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Volumetric glacier change at Gran Campo Nevado, Chile, between 1984 and 2000 derived from the analysis of different digital terrain models

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A digital terrain model (DTM) of the southern Chilean Península Muñoz Gamero based on aerial photographs dating from 1984 was compared with a DTM of the same area generated from the data of the Shuttle Radar Topography Mission in the year 2000. From this analysis the elevation-dependent volumetric glacier changes of the Gran Campo Nevado ice cap during the mentioned period were derived. Previously the terrain elevations of the DTM of 1984 had to be adapted to the level of the DTM of 2000 by using an exposition-dependent correction based on nearly unchangeable rock and forest areas.

From the determination of the spatial distribution of the elevation differences between the glacier surfaces of the years 1984 and 2000 a slightly negative overall mass balance of approximately 3 m vertical loss of ice could be obtained. This corresponds to an estimated overall volume loss of about 0.74 cubic km. The variability of the observed volumetric change with terrain elevation results in a zone of equalized mass balance at around 850 m above sea level. Below that elevation the data indicate a strongly increasing thinning of the glacier tongues with decreasing elevation resulting in a massive loss of ice, whereas above approximately 850 m a.s.l. thickening of the glaciers was observed, which shows a moderate increase with elevation.

The elevation-dependent variation of the volumetric glacier changes of the Gran Campo Nevado could be explained through the combined effects of increased precipitation and increased mean annual temperature. Taking the results of a degree-day model calibrated for the outlet glacier Glaciar Lengua of the Gran Campo Nevado as representative for the whole ice cap, the mean annual loss of about 850 mm water

equivalent within the ablation zone could be realised through a warming of 0.5°C to 0.6°C. The mean gain of ice masses in the accumulation zone of about 450 mm water equivalent per year can be explained by an increase in precipitation of approximately 10%.