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Atmospheric Measurement Techniques Discussions

Interactive comment on "The role of aerosol layer height in quantifying aerosol absorption from ultraviolet satellite observations" *by* Jiyunting Sun et al.

Anonymous Referee #1

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The paper tackles the important issue of the impact of assumptions about aerosol layer height and spectral dependency of the aerosol refractive index on the quantification of aerosol SSA in the ultraviolet. With this aim in mind, the Authors compare the results of the "standard" KNMI retrieval scheme to those of a novel retrieval based on support vector machines (SVM), trained with real observations, on a particular scene of an aerosol smoke plume observed by TROPOMI. The comparison, which uses AERONET SSA as a benchmark, reveals that some assumptions made in the KNMI standard retrieval look problematic, and that the SVM based method is able to circumvent the problem and return more realistic values for the SSA.

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Discussion paper

GENERAL COMMENTS

While the scientific result of this paper is certainly interesting, I think there are a number of issues that need to be addressed before the paper can be published. First of all, I agree with the Editor's opinion that the manuscript does not read smoothly. The explanation of the SVM algorithm is difficult to follow, fails to mention important information (what's a support vector, what's a kernel) and makes it difficult for a reader to understand what is going on. In the description of the pre-processing it is not always easy to understand which quantity comes from which product (e.g., surface reflectance). The actual description of what was done to train the SVR for the retrieval of the AAOD is also confusing. Till Section 3.2.3 I was convinced that only a SVR is trained for the retrieval of AAOD, but at the end of Section 3.2.3 I get to know that there are two, and I don't fully understand why. In general, I think that the description of the entire process flow and of the logic behind it needs to be made more intelligible.

Finally, I have some concerns on validation. Testing the proposed method on a single scene basically means that the validation of the method is done against only one measurement. While the agreement between the SVM-based retrieval and AERONET looks excellent for the case shown, it would be important to see if this result is confirmed by looking at some more high aerosol loading events, which I guess should be possible to find, with $\sim$1.5 years of TROPOMI observations now available. Below are some point-by-point comments.

SPECIFIC COMMENTS

- Abstract, L16. Do you mean inappropriate assumptions on the spectral dependency of the SSA?

- L29. After Eq. 1 it would be useful to recap what are typical values of the UVAI for absorbing and non-absorbing aerosols.

- L37 and L46. Jeong and Su (2008) and Chimot et al. (2017) cannot be found in the

references.

- L72, “Another advantage”. “Another” with respect to what?

- L81. Format reference correctly.

- L83. Yao et al. (2008) cannot be found in the references.

- L83, “. . . as it only depends on a subset of training data”. WHAT exactly depends on a subset of training data? Also, here you mention the term “epsilon-insensitive loss” but don’t say what it is, thus after this sentence the reader is really none the wiser about what you mean.

- L84. Again the same problem. You mention “kernel functions”, but if you don’t say what they are and what they have to do with SVMs, then this sentence is of no use at this point.

- L86. Mountrakis et al. (2011), Noia and Hasekamp (2018) cannot be found in the references.

- L86, “consist” -> “consisting”?

- L90, “expresses” -> “discusses”

- L99 and L110. What is the point of indicating the date of last access for a dataset that is only internally available?

- L109. Sanders and de Haan (2016) is not in the references.

- L125. Earlier you said that the TROPOMI product has a "scene albedo" A_sc. What is the difference between A_sc and A_s? Then later, at L168, you say that you filter your data for A_sc. Does this come from TROPOMI or from OMI then? I don’t get it, I think all this is confusing.

- L142, Dubovik et al. (2000), Dubovik and King (2000) are not in the references.

- L165-166. While the reason for excluding large SZAs looks clear, why are the other

two criteria introduced? Please discuss.

- L181, “a strong spectral dependence . . . aerosols” -> “absorption by biomass burning aerosols in the near-UV has a strong spectral dependence”.

- L199, “by the testing data” -> “on the testing data”

- Feature selection. It looks to me like you decided to train the SVR using only quantities that have a strong linear correlation to the SSA. In this way, though, you may be discarding some quantities that have some nonlinear relationship to the SSA which does not show up in the linear correlation coefficient. Please discuss.

- L209-L210. Please explain the reasons behind these filters for UVAI and ALH.

- L246-248, sentence “This is realized . . . predicted”. You want to replace the OMI ALH with a value that is closer to the one that would have been retrieved by TROPOMI. But then why is OMI the target and TROPOMI the input? I was expecting it to be the other way around.

- L248-249, sentence “It should be noted . . . SVR”. Please discuss why have you chosen to train this ALH-adjusting SVR on the Thomas fire and not on the dataset for the AAOD retrieval SVR.

- L260. I don’t get what you mean by “We fit the SVR for AAOD prediction to both data sets”.

- L262-264. I am lost here. Up to this point I was convinced that you trained two SVMs: one to adjust OMI ALH to the TROPOMI value and one to predict AAOD from UVAI, ALH and AOD, and that the goal of the ALH-adjusting SVM was to allow the use of OMI data to train the SVM for TROPOMI. Now I learn that there is a third SVM. It looks to me like this sentence contains new information, so it does not just "summarize the section". Please make sure that this is better explained in the paper, because it makes it really difficult to follow the discussion.

- L273, “the nonlinear transformation” -> “a nonlinear transformation”

- L275. Either shed some light on the connection between the concept of kernel and the training of SVMs, or avoid mentioning kernels at all.

- L275. You should make it clear that the Mercer theorem sets the conditions for a function to be admissible as a kernel in a SVM (basically, it says that the function should give rise to a positive-definite kernel matrix).

- L280. At line 276 you start the paragraph with “It is clear that”, but actually point 3 is not clear at all from what you say. Nowhere before this line have you introduced the concept of support vector, nor have you explained what you mean by its “influencing area”.

- L282. It would be better to move Section B of the supplement to an appendix in the main paper. Supplement should be used for additional figures and data, not for theoretical explanations.

- L282-283. Before saying that you are using radial basis function kernels, it may be useful to say that these are among the functions that satisfy Mercer’s theorem. You can do this at the end of the previous paragraph (L276). Also, I would advise to write down the expression of the RBF kernel, so that the reader can better appreciate what is the parameter sigma that you mentioned earlier.

- L328. I get a bit confused by the distinction between the validation pixels and the rest of the plume. Are the validation pixels those in the small horizontal strip near the AERONET site in Fig. 9? You may want to indicate that in the paper.

- L352, “trained by the adjusted ALH” -> “trained using the adjusted ALH”.

- L353, "to quantify" -> "of quantifying"

- L366, “representative” -> “well known”

- P10, References. The first reference looks incorrectly formatted.

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