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Atmospheric Measurement Techniques Discussions

Interactive comment on "Aerosol absorption retrieval at ultraviolet wavelengths in a complex environment" *by* S. Kazadzis et al.

Anonymous Referee #2

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The paper describes ground based measurements of column aerosol absorption (single Scattering Albedo, SSA) at 2 near UV wavelengths (368nm and 332nm) conducted from January to October 2010 in Athens, Greece. The measurements are made with commercial UV-MFRSR instrument (Yankee Environmental Systems, Inc) and compared with co-located AERONET/CIMEL SSA retrievals at 440nm. The UV SSA measurements are unique, i.e., first such measurements conducted for an extended time period (10 months) in polluted urban environment of Athens, Greece. Generally, there are only few such measurements reported to date, and those are typically during short-term field campaigns (e.g., MILAGRO [Corr et al 2009]). Co-location of CIMEL and UV-MFRSR is particularly interesting, since both types of measurements are complementary: UV-MFRSR measurements allow extending AERONET SSA data from visible

(>440nm) to near UV wavelengths and also to lower solar zenith angles. On the other hand, AERONET data allow independent check on the MFRSR's calibration and provide important constrain on aerosol size distribution. Previous UV SSA measurements indicated enhanced UV aerosol absorption, which is important for atmospheric composition measurements, e.g., black versus organic aerosol speciation and for measurements of pollution trace gases and aerosol precursors in UV, e.g., tropospheric ozone, SO2, HCHO. Presented results are in line with previous studies. I feel the paper should be published after addressing suggested revisions aimed to describe more clearly MFRSR operation and calibration procedures. Below are main suggestions for improvements. 1) Previous work and motivation is well described in Introduction. I suggest adding pioneering references for the diffuse/direct ratio technique: B. M. Herman, S. R. Browning, and J. J. DeLuisi, "Determination of the effective imaginary term of the complex refractive index of atmospheric dust by remote sensing: the diffuse-direct radiation method," J. Atmos. Sci. 32, 918–925, 1975. M. King and B. M. Herman, "Determination of the ground albedo and the index of absorption of atmospheric particles by remote sensing. Part I: Theory," J. Atmos. Sci. 36, 163–173. 1979 M. King, "Determination of the ground albedo and the index of absorption of atmospheric particles by remote sensing. Part II: Application," J. Atmos. Sci. 36, 1072–1083, 1979. Early paper suggesting combining co-located MFRSR and CIMEL measurements for estimating SSA: T. F. Eck, B. N. Holben, I. Slutsker, and A. Setzer, "Measurements of irradiance attenuation and estimation of aerosol single scattering albedo for biomass burning aerosols in Amazonia," J. Geophys. Res. 103, 31865–31878, 1998.

2) 2.1 Instrumentation: Need more details here, e.g.: Is UV-MFRSR part of any broader network? How well is MFRSR characterized: what is its angular (cosine) characteristic and how it was measured (providing cosine correction plots will be best)? Does MFRSR have clear horizon view (picture will be appropriate)? How the instrument leveling is verified? How the effective wavelengths for the spectral channels were determined? Are these stable? Are the cosine, temperature and forward scattering corrections applied to raw measurements? 3) MFRSR calibration needs more de-

tailed description. Examples of Langley zero voltage intercepts (V0_Langley or ETC) are needed obtained on clear calibration days for different start and stop times (initial and final air-masses). 3) 2.2 Retrieval methodology: "We have limited the method to SZA<80 degrees to avoid uncertainties related with low solar irradiance levels." – MFRSR measurements are increasingly difficult for SZA > ∼60deg because of non-ideal cosine response and amplification of alignment errors. Suggest adding plot of Vo_aeronet as function of time of day or SZA to prove it is constant for SZA > 60deg.

6) 'Since the CIMEL instrument provides measurements of AOD at 340nm and 380 nm, we first calculated the CIMEL derived AOD at 332nm and 20 368 nm using the wavelength dependence described by the A° ngstroÂÍm Exponent (AE) at these wavelengths."

- To extrapolate AERONET AOD measurements to MFRSR wavelengths (332 and 368nm) I suggest using least squares quadratic spectral extrapolation of the ln(AOD) AERONET measurements at 340nm 380nm, 440nm and 500nm as function of ln(wavelength). This method is more accurate than extrapolation based on AE: T. F. Eck, B. N. Holben, J. S. Reid, O. Dubovik, A. Smirnov, N. T.O'Neill, I. Slutsker, and S. Kinne, "Wavelength dependence of the optical depth of biomass burning, urban and desert dust aerosols," J. Geophys. Res. 104, 31333–31350. 1999.

4) "Following this, the Beer-Lambert law for the direct sun (UVMFR) was used to calculate the extraterrestrial Langley calibration constants (ETC) for each UVMFR synchronous measurement. Based on the results presented in Fig. 2a, b, we decided to use a single ETC for the whole period and for each wavelength"

- Fig 2 is not enough. Proving agreement between AERONET and MFRSR AOD measurements better than 0.01 is a necessary condition for SSA inversions. I suggest adding plots showing comparison of MFRSR's V0_Langley with individual V0 estimates for each 1 min measurement using AERONET AODs: V0_aeronet. I suggest adding plot showing a diurnal dependence of V0_aeronet as time of day for selected clear

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days in different months. Only time periods where V0_aeronet is constant (indicating consistency between MFRSR and AEONET data), should be used for SSA retrievals. Second plot can show daily average <Vo_aeronet> (plus Vo_Langley) during 10 months for both 332nm and 368nm MFRSR channels, indicating MFRSR stability. - Noise in V0_aeronet values needs to be estimated and propagated to AOD and SSA measurements.

5) Describe what values of surface albedo were used in retrievals and how these were determined? How does albedo uncertainty affect SSA results?

6) 3. Results. - Figure 5: explain extremely low SSA$\sim$0.6 in February. Are these due to low AODs? Add daily AOD values to the plot. - Fig 6: AERONET SSA retrievals are not reliable for SZA < $\sim$50deg and not recommended for scientific use by AERONET group. Suggest removing AERONET data for SZA<50deg. MFRSR retrievals has large errors for SZA > $\sim$60 deg. Suggest re-do Fig 6 as function of SZA, not local time. - 7) 4. Conclusions "SSA retrievals with the uncertainty of $\pm$0.03 can be derived for SZA>40 degrees and with an uncertainty of $\pm$0.04 for all SZA where AOD< 0.2" - should be AOD > 0.2

8) "the UVMFR instrument can be carefully characterized and corrected for known systematic errors by monitoring instrument performance using daily CIMEL intercomparisons and quality checking" - This conclusion needs to be proved by showing diurnal plots of V0_aeronet and timeseries of daily V0_aeronet values for both channels.

9) English needs to be improved

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 6991, 2012.