

Rainfall Organization and Atmospheric Conditions of Heavy Precipitation in the Northeastern United States

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Although the basic ingredients to produce heavy precipitation are universal, the local concatenation of these ingredients – manifested in the dominant patterns of rainfall organization – appears to differ from one region to another. To investigate how heavy precipitation is organized differently in the northeastern United States as compared to the more extensively studied midwestern U.S., we examined 196 events in the northeastern U.S. during the warm seasons of the years 2003-2007. Events were selected from flash flood reports in NOAA's Storm Data publication. To focus on mid-latitude processes, events due to named tropical systems and their remnants were excluded. We classified the events based on the patterns of rainfall as exhibited in radar reflectivity and diagnosed their atmospheric conditions using the North American Regional Reanalysis and surface and upper air observations.

The dominant rainfall patterns for the events in this study exhibit a dichotomy between strongly and weakly organized events. The mode of rainfall organization that occurred most frequently was that of back-building precipitation, in which precipitation was sustained by the regeneration of convection lifted by storm-scale cold outflow. This pattern typically produced higher basin-scale rainfall accumulations than the other common modes of convection identified in this study. A subset of back-building events exhibited a common pattern of back-building cells which remained quasi-stationary as a convective line of precipitation approached. This category included several of the highest estimated precipitation totals, and its signature is significant for real-time forecasting applications, as the key components are often in place before the sustained heavy precipitation develops and hence may provide the opportunity for early warning.

In contrast to the organized back-building events, the second most common precipitation pattern was that of scattered precipitation, often peppered within the warm sector of a mid-latitude cyclone. Heavy precipitation under this scenario was a result of several of these scattered cells or lines of convection traversing the same area, either via uni-directional training or multi-directional random motion. These events often lacked a prevalent synoptic or mesoscale forcing mechanism to focus the precipitation, so the means of organization for these events were more subtle. This high frequency of weakly organized events appears to distinguish the northeastern U.S. from the midwestern U.S., where more organized mesoscale convective systems are the dominant mode of heavy precipitation.