Reviewer #1 (General Comments)

The authors present an algorithm to retrieve nighttime aerosol optical thickness (AOT) over areas where artificial light sources exist using VIIRS day/night band. The present method improves their previous work introduced in Johnson et al. (2013) in terms of retrieval accuracy at four study locations, and easier application to large scale processing without prior knowledge about aerosol optical properties. This work is scientifically significant in that it can eventually provide more complete diurnal cycle of aerosol loading over broad areas and help improve aerosol forecasting skill of numerical models. The manuscript is well written, with a nice flow and structure. However, the short-term study period hindered to quantify quite obvious error sources, such as the moonlight and viewing geometry, due to insufficient number of data samples. The reviewer believes that the work can further be improved if the study period is extended to resolve the issue.

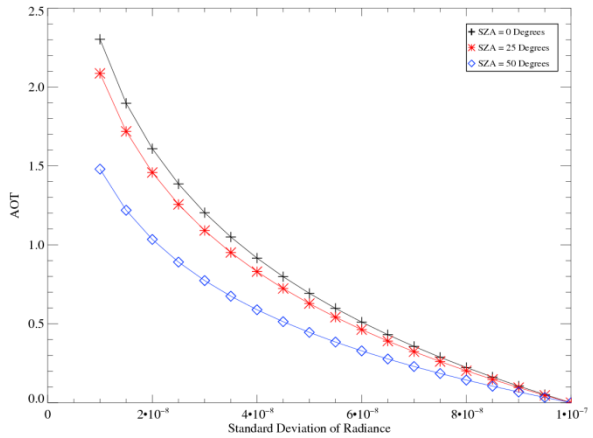
We thank Referee #1 for his/her constructive comments and suggestions. The reviewer has a very nice point and we agree that the short study period hinders the conclusiveness of the sensitivity studies performed, especially those relating to potential error sources; however, we would like to keep the same study periods for a few reasons. First, we consider this paper primarily a demonstration of concept. Second, we have adopted these from Johnson et al. (2013) so a paired comparison can be made between the two methods, and wish for this comparison to remain the focus along with the concept demonstration. Still, we have added the Huntsville site to compare with the HSRL measurements, providing additional validation for the method. Third, the short study periods are selected to ensure the relative stability of artificial light sources. For a longer study period, the seasonal variations in artificial light sources will need to be accounted for, which is beyond the topic of this paper and is a subject of our next planned study. Also, to gain enough data samples for the error source analysis, doubling of the study periods for the selected sites is less likely to be sufficient, especially after AERONET data availability for the chosen sites and additional cloud screening. In fact, we attempted to increase the study period as suggested by the reviewers and ran into these issues. We are currently working on a new study that explores the method on a much large spatial domain, which should give us a data sample that is sufficiently large enough to explore the mentioned error sources. The following discussion has been added at the end of Section 4:

"A major caveat regarding the previously discussed sensitivity studies that has been mentioned is sample size. While these sensitivity studies appear to be relatively inconclusive, the study period has not been extending to achieve statistical robustness for a few reasons. The first is that the primary goals of this study are to demonstrate the efficacy of the variance method and to compare the results directly with the results presented in Johnson et al. (2013). Second, the short study periods are selected to ensure the relative stability of artificial light sources. For a longer study period, the seasonal variations in artificial light sources will need to be accounted for, which is beyond the topic of this paper and is a subject of our next planned study. Third, a regional scale study is underway that will increase the sample size by an order of magnitude; this should be sufficient enough for conclusions regarding error sources to be made."

Specific comments:

1) It would be helpful to include a plot that graphically shows Eq. (6). For example, variance of the observed radiance as a function of AOT for certain variance of artificial light source and viewing geometry. This would help to understand how sensitive AOT is with respect to errors in the variance of the observed radiance.

Response: This is a nice suggestion and a figure as described (below) has been added to the paper.



2) The sensitivity study shown in Figs. 2-4 would benefit from a longer-term evaluation. The reviewer highly recommends to extend the study period at least at one location for more decisive conclusion about the effects of error sources.

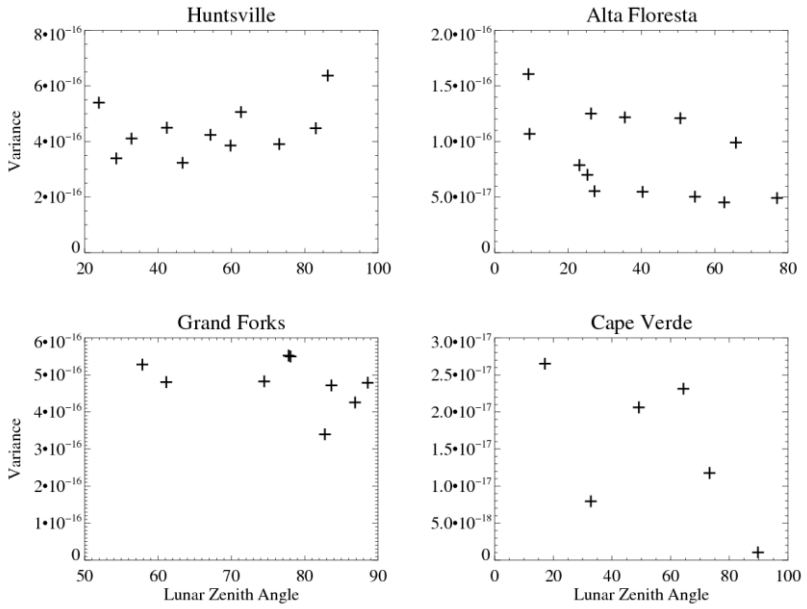
Response: We agree with the reviewer in that a longer-term evaluation is required, however, the purpose of this study is to introduce the variance method and investigate the efficacy of said method, while introducing potential sources of error. Indeed, there is lengthy discussion about potential sources of error, however, the authors have concluded (and acknowledged in the paper) that a conclusive examination on the errors sources, especially those relating to the moon, would require a much larger study than is performed here. Merely extending the study period of one (or even multiple) site(s) would likely not provide sufficient data samples for a robust error analysis, therefore the authors have decided to hold off on conclusions relating to error sources until a regional scale study can be performed. As mentioned above, discussion has been added to the paper to clarify these issues.

3) The authors tested the effect of lunar fraction (Fig. 3) at Huntsville where the variance of the observed radiance showed smallest relationship with lunar fraction in Fig. 2. This is likely due to lack of lidar measurements at other locations, and including similar plots to Fig. 3 except for as a function of AERONET AOT at the other locations would be helpful.

Response: While this is a constructive suggestion, the other sites do not lend themselves well to this type of analysis. Huntsville AOT as indicated by the HSRL data is fairly consistently within 0.1-0.4, allowing for enough pairs of data points with similar enough AOT to be worthwhile. After looking at the data, Alta Floresta has one pair of retrievals with similar AOT and sufficiently different lunar fraction, Grand Forks has two, and Cape Verde has none. And while these points could simply be added to the current plot, we feel the differences between each location and between HSRL retrievals and AERONET overnight estimates are enough such that they should not be plotted together. We will keep this suggestion in mind in the future.

4) It would be helpful if the authors could include analysis/make comment on the effect of lunar geometry (in addition to the lunar fraction) on the variance of observed radiance.

Response: Discussion regarding lunar zenith angle, which displays little regarding relationship with variance, has been added to the paper. A plot similar to figures 2/4 for lunar zenith angle (removing points with >90 LZA) is shown below:



Minor Comments:

1) [Page 5160, Lines 17-18] as HSRL total-column AOT "increases".

Response: This has been fixed.