Agenda
Northeast Regional Operational Workshop X
Albany, New York
Wednesday, November 5, 2008

9:00 am
Welcoming Remarks
Eugene P. Auciello, Meteorologist In Charge
Warren R. Snyder, Science & Operations Officer
National Weather Service, Albany, New York

Session A – Cool Season Topics / Winter Weather
Session Chair – Joseph P. Villani

9:05 am
The Inland Extent of Lake Effect Snow Bands in Central and Eastern New York
Joseph P. Villani
NOAA/National Weather Forecast Office, Albany, New York

9:25 am
The 8-9 March 2008 Winter Storm in Upstate New York: An Example of a "Multi-Hazard" Event
Brian J. Frugis
NOAA/National Weather Service Forecast Office, Albany, New York

9:45 am
A Further Investigation of Mohawk Hudson Convergence Cases
Hugh W. Johnson IV
NOAA/National Weather Service Forecast Office, Albany, New York

10:05 am
Intense Surface Cyclone Activity in the Arctic during the 2005–06 and 2006–07 Cool Seasons
Brian Silviotti
Department of Earth and Atmospheric Sciences, University at Albany, State University of New York, Albany, New York

10:25 am
Strong Polar Anticyclone Activity over the Northern Hemisphere and an Examination of the Alaskan Anticyclone
Justin E. Jones
Department of Earth and Atmospheric Sciences, University at Albany, State University of New York, Albany, New York

10:45 am
Break
Beverages & Snacks for sale in Rotunda by Capital District Chapter of the AMS

Session B – Ensemble Forecasting and Modeling

Session Chair – Warren R. Snyder

11:10 am
Operational High Resolution Modeling for the Vancouver 2010 Olympics
R. McTaggart-Cowan
Numerical Weather Prediction Research Division, Meteorological Service of Canada, Quebec, Canada

11:30 am
Customization of a Mesoscale Numerical Weather Prediction System for Industrial Site Operations Applications
Anthony P. Praino
IBM Thomas J. Watson Research Center, Yorktown Heights, New York

11:50 am
Using Short Range Ensemble Forecasts and High Resolution Model Output to Assess the Potential for Tornadoes across Southeast Virginia on 28 April 2008
Josh Korotky
NOAA/National Weather Service Forecast Office, Pittsburgh, Pennsylvania

12:10 pm
Validation of Storm Surge Models for the New York Bight and Long Island Regions and the Impact of Ensembles
Tom Di Liberto
School of Marine and Atmospheric Sciences, Stony Brook University, State University of New York, Stony Brook, New York

12:30 pm
Lunch

2:00 pm
Use of Mesoscale Ensemble Weather Predictions to Improve Short-Term Precipitation and Hydrological Forecasts
Michael Erickson
School of Marine and Atmospheric Sciences, Stony Brook University, State University of New York, Stony Brook, New York

2:20 pm
Northeast Regional Ensemble Simulations of the
10 February 2008 Lake Effect Snow Event: WRF Wind Biases and their Implications on Forecasted Snow Band Position
Justin Arnott
NOAA/National Weather Forecast Office, Binghamton, New York

2:40 pm
The Ambrose Jet: Climatology and Simulations of Warm-Season Coastally Enhanced Winds in the New York Bight Region
Brian A. Colle
School of Marine and Atmospheric Sciences, Stony Brook University, State University of New York, Stony Brook, New York

3:00 pm
Verification of SREF Aviation Forecasts at Binghamton, NY
Justin Arnott
NOAA/National Weather Forecast Office, Binghamton, New York

3:20 pm
Break
Beverages & Snacks for sale in Rotunda by Capital District Chapter of the AMS

Session C – General Session and Keynote Presentation
Session Chair – Neil A. Stuart

3:50 pm
Societal Impacts of Severe Weather – The Future of Prediction, Communication and Post-Event Analysis
Neil A. Stuart
NOAA/National Weather Service Forecast Office, Albany, New York

4:10 pm
A New Hampshire Ground-Level Ozone Pollution Forecasting Tool Using Meteorological Criteria
Laura L. Landry
Department of Atmospheric Science and Chemistry, Plymouth State University, Plymouth, New Hampshire

4:30 pm

Keynote Presentation

Introduction – Lance Bosart

The Explicit Prediction of Convective Storms: Progress and Pitfalls

Morris Weisman
National Center for Atmospheric Research, Mesoscale and Microscale Meteorology Division, Boulder, Colorado

6:00 pm
ADJOURN

Agenda
Northeast Regional Operational Workshop X
Albany, New York
Thursday, November 6, 2008

Session C – General Session (Continued)
Session Chair – Neil A. Stuart

8:30 am
2007-8 Verification of the HPC Winter Weather Desk and Upcoming Changes to the National Centers for Environmental Prediction Short Range Ensemble Forecast System
Dan Petersen
NWS/NCEP Hydrometeorological Prediction Center, Camp Springs, Maryland

8:50 am
A Project to Improve Forecasts of Radiation Fog at Elmira, New York
Michael L. Jurewicz, Sr.
NOAA/National Weather Service Forecast Office, Binghamton, New York

9:10 am
Integration of a Mesoscale Ensemble System into National Weather Service Hydro-Meteorological Operations
Jeffrey Tongue
NOAA/National Weather Service Forecast Office, Upton, New York

9:30 am
A Distributed Flash Flood Forecasting Rainfall-Runoff Model Applied to Watersheds in the Northeast United States
Michael Schaffner
NOAA/National Weather Service Forecast Office, Binghamton, New York

9:50 am
Break
Beverages & Snacks for sale in Rotunda by Capital District Chapter of the AMS

Session D – Warm Season / Convection
Session Chair – Steve R. DiRienzo

10:10am
Severe Squall Line Across Quebec on August 18th 2008
An Overview
Robert Michaud
Quebec Storm Prediction Centre, Meteorological Service of Canada, Environment Canada, Montreal, Quebec

10:30 am
Radar Characteristics of the July 2008 New Hampshire Tornado: Precursor and Tornadogenesis Stages
John Cannon
NOAA/National Weather Service Forecast Office, Gray, Maine

10:50 am
The Mesoscale Environment Associated with the Formation and Maintenance of the 24 July 08 New Hampshire Tornado
Mike Cempa
NOAA/National Weather Service Forecast Office, Gray, Maine

11:10 am
A Spatial Climatology of Convection in the Northeast U.S.
John Murray
School of Marine and Atmospheric Sciences, Stony Brook University, State University of New York, Stony Brook, New York

11:30 am
Convective System Morphology over Northeast United States
Kelly Lombardo
School of Marine and Atmospheric Sciences, Stony Brook University, State University of New York, Stony Brook, New York

11:50 am
Preferred Regions of Convective Development over Northern New England as a Function of Flow Regime: Southwesterly Flow Case Studies
Jennifer Q. Belge
Department of Atmospheric Science and Chemistry Plymouth State University, Plymouth, New Hampshire

12:10 pm
Maintenance of a Mesoscale Convective System over Lake Michigan
Nicholas D. Metz
Department of Earth and Atmospheric Sciences, University at Albany, State University of New York, Albany, New York

12:30 pm
Lunch

Session E – CSTAR Projects, and Related Topics
Session Chair - Tomas A. Wasula

2:00 pm
A Storm-Scale Analysis of the 16 June 2008 Significant Severe Weather Event Across New York and Western New England
Thomas A. Wasula
NOAA/National Weather Service Forecast Office, Albany, New York

2:20 pm
A Diagnostic Analysis of a Difficult-to-Forecast Cutoff Cyclone from the 2008 Warm Season
Matthew A. Scalora
Department of Earth and Atmospheric Sciences, University at Albany, State University of New York, Albany, New York

2:40 pm
A High-Resolution Climatology and Composite Study of Mesoscale Band Evolution within Northeast U.S. Cyclones
David R. Novak
NOAA/NWS Eastern Region Headquarters, Scientific Services Division, Bohemia, New York

3:00 pm
The 2008 "PRE-Season" In Review: A Comparison of Tropical Cyclones Fay, Hanna, and Ike with Regards to Predecessor Rainfall Event (PRE) Development
Michael L. Jurewicz, Sr.
NOAA/National Weather Service Forecast Office, Binghamton, New York

3:20 pm
Break
Beverages & Snacks for sale in Rotunda by Capital District Chapter of the AMS

3:40 pm
Use of the Nondivergent Wind for Diagnosing Banded Precipitation Systems
Thomas J. Galarneau, Jr.
Department of Earth and Atmospheric Sciences, University at Albany, State University of New York, Albany, New York

4:00 pm
A Climatology of High Lapse Rates and Associated Synoptic-Scale Flow Patterns over North America and the Northeast US
Jason M. Cordeira
Department of Earth and Atmospheric Sciences, University at Albany, State University of New York, Albany, New York

4:20 pm
Here a TC, There a TC, Everywhere a TC: The "Spin" on the Active Part of the North Atlantic 2008 TC Season
Lance F. Bosart
Department of Earth and Atmospheric Sciences , University at Albany, State University of New York, Albany, New York

5:00 pm
ADJOURN

6:30pm
CSTAR Dinner at Buca di Beppo Italian Restaurant
44 Wolf Road, Colonie, New York

The Inland Extent of Lake Effect Snow Bands in Central and Eastern New York

Joseph P. Villani
NOAA/NWS Weather Forecast Office, Albany, New York

Michael L. Jurewicz
NOAA/NWS Weather Forecast Office, Binghamton, New York

Determining the inland extent of significant lake effect snow bands is an operational forecasting challenge that impacts the Albany and Binghamton Weather Forecast Offices' County Warning Areas (CWA) several times each winter season. Assuming conditions are favorable for significant lake effect snow bands to exist upstream near the shore of Lake Ontario, determining how far inland the snow bands will extend is critical for forecasters. Occasionally, just a few miles can make a significant difference for a location receiving warning criteria snow (greater than 18 cm in 12 hours) or very little snow accumulation.

