Atmos. Chem. Phys. Discuss., 10, C7744–C7748, 2010
www.atmos-chem-phys-discuss.net/10/C7744/2010/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "New particle formation and ultrafine charged aerosol climatology at a high altitude site in the Alps (Jungfraujoch, 3580 m a.s.l., Switzerland)" *by* J. Boulon et al.

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Received and published: 20 September 2010

First of all thank you for your helpfull comments.

1 Response to Hanna Manninen

1. HM: *p. 11364, section 2.1: The instrument is called Neautral cluster and Air ion Spectrometer (NAIS) according to current practice (e.g. Manninen et al. BER 2009, ACPD 2010; Mirme et al. ACP 2010; Paasonen et al. ACPD 2010;*

Wehner et al. ACP 2010). Also check p. 11378, line 23.

A: Correction done

2. HM: *p. 11365, lines 1-4: Why did you choose to use Tammet's mass diameter instead of Millikan-Stokes mobility diameter as you mentioned in the text? Nowadays, with the ion spectrometer data Millikan mobility diameter is commonly used (see e.g. MaÌĹkelaÌĹ et al. JCP 1996). This can cause some difference in results when comparing nucleation parameters calculated for the same size range but in Millikan diameter. What were the mean local pressure and temperature?*

   A: This is in fact a typing mistake due to the presence of an old comment in the inversion code. We did use the Millikan diameter. The mean local pressure and temperature were respectively 660 hPa and 265 K.

3. HM: *Section 2.1, p. 11365: Could you tell something about the calibration of the instrument and the data quality checks ?*

   A: The intrument was calibrated at the same time than other instruments (AIS and NAIS) involved in the EUCAARI project before and after the field campaign, where an intercomparison was performed in order check the quality of the measurements. The total particle concentrations measured by NAISs were ± 50% of the reference CPC concentration at $4 - 40$ nm sizes (see Asmi et al., 2009 and Gagné et al., 2010). This is now included in the text.

4. HM: *Section 2.2.2, p. 11366: The tree first sentences are unclear and needs rephrasing. Usually, the particle formation processes (like activation or nucle-*

ation) are followed by the growth.

A: We changed the orignal version to this: "The new particle formation process can be described by different steps. Four different boundary diameters (1.3, 3, 7 and 20 nm) were determined as representative of different growth steps, as usually chosen for GR calculations (Hirsikko et al., 2005), due to the evolution of growth rates during new particle formation events. Hence the growth could be described as follows: First, the smallest particles (1.3 nm) concentration increases until a local maximum, then it decreases following a gaussian shape. While this population concentration decreases, the next one (3 nm) starts to increase until reaching a local maximum etc... The growth rate between two size classes were computed by calculating the time needed to switch from the lower size class local maximum concentration to the nearest higher size class local maximum concentration, as proposed by (Hirsikko et al., 2005). In the present work, a normal distribution is fitted to the different size class concentration maxima using a trust-region algorithm (Byrd et al, 1987) by minimizing the least square residues. Thus the growth rate was computed using the fitted parameters as follows ($GR_{x-y} = y - x/t_{0,y} - t_{0,x}$). GRs were computed for class Ia and Ib NPF classes. However, for some class Ib days, the GRs calculation was not possible due to local pollution events, changes in air masses or NPF interruption by clouds. Those days were not taken into account in the growth rate analysis. Furthermore, the effect of coagulation on the size evolution was not included in the GR analysis since its effect is negligible (Manninen et al., 2009)."

5. HM: *Section 2.2.3, p. 11367: How was the coagulation sink calculated? Why did you choose to use both the NAIS and the SMPS data? The SMPS data is much more reliable in the large particle sizes because the NAIS does not take into account multiple charging of the particles (see Manninen et al. BER 2009).*

A: We used NAIS data because we could not compute $CoagS_2$ with SMPS data since the lowest diameter of the SMPS used during this field campagn is 16.8 nm.

6. HM: *Section 3.2.2, p. 113673: How was the condensation sink calculated? The units are wrong (cm-3 s-1 should be s-1).*

A: Condensation sink was computed using SMPS data. $\bar{CS} = 2.39 \pm 1.56 \times 10^{-4} s^{-1}$ at Jungfraujoch (nucleation event: $\bar{CS} = 2.90 \pm 1.12 \times 10^{-4} s^{-1}$, non-event: $\bar{CS} = 2.54 \pm 1.52 \times 10^{-4} s^{-1}$). The mistake of units was just an error of typewritting.

7. HM: *Section 3.3: How comparable are the different methods to calculate e.g. growth and formation rates? Could you say something about the error limits of your calculations? What could explain the difference in results between this study and study by Manninen et al. ACPD 2010?*

A: Growth rate is computed following the method previously explained on point 4. Formation rates are computed according eq. 1. The term dN_{23}/dt is estimated in our code as the difference between the 2nm particle maximum concentration and the 3nm particle maximum concentration. To find the maximum concentration, we fitted the population peaks with a gaussian curve. Errors in our calculation are introduced by the fact that 1- we smooth our data with a linear moving average on 5 spectra, 2- operator have to choose time boundary within the nucleation occur. This could affect the fitting procedure since the noise increase. In general, we repeat the calculation 3 or 4 times for each events and we averaged the values in order to smooth the result. We do not know how Manninen et al. compute those nucleation "parameters" but it's clear that difference between our results

are mainly due to 1- data processing and 2- the code and approximations used by each research team. We test our CS and CoagS code with an old one made by an ancient PhD student and results are the same at 3% even thought we used different software (Python VS Matlab) and different mathematical procedure. So we believe that the error are mainly introduced when a graphical decision has to be made by the operator (GR and J calculation). We now mention the differences in calculation methods between your study and ours, and the uncertainty which follows.

8. We checked all others comments and corrected the original version of the paper.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 11361, 2010.