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Mapping Glacier Variations at Regional Scale through Equilibrium Line Altitude Interpolation: GIS andStatistical Application in Massif des Écrins (French Alps)

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ABSTRACT
Glacier variation is one of the best indicators of climate change in mountainous environment. In French Alps, many temporal data are acquired by glaciologists at glaciers scale: geometrical parameters (surface area, thickness, length and front altitude) are surveyed since the end of the 19th century. Those parameters are necessary to estimate the mass-balance of glaciers and, then, an accurate temporal signal of glacier variation. However, the time-response of the glaciers can be highly variable because of the topoclimate, and more generally the local settings of the glaciers. Moreover, climatologists and hydrologists are requiring estimation of glacier variations at regional scale and not only at local scale. In this paper, we highlight that the Equilibrium Line Altitude (ELA) is a parameter prone to spatio-temporal reconstructions at regional scale. ELA can indeed be interpolated at a region scale from local data: for instance, many geographers have reconstructed spatial trends during 1980s. Here, we try to interpolate ELA from multi-dimensionnal regression analysis: ELA is explained by many local parameters (Incoming solar radiation, topographic indexes, snow-redistribution by wind, etc.). Regression model was adjusted from a spatio-temporal database of 50 glaciers, located in the Massif des Écrins. ELA was estimated for each glacier thanks to the Accumulation Area Ratio (ratio = 0.65) at two stages: LIA maximum and at present. Results first show that the multiple regression analysis is efficient to interpolate ELA through space: the adjusted r^2 is about 0.49 for the reconstruction during the LIA, and 0.47 at present. Moreover, the RMSE error is about 50 meters for the LIA period, 55 meters at present. Finally, a high spatial variability (standard deviation of about 150 meters) is highlighted: incoming solar radiation and snow redistribution by wind mostly explain the observed differences. We can also assess a rise of the ELA of about 250 meters during the 20th century.

KEYWORDS
Glaciers, Equilibrium line, Interpolation, GIS, Massif des Écrins, Alps

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