Replies to comments by Referee #1 concerning the manuscript: Assessment of diverse algorithms applied on MODIS Aqua and Terra data over land surfaces in Europe"

We thank the reviewer for the constructive criticism, which we have taken into consideration to improve the manuscript. More detailed answers to the major and minor concerns are presented below. If nothing else is written about the changes that have been performed we refer to the original version of the manuscript. Although no major criticisms about the language of the manuscript were presented by the reviewers the revised version of the manuscript has been proofread. We apologues if not all of these changes made in the text are presented in our answers to the referee's comments.

Overall comments

"*This paper is interesting in principle, but in its present form, is not useful. The MODIS science team collection 5 AOT product has been analysed thoroughly in many studies, some of which are cited in this paper. In that regard, the paper does not add significantly to the understanding of the collection 5 product. The other algorithm, Satellite AErosol Retrieval (SAER), is newer (although described in several other publications cited) and so it is useful to perform the validation and comparison with AERONET/the MODIS collection 5 product. However, as discussed in the specific comments, I do not think that the analysis has been done in an appropriate way. The discussion is not particularly comprehensive, and the volume of data not very extensive (three periods of one to two weeks each does not provide many matches at individual AERONET sites).*
Additionally, there is the wider question: why should we be interested in SAER? Is the SAER dataset available somewhere for users to download (or will it be soon)? Does it have some advantage over existing datasets? This is not mentioned anywhere in the paper. The validation performed suggests that the collection 5 product is better in this region (Europe), so an advantage I could see in SAER is the finer spatial resolution, an aspect which is not discussed in the paper. If this dataset is not available to the community, or intended to be used for some purpose by someone, it is not clear what the utility of the analysis is. Unless this question is answered in the revised paper, then I do not see much scientific use in publishing it."

Respond to overall comments:

We agree that we not clearly explain why the SAER retrieval algorithm could be useful to estimate AOT in the atmosphere, although we mention on lines 20 to 27, page 2366, that the algorithm is applied on level 1data. This means that the AOT is estimated based on a better horizontal resolution at ground than the MODIS collection 5 product. We also mention in this section that the algorithm has a good development potential to be used in air quality studies. Even so, we have included more information in the revised version of the manuscript about the air quality study by Glantz et al., 2009a. We now also refer to the study by Rohen et al. (2011), who have used the BAER algorithm to estimate PM_{10} in urban environment, in an attempt to give reason for the usefulness of the present algorithm. The latter reference has been included on line 27, page 2366, after "Glantz et al., 2009a" and in the reference list. The following text "For example, by using the full resolution MERIS data (~300 m) it seems that

the satellite retrievals can resolve the increased aerosol concentrations along the main highways close to the city of Stockholm (Glantz et al., 2009a)." has been included before the sentence beginning with "Even so.." at line 27 on page 2366 in the original version of the manuscript. Additionally, we have also included the following text "For air quality studies and estimations of particulate matter concentrations in urban environment highly resolve data is however required (Rohen et al., 2011). From this perspective, such data can be provided by using the SAER retrieval instead of the standard MODIS c005 products.“ after the sentence ending with "and climate models." at line 13 on page 2379:

Here we also briefly describe some differences between the two algorithms. It is also obvious that we need to include more information about this in the manuscript. Therefore, after "aerosol reflectance and AOT." at line 13 on page 2369 the following sentence has been changed to "The LUTs were obtained by radiative transfer calculations performed with aerosol phase function, single scattering albedo (equal to 0.98) and spectral surface reflectance all measured during the LACE-98 experiment (von Hoyningen-Huene et al., 2003)." Thus, it is obvious that the treatment of the surface reflection is somewhat more physical based in the BAER algorithm compared to the MODIS c005 approach. Therefore, in Section 2.1.2 after the sentence ending with "wavelengths 0.469 and 0.645 μm can be estimated." at lines 25 and 26 on page 2370 we have included a sentence that emphasize the surface reflectance assumptions that has been introduced in the MODIS c005 algorithm: “Note that the surface reflectance relationship is empirical, established according to 4 years of collocated MODIS and AERONET data.”

