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Demasking the integrated value of discharge – Advanced sensitivity analysis on the components of hydrological models

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The hydrologic response variable most often used in sensitivity analysis is discharge which provides an integrated value of all catchment processes. The typical sensitivity analysis evaluates how changes in the model parameters affect the model output. However, due to discharge being the aggregated effect of all hydrological processes, the sensitivity signal of a certain model parameter can be strongly masked. A more advanced form of sensitivity analysis would be achieved if we could investigate how the sensitivity of a certain modelled process variable relates to the changes in a parameter. Based on this, the controlling parameters for different hydrological components could be detected.

Towards this end, we apply the approach of temporal dynamics of parameter sensitivity (TEDPAS) to calculate the daily sensitivities for different model outputs with the FAST method. The temporal variations in parameter dominance are then analysed for both the modelled hydrological components themselves, and also for the rates of change (derivatives) in the modelled hydrological components. The daily parameter sensitivities are then compared with the modelled hydrological components using regime curves.

Application of this approach shows that when the corresponding modelled process is investigated instead of discharge, we obtain both an increased indication of parameter sensitivity, and also a clear pattern showing how the seasonal patterns of parameter dominance change over time for each hydrological process.

By relating these results with the model structure, we can see that the sensitivity of model parameters is influenced by the function of the parameter. While capacity parameters show more sensitivity to the modelled hydrological component, flux parameters tend to have a higher sensitivity to rates of change in the modelled hydrological component.

By better disentangling the information hidden in the discharge values, we can use sensitivity analyses to obtain a clearer signal regarding how the temporal variations in parameter dominance are related to the corresponding processes. Such an approach should lead to more advanced uses of sensitivity analysis towards better understanding of how parameters control the processes being modelled.