Atmos. Chem. Phys. Discuss., 8, S11302–S11305, 2009
www.atmos-chem-phys-discuss.net/8/S11302/2009/

Atmospheric Chemistry and Physics Discussions

ACPD

8, S11302–S11305, 2009

Interactive Comment

Interactive comment on "Calibrated sky imager for aerosol optical properties determination" *by* A. Cazorla et al.

A. Cazorla et al.

Received and published: 17 February 2009

Answers to Reviewers #1 and #2

We would like to thank the anonymous Referee #1 and #2 for their positive evaluation of the paper and the helpful critical comments that favors the discussion and could serve for improving the manuscript.

We shall starts with the criticism on the motivation of the manuscript. The focus of the work presented in this manuscript is to check the capability of the Whole Sky Imager, WSI, to derive aerosol optical depth and its spectral dependence. In this way, the idea behind this objective is to obtain a value-added for the WSI, designed originally to characterize cloud cover. The method applied is based on previous findings, obtained with a simpler and non-absolutely calibrated CCD sky imager operated at the University of Granada, the All Sky Imager (Cazorla et al, 2008a). Results of that previous work have been published in Atmospheric Environment (Cazorla et al, 2008b). In this sense, the challenge we have approached is the application of the previously developed and tested methodology to the radiance calibrated sky imager system. Considering the increasing interest in automatic ground-based devices that could provide cloud detection and characterization in near real time, our work could contribute to the search of solutions that combine the cloud and aerosol characterization in the same instrument. One additional advantage of these devices is the capability of register a whole sky image with a high frequency, typically every 5 minutes, although higher frequencies can be used. Following these lines we will improve the justification of the work in the revised version of the manuscript.

Concerning the criticism on the neural network methodology, we must say that as we have stated in Cazorla et al. (2008b) there are other possible alternatives. In this way, in a recent publication (Olmo et al., 2008), some of the co-authors of this manuscript have approached the retrieval of aerosol optical depth at 500 nm using a CCD Sky Imager and a radiative transfer methodology. The statistical results are close to the paper object of discussion, but this radiative transfer-based methodology has more uncertainties deriving the Angström parameters. Following our experience and the results obtained in Cazorla et al. (2008b) and Olmo et al. (2008), we think that the use of the radial basis function (RBF) network, widely used in atmospheric sciences, is especially suitable for our purpose. After training, the RBF network can be used with data whose underlying statistics is similar to that of the training set. In this sense, SZA and a single radiance are the only two input parameters if RBF network is good trained. The selection of the input variables has been done by means of a greedy algorithm (Cormen et al., 2001). In the case of the neural network developed for the non-absolutely calibrated sky imager (Cazorla et al., 2008b) at least two radiances per channel have been necessary. Nevertheless, in the case of WSI, due its absolute calibration, our analyses suggest that only a single radiance per channel is necessary.

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Our results for the retrieval of Angström exponent suggest that the use of a neural network, using as input the same radiances used for the retrieval of aerosol optical depth at the three wavelengths considered, provides better estimates than the direct computation of Angström exponent from the retrieved aerosol optical depth. To clarify this point and answer to reviewer #2 criticism, a new Figure will be used in the final version of the manuscript. In spite of Figure 4 in the on line version of the manuscript, that shows a LibRadTran simulation of the radiance at the principal plane for a fixed wavelength, the new proposed figure shows two experimental cases with different spectral dependence of aerosol optical depth, and thus different Angström exponent, including information for the three wavelength considered. In this way, we will show that the combination of spectral radiances at the considered wavelengths and selected scattering angles (37, 71 and 83 degrees) presents different variation depending on Angström exponent. This will illustrate the capability of the Neural Network to retrieve Angström exponent from that set of experimental measurements.

In reference to the question raised by reviewer #2 on the shadow system (question 6 reviewer #2), we do not need a quantitative estimation of the shadow system in our methodology because we exclude this region of the principal plane radiance values considered.

According to reviewers #1 and 2# comments, the description of the methodology in section 3, in particular in section 3-2, will be improved in the revised version of the manuscript. Following the reviewers' comments the terminology will be used in order to make this section readable by any reader interested in aerosol characterization despite of his/her knowledge about neural networks.

Finally, we think that the use of the developed neural network with other WSIs without additional training is possible since the WSI is an absolute radiance calibrated device. And in this sense the proposed model directly relates spectral radiances in fixed geometries with aerosol optical depth and Angström exponent.

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In reference to the specific comments and technical corrections, we will follow the reviewers' comments to improve and correct the revised version of the manuscript.

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