

Interactive comment on “Microphysical processing of aerosol particles in orographic clouds” by S. Pousse-Nottelmann et al.

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Reply ([blue](#)) to comments ([black](#)) by A. Bogdan :

In the atmosphere, as in general on the Earth, water does not exist in pure state but as aqueous aerosol drops of sub/micrometer size. Cloud ice particles are formed by freezing of such drops. Since ice is highly intolerant to impurities, the freezing of sub/micrometer drops results in the formation of not pure ice but mixed-phase spherical particles: an ice core enveloped with a freeze-concentrated solution (FCS). How such coated ice cloud particles are formed and impact water vapor uptake we described in papers: Bogdan, A. and Molina, M. J. 2010, “Aqueous Aerosol May Build up an Elevated Upper Tropospheric Ice Supersaturation and Form Mixed-Phase Particles after Freezing.” *J. Phys. Chem. A*, 114, 2821-2829; Bogdan, A. and Molina, M. J. 2009, C389 ACPD 15, C389–C390, 2015 “Why does large relative humidity with respect to ice persist in cirrus ice clouds?” *J. Phys. Chem. A*, 113, 14123-14130; Bogdan, A., M. J. Molina, K. Sassen, and M. Kulmala, 2006, “Formation of low-temperature cirrus from H₂SO₄/H₂O aerosol droplets.” *J. Phys. Chem. A*, 110, 12541-12542. Further, soon after freezing, the FCS coating around spherical ice particles will surely impact the Wegener-Bergeron-Findeisen process within mixed-phase clouds. The coated ice particles will also impact the riming process. It would be a good thing if the authors will mention the phase separation during the freezing of atmospheric aqueous drops and its impact on microphysics and development of clouds. The freeze-induced phase separation is real and the authors can find pictures and videos of this process in papers: Bogdan, A., Molina, M. J., Kulmala, M., Tenhu, H. & Loerting, T. 2013, Solution coating around ice particles of incipient cirrus clouds. *Proc. Natl. Acad. Sci. USA*, 11, E2439, and A. Bogdan, M. J. Molina, H. Tenhu, E. Bertel, N. Bogdan, T. Loerting, 2014, Visualization of Freezing Process in situ upon Cooling and Warming of Aqueous Solutions.” *Scientific reports* 4: 7414 | DOI: 10.1038/srep07414.

[We would like to thank Anatoli Bogdan for the valuable comments and suggestions. We agree that a freeze-induced phase separation may have an impact on the cloud microphysics including the Wegener-Bergeron-Findeisen process and the riming process. It would be interesting to conduct a corresponding modeling study. However, a detailed discussion of the microphysical freezing process, different freezing modes and a freeze-induced phase separation is beyond the scope of our paper.](#)