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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Characteristics of particle size distributions in the tropical tropopause based on optical particle counter and lidar measurements" *by* S. Iwasaki et al.

Anonymous Referee #2

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Referee Comments of "Characteristics of particle size distributions in the tropical tropopause based on optical particle counter and lidar measurements" by S. Iwasaki, K. Maruyama, M. Hayashi, S. Ogino, H. Ishimoto, Y. Tachibana, A. Shimizu, I. Matsui, N. Sugimoto, K. Yamashita, and The OPC team.

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I recommend that this paper will be accepted for publication after satisfactory response to my comments and questions below.

This paper contains the following original materials for understanding the cirrus cloud

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Interactive Discussion
Discussion Paper

formation in the tropics using the data based on the in situ measurements.

(1) This is the first attempt to use the observational data obtained from both OPC and lidar, in order to understand the characteristics of subvisible cirrus clouds (SVCs) during the transition period from dry season to rainy season of the Asian monsoon at Sri Samrong in Thailand. (2) This study showed the different characteristics of cirrus clouds between the middle and bottom of the Tropical Transition (or Tropopause) Layer (TTL) quantitatively, and the values of parameters related to SVCs (e.g., size distribution) which are almost the same as those found by the previous airborne measurements. (3) This research pointed out the possibility that the deep convection in the vicinity of observation point influenced the mechanism of the formation of SVCs.

[Specific Comments:]==========

I have several suggestions bellow. ('l' and 'p' refer to line and page, respectively.)

(i) Mechanism of ice nucleation

Although the characteristic of ice particles in the tropical SVCs was shown well using the data derived from in-situ measurements, there is insufficient explanation about the ice nucleation mechanism. There are mainly four parameters (temperature, water vapor amount, CCN and vertical velocity) which affect the formation of ice particles. Without clearly showing these parameters, the present study has suggested that the deep convections in the vicinity of the observational point are main causes for cirrus formation. Also, the mechanism of cirrus formation by the deep convection has not been indicated clearly. Figures which explain the observational parameters (i.e. temperature profiles of each launch, Horizontal map of GMS or GOES, time-height section of backscatter ratio of lidar and so on) are needed to clearly show the mechanisms of cirrus cloud formation in detail.

(ii) Reliability of lidar observational data

The manuscript described (in l.11 on p.1601) that the lidar can observe the atmosphere

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up to 14 km with good accuracy under clear sky. Therefore, are the backscatter ratios (of cirrus clouds probably) at about the altitude of 17 km shown in Table 2 not reliable? From Table 2, it can be seen that the lidar measurements show consistently higher altitudes of cirrus clouds than those of the tropical tropopause (TT) derived from the OPC observation. Does this (i.e. the difference of cirrus altitudes between the OPC and lidar measurements) originate from the bias in lidar measurements? Please show us the plot of backscatter ratio of lidar during the observational period (or the period of the OPC launched) as a function of time and altitude to verify the cirrus cloud height detected by the lidar.

First of all, the TT (Tropical tropopause) should refer to a surface; however the data derived from the OPC measurement (May and June) are shown as layers. You need to put a clear definition of TT in the text. The reader may be confused; which (i.e. TT or TTL) is correct for some cases in the text?

Further suggestions follow.

— English usage & Verbiage —

As mentioned above, the author should be consistent in their uses of the abbreviations, "TT" and "TTL". There are many erroneous usages of these in this paper. Example in Abstract, l.7 and 20 : in the TT -> at the TT

Please put the clear definition of "TT (Tropical Tropopause)" used in this study in the text (l.14 on p.1602). Is the definition of the tropopause in this study a cold point temperature? Also, please explain the reason that the temperature colder than -75C is assumed as the threshold for the "TT" (l.23 on p.1602).

– Title —

“On the tropical tropopause” should be changed to "in the tropical tropopause layer.”

— [Section 2] —

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In expression (1), how should we read "delta Csca" and what does "sca" stand for?

— [Section 3.1] —

A map showing the horizontal convective activity using the data from the GMS and GOES during the observational period will be interesting and helpful in order to more clearly understand the cloud variation. Also please add the description about the characteristics of convective activity during the observational period briefly in the text.

