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Do land parameters matter in large-scale hydrological modelling?

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Many of the most pending issues in large-scale hydrology are concerned with predicting hydrological variability at ungauged locations. However, current-generation hydrological and land surface models that are used for their estimation suffer from large uncertainties. These models rely on mathematical approximations of the physical system as well as on mapped values of land parameters (e.g. topography, soil types, land cover) to predict hydrological variables (e.g. evapotranspiration, soil moisture, stream flow) as a function of atmospheric forcing (e.g. precipitation, temperature, humidity). Despite considerable progress in recent years, it remains unclear whether better estimates of land parameters can improve predictions – or – if a refinement of model physics is necessary. To approach this question we suggest scrutinizing our perception of hydrological systems by confronting it with the radical assumption that hydrological variability at any location in space depends on past and present atmospheric forcing only, and not on location-specific land parameters. This so called "Constant Land Parameter Hypothesis (CLPH)" assumes that variables like runoff can be predicted without taking location specific factors such as topography or soil types into account. We demonstrate, using a modern statistical tool, that monthly runoff in Europe can be skilfully estimated using atmospheric forcing alone, without accounting for locally varying land parameters. The resulting runoff estimates are used to benchmark state-of-the-art process models. These are found to have inferior performance, despite their explicit process representation, which accounts for locally varying land parameters. This suggests that progress in the theory of hydrological systems is likely to yield larger improvements in model performance than more precise land parameter estimates. The results also question the current modelling paradigm that is dominated by the attempt to account for locally varying land parameters in ever greater detail. While improved physically-based models are under development, the proposed statistical model can be used to produce full space-time estimates of monthly runoff in Europe, contributing to practical aspects of the discipline including water resources monitoring and seasonal forecasting.