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Interactive Comment

Interactive comment on "Aerosol optical properties at Lampedusa (Central Mediterranean) – 2.of single scattering albedo at two wavelengths for different aerosol types" *by* D. Meloni et al.

D. Meloni et al.

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We would like to thank the referee for his positive comments and for the interesting observations and questions. We addressed all the questions raised by the referee. His comments and our answers are reported below. The paper was changed accordingly.

COMMENT: Meloni et al. used MFRSR data to obtain single scattering albedos (SSA). The paper basically deals with two issues: (1) how good is the technique used, (2) how the obtained results can be incorporated into our knowledge of aerosols in specific location and under specific conditions. My comments are concerned with first part. The method to retrieve SSA from direct-to-diffuse ratios (DDR) was first outlined by

Herman et al. (1975). It seems that MFRSR with its ability to deliver instantaneous direct and diffuse irradiances is an excellent instrument for this approach. Furthermore, because MFRSR measures direct and diffuse through the same opto-electronic channel the absolute radiometric calibration is not necessary to obtain the exact DDR. There are however questions about MFRSR that chiefly are related to the ability to correct signals for angular response (1) that is different for each channel (wavelength), (2) it is not perfectly characterized and (3) that potentially may change in time. Simply MFRSR is not an ideal Lambertian spectroradiometer.

Both direct and diffuse components need to be corrected. The diffuse component correction is not done by the standard MFRSR software according to this reviewer knowledge. This correction is usually SZA independent but some assumption on the nature of radiance distribution (of clear sky) must be made. If this correction was not implemented in the data used for the subsequent retrievals then one could expect that DDR's were used in the retrievals were larger by up to 5% then the actual values. Was this issue addressed by the authors?

ANSWER: We agree with the referee's comments on the need of a correct angular characterization of the MFRSR instrument. The cosine correction is routinely applied to the direct component and not to the diffuse one. The correction of the diffuse requires the knowledge of the radiance angular distribution, which depends on a number of parameters that are not directly measured, like the aerosol phase function, vertical distribution, etc. We performed some tests with the radiative transfer model in order to quantify the impact of the missing correction on the results. We simulated the angular distribution of the diffuse radiance at SZA=60° and calculated the diffuse irradiance for a perfect cosine response and for the cosine response of the MFRSR. The MFRSR cosine response was determined by the manufacturer. The MFRSR deviation from the ideal cosine curve is small (see Harrison et al., 1994). In this study we assume that the change in angular responsivity with time is negligible. We fixed the AOD at 0.6 (a fairly large value) and calculated the DDR at 415.6 and 868.7 nm. Calculation were made for

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desert dust, since the diffuse component is larger for this type of particles than for the other aerosol types considered in our study (i.e. biomass burning or urban/industrial) for the same AOD. Our results show that the DDR for the MFRSR cosine response differ from that of a perfect cosine response instrument by less than 2% at 415.6 nm and 868.7 nm. The difference reduces as AOD decreases. This translates into a 0.02 uncertainty in the SSA at both wavelengths (see Figure 7 a). The correction is smaller for smaller AOD, and the cosine correction of the diffuse component was not implemented in the analysis. A description of the performed analysis and a discussion of the associated additional uncertainty was added to the final manuscript.

COMMENT: Because of how MFRSR is constructed the cosine responses (angular responsivities) usually are not symmetric. Thus the consistent differences in DDR between morning and afternoon periods should be looked upon as a possible cosine correction errors. But obviously morning and afternoon atmosphere differences exists in some locations. The question is whether the authors looked at results keeping this in mind. Were there systematic morning-afternoon differences?

ANSWER: Following the referee's suggestions, we considered the possible differences in the morning and afternoon DDR values. We examined the desert dust cases (the most abundant data set); the morning and afternoon DDR values together were fitted as a function of AOD with a second order polynomial, both at 415.6 and 868.7 nm. The mean morning-afternoon (with standard deviation) differences between the polynomial and the DDR at 415.6 nm are 0.10ś0.08 (6ś5%) in the morning and 0.10ś0.09 (6ś5%) in the afternoon. The differences at 868.7 nm are 0.03ś0.04 (4ś7%) in the morning and 0.03ś0.03 (4ś4%) in the afternoon. Thus, no systematic morning-afternoon differences affect the MFRSR DDR. With the same model input used to answer to the first referee's question, we estimated the differences between DDR in the morning and in the afternoon due to the differences in the instrument cosine response. The DDR values in the afternoon show to be lower than those in the morning by less than 1%.

COMMENT: In reality the claim that DDR is independent of calibration is rather meaningless because to proceed with complete retrievals aerosol optical depths (AOD) are also needed. And they can only be obtained from a well calibrated MFRSR. What I would like to see in the future of usage of MFRSR data and similar instruments is a more thorough analysis of propagation errors due to calibration uncertainty and cosine response uncertainty. I am aware that the error and stability analysis is much more complicated and time consuming that the retrieval process itself, however you cannot trust the latter without the former.

ANSWER: The text states that the determination of DDR is independent of instrumental calibration (not the retrieval of SSA). As suggested by the reviewer, a calibration is needed for the determination of the AOD, and consequently, for the determination of SSA. The method for the derivation of the AOD from the MFRSR observations is described in the companion paper by Pace et al. "Aerosol optical properties at Lampedusa (Central Mediterranean). 1. Influence of transport and identification of different aerosol types". The determination of the extraterrestrial constant, its temporal stability, and the estimated uncertainties on the retrieved optical depths are discussed in the paper. The direct component is corrected for the non ideal cosine response, following the scheme outlined by Harrison et al. (1994).

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 4971, 2005.