1B.1 THE 2009-10 EL NIÑO AND FLORIDA DRY SEASON TORNADOES: A REALITY CHECK FOR THE LIMITS OF PREDICTABILITY

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1. INTRODUCTION

Extratropical storms can produce various societal impacts during Florida's dry season (1 November – 30 April), including deadly tornado outbreaks, hailstorms, damaging thunderstorm winds, coastal flooding, hazardous marine conditions, strong gradient winds, and both beneficial and flooding rains. The lack of extratropical storms can cause drought and increased wildfire risk.

The author (Hagemeyer 2006 and 2007) has documented a very strong relationship between the phase of the EL Niño Southern Oscillation (ENSO) and the number of extratropical storms affecting Florida during the dry season. He has made forecasts of the number of significant dry season extratropical storms based on ENSO phase since 2002 with considerable success (see Dry Season Forecast for Florida).

The environment necessary for the development of tornadic supercell thunderstorms during the Florida dry season: strong vertical motion and wind shear with plentiful low-level moisture and vertical instability, is typically found only in the warm sectors of extratropical storms (Figure 1, Hagemeyer, 1997). Thus, it is not surprising that a strong positive correlation between El Niño and the occurrence of severe weather such as tornadoes, damaging convective wind gusts, and lightning has also been documented by the author (Hagemeyer 1998 and 2000) and others (see, for example, La Joie, 2008, and Cook and Schaefer, 2008). However, it is the impact of violent tornadoes that is of most concern.

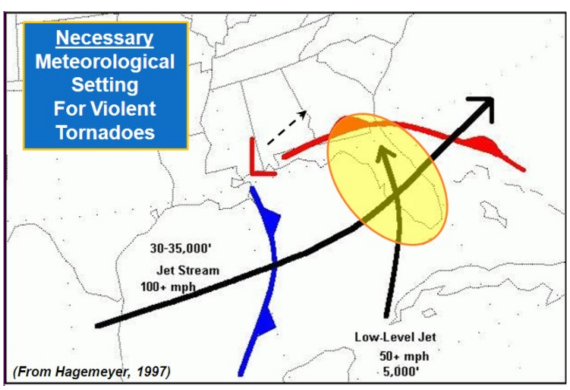


Figure 1. Conceptual model of favorable synoptic conditions for ≥EF2 tornadoes in the Florida Dry Season (Hagemeyer 1997).

The two deadliest Florida tornado outbreaks that were responsible for 63 deaths occurred during the recent El Niño winters of 1997-98 and 2006-07. Figure 2 shows the distribution of dry season tornado deaths in peninsular Florida since 1950 by ENSO phase with 90% of the deaths occurring during El Niños. On a seasonal scale, the greater the number of extratropical storms affecting Florida, the greater the chances that one or several of them will produce the sufficient conditions for violent tornadoes. An explicit dry season forecast of severe weather is not made; however, the Florida NWS offices use the forecast of an El Niño--and the expected increase in storminess and severe weather--to raise awareness of, and preparedness for, strong tornadoes in their outreach activities.

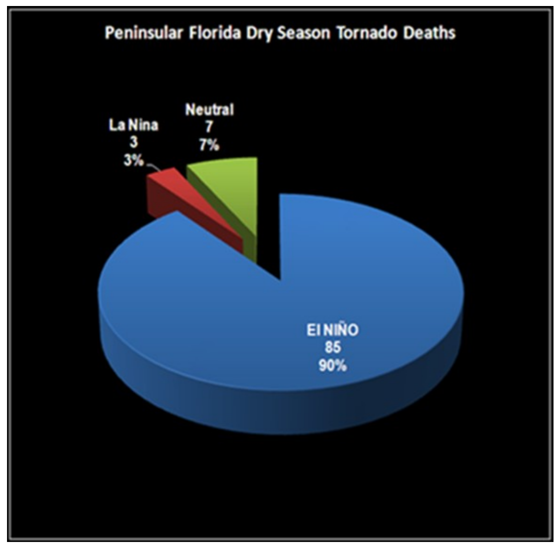


Figure 2. Peninsular Florida dry season tornado deaths (1950-2008) by ENSO phase (Hagemeyer et. al. 2010).

As another El Niño developed during the summer of 2009 and was expected to strengthen into winter, NOAA/NWS established an El Niño Communications Campaign Team of which the author was a member. The El Niño impacts graphic developed for educational and outreach use highlighted the "increased chances for severe weather in Florida" for the first time (Figure 3). The Florida NWS offices, in partnership with emergency managers and the media, conducted an unprecedented campaign to prepare the state for the expected increase in severe weather during the upcoming dry season. The goal was to avoid the large loss of life in tornado disasters of the previous El Niño winters.

As expected, the number of extratropical storms affecting Florida was well above normal. Indeed, the 2009-10 El Niño winter tied the record of 18 extratropical storms set during the 1997-1998 El Niño. While the forecast of above normal extratropical storms was accurate, the tornado activity was actually below normal, with only 18 weak tornadoes reported. By contrast, 71 tornadoes, 10 of which were strong and violent, occurred during the 1997-98 El Niño dry season. The 2009-10 El Niño dry season was the first since 1972-73 without any severe weather-related fatalities.