Although only three time periods have been included in the present study the numbers of aerosol optical values compared between satellite and AERONET retrievals are not low. The number of collocation of satellite and AERONET data was not present in the original version of the manuscript. In addition, since we now have included more AERONET stations in the comparisons (see specific comment 12 below) the number of matches has increased. The present Figures 4a and 4b show that 507 matches occurs between MODIS c005 and AERONET, which can be compared to 985 matches that were included in the MODIS c005 and AERONET comparison for East Europe and West Europe and two years of data (Remer et al., 2005). However, the present satellite/AERONET matches are of course very low compared to the 85 463 valid MODIS/AERONET global land colocations, for the years 2000 – 2008, that are included in the study by Levy et al., 2010.The present pixel-by-pixel inter-comparisons between SAER and MODIS c0005 are on the other hand of course associated with many matches. Thus, although the limited time period investigated here we think that the general findings (Sections 3.4 and 4), for example identified deviations in AOT when both the SAER and MODIS c005 algorithms have been compared to AERONET measurements but also improved retrievals of AOT obtained with the SAER algorithm, are valid. Considering the latter finding the following sentences have now been included in the beginning of the fourth paragraph of Section 4: “Nevertheless, the overestimation by a factor of 2 in mean AOT, found for low aerosol loadings with the BAER algorithm (Hoyningen-Huene et al., 2006 and and Glantz et al., 2009a), has substantially been reduced here when SAER of AOT at the blue wavelengths were compared to the AERONET measurements and MODIS c005 retrievals. In addition, better agreement in mean AOT at 443 nm, obtained with the SAER and AERONET sun photometer, was also found considering both Aqua and Terra for high aerosol loadings compared to the previous studies.”

The SAER dataset is at present day not available for users to download, although we will gladly provide with retrievals of AOT if someone is interested to use it for aerosol investigations.

Specific comments

1) *"Title: The title should be improved. 'Diverse algorithms' is vague, and aerosol is not mentioned, so the casual viewer would not know what the paper is actually about. Additionally, although the title says 'over land', ocean data are also shown (Figure 3). It would be beneficial if the analysis were expanded to include data over ocean, as discussed later in the review, but I don't think 'over land' is absolutely necessary in the title either way. I suggest 'Assessment of two aerosol optical thickness retrieval algorithms applied to MODIS Aqua and Terra measurements in Europe' as a better title."*

We agree with the referee and changed the title to: "Assessment of two aerosol optical thickness retrieval algorithms applied to MODIS Aqua and Terra measurements in Europe"

2) *"Abstract, final two sentences: periods 1, 2, and 3 are meaningless here without context. These sentences should be rewritten."*

We agree with the referee and have changed the two sentences: "Based on the inter-comparison of the SAER and MODIS c005 algorithms it was found that the SAER on the whole is able to obtain results within the expected uncertainty range of MODIS for Aqua and Terra observations."

3) *"Page 2,366, line 13: I see what you are getting at here, but I don't agree that the recommendation of Kokhanovsky et al. (2010) is that more discrete aerosol models are needed. Rather it is twofold. First, because information content is limited, more accurate aerosol models are needed, as well as better constraints on how to pick which one to use. Adding more aerosol models will not help if they do not represent aerosol scattering/absorption well for the particular situation. Second, we need sensors with improved measurement capabilities to decrease this source of uncertainty. However, since in this work SAER is (if I understand correctly) only using 1 model, it is true that additional models would be of use here."*

We agree and the sentence beginning at line 12 on page 2366 has changed to "One important conclusion of this study is that accurate aerosol models are needed in combination with better methods of how to choose the right one for the actual situation. They also concluded that improved sensors are needed to reduce systematic errors and recommend multiangular-spectro-polarimetric measurements."
It is true that only one model is used in the present study, although the BAER/SAER algorithm could be used with several other models. However, a method for matching a model for the valid situation has not yet been developed. Nevertheless, we believe that the single model used here did not introduced large uncertainties in the retrievals of AOT over Europe.

4) *"Page 2,366, line 28: replace BAER for BEAR."*

BEAR has been changed to BAER.

5) *"Page 2,368, lines 1-2: I don't think you need to say 'expected to differ', but rather 'will differ'!"*

We agree and have changed the words to "will differ" in the revised version of the manuscript.

