Scale interaction in Land-Atmosphere feedback - Land-Atmosphere Feedback Initiative (LAFI)

Earth-System Models (ESMs) are the most important tools for global climate projections under various future emissions and land-use scenarios. Yet they feature biases, in particular with respect to turbulent heat fluxes, that could not be resolved over the last decade. These biases raise fundamental questions but are equally relevant for very applied and urgent questions, since they are relevant for heterogeneous landscapes – which include many of the world's typical agricultural and forestry landscapes, where people live, grow food and hope to sequester CO2 as required by many climate-neutrality pathways. It remains unclear how different vegetation states and types, such as different land uses, affect the land-atmosphere coupling under realistic conditions, and how much biases in global modeling are attributable to low resolution versus other shortcomings of these models.

Our project aims at a better understanding of the role of surface heterogeneity in land-atmosphere coupling and plans to test its relevance in case studies guided by detailed, high-quality observations. We aim at closing the methodological gap between global ESMs and small-scale Large-Eddy Modeling (LEM) with respect to vegetation-atmosphere interactions by using the same land surface component - JSBACH4, a part of the ICON-ESM (Jungclaus et al. 2022). JSBACH includes a full functionality of vegetation processes, including land-use and land management aspects, and connects physical climate interactions with biogeochemical fluxes. This will provide the means to directly investigate if resolving the land-atmosphere interactions at high spatial detail will avoid strong known biases of ESMs like biases in turbulent heat fluxes, and how this depends on atmospheric conditions. With the help of high-resolution simulations, we will infer conclusions about the net climate effect of land use (i.e., when water, energy and CO_2 fluxes are considered together) at a level relevant for decision-making.