While extensive research has addressed pattern recognition, anticipated band intensity, and the persistence of lake effect snow, very little research has addressed the physical mechanisms that modulate the inland extent of these significant snow bands. The goal of this study is to determine the primary factors that influence the inland extent of lake effect snow bands in the Albany and Binghamton CWAs, especially when significant snow bands are present upstream. Significant lake effect snow events and null events that have affected the Albany and Binghamton CWAs during the past several winter seasons are being compiled. These events will be analyzed in depth utilizing carefully selected parameters to ascertain the most important factors that modulate inland extent of lake effect snow events. Parameters to be examined include, but are not limited to: mixed layer wind direction and speed, low level convergence, ambient moisture, snow band width, instability class, height of subsidence inversion, and magnitude of vertical wind shear (both speed and directional).

Since this project is in the early stages of development, just one case study from this past winter (20-21 Jan 2008) has been examined using the aforementioned parameters, and will be discussed in this presentation. The 20-21 Jan 2008 case was a two-day event, in which 30 to 91 cm of snow fell in Oswego County, while only 8 to 20 cm fell across portions of southern Herkimer County. This was a null event in terms of inland extent for the Mohawk Valley region of East-Central New York. Since this was a long-duration case lasting 48 hours, the developed parameters will be investigated throughout the evolution of the event.

Future work will focus on comparing and contrasting several events, in the hopes that conclusions that will ultimately assist the forecaster in recognizing the inland extent of lake effect snow will be developed.

The 8-9 March 2008 Winter Storm in Upstate New York: An Example of a "Multi-Hazard" Event

Brian J. Frugis
NOAA/NWS, Weather Service Forecast Office, Albany, New York

The 8-9 March 2008 event was one of the more unique storms to affect the upstate New York (NY) region during the 2007-08 winter season. Aside from the typical winter hazards of snow and ice, this particular storm also brought widespread flooding, strong winds and severe thunderstorms. The unusual combination of unseasonable severe thunderstorms along with wind, rain, snow and ice made this an excellent example of a "multi-hazard" winter event.

The storm track of the 8-9 March 2008 event made the upstate New York region very susceptible to multiple weather hazards. An 988 hPa center traveled across the eastern Catskills and Capital Region and brought warm, moist air to the eastern side of the system. This allowed dewpoint temperatures to exceed 10°C across the mid-Hudson Valley, southern Taconics and nearby adjacent portions of western New England. The abundant low-level moisture and weak instability fueled a rare line of low-topped thunderstorms, which produced damaging wind gusts. Meanwhile, a crippling ice storm occurred as sub-freezing air was in place at the surface across the southern Adirondacks and moisture driven by the storm over this layer produced an extended period of freezing rain. In between these two extreme hazards, heavy rainfall, combined with a frozen ground, several days of snow melt and runoff from a previous heavy rain event, caused widespread flooding across much of the eastern Catskills and Greater Capital Region.

This presentation will focus on the factors that led to this particular storm causing such diverse and unique hazards at the same time across upstate New York. In addition, the presentation will examine previous research regarding cool season severe thunderstorm outbreaks to find any common links between this event and past storms across the upstate New York region. Geostationary Operational Environmental Satellite (GOES) data, radar data from the Albany (KENX) Radar, as well as observational mesoscale data (ie. Local Analysis and Prediction System and Mesoscale Analysis and Prediction System) from the Advanced Weather Interactive Processing System (AWIPS) computer system will be used for analysis.

A Further Investigation of Mohawk Hudson Convergence Cases

Hugh W. Johnson IV
NOAA/NWS, Weather Service Forecast Office, Albany, New York

The meteorological phenomena, known as the Mohawk Hudson Convergence (MHC) has been researched and documented by Mike Augustyniak and others. These occur when a storm center moves to the east or south of the Capital District (located at the apex of the Mohawk and Hudson Valleys), and produces a period of light precipitation in the wake of the main warm and cold conveyor belts of the departing storm. These events are generally not associated with lake effect precipitation, although on occasion it has enhanced them. MHC events usually do not contribute much to the total storm snowfall. However, a correctly forecasted event greatly reduces their impact as persistent light snow prolongs IFR conditions and hampers High Crews.

Augustyniak specifically studied MHC events during the cold season, namely those tied to snowstorms. A Forecast Decision Tree has been devised to assist forecasters to determine when and if MHC would occur.

More research is needed on this topic. Can a MHC event happen during the “warm” season, when low pressure moves to our south and east? Can MHC happen during times of southerly flow in the Hudson Valley and a southwest or west wind in the Mohawk Valley? In this situation, MHC might actually be a focus for convective initiation. Last but not least, “null” cases should be investigated to better define (if necessary) Augustyniak’s Preliminary Flow Chart.

Several MHC cases will presented, including a Classic, Null, Hybrid, Warm, and one in “Southerly” Flow regime.

Intense Surface Cyclone Activity in the Arctic during the 2005–06 and 2006–07 Cool Seasons

Brian Silviotti, Lance F. Bosart, and Daniel Keyser

Department of Earth and Atmospheric Sciences, University at Albany, State University of New York, Albany, New York

It is well known that the arctic can be a source of stormy weather, especially in the winter, with powerful cyclones frequently roaming about the northern oceans. These cyclones can produce hurricane-force winds and pose severe hazards, especially to the shipping industry. The goal of this study is to understand the nature of these strong cool-season arctic-based storms and how they interact with the middle latitudes. A manual analysis of the large-scale spatial and temporal distribution of intense arctic surface cyclones occurring during the 2005–06 and 2006–07 cool seasons is examined. To qualify for inclusion in the analysis, these surface cyclones had to form during the cool season (October through March), originate in the arctic (poleward of 50°N), and had to attain a minimum central mean sea level pressure (MSLP) of at least 980 hPa. A given cyclone in the dataset could have attained a 980 hPa or lower MSLP reading either by itself (nonmerger) or by merging with one or more surface cyclones, which can be of arctic or midlatitude origin, in such a way that only one distinct cyclone can be seen on an MSLP map (merger).

The 0.5° GFS surface analyses were used to construct the cyclone dataset. The surface cyclones were subjectively tracked and their intensity estimated based on MSLP maps. A storm-track climatology was generated and compared with the large-scale arctic flow for each cool season. Mergers and nonmergers were compared in regard to track and intensity of the storms. A brief, representative case study of one such merger event was performed using an "Eady model" perspective to obtain a more detailed look at cyclone interaction.

Results of the subjective analysis reveal 145 intense arctic surface cyclones occurring over both cool seasons. There is high intraseasonal and interannual variability with 50 cyclones analyzed in the 2005–06 cool season, which was characterized by a mainly negative Arctic Oscillation/North Atlantic Oscillation (AO/NAO) pattern, and 95 cyclones analyzed in the 2006–07 cool season, which was characterized by a mainly positive AO/NAO pattern. There is relatively little spatial variability within and between the two cool seasons with clear track clustering in the North Atlantic and East Arctic Oceans. Approximately 27 percent of the cyclones in the dataset are mergers and show similar geographical distributions as nonmergers. Cyclones resulting from a merger event attained a mean minimum MSLP value statistically significantly lower than that of cyclones that did not merge. The representative case study of a merger event shows two surface cyclones and three upper-level disturbances (positive potential vorticity anomalies) merging over the North Atlantic Ocean southeast of Greenland to form one intense cyclone that deepened 53 hPa in 24 h and attained a minimum MSLP value of 928 hPa.

Strong Polar Anticyclone Activity over the Northern Hemisphere and an Examination of the Alaskan Anticyclone

Justin E. Jones, Lance F. Bosart, and Daniel Keyser
Department of Earth and Atmospheric Sciences, University at Albany,
State University of New York, Albany, New York

Strong polar anticyclones (PAs) have a significant impact on the cool-season climate over high-latitude landmasses as they are typically accompanied by arctic airmasses. There is anecdotal evidence the number of strong PAs, defined by a mean sea level pressure (MSLP) threshold of 1050 hPa, has been decreasing in recent decades. The purpose of this study is to investigate the change in frequency of occurrence of strong PAs and to provide an overview of the large-scale dynamical and thermodynamical processes governing their evolution.