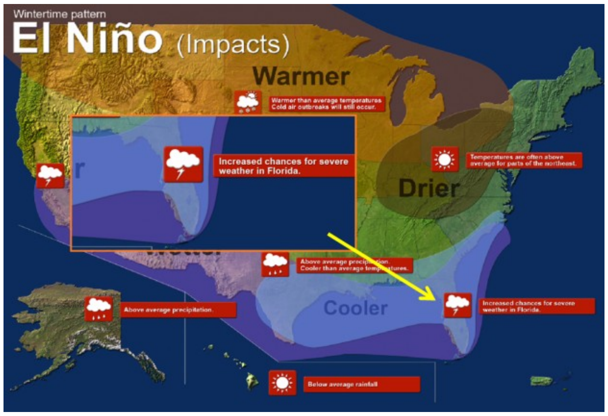


Figure 3. Graphic of expected winter impacts from the 2009-10 El Niño developed by the NOAA/NWS El Niño Communications Campaign Team.

Conventional thinking has been that sufficient warm moist low-level air would be available during an El Niño winter to produce several significant severe weather outbreaks from passing extratropical cyclones. However, the development of a persistent strong negative Arctic Oscillation (AO) in late 2009 and early 2010 (L'Heureux et. al. 2010 and Cohen et. al. 2010) was responsible for significantly modifying the typical impact of El Niño on Florida through frequent incursions of cold continental air masses deep into the southern latitudes, resulting in cold and wet conditions. Indeed, there were two deaths attributed to exposure to cold in Florida. As a result of the deep penetration of the cold air masses, the warm sectors of the majority of the developing extratropical storms that affected Florida were unable to supply enough low-level moisture and instability to fuel the deep convection in a high-shear environment needed to produce significant tornadoes.

The following sections will discuss the 2009-10 El Niño and the implications of the persistent negative AO pattern that likely spared Florida from the impact of violent tornadoes and, instead, brought record cold spells. The challenge of communicating uncertainty with decision makers will also be discussed. The dominance of the negative AO, while rare, raises significant questions regarding the limits of predictability of seasonal impacts based primarily on the ENSO phase and brings into sharp focus the need to improve the prediction of other intraseasonal oscillations such as the AO, the North Atlantic Oscillation (NAO) and the Pacific-North American (PNA) pattern (Hagemeyer and Almeida, 2004) and related blocking phenomena.

2. THE IMPACT OF THE 2009-10 STRONG EL Niño AND RECORD NEGATIVE ARCTIC OSCILLATION ON FLORIDA

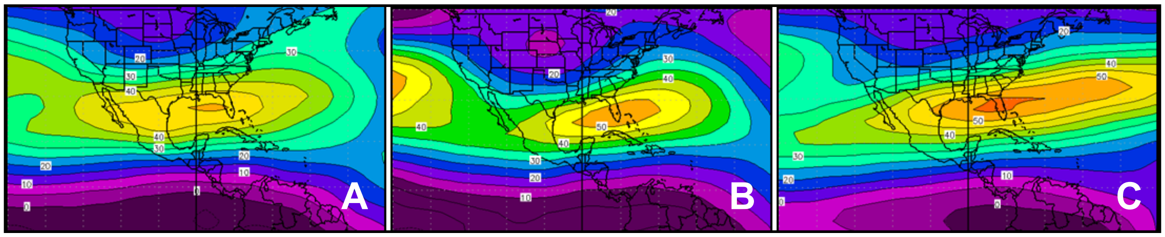
It is well documented that El Niño has a profound effect on Florida's dry season weather by increasing the strength of the subtropical jet stream and shifting it and the associated storm track southward on average over the Gulf of Mexico and Florida. The Florida Peninsula is ground zero for the impact of increased storminess during El Niño and coincidently has the greatest concentration of old-code manufactured housing units, campgrounds, and travel trailer parks in the United States. This convergence of vulnerable housing and climatic factors favoring violent nocturnal tornadoes has resulted in tragedies during past El Niño winters. A detailed discussion of these issues is contained in Hagemeyer et. al. 2010.

2.1 Record El Niño Jet Stream and Florida Storminess

To put the 2009-10 El Niño into historical perspective, the 250 mb zonal mean wind (U) chart for February and March (typically the peak severe weather season) is compared with the two greatest El Niños of 1983 and 1998 (Figures 4a-c). The typical bull's-eye of maximum 250 mb U during El Niño is found right over the Florida Peninsula in each case. However, the jet stream during 2010 was considerably larger and stronger over Florida than during the two greatest El Niños on record (55 m/s vs. 50 m/s). The 250 mb jet during early 2010 also showed a significant eastward extension over the Atlantic compared to 1983 and 1998.

The result of the persistent strong jet stream was 18 significant extratropical storms affecting Florida, tying the record set in the 1997-98 dry season. Figure 5 shows the daily gridded mean sea level pressure (MSLP) over Florida for the dry season with the temporal location of the 18 storms. Typical of strong El Niños, February and March were exceptionally stormy with a trend of successively deeper storms leading to a "climax low" for the season in mid-March.

At first glance, successive severe weather events might be expected across Florida with the warm Gulf of Mexico providing ample low-level moisture. However, the 2009-10 dry season had a below normal 18 weak (none ≥EF2) tornadoes on 10 days (normal is 22 tornadoes with 3≥EF2) compared to the 1997-98 dry season with 71 tornadoes on 21 days with 10 ≥EF2. The lack of significant severe weather, despite the record strength jet stream and number of extratropical storms, was a result of the persistent strongly negative AO.



Figures 4a-c. 250 mb zonal mean wind (m/s) for February and March 1998(a), 1983(b), and 2010(c).

