Reply to interactive comment on *„Ice nucleation properties of fine ash particles from the Eyjafjallajökull eruption in April 2010"* **by A. Ansmann**

First, we would like to thank A. Ansmann for commenting on our paper. Below we respond to the points that he discussed.

Comment 1:
Please do not forget to mention LIDAR in the Introduction section. LIDAR is the work horse with respect to volcanic aerosol monitoring (e.g., Jaeger et al., JGR, 2005, Mattis et al., 2010 and all the references in these papers). Only powerful lidars (in contrast to ceilometers) provide a rather detailed view of volcanic ash layer distributions and can detect traces of volcanic ash and sulphate aerosol up to 30 km height. This potential is especially required with respect to cloud research (and the study of the impact of traces of ash on cloud ice formation, Seifert et al., JGR, 2011, in press).
Reply to comment 1:
We agree that lidars can provide valuable information about the dispersion and composition of volcanic ash layers in the atmosphere. Accordingly, in our introduction we have extended the list of instruments which were used to monitor the dispersion of the Eyjafjallajökull ash cloud (see p. 3). We now mention the study by Seifert et al. (2011) in the context of atmospheric measurements investigating the ice nucleation properties of volcanic ash particles (p.4).

Comment 2:
Now: The paper of Seifert et al. (JGR 2011, JGR webpage, paper in press) dealing with the influence of the Eyjafjallajökull volcanic ash on heteroegenous ice formation in 'real world' tropospheric clouds is available at the JGR webside. The Seifert study is based on lidar observations at Leipzig and Munich in April 2010. I recommend to discuss these observations and compare the findings with your laboratory studies.
The lidar observations clearly show the strong impact of contact freezing. Not only immersion and deposition freezing take place in the atmosphere as one may conclude from the discussion in your paper. On the other hand, how can you be sure that contact freezing does not take place in your laboratory experiments? Freezing temperatures of -10C point to contact freezing according to the study of Fornea et al.
Reply to comment 2:
We observe significant freezing fractions only at temperatures below 252 K but not at warmer temperatures such as 263 K. For these experiments at colder temperatures (starting from IN14_100, see table 1), we observe that the particle concentration measured by the WELAS instruments (corresponding to the droplet concentration) converges towards the aerosol concentration which means that within our measurement uncertainty all ash particles become activated to droplets. Freezing sets in after the droplet activation has been completed. Thus, it is unlikely for contact nucleation to occur during AIDA experiments in the immersion freezing regime since there should be no dry aerosol particles available for contact freezing. However,

quantifying the potential contribution of contact nucleation would require measuring the ice nucleation efficiency of the Eyjafjallajökull volcanic ash particles in this specific ice nucleation mode. Also, it has to be considered that the volcanic ash particles that were used by Fornea et al. were much larger than the particles that we investigate in our AIDA cloud chamber experiments. This makes a direct comparison between the studies by Fornea and al. and the AIDA experiments with volcanic ash rather difficult.
We also added a comment on contact freezing in our paper (see p. 9)): "Since within our measurement uncertainty all volcanic ash particles are activated to droplets (leaving no dry aerosol particles available), it is unlikely for contact nucleation to occur during the AIDA experiments presented in this study."

Comment 3:
In the conclusion section (a bit late to start such an important discussion in the conclusion section) IN number concentrations from FALCON aircraft observations are discussed. Seifert et al. (2011) also provides estimation of IN number concentrations, could be used in this discussion, too.
Reply to comment 3:
We thank A. Ansmann for drawing our attention to these interesting results from atmospheric measurements where IN concentrations are derived from lidar measurements and estimated temperature dependent ratios between ash particle concentrations (APC) and ice nuclei concentrations (INC) (Seifert et al, 2011).
Comparing these APC/INC ratios (given for T=263 K, T=253 and T<243 K) to the inverse of the ice fractions f that we observed, we find that the APC/INC ratio assumed by Seifert et al (2011) is lower than the inverse ice fraction observed in our AIDA experiments at 253 K. For T=263 K we did not observe any ice nucleation whereas for temperatures below 243 K we observed deposition nucleation which depends both on temperature and RH_{ice}. Also, for the estimation of IN concentrations as discussed in our paper, we used the aerosol surface concentration instead of the ash particle number concentration.
Since the basic assumptions for deriving the IN concentrations differ between Seifert et al. and our approach, we think that a direct comparison of the estimated IN concentrations is not useful.

<u>References</u>

- Seifert, P., Ansmann, A., Groß, S., Freudenthaler, V., Heinold, B., Hiebsch, A. , Mattis, I., Schmidt, J., Schnell, F., Tesche, M., Wandinger, U. and Wiegner, M.: *Ice formation in ash-influenced clouds after the eruption of the Eyjafjallajökull volcano in April 2010*, J. Geophys. Res., in press, 2011