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Strength of forest-albedo feedback in mid-Holocene climate simulations

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Reconstructions of the mid-Holocene climate, 6000 years before present, suggest that spring temperatures were higher at high northern latitudes compared to the pre-industrial period. This warming may have been caused by a positive feedback between an expansion of forest and climate. As forests covered by snow have a lower albedo than grass, the regions with more forest presumably favoured a warming in spring, counteracting the relatively low insolation at the mid-Holocene

We investigate this vegetation-climate interaction under mid-Holocene forcing with a comprehensive general circulation model (ECHAM5/JSBACH). We performed two sensitivity experiments with either weak or strong reduction in surface albedo by snow-covered forest. The setup of the experiments allowed us to calculate the pure contribution by the vegetation-climate interaction to the climate signal.

Compared to the experiment with weak snow masking, we simulate in the experiment with strong snow masking a three times higher spring warming by 0.34 °C north of 60° N. By contrast, the additional gain of forest is only 13%. However, in comparison to previous studies we simulate in both experiments a weak spring warming at the mid-Holocene. We show that the parameterisation of albedo leads to uncertainties in the temperature signal but does not explain the strong spring warming by previous simulations. We rather suggest that studies with coarser resolved representation of vegetation than in ECHAM5/JSBACH overestimated the increase in forest at the mid-Holocene and thus the strength of the vegetation climate interaction.