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Solar Radiative Transfer Simulations in Saharan Dust Using a New 3D Monte Carlo Radiative Transfer Model Including Polarization

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By means of a new three-dimensional (3D) vector radiative transfer model, SPARTA (Solver for Polarized Atmospheric Radiative Transfer Applications), a sensitivity study has been carried out where extinction, scattering and absorption are hinge on spatial variability. The SPARTA is a forward Monte Carlo (MC) model for efficient column-response pixel-based radiance calculations. It has been carefully tested by comparison to benchmark results for different atmospheric conditions and participated in the International Radiation Commission (IRC) polarized radiative transfer model intercomparison. The performance of SPARTA in the intercomparison was excellent, considering the noise of the MC method in radiance calculations. Polarized radiance fields in two-dimensional (2D) and one-dimensional (1D) inhomogeneous Saharan dust cloud fields have been calculated at 0.6 μm wavelength. Results are presented exemplarily for two lidar-based dust fields from the Saharan Mineral Dust Experiment (SAMUM). The dust particle scattering and absorption properties have been computed using MIESCHKA code, for spheroids, and ray-tracing code, for irregular shaped particles, according to measurements during the campaign. The domain-averaged normalized radiances of reflection and transmission is insignificant between the 1D and 2D cases. However, in the areas with large spatial gradient in optical thickness, the radiance fields of the 2D scenario differ about $\pm 13\%$ from the fields of the 1D scenario.