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## Unraveling the retreat of the Aneto Glacier (Pyrenees, Spain) since the Little Ice Age

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The Aneto is the largest glacier of the Pyrenees, is located on the Maladeta Massif (Central Pyrenees), close to the highest point of the range, the Aneto peak (42° 37' 52 N, 0° 39' 24 E; 3,404 m a.s.l.). This glacier is 675 meters long, occupy an area of 48.64 ha and their maximum altitude is 3,269 meters. The glacier front ends at 3,029 m a.s.l. and its mean slope is 23.6°, reaching a maximum of 56° in some parts. The main aim of this research is to present a detailed volumetric reconstruction of the glacier since the LIA and analyze their retreat. Based on morphological features, the extent of the glacier has been reconstructed for different periods (LIA, 1957, 2000, 2006, 2015 and 2017) and their ice volume, maximum ice thickness and ELAs has been calculated. To delimitate the glacier extension during the LIA, the moraines have been mapped by using photo interpretation techniques. For the recent phases digital aerial photographs and satellite images have been used. To estimate the topography of the glacier we used a simple steady-state model that assumes a perfectly plastic ice rheology, reconstructing the theoretical ice profiles and obtaining the extent of the glaciers. Later, to reconstruct the ice surface we calculated longitudinal profiles, with these reconstructed profiles a digital elevation model was created and combined with the bedrock topography in order to obtain the ice thickness at each phase. This bedrock topography was obtained by combining the glacier topography with a 3D model of the glacier obtained with geo-radar (ERHIN program, Government of Aragon).

This study reveals a great retreat of the Aneto Glacier since the LIA. The length of the glacier has been reduced from 1,970 m during the LIA to 675 m in 2017, and its tongue has retreated from 2,385 to 3,029 m a.s.l. during the same period. Regarding the area, it has been reduced from 245 ha during the LIA to 48.64 ha in 2017. During this period, the ELA has increased from 2,925 to 3,140 m a.s.l. The glacier volume has been reduced from  $82.57 \times 10^6 \text{ m}^3$  to  $3.48 \times 10^6 \text{ m}^3$ , and the maximum ice thickness from 95 m to 27m. These data reveals a huge retreat of the glacier since the LIA, furthermore, this retreat has been more accelerated since the 50's.

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