Composite Analysis of Cool-Season Florida Tornado Outbreaks

Jonathon Klepatzki*, Dr. Shawn Milrad*, and Todd Lindley~

*Embry-Riddle Aeronautical University, Daytona Beach, Florida

~National Weather Service Norman, Oklahoma

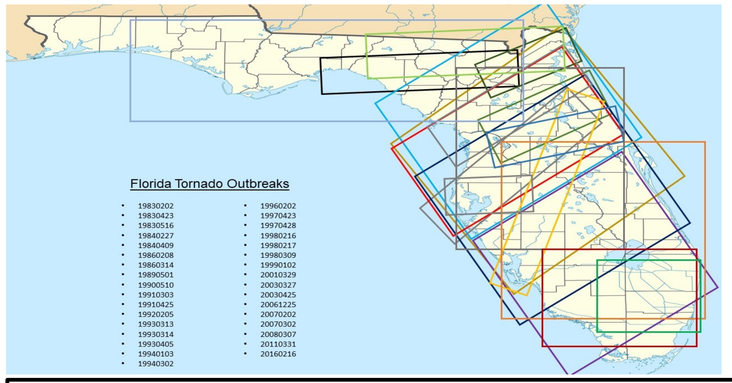
Corresponding author email: klepatzj@my.erau.edu

Introduction/Motivation

The study of tornado outbreaks has been well documented, however, there has only been a few on Florida tornado outbreaks. This study details the composite dynamic and thermodynamic conditions associated with these events.

- Florida tornado outbreaks was defined as 4 or more tornadoes occurring within a 24-h period during the winter and early spring months (Dec–May) from 1979–2016
- December–May was chosen to eliminate tornado outbreaks that were associated with tropical cyclones
- 35 outbreaks were identified using archived severe weather reports
- Composites were produced using the North American Regional Reanalysis (NARR)
- Compared to the Great Plains outbreaks, Florida tornado outbreaks tend to feature weaker tornadoes, however, several case studies (e.g., 1998 Kissimmee Outbreak, 2006 Central Fl Christmas Outbreak); since the 1970's have produced strong EF1-EF3's that impacted major metropolitan areas.

Initial results show Florida tornado outbreaks are associated with a negatively tilted mid-tropospheric trough (dynamics), moderate CAPE and low LCLs (thermodynamics), strong lower-tropospheric wind shear, and the upper-level divergent exit region of the Polar Front Jet (PFJ).



250-hPa Jet Stream Plots

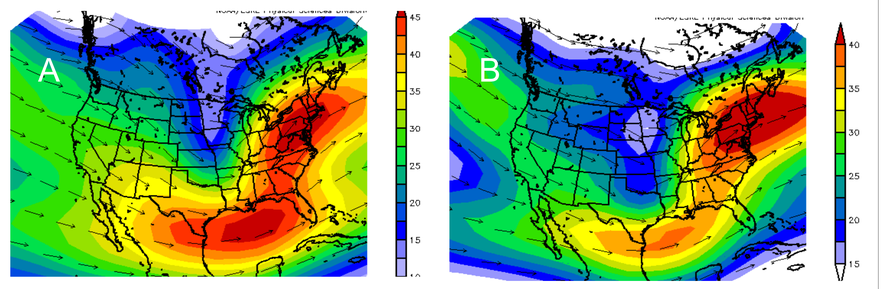
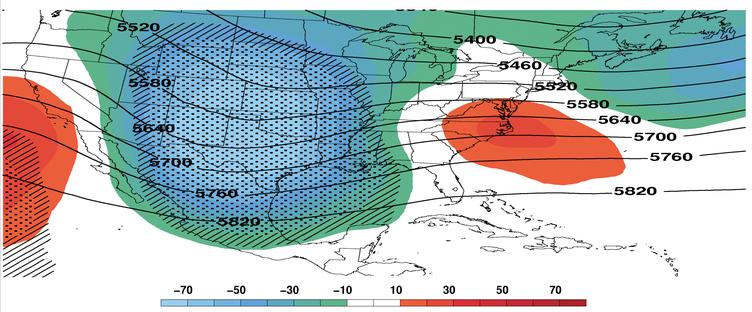


Figure 1: (Left) Florida map outlining outbreaks from 1983-2016. (Right (A)) Mean location of Jet Stream from 1983-1996. (Right (B)) Mean location of Jet Stream from 1997-2016.

