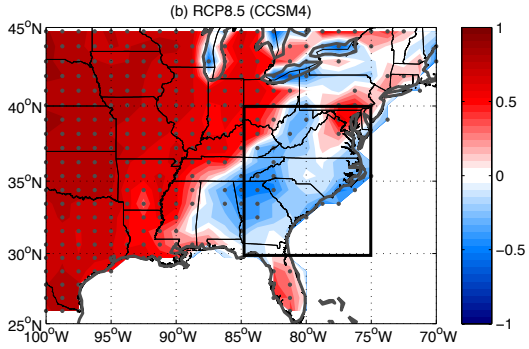
Land-atmosphere interactions

Correlation between precipitation and latent heat flux

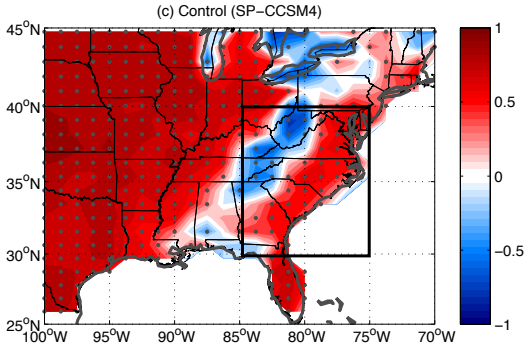
SP-CCSM4 | *CCSM4*

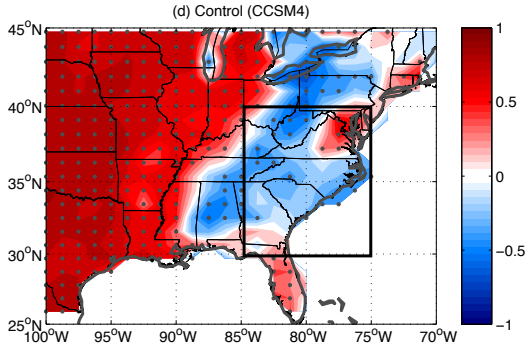
RCP8.5





Control





Large scale effects vs. local feedbacks

Multi-variate EOF analysis of precipitation, latent heat flux, and sea level pressure

	Control Experiment		RCP8.5	
Model	Correlation with PC1 of precipitation		Correlation with PC1 of precipitation	
	LH	SLP	LH	SLP
SP-CCSM4	0.71(0.01)	0.35(0.02)	0.80(0.01)	0.47(0.01)
CCSM4	0.62(0.01)	0.59(0.01)	0.75(0.01)	0.40(0.01)

Number in parenthesis represents the p-value of the correlation coefficient.

Conclusions

- In control simulations the conventionally-parameterized model and super-parameterized model show systematic biases: CCSM4 overestimates the summer precipitation in the Southeast U.S. whereas SP-CCSM4 is drier.
- In CCSM4 the precipitation distribution is equally influenced by the NASH and local effects, whereas in SP-CCSM4 local effects dominate.

- Under the global warming, SP-CCSM4 projects a decrease of summer precipitation whereas CCSM4 projects an increase of summer precipitation by the end of 21st century.
- In SP-CCSM4 the PDF of precipitation shifts towards more frequent occurrence of precipitation with weaker intensity whereas in CCSM4 the PDF shifts towards more frequent occurrence of intense precipitation.
- SP-CCSM4 projects a westward and northward displacement of NASH whereas CCSM4 projects mostly a westward displacement.
- SP-CCSM4 projects a decrease of soil moisture content whereas CCSM4 projects an increase of soil moisture content.
- SP-CCSM4 projects a significant decrease in the latent heat flux whereas CCSM4 does not project a change in the latent heat flux.
- SP-CCSM4 is dominated by a positive feedback between latent heat flux and precipitation whereas CCSM4 is dominated by a negative feedback.
- Both models show that under the global warming scenario the distribution of precipitation is strongly influenced by the local land-atmosphere interactions.