The European Centre for Medium-Range Weather Forecasts ERA-40 and NCEP–NCAR global reanalysis datasets at 2.5° horizontal resolution were used to construct a Northern Hemisphere climatology of the frequency of strong PAs using an MSLP threshold of 1050 hPa. At each grid point, a counter summed the number of times this threshold was met or exceeded and the total number of counts was contoured objectively. This spatial climatology was performed at 10 year intervals from 1 January 1948 through 31 December 2007 using the NCEP–NCAR dataset and from 1 January 1958 through 31 December 1997 using the ERA-40 dataset. The results indicate that there has been a decrease in the maximum PA frequency of approximately three to four counts per decade.

Individual PA events (22 total) reaching an MSLP of greater than 1050 hPa over an Alaskan subdomain occurring from 1 January 1977 through 31 August 2002 were then composited using the ERA-40 dataset. The composite was performed at 24 h intervals beginning 48 h prior to the event and ending 48 h after the initial time, corresponding to the time when each individual PA event first reached an MSLP of 1050 hPa. The composite was used to perform an in-depth examination of large-scale dynamical and thermodynamical aspects relevant to the development of cold-air outbreaks over North America in association with strong PAs.

Operational High Resolution Modelling for the Vancouver 2010 Olympics

R. McTaggart-Cowan
Numerical Weather Prediction Research Division, Meteorological Service of Canada, Quebec, Canada

Environment Canada is responsible for providing weather forecasts for the Vancouver 2010 Olympics (January-March 2010) at lead times ranging from weeks to hours. An important part of the short range prediction system is guidance from the High Resolution Modelling System (HRMS) developed at the Numerical Weather Research Division. This model is designed to run daily to produce high-quality gridded forecasts over interleaved 15h forecast ranges as a background for the SNOW V10 Research Demonstration Project, the nowcasting RDP for the 2010 Olympics.

The influence of steep terrain surrounding the venues is clearly one of the greatest challenges associated with numerical modelling in the Whistler/Vancouver region. This complexity is enhanced by the presence of the Burrard Inlet, the Strait of Georgia, and the Pacific "data void" in the vicinity of the forecast region. In order to provide accurate forecasts in a region so strongly influenced by forcings on the broad range of scales from cyclones in the Gulf of Alaska, through frontal windstorms, to terrain-induced flows, the HRMS uses a triply-nested model grid, with horizontal spacings of 10 km, 2.5 km and 1 km. The inner nest is shown to be capable of resolving many of the orographic features in the Whistler/Vancouver area and producing realistic simulations of channeled and orographically-perturbed flows.

The forecasting requirements for Olympic events make the production of reliable high-resolution next-day and same-day guidance absolutely necessary. Different events have different sensible weather tolerances, which range from 3-5 m/s winds for ski jumping (depending on threshold level and wind angle to the jumping slope) to 20-50 m visibility for downhill races. Not only do the organizers of these events ask for deterministic prediction of these elements, but they require that forecasts be made hourly for the upcoming 24 h period. In addition to event thresholds, participants require additional information, including such non-standard predictions as snow surface temperatures for cross-country and biathlon events.

This talk will describe the HRMS that will be run operationally at the Canadian Meteorological Centre during the Vancouver 2010 Olympics, and will include a description of the lastest modifications implemented to addrsess specific issues associated with short range prediction in steep terrain.

Customization of a Mesoscale Numerical Weather Prediction System for Industrial Site Operations Applications

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

There are many commercial and industrial site operations and processes that are weather sensitive to local conditions in the short-term (3 to 36 hours). In many cases they may reactive and/or suboptimal due to unavailability of appropriate predicted data at this temporal and spatial scale. Hence, the optimization that is applied to these processes to enable proactive efforts utilize either historical weather data as a predictor of trends or the results of synoptic-scale weather models. While near-real-time assessment of observations of current weather conditions may have the appropriate geographic locality, by its very nature is only directly suitable for reactive response. Alternatively, mesoscale numerical weather models operating at higher resolution in space and time with more detailed physics may offer greater precision and accuracy within a limited geographic region for problems with short-term weather sensitivity. Such localized predictive information can be used to improve operational efficiency, reduce operating cost and environmental impact as well as improve safety.

To address these issues, we build upon our earlier work, in the implementation of an operational mesoscale modelling capability, dubbed "*Deep Thunder*". The system provides nested 24-hour forecasts for several geographies including the New York City metropolitan area as well as New England at 1 -3 km resolution. In particular, the goal is to provide weather forecasts at a level of precision and fast enough to address specific business problems. Hence, the focus has been on high-performance computing, visualization, and automation while designing, evaluating and optimizing an integrated system that includes receiving and processing data, modelling, and post-processing analysis and dissemination. Part of the rationale for this focus is practicality. Given the time-critical nature of weather-sensitive business decisions, if the weather prediction can not be completed fast enough, then it has no value. Such predictive simulations need to be completed at least an order of magnitude faster than real-time. But rapid computation is insufficient if the results can not be easily and quickly utilized. Thus, a variety of customized and integrated products are being implemented. They range from techniques to enable more effective analysis to strategies focused on the applications of the forecasts.

The concept behind *Deep Thunder* in this context is clearly to be complementary to what the National Weather Service (NWS) does and to leverage their investment in making data, both observations and models, available. The idea, however, is to have highly focused modelling by geography and application. Therefore, we will review our particular architectural approach and implementation as well as the justification and implications for various design choices. Then we will outline how this approach enabled customization for problems associated with industrial site operations as well as discuss the specific customizations.

Using Short Range Ensemble Forecasts and High Resolution Model Output to Assess the Potential for Tornadoes across Southeast Virginia on 28 April 2008

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

Richard Grumm
NOAA/NWS Weather Service Forecast Office, State College, Pennsylvania

Short Range Ensemble Forecast (SREF) products are used with high resolution model output to identify the potential for supercells and tornadoes across southeast Virginia on 28 April 2008. This study will illustrate that SREF probability forecasts and deterministic high resolution model output shouldn't be considered as mutually exclusive approaches to forecasting. Rather, the complementary strengths of both approaches can lead a forecaster to greater situational awareness for an event with high impact potential.

The tornado outbreak across southeast Virginia during the late afternoon of 28 April resulted in 11 tornadoes and multiple injuries, including an EF3 rated tornado in the city of Suffolk VA. Although clouds ahead of an advancing cold front were expected to limit destabilization across the mid-Atlantic region, persistent low-level moisture inflow coupled with increasing low- to mid-level wind fields provide sufficient vertical wind shear to increase the potential for tornadic supercells and bowing line segments along and ahead of a pre-frontal trough.

This study demonstrates a forecast strategy that utilizes SREF probability forecasts to assess the potential for supercells and tornadoes, SREF departures from climatology to evaluate the climatological context of the model forecasts, and high resolution model output to resolve the mesoscale organization and evolution of deep convection.

Although this tornado outbreak occurred in southeast Virginia, the meteorological environment and resulting storm structures are particularly relevant across the Ohio Valley and northeast United States.

Validation of Storm Surge Models for the New York Bight and Long Island Regions and the Impact of Ensembles

Tom Di Liberto, Brian A. Colle, and Frank Buonaiuto

School of Marine and Atmospheric Sciences, Stony Brook University, State University of New York, Stony Brook, New York

The Stony Brook Storm Surge (SBSS) group has developed a real-time storm surge modeling system for the coastal Northeast U.S using the Advanced Circulation Model for Coastal Ocean Hydrodynamics (ADCIRC) ocean model (http://stormy.msrc.sunysb.edu). This talk will highlight the verification of the ADCIRC over the 2007-2008 cool season (Nov – March) using several water level gauges around New York City and Long Island. The results are compared against NOAA's Extratropical Storm Surge Model and Stevens Institute for Technology's surge modeling system for the same events. The 60-h deterministic ADCIRC run uses hourly surface winds and sea-level pressures from the Penn State- National Center for Atmospheric Research (PSU- NCAR) Mesoscale model (MM5) at 12-km grid spacing. For the 0000 UTC cycle, ADCIRC is also run 48-h using 8 separate ensemble members, including 5 members from the MM5 and 3 members from the Weather Research and Forecasting (WRF-ARW) model. The MM5/WRF ensemble members include varied initial conditions (different operational analyses) and different PBL, convective, and microphysical parameterizations.

During the 2007-2008 cool season, ADCIRC ensemble members had a negative mean error (bias) of about -0.10 to -0.13 m for the 12-36 h forecast period at the Battery, while the root-mean square errors (RMSEs) ranged from 0.17 to 0.20 m. NOAA's ET Surge model had similar errors, with a negative bias of around -0.17 m for 12-36 h and a RMSE of 0.19 m for 12-36 h. The validation of Steven's modeling system will be presented at the meeting. The ADCIRC ensemble mean for the same station had a -0.12 m negative bias for 12-36h, but its RMSE was 0.17 m, which is slightly smaller than most ensemble members. The negative water levels are often largest for days when there are significant wave heights near the coast, which suggests the importance of including wave forcing in these surge models.

