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A long-lived supercell in Alpine environment

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We study the life cycle of a convective storm forming over highly complex topography on the northern side of the Alps. Convective activity was initiated ahead of a cold front in the morning of 2 August 2007 in eastern Switzerland. It developed into a supercell storm that moved along the Alpine main crest for over 8 hours, passing over several 2000-m-high secondary ridges and ultimately dissipating over eastern Austria.

The role of topography in modifying the pre-storm environment and in sustaining the storm throughout its development are analysed using both realistic and idealized simulations with the WRF model, at a maximum horizontal resolution of 833 m. The real case simulation features a convective system evolving in good agreement with observations, as demonstrated by comparisons with radar scans and with the few available ground measurements. Variations in the simulated storm intensity are to some extent related to the topography below the storm, possibly in connection to moisture convergence patterns along secondary mountain ridges.

The Alpine topography may have affected storm initiation and development (i) by modifying the synoptic flow and (ii) by inducing thermally-driven wind systems at scales ranging from single slopes to the whole mountain range. We design and perform idealized simulations to test these two hypotheses. In a first simulation, the Alpine topography is modified to remove all small-scale variability. A supercell storm develops, but dissipates in approximately 90 minutes. In a second simulation, the Alps are replaced by a plateau at uniform altitude. In this case, convection organizes in a straight squall line ahead of the cold front.

These results imply that, for the case in exam, the Alpine ridge modified the wind field providing the shear necessary for supercellular development. Furthermore, thermally driven winds over secondary ridges and valleys may have contributed to enhance the storm's longevity. The physical processes responsible for the latter phenomenon are not completely understood yet.