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Partners or Cooperative Project: NA17WD2383 UCAR Award No.: S0338669

Date: 3-31-04

SECTION 1: PROJECT OBJECTIVES AND ACCOMPLISHMENTS

1.1:

The objective of this COMET Partners project was to conduct a climatological and composite study of cool season tornadoes in the southeast United States (US). The climatological portion of this research was completed using Storm Data tornado reports. F2 and greater tornado reports were stratified according to geography, time of day, and month. Results indicate that there is a primary maximum of tornado occurrence during the spring, as well as a secondary peak of strong (F2 or greater) tornado occurrence across the entire southeast US during the cool season. Regions of the Southeast far away from the Gulf of Mexico (e.g., northern Alabama, Mississippi, Tennessee, North Carolina and Arkansas) tend to exhibit a stronger diurnal signal in cool season (November through March) strong tornado reports than do regions in close proximity to the Gulf of Mexico. Coastal regions of the Southeast, including the Florida peninsula, can even exhibit a nocturnal maximum of strong tornadoes during the cool season.

Work has also progressed in the composite section of this project. Event-relative composites were created of all tornado episodes from 1950-2001 using the NCEP/NCAR reanalysis data. Each grid was translated so that the first tornado was at 32°N, 90°W before the grids were averaged to create the composite. Composites were created for tornado episodes beginning between 0000 and 0600 UTC, 0600 and 1200 UTC, 1200 and 1800 UTC, and 1800 and 0000 UTC. Results of the composites indicate that, while similar dynamics and large-scale forcing for ascent are present at all times, tornado episodes which begin overnight have a 4 m s^{-1} (8 kt) stronger upper level jet and higher theta-e air at 850 hPa than episodes which begin during the daytime hours, near peak diurnal heating (appx. 325K, compared to appx. 320K for daytime episodes) (Fig. 1). Additionally, the low-level (925 hPa) ageostrophic wind was 2 m s^{-1} stronger for events which began overnight or in the early morning (0600-1200 UTC or 1200-1800 UTC), although late-afternoon to early evening episodes exhibited more southeasterly (as opposed to southerly) ageostrophic wind at 925 hPa (Fig. 2). Future work will include the use of radiosonde and surface observations to better understand the diurnal variation of temperature, moisture and wind at stations along the Gulf coast.

A detailed case study of the 22-23 February 1998 central Florida tornado episode was also conducted. Results of the case study suggest that the presence of strong frontogenesis along an east-west oriented baroclinic zone across the Florida peninsula helped rapidly reintensify a squall line as it made landfall after moving eastward across the Gulf of Mexico. Additionally, the intensity of the squall line was related strongly to the sea surface temperature anomalies in the Gulf, as evidenced by high lightning flash totals over the very warm waters of the Loop Current (Fig. 3).

The SPC has benefited significantly from the development of a detailed climatology for this important class of severe weather events and through professional interaction with University scientists. The climatology reaffirms forecaster perception of an enhanced cool-season significant tornado threat during non-standard hours over near-Gulf portions of the Southeast United States. The initial climatological and case study work begun during this one-year Partner's Proposal will be expanded during the current two-year Cooperative Project allowing preliminary results to be refined and tested across a wider variety of cases. Although the initial climatological results are useful to SPC and NWS Operations, the additional work planned during the Cooperative Project is critical expanding the effort's impact on operations. Results from the current research were shared with all SPC operational forecasters during Fall 2003 Training classes and influenced SPC forecasting during the 2003-2004 Cool Season.

