Atmos. Chem. Phys. Discuss., 15, C10858–C10860, 2015
www.atmos-chem-phys-discuss.net/15/C10858/2015/

Atmospheric Chemistry and Physics Discussions

Open Access

ACPD

15, C10858–C10860, 2015

Interactive Comment

Interactive comment on "Cloud chamber experiments on the origin of ice crystal complexity in cirrus clouds" *by* M. Schnaiter et al.

A. Bogdan

anatoli.bogdan@uibk.ac.at

Received and published: 26 December 2015

Dear Authors,

Thank you very much for citing our papers in your work. That was indeed a very nice surprise because our works are usually being ignored by atmospheric scientists dealing with the formation and modeling of cirrus and PSCs. A reason for this could be that they are not able to comprehend a well-known-for-decades fact that ice is highly intolerant to impurities and, consequently, during ice nucleation and subsequent freezing of aqueous solutions a phase separation occurs into pure ice and a freeze-concentrated solution (FCS).

Below I give you a short list of our papers in which you will find pictures and videos

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

(3, 5-7 in a list below) which demonstrate the freezing process in situ and show that indeed there is a freeze-induced phase separation (FIPS) into pure ice and FCS both in aqueous bulk solutions/formulations relevant for biotechnology and small aqueous drops of size and composition relevant for UT and polar stratosphere. After you have read our papers, I hope you will rewrite these sentences of yours and also add a couple of sentences into introduction about the FIPS in the atmosphere.

These are your sentences: "A possible explanation for this observation could be the formation of concentrated H_2SO_4/H_2O residuals on the ice crystal surface, which affects the regular crystal growth. Such a separation into solid ice and unfrozen residual solution was observed by calorimetric measurements on aqueous H_2SO_4 droplets in the cirrus temperature range $190K < T < 230K$ (Bogdan et al., 2006; Bogdan, 2006). Although emphasized by the authors, the formation of a complete H_2SO_4/H_2O coating of the crystal surface was not unambiguously proven by these studies. Further studies with homogeneously nucleated ice particles are necessary to investigate the impact of unfrozen H_2SO_4/H_2O residuals on the ice crystal complexity."

Note, that freezing aqueous drops do produce spherical ice particles. This is easily observed in situ during freezing experiments on micrometer-scaled drops. The FCS-coating is very thin and, consequently, can exist around young cirrus ice particles (see papers 1,2 from the list below).

This is a short list of our papers:

1. Bogdan, A. and Molina, M. J.: Why does large relative humidity with respect to ice persist in cirrus ice clouds? J. Phys. Chem. A, 113, 14123-14130, 2009.

2. Bogdan, A. and Molina, M. J.: Aqueous aerosol may build up an elevated upper tropospheric ice supersaturation and form mixed-phase particles after freezing, J. Phys. Chem. B, 110, 12205-12206, 2010.

3. Bogdan, A., Molina, M. J., Tenhu, H., Mayer, E. and Loerting, T.: Formation of mixed-

ACPD
15, C10858–C10860, 2015

phase particles during the freezing of polar stratospheric ice clouds, Nature Chem., 2, 197–201, 2010.

4. Bogdan, A. and Loerting, T.: Impact of substrate, aging, and size on the two freezing events of (NH4)2SO4/H2O droplets, J. Phys. Chem. C, 115, 10682–10693, doi.org/10.1021/jp2007396, 2011.

5. Bogdan, A., Molina, M. J., Kulmala, M., Tenhu, H. and Loerting, T.: Solution coating around ice particles of incipient cirrus clouds, PNAS, July 2, vol.110, no.27, E2439, 2013.

6. Bogdan, A., Molina, M. J., Tenhu, H., Bertel, E., Bogdan, N. and Loerting, T.: Visualization of freezing process in situ upon cooling and warming of aqueous solutions, Scientific reports 4, 7414, DOI: 10.1038/srep07414, 2014.

7. Bogdan, A., Molina, M. J., Tenhu, H. and Loerting, T.: Multiple glass transitions and freezing events of aqueous citric acid, J. Phys. Chem. A, 119, 4515−4523, doi.org/10.1021/jp510331h, 2015. 8. Räisänen, P., Bogdan, A., Sassen, K., Kulmala, M. and Molina, M. J.: Impact of H2SO4/H2O coating and ice crystal size on radiative properties of sub-visible cirrus, Atmos. Chem. Phys., 6, 4659-4667, 2006.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 30511, 2015.