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3D Shortwave Radiative Transfer in Mountains: Application to the Tibetan Plateau

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Surface fluxes over complex terrain are strongly affected by variation in elevation, slope, and albedo. However, these factors are generally neglected in most of the existing radiative transfer schemes which assume that the lower boundary is flat and homogeneous. We developed a new 3D Monte Carlo photon tracing program for radiative transfer in inhomogeneous and irregular terrain coupled with the correlated k-distribution method for gaseous absorption in the atmosphere for the calculation of broadband shortwave fluxes at mountain surfaces. The atmosphere is discretized by using finite cubic cells characterized by the spectral optical properties of molecules and background aerosols (extinction coefficient, single-scattering albedo, and scattering phase function). To avoid leaks of photons, each land surface pixel consists of eight triangles based on terrain configuration (elevation, slope, and orientation) to create a seamless surface. We selected an area of 100×100 km2 in the Tibetan Plateau near Lhasa city with a horizontal resolution of 1 km2 and used the albedo available from MODIS/Terra dataset for this study. The results show that subgrid variability of the net surface solar fluxes are generally on the order of 10 to 30 W/m2.