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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Transport of Po Valley aerosol pollution to the northwestern Alps. Part 1: phenomenology" *by* Henri Diémoz et al.

Anonymous Referee #1

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General

The manuscript presents three case studies of the exchange of polluted air masses between an Alpine valley and the foreland (Po basin). The case studies are based on multi-site, multi-instrument field data complemented by numerical modelling. They cover three different seasons. The case studies nicely illustrate the complex transport phenomena that occur during the episodes which each last several days. Qualitative agreement is quite good, however, quantitative disagreement between model and observations leads to various hypotheses for the reasons, which require further study and improvements.

The paper is carefully written, well-structured and nicely illustrated. Its content is very relevant in the context of the complex dynamical and chemical (transport) processes in and near mountainous terrain.

I strongly encourage publication in ACP, pending the few minor corrections below.

Specific comments

The authors extensively use lidar backscatter (scattering ratio) for tracking the aerosol load of the valley atmosphere (Figs. 4a, 5, 10a, 11, 13a). This parameter is well correlated with relative humidity, which is strongly temperature dependent, but less so with absolute humidity SH (Fig. S8b). SH is a better indicator of air mass transport (and particulates) than RH, i.e. I would expect to see more variation in SH when Po basin air arrives to replace the valley air mass. This is visible for example in the afternoon on 28 May. Could you discuss the constancy of SH with the arrival of the Po valley air mass and its implications for the humidity profile in more detail?

Another aspect is the vertical extent of the scattering ratio in the late afternoons of case study 1 and 3. The wind field indicates strong winds in the lower few hundred meters above valley floor (up to ca. 1200 m), while higher up winds are rather weak or calm (at 2000 m). Yet the polluted air mass almost instantaneously reaches from 1000 to 2000 m upon arrival. With a wind shear from 10 m/s to 1 m/s over 1000 m can we expect quasi-simultaneous arrival of polluted air on all altitudes? Is this front-like structure real or is it an effect of radiative cooling which increases RH and particle growth throughout the valley atmosphere? Or – alternatively – is this an artifact of the combination of real backscatter measurements with the modeled wind field?

The back-trajectories are good indicators of the regional origin of the polluted air. The graphical representation of all heights up to 4000 m hides, however, the details of the low-level (<1500 m) transport route of the air masses within the valley. I suggest to show additional afternoon graphs only for these low levels.

The COSMO-I2 model with 2.8 km grid resolution might still be too coarse for a detailed 3-d simulation of the valley atmosphere with its various mixing processes. With the valley width of 4 km at Aosta, two grid points fit into the valley cross-section at the floor. This may be insufficient for resolving the complex 3-d flow field of an Alpine valley, and may be another explanation of a part of the discrepancy between model and observations.

Technical corrections

P13L7 omit “the” – should read “covering central and southern Europe”

P22L4 Valley-mountain (and sea-land) breezes are. . . (shift the bracket)

P27L20 hundreds

Fig. 7, caption I could not find the link to the video

Supplement:

P11L15 replace “grow” with “growth”

Fig. S10 mention the PM10 units for all graphs, not only for a) and b). This can be done in the caption.

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