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Using observed dry spell land surface temperature to investigate simulated European heat waves

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There is increasing evidence that European summer temperature extremes can be enhanced by soil moisture-induced land-atmosphere feedback. Moreover, climate model projections indicate that heat wave events could become more frequent in the future. The surface energy partition into latent and sensible heat flux exerts an important control over this feedback, but quite how it responds to soil moisture remains uncertain. For example, climate models disagree to what extent current central European summer evaporation is limited by soil moisture or incident radiation. In situ observations are improving our understanding of these dry down processes, but they are limited to relatively few locations. Alternatively, satellite observations of land surface temperature (LST) provide indirect information about the surface energy partition across the whole of Europe.

Here, we improve dry spell dynamics in the JULES land surface model using satellite observations of LST, and evaluate the corresponding impact on temperatures simulated by the parent climate model, MetUM. We use a spatially and temporally aggregated diagnostic derived from 1 km daytime MODIS-Terra LST observations to describe the composite response of LST during surface dry down in rain-free periods. This diagnostic is produced for Europe at 0.5° spatial resolution to allow comparison with the equivalent values simulated by the land surface scheme. For Mediterranean grasslands, JULES exhibits warming rates during the first 15 days of dry down that compare well with observations, whereas outside of the Mediterranean the simulated warming rates are much weaker than observed. The composite diagnostic is then used to train spatially-invariant JULES parameters that are known to affect the modelled soil moisture control of evaporation on sub-seasonal time scales. The trained parameters are then applied to climate simulations using the Met Office Unified Model (MetUM GA5.0) to examine their effect in the coupled land-atmosphere system. We assess these coupled simulations for their ability to simulate both the composite LST diagnostic and air temperature extremes during dry down periods.