Reviewer 1

(1) *Reviewer: The data and analysis are presented with a lot of detail. By comparison, the conclusions are rather short and broad: "The 3km retrievals can depict finer horizontal structure, albeit at the price of 'noisier' results…"*

Response: We have extensively rewritten the conclusions to address this concern. We have also removed all use of the term "noisier" throughout the manuscript because, based on values of MODIS-AATS AOD RMSD, we cannot conclude that the 3 km AODs are any "noisier" than the 10 km values, except for the (mostly) clear sky 30 June smoke plume comparison.

Reviewer: As a reader, one misses [the following] sorts of questions:

(2) *Reviewer: It is somewhat disappointing that almost no interpretation is given for the systematic biases that are seen/not seen. Do they differ for the different cases? And why? Which pixels stand out? For which pixels is the agreement good and why?*

Response: We believe we have provided a detailed discussion of observed MODIS-AATS AOD differences within the 10 km grid cells for the 30 June case, but we have expanded this discussion slightly. MODIS retrievals for the Terra and Aqua overpasses on 3 July yielded negative MODIS-AATS AOD biases, and we present likely explanations for these underestimates. The presence of clouds confounded the analyses for the 2 July and 9 July cases, and we discuss these results in the context of the MODIS retrieval Quality Flags for each case. For the 2 July case, we have edited the discussion to explain that "the negative biases occur because the MODIS algorithm preferentially retrieves AOD from pixels in the non-smoky part of the cells." For the 9 July case, we feel we have already provided an adequate analysis for specific cells. We note that for two of the three cells with a QF of very good the observed slight positive MODIS-AATS AOD bias "can likely be explained by spatial sampling differences within the MODIS grid cells."

(3) *Reviewer: Why is the center of the plume excluded from the retrievals?*

Response: We thought we addressed this with the three MODIS retrieval scenarios shown in Figure 2 and discussed in paragraph 3 of Section 3.2, where we noted that "…both the aerosol cloud mask and the NDVI mask limited the number or retrievals within the smoke plume, especially west of the P-3/AATS track." In the revised version, we have modified a subsequent sentence by adding the underlined text below: "However, it [the MODIS operational retrieval algorithm] failed to retrieve AOD in two 3 km grid cells in the heart of the plume along the flight track <u>due to application of the aerosol cloud mask</u>."

(4) *Reviewer: Why does the offset in AOD between sunphotometers and MODIS under cloudy conditions go in the opposite direction to what would be expected (e.g., considering the Varnai/Marshak papers about near-cloud bluing)?*

Response: The reviewer may be confusing two issues in the vicinity of clouds: “offset” and “bluing”. Offset is the enhanced AOT measured near clouds. An offset may have spectral dependence or not. Bluing is the increased spectral dependence sometimes, but not always, seen in the vicinity of clouds. Often there is a decrease in spectral dependence, a “reddening”, that will be described below.

The reason for the negative offset, instead of a positive one, is because of spatial inhomogeneity of the cloud fields and where the P3 flew. The MODIS algorithm works hard to find the clearest, darkest pixels in the 10 km box. If ¾ of the box is filled with clouds and enhanced AOD around those clouds, most of those pixels will be discarded in favor of the ¼ of the pixels far from clouds and cloud effects. What we are seeing is that the aircraft flew through a cloudier and more cloud-affected portion of the 10 km box, measuring higher AOT, than MODIS reports, because MODIS based its retrieval on those pixels within the 10 km, further from clouds. This is one of the more interesting results of this paper: the documentation of a possible low bias in MODIS retrievals in these sorts of situations.

As for spectral dependence… Aerosol measurements in the vicinity of clouds have exhibited both bluing (Marshak et al., 2008; Varnai et al., 2013), and reddening or neutral color changes (Koren et al., 2007; Redemann et al., 2009; Twohy et al., 2009; Varnai et al., 2013). Both bluing and reddening are associated with observations of enhanced AOT in the vicinity of clouds. Bluing is a 3D effect, caused by Rayleigh scattered photons that are scattered by the clouds and then to space, where they are measured by the sensor. Reddening occurs when there are larger particles in the vicinity of clouds. Such larger particles include aerosols swollen by humidity and dissipating cloud droplets. In this study we find a decrease in spectral dependence in the proximity of clouds, a reddening, which is supported by a variety of observations and modeling (only a small sample is given below.) Thus, we were not at all surprised. Because these results are not novel and would only provide a distraction from the main purpose of this paper, we have chosen to not mention the spectral dependence in the vicinity of clouds.

