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Atmospheric Measurement Techniques Discussions

Interactive comment on "A weighted least squares approach to retrieve aerosol layer height over bright surfaces applied to GOME-2 measurements of the oxygen A band for forest fire cases over Europe" *by* Swadhin Nanda et al.

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Thank you for your comments. Our response to your suggestions and questions as well as incorporated changes (in line with your suggestions) are detailed point-by-point in the following:

The authors tested the algorithm with synthetic experiments with high AOD (1<AOD<5) conditions. However the retrieved parameters of ALH are showed with low AOD (<1) results in Figure 5c. How much does the improved method increase the accuracy with

low AOD (<1) case? What is the smallest value of AOD with the proposed method compared to formal one?

To clarify, the AOT in the synthetic experiment are values at 550 nm, whereas the retrieved AOT in Figure 5c are at 760 nm. Our synthetic experiments have, so far, dealt with the issue of a bright surface hindering the accurate estimation of aerosol layer height. So, the real retrievals do include some aspects of the synthetic experiments.

If we split the AOD to two different classes, synthetic spectra for AOT <= 2.0 and AOT > 2.0 (AOT at 550 nm), we observe that, in general, the dynamic scaling method improves the accuracy of the retrieved aerosol layer height in the presence of a model error in the surface albedo. This improvement is much larger for scenes with AOT > 2.0.

The same split, when applied to synthetic experiments with a model error in aerosol layer pressure thickness shows that the dynamic scaling method better improves ALH retrieval accuracy for scenes containing optically thinner aerosol layers, in comparison to scenes with AOT > 2.0. This is because optically thin aerosol layers allow more influence of the surface in the ALH retrievals due to more photons interacting with the surface, whereas optically thick aerosol layer do not.

It is also important to note that the AOT is a fitted quantity, and is not the objective of the ALH retrieval algorithm. To this extent, we have now clarified throughout the document that AOT is fitted, and not retrieved.

For further clarity to the reader, we have added the range of AOT values in synthetic experiments in both 550 nm as well as 760 nm in Table 1.

These results are not included in a table format (as in Table 2) in the submitted manuscript. We have now added them in the text as follows.

Amendment to the manuscript:

Added to Page 9 lin 14: '... scaling and formal approach are almost identical. Splitting

the results to AOT <=2.0 and AOT > 2.0, it is observed that the dynamic scaling method reduces retrieval biases of ALH by 40% relative to the same from the formal approach for high aerosol loads, and about 11.5% for low aerosol loads. This is because a scene containing low aerosols allow for more interactions between photons and the surface, which results in ALH retrievals being biased closer to the surface. The dynamic scaling method ameliorates this behaviour by reducing the sensitivity of the retrieval algorithm to these photons.'

Added to Page 10 line 17: '... if the modification is necessary. A similar split of results for AOT <= 2.0 and AOT > 2.0 reveals that the dynamic scaling method is almost similar to the formal approach for low values of AOT, and only results in significant improvements if the scene contains sufficient aerosols. Relative to ALH biases from the formal approach, the biases from the dynamic scaling are reduced by 53% for AOT > 2.0, and is practically the same for AOT <= 2.0.'

Added entry to Table 1 under atmospheric parameters for the parameter 'tau' (or AOT) as follows:

Name: AOT value/remarks: 1.0 - 5.0 @ 550 nm (or 0.60 - 3.0 at 760 nm)

The following changes clarify that AOT is not a retrieval parameter, and is a fitted parameter:

Page 3 line 20-21:

'Finally, this model is fitted to the measured spectrum to retrieve primary unknowns, Aerosol Optical Thickness (AOT) and ALH' replaced with 'Finally, this model is fitted to the measured spectrum to retrieve the primary unknown ALH, while fitting the Aerosol Optical Thickness (AOT).'

Page 7 line 10 - 11:

'The state vector parameters τ and zaer are then retrieved using spectrum' replaced with 'The state vector parameters tau and zaer are then estimated using spectrum'

Page 9 line 3:

'Teach synthetic experiment and the parameters zaer and τ are retrieved using both the formal approach and the dynamic scaling' replaced with 'each synthetic experiment and the parameters zaer and tau are estimated using both the formal approach and the dynamic scaling'

Page 13 line 4:

'The retrieved aerosol optical thickness values are in excess of 6.0 in many cases âĂŤ on average, the retrieved AOT is' replaced with 'The fitted aerosol optical thickness values are in excess of 6.0 in many cases âĂŤ on average, the fitted AOT is' Page 13 line 8:

'The distribution of retrieved τ appears to be spatially' replaced with 'The distribution of fitted tau appears to be spatially'

Page 14 Table 5 Caption:

'mean retrieved τ and standard deviation of the retrieved tau' replaced with 'and the mean and standard deviation of the fitted tau'

Page 14 line 3-4:

'While these retrieved AOT values are still unrealistic to the scene' replaced with 'While these fitted AOT values are still unrealistic to the scene'

Page 14 line 16-17:

'large values in retrieved aerosol heights and optical thicknesses.' replaced with 'large values in retrieved aerosol heights and fitted optical thicknesses.'

Page 14 line 19:

'The retrieved tau at 760 nm' replaced with 'The fitted tau at 760 nm'

Page 14 line 20:

‘Typical retrieved tau over the plume seems’ replaced with ‘Typical fitted tau over the plume seems’

Page 15 line 1-2:

‘The average aerosol optical thickness at 760 nm retrieved is’ replaced with ‘The average aerosol optical thickness at 760 nm fitted is’

Page 16 line 27:

‘The retrieved aerosol optical thickness are unrealistically high’ replaced with ‘The fitted aerosol optical thickness are unrealistically high’

Page 16 line 30:

‘The retrieved aerosol optical thickness’ replaced with ‘The fitted aerosol optical thickness’

Page 17 line 14:

‘The retrieved aerosol optical thickness is systematically’ replaced with ‘The fitted aerosol optical thickness is systematically’

Page 17 line 16:

‘does not necessarily make the retrieved aerosol optical’ replaced with ‘does not necessarily make the fitted aerosol optical’

Page 17 line 21:

‘the retrieved aerosol optical thickness’s representativity’ replaced with ‘the fitted aerosol optical thickness’s representativity’

Page 24 Figure 4 Caption:

‘Retrieved tau at 760 nm from the formal’ replaced with ‘Fitted tau at 760 nm from the formal’ ‘Retrieved tau at 760 nm from the dynamic scaling method’ replaced with ‘Fitted

tau at 760 nm from the dynamic scaling method’

Page 25 Figure 4 Caption:

‘Histograms of retrieved aerosol optical thickness replaced with ‘Histograms of fitted aerosol optical thickness’ ‘Retrieved tau from the GOME-2A pixels over the August 8, 2010 wildfires’ replaced with ‘Fitted tau from the GOME-2A pixels over the August 8, 2010 wildfires’ ‘Retrieved tau from the GOME-2B pixels over the October 17’ replaced with ‘Fitted tau from the GOME-2B pixels over the October 17’

Page 24 Figure 4 Caption:

‘Retrieved tau at 760 nm from the formal’ replaced with ‘Fitted tau at 760 nm from the formal’ ‘Retrieved tau at 760 nm from the dynamic scaling method’ replaced with ‘Fitted tau at 760 nm from the dynamic scaling method’

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