NASA Award NNX09AK26G
Title: Shifts in Extreme Precipitation Events Based on Resolved Atmospheric Changes
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Year 1 Report and Year 2 Plans (May 17, 2010)

In the first year of the project, we have analyzed hourly data of rain gauge measurements from stations extracted from the CPC-HPD data archive (Table 1). For each state, we identified the most extreme daily precipitation events (top 10% in daily precipitation) for stations that contained at least 20 years of data. The timing and strength of these events are then pooled and ranked according to the days with largest number of stations logging an extreme event (spatial coverage dominance). For our preliminary assessment of the ability to construct climate analogues, EOF analyses have been performed for the times series of the MERRA 500mb geopotential height fields (Table 1) with the days corresponding to the filtered observed precipitation extremes. We have also constructed seasonally binned composites (e.g. Figure 1) of 500mb geopotential height. For each state considered thus far, the composites are very similar in the spatial patterns to the leading EOF, with the leading EOF explains about 50% of the variance in these filtered geopotential height fields.

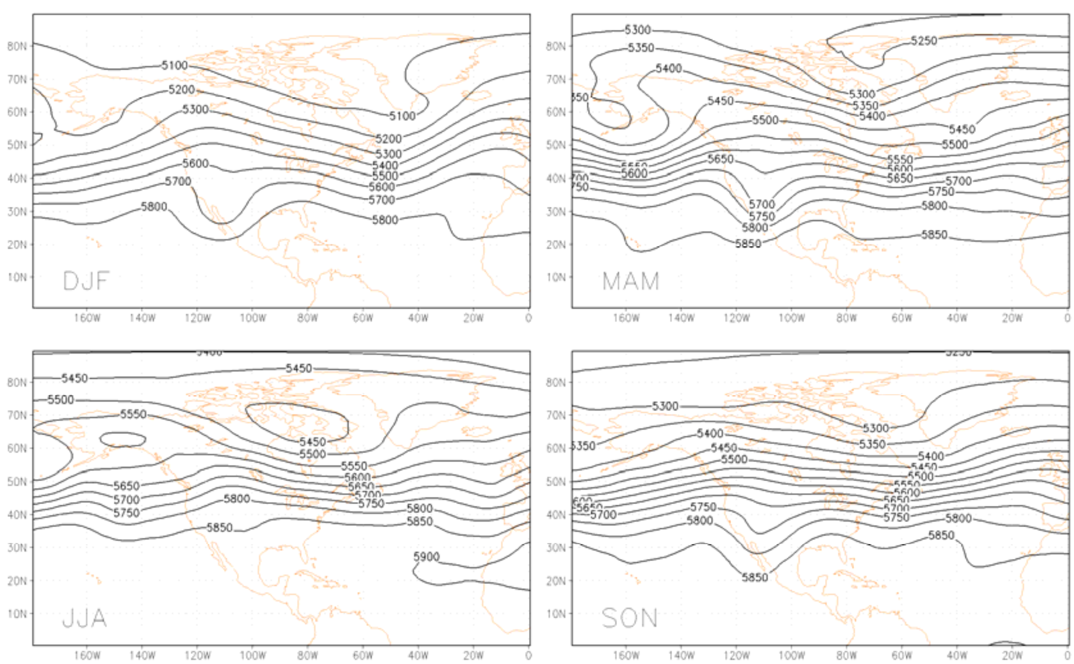

Figure 1. Seasonally binned composites of the MERRA 500mb geopotential height fields for the days in which an extreme precipitation event was recorded in at least 50% of the stations for the state of Texas. In all but the summer composite (JJA), a

prominent trough is seen to the west of Texas. Similar results are found for the composites constructed for Louisiana and Oklahoma.

	Temporal span (resolution)	Spatial domain (resolution)	Source
Precipitation observations	1948-2002 (hourly)	United States (ungridded/gauge)	Climate Prediction Center (CPC) Hourly Precipitation Data (HPD)
MERRA reanalysis atmospheric diagnostics	1979-present (3 hourly)	Global (1.25°)	NASA-GSFC
Climate model simulations	Variable (daily)	Global (variable)	IPCC AR4 archive

Table 1: Summary of the data collected for the identification of precipitation extremes (CPC-HPD) as well as the atmospheric fields used to construct observationally-based (i.e. MERRA) and model-derived (i.e. IPCC) climate analogues.

We have thus far completed the extreme precipitation event analyses of hourly rain gauge observations for the following states: Arkansas, Louisiana, Missouri, Texas, Oklahoma, Connecticut, Massachusetts, Rhode Island, New Hampshire, Vermont, Main, and New York. The preliminary analyses of the 500mb geopotential composites has been conducted for Texas (Figure 1), Louisiana, and Oklahoma. We have found that the patterns of these composites among these states show a strong spatial-correlation, and thus suggest that these atmospheric conditions play a widespread role in the formation of extreme events for the southern states.

We have also started a task on the drought end of extreme events. We focus on West Africa where intense and multi-year droughts have occurred in the historical record. There are several reasons for the choice of this region and this phenomenon: 1) the intraseasonal and interannual variations in the drought severity is known to be linked to large-scale climate features such as the competing Hadley and Walker circulations over the Continent, 2) the rainy season is limited to two to three months so the definition of drought can be clearly made without seasonal shifts/compensation problems, 3) it is a high-impact problem because the affected (and growing) population depends on local rain-fed agriculture.

We have defined duration, begin-time, end-time, accumulation statistical measures for rainfall over a swath of West Africa. We have also defined the continental (including adjacent oceans) regions over which we will develop statistical correspondence between drought and large-scale resolved atmospheric fields.

In the next year we will continue our analyses in order to:

1) Refine the analysis strategy for extracting the observed precipitation extreme events – i.e. should we emphasize the spatial coverage dominance or persistence/intensity dominance?
2) Expand the climate analogue composites to blend other geophysical (e.g. surface pressure and convergence) as well as thermodynamic (e.g. moist static energy) fields.
3) Refine the geophysical/thermodynamic composites associated with observed precipitation extremes – construct anomaly composites and test the implementation of these climate analogues with GCM simulated fields of the AR4 archive (Table 1).
4) Expand the analysis to other major sub-continental domains of the U.S. (i.e. Northeast, Southeast, Midwest, Southwest, and Northwest) to regionalize the analogues.
5) Perform the climate analogue assessment of potential changes in extreme precipitation for IPCC SRES AR4 archives.
6) Create West Africa drought begin, end, duration and accumulation indices based on precipitation gauge records.
7) Develop large-scale atmospheric fields patterns over Africa (and some adjacent waters) using surface pressure, surface temperature, 500 mb height, moisture and heat divergence fields (see Table 1).
8) Use principal components and canonical correlation to link the fluctuations in the West Africa drought indices and large-scale fields
9) Prepare to examine AR4 models for occurrence and frequency of these patters under different IPCC scenarios (year 3).