# J3.7 Cool season heavy rainfall events over west central Florida

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## 1. Background

On occasion west central Florida is affected by nearly stationary bands of precipitation with a procession of cells moving northeast from the Gulf of Mexico producing heavy coastal rains. These events occur every 2 to 7 years (Fig. 1.) and are difficult to forecast. Most occurrences are linked to the ENSO neutral or warm phase (Fig. 1). Crow (1995) studied 62 cool season rain cases of at least 76 mm and found the key ingredients were southwesterly flow aloft, a low level jet, and a surface boundary. For this study, rainfall data were collected from 14 local airport and cooperative sites. A total of 26 non-tropical cases of widespread coastal rains with at least 127 mm from September through May 1948-2006 were chosen. The greatest rainfall occurred on 08 May 1979 with over 280 mm of rainfall at three separate monitoring sites.

A recent case occurred 03 Feb 2006, as a pre-frontal convective band propagated southward along Florida's west coast becoming stationary over the Tampa Bay area and dumping a swath of rain over 200 mm in five hours (Fig. 2a). The Ruskin, FL (KTBW) sounding (Fig. 2b), just south of the heaviest rain shows moderately unstable conditions with increasing winds aloft to a maximum of 40 $ms^{-1}$ at 250 hPa. The 1000 hPa wind vectors (Fig. 2c) shows moderate southerly flow south and east of Florida in advance of a cold front. The southerly lower level flow transports moisture north across Florida as indicated by the 700 hPa specific humidity (Fig. 2d).

