

## ***Interactive comment on “Neural Network for Aerosol Retrieval from Hyperspectral Imagery” by Steffen Mauceri et al.***

**Anonymous Referee #2**

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Summary:

The authors present a neural network based aerosol optical thickness retrieval from a hyperspectral imager – with the intent of improving atmospheric correction of land surface reflectances. The network obtains separate estimate of dust, brown carbon, and sulfate AOT as a mixture for each observed spectra. They apply this network to airborne AVIRIS-NG imagery and demonstrate its usage for a variety of aerosol conditions and compare their results those of AERONET. The efficiency of neural networks, combined with the large scale of the remote sensing datasets produced by hyperspectral imagers makes studies such as this one important.

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General Comments:

Overall I think this paper is good, but I do think there is relatively little discussion as to why the network performs so poorly for low aerosol optical thicknesses (as indicated in the MODIS comparison). The other comparisons could have appeared better because the collocated datasets simply did not have any occurrences of aerosol optical thicknesses below 0.3. In contrast, the MODIS dataset has numerous occurrences of lower aerosol optical thicknesses. You should look into what might be causing the network to behave this way for low optical thicknesses. It is important to note that MODIS has been shown to have fair agreement with AERONET for low optical thickness conditions in other comparisons (see citations below).

Gupta, P. and Remer, L. A. and Levy, R. C. and Mattoo, S., Validation of MODIS 3 km land aerosol optical depth from NASA's EOS Terra and Aqua missions. 2018, Atmospheric Measurement Techniques, 11, 5, 3145-3159, DOI: 10.5194/amt-11-3145-2018

Yuan Wang, Qiangqiang Yuan, Tongwen Li, Huanfeng Shen, Li Zheng, Liangpei Zhang, Evaluation and comparison of MODIS Collection 6.1 aerosol optical depth against AERONET over regions in China with multifarious underlying surfaces. 2019. Atmospheric Environment, 200, 280-301, <https://doi.org/10.1016/j.atmosenv.2018.12.023>.

Specific Feedback:

1. The selection of variables for spherical albedo, transmittance and path radiance in equations 1-4 does not seem to match a convention that I am familiar with. It also seems unconventional to refer to radiances with an abbreviation within an equation rather than a consistent variable. The current format makes the equations opaque, when in reality  $rad_x$ ,  $t$ ,  $f$ , and  $F$  are all radiances.
2. Your dust optical property database seems to be from a very old citation. I would recommend using a non-spherical dust model as they have very different scattering properties from spherical scattering.
3. I'm not sure I understand the neural network output structure, are you

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retrieving a carbon, dust, and sulfate mixture for all aerosol cases? This should be made more clear, as in some cases/regions this mixture approach may not be appropriate. 4. You refer to the preprocessing in section 3.2 as normalization in a couple of places. This is incorrect, it is typically referred to as “standardization”. It is worthwhile to explain why this is useful to perform on neural network inputs before you explain the mathematics. To that end, perhaps it would be helpful to say that the purpose of preprocessing standardization before providing input to a neural network is that it results in a fair comparison of the variability of observations that come from disparate distributions (magnitude and variance). 5. In figures that feature analysis of the validation dataset you need to indicate such in the caption. I think this would apply to Figures 4, 5, 6, 7, and 8. I find that those who are unfamiliar with neural networks and their applications often have difficulty distinguishing between validation dataset figures and those tested on real data unless you very explicitly state that. 6. The novelty detection network is a very clever implementation. I think it would perhaps be useful to further discuss how this works. For example, in many of your images it specifically seems to flag only for very dark surfaces in the true color image – is there an explanation for this behavior? 7. In section 5.4 when you are discussing the comparison to MODIS combined aerosol product you mention that MODIS “uses fewer wavelengths to make this retrieval.” I think this may be misleading in a sense. Both of the MODIS aerosol products included in that dataset have a significantly different relationship spectral information and the number of spectral bands used/required than your approach does.

Text Feedback:

1. Page 3 line 20: There is an extra “s” in “TRANSsmittance” in the MODTRAN name. It should be “Transmittance”
2. Page 6 line 8: Missing article in the sentence. “AOT of 1.0 was selected for each aerosol type.” should read as “An AOT of 1.0 was selected for each aerosol type.”
3. Page 9 line 16: normalization should be standardization.
4. Page 18 line 18: normalized should be standardized.

Figure Feedback:

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1. Figure 2: the formatting of optical thickness in the legend is confusing. The variable should either be a tau or AOT.
2. Figure 8: Within each aerosol type the y-axis limits should be consistent. Otherwise it is very difficult to understand how the impact of noise influences the analysis for each of these aerosol types.

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