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Recent climate evolution and glacier shrinkage in the Central Spanish Pyrenees

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The southernmost glaciers of Europe are located in the Spanish Pyrenees. During the Little Ice Age (LIA) the ice extension covered 1200 ha of terrain in the highest mountainous zones; since then, a continuous retreat has been observed, and today only 355 ha of glacier-ice remain (just about 30% of the LIA extent).

In some massifs, geomorphological evidences (morainic deposits) and the availability of graphic documents (old paintings, old maps, terrestrial and aerial photographs) allowed the assessment of annual rates of ice cover retreat for different periods. This procedure informed that the last two decades of the 20^{th} century registered the fastest glacial shrinkage since the LIA.

In this work, we quantify the degradation of glacial bodies occurred in the southern Pyrenees between 1981-1999 analyzing two parameters: i) the reduction of the area covered by ice; and ii) the volumetric decrease of several representative glaciers. Changes in area were obtained after georeferencing glacial perimeters in geometrically corrected aerial photographs of 1981 and 1999. Volumetric change in the glaciers was evaluated by comparing high-resolution Digital Elevation Models (DEM) from those dates.

A second objective is to detect the changing climate elements that could explain the magnitude of this recent glacial retreat. Thus, we analyzed the evolution in the environment around the glaciers of: i) snow accumulation; and ii) temperature (especially maximum temperature) during the ablation period. Both variables synthesize well the behaviour of annual glacial mass-balance and, therefore, could help to explain the

evolution of the glaciers.

The results evidence that recent climate conditions have been very negative for glacier development. Snow accumulation shows a significant negative trend. Meanwhile, maximum temperatures show marked positive anomalies regarding to the values recorded in previous decades. That may explain the magnitude of the changes observed in the southern Pyrenean glaciers recently. This trend could be maintained or even enhanced during the next decades, since less precipitation and higher temperatures are predicted in most models developed for the Mediterranean mountains. It would lead at short-term to the disappearance of most of smaller glaciers, with only those of them located in suitable topographical context remaining.