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Using a small network of ceilometers in Austria to investigate a Saharan dust episode

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In April 2016, a Saharan dust cloud reached Central Europe, leading to enhanced PM10 concentrations and reduced visibility. Particle matter concentrations significantly increased at the Austrian mountain stations Hoher Sonnblick (3106 m a.s.l.), Dobratsch (2166 m a.s.l.) and Feuerkogel (1592 m a.s.l.) between April 3 and April 6, 2016. On April 5, 2016, daily concentrations exceeded 50 μg m-3 PM10 at most air quality stations in the Eastern Alpine area. The evolution of the atmospheric boundary layer (ABL) at the Eastern Alpine ridge is observed by a network of ceilometers; from the vertical backscatter profiles of these instruments, the aerosol load (qualitatively) and the mixing height are deduced. These data are especially valuable to distinguish whether PM10 concentrations are mainly influenced by long-range transport or by advection of aerosols from the ABL. The software of modern ceilometers is able to analyse the first few kilometres above ground for the existence of so-called aerosol layer heights which mark transitions between layers of different aerosol content. Lotteraner and Piringer (2016) present an algorithm to detect the mixing height from the analysis of the aerosol layer heights which is used also in this investigation. The ceilometers were preferably positioned at the valley floors near the mountain tops where the PM10 measurements were conducted.

The dependence of the PM10 concentrations at mountain tops on the mixing height observed by the closest ceilometer shows that, the higher the mountain, the more likely advection contributes to enhanced PM10 levels. Due to springtime, daytime mixing heights during the dust episode rise often above the mountain tops, especially on Dobratsch and Feuerkogel; thus, the elevated PM10 levels there are a combination of long-range advection and daytime vertical mixing. During the episode, the highest PM10 values are observed at Sonnblick, at the highest of the three mountain sites. This may be interpreted as first indication of long-range transport being the cause of these enhanced PM levels.

The backscatter plots of the three ceilometers used in the investigation reveal first the arrival times of the dust cloud, whereby two sub-episodes could be discerned. In the late evening on April 3, the second much stronger dust cloud arrived. Depending on the placement of the ceilometers (north, near or south of the main Alpine chain), distinct differences in weather patterns and thus PM levels could be found and analysed. The results show how valuable even a small network of ceilometers can be to analyse the onset, course, peaks and decay of a Saharan dust episode over the Eastern Alpine region.