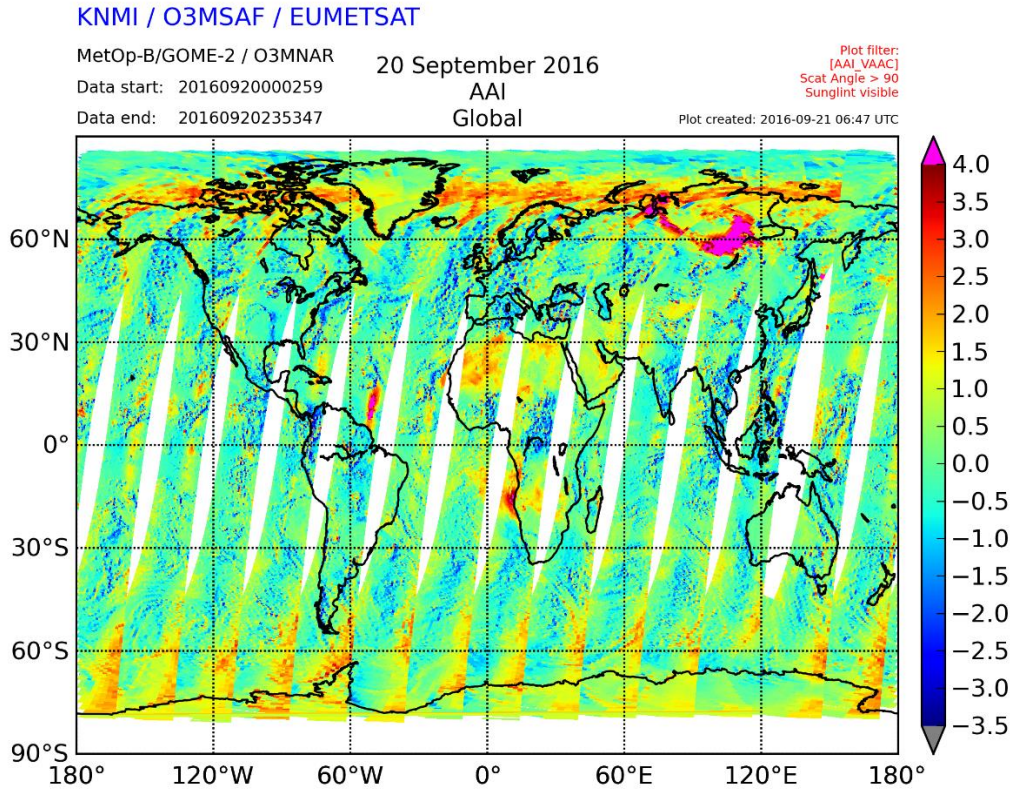
Review of 'Evaluating spectral cloud effective radius retrievals from the Enhanced MODIS Airborne Simulator (eMAS) during ORACLES' by K. Meyer et al.

In this study, a wide range of cloud droplet effective radius observations are compared, both remotely sensed and in-situ measured by different techniques. Sensitivities to retrieval assumptions are quantified, and possible reasons for agreement or disagreement between the different observations are given. This is an extensive analysis, which has been carried out very carefully, and presented extremely well. It is of great value for the scientific community, not only for those doing (satellite) retrievals or in-situ measurements but also for users of these observations for e.g. cloud-aerosol interaction studies. I have only one major concern, related to the effects of above-cloud absorbing aerosols on the results (see below), which needs to be addressed by the authors. Otherwise, I only have a few minor comments.

General

My main comment is about the potential presence of absorbing aerosol (smoke) above the clouds. As mentioned on page 3, 'ORACLES targeted the unique aerosol and cloud environment over the southeast (SE) Atlantic Ocean where an extensive biomass burning smoke layer overlies a quasi-permanent marine stratocumulus cloud deck'. Indeed, on the main day of study, 20 September 2016, extensive smoke appears to have been present in the study region, with absorbing aerosol index (AAI) values (much) higher than 2 (see image below taken from https://www.temis.nl).



Surprisingly, no analysis of this aerosol layer is included in the paper, and it is not taken into account in any of the retrievals. Effects on COT and CER retrievals are discussed on page 17, and it is stated that 'CER retrievals, on the other hand, are substantially less biased, e.g., less

than 5% on a monthly mean scale (Meyer et al., 2015), since the above-cloud aerosol spectral absorption is at a minimum in the SWIR and MWIR (de Graaf et al., 2012; Haywood et al., 2004). However, while it is true that absorption by smoke is minimal in the SWIR and MWIR, CER retrievals are affected through the coupling with COT. Haywood et al. (2004) find CER underestimates of up to 2 μm at 3.7 μm, 1 μm at 2.13 μm, and as much as 5 μm at 1.63 μm. In the context of this paper, these are significant biases, which must be taken into account. The authors either need to include these aerosols in the retrievals or – alternatively – demonstrate that no significant aerosol was present above the clouds in the cases studied.

Specific

Fig. 2: The Aqua MODIS comparisons appear to suggest a much larger eMAS degradation than the RSP comparisons. Can you comment on that? Also, a symbol appears to be missing for the Aqua MODIS comparison of the 2.13 micron channel on 20 September.

Fig. 4: I am somewhat surprised by the large difference in retrieval uncertainties between the spectral channels. In particular, the 3.7 μm CER has a relatively very low uncertainty. Could it be that uncertainties related to estimating the thermal emission contribution to the observed radiance as well as the error of 5% in the solar component (compared to 7% error in the reflectance for the other channels) are judged too optimistically? A related question is that, if I am not mistaken, these uncertainties are not included in the further analysis. For example, in Fig. 11 the whiskers denote spatial variability but single-pixel retrieval uncertainty is not accounted for. If the retrieval uncertainty of the 1.6 μm CER is really as large as 50% (which seems to be the case in Fig. 4) – corresponding to about 4 μm and likely a combination of systematic and random errors – this puts the results in Fig. 11 in a different perspective. Can the authors comment on this?

P29, 647-648: I am not sure what this statement means. The inter-wavelength differences seem to be comparable between the two cases:

- Sawtooth: PDI 7.9-8.3 um, CAS 6.5-6.7 um
- Ramp: PDI 9.0-9.4 um, CAS 7.7-7.9 um

P43, Fig. 21: I do not see how CER at 1.62 micron can increase as a result of doubling above-cloud water vapor. Can you explain?

Technical

P7, L204: remote -> remotely

P19: There is some duplication between text and caption. In general, content of the figure is best described in the caption. Suggest to transfer some of the description to the caption (e.g., arrows, labels, blue boxes).

P30, L677: spectral -> spectrally

P35, L785-787: It would be good to include the meaning of the vertical dotted lines also (or only) in the caption of Fig. 19.

P42, L909: Prefer: ‘it is’.

P43, Fig. 21: Please indicate for clarity what the dotted boxes refer to. I guess these are the ‘default’ retrieval results from Figs. 11a and 15a?

P44, L954: ‘bias difference’ sounds strange and ‘double’. Consider to replace with ‘difference’.

P47, L1051: Incomplete reference

P48, L1087: n/a-n/a. Correct and include doi,

P49, L1103: n/a-n/a. Correct and include doi,

P51, L1185: ldots. Correct and include doi.

P52, L1211: Incomplete reference

P53, L1248: Incomplete reference

P53, L1260: Incomplete reference

P54, L1290: n/a-n/a. Correct and include doi.