Review of “Differences in microphysical properties of cirrus at high and mid-latitudes”, EGUsphere 2023-374, by Castro, Jurkat-Witschas, Afchine, Grewe, Hahn, Kirschler, Kramer, Lucke, Spelten, Wernli, Zoger, and Voigt.

This is an interesting and novel study that uses data from the CIRRUS-HL field program that collected airborne observations at latitudes from about 35^0 to 60^0N and 60^0 to about 75^0N and compares the microphysical properties (number concentration, effective diameter and ice water content) in these two “zones”. Backward trajectories are used to identify the location and basically history of the air parcels sampled. Probably very difficult to do in practice, Lagrangian aircraft sampling along air trajectories would be a better way to identify the source regions and growth/evolution of the particles along the trajectories. Also, comparing southern and northern hemisphere cirrus within these latitudinal zones would be desirable.

I have numerous comments that the authors should consider prior to accepting this article for publication.

Major Comments

It's a pity that aerosol and trace gases, which were measured on the aircraft (line 162) were not used in the analysis. These measurements could have potentially provided insight into the resulting cirrus cloud properties. Also, ice nuclei and residual aerosols collected using a counterflow virtual impactor would have been very useful as part of the analysis. If you had measurements of black carbon, you could have identified contrail influenced cirrus.

At the beginning of Section 2, it is important to have a very clear and detailed statement about particle probe measurement accuracy and the reliability of the ice water content calculations when small particles dominate. Also, the CDP sample volume may be insufficient to collect sufficient particles in small sizes to measure low concentrations of very small particles.

Line 57. Liquid origin cirrus. Why do the ice particles need to ascend in the updrafts. Couldn't it be the commonly observed cloud top liquid water regions (from satellite lidar data, Zhang and others) that form ice crystals that grow and fall out?

Lines 153-155 and elsewhere. Could any of this cirrus been generated by deep convection? Is it possible that some of the cirrus is due to anvil from upstream convection?

Lines 237-238. Don't you have a liquid water probe or RICE probe? Relative humidity would also be sufficient to discern regions where liquid water was observed. Perhaps the temperatures are sufficient to rule out liquid water. Nonetheless, I feel that you are limiting your observations that could potentially result in misleading conclusions.

Line 242. I think that 10 sec is preferable. I suggest comparing 10 to 2 seconds. Later, you compare later measurements but it think all the comparisons should be done with 10-sec averages.

Lines 251-253. Could you determine whether commercial aircraft crossed the trajectories by using commercial aircraft tracks?

252, 262. How do you derive the IWC along backward trajectories. How about generating cells, snowbands, etc? How about generating cells, gravity waves, etc.

Figure 2. Add another panel that shows temperature would be very useful.

Table 2. IWCs below about 0.01 g/m3. How do you possibly derive accurately these very low IWCs. Is the mass dimensional relationship you cite reliable at the very small sizes associated with the low ice water contents?

Satellite-based radiometric measurements could be used to evaluate your findings.

Section 5. Very nice sensitivity studies

Minor Comments

I have a lot more minor comments but these are the main ones.

Line 1 significance>importance

9-11. How good are the small particle measurements-that could account for the differences you find in your analsysis.

20-21. How do you know this with certainty

22: scarce>relatively few

24-26. Important finding

45-47. In-situ generated cirrus form....

45-47. Cirrus can also form by cloud top radiative cooling without the need for lifting.

99-101. Concentration also decreases because the growing ice crystals have an increasing fall velocity.

188-190. The probe at minimum number counts would be 25/liter, which is often the concentration of ice in cirrus.

236. allows us to

348-350. Would this show up in back trajectories?

Figure 5 is really nice. It makes a strong case for your interpretations.

454-455. Not necessarily ascending motion.

Figure S3. Sensitivity rather than Sensibility.

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