6) *"Page 2,368, line 6: Although MODIS has a solar diffuser, as far as I am aware it is not used for absolute reflectance calculation in the level 1 data; rather, a set of vicarious calibration procedures are used by the MODIS Calibration Science Team. I suggest rephrasing this sentence."*

We agree and the sentences on lines 4 to 8 on page 2368 have been changed to: "The SAER algorithm has been used to retrieve AOT from calibrated level 1 TOA radiances measured with the nadir-viewing sensor MODIS over land surfaces. MODIS measures upwelling or TOA radiance (I_{TOA}) at visible and near infrared wavelengths. Normalizing of I_{TOA} in reference to the solar extraterrestrial irradiance (E_0) for each wavelength λ results in the spectral TOA-reflectance ρ_{TOA}:"

7) *"Page 2,370, line 5: 0.2 at which wavelength?"*

The sentence at lines 4 and 5 on page 2370 has been changed to: "First, a pixel is interpreted as a thick cloud if $\rho_{TOA} > 0.2$ at the wavelengths 469, 555 and 645 nm (Kokhanovsky, 2006)."

8) *"Page 2,370, line 18: Levy et al. (2010) is the validation paper. The algorithm paper is Levy et al. (2007)."*

We agree and have changed the reference to Levy et al. (2007) and included this paper in the reference list.

Levy, R. C., Remer, L. A., Mattoo, S., Vermote, E. F., and Kaufman, T. J., Second-generation operational algorithm: Retrieval of aerosol properties over land from inversion of Moderate Resolution Imaging Spectroradiometer spectral reflectance, J. Geophys. Res., 112, D13211, 2007.

9) *"Page 2,370, line 21: I would say 'the 550 nm band cannot be used directly by this algorithm', as there are other AOT retrieval algorithms which do use green bands."*

We agree and have consequently changed this sentence to: "Note that a vegetated surface is not "dark" at 555 nm which is why this wavelength cannot be used directly in the MODIS algorithm."

10) *"Page 2,371, equation 8: I suggest using the standard notation for absolute difference (i.e. |xi-xbar|) rather than abs()."*

We agree and have changed to the standard notation.

11) *"Page 2,371, equation 9: I think this is wrong. Shouldn't the division by 2 appear outside the parentheses?"*

The referee is right and the division by 2 now appears outside the parentheses.

12) *"Page 2,372, section 2.2: Why only these sites, and not others? Additionally, since you are using Level 2 data, you should cite the AERONET cloud screening paper used to create these data, Smirnov et al. (2000)."*

We have included 4 more AERONET sites located within the present investigation area, Moldova, Fontainbleau, Paris, and Mainz, that produced AOT at the 440 and 500 nm wavelengths. 4 more sites, Modens, Villefranche, Le Fauga and Palaiseau, have been included as well, but AOT is measured here only for the wavelength at 440 nm.
The following AERONET sites in Europe were not in operation mode during the periods investigated: Kyiv, Gloria, Eforia, Baneasa, Bucarest, Bucarest_Inoe, Xanthi, Esra, Porquerollos, Aubiere_ LAMP, Archachon, Bordeaux, Aire_Adour, Tarbes, Seysses, Toulouse, TOULOUSE, Kanzelhohe, Munich_Maisach, Cretei, Birkenes, Sopot, Palgrunde, Gotland, Birkenes and Hyytilala.
The text about the AERONET stations previously listed in Section 2.2 has been excluded and a description is now instead included in Section 3.2.3. More details about the sites are found in the new Table 1.

We agree and have included this reference (Smirnov et al., 2000) in the sentence ending with "automatically cloud screened." at line 23 on page 2372 and in the reference list.

13) *"Page 2,372, lines 19-21: You show data over water in this figure. However, this is not discussed anywhere in the paper. You should either discuss the retrieval algorithm and results over water, or remove these points from the figure."*

We suggest keeping the focus of satellite retrievals over just land surfaces. However, it could be interesting for the readers to be aware of the possibility to retrieve AOT by SAER also over ocean surfaces. Even so, we indeed need to more clearly mention that the inter-comparison is only performed over land surfaces. Therefore, the sentences at lines 22 to 25 on page 2373 have been changed to "On the whole, good agreement is found between the results obtained with the two algorithms, particularly for land areas associated with high aerosol loadings. This is confirmed by the statistics for 14507 co-located pixels over land that is shown in Fig. 3a. Retrievals over water have not been analyzed here, but will be the focus in subsequent investigations."
Additionally, the last sentence in figure caption 3 has been changed to "The expression for the linear regression curve was calculated based only on co-located land pixels and without binning the data."

