The Contributions of Atmospheric Rivers to Avalanche Fatalities in the Western United States

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Snow avalanches are a dangerous type of mass movement in the western United States and pose significant hazards to life and property in mountain environments. We evaluated the contributions of atmospheric rivers (ARs) to avalanche fatalities in the western United States using archived incidents spanning 1998–2014, the North American Regional Reanalysis and NCEP/NCAR global reanalysis, an existing catalog of AR events, and daily weather station observations from the SNOTEL network. AR conditions were present during or preceding 118 incidents associated with 142 fatalities (24% U.S. total). Consistent with regional snow climates and November-April cool-season precipitation attributable to ARs, maritime snow climates had the highest percentage of avalanche fatalities occurring during or following ARs (>60%), followed by intermountain (25-45%) and continental climates (<25%). Heavy to extreme precipitation during ARs favored critical snowpack loading rates with mean snow water equivalence increases of 52 mm. CMIP5 model projections suggest increases in AR-related extreme precipitation and the frequency of dry days as well as reduced mountain snow depths and snow covered area in the western United States. Combining these findings with continued growth in the popularity of backcountry recreation, our results suggest a future characterized by reduced snowpack stability and increased human exposure to avalanche hazard.

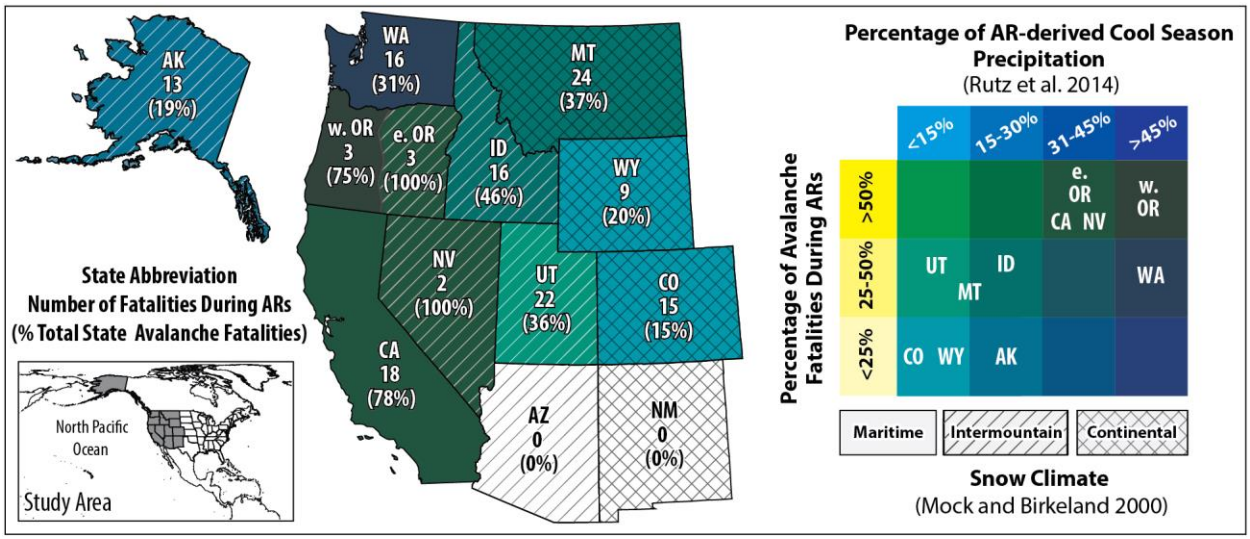

Figure 1: Choropleth map of the western United States where colors are created from blending the percentage of AR-derived cool season precipitation in blues (Rutz et al. 2014) and the fraction of avalanche fatalities during AR events in yellows. Hatching is used to represent snow climates derived by Mock and Birkeland (2000). The state abbreviations are shown with the total number of avalanche fatalities during or following AR events shown with their percentage of total fatalities in parentheses between 1998-2014.

References

Mock, C.J., and K.W. Birkeland, 2000: Snow avalanche climatology of the western United States mountain ranges. *Bull. Am. Meteorol. Soc.*, **81**(10), 2367-2392.

Rutz, J.J., W.J. Steenburgh, and F.M. Ralph, 2014: Climatological characteristics of atmospheric rivers and their inland penetration over the western United States. *Mon. Wea. Rev.,* **142**, 905-921, doi:10.1175/MWR-D-13-00168.1.