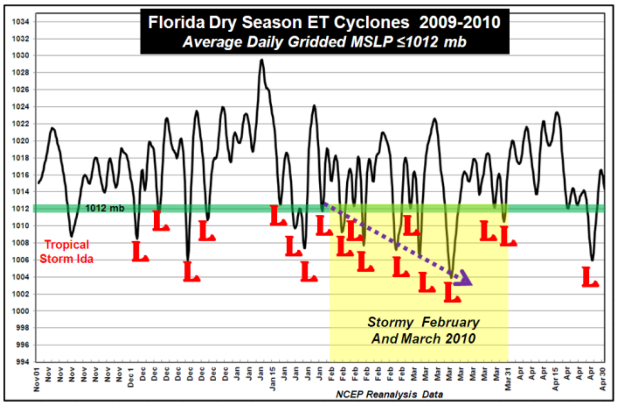


Figure 5. Average daily dry season MSLP for Florida with the 18 significant extratropical storms (<1012mb) indicated by large red "Ls".

2.2 Record Negative Arctic Oscillation – Below Normal Temperature and Tornadoes

Daily AO values during the Florida dry season plotted against the daily mean temperature for Orlando, Florida and the temporal location of the 10 Florida tornado days are shown on Figure 6. The AO index was negative from the 1st of December through early March. There were two major negative AO events with just a brief respite between them in late January. In comparing the daily AO values with Orlando mean temperature, it is easy to see the relationship between the leading negative AO pattern and cold weather in Florida. Indeed, Hagemeyer (2007b) noted there was only one way to get sustained cold weather in Florida: the high amplitude meridional trajectory associated with the negative AO pattern.

As the first negative AO event starting in December strengthened, each subsequent extratropical storm and cold front brought reinforcing cold air deep into Florida and beyond. There were three weak tornado days with passing extratropical storms during the first half of December which is not unusual. However, as the negative AO strengthened and persisted, there were no more tornado days until it briefly abated in mid-January, allowing warmer weather to return.

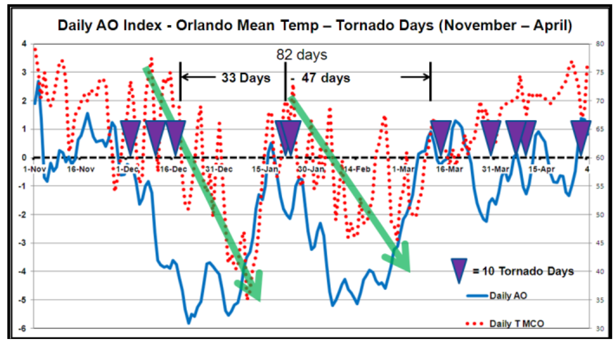


Figure 6. Daily AO index and Orlando mean temperature from 1 November 2009 through 30 April 2010 with the 10 tornado days indicated.

The cold air intrusions associated with the first negative AO event resulted in significantly colder than normal shelf waters by late January, particularly in the northeast Gulf of Mexico (Figure 7), and very cold soil temperatures as far south as the Florida Everglades (Figure 8). In real-time, the author and his colleagues speculated that the cold water could weaken convection with future ET Cyclones in the Gulf of Mexico as the dry season progressed.

After two weak tornado days during the brief warm period in the second half of January 2010, the strong negative AO pattern returned, and reinforcing cold air masses following the passage of strong storms again continually impacted Florida. It would be 47 days until another weak tornado day occurred in mid-March. The total lack of tornadoes in February in an El Niño winter was unprecedented. This second negative AO event ensured that the shelf waters of the Gulf of Mexico would not recover to normal through the end of the dry season. The average 4-inch soil temperature from 1 January through 31 March at the Everglades Agricultural Research Center was 17.7°C in 2010 versus 21.6º during the last El Niño in 2007.

Interestingly, as soon as the strong negative AO abated in mid-March, weak tornadoes again occurred with passing extratropical storms. This illustrates the propensity for strong extratropical cyclones to produce severe weather in Florida. A third period of much weaker negative AO returned in late March and lasted through April. The typical seasonal trend of rising temperatures without extreme cold air intrusions occurred during this period. However, the cold shelf water and soil temperatures persisted until the end of the dry season. The average daily AO index for the entire dry season was -1.7, a record, and the index was negative on 136 of 181 days.

The cumulative effect of the cold weather had a major impact on the ability to develop a warm moist unstable air mass in the warm sectors of passing storms to fuel the deep convection needed to produce supercell thunderstorms capable of spawning violent tornadoes. The net result of the frequent incursions of cold air into and well south of Florida was the modification of the typical maritime tropical (mT) air mass deep into the tropics. This resulted in a huge positive instability anomaly (more stable +5°K) right over Florida during the peak severe weather season of February and March (Figure 9) that greatly reduced severe local storm potential. The cold weather had a negative societal impact, but the lack of violent tornadoes in Florida was a very positive consequence.

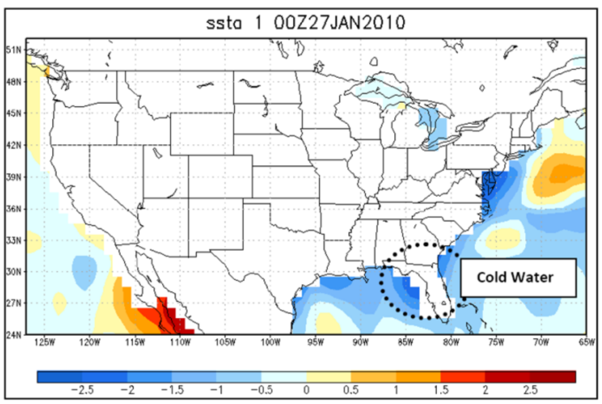


Figure 7. Sea surface temperature (SST) anomaly for 27 January 2010.

