2. Data and Methodology

2.1 Data Sources

Thunderstorm and high-wind reports (instances when the surface wind speed measured ≥ 25 m s^{-1} or when the surface wind caused damage) were extracted from the NCDC *Storm Data* publication for 15 October 1993 through 31 December 2008 for the cool-season months (defined here as October through April). Cloud-to-ground lightning flash reports observed by the National Lightning Detection Network (NLDN; Orville 1991; Idone et al. 1998a,b) were used to verify that gradient wind reports were not associated with thunderstorms.

Composite averages of wind, vertical motion, temperature, relative humidity, and geopotential height were calculated on isobaric surfaces using the four times daily (0000, 0600, 1200, and 1800 UTC) 2.5° × 2.5° National Centers for Environmental Prediction–National Center for Atmospheric Research (NCEP–NCAR) 40-Year Reanalysis (Kalnay et al. 1996). Derived variables, such as 0–6-km shear, equivalent potential temperature, and 1000–500-hPa thickness, were calculated using the composited state variables listed above. Composite averages of mean sea level pressure, precipitable water (i.e., the total column water vapor), and lifted index were also calculated.

Case studies were analyzed using the NCDC thunderstorm and high-wind reports, NLDN cloud-to-ground lightning flash reports, 1.0° × 1.0° NCEP Global Forecast System (GFS) 6-hourly analyses, 20-km Rapid Update Cycle (RUC) hourly analyses (Benjamin et al. 2002), composite National Operational Weather radar reflectivity (NOWrad) imagery (obtained from the University Corporation for Atmospheric Research and the WSI Corporation), radiosonde data, and hourly Automated Surface Observing System (ASOS) observations (obtained from the University at Albany).

2.2 Methodology

2.2.1 Climatology

Thunderstorm and high-wind reports from the greater Northeast (GNE) and the NE form the basis of the climatology (Fig. 2.1). The time of each report was converted to UTC and each report was assigned latitude and longitude values corresponding to the centroid of the public forecast zone within which the report occurred (http://www.weather.gov/geodata/catalog/wsom/html/pubzone.htm). Thunderstorm wind reports were typically associated with a single location or public forecast zone, whereas gradient wind reports were typically associated with multiple public forecast zones. For any high-wind report that was listed as affecting multiple public forecast zones, a new high-wind report was added for every public forecast zone listed in the original high-wind report. Reports whose locations did not correspond to a public forecast zone were assigned the latitude and longitude values of the corresponding county (http://www.weather.gov/geodata/catalog/wsom/html/cntyzone.htm), city, or town centroid (http://www.weather.gov/geodata/catalog/national/html/cities.htm). If a report could not be assigned latitude and longitude values, the location was checked manually using the NCDC online database. Ultimately, 28 867 reports were examined for the GNE and 11 394 reports for the NE. Of the 28 867 reports examined, 315 reports could not be assigned latitude and longitude values.

Observed spatial frequency maps of high-wind days were calculated by overlaying a 0.5° × 0.5° grid over the GNE domain and, for each grid point, counting the number of days when a high-wind report occurred within a 0.5° × 0.5° box surrounding the grid point. The value at each grid point was divided by the number of days from 15 October 1993 through 31 December 2008 and multiplied by 100. The resulting value in each grid point represents the percentage of days during the cool season from 15 October 1993 through 31 December 2008 that severe high wind occurred. The resulting grid was then contoured using the General Meteorological Package (GEMPAK; DesJardins et al. 1991).

The high-wind reports from the NE were stratified into events. An event was defined as any series of greater than or equal to two storm reports separated by less than or equal to 12 h. The events were then categorized based upon the type of reports that constitute the series. If an event consisted of only gradient or thunderstorm wind reports, the event was considered a pure gradient or a pure convective event, respectively. If an event consisted of both thunderstorm and gradient wind reports, the event was considered a hybrid event. To ensure that pure gradient events were not associated with thunderstorms, the gradient wind reports that constitute each pure gradient event were checked to see if a cloud-to-ground lightning flash report occurred at less than or equal to 1° radial distance and 1 h. If a cloud-to-ground lightning flash report did occur at less than or equal to 1° radial distance and 1 h of a gradient wind report, the pure gradient event to which that report belonged was considered a hybrid event.

