Computationally inexpensive identification of non-informative model parameters

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1. Introduction

Environmental models tend to **increase continually in computation time** because they incorporate and improve continuously the physical process descriptions, which contain multiple model parameters. Many-query applications such as sensitivity analysis or model calibration usually require a **large number of model evaluations** leading to high computational demand. This often limits the feasibility of rigorous analyses. Here we present a **fully automated sequential screening** method based on Elementary Effects that selects **only informative parameters** for the chosen model output.

2. Hydrologic Model mHM & Study Area

This computational inexpensive method for identification of parameters important during calibration is applied to a **distributed hydrologic model at the mesoscale** (mHM) with 52 parameters (Fig. 1). The model is open source and can be downloaded from `www.ufz.de/mhm`. The model uses grid cells as a primary hydrologic unit, and accounts for processes like snow accumulation and melting, soil moisture dynamics, infiltration, surface runoff, evapotransp., subsurface storage and discharge generation.

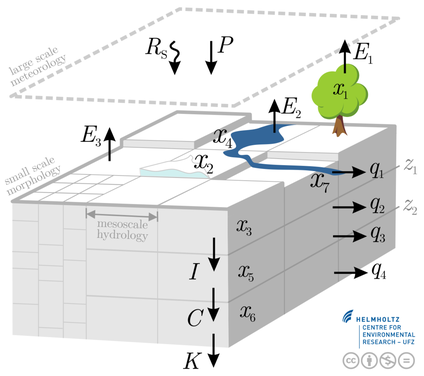

Fig. 1: Hydrologic model mHM

The model is applied in **three distinct catchments** of different hydrological characteristics over Europe.

	DE	SLO	ES
Area [km^2]	12 700	5 180	19 555
Elevation [m]	455	743	860
Aridity index	1.1	1.9	0.4
Annual runoff [mm]	304	927	55
Annual precip. [mm]	885	1579	433
Annual temp. [°C]	8.3	8.1	14.2
Annual snow [mm]	56	137	5

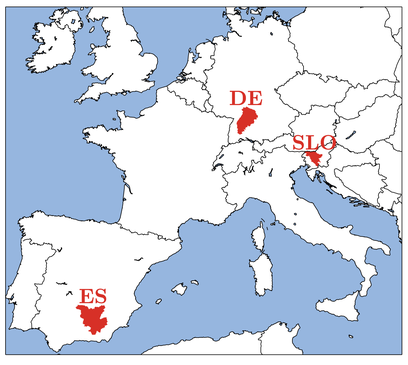

Fig. 2: Catchments: Neckar (DE), Sava (SLO), and Guadalquivir (ES)

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This method is also applied to Land-Surface model **Noah-MP**:
↷ **Poster H33E-0872**
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3. Parameter sensitivities across Europe