This talk will also summarize the storm surge modeling efforts for Hurricane Gloria (26-28 September 1985) in the New York Metropolitan Region. There have been no realistic atmospheric and storm surge model simulations of historic landfalling hurricanes in this urban-coastal environment. This event provides a good test case for these numerical models. Gloria resulted in the highest recorded storm surge of ~7 feet (2.1 m) at the Battery, NY in the last 50 years. The impact of wave forcing on the storm surge will be discussed as well as how small track differences resulted in relatively large water level differences at numerous stations.

Use of Mesoscale Ensemble Weather Predictions to Improve Short-Term Precipitation and Hydrological Forecasts

Michael Erickson[1], Brian A. Colle[1], Jeffrey Tongue[2], Alan Cope[3], and Joseph Ostrowski[4]
[1]School of Marine and Atmospheric Sciences, Stony Brook University, State University of New York, Stony Brook, New York
[2] NOAA/NWS, Weather Service Forecast Office, Upton, New York
[3] NOAA/NWS, Weather Service Forecast Office, Mt. Holly, New Jersey
[4] NOAA/NWS, Mid-Atlantic River Forecast Center, State College, Pennsylvania

This collaborative project focuses on the improvement of short term (< 48 hour) quantitative precipitation forecasts (QPF) and streamflow predictions using both ensemble modeling and verification approaches. The ingestion of ensemble QPF into hydrologic models will hopefully improve probabilistic streamflow and stage height forecasts within the WFO and Mid Atlantic River Forecast Center (MARFC). This talk will describe the ensemble approach, some examples from the system, and present verification of the short range (0-48hr) QPF from the ensemble.

Currently, Stony Brook University (SBU) is running a 13-member ensemble down to 12-km grid spacing over the Northeast U.S. using the MM5 (v3.7) and WRF-ARW (v2.2) mesoscale models. The 7 members of MM5 and 6 members of WRF use different initial conditions (GFS, NAM, CMC, NOGAPS) mixed with different physical parameterizations (convective parameterization, boundary layer, and microphysics). The model output is converted to grib format, and our collaborative partners pull the hourly ensemble data back to their respective offices in real-time using LDM for display on their AWIPS systems. The SBU ensemble can be combined the NCEP SREF and other models to provide forecasters a multi-model ensemble perspective. The QPF data from the SBU ensemble is also used in a variety of ensemble streamflow applications. The Mt. Holly and Upton, NY WFOs use the Site Specific for the Passaic and Lodi river basins in New Jersey. The MARFC ingests the river basin averaged SBU ensemble data into their Ensemble Streamflow Prediction (ESP) system to produce an ensemble of streamflow responses. This allows for probabilistic analyses of river response to model derived QPF for a variety of river basins in the mid-Atlantic. Past cases using the ESP system will be shown for the Passaic.

The SBU ensemble forecasts were verified using Stage IV precipitation (~4-km grid spacing) for the 2006 through 2008 warm (May to August) and cool (December to March) seasons. For the verification, the higher resolution stage IV data was interpolated to the resolution of the model grid with the offshore regions neglected. There is unequal performance in the ensemble members, with the WRF members performing best over the cool season. Most members exhibited an overprediction of precipitation, especially during the warm season, but there are variations across the Northeast U.S. In addition to error and bias analyses, probabilistic verification will also be presented.

Northeast Regional Ensemble Simulations of the 10 February 2008 Lake Effect Snow Event:WRF Wind Biases and their Implications on Forecasted Snow Band Position

Justin Arnott and Michael Evans
NOAA/NWS Weather Forecast Office, Binghamton, New York

Lake effect snow (LES) bands are characterized by large gradients in surface sensible weather, with locations experiencing blizzard conditions often just miles from areas receiving only flurries. For this reason, accurate forecasts of LES band location are critical to National Weather Service forecasters in their preparations of advisories and warnings for heavy snowfall.

Northeast Regional Ensemble (NRE) simulations of the 10 February 2008 LES event indicated that ensemble members utilizing the ARW core of WRF (WRF-ARW) had a persistent southward bias in the forecast position of LES bands. This bias unnecessarily increased ensemble spread in the NRE forecast, adding uncertainty to the warning decision process. This finding was consistent with previous research from the 2006-2007 winter season, and with qualitative observations by WFO Binghamton forecasters for other events during the 2007-2008 winter season.

In this presentation, the reasoning for the LES band position bias will be examined. It will be shown that WRF-ARW simulations forecasted overly strong low-level northwesterly winds upwind of the eastern Great Lakes, with these winds acting to advect LES bands downwind of the eastern Great Lakes to the south and east. A series of sensitivity simulations, using the NMM core of WRF, in addition to two unique versions of the WRF-ARW, will be used to examine the wind bias, and suggest an optimized configuration for the ARW members of NRE. It is hoped that this optimized configuration will lead to improved LES forecasts for the 2008-2009 winter season.

The Ambrose Jet: Climatology and Simulations of Warm-Season Coastally Enhanced Winds in the New York Bight Region

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The coastal regions of New York and New Jersey are often dominated by sea-breeze circulations during the spring and summer months. Occasionally these gentle sea breezes become relatively strong southerly wind events (> 11 m s^{-1}) that may require marine advisories. These strong winds are best described as a jet, since the winds are spatially confined to the New Jersey and Long Island coasts (the New York Bight) and are vertically confined to the boundary layer (< 300 m). The Ambrose Light Station (ALSN6), located at the entrance of New York harbor, often samples this jet. Thus, the winds have been colloquially called the Ambrose Jet. This study investigates the climatology of Ambrose Jet events and the processes responsible for their occurrence.

An Ambrose Jet event was defined as the occurrence of southerly (160–210 degrees) maximum sustained winds (10 m height) exceeding 11 m s^{-1} at ALSN6. This wind speed threshold is one standard deviation greater than the mean wind speed at ALSN6 during 1997–2006. The sustained wind speed maximum must occur between 18 UTC and 03 UTC. To assure the wind maximum is spatially localized, the sustained wind at buoy 44025, located about 50 km to the east-southeast of ALSN6, must be <85% of the maximum sustained wind at ALSN6. Analysis of wind data during 1997–2006 revealed 134 Ambrose Jet events. There is a seasonal maximum in June and July, with a skew towards the spring months, suggesting that land-sea temperature contrast and the associated local pressure gradient are important to Ambrose Jet occurrence. The jet events exhibit a diurnal cycle, with light southwest winds during the 0600–1500 UTC period, backing to south-southeast and strengthening during the 1500–2100 UTC period. The winds become more southerly and reach a maximum generally in the 2100–0000 UTC period. The mean maximum intensity was 12.5 m s^{-1}. After the peak intensity, the winds veer to a southwest direction as they weaken. The veering winds after 1500 UTC suggests the influence of the Coriolis force. A composite analysis shows that the Ambrose Jet is favored on relatively warm days within synoptic-scale southwest flow on the western flank of the Bermuda high.

An Ambrose Jet event on 2 June 2007 was realistically simulated down to 1.33-km grid spacing using the Weather Research and Forecasting (WRF) and Penn State–NCAR Mesoscale Models (MM5). Model sensitivity experiments were conducted to identify how aspects of the complex coastline curvature of New York Bight and the urban land characteristics of New York City modify the local pressure gradient and regulate the Ambrose Jet.

Verification of SREF Aviation Forecasts at Binghamton, New York

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Ensembles are gaining increasing popularity in the forecast process, playing a large role in our development of extended range forecasts, and an ever-increasing role in shorter-term, high impact forecasts. Additionally, in recent years, the resolution of some ensemble forecast systems has reached the mesoscale, making probabilistic forecasts of more localized events possible. A natural question is whether aviation forecasts (i.e. ceiling/visibility forecasts), known for being highly localized, can benefit from the use of ensemble forecast guidance.

In this presentation, ceiling and visibility forecasts from the Short Range Ensemble Forecast system (SREF) will be verified for one terminal aerodrome forecast (TAF) site, Binghamton, NY, for a portion of the 2008 warm season. This study marks the first such verification attempt across the lower 48 states. Mean forecast values, in addition to various probability thresholds are examined. It will be shown that while the SREF forecasts are overly pessimistic in anticipating MVFR/IFR ceilings, and have difficulty identifying visibility restrictions, there are instances where this set of guidance performs similarly to more widely used, deterministic guidance, namely model output statistics (MOS). Because this study was performed during the warm season, a time notorious for more challenging MVFR/IFR forecasts, it is suggested that SREF aviation forecasts may demonstrate increasing skill and usefulness heading into the 2008-2009 cool season.

Societal Impacts of Severe Weather – The Future of Prediction, Communication and Post-Event Analysis

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Weather and climate information affects nearly one-third of the U.S. Gross Domestic Product and influences the decisions of a myriad of users around the world, including but not limited to the general public, emergency managers, utility companies and the shipping, aviation, agriculture and transportation industries. During recent years, there has been an emphasis within the meteorological community to promote the development and use of probabilistic forecast products to provide crucial information on forecast uncertainty resulting in improved decision making among user groups. Better decisions from all users can result in minimization of economic impact and loss of life.

