

**Observational and synoptic analyses of winter precipitation regime change over Utah**

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Previous studies have observed an increase in surface temperature over the U.S. Intermountain West accompanied by widespread declines in snowpack and in the fraction of precipitation that falls as snow. Using an observation-based, gridded daily temperature and precipitation data and utilizing the rain-snow threshold (RST) temperature method, the analysis focused on the state of Utah and estimated that the proportion of precipitation falling as snow has decreased by 7% during the last half century. In addition, observed snow depth has decreased by 35% across Utah, an observation supported by the consistent decreases in snow cover and surface albedo measured from satellites. Regional climate models of the North American Regional Climate Change Assessment Program (NARCCAP) projected a continuous decline in the snow-rain ratio toward the middle of the 21st century. A synoptic analysis was conducted to establish an independent perspective: Weather systems that have the potential to produce precipitation in Utah have decreased in number, with those leading to snowfall decreasing at a considerably greater rate. Further circulation analysis showed that the anomalous anticyclone that has developed over western North America acts to reduce the chance of cyclone waves from affecting the Intermountain West. The results suggest that declines in snowfall, snow depth, and snow cover in Utah (and much of the Intermountain West) are not only a reflection of surface warming, but are also the result of long term changes in the atmospheric circulation.