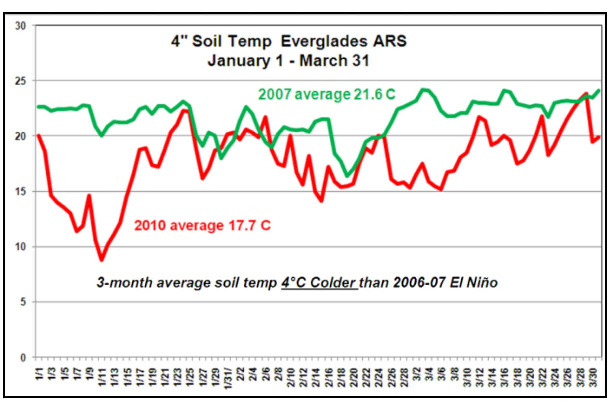


Figure 8. Soil temperature (°C) from January 1 to March 31 at the Everglades Agricultural Research Station for the 2010 (red) and 2007 (green) El Niños.

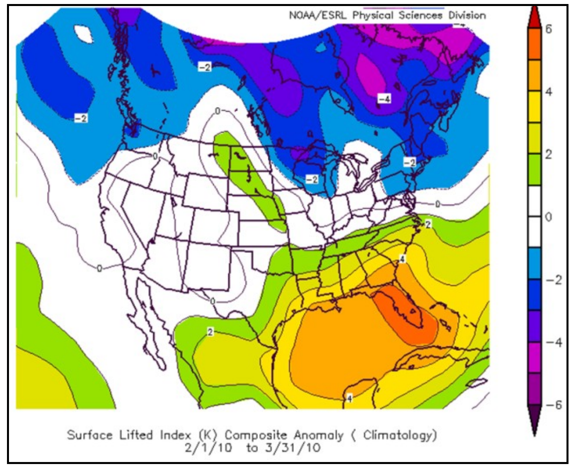


Figure 9. Composite surface Lifted Index (ºK) anomaly from 1 February through 31 March 2010.

2.3 Brief Case Study of 29 March 2010 Grand Bahama Tornado

SSTs in the northeast Gulf of Mexico remained very cold at the end of March 2010 with a large area of 16º C shelf water shown on Figure 10. During 27 March 2010, another in a series of low pressure systems was moving away from Florida, while a new low was developing to the northwest (Fig. 11a). A secondary low was predicted to develop on 28 March to the south over the Gulf of Mexico associated with the 60 m/s southern branch of the jet stream typical of El Niño (Fig. 11b). Ordinarily, this would be a setup for severe weather in Florida. However, in this case, as in all the other prior cases during the 2009-10 dry season, the question was whether sufficient moisture and instability would be available to fuel significant severe storms.

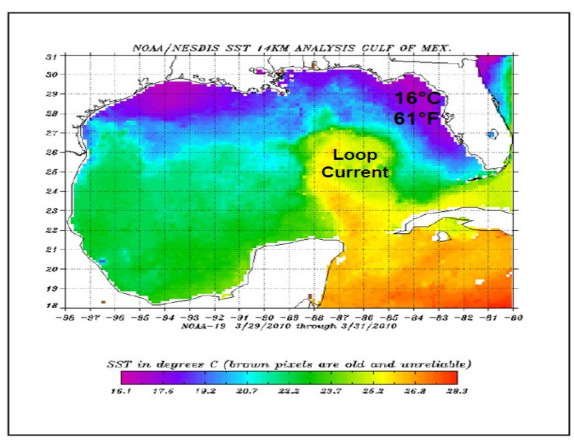
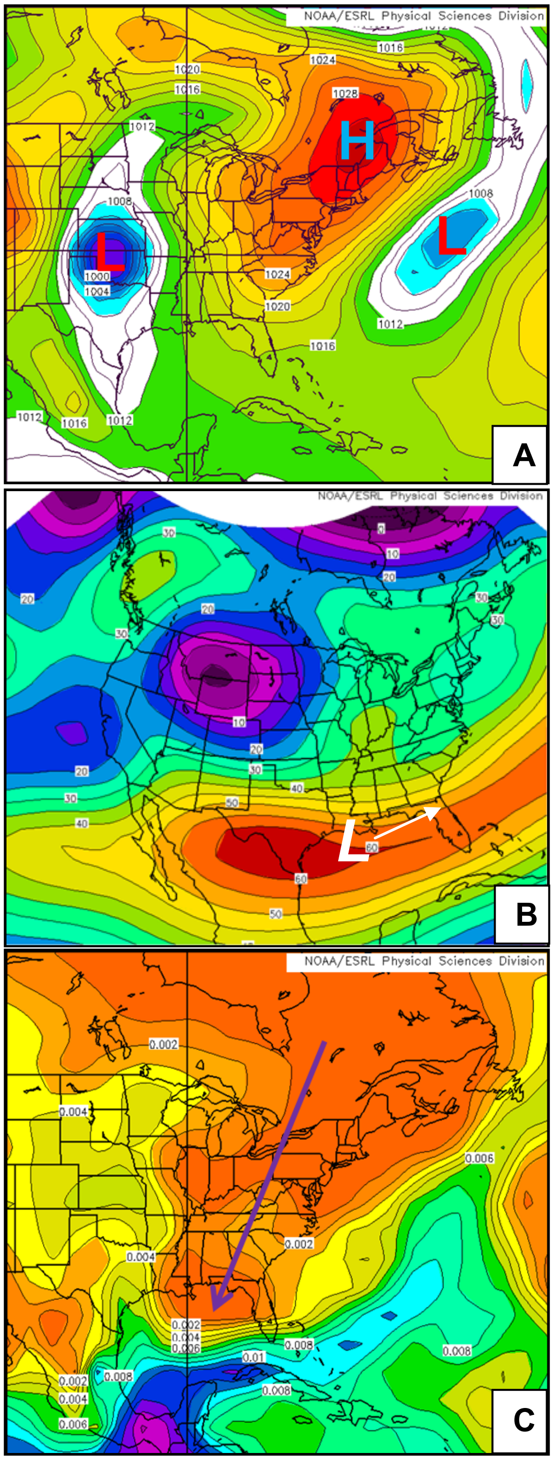
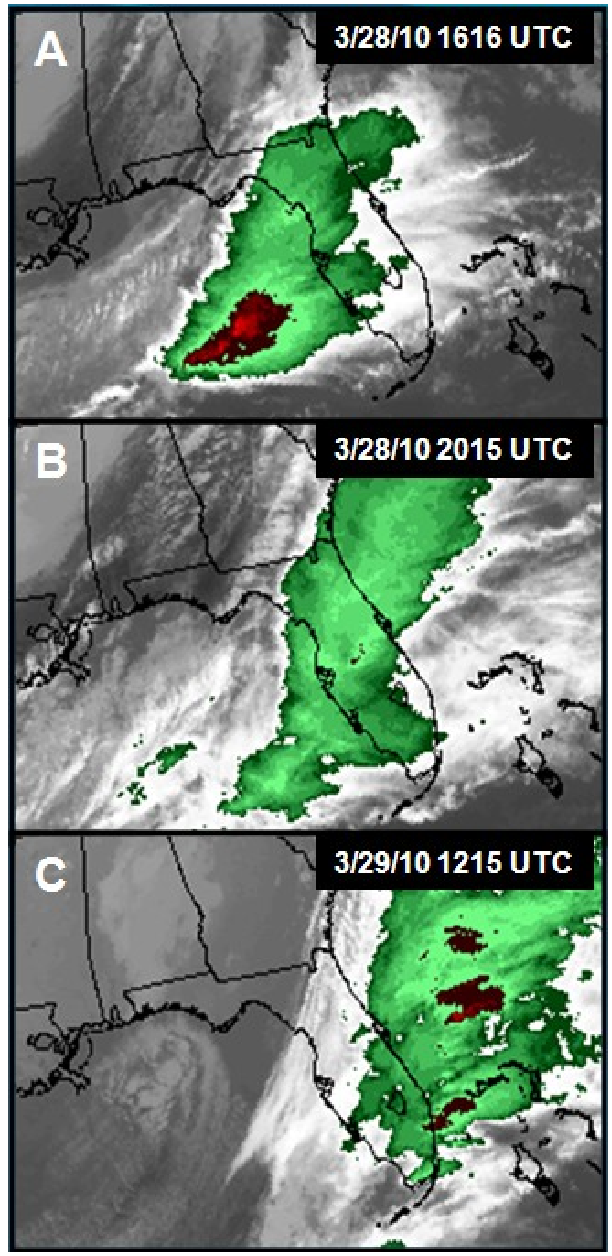