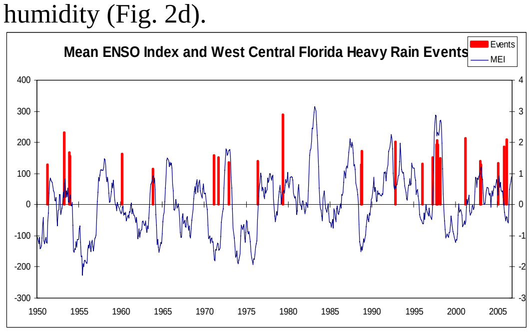


**Fig. 1. Mean ENSO Index and west central Florida heavy rain events 1948-2006 (Wolter et. al., 1998).**

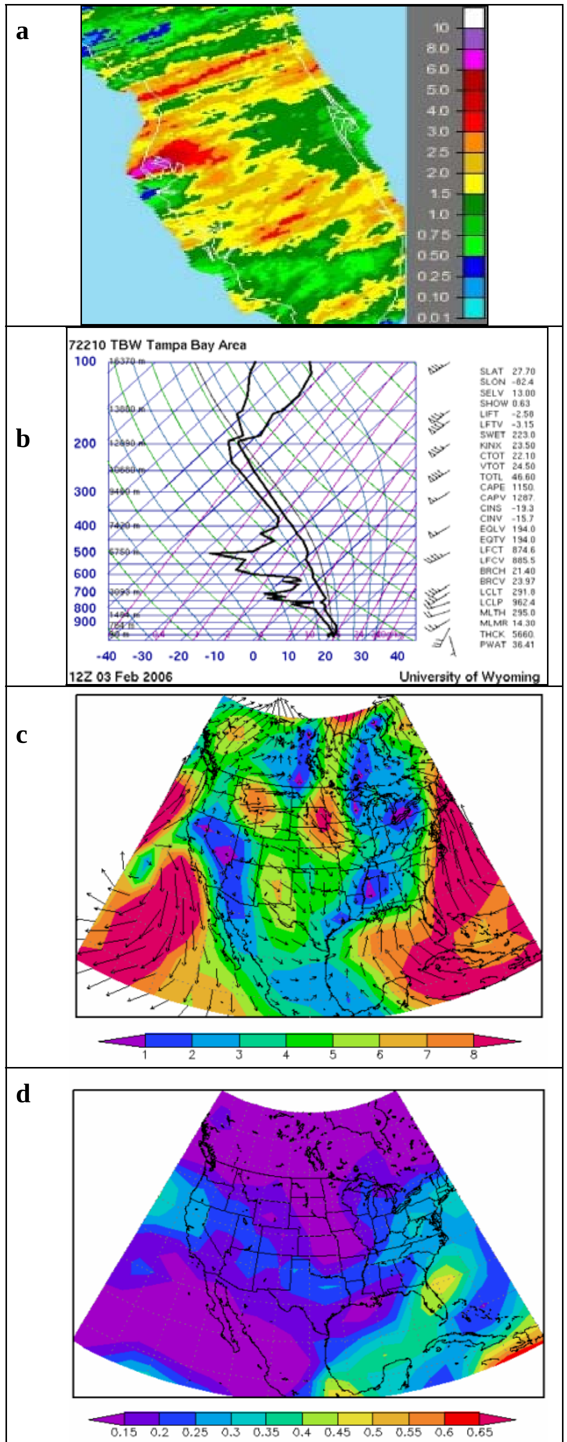


**Fig. 2a. 24h rainfall (in), Fig 2b. KTBW Skew-T, Fig. 2c. 1000 hPa wind ($ms^{-1}$), Fig. 2d. 700 hPa specific humidity ($dgkg^{-1}$). All figures 03 Feb 2006.**

