The reviewed manuscript presents an extensive study of cirrus clouds observed over the coastal station in Indian Kattankulathur in 2016-2018. The authors provide a comprehensive overview of cirrus cloud physics and their role in atmospheric radiative balance. The research is topical, the methodology presented in the article is sound, and the paper is well structured and written (except for some language issues listed in "Other comments"). I believe it can be published if the authors consider the comments and fix the issues indicated below.

Minor comments:

The authors state (line 353) that "the diurnal structure of the cirrus occurrence is of its first in kind". However, I can name at least two studies that yielded the diurnal cycle of cirrus clouds on a global scale. The first one (Noel et al, 2015) used space-borne lidar CATS operating between February 2015 to October 2017. This period overlaps with the period analyzed in the manuscript, and I believe it makes sense to compare the results with those of (Noel et al., 2015). An extensive analysis is not required, but at least some general comparisons should be made and discussed.

In the second work (Feofilov and Stubenrauch, 2019), high clouds have been retrieved from two space-borne infrared sounders, AIRS and IASI, which observe the atmosphere both day and night and their daytime SNRs are the same as the nighttime ones. Even though Fig. 5 and 6 of this work show that the diurnal cycle is not that pronounced at the considered location, I tried to compare its properties to those reported by the authors of the reviewed manuscript. For this, I retrieved the amplitude and peak time values for the point closest to (12.82N, 80.04E) from the publicly available dataset (doi:10.13140/RG.2.2.13038.15681) and analyzed the data.
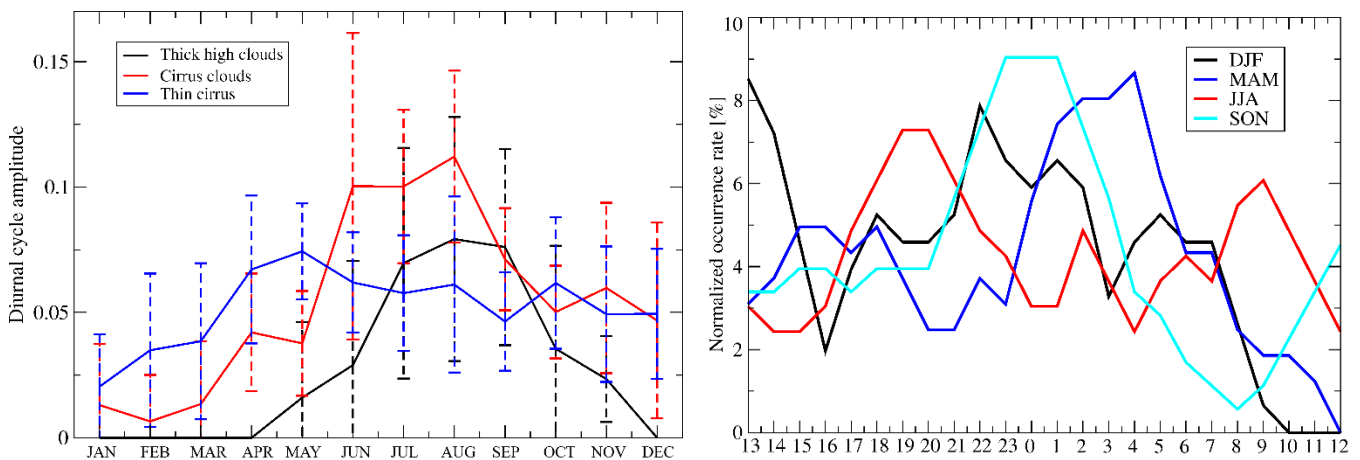

Figure 1. Diurnal cycle of high clouds (P<440 hPa) retrieved from a combination of AIRS and IASI space-borne infrared sounders (Feofilov and Stubenrauch, 2019) in 1ºx1º bin containing the point (12.82N, 80.04E), to be compared with Fig. 5 and 6 of the manuscript under review. (a) diurnal cycle amplitude; (b) occurrence rate of peak time values for DJF, MAM, JJA, and SON for thin cirrus clouds.

