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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Results from the CERN pilot CLOUD experiment" *by* J. Duplissy et al.

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Response to Referee #1, J. Pierce <jeffrey.robert.pierce@gmail.com>
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Introduction

The review of referee #1 is included below, together with our replies (following, in italics, immediately below the corresponding comments of the referee).

Response

This paper describes the experimental setup of the pilot CLOUD experiment at the CERN Proton Synchrotron and discusses some of the results from the pilot experiment. These pilot experiments explored the influence of cosmic rays on new-particle formation. In some experiments there clearly is evidence that ionization from cosmic rays increase new-particle formation rates; however, a major finding of this paper is the sensitivity of new-particle formation rates to undesirable inputs, such as out-gassing of chamber walls, which made it difficult to isolate the factors affecting nucleation. Thus, this pilot experiment provided very important information for improving the design of the CLOUD experiment.

This paper highlights the initial results from a very important experiment, the paper is well written and is within the scope of ACP. I highly recommend this paper to be published in ACPD. I have a few comments that I would like addressed.

General comments

1. It would be great if there was a section at the end dedicated to describing the next CLOUD experimental setup and how it would differ from the one described here. There is some discussion of this throughout the paper, but it would be good if it was organized in one place.

The new CLOUD experimental setup will be described in a forthcoming paper in 2010.

2. The overall goal of the CLOUD experiment is to better understand the effect of cosmic rays not only on aerosols, but on cloud droplets and ice particles too. In doing this, the aerosols must grown to CCN sizes under near-atmospheric conditions. This means that the newly formed particles must grow for hours to several days in the presence of pre-existing particles.

These are indeed the goals of CLOUD. However, it is not necessary to follow all particles from birth to CCN; the experiments can be separated into nucleation experiments and growth experiments, respectively, in various stages up to CCN sizes. The measurements on cloud droplets and ice particles can similarly be carried out with pre-made CCN and IN.

On these time-scales in an 8 m3 chamber, the wall loss of particles will be large and very important.

ACPD

9, C8749–C8752, 2009

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The wall-loss rate is a function of particle size and depends on the particle charge and electric fields in the chamber. This means that the size-dependent wall-loss rate may change greatly depending on the strength of the beam intensity. In general, this size-dependent wall-loss rate is very difficult to quantify, though most of my experience is with teflon-walled chambers rather than stainless steel.

Yes, these are important considerations for ion nucleation measurements. In the pilot CLOUD experiment, the wall loss rates should be largely independent of particle charge since the chamber was largely (but not entirely) made of stainless steel (at ground potential). The exception was the teflon wall that provided the UV-transparent window for the chamber. The final CLOUD chamber is entirely stainless steel and partially-conducting ceramics and so avoids any additional wall loss rates for ions or charged particles.

I would guess that properly correcting for these wall-loss processes will be as important as understanding the sensitive nucleation behavior during full CLOUD experiments with particle growth to CCN sizes. I understand that the particles in these pilot experiments were generally smaller than 20 nm, but was any estimate of the particle wall-loss rates done? experiment to experiment variability of wallloss rates? effect of the beam intensity on wall-loss rates?

The nucleation rates reported in the present paper were relatively insensitive to different assumptions of wall loss rates. Concerning the effect of the beam on wall loss rates, no effect was observed (provided the field cage electrodes were at ground potential). On the other hand, there was certainly a strong reduction of aerosol lifetime when there was a potential on the field cage electrodes, in the presence of the particle beam (this was effectively used to clear the chamber of aerosols between runs). It is important to note that an increase of particle loss rate with increased beam would have the wrong sign to explain the observations made in Run 35 of an increased nucleation rate for increased beam intensity.

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9, C8749–C8752, 2009

Specific comments

1. Page 18244, Line 13: "I = 61", what is I?

"I" is the mean ionisation per cm for a 3.5 GeV/c π^+ *in air at s.t.p. (p.18244, l.13)*

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 18235, 2009.

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9, C8749–C8752, 2009

Interactive Comment