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Atmospheric Measurement Techniques Discussions

AMTD

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Interactive Comment

Interactive comment on "A new thermal gradient ice nucleation diffusion chamber instrument: design, development and first results using Saharan mineral dust" *by* G. Kulkarni et al.

G. Kulkarni et al.

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We also thank anonymous referee 3 for the comments and suggestions. We have revised the manuscript accordingly in response to his or her comments.

General comments:

We agree with the referee that larger size particles (> 10 micron) are not atmospherically important as they are not efficiently transported. This issue is also raised by referee 1 and we have removed the particular statement from the paper. The main goal of our experiments was to perform the process level studies which deal with the understanding of the role of mineral surface or surface elemental composition on

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Interactive Discussion

Discussion Paper

the ice nucleation as a function of time. And the static chamber design provides the opportunity to undertake these studies. Here one can observe the single dust particles for sufficiently long time at various temperature and supersaturation conditions. We are publishing these results in our second paper. For continuous sampling the airborne particles or deployment over the aircraft the static chamber design might need substantial improvement. Instead making use of the continuous flow diffusion chamber would be highly useful.

Specific comments:

It is unclear to me, how the occurrence of ice is detected objectively a) in general and b) on the Sahara sample of Fig. 6 in particular.
Reply: We detect the ice visually with the aid of microscope. The microscope is focused over the particles deposited on the substrate, and when the ice is formed (the dust particles reflectivity changes and the ice embryo starts growing) the nucleation event is recorded. We had sufficiently large particles with median diameter approximately equal to 10 to 15 microns, which further helped us to observe the individual dust particles with available magnification and thus any ice formation. We have added this to the revised manuscript.

How is ice distinguished from other material?
Reply: In our experiments we have used the Teflon material as a substrate. Prior to our experiments we carried out validation experiments to determine the onset RHi of this substrate. It was observed that substrate starts nucleating at water saturation humidity conditions. We also carried out validation experiments where the substrate is exposed to various sub saturated conditions with respect to water for long time (>10 minutes), but no ice nucleation events are observed. This confirmed that Teflon material does not play any role during the ice nucleation of dust particles when sampled at sub saturated water conditions. For our experiments the substrate is cleaned and dried

before it is used in the next experiment. Also no other material was deposited except dust particles on the substrate, and as discussed above when the dust particles gets nucleated its reflectivity changes and starts growing. Thus it was confirmed that we are only detecting ice nucleation over the dust surface.

Can you give dimensions of the particle and of its growth in the Figures 6a through d?
Reply: The dimension of each figure (which is field of view of the microscope) is 125 x 94 micron. Using this information we can say the particle size varied from approximately 10 micron to 20 micron. We also performed size calibration experiments by using standard size glass spheres. It is difficult to calculate the growth rate of nucleated dust particle as we do not know the exactly the initial radius of the ice embryo. But assuming if the initial radius is 0.01 micron and growth is only by water vapor diffusion, then using Maxwell diffusion theory [PP 99-100, A short course in Cloud Physics by Rogers and Yau] and neglecting kinetic corrections an approximate growth rate can be calculated. It should be noted that we are performing only ice nucleation experiments, and not calculating the growth rates. The Fig 6c and 6d are shown only for illustration more specifically to show the growth of nucleated dust particle circled in red. This is made clearer in the revised manuscript.

What was the temperature?
Reply: Fig 6a is at -33.3 deg C, Fig 6b - 6d are at -32.7 deg C. These are added in the revised manuscript.

Is there a threshold in growth above which nucleation is detected?
Reply: The minimum size of ice embryo that can be detected by the microscope is 1.1 micron. Therefore the nucleation event is only recorded when the ice embryo formed over the dust surface reaches 1.1 micron size.

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What is the size of the sample holder, and of the field of view, what is the magnification?

Reply: The size is 3mm in diameter, and field of view shown in Fig 6a is 125 x 94 micron. We calculated the magnification for these images as follows. We deposited 32 micron glass spheres on the substrate, and saved the images. Then we measured the dimensions of these images (each sphere measured on these images was 30 mm) and calculated the magnification which is 938x. We maintained this same magnification throughout all the onset RHi experiments. The magnification can also be varied with the various zoom lenses of the microscope.

Technical comments: Reply: All comments are added in the revised manuscript.

Interactive comment on Atmos. Meas. Tech. Discuss., 2, 153, 2009.