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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Meridionally-tilted ice cloud structures in the tropical Upper Troposphere as seen by CloudSat" *by* J. Gong et al.

Anonymous Referee #2

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Review ofÂă"Meridionally-tilted ice cloud structures in the tropical Upper Troposphere as seen by CloudSat", by J. Gong et al.

The authors present excellent research that fits very well in ACP. The research is important and well-performed. However, the presentation could be significantly improved. Therefore, I recommend publication with minor revisions.

Please find specific comments below.

Page 24919, line 9: The authors mention the vertical levels of 5 km and 9 km. They argue that 5 km is roughly the freezing level. This is mostly true in the tropics, but judging from Figure 1b, the work is not limited to the tropics. Is this limit still valid? Secondly, how do the authors arrive at the 9 km boundary?

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Page 24919, line 15: The authors interpret asymmetries as northward/poleward. Close to the equator, the ground track of Cloudsat is close to perpendicular to the equator (8° angle with the poleward direction). To interpret to what degree asymmetries can be directly translated to north-south asymmetries as opposed to east-west imbalances, it would be instrumental to have a simple diagram showing the angle between the Cloudsat groundtrack as a function of latitude. This can clear any doubts as to the attribution of observed asymmetries to north-south as opposed to east-west phenomena.

Page 24919, line 15: The northward tilt is not immediately obvious. It appears the methodology to calculate this is outlined only in page 24920, up to line 18. The methodology to arrive at the blue line should be explained before the northward tilt is described.

Page 24920, line 8: With "randomly" distributed, I suppose the authors mean randomly distributed according to a uniform random distribution. If ice is randomly distributed according to a non-uniform random distribution, the observation that the different paths would yield the same IWP may no longer hold.

Page 24920, line 15: The authors name the number of 77°, but explain only further down at line 24 how they arrived at this number. Please explain the calculation of the view-angles before giving this number.

Page 24921, line 2: Here, the authors say interpolation was not conducted. However, on page 24920, line 25, the authors say the IWC profile is initially interpolated. I'm confused. What did the authors do?

Page 24921, line 4: The authors talk about tropical ice clouds. However, the maps clearly extend to the extratopics (how far? 35° or so?), and figures 1b and 2b clearly do not relate to the tropics. Is this method still valid?

Page 24921, line 5: "...extend form 5 to 17 km...", please show this or give a citation.

Page 24922, line 1: "differentiating" is not the right word here, you are (as I understand it) taking the difference between slant northward and slant southward. Differentiating

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would yield the vertical gradient of IWP or so.

Page 24922, line 11-15: Here the authors address that the Cloudsat orbital track is not perpendicular to the equator. Could you please elaborate a bit more on how this affects interpretation of the results? I think you are treating it too quickly here.

Page 24922, line 19: Please explain in a quantitative manner how you reached the number 13°

Page 24924, lines 12-17: I think it would be valuable to show some of these results for 5-11 km. Does Figure 5 show this? Then the authors should refer to Figure 5 from the text here.

Page 24924, lines 17-18: What is the level of statistical significance that the authors describe as "barely significant"?

Page 24925, lines 1-4: Please briefly explain what is meant by primary, secondary, and innermost domain, as not all readers may be familiar with those terms.

Page 24925, lines 5-6: Please indicate this domain on a map.

Page 24926, line 9: Why do you integrate "upward"? Why is the geometry of integrating from 5 to 11 km different in integrating from 11 to 5 km? The integrated IWP does not depend on the direction of integration.

Page 24926, line 20: Authors go from Figure 5 to 7 (and later 6). Please fix the order of the figures.

Page 24926, line 20: Are these results now from CloudSat, DARDAR, or WRF?

IWP has almost the same magnitude, but opposite sign, as nadir IWP. That would mean slant IWP is close to 0. Clearly I'm misunderstanding something? Why does Figure 7 (left panels) look the way it does?

Page 24927, line 4-5: Could you quantify this relation with an equation?

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Page 24927, line 8: Please explain a bit more on the two completely different definitions of delta-IWP used in this paper, preferably in the methodology section. It's not really clear to me. Surely if cloud mass is tilted, we should see tilt both from above and from below? This could use an illustration, similar or added to Figure 1.

Page 24927, lines 21-26: One more problem that is not explained is why the sign is different at 5 - 11 km (Figure 5)

Page 24928, line 13: How would this explain the "upward and inward" tilt?

Page 24935, Figure 1a, 1b: it would be helpful to add the date to these figures, in a somewhat easier notation than "day of year".

Page 24935, Figure 1c: The way it is currently drawn, it appears that the slant paths are longer than the nadir path. Instead of drawing a diagonal through the northward and southward views, it would be more correct to draw a vortical line in the middle of each of the green and yellow squares. Then it would become more apparent that the slant path has the same length as the nadir path.

Page 24937, Figure 3: The maps would be somewhat easier to place if the authors would draw lines of longitude and latitude, and label those at the edges of the map. The continents are highly deformed so the user might need to puzzle a bit before realising what area of the world is shown. It is also very relevant where the equator is. Secondly, the authors might want to consider a more appropriate map projection (any pseudocylindrical projection would do)

Page 24937, Figure 3: The contour lines are not very obvious, and the gradient of the contour lines is unclear. I would recommend the authors to explore a clearer way to visualise both IWP and the tilting thereof.

Page 24939, Figure 5: Same comment as earlier. Please add lines of longitude/latitude and/or tick marks, and show more clearly what contour corresponds to what value of IWP.

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Page 24941, Figure 7: Please add ticks to the right y-axis, indicating the values of the absoluwe IWP. It seems strange to use the same axis to indicate the difference and the absolute value.

Page 24941, Figure 7: Please add the seasons in the figure caption.

Editorial comments:

Page 24916, line 9: Replace "little" by "less"

Page 24917, line 1: Replace "require" by "requires"

Page 24918, line 26: Add "the" before "CloudSat"

Page 24919, line 8: Add "the" before "CloudSat"

Page 24919, line 12: Replace "showed" by "show"

Page 24919, line 23: Replace "good" by "well"

Page 24920, line 28: Replace "resulted" by "resulting"

Page 24924, line 12: Remove "the lower level" (duplication)

Page 24925, line 15-16: I would suggest to write: "...interpolated to 250 metre vertical and 1 km vertical resolution". As short as now and more readable.

Page 24925, lines 17-20: Swap those lines around, they are confusing now.

Page 24927, line 25: Replace "slopping" by "sloping"

Page 24928, line 3: Remove "that"

Page 24928, line 6: Replace "structures" by "structure"

Page 24935, Figure 1: Please make sure all labels are large enough to be readable

General: In many places, the authors use the compact notation such as "a positive (negative) value means it tilts northward (southward)". I think it would benefit readability

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to describe this more verbosely, i.e. "a positive value means it tilts northward, whereas a negative value means it tilts southward" or "...means the opposite" or so.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 24915, 2014.

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