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Comment on acp-2022-67

Anonymous Referee #2

Referee comment on "Retrieving ice-nucleating particle concentration and ice multiplication factors using active remote sensing validated by in situ observations" by Jörg Wieder et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-67-RC2>, 2022

Review for Wieder et al., "Retrieving ice nucleating particle concentration and ice multiplication factors using active remote sensing validated by in situ observations", submitted to Atmospheric Chemistry & Physics

This manuscript presents a method to retrieve ice-nucleating particle (INP) concentrations using a polarization Raman lidar and a Ka-band cloud radar as well as ice multiplication factors due to secondary ice production in orographic mixed-phase clouds. The retrievals were compared against in situ observations derived from a tethered balloon system at two locations: the WFJ and WOP sites at different altitudes during the RACELETS field campaign in the Swiss Alps.

Retrievals of INP concentrations and ice multiplication are both extremely poorly constrained and valuable for better constraining cloud properties. The study is thus well-motivated and using tethered balloons for ice crystal number concentration is advantageous compared to aircraft in situ probe measurements because they don't suffer from ice crystal shattering effects. However, details describing the methodology and a clear disclosure of assumptions and quantification of limitations is lacking. Specific comments follow.

- The method is not described in sufficient detail. This is especially important given the large number of assumptions that need to be made in the retrievals. For example, the method to retrieve the INP number concentration appears to use the various INP concentrations, but not a single equation for any of the parameterizations appears in the manuscript. The same goes for the ICNC retrieved by the radar under the assumption of a particular ice crystal size distribution which was not described.
- Error quantification is almost nonexistent in this work.
- Why does the lidar almost always overestimate the in situ observations at the WFJ site? I couldn't find an explanation for this.

- For the non-expert in in situ measurements, why does the ambient air need to be heated to 46C in the inlet?