Agenda
Northeast Regional Operational Workshop
Albany, New York
Tuesday, November 1, 2005

Day Chair – Raymond O'Keefe

8:30 am
Welcoming Remarks
Eugene P. Auciello, Meteorologist In Charge, NWS Albany, New York
Warren R. Snyder, Science & Operations Officer, NWS Albany, New York
Raymond O'Keefe, Warning Coordination Meteorologist, NWS Albany, New York

Session A. Modeling

8:45 am
Predictability and Extended Range Forecasts: The Complimentary Roles of HPC and WFOs
Peter Manousos
NOAA/NWS National Center for Environmental Prediction, Hydrometeorological Prediction Center, Silver Spring, Maryland

9:10 am
Predictability and Extended Range Forecasting
Josh Korotky
NOAA/NWS, Weather Forecast Office, Pittsburgh, Pennsylvania

9:35 am
An Investigation of Model-Simulated Band Placement and Evolution in the 25 December 2002 Northeast U.S. Banded Snowstorm
David Novak
NOAA/NWS Eastern Region Headquarters, Bohemia, New York

10:00 am
Storm Surge Modeling for the New York Metropolitan Region
Brian A. Colle
Marine Sciences Research Center
Stony Brook University/SUNY

10:25 am
Break

10:50 am

Convective Forecast Performance of an Operational Mesoscale Modeling System

Anthony P. Praino
IBM Thomas J Watson Research Center,
Yorktown Heights, New York

Session B. Severe Convection/Warm Season

11:15 am

An Examination of Three Derecho Events and MCS Interactions During the First Week of July 2003 Concurrent With BAMEX

Nicholas D. Metz
Department of Earth and Atmospheric Sciences, University at Albany, State University of New York, Albany, New York

11:40 am

A Statistical Analysis and Synoptic Climatology of Heat Waves over the Northeast United States

Scott C. Runyon
Department of Earth and Atmospheric Sciences, University at Albany, State University of New York, Albany, New York

12:05 pm

Ridge Rollers: Mesoscale Disturbances on the Periphery of Cutoff Anticyclones

Tom Galarneau, Jr.
Department of Earth and Atmospheric Sciences, University at Albany, State University of New York, Albany, New York

12:30 **Lunch**

2:00 pm

Elevated Mixed Layers and their Role in Significant Severe Thunderstorm Episodes in the Northeastern United States

Michael L. Ekster
NOAA/NWS, Weather Service Forecast Office, Upton, New York

2:25 pm

A Multiscale Analysis of the 23-24 November 2004 Southeast United States Tornado Outbreak

Alicia Wasula

2:50 pm

The Thanksgiving 2004 Severe Weather Event across Upstate New York and New England

Thomas A. Wasula
NOAA/NWS Weather Forecast Office, Albany, New York

3:15 pm
Tornadoes to Torrents: The Southern Ontario Severe Weather Event of August 19, 2005
Robert Hamilton
NOAA/NWS Weather Forecast Office, Buffalo, New York

3:40 pm
Break

4:00 pm – Keynote Presentation NCEP Update; Focus on the Winter Weather Desk
Dr. Louis W. Uccellini, Director
NOAA/National Centers for Environmental Prediction
Camp Springs, Maryland

5:00 pm
Adjourn

Agenda
Northeast Regional Operational Workshop
Albany, New York
Wednesday, November 2, 2004

Day Chair – Warren R. Snyder

Session C. Hydrology

8:30 am
An Examination of the Environmental Characteristics of Flash Flooding in the Binghamton, NY County Warning Area
Stephen Jessup
Cornell University, Ithaca, New York

8:55 am
Winter Hydrology:
Modeling River Ice and Ground Frost to Improve Flood and Flash Flood Warning Accuracy
Stephen N. DiRienzo
NOAA/NWS Weather Forecast Office, Albany, New York

Session D. CSTAR Projects and Related Topics

9:20 am
The Tropical Transition of Hurricane Alex (2004): Observations and Forecast Implications
Lance F. Bosart
Department of Earth and Atmospheric Sciences, University at Albany, State University of New York, Albany, New York

9:45 am
Modeling the Initialization and Tropical Transition Hurricane Alex (2004)
R. McTaggart-Cowan
Department of Earth and Atmospheric Sciences, University at Albany, State University of New York, Albany, New York

10:10 am
Break

10:35 am
A Comparison of Tropical Cyclones Cindy (2005) and Ivan (2004) during their Extratropical Transition (ET) Phases
Michael L. Jurewicz, Sr.
NOAA/NWS, Weather Forecast Office, Binghamton, New York

11:00 am
Cool-Season Regime Transition and Its Impact on Precipitation in the Northeast
Heather Archambault
Department of Earth and Atmospheric Sciences, University at Albany, State University of New York, Albany, New York

11:25 am
Cool-Season Moderate Precipitation Events in the Northeastern United States
Keith Wagner
Department of Earth and Atmospheric Sciences, University at Albany, State University of New York, Albany, New York

11:50 am
A Climatological Study of Storm Track and Banding for Mid-Atlantic Snow Storms from 1960 – 2004
Patrick F. Maloit
NOAA/NWS Weather Forecast Office, Wakefield VA

12:15 pm
Examining the Role of Mesoscale Features in the Structure and Evolution of Precipitation Regions in Northeast Winter Storms
Matthew D. Greenstein
Department of Earth and Atmospheric Sciences, University at Albany, State University of New York, Albany, New York

12:40 pm
Lunch

Session E. Aviation and Operations

2:00 pm
Aviation Cloud Forecasts – A True Challenge for Forecasters
Jeffrey S. Tongue
NOAA/National Weather Service, Upton, New York

2:25 pm
Multi-Year Examination of Dense Fog at Burlington International Airport
John M. Goff
NOAA/NWS Weather Forecast Office, Burlington, Vermont

2:50 pm
The "Similar Sounding" Technique for Incorporating Pattern Recognition Into the Forecast Process at WFO Binghamton, New York
Michael Evans and Ron Murphy
NOAA/NWS Weather Forecast Office, Binghamton, NY

3:15 pm
A Study of Coherent Tropopause Disturbances within the Northern Hemispheric Circumpolar Vortex
Joseph R. Kravitz
Department of Earth and Atmospheric Sciences, University at Albany, State University of New York, Albany, New York

3:40 pm
Closing Remarks
Warren R. Snyder

3:45 pm
Adjourn

NROW 8 will be held November 7-8, 2006

Predictability and Extended Range Forecasts: The Complimentary Roles of HPC and WFOs

Peter Manousos
NOAA/NWS National Center for Environmental Prediction, Hydrometeorological Prediction Center, Silver Spring, Maryland

Josh Korotky
NOAA/NWS Weather Forecast Office, Pittsburgh, Pennsylvania

The National Oceanic and Atmospheric Administration (NOAA)/National Center for Environmental Prediction's (NCEP) Hydrometeorological Prediction Center (HPC) provides medium range guidance for days 4 through 7 lead times over the contiguous US (CONUS). These forecasts are generated by HPC Medium Range Desk forecasters using NCEP and non-NCEP deterministic and ensemble model output. Given the uncertainty in forecast solutions and limits of predictability, forecaster experience is used in combination with objective and statistical tools to establish the most likely evolution of the synoptic scale pattern. The synoptic scale pattern evolution is conveyed in terms of point forecasts (384 points) over the CONUS for a number of sensible weather elements, and converted to 5 km grids through statistical and climatological algorithms.

