

**“The Collaborative Science, Technology,  
and Applied Research (CSTAR) Program”**

**Title:**

**“Continuing Studies of Cool- and Warm-Season Precipitation  
Events over the Northeastern United States”**

University: University at Albany

Name of University Researchers Preparing Report: Lance F. Bosart and Daniel Keyser

NWS/AFWA/Navy Office: National Weather Service, Albany, New York

Name of NWS/AFWA/Navy Researcher Preparing Report: Eugene P. Auciello

National Oceanic and Atmospheric Administration Award Number: NA04NWS4680005

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## **SECTION 1: Summary of Graduate Student Research Activities**

### **(a) CSTAR Graduate (Matthew D. Greenstein)**

Matthew D. Greenstein - 2006: "Mesoscale Structure of Precipitation Regions in Northeast Winter Storms"

While forecasters can predict likely areas of precipitation, problems remain in correctly anticipating mesoscale precipitation patterns within those areas. In northeastern United States snowstorms, precipitation takes on numerous patterns, or modes, in radar reflectivity imagery, e.g., relatively uniform, fractured, and banded. Better forecasts of these mesoscale characteristics would allow for enhanced prediction of snowfall amount and variability and for the differentiation between high-impact and low-impact snows.

Twenty "heavy snow" events in the Northeast from the winters of 2002–03 through 2004–05 are selected for analysis using several criteria based on precipitation type, snowfall, time of year, and location. High-resolution WSI Corporation NOWrad composite reflectivity radar mosaics are used to identify five main precipitation modes, or mesoscale patterns, among the cases. The NCEP North American Regional Reanalysis is used to create plan-view maps and cross sections in order to ascertain which aspects of the ingredients—lift, instability, moisture, and microphysics—can assist in distinguishing the observed precipitation modes.

Ultimately, it is shown that the frontogenesis pattern and conditional instability help to differentiate between the five modes. Some aspects of the frontogenesis pattern that accomplish this goal are its strength, steepness, and whether it is surface-based. Notably absent from a discussion of the distinguishing features is weak moist symmetric stability, which appears to be a favorable condition for heavy snow but is not a precipitation mode-distinguishing parameter. Lastly, conceptual models and a flowchart are developed that a forecaster can use operationally to improve the mesoscale forecast of these heavy snow events.

**(b) CSTAR Graduate (Keith R. Wagner)**

Keith R. Wagner - 2006: "Cool-Season Moderate Precipitation Events in the Northeastern United States"

Moderate precipitation events contribute a significant percentage of all cool-season (1 October–30 April) precipitation in the northeastern United States. It is important to investigate the structure and causes of these moderate precipitation events because 1) they are relatively common, 2) they tend to occur in relatively weak synoptic-scale forcing regimes, and 3) they can be challenging to forecast. The purpose of this research, through use of a climatology and case studies, is to determine the spatial and temporal characteristics of cool-season moderate precipitation events in the Northeast, and to examine the synoptic-scale and mesoscale forcing that governs when and where these events occur. This research was conducted under the National Weather Service (NWS) Collaborative Science, Technology, and Applied Research (CSTAR) program.

A 10-yr climatology (October 1994–April 2004) of cool-season moderate precipitation events across the northeastern United States was constructed using hourly and daily precipitation data provided by the National Climatic Data Center (NCDC). A total of 35 first-order NWS stations across the Northeast were included in the study. The results of the climatology indicate that important variations in the frequency of occurrence of moderate precipitation events occur within the cool season. October received the lowest number of events during the 10-yr period, while a peak in frequency was observed in early winter and again in spring. These peaks in frequency of occurrence correspond to times when the synoptic-scale storm track is favorably located to produce moderate events across the Northeast (early winter and spring) and lake-effect precipitation is most likely (early winter). They also coincide with times during the cool season when 500 hPa cyclone frequency is at a maximum (spring) and cold air aloft over heated and/or elevated terrain results in showery precipitation (spring).

Variations in frequency of occurrence also are observed based on geographical location. A general decrease in the number of moderate events occurs to the south and east across the domain. Regions of enhanced frequency are located downwind of the Great Lakes, across the northern section of the domain, and along the spine of the Appalachians. These regions likely experience a higher frequency of occurrence due to a favorable synoptic-scale storm track, lake-effect precipitation, and/or orographic enhancement.

Four moderate event cases were selected for further study in order to examine the synoptic and mesoscale forcing that led to the observed precipitation. It was found that moderate precipitation events have ingredients that are similar to heavier events. In moderate events synoptic-scale forcing is present but generally weaker than for heavy events. Also, mesoscale features such as frontogenesis and weak moist symmetric stability or negative saturation equivalent potential vorticity are not as intense, deep, upright, or well aligned as is typical for heavy events. These features also tend to be more transient in moderate events since the associated storm typically moves at a faster speed than for heavy events. Therefore, although ingredients observed in heavy events are also found in moderate events, they are weaker in the moderate events, thus reducing precipitation totals.

**(c) Heavy Rain Events Preceding the Arrival of Tropical Cyclones.  
(Matthew Cote)**

**(Focal Point: Michael Jurewicz – NWS Binghamton, NY)**

**Research Summary (1 May 2006–31 October 2006):**

Work began during this period on a new CSTAR project involving heavy rain events that occur well out ahead of landfalling and near-coastal-tracking tropical cyclones (TCs). The seed for this venture was first planted in the 21 Oct 2005 CSTAR report, as two such predecessor rain events (PREs) occurred during the 2005 hurricane season in the Taunton County Warning Area (associated with Katrina and Ophelia). Just prior to these flash flooding events, most of the attention was given to the projected paths of the TCs themselves, and there was little or no advance warning that such hazardous weather would occur prior to the arrival of the main system. As such, two of the goals of this project stated at the 19 May 2006 CSTAR meeting were to a) develop a comprehensive climatology of PREs so that many of their relevant characteristics could be determined, and b) perform specific case studies of recent events and null events to aid in developing a useful forecasting framework. Both of these objectives were addressed during this period, but with a focus on the 2004 and 2005 hurricane seasons.

TCs during 2004 and 2005 associated with at least one PRE were identified and analyzed using radar imagery from NCDC, NHC best-track data, and NCEP/NARR gridded datasets. Precipitation data obtained from the NPVU online QPE archive and NWS text products gleaned from online sources were used to approximate how much rain fell during each TC/PRE event. Though it was not too difficult to acquire this data, the lack of a consistent dataset capable of isolating rainfall amounts for individual PREs (as opposed to just 24-h totals) further back in time will be one of the upcoming hurdles for this project. Each recent TC examined showed some evidence of a peripheral moisture surge into the PRE, and each associated PRE produce 24-h normalized rainfall amounts of greater than 100 mm. A detailed data catalog was created to establish some general characteristics of each PRE.

Early research presented at the 19 May 2006 CSTAR meeting showed through the brief case study of Gaston (2004) that the Bosart and Carr (1978) schematic model of antecedent heavy rain occurring in a mid- and upper-level jet-entrance region confluence zone well downstream of Hurricane Agnes (1972) may be applicable to the PRE cases (Fig. 1). Comparison of 11 other TCs having at least one PRE with the null case of Cindy (2005) has strengthened this claim. The 500 and 850 hPa flow patterns shortly after Cindy's landfall along the Gulf Coast (Fig. 2a and 2b, respectively) should be contrasted with Fig. 1, as they illustrate the differences with the idealized model. Westerly flow aloft coupled with a massive low-level ridge over and to the northeast of the TC likely prohibited any PRE activity. A trough axis was draped across New England at this time, but it was seemingly too far east to stir up any trouble. Thus, it has been suggested that the longitude of the nearest trough axis to the TC may be a determining factor in the occurrence of PREs.

Fig. 3 casts the relative locations of PREs in terms of "Left of Track," "Along Track," and "Right of Track" for easy comparison with previous CSTAR-related research, showing that PREs have a significant tendency to develop left of the eventual TC track. While far fewer events in this sample formed along the eventual TC track, the impact of such a PRE would be to enhance the likelihood of major widespread flooding when the rainfall from the TC itself traverses the region.

Fig. 4 displays a climatological chart comparing frequency of all tropical cyclones in the Atlantic Basin to those producing at least one known PRE in the 1979-2005 period. It shows that the frequency distribution of PRE occurrence coincides very well with that of the hurricane season as a whole, so that PRE formation is directly related to overall TC activity. Statistical analysis of the extensive data

catalogued for these events has expanded this information, demonstrating that “typical” PREs are located ~1000 km ahead of the parent tropical system, occur 1-2 days prior to the arrival of the TC at the latitude of the PRE, and last for ~12 h. It is also evident that the development of multiple PREs (an average of 2-3 per storm) is somewhat common when at least one evolves. It was originally suggested at the last CSTAR meeting that subsequent PREs may tend to form closer to the parent TC than previous ones, but closer inspection has revealed no preference for subsequent events to form either closer to or further from the TC. Finally, PRE formation does not appear to be favored with slower-moving TCs.

## NWS Interactions

I have met and corresponded regularly with focal point Michael Jurewicz from NWS WFO Binghamton, NY and David Vallee from NWS WFO Taunton, MA. Aside from periodic e-mail exchanges, I have visited each Weather Forecast Office once, and examined available cases on the Weather Event Simulator while there. I have also had personal meetings with each NWS contact twice on the UAlbany campus to discuss the research. In addition to providing valuable insight into this project, Mike and Dave have proven to be instrumental in providing a number of relevant NWS products from their offices. Mike has also taken the lead in contacting other offices for their products on the days surrounding the occurrence of PREs in their CWAs.

## Abstract Submissions

I have submitted an abstract for a talk to be presented at the Eighth Northeast Regional Operational Workshop in Albany, NY 1-2 Nov 2006. Mike Jurewicz has submitted an abstract for a presentation he will give on this research during the “Weather to Climate Scale Flood Forecasting” session of the 21<sup>st</sup> Conference on Hydrology at the AMS National Conference in San Antonio, TX 14-18 January 2007.

## Reference

Bosart, L.F., and F.H. Carr, 1978: A Case Study of Excessive Rainfall Centered Around Wellsville, New York, 20-21 June 1972. *Mon. Wea. Rev.*, **106**, 348-362.

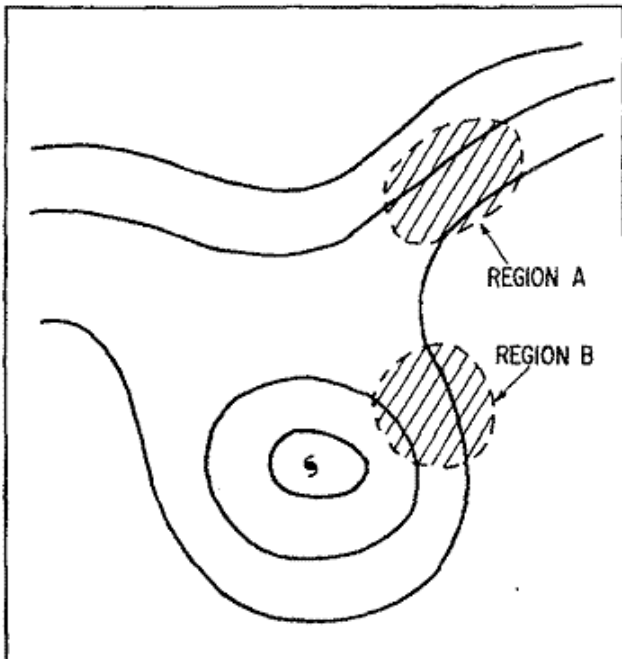


Fig. 1. Conceptual diagram of mid-level streamlines when a tropical cyclone approaches a mid-latitude trough. Two regions of possible heavy precipitation are noted. From Bosart and Carr (1978).

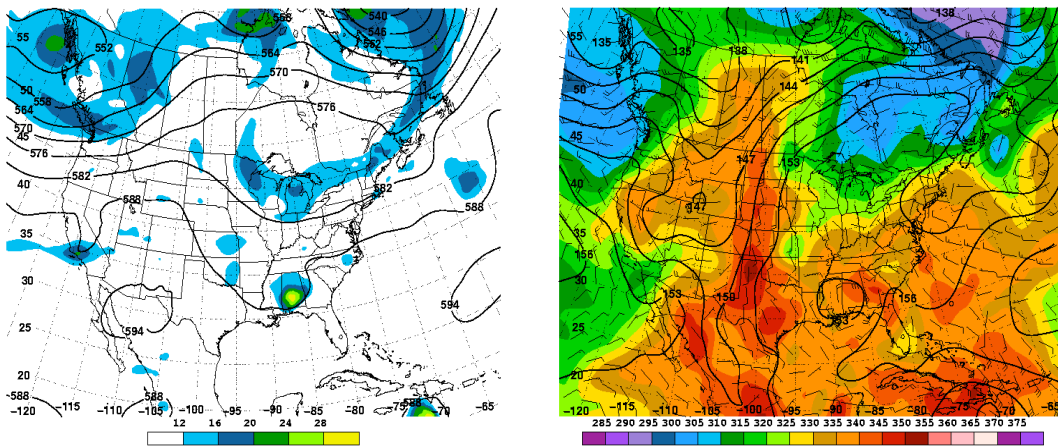


Fig. 2. (a) 500 hPa heights (contoured every 6 dam) and absolute vorticity (shaded every  $4 \times 10^{-5} \text{ s}^{-1}$ ) and (b) 850 hPa heights (contoured every 3 dam), theta-e (shaded every 5 K), and wind barbs at 0000 UTC 7 July 2005 for the null case of Cindy.

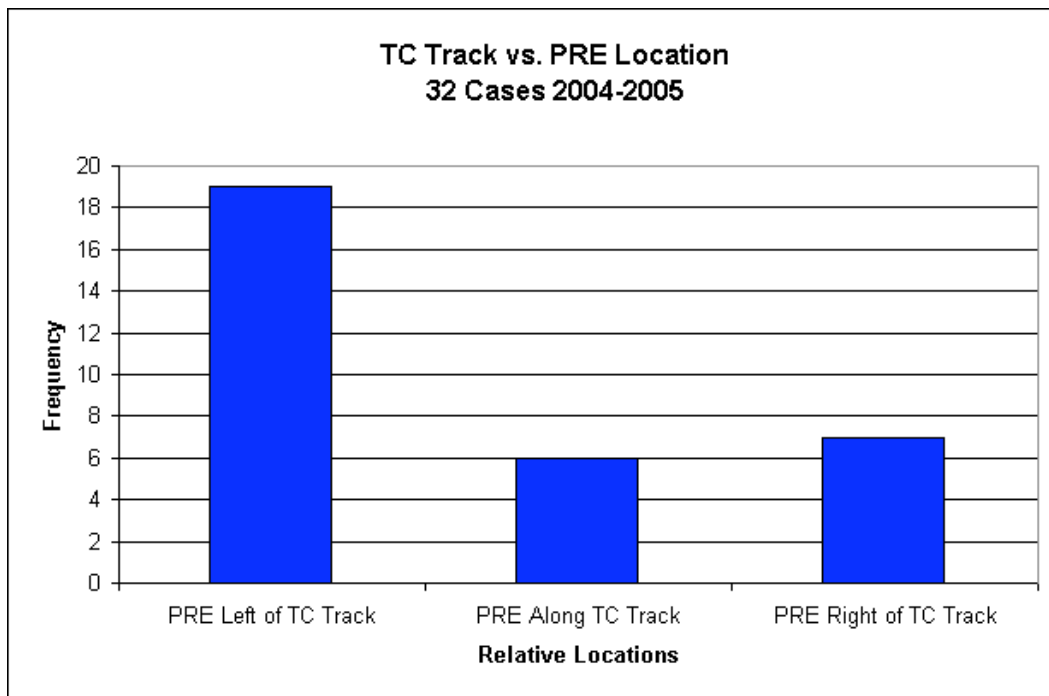


Fig. 3. Frequency distribution of PRE tracks relative to parent TC tracks.

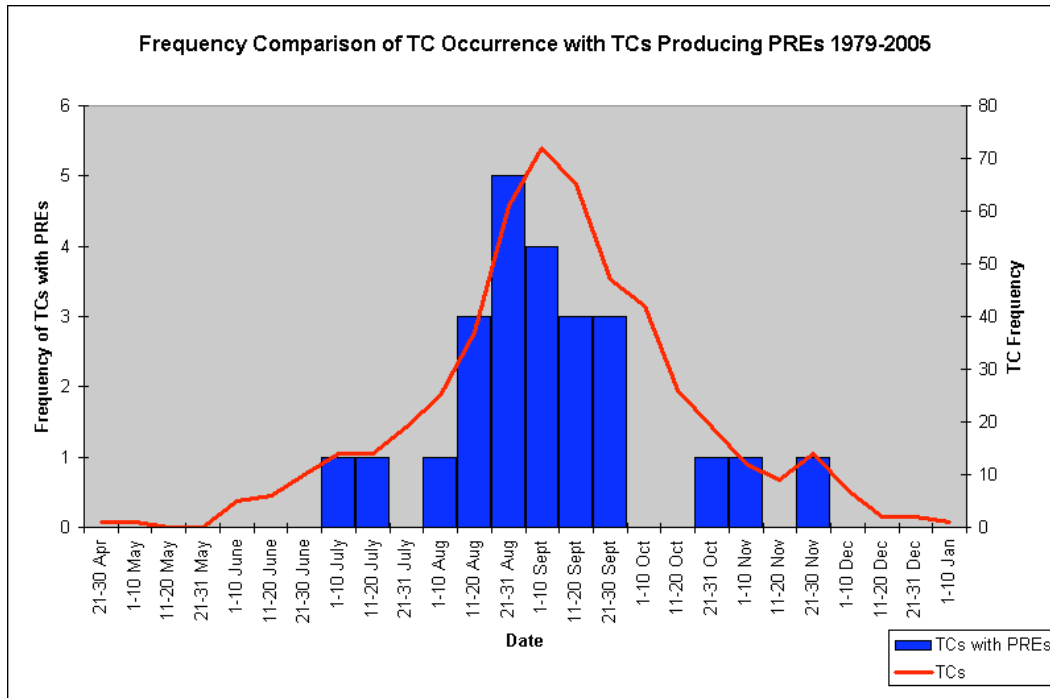


Fig. 4. Climatological chart comparing frequency of all tropical cyclones in the Atlantic Basin to those producing at least one known PRE.

**(d) Mesoscale Precipitation Structures Accompanying Landfalling and Transitioning Tropical Cyclones in the Northeast United States (Jared Klein)**

**(Focal Point: David Vallee- NWS Taunton, MA)**

**Research Summary (1 May 2006–31 October 2006):**

This report is a summary of a warm season CSTAR project on mesoscale precipitation structures in landfalling and transitioning tropical cyclones (TCs) in the northeastern U.S. The underlying purpose of this research project is to better understand how the observed mesoscale distribution of heavy rainfall in landfalling and transitioning TCs is modified by the interactions of mesoscale and synoptic-scale features over the intricate topography of the northeastern U.S. It is hoped that the knowledge gained from this project will be applicable to operations once the research is completed.

A total of 67 landfalling or transitioning TC cases that produced  $\geq 100$  mm ( $\geq 4''$ ) of rainfall over the northeast U.S. were identified from 1950-present (Table 1). The list of storms was provided by David Vallee of the NWS Weather Forecast Office in Taunton, MA (BOX). Rainfall totals from 1950-1996 were obtained from DeLuca (2004) while rainfall totals for storms subsequent to 1996 were derived from NCEP/HPC analyzed precipitation maps. Of these 67 cases, only events from 1979 to present will be used for further analysis so as to coincide with the availability of the eight times daily NCEP North American Regional Reanalysis (NARR) gridded datasets. Currently, 17 cases (bolded TCs in Table 1) from 1999-2006 were analyzed in order to extend DeLuca's (2004) previous CSTAR research on landfalling and transitioning TCs in the northeast U.S. A mesoscale study of these storms was possible in part due to the availability of the high-resolution (32 km) NCEP NARR gridded datasets. Analyses of surface and upper-air features and derived quantities were constructed from the 3 h NCEP NARR gridded datasets in order to identify synoptic and larger mesoscale features commonly associated with heavy precipitation such as favorable divergence/convergence patterns found in upper and lower level jet streaks, mid-tropospheric cyclonic vorticity advection, and lower level warm air advection. The spatial distribution of rainfall was examined on an individual storm basis using NCEP/HPC analyzed 24 h and storm total precipitation maps and the NCEP Unified Precipitation Dataset (UPD) (1200 UTC to 1200 UTC) for pre-2004 cases.

