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The effect of soil-moisture on human heat stress during hot spells

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Hot extremes are typically instigated by a combination of favorable large-scale conditions and positive land surface feedbacks: as heatwaves evolve, the soil dries out and the decreased evaporation is accompanied by further heating of the atmosphere. Extreme high temperatures are known to cause increased mortality, and thus dry soils are typically thought to be associated with higher risk for human health. However, empirical studies indicate that health-threatening consequences and overall human discomfort during heatwaves not only depend on air temperature, but on air humidity as well. Drying soils are expected to reduce air humidity, which may — to a yet-unknown degree — offset the detrimental effect of soil dryness on increased temperatures in what relates to human heat discomfort. Here, we provide observational evidence for the role of anomalies in soil moisture on heat stress worldwide. We use a novel framework that combines weather balloons, reanalysis and satellite data with a mechanistic model of the atmospheric boundary layer. The health-threatening nature of hot spells is diagnosed by adopting a definition based on the concept of wet-bulb temperature and findings from recent meta-analysis of global human lethal impact data. Results indicate that the detrimental effect of drying soils on air temperature is overcompensated by the beneficial effect on reduced air humidity, which is partly related to the enhanced dry air entrainment. These findings can be used to design climate change adaptation strategies, being aware that ongoing trends in land and atmospheric dryness will impact human heat stress during future heatwaves.