Thanks for all the valuable comments, the replies are listed below.

"Study of satellite retrieved aerosol optical depth spatial resolution effect on particulate matter concentration prediction" by Strandgren et al. addresses a potentially very useful application of satellite data for monitoring the particulate mass, PM2.5. This topic is of scientific significance, because the surface-level aerosol mass is relevant to the climate, regional air quality and human health and because the mass is costly to directly observe with high spatial and temporal resolution.

The relationship between satellite aerosol optical depth (AOD) data and ground-based PM2.5 measurements must be influenced by three factors: the measurement errors, the variability in aerosol loading within the satellite grid box, and the aerosol intensive properties. The magnitude of the first two factors varies with the spatial resolution of satellite data, as the authors point out in the introduction. Separating the three factors from each other would help determine the optimal satellite resolution for monitoring purposes. The manuscript largely fails to do this. It matches the AOD product of the MODIS MAIAC retrieval scheme with near-coincident ground-based PM2.5 measurements and applies a linear regression between them. The variation in the regression results with the spatial resolution and coverage of the satellite data is reported but not effectively explained. The reader is left with few clues as to how the results are relevant to other places, time periods, aerosol types and meteorological conditions. For this reason, I recommend major revision.

Response: Thanks for the valuable comments. First of all we want to clarify that this is not a study that aims to provide a $PM_{2.5}$ prediction method or to provide a method for improving the correlation between AOD and $PM_{2.5}$ using additional data sets, but a study which objective is to increase the understanding of the spatial resolution effect on the linear correlation between AOD and ground-based $PM_{2.5}$ measurements for different scales of coverage (urban scale, meso-scale and continental scale), in order to provide a better understanding to the atmospheric science community.

We agree that the three factors, that are aerosol variability inside the box, in-situ measurement errors and the aerosol intensive properties, do play a role for the relationship between AOD and $PM_{2.5}$. The York regression analysis has been included in the revised version to address the MAIAC AOD and $PM_{2.5}$ data errors, since the data errors play a significant role for the regression slope and intercept (see Fig.1 below), which is presented with more details in the revised version. In order to separate the three factors the overall analysis in the revised version has been improved and made in a clear and more logical way for the individual factors. This means that when the data errors and aerosol intensive properties (like the particle grows with higher RH) are analyzed, the analysis focuses on the same AOD spatial resolution. Similarly when the AOD spatial resolution effect is presented, which is the key part of the paper, then the data error and aerosol intensive properties variations are excluded and a more quantitative and detailed analysis is included for the spatial resolution effect for the different scales of coverage.

