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Seasonal changes of apparent thermal diffusivity of different kinds of soils

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The paper addresses the problem of seasonal changes of apparent thermal diffusivity (ATD) in different types of soils in different climatic conditions. The long-term (several years) temperature series recorded at observatories in Czechia, Slovenia and Portugal were processed using a program based on the error function solution of the heat conduction equation for a semi-infinite solid. The program simulates penetration of temperature changes represented by the observed time–temperature series in differently wide time floating intervals, and in different depth levels of the soil profile. Synthetic temperature series for different values of thermal diffusivity (with a step of 1E-8 m2/s) are automatically compared with measured temperature time series in a given depth. The ATD value minimizing the standard deviation of difference between the measured and computed temperature series is considered as the best approximation of reality.

The method has been applied to the temperature series from (i) observatory in Prague, where the temperature monitoring in different kinds of soil (sand, bare clayey soil, grassy soil) and asphalt is running from 2002, (ii) Evora - Portugal (gravelly sand, running from 2005), and finally (iii) Malence - Slovenia (grassy clayey soil, running from 2003). The soil temperature is measured at the depths of 2, 5, 10, 20 and 50 cm at each of the observatories.

Results have shown a gradual increase of the ATD with depth caused by the soil density gradient in case of Malence and Prague (excluding asphalt). The ATD of the upper part of sand (2 – 5 cm), contrary to grassy surface, is quite sensitive to weather pattern (e.g. periods of rain or drought), when the strong convective heat transport in soil can occur. The ATD values in Evora show an annual run connected with a long dry summer season. The seasonal pattern is characterized, especially in the upper part of soil, by a rapid decrease from 7*E-7 to 4*E-7 m2/s in June and a return to higher values in the end of September only.