

## ***Interactive comment on “Source and origin of atmospheric trace elements entrapped in winter snow of the Italian Eastern Alps” by P. Gabrielli et al.***

### **Anonymous Referee #1**

Received and published: 2 November 2006

Gabrielli et al. describe a study of concentrations of trace elements and ionic species in winter snow samples from 21 sites in the Italian Alps. A large variation of the concentrations was observed and attributed to the site characteristics (pre-alpine, low elevation versus inner-alpine, high elevation) and to the prevailing deposition mechanism (wet deposition resulting in low concentration, dry deposition in higher concentrations). A Principal Component Analysis was performed using the ranked data sets and the results are discussed with respect to possible sources. I consider the topic of the study as relevant for publication in ACP. However, I can't recommend publication in its present form, because of conceptual errors in the experiment design and the subsequent data interpretation.

## General comments:

**Experiment design:** Although the treatment and analysis of the samples using stringent contamination-free procedures is described in detail, the actual snow sampling method is not at all discussed. From the flux calculation on page 8792, I assume that a 2 cm snow layer was collected every week, independent on the actual amount of snowfall. This might be an acceptable method to study dry deposition (or sublimation, see below), but the wet deposition flux cannot be determined. A snow pit, collected at the end of the studied period, would have been a more suitable experiment.

**Deposition fluxes:** I don't understand how the deposition fluxes in  $\text{g ha}^{-1} \text{ yr}^{-1}$  were calculated from two 14-day periods of observation. Although the concentrations in fresh snow were much lower, the wet deposition might be significant simply because of the amount of snow and should therefore be considered. In addition to dry deposition, sublimation of snow might have occurred, a process which has been observed on glaciers during long dry periods (see e.g. Schotterer et al., The influence of post-depositional effects on ice core studies: examples from the Alps, Andes, and the Altai, in: Earth Paleoenvironments: Records preserved in Mid- and Low-Latitude Glaciers, Eds. L.D. Cecil, J.R. Green, and L.G. Thompson, Kluwer Academic Publishers, and references therein). Sublimation results in an enrichment of irreversibly deposited trace species in the upper snow layer, but would not increase the flux - in contrast to dry deposition.

**Principal Component Analysis:** The interpretation is rather descriptive and weak. The results seem to be interpreted in the light of assumptions to find the crustal, marine and anthropogenic source. Only the second and third principal components are discussed although they represent together just 16% of the variability. The finding that all the trace elements show high scores in P1, whereas the major ions don't, is not further investigated. Probably the concentration data were influenced mainly by the different processes wet and dry deposition (or sublimation), rather than by different emission sources and accordingly P1 could reflect the enrichment behaviour of the trace ele-

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ments. Maybe a classification of the data set in a wet and dry period before the PCA could give a clearer picture.

Chapter 3.5 about meteorological data is weak and not supported by any data or figure.

I suggest English editing.

Specific comments:

Page 8786: “sampling downwind of the technicians”: I assume this was done upwind.

Page 8788, Table 2: Concentrations below detection limit are measured values and cannot simply be ignored for the calculation of averages. A normal practice is to use the detection limit divided by two.

Page 8789: The last paragraph belongs to the introduction.

Page 8791: Define the concept of critical loads.

Page 8795: The statement that Saharan dust transports usually don't occur in the cold season is wrong. Highest frequency is from March to July (see e.g. Collaud Coen et al., Atmos. Chem. Phys., 4, 2465-2480, 2004).

Page 8797: SO<sub>4</sub><sup>2-</sup> and NO<sub>3</sub><sup>-</sup> are most probably not deposited as acids, but mostly neutralized by NH<sub>3</sub>. NO<sub>x</sub> and SO<sub>2</sub> are precursors and not original compounds. To my knowledge agriculture is not a source of SO<sub>2</sub>.

Table 4: Font size is too small.

Technical corrections: Page 8784 and references: correct: Kappenberger

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Interactive comment on Atmos. Chem. Phys. Discuss., 6, 8781, 2006.

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