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Interactive comment on "Preliminary investigations toward nighttime aerosol optical depth retrievals from the VIIRS day/night band" *by* R. S. Johnson et al.

Anonymous Referee #1

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The authors present a concept paper for a nocturnal aerosol optical thickness retrieval using the VIIRS Day Night Band (DNB). The new VIIRS channel offers the possibility of retrieving nighttime aerosol loading from an imager, which is unquestionably needed by the community. The key concept is the use of the contrast between bright artificial lights from Earth city sources and nearby areas without artificial light. It is a nice concept, worthy of publication, though the concept is far from implementation into an operational product. The three cases with comparison to before/after pairs of AERONET day time observations are sufficient examples for a concept paper. However, I cannot understand a few key elements of the paper and the sensitivity analysis requires expansion. I will call these minor revisions because overall the authors have a good, publishable,

concept. My criticisms below are significant but should not overly color the perception of the paper.

I also want to point out a few major difficulties of applying this concept operationally that are not mentioned in the paper. High in my concern is the very broad wavelength band encompassed by the DNB. Hidden in this broad band are gas absorption bands. The oxygen-A band is mentioned, but water vapor is not, and water vapor is going to play a large confounding role in turning this concept into something quantitatively useful on a large scale. No mention of the possibility that water vapor may change from the night that Ia is obtained from the night that Isat and I'sat are obtained is too glaring an omission. No mention of the DNB's broad spectral band is made at all.

Another issue is the question of adjacency effects, pixel sizes and distances from light sources. If the contrast is calculated from two adjacent pixels, then the "dark" pixel will have elevated radiance from the "bright" pixel, due to scattering of the light by the atmosphere into the field of view. How far apart do the "dark" and "bright" pixels have to be? If the contrast is calculated from pixels very far apart then there is the danger of the atmosphere (including both aerosol and absorbing gases) changing between dark and bright. How far apart is too far apart? And does pixel size matter? Some of this is handled implicitly by how Ia pixels are chosen in the three examples, but an explicit discussion with appropriate figures would provide a more complete quantitative understanding.

There are two places where I cannot understand what the authors did.

1. bottom of page 595, continuing into the top of page 596. This is where there is an attempt to quantify an error of the method, except I cannot understand what this error is. They write, "The absolute relative error of each sample" What is the sample? "The three sample mean as truth". Are they simply calculating the standard deviation from the three colored blocks northwest of the airport in figure 1e? Is this a sufficient sample size? Wouldn't it be better to calculate the truth and standard deviation from a larger

set of pixels outside of the city lights in the image? “The absolute value of the relative error for the three samples over the course of the study period was approximately 0.06”. Is this $\pm$6% of the radiance? Of the retrieved AOT? “This results in an 11% error at Grand Forks.” Is this then 11% of AOT and the other radiance? How do we get from 6% uncertainty for radiance results in a 11% uncertainty of AOT?

Why wasn’t something similar done at Capo Verde and Alta Floresta? Capo Verde looks fairly uniform as long as you stay on the island, but the “background” around Alta Floresta appears sufficiently variable to deviate significantly depending on where you put your green squares. Is Figure 2a moonlit? The authors mention obtaining higher signal to noise on moonless nights. Would it be more illustrative to show two images of Alta Floresta at different stages of the moon? Is the “error” described by this standard deviation a function of moon phase? These are all important questions to ask and answer as quantitatively as possible in a concept paper.

2. Handling of the direct to total Ia ratio constant, k. We are shown two sets of results in the end, one for direct only and one that applies values of k that accounts for the contribution from the diffuse light. The values of k are calculated for each example for 19 values of AOT, assuming an aerosol model. How are these 19 values of k used in the retrieval? I don’t understand. There should be 19 values of k, dependent on the AOT. As aerosol loading increases, k should decrease. There must be an iterative procedure and some type of minimizing a cost function, then to solve Eqn. 7. No mention of this is made in the paper. This is a glaring omission.

Finally, I was very happy to see an attempt of a sensitivity study, but it doesn’t provide sufficient information. There should be information on both relative and absolute errors on AOT retrievals from uncertainties of the inputs. Also the discussion about relative uncertainty decreasing as AOT increases does not make sense for the parameter, k. The uncertainty, dk, itself, should increase as AOT increases. k is dependent on aerosol model. What if you have the wrong aerosol model? It will not make any difference if AOT =0.1, but it will make a very large difference if AOT=1.0. Look at Figure

5. Mostly the k correction improves agreement with AERONET, but at Alta Floresta, the k correction only makes things worse as the season progresses and AOT increases. Another point here is that water vapor steadily increases at Alta Floresta as the season progresses. If the original value of Ia were made in early August, water vapor could be adding to the amount of retrieved AOT by the end of September.

The results of the sensitivity study should be logically laid out with values for each of the studied parameter uncertainties, and how those values were estimated, and then the resulting total uncertainty on the retrieved AOT. It would also be helpful to see how sensitive the results are to night-to-night variations in water vapor also. This cannot be done till the DNB is represented as the broad spectral band that it is and not a monochromatic value at 0.7 μm. In my opinion, either there needs to be a lot more words in the discussion identifying the over simplification of the concept presented here, or to bite the bullet and do a sensitivity study with a broad band DNB. By no means should the reader be left with the impression that we’ll soon be getting quantitative aerosol retrievals at night from the DNB.

Interactive comment on Atmos. Meas. Tech. Discuss., 6, 587, 2013.