Investigating the Climatological Impact of Atmospheric Rivers on the Sierra Nevada (USA) Seasonal Snowpack

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Precipitation and snow water equivalent (SWE) are highly variable in both space and time, particularly in complex montane regions such as Sierra Nevada, USA. California derives a large fraction of its water resources from the Sierra Nevada snowpack, which accumulates over a relatively short cold season. Multiple moisture-rich, atmospheric river (AR) events can significantly contribute to the accumulation and/or ablation of SWE across the range as these low-level jets make landfall, traverse mountainous terrain, and promote orographic precipitation. An accurate assessment of the total AR-derived SWE volume remains a missing piece in high-elevation montane regions. Moreover, an improved understanding of the spatiotemporal variability and distribution of AR-derived SWE across a mountain chain has significant societal implications related to water resources, flooding, etc. Therefore, we use a novel, high-resolution (90-m) and spatially-distributed SWE dataset to provide a more comprehensive characterization of AR-derived changes in SWE (accumulation and ablation) than previously possible with coarser resolution snow products or point-scale measurements during the cold season in the Sierra Nevada. In this multi-decadal study, we not only quantify the fraction of the snowpack that is derived from AR events, but also the average annual volume of AR-derived SWE at the range-scale. We investigate the inter-annual variability of AR-derived SWE distributions over the Sierra Nevada from the basin-scale to the range-scale. The relationships among factors such as the number, frequency, duration, and intensity of ARs and changes in SWE, total accumulated SWE, and peak SWE are explored across the Sierra Nevada.