2nd review of Vassel et al., ACP 2018

Summary of the manuscript acp-2018-774

The study titled "Classification of Arctic multilayer clouds using radiosonde and radar data in Svalbard" by Maiken Vassel et al. describes an algorithm for the classification of multi-layer cloud occurrence for a one year dataset in Ny Alesund, Svalbard based on radiosonde and vertically-pointing cloud radar observations. The classification is two-fold: Firstly, only the conditions for cloud occurrence based on radiosonde humidity profiles consisting of two supersaturated layers separated by a subsaturated layer are analyzed. The fall distances of a hexagonal ice crystal of 100/200/400 micron size before complete evaporation in the subsaturated layer are estimated. The subsaturated layers are then classified into two categories. The first category is called "seeding", referring to layers with a vertical extent lower than the fall distance before complete ice crystal sublimation – it was observed during 23% of the investigated days. The second category is called "non-seeding", referring to layers with a vertical extent higher than the fall distance before complete ice crystal sublimation. These maximum possible occurrence frequencies for multi-layer cloud occurrence based on supersaturated layers as identified by radiosonde ascents are then verified by cloud radar reflectivity profiles obtained within 30min before radiosonde launch and 30min after the radiosonde has reached 10 km altitude.
Multilayer mixed-phase cloud occurrence was found in 8-29% of the cases (depending on assumed ice crystal size, shape, and radiosonde humidity error) based on the combined radiosonde-cloud radar estimation..

General Comments:

The re-submitted version of the manuscript has improved with respect to the original submission by including more precise wording and extending the analysis. The authors addressed the comments made in the first review sufficiently. Specifically, sublimation calculations (of fall speed and ice crystal mass change with time) of ice crystals of varying sizes which are realistic for the considered clouds (radius of 100/200/400 microns) and their impact on seeding probability was included. The study was also extended by a sensitivity study on the influence of varying ice crystal shape (hexagonal plate, rimed column, sector plate, aggregate) in the Appendix. Moreover, a sensitivity study on how the classification results would change when considering a radiosonde humidity of +/- 5% was included in the Appendix.

The conclusion that radio sounding data alone is not sufficient for multi-layer cloud occurrence classification since not only liquid/ice saturation but also concentrations of ice nucleating particle (INP) and cloud condensation nuclei (CCN) are crucial is now made in the results- and conclusions sections but should also be mentioned in the abstract.

Also, please include a statement that no lidar Micro-Pulse Lidar (MPL) - which would have improved the cloud statistics in cases of clouds with low liquid water paths that are missed by the cloud radar - was available during your observation time period.

Even though the readability has improved, there is room for further improvement by shortening sentences or splitting them or simplifying the sentence structure.

I would suggest the manuscript to be published after minor revisions. The authors should address the following points:

Minor comments

p.8 Fig 4: Mention the assumed ice crystal shape used in the simulations for this plot.

Appendix:
p.19: Please refer to the included Table A1 in the main part of the manuscript. Table A1 should be extended by a terminal particle fall speed value for each assumed ice crystal shape.
p.20: Fig A2+A3: Regarding the radiosonde, mention that the +/-5% uncertainty is for the relative humidity.