Figure 10. Gulf of Mexico SST analysis for 29-31 March 2010.



Figures 11a-c. Mean daily MSLP (A), 250 mb U (B, m/s), and 850 mb specific humidity (C, kg/kg) for 27 March 2010. Predicted low and track shown in white on 11b.



Figures 12a-c. GOES IR satellite imagery for 1616 UTC (A) and 2015 UTC (B) 28 March 2010, and 1215 UTC 29 March 2010 (C). Bright red indicates very cold (high) convective cloud tops.

By 27 March the cool and extremely dry air mass behind the departing low had moved over Florida and the northeast Gulf of Mexico. The 850 mb specific humidity over northern Florida was as low as over Hudson Bay – the source region of the air mass due to negative AO conditions. A strong gradient of low level moisture existed across south Florida with the area of highest values pushed to the extreme southern Gulf of Mexico south and west of Cuba. Due to strong jet stream dynamics the new low was expected to develop rapidly over the Gulf of Mexico on 28 March and move quickly east of Florida early on the 29th.

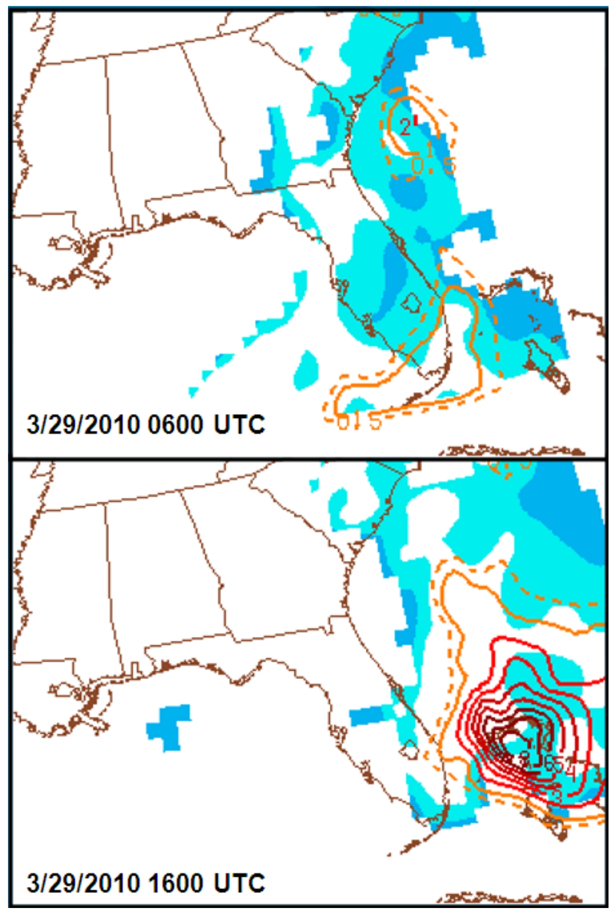
The low did develop over the northern Gulf of Mexico on 28 March and by 1616 UTC a strong convective complex was located west of Florida (Fig. 12a). This type of IR satellite signature is a typical indicator of severe weather potential for Florida and this would appear to be a fairly classic case. However, the strong convection shown in Figure 12a was over the warm Gulf Loop Current (Fig. 10). As the storm system moved over the unusually cold shelf waters of Florida by 2015 UTC (Fig. 12b), cloud tops warmed significantly, indicating rapid weakening. Only one severe weather event occurred during the evening of 28 March in Florida – an extremely weak, short-lived, tornado near Melbourne.

