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Atmospheric Measurement Techniques Discussions

Interactive comment on "Low-level liquid cloud properties during ORACLES retrieved using airborne polarimetric measurements and a neural network algorithm" *by* Daniel J. Miller et al.

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We would like to thank the reviewers for their thoughtful comments. In response to the reviewer's suggestions we will make several important clarifications in the paper text. In addition to this, we will update the paper to include links to the public dataset.

Specific Comments:

1) The NJK method is not implicitly used in the training of the network. The network is simply trained based on the total reflectance and polarized reflectances in a number

of spectral bands and scattering geometries. However, we do agree that the greater uncertainty in the total reflectance has been one of our primary difficulties in this research. It is also important to note that without total reflectances there is no method for obtaining an accurate estimate cloud optical thickness. Refer to my answer to your third question for some expanded discussion as to why we did not want to separate total and polarized reflectances in the implementation of this network.

2) We understand the source of the confusion, it is a rather tortured explanation. We could of course modify the input vector in whatever manner we choose, but the idea here is to modify the relative importance of each measurement by the uncertainty. It is also important to understand that we are not simply replacing standardization in the normalization process, we are just introducing a pre-processing step before submitting data to the network. Batch renormalization occurs throughout the network, as indicated in our network diagram in figure 3.

We have clarified this statement in our revision: "After this standardization relative to instrument uncertainty the range of variability in the DoLP training set input is approximately four times greater than the range of variability in the RI. This variability difference is a result of the better relative measurement uncertainty of DoLP compared to RI. As a result the network should initially place a greater weight on changes in DoLP than on changes in RI."

3) It is a difficult question, as both of the baseline retrievals exhibit their own uncertainties and dependence on observational conditions. However, as we mentioned in the paper in the last two paragraphs of section 2.3 (page 10-11), our previous work in Miller et al., 2018 showed that a synthetic comparison of the bispectral (NJK) and polarimetric (PP) retrievals revealed that at high spatial resolutions obtained by airborne instruments like RSP the retrievals should be nearly identical for optically thick clouds. This indicates that the information content (with regard to re and tau) contained in these two measurements is relatively similar. Additionally, we examined this in the background section by examining the comparison of NJK and PP for both field cam-

paigns in this study and found similar results for optically thick clouds (shown in figure 2).

While it is possible to use only one type of measurement to train a network retrieval on, but the two different type measurements (total and polarized reflectances or DoLP) contain additional information content about aerosols. One of the main reasons we wanted to mix them in our retrieval stems from our eventual final objective of this research program – a NN estimate of aerosol above cloud and cloud properties. The existing robust methods of inferring above cloud aerosol properties require both total reflectance and DoLP to tease out the different signals of the above cloud aerosol and the cloud itself. For the purposes of our future exploration of the NN approach we needed to understand how mixing these two types of information into one NN might influence our approach.

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