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Atmospheric Measurement Techniques
Discussions

Interactive comment on "Neural Network Radiative Transfer for Imaging Spectroscopy" *by* Brian D. Bue et al.

Anonymous Referee #2

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The paper presents a neural network developed to calculate radiative transfer for the solar spectral region in clear sky. The model is applied to retrieve the surface spectral reflectance function from PRISM (airborne imaging spectrometer) data. As examples the retrieved surface reflectance spectra for 5 different surface types are shown to demonstrate that the method works well. The neural network method highly accelerates the atmospheric correction methodology, thus it is certainly an interesting approach which might become standard since the data to be processed increases rapidly with improvements in spatial and spectral resolution of sensors. The topic of the paper fits well in the scope of AMT, however, it needs to be revised, because the methodology needs to be described more precisely. Further the authors need to point, what makes their approach novel compared to other neural networks based approaches. I

recommend publication in AMT after these revisions.

Major comments:

1. The application of neural networks for remote sensing has become rather common in the last decade (besides the mentioned references e.g. Kox et al. 2014, Loyola et al. 2016, Eferemeko et al 2017, Strandgren et al. 2017, Loyola et. al 2018). The authors say that they for the first time apply a neural network based algorithm to imaging spectroscopy. I am not sure whether this is correct. At least, the operational cloud retrieval algorithm for TROPOMI, a spaceborne imaging spectrometer, also applies a neural network RTM (Loyola et al., 2018). So in my opinion the authors should point out, what makes their approach novel and what is the difference to other similar approaches.

If I understood correctly, the physical knowledge that is incorporated is the "analytical decomposition of the radiance spectrum into quantities that are individually easier to model". Later I find, that this means to use reflectances ("pi*y/phi0*E0" with y-radiance, phi0 - solar zenith angle and E0 -extraterrestrial irradiance; apart from E0 very uncommon nomenclature) instead of radiance. This is a very common approach, also in look-up-table based retrieval algorithms and not a new idea. I think that all publications mentioned below use reflectances and not radiances.

The second "novel" idea that is mentioned is the channel-wise training. This is as far as I know already applied in Kox et al. 2014. The only new idea, that I have not seen so far, is the channelwise weight propagation, which makes sense to me.

2. The setup of the neural network needs a more comprehensive description: - Most symbols in Figure 1 are not explained - It is not clear to me, whether the "monochromatic subnetworks" (p4, l.4) are really monochromatic (for 1 wavelength) or for one channel (convolved with the spectral response function). E.g. on p5, l4 it reads "To ensure each subnetwork reliably models its corresponding channel ..." - Explain settings: "feed-forward architecture with two hidden layers of 50 units each ... Why is the neural network set up as shown in Figure 1? Why are these particular settings chosen for this

particular application? - Explain terms "rectifying" and "early stopping"

3. The radiative transfer simulations for training and validation were performed using the libRadtran package, which is a comprehensive package including various parameterizations, atmospheric setups, aerosol types etc. The setup of libRadtran needs to be specified, i.e. which atmosphere is used, which absorption parameterization, how is the aerosol defined, which radiative transfer solver is used etc. The symbols in Table 1 (input parameters) are also not defined.

4. Figure 3: How is the linear regression done? Linear interpolation in a lookup-table for the parameters listed in Table 1? This is not explained in the text.

5. Why are only 5 examples of retrieved surface reflectivity spectra shown. Since the method is so fast, it could be easily be applied on a full image. The difference between the traditional atmospheric correction approach and the new neural network approach should be assessed in a statistical sense.

Minor comments:

- Figure 5: I suggest to create a separate figure for the histograms shown in the diagonal with proper y-axis labels.

- It is confusing that the term reflectance is used for the top-of-atmosphere reflectance and the surface-reflectance. It should always be specified, which reflectance is meant

p11, l.5: traditional RTMs required over 10 minutes to run -> this depends very much on the settings, on the radiative transfer solution method etc. Specify, which kind of RTMs you refer to.

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