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Elevation and mass change of the Echaurren Norte Glacier (Central Andes, Chile) from 1955 to 2015.

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The Echaurren Norte Glacier (33°34'S 70°07'W) is a small mountain glacier located at the upper Maipo basin, approximately 80 km to Santiago de Chile. The glacier has the longest surface mass balance record in South America (1975 to 2016). The measurements are carried out by DGA (water directory of Chile) using the direct glaciological method. The surface mass balance show continuous negative values, but exceptional positive mass balances were identified during ENSO periods. The aim of our study is complement the in-situ observations on Echaurren Norte Glacier with the geodetic mass balance measurements for the period 1955 to 2015. Our database comprises digital elevation models (DEM) from historical cartography based on aerial photographs (1955), SRTM (2000) and Lidar data. In addition, we mapped changes in glacier extent using aerial photography and multi-mission satellite data. TanDEM-X (2012-2015) and SRTM data will be used to investigate surrounding glaciers that have not such extensive and detailed coverage as Echaurren Norte Glacier.
The aerial photographs from 1955 were scanned from the original negative using a photogrammetric scanner and processed on a digital photogrammetric workstation (DPW) and georeferenced with the aid of GCPs derived from the Lidar dataset. The TanDEM-X data was processed using differential interferometry using SRTM C-band DEM as reference. Differences resulting from X- and C-band penetration are considered comparing X- and C-band SRTM data. All DEMs were laterally and vertically co-registered to each other. Error assessment was done over stable ground. Our preliminary results indicate an elevation change of -42.2 m $\pm$ 4 m (1955-2015) for Echaurren Norte Glacier. The estimated averaged annual mass balance is -0.59 m water equivalent for the period 1955-2015 using a density of 0.85 kg/cm3 for volume to mass conversion. Significant changes of the surface cover were identified, with a considerable increase of the debris cover, in particular in the medial zone of the glacier with a layer approximately 0.35 m of thickness (2009-2015).