

# Monitoring activities of the last pyrenean glaciers

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Pyrenean glaciers are classified as very small glaciers (<0.5 km<sup>2</sup>), but still they are the most important concentration of ice bodies in southern Europe. The increase of temperature after Little Ice Age (LIA) produce an evident shrinkage and wastage since 1850 with a marked tendency of glacier retreatment, and this decline has been accelerated in the last decades, leading them to a situation close to disappear. Under such situation is expected a heterogeneous response of their mass balance to regional climate as topographic factors gain in importance. To confirm this hypothesis different remote sensing techniques (satellite, TLS, UAV) and ground surveys are used, to estimate glacier changes in the last decade. Also, the most important ice bodies other techniques (GPR) have been exploited to quantify ice thickness.

Results show that in the last decade Pyrenean glaciers have lost 23.2% (293.9 ha to 229.2 ha) of its area and the mean thickness loss in all the glaciers studied (17 out of 24) is 6.3 m, which means that some of these glaciers have lost half thickness in this time period. The most substantial reductions are found in the four largest glaciers, while the smallest ones showed a very heterogeneous response. There is no sign of slowdown in glacier shrinkage respect to previous decades, specially with the occurrence of extreme hot summers as 2022. In addition, ground penetrating radar reveals extended areas in the largest glaciers with an ice thickness <15 meters. These results point out that pyrenean glaciers are really in their last stage, and Pyrenees can turn shortly into an ice free mountain range.