Both daily precipitation plots and storm total plots with superimposed storm tracks (using the NHC best-track TC data) were constructed using the UPD data for representative TCs. Daily precipitation maps were also prepared and overlaid on RUC-derived topography in order to assess the extent of orographic influence on the observed heavy precipitation. Archived WSR-88D radar mosaics and NCDC individual archived radar data were used to identify mesoscale precipitation structures for each selected storm. Figure 1 shows an example of storm track versus storm total precipitation (UPD) map for TC Isabel (2003). Mesoscale precipitation structures in relation to Isabel's storm track can clearly be seen. The heaviest rainfall occurred mostly along Isabel's track as the storm did not interact strongly with midlatitude synoptic-scale features over the northeastern U.S. A clearly defined mesoscale precipitation structure can also be seen over the Appalachian Mountains in western Virginia as defined by two local rainfall maxima in excess of 175 mm. Due to Isabel's track and intensity, a strong easterly flow resulted in intense orographic rainfall enhancement on the upslope (eastern) side of the mountains in Virginia.

In the early portion of this investigation a substantial part of the time was spent acquiring critical data and creating satisfactory maps to represent particular synoptic and mesoscale surface features. In particular, maps of two-dimensional Petterssen frontogenesis were calculated from archived surface observations using GEMPAK. The derived frontogenesis fields were overlaid on maps of surface potential temperature and temperature gradients to help locate and identify coastal fronts over the Northeast. As an example, Fig. 2 shows a map of surface streamlines, potential temperature contours, and



frontogenesis while tropical depression Ernesto (2006) was located over southern Florida at 1800 UTC 30 August 2006. The streamlines and frontogenesis distribution provide evidence for the existence of a coastal front in extreme northeast North Carolina. The 6 h period ending at 0000 UTC 31 August 2006 showed coastal frontogenesis, albeit weaker than at 1800 UTC, continuing throughout this region. Elizabeth City, NC (KECG) reported 127 mm of rainfall, evidence of enhanced mesoscale precipitation in this 6 h period. This analysis procedure was used in an attempt to identify possible coastal fronts in each of the 17 cases studied.

Preliminary results show that enhanced ascent associated with coastal frontogenesis occurred in 16 out of the 17 cases. This mesoscale boundary was generally located to the left and poleward of the storm track with an area of enhanced precipitation along or in the cold sector of the coastal front. The interaction between a landfalling and transitioning TC, an advancing upper-level trough, and a pre-existing mesoscale coastal front or synoptic-scale front occurred in almost every recent heavy rainfall case examined. Also, orographically enhanced lift was found in 9 out of the 17 cases studied where low-level easterly flow was upslope. A focus for ascent appeared on the eastern sides of the Appalachian Mountains from northern Georgia to New England. A summation of these initial results from the past six months of research is given in Table 2.

Finally, a CSTAR website (available at <http://www.atmos.albany.edu/student/jklein/>) was constructed in an attempt to connect previous CSTAR work done by David DeLuca to this current research project. A link to Dave DeLuca's earlier CSTAR webpage, the current updated case list, and updated UPD daily and storm total precipitation maps were added to the above website. It is anticipated that this website will serve as a portal to present the results of current and future warm season tropical precipitation studies.

#### **NWS Interactions:**

My focal point, David Vallee (NWS BOX) and I have interacted on multiple occasions via several emails and two formal visits. On 19 May 2006, David Vallee and I met at the spring CSTAR meeting at NWS ALY and then at the NWS BOX office on 29 June 2006. We mainly discussed ideas about how to approach the early phases of this research project.

#### **Future Work:**

In the next few months, the goal is to 'go back in time' and examine earlier cases from 1979-1998 using procedures similar to those explained in this report. I also plan on taking cross sections perpendicular to coastal fronts of various cases to examine different stability parameters. Hopefully, the aid of Ron Horwood's (NWS BOX) rainfall maps will be available in the near future to better examine mesoscale precipitation patterns in the Northeast. Preliminary results will be presented at the 8<sup>th</sup> annual NROW conference on 1-2 November 2006.

#### **Reference:**

DeLuca, D. P., 2004: The distribution of precipitation over the Northeast accompanying landfalling and transitioning tropical cyclones. M.S. Thesis, Department of Earth and Atmospheric Sciences, University at Albany-SUNY, 178 pp.

Table 1. A 67 storm dataset of landfalling or transitioning TCs that produced  $\geq 100$  mm ( $\geq 4''$ ) of rainfall in or near the study area from 1950-present. Bold denotes the 17 cases studied at this time. Case list was constructed by Dave Vallee (NWS BOX) and maximum rainfall amounts courtesy of DeLuca (2004).

**67 TCs producing  $\geq 100$  mm of rainfall in the Northeast U.S. (1950 – 2006)**

<b>YEAR</b>	<b>NAME</b>	<b>PERIOD</b>	<b>Max Rainfall</b>
1950	Able	Aug 12 - 22	100 - 125 mm
1950	Dog	August 31 - Sept 13	100 - 125 mm
1952	Able	Aug 25 - Sept 2	-
1953	Barbara	August 9 - 16	100 - 125 mm
1953	Carol	Sept 2 – 8	-
1954	Carol	August 23 - Sept 12 (including Dolly/Edna)	125 mm
1954	Dolly	Covered by Carol	-
1954	Edna	" "	200 mm
1954	Hazel	Oct 12 - 16	250+ mm
1955	Connie	Aug 5 - 20 (including Diane)	175 - 200 mm
1955	Diane	Covered by Connie	500+ mm
1955	Ione	Sept 15 - 21	-
1958	Daisy	Aug 23 - 30	-
1958	Helene	Aug 21 - 29	-
1959	Cindy	Jul 4 – 12	-
1959	Grace	Sept 20 - Oct 2	-
1960	Brenda	July 27 - 31	-
1960	Cleo	Aug 16 - 21	-
1960	Donna	Sept 5 - 13	200 mm
1961	Unnamed	Sept 12 - Sept 26 (including Esther)	-
1961	Esther	Covered by Unnamed	200 mm
1961	Frances	Oct 2 – 9	-
1961	Gerda	Oct 15 - 22	-
1962	Alma	Aug 25 - Sept 3	150 mm
1962	Daisy	Oct 2 – 9	350 mm
1962	Ella	Oct 14 - 22	-
1963	Ginny	Oct 16 - 30	-
1968	Gladys	Oct 14 - 21	-
1969	Gerda	Sept 5 - 10	100 mm
1971	Beth	Aug 9 - 16	-
1971	Doria	Aug 23 - 29	250 mm
1971	Heidi	Sept 10 - 15	125 mm
1972	Agnes	Jun 18 - 23	250+ mm
1972	Carrie	Aug 28 - Sep 5	300 mm
1974	Dolly	Sept 2 - 6	-
1975	Blanche	July 23 - 28	-

1976	Belle	Aug 5 - 11	125 mm
1979	David	Aug 29 - Sept 7	375+ mm (Outerbanks)
1985	Gloria	Sept 21 - 28 (including Henri)	200 mm
1985	Henri	(covered by Gloria)	-
1986	Charley	Aug 13 - 20	175+ mm (Outerbanks)
1988	Alberto	Aug 4 - 8	-
1988	Chris	Aug 24 - 30	125+ mm
1991	Bob	Aug 15 - 20	225 mm
1996	Bertha	July 7 - 14	175 mm
1996	Edouard	Sept 1 - 3	150 mm
1996	Fran	Sept 7 - 9	250+ mm (N. Virginia)
1996	Hortense	Sept 14 - 15	-
1997	Danny	July 20 - 27	150 - 175 mm
1998	Bonnie	Aug 21 - 30	350 mm (Outerbanks)
1999	<b>Floyd</b>	Sept 10 - 18	250+ mm
2001	<b>Allison</b>	June 10 - 18	100 - 125 mm
2002	<b>Isidore</b>	Sept 27 - 29	-
2002	<b>Kyle</b>	Oct 11 - 13	150 - 175 mm (NC/VA border)
2003	<b>Bill</b>	July 2 - 4	125+ mm (C. Virginia)
2003	<b>Isabel</b>	Sept 18 - 20	250 - 500+ mm (W. Virginia)
2003	Juan*	Sept 24 - 29	-
2004	<b>Alex</b>	Aug 1 - 4	175+ mm (C. Virginia)
2004	<b>Bonnie</b>	Aug 13 - 15	150+ mm
2004	<b>Charley</b>	Aug 14 - 16	(see Bonnie)
2004	<b>Frances</b>	Sept 8 - 10	175 - 200+ mm
2004	<b>Gaston/Hermine</b>	Aug 29 - Sep 1	250+ mm (E. Virginia)
2004	<b>Ivan</b>	Sept 17 - 19	175 - 200+ mm
2004	<b>Jeanne</b>	Sept 28 - 30	175 - 200 mm
2005	<b>Cindy</b>	July 7 - 10	175+ mm
2005	<b>Katrina</b>	August 30 - Sept 1	125 - 150 mm
2005	<b>Ophelia</b>	Sept 15 - 17	125 - 150 mm
2006	<b>Ernesto</b>	August 30 - Sept 2	250+ mm (E. Virginia)

Table 2. Summary of the 16 out of 17 total landfalling and transitioning TCs in the northeast U.S. containing orographic enhancement and/or coastal fronts during 1999-2006.

<b>Mesoscale feature</b>	<b>Orographic Enhancement</b>	<b>Coastal Frontogenesis</b>
<b>Number of storms</b>	9	16
<b>Percentage of storms (based on 17 total)</b>	53	94
<b>Individual Storm Name (Year) - Location of meoscale feature</b>	Floyd (1999) - Green Mts. In N VT	Floyd (1999)
	Isabel (2003) - Appalachian Mts. in VA	Allison (2001) - DE/NJ/S New England
	Bill (2003) - Appalachian Mts. in N GA	Kyle (2002) - NC
	Isidore (2002) - Appalachian Mts. in NC	Bill (2003) - E SC/ NC
	Frances (2004) - Appalachian Mts. in N GA, NC, VA, W PA	Isabel (2003) - NC/VA
	Ivan (2004)- Appalachian Mts. in N GA, NC, W&C PA	Alex (2004) - VA/DE
	Jeanne (2004) - Berkshires in W MA	Bonnie/Charley (2004) - SC/NC/VA
	Katrina (2005) - Appalachian Mts. in W NC/Green/White Mts. N VT, N NH, SW ME	Frances (2004) - coastal New England/NYC region (out ahead of storm) and W VA/W PA/W NY/E OH
	Cindy (2005) - Green Mts. N VT	Gaston (2004) - SE VA
		Ivan (2004) - SE OH/PA/SE NY
		Jeanne (2004) - SE PA/NJ/coastal New England
		Cindy (2005) - SE VA/Delmarva
		Katrina (2005) - W NY
		Ophelia (2005) - extreme E MA
		Ernesto (2006) - NC/VA

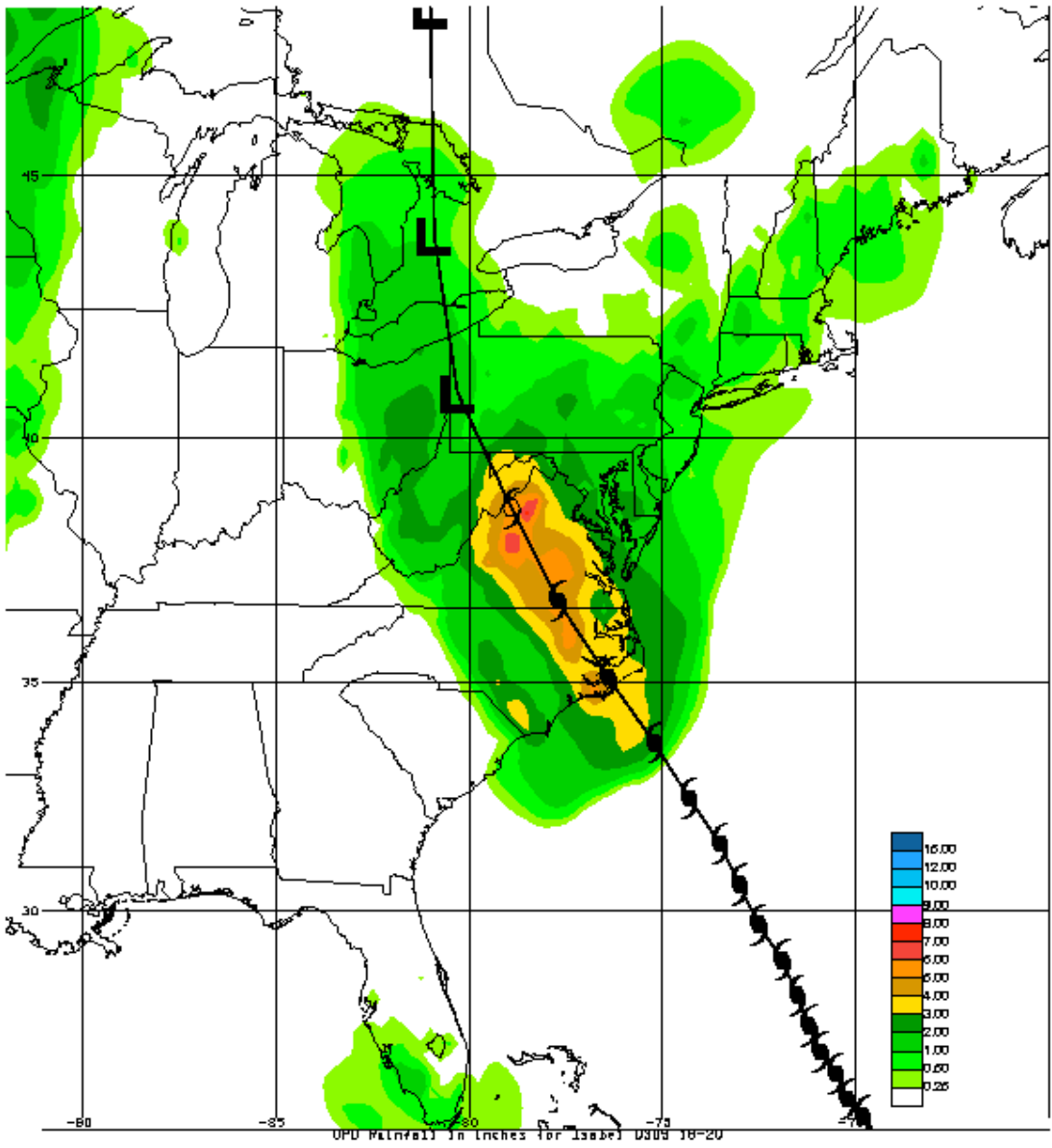


Fig. 1. Storm-total rainfall from TC Isabel from 18-20 September 2003 and TC track using the UPD and NHC best-track datasets.

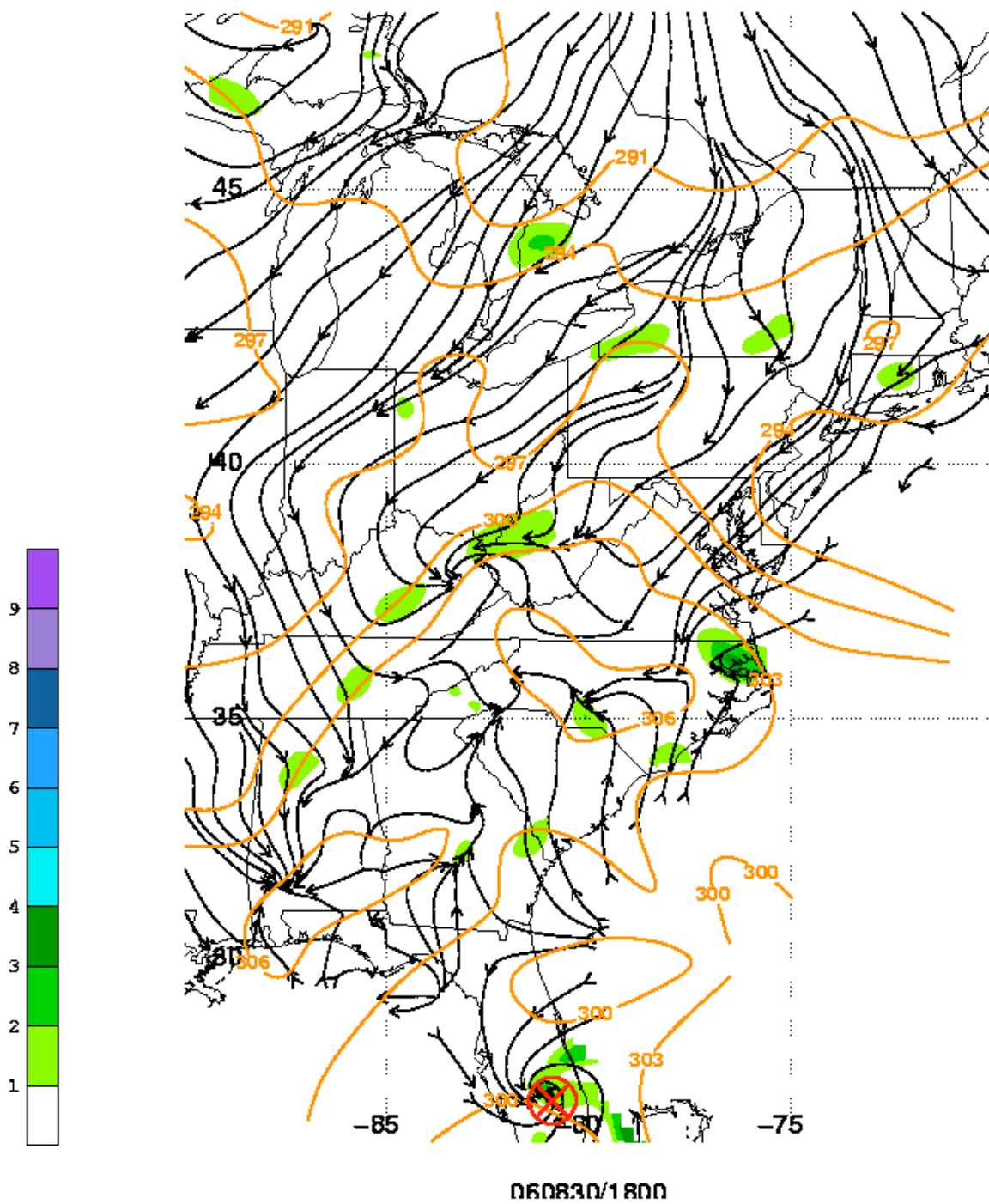


Fig. 2. Surface streamlines, potential temperature contoured orange every 3 K, and frontogenesis, shaded according to the color bar in units of  $C 100 \text{ km}^{-1} 3 \text{ h}^{-1}$  for 1800 UTC 30 August 2006. The location of tropical storm Ernesto is indicated by the tropical depression symbol.

**(e) Warm-Season Lake-/Sea-Breeze Severe Weather in the Northeast (Patrick Wilson)**  
**(Focal Point: Tom Wasula – National Weather Service, Albany, NY)**

**Research Summary (1 May 2006–31 October 2006):**

This is the first CSTAR summary for the research on Northeast severe weather triggered by lake- and sea-breezes during the warm season. The goal of this study is to investigate the dynamical and thermodynamical processes along with the physiographic effects that are responsible for producing severe weather from lake- and sea-breezes. Several cases shall be chosen for analysis. Plots of various severe weather variables and data from radar, soundings, surface observations, and other sources shall be used to analyze these cases. The focal point for this research is Tom Wasula from the National Weather Service in Albany, NY.

This project has come a long way since the spring 2006 CSTAR meeting. Ten cases have been selected for analysis. They have been divided into two classes: pure cases where lake- and sea-breeze convergence zones were primarily responsible for initiating severe weather in the apparent absence of synoptic-scale forcing, and mixed cases where synoptic-scale forcing acted in conjunction with mesoscale forcing from the lake- and sea-breezes to generate severe weather. The 10-case sample includes a null event where the arrival of marine air from a sea breeze suppressed convection.

Using NCEP/NARR gridded datasets, winds and geopotential heights at various pressure levels, equivalent potential temperature, vertical motion, absolute vorticity, frontogenesis and mixing ratio at 850 hPa, wind shear and equivalent potential temperature lapse rates in the 925-700 hPa layer, absolute vorticity advection and temperature advection at selected pressure levels, 1000-500 hPa thickness, and surface pressure were plotted in GEMPAK. In addition, soundings, radar data, and surface observations were collected for each case. Several conclusions were made about the atmospheric processes responsible for these cases. Because this sample size is small, all of the findings that are presented here should be considered preliminary until further confirmation with more events is obtained.

Several noteworthy similarities were found with the pure cases. A ridge axis was found either at the surface or aloft. Additionally, a 925 hPa equivalent potential temperature ridge axis was also detected and appeared to signify when and where convection would fire. All of the cases had several hours of appreciable vertical motion at 700 hPa, which often reached -3 microbars/s prior to firing of convection. No significant sources of cyclonic vorticity, cyclonic vorticity advection, upper-level divergence from jet entrance and exit regions, and frontogenesis were observed. Thus, pure cases can pose a significant forecasting challenge because they typically form under conditions of weak synoptic-scale forcing. However, the boundary between the air mass over land and the onshore flow of cooler, moister air from the lake or sea can become quite sharp, and its associated convergence can lead to enhancing convection along the sea-breeze or lake-breeze front (Bennett et al. 2006). Cross-sections revealed these fronts in some detail although the resolution of the NCEP/NARR gridded datasets is way too coarse to capture these boundaries with complete accuracy. See Fig. 1 for an example of a cross-section through a lake breeze boundary from 9 August 2001.

