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Spectral dependence of optical parameters of urban aerosols

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To improve understandings of the physico-chemical behavior of aerosols, an intensive aerosol experiment was conducted at the Taipei Aerosol and Radiation Observatory (TARO) (22.5 ^{o}N, 121.5 ^{o}E). TARO is on the campus of the National Taiwan University in Taipei, Taiwan. Because it locates around the center of the Taipei Basin, it is suitable for characterization of aerosols in a subtropical mega-city. Besides, given that Taiwan is on the lee side of the East-Asian winter monsoons, the properties of the Asian outflow aerosols can be measured during specific episodes.

A three-wavelength integrating nephelometer (Model 3563, TSI Inc., MN) was employed in measuring the light scattering coefficients of aerosols (σ_s) at 450, 550, and 700 nm, respectively. An aethalometer (Model AE-31, Magee Inc., CA) was used to measure the light attenuation coefficients of aerosols (σ_{aeth}) at 7 wavelengths (370, 470, 520, 590, 660, 880, and 950 nm). The σ_{aeth} were in turn converted to the light absorption coefficient of aerosols (σ_a). In addition, for correcting the bias due to multi-scattering effects in the aethalometer measurements, a photoacoustic spectrometer (Model PASS-1, DMT Inc., CO) at 781 nm was applied to calibrate the aethalometer-based σ_a.

This study focused on the variations in the optical properties of aerosols measured at the TARO during December 1-5, 2007, when Taipei switched from a typical urban environment to being in the region of Asian continental outflow. It was found that the mass concentration of aerosols and the values of optical parameters exhibited typical diurnal patterns corresponding to the urban traffics while the local sources were dominating. The diurnal amplitudes of BC and σ_a were much larger than PM_{10} and σ_s and, consequently, the values of SSA dropped significantly during the daily rush hours. An air parcel transported from the Asian mainland arrived Taipei in the early morning of December 3, resulting in drastic increases of σ_s and σ_a; the hourly averaged σ_s (550 nm) and σ_a (520 nm) reached their respective maxima of 569 and 40 Mm^{-1}. Note that the increases in σ_s were much stronger than in σ_a. Consequently, the SSA (520 nm) increased from 0.82 to 0.94. Moreover, it was revealed that the Angstrom exponent of scattering (A_s) decreased slightly from 2.18 for local pollution period to 2.00 for outflow episode, and the Angstrom exponent of absorption (A_a) kept around 1.3 throughout the campaign. In contrast to A_s and A_a, the wavelength dependency of SSA varied significantly; the episode averaged A_ω decreased from 0.10 for local pollution to 0.06 for AO period. It was found that the values of A_ω exhibited significant anti-correlation with SSA, and that the values of SSA were dominated primarily by BC content in aerosols. Nevertheless, as the aerosol composition was stable, the scattering efficiency took the place of the dominant factor of SSA.