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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Seasonal impact of natural and anthropogenic emissions on the highest glacier of the Eastern European Alps" *by* J. Gabrieli et al.

Anonymous Referee #1

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General comments:

The study presents trace element and ionic concentrations from a 4.5 m deep snow pit collected at the 3830 m high glacier Alto dell'Ortles on Mt. Ortles in the Eastern part of the European Alps. The pit covers snow which accumulated during the time period June 2009 to about summer 2007, which was dated using physical stratigraphy, concentration of NH4+ and the stable isotope ratio of δ18O. Trace element concentrations are generally low compared to data from sites in the Western Alps. A strong seasonal pattern was detected for most of the geochemical parameters and this is explained by the vertical structure of the atmosphere being more stable in winter and allowing

vertical exchanges between low level and free tropospheric air in summer.

Trace element concentrations in Alpine snow and ice have been investigated in many studies, covering in most cases much longer time periods. The findings which elements and ions are of anthropogenic origin are not new. The discussion of possible anthropogenic sources of trace elements is purely based on literature and not related to the results of this study. Also the strong seasonality of aerosol-related parameters due to changing vertical stability of the atmosphere especially in mountain regions is well known. The data set covers only two years which is too short for sound statements about spatial or temporal trends, considering the strong variability due to changing meteorological conditions (seasonality, year-to-year variations). A related paper was published in 2010 (Gabrielli et al., J. Glaciology), where parts of the results of the snow pit study are already presented.

Overall the authors should point out more clearly what was the motivation of this study, what is the added value and what is not already known from previous studies.

Specific comments:

Trace element and major ion concentrations in Alpine snow and ice generally show high variability and most of them have strong temporal trends. This high variability was also detected in the snow pit from Alto dell'Ortles (Table 1, e.g. Al mean: 3440 pg g-1 SD 4290 pg g-1). Considering the high variability at individual sites (t-test) and the different time periods compared (apples and oranges) I doubt that the two years data are sufficient to deduce significant spatial or temporal trends between Eastern and Western Alps. In addition, it is not clear how much the trace element and ion concentrations at Alto dell'Ortles are influenced by melt water percolation and ablation.

The same limitations apply for the flux comparison. Fluxes are even more complex, since secondary processes such as wind erosion and ablation by summer melt/evaporation play a role. Net accumulation rates are regionally extremely different, depending on local topography and meteorology and can not easily be interpreted

in terms of precipitation to calculate fluxes. Is there anything known about wind erosion or summer ablation at Alto dell'Ortles?

Geogenic tracers in Alpine snow are strongly influenced by Saharan dust deposition which has a sporadic nature and induces even larger inter-annual variability. The positive relation between accumulation and ionic fluxes (page 6504 and 6505) is trivial since the flux is calculated as product of concentration and accumulation. This does not indicate anything about the scavenging process.

The first component of the PCA (PC1) accounts for 57% of the total variance, but it is not explained at all why it has loadings in every trace element and major ion. Since the concentration levels of the trace species differ by more than an order of magnitude, concentrations should be normalized (probably using the logarithmic data, depending on the distributions) before conducting the PCA. Again, considering the short time period of two years the data set is probably over-interpreted by conducting a PCA.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 6493, 2011.