On spectral invariance of single scattering albedo for weakly absorbing wavelengths

The single scattering albedo $\omega_{0\lambda}$ in atmospheric radiative transfer is the ratio of the scattering coefficient to the total extinction coefficient. For cloud water droplets both the scattering and absorption coefficients, thus the single scattering albedo, are functions of wavelength λ and droplet size r. In this presentation we will show that for water droplets at weakly absorbing wavelengths, the ratio $\omega_{0\lambda}(r)/\omega_{0\lambda}(r_0)$ of two single scattering albedo spectra, $\omega_{0\lambda}(r)$ and $\omega_{0\lambda}(r_0)$, is a linear function of $\omega_{0\lambda}(r)$. The slope and intercept of the linear function are wavelength independent and sum to unity. This relationship allows for a representation of any single scattering albedo $\omega_{0\lambda}(r)$ via one known spectrum $\omega_{0\lambda}(r_0)$. We will provide a simple physical explanation of the discovered relationship. In addition to water droplets, similar linear relationships were found for the single scattering albedo of non-spherical ice crystals.

The single scattering albedo $\omega _{0\lambda }$ in atmospheric radiative transfer is the ratio of the scattering coefficient to the total extinction coefficient. For cloud water droplets both the scattering and absorption coefficients, and thus the single scattering albedo, are functions of wavelength $\lambda $ and droplet size r. We show that for water droplets at weakly absorbing wavelengths, the ratio $\omega _{0\lambda }(r)$/$\omega _{0\lambda }(r_{0})$ of two single scattering albedo spectra for two different droplet sizes is a linear function of $\omega _{0\lambda }(r)$. The slope and intercept of the linear function are wavelength independent and sum to unity. This relationship allows for a representation of any single scattering albedo $\omega _{0\lambda }(r)$ via one known spectrum $\omega _{0\lambda }(r_{0})$. We provide a simple physical explanation of the discovered relationship. Similar linear relationships characterize the single scattering albedo of non-spherical ice crystals.