500-hPa 24-h Prior



500-hPa at start of outbreak

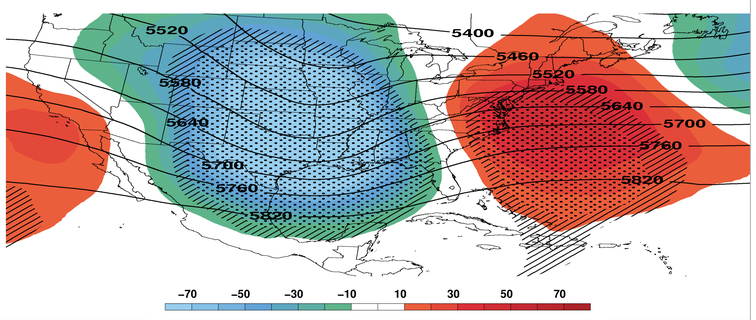


Figure 2: (Left) 24-h period prior to tornado outbreaks. (Right) During tornado outbreaks.

SLP Plots

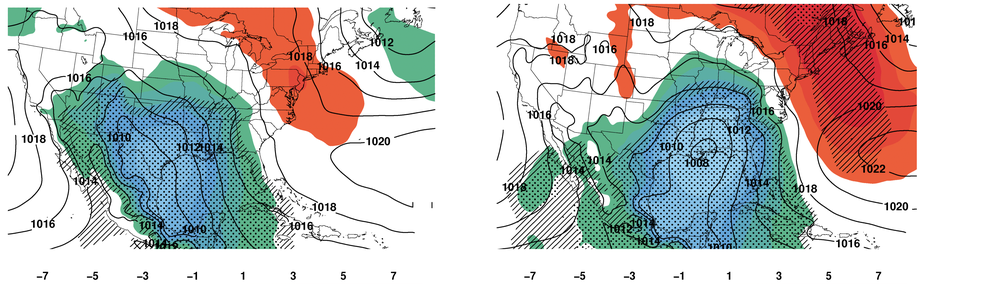


Figure 3: As in Fig. 2, (Left) 24-h prior to tornado outbreaks. (Right) During tornado outbreaks.

850-hPa θ_e Plots

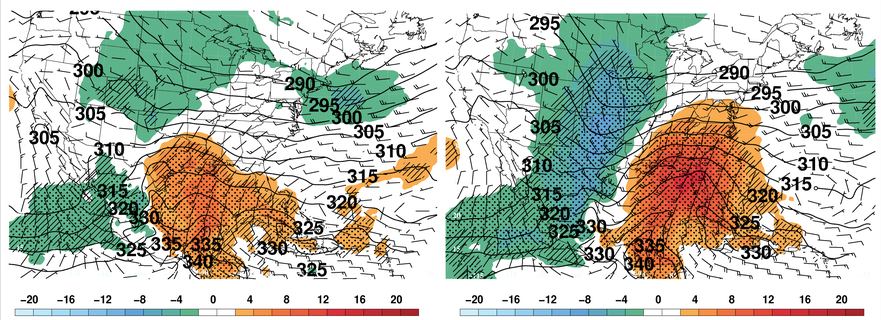


Figure 4: As in Fig. 2 and 3, (Left) 24-h period prior to tornado outbreaks. (Right) During tornado outbreaks.

PWTR Plots

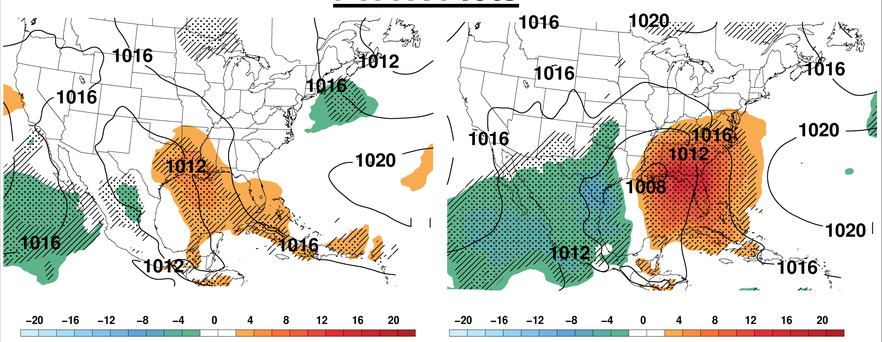


Figure 5: As in Fig. 2, 3, and 4, (Left) 24-h period prior to tornado outbreaks. (Right) During tornado outbreaks.