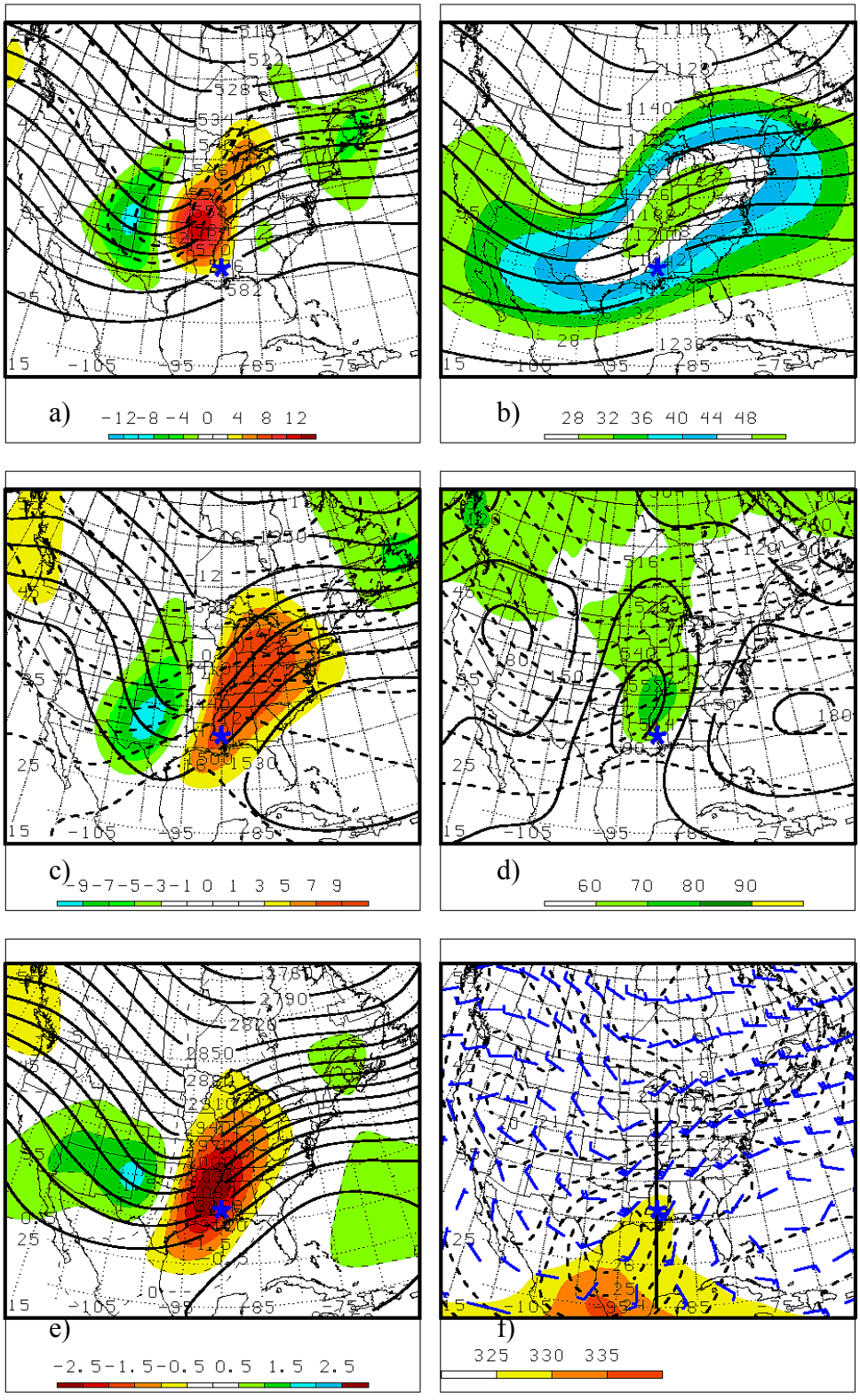

Fig. 1: a) 500 hPa heights (solid, dam), vorticity (dashed, x 10^{-5} s^{-1}), vorticity advection (shaded, x 10^{-10} s^{-2}), b) 200 hPa heights (solid, dam), isotachs (shaded, m s^{-1}), c) 850 hPa heights (solid, m), temperature (dashed, °C), temperature advection (shaded, x 10^{-5} °C s^{-1}), d) 1000 hPa heights (solid, m), 1000-500 hPa thickness (dashed, dam), 700 hPa relative humidity (%), e) 700 hPa heights (solid, m), vertical motion (dashed and shaded, x 10^{-3} hPa s^{-1}), f) 850-500 hPa lapse rate (dashed, °C), 850 hPa θ_e (shaded, K), 850 hPa winds (kt) for storm-relative composite of tornado events beginning between 0600 and 1200 UTC. '*' denotes location of first tornado. Black line in f) denotes cross section line (not shown).

