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Heat transfer in shallow subsurface under different climate conditions in Europe (Czechia, Slovenia, Portugal)

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The long-term records of soil and air temperatures collected at several geothermal observatories in Prague, Bedrichov, Svojsice (Czechia), Malence (Slovenia) and Evora (Portugal) were used to analyze the surface air temperature (SAT) vs soil temperature coupling at several depth levels. The work assesses (a) the influence of solar radiation, vegetation or snow cover, as well as the precipitation and albedo of the surface on mean annual air – surface temperature offset and (b) the heat transfer within the shallow subsurface. As thermal diffusivity (TD) plays a fundamental role in heat transfer in soil, two different methods based on attenuation and phase shift of annual temperature wave and on modeling of thermal response by error function solution of heat conduction equation were used to estimate TD in particular soil levels. It was found that low-frequency changes of the surface temperature such as the annual wave and/or multi-year and secular variations propagate downwards mainly by the heat conduction contrary to high-frequency (diurnal wave) where the convective heat transport during wet periods plays an important role. Significant seasonal changes of thermal diffusivity of upper soil layer caused by rotating of long wet and dry periods in Evora produce negative offset values between ground and soil mean annual temperature.