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Role of the North Atlantic Subtropical High and Midlatitude Circulations in the Springtime Onset of Isolated Convection across the Southeastern United States

Thomas Rickenbach*[1], Rosana Nieto Ferreira[1], Hannah Wells[2], and Christopher M. Jarrett[1]

[1]Department of Geography, Planning, and Environment, East Carolina University, Greenville, North Carolina, USA

[2]Cooperative Institute for Mesoscale Meteorological Studies @ U. of Oklahoma, and NOAA/NWS Warning Decision Training Division, Norman Oklahoma USA

*Corresponding author email: rickenbacht@ecu.edu

1. Introduction

In the southeastern United States (SE US), recent radar-based studies diagnosed a clear summer maximum in precipitation from isolated, diurnally forced convection, in contrast with year-round precipitation from mesoscale systems, illustrated in Figure 1.[1,2] Superficially, the annual cycle of isolated precipitation resembles that of a monsoon. However, rather than the distinct wet and dry seasons of a monsoon climate, the summer regime of isolated thunderstorms in the SE US emerges from changing characteristics of precipitation systems that occur all year (Figure 1).

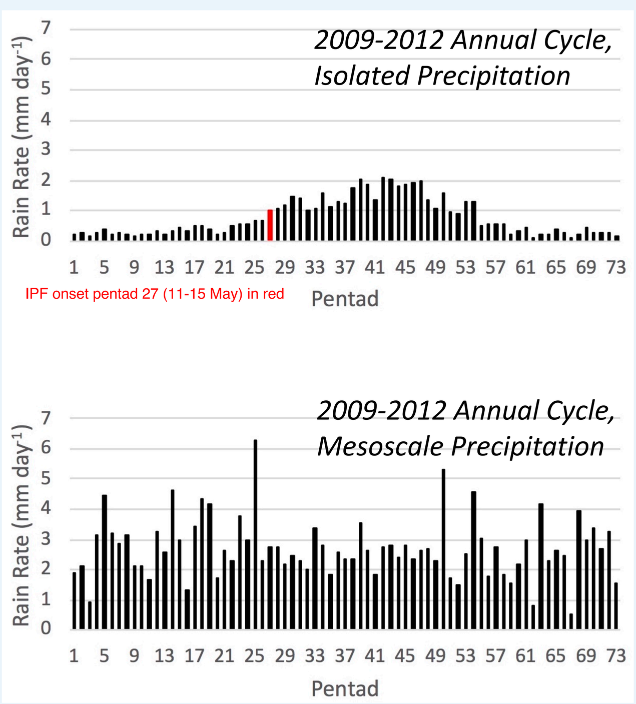


Figure 1

Though not a monsoon, it is useful to use a monsoon framework to study the mechanisms for the 'onset' of the summer isolated precipitation regime. In Southeast Asia and in South America, monsoon onset is rapid, associated with stalled extratropical frontal zones extending into the subtropics.[3,4,5]

Westward extension of the North Atlantic subtropical high (NASH) in late spring influences the summer precipitation regime in the SE US via poleward moisture and energy transport[6,7,8]. In this poster we present two onset cases to explore mechanisms for the observed rapid onset[1] of the summer isolated convection regime, specifically:

- ***Do extratropical cyclones help trigger the onset of summer isolated convection?***
- ***Is the timing of onset related to the seasonal westward extension of the NASH?***

2. Methodology

Dataset: Four-year (2009-2012) NEXRAD radar-based hourly precipitation rate (NMQ-Q2, 0.01° x 0.01°) for the SE US domain shown in Figure 2.[9]

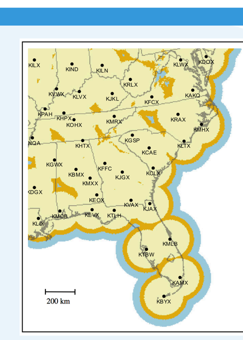


Figure 2

Identifying precipitation features: Isolated Precipitation Features (IPF) < 100 km length and Mesoscale Precipitation Features (MPF) ≥ 100 km are objectively identified in each hourly image (see Figure 3 for example). Rain associated with IPF and MPF are separated each hour of the four-year dataset.

