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Hydrological implications of the Chile Megadrought in high mountain basins and lessons for climate adaptation.

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La Niña years are historically associated with precipitation deficits in central Chile. However, since the onset of the so-called Chile Megadrought in 2010, the teleconnection between the El Niño-Southern Oscillation phases and the hydroclimate in central Chile has either weakened or disappeared. This study investigates the hydrological response of high mountain watersheds to La Niña (LN) and megadrought conditions (MD) in the Andes of central Chile (30°S – 35°S) through physically-based simulation of processes at the watershed scale. It is shown that during LN years, winters and summers are colder, but spring seasons are warmer, while in MD years the summers are warmer. In addition, the hydrologic response to LN and MD is distinct and amplified during MD in terms of flow deficit. Simulation results for five snow-dominated basins within the central Andes suggest lower efficiency in the transformation of precipitation to snowmelt flow (-3.7% and 1.6% with respect to the long-term average, for MD and LN, respectively), accompanied by higher evaporation (8.7% and 6.1%) and lower flow (-9.3% and -3.4%) relative to annual precipitation. Also, snow accumulation deficits at the end of winter propagate (-36.2% and -17.7%) with respect to the deficit of solid precipitation (-29.7% and -17.5%) and total precipitation (-26% and -19.3%), and during the MD the duration of snow is shorter compared to LN (-16.3 and -10.6 days). Thus, the key role played by snow processes and their variability in the hydrological response to droughts in central Chile is highlighted. The findings presented here are expected to inform ongoing discussion on adaptation strategies to climate change, as the observed climate during the megadrought (2010-?) is strikingly similar, on average, to GCM projections for this region toward the end of the 21st century.