Reddening (larger particles in the vicinity of clouds)

Koren, I., L. A. Remer, Y. J. Kaufman, Y. Rudich, and J. V. Martins (2007), On the twilight zone between clouds and aerosols, Geophys. Res. Lett., 34, L08805, doi:10.1029/2007GL029253.

Redemann, J., Q. Zhang, P. B. Russell, J. M. Livingston, and L. A. Remer (2009), Case studies of aerosol remote sensing in the vicinity of clouds, J. Geophys. Res., 114, D06209, doi:10.1029/2008JD010774.

Twohy, C. H., J. A. Coakley Jr., and W. R. Tahnk (2009), Effect of changes in relative humidity on aerosol scattering near clouds, J. Geophys. Res., 114, D05205, doi:10.1029/2008JD010991.

Bluing (3D effects scattering blue light to the sensor)

Marshak, A., G. Wen, J. A. Coakley Jr., L. A. Remer, N. G. Loeb, and R. F. Cahalan (2008), A simple model for the cloud adjacency effect and the apparent bluing of aerosols near clouds, J. Geophys. Res., 113, D14S17, doi:10.1029/2007JD009196.

Both (correcting for 3D effects and taking out the bluing, leaves larger particles near clouds)

Várnai, T., Marshak, A., and Yang, W.: Multi-satellite aerosol observations in the vicinity of clouds, Atmos. Chem. Phys., 13, 3899-3908, doi:10.5194/acp-13-3899-2013, 2013.

(5) *Reviewer: Where does the "curvature" in Fig. 3 come from – just uncertainty or systematic effects?*

Response: We are not exactly sure what curvature the reviewer is talking about. We do note there is curvature in Fig. 3e that occurs because the linear MODIS EE=f(AOD) relationships (slightly different for the 3 km and 10 km retrievals) appear nonlinear on the log scale.

(6) *Reviewer: There is one major problem in the statistics: It is unclear what the regression coefficient's function is in this paper…a value of R2…may not be a statistically significant correlation, depending on the number of data points in the scatter plot. Please provide the required statistical measures.*

Response: We have calculated p-values (probability of getting a correlation as large as the observed value by random chance, when the true correlation is zero), and these values have been added to Tables 2 and 3, and in the text, where appropriate. From the MATLAB function: "The p-value is computed by transforming the correlation to create a t statistic having n-2 degrees of freedom, where n is the number of rows of X."

(7) *Reviewer: Section 3.6 addresses what Levy et al. (2010) have already stated on theoretical grounds. I therefore don't see the purpose of Fig. 14 and section 3.6 for that matter because it seems to re-state the obvious.*

Response: We have deleted Fig. 14 and the second paragraph in Section 3.6. However, we have chosen to retain Table 3.

(8) *Reviewer: Can the mechanism of deselection, which, in the abstract, is presented as the reason for the failure of the aerosol algorithm to retrieve thick smoke in cloud-contaminated as well as clear-sky zones be [more clearly] explained somewhere in the main text?*

Response: We now address this in the third conclusion (Section 4), and it is also mentioned in the next to last sentence added near the end of Section 3.3.

(9) *Reviewer: There are multiple occurrences of "Figure XX (over)plots/overlays…". This is wrong syntax; a figure cannot do anything, please modify to passive voice or correct otherwise.*

Response: We have changed the syntax in almost all instances to comply with the reviewer's request.

(10) Reviewer: P15027,l26: What is "overburden"?

Response: We have replaced "aerosol overburden" with "AODs were small".

(11) Reviewer: Some of the figures are extremely densely spaced. Consider revising.

Response: Striking a balance between maximizing information content and optimizing readability in figures is always a challenge. This is especially true when a single figure contains multiple frames that contain different types of data, as is the case in many of the figures in our manuscript. In designing the figures, we decided to adopt a multi-frame approach primarily because we felt it was important for the reader to see the disparate but related data pertaining to a single satellite overpass in a single view; separately, it allowed us to keep the number of figures to a manageable total. We agree with the reviewer that some of the figures are densely spaced, but we feel strongly that these figures present the results in the best way we can and, hence, we have chosen to keep the figures as is. Even so, that the reviewer raised this concern indicates that we did not achieve the desired balance between information content and readability in certain figures. To mitigate this, we are requesting that the more densely packed figures be published as a full page.