2.2.2 Composite analysis

The pure gradient and hybrid events were subjectively divided into four subcategories (northeast, northwest, southwest, and southeast) based upon where the initial NE report occurred relative to the center of each event's respective surface cyclone. The pure gradient and hybrid events were subcategorized in this way for the following reasons: 1) the pure gradient and hybrid events were almost exclusively associated with surface cyclones; 2) the location of an initial NE report relative to the center of a surface cyclone is simple to determine; and 3) we hypothesize that stratifying the pure gradient and hybrid events based upon the location of the initial NE report relative to the center of a surface cyclone will isolate the mechanisms responsible for the production of high winds in each quadrant of a surface cyclone. Because a visual inspection of the pure convective events revealed that they are typically associated with either an upper-tropospheric trough or ridge, the pure convective events were subjectively divided into two subcategories based upon whether a 300-hPa trough or ridge was present in the vicinity of the initial NE report. For each of the resulting 10 subcategories, composites were calculated in a report-relative framework, that is, the NCEP–NCAR analysis for each event was shifted to the average location of the initial NE reports. For each event, the analysis time (0000, 0600, 1200, or 1800 UTC) closest to the time of the initial NE report, which is defined as the first report that occurred in the NE and had been successfully assigned latitude and longitude values, was used for the composites. For initial NE reports that occurred at the midpoint between two analysis times, the earlier analysis time was chosen.

2.2.3 Case studies

The 17 February 2006 and 15 April 2007 high-wind events were chosen as case studies because they caused extensive damage in the NE, they are representative of the composite analyses, and they more clearly illustrate the mechanisms responsible for the production of high winds than the composite analyses. The case studies will focus on identifying features and processes, as highlighted in Chapter 1, associated with high winds. Storm reports and observed hourly surface wind gusts will be used to determine where the strongest surface winds occurred.

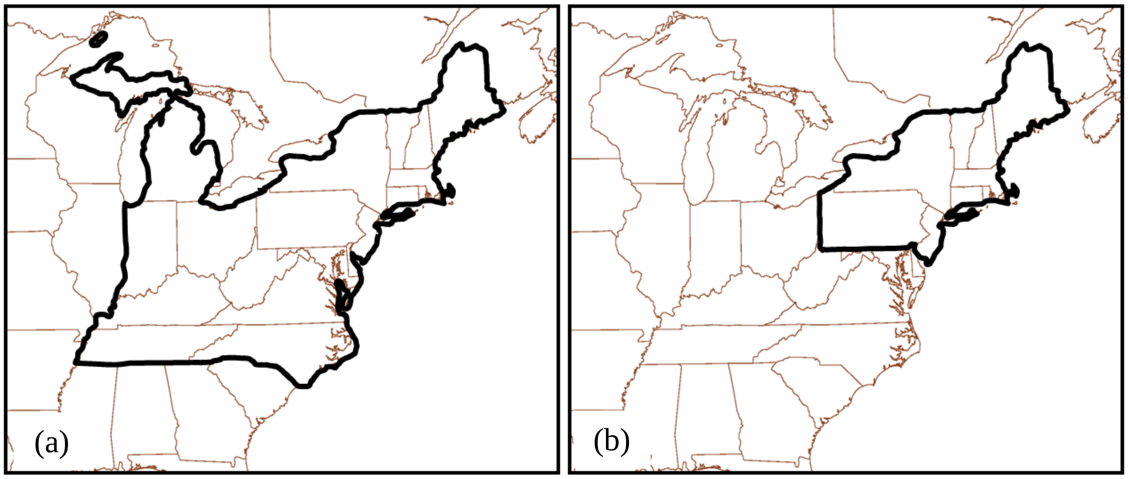

Fig. 2.1. (a) Greater Northeast (GNE) and (b) Northeast (NE) domains.