

Interactive comment on “Measurements of ice nucleation by mineral dusts in the contact mode” **by K. W. Bunker et al.**

Anonymous Referee #1

Received and published: 24 August 2012

The study by Bunker et al. aims to provide some measurements on contact nucleation by mineral dusts. They supercool a water droplet on a substrate, expose it to a stream of aerosol particles and look for freezing when an LED laser light is scattered. Bunker et al. tested Arizona Test Dust (ATD) and kaolinite in five different mobility diameters and at a few different temperatures (-15°C to -18°C). Though contact nucleation has gained a lot of interest recently and is an important yet missing piece in our understanding of ice nucleation, it is a nontrivial experiment to tackle. There are major weaknesses in this study. For example, placing a water droplet on a cold plate is not the same as suspending a water droplet in air or let it fall freely. Therefore, results from cold plate studies cannot be extrapolated to contact nucleation in clouds readily. Also, the size of the water droplet used in this study is too large in comparison to cloud water droplets. The temperature range reported is too narrow, and the error bars on the data are too

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large. The details of major issues are discussed below. The reviewer believes that major revision of the current study is required before publishing in ACP.

Major issues:

1. Laying a water droplet on a cold plate is not the same as suspending a water droplet in air or a free-falling water droplet in air. The difference in surface area can lead to significantly reduced collection efficiency of aerosol particles, as observed in this study. Therefore, the data obtained using this method require additional consideration and cannot be readily extrapolated to represent the real phenomena in the atmosphere.
2. The water droplet used here has a volume of 5 microliter. This is too big a water droplet and not representative of water droplets in clouds. This could be a cause to the low collection efficiency and low number of freezing events observed in the study.
3. Temperature measurements in contact nucleation study are crucial and challenging. The authors performed experiments in a narrow window of temperatures (-15°C , -17°C and -18°C). It is unclear that given the uncertainty in RTDs and thermocouples ($\pm 0.5^{\circ}\text{C}$ and larger) how the authors are able to make distinct measurements between -17°C and -18°C and attribute data accordingly. It is necessary to have as wide a temperature range as possible to assess the importance of contact nucleation.
4. Relative humidity is another key component in contact nucleation since evaporation of the water droplet can introduce thermophoresis and diffusiohoresis. The authors did not pay any attention to the issue of relative humidity in the experiments and did not correct for this in the analysis.
5. Due to the experimental design, the authors cannot easily measure or assess the number of aerosol particles deposited to the droplet. The authors “measure the total, projected surface area of dust apparent within the area of the droplet’s residue, then divide that by the average projected area of a single aerosol particle of the same mobility diameter.” This is one of the largest sources of uncertainty in the measurement. The

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authors need to research other methods of assessing the number of aerosol particles that come into contact with the droplet.

6. Representation and quality of data is poor in the reviewer's opinion. On Figure 3, the error bars easily span several orders of magnitude for almost all data points, especially those for ATD at -17°C . It is unclear why the uncertainty would be particularly large for -17°C . It is also intriguing why the data for ATD at -17°C and -18°C are noticeably different by an order of magnitude.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 20291, 2012.