14) *"Section 3.2. I have several comments on this section:*
So in page 2,374, lines 20-21 you are comparing the SAER and MODIS science team data to AERONET in two different ways. This is not a good idea, as your spatial sampling will be different, so it is not an apples-to-apples comparison. See e.g. Anderson et al.(2003) about length scales for aerosol distributions. It would be much more meaningful to average the two datasets in the same way."

By extending the SAER 1 km-pixel resolution to MODIS c005 averaging means that 900 pixels have to be included in the SAER averaging. This means that we are forced to close in to the MODIS c005 approach; deciding for example the minimum number of cloud-free pixels to proceed calculating a mean value for this substantially larger area. We prefer performing comparison with AERONET under optimal conditions for the SAER approach. Note also that the results from the two algorithms actually are compared to each other in Section 3.2, based on the MODIS c005 pixel resolution. We in any case agree that the present comparison with AERONET differ between SAER and MODIS c005, although we suggest to adapting it instead according to AERONET. By performing averaging according to 1 hour of the data from AERONET and assuming a transport of the air of 3 m s^{-1} this corresponds to a spatial resolution of approximately 11 km. However, in practical the distance is shorter, since the AERONET values are recorded every 15 minutes. This is also indicated by the number of AERONET measurements shown in Table 1 in the original version of the manuscript. Consequently, we have changed the averaging of SAER AOT according to a box of 5 * 5 pixels in the revised version of the manuscript instead of the previous 9 pixels. In addition, to make the comparison between MODIS c005 and AERONET more properly the time periods for the AERONET stations have been averaged according to 3 hours instead of the previous 1 hour. Section 3.2 has consequently been rewritten according to these changes.

15) *"Your estimates of the area averaged are also incorrect: because of the MODIS scan pattern, pixels near the edge of the swath are larger than those near the middle. As the MODIS science team algorithm averages level 1 data on a pixel grid rather than an area grid, the AOT retrieval pixels near the edge of the swath are significantly coarser than 10 km x10 km."*

The reviewer is right and it is also obvious that the areas of 10 and 100 km^2" written on line 21, page 2374, are wrong. We have therefore changed this sentence to: "This means that the outputs of the SAER and MODIS c005 retrievals were averaged according to a maximum area of 5 and 30 km^2, respectively."

16) *"Did you apply any quality screening to the MODIS science team data? This is not mentioned*
in the text. If not, you probably should do. I believe QA=3 is the recommendation
for the highest quality retrievals (e.g. results in Levy et al., 2010, which you cite)."

Yes, we have used the MODIS c005 retrievals with best quality (Quality flag=3) and have therefore change the sentence on line 14 and page 2370 to: "In the present study we use the MODIS c005 level 2 standard products for best quality retrievals (quality flag=3) over land surfaces ....."

17) *"The wavelengths used in your analysis differ between MODIS and AERONET, and so, for the collection 5 product, there will be some difference in AOT because of this (less so for SAER where the wavelengths are more similar). This is another example of the comparison*

not really being of the same things. As the satellite wavelengths are longer than AERONET (469 nm vs. 440 nm, 555 nm vs. 500 nm), and the Angstrom parameter is positive, MODIS would naturally be expected to retrieve a lower AOT for these wavelength pairs. You could account for this by interpolating the AERONET data to the MODIS wavelengths using the Angstrom power law (your equation 7), and remove this source of bias from the comparison, which is often done in other studies. This would make your error analysis more meaningful, and is simple to do. For a typical Angstrom parameter of 1-2, the wavelength difference will lead to about a 5%-15% difference in AOT, which is similar to the biases you are reporting in your least-squares regression fits. The discussion of the uncertainty estimates, RMS difference etc is also not appropriate because of this bias you are not accounting for (if you don't account for the wavelength shift, you can't consider AERONET an unbiased 'ground truth' to base the confidence envelope on)."

We agree with the referee and have performed the changes suggested. Therefore, the beginning of Section 3.2 has been changed to "For a proper comparison of satellite- and ground-based measurements the Ångström power law (eq. 7) was used to convert AERONET AOT to the wavelengths 469 and 555 nm (MODIS c005) as well as 443 and 488 nm (SAER)." Furthermore, the results have therefore changed somewhat and we refer to our answers to comment 22 below.