CAPE-Shear Plots

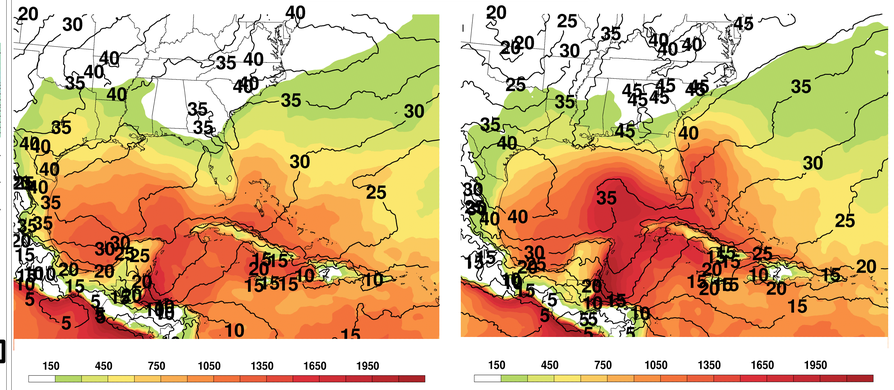


Figure 6: As in Fig. 2, 3, 4, and 5, (Left) 24-h period prior to tornado outbreaks. (Right) During tornado outbreaks.

Omega Plots

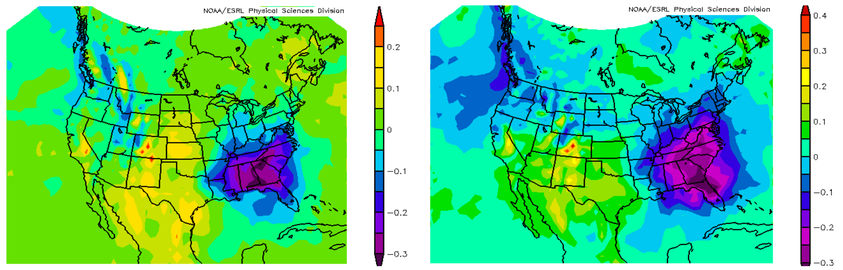


Figure 7: As in Fig. 2, 3, 4, 5, and 6, (Left) 24-h period prior to tornado outbreaks. (Right) During tornado outbreaks.

Results/Conclusions

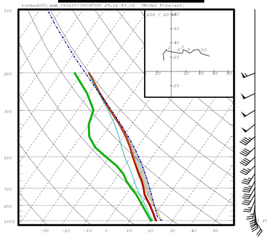
Similarities between Tornadic Outbreaks in N. Fl versus C. Fl:

- Location of the Polar Front Jet (PFJ) Max contributes to the development of Florida Tornado Outbreaks
- Enhanced 500-hPa divergence due to dual exit and entrance region of the subtropical and polar front jet
- Small to Moderate CAPE with large low-level wind shear profiles enhances the risk of tornadoes
- Speed and direction of the low-level jet enhances the low-level wind shear

Conclusions:

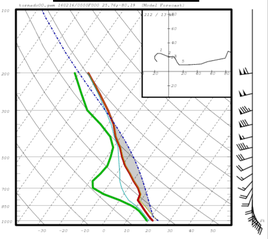
- Mostly cloudy skies dominated Florida up to 24-h prior to each event that produced subsidence (key ingredient for tornado outbreaks)
- Precipitable Water increased validating cloud coverage
- Negative-Tilted Major Short Wave Trough creates enough backing for cells to continue to develop
- Neutral ENSO conditions of +/- 0.4 in the Pacific limits the strength of cold air to counteract the warm moist air in the warm sector

20061225



DATE(S)	CAPE (J/kg)	Bulk Richardson Number (m^2/s^2)
19860208	467	23
19860314	1067	64
19910303	1457	51
19930313	960	45
19930405	655	23
19940103	0	53
19970423	2141	17
19980216	74	172
19980309	1569	19
20010329	0	81
20030327	963	34
20030425	175	41
20061225	461	42
20160216	967	52

20160216



Future Work

- Develop a composite analysis of cloud tops over Florida up to 24-h prior and during each tornadic outbreak
- Measure the ocean temperatures off the coast of Florida up to 24-h prior and during each tornadic outbreak
- Study the effects of sea-breezes during tornado outbreaks in Florida.

References

Cook, A. R., and J. Schaefer 2007. The Relation of El Nino-Southern Oscillation (ENSO) to Winter Tornado Outbreaks. *Mon. Wea. Rev.,* **136,** 3121-3137

Lanicci, J. M. 2016. A Multi-Scale Analysis of the Atmospheric Conditions Associated with the Daytona Beach Tornado of Christmas Day 2006. *Electronic J. Severe Storms Meteor.,* **11**(5), 1-44

Hagemeyer, B. C., and G. K. Schmocker 1991. Characteristics of East-Central Florida Tornado Environments. *Wea. Forecasting*, **6,** 499-514

Straka, J. M., and A. K. Kis 2009. Nocturnal Tornado Climatology. *Wea. Forecasting,* **25**, 545-561