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Vegetation-snowpack feedbacks from plot to regional scales

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Advances in remote sensing and in situ measurement capabilities afford improved understanding of the feedbacks between mountain snow and vegetation structure. In this regard, distributed hydrologic instrument clusters allow us to observe micro-scale variability in snow-vegetation interactions while remotely sensed data allow us to observe integrated ecosystem-scale response to water availability. Instrument clusters deployed in the Central and Southern Rockies and the Sierra Nevada mountains of the United States reveal the dominant role of vegetation in controlling snow accumulation, snowmelt, and snowpack microstructure. Snow accumulation in these sub-alpine forests was 29 percent greater in open versus under-canopy locations, indicating a significant influence of vegetation structure. Snow ablation rates were diminished by 39 percent in under-canopy locations, indicating increases in vegetation density act to reduce energy fluxes and therefore the duration of the snowmelt season. Similarly, differences in climate altered snow-season duration, snowmelt infiltration and evapotranspiration. Interestingly, the timing of peak soil moisture was highly dependent upon snow ablation, occurring within 7 days of snow disappearance across the study region.

Analysis of remotely sensed vegetation greenness data at the regional scale reveals a coherent signal with regard to these plot-scale measurements. A strong elevational dependence in the relationships between snow disappearance timing and peak vegetation greenness are evident whereby vegetation greenness is highly sensitive to inter-annual variability in snow disappearance timing at low - mid elevations whereas higher elevation forest greenness was relatively insensitive. These elevational variations suggest a switch from water limitations at the lower elevation to energy limitations at the highest elevations. Given potential future changes in the hydroclimatology of mountainous regions, the results of these multi-scale measurements may identify important thresholds with regard to snowpack-vegetation feedbacks.