Atmos. Chem. Phys. Discuss., 12, 20383–20433, 2012

Airborne observations of aerosol microphysical properties and particle ageing processes in the troposphere above Europe

by Hamburger et al.

Review

General

The paper describes vertical and horizontal measurements of aerosol number size distributions and aerosol volatility in central and northern Europe in a very wide area ranging from the Atlantic Ocean west of Ireland to the Baltic states in the east and from northern Italy in the south to southern Finland in the north and vertically from the lower boundary layer up to stratosphere. The volatility measurements tell about aging processes and the authors have combined this information with estimates of aerosol source regions and emission strengths. All this information is very valuable, especially for evaluating various models. The paper is definitely suitable and worth publishing in ACP. It is mainly well written the amount of graphs and tables is almost ok but I did find some issues that I did I wish you could answer and/or modify.

Detailed comments

p. 20387, L 3 – 6, “Airborne measurements mostly cover areas on a regional scale (Ansmann et al., 2002; Minikin et al., 2003) or focus on certain altitude levels (Crumeyrolle et al., 2010; Voigt et al., 2010). “ You should also refer to the CARIBIC project and tell what there has been done.

Section 2.1. I did not find an information on how many fligths were there altogether. What time of the day were the flights? Time of the day affects a lot of things so that information should also be carried to the discussion of the results.

P. 20389, L 9 – 11. “The regions for the vertical profiles were limited by ATC like the air routes. Thus, vertical profiles frequently had to be performed during take-off and landing and in Temporary Reserved Areas (TRA)”. Do you have any idea whether the profiles would be significantly different outside the TRA?

Section 2.2. Measurements
I did not find any discussion on the uncertainties of the instruments. For instance, you had several size distribution measuring instruments with overlapping size ranges. In my experience, they never agree within 1%. How about in your measurements? I would suggest adding at least one scatter plot where the sums of the number concentrations in the overlapping ranges are shown. And how about the different aircraft: you had similar instruments at least for some parameters – how did these agree? Then about the CPSA: what were the CPCs? I did not get the paper referenced (Stein et al, 2001), it is a conference proceedings, more difficult to get acess. Did the CPCs actually all the time show concentrations in the right order, i.e., N4 >= N10 >= N14? I have also done similar

stuff with TSI CPCs and there are often cases when the order is not that and that means something is wrong. Write some discussion on this.

Section 2.3
P 20392 – 20393 You explain about calculating the normalized emission factor E_N. I find this discussion much too qualitative. For example, how do the different compounds affect the value of the E_N? There should be a formula so that also other people can calculate the same thing. Has the formula been presented in some other paper? If not, write it here. You could add another appendix for that.
P 20393 L12 – 14 "The observed air masses are classified by the time between the measurement and the time of the strongest emission events occurring along the air mass transport pathway within the last 96 h before the measurement." OK, this is a simple approach but it disturbs me a bit. Let us say along the air mass transport route there are four E_Ns, 0.9, 0.8, 0.8. and 0.8. Then you calculate the aging from the 0.9 only. The three 0.8 values most probably have a larger impact on the observations. I have a suggestion that would require a bit work but not much: why don't you calculate the weighted average transport time from them different source regions with ave(t) = (sum(dt(i)*E_N(i))/sum(E_N(i)) or somethng similar? I don't require this, I leave it up to you to consider whether this is a good or a bad idea. Anyway, if you do this, I would expect that the ranges in the results of the aging analyses might get smaller.

Section 3.
A general point: I would like to know, how large a fraction of the total aerosol column lies within boundary layer or other altitude ranges in the various regions. That data would be useful for instance in evaluating AOD measurements. Your data would show that but I don't find that information anywhere explicitly. Consider whether this would be something to present.

Another thing I don't find in the results is comparison with ground based observations at the same time at some representative station. You could very easily get that data from the EBAS (http://ebas.nilu.no/) data base. Then you could add a few symbols to your plots at ground level (ave, median, a couple of percentiles), for instance in Fig 5, no new figures.

P 20407 L19 – 20 "Coagulation of particles caused an almost entirely internal mixing state..." Coagulation plays a minor role here, growth by condensation is the dominant effect.

Table 2 could be Table 1. In table 1 you could give also more information on the flights: dates or date ranges, regions etc.