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Soil- and crop-dependent variation in correlation lag between precipitation and agricultural drought indices as predicted by the SWAP model

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Droughts have a devastating impact on agriculture and economy. The risk of more frequent and more severe droughts is increasing due to global warming and certain anthropogenic activities. At the same time, the global population continues to rise and the need for sustainable food production is becoming more and more pressing. In light of this, drought prediction can be of great value; in the context of early warning, preparedness and mitigation of drought impacts. Prediction of meteorological drought is associated with uncertainties around precipitation variability. As meteorological drought propagates, it can transform into agricultural drought. Determination of the maximum correlation lag between precipitation and agricultural drought indices can be useful for prediction of agricultural drought. However, the influence of soil and crop type on the lag needs to be considered, which we explored using a 1-D Soil-Vegetation-Atmosphere-Transfer model (SWAP (http://www.swap.alterra.nl/), with the following configurations, all forced with ERA-Interim weather data (1979 to 2014): i) different crop types in the UK; ii) three generic soil types (clay, loam and sand) were considered. A Sobol sensitivity analysis was carried out (perturbing the SWAP model van Genuchten soil hydraulic parameters) to study the effect of soil type uncertainty on the water balance variables. Based on the sensitivity analysis results, a few variations of each soil type were selected.
Agricultural drought indices including Soil Moisture Deficit Index (SMDI) and Evapotranspiration Deficit Index (ETDI) were calculated. The maximum correlation lag between precipitation and these drought indices was calculated, and analysed in the context of crop and soil model parameters. The findings of this research can be useful to UK farming, by guiding government bodies such as the Environment Agency when issuing drought warnings and implementing drought measures.