Are there any other studies which use the lidar data at Sri Samrong? Please show us the characteristic of cirrus clouds detected by the lidar at Sri Samrong, for example, seasonal cycle of top and bottom heights and vertical profile of occurrence frequency.

— [Section 3.2] —

I recommend that the temperature and mixing ratio of saturated water vapor at the TT are added to Figure 2. Is the onset date of Monsoon at Sri Samrong derived from the precipitation data? If so, please add the precipitation data in Figure 2 as well.

l.18 on p.1602: Just because the cirrus clouds in the TTL happen to be observed frequently during the rainy season, it cannot be concluded that the occurrence of cirrus increases during the monsoon season in general. Rather, the sentence in the text should be rewritten like as follow. "This study mainly investigated the characteristics of cirrus clouds during the rainy season."

As suggested above, the explanation of the TT (tropical tropopause) is required in this section.

How does the interdiurnal variation of the launch time of the OPC influence the results?

— [Section 3.3] —

It makes no sense that the figures 3 (a) and (b) show the different values for the same supposedly profile (e.g 26 March). Did you divide one profile into the data with and without clouds for describing Figures 3 (a) and (c)? It makes sense if Figures 3 (b) and

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(d) were drawn by the only data associated with the layers where clouds exist. Please show us the all profiles of OPC for validating the cloud layers at each profile.

l.4 on p.1603 : The values of regression line are different from the ones mentioned in the caption of Figure 3.

l.6 on p.1603 : The profile of 26 May deviates from regression line at 0.3um. Can you conclude that 0.7um is a representative value for all profile?

— [Section 3.5] —

l.12 on p.1604 : Figure 5 is too small to clearly see. The profiles of three days that you mentioned are not found. You should remake figures and describe these three days in the text.

— [Section 3.6] —

l.21 on p.1604 (probably...): Is it possible that the difference of vertical resolution between OPC and lidar cause the differences of cirrus' altitude?

Since the temperature and height variations at the tropopause are most likely small within the synoptic scales, are the differences in height caused by the bias (or noise) of lidar measurement rather than the difference of spatial variations of clouds (or temperature)?

Do the lidar and OPC provide consistent data on cirrus height at the altitude between 10 and 15 km where the precision of a lidar is generally quite good?

— [Section 4] Discussion —

l.17 on p.1606 (... activity frozen.): What causes activity frozen (frozen activity?)? cooling or/and quick vertical movement of humid air?

l.19 on p.1606 (Only once was...): Table 2 indicates that on 1 June, the temperature and height of the TT is lower than the data of other days. Is the local maximum of size

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distribution at 10-15km on 1 June caused by this minimum height of TT?

l.4 on p.1607 (...therefore indicate that ...): It is not appropriate to conclude that the all profiles of the cirrus result from a single type of mechanism, because each profile most likely has experienced different weather condition. The weather conditions (i.e. the temperature and water vapor distributions) that might alter the characteristics of cirrus in the TTL should be provided to clarify the mechanism of cirrus formation.

l.10 on p.1607 (Computer simulations...): To illustrate the mechanism of ice nucleation, you should add the information about the calculation condition of computational simulations in much more details.

— [Section 5] Summary —

l.16 on p.1607: The authors show no evidence (figure) to support their argument that cirrus was created under the influence of deep convection. It makes readers suspicious of the validity of this argument.

— Appendix A —

l.25 on p.1608: You should add the method or condition of how each threshold was derived in this section.

l.6 on p.1609: Model C is not found in Figure 6.

— Tables —

Table 2: The definition of TT used for this study should be added.

— Figures —

You should rewrite the captions so that the readers can understand what you are trying to say with each figure even without reading the main body of text.

The figures are too small and not clear.

Figure 2 : The upper leftmost mark at top of Figure 2 ("x") is not shown in Table 2.

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The time scale in Figure 2 (i.e. bottom axis) should be expressed in date rather than Julian day.

The explanation of the Tbb data source (GMS and GOES) should be clearly indicated in the caption of Figure 2.

Figure 5: Please add the value of the slope of the regression line to the caption of Figure 5.

Figure 6: Please add legends to this figure. Which threshold corresponds to which dotted line ?

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 1595, 2007.