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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Modelled and measured effects of clouds on UV Aerosol Indices on a local, regional, and global scale" *by* M. Penning de Vries and T. Wagner

Anonymous Referee #2

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This paper has focused on the UV Aerosol Index (AI) derived from satellite observations of fully or partly cloud-covered fields of views. The authors have compared observed AI derived from SCIAMACHY measured UV radiances with those simulated (or modeled) based on measured effective cloud fraction or cloud optical thickness on various spatial and temporal scales. The authors have come to the conclusion that observed UV AI dependence on cloud parameters, such as effective cloud fraction or cloud optical thickness, can be reproduced (with a few caveats) using a simplified cloud model that depends on these same parameters.

The idea of correcting an observed AI using a modeled cloud AI, therefore obtaining

a more accurate measure for true aerosol contribution, is certainly a novel concept and is encouraged to be further investigated and extensively tested. This paper is one of a series planed by the authors to demonstrate that observed AIs can be corrected for cloud effects by subtracting from it the modeled AI values computed with measured cloud parameters. The goal is to improve the observed AIs so that they can be used for more quantitative analysis and for extending the range of AI applications to the study of 'scattering' (weakly or non-absorbing) aerosols.

In setting this goal, the authors have made an implicit assumption: UV AI can be decomposed into cloud and aerosol components, and the sum of the two is equal to the total. But its validity has not been discussed or illustrated thus far. It is recommended that the authors to describe the physical basis for this assumption, and/or to provide case studies to illustrate its validity under various observing conditions, since it is not obvious that when both cloud and scattering aerosol are in the same IFOV, the observed AI would always become more negative comparing to cloud or aerosol alone.

Furthermore, even for the cases when UV AI is additive (i.e., the sum of the components equals to the whole), it is not clear that in practice the aerosol contribution can be separated from that of the clouds, in part because cloud parameters (especially the effective cloud fraction) used by the simplified cloud model for cloud AI calculation are likely affected by the presence of aerosols.

A discussion of these two aspects, the validity of AI addition and the ability to separate its components, would help a reader to better understand this paper and set the stage for further investigation.

The bulk of the work presented in this paper is the comparison of modeled cloudUVAIs and those observed by SCIAMACHY. While the authors see agreements (in Figure 7) between modeled and measured AIs, this figure also reveals large biases (as large as half an AI unit even when effective cloud fraction is small) between the averages of measured and two modeled AIs for the full range of effective cloud fractions and for the three solar zenith angle bins, implying that biases will be introduced into the AIs when correction is performed. This problem is likely due to unrealistic cloud model employed in this study. This observation is based on the conclusions reached in a previous work by Ahmad, Z., P. K. Bhartia, and N. Krotkov (2004) (Spectral properties of backscattered UV radiation in cloudy atmospheres, J. Geophys. Res., 109, D01201, doi:10.1029/2003JD003395), which has shown that the spectral dependence of cloudy observations can be very well modeled with Mie scattering clouds. In other words, the cloudUVAI can be modeled more accurately (with less bias) with a more realistic cloud model.

Another issue with this paper is the use of Lambert Equivalent Reflectivity (LER) model in deriving the observed AIs. The work by Ahmad et al. [2004] has shown that LER model in general could not reproduce the spectral dependence of UV radiances. This is the reason why large negative AIs are derived for cloudy observations using the LER model, as seen in the results presented in this paper. Correcting a large negative measured AI with a large negative modeled AI to extract a small signal of scattering aerosols does not seem to be an optimal approach to achieve the objective of this paper. I would recommend that the authors to look at a new scheme for cloudAI correction. Specifically, Ahmad et al's work has also shown that the Mixed LER (MLER) model does a pretty decent job in reproducing the spectral dependence of cloudy observations, implying that using MLER model for AI computation would reduce the magnitude of the negative AI values associated with clouds. Note that NASA's AI products are computed using the MLER model, and the negative AI values associated with clouds are generally smaller than those presented in this paper. Therefore it may be worthwhile to derive the observed AIs using the MLER model, and to develop a scheme to correct the smaller negative AIs based on the derived effective cloud fraction.

In summary, providing the physical basis for AI corrections and demonstrate that it can be achieved with limited cloud information, as well as improving the cloud model and investigating the merit of alternative AI computation scheme are recommended.

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