Hot and humid conditions, however, were shown to be crucial for the pure cases. The mixing ratio at 850 hPa was at least 10 g/kg, the equivalent potential temperature at 925 hPa was at least 335 K, and the 1000-500 hPa thickness was at least 570 dam. Surface temperatures (dewpoints) were at least 30°C (20°C). This data suggests that a planetary boundary layer with ample heat and moisture provided the instability. Conditionally unstable conditions were found aloft in the soundings. Not surprisingly, the convective available potential energy (CAPE) for these cases exceeded 1500 J/kg when convection fired. See Fig. 2 for an example sounding from 00 UTC on 7 July 2003. Lastly, the storms tended to develop into squall lines and follow river valleys according to the radar data. These storms could also travel considerable distances away from their source origins.

Several noteworthy similarities were also found for the mixed cases. Troughs were generally found at the surface or aloft. Northwest flow was commonly observed for these events as opposed to the general westerly flow for the pure cases. Synoptic-scale forcing was stronger as significant contributions from cyclonic vorticity, cyclonic vorticity advection, and frontogenesis existed. Stronger flow with stronger wind shear was found as opposed to the weak flow with weak unidirectional wind shear in the pure cases. Cyclonic vorticity advection increasing with height and warm air advection decreasing with height were observed often, and these factors are known to support rising motion. Vertical motion was found mainly aloft instead of near the surface. Heat and humidity were still needed in the planetary boundary layer to promote convection, and this was shown with the 850 hPa mixing ratio being at least 6 g/kg and the 925 hPa equivalent potential temperature being at least 320 K. Surface temperatures ranged from 20°C to 30°C with dewpoints approaching but not exceeding 20°C.

Not as many conclusions can be inferred from the mixed cases due to the increased complexity of interacting mesoscale and synoptic-scale features. The differences between pure cases and mixed cases suggest that there is actually a spectrum of lake- and sea-breeze cases possible ranging from those that almost entirely depend on synoptic-scale processes to those that almost entirely depend on mesoscale processes. Overall, mixed cases occur more often during the late spring and early autumn, and pure cases occur more often during the hottest months of the summer. Perhaps the most essential general finding for all cases was the prevalence of multiple synoptic and mesoscale boundary intersections. These boundary intersections served as locations where convergence and lift were enhanced to the point where deep convection was initiated.

The only significant problem encountered so far in this research is obtaining a climatology of lake- and sea-breezes. It is difficult to quantify a reasonable average number per year of these events from storm data as many severe weather reports originate from times when lake- and sea-breezes were absent. The climatology would help provide better information to the frequency and severity that is commonly experienced in the Northeast from these events, and it would provide more cases to confirm the preliminary findings. It is hoped that this matter will be resolved in the next several months.

#### **NWS Interactions:**

Tom Wasula from the National Weather Service in Albany, NY has been in contact throughout the last six months through personal meetings and emails. Tom has offered operational input and provided feedback on the results obtained so far for this research.

#### **Publications and Workshop Submissions:**

The preliminary results are scheduled to be shown at the Eighth Northeast Regional Operational Workshop on 1-2 November 2006. No publications have been made yet on this research.

#### **Reference:**

Bennett, Lindsay J., Browning, Keith A., Blyth, Alan M., Parker, Douglas J., and Clark, Peter A., 2006: A review of the initiation of precipitating convection in the United Kingdom. *Quarterly Journal of the Royal Meteorological Society*, **132**, 1001-1020.



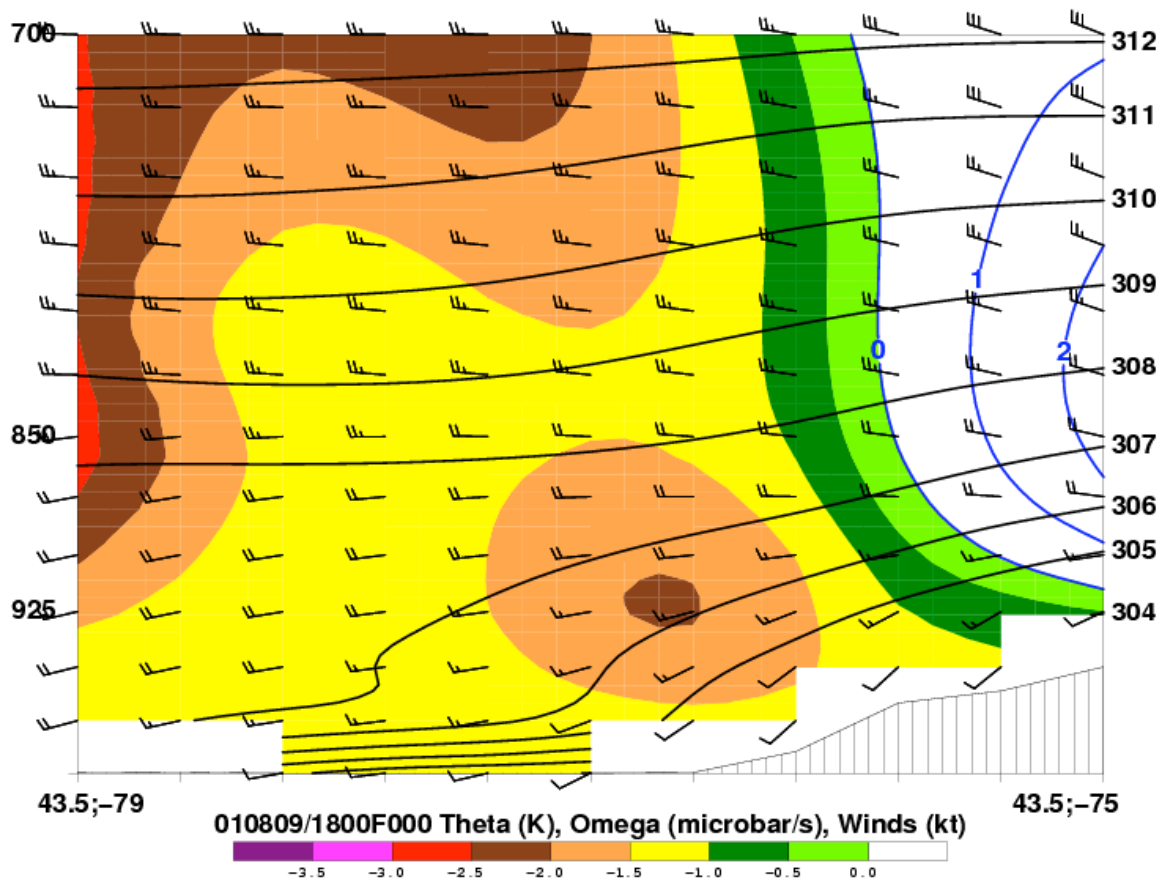
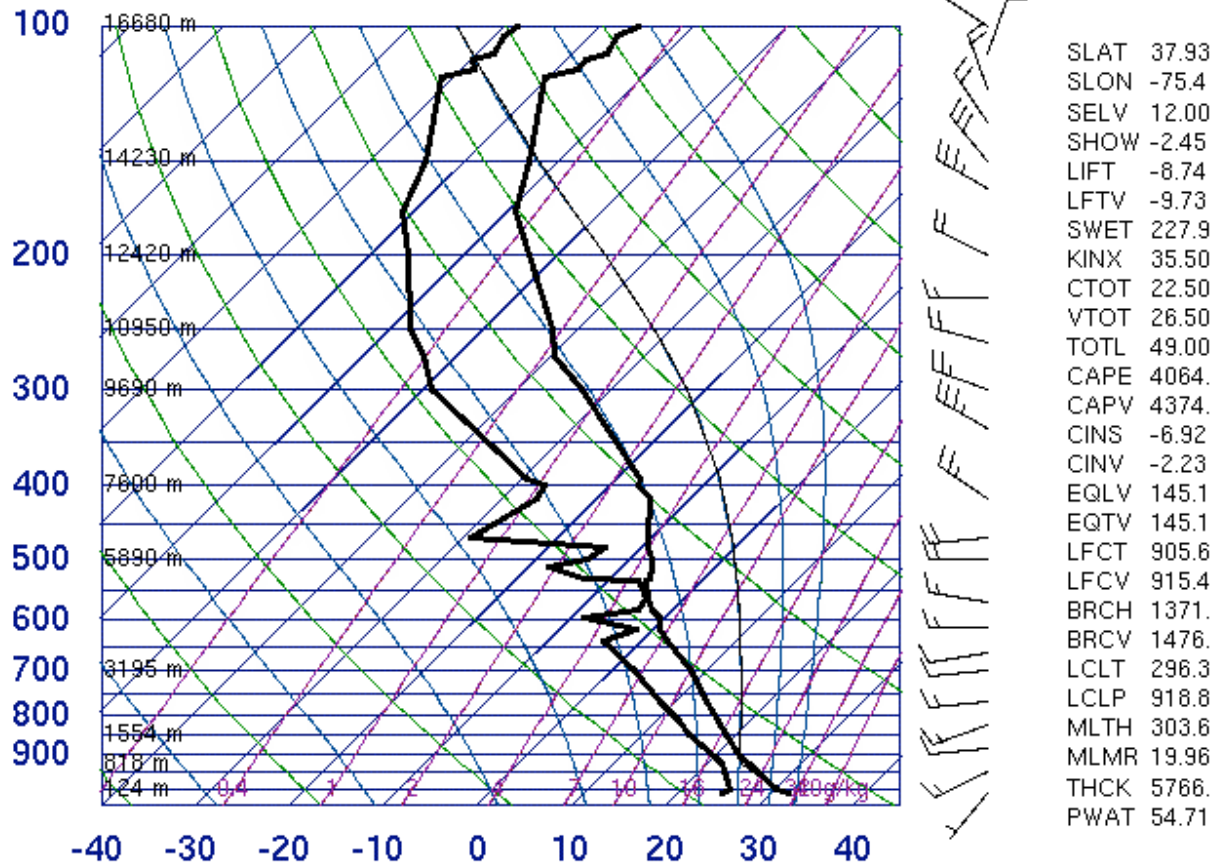


Fig. 1: GEMPAK cross-section plot zoomed in to below 700 hPa from 18 UTC on 9 August 2001 of potential temperature contoured in black every 1 K, vertical motion contoured every 1 microbar/s in blue if positive (sinking motion) and shaded in color every 0.5 microbars/s if negative (rising motion), and wind barbs with a half barb equal to 5 kt and a full barb equal to 10 kt. Note the coexistence of the potential temperature boundary and the maximum in rising motion, which depicts the location of the lake breeze front originating from Lake Ontario.

### 72402 WAL Wallops Island



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University of Wyoming

Fig. 2: Sounding from Wallops Island, VA (KWAL) that was retrieved from the University of Wyoming website (<http://weather.uwyo.edu/upperair/sounding.html>) at 00 UTC on 7 July 2003. Note the large amount of CAPE and the favorable environment for severe weather that was present before convection that initiated from the lake breeze at Lake Erie traversed across PA and reached the Delmarva Peninsula.

## **SECTION 2: Cumulative CSTAR Project Publications**

### **a) Theses completed:**

- Groenert, D., 2002: Large-scale circulation anomaly indices in relation to cool-season precipitation events in the Northeastern United States. Master of Science Thesis, Department of Earth and Atmospheric Sciences, University at Albany/SUNY, Albany, NY, 144 pp.
- Novak, D., 2002: A climatological and composite study of cold season banded precipitation in the Northeast United States. Master of Science Thesis, Department of Earth and Atmospheric Sciences, University at Albany/SUNY, Albany, NY, 182 pp.
- Smith, B. A., 2003: Cutoff cyclones: A global and regional climatology and two case studies. Master of Science Thesis, Department of Earth and Atmospheric Sciences, University at Albany/SUNY, Albany, NY, 165 pp.
- DeLuca, D., 2004: The distribution of precipitation over the northeast accompanying landfalling and transitioning tropical cyclones. Master of Science Thesis, Department of Earth and Atmospheric Sciences, University at Albany/SUNY, Albany, NY, 178 pp.
- Fracasso, A., 2004: Case studies of cold season 500 hPa cutoff cyclone precipitation distribution. Master of Science Thesis, Department of Earth and Atmospheric Sciences, University at Albany/SUNY, Albany, NY, 121 pp.
- Najuch, J. S., 2004: Case studies of warm season cutoff cyclone precipitation distribution. Master of Science Thesis, Department of Earth and Atmospheric Sciences, University at Albany/SUNY, Albany, NY, 108 pp.
- Archambault, H., 2005: Cool-season regime transition and its impact on precipitation in the northeastern United States. Master of Science Thesis, Department of Earth and Atmospheric Sciences, University at Albany/SUNY, Albany, NY, 163 pp.
- Wasula, A. C., 2005: A comprehensive study of cool season tornadoes in the southeast United States. Ph.D. Dissertation, Department of Earth and Atmospheric Sciences, University at Albany/SUNY, Albany, NY, 222 pp.
- Wagner, K. R., 2006: Cool-Season Moderate Precipitation Events in the Northeastern United States. Master of Science Thesis, Department of Earth and Atmospheric Sciences, University at Albany/SUNY, Albany, NY, 134 pp.
- Greenstein, M. D., 2006: Mesoscale structure of precipitation regions in northeast winter storms. Master of Science Thesis, Department of Earth and Atmospheric Sciences, University at Albany/SUNY, Albany, NY, 128 pp.

### **b) Preprints:**

- Groenert, D., L. F. Bosart, D. Keyser, and R. H. Grumm, 2002: Large-scale circulation anomaly indices in relation to cool-season precipitation events in the northeastern United States. Preprints, 19th Conference on Weather Analysis and Forecasting, American Meteorological Society, 12-16 August 2002, San Antonio, TX, pp 168–171.
- Grumm, R. H., N. W. Junker, R. Hart, and L. F. Bosart, 2002: Can possible heavy rainfall events be identified by comparing various parameters to the climatological norms? Preprints, 19th Conference on Weather Analysis and Forecasting, American Meteorological Society, 12-16 August 2002, San Antonio, TX, pp 160–163.
- Junker, N. W., R. Hart, R. H. Grumm, and L. F. Bosart, 2002: Establishing a 10 Year climatology of 101.6 mm (4 inch) rainfall days, Part I. Preprints, 19th Conference on Weather Analysis and Forecasting, American Meteorological Society, 12-16 August 2002, San Antonio, TX, pp 156–159.

- Novak, D. R., and R. S. Horwood, 2002: Analysis of mesoscale banded features in the 5–6 February 2001 New England snowstorm. Preprints, 19th Conference on Weather Analysis and Forecasting, American Meteorological Society, 12-16 August 2002, San Antonio, TX, pp J103–J105.
- Novak, D. R., L. F. Bosart, D. Keyser, and J. S. Waldstreicher, 2002: A climatological and composite study of cold season banded precipitation in the northeast United States. Preprints, 19th Conference on Weather Analysis and Forecasting, American Meteorological Society, 12-16 August 2002, San Antonio, TX, pp 164–167.
- Novak, M. J., L. F. Bosart, D. Keyser, T. A. Wasula, and K. D. LaPenta, 2002: Climatology of warm season 500 hPa cutoff cyclones and a case study diagnosis of 14-17 July 2000. Preprints, 19th Conference on Weather Analysis and Forecasting, American Meteorological Society, 12-16 August 2002, San Antonio, TX, pp 68–71.
- Smith, B. A., L. F. Bosart, D. Keyser, and D. St. Jean, 2002: A global 500 hPa cutoff cyclone climatology: 1953-1999. Preprints, 19th Conference on Weather Analysis and Forecasting, American Meteorological Society, 12-16 August 2002, San Antonio, TX, pp 74–77.
- Wasula, A. C., L. F. Bosart, R. Schneider, S. J. Weiss, and R. H. Johns, 2003: Mesoscale aspects of the rapid intensification of a tornadic squall line across central Florida: 22-23 February 1998. Preprint CD-ROM, 10<sup>th</sup> Conference on Mesoscale Processes, American Meteorological Society, 23-27 June 2003, Portland, OR.
- Bosart, L. F., W. Drag, and A. C. Wasula, 2003: The unusually intense coastal front passage of 17-18 April 2002 in eastern New England. Preprints, Fifth Conference on Coastal Atmospheric and Oceanic Prediction and Processes, American Meteorological Society, 6-12 August 2003, Seattle, WA, pp 169–174.
- Novak, D. R., J. S. Waldstreicher, L. F. Bosart, and D. Keyser, 2003: An observational study of cold season mesoscale band formation in the Northeast United States. Preprints, 31st Conference on Radar Meteorology, American Meteorological Society, 6-12 August 2003, Seattle, WA, pp 969–972.
- Archambault, H. M., L. F. Bosart, D. Keyser, and R. Grumm, 2004: Large scale regime transition and its relationship to significant cool season precipitation events in the Northeast. Preprint CD-ROM, 20<sup>th</sup> Conference on Weather Analysis and Forecasting, 11-15 January 2004, Seattle, WA.
- DeLuca, D. P., L. F. Bosart, D. Keyser, and D. R. Vallee, 2004: The distribution of precipitation over the Northeast accompanying landfalling and transitioning tropical cyclones. Preprint CD-ROM, 20<sup>th</sup> Conference on Weather Analysis and Forecasting, 11-15 January 2004, Seattle, WA.
- Fracasso, A. R., 2004: Cold season 500 hPa cutoff cyclone precipitation distribution and a case study. Preprint CD-ROM, 20<sup>th</sup> Conference on Weather Analysis and Forecasting, 11-15 January 2004, Seattle, WA.
- Junker, N. W., R. H. Grumm, R. Hart, and L. F. Bosart, 2004: A climatological study of 100 mm or greater days in northern California. Preprint CD-ROM, 20<sup>th</sup> Conference on Weather Analysis and Forecasting, 11-15 January 2004, Seattle, WA.
- Najuch, J. S., L. F. Bosart, D. Keyser, T. Wasula, and K. D. LaPenta, 2004: Case studies of warm season cutoff cyclone precipitation distribution. Preprint CD-ROM, 20<sup>th</sup> Conference on Weather Analysis and Forecasting, 11-15 January 2004, Seattle, WA.
- Novak, D. R., J. S. Waldstreicher, L. F. Bosart, and D. Keyser, 2004: A forecast strategy for anticipating cold season mesoscale band formation within developing extratropical cyclones. Preprint CD-ROM, 20<sup>th</sup> Conference on Weather Analysis and Forecasting, 11-15 January 2004, Seattle, WA.
- St. Jean, D. P., P. A. Sisson, L. F. Bosart, D. Keyser, and B. Smith, 2004: Characteristics of upslope snowfall events in Northern New York State and Northern Vermont: Diagnostics and model simulations of several Northwest-flow cases. Preprint CD-ROM, 20<sup>th</sup> Conference on Weather Analysis and Forecasting, 11-15 January 2004, Seattle, WA.

- Wasula, T. A., A. C. Wasula, and L. F. Bosart, 2004: A multi-scale analysis of the end of the millennium snowstorm. Preprint CD-ROM, 20<sup>th</sup> Conference on Weather Analysis and Forecasting, 11-15 January 2004, Seattle, WA.
- Wasula, A. C., L. F. Bosart, R. Schneider, S. J. Weiss, and R. H. Johns, 2004: Cool season tornadoes in the southeast United States: A climatological and case study perspective. Preprint CD-ROM, 20<sup>th</sup> Conference on Weather Analysis and Forecasting, 11-15 January 2004, Seattle, WA.
- Bosart, L. F., K. LaPenta, A. Seimon, M. Dickinson, and T. J. Galarneau, Jr., 2004: Terrain-influenced tornadogenesis in the northeastern United States. Preprint CD-ROM, 11th Conference on Mountain Meteorology, 21-25 June 2004, Bartlett, NH.
- Sisson, P. A., D. St. Jean, E. Evenson, W. E. Murray, S. F. Hogan, L. F. Bosart, D. Keyser, and B. Smith, 2004: Applying local research to National Weather Service operations: Forecasting heavy mountain snowfalls in Vermont and Northern New York. Preprint CD-ROM, 11th Conference on Mountain Meteorology, 21-25 June 2004, Bartlett, NH.
- Bosart, L. F., K. D. LaPenta, A. Seimon, and M. J. Dickinson, 2004: Terrain-influenced tornadogenesis in the northeastern United States: An examination of the 29 May 1995 Great Barrington, Massachusetts, Tornado. Preprint CD-ROM, 22nd Conference on Severe Local Storms, 4-8 October 2004, Hyannis, MA.
- LaPenta, K. D., L. F. Bosart, T. J. Galarneau Jr., and M. J. Dickinson, 2004: A multiscale examination of the 31 May 1998 Mechanicville, New York, Tornado. Preprint CD-ROM, 22nd Conference on Severe Local Storms, 4-8 October 2004, Hyannis, MA.
- Novak, D., and A. Aiyyer, 2004: The 2004 April fool's New England flooding event: Analysis of three heavy precipitation episodes associated with a slow moving cutoff cyclone. Preprint CD-ROM, 22nd Conference on Severe Local Storms, 4-8 October 2004, Hyannis, MA.
- Seimon A., and L. F. Bosart, 2004: An observationally based hypothesis for significant tornadogenesis in mountain environments. Preprint CD-ROM, 22nd Conference on Severe Local Storms, 4-8 October 2004, Hyannis, MA.
- Wasula, A. C., L. F. Bosart, R. Schneider, S. J. Weiss, R. H. Johns, G. S. Manikin, and P. Welch, 2004: The structure and climatology of boundary layer winds in the southeast United States and its relationship to nocturnal tornado episodes. Preprint CD-ROM, 22nd Conference on Severe Local Storms, 4-8 October 2004, Hyannis, MA.
- Archambault, H. M., D. Keyser, L. F. Bosart, and A. Aiyyer, 2004: Cool-season regime transition and its impact on precipitation in the northeast United States. Preprint, The First THORPEX International Science Symposium, 6-10 December, Montréal, Québec, Canada.

