Freezing rain can have severe impacts, from dangerous road conditions to tree and power line damage leading to long-lasting power outages. Because of its typically light intensity, the severity of a freezing rain event is closely related to its duration. Predicting the maintenance of the precise vertical temperature profile necessary for freezing rain remains a major forecast challenge. In this presentation, we examine freezing rain events over the United States and Canada using surface and upper-air observations from 1979–2016. Upon identifying events at 579 surface stations, we perform a comparison of the conditions that have produced long-duration (6 or more hours of freezing rain) events with those that have led to less-severe short-duration (3 or fewer hours) events. We identify statistically significant, regionally coherent differences between the two event types, with a focus on three geographic regions.

Long-duration events occur most frequently in the northeastern United States and southeastern Canada, primarily the result of a common wintertime storm track that brings cyclones and their associated warm fronts over the Great Lakes region. Long-duration events there, compared with short-duration events, exhibit a significantly stronger surface anticyclone to the north of the region at event onset. This anticyclone serves as a nearby source of low-level cold air that sustains the surface-based cold layer necessary for freezing rain. In the southeastern United States, freezing rain is typically associated with Appalachian cold-air damming (CAD), with stronger and more persistent CAD leading to longer-duration events. In particular, long-duration events exhibit a stronger surface anticyclone supported by a deeper downstream 500-hPa trough compared with short-duration events. Finally, while event duration in the two aforementioned regions is primarily dependent on conditions in the surface-based cold layer, duration in the South Central United States is particularly sensitive to upper-level flow patterns that influence the evolution of the warm layer aloft. Long-duration events there occur with a positively tilted 500-hPa trough over the southwestern United States and a deep ridge over eastern North America, with southerly flow transporting warm, moist air from the Gulf of Mexico into the warm layer. Short-duration events involve a more transient trough and rapid warm layer erosion as the trough axis passes. Through an improved understanding of the conditions leading to persistent freezing rain, we hope to provide forecasters with additional information to help them better predict these potentially damaging events.