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Supercell thunderstorms in complex topography - how lakes in mountain valleys can increase occurrence frequency

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While supercell thunderstorms are one of the most severe convective phenomena, their behavior in complex terrain is still poorly understood.

Observational studies in the Southern Alps have revealed local supercell "hotspots" associated with valleys with large lakes. With a newly developed radar-based, mesocyclone-detection algorithm, the occurrence and evolution of supercell thunderstorms in the Alpine region were characterized. That study highlights the influence of orography on both storm intensity and occurrence frequency. To disentangle the different influential factors, an idealized modeling framework is established using the mesoscale model CM1. In different modeling experiments the key characteristics of this region have been generalized. The modeling scenarios are based on a high-CAPE environment with unidirectional shear, where a warm bubble serves to initiate the convection. Mimicking the environment of the southern Prealps in central Europe, scenarios with a high mountain ridge, valleys and lakes are explored. Varying both the topographic features and the initial conditions permits the investigation of the individual impact of slopes, valleys and moisture sources.

The dynamic and thermodynamic impact of mountain valleys with lakes increases the range of atmospheric conditions that supports supercellular development through horizontal vorticity production and maintenance of high equivalent potential temperature. This influence results in a systematic location dependence of the frequency, intensity and lifetime of supercells, as also found in observations.