HPC guidance grids are intended to be ingested into the Graphical Forecast Editor (GFE) at WFOs, where they will be used as a background field representing the most likely synoptic pattern evolution. WFO forecasters can then apply Smart Tools to add mesoscale (e.g., terrain–induced) details. The main goal of the extended range forecast process is to get the most “bang” (skill) for the “buck” (effort), given predictability limits, available resources, and operational necessities. Shared responsibilities between HPC and WFOs will allow local forecasters to concentrate their efforts on short range forecasts, where predictability and urgency are generally greatest.

This presentation will demonstrate the forecast strategy used by HPC Medium Range forecasters. The discussion will include a listing of the guidance available to HPC forecasters, the tools/techniques utilized to establish the most likely evolution of synoptic scale features, and details of how the point and gridded forecasts are generated. After presenting the HPC role, the discussion will focus on how WFO forecasters can best interact with HPC (and each other) to ensure the most skillful extended range forecast, and (given limits to predictability) problems to avoid.

Predictability and Extended Range Forecasting

Josh Korotky
NOAA/NWS, Weather Forecast Office, Pittsburgh, Pennsylvania

Chaos theory asserts two main ideas: 1) systems (regardless of complexity) rely upon an underlying order, and 2) very simple or small systems and events can cause very complex behaviors or events to occur over time. The latter condition is known as sensitive dependence on initial conditions.

The atmosphere is a chaotic (non-linear and non-periodic) dynamical (deterministic) system in which two nearly identical initial states, each evolving according to the same physical laws, can develop into final states that bear no resemblance at all to one another. Sensitive dependence on initial states imposes a limit to predictability because there is no way to know precisely the initial state of the atmosphere. Our ability to make skillful forecasts can be restricted by very small initial condition uncertainty, and further limited by 1) our incomplete knowledge of atmospheric processes and scale feedbacks, and 2) the inability of Numerical Weather Prediction (NWP) to precisely model many of the physical laws governing the atmosphere. The predictability of atmospheric flows depends on the effects of Chaos, and the scale at which key atmospheric process are occurring. Predictive skill often falls away quickly (within hours) for small scale features like thunderstorms, and more gradually for synoptic scale features like mid-latitude storms. Considering the limits of predictability, single model forecasts frequently lose their utility after 2 or 3 days.

An Ensemble Prediction System (EPS) was developed to optimize the predictability of forecasts. In contrast to a single deterministic forecast, an EPS is composed of several, perhaps numerous model integrations (ensemble members), individually starting from minute differences in their initial conditions. Although each ensemble member is equally likely to verify, the individual forecast solutions generally diverge over time, until error saturation precludes any predictability. At times the individual forecasts will cluster toward a common outcome, which increases confidence in the forecast. At other times, the ensemble may exhibit more than one cluster of solutions, leading to a more complex decision process. In any case, an EPS optimizes the predictability of forecasts, and offers the most skillful solution for extended range forecasts. This presentation will illustrate methods to optimize skill for extended range forecasts, given the limits of predictability imposed by chaos and model errors. The complimentary roles of HPC and WFOs (in optimizing skill in the extended range forecast process) will be discussed in a separate presentation.

An Investigation of Model-Simulated Band Placement and Evolution in the 25 December 2002 Northeast U.S. Banded Snowstorm

David Novak
NOAA/NWS Eastern Region Headquarters, Bohemia, New York
Stony Brook University, State University of New York,
Stony Brook, New York

Brian Colle
Stony Brook University, State University of New York,
Stony Brook, New York

Daniel Keyser
University at Albany, State University of New York, Albany, New York

High-resolution versions of the MM5 and WRF models have shown the capability to predict band formation, movement, and dissipation in the 25 December 2002 northeast U.S. banded snowstorm. However, the predicted bands were displaced to the southeast of the observed location, and their predicted evolution ranged from the formation of a short-lived single band in the MM5 forecast to the formation of two bands over a 9-h period in the WRF forecast. This study will use various observational platforms and potential vorticity (PV) diagnostics to explore the above variations in model-simulated band placement and evolution in the 25 December 2002 snowstorm.

Consistent with previous observations and theory, the model-simulated bands occurred in conjunction with intense midlevel frontogenesis and weak moist symmetric stability in a moist environment. The model-simulated midlevel frontogenesis maximum in both models was associated with a sharp 700-hPa trough that served as a focus for midlevel convergence. This feature, although plausible, could not be verified with conventional observations. However, wind profiler, aircraft, and radar observations in the vicinity of the model-predicted 700-hPa trough provide evidence that a sharp 700-hPa trough did exist, although it was located 50–100 km farther west than in the model predictions. Such a westward displacement could explain the band position errors noted in the simulations.

In addition to the primary 700-hPa trough, the WRF simulation exhibited a second 700-hPa trough later in the cyclone evolution. Both 700-hPa troughs are evident on the dynamic tropopause (2.0 PVU surface) as high pressure (low potential temperature) filaments extending outward from the primary PV anomaly. Preliminary analysis suggests that the formation of these

filaments is tied, in part, to diabatic heating associated with elevated convection occurring off the New Jersey and southern New England coast just prior to and during the banding event. It is hypothesized that such diabatic heating reduces upper-tropospheric PV, creating asymmetries in the primary PV anomaly. These asymmetries are stretched in the deformation zone north and northwest of the cyclone, resulting in the PV filaments. Further analysis of the relationship between elevated convection off the northeast U.S. coast, and band placement and evolution in this case will be presented at the workshop.

Storm Surge Modeling for the New York Metropolitan Region

Brian A. Colle, Frank Buonaiuto, Malcolm J. Bowman,
Robert E. Wilson,Roger Flood, Douglas Hill, Yi Zheng,
Robert Hunter, and Christian Mirchel

Marine Sciences Research Center
Stony Brook University/SUNY

New York City (NYC) and the adjacent part of New Jersey and Long Island surround a complex of waterways influenced by tides and weather. Much of the region is less than five meters above sea level, with about 260 square kilometers at risk for storm surge flooding from both tropical cyclones and nor-easters. Moderate flooding has occurred in the metro NYC area, such as during the December 1992 nor-easter. As a result, coastal flooding in this region is a major forecast problem for the NOAA National Weather Service.

The Stony Brook storm surge group has developed a real-time storm surge model for the NYC region using both high resolution atmospheric and ocean models. The atmospheric forcing used for the Stony Brook Storm Surge (SSBS) modeling system is the Penn State- National Center for Atmospheric Research (PSU-NCAR) Mesoscale model (MM5), which has been in running twice-daily around for the Northeast U.S. and offshore waters for several years. The surface winds and sea-level pressure from the 12-km MM5 domain are used to drive the Advanced Circulation Model for Coastal Ocean Hydrodynamics (ADCIRC) model, which solves time-dependent, free-surface circulation and wind-driven transport in a barotropic configuration. The triangular elements of ADCIRC range from 70-km several hundred kilometers offshore to nearly 8-m around NYC.

