Anonymous Referee #2

We would like to thank Reviewer #2 for her/his time devoted and the constructive and helpful comments to which we will respond point by point.

The authors analyse an interesting meteorological/aerosol event named Ophelia, that took place in mid-October 2017 over western Europe. They use CAMS global day-1 forecast data to assess the aerosol spatiotemporal distribution and determine the source and type of aerosol species. Validating the performance of CAMS in these kind of events is quite crucial to understand the current limitations in CAMS aerosol forecast system and the possible upgrades that need to be planned (e.g. assimilating more and different kinds of aerosol observations). The manuscript is well written providing all the necessary information to introduce the event to the reader. I would recommend for publication in ACP after addressing some minor comments below:

We thank the Reviewer for the general comment.

CAMS AOD is evaluated using dependent observations (as mentioned at P7, L10-11) from MODIS Dark Target and Deep Blue algorithms showing reasonable agreement with the observations and improvement in both correlation and bias in comparison to the no assimilation experiment. The paper does not provide a comparison with independent observations to prove that data assimilation improves AOD. I would suggest to mention again in conclusions that this is a dependent evaluation (P10, L28-31) or perform a small analysis using independent observations (e.g. AERONET AOD) to prove that CAMS AOD really improves, although the latter option may be out of the scope of this paper.

We agree with the comment raised from the Reviewer and thus in the Conclusions of the RM (P12, L8-9) we explicitly state that findings are drawn from a depended evaluation: **"The dependent evaluation against MODIS satellite observations reveals a satisfactory agreement with CAMS global AOD$_{550}$ (R=0.77 and FGE=0.4), while the comparison.."**. As assumed by the Reviewer, a comparison with AERONET AOD was not a primary scope of the present paper. Moreover, there is a limited availability of AERONET data during the passage of Storm Ophelia (due to cloud presence), with a few stations exhibiting fragments of observations (see also Figure 9 in the study of Osborne et al. (2019)), which in any case are not sufficient to conduct a comprehensive independent evaluation of CAMS global AOD product taking also into account its temporal resolution (3-hour).

Figure 6 and discussion starting at P8, L1: A very interesting analysis highlighting the contribution of each species to AOD. Nevertheless the contribution of each species to AOD may differ depending on the aerosol-species optical properties. Black carbon AOD is low (and Absorption AOD high) in comparison to the other species. A 15% to 25% contribution of black carbon AOD to the total AOD might seem mediocre, but climatologically is only observed during fire season in the Tropical band. Maybe the authors would like to comment on that.

We agree with the comment and therefore we include the following sentence in the RM (P9, L3-5): **"Such black carbon contributions are considered high being similar to climatological contributions over global fire hot spots (e.g. summertime central southern Africa; Penning de Vries et al. (2015))."**

Figure 7 and discussion starting at P8, L17: Although this is more of a qualitative comparison to discuss the vertical distribution of aerosols per species, the depiction of CALIPSO and IFS are very different above 4km in both tracks. Is it possible to conclude something about the observations or the model? For example is CALIPSO unable to retrieve trustworthy measurements during the pass of Ophelia above 4km or is IFS overestimating aerosol mixing ratio above a certain height?

The respective Figure has been revised correcting a minor bug in our code and converting IFS sea salt from 80% RH ambient conditions to dry, as suggested by ECMWF, which was inadvertently omitted. However, the Figure and the respective discussion have not changed substantially. Regarding the inconsistencies above 4km, this is a rather complex and still uncertain issue. As discussed comprehensively in Georgoulias et al. (2018) the non-zero aerosol concentrations appearing systematically at heights above 5 km in model simulations compared to remote sensing observations (also see Mona et al., 2014; Binietoglou et al., 2015; Cuevas et al., 2015 and Ansmann et al., 2017) could be due to:

- The way the model deals with the aerosol distribution in different size bins and aerosol deposition, vertical transport and mixing.
- The IFS assimilation process and the fact that nitrate aerosols are missing in the present IFS aerosol version, which might lead to the appearance of small aerosol concentrations further high.
- The limitation of CALIPSO in detecting aerosol layers with signals lower than the satellite's signal-to-noise ratio.

References

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