**c) PI and/or student oral presentations:**

- Bosart, L. F., 2001: Scientific and operational lessons from the 25 Jan '00 and 30 Dec '00 snowstorms. Oral presentation at the 26th Annual Northeastern Storm Conference, 9-11 March 2001, Saratoga Springs, NY.
- Bosart, L. F., 2001: An overview of derechos and their environments. Oral presentation at the CSTAR Conference and Albany Weather Forecasting Office Spring Meeting, 25-26 April 2001, Albany, NY.
- Bosart, L. F., 2001: Death by 1000 Cuts? Oral presentation at the Third Northeast Regional Operational Workshop, 6-7 November 2001, Albany, NY.
- Groenert, D., L. F. Bosart, D. Keyser, and R. Grumm, 2001: Large-scale circulation anomaly indices in relation to cool-season precipitation events in the northeastern United States. Oral presentation at the Third Northeast Regional Operational Workshop, 6-7 November 2001, Albany, NY.
- Novak, D., L. F. Bosart, D. Keyser, and J. Waldstreicher, 2001: A climatology of cold season banded precipitation in the northeast United States. Oral presentation at the Third Northeast Regional Operational Workshop, 6-7 November 2001, Albany, NY.

- Smith, B. A., L. F. Bosart, D. Keyser, and D. St. Jean, 2001: A climatology of 500 hPa cutoff cyclones. Oral presentation at the Third Northeast Regional Operational Workshop, 6-7 November 2001, Albany, NY.
- Bosart, L. F., 2002: Dynamic tropopause and PV maps: A user's guide. Oral presentation at the 27th Annual Northeastern Storm Conference, 8-10 March 2002, Saratoga Springs, NY.
- Groenert, D., L. F. Bosart, and D. Keyser, 2002: Large-scale circulation anomaly indices in relation to cool-season precipitation events in the northeastern United States. Oral presentation at the 27th Annual Northeastern Storm Conference, 8-10 March 2002, Saratoga Springs, NY.
- Novak, D., L. F. Bosart, D. Keyser, and J. Waldstreicher 2002: A climatological and composite study of cold season banded precipitation in the northeast United States. Oral presentation at the 27th Annual Northeastern Storm Conference, 8-10 March 2002, Saratoga Springs, NY.
- Bosart, L. F., 2002: Mesoscale boundaries, organized deep convection and forecast derailments. Oral presentation at the Northeast Regional Operational Workshop, 5 November 2002, Albany, NY.
- Novak, D., J. Waldstreicher, L. F. Bosart, and D. Keyser, 2002: Anticipating mesoscale band formation in winter storms. Oral presentation at the Northeast Regional Operational Workshop, 5 November 2002, Albany, NY.
- Novak, M. J., L. F. Bosart, D. Keyser, T. A. Wasula, and K. D. LaPenta, 2002: A climatology of warm season 500 hPa cutoff cyclones and case study. Oral presentation at the Northeast Regional Operational Workshop, 5 November 2002, Albany, NY.
- Smith, B. A., L. F. Bosart, D. Keyser, and D. St. Jean, 2002: Cutoff cyclones: A global and regional climatology (1948–2001) and two case studies. Oral presentation at the Northeast Regional Operational Workshop, 5 November 2002, Albany, NY.
- Atallah, E. H., and L. F. Bosart, 2003: Tropical cyclone extratropical transition evolutions: Forecast vs. observed. Oral presentation at the 28th Annual Northeastern Storm Conference, 7-9 March 2003, Saratoga Springs, NY.
- Atallah, E. H., A. Aiyyer, and L. F. Bosart, 2003: Teleconnections, 1000-500 hPa thickness and storm tracks in the Northern Hemisphere. Oral presentation at the 28th Annual Northeastern Storm Conference, 7-9 March 2003, Saratoga Springs, NY.
- Brewster, J., and M. Evans, 2003: Forecasting the Christmas Day 2002 Snowstorm using modernized National Weather Service tools, training and technology. Oral presentation at the 28th Annual Northeastern Storm Conference, 7-9 March 2003, Saratoga Springs, NY.
- Bosart, L. F., and M. J. Dickinson, 2003: The double transition of Hurricane Michael (2000): Baroclinic to tropical to baroclinic. Oral presentation at the 28th Annual Northeastern Storm Conference, 7-9 March 2003, Saratoga Springs, NY.
- Novak, M. J., A. Aiyyer, L. F. Bosart, D. Keyser, T. A. Wasula, and K. D. LaPenta, 2003: Climatology of warm season 500 hPa cutoff cyclones and case study diagnosis of 14–17 July 2000. Oral presentation at the 28th Annual Northeastern Storm Conference, 7-9 March 2003, Saratoga Springs, NY.
- Smith, B. A., L. F. Bosart, D. Keyser, and D. St. Jean, 2003: Cutoff cyclones: A global and regional climatology (1948–2001) and two case studies. Oral presentation at the 28th Annual Northeastern Storm Conference, 7-9 March 2003, Saratoga Springs, NY.
- Archambault, H. M., 2003: Large-scale regime transition and its relationship to significant cool season precipitation events in the Northeast. Oral presentation at the NWS/UAlbany/NCSU CSTAR Workshop, 9-10 July 2003, Silver Spring, MD.
- DeLuca, D. P., L. F. Bosart, D. Keyser, and D. Vallee, 2003: The distribution of precipitation over the Northeast accompanying landfalling and transitioning tropical cyclones. Oral presentation at the NWS/UAlbany/NCSU CSTAR Workshop, 9-10 July 2003, Silver Spring, MD.

- Fracasso, A., A. Aiyyer, L. F. Bosart, D. Keyser, and M. Evans, 2003: Case studies of cold season cutoff cyclone precipitation distribution. Oral presentation at the NWS/UAlbany/NCSU CSTAR Workshop, 9-10 July 2003, Silver Spring, MD.
- Najuch, J. S., A. Aiyyer, L. F. Bosart, D. Keyser, T. A. Wasula, and K. D. LaPenta, 2003: Case studies of warm season cutoff cyclone precipitation distribution. Oral presentation at the NWS/UAlbany/NCSU CSTAR Workshop, 9-10 July 2003, Silver Spring, MD.
- Novak, M. J., A. Aiyyer, L. F. Bosart, D. Keyser, T. A. Wasula, and K. D. LaPenta, 2003: Climatology of warm season 500 hPa cutoff cyclones and case study. Oral presentation at the NWS/UAlbany/NCSU CSTAR Workshop, 9-10 July 2003, Silver Spring, MD.
- Novak, D., J. Waldstreicher, L. F. Bosart, and D. Keyser, 2003: Anticipating mesoscale band formation in Winter storms using radar and model guidance. Invited speaker at the 28<sup>th</sup> Annual National Weather Association Meeting, 18-23 October 2003, Jacksonville, FL.
- Archambault, H. M., L. F. Bosart, D. Keyser, and R. Grumm, 2003: Large-scale regime transition and its relationship to significant cool season precipitation events in the Northeast. Oral presentation at the Northeast Regional Operational Workshop, Albany, NY, 4-5 November 2003.
- Bosart, L. F., W. Drag, and A. C. Wasula, 2003: The unusually intense coastal front passage of 17-18 April 2002 in Eastern New England. Oral presentation at the Northeast Regional Operational Workshop, Albany, NY, 4-5 November 2003.
- DeLuca, D. P., L. F. Bosart, D. Keyser, and D. R. Vallee, 2003: The distribution of precipitation over the northeast accompanying landfalling and transitioning tropical cyclones. Oral presentation at the Northeast Regional Operational Workshop, Albany, NY, 4-5 November 2003.
- Fracasso, A., L. F. Bosart, D. Keyser, and M. Evans, 2003: Cold season 500 hPa cutoff cyclone precipitation distribution and a case study. Oral presentation at the Northeast Regional Operational Workshop, Albany, NY, 4-5 November 2003.
- LaPenta, K. D., 2003: The Eastern New York and Western New England F2 Tornado of 21 July. Oral presentation at the Northeast Regional Operational Workshop, Albany, NY, 4-5 November 2003.
- Najuch, J. S., L. F. Bosart, D. Keyser, T. A. Wasula, and K. D. LaPenta, 2003: Case studies of warm season cutoff cyclone precipitation distribution. Oral presentation at the Northeast Regional Operational Workshop, Albany, NY, 4-5 November 2003.
- Waldstreicher, J. S., 2003: Assessing the impact of collaborative research projects on NWS Warning performance. Oral presentation at the Northeast Regional Operational Workshop, Albany, NY, 4-5 November 2003.
- Wasula, A. C., L. F. Bosart, R. Schneider, S. Weiss, and R. Johns, 2003: A study of cool season tornadoes in the Southeast United States. Oral presentation at the Northeast Regional Operational Workshop, Albany, NY, 4-5 November 2003.
- Archambault, H. M., L. F. Bosart, and D. Keyser, 2004: Large-scale regime transition and its relationship to significant precipitation events in the Northeast. Oral presentation 29<sup>th</sup> Annual Northeastern Storm Conference, 12-14 March 2004, Saratoga Springs, NY.
- Bosart, L. F., 2004: Coastal fronts, cold air damming, and fronts adjacent to higher terrain. Oral presentation 29<sup>th</sup> Annual Northeastern Storm Conference, 12-14 March 2004, Saratoga Springs, NY.
- Cannon, J., 2004: Environmental flow regimes and heavy rainfall distribution associated with tropical cyclones in the northeast United States. Oral presentation 29<sup>th</sup> Annual Northeastern Storm Conference, 12-14 March 2004, Saratoga Springs, NY.
- DeLuca, D. P., L. F. Bosart, D. Keyser, and D. R. Vallee, 2004: The distribution of precipitation over the Northeast accompanying landfalling and transitioning tropical cyclones. Oral presentation 29<sup>th</sup> Annual Northeastern Storm Conference, 12-14 March 2004, Saratoga Springs, NY.

- Fracasso, A., L. F. Bosart, D. Keyser, and M. Evans, 2004: Cold season 500 hPa cutoff cyclone precipitation distribution and a case study. Oral presentation 29th Annual Northeastern Storm Conference, 12-14 March 2004, Saratoga Springs, NY.
- Najuch, J. S., L. F. Bosart, D. Keyser, T. A. Wasula, and K. D. LaPenta, 2004: Case studies of warm season cutoff cyclone precipitation distribution. Oral presentation 29th Annual Northeastern Storm Conference, 12-14 March 2004, Saratoga Springs, NY.
- Sisson, P. A., D. St. Jean, E. Evenson, W. E. Murray, S. F. Hogan, L. F. Bosart, D. Keyser, and B. Smith, 2004: Application of local research results to National Weather Service Operational Forecast Challenges – A success story forecasting heavy mountain snowfalls in Vermont and Northern New York. Oral presentation 29th Annual Northeastern Storm Conference, 12-14 March 2004, Saratoga Springs, NY.
- Bosart, L. F., K. D. LaPenta, A. Seimon, and M. J. Dickinson, 2004: Terrain-influenced tornadogenesis in the northeastern United States: An examination of the 29 May 1995 Great Barrington, Massachusetts, Tornado. Oral presentation, 22nd Conference on Severe Local Storms, 4-8 October 2004, Hyannis, MA.
- LaPenta, K. D., L. F. Bosart, T. J. Galarneau Jr., and M. J. Dickinson, 2004: A multiscale examination of the 31 May 1998 Mechanicville, New York, Tornado. Oral presentation, 22nd Conference on Severe Local Storms, 4-8 October 2004, Hyannis, MA.
- Seimon A., and L. F. Bosart, 2004: An observationally based hypothesis for significant tornadogenesis in mountain environments. Oral presentation, 22nd Conference on Severe Local Storms, 4-8 October 2004, Hyannis, MA.
- Wasula, A. C., L. F. Bosart, R. Schneider, S. J. Weiss, R. H. Johns, G. S. Manikin, and P. Welch, 2004: The structure and climatology of boundary layer winds in the southeast United States and its relationship to nocturnal tornado episodes. Oral presentation, 22nd Conference on Severe Local Storms, 4-8 October 2004, Hyannis, MA.
- Archambault, H. M., L. F. Bosart, D. Keyser, A. Aiyyer, and R. Grumm, 2004: Cool-season regime transition and its impact on precipitation in the northeast. Oral presentation at the Sixth Northeast Regional Operational Workshop (NROW), 2-3 November 2004, Albany, NY
- Bosart, L. F., 2004: A long-lived intense continental-scale front: 28 February-4 March 1972. Oral presentation at the Sixth Northeast Regional Operational Workshop (NROW), 2-3 November 2004, Albany, NY.
- Fracasso, A., L. F. Bosart, and D. Keyser, 2004: Cool season 500 hPa cutoff cyclones: Precipitation distribution and a case study. Oral presentation at the Sixth Northeast Regional Operational Workshop (NROW), 2-3 November 2004, Albany, NY.
- Novak, D., B. Colle, and D. Keyser, 2004: High-resolution simulations of the 25 December 2002 banded snowstorm using Eta, MM5, and WRF. Oral presentation at the Sixth Northeast Regional Operational Workshop (NROW), 2-3 November 2004, Albany, NY.
- Runyon, S. C., and L. F. Bosart, 2004: A statistical and synoptic climatological analysis of U.S. heat waves. Oral presentation at the Sixth Northeast Regional Operational Workshop (NROW), 2-3 November 2004, Albany, NY.
- Wagner, K., L. F. Bosart, and D. Keyser, 2004: Cyclogenesis and upper-level jet streaks and their influence on the low-level Jet. Oral presentation at the Sixth Northeast Regional Operational Workshop (NROW), 2-3 November 2004, Albany, NY.
- Wasula, A. C., L. F. Bosart, R. S. Schneider, S. Weiss, R. H. Johns, G. S. Manikin, and P. Welsh, 2004: The structure and climatology of boundary layer winds in the southeast United States and its relationship to nocturnal tornado episodes. Oral presentation at the Sixth Northeast Regional Operational Workshop (NROW), 2-3 November 2004, Albany, NY.



- Bosart, L. F., W. Drag, and A. Wasula, 2004: Backdoor and sidedoor cold fronts: A continual forecast challenge. Invited presenter, 5th Southern New England Weather Conference, 6 November 2004, Brookline, MA.
- Archambault, H. M., L. F. Bosart, D. Keyser, A. Aiyyer, and R. Grumm, 2005: Cool-season regime transition and its impact on precipitation in the northeast. Oral presentation at the 30th Annual Northeastern Storm Conference, 18-20 March 2005, Burlington, VT.
- Runyon, S. C., and L. F. Bosart, 2005: A statistical analysis and synoptic climatology of heat waves over the United States. Oral presentation at the 30th Annual Northeastern Storm Conference, 18-20 March 2005, Burlington, VT.
- Wagner, K., L. F. Bosart, and D. Keyser, 2005: Moderate precipitation events in the Northeastern United States. Oral presentation at the 30th Annual Northeastern Storm Conference, 18-20 March 2005, Burlington, VT.
- Archambault, H. M., L. F. Bosart, D. Keyser, A. Aiyyer and R. H. Grumm, 2005: Cool-season regime transition and its impact on precipitation in the Northeast. Oral presentation, 21st Conference on Weather Analysis and Forecasting/17th Conference on Numerical Weather Prediction, American Meteorological Society, 1-5 August 2005, Washington, DC.
- Greenstein, M. D., L. F. Bosart, D. Keyser, and D. J. Nicosia, 2005: Examining the role of mesoscale features in the structure and evolution of precipitation regions in northeast winter storms. Poster presentation, 21st Conference on Weather Analysis and Forecasting/17th Conference on Numerical Weather Prediction, American Meteorological Society, 1-5 August 2005, Washington, DC.
- Junker, N., R. Grumm, R. Hart, L. F. Bosart, K. M. Bell and F. J. Pereira, 2005: Forecasting extreme wintertime precipitation events in northern California. Oral presentation, 21st Conference on Weather Analysis and Forecasting/17th Conference on Numerical Weather Prediction, American Meteorological Society, 1-5 August 2005, Washington, DC.
- Novak, D. R., B. A. Colle, and D. Keyser, 2005: High-resolution modeling of the 25 December 2002 Northeast U.S. banded snowstorm. Oral presentation, 21st Conference on Weather Analysis and Forecasting/17th Conference on Numerical Weather Prediction, American Meteorological Society, 1-5 August 2005, Washington, DC.
- Runyon, S. C., and L. F. Bosart, 2005: A Statistical analysis and synoptic climatology of heat waves over the United States. Oral presentation, 21st Conference on Weather Analysis and Forecasting/17th Conference on Numerical Weather Prediction, American Meteorological Society, 1-5 August 2005, Washington, DC.
- Wagner, K. R., L. F. Bosart, D. Keyser, and M. S. Evans, 2005: Cool-season moderate precipitation events in the Northeastern United States. Poster presentation, 21st Conference on Weather Analysis and Forecasting/17th Conference on Numerical Weather Prediction, American Meteorological Society, 1-5 August 2005, Washington, DC.
- Archambault, H., L. F. Bosart, D. Keyser and R. Grumm, 2005: Cool-season regime transition and its impact on precipitation in the Northeast. Poster presentation, NOAA 30th Annual Climate Diagnostics and Prediction Workshop, 24-28 October 2005, University Park, PA.
- Archambault, H., L. F. Bosart, D. Keyser and R. Grumm, 2005: Cool-season regime transition and its impact on precipitation in the Northeastern United States. Oral presentation, The 6th Southern New England Weather Conference, 5 November 2005, Brookline, MA.
- Archambault, H., L. F. Bosart, D. Keyser and R. Grumm, 2005: Cool-season regime transition and its impact on precipitation in the Northeast. Oral presentation at the Seventh Northeast Regional Operational Workshop (NROW), 1-2 November 2005, Albany, NY.

- Novak, D., B. Colle, and D. Keyser, 2005: An investigation of model-simulated band placement and evolution in the 25 December 2002 Northeast U.S. Banded Snowstorm. Oral presentation at the Seventh Northeast Regional Operational Workshop (NROW), 1-2 November 2005, Albany, NY.
- Greenstein, M. D., L. F. Bosart, D. Keyser, and D. J. Nicosia, 2005: Examining the role of mesoscale features in the structure and evolution of precipitation regions in northeast winter storms. Oral presentation at the Seventh Northeast Regional Operational Workshop (NROW), 1-2 November 2005, Albany, NY.
- Wagner, K., L. F. Bosart, D. Keyser, and M. S. Evans, 2005: Cool-season moderate precipitation events in the Northeastern United States. Oral presentation at the Seventh Northeast Regional Operational Workshop (NROW), 1-2 November 2005, Albany, NY.
- Runyon, S. C., and L. F. Bosart, 2005: A statistical analysis and synoptic climatology of heat waves over the Northeast United States. Oral presentation at the Seventh Northeast Regional Operational Workshop (NROW), 1-2 November 2005, Albany, NY.
- Wasula, A. C., 2005: A multiscale analysis of the 23-24 November 2004 Southeast United States tornado outbreak. Oral presentation at the Seventh Northeast Regional Operational Workshop (NROW), 1-2 November 2005, Albany, NY.
- Archambault, H., L. F. Bosart, D. Keyser, A. Aiyyer, and R. Grumm, 2006: Cool-season regime transition and its impact on precipitation in the Northeast. Oral presentation 31st Annual Northeastern Storm Conference, 10-12 March 2006, Saratoga Springs, NY.
- Bosart, L. F., 2006: The small-scale New England coastal bomb of 9 December 2005: A near-miss Hurricane Zeta? Oral presentation 31st Annual Northeastern Storm Conference, 10-12 March 2006, Saratoga Springs, NY.
- Greenstein, M. D., L. F. Bosart, D. Keyser, and D. J. Nicosia, 2006: Mesoscale structure of precipitation regions in northeast winter storms. Oral presentation 31st Annual Northeastern Storm Conference, 10-12 March 2006, Saratoga Springs, NY.
- Wagner, K., L. F. Bosart, and D. Keyser, 2006: Cool-season moderate precipitation events in the Northeastern United States. Oral presentation 31st Annual Northeastern Storm Conference, 10-12 March 2006, Saratoga Springs, NY.
- Wasula, A. C., 2006: The diurnal variation of synoptic scale structure of cool season tornado episodes in the Southeast United States. Oral presentation 31st Annual Northeastern Storm Conference, 10-12 March 2006, Saratoga Springs, NY.
- Wasula, T. A., 2006: The Thanksgiving 2004 severe weather event across upstate New York and New England. Oral presentation 31st Annual Northeastern Storm Conference, 10-12 March 2006, Saratoga Springs, NY.
- Bosart, L. F. (with contributions from A. Wasula, W. Drag, and K. Meier), 2006: Strong surface fronts over sloping terrain and coastal plains. Oral presentation, St. Louis (LSX) National Weather Service Forecast Office, 15 March 2006, St. Louis, MO.
- Bosart, L. F., 2006: Modern weather forecasting: A scientific and operational perspective. Guest speaker, Eastern Region MIC Conference, 28 March 2006, Raleigh, NC.
- Archambault, H. M., D. Keyser, and L. F. Bosart, 2006: Cool-season regime transition and its impact on northeast precipitation. Seminar (presented by D. Keyser), Program in Atmospheres, Oceans, and Climate, Massachusetts Institute of Technology, 8 May 2006, Cambridge, MA.
- Archambault, H. M., D. Keyser, and L. F. Bosart, 2006: Cool-season regime transition and its impact on major northeast precipitation events. Oral presentation, Second Annual Eastern US Weather Conference, 8 July 2006, Baltimore, MD.

