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Changes with elevation in the energy balance of an Andean Glacier, Juncal Norte Glacier, dry andes of central Chile

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The energy balance of snow and ice surfaces in the dry Andes of Chile is dominated by solar radiation. Sublimation is important at high elevations and radiative cooling at night is favoured by the absence of clouds. Because of the scarcity of data in the region, the interaction between glaciers and atmosphere, and the related processes of energy exchange, has been studied only partially, despite the fact that they control melt and runoff generation. We intend to explore the variations in the interaction between climate and surface snow and ice associated with elevation, as a premise to distributed modelling of glacier ablation in the region.

Two Automatic Weather Stations (AWSs) were setup on Juncal Norte Glacier, central Chile, for a 3-month period from December 2008 to February 2009. The two locations are at 300 m difference in elevation, and differ also in terms of fetch available for the development of the katabatic wind. The surface energy balance is studied with an energy balance model including the subsurface heat conduction flux. Computations are driven by measurements of incoming and reflected shortwave radiation, wind speed and atmospheric temperature and humidity. The glacier surface temperature is simulated and used for computation of the longwave radiation and turbulent fluxes. These are simulated using the bulk aerodynamic method.

We analyse meteorological forcing and the components of the energy balance and resulting ablation at the two stations. These show a very pronounced diurnal cycle, reflecting in the strong diurnal variability of runoff, mainly controlled by shortwave radiation. Net shortwave radiation and sensible heat fluxes are positive over the season, while net longwave radiation and latent heat fluxes are on average negative. We show that differential melt at the two AWSs sites (almost 10 mm w.e. per day on average) is caused by differences in albedo, resulting in a lower shortwave radiation flux at the uppermost station, and by differences in the sensible heat flux, associated with both lower air temperature and wind regime. Katabatic wind is evident at both stations, and together with air temperature governs the turbulent heat exchange. The heat flux into the snowpack is important at both sites.