This paper describes the setup of SBSS and its performance during tropical storm Floyd, which impacted the NYC region on 16-17 September 1999. During this event, which was well simulated by MM5 in the 36-h time frame, easterly surface wind speeds to the north of Floyd were 15-20 m s^{-1} (30-40 kts) along the southern New England coast, which created a 0.5-1.0 m storm surge around NYC and western Long Island Sound. ADCIRC was able to successfully simulate the highest water levels to within 5-10 cm at many locations. No coastal flooding was observed during Floyd, which is attributed to the approach of Floyd near low tide and its rapid weakening as it moved up the coast. Additional ADCIRC simulations were completed by shifting Floyd’s nearby approach earlier to the spring high tide the previous week and also by doubling Floyd’s wind speed to mimic a weak category 1 hurricane. Both of these scenarios resulted in minor to moderate coastal flooding around NYC. Since the City’s vulnerability to coastal flooding will increase as sea level continues to rise, the feasibility of constructing storm surge barriers around NYC is also discussed. Users are able to monitor the SSBS 48-h forecasts and verification at http://stormy.msrc.sunysb.edu, which will include 4-5 ensemble members this winter.

CONVECTIVE FORECAST PERFORMANCE OF AN OPERATIONAL MESOSCALE MODELLING SYSTEM

Anthony P. Praino & Lloyd A. Treinish
IBM Thomas J Watson Research Center,
Yorktown Heights, New York

In our continuing work on the implementation and applications of an operational mesoscale modeling system dubbed "Deep Thunder", we examine its forecast performance for convective events over the several geographic regions in the United States. Initially, this prototype provided nested 24-hour forecasts, which are typically updated twice daily, for the New York City metropolitan area to 1 km resolution. It has been extended to also provide forecasts for the Chicago and Kansas City metropolitan areas at 2 km resolution, at least once per day. Explicit, bulk cloud microphysics are included in the model predictions for all three geographies. All of the processing, modelling and visualization are completed in one to two hours on relatively modest hardware to enable sufficiently timely dissemination of forecast products for potential weather-sensitive applications.

In order to evaluate the quality of the forecasts produced by Deep Thunder at a storm-scale and its potential skill, we have identified a number of interesting cases for moderate and severe convective events in each of the three aforementioned geographies. We compare the model results with observational data and other available forecasts as well as the operational availability of specific forecast products. Such performance is examined by considering forecast timing, locality, and intensity of convective events

An Examination of Three Derecho Events and MCS Interactions During the First Week of July 2003 Concurrent With BAMEX

Nicholas D. Metz and Lance F. Bosart
Department of Earth and Atmospheric Sciences, University at Albany, State University of New York, Albany, New York

The first week of July 2003 saw twelve coherent mesoscale convective systems (MCSs) propagate across the upper Midwest. Three of these met the criteria set forth for a derecho and are of interest here. Pre-existing baroclinic zones were the focus for moisture pooling while warm advection and the associated isentropic upglide over the baroclinic zones allowed for continued moisture infusion. Steep mid-level lapse rates, along with daily diabatic heating, allowed for destabilization of high CAPE atmospheres. Shortwave disturbances (potential vorticity anomalies) helped to strengthen the upper-level flow, which aided in the generation of the derechos once organized MCSs developed. Deep-layer shear in excess of 40 knots favored derecho evolution. The intensification of the nocturnal low-level jet further enabled high equivalent potential temperature/CAPE (surface-based) air to accelerate poleward where it was intercepted by the eastward traveling MCSs. As a result of a combination of these factors, the upper Midwest saw extensive wind damage during this period associated with the derechos.

Complex interactions occurred on both the synoptic and mesoscale with each derecho event. This allowed each derecho to develop and evolve in a unique fashion as different dynamic and thermodynamic factors coexisted. In addition, other features such as the Great Lakes influenced the bow echoes, leading to intensification in one case and weakening in another. However, these interactions were not limited to the derecho MCSs. The less severe MCSs also played a vital role in the development of future convection. Fortuitously, these three derechos along with the other nine MCSs occurred during the Bow Echo and Mesoscale Convective Vortex Experiment (BAMEX), which made for the availability of enhanced observational datasets.

A detailed assessment of the similarities and differences between the derecho events will be presented using model forecasts, satellite imagery, radar composites and surface observations. Additionally, a synoptic and mesoscale analysis will be presented of derecho/MCS interaction on 4-5 July 2003. Supplementary observations from P-3 aircraft as well as dropsondes released during BAMEX augment the other data. These all contribute to an understanding of the synoptic and mesoscale environments present in the upper Midwest during this week, permitting the derechos and other MCSs to be examined in great detail.

A Statistical Analysis and Synoptic Climatology of Heat Waves over the Northeast United States

Scott C. Runyon and Lance F. Bosart
Department of Earth and Atmospheric Sciences, University at Albany, State University of New York, Albany, New York

Heat waves remain a relatively understudied weather phenomenon within the meteorological research community. This is surprising given the large number of heat wave related deaths that occur annually. With the goal of improving the forecasts of these high-impact events, this study presents a synoptic climatology of heat waves over the Northeast and a statistical analysis of the frequency of heat waves nationwide.

Heat waves were identified using a 54-station dataset of daily high temperatures over a 54-year period (1948–2001). These data were retrieved from the National Climatic Data Center (NCDC) Daily Surface Dataset. Stations were distributed equally across the conterminous United States and separated for analysis purposes into the nine standard climate regions defined by NCDC. Warm periods were considered heat waves if, for at least three consecutive days, high temperatures at a station exceeded the climatological 97.5 percentile temperature (approximating a plus two standard deviation anomaly). Percentiles were used in place of standard deviation anomalies because it was found that high temperatures in most cities are not normally distributed. Heat waves were defined as regional when they occurred simultaneously at two or more cities within a NCDC region. In order to identify temporal trends in frequency, time series of both heat waves and anomalously hot days exceeding the 97.5 percentile were also prepared.

Although high temperature data is widely assumed to be normally distributed, statistical analysis shows that non-normal high temperature distributions are common. For most cities (e.g., Denver), high temperatures more than two standard deviations below normal are more frequent than daily highs more than two standard deviations above normal. An exception is Los Angeles where anomalous high temperatures are associated with downslope offshore flow. A time series analysis indicates an increased (decreased) frequency of heat waves in the Northeast, Southeast, and Southwest (Mid-West).

Composite analyses were used to examine the large-scale antecedent conditions and the synoptic-scale evolution of heat waves. Composites show that Northeast heat waves are associated with a wave train that amplifies a preexisting ridge over North America and that appears to have an equatorial energy source. Northeast heat waves occur when the region is located underneath the equatorward side of a jet streak exit and downstream of a ridge axis; a favored area for subsidence. In addition, time series composite plots indicate that the transportation of warm air from over the Rockies into the Northeast is likely a contributor to elevated surface temperatures.

Ridge Rollers: Mesoscale Disturbances on the Periphery of Cutoff Anticyclones

Tom Galarneau, Jr. and Lance Bosart
Department of Earth and Atmospheric Sciences, University at Albany, State University of New York, Albany, New York

Warm season continental anticyclones are frequently associated with heat waves and droughts. A less appreciated aspect of continental anticyclones is that mesoscale disturbances evident on the dynamic tropopause (DT, defined as the 1.5 potential vorticity unit (PVU) surface), known as “ridge rollers” (RRs), are often observed to circumnavigate the periphery of these anticyclones. RRs often originate as fractures from the equatorward ends of northeast-to-southwest oriented PV tails, and move westward along the equatorward periphery of continental anticyclones. As these RRs move poleward and then eastward around the upstream and poleward periphery, respectively, of the anticyclone they may interact with other subsynoptic-scale disturbances embedded in the westerlies on the poleward periphery of the anticyclone.

