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Impact of soil properties for European climate simulations

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Soil properties have a strong influence on the terrestrial water cycle, in particular by influencing soil water distribution and dynamics. This in turn affects evapotranspiration from the land to the atmosphere and thus climate conditions. While many studies have looked at the climatic influence of vegetation characteristics/land cover change, fewer investigated the importance of soil properties for climate, although soil properties can also be indirectly altered by land use changes.

In this study, we investigate the influence of soil properties on the European climate using a regional climate model. First, two simulations using two different soil maps are investigated: the soil map of the world from the Food and Agricultural Organization (FAO) and the European Soil Database (ESDB) from the European Commission Joint Research Center (JRC). These simulations highlight the importance of the specified soil texture in summer, with differences of up to 2°C in mean 2-meter temperature and 20% in precipitation due to changes in the partitioning of energy at the land surface into sensible and latent heat flux.

In an additional set of experiments, we modify different sets of soil physical parameters to evaluate their relative importance. Hydraulic diffusivity as well as field capacity and plant wilting point are shown to play an important role, unlike hydraulic conductivity. We highlight the importance of the vertical profile of soil moisture for evapotranspiration as it impacts soil moisture dynamics.

Our study highlights the importance of soil texture and related parameters for climate simulations. Given the uncertainty associated with the geographical distribution of soil texture, efforts to improve existing databases and their integration in climate and hydrological models are needed. Tackling unresolved issues in land-surface modeling related to the high variability of soil parameters, both spatially and within a soil textural class, would benefit a large community and improve the representation of land-atmosphere feedbacks.