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Comparing in-situ neutron probe measurements of soil moisture with grid-based hydrological model estimates

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The Grid-2-Grid (G2G) model is a spatially distributed hydrological model that provides estimates of river flow and soil moisture on a 1km resolution across Britain. G2G is routinely used for high flow applications, such as operational fluvial flood forecasting, pluvial flood forecasting and assessments of the effect of projected climate change on peak river flows. It has recently been shown to perform well for low flows and for drought identification. The G2G flow estimates have been assessed at hundreds of river gauging station sites across Britain, but as yet there has been no assessment of the corresponding soil moisture estimates. The work presented here provides the first results comparing G2G-modelled soil moisture with long-term records of in-situ soil moisture measurements from a network of neutron probes.

Remotely-sensed soil moisture programmes, such as SMAP (Soil Moisture Active Passive) and COSMOS (COsmic-ray Soil Moisture Observing System), are increasing the availability of regular estimates of near-surface soil moisture; however, automatic measurements of soil moisture in deeper soil layers continue to prove elusive. Good quality estimates of soil moisture throughout the depth of the soil-column are essential for assessing and improving hydrological and agricultural models and forecasts. In-situ soil moisture monitoring can provide this information, but the measurements can be sparse and labour intensive.

In-situ measurements of soil moisture at a range of depths using neutron probes have been undertaken in the UK since the 1970s (if not earlier), but these observations have not routinely been collated. In recent years a requirement to assess the performance of national-scale hydrological models and their estimates of soil moisture led to a search for such data. A total of 2-300 data years of neutron probe data have been identified, including measurements from over 150 UK sites, spanning 1970 to 2003. These datasets are currently being checked for errors, omissions and consistency.

Here, vertically-integrated soil moisture estimates from the G2G model are compared to historical in-situ measurements from a network of neutron probes across Britain. The challenges of comparing soil moisture estimates at very different spatial scales are discussed. For example, spatial datasets of terrain and soil properties are used to configure the model to local conditions in preference to parameter identification via calibration; for some sites this can lead to discrepancies between observational site conditions (e.g. soil type and measurement depth) and corresponding model assumptions.

This comparison will facilitate improvements in model performance and assist in the development of future soil moisture products, including the ability to more confidently predict short-term variation and long-term trends in soil moisture based on weather forecasts and climate scenarios.