The direct comparison is hindered by differences in the cirrus cloud definitions between the reviewed manuscript and in (Feofilov and Stubenrauch, 2019), differences in sensitivities, wavelengths, and observation geometry. Still, one can see a correlation between the monthly occurrence of cirrus clouds (Fig. 6 of the reviewed manuscript) and the diurnal cycle amplitude (Fig. 1a) and between the peak times occurrence frequency for DJF, MAM, JJA, and SON (Fig. 1b). The latter plot is a combination of single- and multi-layer clouds because the infrared sounders use to retrieve the upper cloud in the case of a multi-layer cloud. Therefore, it should be compared to a weighted average of Fig. 5a and 5b of the manuscript. One can note that JJA peak of Fig. 1b corresponds to JJA peak in Fig. 5a of the manuscript,

MAM peak of Fig. 1b corresponds to MAM peak of Fig. 5b, whereas DJF and SON peaks correspond to a superposition of Fig. 5a and 5b. Further analysis is beyond the scope of this review. The main purpose of this exercise was to put the results obtained by the authors in a more general context. The authors are encouraged to develop this further themselves.

Line 30: Please, specify the heights and/or state that the effect applies to the whole column.

Line 56: To my knowledge, the probability of inhomogeneous nucleation is much higher than that of homogeneous one. The way the phrase is formulated makes one think that their probability is comparable and homogeneous one might be even more preferable.

Line 110, Eq. 1: I would expand alpha and beta coefficients and add the coefficient of multiple scattering here. By the way, what is the value of this coefficient for the MPL lidar? Does it affect the analysis?

Line 154: Indeed, the vertical smoothing increases SNR. But, wouldn't it be better to average in time and keep the original vertical resolution? What is the rational for vertical averaging?

Line 164 and elsewhere (e.g. line 284): the authors mention the difference between daytime and nighttime SNR. Indeed, the sensitivity of cloud detection is not the same for daytime and nighttime, and clouds of certain type cannot be detected during the day. Normally, this should reduce the diurnal cycle retrieval only to optically thicker clouds, but I do not see a clear threshold defined for the analysis. Another methodological issue I see here is the attenuation of the backscattered radiation. This does not affect the lower cloud boundary detection, but it might affect the upper boundary and if the photons are absorbed then there's no information coming from the upper layers. This makes these layers indistinguishable from clear sky. I did not get whether the methodology described in lines 155-164 manages to tell the attenuated signal from clear sky one. I would say that the reference molecular backscatter profile could be estimated from atmospheric pressure/temperature profile and added to the analysis, but I do not see this in this section. Could you, please, clarify?

Line 336: color scale is missing for Fig. 4

Lines 347-348: how does this statement match the main purpose of the manuscript, which is the diurnal cycle retrieval?

Lines 410-411: how to tell the increase in sedimentation load from other reasons for the descending? What is the proof of this statement?

Lines 434-439 and elsewhere: sometimes, the term POC (percentage of occurrence of cirrus) is used as some cloud type: "the lower layer of POC", "the POC has a limited vertical extent", and so on. Strictly speaking, the POC has no vertical extent, it's just a percentage. This misusage is misleading. Please, fix it throughout the whole manuscript.

Lines 562-564: where is the proof of this relation? What are the values of Pearson's correlation coefficients for the interannual variation and ENSO or QBO strength?

Line 618: please, add the uncertainty values to each occurrence rate value here and elsewhere.

Lines 623-624: please, see the comment to lines 347-348 above

Other comments:

Line 30: "have net warming" – please, reformulate

Line 353: "is of its first in kind" – language issues

Line 299: "shaper and colder" – I didn't get what is meant here

Line 498: "at" is missing in "POC is higher altitude"

Line 506: please, change "May month" to "month of May" or just to "May"

Line 525: "11778 hours lidar was operated", please rephrase

Line 599: "at relatively higher altitudes": please, change either to "at relatively high altitudes" or to "at higher altitudes" depending on what you want to say here

References used:

Noel, V., Chepfer, H., Chiriaco, M., and Yorks, J.: The diurnal cycle of cloud profiles over land and ocean between 51° S and 51° N, seen by the CATS spaceborne lidar from the International Space Station, Atmos. Chem. Phys., 18, 9457–9473, https://doi.org/10.5194/acp-18-9457-2018, 2018.

Feofilov, A. G. and Stubenrauch, C. J.: Diurnal variation of high-level clouds from the synergy of AIRS and IASI space-borne infrared sounders, Atmos. Chem. Phys., 19, 13957–13972, https://doi.org/10.5194/acp-19-13957-2019, 2019.