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Disentangling the forcing mechanisms of extreme precipitation events along the Alpine south-side by using potential vorticity inversion

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Previous studies have shown that a deep upper-level trough over Western Europe typically accompanies events of extreme precipitation along the Alpine south-side. These troughs are discernible as meridionally elongated intrusions of stratospheric, high potential vorticity (PV) air into the troposphere, so-called PV streamers.

Here we use piecewise PV inversion to modify a PV streamer to better understand how the meso-scale substructure of this dynamical feature influences heavy Alpine precipitation. The modifications include: (a) an overall variation in the streamer's PV values; (b) a geometrical distortion of its meridional length and zonal width; and (c) distinct changes of its substructure. Physically the modifications are motivated by the streamer's impact on the static stability in the troposphere beneath it and the northward moisture transport on its eastern side. We quantify this impact by considering the induced changes in available convective potential energy (CAPE) and in the moisture transport. Additionally, changes in the moisture source regions are studied by means of Lagrangian trajectories.

Finally, it is shown that the spatial scale and the amplitude of the modifications of the PV streamer are in accordance with and of the scale of typical analysis and forecast errors.