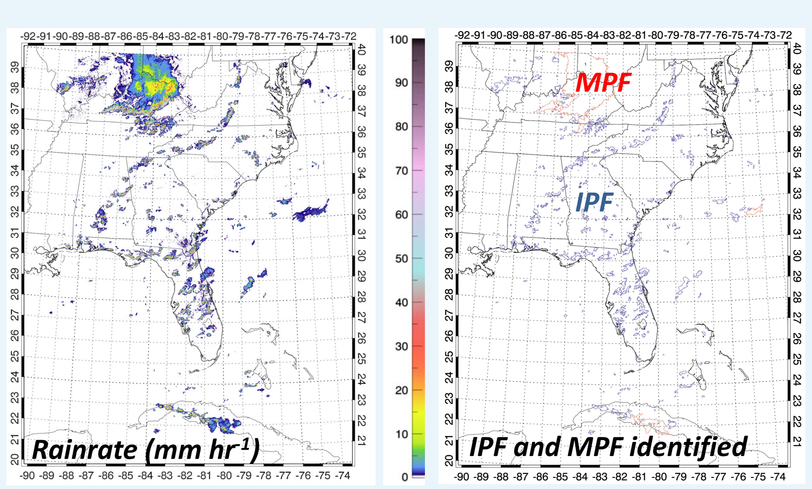


Figure 3

Determining IPF onset: Springtime onset of isolated convection rain (IPF) is objectively determined in each of the 34 boxes (2°x2°) shown in Figure 4 below.

Pentad-averaged annual time series were constructed in each box. Using methods for determining South America monsoon onset[5,10,11], the first pentad to meet the following criteria is chosen as the onset pentad:

1) Exceed the four-year mean IPF rainrate of 0.76 mm day^{-1}.

2) Five of eight subsequent pentads must exceed this mean value to ensure a sustained increase.

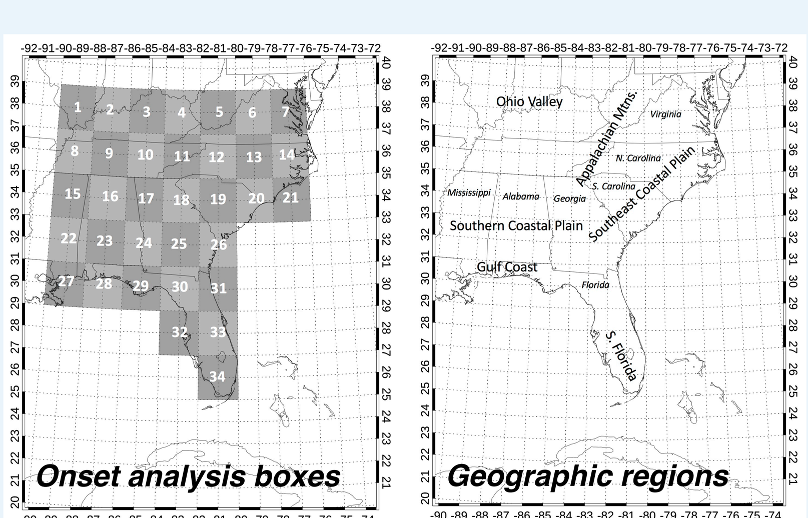


Figure 4

3. Results

1. Seasonal variation in IPF rain: Across the SE US, IPF rain increases sharply from spring (MAM) to summer (JJA) each year (Figure 5).

