COEFFICIENTS OF AN ANALYTICAL AEROSOL FORCING EQUATION DETERMINED WITH A MONTE-CARLO RADIATION MODEL

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Simple analytical equations for global-average aerosol radiative forcing are useful to understand how aerosol forcing depends on key atmosphere, surface and aerosol parameters (Chýlek and Wong, 1995). The surface and atmosphere parameters in these analytical equations are the globally uniform atmospheric transmittance and surface albedo, and have so far been estimated from simplified observations under untested assumptions. In the present study, we take the state-of-the-art analytical equation and modify it to be a function of the single scattering albedo and the asymmetry parameter. Then we determine the surface and atmosphere parameter values of this equation using the output from the global MACR (Monte-Carlo Aerosol Cloud Radiation) model, as well as testing the validity of the equation. The MACR model incorporated spatio-temporally varying observations for surface albedo, cloud optical depth, water vapor, stratosphere column ozone, etc., instead of assuming as in the analytical equation that the atmosphere and surface parameters are globally uniform, and should thus be viewed as providing realistic radiation simulations.

The modified analytical equation needs globally uniform aerosol parameters that consist of aerosol optical depth, single scattering albedo, and asymmetry parameter. The MACR model is run here with the same globally uniform aerosol parameters. The MACR model is also run without cloud to test the cloud effect. In both cloudy and cloud-free runs, the equation fits in the model output well. This means the equation is an excellent approximation for the atmospheric radiation. On the other hand, the determined parameter values are realistic for the cloud-free runs but not realistic for the cloudy runs. The global atmospheric transmittance, one of the determined parameters, is found to be around 0.74 in case of the cloud-free conditions and around 1.03 with cloud. The surface albedo, another determined parameter, is found to be around 0.18 and 0.28 in case of cloud-free and cloudy-sky conditions respectively. Because the cloudy-sky runs yield unrealistic parameter values, we conclude that the equation is more adequate for cloud-free conditions (Hassan et al., 2015).

References:

Chýlek, P., and J. Wong (1995). Effect of Absorbing Aerosol on Global Radiation Budget. *Geophys. Res. Lett.*, **22**, 929-931.

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