A multi-scale analysis of widespread long-duration freezing rain events over North America

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Freezing rain can have devastating impacts, particularly when it persists for many hours. Predicting the precise temperature stratification necessary for freezing rain to persist remains an important forecast challenge. To better elucidate the conditions responsible for the most severe impacts, we concentrate on surface observations of long-duration (6 or more hours) freezing rain events over North America from 1979-2015. Furthermore, we analyze cases in which multiple stations observe long-duration events simultaneously. Following these cases over successive days allows us to generate maps of freezing rain “tracks.” We then categorize recurring geographic patterns to examine the conditions leading to these events.

The climatology of long-duration freezing rain events is largely controlled by a combination of synoptic regimes in conjunction with local terrain effects, which help to maintain or replenish cold air at the surface. Long-duration events occur most frequently from Southeastern Canada into the Northeastern United States. However, the South Central United States has observed a disproportionately large number of very long duration (18 or more hours) events, relative to their climatological frequency, during our period of study. Classification of individual events highlights a recurring pattern with freezing rain falling over a broad southwest-northeast swath from Texas/Oklahoma into the Northeastern U.S. and Eastern Canada. Storms classified within this pattern include the January 1998 and December 2013 ice storms that heavily impacted Eastern Canada as well as the January and December 2007 storms which produced the most severe damage over the South Central and Midwestern U.S. During these cases, freezing rain falls within a frontogenetic deformation zone situated between a weak cyclone in the lee of the Rocky Mountains, an Arctic anticyclone over the Northern Plains states, and another anticyclone located off the Southeastern U.S. Atlantic coast. Freezing rain is able to persist for many hours over the South Central states as surface cold air is constantly replenished by northerly flow from the Arctic anticyclone, while the above-freezing inversion layer aloft is maintained as warm, moist southerly flow from the Gulf of Mexico overruns this cold surface air. The combination of the large geographic extent and particularly long durations associated with these events make them especially impactful. Through an analysis of the planetary-, synoptic-, and mesoscale patterns associated with these cases, as well as the differences among individual storms, we hope to provide forecasters with additional tools/insight to help predict these potentially-damaging weather events.