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Atmospheric Measurement Techniques Discussions

Interactive comment on "Retrieval of liquid water cloud properties from POLDER-3 measurements using a neural network ensemble approach" *by* Antonio Di Noia et al.

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We thank the Reviewer for his/her comments. Below are our replies. Reviewer's comments are in bold, our replies are in plain text.

Abstract: It is good that you have highlighted upfront the limitations of the algorithm in the abstract. I would also like an indication of the sign of the bias, so that is is obvious that, for example, -2 bias in COT means NN > MODISstandard.

Actually, by -2 bias we mean that the NN scheme is biased low with respect to MODIS (NN < MODIS). We have rephrased that sentence in the abstract in order to reduce

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ambiguity.

Page 2, line 20: probably want to indicate 'liquid' cloud.

Agreed. We inserted "liquid water" before "cloud" in the revised text.

Page 3, line 3: By LUT do you mean training set?

In this sentence we mean that NNs are often more accurate than LUT retrievals, at least when compared to LUTs that are not unrealistically large.

Page 3, line 27: I think I understood but I was a little confused at this point – thebeffective radius retrieval is an entirely separate NN, right?

Yes, the effective radius is retrieved by an entirely separate NN, but we defer the discussion of this detail of our NN scheme to Section 4.

Section 4.2, page 17, line 20: Now that you have binned to a 1x1 degree grid, we would expect polarimetric and bispectral retrievals to have greater biases, right? Please discuss.

We do not expect greater biases with this type of regridding. The starting point for this regridding consists of MODIS data that had been already remapped on the POLDER pixel size, and the regridding was made by trying to ensure - as far as possible - that the same clouds would enter in both NN and MODIS gridded retrievals. On page 18 of the revised manuscript we have added a sentence discussing this.

Page 18, line 5: Aerosols above clouds will have a specific impact on cloud optical property retrievals with the bispectral approach, that would presumably not be present in the polarimetric approach (I recall a paper by Kerry Meyer about this). Is the bias you're seeing consistent with this potential issue?

We are not sure that our approach would not be affected by aerosols above clouds, as the NN occasionally also uses measurements outside the rainbow range, at scattering angles that are low enough to be affected by aerosols (Waquet et al., 2009). This is

necessary as the NN needs 14 angles as input, and it is very rare that they all fall within the rainbow range. Furthermore, the NN has not been trained with cloud scenes with aerosol above clouds. During the analysis of our results, we have tried to define a rough "aerosol above cloud" flag for our retrievals by looking at the polarized reflectance at scattering angles roughly between 100°and 120°(based on Waquet et al., 2009, the polarized reflectance in this angular range should be much higher over clouds with an aerosol layer above than over "pure" clouds). However, using such flag as a filter did not yield any interesting insight in the observed biases, and we decided not to present this analysis in detail. This is discussed on page 21 in the revised manuscript.

Page 21, line 19: Based on your figure 10, it looks like the assumptions of POLDER-2 level 2 COT are problematic, right? Over land the peak is much lower than 9microns, and both of the distributions are quite large (and thus hard to approximate with a single value).

While this can have some effects, we do not expect POLDER Level 2 COT retrievals to be very sensitive to assumptions on effective radius.

Figure 16-18: It looks like the POLDER-CDR algorithm clusters at the edges of the LUT, can this be discussed more?

We are not sure about the reason why the POLDER-CDR tend to cluster at the edge of the LUT. We have added a sentence about this on page 24 in the revised manuscript (also in response to a similar comment by Reviewer 2).

Conclusions: It might be nice to have more speculation how the NN algorithm is even able to retrieve properties at the inherent pixel resolution, where presumably the cloudbow is not always observed and there is no information about the cloud microphysical properties. I think I get it, but more detail would be nice.

We think that the NN uses the relative wavelength shift of the observed maxima and minima in polarized radiance in order to retrieve information about cloud properties.

It must be considered, though, that the scatter in cloud effective radius retrievals at the inherent pixel size is significantly larger than that of gridded retrievals. This, in our opinion, means that the fact that the polarization maximum of cloudbow is sometimes missed may still be a limitation for the retrieval, but it gets compensated by spatial averaging, as it leads to random errors rather than systematic ones. We have added these considerations to the conclusions, on page 25.

Page 24. Line 1, Would this algorithm be feasible for another instrument in your group, SPEXone?

In principle this algorithm can be adapted to other types of multiangle polarimetric observation, including SPEXone. While 3MI and HARP may be more natural candidates for a direct extension of this method, in the case of SPEXone we would probably adapt the method by using high spectral resolution information to compensate for the limited number of available viewing angles. We have added this consideration to the conclusions.

Page 24, line 20-25: regarding ice clouds, could a NN be created that doesn't retrieve size, but the parameters van diedenhoven does mention (ie aspect ratio and roughness)?

In principle this is possible, as van Diedenhoven et al (2012) use simple crystals with varying aspect ratio and roughness as proxies for complex crystals in top of ice clouds. However, this is outside the scope of this paper. We discuss this on page 26, line 15.

Finally, it would be nice to have the data and code archived somewhere and not just available upon request.

The gridded data will be uploaded to a public ftp repository mentioned in the revised manuscript. Also the code will be gradually added once it is made easier to read for external users. Honoring your request for the entire Level 2 dataset is much more difficult, unfortunately, as the dataset is approximately 1TB large, and the FTP servers

available at SRON cannot provide so much space at the moment.

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