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Atmospheric Dust Burden for Last Glacial, Present and Doubled Carbon Dioxide Climate Conditions from CLIMBER-2 Simulations

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The atmospheric burden of mineral dust is controlled by processes of dust emission, transport and deposition. Changes in vegetation cover from natural or anthropogenic climate change are a key factor for changes in dust emission. Increases in surface temperature and precipitation imply a decrease of the land area with no or little vegetation cover and consequently the potential dust source area diminishes. Other factors controlling the strength of dust emission are surface wind speed and soil dryness which also depend on climate conditions. Our goal is to simulate with the CLIMBER-2 Earth system model the mineral dust cycle dynamically consistent with the climate system and to investigate the radiative impact of the dust cycle on the climate system. As an essential step towards this goal we demonstrate that the present-day distribution of dust optical thickness simulated with the dust cycle agrees reasonably with GCM simulations and satellite retrievals. Also, the simulated dust deposition fluxes for the present climate and the Last Glacial Maximum compare closely with reconstructions from Dust Indicators and Records of Terrestrial and MArine Palaeoenvironments (DIRTMAP). However, simulations over glacial cycles suggest that the agreement between simulated and reconstructed dust deposition fluxes can be improved on orbital time scales by accounting for the stimulating effect of carbon dioxide on vegetation growth. The relative importance of this extra factor is shown for the simulated atmospheric dust burden for last glacial, present and doubled carbon dioxide climate conditions. These results are comparable with the simulations of the NCAR Community Climate System model (CCSM3).