1st TERRABITES Symposium
Hamburg, Germany, 9-11 February 2010
TERRABITES-57

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Albedo-climate feedbacks in North Africa: the mid-Holocene and the present

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During several intervals in the past North Africa has seen an increase in monsoonal precipitation and in vegetation cover. The latest such interval was the mid-Holocene, when the palaeo-monsoon reached to at least 23°N. The main mechanism driving these changes was an orbitally induced increase in summer insolation in the northern hemisphere. It has been hypothesized that feedbacks between biosphere and climate further amplified the orbitally-induced signal. The main positive biosphere-climate feedback in this region arises due to differences in surface albedo between desert areas and areas covered by vegetation. The mid-Holocene insolation increase strengthened the monsoon, which enhanced the vegetation cover, which in turn intensified the monsoon by altering the surface albedo. We are interested in finding out the strength of this feedback.

It has been shown that areas with extremely high surface albedo in present-day Sahara inhibit 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-JSBACH/ MPIOM) to study these relationships in more detail. By varying orbital parameters (early- and mid-Holocene) and bare-ground albedo in a box across North Africa we find that the bare-ground albedo indeed exerts a significant control on the monsoonal precipitation and thus on the vegetation cover in the present-day as well as in the early- and mid-Holocene simulations. Bare-ground albedo could thus be an important factor for studies of the transient behaviour of precipitation and vegetation cover in North Africa. It should therefore be included as a dynamic part in land-surface models when applied to palaeo-studies. We will present such a dynamic scheme and show how it affects the climate in present-day and mid-Holocene atmosphere-only simulations.