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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Retrieval of aerosol optical depth from surface solar radiation measurements using machine learning algorithms, nonlinear regression and a radiative transfer based look-up table" *by* J. Huttunen et al.

Anonymous Referee #1

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General comments: The paper has interest considering the relevance to obtain aerosol optical depth (AOD) from available measurements such as solar radiation measurements. In this sense, the authors have compared several methods to estimate AOD from solar radiation measurements considering additional variables (solar zenith angle and water vapor content).

Particular comments:

1) In the paper the term "surface solar radiation" is mentioned the first time using the acronyms SSR. In order to avoid confusion is necessary to specify that it refers to

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global irradiance (not direct or diffuse solar irradiance).

2) In section 1 (Introduction), the method of Foyo-Moreno et al. (2014) is mentioned along with the machine learning methods, but this method estimates AOD from solar radiation measurements using a linear relationship between AOD and a ratio. The neural network has been used to confirm the most adequate variables to take into account in the model. This should be clarified.

3) I consider that the criterion used by the authors to eliminate clouds is arbitrary or subjective in nature. Additionally, the criterion uses a function of SSR with AOD for a given solar zenith angle. What solar zenith angle? Is there then a different relationship for every solar zenith angle? The authors should use other methods, considering that there are several standard methods such as that of Long and Ackerman (2000), an automated method to identify periods of clear skies using solar radiation measurements. On the other hand, the authors assume a priori a dependence between SSR and AOD and this the task of the paper: evaluating and comparing various methods with an additional variable (water vapour content-WVC-)

4) On page 7 where the nonlinear regression method (NR) is described there is an equation with different variables, and one of them is 'flux'. Variables should be mentioned consistently; I suppose that this is Global Irradiance (SSR). On the other hand, in a paper the equation should be numbered. Also the coefficients should be specified together with their errors.

5) I don't understand paragraph 10 on page 9, with the terms used theta=, theta1L, thetaU, nugget. The same comment can be made regarding the explanation of the Random Forest method (min_samples_split, etc). In short, the machine learning methods are not clearly explained.

6) In section 3.1, in Table 1, what are the four last rows?

7) In Figure 1 the fitting equation should be included.

8) In Figure 1 I don't understand the mean of the colorbar because I think the colors should not be superimposed. The authors should clarify this.

9) In order to study the effect of water vapour content on AOS predictions, Figure 5 shows measurements of SSR versus AOD considering different values of WVC, but for a limited range of solar zenith angles (40.75o-50.25o). Why precisely this selection and not another? And how it may affect the results for other angles?

10) The pattern followed by WVC and AOD (Figure 5.a) is different from the positive correlation found by Huttuen et al. (2014).

11) Figures 5 b and 5c show no clear differences between them.

12) In their analysis, the authors have used the single scattering albedo at 550 nm, but in Figure 6 a they use the albedo for another wavelength, why?

13) Figures 6a and 6b should use the same scale for the same variable (water vapor column) in order to enable comparison. On the other hand, in Figure 6a the pattern shown for the albedo with WVC is different depending on the interval considered for the WVC (slopes with contrary signs), thus there is no consistency between Figures 6a and 6b because the pattern followed by WVC in Figure 6b is independent of the range considered at WVC. It More discussion is necessary about the effect of water vapour, considering other solar zenith angles for example.

Concluding remarks: the paper can be accepted for publication after these comments are taken into consideration and addressed.

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