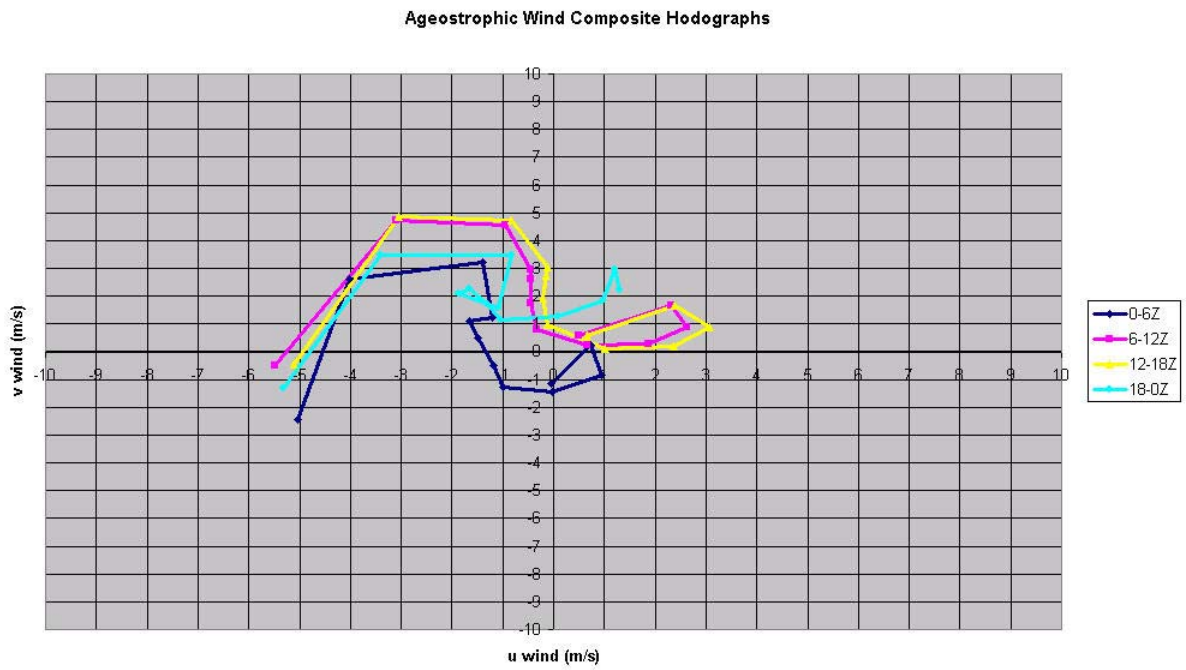

Fig. 2: Hodograph of ageostrophic wind (m s^{-1}) for all composites.

