RC2: 'Comment on amt-2022-80', J. Yorks, 08 Jun 2022

This paper investigates the satellite sampling of cloud amount and cloud top height from several sun-synchronous satellites hosting lidar instruments compared to SEVERI. The paper is well written, clear, and provides results that are important for designing future space-based lidar mission architectures. It deserves to be published after a few minor revisions that I believe will strengthen the paper.

My 2 major comments are:

- Diurnal variability: It is not clear to me what role diurnal variability plays in this sampling study. Based on #3 on line 156, I believe only Meteosat data from the time of the satellite overpass was used in the "truth" dataset. Is that true? If so, your monthly and annual averages are biased to the times of the overpasses and thus diurnal variability will not be accounted for. That is fine for assessing the sampling at the equatorial crossing times of each satellite, but that needs to be explicitly stated in the paper. If the SEVIRI "truth" dataset DOES include clouds from all times of day, then the geographical distribution of absolute differences in CA/ CTH estimations (Figure 2) will be influenced by diurnal variability of CA or CTH. This pattern (1-day climatology was most accurately reproduced by n-day data at high latitudes but with lower accuracy at lower latitudes) would also be more consistent with where the largest diurnal variability was reported by Noel et al. (2018).

  Reply: The first conclusion of the Reviewer is correct. Simulations used the exact (actual) pass time of the lidar mission (a single Meteosat observation per day, per mission was used). The high (15-minute) temporal resolution of Meteosat was key, since it made it possible to select an observation that was closest in time to the lidar's overpass. Monthly/ annual means are biased to the overpass time (as in real lidar-based climatologies from sun-synchronous missions), and that was also the assumption used in this research.

  Clarification has been added, as suggested by the Reviewer (see lines: 165-167).

- Big picture impacts: The author does a great job discussing what these results mean for future lidar missions in the Conclusion. But after reading the paper, I found myself asking - what does this means for current data users? For example, if I want to use the data from these missions to compute global, annual cloud radiative effects based on CA and CTH, I can do that confidently. However, if I want to compute radiative effects at seasonal/monthly and regional/finer spatial scales, the CA and CTH from these lidar datasets may be biased based on Table 4. That is an important point for data users and will make this paper worth citing for future authors. I suggest adding a few sentences on this topic to the Discussion or Conclusion.

  Reply: Comments have been added to the Discussion (see lines: 423-430).

The 4 minor comments to be addressed are:

- Table 1: Do all these satellites have a 98-degree inclination angle? If not, I suggest adding an inclination angle column to this table since it impacts the repeat times.

  Reply: Orbital inclination has been added to Table 1, as suggested.

- Line 66: I suggest citing Yorks et al 2016 for CATS as it is more of an overview paper. The citation is: Yorks, J. E., M. J. McGill, S.P. Palm, D. L. Hlavka, P.A. Selmer, E. Nowottnick, M. A. Vaughan, S. Rodier, and W. D. Hart (2016), An Overview of the CATS Level 1 Data Products and Processing Algorithms, Geophys. Res. Let., 43, doi:10.1002/2016GL068006.

  Reply: The reference has been updated to Yorks *et al.* 2016. as suggested.

- Line 110-111: Are there any papers that reports the accuracy of CA and CTH from the SEVIRI products? If so, I suggest adding a sentence to report those accuracies and cite those papers. I know that doesn't impact the results of the study, but I found myself wondering what the accuracies are as I read the paper.

Reply: Accuracy measures have been added, as suggested (see lines 115-119).

- Line 445-446: This is a highly relevant point for future architecture designs. Did you consider looking at the ISS to provide a reference point for a lower inclination angle? I know it would be more work, but I think it would really strengthen the paper to add the ISS to this analysis. At the very least, it would be beneficial to add a sentence or two about the ISS revisit time and where it may fall compared to the satellites you studied.

  Reply: Yes, I did consider the ISS, but eventually decided to only base the study on polar orbiting satellites. This was because I wished to investigate lower inclination satellites separately, focusing not only on the ISS (and ISS+CALIPSO), but also the anticipated architecture(s) of the future Atmospheric Observing System (AOS). At the present moment, I have no results that would allow me to draw any conclusions regarding how the ISS compares with polar orbiters (it requires a full-scale study; I prefer not to speculate).