



The aerosol single scattering albedo during the SCOUT-O3 Aerosol - UV radiation campaign



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Introduction

In recent years, the optical properties of aerosols in the UV and visible range have begun to receive more attention. Aerosol effects on radiative transfer and climate in general have been recognized as a research area with scientific questions that need further study. Although the accuracy in measuring other main factors that affect UV and visible irradiance (e.g. total ozone, aerosol optical depth) is nowadays sufficiently good, measurements of the optical properties of the aerosols (like the single scattering albedo, the asymmetry factor and phase function) are either nonexistent or inadequate to represent their vertical variability, since they are mostly conducted near the surface. The importance of these parameters in modifying the transmission of ultraviolet radiation through the atmosphere has been already recognized and several studies were devoted to the investigation of their effects with respect to solar zenith angle, wavelength and surface albedo.

In this study, measurements of aerosol single scattering albedo during SCOUT-O3 campaign at Thessaloniki, Greece, are presented and discussed. Estimations of single scattering albedo derived from ground-based and air-borne measurements at UV-A and visible wavelengths are compared and their possible differences are examined.

Ground-based measurements of single scattering albedo

The combined determination of aerosol total scattering (σ_{sp}) and absorption (σ_{ap}) coefficients allowed for the calculation of single scattering albedo (SSA):

$$SSA = \sigma_{sp} / (\sigma_{sp} + \sigma_{ap})$$

Figure 1 shows a strong diurnal cycle of the SSA with the highest values between 2:00 and 6:00 AM (local time) of about 0.87, and the lowest values at around 7:00 AM (local time) in the morning and in the evening could be attributed to the low boundary layer conditions and high emissions.

The diurnal variability of SSA is correlated with the wind speed conditions. During almost all days, the lower SSA values are observed for low wind speed conditions, when the impact of the local emissions is dominant. Some indicative examples of diurnal variability of SSA and wind speed conditions are presented in figure 2.

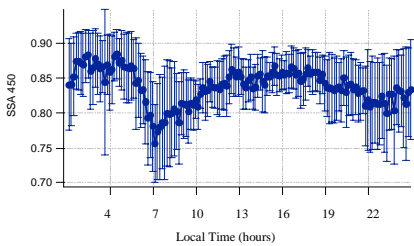


Figure 1. Diurnal cycles of single scattering albedo at 450nm (SSA450) at the ground, derived from ground measurements, during the SCOUT-O3 UV radiation and aerosol campaign

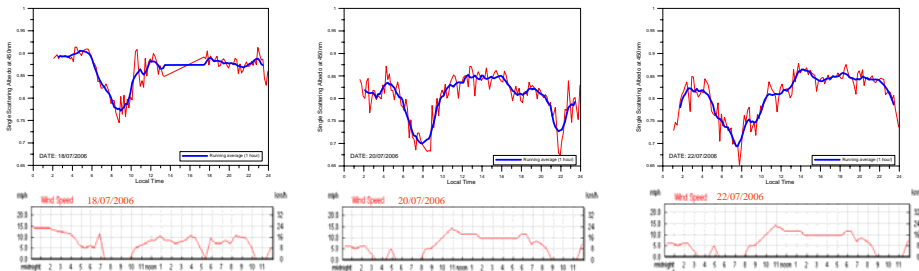


Figure 2. Variation of single scattering albedo and wind speed for two days of SCOUT-O3 aerosol-UV radiation campaign. Lower values of single scattering albedo were observed for low wind speed conditions for almost all days.

Measurements for Brewer and CIMEL instruments

Measured values of SSA, derived from CIMEL instrument at 440nm and Brewer global irradiance at 350nm, are presented in figures 3, 4 and 5. Values of CIMEL aerosol optical depth at 340nm and pictures of the sky from a sky camera are also presented.

For all days, the agreement between the two instruments is quite good under cloud-free conditions. Higher values of CIMEL aerosol optical depth are observed under cirrus cloud conditions, indicating the limitation of the methodology to distinguish thin clouds from aerosols.