18) *"More information about the AERONET comparisons should be presented in the revised manuscript. Perhaps a table with information about each site, and the statistics and number of matches obtained at each. Then we could see more clearly whether performance is the same over all of Europe."*

We agree with the referee's comment and have therefore created a table presenting the comparisons between satellite retrievals and AERONET according to each site. This is presented in a new section introduced (3.2.3) in the revised version of the manuscript.

19) *"Page 2,375, line 13, and 15-18: I would have thought Levy et al. (2010) was the more appropriate reference to cite here, as this is where the MODIS science team data are validated and this confidence envelope is tested. The Levy et al. (2010) analysis largely supersedes Remer et al. (2008) as it is more comprehensive in scope, with more MODIS and AERONET data becoming available in the intervening years."*

We agree with the referee and have changed to "Levy et al. (2010).

20) *"Page 2,376, section 3.3: This section is quite lacking in detail and would be more useful if you e.g. separated the points according to perhaps surface or aerosol type.*

Since neither MODIS nor AERONET are able to classify the aerosols it is not possible to separate the points according to aerosol type. Even so, by combing the MODIS uncertainty with aerosol loading (range of AOT) shown in Figure 9 the readers have in any case opportunity to compare the SAER and MODIS c005 results according to a broad proxy separation of aerosol type.

We think that the results presented in this section contribute to the findings about the SAER algorithm and we refer to our responds to point 25 below. However, the following sentences have been included at the end of Section 3.3: “Note that the figures indicate that the slope of the regression line is on the whole steeper for Aqua compared to Terra. In the previous sections it was shown that this also occurs when SAER as wells as MODIS c005 are compared to AERONET observations, although somewhat steeper slope is found in the former comparison. The overpasses of Aqua on the whole occurred after that Terra passed the investigation area, which means that a difference in the sun elevation associated with the two platforms is expected. Thus, the treatment of the sun-zenith satellite-viewing geometry may cause the deviation found..” Corresponding to this finding we have included the following sentence " However, as for the 469 nm an overestimation of MODIS AOT at 555 nm occurs, particularly for Aqua, here as well with respect to AERONET." in the last paragraph of Section 3.2.1. In addition the following sentence " Note that Figures 7 and 8 indicate that the slope of the regression line for the SAER is somewhat steeper for Aqua than Terra at both wavelengths, similar as the results obtained with the MODIS c005 algorithm." have been included at the end of Section 3.2.2.

21) "*Additionally, you do not mention one obvious point: SAER assumes a perfectly scattering aerosol while the MODIS science team product does not. So that is one simple reason why SAER tends to retrieve lower AOT in high-AOT conditions."*

With the SAER algorithm a single scattering albedo of 0.98 is used (unfortunately a value of 1 was wrongly written in the original version of the manuscript) and 0.95 in the MODIS c005 retrieval. Consequently the text in Section 2.1.1 has been corrected and the sentence on line 16 on page 2369 has been changed to “Note that a single-scattering albedo of 0.98 represents nearly non-absorbing aerosols”.
Thus, the difference in single scattering albedo used in the SAER and MODIS c005 algorithms is small and could not explain a major part of the discrepancy found between the two algorithms. We suggest therefore not discussing this in the manuscript.

22) *"Page 2,377, line 7: I would suggest you mean ‘relative overestimation’ here, since you don’t have evidence that the collection 5 product is overestimating AOT. All you know is that it is higher than SAER. Comparing with AERONET, both look similar."*

Note that the comparison with AERONET was performed according to different wavelengths for SAER and MODIS c005, which the referee also relevant suggests a solution for in point 17) above. Thus, in line with the referee's comments we have used the results from the AERONET Ångström exponent to estimate AOT representing the same wavelengths as the satellite retrievals. It seems that we now actually more clearly obtain a minor overestimation of the MODIS c005 algorithm, particularly for Aqua. This is shown both for the 469 and 555 nm wavelengths. Therefore, we suggest changing the first sentence of Section 3.4 to “The inter-comparison of the findings of MODIS c005 and SAER retrievals and the validation of these algorithms against AERONET measurements suggests that a small part of the deviation found for high aerosol loadings seems to be due to a general overestimation of AOT by the operational MODIS algorithm.”
Furthermore, the following sentence "However, the validation of the MODIS c005 algorithm against AERONET measurements suggests that a small part of the deviation found for high aerosol loadings seems to be due to a general overestimation of MODIS AOT." has been included in the middle of the third paragraph in Section 4.