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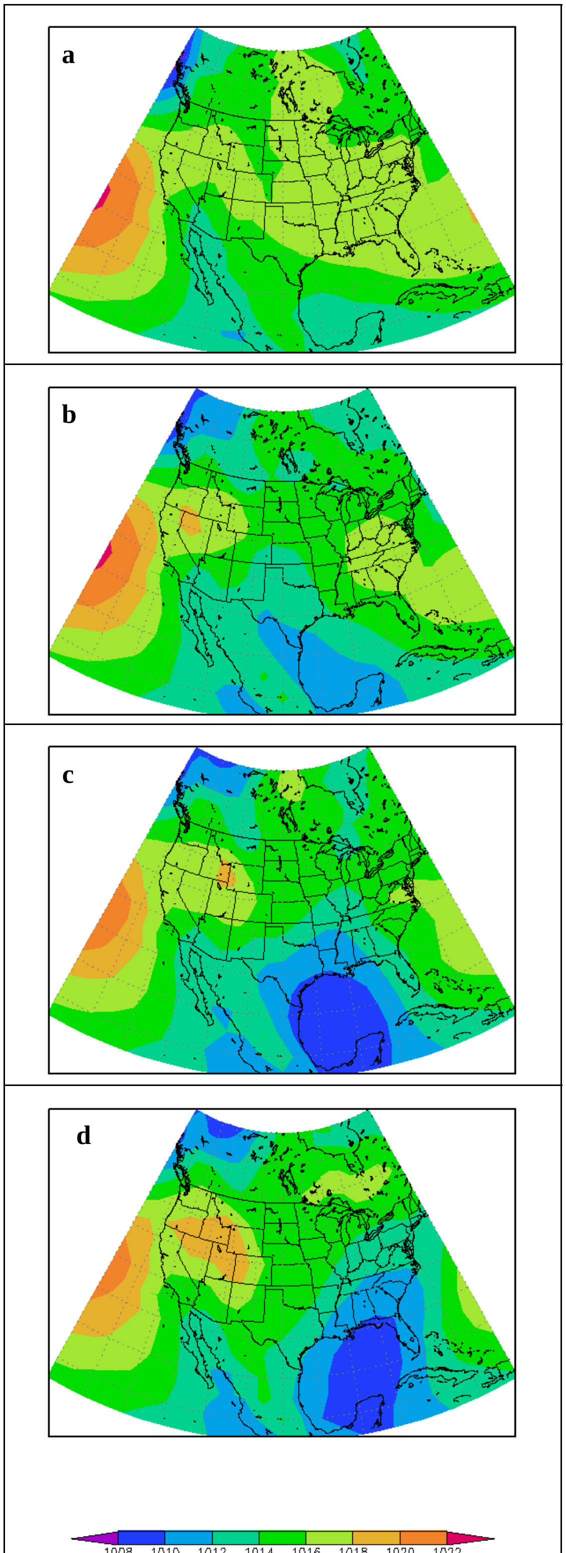
