Death by 1000 Cuts?

by

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Numerous minor precipitation events (< 5 mm) can occur over the northeastern US during the cool season in association with the passage of weak synoptic and subsynoptic disturbances aloft. Many of these minor events can turn into big nuisance events when frozen precipitation occurs, especially during the morning and evening rush hour. Additionally, the forecasting of minor precipitation events (amount, onset time, duration, ending time) presents a big challenge because model uncertainty is apt to be especially large in these situations.

This talk will highlight several examples of troublesome minor precipitation events. A dynamic tropopause (DT)/potential vorticity (PV) perspective will be used for this purpose. It will be demonstrated that it is possible to use DT maps to locate and track small-scale PV anomalies that can be associated with minor precipitation events.
A Climatology of 500 hPa Cutoff Cyclones

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ABSTRACT

Cutoff cyclones are associated with many significant forecasting problems in the northeastern United States. Given the complex terrain in the Northeast, the precipitation distribution associated with slow-moving cutoff cyclones is often a challenge to predict. As an initial step toward addressing this challenge, we present the results of a 46-year climatology of 500 hPa cutoff cyclones in order to map the spatial and temporal distributions of these events. This task is accomplished by using twice daily (0000 and 1200 UTC) 500 hPa gridded geopotential height analyses from the National Centers for Environmental Prediction /National Center for Atmospheric Research (NCEP/NCAR) reanalysis dataset.

Cutoff cyclones are identified through an objective analysis technique. For our purposes, a cutoff cyclone is defined as a minimum geopotential height center surrounded by at least one closed 30 m height contour. Cutoffs are identified and catalogued and cyclone tracks are determined to delineate favored areas for genesis/lysis and to locate “cutoff freeways.” Frequency diagrams showing total number of cutoff cyclones and number of “cutoff 12 h periods” are presented for the Northern and Southern Hemispheres and for eastern North America. Also shown are maps of seasonal mean frequency and standard deviation of cutoff cyclone events for the same geographical regions.

In-progress and future work includes correlating favorable areas of cutoff events with significant large-scale circulation features such as mean jet stream positions and teleconnection indices such as the North Atlantic Oscillation. Our cutoff climatology will also be used in conjunction with the Unified Precipitation Dataset (UPD) to map precipitation distributions in cutoff cyclones over the northeastern United States.
Large-Scale Circulation Anomaly Indices in Relation to Cool-Season Precipitation Events in the Northeastern United States

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Interest in relationships between large-scale circulation anomaly indices, such as the North Atlantic Oscillation (NAO), Pacific-North American (PNA) pattern, and Southern Oscillation Index (SOI), and regional to local precipitation anomalies over the northeastern United States calls for compilation of daily time series of these large-scale circulation anomaly indices. The rationale for using daily as opposed to monthly values of large-scale circulation anomaly indices is to better understand the evolution of individual cyclone structure and life cycles in relation to changing large-scale circulation regimes. The first goal of this project is to calculate a daily NAO index from 1948 to the present. Future goals include calculation of daily time series for the PNA and SOI. Upon completing each time series, relationships will be determined between these indices and planetary-scale flow signatures crucial to cool season precipitation events associated with extratropical cyclones in the northeastern United States.

A calculation of the daily NAO index from 1948 to the present is shown. The differences of normalized sea-level pressure (SLP) and 500 hPa heights between Stykkisholmur, Iceland (65°05'N, 22°44'W) and Ponta Delgada, Azores (37°45'N, 25°40'W) are used to determine the daily NAO index. These daily values are averaged over one-month periods and compared to monthly NAO values as compiled by Hurrell (2001). Results will be shown in the form of an NAO timeline for comparison to corresponding large-scale SLP and 500 hPa plots. Future research will focus on the downscale effects of large-scale circulation anomalies on the occurrence of cutoff lows and mesoscale substructures in extratropical cyclones over the Northeast.
The End of the Millennium Snowstorm: A Brief Synoptic Review with an Emphasis on the role of Jet Streaks

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On 30-31 December 2000, a major snowstorm struck the Northeast, dropping copious amounts of snowfall over the region. This major nor'easter produced widespread snowfall accumulations of 25 cm (10 inches) and greater across eastern New York, New Jersey, the extreme eastern border of Pennsylvania and adjacent New England in 10 to 15 hours. Portions of the eastern Catskills and northern New Jersey received 50 to 75 cm (20 to 30 inches) of snow from the storm. Many daily snowfall records were set in the Northeast. Little or no snow fell across most of Pennsylvania, Delaware and Maryland. The major cities such as Trenton, Newark, New York City, Albany and Hartford were hit hard. Snowfall rates of 5 cm to 7.5 cm (2 to 3 inches) per hour were common with the storm north and west of the area of low pressure. Near-blizzard conditions occurred at times with high winds in excess of 15 to 20 m/s (30 to 40 knots). The storm wreaked havoc on travelers on the last weekend before the dawn of a new millennium. This talk will examine how the synoptic-scale features (e.g.: jets, vorticity advection, etc.) evolved in the rapid development of this system.

The synoptic situation at 0000Z/30 featured an area of low pressure (1012 hPa) moving eastward through eastern Ohio, while a second low was situated 250-300 km southeast of North Carolina. By 0600Z/30, a new coastal low of 1004 hPa had formed (much further north than anticipated by forecasters) near the Delmarva Peninsula. By 1200Z/30, this surface low was about 200 km southeast of Atlantic City, and heavy snow began falling across most of northern New Jersey and the New York City metropolitan area. By 1500Z/30, heavy snow was falling along the east facing slopes of the Catskills and was pushing rapidly north into the greater Capital Region and western New England. The surface low (995 hPa) moved over New York City by 1800Z/30 and then progressed rapidly to the northeast to the Connecticut-Rhode Island border (992 hPa) at 0000Z/31. This strong surface cyclone developed due to a powerful 500 hPa low that barreled southeastward through the Midwest and into the Mid-Atlantic states on the morning of 30 December.

The role of upper and lower level jets and their evolution will be investigated from a synoptic point of view to gain an understanding why so much snow fell in a short duration of time. In addition, surface observations will be examined to help explain any local enhancements or inhibitions to snowfall totals. AVN model grids, surface weather observations, upper air data, satellite images and vertical cross sections will be used in the analysis of this major storm which ended the millennium.
A Climatology of Cold Season Banded Precipitation in the Northeast United States

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ABSTRACT

A climatology of banded precipitation events in the northeast U.S. during the cold season (October through April) is presented. Precipitation systems in the northeast U.S. which exhibited greater than 1.00" of rainfall, or 0.50" liquid equivalent were identified as cases for study using the Unified Precipitation Dataset (UPD). Composite radar data from these cases were viewed to develop a band classification scheme. This scheme was then applied to cases from November 1996 through April 2001. Out of the 112 cases identified during this period, 89 cases had complete radar coverage. Examination of these 89 cases revealed that 36 exhibited single banded structure at least once during their evolution, 29 multibanded structure, 30 narrow cold-frontal structure, 32 transitory or undefined structure, and 13 exhibited no defined banding. Note that many cases had more than one type of banded structure during their duration. Further investigation of the single band events highlighted banded structure in the comma head portion of storms, with nearly 70% of the bands exhibiting some portion of their length in the northwest quadrant of the surface cyclone.