Vertical profiles of single scattering albedo

The vertical variability of the lidar backscatter coefficient was combined with profiles of the single scattering albedo acquired on-board a Cessna aircraft nearby the measuring site. The weighted average of ssa at 550nm during one flight day of the campaign is presented in figure 5.

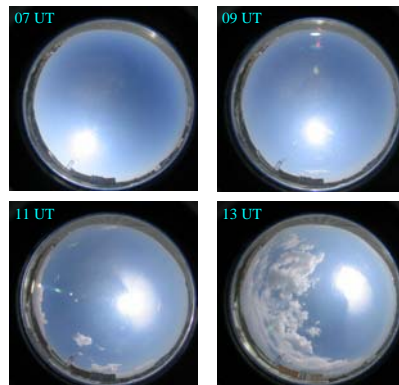
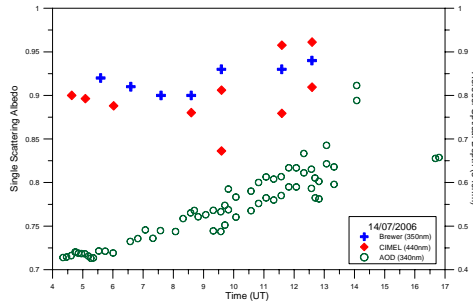


Figure 3: Measurements of CIMEL aerosol optical depth (340nm), CIMEL SSA (440nm) and Brewer SSA (350nm) during 14/07/2006 (upper panel). Indicative sky pictures during that day are also presented (lower panel) at 07, 09, 11 and 13 UT

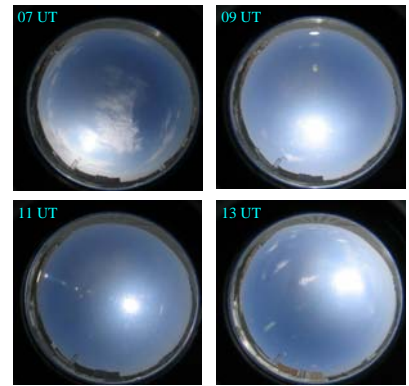
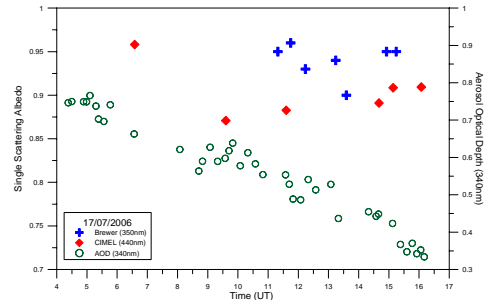


Figure 4: Same as figure 3, but for 17/07/2006

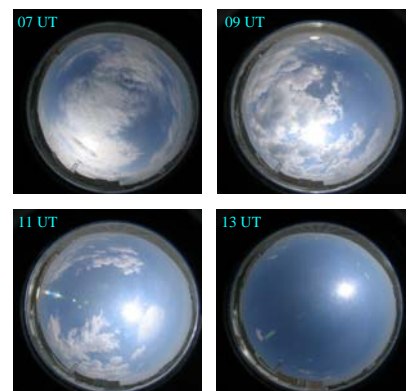
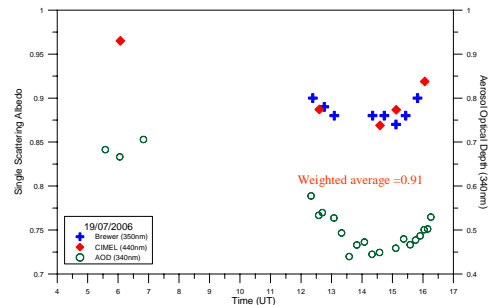


Figure 5: Same as figure 3, but for 19/07/2006

Acknowledgement

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