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Quantifying the discrepancy between regional climate and climate in the micro-habitats of a rare, endemic plant of the Alps

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Alpine vegetation is predicted to be extremely vulnerable to climate change. Effects of ongoing climate warming on plant species have already been reported in the Alps, such as upward shift of species distribution, range contraction or changes in species composition in the form of thermophilisation. Extrinsic factors such as land-area reduction occurring at high elevations in a mountain range and species' intrinsic properties (e.g., their growth form, reproductive strategy or dispersal capacity) are both affecting the response of alpine species to rapid climate change. However, recent studies have shown that the topographic complexity usually found in the alpine zones creates a variety of microclimate conditions that counteract the effect of warming climate.

Here we aimed at characterising the microclimate conditions that alpine plant species experience. We used a rare endemic plant of the Maritime Alps, Saxifraga florulenta, as a model taxon because of its specific topographic and edaphic requirements. We hypothesized that temperature conditions at sites where populations of S. florulenta are located are decoupled from the local and regional climate. We also hypothesised topographic-related factors are better predictors than other proxies constrained by elevation only to explain the variation of water stress.

To test these hypotheses, we recorded temperature conditions at the microsite where individual grow and reconstructed 30-year time series. We used stable isotopes signal (13C) as the best proxies for water availability. We then compared our recorded temperature data to temperature produced by coarse scale geographic climate layers that are commonly used for predicting species distribution under current and changing climate.

We found that the reconstructed extreme temperatures were significantly different from the temperatures of the coarse scale geographic climate layers. In particular, the reconstructed maximum temperatures were lower than the ones of the climate layers and the reconstructed minimum temperatures were higher than those predicted by climate layers. Moisture index driven by topography has a significant linear relationship with the variation of 13C signal.

Our results show that the microclimate alpine species experience is decoupled from the regional climate and elevation-driven factors. Thus, they may be less exposed to warming climate than model predictions based on coarse resolution climate layers. Moreover, we quantified for the first time the amplitude of the mismatch between regional climate and microclimate. We suggest that studies using species distribution models in alpine ecosystems should implement the difference between microclimate and regional climate into the projections by generalising relationships between these two scales for more accurate predictions of the fate of species under climate change.