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Implementation and Evaluation of the Land Surface Model JSBACH in the ECHAM/MESSy Atmospheric Chemistry Model

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We present the integration and evaluation of the land surface model JSBACH (Jena Scheme for Biosphere-Atmosphere Coupling in Hamburg) in EMAC (ECHAM/MESSy Atmospheric Chemistry General Circulation Model).
JSBACH replaces the former simplistic SURFACE submodel, introducing a five-layer diffusive hydrological transport model for soil water and a five-layer snow scheme accounting for phase changes of water. It encompasses various land cover types, forest age structures, phenology, and introduces a range of new vegetation and soil-related features, including processes like photosynthesis, plant carbon uptake, and feedback mechanisms linked to surface energy and moisture fluxes. Additionally, JSBACH provides a three-layer canopy scheme, incorporating photosynthesis and solar radiation absorption within the canopy layers. The newly coupled model is evaluated based on ERA5 reanalysis datasets, observations of the Global Precipitation Climatology Project (GPCP), and MODIS satellite data. We Evaluate land surface temperature, terrestrial water storage, surface albedo, precipitation, top-of-atmosphere radiation flux, fraction of absorbed photosynthetic active radiation, leaf area index and gross primary productivity, representing a selection of the most important drivers within the Earth System. We show that, despite the many newly included processes and features, the coupled model performance is not significantly degraded and the run time increase using the new submodel is negligible. The coupling of JSBACH extends the capabilities and versatility of EMAC, taking it a step closer to a comprehensive Earth system model. Additionally, we discuss future work, including the investigation of land-atmosphere interactions, with a particular focus on the feedback of water stress on biogenic organic compound emissions and related changes in atmospheric composition.