Responses to Anonymous Referee #2

We would like to thank the reviewer for his/her time, thoughtful insights and helpful comments. A point-by-point response to each of the reviewers concerns is listed below. The reviewers comments are shown in bold italics, while the authors' responses are indented and displayed in regular type.

As mentioned in Section 2.1, data corresponding to the DC3 campaign are obtained at one single wavelength (532 nm) adding two more wavelengths (473 nm and 671 nm) during the SEAC4RS campaign. By analyzing the wavelength dependence of the $-F_{12}/F_{11}$ ratio much information can be retrieved on the aerosols optical properties. However, all data presented in the paper are performed at 532 nm. There is no information/discussion on the wavelength dependence of the measured data during SEAC4RS campaign. What is the reason for that? They were finally discarded? If so, what is the reason for that?

This manuscript focuses primarily on the ancillary data classification scheme and, more specifically, on the ability of single wavelength PI-Neph data to predict this categorization. While there certainly is significant additional information in the wavelength dependence of the scattered light the authors wanted to develop a single prediction technique that could be applied to both the DC3 and SEAC4RS dataset simultaneously. The prediction schemes presented in Sections 5.2 and 5.3 are both based on the scores derived from PCA. In order for the PCA routine to be run simultaneously on both the SEAC4RS and DC3 measurements variables that were not present in both datasets had to be discarded. As the DC3 data did not contain any measurements at 473 nm or 671 nm the corresponding SEAC4RS measurements had to be excluded.

This combined dataset allows for a significantly larger number of cases on which the predictions can be made, which helps to emphasize the robustness of the technique. Furthermore, the exclusion of information contained in the spectral dependence of the scattered light helps to more clearly demonstrate the power of angular and polarization information when discerning aerosol types. It would of course be possible to simply plot the spectral dependence of some SEAC4RS types in Section 4 but the authors felt that showing this data might be a distraction from the central message of the work since these measurements were not included in the PCA based prediction schemes. Moreover, interested parties can consult Espinosa et al. (2017) which shows the spectral dependence of F_{11} and F_{12} measurements for several aerosols sampled during SEAC4RS. Although, it is important to note that an explicit evaluation of the additional information provided by multi-wavelength data is not performed by Espinosa et al. (2017). The authors agree that this would be a worthwhile topic of future study.

Section 4, third paragraph: There is a discussion about the implications on aerosols size based on the measured phase functions at back-scattering region. However, the measured phase functions are arbitrarily normalized to unity at 30 degrees. If they would be normalized to e.g. 120 degrees the AL would show the strongest back- scattering intensity. In this case it would be best to talk in terms e.g. of steepness of the phase function (measured maximum value divided by the measured minimum). Still as mentioned, the maximum of the $-F_{12}/F_{11}$ ratio is a better diagnostic tool for aerosol size specially in the fine mode peak. As stated at the end of the third paragraph the effect of particle

size on the maxima of the $-F_{12}/F_{11}$ ratios is moderated by differences in the refractive index. Multiwavelength measurements of the $-F_{12}/F_{11}$ would help in disentangling both effects (size and refractive index).

The authors intended to refer to the amount of light scattered within a certain angular range relative to the total amount of light scattering over all angles. This is equivalent to the value of the phase function given the alternative normalization scheme where the integral of $\tilde{F}_{11}$ over all scattering angles is set to a consistent value (ex. 4π). We appreciate the reviewer pointing out the ambiguity in the original text and the first sentence of the third paragraph of Section 4 has been changed to the following:
"The same progression is evident in the backscattering angles of the DC3 storm categories, with the CO storms having the largest fraction of the total scattered light that is directed into the scattering angles larger than 90 °."

References

W Reed Espinosa, Lorraine A Remer, Oleg Dubovik, Luke Ziemba, Andreas Beyersdorf, Daniel Orozco, Gregory Schuster, Tatyana Lapyonok, David Fuertes, and J Vanderlei Martins. Retrievals of aerosol optical and microphysical properties from imaging polar nephelometer scattering measurements. *Atmospheric Measurement Techniques*, 10(3):811, 2017.