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Simulation of physical soil characteristics in a General Circulation Model: An amplifying mechanism for glacial and mid Holocene climate

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Proxy records indicate that regions of potential vegetation feedbacks have undergone dramatic climate changes during the Quaternary (last 2.588 Ma before pre-industrial). State-of-the-art General Circulation Models (GCM) struggle to simulate the full range of reconstructed climate alterations in these regions, either by underestimating, or by not capturing the impact of important feedback-mechanisms. Recent modelling studies suggest that on longer time scales (kiloyears, ka) pedogenesis might be a crucial feedback, which is not yet included in GCMs. We developed a soil scheme which is asynchronously coupled to a state-of-the-art GCM. Here, we test the scheme for conditions representative of a warmer (mid Holocene, 6 ka ago) and colder (Last Glacial Maximum, 21 ka ago) than present-day climate. The computed change of physical soil properties (e.g. albedo, water storage capacity, and soil texture) for these different climates leads to amplified global climate anomalies. Especially regions like the transition zone of desert/savannah and taiga/tundra, exhibit an increased response as a result of the modified soil treatment. This shows that the inclusion of an interactive soil scheme and associated feedback-mechanisms in climate models might be an important step towards a better representation of past climate changes as recorded in the geological past.