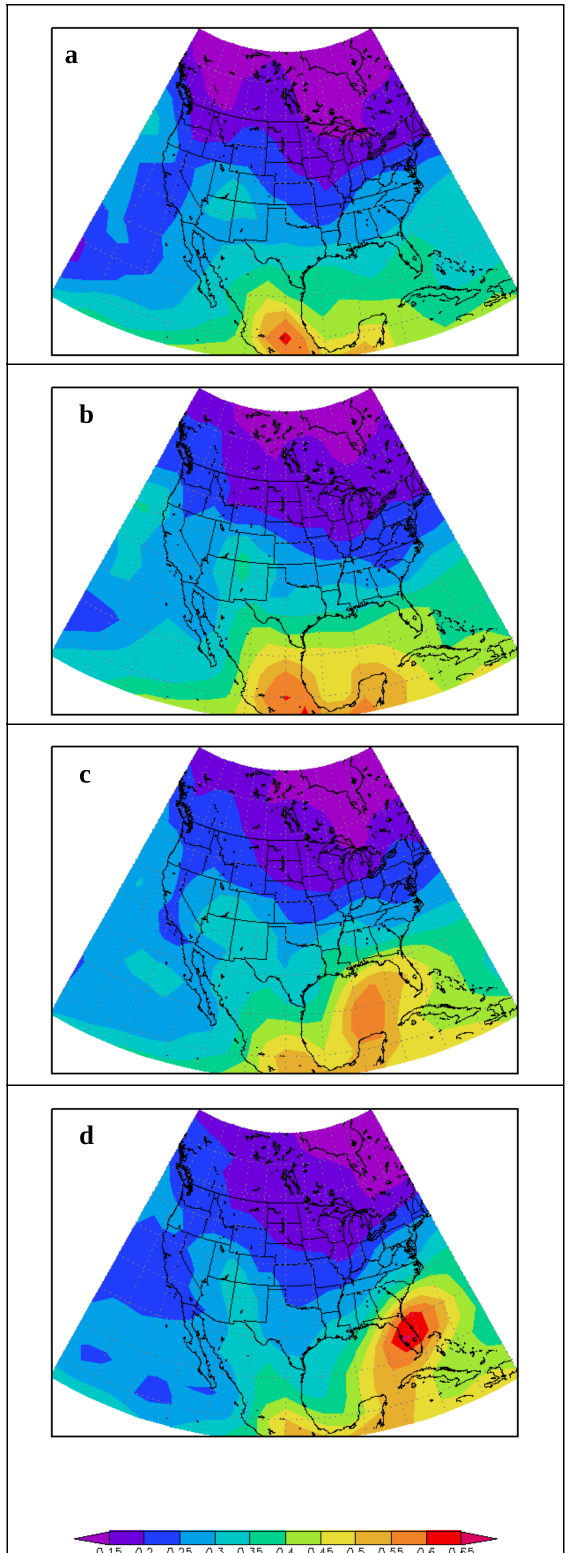
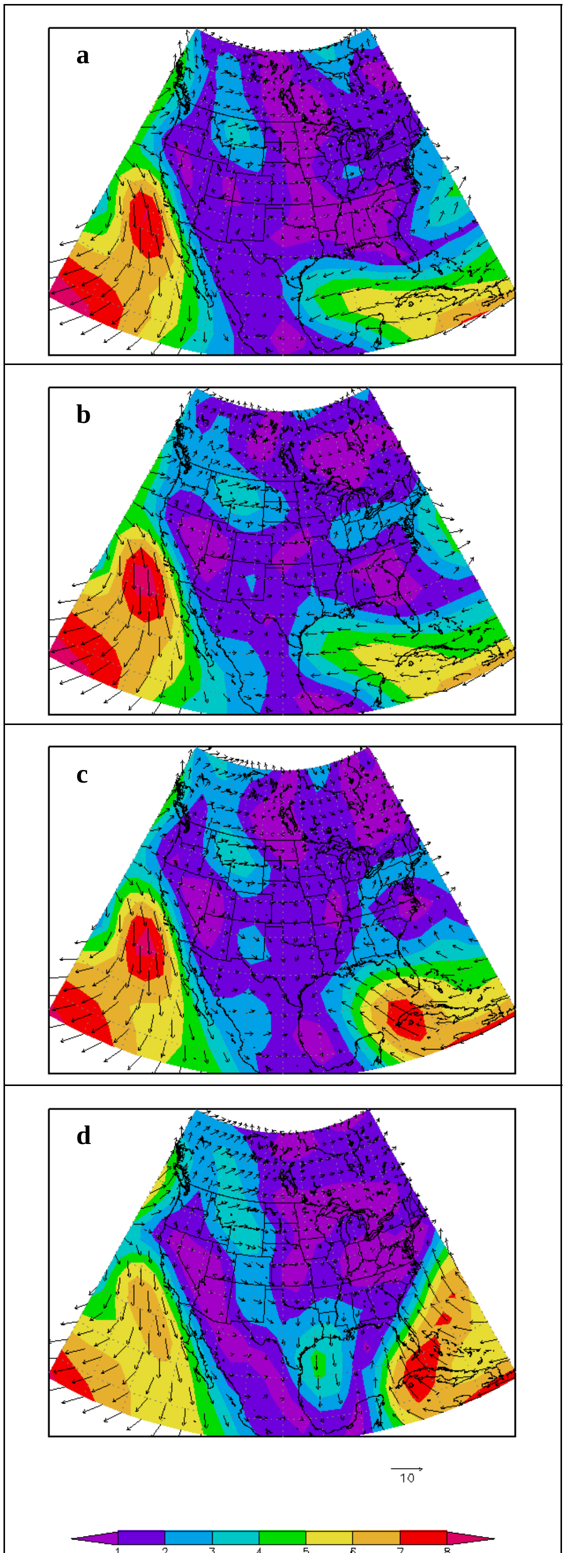


