Relating Extreme Weather Events to Large-Scale Meteorological Patterns: Is the Glass Half Full or Half Empty?

Steve Vavrus

University of Wisconsin

The extent of extreme weather has been increasing within the U. S. during the past two decades, especially heat waves and heavy precipitation. Weather extremes typically have discernible large-scale meteorological patterns (LSMPs) associated with them, even when they occur during summer (when large-scale dynamics are weaker) and even though heavy rainfalls are often spatially heterogeneous. For example, the Southwest has experienced the greatest regional increase in extreme heat and drought in the country during the past one-two decades, related to a trend toward summertime ridging. The atmospheric circulation patterns associated with extreme weather are often highly amplified and slow moving, providing strongly anomalous advective forcing and prolonged conditions. Arctic amplification of global warming may therefore promote more extreme weather in middle latitudes by weakening the polar vortex, thus favoring a slower and more meandering hemispheric circulation pattern resembling the negative phase of the Arctic Oscillation. Global climate models can generally capture the primary LSMPs driving extreme weather events and their accompanying temperature extremes, but GCMs have difficulty reproducing heavy precipitation due largely to their coarse resolution. These models suggest that although the synoptic structure of LSMPs promoting weather extremes won't change appreciably in future climates, the frequency and intensity of favorable circulation patterns will be affected by overlying dynamic and thermodynamic changes. Even though LSMPs are critical drivers of extreme weather, they are not the only important factors; surface conditions, such as snow cover and soil moisture, are also key regulators of major temperature and precipitation anomalies.