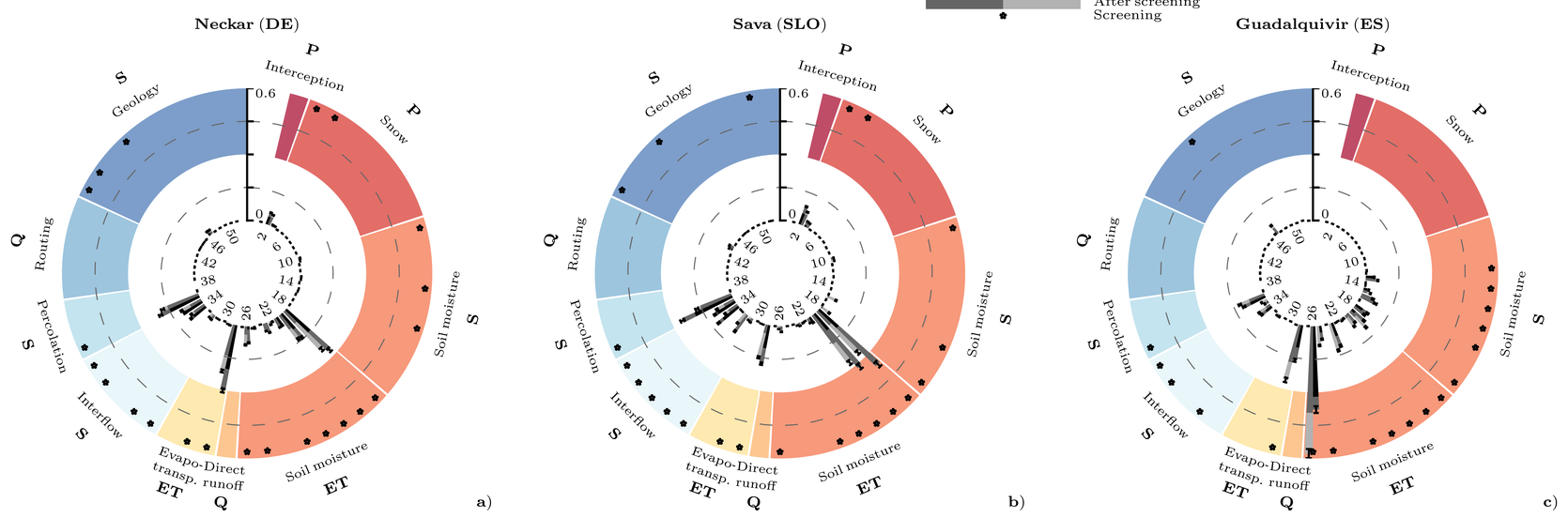

Fig. 3: Stacked bar chart of mean Sobol indexes (S_i) before (darker stacks) and after screening (lighter stacks) with the proposed sequential method for three catchments. The lower bars in the stacks are the first-order indexes S_i and the total heights give the total-order indexes S_{Ti}. The stars mark the parameters that would be retained with the sequential screening method. The error bars are determined using bootstrapping of the time series.

4. Sequential parameter screening

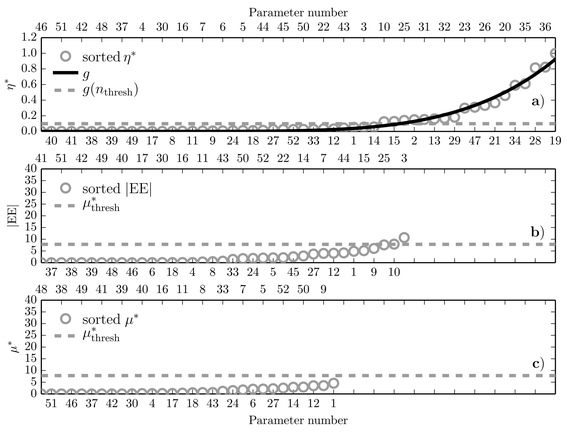

Fig. 4: Three steps of screening method for Neckar (DE): a) In the first iteration the Elementary Effects are estimated using 3 trajectories and then a fitting function is used to determine the threshold $g(n_{\text{thresh}})$. b) Parameters with Elementary Effects above the threshold are discarded during next iterations. Only single trajectories are used. c) The procedure finishes when no additional parameter was above threshold. For verification, the last iteration also runs with a higher number of 5 trajectories.

5. Model performance

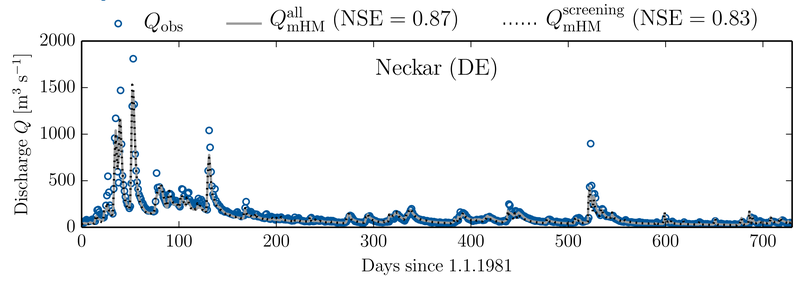

Fig. 5: Observed and simulated discharge before and after parameter screening for Neckar (DE). Before screening 16 000 model evaluations were required for calibration until convergence, after screening only 6 000. Results are comparable for Sava (SLO) and Guadalquivir (ES).

6. Conclusion

- The sequential screening identified the same informative parameters as the standard Sobol method, but required **less than 1% model runs**. On average the number of model runs was **10 times number of model parameters**.
- The Sobol indexes of only screened parameters are practically the same as before screening, but only 50% model runs were necessary.
- Generally more than half of the model parameters were non-informative.