Weather-related disasters such as Hurricane Katrina in 2005, the northeastern U.S. snow event of 13 December 2007 and tornado outbreaks such as the Super Tuesday 2008 outbreak highlighted the need to collaborate with social scientists to address vulnerability and behavioral factors that contributed to the significant economic impact and death toll in these and similar recent events. Many of the probabilistic forecast products that are being developed are the result of multi-sector collaborations, and incorporates social science research for increased consideration of user needs.

Several examples of products and services will be shown that are under development within the National Weather Service and the Hazardous Weather Test Bed. These potential future products and services will address societal impacts and forecast uncertainty with regard to severe weather hazards such as winter storms, severe thunderstorms and tornadoes. An experimental winter weather impact scale will be presented that can guide forecast staff to address different societal impacts in winter weather warning products. Probabilistic severe thunderstorm and tornado warnings will be compared to the current warning polygon paradigm.

Examples of potential usage of the new products and services will be presented using recent winter storm and severe weather events, specifically the Valentine's Day 2007 snowstorm and the 24 July 2008 EF2 tornado in New Hampshire and Maine. Current and future formal verification techniques will be discussed as well.

A New Hampshire Ground-Level Ozone Pollution Forecasting Tool Using Meteorological Criteria

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For over 15 years, New Hampshire Department of Environmental Services (NHDES) has forecasted ground-level ozone conditions. In March 2008, the Environmental Protection Agency (EPA) implemented a new National Ambient Air Quality Standard for the 8-hour average ozone concentration, lowering it from 84ppb to 75ppb. A forecasting tool was developed to provide guidance for NHDES air quality forecasters predicting exceedances of the new standard. Select New Hampshire air monitoring sites were investigated with datasets consisting of meteorological and air quality monitoring data for 2002-2007. The data were analyzed for relationships between meteorological parameters and ozone concentration at each station to define threshold values beyond which exceedances are probable. Meteorological parameters chosen to study were daily maximum surface temperature, 850hPa temperature at 1200UTC, and 1200UTC and 1800UTC surface wind speed, surface wind direction, and cloud cover for June-August. Criteria values were established by subjectively determining a threshold value above (such as with 850hPa temperature) or below (such as with wind speed) which most maximum daily ozone concentrations exceeded 75ppb.

The final product is presented in a tabular format with each variable's threshold value per station. While there were a few differences, in most cases every station resulted in similar threshold values for 75ppb. In general, an exceedance day is most likely to occur within the study area when the following conditions occur: daily maximum surface temperature of about 83˚F or higher, 850hPa temperature at 1200UTC of approximately 12˚C or greater, surface wind speeds at 1200UTC of 5 kts or less, southwesterly to southerly surface wind direction at 1200UTC, cloud cover at 1200UTC of 25% or less, surface wind speeds at 1800UTC of approximately 10 kts or less, westerly to southwesterly surface wind direction at 1800UTC, and cloud cover at 1800UTC of 50% less. These results are consistent with meteorological conditions known to promote ozone production. Overall for each station, threshold values do not seem to vary significantly regardless of the number of years used to determine them. The results from this project will be used as an additional operational tool by NHDES air quality forecasters in their daily assessment of ground-level ozone in New Hampshire.

The Explicit Prediction of Convective Storms: Progress and Pitfalls

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Over the past several spring and summer seasons, 36 h realtime explicit convective forecasts have been produced for the central US with the WRFARW model, using a 4 km horizontal grid resolution for 2003-2006 and 3 km in 2007 and 2008. These forecasts suggest significant value added for such high resolution guidance as compared to coarser resolution forecasts using convective parameterizations; most notably, in the realistic representation of convective mode (e.g., squall lines, bow echoes, supercells, mesoscale convective vortices) as well as in representing the climatological characteristics of convection, such as precipitation episodes and the diurnal convective cycle. However, no improvement in overall guidance can be documented as to the timing and location of significant convective outbreaks. Perhaps the most notable result has been the strong correspondence between the coarse resolution NAM/GFS and WRF-ARW guidance, for both good and bad forecasts, suggesting the overriding influence of larger-scales of forcing on convective development in the 24-36h timeframe. In this talk, I will summarize the key successes and failures we have experienced to date in this endeavor, and will discuss the implications for the future of multi-day convective predictions.

2007-8 Verification of the HPC Winter Weather Desk and Upcoming Changes to the National Centers for Environmental Prediction Short Range Ensemble Forecast System

Dan Petersen
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First, verification of HPC's Winter Weather Desk (WWD) forecasts from the winter of 2007–2008 will be presented, including snowfall, freezing rain, and low track forecasts. Verification of snow-to-liquid ratio (SLR) techniques will be shown. Upcoming changes to the National Centers for Environmental Prediction (NCEP) Short Range

Ensemble Forecast System (SREF) will be shown. The SREF changes will outline member composition and resolution changes, and the need to correct for 2 meter low temperature biases in a few of the members. A case study will be shown comparing how the new SREF performed in a winter event over the northeast in February 2008 versus how the prior operational version of the SREF performed.

A Project to Improve Forecasts of Radiation Fog at Elmira, New York

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One of the primary missions of the National Weather Service (NWS) is to support the nation's commerce and transportation industries. As such, accurate forecasts of conditions which impact aviation operations are critical.

The Weather Forecast Office in Binghamton, NY (WFO BGM) is responsible for issuing Terminal Aerodrome Forecasts (TAFs) for six different sites in Central New York and Northeastern Pennsylvania. One of these airports is located in Elmira New York (KELM), within the Chemung River Valley, which is a favored location for radiation fog formation, and thus frequent episodes of Low Instrument Flight Rules/Instrument Flight Rules (LIFR/IFR) conditions. This presentation will detail work done at WFO BGM to improve forecasts of LIFR/IFR conditions associated with radiation fog at KELM.

Statistics were compiled using observations and archived data from model soundings associated with the occurrence and non-occurrence of fog at KELM on nights with clear skies and light winds during a 2 year period (2001-2002). The study determined that critical parameters that control the development of radiation fog at KELM include boundary layer wind speed (above the surface), departures between observed temperature and the previous day's cross-over temperature (from the "UPS Technique"), and river/air temperature gradients.

The results from this study are being incorporated into operations by utilizing a locally developed application that compares current forecast data to a database of historical radiation fog events. The application works by identifying historical events that are most similar to current expected conditions, based on the similarity of the parameters from the aforementioned study. After the most similar historical events are identified, the application returns information on these events, including event minimum visibility, and the duration of associated LIFR/IFR conditions. This information helps forecasters anticipate upcoming conditions, based on the assumption that current events will most likely produce conditions that are similar to their historical analogues.

Integration of a Mesoscale Ensemble System into National Weather Service Hydro-Meteorological Operations

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Michael Erickson
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The National Weather Service (NWS) forecast offices utilize the Advanced Weather Interactive Processing System (AWIPS) for weather analysis and forecasting. Data from local numerical weather prediction systems can be ingested into the system via the Local Data Manager (LDM) software program within AWIPS. Once the data are ingested into AWIPS, the AWIPS software must be modified to recognize the data for display and interrogation. Lastly, forecasters must be trained on data usage and develop personal methodology to integrate these data into their forecast process.

Data from the Stony Brook University (SBU) Mesoscale Ensemble System (MES) has been integrated into the NWS New York City Weather Forecast Office AWIPS. These data are incorporated into the various applications within AWIPS including the Site Specific Hydrologic Prediction System (SSHPS). The SSHPS allows forecasters at the NWS to perform mesoscale hydrology on small, fast responding basins. The integration of the SBU MES quantitative precipitation forecast (QPF) data into SSHPS allows for the evaluation of mesoscale hydrology using mesoscale ensemble QPF for the first time in an operational environment.

This presentation will demonstrate how the Stony Brook MES data are integrated into AWIPS, how the data are assimilated by forecasters, and how SSHPS integrates the data for hydrological predictions.

A Distributed Flash Flood Forecasting Rainfall-Runoff Model Applied to Watersheds in the Northeast United States

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Carl Unkrich
US Department of Agriculture, Agricultural Research Services, Tucson, Arizona

Flash floods pose a significant danger to life and property in the northeast United States. One effective way to mitigate flood risk lies in implementing a real-time forecast and warning system based on a rainfall-runoff model. The Kinematic Runoff and Erosion Model (KINEROS2 - www.tucson.ars.ag.gov/kineros) is a spatially distributed watershed model driven by high resolution radar rainfall input. In this study, KINEROS2 was used to evaluate such a system in several watersheds in New York State.

KINEROS2 provides a temporal and spatial resolution not currently available with other National Weather Service flash flood forecasting models. KINEROS2 can run on a user defined time-step. For this study, the model time-step was set to a 5-minute interval to match input from the 5 minute Digital Hybrid Reflectivity (DHR) radar product which has a 1-degree by 1-km resolution on average. KINEROS2 can also run ensembles that allow the forecaster to evaluate various scenarios. The scenarios may be precipitation based, allowing forecasters to examine the effect of different Z-R relationships on watershed response. Scenarios can also be modeled by varying model parameters which allows the forecaster to examine a range of natural variation in watershed hillslope and channel characteristics. KINEROS2 can be applied to watersheds with or without stream gauges.