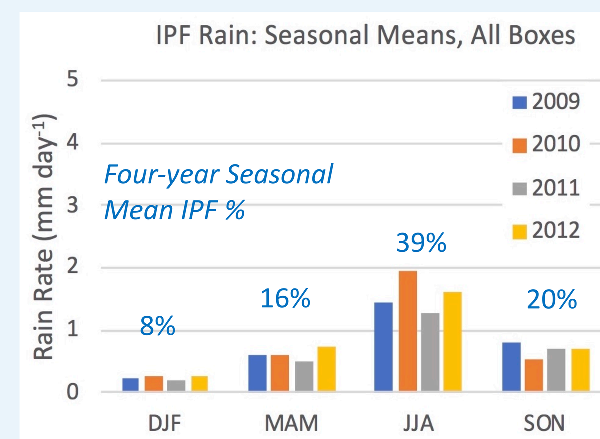


Figure 5

2. Geographic pattern of IPF rain during spring onset transition: The four-year monthly mean IPF rainmaps (Figure 6) show that IPF begins in S. Florida in April, then along Gulf Coast and SE coastal plain in May-June. Land/ocean contrast is clear from May-July, suggesting that thermodynamics force IPF.

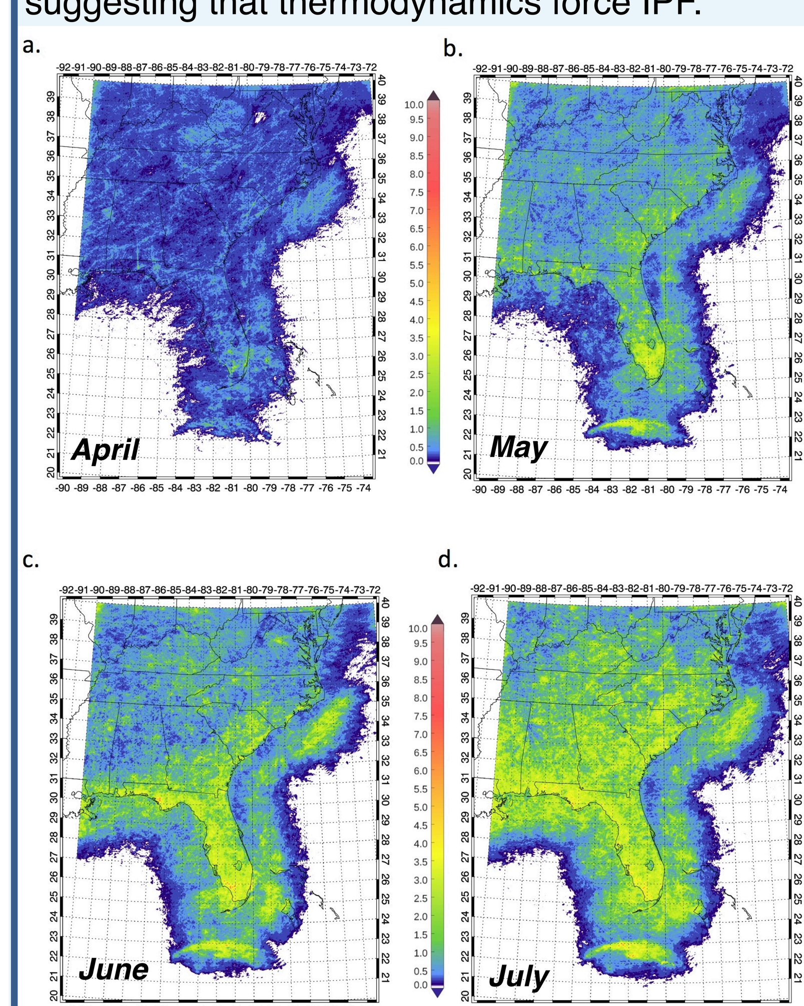


Figure 6

3. Onset metrics, 2009-2012 mean: Across the SE US, IPF rain onset (Figure 7a) begins in mid-April in South Florida. By early May onset occurs simultaneously across the Gulf Coast and SE coastal plain, where there is the greatest increase in post vs. pre onset IPF rain (Figure 7b). This, along with Figure 6, suggest a thermodynamic threshold may be reached in May for those regions. In the northern domain onset timing was quite variable (Figs. 7a,c) with only weak onset rain increase – suggesting a greater role of baroclinic systems for IPF onset in the northern domain..

