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Shortwave Radiative Impacts of Atmospheric Dust Burden on the Earth Climate of the Last Glacial Cycle Simulated with CLIMBER-2

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Mineral dust particles provide the dominant contribution to the aerosol mass in the atmosphere while showing enormous variations in space and time. Dust deposition flux data range over more than four orders of magnitude. The largest values are reconstructed from Asian loess areas, followed by values from the Arabian Sea and the low latitudes in the eastern Atlantic, and the smallest values are from Antarctica. In general, deposition fluxes are about one order of magnitude larger in glacial periods than during interglacials. We present a dust cycle scheme for the CLIMBER-2 Earth system model of intermediate complexity for studying large-scale changes of the climatic impact of mineral dust. The scheme describes in a simple manner processes of dust emission, transport and deposition. We show that simulated and reconstructed time series of dust deposition fluxes for Antarctica agree reasonably well over the last glacial cycle. In the next step we account for the radiative forcing caused by dust particles with radii in the range of the solar wavelengths. With relevant optical parameters, the atmospheric dust burden leads to a global cooling that is concentrated in low and middle latitudes. Subsequently, precipitation decreases, potential dust source regions grow and the dust emission increases. This positive feedback in the dust cycle simulation enhances the dust emission considerably in glacial periods and thus brings long-term series of dust deposition flux from simulation and reconstruction into closer agreement.