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Optimal soil model grid configuration and its relevance on NWP and climatological time scales

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In the last years multi-layer soil models for the dynamic variables temperature and humidity have been introduced in numerical weather prediction (NWP) and regional climate models (RCM) in order to improve the behaviour of the soil-atmosphere system on short and long time scales.
The question arises, what the optimal configuration of the soil model grid is with respect to soil model physics and dynamics on different time and horizontal space scales. Smerdon and Stieglitz (2006) investigated the influence of the soil depth on climatological time scales by solving the heat conduction equation for a typical soil type. They showed that the accuracy of the temperature in 1m depth falls below 95% on decadal time scales for a 10m deep soil. It remains above 98% for a 20m deep soil. Other aspects, of the models grid, like the thickness of the upper soil layer or the grid stretching allowed, have not been discussed.
Several constraints originating in the soil physics and dynamics and in the interaction between atmosphere and soil at the surface have to be fulfilled. The representation of the main forcing frequencies (daily and annual cycle), Melting and freezing at the surface and wave damping characteristics in the soil are the most important.

It will be shown, that all grid parameters can be derived for a uniform soil under these constraints. The comparison of the results with typical configurations of weather and regional climate models reveals a systematic overestimation of the grid stretching parameter. A comparison of the results of a systematic simulation study with the regional climate and NWP model COSMO-CLM confirms the theoretical results and shows an underestimation of the daily and annual cycle of the soil temperature.