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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The origin of midlatitude ice clouds and the resulting influence on their microphysical properties" *by* A. E. Luebke et al.

Anonymous Referee #2

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The authors have conducted an interesting study on the origin of cirrus clouds. They categorize cirrus as either in situ generated or of liquid origin. By using back modeling they have shown that the different origins can lead to different particle properties in the cirrus. I have a number of suggestions that I think the authors should consider before publication. Overall terminology: The authors state in the abstract that "It has recently been proposed that there are two types of cirrus clouds – in situ and liquid origin". For decades, cirrus clouds have been separated into "in situ" and "convectively generated" categories. The authors need to state much earlier how their categories differ from the traditionally used categories. Currently, this difference isn't stated until the beginning of the second section. Throughout the manuscript, the authors use ppmv as the unit of measure for IWC. The microphysics community generally uses grams per cubic meter.

As this is a microphysics oriented publication, I'd suggest that the authors use grams per cubic meter rather than ppmv when referring to IWC values. 34245 line 2: Re-word this sentence without "despite". Using the word 'despite' suggests that there has been controversy in this. Line 10: Is the 2002 Boudala paper still the most up to date on how ice crystals are represented in models? 34246 line 8: The large particle mode is between 40 and 100 um? This seems small when you state in the abstract that median sizes are around 200 um with large particles up to 750 um. 34248 line 1-2: This suggests that "ice only" cirrus clouds cannot form "in situ" at temperatures warmer than 235K. Line 24: The authors state that "aggregation and riming are not typically seen in cirrus environments". If cirrus environments include cirrus clouds which were formed in convective systems, then aggregation and riming do exist and are very important factors in particle development. 34251: What is the resolution of the CIP (10 microns or 15). Do you do out of focus corrections for small sizes? How much would the results differ if you used CAS PSDs out to 50 um rather than only to 20 um? Some would consider the use of the CIP for 20 micron particles to be unsatisfactory as this is where there is larger uncertainty due to depth of field and focus issues. Is Ntot calculated for all particles larger than 3 um? Section 3.1.2, the authors derive IWC from the NIXE-CAPS measurements. There are numerous publications available where mass dimensional relationships are derived from "in situ" and "convective" cirrus yet the authors use one mass dimensional relationship which was derived from the TC4 project, which was for convective cirrus. There can be large differences in particle mass when comparing in situ vs convective mass dimensional relationships. The authors need to justify the use of a "convective" mass dimensional relationship for their non convective cases. You state on 34250 line 25 that you calculate "area equivalent diameter" for CIP. Is the Mitchell et al (2010) relationship for area equivalent size? How does the Mitchell et al (2010) mass dimensional relationship compare to Heymsfield et al (JAS 61, 982-1003) where they used PSDs and CVI data in convective and in situ cirrus separately? What is the maximum particle size considered? Cirrus, especially anvil cirrus, can have particles up to 1 cm and larger. Section 3.1.4: What is the reason that you chose to

not use particle mass for each size bin from the mass dimensional relationship and instead assume that the ice crystals were spheres when calculating the modal mass diameter? Section 3.2: ML-CIRRUS was a field campaign looking at cirrus clouds over Europe where convective systems aren't as common as over North America. It would be interesting for the authors to conduct a cirrus origin study for North American field campaigns. 34256, first paragraph: Were these small ice cases near the tropopause? Tropopause cirrus in many regions contain only small ice crystals. Especially in the tropics where aviation is less likely. Aviation is likely important here, but it isn't the only source of high concentrations of small particles. 34260 line 2-3: The lack of evidence of homogeneous freezing could be due to the lack of observations of strong convection given that strong convection is less frequent in Europe. 34260 line 2-3 then lines7-17: On lines 2-3 you state that no evidence of homogeneous drop freezing was found, then on lines 7-17 you describe a "strong homogeneous freezing event". "strong events" such as you describe could be more common in North American mid latitude cirrus. Section 6: The authors should clearly state that the results shown in Figure 12 are for the ML-CIRRUS project and may not be representative of all mid-latitudes, ie. North America and Asia where more convection is common.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 34243, 2015.