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Impact of the model resolution on the simulation of elevation-dependent warming in the Tibetan Plateau-Himalayas, Greater Alpine Region, and Rocky mountains

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The enhancement of warming rates with elevation, the so-called elevation-dependent warming (EDW), is one of the clearest regional expressions of global warming. Real sentinels of climate and environmental changes, mountains have experienced more rapid and intense warming rates in the recent decades, leading to serious impacts on mountain ecosystems and downstream societies, some of which are already occurring.
In this study we use the historical and scenario simulations of one state-of-the-art global climate model, the EC-Earth GCM, run at five different spatial resolutions, from ∼125 km to ∼16 km, to explore the existence, characteristics and driving mechanisms of EDW in three different mountain regions of the world – the Colorado Rocky Mountains, the Greater Alpine Region and the Tibetan Plateau-Himalayas. The aim of this study is twofold: to investigate the impact (if any) of increasing model resolution on the representation of EDW and to highlight possible differences in this phenomenon and its driving mechanisms in different mountain regions of the northern hemisphere.
Preliminary results indicate that autumn (September to November) is the only season in which EDW is simulated by the model in both the maximum and the minimum temperature, in all three regions and across all model resolutions. Regional differences emerge in the other seasons: for example, the Tibetan Plateau-Himalayas is the only area in which EDW is detected in winter. As for the analysis of EDW drivers, we identify albedo and downward longwave radiation as being the most important variables for EDW, in all three areas considered and in all seasons. Further these results are robust to changes in model resolution, even though a clearer signal is associated with finer resolutions.
We finally use the highest resolution EC-Earth simulations available (∼16 km) to identify what areas, within the three considered mountain ranges, are expected to undergo a significant reduction of snow or ice cover in the period 2039-2068 with respect to the period 1979-2008, using the EC-Earth projections under the RCP 8.5 concentration scenario.