Results from three watersheds in the Catskill Mountains of Delaware County will be shown. Both gauged and ungauged watersheds were evaluated. Model parameter variation, both in saturated hydrologic conductivity and channel length, was also observed. Parameter variation was attributed to storm size, duration, and resultant basin averaged rainfall totals. Model calibration based on these two model parameters with reference to basin average rainfall produced a robust set of streamflow ensembles that can be run to predict the timing and magnitude of the peak flow from flood flows in small, fast-responding watersheds in complex terrain.

Severe Squall Line Across Quebec on August 18th 2008
An Overview

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A severe squall line moved across the province of Quebec on August 18th 2008 causing wind gusts up to 90 km/h with few reports of small hail (1 to 2 centimetres in diameter) and few reports of funnel clouds with its passage. This event will be analyzed synoptically and thermodynamically in order to reveal its classical structure and behaviour. The Montreal radar (McGill) was not operational during the past summer for maintenance but the event was depicted by either the Franktown (near Ottawa) or Villeroy (just southwest of Quebec City). The radar data used will show the classical nature of the squall line as it moved across the southern part of the province (convective and stratiform parts). The data will also show a well defined supercell ahead of the main squall line which gave challenge to the Severe Weather forecaster team.

Radar Characteristics of the July 2008 New Hampshire Tornado: Precursor and Tornadogenesis Stages

John Cannon, Dan St. Jean and Mike Cempa
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On 24 July 2008, a long-lived tornado raced across eastern New Hampshire. The 52 mi (84 km) path was the longest continuous tornado track ever recorded in New England. This path length eclipsed other well known historical New England storms such as the Worcester, Great Barrington and Stockbridge tornadoes. One death occurred and hundreds of homes were damaged by the rain wrapped EF-2 (Enhanced Fujita) tornado. Detailed storm track information and storm damage photos can be viewed at http://www.erh.noaa.gov/er/gyx/.

An anomalously vigorous (three standard deviations from the atmospheric mean), cut-off, upper level low pressure system and strong low level winds provided favorable dynamics to produce the tornadic storm. Tornadogenesis occurred despite modest atmospheric instability and limited cloud to ground lightning. Rather, a series of storm scale interactions likely enhanced the evolving tornadic cell, which was evident in radar animations.

High resolution radar products from the National Weather Service WSR-88Ds in Brookhaven, New York, Taunton, Massachusetts and Gray, Maine were collected to further examine storm morphology. The imagery revealed two unique stages to the convective lifecycle of the storm, which will be defined as a "precursor stage" and a "tornadogenesis stage".

The "precursor stage" was associated with storm scale dynamics that preceded the development of the tornadic cell. This period was initially characterized by a pulse of inbound velocities approaching Long Island, New York early on 24 July. Subtle, but distinct cell mergers occurred as this storm entered Connecticut. Radar reflectivity images showed this enhanced convection triggered the formation of a bowing segment which propagated to the right of the mean atmospheric flow.

During the formative "tornadogenesis stage", the convective cell which eventually produced the tornado evolved. A circulation formed near the apex of the bow echo. Rotation increased as the cell intersected the junction of the Merrimack Valley and surrounding hill towns and continued to fluctuate as the storm traversed northeast at 40 kts across complex terrain. A final cell merger was then coincident with the development of a second bow echo and a rapid increase in low-level shear. A tornado touchdown soon followed. Radar animations detailing the storm morphology which produced the long-lived tornado will be presented. A conceptual diagram will be displayed to demonstrate that complex and discrete storm scale interactions accompanied the organized convection and tornadogenesis.

The Mesoscale Environment Associated with the Formation and Maintenance of the 24 July 08 New Hampshire Tornado

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On 24 July 2008, a long lived tornado tracked across eastern New Hampshire. The 52 nm path from Deerfield to Freedom was the longest continuous tornado track ever recorded in New England. This path length exceeded the path length of the previous longest tornado in New England, the 46 nm Worcester tornado of 1953. One death occurred, while hundreds of homes and tens of thousands of trees were damaged by the rain-wrapped Enhanced Fujita Scale (EF-2) tornado. Detailed storm track information and storm damage photos can be viewed at http://www.erh.noaa.gov/er/gyx/.

An anomalously vigorous (three standard deviations stronger than the atmospheric mean) upper level low pressure system and associated strong low level wind fields provided favorable upward vertical motion and vertical wind shear to support a tornadic storm. Tornadogenesis occurred despite modest instability parameters for summertime. It will be proposed that a series of mesoscale interactions likely enhanced the environment to allow tornadogenesis, and maintenance of the tornado for approximately 80 minutes.

The tornado developed in an environment that featured above-normal precipitable water values, with strong lower-tropospheric southerly flow atop a boundary layer inversion. Significant cloud cover existed across eastern New England, with relatively stable marine air trapped below the inversion, yet there was modest elevated instability above the boundary layer. Storms that formed in this environment prior to the development of the tornado produced heavy rain but did not transport any of the strong winds down to the surface.

An area of mid-morning clearing in eastern New Hampshire allowed sufficient insolation to increase surface based instability. Additionally, the resulting differential diabatic heating along the clear-cloud boundary would likely have increased the local wind shear and horizontal vorticity. A line of weak storms moved into this area and two cells rapidly developed on this line, resulting in strong winds aloft mixing down to the surface. Both cells produced damaging winds, with the northern storm producing the tornado. Some ideas will be presented as to why the tornado formed with the northern cell, including the presence of a surface moisture gradient in the area of the tornado producing storm, enhanced low-level southeast flow just ahead of and prior to the storm, existing outflow boundaries from previous storms and the influences of terrain. The importance of these features in maintaining the tornado along its lengthy track will also be examined.

A Spatial Climatology of Convection in the Northeast U.S.

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The goal of this presentation is to highlight the spatial distribution and evolution of deep convection over the Northeast U.S. during the warm season (April through September). There is little knowledge of where convection is initiated over the Northeast U.S. in relation to the terrain, coastal, and urban areas. It is also not well known how convection evolves diurnally and as the warm season progresses. A convective climatology was constructed for the Northeast U.S. using 2km by 2km resolution NOWrad radar data from 1996-2007 as well cloud-to-ground lightning from the National Lightning Data Network (NLDN) from 2001-2007. The lightning counts were interpolated to a 10km by 10km grid over the Northeast U.S.

The frequency of convection at each grid point over the Northeast U.S. was obtained by summing every 15-min the composite reflectivity values that are at least 45 dbZ. There are preferred regions for convection within the Hudson Valley, western and southeast Pennsylvania, central New Jersey and into the Delmarva Peninsula. A favored initiation area includes the immediate lee of the Appalachians. There is a sharp gradient in convective frequency immediately west of the coast (around New York City) as a result of the cooler marine boundary layer. As the warm season progresses, the convective activity shifts more towards the coast, which is consistent with the warming sea surface temperatures. During the mid-day period (18-00 UTC), the maximum convection is clearly over inland areas, but by late at night (06-12 UTC) the convective maximum shifts more offshore from the southern New England coast extending southwest across the waters through the vicinity of the Chesapeake Bay. Composites using the North American Regional Reanalysis (NARR) will highlight some of the flow patterns attached to the favored areas of convective development. The various life cycles of convection over the Northeast are analyzed using Hovmoller plots to highlight genesis and decay regions.

Convective System Morphology over Northeast United States

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Convection organization is often related to the type of severe weather most likely to occur (tornadoes, straight-line winds, and/or flash flooding). Previous work has classified the convective structures over the Central U.S., but a similar study for the Northeast U.S. does not exist. The ambient environment over the Northeast is much different than the Plains, typically with less CAPE over the Northeast, as well as influences by the Appalachian terrain, coastal marine boundary layer, and major urban metropolitan areas, such as New York City.

The different convective structures over the Northeast were classified during the 2007 warm season (May – Sept) using the same approach as Gallus et al. (2008) over the central U.S. This involved perusing hourly NOWRAD (2-km grid-spacing) radar imagery and classifying the convection into five types of cellular convection (long-lived individual cells, short-lived individual cells, clusters of long-lived cells, clusters of short-lived pulse cells, and broken squall lines), five types of linear systems (bow echoes, squall lines with trailing stratiform rain, lines with leading stratiform rain, lines with parallel stratiform rain, and lines with no stratiform rain), and nonlinear systems.

Preliminary results suggest a nearly equal frequency of cellular, nonlinear, and linear events across the Northeast, with multiple types coexisting simultaneously. This distribution is similar to the upper Midwest (Gallus et al. 2008). While nonlinear convection and convective clusters do not have a preferred time of development during the day, individual cellular events preferentially occur between 1700-1800 UTC. Similarly, linear systems develop in the late afternoon and early evening. Typically, cellular archetypes both develop and decay within the Appalachian high terrain, while there is evidence that linear systems propagate away from the high terrain.

