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Sublimation on the glaciers of the upper Huasco valley, Chile, using eddy covariance data and energy balance modelling

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On the cold, arid glaciers of the Norte Chico region, Chile, sublimation plays an important role in mass loss from the glacier surface. The ratio of sublimation : melt on these glaciers dictates not only the amount of meltwater delivered to the watershed, but it also drives the development of morphological features on the glacier surface, such as penitentes. As the rate of sublimation is driven by the latent heat flux, understanding the behaviour of the turbulent heat flux across the glacier surface is key to quantifying the spatial and temporal patterns of ablation.

We measured the turbulent heat fluxes at a point on the surface of the Guanaco Glacier during 23-31 January, 2008 using an open-path eddy covariance system. The eddy covariance system was installed adjacent to an existing automatic weather station operating at 5325 m on the glacier surface, in a region devoid of penitents and other surface deformities. The results from the eddy covariance measurements were subsequently used to assess the sublimation results calculated using a point energy balance model. Results showed that 0.5-3 mm w.e. of sublimation occurred per day during the study period, which corresponded well with the energy balance results. However to assess the total sublimation rate on this glacier, sublimation rates from penitentes, ablation cusps and debris-covered regions must also be calculated.

Thus this paper will also take a first look at another set of eddy covariance measurements made in a penitente field on the Toro 1 Glacier between December 2009-January 2010 to quantify the importance of penitentes for producing ablation on these glaciers as well. The eddy covariance system was installed adjacent to an existing automatic weather station operating at 5200 m on the glacier surface, in a location with a 100 m fetch of penitentes. From these measurements we are able to ascertain the role that penitentes play in modifying turbulent heat fluxes in the main part of the ablation season, the results of which were compared to results from a point energy balance model. In future, these results will also be used to validate a distributed energy balance model for this glacier.