23) *"Page 2,377, lines 25-27: I would not say that the poor agreement between MODIS and AERONET Angstrom parameter is 'surprising'. These comparisons were also performed and discussed in the MODIS collection 5 aerosol validation paper (section 3.3 of Levy et al., 2010, which you cite). They suggest a typical uncertainty of 0.4, although note that retrieved values tend to cluster in two populations."*

Since good agreement in AOT is found between MODIS c005 and AERONET at two wavelengths, where the estimates are used to calculate alpha, we think that the results are in any case somewhat surprising. Thus, it is obvious that the estimation of alpha is actually highly sensitive to the equation used. Levy et al. (2010) suggest that the uncertainty of 0.4 is obtained when for example also dust aerosol was involved. We assume that the latter aerosol was not present over Europe during the time period investigated in the present study. In any case we have included the following text "Levy et al. (2010) also found poor agreement in α when comparing MODIS c005 and AERONET, and concluded that this parameter has little globally quantitative value." at the end of Section 3.4. In addition, in the revised figures where results of the Ångström exponent are shown we now also present median α and corresponding one standard deviation calculated for all values included in the figures. Therefore, the sentences in the middle of the first paragraph of Section 3.2.1 have been changed to "Median values of MODIS c005 α (469/645 nm) and AERONET α (440/675 nm) and corresponding one standard deviation are also given in Figures 4a and 4b, respectively. The figures indicate that large discrepancy in α occurs, which is more clearly shown in Figure 5 where comparisons of the absolute values are presented for the time periods investigated."

24) *"Page 2,378, lines 16-18: You mention the MODIS collection 5 uncertainty envelope with respect to the SAER data. What reason do you have to expect that the same uncertainty envelope should apply to both algorithms? It would be more useful for future work with SAER to estimate an uncertainty estimate for SAER (which I'd suspect may be larger than the collection 5 uncertainty), and then frame your discussion based on that."*

When the SAER algorithm has been improved and developed in the way that no or limited systematic error appears in the results (see answers to point 25 below) we agree that an uncertainty estimate for SAER is relevant. We do not think that we should expect the same uncertainty range for SAER, but by using the MODIS c005 uncertainty envelope give us the opportunity to value the results of SAER, which we think is in any case useful information for the readers.

25) *"Discussion/conclusions: Your main new result from this study seems to be that there are problems in SAER relating to certain viewing geometries. Yet, the relevant figures and information on this aspect are not shown and only mentioned briefly. This is something which should really be discussed in more detail in the paper."*

We think that Figure 10 shows this behavior quit well. However, we should emphasize this more clearly by also discussing comparison with AERONET. Therefore, the following sentences "This is also confirmed when the satellite retrievals are compared to AERONET measurements. While AERONET AOT varied marginally at the Belsk station between the

two satellite overpasses (1.02 and 1.07, respectively) the SAER AOT varies by approximately 0.3 at MODIS values around 1 shown in Figure 10. A similarly large difference in AOT (~0.3) is also obtained for high aerosol loadings when SAER is applied to the two MODIS Aqua overpasses on 1 April 2007 (not shown)." has been included in the middle of Section 3.4. In addition, the following sentence "The present results suggest that the deviations that occurs between the two algorithms (i.e., values outside the MODIS expected uncertainty range) and satellite AOT compared to AERONET are most likely caused by the treatment of the sun-satellite viewing geometry in the SAER algorithm." has been included in paragraph 3 of Section 4.

26) *"Table 1: the maximum possible number of satellite points is 9, but the mean plus one standard deviation is typically more than 9. This suggests that the distribution of the number of points is quite skewed. It would be interesting to see this distribution. (However note my previous comment that since the areas averaged for the two MODIS datasets differ, this is not a very fair method of comparison.)"*

We agree that the conclusions drawn from the results presented in Table 1 could be questioned for the reason the referee is given. Thus, the distribution of the number of values used in the SAER averaging is skewed. This means that the majority of the number of pixels used in the averaging is 9 or just below, which in turn means that estimation of the standard deviation is highly sensitive to the few lower values that occur. Therefore, we suggest excluding Table 1 in the original version of the manuscript and replace the corresponding discussion in Section 3.2 with the following sentence "However, generally the number of pixels averaged both for the SAER and MODIS c005 retrievals are close to the maximum numbers (not shown)."

