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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Contact freezing: a review" *by* L. A. Ladino et al.

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General remark: The paper is well written, contains a lot of valuable information and is clearly worthwhile to be published. However, as a field experimentalist (and in addition meteorologist), I am not satisfied when a REVIEW only covers modeling and laboratory studies and efforts, and does not consider the literature dealing with field activities (heterogeneous ice formation in real clouds in their natural environment observed routinely and/or in field campaigns).

So, there are two possibilities: include the field activities, or change the title to make sure that this REVIEW only covers laboratory studies and modeling.

What do I mean when I say: field studies? Then I want to say that besides aerosol-cloud interaction there are further meteorological aspects (besides temperature and

relative humidity), namely dynamical effects: organized updraft and downdraft motions, wind shear, turbulence, entrainment etc.

Or more precise: Heterogeneous ice formation (e.g., contact freezing) not only depends on aerosol type, temperature, and moisture. Vertical motions are required to trigger cloud formation and many processes that increase the lifetime of the cloud or terminate the life cycle. Entrainment of dry air (and thus dry particles) into the cloud (from the side, from above) is needed to get a significant effect caused by contact freezing.

So what I wanted to see is also a review of the literature dealing with field experiments. There are not so many papers, I believe, may be Hobbs et al. (in the 1980ies, stating that contact freezing is favorable for cumulus cloud glaciation, starting in turrels in cloud tops), Levin et al. (several journals, in the 1990ies and early 2000s), Ansmann et al. (JGR, 2005), Heymsfield papers (I am not sure. . .) , special issue on ICE-D (JAS 2010 special issue?), Seifert et al., (JGR 2011, volcanic impact). And, Korolev et al (JAS, 2003, 2007, 2008), focusing on the impact of updrafts and downdrafts on cloud glaciation (modeling paper!).

The topic of the review should be: At which natural aerosol-cloud-dynamics conditions the situation is obviously favorable for contact freezing. Otherwise the question remains: Ok, contact freezing may be important (as laboratory and modeling work suggest), but is it really of importance????

Some examples: We (Ansmann et al, JGR 2005) showed a case, where layered water clouds in Saharan dust began to glaciate at cloud base and top, this points to contact freezing, when large dry dust particles come close to drops. Seifert et al. (2011) suggest that boundary layer water clouds start to glaciate via contact freezing when they penetrate into the free troposphere with large IN concentration which was the case after the Eyjafjallajokull volcanic event over central Europe in April 2010. The favorable dry IN get entrained and trigger contact freezing. What other scenarios provide favor-

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able contact freezing conditions?..... That should be summarized somehow in such a REVIEW (the field experiment part of the REVIEW).

I should state (again) that I like the paper and do not want to criticize it too much, the aim is just increase the sensitivity of the authors towards the real world (outside the labs and models. . .).

Some details:

Page 7814, line 12: . . . conditions relevant for the different heterogeneous modes of ice formation. . . to my opinion RELEVANT must include statements concerning dynamics, not only aerosol, temperature, water vapor. . .

Page 7815, line 12: ..to explain observations. . . which observations do you mean? Certainly not the 'real ones . . . in the atmosphere, in the natural cloud environment. . .'

Page 7815, line 19: . . .. If the laboratory observations are representative for atmospheric conditions. . .. How can they be representative without any potential of labs to study of the impact of air motion?

Page 7815, line 28: Hoose et al (2010) developed . . . with the aim to investigate the importance of this freezing mode. . .. Did these authors include cloud dynamics and entrainment studies? How can one model global effects of heterogeneous ice formation without a clear understanding of cloud life cycles and the link to het. ice formation? How can one then say anything about the importance of a given effect?

Page 7816, line 9-11: . . . we summarize the available . . .. . . but we leave out the field experiments. . .. (would be my comment)

Page 7816, line 16 up to the end: These key questions do not cover dynamics aspects.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 7811, 2013.