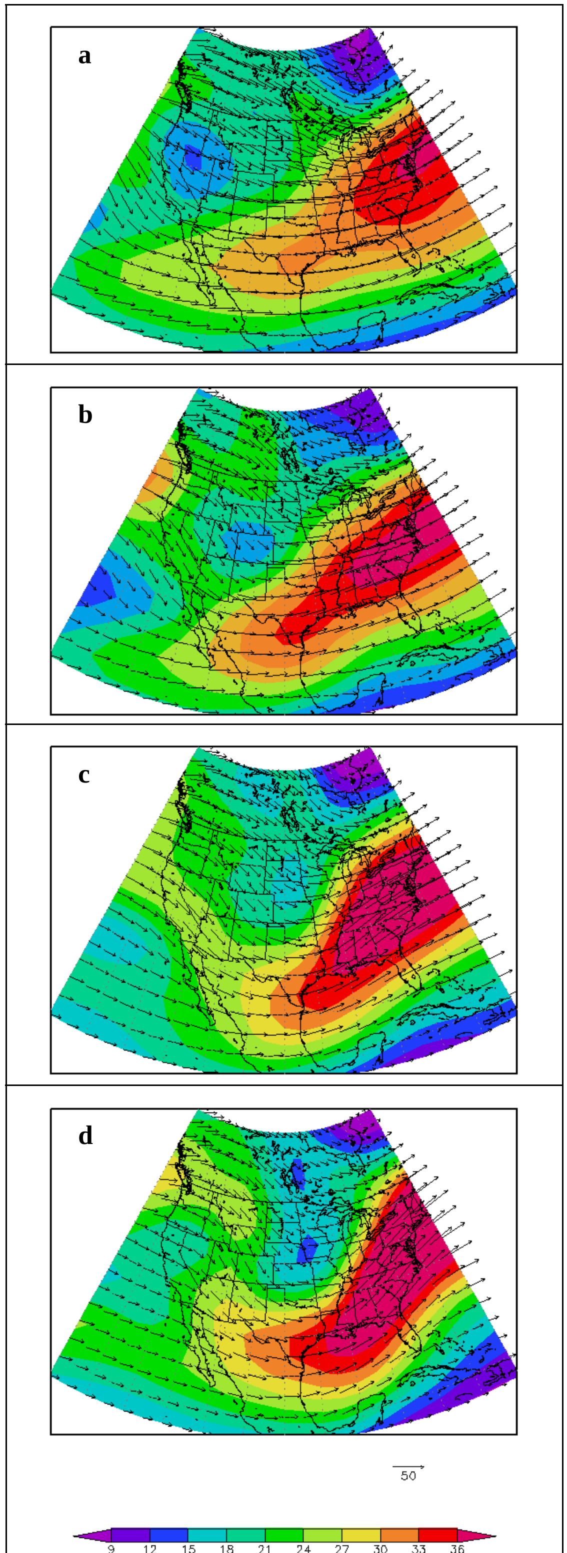

**Figures 3a-3d. Day -3 to day 0 respectively showing composite sea level pressure (hPa)**




**Figures 4a-4d Day -3 to day 0 respectively showing composite specific humidity (dgkg$^{-1}$) at 700 hPa**




**Figures 5a-5d Day -3 to day 0 respectively showing composite 1000 hPa wind vectors ($ms^{-1}$)**



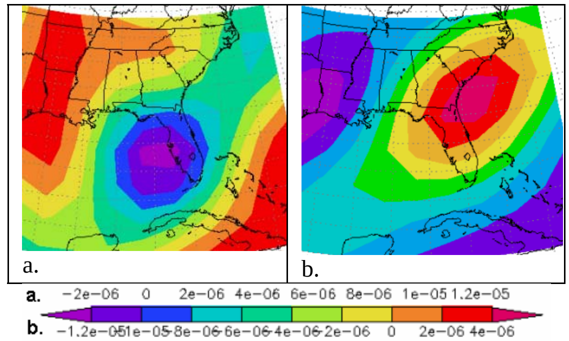

**Figures 6a-6d Day -3 to day 0 respectively showing composite 250 hPa wind vectors ($ms^{-1}$)**

## 2. Composite patterns

NCEP reanalysis data (Kalnay et. al., 1996) were used to produce composites three days prior to the event (day -3) to the event day (day 0). Figures 3(a-d) show low sea level pressure over the southwestern Gulf of Mexico and Gulf of California at day -3 that intensifies over the western Gulf of Mexico and moves toward Florida. A southeast wind maximum at 1000 hPa over the Caribbean Sea on day -3 propagates northwest across western Cuba on day -1 then becomes southerly while propagating eastward across south Florida on day 0 [Figs. 5(a-d)]. Above the surface, winds continue with a southerly component but veer more westward to 200 hPa. At 250 hPa [Figs. 6(a-d)] a wind maximum across the eastern U.S. elongates westward as a trough intensifies over the central U.S. By day 0 the jet stream has dipped south with the right entrance region favoring upper divergence over the Tampa Bay area. As areas of low pressure west of Tampa Bay intensify, winds bring tropical moisture northward near the surface and from the southwest above the surface. This is evident in specific humidity values at 700 hPa, [Figs. 4(a-d)]. Values are highest over Southern Mexico at day -3 and the area becomes consolidated, drifting east across the Yucatan at day -1 and over Florida by day 0 resulting in precipitable water values increasing to over 40 mm with a strong decreasing gradient to the north. This scenario resulted in upward vertical motion by means of strong negative omega anomalies through the atmosphere across central Florida. Composite lifted indices values in the moderate (-1 to -3) range combined with increasing moisture advection at all levels within the atmosphere, and increasing upper divergence from the favorable jet position aloft all contributed to facilitate convection across the Tampa Bay Area. Figs. 7(a-b) show focused composite lower convergence and upper divergence patterns over Florida.

## 3. Skew-T Comparison

Averaged sounding parameters (Table 1) from Ruskin, FL (KTBW) match well to the NCEP Reanalysis composites. The typical sounding during these events indicates moist and moderately unstable conditions near the event times. The values indicate a convective scenario with individual sounding shear profiles similar to the 03 Feb. 2006 case (fig. 2b). Directional shear in the lowest layers and speed shear in the mid to upper levels decreased boundary movement resulting in a heavy rain scenario.




**Figs. 7(a) 1000 hPa divergence ($s^{-1}$), 7(b) 250 hPa divergence ($s^{-1}$).**

| | | | |
|---|---|---|---|
| CAPE (J/kg) | 1067 | CIN (J/kg) | -17 |
| Lifted Index | -2.84 | Thickness (m) | 5705 |
| Sweat Index | 340 | LFC (hPa) | 872 |
| K Index | 34.40 | Totals Index | 47.4 |
| Equilibrium Level (hPa) | 256 | Mixing Ratio (g/kg) | 15.46 |
| Precipitable Water (mm) | 50 | Bulk Richardson | 47 |

**Table 1. KTBW Averaged sounding parameters.**

## 4. Conclusion

The typical heavy rainfall day over west central Florida has a mid to upper level trough well west of Florida with surface low pressure to the west and an elongated slow moving trough over Florida. The Gulf of Mexico provides a source of low level moisture and instability. As convection continuously develops along the boundary over the gulf, subtle southwest wind veering with height moves convection northeast along the boundary. The details of this study provide forecasters with a generalized guide for predicting heavy rainfall events. It is still difficult to predict where slow moving convective bands will become stationary. Local wind convergence and stability effects of Tampa Bay may cause the already slow moving boundary to become stationary but a more detailed look will need to be taken.

## 5. References

Crow M. R., 1995, Climatology of Dry Season Heavy Rainfall in Central Florida--November through April, *NWS SR-165 (PB 95-191367).*

Kalnay et al., 1996, The NCEP/NCAR 40-year reanalysis project, *Bull. Amer. Meteor. Soc.*, 77, 437-470.

Wolter, K., and M.S. Timlin, 1998: Measuring the strength of ENSO - how does 1997/98 rank? Weather, 53, 315-324.