Archambault, H. M., D. Keyser, L. F. Bosart, and A. Aiyyer, 2006: Cool-season regime transition and its impact on Northeast precipitation. Seminar (presented by H. Archambault), NCEP/Climate Prediction Center, 6 September 2006, Camp Springs, MD.

**iv) CSTAR/COMET related refereed publications:**

Wasula, A. C., L. F. Bosart, and K. D. LaPenta, 2002: The influence of terrain on the severe weather distribution across interior Eastern New York and Western New England. *Wea. Forecasting*, **17**, 1277–1289.

Weisman, R. A., K. G. McGregor, D. R. Novak, J. L. Selzler, M. L. Spinar, B. C. Thomas, and P. N. Schumacher, 2002: Precipitation regimes during cold-season central U.S. inverted trough cases. Part I: Synoptic climatology and composite study. *Wea. Forecasting*, **17**, 1173–1193.

Bosart, L. F., 2003: Whither the weather analysis and forecasting process? *Wea. Forecasting*, **18**, 520–529.

Novak, D. R., L. F. Bosart, D. Keyser, and J. S. Waldstreicher, 2004: An observational study of cold season-banded precipitation in northeast U.S. cyclones. *Wea. Forecasting*, **19**, 993–1010.

LaPenta, K. D., L. F. Bosart, T. J. Galarneau Jr., and M. J. Dickinson, 2005: A multiscale examination of the 31 May 1998 Mechanicville, New York, F3 tornado. *Wea. Forecasting*, **20**, 494–516.

Novak, D. R., J. S. Waldstreicher, D. Keyser, and L. F. Bosart, 2006: A forecast strategy for anticipating cold season mesoscale band formation within eastern U.S. cyclones. *Wea. Forecasting*, **21**, 3–23.

Bosart, L. F., A. Seimon, K. D. LaPenta, and M. J. Dickinson, 2006: Supercell Tornadoogenesis over Complex Terrain: The Great Barrington, Massachusetts Tornado on 29 May 1995, *Wea. Forecasting*, **21**, (in press).

Wasula, A. C., L. F. Bosart, R. S. Schneider, S. J. Weiss, G. S. Manikin, and P. Welch, 2006: Mesoscale aspects of the rapid intensification of a tornadic convective line across central Florida: 22-23 February 1998. *Wea. Forecasting*, **21**, (in press).

Bosart, L. F., A. C. Wasula, W. Drag, and K. Meier, 2007: Strong surface fronts over sloping terrain and coastal plains. *Mesoscale Weather Systems*, L. F. Bosart and H. B. Bluestein, Ed., *Meteor. Monogr.*, American Meteorological Society, (in press).

### **SECTION 3: Report by Warren R. Snyder, (NWS Perspective)**

**CSTAR: April 2006-October 2006**

**National Weather Service Perspective  
Science & Operations Officer  
WFO Albany, NY**

The CSTAR II Project, “*Continuing Studies of Cool and Warm Season Events over the Northeast United States*,” continues at a high level. Work from several projects will be presented at various conferences this fall, and is in the publication process.

On May 19, 2006, a CSTAR II meeting was conducted at the Center for Environmental Sciences and Technology Management, University at Albany, to address current and planned research activities. Attendees included CSTAR principal investigators, graduate students, and NWS collaborators from across the Northeast. The meeting focused on planning project work for the summer of 2006, technology transfer opportunities from CSTAR student research, and documenting operational successes.

Principal investigators, graduate students, and Science and Operations Officers have engaged NWS meteorologists and hydrologists in CSTAR II projects, and associated research projects, at the following NWS Eastern Region offices. CSTAR Projects with \* have been completed.

- WFO Albany, New York

*Project: Northeast Warm Season Severe Weather, Identifying the Role Terrain Features, and Land/Water Boundaries Have on Convective Development and Evolution*

*Project: Integration of Research into Operations*

- WFO Binghamton, New York

*Project: Mesoscale Aspects of Heavy Snow/Icing Events in the Northeast*

*Project: Weakly Forced Moderate Cool-Season Precipitation Events in the Northeastern United States*

*Project: Compare and Contrast Three Ice Storms Over New York\**

*Project: Develop WES Simulation for 17 February 2003 Event\**

- WFO Caribou, Maine

*Project: Northern New England Inverted Coastal Trough*

- WFO Gray, Maine

*Project: Upslope Localized Flood Events*

- WFO State College, Pennsylvania

*Project: Cool Season Regime Transition and Its Impact on Precipitation in the Northeastern United States\**

- WFO Taunton, Massachusetts

Northeast River Forecast Center, Taunton, Massachusetts

***Project:** Landfalling and Transitioning Tropical Cyclones*

• WFO Upton, New York

***Project:** Transition of Ensembles of Mesoscale Models to Operational Forecasting – Exploring the Use of Multiple Runs of Mesoscale Models and Their Utility to Forecasting\**

• Center Weather Service Unit, Oberlin, Ohio

***Project:** Assess the Work Station ETA's Ability to Access Thunderstorm Formation to Improve Air Traffic Routing at the Cleveland FAA Air Route Traffic Control Center\**

As remaining CSTAR II projects move toward conclusion, an exciting group of projects has been developed for the CSTAR III proposal. CSTAR III will involve 13 offices and up to 40 people if funding is approved. A CSTAR planning and CSTAR III organizational meeting will be held at the University at Albany on November 3, 2006, in conjunction with the 8<sup>th</sup> Northeast Regional Operational Workshop. The workshop is co-hosted by WFO Albany and the Department of Earth and Atmospheric Sciences. The American Meteorological Society is a cooperating organization. The workshop will highlight CSTAR research, and Northeast United States forecasting challenges.

Finally, the Information Technology Specialist at WFO Albany has developed a plan focusing on the integration of research into operations in order to capitalize on the scientific and technological advances that result from CSTAR research. Activities include AWIPS SmartTool development, AWIPS visualizations, AWIPS procedures and diagnostics, weather event simulator training, and teletraining.

## **SECTION 4: NWS Semi-Annual Reports**

### **(a) NWS Binghamton, NY**

#### **Mike Evans (NWS WFO BGM)**

##### **April 2006 – October 2006.**

The following projects have been completed this year, or are on-going:

Mike Evans is working on developing VISIT teletraining related to the completed CSTAR projects on cool season moderate precipitation events in the northeast U.S., and mesoscale structure of precipitation regions in northeast winter storms. Both of the students who worked on those projects during the past 2 years received their Master's degrees this spring. Mike Evans served as the NWS focal point for the project on moderate precipitation events, and Dave Nicosia served as the NWS focal point for the research on mesoscale structure of precipitation regions in northeast winter storms.

Mike Evans and Mike Jurewicz continue to work on a sub-project on correlations between observed snowfall and NAM forecasts parameters. The idea behind this project is to quantitatively test some of the findings in the moderate precipitation study over a much larger set of cases. Lance Bosart and Dan Keyser both provided helpful reviews of this work last spring.

Mike Evans is planning on combining findings associated with the study on NAM forecast parameters, with findings from the study on moderate precipitation events to create a VISIT teletraining session. This session could potentially be made available to NWS forecasters as early as late this fall. Findings from the NAM forecast parameter study will also be presented this fall at the NWA conference in Cleveland, the U.S. Canadian Great Lakes conference in Niagara Falls, and the NROW at Albany.

Mike Evans completed work on his portion of the winter Advanced Warning Operations Course (AWOC) this spring. The result was a lesson that contained material from several CSTAR-supported projects, including work by Novak, Bosart, Keyser, Waldstreicher, Wagner, Evans and Jurewicz. This course is being provided to the entire NWS forecaster community this fall.

Mike Jurewicz has assumed the role of NWS focal point for a study on predecessor rainfall events in advance of tropical cyclones. Mike has begun work on this study with Matt Cote, a graduate student at SUNY Albany. Mike and Matt have met in person, and have begun to collect data and share ideas for the study. Mike is planning on presenting some preliminary findings from this study at the national AMS meeting in San Antonio in January 2007.

Mike Evans, Mike Jurewicz and Tom Wasula (general forecaster at ALY) have begun some preliminary data collection on a potential collaborative project involving severe weather associated with warm fronts across upstate New York.

Some preliminary work is being done on a project that will involve the development of a WRF ensemble for the purpose of forecasting lake effect snow. The project was initially conceived to help support with forecasting operations associated with the Eastern Great Lakes Lake-Effect Snow (EAGLES) project (a field study planned for the winter of 2008-2009). However successful execution of this project will require a collaborative effort between several NWS forecast offices, and possibly SUNY Albany, which may help by providing some computer resources, and some modeling expertise.

**(b) NWS Taunton, MA**

**Focal Point: David Vallee (NWS WFO KBOX)**

**Period Oct 2005 through September 2006**

**CSTAR Topic: Warm Season – Tropical**

**CSTAR Topic: Warm Season – Tropical**

**NWS Focal Point: David Vallee**

Period Oct 2005 through September 2006

**Project name: Mesoscale Features Associated with Land Falling &  
Transitioning Tropical Cyclones**

NWS Project Focal Point: David Vallee

Participants: Michael Evans, Mike Jurewicz, John W. Cannon and Ron Horwood

The NWS has continued its work on the construction of detailed rainfall reanalyses for storms in this study. Ron Horwood, NERFC, has completed work through the 2001 season. Work is above to begin for storms in the period 2002 through 2005. The master listing of storms has been updated to include systems in the 2002 through 2005 period, including such events as Katrina, Charley, and Jeanne.

The rainfall reanalysis images will be posted to the CSTAR / Extra-tropical Transition website, formally developed by Dave DeLuca. It is our hope that a Warm Season Tropical web portal can be developed and hosted by SUNY Albany to provide a one-stop location for all related information for this project.

Based on rainfall amounts and distribution (Fig. 1), it is believed that Tropical Storm Ernesto may be another candidate for inclusion into this study,

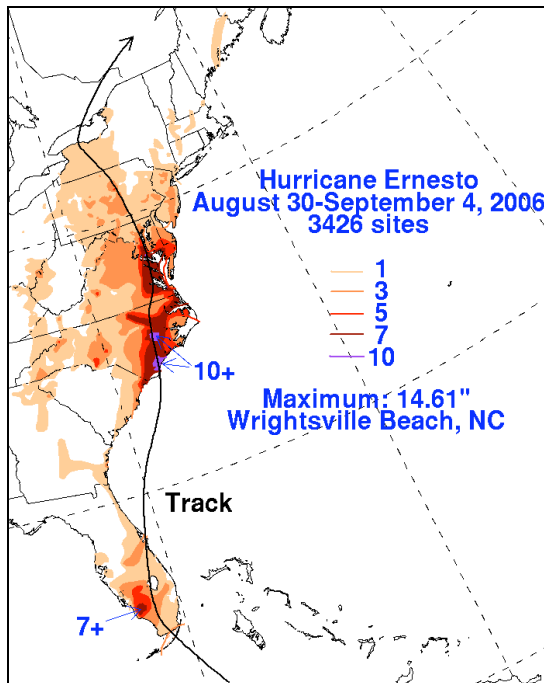


Figure 1. Rainfall associated with the U.S. mainland land fall of Tropical Storm Ernesto. Image provided by NWS/HPC.

**Project name: Flash Floods Preceding Land Falling Tropical Cyclones in the Northeast United States**

NWS Project Focal Point: Mike Jurewicz

Participants: Mike Evans and David Vallee

This new project initiative has made great headway. The NWS has built an event database, consisting of over one dozen storms, which were preceded by significant flash flooding somewhere in the Northeast region of the United States. The NWS has been collecting Area Forecast Discussions over the past several seasons pertaining to flash floods which may have indirectly been influenced by an approaching tropical cyclone.

**Project name: Examining the Recurvature and Acceleration of Land Falling Tropical Cyclones in New England**

NWS Project Focal Point: David Vallee

Participants: John W. Cannon and James Notchey

The goal of this project is to develop a better understanding of the patterns which promote recurvature and acceleration of tropical cyclones into New England. The NWS has completed synoptic reanalyses, using the NCEP/NCAR datasets, for 20 of 22 systems classified for this project. Storms in this study range from decaying or transitioning tropical cyclones to full fledged category 3 hurricanes.

Three distinct upper level flow regimes have been identified, with 19 of 22 storms falling into two of these three regimes. The two primary regimes include: a) Rapid evolution or intensification of a pre-existing upper level closed low in the vicinity of the Great Lakes and/or Ohio Valley (Fig 2) and b) Intensifying short wave(s) dropping into the mean trough positioned approximately along 100 W Longitude (Fig 3). Further investigation will include the identification of variations within each theme and compositing cases to provide a baseline for each flow regime.

It is anticipated that project results will be compiled into a Preprint article for one of the upcoming AMS conference in the FY07 time frame.



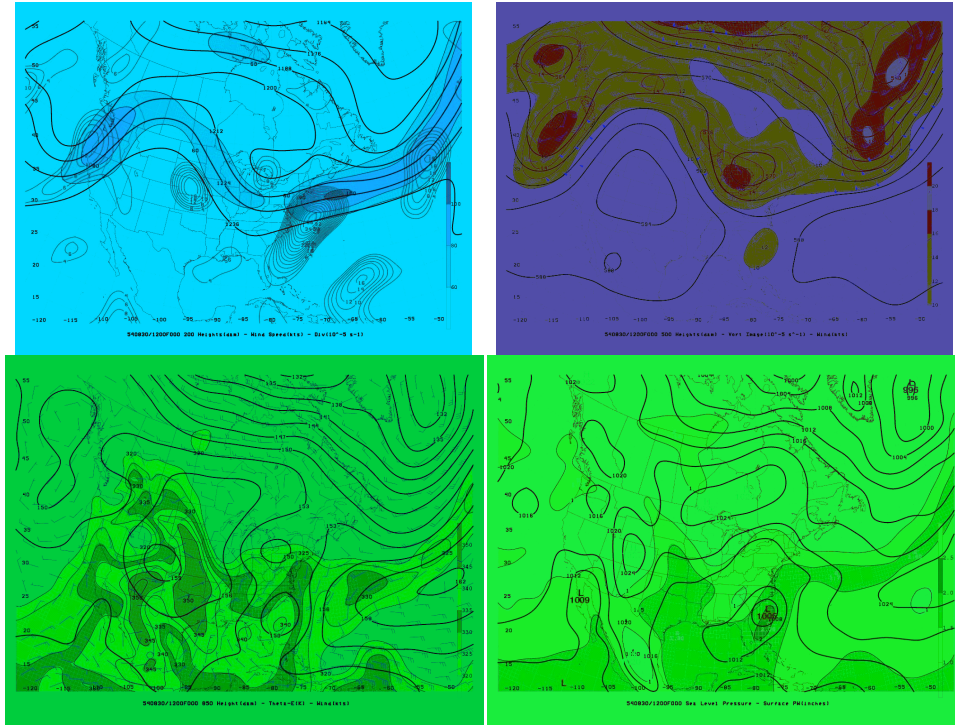


Figure 2. Four panel of upper air and surface features associated with Hurricane Carol, August 1954. This pattern represents a “Type A” upper air evolution which can accelerate a tropical cyclone toward New England. Note the pre-positioning of the jet entrance region northeast of the cyclone center 30 hours before landfall, and The pronounced closed low at 500 mb over the Great Lakes.

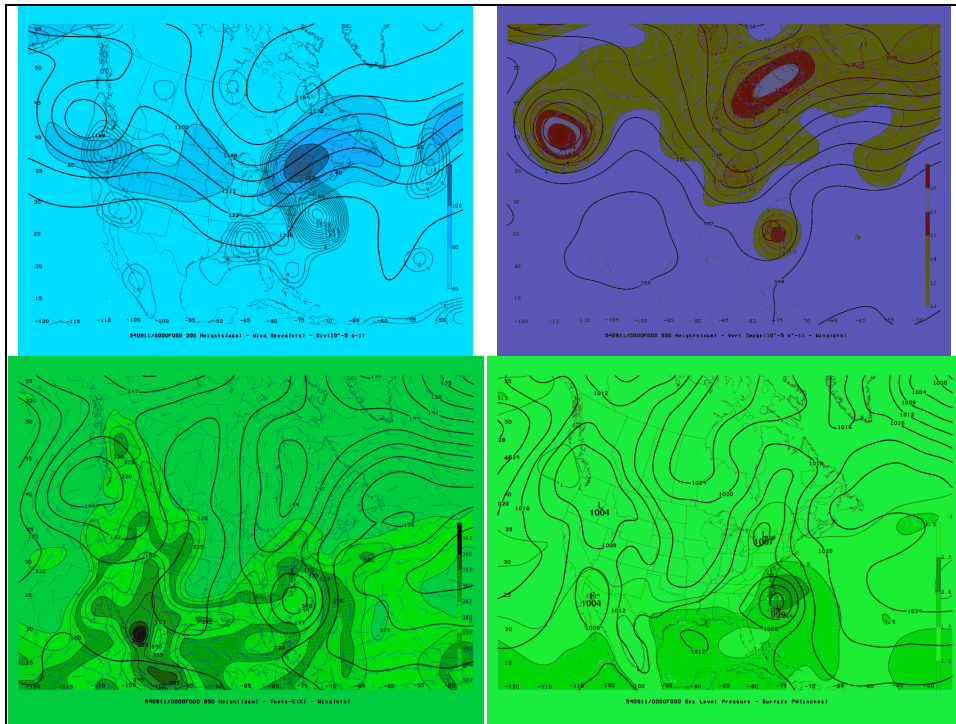


Figure 3. Four panel of upper air and surface features associated with Hurricane Edna, September 1954. This pattern represents a “Type B” upper air evolution which can accelerate a tropical cyclone toward New England. Note the pre-positioning of the jet entrance region northwest of the cyclone center 24 hours before landfall, and a pattern which produces a series of short waves rotating through a mean trough located along approximately 90W longitude.

### Training Activities

1. Matt Cote and Jared Klein visited WFO BOX on June 29<sup>th</sup>, 2006. This visit included an orientation for Matt and Jared on the WFO operations, forecast systems including IFPS and an introduction to the Weather Event Simulator and case study capability for the WFO where their research results can be applied directly into forecast operations.
2. Matt Cote visited WFO BGM on July 13<sup>th</sup> and meet with Mike Jurewicz to discuss the Flash Flood Project, cases and associated work.
3. David Vallee, SOO WFO BOX participated in the WFO GYX Hurricane Workshop. David provided a 1 hr 15 min session on the results from CSTAR I – “An Examination of Rainfall Distribution Associated with Land Falling Tropical Cyclones in the Northeast”. David also provided preliminary results from the research “Examining The Recurvature and Acceleration of Land Falling Tropical Cyclones in the Northeast United States”.

