Submitted Abstract

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Abstract

South Foehn winds are associated with a characteristic warming as the air parcels descend from the Alpine crest or pass levels downslope into the northern lee-side valleys. Both upstream latent heating in clouds on the Alpine south side, and adiabatic descent and compression (isentropic drawdown) on the Alpine north side, have been invoked as key mechanisms for this warming. We use a mesoscale model simulation at 1.1 km grid spacing, coupled to an online trajectory module and combined with a Lagrangian heat budget, to illustrate that both adiabatic and diabatic warming can contribute substantially to the overall heat budget. To this end, a hindcast of an intense and long-lasting Alpine South Foehn event in November 2016 is evaluated focusing on Swiss and Austrian Foehn valleys. It is revealed that, while adiabatic warming constitutes the overall most important process for most of the air parcels arriving in the northern Foehn valleys (57%), upstream diabatic heating on the Alpine south side is dominant for a considerable fraction of the trajectories (35%). The analysis demonstrates that there is a clear east-west gradient in terms of the different heating contributions, with diabatic heating being more important for valleys in the western Alps (‘Swiss Foehn’) and adiabatic heating driving the warming in the eastern Alps (‘Austrian Foehn’). Further, we identify a distinct temporal evolution of the respective warming mechanisms. Hereby, our results underline the need for a nuanced view on Foehn air warming, as both mechanisms can co-occur with varying relative importance, depending on the valley and the time period of a Foehn event.

It is well-known that the Alpine South Foehn can develop not only to the east of an upper-level trough and the associated southwesterly flow impinging on the Alps (Deep Foehn), but a rich palette of different Foehn types exists based on varying synoptic and mesoscale situations (e.g., Shallow Foehn, Dry Foehn, Dimmer Foehn, Gegenstrom Foehn). The heat budget analysis will thus be expanded to a multitude of model simulations representing these different Foehn flavors. Furthermore, a preliminary analysis of the main penetration pathways of Foehn air into several northern Foehn valleys will be presented. Finally, the different Foehn types will be set into a climatological perspective using five years of km-scale operational analyses from the Swiss national weather service.