Answers to reviews for acp-2020-1155 – Chiapello et al., Aerosol optical properties derived from POLDER-3/PARASOL (2005-2013) over the western Mediterranean Sea – Part 2: Spatial distribution and temporal variability

We thank Referee #1 for helpful evaluation of the manuscript and providing us feedback on its content. Detailed responses are presented in the body of the text here below in blue.

Anonymous Referee #1

The paper investigates the spatial distribution and temporal evolution of aerosols over the western Mediterranean using the 8.5-year data record of POLDER-3/PARASOL aerosol relevant parameters like AOD, AOD fine and coarse fractions, the ansgtroem exponent (AE), spherical and non-spherical fractions. On top of confirmation of known features (i.e. seasonality and geographical trends) the impact of NAO and AQ trends are also revealed. The paper is well written and constitutes a valuable, yet not unique in terms of new knowledge, contribution to know literature, also supplementing Formenti's paper that focused on the evaluation of the data set. The following comments could be taken into account before publication to ACP.

L 68-78: A brief literature review and basic comparison of the respective conditions met in the eastern part of the Mediterranean basin would be useful to highlight the particularities of this work.

Yes, we agree. Considering as well Referee # 2 comment, we have added a brief literature review, including this topic in the introduction, L 75-87 on the revised manuscript.

L 170-175: The AE exponent has been traditionally used in the past as a proxy for particle size. Now that we are having the fine and coarse mode do you see any difference in the patterns observed? Is there any added value deriving from both types of information to justify their combined use? (a correlation map of AE with AODf and AODc might be interesting in this aspect.

We thank Referee #1 for this question which has been taken into consideration through further analysis of our dataset. Our main conclusion is that POLDER-3 AE is mostly correlated to fine mode fraction (FMF, corresponding to the ratio AOD_F/AOD), rather than to AOD_F or AOD_C. This result can be clearly observed on Figure 3, considering climatological monthly means of POLDER-3 retrievals. Correlations between AE and FMF reach 0.94, 0.91, and 0.84, respectively for NW MED, CW MED, and SW MED. No correlation is observed between AE and AOD_C, although some moderate correlations appear between AE and AOD_F over NW MED (r=0.72) and CW MED (r=0.62). This result is also highlighted, when considering the monthly POLDER-3 retrievals at Ersa (Figure 4), Barcelona (Figure 5), and Lampedusa (Figure 6), with high correlation coefficients between AE and FMF: r=0.96 (Nobs=103, Ersa), r=0.91 (Nobs=104, Barcelona), r=0.92 (Nobs=104, Lampedusa). A sentence has been added in the revised manuscript to clarify this point, L 280-282.

