We thank the two reviewers for their comments on our paper, and are pleased that they recommend publication after accounting for these comments. In the below, reviewer comments are in **bold** and our responses in regular type.

In addition to changes to address these comments, we have also added a little more detail about MODIS pixel size calculation to Section 2 of the manuscript (mostly to note that the assumption that sensor pixels are independent squares is also a simplification), to provide a more complete description of relevant features of the MODIS instruments.

Review from L. A. Munchak

This article focuses on describing the impacts of the spatial distortion of MODIS sensor pixels on aerosol retrieval, and proposes two methodologies to mitigate the growth in pixel size. Although there are a handful of papers that discuss the MODIS "bowtie effect" and potential mitigation, most come from the engineering perspective and not from an algorithm/product perspective. The information the authors provide will be useful for users who have no reason to look into the instrumental literature. Additionally, this old topic has new relevance due to active work on development of multi-sensor algorithms for both MODIS and VIIRS, which handles the bowtie effect differently than MODIS (and the authors provide and excellent description of the VIIRS instrument as well). The paper is well written, gives clear evidence, and is straightforward. I only have a few comments.

We are glad that the reviewer has a positive impression of our paper, and hope that our revised version addresses their comments adequately.

Page 8728, Line 1: The bowtie effect occurs both from the scan geometry (mentioned) and the Earth's curvature (not mentioned).

This is true; we now also mention the Earth's curvature in the revised version here and elsewhere. (We had not explicitly mentioned this before.)

Page 8731, Line 17: Since the algorithms are performed in reflectance space rather than radiance space, probably should change 'radiance' to 'reflectance' (even though radiance is technically correct).

We have made this change in the revised manuscript.

Page 8731, Line 21,22 and Page 8732 Line 2: Did you mean "pixels", not "positions"?

We had used the word 'positions' intentionally but see how this could be more confusing than just saying 'pixels', which we had worried previously could be confusing. So we have now changed the first instance to read 'retrieval-pixel positions' and the others to refer to pixels.

Page 8733 : The authors contend that aerosol variability is decreased at large viewing zenith angles is mainly due to the increase in pixel size, and they also assert that the decrease in AOD variability is undesirable. Certainly, there is smoothing of the retrieved aerosol field at the edge of scan due to pixel size. However, the authors gloss over the well-supported argument that AOD retrievals tend to be more accurate at the edge of scan due to increased atmospheric path length. Part of the decrease in standard deviation for the VZA population of >55° is a decrease in

noise/error; Figure 6c shows that negative dark target retrievals are more common (by a factor of 2 or 3) at the more nadir viewing angles. This would narrow the distribution, but in a desirable way. I am very curious how the histograms change if both mitigation techniques are applied. This would help ascertain whether the narrowing of the distribution at larger VZA is actually due to pixel spreading, or a something else. It would be worthwhile to run a year of aerosol retrievals with the mitigation techniques, and analyze the global impact.

As a clarification: it is the oversampling and pixel size distortion in the L2 data (which will decrease AOD variability) which is undesirable, and we are not suggesting that any component of the decrease in AOD variability with VZA resulting from AOD error reduction is undesirable. We also want to note that performing this reaggregation would not remove the benefits of long atmospheric path length for reducing retrieval error.

We had mentioned the change of retrieval uncertainty with geometry briefly at the top of page 8734, with supporting references, and have expanded this text in the revised manuscript. It is difficult to disentangle changes in the histogram shape due to error from those due to pixel spread and oversampling. We contend that even if much of this variance reduction near swath edge is due to decreased error, then resampling the level 1 data to mitigate the effect of the bowtie distortion is still desirable from the point of view of removal of the pixel overlap and increasing the homogeneity of the data's spatial characteristics across the swath. It is also difficult and algorithm-specific to figure out how much each of the two factors contributes to the observed decrease in variability. That is why we did not include too much discussion of the comparative magnitude of smoothing vs. error reduction on the AOD histograms.

In the revised version, we have reprocessed the Deep Blue algorithm from MODIS Terra over eastern North America for the year 2006 (1,978 granules) using the three aggregation techniques. Processing a larger data volume is unfortunately prohibitive at the present time, and we don't have ready access/expertise to the Dark Target processing software, so the comparison is done only for Deep Blue (which predominantly uses its 'vegetated' code path over this area). This provides a broader-scale assessment of the expected effects of these aggregation changes on retrieval statistics, and is included as the new Section 3.3.

