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Towards a first assessment of the permafrost distribution in the French Alps


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In mountain regions, permafrost is important for the geomorphology of high altitudes areas as well for the water resources of inhabited watersheds. Under the present Global Warming, the possible degradation of permafrost during the coming decades could hence provoke various kind of slope instability and change drastically the hydrological functioning (Kääb et al., 2006). A better understanding of the distribution of the permafrost is therefore a necessary prerequisite for further analysis and mitigation of those hazards.

As permafrost is in most cases invisible and, though covering large areas, its distribution is largely unknown. Extensive permafrost “mapping” can be approached only through either empirical, statistical or physically based modelling (Riseborough et al., 2008). Permafrost maps have been produced this way for the Swiss Alps. As no such map existed yet for the French Alps, this paper thus intends to present an overview of the main available datasets on the presence of permafrost, in rockfaces as well within debris accumulations: inventories of geomorphological indicators (rockglaciers and other creeping landforms related to the presence of ground ice) and in-situ measurements (BTS, geophysical soundings...).

Among various types of available models, a statistico-empirical one has been set up: it is based on the relation between the two most important topoclimatic controls (solar radiation and air temperature) of the rockglaciers presence. This relation was computed on a lithologically, geomorphologically and climatically homogeneous small massif (Combeynot Massif, ≈ 45° N, 40km²) which presents numerous rockglaciers in various topoclimatic contexts (Bodin, 2007). Two versions of the model, one for the root of rockglaciers, one for their frontal part, have been combined to assess the potential presence of permafrost in the entire French Alps.

Two validation procedures have been performed using independent rockglaciers inventories: one in the Mercantour Massif (lat. ≈ 44° N), one in the Vanoise Massif (lat. ≈ 45.5° N). The comparison between training set and validation set shows a good correspondence of the altitude and aspect of the actual rockglaciers and of the modelled front and root areas. Those first results are thus encouraging as they already provide to public and to decision-makers usable new information about permafrost presence in their territory. At fine scales (lower than the watershed), more investigations are nevertheless necessary to detect and characterise precisely the permafrost, either in debris accumulation or in rock-face.

REFERENCES
Figure 1. Map of the potential permafrost distribution in the French Alps.