

Interactive comment on “Results from the

University of Toronto continuous flow diffusion chamber (UT-CFDC) at the international workshop for comparing ice nucleation measuring systems (ICIS 2007)” by Z. A. Kanji et al.

Anonymous Referee #1

Received and published: 20 September 2010

This paper presents an instrument inter-comparison study of the investigation of heterogeneous ice nucleation for temperatures as low as 230 K. The following types of potential ice nuclei (IN) were employed for instrument evaluation: Arizona test dust (ATD), desert mineral dust (Saharan, Canary Island, Israeli), graphite soot particles, and live and dead bacterial cells. The ice nucleation experiments were performed at the AIDA (Aerosol Interactions and Dynamics in the Atmosphere) facility at Karlsruhe Institute

C7761

of Technology (Institute for Meteorology and Climate Research). Ice nucleation onsets with respect to aerosol temperature and relative humidity (RH) were measured by the University of Toronto continuous flow diffusion chamber (UT-CFDC), CSU (Colorado State University) CFDC, and AIDA expansion chamber. At higher temperatures good agreement was found between the different instruments, at lower temperatures significant differences in ice nucleation onsets were obtained by the various instruments. Possible reasons for these findings are discussed.

Overall this is a well written paper and fits very nicely within the scope of Atmospheric Chemistry and Physics. Atmospheric ice nucleation is one of the least understood topics in atmospheric sciences and this instrument inter-comparison study is an important step to improve our understanding of how aerosol particles affect ice nucleation. The atmospheric science community will greatly appreciate the discussion of the various instrument performances.

I suggest this manuscript for publication after the authors have addressed the points given below.

The authors discuss their results in terms of deposition and condensation mode ice nucleation although none of the instruments can directly discriminate between these modes. Immersion mode freezing is left out entirely. The authors assume that activation below water saturation proceeded by deposition nucleation and activation at or above water saturation proceeded by condensation freezing. Is such a categorization valid?

Discussion lines 1-8, page 20867: At temperatures above 263 K usually no deposition ice nucleation occurs. Looking at Fig. 2 and taking into account the experimental uncertainty it cannot be stated how Snomax and bacteria samples nucleated ice. Snomax studied at 247 K may have nucleated ice via deposition mode. Also, Fig. 2 indicates that there is an ATD sample which nucleated ice at lower RH_i than Snomax, so the statement “. . . which is more active than all of the dust particles sampled, forming ice at

C7762

RH_i that is 10% lower than that required for SD, ID and CID.” is in part not correct.

Particle sampling seems to have a significant effect on the determination of ice nucleation onsets. All instrument supply lines except the one for the CSU-CFDC are at room temperature. At which temperature was the supply line for the CSU-CFDC? How long was the residence time for particles in the warm supply tubing for the AIDA and UT-CFDC instruments? Was the residence time sufficiently long and the temperature warm enough to avoid pre-activation effects?

The trend in ice nucleation onsets of ATD with regard to sampling from APC and AIDA is opposite for UT- and CSU-CFDC for ice nucleation at around 230 K. Could you elaborate on this?

How much time has passed between the ending of an expansion experiment and sampling of the particles? In other words, how large can the ice crystals grow within the AIDA chamber to justify the argument that sedimentation could be an issue. How quick is the sedimentation rate and does this result in a bias of sampled particles. E.g. Does the CSU-CFDC at the bottom of the AIDA chamber receive more “active” particles?

Looking at Fig. 3 at around 233 K, the range of ice nucleation onsets for the first expansion spans from 70% to about 84% RH_w not accounting for pre- and post sampling and expansion experiments. This corresponds to about 102% to 126% RH_i . If the instrument uncertainties are included the range becomes even larger. This is a significant range in RH when discussing ice nucleation onsets. When comparing this to Fig. 7, it could be argued that the differences in ice nucleation onsets for graphite spark generated soot particles at approx. 231 K is about 16% RH_w (without instrument uncertainty), only a little more compared to Fig. 3. If the interpretation of Figs. 3 and 7 is correct, then it should be concluded that not only for graphite spark generated soot particles but also for ATD at the lowest sampled temperatures significant differences in ice nucleation onset values were observed by the instruments.

The authors state in chapter 4 and in the conclusions section, that there was generally

C7763

good agreement between the instruments. What does “generally good agreement” indicate? When referring to the discussion above I am not sure if this statement is still valid for temperatures below about 240 K. This may affect the abstract and conclusion section. For this inter-comparison study it would be very beneficial to state which maximum uncertainty in ice nucleation onsets is aimed for to advance this field and if this has been achieved in the presented campaign or not. Differences in RH_i of over 25% might be too large to describe ice crystal formation in typically very dynamic atmospheric environments. A discussion of this point would benefit the reader and the broader community. This may also spark further instrument development. Clearly, more inter-comparison studies of these kinds are necessary.

Technical comments:

Throughout the text and figure captions, when listing objects, a comma is missing before the final “and”.

Page 20868, line 5: Change “repeat” to “repeated”.

Figures 2 and 3: Please give uncertainties for selected data points.

Figures 3-7: It would be nice to have as second y-axis RH_i given.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 20857, 2010.

C7764