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Integrating Land Cover and Land Management feedbacks into climate models: an emulator approach

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The role of Land Cover and Land Management (LCLM) changes in shaping the climate has garnered increasing interest, particularly in light of its potential for climate adaptation and mitigation. Earth System Models (ESMs), however, have hitherto handled LCLM-climate interactions as a unidirectional process, lacking explicit treatment of LCLM-Climate feedbacks. These feedbacks nevertheless are linked to extreme climate events such as heat waves and drought, which in turn carry economic costs through worker productivity, crop yields and food prices. It is thus essential to integrate LCLM processes and their feedbacks into a ESMs, in order to build consistent storylines for future development pathways that take into account their potential for adaptation and mitigation. Emulators represent a computationally cheap but effective way of approximating ESM with an added advantage of agility in scenario exploration. Here we outline an emulator approach to represent LCLM-Climate feedbacks based on a framework developed by Beusch et al. (2020). The emulator provides monthly, spatially explicit data from yearly global mean temperature and uses Generalised Additive Models (GAMs) to represent LCLM-Climate feedbacks. The emulator is to be used in the LAnd Management for CLimate Mitigation and Adaptation (LAMA CLIMA) project, and is trained on dedicated ESM simulations that isolate the effects of key land management practices focussed on by LAMA CLIMA: irrigation, de/reforestation and wood. Key variables produced by the emulator include temperature, Wet Bulb Globe Temperature and labour productivity.

Beusch, L., Gudmundsson, L., & Seneviratne, S. I. (2020). Emulating Earth System Model temperatures: from global mean temperature trajectories to grid-point level realizations on land. *Earth System Dynamics*, 11(1), 139–159. <https://doi.org/10.5194/esd-11-139-2020>