

# Intensification of Southeast United States Summer Rainfall Variability in Recent 30 Years

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## 1. Introduction

The Southeast United States is one of the fastest growing regions in the nation. Water supplies in this area are increasingly stressed especially during summer. The year-to-year fluctuations in summer precipitation over the Southeast thus have vital influence on regional hydrology, agriculture, and related industries. In the past three decades, summer droughts repeatedly struck the Southeast and had a devastating impact on this region both socially and economically.

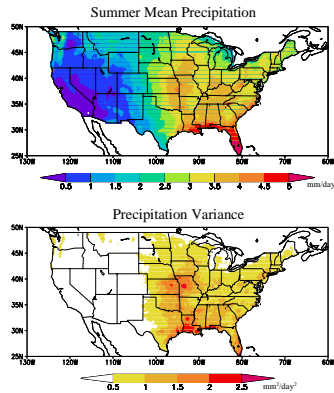


Fig. 1

Figure 1. Southeast summer rainfall with large seasonal means and variability is an important part of continental-scale warm season rainfall.

## Objectives

- To determine whether interannual anomalies of Southeast summer rainfall have become more variable and whether summer droughts and wetness have become more intense in recent 30 years.
- To explore potential causes of the intensification of the Southeast summer rainfall variability.

## 2. Data

**Precipitation:** U.S. Unified Precipitation, 1948–1998  
 U.S. Daily Precipitation Analysis, 1999–2004  
 U.S. Hourly Precipitation Analysis, 1948–2002

**NCEP Reanalysis:** 200-hPa wind, 1948–2004

**SST:** Reconstructed Reynolds Data, 1948–2004

**IPCC A4 model simulated precipitation:** 1900–1999 and 2000–2099

## 3. Summer Rainfall Variability

Southeast summer rainfall (Fig. 2) displays higher interannual variability with more wet and dry extremes in the second half of the period (1977–2004).

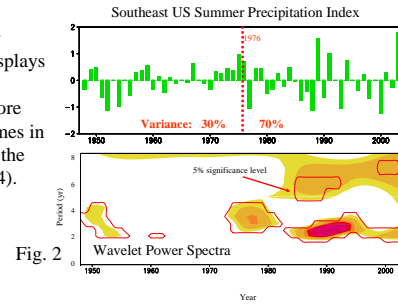


Fig. 2

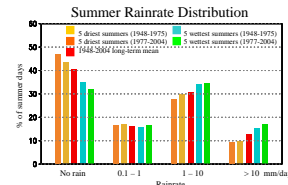


Fig. 3.

Changes in frequency and intensity of rainfall contribute to the higher precipitation variability after 1976.

Changes in the diurnal cycle between the two periods may suggest a significant change in roles played by surface heat fluxes and soil moisture in summer rainfall.

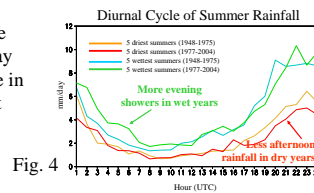


Fig. 4

## 4. Potential Causes

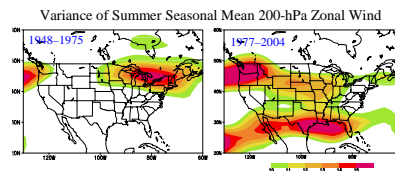
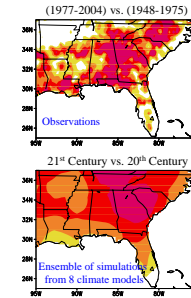


Fig. 5

### Changes of large-scale circulation variability

Higher interannual variability of jet stream over the Great Lakes prior to 1976 shifted to the southern states after 1976. The strong variation of the upper-level jet over the Gulf coast after 1976 is consistent with the higher interannual variability of Southeast summer precipitation observed since then.



Rainfall variability may increase with global warming in the 21st century.

Fig. 5. Percentage of increase in summer rainfall variance.

20<sup>th</sup> Century simulations  
 1900–1999 with observed CO<sub>2</sub>,  
 representing present-day climate  
 21<sup>st</sup> Century simulations  
 2000–2099 with increased CO<sub>2</sub>,  
 representing future climate (global warming)

### SST Influence

Southeast drought is associated with an anticyclone over the central and eastern United States. The northeasterly flow off the Gulf coast suppresses moisture transport to the Southeast. In the

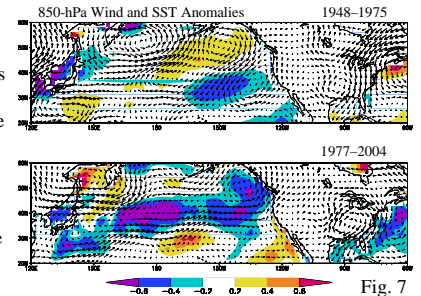


Fig. 7

North Pacific large wind anomalies occur in regions between warm and cold SSTs, indicating a circulation response to SST gradient.

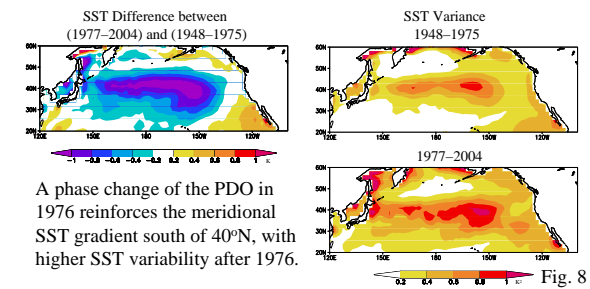


Fig. 8

A phase change of the PDO in 1976 reinforces the meridional SST gradient south of 40°N, with higher SST variability after 1976.

## 5. Summary

Southeast summer rainfall has exhibited higher interannual variability since around 1976, with more intense droughts and wetness in recent 30 years. Potential causes are the changes in large-scale circulation variability, land surface fluxes, global warming and North Pacific SST variability.