Though the convective morphologies are similar across the two regions, the production of severe weather varies significantly in association with these structures. For example, Northeast hail events are evenly distributed among convective clusters, nonlinear, and non-stratiform linear systems. Central U.S. hail develops primarily with broken lines, bow echos, and parallel stratiform linear systems. This presentation will further highlight the severe weather associated with each convective type and the favored large-scale ambient conditions.

Preferred Regions of Convective Development over Northern New England as a Function of Flow Regime: Southwesterly Flow Case Studies

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Lowery (2008) performed a 5 year (2003-2007) climatology on northern New England thunderstorms as a function of large-scale flow. This study examined the spatial distribution of convection relative to the terrain in the Gray, ME (KGYX) radar and found that for southwesterly flow at 700 hPa, the most significant convective initiation region was located in central Oxford (ME), central Franklin (ME), and southern Somerset (ME) counties. Lowery's study did not address the question of why thunderstorms favor these genesis regions for a particular flow regime. Therefore this study will attempt to answer this question by looking at two case studies for southwesterly flow at 700 hPa.

In order to choose case studies, radar reflectivity was examined for each case indentified by Lowery (2008) from just one season: May-September 2007. Case studies were selected based on the following criteria: 1) the thunderstorm cells were observed to initiate in the areas identified by Lowery (2008); and 2) the thunderstorm cells were not associated with a frontal zone. The purpose for the 2nd criterion was that we wanted to analyze the mesoscale interaction between the terrain and large-scale flow for cell development in these significant genesis regions, and therefore we wanted to be able to eliminate the influence from a frontal boundary. This presentation will focus on the southwesterly flow cases from July 13, 2007 and August 3, 2007.

Each case study will analyze moisture, instability, and lift in the genesis regions using the LAPS (Local Analysis and Prediction System) dataset. Results from the July 13, 2007 case show that dew point values at 1700 UTC, just before convective initiation, were around 55° F and CAPE values were about 600 J/kg. For the August 3, 2007 case, CAPE values were about 2500 J/kg with dew points around 65° F. For each case study, areas with no convective initiation had the same or even a more sufficient supply of moisture and/or instability. This suggests that moisture and instability are not the critical factors for determining the location for convective initiation in the prefrontal environment in southwesterly flow. When the surface flow field was examined, an area of convergence was seen in both cases in the vicinity of the genesis region. Furthermore, a weak surface trough was also observed in this area. We are hypothesizing that the surface convergence and corresponding pressure trough could provide the necessary lift for the convection to initiate in the favored areas identified by Lowery (2008).

Maintenance of a Mesoscale Convective System over Lake Michigan

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Mesoscale convective systems (MCSs) are ubiquitous features across the upper Midwest during the warm season. MCSs that traverse the Great Lakes and vicinity during the warm season are of interest because the cooler lake waters relative to the surrounding land may decrease (increase) surface-based CAPE (CIN) and result in weakening of the MCSs. However, some MCSs are observed to maintain their strength, or even intensify, as they traverse the Great Lakes, suggesting that these MCSs may be feeding on an accelerated "surface" flow that lies just above a shallow surface-based stable dome of cold air over the Great Lakes. The purpose of this presentation will be to explore the dynamical and physical mechanisms that control the maintenance of a warm-season MCS as it crosses the Great Lakes.

Around 1100 UTC 7 June, an MCS developed over northwestern Iowa, on the eastern end of a surface boundary. The cold pool from the MCS acted to extend this surface boundary into southern Minnesota and Wisconsin as the MCS progressed eastward. Enhanced shear along and isentropic ascent over the surface boundary led to additional convective development and numerous associated tornado, severe wind, and severe hail reports. Additionally, a large supercell formed as a separate outflow boundary intersected the MCS cold-pool-induced boundary and produced many tornado reports near Chicago. As the MCS crossed Lake Michigan, composite radar reflectivity did not show any weakening and severe wind reports continued to occur as the eastern extent of the MCS reached western Michigan.

A detailed examination of the MCS that crossed Lake Michigan on 7–8 June 2008 and the associated MCS cold-pool-induced boundary will be presented. Our analysis of the 7 June 2008 meteorological environment shows that the MCS was able to form in a high shear environment. Dry air around 800-hPa allowed for the formation of a strong and deep surface cold pool, and the balance between the strong shear and cold pool promoted vigorous ascent. The depth of the MCS cold pool as the system approached Lake Michigan was much larger than the depth of the cold dome over Lake Michigan, allowing for continued ascent over the lake. Additionally, the MCS crossed Lake Michigan in the presence of intense frontogenesis along the western Lake Michigan shore and a low-level jet that advected warm unstable air into the MCS region.

A Storm-Scale Analysis of the 16 June 2008 Significant Severe Weather Event Across New York and Western New England

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On 16 June 2008, a widespread severe weather event occurred across much of upstate New York and portions of New England. The Storm Prediction Center posted a moderate risk that afternoon from the Mohawk River Valley, Greater Capital Region and southwestern New England southward into the Mid Atlantic region. The Northeast United States had over 100 severe reports of damaging winds in excess of 50 knots (58 mph), and large hail (greater than 1.9 cm). There was also one confirmed tornado in the lower Hudson Valley. The vast majority of the severe reports were large hail, with a few hail stones exceeding 5.0 cm in diameter. The severe convection was focused ahead of a surface cold front and a potent short wave trough rotating around a strong 500 hPa cutoff low, meandering southeast from Southern Ontario and Lake Superior.

Observational data, as well as short range deterministic and probabilistic model guidance suggested a major severe weather outbreak was about to occur. A cyclonically curved upper-level jet was located southwest of New York with a plume of divergence over the Northeast in the afternoon. Much of the southern portion of the Albany forecast area was in the favorable left front quad of a mid-and upper-level jet streak. The 1800 UTC KALB sounding indicated convective temps would be in the mid to upper 70s°F, if appreciable surface destabilization happened ahead of the surface cold front. Surface based convective available potential energy values of 1000-2000 J kg^{-1} were expected with steepening mid-level lapse rates to around 7ºC km^{-1}, coupled with wet bulb zero heights falling to 9-10 kft. The bulk shear values in the 0-6 km layer were in the 45-50 kt range, suggesting the possibility of isolated to scattered supercells. The forecaster thinking for predominant convective mode this day, however, was for mainly multi-cellular convection with large hail and damaging winds due to the steep lapse rates and strong jet dynamics.

This talk will focus on a detailed radar analysis of the event, utilizing some of the new tools available for operational forecasters this past warm season. Those tools include the Four -Dimensional Stormcell Investigator and GR2Analyst software. Traditional base and derived radar products will also be shown. The storm-scale analysis will focus on helpful techniques to determine what produced the copious hail reports.

A Diagnostic Analysis of a Difficult-to-Forecast Cutoff Cyclone from the 2008 Warm Season

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Forecasting both heavy precipitation and severe weather associated with slow-moving 500 hPa cutoff cyclones can be challenging during the warm season. Models often have trouble predicting the evolution of cutoff cyclones and forecasting accurate precipitation amounts. Short-wave troughs and associated vorticity maxima are observed to rotate around the center of these cyclones. The forecast challenge is to predict the timing of short-wave troughs and vorticity maxima, along with the thermodynamic environment these features will encounter. The 2008 warm season over the Northeast was an active cutoff season. This study takes a close look at the 22–25 July 2008 cutoff cyclone that was challenging to forecast.

The 0.5° GFS analyses were used as the basis for the case study. In addition, climatologies were created using the 6-h 2.5° NCEP–NCAR reanalysis by computing monthly averaged data for 1992–2007. This period is felt to be long enough to establish accurate means and standard deviations. Standardized anomalies of the 0.5° GFS analyses were computed for parameters such as 700–500 hPa lapse rates, 925–700 hPa wind shear, 850 hPa jet strength, and precipitable water. Other sources of data used in this study include soundings, radar, and surface observations. Precipitation plots were created from 6-h analyses obtained from the NWS National Precipitation Verification Unit.

The 22–25 July 2008 cutoff cyclone developed from a preexisting trough over eastern Canada. An elongated upstream 500 hPa vorticity lobe and associated cyclonic vorticity advection contributed significantly to severe weather, as did surface boundaries and +2 to +3 standard deviation (SD) 925–700 hPa vertical wind shear. Its +2 to +3 SD precipitable water anomalies yielded flash flooding and widespread rain amounts of 7–9 cm. Severe weather on 24 July, including two tornadoes, was also associated with low-level θ_e advection and a +4 to +5 SD 850 hPa jet. These features contributed to the rapid transport of moisture from the Gulf of Mexico and western North Atlantic and to the convergence of moisture over the Northeast.

A High-Resolution Climatology and Composite Study of Mesoscale Band Evolution within Northeast U.S. Cyclones

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Intense precipitation bands are frequently observed in the comma-head sector of extratropical cyclones. Although previous climatologies over the northeast U.S. have established that these bands are favored during the development of a closed midlevel low, many cyclones with closed midlevel lows fail to produce bands. In addition, limited observations and coarse resolution analyses have prohibited the description of the mesoscale forcing and stability evolution during band life cycle. This study utilizes hourly 20-km Rapid Update Cycle analyses and 2-km composite radar data to explore the mesoscale forcing and stability evolution during banded events. The study also explores how the mesoscale forcing and stability evolution differ between cyclones with closed midlevel circulations that develop bands and those that do not.

