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アジア域における大気エアロゾルとその放射効果に関する十年規模変化のシミュレーション

Simulation of decadal trends in atmospheric aerosols and their radiative effects in Asia

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Atmospheric aerosols may affect climate change by the direct, semi-direct, indirect, and other aerosol-induced effects. The direct effect is that aerosols scatter and absorb the solar and thermal radiation. The semi-direct effect is that stability of the atmosphere changes due to aerosols which absorb the radiation. An increase in the aerosol number concentration has the effect on cloud microphysics by forming smaller and numerous cloud droplets reducing precipitation and increasing cloud lifetime -- that is the indirect effect. The other aerosol-induced effects are, for example, reduction of the insolation at the Earth surface results in decreases in the surface temperature, evaporation, and availability of water vapor to form clouds.

In this study, trends of concentrations and radiative forcings of atmospheric aerosols in the Asian region from the year 1980 to 2009 are simulated and analyzed with an aerosol transport-climate model, SPRINTARS. SPRINTARS is coupled with MIROC which is a general circulation model (GCM) developed by Center for Climate System Research (CCSR)/University of Tokyo, National Institute for Environmental Studies (NIES), and Frontier Research Center for Global Change (FRCGC) [Takemura et al., 2000, 2002, 2005, 2009]. The horizontal and vertical resolutions are T106 (approximately 1.1°by 1.1°and 56 layers, respectively. SPRINTARS includes the transport, radiation, cloud, and precipitation processes of all main tropospheric aerosols (black and organic carbons, sulfate, soil dust, and sea salt). The model treats not only the aerosol mass mixing ratios but also the cloud droplet and ice crystal number concentrations as prognostic variables, and the nucleation processes of cloud droplets and ice crystals depend on the number concentrations of each aerosol species. Changes in the cloud droplet and ice crystal number concentrations affect the cloud radiation and precipitation processes in the model. Historical emissions, that is consumption of fossil fuel and biofuel, biomass burning, aircraft emissions, and volcanic eruptions are prescribed from database provided by the Aerosol Model Intercomparison Project (AeroCom) and the latest IPCC inventories.

Especially, a change in the surface solar radiation due to the aerosol effects is discussed. Long-term records of surface radiation measurements indicate a decrease in the solar radiation between the 1950s and 1980s ("global dimming"), then its recovery afterward ("global brightening") at many locations all over the globe. On the other hand, the global brightening is delayed over the Asian region. Contribution of the aerosol effects to its delay is analyzed from the simulated results.

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