Links between chemical composition of positive and negative air ions

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Keywords: atmospheric aerosols, aerosol chemistry, water
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The chemical composition of nanoparticles including small air ions (diameter <1.6 nm) is very difficult to investigate due to the small amount of substance carried by these particles and thousands of chemical compounds existing in the air and contribute to composition. The electrical mobility measurements might give some insight into the sizes of air ions. Using known mass-size-mobility relations we can estimate the masses of particular ions and propose the chemical composition. One way to support our proposal are mass spectrometric measurements.

Earlier (Luts *et al*. 2011a), we found some links between different types of mobility spectra measured by Small Air Ion Spectrometer (KAIS) and Balanced Scanning Mobility Analyzer (BSMA). Through that we compared one-second-aged small air ions produced by corona discharge and natural air ions. Now we use these data to point out the similarity in positive and negative ions size distribution for mobility range 1.4 – 1.9 $cm^2V^{-1}s^{-1}$ (KAIS) and 0.5 – 2.8 $cm^2V^{-1}s^{-1}$ (BSMA). Air ions $X^+(XY)_m(H_2O)_n$ and $Y^-(XY)_m(H_2O)_n$ can be considered consisting of large neutral molecules and small-size charged part. We propose that the size of air ions is substantially determined by neutral part (neutral clusters) whereas simple ions have only small effect onto the size. Certain example of these neutral part could be the “magically” stable water clusters $(H_2O)_n$. These water clusters can have fullerene–like structures in the air. Hexagonal ring of water molecules $(H_2O)_6$ linked by hydrogen bonds is one very stable cluster (Fowler *et al*. 1991, Dunn *et al*. 2004) and could be responsible for the size of observed dominant smaller ions. Air ions themselves could be $X^+(H_2O)_n$ and $Y^-(H_2O)_n$ or $X^+(XY)_m(H_2O)_n$ and $Y^-(XY)_m(H_2O)_n$.

Also, in the previously reported paper by Luts *et al*. (2011b) we studied the composition of negative air ions as a function of ion age and selected trace gases in laboratory experiments. Using the data from Air Ion Spectrometer (AIS) (Figure 1) and mass spectrometer (MS, Sciex API-300) we proposed some typical negative ions chemical composition responsible for corresponding *m/z.*

The composition of positive air ions also depends on ion age and trace gases. Mass spectra of positive ions are different from negative ones. Identification of the chemical compounds responsible for observed masses in MS is a very difficult task (Smith *et al*. 2004). Nevertheless, we can made certain assumptions taking into account the specific chemical characteristics of compounds.

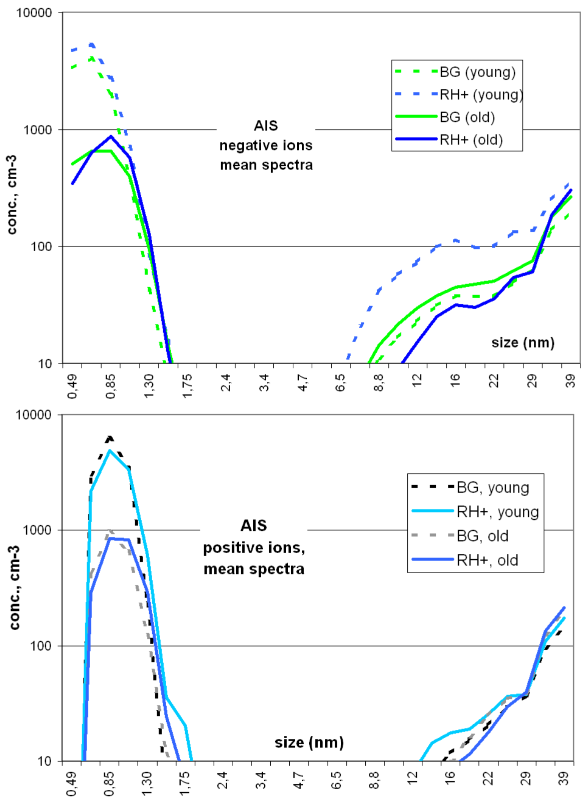

Fig. 1. Size distribution of background (BG) negative and positive ions depending on relative humidity (RH).

This work was supported by the Institutional Research Funding IUT20-11 of Tartu University.

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