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Hail Day Frequency Trends and Associated Atmospheric Circulation Patterns over China during 1960–2012

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Based on a comprehensive collection of hail observations and the NCEP–NCAR reanalyses from 1960 to 2012, the long-term trends of hail day frequency in mainland China and the associated changes in atmospheric circulation patterns were analyzed. There was no detectable trend in hail frequency from 1960 to the early 1980s, but a significant decreasing trend was apparent in later periods throughout most of China and in particular over the Tibetan Plateau from the early 1980s and over northern and northwestern China from the early 1990s. Hail frequency in southern China did not decrease as significantly as in other regions over the last couple of decades. An objective classification method, the obliquely rotated T-mode principal component technique, was used to investigate atmospheric circulation patterns. It was found that 51.85% of the hail days occurred during two major circulation types, both of which were associated with cold frontal systems in northern China. More specifically, the synoptic trough in East Asia, signified by the meridional circulation at 850 hPa, became considerably weaker after 1990. This change in the synoptic pattern is consistent with a weakening trend in the East Asian summer monsoon, the primary dynamic forcing of moisture transport that contributes to the generation of severe convection in northern China. The long-term variability of hail day frequency over the Tibetan Plateau was more strongly correlated with the change in mean freezing-level height (FLH) than the strength of the East Asian monsoon.