27) *"Figure 1: I would delete the data measured at night from this, as it will be 12 hours or so removed from the MODIS overpasses, and aerosol can change a lot in that period."*

Even so, for the present situation Figures 1 shows that the CALIPSO values, corresponding to the overpass of 01:08 UTC, relatively well reflect the variation in AOT shown in Figure 3; lowest values in the upper part of the scene and the highest values just south of the Baltic Sea (aerosols generated from the agriculture fires) but also enhanced values further south. The CALIPSO values, corresponding to the overpass of 02:47 UTC, also agree reasonable well with AOT shown in Fig. 3 for this area. We mention in the manuscript that a comparison of AOT from CALIPSO and MODIS should be considered as qualitative, since CALIPSO level 2 AOT is current not intended for scientific use. However, we also give an example how profiles of CALIPSO scientific extinction coefficient used together with MODIS column values provide a much more detailed view of the observed aerosol situation. This in turn provides a good foundation for validation of regional and climate models. Thus, with this discussed in the manuscript we suggest to keep the AOT values corresponding to the CALIPSO night tracks, but more clearly mention the time difference that occurs when results obtained from the two different platforms are compared: "CALIPSO measurements close to Belsk at 01:08 UTC on 1 April 2007 give extinction coefficients of about 0.4 km^{-1} within a homogeneous layer from the surface up to 2.3 km (not shown). The resulting 532-nm AOT of about 0.9 agrees well with measurements of the AERONET sun photometer. Thus, the highest AOT values at 555 nm (>0.8) shown in Figures 6 were observed at Belsk at 09:00 UTC during this day."

28) *"Figures 4-10: In all of these plots, you quote relative differences and give units of % for them. I think this is probably incorrect, i.e. a label of 0.12% probably means 12% (i.e. a fraction of 0.12) rather than 0.12%!"*

The referee is right and we have corrected this. Unfortunately we found a error in the code used to calculate AAD and relAAD (equations 8 and 9 in the manuscript) for Figures 9 and 10. The correction results in somewhat higher values shown in the revised figures.

29) *"Additionally, least-squares regression is not appropriate to calculate the linear fits presented in most of these plots. This is because the uncertainty is not constant over the range of the data (as you write, the error is proportional to AOT). Also, at low AOT, as there is a minimum value of AOT which can be measured/retrieved, which means that the errors cannot be Gaussian in this regime. This means that the linear fits and their uncertainties presented are not meaningful, as the assumptions required for least squares regression are violated. Figures 9 and 10 might be ok in this regard."*

It is true that the expected uncertainty range for the MODIS c005 retrieval, calculated from prelaunch analysis, is not constant over the range of AOT values, but this not necessary mean that the present results show the same behavior, particularly then considering the SAER retrievals. In addition, the referee is doubtful also about the linear fits calculated for the results presented in Figures 9 and 10. You may then ask; which situation is valid to apply least-square regression? Even so, we agree that the least-square regression applied on the present data is not full appropriate, particularly then considering the highest range of AOT where few values are retrieved. And the criteria of normal distribution for the errors may also not be fulfilled. One way to improve the statistical treatment is to merge the results subdivided according to the three time periods in the original version of the manuscript to one figure, but still subdivided according to Aqua and Terra (see revised Figures 4, 6, 7 and 8). It is no problem to motivate this change for the MODIS c005 results, since there is no indication that the algorithm produces significant systematic errors due to the sun-zenith/satellite-viewing geometry. For the SAER AOT retrievals, however, we think that a systematic error occurs (Section 3.4), although a statement about this can in any case be based on the results presented in Figure 10 and the discrepancy found between SAER and AERONET (see answer to specific comment 25 above).
For the results presented in the revised versions of Figures 4, 6, 7 and 8 we suggest to calculate AAD and AAD^{rel} instead of RMSD and $RMSD^{rel}$ and have therefore rewritten Section 2.1.3 in the original version of the manuscript. In addition, this section has been moved forward in the text, which means that this section is now named with "2.3 Statistical approach used to validate comparisons of AOT", in the revised version of the manuscript

Additional references used in this review:

Anderson, T. L., R. J. Charlson, D. M. Winker, J. A. Ogren, and K. Holmén (2003), Mesoscale variations of tropospheric aerosols, J. Atmos. Sci., 60, 119–136.

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