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

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Abstract

We have developed a quality-controlled Soil Temperature (ST) Observational dataset for Spain **(SoTOS).** 39 sites including ST at 5, 10, 20, 50 and 100 cm depth and 2m air temperature (SAT). Daily resolution spanning from 1987 to 2018. In this work, we use **SoTOS** to explore the connection between air and soil temperatures and the propagation of heat into the subsurface.

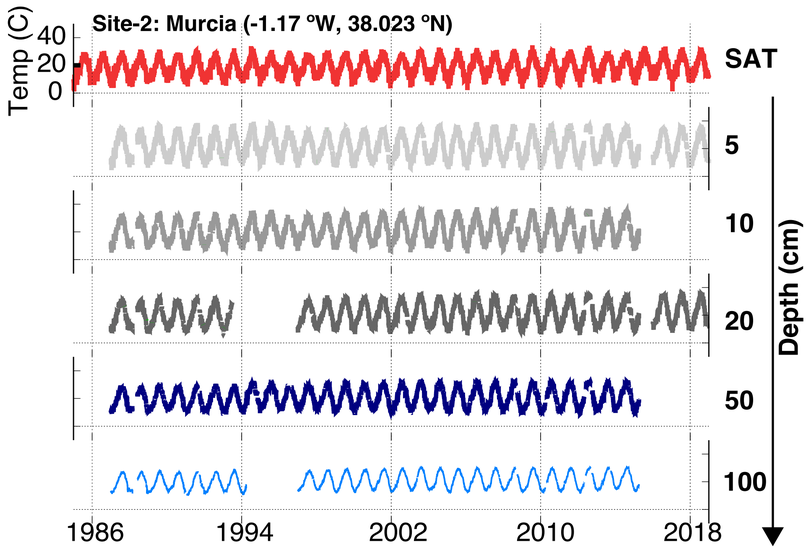
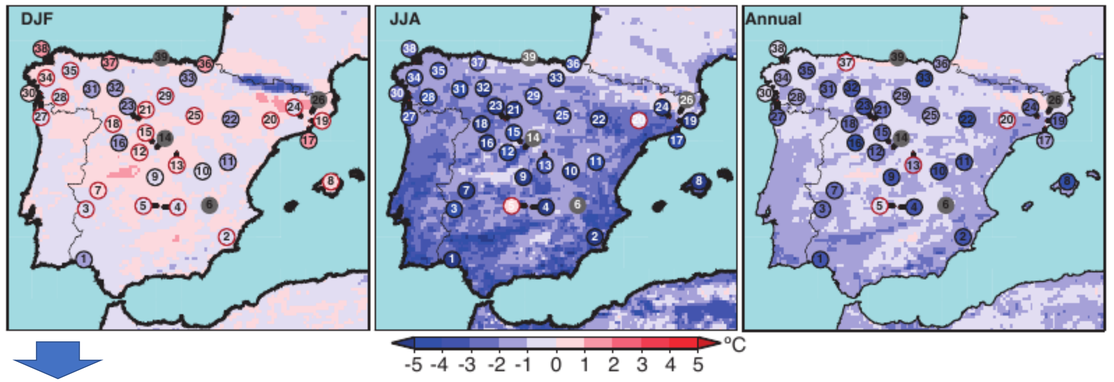


Figure 1. Example of one of the **SoTOS** sites. There may be gaps in the temperature records.

Surface air—soil temperature relationship:



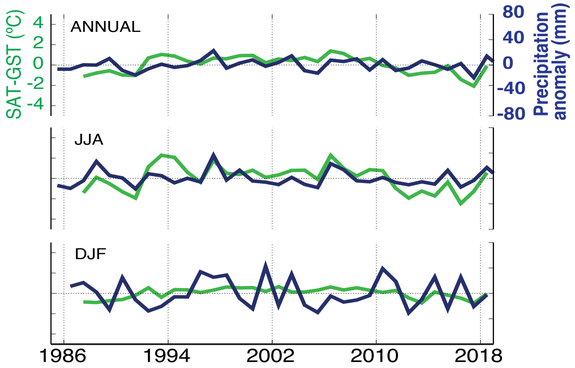
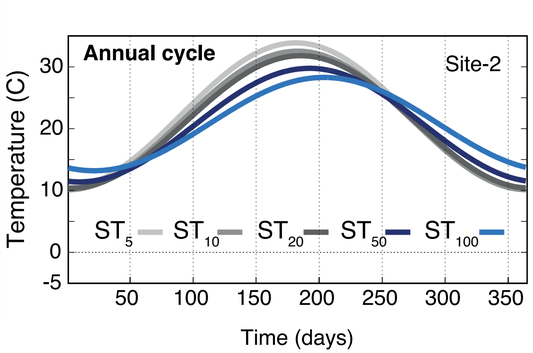
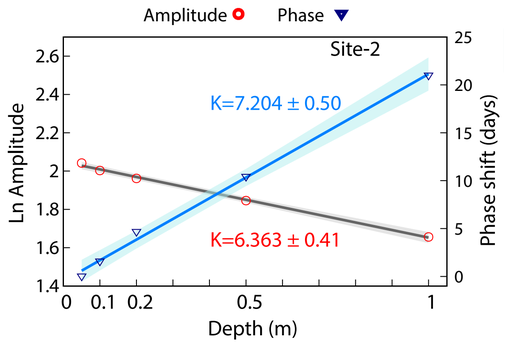


Figure 2. DJF, JJA and annual mean SAT minus GST for **SoTOS** and ERA5-Land. Observations and reanalysis show a strong coupling between SAT and GST. However, in JJA there is an offset between SAT and GST that dominates the annual response. **Low soil moisture in JJA and land cover type (mostly bare soil and short grass) enhance the radiative heating of the ground surface.**

Figure 3 DJF, JJA and annual SAT minus GST and precipitation evolution. **Interannual to multidecadal SAT—GST decoupling due to changes in precipitation/soil moisture.**

Near surface thermal regime:





$$T(z,t) = Ae^{(-z\sqrt{\pi}/\tau\kappa)}\cos(\frac{2\pi}{\tau}t - z\sqrt{\pi}/\tau\kappa)$$

Figure 4. Annual cycle of STs (left) and linear regression between amplitude attenuation and phase shift vs depth (right). **Heat conduction accounts for most of the temperature propagation in the shallow subsurface.**

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