Atmos. Chem. Phys. Discuss., 12, C5321–C5324, 2012
www.atmos-chem-phys-discuss.net/12/C5321/2012/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Effect of photochemical aging on the ice nucleation properties of diesel and wood burning particles" *by* C. Chou et al.

Anonymous Referee #2

Received and published: 3 August 2012

GENERAL REMARKS

The manuscript presents results from laboratory studies on the ice nucleation properties of combustion particles emitted from two diesel engines and from wood burning on their fresh and photochemically aged states. The combustion particles were introduced into a smog chamber which allowed for photochemical processing of the particles by simultaneously emitted gas-phase organic species. The ice nucleation properties were investigated for temperatures of -30°C, -35°C, and -40°C using the Portable Ice Nucleation Chamber PINC. The reported results are part of the larger measurement campaign IMBALANCE.

Reported results indicate that combustion particles from wood burning are more efficient ice nuclei at -35°C to -40°C than particles emitted from the diesel engine. Pho-

tochemical processing appears to having only little impact on the ice nucleation ability. The only photochemically induced enhancement of ice nucleation is associated to the presence of α-pinene and irradiation. The main conclusion the authors draw fro study is that particle size is the controlling factor for enhanced ice nucleation ability.

The material presented in the manuscript fits well into the scope of ACP and deserves publication. The design of the study is scientifically sound, whereas the reference to previous work, the presentation of the study and the obtained results require considerable improvement. Specific issues will be discussed in the following.

SPECIFIC COMMENTS

1. The literature on ice nucleation experiments cited on the introduction should include more recent work, such as (Koehler et al., 2009;DeMott et al., 2009), including papers reporting on the effect of photochemical aging on the ice formation ability of particles, e.g. (Moehler et al., 2008;Sullivan et al., 2010).

2. The description of the applied methodology is incomplete. The operation conditions for the diesel engines are stated as idle. Does that mean that the engine was just sitting there and idling without any load on the engine? If this is the case then I am surprised by the extremely low ratio of organic to black carbon, because for an idle condition with it's extremely inefficient combustion the exhaust aerosol is usually dominated by organic matter. Please add OC-BC ratios for fresh exhaust to Tables 1 and 2. Furthermore, a short description is needed how OC and BC were measured. In the present version, the reader has to consult several publications from the same experiment in order to get a full overview over the applied methods.

3. The authors state that the PINC instrument cannot separate drops from ice above the droplet survival line by size alone (P 14704, line4). Are there other instrumental options fro separating ice particles from water drops? If not then this should be stated clearly that for all cases where PINC sees particles above the droplet survival line

ACPD

12, C5321–C5324, 2012

these data cannot be interpreted as ice nucleation and have to be excluded from the data interpretation. If I understand the results and discussion section correctly, then this was done in the presented data analysis. However, if there are other means available to separate drops from ice (e.g., depolarisation of scattered light), then this method should be mentioned and applied. In particular, a much clearer discussion of results presented in Figures 2-6 is needed. It should be made clear that all data above this survival line are excluded from interpretation. Such a statement is made for Figure 4 in the first paragraph of section 3.1, but not for the other Figures presented.

4. The sequence of figures is not straightforward. Fig. 7 is referenced prior to Fig.5.

5. Particle size appears to be a crucial parameter in the presented data interpretation. However, data shown for particle size are very sparse. Why not presenting a kind of mass closure using OC-BC data (Figures 8 and 9) and particles size distributions from SMPS measurements? Performing such an analysis would also indicate whether all bulk components were recovered by the applied analysis, and it would show the relevance of particle shape for this kind of mass closure. Fresh combustion particles are of highly irregular and fractal-like shape while particles showing a larger OC coating may exhibit a more spherical shape. Furthermore, I would like to see a Figure which investigates a potential link between particle size and ice fraction. Figure 7 is the only graph linking particle size to activated fraction, but this link is difficult to get from the figure. Hence, the main conclusion of the paper that size governs ice nucleation ability is not convincingly presented.

TECHNICAL CORRECTIONS

P 14703, line 2: should read: “neither ozone nor propene”.

P 14704, line 24: should read, e.g., “photochemically aged particles due to . . .”.

Fig. 7: please add the unit to the RHwater - axis

ACPD

12, C5321–C5324, 2012

Figures 8 and 9: please add the unit to the time - axis.

REFERENCES

DeMott, P. J., Petters, M. D., Prenni, A. J., Carrico, C. M., Kreidenweis, S. M., Collett, J. L., and Moosmuller, H.: Ice nucleation behavior of biomass combustion particles at cirrus temperatures, J. Geophys. Res.-Atmos., 114, 10.1029/2009jd012036, 2009.

Koehler, K. A., DeMott, P. J., Kreidenweis, S. M., Popovicheva, O. B., Petters, M. D., Carrico, C. M., Kireeva, E. D., Khokhlova, T. D., and Shonija, N. K.: Cloud condensation nuclei and ice nucleation activity of hydrophobic and hydrophilic soot particles, Physical Chemistry Chemical Physics, 11, 7906-7920, 10.1039/b905334b, 2009.

Moehler, O., Benz, S., Saathoff, H., Schnaiter, M., Wagner, R., Schneider, J., Walter, S., Ebert, V., and Wagner, S.: The effect of organic coating on the heterogeneous ice nucleation efficiency of mineral dust aerosols, Environmental Research Letters, 3, 025007 10.1088/1748-9326/3/2/025007, 2008.

Sullivan, R. C., Minambres, L., DeMott, P. J., Prenni, A. J., Carrico, C. M., Levin, E. J. T., and Kreidenweis, S. M.: Chemical processing does not always impair heterogeneous ice nucleation of mineral dust particles, Geophysical Research Letters, 37, L24805 10.1029/2010gl045540, 2010.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 14697, 2012.