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Model coupling instead of calibration: what can a catchment model learn from landscape evolution?

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Soil depth has been recognized as the prominent factor controlling the water balance and influencing water residence times and streamflow source areas with implications for floods forecasting, long-term water balance at the catchment scale and solutes dynamics and transport in natural catchments. Actual soil depth patterns derive from long-term interactions between soil production and removal, triggered by biotic and/or abiotic mechanisms. Climate, vegetation and topography impact these mechanisms and determine the actual control volume where hydrologic processes and chemical reactions take place. Calibration of hydrologic models is strongly affected by a correct definition of the extent of the control volume. In fact, depth to bedrock is often the most sensitive (and yet uncertain) parameter to be tuned. Depending on the level of conceptualization of the model (i.e. lumped, semi-distributed, fully distributed models) the identification of proper soil depth values (or maps, for distributed models) is a more or less challenging task, often performed with minor (or absent) field information. As such, quantitative information provided by coupled hydrologic/geomorphologic landscape evolution models has the potential to strongly impact model calibration and parameter uncertainty. The relevance of the study stems from the potential improvement in hydrologic predictions for ungauged basins that would be derived by direct use of remotely measured and objectively manipulated geomorphic features related to soil depth, thus defining process based, spatially distributed, boundary conditions for modeling the catchment scale water cycle.
In particular, in this work we analyze the impact of spatial maps of soil depth on a semi-distributed hydrologic model. We use model derived patterns of soil depth (resulting from previous work on long-term landscape evolution under dynamic equilibrium). To study the effect of spatially detailed soil depth information on parameters uncertainty. Given prior parameter distributions we perform MonteCarlo simulations and study parameter posterior distributions by using state of the art tools for parameter identification and uncertainty assessment.