Spatiotemporal Changes in Precipitation Extremes over Canada and Their Teleconnections to Large-Scale Climate Patterns

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In the past few decades, there have been more extreme climate events occurring worldwide, including Canada, which has also suffered from many extreme precipitation events. In this paper, trend analysis, probability distribution functions, principal component analysis, and wavelet analysis were used to investigate the spatial and temporal patterns of extreme precipitation events of Canada. Ten extreme precipitation indices were calculated using long-term daily precipitation data (1950–2012) from 164 Canadian gauging stations. Several large-scale climate patterns such as El Niño–Southern Oscillation (ENSO), Pacific decadal oscillation (PDO), Pacific–North American (PNA), and North Atlantic Oscillation (NAO) were selected to analyze the relationships between extreme precipitation and climate indices. Convective available potential energy (CAPE), specific humidity, and surface temperature were employed to investigate potential causes of trends in extreme precipitation. The results reveal statistically significant positive trends for most extreme precipitation indices, which means that extreme precipitation of Canada has generally become more severe since the mid-twentieth century. The majority of indices display more increasing trends along the southern border of Canada while decreasing trends dominated the central Canadian Prairies. In addition, strong teleconnections are found between extreme precipitation and climate indices, but the effects of climate patterns differ from region to region. Furthermore, complex interactions of climate patterns with synoptic atmospheric circulations can also affect precipitation variability, and changes to the summer and winter extreme precipitation could be explained more by the thermodynamic impact and the combined thermodynamic and dynamic effects, respectively. The seasonal CAPE, specific humidity, and temperature are correlated to Canadian extreme precipitation, but the correlations are season dependent, which could be positive or negative.

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