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Aerosol optical properties and the mixing state of black carbon at a background mountainous site in Eastern China

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In-situ measurements of aerosol optical properties were conducted at Mt. Huang from September 23 to October 28, 2012. Low averages of 82.2 Mm^{-1}, 10.9 Mm^{-1}, and 14.1 Mm^{-1} for scattering coefficient ($\sigma_{sp,neph,550}$), hemispheric backscattering coefficient ($\sigma_{hbsp,neph,550}$), and absorption coefficient ($\sigma_{ap,550}$), respectively, were obtained. Atmospheric aging process resulted in the increase of $\sigma_{ap,550}$ but the decrease of the single scattering albedo (ω_{550}) at constant aerosol concentration. However, the proportion of non-light-absorbing components (non-BCs) was getting higher during the aging process, resulting in the increase of aerosol diameter, which also contributed to relatively higher $\sigma_{sp,neph,550}$ and ω_{550}. Diurnal cycles of $\sigma_{sp,neph,550}$ and $\sigma_{ap,550}$ with high values in the morning and low values in the afternoon were observed closely related to the development of the planetary boundary layer and the mountain-valley breeze. BC mixing state, represented by the volume fraction of externally mixed BC to total BC (r), was retrieved by using the modified Mie model. The results showed r reduced from about 70% to 50% when the externally mixed non-BCs were considered. The periodical change and different diurnal patterns of r were due to the atmospheric aging and different air sources under different synoptic systems. Local biomass burning emissions were also one of the influencing factors on r. Aerosol radiative forcing for different mixing state were evaluated by a "two-layer-single-wavelength" model, showing the cooling effect of aerosols weakened with BC mixing state changing from external to core-shell mixture.