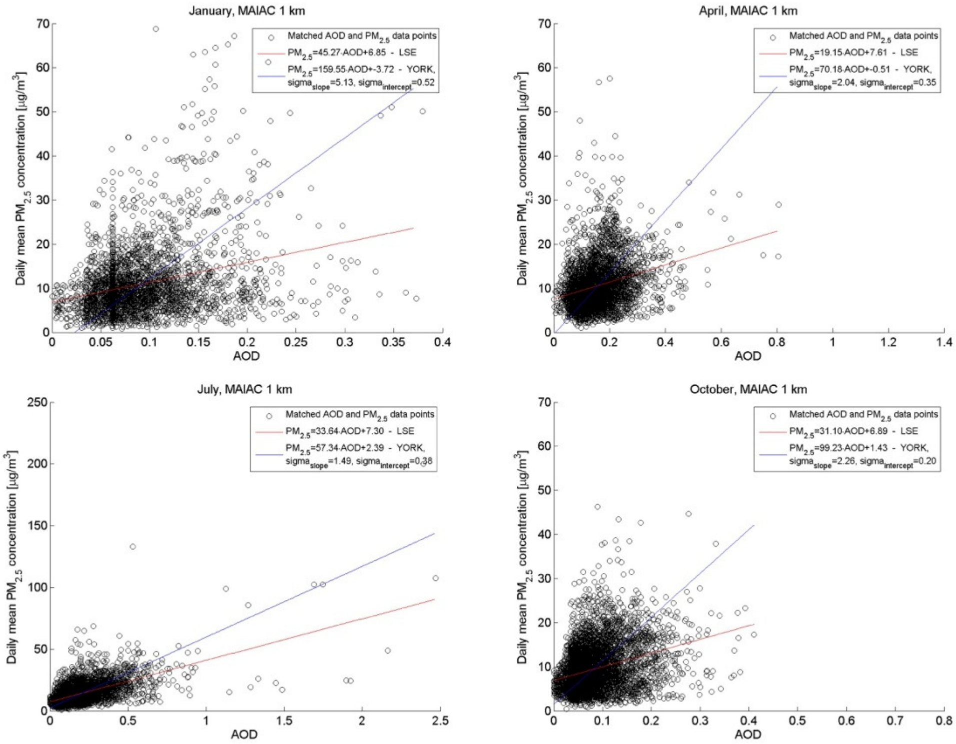

Fig. 1 The AOD and PM2.5 correlation using two fitting methods, one is the standard RMSE fitting (red), the other one is the York fitting (blue).

The method of the linear regression, on which the entire manuscript hinges, should be presented in a clear way. The lack of a description otherwise makes this reviewer believe that the standard least squares fitting was employed. This method underestimates the slope when both x and y have an uncertainty and when the correlation coefficient is low. Importantly, for this effect to manifest itself the uncertainty in x does not have to be systematic; a random error is sufficient (Cantrell 2008). Therefore, a systematic bias in the slope by itself should not be taken as a proof of a systematic bias in x. The observed slope systematically varies with the spatial resolution and coverage, as repeatedly pointed out in the manuscript, for example in the third paragraph of section 3.1. What can explain this? The authors speculate that this might “be due to the higher risk of cloud contamination” at coarser resolutions. The cloud contamination, which biases the AOD to higher values, can indeed be the explanation. But, so can any source of a random error in the AOD, and the aerosol horizontal variability for that matter, that varies with the spatial resolution and coverage. The regression analysis by itself does not reveal how influential the signal-to-noise ratio, the surface properties, the cloud contamination and the aerosol spatial heterogeneity are compared with each other.

Response: This part has been improved according to Cantrell (2008) by using the York regression. Significant changes of the regression slopes and intercepts are achieved and compared to the normal linear regression method. However the main analysis tool, which is the correlation coefficient, will be kept in its previous form also in the revised version.

Figure 6 is an effort to separate the impact of horizontal variability from other factors. It should be studied for all cases, not just two cities. Similarly, analysis should be made in order to isolate other factors such as the aerosol vertical variability (e.g., Figure 5), the intensive properties (Figure 4, 8 and 9), the surface properties and the singal-to-noise ratio.

Response: The similar analysis for Fig.6 has been extended to all the cities mentioned in the paper.

Additionally the spatial effect of other factors mentioned by the reviewer like the RH, BLH, FMF and the surface characteristics are analyzed and included in the revised paper.

Besides, it is not clear whether cloud contamination is likelier in the coarser resolutions. A satellite algorithm may have a better chance of identifying clouds with a greater number of sub-pixels. The aggregates of 1-km MAIAC products used in the study are not adequate for addressing this issue.

Response: The cloud mask is always a big issue for the aerosol community. Normally the cloud spectral, spatial and temporal properties which may be spatial resolution dependent are used to detect cloud. A 10km region contains only one 10km pixel and 100 1km pixels, if in these 100 pixels, one pixel is cloud, that mean the 10km pixel is cloud contaminated. So normally a high spatial resolution like 1km provides a better chance to detect the cloud and avoid the cloud contamination. Since the 10km AOD data is an aggregated form of the 1km AOD, the cloud contamination can somehow be avoided compared with those products that directly relies on a 10km cloud mask. This issue is explained in a better way in the revised version.

Minor comments. (The page and line refer to those of the printer-friendly version of the manuscript.)

Page 25872, Line #3. What do you mean by "auxiliary data"?

Response: Here "auxiliary data" refers to the sentence before, that is aerosol vertical distribution, relative humidity

Page 25878, Line #14. This sentence essentially says "not significantly better but clearly better". This is confusing. Clarify.

Response: Thanks for the suggestion. The problem highlighted by the reviewer can be further improved from two aspects: (1) More quantitative analysis related the change of the correlation between AOD and $PM_{2.5}$ will be contained in the revised version; (2) The significance of the statistical test like the p-values is also included. This has been modified in the revised version. According to the p-values, all the statistical tests in the paper are significant.

