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Modeling the Earth's radiation budget: impact of multiple scattering and emission presentation on shortwave and longwave fluxes

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Modeling the Earth's radiation budget, both shortwave (SW) and longwave (LW) radiation, is essential for understanding of the Earth's climate and climatic changes. In order to improve the representation of the SW and LW fluxes in atmospheric models, a new form of the analytical solution of the radiative transfer equations has been performed. This approach greatly simplifies the mathematical form of the radiation solutions and simulates quite well the effects of multiple scattering. For shortwave radiation taking into account the rescattering, we evaluate absorption, e.g. on aerosols, more realistically. With higher atmospheric absorption we can describe quantitatively the decreasing the surface insolation due to a decrease in transmittance of atmosphere. As a result, the approach is able to reproduce trends in the surface solar radiation, i.e. a decrease to the mid-1980s and an increase after this period. To evaluate the longwave fluxes, a set of the integral equations for radiations in atmosphere and ground (bare soil) has been solved. A joint solution allows for correct accounting the multiple reflections from surface, multiple rescattering and reemitting in atmosphere. Also the longwave radiation emitted by the ground due to an increase (decrease) in ground temperature has been described more realistically. As a result, we can greatly improve a simulation of the effect of enhanced emission of thermal radiation from the atmosphere back to the surface due to an increase in atmospheric greenhouse gases.