(c) NWS Albany, NY

## **Semi-annual Report**

### **CSTAR II Research (April 2006 - September 2006)**

*Focal Point Leader: Thomas A. Wasula, NWS Albany, NY*

*Robert LaPlante, NWS Cleveland, OH*

*Dave Zaff and Thomas Niziol, NWS Buffalo, NY*

*Steve Zubrick, NWS Sterling, VA*

*Michael Ekster, NWS Upton, NY*

*Dr. Lance Bosart, University at Albany*

*Dr. Daniel Keyser, University at Albany*

*Warren Snyder, NWS Albany, NY*

#### **I. Project Activities and Work Done**

- Tom worked with Robert Tracey, a NOAA Hollings scholar, during June and July on a lake breeze severe weather case that impacted northern Ohio. Robert LaPlante, the SOO at Cleveland, recommended doing research on the case, since an F0 tornado occurred associated with the boundary. Robert gave a research presentation on the April 19, 2002 Northern Ohio Lake Breeze Severe Weather case in early August at Silver Spring. Robert will present our research findings from the case at the NROW 8 conference November 1-2, 2006.
- Mike Ekster continued his work on the impressive Long Island sea breeze case that occurred on August 5, 2005 in the Upton forecast area. He will be co-giving a talk entitled " The August 5, 2005 Widespread Severe Weather Outbreak; Classic Microburst Environment" at the 7<sup>th</sup> Southern New England Conference October 28<sup>th</sup>.
- Tom completed two preprint publications for the November 6-10, 2006 23<sup>rd</sup> AMS Severe Local Storms Conference. One preprint analyzed the Thanksgiving 2004 severe weather event that impacted the Northeast. The case was a classic cool season high shear-low CAPE event. There was some evidence channeled southerly flow up the Hudson River Valley, may have intensified the squall line with embedded supercells. A second preprint examined the role an outflow boundary had on the formation and evolution of the long-lived tornadic supercell that occurred July 21-22, 2003. It was speculated that backed flow in the Hudson River Valley enhanced the low-level shear and helicity for the tornadic supercell to form along the squall line. The publications are listed below.
- There are no new items to report from Dave Zaff (SOO at Buffalo), and Steve Zubrick (SOO at Sterling) over the past 6 months.
- Patrick Wilson, a University at Albany graduate student, has met with me a few times concerning his M.S. research on the warm season Northeast severe weather CSTAR II

topic entitled ""Identifying the role terrain features and land/water boundaries (i.e. Great Lakes, Long Island, Chesapeake Bay) have on convective development and evolution." Most recently we met on Sept 1<sup>st</sup> discussing his case study work on lake/sea breeze cases. He has created two groups. One group of cases is pure lake breeze cases with severe weather. Another group is labeled "mixed", where lake breezes are coupled with synoptic boundaries producing severe weather. Here is an e-mail summary on some of his initial findings:

1. No strong synoptic lift evident - There was no cyclonic vorticity or even cyclonic vorticity advection to speak of at 500 hPa. There is also just neutral jet dynamics taking place at 200 hPa. The cases didn't occur in any exit or entrance region of any jet streaks.
2. Light winds/Little low-level wind shear - The winds were 30 kt or less from the ground up to 500 hPa. Both the soundings and the NARR data show this for the first four cases. The sounding on the fifth case also agrees here.
3. Ridge axis in place - This explains points #1 and #2. I found that the cases occurred when a ridge axis was in place either at the surface or aloft. A few events occurred under an upper ridge from 700 hPa on up, which puts them west of a surface high. A little lift from an approaching trough and some warm air advection certainly helped these cases. I also found a couple that just occurred when it was in a surface high. With the need for high pressure, light winds and high thicknesses seem to be necessary for a pure case, which leads to points #4 and #5.
4. High theta-e - Not only was this variable necessary for this study, I feel it is crucial for these events. Every event happened near a 925 hPa theta-e ridge axis. In fact, this parameter seems to be involved with the location and timing of when convection will fire. It makes sense that thunderstorms would develop when and where the best conditions for heat and moisture were in place.
5. Hot & humid - The 1000-500 hPa thicknesses were at least 570 dam, and the 850 hPa mixing ratios were at least 10 g/kg. So, a PBL of heat and humidity is needed to provide the instability when there was little or none to begin with synoptically. The lake and sea breezes take care of the convergence and lifting. The moisture in the PBL originates mainly from the Gulf of Mexico though there are certainly local contributions from the lakes and the Atlantic Ocean. The soundings show that the free troposphere is pretty much conditionally unstable, so breaking the inversion after the daytime heating and moisture advection would result in a good amount of CAPE. I found a few soundings that show it well. I want to see the temperatures and dewpoints from the surface data to further emphasize this point.

## **II. Presentations on CSTAR II Research (October 2004 – September 2006)**

Ekster, M. L., T. A., Wasula 2005. The August 5, 2005 Long Island Sea Breeze Severe Weather, 7<sup>th</sup> Northeast Operational Workshop, Albany, NY, October 31, 2004.

Wasula, T. A., 2004. The August 9, 2001 Lake Breeze Severe Weather Event across New York and Western New England, 6<sup>th</sup> Northeast Operational Workshop, Albany, NY, November 2, 2004.

Wasula, T. A., K. D. LaPenta, 2006. The Thanksgiving 2004 Severe Weather Event across Upstate New York and New England, 31<sup>st</sup> Northeastern Storm Conference, March 10-12, 2006.

Wasula, T. A., K. D. LaPenta, 2005. The Thanksgiving 2004 Severe Weather Event across Upstate New York and New England, 7<sup>th</sup> Northeast Operational Workshop, Albany, NY, November 1-2, 2005.

## **III. Publications and Preprints (October 2005 – September 2006)**

Wasula, T. A., K. D. LaPenta, 2006: The Role of a Squall-line and Boundary Interaction in the Development of the Long-lived 21-22, July 2003 Tornadoic Supercell across Eastern New York

and Western New England. *Preprints, 23<sup>rd</sup> Conf. on Severe Local Storms*, St. Louis, MO, Amer. Meteor. Soc., 18.6.

Wasula, T. A., K. D. LaPenta, 2006: The Thanksgiving 2004 Severe Weather Event across Upstate New York and New England. *Preprints, 23<sup>rd</sup> Conf. on Severe Local Storms*, St. Louis, MO, Amer. Meteor. Soc., P12.9.

## **(d) CSTAR Technology Transfer Six Month Report**

**Vasil T. Koleci: ITO NWS Albany, NY**

### **I. CSTAR Technology Transfer activities completed during the past fiscal year**

1. A process was formulated for the development of software based on completed research.
2. Two completed CSTAR cases were chosen for the initial alpha test development.
3. A prototype model was developed. This was based on cases that were analyzed as indicated in item III below.
4. A cutoff low/closed low electronic checklist was developed.

### **II. Software engineering process for developing applications based on CSTAR research**

During the software development process, it is vital that all the background project information is analyzed before any development begins.

The following nine-step software development process will be utilized to incorporate CSTAR research into operations:

1. Obtain information from project
2. Requirement elicitation
3. UML documentation
4. Storyboard the application
5. Software development
6. Risk-reduction testing
7. Fix any defects
8. Alpha/Beta test software
9. Release to field with full software documentation

### **III. Completed CSTAR projects that will be used for phase I of technology transfer process**

- A. The Distribution of Precipitation over the Northeast Accompanying Landfalling and Transitioning Tropical Cyclones
- B. Warm Season Closed Lows
- C. Mesoscale Structure of Precipitation Regions in Northeast Winter Storms

The following classification will be used for determining the type of technology best suited based on the completed papers:

- A. AWIPS applications
- B. IFPS/GFE applications
- C. Web based/AWIPS-based checklists
- D. AWIPS procedures

### **IV. Completed Software Project**

- Warm Season Closed Low checklist  
<http://cstar.cestm.albany.edu/Technology/cklists/Cutofflow.htm>

### **V. Future Project Plans**

- Incorporate Matthew Greenstein's Master project on Mesoscale Structure of Precipitation Regions in Northeast Winter Storms into a neural network and/or smart tool application.

## **SECTION 5: Computer and Technology Transfer Issues (David Knight)**

Adequate computing infrastructure is critical both to support the research, and to exchange results. Students are exposed to NWS facilities and software, and NWS staff have access to capabilities not available in the local office. Both groups benefit from this interaction and sharing of facilities. Several Sun workstations and PCs are available for use by CSTAR participants. Approximately 160 GB of disk space on the UAlbany Department of Earth and Atmospheric Science (DEAS) Sun servers is dedicated to storing CSTAR related data and software. This disk space is available on all DEAS workstations and provides a central location where both UAlbany and NWS personnel can store, process, and exchange large datasets. Each CSTAR student has a PC laptop, which enables them to take familiar computers with them when visiting NWS staff, and provides them ready access to the DEAS UNIX machines. Email lists created on the DEAS computers at the beginning of the project continue to be important conduits for exchange of scientific ideas, results, and information between CSTAR participants. There are email lists for all the CSTAR participants, as well as focused lists for those involved in specific projects. Albany WSFO staff took the lead in maintaining content for the CSTAR webpage at <http://cstar.cestm.albany.edu>. The web page provides an additional mechanism for exchanging information and ideas. The DEAS web server (<http://www.atmos.albany.edu>) and ftp server (<ftp://ftp.atmos.albany.edu>) are being used to facilitate exchange of large datasets between CSTAR collaborators. Recently PI's in the DEAS were awarded a large NSF grant for equipment upgrades. Among these is a new Sun server (with 8 CPUs and 16GB RAM) and a large (8 TB usable space) disk storage array, which have recently been put into service. While CSTAR money was not used for this, and the machines were not bought specifically for CSTAR use, they nonetheless directly benefit the CSTAR research by providing much faster servers for computation and storage space for commonly used datasets.

**SECTION 6: Selected Documentation of CSTAR Project Activities:**

----- Forwarded message from Matthew Greenstein -----

>From green@atmos.albany.edu Wed May 24 20:01:22 2006  
Message-ID: <01fd01c67f6c\$d3db54c0\$6566a8c0@matthew>  
From: "Matthew Greenstein" <green@atmos.albany.edu>  
To: "Lance" <bosart@atmos.albany.edu>  
Cc: "Dan Keyser" <keyser@atmos.albany.edu>  
Subject: Fw: cstar  
Date: Wed, 24 May 2006 16:01:20 -0400  
X-Priority: 3  
X-MSMail-Priority: Normal  
X-Mailer: Microsoft Outlook Express 6.00.2900.2869  
X-MimeOLE: Produced By Microsoft MimeOLE V6.00.2900.2869  
X-Virus-Scanned: Symantec AntiVirus Scan Engine  
X-Spam-Checker-Version: SpamAssassin 2.63 (2004-01-11) on  
cypress.atmos.albany.edu  
X-Spam-Status: No, hits=-3.3 required=8.0  
tests=AWL,BAYES\_00,HTML\_MESSAGE,  
RCVD\_IN\_SORBS autolearn=no version=2.63  
X-Spam-Level:

Lance,

Below is the response I received from Vasil about the question I posed in my previous e-mail.

- Matt

cc: Dan

----- Original Message -----

From: Vasil Koleci  
To: Matthew Greenstein  
Sent: Wednesday, May 24, 2006 3:56 PM  
Subject: Re: cstar

Hey Matt,

The ultimate goal is to have a neural network program automated as you stated in step 2. Your presentation really showed how much value this could add for NWS operations and other aspects. What I might initially do is, write a web application to get the operational staff familiar with the research. After that, I will shift gears and have the program run on its own using a neural networks. I will keep you posted on the status.

Take Care,

Vasil

Matthew Greenstein wrote:

Vasil,

When I spoke to you after the CSTAR meeting last Friday, you mentioned to me that the next project of yours is to turn my research of precipitation patterns during snowstorms into a neural network. I was wondering which of the following two ideas you had in mind: 1) the forecaster would make subjective observations of cross sections,



i.e. frontogenesis detached from the surface, and enter that into a webpage like was shown for checklists during the CSTAR meeting, or 2) you'd write some sort of program to objectively examine the cross sections to cull certain parameters for use in a neural network. The latter would be awesome, if possible! When you get a chance, please let me know which you had in mind and what other information you'd need from me.

Also, here are the links to my talk (<http://www.atmos.albany.edu/student/greenstein/seminar.ppt>) and thesis (<http://www.atmos.albany.edu/student/greenstein/thesis.pdf>).

Take care,  
Matt Greenstein

--

Vasil Koleci  
Information Technology Officer  
NOAA National Weather Service  
251 Fuller Road Suite B-300  
Albany, NY 12203-3698  
Email: [Vasil.Koleci@noaa.gov](mailto:Vasil.Koleci@noaa.gov)  
Phone: 518-435-9571 X 235  
Website: <http://weather.gov/aly>

----- End of forwarded message from Matthew Greenstein -----

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FXUS61 KALY 070710

AFDALY

AREA FORECAST DISCUSSION

NATIONAL WEATHER SERVICE ALBANY NY

310 AM EDT WED JUN 7 2006

.SYNOPSIS...A LOW PRESSURE SYSTEM WILL SLOWLY MOVE NORTHEAST ALONG THE EASTERN SEABOARD THIS MORNING AND WILL BE WELL SOUTHEAST OF LONG ISLAND. HOWEVER...THIS CYCLONE WILL PRODUCE PERIODS OF RAIN...AS FAR NORTHWEST AS EASTERN NEW YORK. THE RAIN WILL TAPER OFF TO SCATTERED SHOWERS WEDNESDAY NIGHT...AS THE LOW MEANDERS EAST OF CAPE COD BY THURSDAY MORNING. AS THE COASTAL CYCLONE DEPARTS INTO THE GULF OF MAINE ON THURSDAY...ANOTHER SYSTEM MOVING THROUGH THE EASTERN GREAT LAKES AND PENNSYLVANIA WILL BRING SHOWERS BACK INTO THE REGION LATE THURSDAY AFTERNOON INTO FRIDAY.

LARGE SCALE OVERVIEW...500 MB CLOSED/CUTOFF LOWS HAVE BEEN BIG RAIN MAKERS FOR THE NORTHEAST MAY INTO THE FIRST WEEK OF JUNE. **CSTAR WARM SEASON RESEARCH HAS VALIDATED THAT A LARGE PORTION OF THE SYNOPTIC RAINFALL CAN COME FROM CLOSED LOWS IN THE SPRING IN THE NORTHEAST.** YET ANOTHER ONE...WILL PRODUCE SIGNIFICANT RAINFALL FOR PORTIONS OF NEW YORK AND NEW ENGLAND TODAY INTO THURSDAY. THE LATEST WATER VAPOR LOOP SHOWS THE CUTOFF LOW CHURNING SLOWLY N/NE OFF CAPE HATTERAS. A LONGWAVE TROUGH PERSISTS OVER THE EAST COAST...WITH A REX BLOCK CONFIGURATION IN PLACE WITH A RIDGE OVER ERN CANADA SOUTH OF HUDSON BAY. FURTHER UPSTREAM...A BROAD H500 RIDGE IS IN PLACE OVER THE ROCKIES AND CNTRL PLAINS. A TROUGH IS MOVING INTO BRITISH COLUMBIA AND THE PACIFIC NORTHEAST...WITH AN AREA OF DIFFLUENCE AND ZONAL JET MAX OVER CNTRL CANADA AND THE UPPER MIDWEST.

&&

.SHORT TERM /TODAY THROUGH FRIDAY/...

TODAY AND TONIGHT...THE REGION BRACES FOR ANOTHER SOAKING RAIN EVENT. THE NAM REMAINS THE OUTLIER AGAINST THE GFS...CAN REG...GGEM...AND UKMET FOR THE OCEAN LOW THAT WILL IMPACT THE REGION. AT 0630Z...THE REGIONAL MOSAIC RADAR SHOWS RAIN MOVING INTO WRN NEW ENGLAND AHEAD OF WAVE AND WARM FRONT. THE OVER RUNNING RAINFALL THUS FAR HAS PRODUCED SOME HOURLY RATES IN EXCESS OF A QUARTER OF AN INCH IN AN HOUR OVER COASTAL SE NEW ENGLAND. WE COLLABORATED WITH HPC ABOUT QPF WITH THIS EVENT. THE GFS ADVERTISES 1-2" OVER THE FCST AREA BY 06Z. THE CAN REG WAS IN THAT CAMP TOO. THE NAM PRODUCED ONLY 0.25" TO 0.75" FROM THE HUDSON RIVER VALLEY EASTWARD. AGREED WITH HPC DUE TO THE FACT THAT A STRONG WARM CONVEYOR BELT DEVELOPS...AS THE H850 LOW LEVEL JET STRENGTHENS FROM THE E/SE TO 40-55 KTS. THIS WILL HELP ADVECT IN PLENTY OF ATLANTIC MOISTURE WITH SOME OROGRAPHIC UPSLOPE LIFT OFF THE SRN GREENS...BERKS...AND ADIRONDACKS. THE WAVE DEEPENS AND INTENSIFIES AS IT GETS NEAR SRN NEW ENGLAND LATE IN THE DAY. THIS IS SUPPORTED BY STRONG UPPER LEVEL DIVERGENCE AND THE RIGHT REAR QUAD OF THE H250 JET STREAK. GFS

SHOWS STRONG H700 FRONTGENESIS OVER THE HUDSON RIVER VALLEY 18Z TO 00Z. POTENTIAL FOR A MESOSCALE RAINBAND IS IN THE CARDS. HOWEVER...RAINFALL OF 0.75"-1.50" WITH A FEW LOCALLY HIGHER AMOUNTS WILL PREVENT ANY WIDESPREAD HYDRO OR FLOOD ISSUES. FOR MORE SPECIFICS ON HYDRO SITUATION...PLEASE SEE HYDRO SECTION OF DISCUSSION. WE WENT CLOSE TO GFSMOS VALUES TODAY. COOL AND DANK WEATHER CONTINUE OVERNIGHT WITH OCCLUDING LOW TIP TOEING TO NEAR CAPE COD BY 12Z. AFTER MIDNIGHT...THE RAIN WILL TAPER MORE TOWARD SHOWERS AS A H850 DEFORMATION ZONE REMAINED DRAPED OVER THE REGION.

THU-THU NIGHT...THE REGION IS CAUGHT BETWEEN SYSTEMS. COASTAL LOW CONTINUES TO SLOWLY RETROGRADE NORTHEAST INTO THE GULF OF MAINE...WHILE A SHORTWAVE TROUGH FROM THE OHIO VALLEY AND ERN GREAT LAKES REGION MOVES IN FROM THE WEST. THURSDAY WILL NOT BE A COMPLETE WASHOUT WITH A LULL IN THE PCPN...BUT IN THE AFTERNOON SHOWERS MAY MOVE BACK IN FROM WRN-CNTRL NY. THE ENERGY FROM THE UPSTREAM SYSTEM GETS ABSORBED INTO THE COASTAL CYCLONE...AS IT BACKS INTO N-CNTRL NEW ENGLAND. BROAD MOIST CYCLONIC FLOW CONTINUES OVERNIGHT. SCT -SHRA'S MAY PERSIST INTO THE EARLY EVENING. HENCE...WE KEPT A LOW CHANCE IN OVERNIGHT.

ON FRI...A 500 MB LONGWAVE TROUGH IS OVER THE NORTHEAST-MID ATLANTIC REGION WITH A SFC WAVE MOVING ALONG THE COASTLINE EAST OF NJ BY 18Z. THIS WEAK WAVE WILL PRODUCE ANOTHER ROUND OF RAINFALL. THE MOISTURE FETCH IS NOT AS STRONG AS THE NEAR TERM SYSTEM. HOWEVER...ANOTHER ROUND OF LIGHT RAIN WILL BE SPAWNED BY LOW LEVEL CONVERGENCE GENERATED BY THE SFC WAVE.

&&

.LONG TERM /FRIDAY NIGHT THROUGH TUESDAY/...

THE NEXT COASTAL SYSTEM THAT FORMS NEAR LONG ISLAND WILL BRING SOME RAINFALL TO THE REGION FRI NIGHT. THE GUIDANCE DOES NOT SPIT OUT TOO MUCH QPF FROM THIS SYSTEM. WE UPPED THE POPS TO HIGH CHANCE AND LIKELY VALUES DURING THIS PERIOD...WITH THE LIKELY VALUES BEING FROM THE HUDSON RIVER VALLEY NORTH AND EAST. THE H500 TROUGH CONTINUES TO HANG OVER NY AND NEW ENGLAND ON SAT. THERE WILL STILL BE A CHANCE OF SHOWERS ACROSS MOST OF THE FORECAST AREA. A 500 MB RIDGE OVER THE CNTRL US AND CANADA BUILDS IN QUICKLY SAT NIGHT WITH THE SFC HIGH MOVING IN FROM THE UPPER MIDWEST WITH SHOULD YIELD A DRY AND COOL SUNDAY. EARLY NEXT WEEK THERE IS A LOW OR SLIGHT CHANCE OF -SHRA'S EACH DAY WITH ACTIVE W/NW FLOW IN THE GRIDS...THOUGH THE LATEST

GFS AND CAN GGEM HAVE TRENDED DRIER. NO CHANCE MADE BEYOND SATURDAY IN THE GRIDS.

