

Review of MS No.: acp-2018-20

Title: Ice crystal number concentration estimates from lidar-radar satellite remote sensing. Part 1: Method and evaluation

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MS Type: Research article

General Comments:

The authors have provided thorough replies and explanations to all my comments/questions. I appreciate all the work they have invested into this process and which has provided the research community with a valuable tool. I have only a few specific comments.

Specific Comments:

1. Regarding the 2nd author comment and Fig. S3, please include SPARTICUS data in the analysis for Fig. S3. SPARTICUS (dedicated to sampling cirrus clouds) was conducted over a 6-month period with several flights per month. Some flights were downwind of the Rocky Mountains of North America while many others were over the ARM Southern Great Plains facility. This should provide a diversity of cirrus conditions and should thus provide representative sampling over continental regions. The other campaigns listed do not provide the long-term and spatially extensive sampling that SPARTICUS provides. I'm assuming that the ARM data indicated is for the year 2000 ARM campaign.

2. Regarding major comment/response #5 and Sec. 6.1, the cirrus sampled by the lidar-IR method in Mitchell et al. (2016; 2018) roughly correspond to visible optical depths (ODs) between 0.3 and 3.0. Most would probably agree that cirrus clouds that completely block the Sun's image are not thin cirrus, and one can just make out the orb of the Sun at a cirrus OD of 1.0 (Peter Francis, private communication). That is, the Sun's orb is not visible for $OD > 1.0$ approximately. Therefore, it is suggested that in Sec. 6.1, that the sentence appearing as "Lidar and thermal-infrared measurements indeed only provide the concentrations of thin cirrus or at cloud-top found at this temperature range, ..." be changed to "Lidar and thermal-infrared measurements indeed only provide the concentrations of **thin-to-moderately thick** cirrus or **near** cloud-top found at this temperature range, ...". This revised sentence appears consistent with the findings of Hong and Liu (2015, J. Climate).

This reviewer agrees that OD differences in the tropical cirrus clouds sampled by the lidar-IR method vs. the DARDAR-LIM method is the most logical explanation for the relative differences in tropical N retrieved by these two methods. The fact that the two retrievals exhibit similar relative differences in N in the mid-to-high latitudes is indeed encouraging.