Project Title: Impact of land model depth on climate and climate change scenario Simulations (ILModelS)

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Project overview

ILModelS poses the hypothesis that nowadays General Circulation Models (GCMs) use land surface sub-models that are too shallow. There is a number of evidences suggesting that the simulations of sub-surface thermodynamics in current GCMs might not be accurate enough since typically the thermodynamic component in a land-surface model makes use of an insufficient number of discretized subsurface layers and imposes a zero heat flux boundary condition that is located too close to the surface. It has been analytically demonstrated that too shallow subsurfaces distort the amplitude and phase of the heat propagation in the subsurface with implications for enery storage and land-air interactions. Off line land surface model experiments forced with GCM climate change simulations suggest there is a large reduction of the storage capacity of the soil in shallow model experiments. However, up to date the impact of increasing the depth of the soil model on subsurface thermodynamics has not systematically been explored nor its potential effect in climate variations or climate change simulations derived from high-complexity climate models. ILModelS challenges the realism of land surface models in current GCMs and offers to assess the corresponding influence on the energy, water and momentum exchange between land and atmosphere. To do so we aim at modifying the source code of a state-of-the-art GCM to include various depths in the land model thus allowing for assessing the sensitivity of the GCM response in climate variability and climate change scenario experiments.

If ILModelS proves to be successful this will be an indication of a systematic bias in nowadays GCMs with implications for current climate change assessments involving not only the temperature response but also the hydrological cycles, ice cover extent, etc. as interacting components that could be affected if the energy balance is modified.

In ILModelS, we will test the effects of improved surface layer representation in the stand-alone version of JSBACH, the atmosphere model ECHAM6.3 (including JSBACH), and the Max Planck Institute Earth System Model (MPI-ESM1.2).