RRs may be associated with convection along the anticyclone periphery with organized mesoscale convective systems (MCSs) occurring on the poleward periphery where the aforementioned upper-level westerly flow, and associated jet-entrance region, provides enhanced ascent and deep-layer shear. A limiting factor is the presence (or absence) of a moist planetary boundary layer (PBL). The purpose of this presentation is to document the structure and evolution of heat wave-related continental anticyclones over the US and Australia during July 1995 and February 2004, respectively. Particular attention will be paid to the behavior of RRs and their impact on the flavor and severity of convection along the periphery of these anticyclones.

Understanding the structure and behavior of RRs are an important aspect of severe weather forecasting in the northeast US, particularly in northwest flow situations where high wind events associated with bow echoes may occur. For example, the derecho that moved through eastern New York and western New England on the morning of 15 July 1995 developed in association with a RR just north of the Great Lakes near 0000 UTC 15 July. This derecho subsequently moved eastward then southeastward around the poleward and eastern periphery of the anticyclone.

For preliminary results, go to http://www.atmos.albany.edu/student/tomjr/conflinks/conflinks.html and click on the link for NROW.

Elevated Mixed Layers and their Role in Significant Severe Thunderstorm Episodes in the Northeastern United States

Michael L. Ekster
NOAA/NWS, Weather Service Forecast Office, Upton, New York

Peter C. Banacos
NOAA/NWS, Weather Service Forecast Office, Burlington, Vermont

The elevated mixed layer (EML) is a common attribute of severe weather proximity soundings in the Great Plains region of the United States. These layers of relatively warm, dry continental air and steep, nearly dry adiabatic lapse rates are generated during the spring and summer in the high terrain of the U.S. and Canadian Rockies, as well as the Mexican Plateau. They are then advected downstream by the mean westerly flow. The EML is a necessary ingredient in the formation of the classic Miller Type I “loaded gun” sounding, which is thermodynamically favorable for high-end severe convection.

While the EML is a widely known contributor to Great Plains severe weather outbreaks, limited research to identify these important features in the Northeastern U.S. has been conducted. Typically, the EML is destroyed by deep convection or other diabatic effects across the Plains or Midwest. However, traceable “plumes” of EML air can, on rare occasions, reach the Northeastern U.S. despite traveling distances of 2000-3000 km from their source. It is hypothesized that the presence of an EML in the Northeastern U.S. results in greater than normal potential instability, as well as a stronger than normal capping inversion. The eventual release of high potential instability under such circumstances would allow for higher-end severe weather episodes reminiscent of those witnessed in the Great Plains – given a favorable mesoscale and synoptic scale environment for convection initiation. Identification of flow regimes favorable for advection of EML air into the Northeastern U.S. would therefore be of interest and utility to operational forecasters.

This presentation will focus on an ongoing research project that will help identify the rare Northeastern United States EML and its contribution to higher-end severe weather episodes. The origin, advection, and maintenance of the EML will also be discussed. EML characteristics and structures that allow “ordinary” severe weather soundings in the Northeast to become more representative of what might be seen in the Great Plains will be presented. A number of case studies will be shown to illustrate specific Northeastern U.S. warm season EML occurrences

and their suspected contribution to higher-end severe weather episodes.

A Multiscale Analysis of the 23-24 November 2004 Southeast United States Tornado Outbreak

Alicia Wasula

Severe convection which results in strong (F2 or greater) tornadoes has a cool season maximum during the nocturnal hours along the Gulf coast of the southeast United States (US). Results of previous research indicate that there is a climatological tendency for a 0-1 km shear profile favorable for supercells to occur overnight along the Gulf coast, due to the low-level jet at ~1 km and the tendency for surface winds to back from southerly to southeasterly at night. When a system with strong forcing for ascent (e.g. vigorous 500 hPa trough, upper-level jet streak, and 850 hPa jet > 15 m s-1) and favorable thermodynamics (e.g., CAPE > 1000 J/kg and 850 hPa equivalent potential temperature > 335 K) moves across the southeast US, a nocturnal tornado episode can result. Results of case studies (e.g. 22-23 February 1998 central Florida tornado outbreak) emphasize the importance of surface boundaries in areas with favorable thermodynamic and shear profiles in serving as a focus for the intensification and organization of convection.

On 23-24 November 2004, a widespread tornado episode occurred across the southeast US. Tornadoes were reported over a 24 hour period (23/1700 UTC to 24/1300 UTC) across Texas, Mississippi, Louisiana, and Alabama. 80 tornadoes (17 of F2 or greater magnitude) were reported during this time period. There were three fatalities and 38 injuries. The majority (65%) of the tornado reports during this event occurred after dark (24/0000 UTC-24/1200 UTC), and nearly half of the tornadoes (45%) were in close proximity to the Gulf of Mexico coastline (south of 32° N).

A large 500 hPa trough was moving eastward across the southwest US between 22/0000 UTC and 23/1200 UTC. By 23/1200 UTC, rapid surface cyclogenesis was occurring over eastern Texas as the surface low deepened from 1012 to 1004 hPa in 12 h. Ahead of the surface low in Louisiana and Mississippi, ample warm, moist unstable air was present on 23/1200 UTC as surface dew points greater than 19° C were in place across much of this region. At 850 hPa, equivalent potential temperatures greater than 330 K was present across southern Louisiana and Mississippi, and a strong southerly low-level jet (> 18 m/s at 850 hPa) was present on 23/1200 UTC. The environment was favorable for supercells ahead of the surface low as evidenced by the high CAPE (2986 J/kg) and strong vertical wind shear (16 m/s from 0-6 km) in the Lake Charles, LA (LCH) sounding from 23/1800 UTC. Winds were strongly veering with height and an upper-level jet of 50 m/s (100 kt) at 200 hPa helped to create strong vertical wind shear over a deep layer. Convection developed in eastern Alabama ahead of the main convective line between 23/1800 UTC and 24/0000 UTC. By 24/0000 UTC, the pre-frontal squall line had moved eastward into Louisiana and northwest Mississippi. A strong bow echo embedded in this line was responsible for producing wind damage across northern Mississippi between 24/0000 and 24/0400 UTC. During the overnight hours between 24/0600 and 24/1000 UTC, widespread supercellular convection erupted across Mississippi and Alabama. The low-level (surface-850 hPa) shear had markedly increased across Mississippi during the overnight hours due to the rapidly strengthening low-level jet. The ~850 hPa wind in the Jackson, MS sounding from 24/1200 UTC had increased to 25 m/s (50 kt). Ample instability and vertical wind shear was present and numerous tornadic supercells resulted. The event ended by 24/1300 UTC as a narrow but intense band of convection moved from west to east across the region with the cold front between 24/1200 and 24/1600 UTC.

The purpose of this study is to examine this event in the context of previous work on cool season tornadoes in the southeast US. The large-scale setup of this event will be compared to the composite large-scale environment of cool season tornadoes in the southeast US. Further, a detailed examination of surface and radiosonde data will be conducted to look for evidence of parameters which may have enhanced the evolution of tornadoes in close proximity to the coastline during the overnight and early-morning hours (e.g., backing of the surface winds along the Gulf of Mexico coastline and/or preferential increase of the nocturnal low-level jet along the coast).

