Geophysical Research Abstracts
Vol. 20, EGU2018-2313, 2018
EGU General Assembly 2018

Simultaneous determination of aerosol single scattering albedo and asymmetry factor at single wavelength from Sun-sky radiometer measurements based on DVL method

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Aerosol Single scattering albedo (SSA) and asymmetric factor (g) are two of the key parameters in evaluation of aerosol direct radiative effect. Devaux-Vermeulen-Li method (DVL method) is a simple method that directly retrieve aerosol optical parameters based on single-wavelength Sun-sky radiation observation, without the assumption about aerosol microphysical properties. Inheriting the previous retrieval of SSA and scattering phase function, Interpolation methods were proposed to estimate the phase function over the extreme forward and backward scattering regions where instrumental observations are missing, then the DVL method is modified to derive g too.

To evaluate SSA and g accuracy of DVL algorithm, especially for the non-spherical aerosols, synthetic retrieval with typical aerosol models (water-soluble, biomass burning, dust-sphericity and dust-spheroid model) were implemented at 4 wavelengths (440, 675, 870 and 1020 nm) . The numerical experiments show that, DVL retrieves both SSA and g with errors less than $\pm$ 0.02 under "error free" condition. When measurement uncertainties were present, SSA error increased about 0.01 to 0.1 for AOD error ($\pm$ 0.01) (depending on the wavelength), around $\pm$ 0.02 for sky radiance calibration error ($\pm$ 3% L), and about 0.01 $\sim$ 0.02 for ground albedo error ($\pm$ 30% ϱ) when ϱ is 0.2. g retrievals were not sensitive to the AOD and sky radiance errors. The $\Delta\varrho$ ($\pm$ 30% ϱ) lead to about 0.01 $\sim$ 0.02 g error when ϱ is 0.2. For the coarse mode dominated dust-sphericity/spheroid aerosols, both SSA and g retrievals were strongly affect by instrumental pointing error ($\Delta\varphi = \pm$ 0.5°), both the errors increased about 0.03 $\sim$ 0.05.

Then DVL method was applied to one year of AERONET real measurements at Beijing site. Comparison with AERONET level 2.0 products shows that, the SSA RMSD and MBD deviations between them are 0.025 and $\pm$ 0.015 respectively, below the AERONET declared SSA uncertainty of 0.03 for all wavelengths. The g deviations are rather small for the 675, 870 and 1020 nm bands, with RMSD smaller than 0.02 and absolute values of MBD smaller than 0.01. Relatively larger deviations occurred at 440 nm band, where g values were underestimated by approximately 0.03 compared to those of AERONET.

Both the Synthetic retrieval and comparison with AERONET have not exhibited distinctly different performance of DVL algorithm for spherical and non-spherical particles in retrieving SSA and g, indicating the advantage that the DVL method is particle shape-independent. The DVL method is a simple method for retrieving aerosol optical parameters directly. The retrievals can be used for the evaluation of aerosol direct radiative effects.

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