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Data-driven modelling of soil moisture: mapping organic soils

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Improving our understanding of soil moisture and hydraulics is crucial for flood prediction, smart agriculture, modelling nutrient and pollutant spread and evaluating the role of land as a sink or source of carbon and other greenhouse gases. State of the art land surface models rely on poorly-resolved soil textural information to parametrise arbitrarily layered soil models; soils rich in organic matter – key to understanding the role of the land in achieving net zero carbon – are not well modelled. Here, we build a predictive data-driven model of soil moisture using a neural network composed of transformer layers to process time series data from point-sensors (precipitation gauges and sensor-derived estimates of potential evaporation) and convolutional layers to process spatial atmospheric driving data and contextual information (topography, land cover and use, location and catchment behaviour of water bodies). We train the model using data from the COSMOS-UK sensor network and soil moisture satellite products and compare the outputs with JULES to investigate where and why the models diverge. Finally, we predict regions of high peat content and propose a way to combine theory with our data-driven approach to move beyond the sand-silt-clay modelling framework.