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Teleconnections between ENSO and hydrological response at the catchment-scale in Central-Southern Chile

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Despite the large evidence on teleconnections between the El Niño South Oscillation (ENSO) phenomenon and the hydroclimatology of Central-Southern Chile, the propagation of the ENSO signal through the hydrological cycle is still unclear, because of the complex hydrological processes and compensatory/amplifying effects of meteorological anomalies on the hydrology. In this work, we examine the sensitivity of hydrological responses to contrasting ENSO phases – El Niño, La Niña or neutral phase – against local climatic conditions across 55 near-natural catchments, whose location provides a strong north-south latitudinal dry-wet gradient, with the Andes Cordillera acting as a longitudinal elevation control. We analyze the dependence of four meteorological variables and four hydrological signatures with ENSO phases across three different hydrological regimes – snowmelt-dominated, rainfall-dominated and mixed –. Additionally, we calculate the sensitivity of hydrological signatures to meteorological variables as the total derivative, to assess the full interactions of the system.

Our results confirm statistically significant anomalies of streamflow and meteorological variables at the catchment-scale according to ENSO phases. Hydrological regimes (i.e. seasonality) are enhanced during El Niño years, showing a clear latitudinal gradient. We obtain negative (positive) sensitivities of non-dimensional annual streamflow to increased mean winter temperature at higher (lower) elevations, but positive sensitivities to mean winter storm temperature in the entire study domain. We advise these different sensitivities of non-dimensional annual streamflow – to mean winter storm temperature compared to the whole winter mean temperature – may depict different hydrological implications. We confirm positive (negative) streamflow anomalies with El Niño (La Niña) phases, and we note concomitancy in snowmelt-dominated basins with lesser (higher) runoff ratio anomalies. In rainfall-dominated basins, we obtain higher (lower) runoff ratio anomalies with El Niño (La Niña) phases. This is, for snowmelt-driven/semiarid basins, we note compensatory anomalies between annual streamflow and runoff ratio, and our results suggest that runoff ratio anomalies may be driven by precipitation anomalies rather than by temperature anomalies.