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Sensitivity of North African climate to orbital forcing and soil albedo in an Earth System model

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North Africa is covered to a large extent by the Sahara, a region characterised by extremely low precipitation and sparse vegetation. Six to ten thousand years ago, this region was covered by much more vegetation and the monsoon was more intense and reached further north than it does today. The main mechanism driving these changes was an orbitally induced increase in summer insolation in the northern hemisphere. The insolation increase strengthened the monsoon, this enhanced the vegetation cover, which in turn intensified the monsoon by altering the surface albedo. Furthermore, it has been suggested that areas with extremely high surface albedo in present-day Sahara could be inhibiting the monsoon today. The use of present-day surface albedo in mid-Holocene modelling studies could thus lead to a weaker-than-expected simulated palaeo-monsoon.
We use a coarse resolution (T31) atmosphere-ocean general circulation model with dynamic vegetation (ECHAM5-MPIOM-JSBACH) to study these relationships in more detail. By varying orbital parameters (early- and mid-Holocene) and soil albedo (soil-surface part of total surface albedo) in a box across North Africa we investigate the sensitivity of the west African monsoon. We find that soil albedo strongly influences both the simulated present-day and mid-Holocene monsoon. Soil albedo could thus be an important factor for studies of the transient behaviour of precipitation and vegetation cover in North Africa. For this purpose it needs to be implemented dynamically into land surface models. We will present ways of constructing such a dynamic soil albedo scheme and show results from prototype implementations.