Page 25879, Line #12. Heating does not remove any particle. It dries particles and reduces their mass and extinction. Rephrase the sentences.

Response: Thanks for the suggestion. This is rephrased in the revised version as follows:

A $PM_{2.5}$ instrument heats the investigated air mass, leading to removal of the mass and extinction contribution from wet particles to the final $PM_{2.5}$ mass concentration.

Page 25881, Line #8. This sentence should move to the beginning of the next paragraph.

Response: Revised

Page 25881, Line #24. Figure 7 seems to show standard deviation over time. But the context of this paragraph calls for a measure of the AOD variability over space. Revise.

Response: Revised

Page 25883, Line 26. Is there a reference for "very low fine mode fraction" in Los Angeles?

Response: According to both the *in-situ* AERONET measurement and the MODIS FMF product, there is a large coarse mode particle contribution, which means that the fine mode fraction is small in this area.

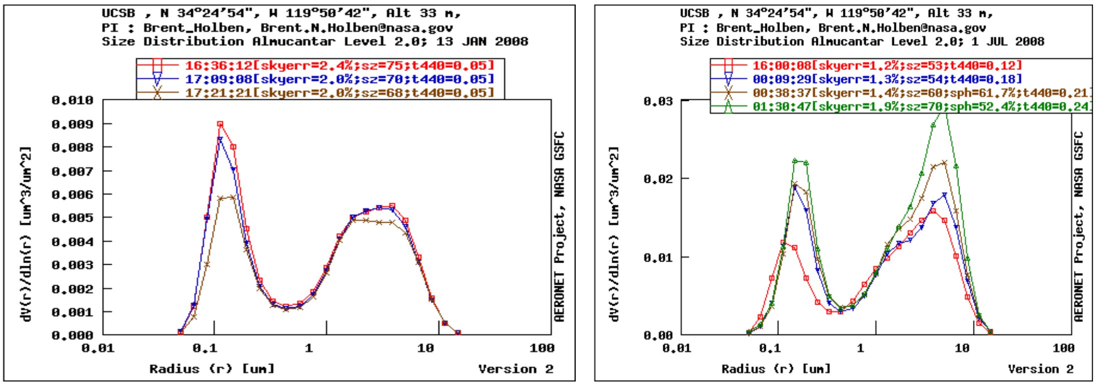

Fig. 2 The AERONET observation for the size distribution for site UCSB which is nearby Los Angeles for 13 Jan. and 1 Jul.2008.

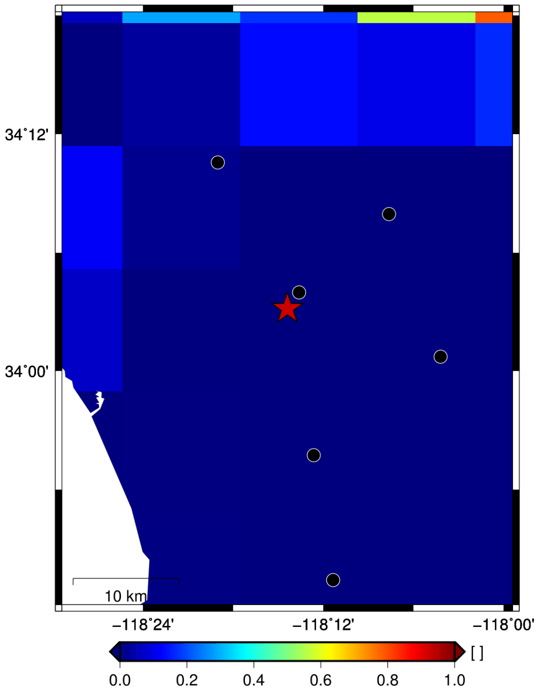

Fig. 3 The MODIS FMF product over Los Angeles at urban scale averaged over the days when AOD-$PM_{2.5}$ match-ups were found in 2008. The red star represents the center of Los Angeles.

Reference Cantrell, C. A.: Technical Note: Review of methods for linear leastsquares fitting of data and application to atmospheric chemistry problems, Atmos. Chem. Phys.,

8, 5477–5487, 2008, http://www.atmos-chem-phys.net/8/5477/2008/