

Interactive comment on “Quantification of topographic venting of boundary layer air to the free troposphere” by S. Henne et al.

Anonymous Referee #1

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General Comments

The paper is well written and presents a thorough discussion of the vertical export of air masses from the atmospheric boundary layer to the free troposphere aloft due to the thermal circulation in a deep Alpine valley.

Based on aircraft measurements as well as sodar and radiosonde soundings the mass fluxes horizontally along the valley and vertically along the slopes and across the top of the BL are well illustrated, leading to a very nice schematic draft which summarises the daytime atmospheric structure and the pollution transport processes in and above the Alps.

Quantification of the mass exchange driven by the valley winds and up-slope winds is undertaken with mass budget calculations based on the experimental wind data.

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Finally, the main pathways of the pollutants (which are exported from the Alpine valleys) are investigated by trajectory analysis. This discussion focuses on the regional to synoptic scale while the main topic of the paper is on a rather local scale - giving information about the typical exchange quantities above two specific deep valleys in the Swiss Alps.

An extrapolation of the export rates derived for these valleys to the whole Alpine region is undertaken which requires further discussion (see specific comments). The connection between the investigations for specific deep valleys and the conclusions and transport studies concerning the whole Alpine region in this paper need further clarification - e.g. in the description of the methodology.

Specific Comments

1) How is the amount of N-emission from the valleys (section 2.1) estimated? As the NO_x-emission factor for trucks is roughly 5 g/km per vehicle, the values are plausible, but should be explained or referenced.

2) The maximum vertical range of the PA2 sodar is usually around 800m at undisturbed sites. Fig. 9 is restricted to this height and reveals a lower range around noon (as usual in neutral stratification). I suggest to give this range instead of "up to 1km" at the end of section 2.1.

3) According to section 2.1, the mean uncertainty of horizontal mass flux calculations is about 7 % due to wind measurement uncertainties. Error estimates are important for a proper quantification, thus, some more details about the measurements uncertainties and how this percentage is determined would be helpful.

4) section 3.1: What are the reasons that the vertical mass flux is twice as high in June than in July and August? Do the measurements reveal that the atmospheric stability is weaker in June than in July and August? How can this be explained? Do the formation of convective clouds or synoptic subsidence play a role? This finding needs

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clarification.

5) section 3.2: "The convective boundary layer is visually indicated by constant to decreasing theta with height ..." If theta stands for the potential temperature, theta is INcreasing at the top of the CBL!

6) Discussion: If the total NO_x export over the Alps should be part of this paper, the "calculation that considers advection from the forelands, accumulation of nighttime emissions in the ABL" must be shown in detail or be supported by references if available. On the whole, quantification of the pollution fluxes is not essential for the discussion of your findings as the title of the paper is restricted to topographic venting i.e. air mass fluxes only.

7) Figures: Fig 3 It is not clear to me, why the wind profiles are depicted not as single value per height, but as bars, although horizontally averaged.

Fig 4 The thin black line is not explained. Mixing height? Top of boundary layer? The line suggest that these are horizontally flat across the valley which is certainly not the case.

Fig 4, 5, 6 What do the arrow and N stand for in these vertical cross-sections from west to east?

Technical Corrections

page 4, 2nd para ...in the southern Swiss Alps Fig.1. (Fig.1) missing

page 6, 2nd para The larger the sensible heat flux... Verb is missing

pge 10, 2nd para Typically, a height of 2000m asl ... I suggest: the height of the CBL was observed at 2000m asl...

References: Feytag, C., ... MERKUR Experiment ... Experiment

Fig. 10 initial altitude is 3428m in figure caption and 3500m in text (page 11)

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