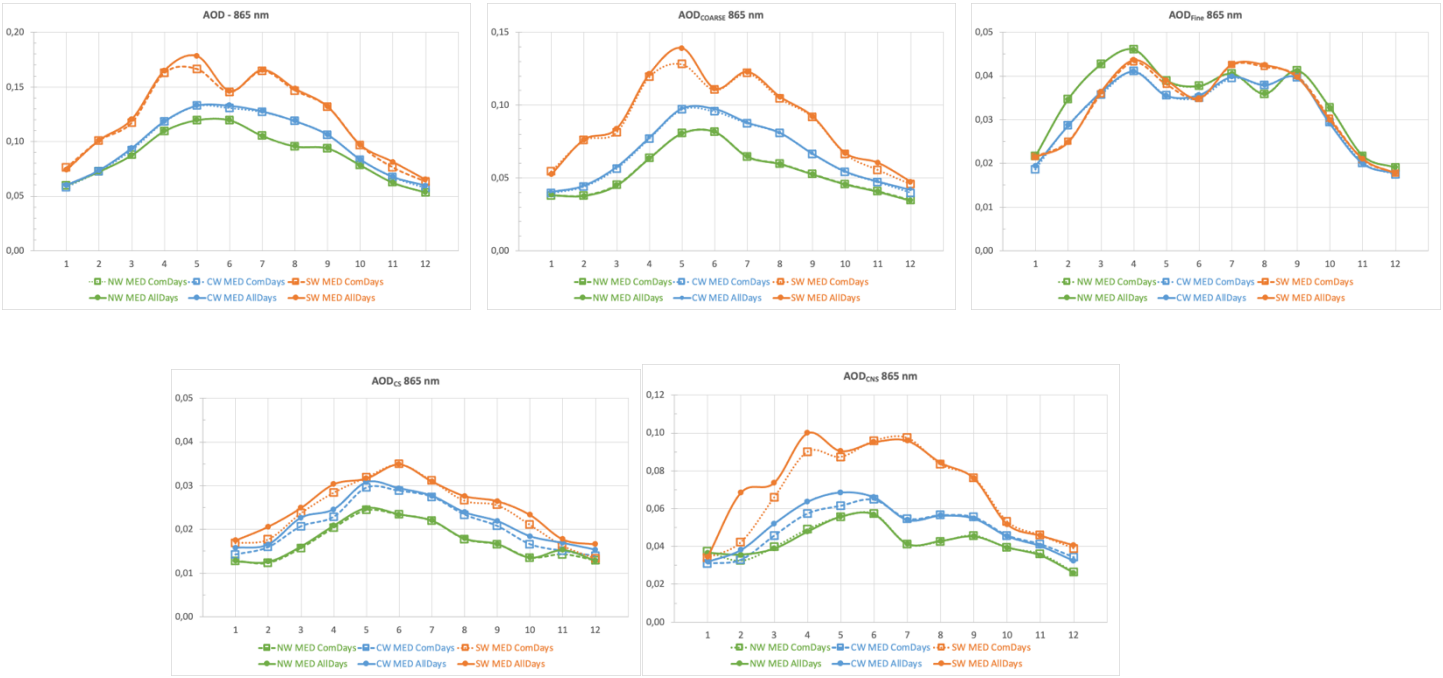
L 185-188: You may also wish to see Hansson et al., (2021) https://doi.org/10.3390/atmos12040445

Thanks for this suggestion: this very recent reference has been added in the revised manuscript, L 197-199

L 215: If only common days are used in Figure 3, would there be any substantial change in the sub-regional comparison?

This point has been verified. No substantial change is evident, as shown by the figures below which compare the sub-regional seasonal cycles obtained when considering all days (continuous lines) and

when selecting only common days (dashed lines), for AOD, AOD_{Coarse}, AOD_{Fine} (top figures) and $AOD_{Coarse\ Spherical}$, $AOD_{Coarse\ Non\ Spherical}$ (bottom figures). Minor differences appear for SW MED (orange curves), especially in May (AOD, AOD_{Coarse}), and from February to April ($AOD_{Coarse\ Spherical}$ and $AOD_{Coarse\ Non\ Spherical}$). These differences in $AOD_{Coarse\ Spherical}$ and $AOD_{Coarse\ Non\ Spherical}$ are also apparent for CW MED (blue curves, bottom figures), but remain weak.



L 344: In Fig. 7 the y-scale does not allow for discriminating details in the time series. I would suggest an axis break so that the data populated lower part of the plots occupies more surface (like 60% or more).

Thanks for this suggestion. We agree, the quality of Figure 7 was not sufficient in the submitted version. Figure 7 has been completely redone and largely improved with double y-scales to enable analysis of both lower parts and higher parts of the time series. As Referee 2 also mentioned this problem, and as he suggested, these time series have been moved to the supplementary material (new Figure S4 in the revised manuscript), and replaced by more readable histogram frequencies in the main manuscript (modified Figure 7 of the revised manuscript).

L 399: Have you investigated to what extend do the trends in Fig .9 (AODf) might relate, in excess to global brightening, also to the economic crisis and the respective cutting down of many anthropogenic activities in the region? Could the Barcelona case be used as a proxy to support this assumption and further delineate/decompose the trends? (see L 428-432)

This is an interesting point, but it is out of the scope of this article. The Barcelona case is undoubtedly striking. Its use as a proxy in order to relate the observed decreasing AOD_F trend to cutting down of anthropogenic activities would need further analysis including economic data of the region. This aspect has not been investigated yet, as it would need a robust and comprehensive multi-factor statistical analysis that require much more time and effort. However, some references have been included in the text to open the discussion on this worthwile assumption (Querol et al., 2014; Pandolfi et al., 2016). Two sentences have been added in the revised manuscript, L400-404.