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A modelling study of the seasonal snowpack energy balance at three sites along the Andes Cordillera. Regional climate and local effects.

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Seasonal snowpack melt constitutes the main water source for large portions of extratropical South America, including central Chile and Western Argentina. The properties and distribution of snow in the Andes are threatened by rapid climate change, characterised by warming and drying. This study provides a first attempt at detailed description of the energy balance of the seasonal snowpack and its variability along a latitudinal gradient, which is also correlated with an elevation and precipitation gradient, in the Andes Cordillera. The Snowpack model was validated at semi-arid, Mediterranean and temperate humid sites, where meteorological and snowpack properties have been observed since year 2013. Site elevations decrease from north to south, whereas precipitation climatology increases with latitude. Results show that turbulent energy exchange becomes relatively more important in periods of low snow accumulation, with sensible heat fluxes having a greater effect in cooling the snowpack at the high-altitude, low latitude site. Likewise, daily melt-freeze cycles are important in maintaining positive cold contents throughout the accumulation season at this site, and contribute to extending the duration of snow cover despite low accumulation and high radiation loads. In contrast, the southernmost, lowest elevation site shows smaller daily temperature amplitude and a much more preponderant radiation component to the energy balance. This modelling exercise highlights the nonlinearities of snow dynamics at different geographical settings in a sparsely monitored mountain area of the world, as well as the need for further understanding in order to evaluate the sensitivity of snow-dominated watersheds to global warming and climate change.