The Thanksgiving 2004 Severe Weather Event across Upstate New York and New England

Thomas A. Wasula and Kenneth D. LaPenta
NOAA/NWS Weather Forecast Office, Albany, New York

Severe thunderstorms across the Northeast, are very uncommon in the late Fall and Winter. For example, Albany only averages about 3 thunderstorm days every decade in the month of November. Severe thunderstorms producing damaging winds in excess of 50 knots (58 mph) and large hail (greater than 1.9 cm) occurred Thanksgiving morning over much of eastern New York and Western New England. An anomalously strong low pressure system and its associated cold front focused an area of thunderstorms that developed between 1000 UTC and 1200 UTC 25 November 2005 from central New York southward into Pennsylvania and Maryland. There were nearly two dozen wind damage reports over New York and New England from this severe weather event.

Most of eastern New York and western New England were located in the warm sector of this complex weather system after 1000 UTC 25 November 2005. A strong 500 hPa jet streak of nearly 100 knots moved northeastward from the Delmarva region on the east side of a developing negatively tilted, high amplitude trough extending from Hudson Bay south to the Tennessee Valley. Eastern New York and New England were located on the left front quadrant of the mid and upper level jet streaks with moderate divergence at 300 hPa. A very strong low-level baroclinic zone was pushing eastward across New York at 1200 UTC with 850 hPa temperatures around -1°C near Buffalo and as high as +13°C over southwest New England. Surface dewpoints were excess of 10°C ahead of the cold front that morning. The 1200 UTC sounding from Albany revealed convective available potential energy values (CAPE) in the 250 - 750 J kg^{-1} range (Mean Layer CAPE was 637 J kg^{-1} and the Downdraft CAPE value was 629 J kg^{-1}). The 0-6 km shear values over eastern New York were in excess of 60 knots. This indicated the high potential for organized severe convection including supercells. By 1200 UTC, a squall line developed west of the Hudson River Valley region.

This presentation will take a multi-scale approach analyzing the event from the synoptic-scale to the storm scale, in order to understand the environment that caused the anomalous and under-forecasted severe weather over the Northeast. Observational data used in the analyses will include surface and upper air observations, satellite imagery, and Albany (KENX) Doppler radar data. Also, high resolution initialized North American Model (NAM) data will be shown in the presentation.

Tornadoes to Torrents: The Southern Ontario Severe Weather Event of August 19, 2005

Robert Hamilton
NOAA/NWS Weather Forecast Office, Buffalo, New York

A significant severe weather event affected Southern Ontario during the afternoon of August 19, 2005. Two F2 tornadoes crossed rural Southern Ontario, northwest of Hamilton, then, the parent supercell evolved into a torrential rain producer. Over 8 inches of rain fell in less than 2 hours across parts of the Greater Toronto Metropolitan area. Property losses exceeded $400 million in the Toronto area alone, making this the highest insured loss in the province's history.

The severe weather occurred in a highly sheared, very unstable air mass where modified point soundings revealed 0-1 km helicity values in excess of 200 m^2 s^{-2} and CAPES near 2000 j/kg. The area was accurately highlighted by Environment Canada in their early morning convective outlooks and later by severe thunderstorm and tornado watches. While the National Oceanic and Atmospheric Administration's (NOAA) Severe Storms Prediction Center does not forecast for sites north of the Great Lakes, they depicted adjacent portions of Ohio, Pennsylvania and Western New York in a moderate risk area.

The synoptic and thermodynamic setting that supported this particular severe weather event will be examined along with detailed radar imagery. Tremendous international teamwork between Environment Canada's Warning Office in Toronto, Canada, and the National Weather Service Office in Buffalo, NY, will also be discussed. Phone coordination between the offices heightened the situational awareness in the Toronto office, which at that time was experiencing cone of silence problems with the tornado bearing supercell. The ensuing tornado warning was issued with greater lead time and confidence due to this collaboration.

NCEP Update; Focus on the Winter Weather Desk

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Recent advancements and ongoing plans at NCEP will be reviewed with a focus on the evolving modeling suite and the Winter Weather Desk located in Hydrometeorological Prediction Center. The presentation will include an update on modeling plans related to the upcoming WRF implementation and the expansion of the ensemble model runs associated with the North American Ensemble Forecast System (NAEFS) and the Short Range Ensemble Forecast (SREF) system. The review of the Winter Weather Desk will include results from last winter season and plans for the upcoming season.

An Examination of the Environmental Characteristics of Flash Flooding in the Binghamton, NY County Warning Area

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This study examines the environmental conditions during and prior to flash flood events in the portions of northeast Pennsylvania and central New York comprising the Binghamton, NY (BGM) County Warning Area of the National Weather Service (NWS). Although there is much research regarding both heavy precipitation and flash flooding, there exists little research into the mechanisms distinguishing between these two similar types of events. In addition, the majority of the literature addresses flash flooding or heavy precipitation in the midwestern U.S., where mesoscale convective complexes dominate warm-season precipitation.

This study compares the environmental conditions of flash floods, heavy precipitation events, and days in which flash flood watches were issued but a flash flood did not occur. A secondary focus of the work is to determine how flash flooding events in the northeastern U.S. differ from those in the Midwest, which will result in a revised flash flood forecast checklist for NWS BGM.

Early results indicate that flash floods and heavy precipitation events without flash flooding differ in antecedent precipitation and antecedent soil moisture. Flash floods appear more likely to occur during periods of above-normal precipitation. The trends of several other atmospheric variables will also be discussed.

Winter Hydrology:
Modeling River Ice and Ground Frost to Improve Flood and Flash Flood Warning Accuracy

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A two part study was undertaken to quantify cold season hydrologic parameters: river ice and ground frost. There is a history of freeze up and break up ice jam floods in the Albany Hydrologic Service Area. It is known that frozen ground and resultant reduced infiltration has played a part in winter flooding and flash flooding. The frost depth is an important state variable in the National Weather Service (NWS) River Forecast System (RFS) used at the River Forecast Centers (RFCs), but it is not currently measured in the northeast. This presentation will show results of attempts to model river ice thickness, determine when freeze up and break up river ice jams are most likely, and model frost depth. Results have been incorporated into Albany NWS forecast office winter operations to improve flash flood warning accuracy during the winter season.

The first study was an examination the relationship between daily average temperature and river ice to predict when freeze up ice jams were possible, and when break up of river ice was most likely. Temperatures were from daily climate reports for the nearest METAR location to the individual river basins. These temperatures were input into an accepted formula for calculating river ice thickness developed by the U.S. Army Cold Regions Research and Engineering Lab. It was determined that ice thickness could be estimated fairly close from METAR temperature data. We also found that the date of break up was predictable to the nearest day from METAR observations. This finding makes it possible to use numerical weather prediction model output statistical guidance of temperature forecasts as guidance to issue ice break up flood watches and warnings (for the possibility of ice jams).

Then, an attempt to model ground frost under snow cover was examined. A method to quantify the moderating or insulating effects of snow cover was developed. Daily average temperatures and measured snow depth were input into a ground frost model to estimate a daily frost depth. These model estimates were compared with measured frost depths. It was determined that since frost penetration into the ground is a function of many variables including soil type, soil water content, depth of the water table etc., estimating frost depth under snow with a single equation is not highly accurate. It is suggested that a network of frost gauges should be set up to measure frost depth in the ground. This information would not only be useful to individual NWS offices, but also for the RFCs as input into the NWS RFS.