The focus for severe weather potential for early on 29 March shifted to extreme south Florida as the air mass further north was simply too cool and stable to support strong convection. The significant tornado potential (STP) index for 0600 UTC on the 29th (Fig. 13a) shows an area exceeding 1.0 over south Florida and the Keys, indicating the threat for supercell thunderstorms capable of producing significant tornadoes (strength ≥EF2) was at the very low end of the scale. The STP index takes into account the bulk shear of the storm environment, storm-relative helicity, or turning of the low-level wind, mean parcel Convectively Available Potential Energy (CAPE), an indicator of low-level moisture and instability, and Convective Inhibition (CIN).

In this case the STP index at 0600 UTC reflected the fact that shear and helicity were extremely high, but CAPE was very low. The moist, unstable air mass to the south was simply unable to be advected rapidly enough into the warm sector to be in phase with the strongly favorable dynamic environment. By early morning of the 29th the trailing edge of the storm complex was moving offshore the southeast coast of Florida. IR satellite imagery at 1215 UTC indicated that the storm was re-strengthening east of Florida (Fig. 12c). At 1227 UTC, an isolated EF0 tornado briefly touched down in Oakland Park in coastal Broward County within an area of convection that moved offshore and passed to the north of the Bahamas. This was the only severe weather reported in Florida on March 29th.

As the storm system moved offshore, the low-level flow strengthened considerably in the warm sector, pulling moist unstable air rapidly northward. After 1200 UTC the STP index increased dramatically over the western Bahamas, indicating the rapid increase in CAPE; by 1600 UTC had reached extremely high values exceeding 8.0 (Fig. 13b). During this time, an organized area of strong supercell thunderstorms developed just east of Biscayne Bay and moved rapidly northeast. Figure 14 shows these supercells just as the first tornado touched down at the Island Seas Resort on Grand Bahama Island around 1106 AM EST. The second supercell produced a violent tornado that made a direct strike on the Freeport container port around 1130 EST. That tornado knocked down huge cranes used for moving containers, killing three workers (Fig. 15). The third supercell produced a third tornado over the west end of Grand Bahama Island around 1145 EST.

This type of case of a family of long-lived strong supercell thunderstorms each producing strong to violent tornadoes has unfortunately been the hallmark of past El Niños in Florida. With record-tying storminess and the jet stream at record strength over Florida during much of the 2009-10 dry season, it was indeed fortuitous that an area of STP such as that shown on Figure 13b did not develop upstream of Florida in the eastern Gulf of Mexico. A significant tornado outbreak would have likely resulted.



Figures 13a-b. Significant Tornado Potential analyses (Thompson et. al. 2002) for 29 March 2010 at 0600 UTC (a) and 1600 UTC (b).
Source: http://www.spc.noaa.gov/

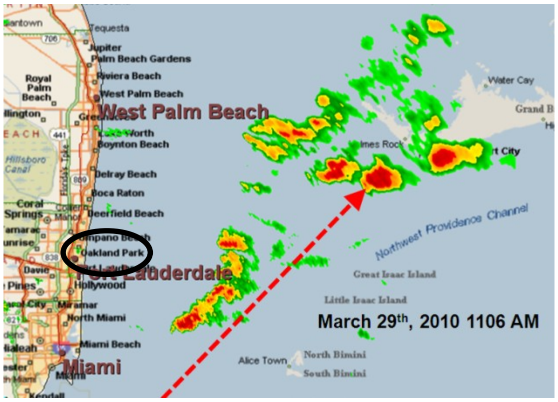


Figure 14. NWS Miami WSR-88D base reflectivity imagery at 1506 UTC 29 March 2010 showing supercells approaching Grand Bahamas Island. Oakland Park tornado location at 1227 UTC indicated by the oval. The Oakland Park storms passed to the north of the Bahamas several hours earlier.

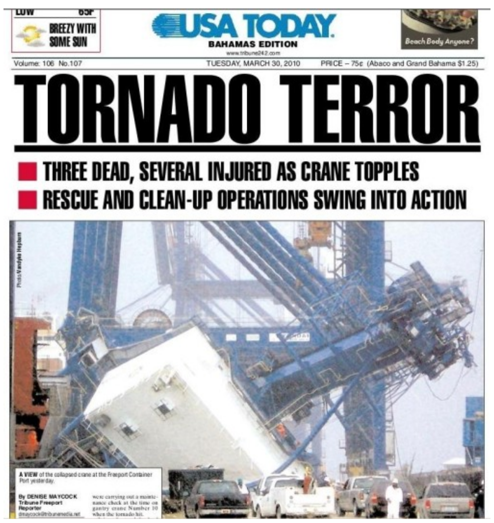

USA TODAY
BAHAMAS EDITION
Volume: 106 No.107 TUESDAY, MARCH 30, 2010
TORNADO TERROR
THREE DEAD, SEVERAL INJURED AS CRANE TOPPLES
RESCUE AND CLEAN-UP OPERATIONS SWING INTO ACTION

Figure 15. USA Today's Bahamas Edition coverage of the 29 March 2010 killer tornado.

