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The influence of prescribed soil type in a regional climate model

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As a component of the land surface, soil moisture plays a crucial role within the climate system through both memory effects and feedbacks to the atmosphere (e.g. Seneviratne et al. 2010). The sensitivity of the local climate to soil moisture also depends on local properties of the land surface such as porosity, heat capacity and hydraulic conductivity. In most regional climate models (RCMs), predefined soil types correspond to a set of such parameters, which are fixed for each soil type, and one soil type is attributed to each grid point. The values given to the parameters as well as the chosen spatial distribution of soil types can thus influence the results to a non-negligible extent.
The Food and Agricultural Organization (FAO) provides a world soil map that is used as a reference in most RCMs. More recently, the European Commission Joint Research Centre published a new soil type map for Europe, the European Soil Database (ESDB), based on more comprehensive presently available soil-related information for the continent. The objective of this study is to compare model simulations using both maps and to evaluate the role of soil types and their related parameters for European climate simulations.

Two model simulations with the regional climate model COSMO-CLM using different prescribed soil type distributions (based on the FAO and ESDB soil maps, respectively) are analyzed to investigate the role of soil parameters in the model. Both simulations show considerable differences over parts of Europe and highlight the impact of variations in soil types for land-atmosphere interactions, mainly in controlling the energy partitioning between sensible and latent heat flux at the surface. Even though the new map does not necessarily lead to improvements everywhere, it demonstrates the crucial role of soil types in climate model simulations. This is especially relevant given that soil type distribution in most models is to some extent arbitrary since categories are often not very precisely defined and therefore even different interpretations of the same source (e.g. FAO world soil map) can lead to non-negligibly different maps in the model.
Different soil type conversions are compared to identify which changes lead to a certain signal, also as function of the climate regimes and latitude. We then further investigate the role of the soil type and we decompose the signal into three driving factors: 1) the overall water-holding capacity of the soil (determined by the field capacity and plant wilting point); 2) hydraulic conductivity; and 3) hydraulic diffusivity. With the help of additional simulations, we show a negligible role of hydraulic conductivity, while both the overall water-holding capacity and the hydraulic diffusivity can play an important role, their relative importance being dependent on the soil type conversion.

References
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