&&

.AVIATION...VISUAL FLIGHT RULES WILL APPLY OVER MUCH OF THE ROUTE FROM GLENS FALLS TO POUGHKEEPSIE THROUGH DAYBREAK. THERE WILL BE SOME PATCHY MARGINAL FLIGHT RULE CONDITIONS AROUND GLENS FALLS BEFORE DAYBREAK IN MIST. RAIN MOVING IN FROM NEW ENGLAND WILL REACH THE MID AND LOWER HUDSON VALLEY ABOUT DAYBREAK AND CONDITIONS WILL

DETERIORATE TO MARGINAL FOR VISUAL FLIGHT RULE FLYING. AS THE RAIN SPREADS NORTHWARD TO THE GLENS FALLS AREA SHORTLY AFTER NOON...MARGINAL FOR VISUAL FLIGHT RULE CONDITIONS WILL FOLLOW. TWO TO 3 HOURS AFTER THE RAINFALL BEGINS...CONDITIONS WILL AVERAGE VISIBILITY 4 TO 6 MILES AND CEILINGS FROM 2 TO 3 THOUSAND FEET ABOVE GROUND. SURFACE WIND WILL BE NORTH NORTHEAST AND INCREASE TO 10 TO 15 KNOTS THIS AFTERNOON. TONIGHT...RAINFALL WILL TAPER OFF DURING THE EVENING...WITH PATCHY LIGHT RAIN AND DRIZZLE FOR THE BALANCE OF THE NIGHT. CONDITIONS WILL GENERALLY BE MARGINAL FOR FLIGHT RULE CONDITIONS WITH CEILINGS BETWEEN 15 HUNDRED AND 25 HUNDRED FEET ABOVE GROUND AND VISIBILITY 3 OR 4 MILES. LOCALLY...VISIBILITY WILL BE LESS THAN 3 MILES AND CEILINGS AROUND 1 THOUSAND FEET ABOVE GROUND. THE SURFACE WIND WILL DIMINISH TO LESS THAN 10 KNOTS BY MIDNIGHT. THE OUTLOOK FOR THURSDAY IS FOR MARGINAL FOR FLIGHT RULE CONDITIONS UNTIL MID MORNING...THEN IMPROVING TO MAINLY VISUAL FLIGHT RULE CONDITIONS. CEILING WILL BE RISING TO 35 HUNDRED TO 4 THOUSAND FEET ABOVE GROUND BY NOON...WITH VISIBILITY UNRESTRICTED. SCATTERED SHOWERS ARE POSSIBLE...MAINLY IN THE AFTERNOON. SURFACE WIND WILL BE FROM THE NORTH AND LIGHT...AROUND 5 KNOTS.

&&

.HYDROLOGY...RIVER FLOWS CONTINUE ABOVE NORMAL FOR THIS TIME OF THE YEAR. MOST RESERVOIRS ARE WELL ABOVE NORMAL...WITH SCHOHARIE RESERVOIR SPILLING A SMALL AMOUNT OF WATER. THE LEVEL OF GREAT SACANDAGA HAS DROPPED JUST BELOW THE SPILLWAY LEVEL WHILE THE LEVEL OF HINCKLEY IS JUST SHORT OF SPILLING. A COASTAL STORM WILL BRING BETWEEN THREE QUARTERS OF AN INCH AND 1.5 INCHES OF RAINFALL THROUGH THIS EVENING...WITH PRECIPITATION MAINLY FALLING AS DRIZZLE FOR THE BALANCE OF TONIGHT. TWENTY-FOUR HOUR FLASH FLOOD GUIDANCE VALUES ARE FROM 2.5 TO 4 INCHES SO FLOODING DOES NOT APPEAR TO BE IN THE CARDS...ALTHOUGH SPILLOVER MAY OCCUR FROM THE GREAT SACANDAGA. THERE IS A POSSIBILITY OF ANOTHER COASTAL STORM FRIDAY NIGHT OR SATURDAY. AT THIS TIME...IT IS UNCERTAIN HOW MUCH RAINFALL WOULD OCCUR IN EASTERN NEW YORK AND WESTERN NEW ENGLAND. HOWEVER...BEST BET AT THIS TIME IS THAT THE HEAVIEST RAINFALL WOULD BE EAST OF OUR AREA OF CONCERN...SO THE THREAT OF FLOODING APPEARS TO BE MINIMAL.

&&

.FIRE WEATHER...SOGGY AND COOL ATMOSPHERIC CONDITIONS WILL OCCUR IN EASTERN NEW YORK AND ADJACENT WESTERN NEW ENGLAND THROUGH THURSDAY. THERE WILL BE WIDESPREAD RAINFALL TODAY...TAPERING OFF THIS EVENING. UP TO AN INCH AND A HALF OF RAINFALL IS POSSIBLE IN WESTERN NEW ENGLAND...WITH LESS THAN HALF AN INCH IN THE WESTERN ADIRONDACKS AND WESTERN MOHAWK VALLEY. THE RELATIVE HUMIDITY WILL BE HIGH THROUGH THURSDAY. TODAY'S MINIMUM RELATIVE HUMIDITY WILL BE BETWEEN 75 AND 85 PERCENT. TONIGHT...THE RELATIVE HUMIDITY WILL BE NEAR 100 PERCENT EVERYWHERE. AND ON THURSDAY...LOOK FOR THE MINIMUM RELATIVE HUMIDITY TO BE FROM 55 TO 65 PERCENT DURING THE MID AND LATE AFTERNOON HOURS. THE SURFACE WIND TODAY WILL BE FROM THE NORTH AND NORTHEAST AT 5 TO 15 MILES AN HOUR...WITH THE STRONGEST WIND OVER WESTERN NEW ENGLAND DURING THE AFTERNOON. TONIGHT'S WIND WILL

DIMINISH TO 10 MILES AN HOUR OR LESS BY MIDNIGHT. ON THURSDAY...THE  
WIND WILL BE FROM THE NORTH AT MAINLY LESS THAN 10 MILES AN HOUR.

&&

.ALY WATCHES/WARNINGS/ADVISORIES...

CT...NONE.

MA...NONE.

NY...NONE.

VT...NONE.

&&

\$\$

SYNOPSIS...WASULA

SHORT TERM...WASULA

LONG TERM...WASULA

AVIATION...HEMMERICH

FIRE WEATHER...HEMMERICH

HYDROLOGY...HEMMERICH

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Date: Fri, 09 Jun 2006 15:03:24 -0400  
From: norman w junker <Norman.W.Junker@noaa.gov>  
Subject: abstract  
To: Lance Bosart <bosart@atmos.albany.edu>

Lance,

I read your abstract entitled "Precipitation Structure and Distribution in Landfalling and Transitioning Tropical Cyclones" and was wondering whether I could get copies of the composites. I'm currently putting together a training package for predicting heavy rainfall here at HPC and right now, am currently working on the section on landfalling tropical cyclones. You Bosart and Dean schematic and Floyd pretty much explain the precipitation structure of storms that end up having their rainfall max on the left side of the storm. I'm guessing that shear plays a big role in the Alicia type storms but that's just a guess. Any help you can provide would be appreciated. If don't feel comfortable providing the composites prior to them being published, I'd understand and will muddle along in my typically muddle along manner.

On a different subject, the last composites for the CA rainfall events were bad. I gave Bob the wrong set of years except for the 3 big dog associated days. We now have a list of 47 days that got over 4 inches of rain that I went back and looked at the maps for each day to make sure they were OK. With the larger composite side, do you still think we need to partition out the 3 big multi-day events from the larger population?

Wes

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I forwarded the email to Anantha and asked him to make Atallah et al. (2006) available to Wes.

.....

Date: Wed, 14 Jun 2006 09:03:45 -0400  
From: norman w junker <Norman.W.Junker@noaa.gov>  
Subject: Re: abstract  
To: Anantha Aiyyer <aiyyer@atmos.albany.edu>,  
Lance Bosart <bosart@atmos.albany.edu>  
Cc: Edwin Danaher <Edwin.Danaher@noaa.gov>

Anantha,

Thank you for the link. I've downloaded the paper and made print copies for the HPC forecasters to read.

I liked the paper, maybe because your composites of the loc and roc fit my preconceived notions of the synoptic patterns associated with each type. I have a couple of comments. It would be nice if there were a table with the names and dates of the left of track and right of track storms. You then could also number the track and storms so a

reader would know what part of the country each storm was located in. My reason is that such a table would allow forecasters to go back and look at the maps associated with the storms which would allow them to get some idea of how the synoptic patterns varied within the two populations and also to see how the synoptic pattern of any projected storm compared to other storms in a general area. With your dates, a reader might also look at the following web site provides storm tracks and precipitation for many of the storms .

<<http://www.hpc.ncep.noaa.gov/tropical/rain/tcrainfall.html>><http://www.hpc.ncep.noaa.gov/tropical/rain/tcrainfall.html>

I had started a discussion of right versus left track storms and quickly latched onto Floyd and Berta as the two storms were both cat 2 storms at landfall and had similar track and speed. Both had substantially different rainfall distributions with significant differences in volume. I've attached an htm file with a more detailed precipitation analysis and a few maps that contrast Floyd with Bertha. You can view it through Microsoft Internet Explorer (I'm not sure whether Mozilla will work). Note the similarities between the Bertha upper pattern when the storm was over NC with your ROC cases and Floyd and your LOC cases. Floyd was a bigger storm than Bertha which partially explains the differences in the volume of rainfall. However, my take on it is that the volume of the rainfall is typically larger with the LOC storms since they have the front to provide an additional lifting mechanism. It would be interesting to see if the mean volume of rainfall with the LOC cases was greater than the mean for you ROC cases. I'd bet there is a difference. The complication with Bertha is that the bulk of the rain over New England was LOC even though the synoptic pattern was not a clear cut LOC pattern (at least to me). I suspect that orographic lifting somewhat aided the precipitation across New England.

I'm currently working on a training package for forecasting heavy/extreme rainfall for HPC. The package will be web-based. I'm trying to incorporate the latest research that is applicable to forecasting. Your paper is one that to me is very applicable. Right now I'm working on a section on forecasting the QPF associated with tropical systems. My plan is to tie the discussion of Floyd and Bertha that I've sent you with your composites in hopes of providing guidance of where in relationship to the storm track, the heaviest rainfall is most likely to occur.

Wes

Anantha Aiyyer wrote:

Dear Wes,

This is in reference to the paper Lance mentioned in his email. Since the document is about 14 MB in size, I thought it may be prudent to send you a link to it instead of clogging your

email! Please access the paper from:

<<http://www.atmos.albany.edu/student/aiyyer/papers/eyad.etal.pdf>><http://www.atmos.albany.edu/student/aiyyer/papers/eyad.etal.pdf>

We would welcome your comments very much!

Thanks,

Anantha

Hi Wes,

Much of the material you are asking about is in a paper, Atallah et al. (2006), that is currently in the MWR review process. Co-author Anantha Aiyyer has access to an electronic copy of the manuscript here. I'll have him make a copy of the manuscript available to you. Please keep in mind the usual caveats about referencing papers that have not yet been formally accepted.

Lance

.....

Date: Wed, 14 Jun 2006 10:36:17 -0400  
From: norman w junker <Norman.W.Junker@noaa.gov>  
Subject: Re: abstract  
To: Anantha Aiyyer <aiyyer@atmos.albany.edu>, bosart@atmos.albany.edu  
Cc: Edwin Danaher <Edwin.Danaher@noaa.gov>

The htm file I sent will not show the pictures if you view it using a web browser. I forgot you need a folder with all the images on it to be able to view it, otherwise the images are blank. I've attached a Powerpoint file that provides the images. The important ones are the Floyd and Bertha images. Both had almost identical track, were cat 2 hurricanes at landfall but had very different rainfall patterns. Floyd had the bulk of the precipitation fall to the left of the track. Bertha had it fall to the right side until the precipitation got northward to northern New Jersey, then the bulk fell the the left. Note how Floyd fits your LOC composite while the 250 and 925h maps for Bertha fit the ROC composite while the storm is over NC. Even over New England, to me the upper pattern looked more like the ROC composite than the LOC though I didn't look at it in the detail you did.

I thought you might be interested in the images. Sorry that my first attempt was poorly executed.

Dan: give a holler if you want the PP slides.

Date: Wed, 14 Jun 2006 14:08:37 -0400  
From: norman w junker <Norman.W.Junker@noaa.gov>



Subject: Re: Boulder poster PP slides: QPF/hydro conference (5-8 Jun'06)  
To: Lance Bosart <bosart@atmos.albany.edu>

Lance, your slides will help alot. I'll have to rewrite my section to include it and revise my take on tilt. I note the Atallah paper does have a table with the names of the LOC and ROC storms on it. I suggest they be given numbers and then that you also number the tracks on the other slide. That way, people can identify which storms went where, etc. My other comment is that to me Bertha is mis-identified. The bulk of the precipitation fell to the right of the storm until it got to northern New Jersey, even then, the 250 pattern does not fit the composite for LOC. At best it is a hybrid rather than a LOC.

I'm glad someone is working on hurricanes and precipitation.

Wes

Lance Bosart wrote:

Hi Wes,

I am sending a PowerPoint file containing 30 slides that were used for my poster presentation at the 2nd international QPF/hydro conference held in Boulder, CO, from 5-8 June 2006. Some of the forthcoming Atallah et al. (2006) figures were used on this poster.

Also included in the 30 slides are some excerpts of three MS theses from students of mine as follows:

Joshua Darr, 2002: A Quantitative Assessment of Extratropical Transition in the Atlantic Basin.

David DeLuca, 2004: The distribution of Precipitation over the Northeast Accompanying Landfalling and Transitioning cyclones.

Alan Srock, 2005: A Study of Precipitation Enhancement in Landfalling Tropical Cyclones Due to Induced Mesoscale Features.

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Slide 12 shows a figure from Sanders (1986) thart shows the path of the 500 hPa vorticity maximum relative to the surface cyclone center for rapidly deepening oceanic cyclones.

Slides 13 and 14 are identical to slide 12 except for composite strongly transitioning and nontransitioning TCs, respectively, as updated from Darr (2002). The blue and green dots represent the centers of the thermal vorticity maxima and minima (1000-200 hPa) relative to  $t = 0$  (time NHC declared that transition began) and the insert shows the behavior of the individual storms. For the ET storms (slide 13) the agreement with slide 12 is excellent, i.e., ET is a

baroclinic process. In strongly transitioning storms the thermal vorticity maximum works its way to the SW of the cyclone center while approaching the cyclone center as the downstream half wavelength decreases.

Slide 15 shows basic dynamical structures at the NHC designated transition time while slide 16 shows the same features at the time NHC downgraded TCs that did not undergo ET.

Slides 17 and 18 show the composite precipitation structure for the strongly transitioning and nontransitioning composites. Note the greater volume of precipitation and the left of track distribution for strongly transitioning storms vs. non transitioning storms. CAVEAT: Because of difficulty in obtaining rainfall distributions for all of the storms the sample size is ~6 in Slides 17 and 18 vs. ~15 in slides 13 and 14. Note also that in Atallah et al. (2006) the storms were stratified by whether the rain fell to the left or the right of the track of the storm center. Then we backed out the dynamics. In Darr (2002) we stratified the storms based on the dynamics (strong ET vs. no ET) and backed out the precipitation. Two different ways of doing things and we essentially got the same answer, giving us some confidence in our findings.

Slides 21-22 are from Srock (2005) that included a study of Marco (1990) for which you should recognize the HPC rainfall maps that we annotated. The point of these slides was to show the importance of jet-entrance regions and coastal frontogenesis to the mesoscale distribution of the heaviest precipitation. Slide 23 shows the DeLuca (2004) and Srock (2005) conceptual models.

Slides 24-29 deal with a separate study I did of the heavy rains that fell in the NYC metro area well in advance of Frances (2004).

The Darr, DeLuca and Srock work has not been published yet, but we are working on it. The NSF (CSTAR) funded the Darr and Srock (DeLuca). We have been working with David Vallee on a lot of this work and he has been using the DeLuca and Srock conceptual models for his forecasters.

Enough for now. Take care.

Lance

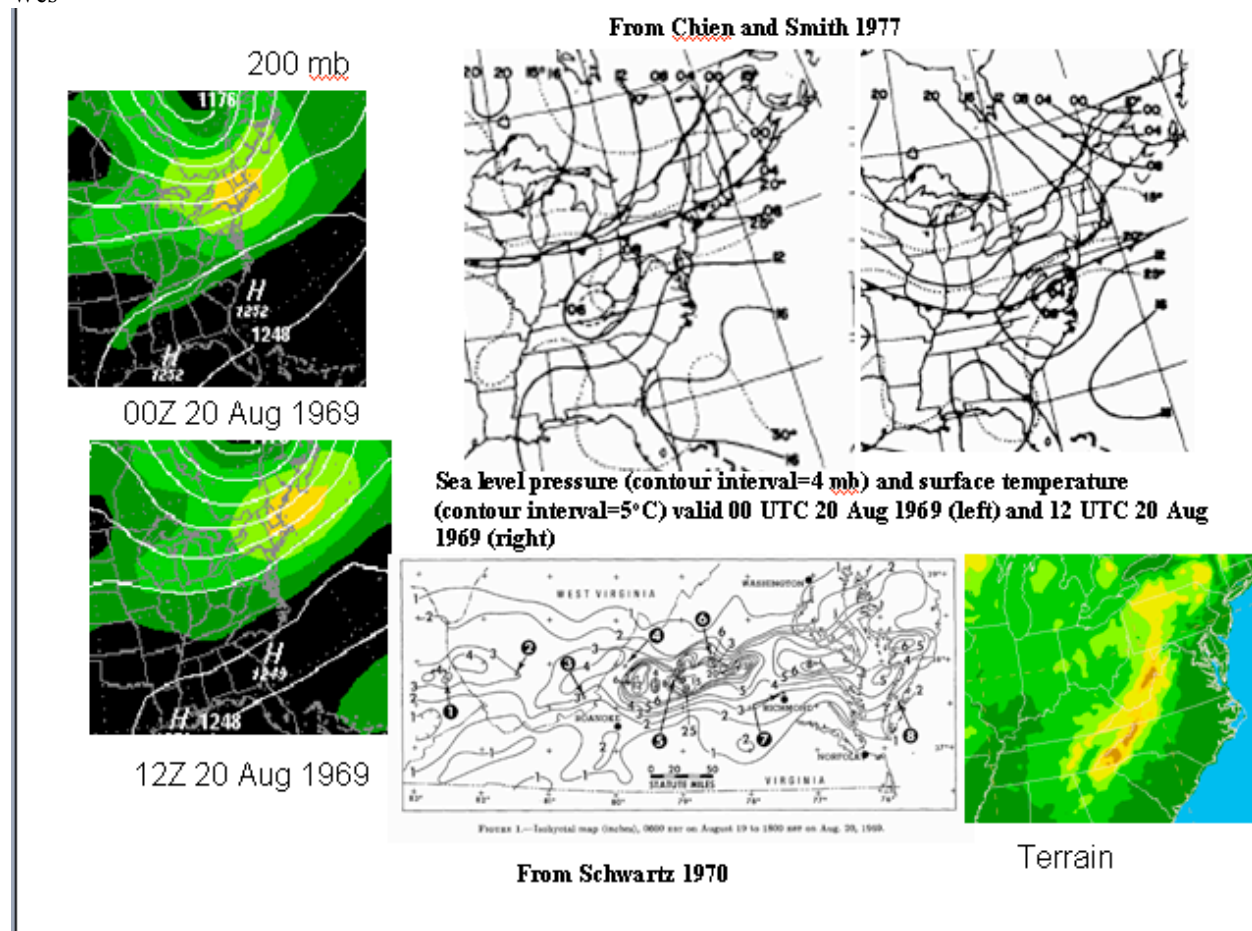
.....

Date: Fri, 29 Sep 2006 08:40:48 -0400  
 From: norman w junker <Norman.W.Junker@noaa.gov>  
 Subject: Possible research  
 To: Lance Bosart <bosart@atmos.albany.edu>  
 Cc: Louis Uccellini <Louis.Uccellini@noaa.gov>, Edwin Danaher <Edwin.Danaher@noaa.gov>

Lance,

I showed the Louis the attached figures of Camille and how much heavier its precipitation was compared to Danny....a storm with a slightly different but similar track. Why was there such a big difference in the precipitation? Louis attributes the difference to the jet streak during Camille. Danny did not have a strong jet streak associated with it so a more detailed comparison between the two might be interesting. It looks like there was low level frontogenesis taking place during both cases. Note how gradient of the the isotherms really tightens during Camille. However, the rainfall associated with Camille was much heavier. Louis encouraged me to to contact you about the possibility of your institute conducting research on the cases...especially camille and the feedback between from the latent heat into the jet streak and associated ageo circulations. He also mentioned the possibility of obtaining NARR type reanalysis of 7 day period that would include the period of Camille. He can give you more details about that possibility if you are interested. I think such research would make a good Masters thesis but realize you probably have loads of stuff you'd like to conduct research on if you had the time and funding.

Wes





Note that at 00 UTC 20 August the composite radar is aligned ahead of the front near the entrance region of the jet streak.