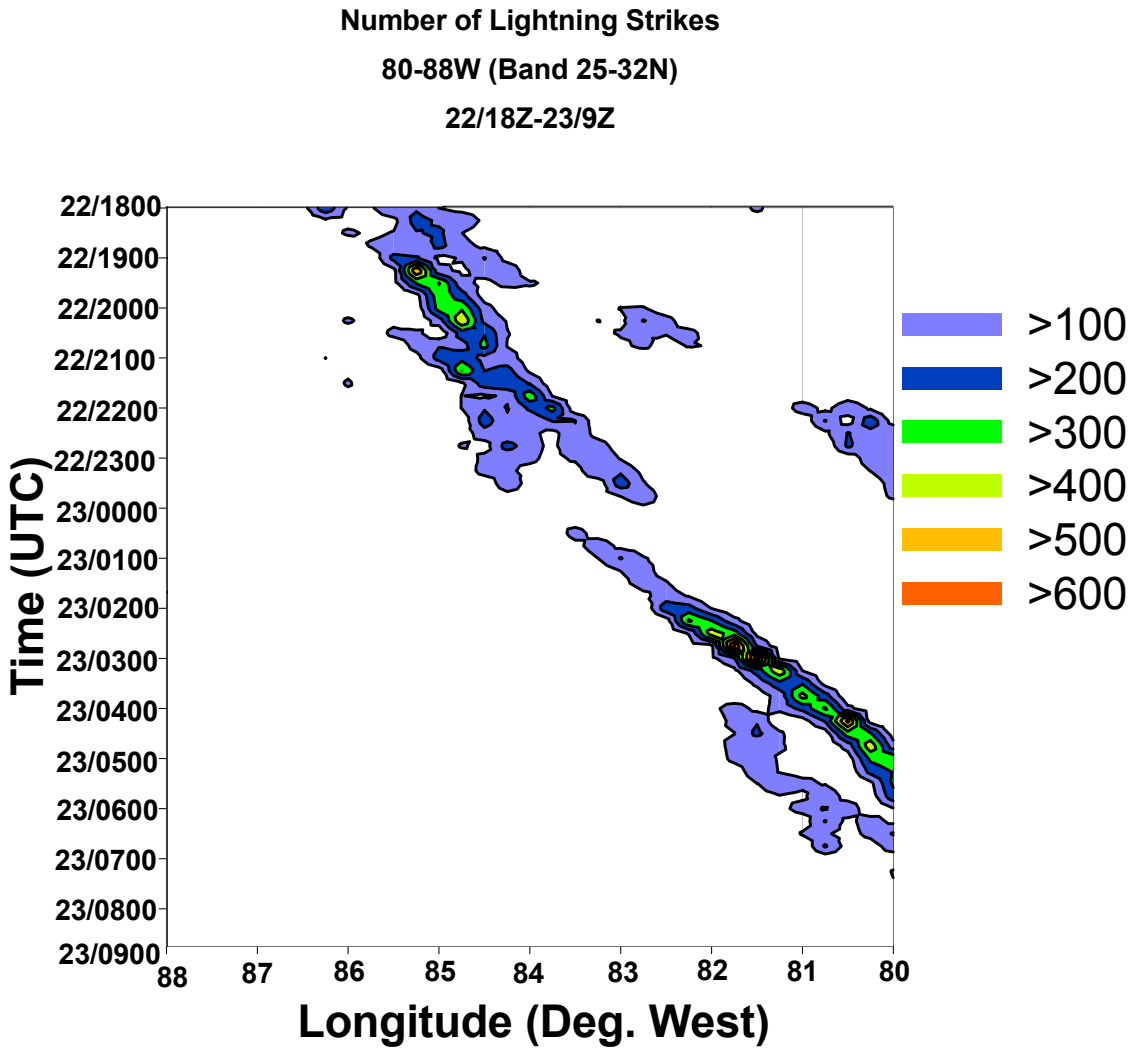

Fig. 3: Hovmoller diagram of number of lightning flashes (15 minute intervals) from 22/1800 UTC to 23/0900 UTC. Dotted line represents longitude where SST anomaly changes sign from positive to negative. Dashed line represents roughly the longitude of the Florida west coast.

SECTION 2: SUMMARY OF UNIVERSITY/NWS/DOT EXCHANGES:

2.1:

Cooperative exchanges between the partners on this project largely took place at regularly scheduled conference calls. A web page with current results was updated regularly, and results, ideas, and issues that arose were discussed at the conference calls (http://www.atmos.albany.edu/student/alicia/phd.htm). Additionally, informal meetings with various partners were conducted at national AMS conferences, where results were discussed in person. A visit by University at Albany researchers to Norman, Oklahoma also aided in collaboration. Meetings with SPC forecasters/NSSL researchers (e.g., Harold Brooks, David Schultz, Chuck Doswell) and project participants were conducted during this visit, and a seminar entitled "A Study of Cool Season Tornadoes in the Southeast United States" was given by Alicia Wasula and attended by many SPC forecasters. Informal discussion following the seminar helped facilitate an exchange of ideas regarding the current results and future direction of this research.

2.2:

The visit to Norman Oklahoma by University at Albany researchers not only strengthened our ongoing research collaboration but provided the opportunity to share current research results directly with NWS forecasters. During their visit, University at Albany researchers spent considerable time directly in SPC forecast operations discussing the research project. Alicia Wasula's SPC seminar was attended by numerous SPC forecasters and helped familiarize them with new aspects of the Southeast U.S. cool season severe storm problem. The seminar was constructed to facilitate maximum informal exchange between forecasters and University at Albany research partners. This objective was overwhelmingly achieved. As a follow up to these exchanges with SPC forecasters, the University at Albany web based project summary has recently been distributed to all SPC forecasters. This directly benefited SPC forecaster preparedness for these phenomena during the 2003-2004 cool season.

SECTION 3: PRESENTATIONS AND PUBLICATIONS

3.1:

Wasula, A. C., L. F. Bosart, R. Schneider, S. J. Weiss and R.H. Johns: An examination of the contrasting evolution of two southeast United States cool season severe weather episodes. *Preprints, 21st Conf. on Severe Local Storms*, San Antonio, TX, 12-16 August 2002.

Wasula, A. C., L. F. Bosart, R. Schneider, S. J. Weiss and R. H. Johns: Mesoscale aspects of the rapid intensification of a tornadic squall line across central Florida: 22-23 February 1998. *Preprints, 10th Conf. on Mesoscale Processes*, Portland, OR, 23-28 June 2003.

Wasula, A. C., L. F. Bosart, R. Schneider, S. J. Weiss, and R. H. Johns, 2004: A Study of Cool Season tornadoes in the southeast United States. Oral presentation at the 29th Annual Northeastern Storms Conference, 12-14 March 2004, Saratoga Springs, NY.

SECTION 4: SUMMARY OF BENEFITS AND PROBLEMS ENCOUNTERED

4.1:

Regular communication via conference calls between participating members of this project and maintenance of a web page (http://www.atmos.albany.edu/student/alicia/phd.htm) has helped to facilitate sharing of data and discussion of results. Informal meetings at national AMS conferences have also helped facilitate discussion amongst project participants.

4.2:

The seminar by University at Albany researchers was well attended and served to both educate SPC forecasters on the initial research results, and guide University at Albany researchers toward research lines of direct interest to NWS forecast operations. The University at Albany web site has provided an important vehicle for education of the entire SPC forecast staff on the climatological characteristics of the cool-season tornado threat over the Southeast United States despite the difficulties of communication in a 24x7 environment. The SPC and its NWS partners have encountered no significant problems in our interaction with University at Albany researchers.