3. CONCLUDING REMARKS: A REALITY CHECK FOR THE LIMITS OF PREDICTABILITY

The author (Hagemeyer 2007a) found that the AO had a significant correlation to jet stream strength over Florida that was additive to the impact of El Niño. In other words, a negative AO would tend to make the jet stream stronger over Florida during an El Niño and presumably increase the chances for stronger extratropical cyclones and severe weather. The record strong, persistent, negative AO pattern indicative of blocking of early 2010 did indeed result in a jet stream of record strength over Florida during the peak severe weather season. However, while not significantly modifying the traditional tracks of extratropical storms up to the point of impacting Florida, the influence of the record negative AO resulted in higher amplitude storms downstream of Florida compared to past El Niños. This influence can be seen in the significant eastward extension of the jet stream into the Atlantic Ocean east of Florida that is not present in the two greatest El Niños of 1983 and 1997 (see Figs. 4a-c). This pattern left Florida largely on the cold side of the mean upper level jet circulation. It is perhaps not a coincidence that rare winter tornadoes, stronger than any in Florida, struck both the Bahamas and Bermuda (Guishard, 2009) during these unusual mean conditions.

Historic deadly tornado events in the El Niños of 1966, 1983, 1998, and 2007 all occurred when the AO was weakly negative. It is a subject ripe for more research. But, it is reasonable to conclude that a little bit of negative AO during El Niños favors increased chances of severe weather in Florida, but a very strong negative AO is a limiting factor. This would be very important information for seasonal preparedness. The reality is that the AO and other *teleconnections* are not reliably predictable beyond a few weeks and a negative AO the likes of the 2009-10 event had never been seen before.

It would, of course, be scientifically incorrect to state that El Niño causes violent tornadoes in the Florida dry season. But, it might not be incorrect to say that a strong negative AO can limit them. Figure 15 is a simple conceptual schematic time/space scale diagram that illustrates the predictability of dry season tornadoes in Florida. There is a cascade of environmental processes on various scales that must take place to produce a violent tornado, but there are certain basic requirements that must be met such as the synoptic setting of the warm sector of an extratropical cyclone (Fig. 1). To this extent, El Niño certainly sets the stage for increased severe weather in Florida, but all the various actors from the synoptic scale to the sub-storm scale have to play their parts a certain way.

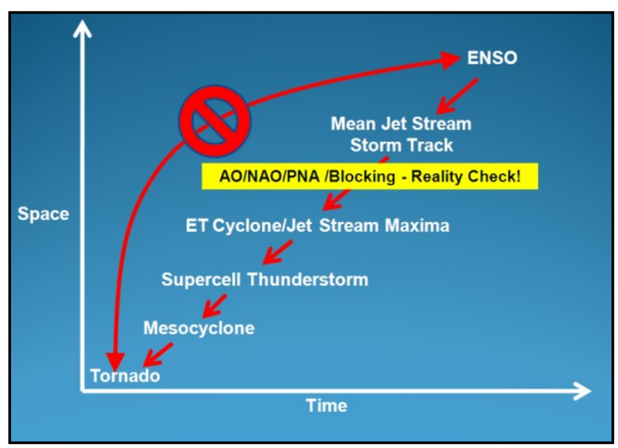


Figure 16. Simple conceptual predictability considerations for conditions leading to strong tornado development over Florida.

The rarity of violent killer tornadoes is testament to the difficulty of all the right atmospheric conditions coming together in space and time and striking vulnerable areas. How many ≥ EF2 tornadoes would have impacted Florida during the 2009-10 dry season without persistent cold air outbreaks and cooling of land and sea associated with a record negative AO, and would any of them have resulted in fatalities? It is impossible to know. Insight can be gained into this hypothetical question by considering the Grand Bahama tornado of March 29th just east of Florida where all the sufficient atmospheric conditions converged in space and time to produce strong tornadoes that intersected with a vulnerable population.

El Niño significantly increases the odds that the necessary conditions for severe weather will be more likely in Florida, the repeated cold outbreaks associated with the strong negative AO can mean that sufficient low-level moisture and instability in the warm sectors of extratropical storms are impossible – hence, for example, the total lack of tornadoes in February despite record storminess (Fig. 6).

The phases and combinations of ENSO, AO/NAO, PNA, and the MJO can greatly affect the odds off certain extreme weather events occurring in a region such as Florida on a seasonal scale and there would be tremendous benefits to be gained in their reliable prediction. Until significant progress is made in this area, the reality check on ENSO-based forecast schemes remains.

Regardless of the "reality check" and challenges of forecasting major teleconnections and oscillations, decision-making must go on! In the context of El Niño and severe weather in Florida, the dry season forecast is used to coordinate the efforts of the NWS, state and local Emergency Management (EM), and the media to raise awareness and educate to improve preparedness and mitigation efforts prior to the beginning of the season (see for example: http://www.srh.noaa.gov/media/mlb/Physical_Link_Between_El_Nino_and_Florida_Dry_Season_Weather/player.html).. Detailed discussions on these issues are contained in Hagemeyer et. al. (2010).

The goal is to motivate families and businesses to develop all-hazards plans and be prepared for whatever the upcoming dry season might bring. Not unlike the hurricane season, once the dry season has begun the focus for decision-making shifts from the seasonal outlook to preparing for the individual extratropical storms that are forecast to impact Florida. During the 2009-10 dry season, the potential impacts of each of the 18 extratropical storms were coordinated with EM officials typically starting 3 to 5 days in advance based on numerical models. In most cases, the necessary dynamic environment for severe storms was expected to be present, and the limiting factor was availability of low-level moisture and instability. The net effect of all these briefings was to bring the EM community to a much higher level of understanding of the challenges of forecasting dry season severe weather.