The Tropical Transition of Hurricane Alex (2004): Observations and Forecast Implications

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A low-level (925-850 hPa) vorticity seedling that became associated with the incipient disturbance that became Hurricane Alex (2004) was first evident in the 1.0 degree National Centers for Environmental Prediction (NCEP) Global Forecast System (GFS) analyses as part of an inverted trough over the southern Bahamas at 0000 UTC 29 July 2004. The National Hurricane Center (NHC) began tracking the tropical depression that was to become Alex at 1800 UTC 30 July 2004. Hurricane Alex reached maximum intensity as a Category 3 storm (105 kt) at 0000 UTC 5 August.2004. A noteworthy aspect of Alex was that it achieved hurricane intensity contrary to the expectations of forecasters and the available operational numerical and statistical guidance. The purpose of this presentation is to give an overview of the analyzed development of Alex and to discuss some of the forecast implications of its development. In particular we will show that Alex was another example of a tropical transition (TT), a category of tropical cyclones that seems especially difficult for numerical models to predict.

Extended analyses of potential temperature on the dynamical tropopause and potential temperature, winds and vorticity in the lower troposphere constructed from the NCEP GFS 1.0 degree gridded datasets revealed that the non-tropical development of Alex was influenced by 1) a westward-moving potential vorticity (PV) filament, 2) a digging upstream midlatitude trough, and 3) a local maximum in lower-level shear vorticity. Cyclogenesis occurred on 29 July in association with large-scale environmental ascent to the east of two merging PV filaments, a rapid reduction in shear (and stability) during the merger of these two PV filaments, and the production of mesoscale cyclonic vorticity by dynamically forced and convectively driven ascent. TT occurred on 30-31 July as deep convection created a warm core and maintained weak shear in conjunction with the redistribution of PV in the vertical. Alex gained tropical storm status on 1-2 August as both

PV anomalies interacted with one another in the presence of a narrow coastal ridge that enveloped Alex from the north. Alex rapidly achieved hurricane intensity by 1200 UTC 3 August as a second midlatitude PV anomaly approached the storm from the northwest. The forecast implications of these multiple PV interactions will be discussed.

Modeling the Initialization and Tropical Transition Hurricane Alex (2004)

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The development and intensification of Hurricane Alex in July 2004 represented a significant forecasting challenge because of the developing storm's hybrid nature during the early portion of its lifecycle. Lower-level easterly wave forcing combined with complex upper-level potential vorticity structures of midlatitude origin to initiate the incipient system's tropical transition (TT) on 30-31 July. The tropical cyclone moved slowly along the Eastern Seaboard and generated hurricane force winds on the Outer Banks of North Carolina before recurving near the northern boundary of the Gulf Stream. Despite 26°C sea surface temperatures, the hurricane continued to intensify and reached major hurricane status (Category 3 on the Saffir-Simpson scale) with winds of 105 kt on 5 August.

Operational numerical forecast models under-predicted the intensity of the hurricane throughout its lifecycle. The initial deepening of the storm following TT was under-forecast by 40 kt in 36 h numerical guidance as the hurricane developed 85 kt winds near Cape Hatteras on 3 August. Despite known issues with deterministic hurricane intensity prediction in numerical models, the environmental forcings that contributed to the system's intensification close to the North American continent should have facilitated numerical prediction in this case. For example, a dramatic reduction in the deep-layer shear resulted from the interaction of two upper-level potential vorticity features. This process should have been well predicted by models in real time. This study undertakes the re-forecasting of Hurricane Alex during its critical initiation and TT lifecycle stages. A multi-model approach is employed in order to assess the components of the forecast failure modes that are attributable to individual model deficiencies versus those that are fundamental to the case itself. Comparisons between re-forecasts made using different analyzed initial states allows for a similar error decomposition of the analysis fields. Error modes that are of particular diagnostic interest are those that are common to a range of modelling and analysis schemes since they highlight the structures and processes that were poorly represented in numerical forecasting systems during the initiation and TT of Hurricane Alex. It is important to understand and rectify these model and analysis deficiencies that allowed a major hurricane to form close to North America without adequate warning from the numerical guidance.

A Comparison of Tropical Cyclones Cindy (2005) and Ivan (2004) during their Extratropical Transition (ET) Phases

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Numerous tropical cyclones affected the eastern United States in 2004 and 2005. This presentation will focus on two of those systems that made landfall along the Gulf Coast: Ivan in September of 2004 and Cindy in July of 2005. Emphasis will be placed on the distribution and intensity of rainfall over the Mid-Atlantic and Northeastern states, along with the main forcing mechanisms for precipitation. Despite similar structural development during each cyclone's ET, Ivan was a more prolific inland rainfall producer than Cindy. Some of the above mentioned forcing mechanisms will be referenced, within the overall synoptic setting, to demonstrate why these rainfall differences occurred. Both Cindy and Ivan acquired similar structural components during their ET as they moved towards higher latitudes. Some of these structures included a transition to a frontal-wave appearance at the surface, an increasingly enhanced upper-level jet core poleward of the cyclones, and the formation of stratiform heavy rain bands to the north and northwest of the cyclone centers. Despite the aforementioned similarities, the distribution and intensity of rainfall associated with these systems differed considerably, especially over the Northeastern states. It is theorized that this disparity comes from a stark contrast in how each of these cyclones interacted with the main flow of Westerlies to their north.

In the case of Ivan, a much better potential vorticity (PV) coupling between the remnant tropical circulation and short-wave energy within the northern-stream flow of Westerlies, allowed for a stronger jet circulation. As a result, a deeper plume of moisture, with elevated freezing levels, was more effectively transported northward across the portions of New York State and Pennsylvania affected by persistent, stratiform heavy rain bands. This ingest of warm, moist air allowed tropical rain rates and much more efficient precipitation accumulation to be realized.

Conversely with Cindy, the main PV anomaly with the transitioning tropical system remained distinct from short-wave energy rotating around a closed upper-level vortex to the northwest across the Great Lakes region. This separation of PV kept the jet circulations much more modest, by comparison with Ivan. Thus, the lower-level jet was somewhat weaker and the flow not as backed, as was the case with Ivan. The plume of deeper moisture was shunted more towards the northeast off the Mid-Atlantic

coast. As a result, warm rain processes never had a chance to dominate in areas affected by stratiform heavy rain bands, with much lower accumulation rates.

Cool-Season Regime Transition and Its Impact on Precipitation in the Northeast

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Past research has indicated that reconfigurations of the large-scale flow can alter regional weather patterns due to shifts in storm tracks and associated eddy transports of heat, momentum, and vorticity. Meteorological wisdom also suggests that high-impact weather events tend to occur during large-scale regime transitions. Motivated by these considerations, this research investigates relationships between large-scale regime transitions and cool-season (November–April) Northeast precipitation from a statistical and observational perspective.

In this study, regime transitions are identified as periods when the North Atlantic Oscillation (NAO) index or Pacific/North American (PNA) pattern index undergoes a two-standard deviation change centered on zero over seven or fewer days. A positive-to-negative (negative-to-positive) NAO regime transition can be interpreted physically as a significant weakening (strengthening) of the North Atlantic westerlies, while a positive-to-negative (negative-to-positive) PNA regime transition can be interpreted as the amplification of a ridge (trough) over eastern North America and a trough (ridge) over western North America. To identify regime transition periods, 56-year (1948–2003) time series of daily NAO and PNA indices were generated from the National Centers for Environmental Prediction (NCEP)–National Center for Atmospheric Research (NCAR) reanalysis dataset. A daily precipitation anomaly time series for the Northeast derived from NCEP's Unified Precipitation Dataset (UPD) for the same 56-year period was used to calculate precipitation anomalies during these periods.