Fifty-six heavy precipitation cases with a 700-hPa low over the northeast U.S. were identified during five cold seasons (Oct–Apr). Twenty-seven single-banded events were observed in the comma-head in 23 of the heavy precipitation cases (three cases exhibited multiple events). The remaining 33 cases exhibited a 700-hPa low, but failed to develop a single band in the comma-head. Nineteen of these 33 cases were considered pure null events, exhibiting an absence of single-banded or even transitory banded features. Composites were created for the 27 banded and 19 null events, with analysis focused on the frontogenesis and stability evolution.

The results reveal a common band life cycle, which is marked by small conditional stability and increasing frontogenesis during band formation, and large conditional stability and diminishing frontogenesis during band dissipation. The composite band develops as forcing for ascent increases along a mesoscale trough that extends poleward of the 700-hPa low. This trough is a reflection of the development of a midlevel thermal ridge (the trowal). Band dissipation occurs as deformation weakens, associated with larger height falls occurring to the east of the midlevel trough. Many null events also exhibit midlevel trough formation and associated forcing for ascent; however, the mean null event frontogenesis was only half the magnitude of the mean banded event frontogenesis. Banded cyclones are deeper and exhibit a stronger temperature gradient and deformation maximum than the null cyclones, resulting in faster growth of frontogenesis. The stability was similar between composites, highlighting that the primary discriminator between banded and null events is the strength of the midlevel frontogenesis. Predictability implications of these results will be presented at the workshop.

The 2008 "PRE-Season" In Review: A Comparison of Tropical Cyclones Fay, Hanna, and Ike with Regards to Predecessor Rainfall Event (PRE) Development

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PREs are coherent areas of heavy rainfall that develop in advance of tropical cyclones (TC). Although rainfall associated with PREs occurs separately from the main precipitation shields of a TC, there is a relationship between the PRE and their parent TC. On average, one out of every three TC that make landfall along the Atlantic or Gulf coastal regions of the United States has at least one associated PRE.(Cote, et. al, 2007). Since attention is often focused on regions more directly affected by the TC, a PRE can create significant runoff problems for areas where flooding is not initially expected.

This presentation will look at three TCs from the 2008 season in the Atlantic Basin. Tropical Storm Fay made landfall in the Florida Keys in August, and Hurricanes Hanna and Ike affected the Eastern Seaboard and Gulf Coastal regions, respectively, during September. For each of these TC, PRE development, if any, will be examined. Factors which enhanced, or discouraged PRE formation will also be discussed.

Use of the Nondivergent Wind for Diagnosing Banded Precipitation Systems

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Mesoscale bands modulate the spatial distribution and intensity of precipitation associated with cyclones. Cold-season examples include snowbands within coastal extratropical cyclones, and warm-season examples include rainbands along coastal fronts associated with landfalling and transitioning tropical cyclones. Previous work has shown that for cold-season coastal cyclones, mesoscale band formation occurs in conjunction with deep-layer frontogenesis that slopes toward colder air. The mesoscale band forms on the warm-air side of the frontogenesis maximum in the presence of weak moist symmetric stability. In this presentation, we will compare diagnostic signatures of vertical motion forcing, frontogenesis, and moist symmetric stability for mesoscale precipitation bands within the northeast U.S. cyclones of 14 February and 16 April 2007 using the nondivergent wind ($\mathbf{V}_{nd}$), geostrophic wind ($\mathbf{V}_g$), and full wind ($\mathbf{V}$) in a balanced dynamical framework. The diagnostics considered here are $\mathbf{Q}$ divergence, Petterssen frontogenesis, and saturation equivalent potential vorticity (EPV*).

The purpose of this presentation is to extend the applicability of the balanced framework in diagnosing mesoscale circulation systems by using $\mathbf{V}_{nd}$ in place of $\mathbf{V}_g$ and $\mathbf{V}$. The rationale for considering $\mathbf{V}_{nd}$ is that it is expected to better represent the balanced wind in curved flow than $\mathbf{V}_g$ or $\mathbf{V}$. Use of $\mathbf{V}_{nd}$ is further motivated by continuing increases in the horizontal and vertical resolution of global analyses. While increases in analysis resolution have resulted in the improved representation of mesoscale circulation systems, these increases also have resulted in noisier diagnostic signatures of mesoscale circulation systems using $\mathbf{V}_g$ and $\mathbf{V}$. Use of $\mathbf{V}_{nd}$ in a balanced dynamical framework is hypothesized to produce cleaner and more coherent diagnostic signatures of mesoscale circulation systems than $\mathbf{V}_g$ and $\mathbf{V}$.

The results show that using $\mathbf{V}_{nd}$ in place of $\mathbf{V}_g$ and $\mathbf{V}$ produces improved diagnostic signatures of $\mathbf{Q}$ divergence, Petterssen frontogenesis, and EPV* within banded precipitation systems for the northeast U.S. cyclones of 14 February and 16 April 2007. The improved diagnostic signatures for these two cases agree with previous work on mesoscale band formation, indicating the band forms on the warm-air side of a deep-layer frontogenesis maximum that slopes toward colder air in the presence of weak moist symmetric stability. In particular, the use of $\mathbf{V}_{nd}$ in the EPV* calculation minimizes the spatial extent of EPV* < 0 and the occurrence of localized regions of EPV* $\ll 0$. It is suggested that this modification to the EPV* calculation produces a more accurate assessment of the contribution of conditional symmetric instability to the formation and evolution of mesoscale precipitation bands.

A Climatology of High Lapse Rates and Associated Synoptic-Scale Flow Patterns over North America and the Northeast US

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Atmospheric instability, in the presence of low-level moisture and forcing for ascent, has been demonstrated as an important ingredient when forecasting the development of deep, moist convection (DMC). This instability can be produced by the superposition of elevated high lapse rates (e.g. diabatically-induced mixed layers generated over an elevated semi-arid source region and/or dynamical-driven processes associated with upper-level troughs and jet streaks) above a region of low-level warm, moist air. Given that instability is an important ingredient to the development of DMC, the purpose of this presentation is two-fold: (1) establish an annual and seasonal climatology of high lapse rates over North America and (2) examine regional and synoptic-scale composite flow patterns associated with occurrences of high lapse rates over North America with an emphasis on the Northeast US.

The lapse rate climatology was generated using the North American radiosonde network archive at the National Climatic Data Center from 1974–2007. The filtering of radiosonde observations counted the occurrence of high lapse rates when the 700–500-hPa lapse rate was $\geq$ 8.0 K km^{-1}. The climatology was restricted to radiosonde observations taken during the time period 1000–1400 UTC to avoid data contamination by the presence of DMC as much as possible. Synoptic-scale flow pattern composites were generated using the NCEP-NCAR Reanalysis at stations for days meeting the high lapse rate threshold and were stratified by representative mean 700–500-hPa potential temperatures.

Results highlight a warm-season maximum in high lapse rates over the Intermountain West that expands poleward during March through August, and extends eastward over the southern Great Plains during March through May and east over the Northern Great Plains and Ohio Valley region during June through August. A cold-season maximum in high lapse rates over the Gulf of Alaska region expands equatorward along the Rocky Mountains and extends eastward across the Canadian and US Plains from November through March. The eastward extension of high lapse rates into the Northeast during the warm season is likely associated with the advection of high lapse rates poleward of the climatological summer-time upper-level anticyclone with an origin over the Intermountain West, while the cold-season extension is likely associated with the evolution of high lapse rates beneath migratory cold upper-level troughs.

Here a TC, There a TC, Everywhere a TC: The "Spin" on the Active Part of the North Atlantic 2008 TC Season

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During mid-August through mid-September 2008 six tropical cyclones (TCs), Fay, Gustav, Hanna, Ike, Josephine, and Kyle, formed over the North Atlantic Ocean and threatened coastal regions of the United States. Fay, Gustav, Hanna, and Ike made coastal landfalls in the United States, while Kyle made landfall over Atlantic Canada. Josephine never reached hurricane status and eventually died over the North Atlantic. A distinguishing feature of this concentrated period of North Atlantic TC activity was the apparent multiple interactions between individual storms and their associated outflow anticyclones. Also of interest was the reinforcement of the potentially warm upper-level outflow anticyclone from Ike by a similar potentially warm upper-level anticyclone from eastern North Pacific TC Lowell.

The purpose of this presentation is twofold. First, the structure of the large-scale environment that governed a very active part of the 2008 North Atlantic TC season will be reviewed with emphasis on the mutual interactions between individual TCs and associated storm-track predictability issues. Second, the precipitation characteristics of selected storms will be discussed and reviewed with emphasis on the predecessor rain event (PRE) over the Chicago area associated with Ike, the "pseudo" PRE that formed in association with Hanna and moved through the Albany area, and the role of surface boundaries as a focus of heavy rainfall.

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