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# Hierarchical set of models to estimate soil thermal diffusivity

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Soil thermal properties significantly affect the land-atmosphere heat exchange rates. Intra-soil heat fluxes depend both on temperature gradients and soil thermal conductivity. Soil temperature changes due to energy fluxes are determined by soil specific heat. Thermal diffusivity is equal to thermal conductivity divided by volumetric specific heat and reflects both the soil ability to transfer heat and its ability to change temperature when heat is supplied or withdrawn. The higher soil thermal diffusivity is, the thicker is the soil/ground layer in which diurnal and seasonal temperature fluctuations are registered and the smaller are the temperature fluctuations at the soil surface.

Thermal diffusivity vs. moisture dependencies for loams, sands and clays of the East European Plain were obtained using the unsteady-state method. Thermal diffusivity of different soils differed greatly, and for a given soil it could vary by 2, 3 or even 5 times depending on soil moisture. The shapes of thermal diffusivity vs. moisture dependencies were different: peak curves were typical for sandy soils and sigmoid curves were typical for loamy and especially for compacted soils. The lowest thermal diffusivities and the smallest range of their variability with soil moisture were obtained for clays with high humus content.

Hierarchical set of models will be presented, allowing an estimate of soil thermal diffusivity from available data on soil texture, moisture, bulk density and organic carbon. When developing these models the first step was to parameterize the experimental thermal diffusivity vs. moisture dependencies with a 4-parameter function; the next step was to obtain regression formulas to estimate the function parameters from available data on basic soil properties; the last step was to evaluate the accuracy of suggested models using independent data on soil thermal diffusivity. The simplest models were based on soil bulk density and organic carbon data and provided different regression formulas for soils of different textural classes. For the higher level models we additionally used data on soil texture and in some cases the texture rank index, varying from 1 for light soils to 7 for heavy ones. The accuracy of suggested models varied between 17% for loams and 44% for clays which is better than the results published so far.

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