Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2018-1326-RC2, 2019

Atmospheric Chemistry and Physics Discussions

Interactive comment on "The importance of crystalline phases in ice nucleation by volcanic ash" *by* Elena C. Maters et al.

Anonymous Referee #2

Received and published: 17 February 2019

General Comments:

The manuscript of Maters et al. describes immersion-mode ice nucleation experiments conducted on volcanic ash samples from several different volcanoes with variable magma compositions. The ice nucleation activity is compared between tephras (containing both glass and minerals) and the pure glass equivalents of these tephras. This is a novel approach to exploring the role of crystalline vs. amorphous phases in volcanic ash as ice nuclei, and the study is appropriate to ACP. The difficult nature of immersion-mode experiments and the limited knowledge of volcanic ash nucleation activity makes this study an important contribution to the state of knowledge. The manuscript is well-constructed and well-written. I think it will be suitable for publication following some minor revisions and further interpretation. Some more specific com-

ments are provided below.

Specific Comments:

Throughout the manuscript you refer to the vertical eruption "plume", and the laterally dispersed "cloud", as defined on line 27 of the introduction. I understand that these terms are not explicitly set by anyone, but physically, it is more correct to call the vertical part the "column" and the laterally spreading part the "plume." Calling the plume a "cloud" is not technically correct and can cause some confusion amongst atmospheric scientists.

Why not refer to the ice nucleation activity (INA) instead of the ice-nucleating effectiveness (INE). INE is already used for other descriptors.

In the Materials and Methods section, more information on the preparation of the tephra samples is required. Were accidental lithics removed? Were the samples rinsed to remove adsorbed salts? This second question relates to the statement on page 7, line 37. Were they altered in any way following eruption? Weathering of the glass post-deposition may introduce small amounts of clay minerals into the samples that are not in high enough quantity to be detected by XRD.

Following milling of the tephras, was a grain size distribution analysis performed to insure the sizes of particles were consistent between samples? Although surface area was measured, the size distribution of the particles may also affect the ice nucleation (i.e., more smaller particles will increase SA compared to fewer, larger particles). Although the milling procedure should effectively homogenize the size distribution, checking this would strengthen the reliability of the results.

Although they used deposition-mode experiments, and not immersion-mode, the recent study of Kiselev et al. (2017) examined variations in ice nucleation due to defects in the crystal structure of K-feldspars. It may be worthwhile to look at this study for additional information on your interpretations. Specifically, it may be worth considering

not only the presence of particular minerals, but the crystal shapes and surface attributes of these minerals, as they may also affect the likelihood of ice nucleation. This point is partly discussed on page 6, line 5, regarding the study of Whale et al. (2017), but should be explored further. I have included the Kiselev reference below.

Additionally, it is mentioned on page 6, line 18, that any relevant mineral textures are difficult to resolve in powdered samples, but these samples can be easily examined in backscattered SEM mode to check for any notable mineral textures. Without knowing the size of the grains, it is difficult to say for sure.

Technical Corrections:

Line 19 of the abstract: delete the word “partly”

The sentence beginning on page 2, line 35 just sounds awkward and should be rephrased.

The third and fourth paragraphs in section 2.1 are not materials or methods and should be placed somewhere else, perhaps the introduction?

Page 7, line 21, tephra should be plural.

Can you discuss further the characteristics of pyroxene minerals that might influence their ice nucleation abilities?

I don’t quite understand the point of plotting both the tephras and glasses in Figure 1a, since they directly overlap in most cases.

When reporting the INE (Tns $\sim$ 1 cm -2) throughout the text, why is the 1 so small. . .is it subscripted?

Please state in the caption of Table S1 that these are XRF measurements.

Please state in the caption of Table S2 that these are XRF measurements.

Is the “Text S1” mislabeled? I think the supplementary tables are not currently labeled

correctly. Should they be: Table S1 (XRF measurements of bulk samples); Table S2 (Electron microprobe measurements of tephra glasses; Table S3 (Electron microprobe measurements of feldspars).

Figures 4, 6, S1, and S2 need to include error bars or a statement of the errors in the captions.

Additional References:

Kiselev, A.; Bachmann, F.; Pedevilla, P.; Cox, S.J.; Michaelides, A.; Gerthsen, D.; Leisner, T. Active sites in heterogeneous ice nucleationâĂŤThe example of K-rich feldspars. Science 2017, 355, 367–371.

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2018-1326, 2019.