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The impact of embedded valleys on daytime pollution transport over a mountain range

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Idealized large-eddy simulations were performed to investigate the impact of different mountain geometries on daytime pollution transport by thermally driven winds. The main objectives of this study were (i) to investigate the interactions between plain-to-mountain and slope wind systems and (ii) to analyze their influence on daytime pollution distribution over complex terrain. For this purpose, tracer analyses were conducted over a quasi-two-dimensional mountain range with embedded valleys bordered by ridges with different crest heights and a flat foreland in cross-mountain direction. The valley depth was varied systematically. It was found that different flow regimes develop dependent on the valley floor height. In the case of elevated valley floors, the plain-to-mountain wind descends into the potentially warmer valley and replaces the opposing upslope wind. This superimposed plain-to-mountain wind increases the pollution transport towards the main ridge by additional 20 % compared to the regime with a deep valley. Due to mountain and advective venting, a more than threefold increased earth-atmosphere exchange is found over the various mountain geometries when compared to the reference plain simulation. However, the calculated vertical exchange is strongly sensitive to the definition of the convective boundary layer height.