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Atmospheric Chemistry and Physics Discussions

Interactive comment on "16 year climatology of cirrus clouds over a tropical station in southern India using ground and space-based lidar observations" *by* A. K. Pandit et al.

Anonymous Referee #2

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Review of "16 year climatology of cirrus clouds over a tropical station in southern India using ground and space-based lidar observations" by Pandit and coauthors.

Summary

This manuscript summarizes the comparison of ground and space-based lidar observations over Gadanki, a tropical location in southern India. 16-yr of night-time ground based lidar observations are evaluated against 6.5 yr of space-based CALIOP observations for both day and night-time cases. The main objective is to understand discrepancies in statistical comparisons of cloud frequency, altitude, thickness, temperature,

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and optical depth between the two datasets, and to use the dataset to understand long-term trends in altitude and optical thickness of sub-visible cirrus clouds using the 16-yr ground based dataset. The primary finding is that mid-cloud altitude of sub-visible cirrus clouds is increasing and optical depth is decreasing over the long-term. This finding is consistent with climate model predictions of a warming climate.

The bulk of this manuscript is a straightforward analysis of the climatology of cirrus clouds, very similar to previous studies in other locations, all of which have been referenced by the authors. This study focuses on a region of the globe that is underrepresented in terms of long-term statistical data records, which is relevant and important to have reported in the literature. Though the statistics do not bring to light any new findings. The trend analysis is by far the most intriguing result of this study and should be better emphasized in the title and abstract (more on this below). Overall the manuscript is well written (though could use a technical editor) and organized. I recommend that the manuscript be accepted after some revisions and clarifications.

Specific Comments

1. Abstract and Title: The abstract and title mainly reflect the climatology portion of the work, which is the bulk of what is presented. But the trend analysis is also important and suggest you add specific language in the abstract about the magnitude of the trends and their link to signatures of climate change. Also, you modify the title to draw some attention to the work. Suggest "Long-term trend analysis and climatology of tropical cirrus clouds using 16-yr lidar dataset over southern India" or something similar.

2. P. 15800, Line 14: "Data product is known as. . ." suggest "We use the feature optical depth data product from the CALIOP level-2 data product."

3. In many places you discuss the differences in cloud thickness or altitude between the two datasets, but you do not consider the differences in vertical resolution of the two lidar systems as a possible source of the discrepancies. This needs to be discussed

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in many instances. You could start with a discussion in the methodology section about the relative sensitivity of the two lidar systems (i.e. signal to noise ratio) and the vertical resolution differences. You mention a 5 km CALIOP cloud layer product. This is very large! For NARL you state 300 m. This is a big discrepancy. Please address how you handled these differences in your analysis.

4. Discussion on P. 15801 and 15802, Frequency and maintenance of tropical tropopause layer (TTL) cirrus clouds: You state that the formation of cirrus clouds in the tropics is due to deep convective clouds. Yes, this is true for some tropical cirrus, but the TTL cirrus is not necessarily formed by deep convection, but can be the result of stratospheric waves (Boehm et al.) or can self maintain for up to 2 days through cloud radiative heating processes (Dinh, et al. 2010). You need to consider these studies in your discussion. TTL cirrus can last for days and has been shown to do so by many. If there is a discrepancy between day and night time TTL cirrus occurrence, then it is due to instrument sensitivity during the daytime. Please address these issues more quantitatively in the discussion of the results.

5. Last sentence of Sec. 4.1: This statement should be removed because it is not a legitimate physical difference but an artifact of the instrument.

6. Again on p. 15803 Lines 13-15: we can't definitely conclude that the day-night differences are a real atmospheric phenomenon because of the instrument issues.

7. P. 15804: The tropical tropopause is not well defined. How are you identifying the tropopause?

8. P. 15805, lines 10-15: Could this discrepancy be the vertical resolution or sensitivity issue?

9. P. 15806: How accurate are the NARL optical depths <0.01? what is the uncertainty?

10. P. 15807, Lines 20-22: I believe this is an instrument detection issue in daytime

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coupled with vertical resolution.

11. P. 15808, last paragraph: you should acknowledge the reasons for the differences in cloud properties in these temperature regimes is due different cloud formation mechanisms. See (4) above.

12. P. 15809, line 15-16: Why not use cloud top temperature for this analysis? Mid-cloud height has thickness and cloud altitude influences. Cloud top altitude would be the trend in altitude alone. Are the trends robust for cloud top temperature? Please add to the discussion.

13. P. 15809 Line 23-25: Do you expect that midlatitude cirrus would have similar trends? I would not expect this because midlatitude clouds are primarily synoptically forced and the dynamic feedbacks might be different in each case. Do you have any thoughts on why optical depth would be decreasing in a warming climate?

14. Figure 1 font sizes are much to small to be legible. Hopefully the final version will be a large portion of the page.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 15791, 2015.