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Retrieval of radiativelycritical aerosol parameters from direct and diffuse irradiances

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In radiative transfer models the scattering and absorbing properties of aerosols can be adequately defined by three parameters: aerosol optical depth (AOD), single scattering albedo (SSA) and asymmetry parameter (AP). The parameters are wavelength dependent: AOD(λ), SSA(λ), AP(λ). The retrieved values are considered 'effective' parameters because they are: (1) column averaged (actual aerosol profiles are unknown) and (2) the retrieval assumes aerosols to be homogeneous spheres. These functions of wavelengths are "bland", i.e, they and their low order derivatives are monotonic. On the other hand the surface albedo SA(λ) is not typically a "bland" function of wavelength, especially for vegetative surfaces, and it is sun-zenith angle (SZA) dependent. The AOD is retrieved from direct normal irradiance (I_{dir}) and is unaffected by SA(λ), however, the diffuse component (I_{dif}) depends on the SA(λ), all three aerosol parameters and Rayleigh optical depth. Either SSA(λ) or AP(λ) can be retrieved from I_{dif} provided one of them is known. Kassianov et al. (2007, Atmospheric Chemistry and Physics) demonstrate the viability of the retrieval of AP(λ) from AOD(λ) via solving the inverse problem leading to an estimate of the aerosol particle size distribution (PSD). The retrieval process is iterative. Our method is based on a similar approach, however, we also consider cases when aerosols are spectrally congruent for different SZA angles, i.e., d[AOD(λ, SZA1)/AOD(λ, SZA2)]/dλ=0. Then SSA(λ) or AP(λ) can be retrieved simultaneously using I_{dif} or what is more convenient the ratio I_{dif}/I_{dir}. The validity of the retrieval is aided by testing SSA(λ) or AP(λ) for the presence of residual SA(λ) signatures. We perform retrievals using shadow banding instruments: MFRSR (6 spectral channels), VIS-RSS (365-1025nm) and the UV-RSS (300-380nm) that provide I_{dir} and I_{dif} with a common radiometric calibration. The instruments are/were deployed at the ARM Southern Great Plains Facility near Billings, Oklahoma, and Table Mountain near Boulder, Colorado,. Both sites are equipped with MFRSR's measuring upwelling and downwelling irradiances to provide realistic estimates of SA(λ).