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The Interruption of Alpine Foehn by a Cold Front. Part II: Numerical Simulations

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In this work the interaction of Alpine foehn winds with a cold front is investigated. Despite the wealth of studies on south foehn in the region of Innsbruck during the last century not much is known about the dynamics of foehn breakdown. In most cases, the interruption of foehn is connected with a cold front, which approaches the Alps from northerly or northwesterly directions. The resulting change of warm and dry southerly winds to a cold and moist airmass may occur within less than an hour. The objective of this study is to receive a better understanding of the dynamical processes connected with the collision of two airflows from opposing directions in an Alpine valley by means of numerical simulations conducted with the Weather Research and Forecasting (WRF) Model, Version 3.1.

For this purpose a foehn event at the Special Observing Period (SOP) of the Mesoscale Alpine Programme (MAP) has been chosen. On 6 November 1999 a cold front impinged on the Alps and caused the breakdown of the foehn flow. The investigations are mainly focused on the Austrian Inn- and Wipp Valley, which has been one of the target areas during the MAP SOP. The results from the mesoscale model are compaired against the large available observational data set, including surface station, radiosonde and lidar measurements.

Nested model runs provide the ability to investigate a wide range of temporal and spatial scales. The model is able to capture the blocking of moist air south of the Alps during foehn and the deformation of the cold front by the mountain range north of the Alps. To quantitatively describe the exchange of air masses in a given box near Innsbruck a mass budget calculation has been accomplished. The most prominent feature is a sudden increase of the inflow from the west during the cold front passage. The fine-scale structure of the cold front, which shows the nature of a density current, is determined with an additional one-way nested high-resolution simulation in the Wipp Valley. Futhermore, the sensitivity of the model results on the initial and boundary conditions, which are based on different ECMWF analysis products, is studied. Apart from these tests, it is shown, that the quality of the numerical simulations strongly depends on the type of boundary-layer parametrization used in the model.