Page 8738, Lines 9-12 : The authors recommend implementing their techniques for mitigating the bowtie distortion in future reprocessings. In my opinion, one of the strengths of the MODIS sensor is that there is collocated aerosol, cloud, water vapor, snow and ice data. If aerosols, on their own, choose to leave the common swath grid, it will be much more difficult to do cross-disciple science with the MODIS sensor. The authors should present their work without recommendations, and allow this to paper to lend support in further discussions of what to do in the future.

We agree that this is a benefit of the MODIS product suite. However we do feel that it is appropriate for us to advocate this position, since it improves the quality of the data with basically no real downsides. Other disciplines which aggregate to coarser resolutions will suffer from these same issues and will also benefit as a result; those which do not would not be affected by this change to aerosol products, since their grids don't match up with the aerosol one anyway, so it shouldn't affect these interdisciplinary analyses. Since Deep Blue and Dark Target are produced as the same data files, though, it would make the most sense for both of these algorithms to adopt the proposed techniques, rather than only one, in any future MODIS reprocessing. We have added an additional paragraph to the Perspectives/Conclusions to comment further on this.

Review from anonymous referee

The authors of this manuscript discuss the "bowtie effect" - the effects of the increasing distortion of the MODIS pixels with its increasing scan angles - on the MODIS aerosol products. Given the wide use of the MODIS aerosol products over the world, I think it is necessary to bring up the issue at this time as many users of MODIS aerosol products are not aware of the issue and sometimes complain about the strange feature and relatively low resolutions MODIS aerosol products near the edges of MODIS scans when they plot the maps of the MODIS aerosol products. The manuscript is very well written. The authors concisely discuss the issues related to the bowtie effect and provide potential solution for the operational MODIS aerosol products to reduce the impact of the distortion. I believe the topics and the methods of this study are appropriate for Atmospheric Measurement Techniques (AMT) and I would like to recommend publication of this manuscript in AMT. I have minor comments as provided below.

Thank you for these positive comments; we have tried to address these concerns as detailed below.

In section 3.1, it would be great if authors can explain more details on how reordering L1B data can be done. Was it done by simply rearranging the L1B pixels in increasing/decreasing order of latitudes at each column of MODIS data array and by providing new row indices to the corresponding L1B pixels?

Yes, it is simply rearranging them like this (very quick and easy to do). We have clarified this in the revised version of the manuscript.

I believe that the aggregation of number of L1B pixels for aerosol products have an effect to reduce the noise in aerosol retrievals. So, reducing the number of pixels to aggregate toward the both edges of MODIS scan may have an effect on the retrieval noise level. It would be great if authors can address such possibility and present any suggestion on relevant data quality control methodology.

This is correct and is something we noted indirectly on page 8736 of the original version of the manuscript. We have added an extra paragraph to discuss this explicitly at that point. Essentially, it would require some larger-scale processing to understand to what degree the noise in edge-of-scan retrievals would increase. It is our expectation that any increase in noise would be minor, since the long atmospheric path length (beneficial for reducing error) would be the same after reaggregation, and the variability of AOD within a 10x10 km^2 retrieval pixel tends to be low, suggesting low noise. Also, the atmospheric path length of these observations, which reduces noise, is still long. This is also consistent with our AERONET validation results which suggest that the bulk of retrieval error is contextual (i.e. systematic to the situation at hand) rather than noise.

Do the potential mitigation methods suggested in the manuscript have any impact on the aerosol size parameters such as Angstrom exponent?

Yes, they would be expected to have a similar type of effect. We did not discuss this since AOD at 550 nm is the main data product of interest, and Ångström exponent is less quantitatively reliable than AOD (and is not available from the Dark Target land data set). We have mentioned this in the revised version of the manuscript in the Perspectives/Conclusions.

Also, it would be great if authors can mention about the implication of the methods on the L3 data processing (or resultant aerosol statistics)?

We have added some more discussion of this in the revised manuscript in the Perspectives/Conclusions. We do not expect large changes since the effect on individual retrievals is small, although spatial-average quantities (such as mean AOD) may become more accurate due to better sampling of the spatial distribution of aerosols within a grid cell. The effect is hard to predict since it is likely dependent on the region of interest. This is also shown a bit in the new Section 3.3. The main benefits of reaggregation are that the L2 products would become more spatially uniform in size/shape, and more representative of the actual area sampled by the MODIS measurements near the edge of swath.