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Key Points:

- U.S. warm-West/cool-East dipole events associated with large circulation anomalies across the Northern Hemisphere mid-latitudes
- Historical increase in dipole events linked to increasing frequency of events when associated circulation patterns occur
- Positive trend in dipole events attributable to historical anthropogenic warming, though future warming is likely to reverse trend

Supporting Information:

- Supporting Information S1

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Recent amplification of the North American winter temperature dipole

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Abstract During the winters of 2013–2014 and 2014–2015, anomalously warm temperatures in western North America and anomalously cool temperatures in eastern North America resulted in substantial human and environmental impacts. Motivated by the impacts of these concurrent temperature extremes and the intrinsic atmospheric linkage between weather conditions in the western and eastern United States, we investigate the occurrence of concurrent "warm-West/cool-East" surface temperature anomalies, which we call the "North American winter temperature dipole." We find that, historically, warm-West/cool-East dipole conditions have been associated with anomalous mid-tropospheric ridging over western North America and downstream troughing over eastern North America. We also find that the occurrence and severity of warm-West/cool-East events have increased significantly between 1980 and 2015, driven largely by an increase in the frequency with which high-amplitude "ridge-trough" wave patterns result in simultaneous severe temperature conditions in both the West and East. Using a large single-model ensemble of climate simulations, we show that the observed positive trend in the warm-West/cool-East events is attributable to historical anthropogenic emissions including greenhouse gases, but that the co-occurrence of extreme western warmth and eastern cold will likely decrease in the future as winter temperatures warm dramatically across the continent, thereby reducing the occurrence of severely cold conditions in the East. Although our analysis is focused on one particular region, our analysis framework is generally transferable to the physical conditions shaping different types of extreme events around the globe.

1. Introduction

Simultaneous occurrence of extreme climate events in adjacent regions can exacerbate impacts on the economy, natural resources, and emergency services. Understanding the causes of such extremes can inform disaster preparation, early warning, and risk management systems.

The winters of 2013–2014 and 2014–2015 were characterized by severe meteorological events that had wide-ranging impacts across sectors in North America [*NOAA*, 2015]. Much of the western U.S. experienced exceptionally warm and dry conditions that aggravated the region's extraordinary multi-year drought [*Diffenbaugh et al.*, 2015]. Persistent warm temperatures [*Griffin and Anchukaitis*, 2014] were accompanied by record-low soil moisture and mountain snowpack, increasing wildfire risk [*Yoon et al.*, 2015] and reducing water availability for agriculture, ecosystems, and urban areas. The central and eastern U.S., meanwhile, experienced frequent cold Arctic air outbreaks and intense winter storms. Associated heavy snowfalls and blizzard conditions crippled transportation infrastructure and disrupted the economies of several major American cities, particularly along the Eastern Seaboard [*Bacon*, 2015]. Insured losses in the 2014–2015 winter amounted to 2.4 billion USD, double the average of the last decade [*Yoon et al.*, 2015].

These contrasting "warm-West/cool-East" conditions have been linked by a well-defined pattern of anomalous atmospheric circulation extending over a large portion of the Northern Hemisphere mid-latitudes [*S.-Y. Wang et al.*, 2015]. Land-sea contrasts and the mountainous topography of the western U.S. influence the position and amplitude of the climatological mid-tropospheric wave pattern, which in winter exhibits a mean ridge along the West Coast and a mean trough near the Eastern Seaboard [*Blackmon et al.*, 1977]. The atmospheric pattern associated with the warm-West/cool-East events represents an amplification of this