Characterization of the optical properties of rural and urban aerosol in Hungary

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In this work the optical properties of regional background and urban aerosol as a function of the aerosol mass concentration (PM_{10}) are summarized. On the basis of rural aerosol data the scattering and absorption coefficients, backscattering, single scattering albedo and Angström-exponent is discussed. On the other hand, the results obtained in a closure experiment in Budapest are also presented. Under urban environment the aerosol extinction coefficient is estimated from visibility data and reconstructed on the basis of PM_{10} and aerosol composition.

The data presented in this work are monitored at the Hungarian background air pollution monitoring station (2008–2009), K-puszta. The total and backscattering coefficients are measured at three wavelengths (450 nm, 550 nm, 700 nm) by TSI 3563, while the absorption coefficient is monitored at 550 nm by PSAP. PM_{10} mass concentration is detected by beta-gauge measurements. In Budapest visibility and aerosol data were collected in two sampling campaigns in winter and summer of 2009. Form visibility data the extinction coefficient is estimated by the Koschmieder formula.

Our results show that in rural air, the absorption and the scattering coefficients are quasi linear functions of the PM_{10} (below of 85 μg m^{-3}), while the backscattered fraction is in an inverse relationship with PM_{10}. Further results show that the increase of PM10 results in the rise of the single scattering albedo. The wavelength dependence of scattering coefficients (total and backscattered) is evaluated by the Angström-exponent. It is found that when PM_{10} increases, the Angström-exponent decreases in the whole wavelength range (450–700 nm) suggesting that in background air the growth of PM_{10} mass concentration involves the increase of mean particle size. This can be explained by the fact that in clean air (low PM_{10}) the role of freshly formed secondary particles is higher than that of aged and coarse particles. Finally, the results make it clear that the Angström-exponent in different wavelength ranges are not equal, they are smaller at shorter (450–550 nm) than at longer (550–700 nm) wavelengths.

In Budapest, visibility and PM_{10} mass concentration are available on hourly basis. Parallel daily aerosol samplings are carried out in order to measure the chemical composition of PM_{10}. The extinction coefficient referring to dry air is estimated by applying the γ-approach. A significant, linear correlation is found between PM_{10} mass concentration and the dry extinction coefficient. Considering the aerosol chemical composition the mass concentration of PM_{10} aerosol is reconstructed, further, by means of multiple linear regression analysis, the relationship between the aerosol chemical composition and the extinction coefficient is evaluated. Our results show that the extinction coefficient (the scattering coefficient) can be effectively estimated from the chemical composition of the PM_{10}. The relationship between the extinction coefficient and the relative humidity is also studied; and it is found that hygroscopic growth is substantially different in winter and in summer. In winter the growth rates at 80 and 90% RH are two times higher than in summer. The seasonal difference in hygroscopic behavior of extinction coefficient is probably due to the change in the chemical composition of the aerosol particles.