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Abstract

Snowmelt is the primary source of water for streams and groundwater in the western side of the Desert Andes (20-32°S). This high-elevation region (with peaks > 6000 m a.s.l.) is characterized by scarce precipitation concentrated in winter, and warm and dry summers. While complex spatial patterns of winter snow accumulation are shaped by strong winds and the rough topography, the dry air and intense radiation favour sublimation in spring and summer. These conditions likely restrict snowmelt to specific sites with available snow and sufficient energy for melt. In this work, we identify sites dominated by snowmelt and quantify the physical processes that explain their location using a combination of i) field data, ii) satellite-derived indices of snow presence, iii) retrospective snow water equivalent reconstructions, and iv) numerical simulations with a process-based snow evolution model. As study site we select La Laguna River basin, a high-elevation (~3000-6000 m a.s.l., 513 km2) catchment in north-central Chile. Our results show that snow tends to accumulate on south-east oriented slopes that are protected from the dominant western winds. These sites remain snow-covered during more than 40% of the melt season, and their meteorological conditions favour melt over sublimation. On the other hand, there is little snow accumulation on the north-west oriented slopes, and strong winds and solar exposition yield large sublimation amounts (>70% of the total accumulation) that largely reduce snowmelt contribution to runoff. In recent years, the current drought in north-central Chile might have enhanced sublimation-favourable conditions and reduced snowmelt runoff contribution. We show that south-east slopes near to valley bottoms produce the largest runoff contribution and we suggest that a detailed monitoring of these sites would improve our understanding of the hydrology and ecosystems of the Desert Andes.