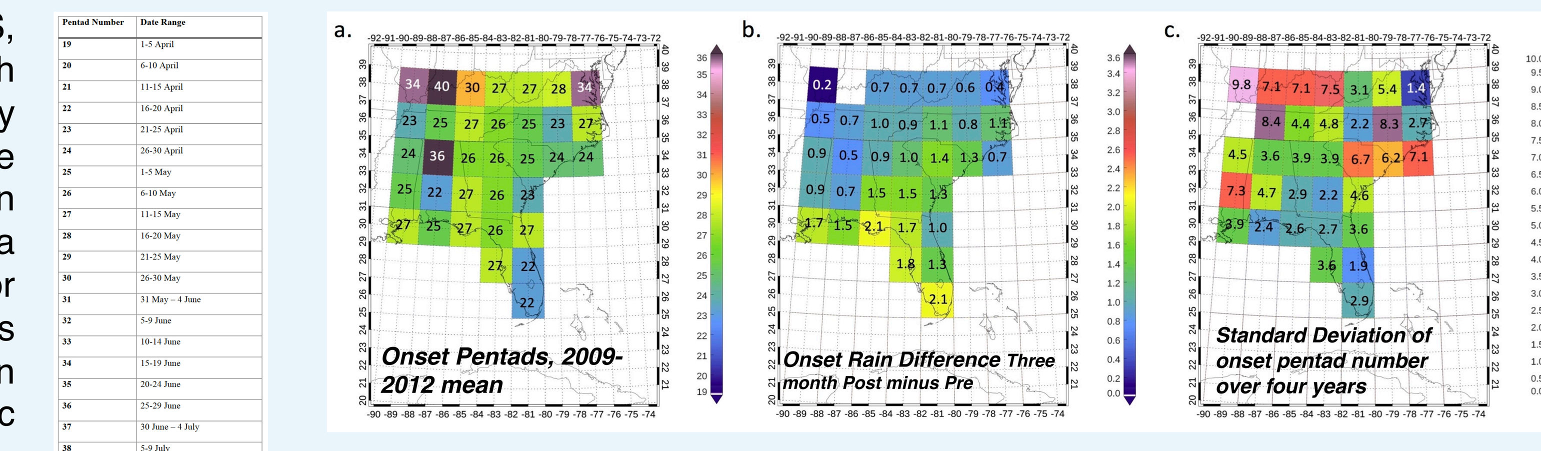
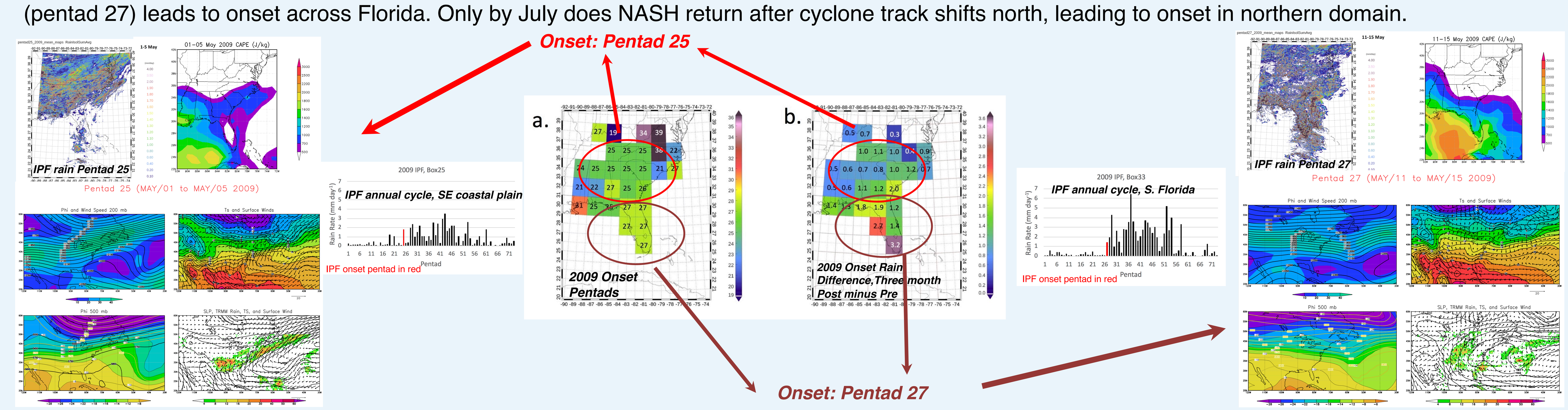
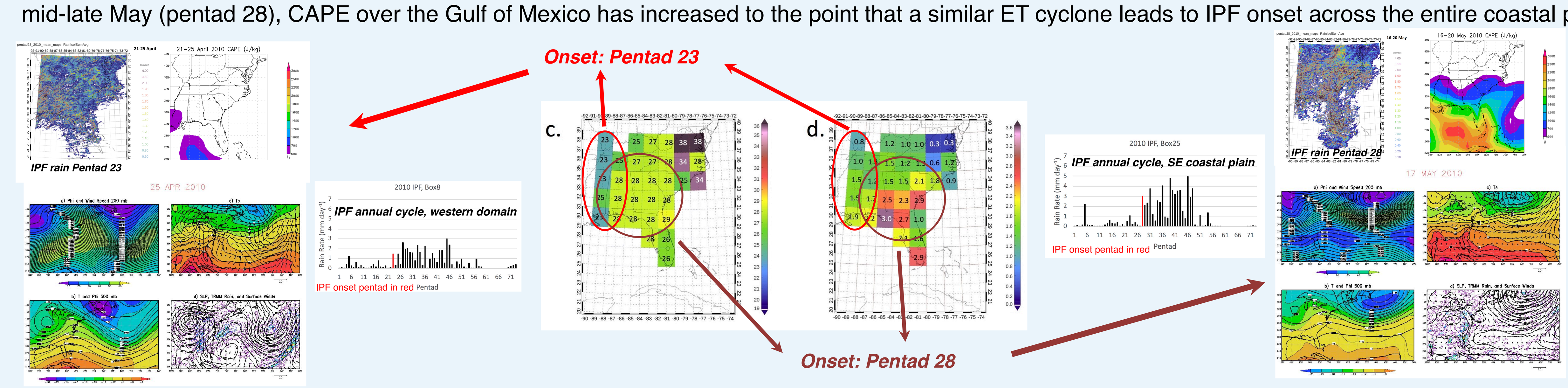