In this case (2009-10), the seasonal forecast for a higher risk of severe weather in Florida was a bust, or false alarm, as a result of the influence of the persistent negative Arctic Oscillation. Within a season of 18 storms, each individual storm was an opportunity for a false alarm. NWS staff were very aware of the risk of false alarms regarding severe weather potential with early season storms as that might result in inaction for more dangerous storms later in the season. Because the bulk wind shear and low-level winds were so strong during most storms, forecasters had to be careful not to totally minimize the risk, as only a slight increase in CAPE could result in significant nocturnal tornadoes – and this could occur on the scale of a few hours as the storm was crossing the state. This process resulted in the EM community and media becoming part of an ongoing dialog during the season. NWS forecasters were able to eliminate concern over most February and early March storms as the air masses were just too cool to support severe storms.

NWS products addressed the severe weather potential and uncertainty at temporal scales in agreement with Figure 16: Hazardous Weather Outlooks several days in advance, Tornado Watches several hours in advance and Tornado Warnings less than an hour in advance. Despite the inherent uncertainty, there would typically be ample opportunity for people to be prepared if they had an all-hazards plan in place. There was little negative reaction to the lack of severe weather on the seasonal scale noted, and tornado watches associated with strong winter storms were generally well-tolerated even for the many marginal tornadic potential situations. There is generally less tolerance for individual tornado warning false alarms, which put pressure on NWS warning meteorologists not to over-warn or "cry wolf", although this did not appear to be a negative issue during the 2009-10 dry season.

When the next strong El Niño develops, history demands that the same level of effort be made to educate and prepare for the increased potential of deadly tornadoes in Florida. We now know that the AO can have a much greater impact than previously thought possible. Additional studies of the relationship of AO to Florida dry season weather are already underway, as are improved outreach and educational material. However, the bottom line is that decision-makers, which include all people, families, and businesses, must develop an all-hazard plan that can leverage/exploit the best available information on predictions in the face of uncertainty.

4. REFERENCES

Cohen, 2010: Winter 2009–2010: A case study of an extreme Arctic Oscillation event. GEOPHYSICAL RESEARCH LETTERS, VOL. 37, L17707, 6 PP.

Cook, A. R., J. T. Schaefer, 2008: The Relation of El Niño–Southern Oscillation (ENSO) to Winter Tornado Outbreaks. Mon. Wea. Rev., 136, 3121–3137.

Guishard, M., and K. Zuill, 2009: Report on Tornado & Severe Thunderstorm 19, December . BAS-SERCO 2009http://www.weather.bm/DownloadsAndPresentations/19Dec2009_TornadoReport_webversion.pdf

Hagemeyer, B. C., 1997: An Investigation of Tornado and Thunderstorm Deaths in Florida. Presented to the 22nd Annual Meeting of the National Weather Association. Reno, NV (10/97).

Hagemeyer, B. C., 1998: Significant extratropical tornado occurrences in Florida during strong El Niño and strong La Niña events. Preprints, 19th Conference on Severe Storms, Amer. Meteor. Soc., Minneapolis, MN, 412-415.

Hagemeyer, B. C., 2000: Development of a Low Pressure Index as a Proxy for Dry Season Severe Weather in Florida and its Relationship with ENSO. Preprints, 20th Conference on Severe Local Storms, Amer. Meteor. Soc., Orlando, FL, 439-442.

Hagemeyer, B.C. and R.A. Almeida, 2004: Extreme Interseasonal and Intraseasonal Variability of Florida Dry Season Storminess and Rainfall and the Role of the MJO, PNA, and NAO, Preprints, 15th Symposium on Global Change and Climate Variations, Amer. Meteor. Soc., Seattle, WA, CD-ROM P7.1.

Hagemeyer, B.C., 2006: ENSO, PNA and NAO Scenarios for extreme storminess, rainfall and temperature variability during the Florida dry season, Preprints, 18th Conference on Climate Variability and Change, Amer. Meteor. Soc., Atlanta, GA, CD - ROM P2.4.

Hagemeyer, B.C., 2007a: The relationship between ENSO, PNA, and AO/NAO and extreme storminess, rainfall, and temperature variability during the Florida dry season: thoughts on predictability and attribution, Preprints, 19th Conference on Climate Variability and Change, Amer. Meteor. Soc., San Antonio, TX, CD-ROM JP2.16.

Hagemeyer, B. C., 2007b: Attribution of extreme variability of temperature and rainfall in the Florida dry season. NOAA 32nd Annual Climate Diagnostics and Prediction Workshop. Tallahassee, FL (10/07).

Hagemeyer, B.C, L. A. Jordan, A. L. Moses, S. M. Spratt, and D. F. Van Dyke, 2010: Climatological, meteorological, and societal implications for the large number of fatalities from central Florida Dry Season tornadoes during El Niño. Preprints, 22nd Conference on Climate Variability and Change. Amer. Meteor. Soc, Atlanta, GA, CD-ROM J4.5.

La Joie, M., and A. Laing, 2008: The Influence of the El Niño–Southern Oscillation on Cloud-to-Ground Lightning Activity along the Gulf Coast. Part I: Lightning Climatology. Mon. Wea. Rev., 136, 2523-2542.

L'Heureux, M., A. Butler, B. Jha, A. Kumar, and W. Wang, 2010: Unusual extremes in the negative phase of the Arctic Oscillation during 2009. GEOPHYSICAL RESEARCH LETTERS, VOL. 37, L10704, 6 PP.

Thompson, R. L., R. Edwards, and J. A. Hart, 2002: Evaluation and Interpretation of the Supercell Composite and Significant Tornado Parameters at the Storm Prediction Center. Preprints, 21st Conference on Severe Local Storms, Amer. Meteor. Soc., San Antonio, TX. Paper J3.2.