Extratropical Cyclones leading to Extreme Weather Events over Central and Eastern North America

Alicia M. Bentley, Lance F. Bosart, and Daniel Keyser
Department of Atmospheric and Environmental Sciences
University at Albany, State University of New York, Albany, NY 12222

Cool-season extreme weather events (EWEs) occurring over central and eastern North America are typically associated with strong extratropical cyclones (ECs) that are governed by varying combinations of baroclinic, diabatic, and barotropic processes. The opportunity to investigate the ways in which baroclinic, diabatic, and barotropic processes evolve and combine to produce ECs leading to EWEs motivates this study. A 1979–2016 climatology of ECs leading to EWEs over central and eastern North America constructed using the 0.5° NCEP Climate Forecast System Reanalysis reveals that ECs leading to EWEs typically form: 1) in the lee of the Rocky Mountains, 2) over the south central United States, and 3) along the east coast of North America. Metrics representing baroclinic, diabatic, and barotropic processes are calculated as regional averages of their corresponding Lorenz (1955) energy generation and conversion terms during the evolution of ECs included in the 1979–2016 climatology. These metrics reveal that contributions from baroclinic, diabatic, and barotropic processes are significantly larger during the evolution of ECs leading to EWEs than during the evolution of ordinary ECs.

The 1979–2016 climatology of ECs leading to EWEs over central and eastern North America will be used to examine baroclinic, diabatic, and barotropic processes occurring during the evolution of ECs leading to EWEs that form: 1) in the lee of the Rocky Mountains, 2) over the south central United States, and 3) along the east coast of North America. A cyclone-relative composite analysis performed on ECs leading to EWEs that form in these three regions will be presented to document the spatial distribution and temporal evolution of the metrics representing baroclinic, diabatic, and barotropic processes. Case studies of ECs leading to EWEs that are representative of ECs forming in these three regions, specifically the “Midwest Cyclone” of November 1998 (MC98), “Superstorm” of March 1993 (SS93), and “East Coast Cyclone” of February 2014 (EC14), will be presented to complement the results of the cyclone-relative composite analysis. The metrics representing baroclinic, diabatic, and barotropic processes associated with MC98, SS93, and EC14 will be calculated and placed within the context of a three-dimensional phase space in order to determine the significance of these respective ECs relative to the 1979–2016 climatology.