Key statistical results indicate that cool-season positive-to-negative NAO transition periods and negative-to-positive PNA transition periods are favorable for above-normal precipitation in the Northeast. Results also show that the NAO index tends to decrease and the PNA index tends to increase surrounding major cool-season Northeast precipitation events. To interpret these relationships synoptically, composite analyses of cool-season positive-to-negative NAO regime transitions and negative-to-positive PNA regime transitions surrounding major Northeast precipitation events are presented. The analyses suggest that strong warm air advection over the western North Atlantic poleward of the surface cyclone associated with the Northeast precipitation event plays a critical role in this type of NAO regime transition. In the case of negative-to-positive PNA regime transitions, the most important synoptic-scale feature appears to be persistent warm air advection over the eastern North Pacific that results in ridge amplification over western Canada and subsequent downstream trough amplification over the eastern United States.

Cool-Season Moderate Precipitation Events in the Northeastern United States

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Moderate precipitation events contribute a significant percentage of total cool-season (1 October–30 April) precipitation in the Northeast. 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 presentation is to provide a 10-year climatology of cool-season moderate precipitation events across the Northeast and to examine the synoptic-scale and mesoscale forcing that governs when and where these events occur.

A moderate precipitation event in the Northeast was defined as having a liquid equivalent of 0.6–1.3 cm (±0.1 cm) or a snow total of 6.4–19.0 cm. Daily precipitation amounts were obtained from NOAA's Local Climatological Data available through NCDC from 1994 through 2004 for 35 first-order NWS stations across the Northeast. The station domain was bounded on the west by Detroit, MI, and on the south by Charleston, WV. For each station, every day between 1 October and 30 April was examined to see if a moderate precipitation event occurred. Hourly precipitation data were used to refine the event selection process in potentially ambiguous cases such as back-to-back days where moderate precipitation occurred, but the event total was above the moderate criterion. Based on the hourly rainfall data, if there was less than a 6-h gap in the precipitation, it was considered to come from one event. Histograms were produced from these data to show the distribution of cool-season moderate precipitation events across the Northeast by city, state, and geographic region.

The results from the histogram analysis indicate that more cool-season moderate precipitation events occurred in the Great Lakes and northern New England, with fewer events farther south and east. Another peak in moderate events occurred in elevated terrain. Erie, PA, received the most cool-season moderate precipitation events over the past 10 years (197), while Baltimore, MD, received the least (95).

To help illustrate the importance of weak synoptic-scale forcing on the evolution and structure of moderate precipitation events, the results from several brief case studies will be presented. Cross sections of heavy events usually show a deep layer of weakly negative saturation equivalent potential vorticity (EPV*) in conjunction with strong midlevel frontogenesis. It was found that moderate events have a similar structure to heavy events, except that the regions of negative EPV* and frontogenesis are not as strong, deep, sloped, or well aligned. The features in moderate events also tend to be more transient, thus reducing the event precipitation amount.

A Climatological Study of Storm Track and Banding for Mid-Atlantic Snow Storms from 1960 – 2004

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Significant snowstorms (for this study defined as producing 4 inches or more of snowfall, isolated amounts excluded) are a typical occurrence each winter in the eastern United States. A past study was conducted of significant snow storms (using the same definition as this study) in the Mid Atlantic region (Maryland, Delaware, Virginia, and North Carolina) establishing 5 different composite climatological types, based upon surface, 850hPa, 500hPa, and 300hPa patterns. An examination of the snowfall distribution associated with significant snow storms, which fit the climatological classifications of the previous study, from 1960 until 2004 has revealed that banding possibly occurred, as evidenced by a relatively narrow swath of higher snowfall amounts compared with surrounding observations of snowfall.

NCEP reanalysis of these storms will be examined, to determine if the general synoptic conditions for banding, in particular frontogenetic forcing, existed in each case. This presentation will identify winter storm patterns favorable for banding in the Mid-Atlantic region. It will then be determined if any particular storm track type seemed to favor banding, and where any banding occurred in relation to the surface. Finally, case studies of recent events of each type associated with banding will be presented. Enhancing pattern recognition forecasting techniques will help to increase the lead time with which potentially significant snow storms are identified.

Examining the Role of Mesoscale Features in the Structure and Evolution of Precipitation Regions in Northeast Winter Storms

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Cold-season frozen precipitation in the northeastern United States is manifest in a variety of spatial patterns evident on radar imagery. Although forecasters can predict likely areas of precipitation, considerable difficulty remains in properly identifying mesoscale precipitation signatures within the main precipitation shield. As viewed on a radar reflectivity image, precipitation can appear relatively uniform, fractured, banded, or a combination of all three. In addition, the bands themselves can take on a number of forms. Being able to forecast such mesoscale precipitation characteristics is vital in adding value to a forecast by enhancing the mesoscale prediction of snowfall amount and variability. The purpose of this presentation is to examine the role of quasi-geostrophic (QG) and mesoscale forcings, along with upright and slantwise instabilities and microphysics, in the structure and evolution of precipitation regions in Northeast winter storms.

Twenty-one "heavy snow" events in the Northeast from the past three winters have been selected for analysis. The “heavy snow” criterion is met if at least 15 cm of snow accumulates in 12 hours over an area the size of Connecticut. High-resolution WSI NOWrad composite reflectivity radar mosaics are used to diagnose the character of the mesoscale precipitation patterns in each of the events. Using the NCEP North American Regional Reanalysis, appropriate horizontal maps are created for each event in order to ascertain which parameters – QG forcings, frontogenesis, slantwise and upright instability, and microphysics – can assist in distinguishing the precipitation’s character. For this presentation, such relationships between the aforementioned parameters and precipitation patterns are presented. Lastly, a representative case study is included to demonstrate how the temporally changing variables delineated above alter the mode of precipitation of one heavy snow event during its lifetime.

Aviation Cloud Forecasts – A True Challenge for Forecasters.

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For decades, forecasters have struggled with predicting the various parameters related to clouds. Words such as "Partly Cloudy" or "Partly Sunny" have sparked great debates among forecasters. While the percent of cloudiness is important to the general public, the three dimensional structure of the cloud field in the lower troposphere is critical to aviation operations.

Cloud amount and base height are important factors to aviation operational decisions. Currently, the National Weather Service's (NWS's) official aviation forecasts, Terminal Aerodrome Forecast (TAF), contain cloud amount and base height for over 500 airports across the county. Unfortunately, these only cover a portion of the nation's airports. For example, in New York State, there are over 150 airports in operation, but forecasts are only issued for 20 of them. In addition, heliports, including those at hospitals currently do not have forecast data. Efforts are now underway by both the NWS and the Federal Aviation Administration (FAA) to begin addressing this need by developing gridded forecasts of cloud base (ceiling) to eventually provide additional TAFs.

Forecasting ceilings remains a great challenge for forecasters. Verification of ceiling forecasts has shown a relatively low probability of detection with a high false alarm rate. Conditional climatology (CC) and model output statistics (MOS) data sets may provide a method to significantly improve TAF verification scores.

This presentation focuses on techniques that forecasters can use to effectively integrate CC and MOS data sets into their forecast process. These techniques can help improve ceiling forecasts. The presentation will also briefly discuss current efforts by the NWS and FAA to help expand the number of TAFs.

