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Feedbacks of the plant physiology in a coupled climate model under a "hypothical" cooler climate during the Holocene

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We use the NCAR's Community Climate System Model (CCSM3) forced by greenhouse gas concentrations that are lower than nominal pre-industrial (1̃750 AD) levels and instead based on natural levels that were reached in similar stages of previous interglaciations. The aim is to test the plant physiology feedback from the vegetation model with the coupled atmosphere-slab ocean configuration at a moderate resolution (T42).

According to previous modeling work allowing interactive vegetation but no physiology feedback, the response of this model to lowered greenhouse gases is a global cooling of about 3 K and an expansion of arctic snow area, resulting from an arctic desert expansion and a decrease mainly of boreal trees and also tundra.
We focus on the comparison of two experiments with both the vegetation feedbacks (interactive vegetation) but one with no plant physiology feedback (NOANTHRO_VEG) and the other with plant physiology feedback (NOANTHRO_VEG_PHYSIO). The physiology feedback produces an even cooler northern hemisphere high latitude climate, about -0.5 K on average. But the land winter temperature difference can reach 2 K near the northern pole. Furthermore, the physiology feedback amplifies the decrease of boreal tree cover in high latitudes and the tundra area in many places except on the southern limit (South-west and south-east Russia and south-east Canada), where the tundra is increasing. In some tropical forest regions, the physiology effect interacts with the recycling and affects the evaporation, the evapo-transpitation locally.

Viewed from the perspective of explaining the unusual late-Holocene increases of CO2 that occurred prior to the Industrial Revolution, these simulated changes in the vegetation support the hypothesis that early agriculture played a role in initiating anomalous warming that thwarted incipient glaciation beginning several thousand years ago. In this work, we will show the impact of the vegetation feedback and the physiology effect on the climate.