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Constraints on Late-Glacial climate from moraines and landslide-dammed paleolakes in the southern Central Andes

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The southern Central Andes of northwestern Argentina feature a wealth of landforms that attest to formerly cooler and/or wetter conditions. Among these are well-preserved glacial moraines on the highest ranges and lacustrine sediments at the floor of the intermontane basins. Unfortunately, the timing and magnitude of the recorded climatic signal in terms of past temperatures (T) and precipitation (P) are only loosely constrained in limited locations. Here, we present results from a combined reconstruction of landslide-dammed paleolakes in the Santa Maria Basin (SMB), and glacial advances at Nevado de Chañi (24°S), Sierra Quilmes (26°S) and Sierra de Aconquija (27°S), whose 10-Be-ages correspond to Heinrich Stadial 1 (HS1) and the Younger Dryas (YD). By simultaneously modelling paleolakes and glacier advances, we are able to place precise new constraints on T-P conditions for several critically-important climate episodes in the Andes. In the lake model we combined the energy balance and the bulk-transfer methods to compute modern evaporation for the SMB in a fully distributed manner. Next, we solved for T-P conditions, under which the lake level would stabilize at the inferred paleolake elevations of 1700 m (HS1) and 1650 m (YD) above sea level. To reconstruct past glacier geometries we used a 2-d ice-flow, surface energy and mass balance model and propagated the parameter uncertainty using a Monte Carlo simulation. For HS1 (YD), we find an overlap in the hypothetical T-P conditions from both models indicating a temperature drop of 2.2 – 3.1 °C (1.5 – 2.3 °C) and a precipitation increase of 2 – 25 % (7 – 28 %) with respect to the spatially averaged, modern mean annual precipitation in the Santa Maria Basin (185 mm). Our findings reveal that the climate of the southern Central Andes during these short-lived episodes was characterized by a modest reduction of temperature and a small increase in precipitation with respect to modern values.