Multi-Year Examination of Dense Fog at Burlington International Airport

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An examination of the occurrence of dense fog at Burlington International Airport (KBTV) is performed in an effort to understand possible synoptic and mesoscale signals that favor its formation, and to improve aviation forecasts of low instrument flight rule conditions at the site. Hourly weather data at KBTV from January 1979 through December 2003 (24 years) is used to identify all dense fog events (surface visibility less than ½ mile). Each event is then classified by type, reflecting the mechanism responsible for its formation. Six fog types are identified, including those produced by radiation, advection, precipitation, lowering of cloud base, evaporation of surface moisture, and indeterminate.

The data indicates that 94% of all events identified are either radiation fog (Type RF) or fog produced by precipitation and/or lowering of cloud base (Types PF and LCB, respectively). Frequency distribution plots show distinct time periods within each year in which these three dominant fog types are favored, with maxima in Type RF occurrence in late summer to early fall, and maxima for types PF and LCB throughout the cold season of November through March. Wind rose plots were then constructed for all Type RF and combined Type PF and LCB events. Clear directional trends in the wind data are evident in the plots, with a strong signal from the northeast to east in Type RF events, and north to northwest in the majority of Type PF and LCB events. This supports prior evidence that Type RF events are strongly influenced by fog drifting across KBTV from the Winooski River valley to the immediate northeast, and that cool moist northerly to northwesterly flow evident in Type PF and LCB events produces marked low level mesoscale convergence in the northern Champlain Valley.

Analysis of mean sea level pressure across the eastern United States during the same 24-year period was then performed at the time of onset of each Type RF, and Type PF and LCB event using plots from National Weather Service North American Regional Reanalysis (NARR) data. Examination of the NARR plots reveals several synoptic patterns that favor each dominant fog type. These include a large anticyclone building into northern Vermont from the 1) north or northwest or 2) from the west or southwest for Type RF events. This appears to be preceded by a weak frontal passage 6 to 18 hours in advance of fog onset. For Type PF and LCB cases, three signals were identified, including 1) a cold or

occluded frontal passage, 2) the approach of a warm front, and 3) convergent northerly to northwesterly flow on the northern to western portions of a surface cyclone. It is argued that proper identification of both the synoptic and mesoscale signals favorable to Type RF, Type PF, and LCB fog formation will aid the operational forecaster to better identify the potential for dense fog at Burlington International Airport, and thereby improve short term aviation forecasts at the site. The presentation will review preliminary findings on dense fog climatology at Burlington International Airport, with emphasis on the three dominant fog types identified through the use of frequency distribution, wind rose and NARR data. Favored synoptic and mesoscale patterns conducive to dense fog formation at the airport will be discussed, along with future research initiatives supporting this project.

The “Similar Sounding” Technique for Incorporating Pattern Recognition Into the Forecast Process at WFO Binghamton, New York.

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Every significant weather event (defined as an event with high public impact) is characterized by its own unique combination and magnitude of meteorological parameters. However, it is also true that many types of significant weather events are associated with characteristic signatures in the data that appear each time that type of event occurs. For example, supercell thunderstorms typically occur with favorable combinations of instability and shear, and lake effect snowstorms typically occur with favorable combinations of air-lake temperature differential and wind direction. Therefore, one important aspect of forecasting significant weather events is the ability to call on a wealth of experience in order to recognize when characteristic environmental patterns that have led to significant weather events in the past, are about to occur again.

Many outstanding forecasters have an amazing ability to recall large amounts of detail regarding the meteorological parameters associated with past significant weather events. This presentation details a technique being developed at the NOAA/National Weather Service Weather Forecast Office (WFO) in Binghamton, NY (BGM) that aids forecasters in recalling details from previous significant weather events, and to apply that knowledge to current forecasts. The technique, as it has been developed to date, can be used for lake effect snow forecasting and severe weather forecasting. Examples will be shown for both of those types of events.

When applying the technique to lake effect snow forecasting, forecasters are prompted to enter values of several critical parameters from forecast soundings into a graphical user interface (GUI) developed at WFO BGM. Once the forecaster enters the data, a search is performed that compares the entered data with data stored in a locally developed database of historical lake effect snow event sounding parameters. The software returns a short list of links to dates characterized by soundings that are “most similar” to the current forecast soundings. The forecaster then clicks one of those links, and is directed to a web page that contains a discussion on the snowfall distribution and intensity associated with the historical event, as well as corresponding images of radar reflectivity and model forecast soundings (as displayed by BUFKIT). It is then up to the forecaster to determine how similar the current event will be to the historical event. A similar methodology was also applied to severe weather forecasting during the past warm season, by comparing data entered into an online severe weather checklist, in real time, to data from a historical data base. Preliminary indications are that this procedure was able to assist forecasters with distinguishing between different types of severe weather evolutionary patterns (for example, bow-echoes vs. pulse storms). In many cases, it was also helpful in that it indicated a wider range of possible evolutions than forecasters may have been anticipating. In addition to real-time application, the use of this technique as a localized training tool will be discussed.

A Study of Coherent Tropopause Disturbances within the Northern Hemispheric Circumpolar Vortex

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Coherent tropopause disturbances (CTDs) are mesoscale, tropopause-based vortices embedded within the Northern Hemispheric (NH) circumpolar vortex (CPV). CTDs are characterized by closed potential temperature or pressure contours on maps of the dynamic tropopause (DT). The interaction of CTDs with the polar-front jet stream (PFJ), as well as mergers with similar, but weaker midlatitude disturbances, may result in high-impact weather events such as intense cyclogenesis and associated surges of arctic air into middle latitudes. This scenario is particularly likely to occur when the CTD is strong (high pressure on the DT) and thus close to the surface, and when the Rossby penetration depth is large due to small static stability below the disturbance (e.g., CTD moving over the Gulf Stream).

The purpose of this presentation is to document the behavior of CTDs from climatological and case study perspectives. This research expands upon previous work by applying an objective tracking program to a higher resolution dataset [NCAR-archived NCEP GFS $1.0^\circ \times 1.0^\circ$ final (FNL) analyses] for the period January 2000 through December 2004 to better capture the mesoscale structure of CTDs. Subjective tracking of CTDs for the NH extended cool season months of September 2002 through May 2003 (GFS $2.5^\circ \times 2.5^\circ$ initial analyses) is also used in conjunction with real-time tracking utilizing the GFS $0.5^\circ \times 0.5^\circ$ initial analyses during the 2004–2005 NH winter season to document CTD behavior and to select case studies.

Distributions of CTD frequency, preferred genesis/lysis regions, and tracks will be discussed. Findings indicate different categories of CTD behavior based upon longevity. Short-lived ($\leq$3 days) disturbances have frequency and genesis/lysis maxima along the cyclonic shear side of the PFJ. Invigoration of the PFJ by these CTDs is rare. Long-lived (1–5 weeks) disturbances appear to be of the most interest in terms of high-impact mid-latitude weather events. These disturbances tend to be of polar origin and may migrate to the southern periphery of the CPV with subsequent invigoration of the PFJ. A portion of the presentation will be devoted to an illustrative case study (22-24

January 2005 northeastern U.S. snowstorm). This case provides an excellent demonstration of CTD behavior and interactions with the PFJ and midlatitude weather systems, as well as limitations in model forecast skill for these interactions.