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The Interruption of Alpine Foehn by a Cold Front. Part I: Observations

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The propagation of a cold front and its interaction with foehn winds is investigated in an Alpine valley, based on observations collected during the field campaign of the Mesoscale Alpine Programme (MAP) on 6 November 1999. The key instrument of this study is a Doppler lidar that had been operated in the Wipp Valley (Austria). The cold front approached the European Alps from the northwest, became distorted at the mountain barrier and entered the east-west aligned Inn Valley near the town of Innsbruck primarily via two passes. It continued to propagate towards Innsbruck from both valley directions as two separate fronts that eventually collided east of Innsbruck after part of the cold air had entered the adjacent north-south aligned Wipp Valley. In the Inn and Wipp Valley, the front caused the interruption of foehn winds.

A synthesis of Doppler lidar measurements with conventional meteorological data, including automatic weather stations and radiosondes, leads to the conclusion that the cold front in the Wipp Valley was an atmospheric density current characterized by an elevated head, a front-relative feeder flow and a typical propagation speed of 7 m s^{-1}. The foehn flow on top of the density current caused strong wind shear and triggered shear-flow instability that led to the formation of a turbulent wake behind the head. As the density current propagated towards the Brenner Pass, it slowed down. The shape of the frontal surface varied in time. Its inclination of about 10°–20° is steeper than previously reported for the Inn Valley but is consistent with other observations of atmospheric density currents. In a follow-up presentation (part 2) this observational study is complemented by high-resolution numerical simulations.