Figure 7

4. IPF Onset Analysis: 2009: In late April 2009 a series of ET cyclones in mid-Atlantic give way to establishment of the NASH western ridge. By early May (pentad 25) a stationary front extends across SE US, with onset across Appalachia and Gulf Coast. Spin-up of surface low over Gulf of Mexico by mid May (pentad 27) leads to onset across Florida. Only by July does NASH return after cyclone track shifts north, leading to onset in northern domain.



5. IPF Onset Analysis: 2010: In late April (pentad 23) onset occurs in the western domain in the warm sector ahead of a cold front associated with a large ET cyclone moving slowly across the central domain. The western ridge of the NASH is not yet established, as a series of cyclones disrupts the NASH circulation. By mid-late May (pentad 28), CAPE over the Gulf of Mexico has increased to the point that a similar ET cyclone leads to IPF onset across the entire coastal plain.



4. Preliminary Conclusions

1. ***Geographic pattern and amplitude of isolated precipitation feature (IPF) rain onset in May suggests a thermodynamic priming in Florida, Gulf Coast, and SE coastal plain.***

2. ***Variable timing and lower amplitude of IPF rain onset in northern domain suggests propagating baroclinic systems may play a larger role in onset timing there.***

3. ***Establishment of frontal boundary across the coastal plain and Appalachian mountains appears important in timing of IPF onset following seasonal thermodynamic priming.***

4. ***As ET cyclone track moves northward in late spring, westward extension of the NASH circulation establishes summer IPF regime in the SE US following IPF onset.***

Acknowledgements

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