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Surface air–soil temperature relationship and shallow soil thermal regime: a case study using a soil temperature observational dataset for Spain.

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The land-atmosphere interactions via the energy and water exchanges at the ground surface generally translate into a strong connection between the surface air temperature (SAT) and the ground surface temperature (GST). In turn, the surface temperature affects the amount of heat flowing into the soil, thus controlling the subsurface temperature profile. As soil temperature (ST) is a key environmental variable that controls various physical, biological and chemical processes, understanding the relationship between SAT and GST and STs is important.

In situ ST measurements represent the most adequate source of information to evaluate the distribution of temperature in soils and to address its influence on soil biological and chemical processes as well as on climate feedbacks. However, ST observations are scarce both in space and time. Therefore, the development of ST observational datasets is of great interest to promote analyses regarding the soil thermodynamics and the response to atmospheric warming.

We have developed a quality-controlled dataset of Soil Temperature Observations for Spain (SoTOS). The ST data are obtained from the Spanish meteorological agency (AEMET), including ST at different layers down to a depth of 1 m (i.e., 0.05, 0.1, 0.2, 0.5 and 1 m depth) for 39 observatories for the 1985–2018 period. Likewise, 2m air temperature has also been included for the same 39 sites.

SoTOS is employed to evaluate the shallow subsurface thermal regime and the SAT–GST relationship on interannual to multidecadal timescales. The results show that thermal conduction is the main heat transfer mechanism that controls the distribution of soil temperatures in the shallow subsurface. Regarding the SAT-GST relationship, there is a strong connection between SAT and GST. However, the SAT–GST coupling may be disrupted on seasonal to multidecadal timescales due to variations in the surface energy balance in response to decreasing soil moisture conditions over the last decade at some SoTOS sites. This results in larger GST warming relative to

SAT. Such a response may have implications for climate studies that assume a strong connection between SAT and GST such as air temperature estimations from remote sensing products or even for palaeoclimatic analyses.