The Role of Soil Properties on Regional Climate Simulations

E. Hugo Berbery and Eli Dennis
University of Maryland, ESSIC/CISESS, College Park, United States of America (berbery@umd.edu)

The land surface is inextricably linked to the atmospheric circulation as it dictates the location and strength of land surface-atmosphere (LA) coupling mechanisms. In this context, soil hydraulic properties are critical to estimate sub-surface processes and fluxes at the surface. In most numerical weather and climate models, those properties are assigned through maps of soil texture complemented with look-up tables. Then, the hydraulic properties are used in a large variety of process parameterizations within the models. In this study, we investigate the sensitivity of the simulated regional climate to changes in the prescribed soil maps in the WRF/CLM4 modeling suite. Comparison of two widely used soil texture databases, the USGS State Soil Geographic Database (STATSGO) and Beijing Normal University's soil texture database (GSDE), over the United States and Central America reveals that only 32% of soil texture classifications are in common. Further, the differences are not random but tend to depict small-to-large spatial patterns with a preponderance of either finer or coarser grains. Over North America, the US Great Plains have finer grains in GSDE than in STATSGO, while the opposite is true over Central Mexico.

Seasonal simulations were carried out to assess the changes in the soil-water system that result from changing the soil types (GSDE vs. STATSGO) and their corresponding hydraulic properties. Wherever GSDE has finer grains than STATSGO (e.g., over the US Great Plains), the soil will retain water more strongly as evidenced by smaller latent heat fluxes and larger sensible heat flux. On the other hand, areas of coarser grains in GSDE (e.g., over central Mexico) exhibit an increase in latent heat fluxes and a corresponding decrease in sensible heat flux. Regions with an increase/decrease in latent heat flux have a corresponding increase/decrease in the 2-m moisture content. Similar relations are obtained between sensible heat flux and 2-m temperature. These changes also affect the atmospheric column, which responds with an increase/decrease of temperature and height of the planetary boundary layer. Changes in the vertical structure induce changes in the vertical instability and winds. Interestingly, the chain of modifications resulting from soil texture changes impact the moisture fluxes, and more generally, the atmospheric water budget.