Atmospheric
Measurement
Techniques
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Discussions

Interactive comment on "Satellite retrieval of aerosol microphysical and optical parameters using neural networks: a new methodology applied to the Sahara desert dust peak" *by* M. Taylor et al.

Anonymous Referee #3

Received and published: 2 April 2014

General comments

This paper discusses the new methodology to retrieve aerosol microphysical and optical parameters from satellite remote sensing based on the artificial neural networks. Global retrieval of aerosol microphysical properties is well-recognized and challenging task. This work suggests an alternative to well-established methods of aerosol properties retrieval by utilizing the methodology of neural networks. NNs are widely used in many other fields but still remain exotic in aerosol remote sensing.

The paper is well written, has a good structure and clear. It has good and detailed description of the methodology, data selection and the discussion of results. Additional attention was paid to such NN-specific topics like training dataset preparation, selection of NN architecture and training rules.
At the same time, I spotted few inaccurate and unclear statements in the paper that should be corrected before the publication.
Therefore, in my opinion, the paper can be accepted for publication in Atmospheric measurements Techniques "after minor revision". I have outlined below few comments for the authors consideration.

Specific comments:

Page 10959, line 24. "sensors by performing multivariate regression" that's not exactly correct as AERONET retrieval performs a numerical inversion of the observations.

Page 10966, line 25. "normalize all input and output variables". I think authors should provide a more detail here. First of all NN is a rather new technique in the atmospheric remote sensing and not everyone is familiar with the fact that the values of input and output data should be in the certain range, if I'm not mistaken from 0 to 1. Secondly it is not clear how the normalization is performed, I assume it is applied for each value of the vector. I think this should be outlined because input dataset contains size distribution and it could be mistaken if normalization should be applied to each value or to the whole distribution. Maybe term "scaling" would be more appropriate for this operation. Thirdly, as I understand, to perform such normalization we need to know the range of possible values of each variable (min and max) since they all have different scales. It is not clear which ranges were used, if they were defined for aerosol in general, or for dust aerosol type. You can add a reference here.

Page 10966, line 26. "apply principal components analysis", I assume this is a well known and widely used operation, however I think authors could provide a bit more

information on this operation, at least give a reference to some papers describing PCA itself.

Page 10969, line 8. "the outputs produced 7 PCs (see Sect 2.2 for details)" this comment directly connected with the previous one, it is not very clear according to the section 2.2 how 116 values were reduced to 7 and vice versa.

Page 10975, line 8. "There appears to be a play-off... " In terms of NN learning it seems that the learning dataset wasn't big enough for NN to learn all the possible combinations of the output.

Page 10975, line 12. "unsupervised (testing) mode" I think the term "unsupervised" is not very suitable, usually in NN terminology it is used for one of the paradigms of NN learning, alternate to "supervised learning" used in this paper. This could lead to misunderstanding of the NN test, as during this process no weights are adapted.

Page 10976–10977, lines 23–5. The differences between MODIS OMI and AERONET are discussed. Conclusion made that differences are explained by the different angular variations of aerosol in ground-based and space measurements. In my opinion, starting from the phrase "... whereas MODIS's spectro-radiometers measure the intensity of solar radiation reflected vertically by the earth system", it is more logical to assume that it is much harder to differentiate the contributions of the surface reflection and aerosol extinction to the total measured radiance in the case of measurements from orbit, which is also worsen by the fact that deserts where most of the dust measurements are performed could have comparatively bright surfaces. So the mentioned systematical error could be explained by the influence of the surface reflectance.

Technical comments:

Page 10957, line 10. Could also add reference to IPCC 2013.

Page 10975, line 14. "The testing performance of the trained NN was tested", I assume

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word "testing" is a duplicate and could be deleted.

Page 10977, line 13. "and also the location of the coarse mode peak (radial bin 15)" I think the term "location" is more suitable for the radius, which is defined, maybe it is better to use term "value", "height" or "magnitude".

Page 10983, line 13. "aerosol microphysical and optics parameters", replace "optics" with "optical".

Page 10984, lines 9–13. "In assessing the performance of the NN model". The whole sentence is too big and hard to understand, try to split it in several simpler sentences.

Page 10992. Table 2. The line delimiting "inputs" and "outputs" as well as "optics" and "microphysics" in the first and second columns should be one row upper.

Page 10996. Table 5. I don't think "Mishchenko parameter" is the best headline for this column, it gives the impression that these parameters were invented by Mishchenko or were named to his honor, maybe "parameter" or "parameter according to Mishchenko et al." would be better.

Page 11004. Figure 4d. I think the x axis label should be "epoch" not "15 epochs"

Pages 11004–11010. Figures 4–10. General remark. I don't know what will be the sizes of these figures in the published article, but consider making axis labels and values as well as legends bigger for better readability.