Characterization of spectral absorption properties of aerosols using satellite observations

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The wavelength-dependence of aerosol absorption optical depth (AAOD) is generally represented in terms of the Angstrom Absorption Exponent (AAE), a parameter that describes the dependence of AAOD with wavelength. The AAE parameter is closely related to aerosol composition. Black carbon (BC) containing aerosols yield AAE values near unity whereas Organic carbon (OC) aerosol particles are associated with values larger than 2. Even larger AAE values have been reported for desert dust aerosol particles. Knowledge of spectral AAOD is necessary for the calculation of direct radiative forcing effect of aerosols and for inferring aerosol composition. We have developed a satellite-based method of determining the spectral AAOD of absorbing aerosols. The technique uses high spectral resolution measurements of upwelling radiation from scenes where absorbing aerosols lie above clouds as indicated by the UV Aerosol Index. For those conditions, the satellite measured reflectance (ρ_λ) is approximately given by Beer's law

$$\rho_\lambda = \rho_{0_\lambda} e^{-m\tau_{abs_\lambda}}$$

where ρ_{0_λ} is the cloud reflectance, *m* is the geometric slant path and τ_{abs_λ} is the spectral AAOD. The ρ_{0_λ} term is determined by means of radiative transfer calculations using as input the cloud optical depth derived as described in Torres et al. [JAS, 2012] that accounts for the effects of aerosol absorption. In the second step, corrections for molecular and aerosol scattering effects are applied to the cloud reflectance term, and the spectral AAOD is then derived by inverting the equation above.

The proposed technique will be discussed in detail and application results will be presented. The technique can be easily applied to hyper-spectral satellite measurements that include UV such as OMI, GOME and SCIAMACHY, or to multi-spectral visible measurements by other sensors provided that the aerosol-above-cloud events are easily identified.