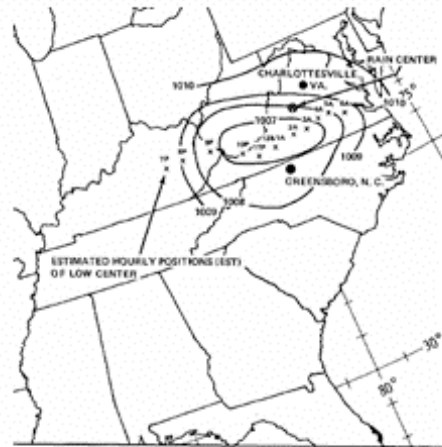
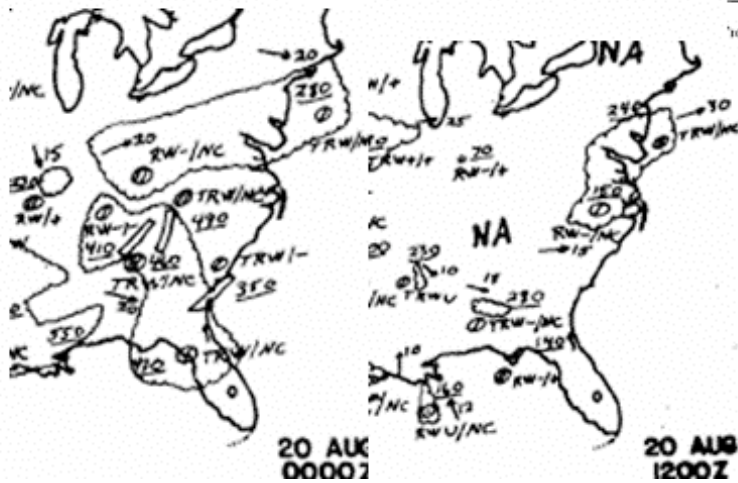


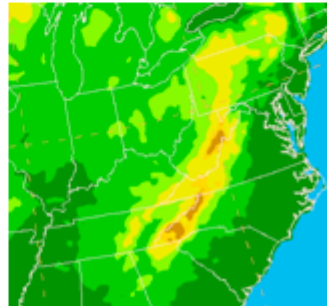
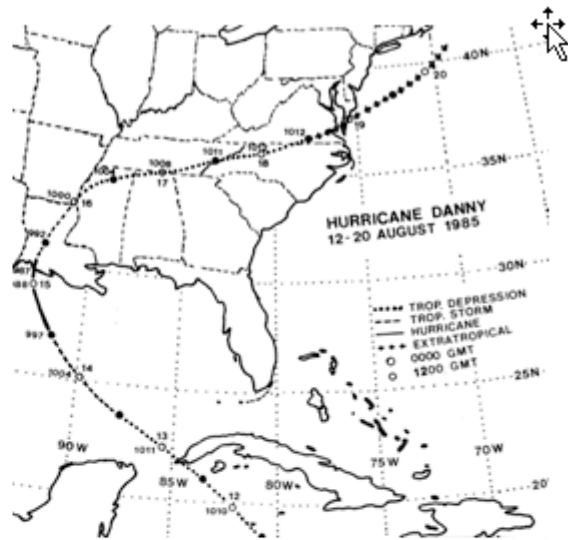
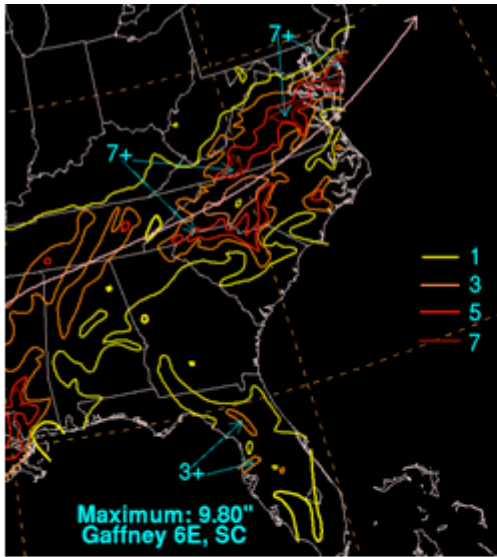
FIGURE 4.—Mean sea level pressure charts for the period 2200 to 0300 est on Aug. 19–20, 1969.



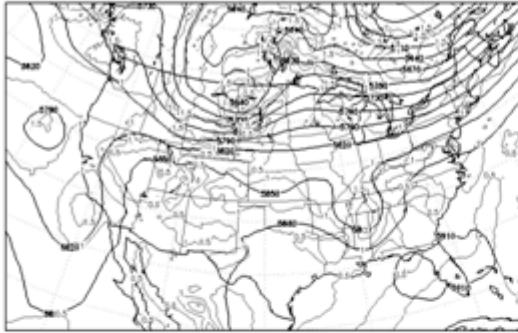
From Chien and Smith 1977



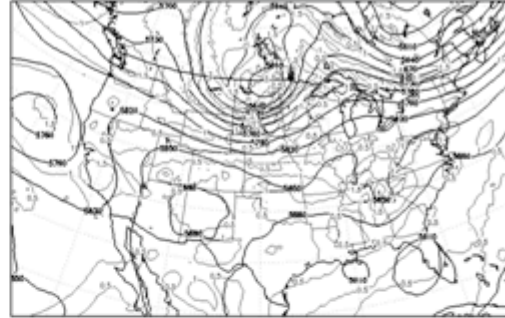
FIG. 2. Track of Castillo. "O" and "A" denote positions of storm center at 0000 and 1200 GMT, respectively.



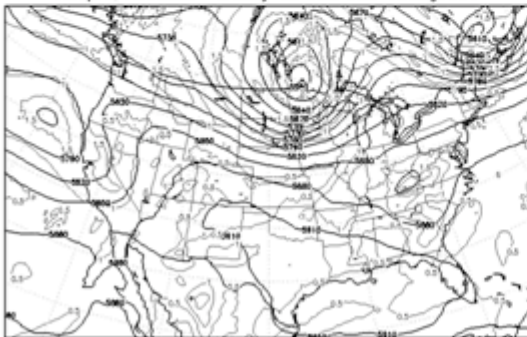
HGTprs, Absolute Vorticity at 00Z Sat 17aug1985



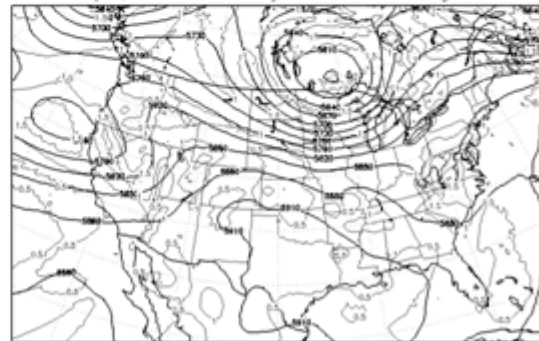
HGTprs, Absolute Vorticity at 12Z Sat 17aug1985



HGTprs, Absolute Vorticity at 00Z Sun 18aug1985



HGTprs, Absolute Vorticity at 12Z Sun 18aug1985



Date: Mon, 16 Oct 2006 10:42:11 -0400  
>From: Thomas Niziol <Thomas.Niziol@noaa.gov>  
>Subject: Re: [Fwd: Synopsis of Friday map discussion (Part I): 13 Oct'06]  
>To: David Vallee <David.Vallee@noaa.gov>  
>Cc: bosart@atmos.albany.edu, Jeff Waldstreicher <Jeff.Waldstreicher@noaa.gov>  
>  
>Dave and Lance,  
>  
>It is really comforting to hear some confirmation that this was  
>indeed a very complicated weather event. Lance, your observations  
>and comments regarding the storm are very enlightening. I worked  
>the 18 hours from Thursday evening through early Friday afternoon  
>and it was indeed surreal! I was outside the office at one point, I  
>believe around 2AM Friday morning, watching snow pellets >1/4"  
>diameter piling up at rates of 3 to 4 inches an hour as trees  
>cracked like shotgun blasts all around. I can only describe it  
>further as "sickening", almost like the trees were crying out.  
>  
>We agonized in the 48 hours before the event amongst the forecasters  
>on duty, trying to determine whether or not this would be a rain or  
>snow event. Of course, we went with experience in deciding it would  
>be mostly rain due to the warmth of the lake and the marginally cold  
>temps aloft. However, we discussed dynamic cooling etc as possible  
>scenarios that would keep this all snow. Thursday afternoon I  
>remember seeing the lower dewpoints across MI and wondering what  
>role low level evaporational cooling might play as the event  
>unfolded.  
>One of the issues you must consider in these types of catastrophic  
>events is causing "panic" among the public. I am convinced however,  
>that even if we would have hit the snowfall forecast on the nose,  
>nobody would have understood the catastrophic impact that it would  
>have had on the trees, except of course, if they experienced the  
>October '87 event. Our warning went with 6 inches of snow. Early  
>that morning, as I emerged from my "admin" office into the  
>operational world (yes, snide remark included there) and looked at  
>the progs, my stomach turned. I discussed potential impacts with  
>the staff, then called the Emergency managers from 3 of the 4  
>counties that would be affected. I told them that the main problem  
>would not be snow on roads, it would be snow on trees and that  
>widespread power outages were likely. At 2PM that afternoon, I  
>reiterated those comments. In retrospect, we started getting damage  
>reports with only a couple of inches of snowfall, so I am really not  
>sure how much snow it really took to put us "over the edge" and into  
>catastrophic results.  
>On Saturday, we had a brief burst of heavy, wet snow across our  
>Southern Tier. I called up a web cam to see if I could notice any  
>impact on fully leafed trees down there when the snow began. One  
>large maple tree, started the morning under beautiful sunshine,  
>advertising its fantastic colors. Once the snow began, in a matter  
>of an hour or so, you could actually watch the animation of images  
>and see the branches began to droop. I captured the images and want  
>to use them to teach forecasters and others just how quickly heavy,  
>wet snow can impact foliage in these situations. Yes, even as an

>MIC, you will never be able to get the researcher out of me :)  
>  
>In summary, I go through my 4th day of no power at home, 13 trees  
>on my property that have major damage, and I have not gotten my 5k  
>run in for a week now :),  
>we are getting by. The staff has been fantastic. Life will return  
>to normal eventually. My staff and I will need to put on our "thick  
>skin" coats for quite awhile as we continue to feel the sting of  
>"Surprise Storm" etc. is brought up in conversation. But we will  
>learn from the event. I would love to work with Lance on a research  
>project/paper on this event. I have at least one or two staff  
>members that would be willing to collaborate on this. By the way,  
>even though we were getting a new radiosonde system installed, we  
>actually have paper copies of launches from Friday. I have to see  
>exactly what we have, but we may even have more than we normally  
>get, possibly an 18z and 21z sounding too! So, Lance in this case,  
>Murphy's Law may have given us some sort of reprieve.  
>Dave, Thanks again for forwarding the discussion. I look forward  
>to hearing from you and Lance. Until then, I will leave you with  
>one other story. As you may or may not know, we name all of our  
>lake effect storms (for use internally only of course) and have a  
>different theme each year. We were going to go with an insect theme  
>this year (Aphid, Beetle, Caterpillar etc.) but one of our  
>historical buffs wanted military battles (Antietam, Battle of the  
>Bulge etc). We may opt for Antietam with total destruction of our  
>trees, cracking like shotgun blasts all night, the battle them might  
>be more appropriate :)  
>Take care,  
>  
>Tom Niziol  
>  
>David Vallee wrote:  
>>Tom,  
>>  
>>Lance does these each week - I'm lucky enough to be on the email  
>>list. It's a great read from Lance  
>>- tremendously enlightening to the connection to the Dynamic Trop  
>>disturbances and their associated  
>>cold pools timed just right to enhance the lake action. Seems he  
>>is up for the investigation if the BUF  
>>office is a will'n.  
>>  
>>Enjoy.  
>>  
>>David  
>>  
>>-----  
>>  
>>Subject:  
>>Synopsis of Friday map discussion (Part I): 13 Oct'06  
>>From:  
>>Lance Bosart <bosart@atmos.albany.edu>  
>>Date:



>>Sat, 14 Oct 2006 19:01:26 +0000

>>To:

>>map@atmos.albany.edu

>>

>>To:

>>map@atmos.albany.edu

>>CC:

>>bosart@atmos.albany.edu

>>

>>Hi Folks,

>>

>> Friday the 13th (Jason was missing....we think) map  
>>discussion for 13 Oct'06 opened with an examination of the  
>>just-concluded remarkable early season Buffalo snowstorm (Part I)  
>>and closed with an overview of the persistent storminess in the  
>>South Atlantic Ocean from mid-September through early October 2006  
>>(Part II)

>>

>> In the 24 h period ending 12Z/13 storm-total snowfalls of  
>>45-65 cm were observed in parts of the Buffalo area, breaking  
>>maximum daily and monthly snowfall records for October (Chicago and  
>>Detroit also broke records for their earliest measurable snowfall  
>>in this storm, but the amounts were trivial: 0.5 to 1.0 cm). To  
>>help describe this event I have attached the following goodies:

>>

>>1. KBUF radar imagery for 00Z/13 and 06Z/13 (from NCAR/RAP).

>>2. Unanalyzed surface maps for 12Z and 18Z/12, and 00Z and 06Z/13  
>>(from NCAR/RAP).

>>3. 850/300 hPa maps for 00Z and 12Z/13 (from the SPC).

>>4. Dynamic tropopause (DT) pressure/DT-850 hPa shear/925-850 hPa  
>>layer-averaged relative vorticity for 18Z/12, 00Z/13 and 06Z/13  
>>(from Ron McTaggart-Cowan's animation builder link).

>>5. 00Z/13 sounding from 72632 (DTX-White Lake).

>>

>> Alas, there were no soundings from BUF throughout the event  
>>because of a previously planned radiosonde equipment upgrade that  
>>illustrates once again that the atmosphere, like the Shadow of old,  
>>always "knows." Sigh....

>>

>> Appended below are the BUF metars for the 24 h period  
>>ending 12Z/13. Thundersnow was common and in the 3 h ending 07Z/13  
>>25 cm of snow was measured. It must have been quite the night, and  
>>a very scary one too, with the sounds of falling trees and tree  
>>branches everywhere (I remember what it was like here on 4 Oct'87).

>>

>> As for the event, the first eye-opener (for me) was the  
>>warmth of the water in Lake Erie (15-16 C). It boggles the mind  
>>(at least mine) to think that a persistent along-lake WSW flow  
>>under these conditions could produce and sustain surface air  
>>temperatures near freezing as was observed (this could be a good  
>>thermodynamic problem to "torment" students down the road).  
>>Figuring conservatively, and without benefit of the BUF sounding  
>>data, the 850 hPa and 500 hPa temperatures over BUF at 00Z/13 were

>>~ -5 C and -34 C, respectively. This temperature estimate equates  
>>to a water-850 (500) hPa temperature difference of 20-21 (49-50) C,  
>>respectively. How do you spell steep lapse rates near the east end  
>>of Lake Erie?

>>

>> Base reflectivity loops from KBUF and KCLE show that at the  
>>outset of the event the radar echoes over northern Ohio, southern  
>>Michigan and western Lake Erie had a splotchy "convective-looking"  
>>appearance. Over eastern Lake Erie the echoes eventually  
>>consolidated into an along-lake band that contained 40+ dBZ cores  
>>and appeared to contain "wave-like" motions. Base velocity loops  
>>from KBUF supported a strong along-lake low-level flow between  
>>25-35 kt.

>>

>> The arrival of the cold air into the BUF region is of  
>>interest. The attached plotted surface maps and the appended BUF  
>>metars suggest that the cold air initially reached extreme western  
>>New York along a continental westerly trajectory that came from  
>>Michigan across southern Ontario. This initial continental air  
>>trajectory may have been an important ingredient in providing  
>>sufficient early cooling and allowing the rain observed before  
>>12Z/12 to mix with and change to graupel and snow. The onset of the  
>>heavy snow in the BUF area subsequent to 18Z/12 in an environment  
>>of broad confluence across Lake Erie as seen from the observed  
>>WSW/W (SW/SSW) flow on the north (south) side of the lake. However,  
>>it was difficult to see this inferred confluence in the BUF area  
>>obs (IAG, BUF, DKK), given the reported variations in wind  
>>direction and wind speed from BUF. I am suspicious that heavy wet  
>>snow may have interfered with the ability of the ASOS sensors to  
>>report reliable wind directions and speeds (comments welcome on  
>>this potential problem).

>>

>> The DT pressure, DT-850 hPa shear, and layer-averaged  
>>925-850 hPa relative vorticity maps for 18Z/12-06Z/13 illustrate  
>>that any explanation for this remarkable early season lake-effect  
>>snowstorm can't rest on surface mesoscale features alone but must  
>>also consider the likely role of transient upper-level disturbances  
>>in determining the timing, intensity and location of the  
>>precipitation. The leading edge of the arctic air as manifest by  
>>higher values of pressure (>450 hPa) on the DT was just reaching  
>>the BUF area at 12Z/18 as rain was changing to snow. As anticipated  
>>during the Friday map discussion of 6 Oct'06 (three-part post from  
>>Tom Galarneau), the arrival of this arctic air was a realization of  
>>downstream flow amplification and development stimulated by  
>>recurving and transitioning western Pacific typhoons and their  
>>associated upper tropospheric warm pools. Also of interest is a  
>>second trailing DT disturbance over Minnesota and Wisconsin at  
>>18Z/12. This second DT disturbance, still attached to its arctic  
>>umbilical cord, is near the south end of Lake Michigan at 00Z/13  
>>(note low tropopause, -37 C 500 hPa temperature, steep lapse rate  
>>and 518 dam thickness in the 00Z/13 72632 sounding) and is moving  
>>ENE across Lake Erie at 06Z/13. Note also the narrow thermal trough  
>>(DT to 850 hPa) just west of BUF at 06Z/13. The arrival of the

>>coldest air above the surface coincided with the heaviest snowfall  
>>period in BUF (25 cm in the 3h ending 08Z/13) and suggests that  
>>vigorous ascent associated with the second DT disturbance may have  
>>helped to enhance the snowfall rates in an environment of very  
>>steep lapse rates throughout the lower half of the troposphere. It  
>>is also possible that sensible cooling associated with melting snow  
>>in a vigorous updraft have helped to keep the lowest 100-200 m  
>>of air adjacent to the ground close to 0 C despite 15 C water  
>>upwind. The importance of sensible cooling associated with melting  
>>snow in saturated environments was noted by Bosart and Sanders  
>>(1991) in conjunction with the "surprise" 4 Oct'87 snowstorm in  
>>eastern NY.

>>  
>> The events of 12-13 Oct'06 would make for an interesting  
>>multiscale research investigation. There is more to the story here  
>>than just a "simple" mesoscale lake-effect snowstorm.

>>  
>> Lance  
>>

>>An Early-Season Coastal Storm: Conceptual Success and Model Failure  
>>Lance F. Bosart and Frederick Sanders  
>>Monthly Weather Review Volume 119, Issue 12 (December 1991) pp. 2831-2851  
>>

>>KBUF 131152Z 20007KT 1SM -SN BR FEW005 OVC012 01/M05 A2970 RMK AO2  
>>VIS 1/2V1 1/2 TSE49 SLPNO SNINCR 1/22 4/022  
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>>OCNL LTGIC OHD TS OHD MOV NE  
>>KBUF 130954Z 31004KT 3SM -TSSN BR SCT005 OVC012CB 02/M02 A2970 RMK  
>>AO2 OCNL LTGIC OHD TSB36 OHD MOV NE SLPNO SNINCR 1/20  
>>KBUF 130937Z 00000KT 3SM TS BR SCT005 OVC012CB A2969 RMK AO2 OCNL  
>>LTGIC OHD TS OHD MOV NE  
>>KBUF 130929Z 22005KT 11/2SM -TSSN BR SCT004 OVC009CB A2968 RMK AO2  
>>OCNL LTGIC OHD TS OHD MOV NE  
>>KBUF 130852Z 20010KT 1/2SM TSSN FG OVC003CB 00/M03 A2969 RMK AO2  
>>OCNL LTGIC OHD TSB36 OHD MOV NE SLPNO SNINCR 2/19  
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>>TSB14 OHD MOV NE  
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>>SNINCR 2/10 4/010  
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>>SNB0358 P0000 RVRNO \$  
>>KBUF 130419Z 26008KT 3/4SM -SN BR VV009 01/M01 A2974 RMK AO2  
>>SNB0358 P0000 RVRNO \$  
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 >>SNB58 P0000 \$  
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 >>A2973 RMK AO2 OCNL LTGIC OHD TS OHD MOV NE P0000 \$  
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 >>RMK AO2 OCNL LTGIC OHD TS OHD MOV NE P0000 \$  
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 >>KBUF 121751Z 27013G19KT 5SM RASNGS BR BKN007 OVC012 02/01 A2957 RMK  
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 >>RMK AO2 GSB1658 P0001  
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>>RAE31 SLP984 CIG LWR E-S P0010 60024 70113 T00780044 10139 20078  
>>53013

----- End of forwarded message from Lance Bosart -----

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