H33E-0872: Sensitivity Analysis for the Land Surface Model NOAH-MP for Different Model Fluxes

Stephan Thober[1], Juliane Mai[1], Luis Samaniego[1], Martyn Clark[2], Pablo Mendoza[2], Volker Wulfmeyer[3], Oliver Branch[3], Sabine Attinger[1], Rohini Kumar[1], Matthias Cuntz[1]

1: Helmholtz Centre for Environmental Research - UFZ, Leipzig, Germany; 2: NCAR Boulder, CO; 3: University of Hohenheim, Hohenheim, Germany

stephan.thober@ufz.de

1. Motivation

Complex land surface models (LSMs) incorporate a great variety of processes and parameters. Some of these processes will be inactive when LSMs are applied at a given location (e.g. snow processes are inactive under tropical conditions). The parameters of these inactive processes become non-informative and might lead to artificial equifinality during model calibration. Investigating only the informative parameters and leaving others at their default values circumvents this issue and allows an efficient model calibration. In this study, an efficient fully automated screening is applied to identify these parameters for the NOAH-MP LSM [1].

2. Methods

Elementary effects (EE) are calculated sequentially to quantify the impact of a parameter p on a model output M.

$$EE = \frac{M(p+\delta) - M(p)}{\Delta},$$

where δ is a change within a given parameter range and Δ is the change δ mapped to $[0,1]$. Informative parameters are identified in two steps. Step 1, five trajectories through the parameter space are sampled, where only one parameter is changed at a time (Fig. 1).

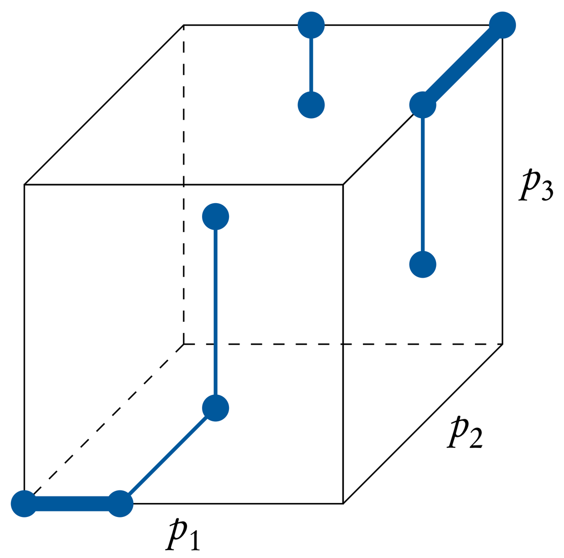

Fig. 1: Three exemplary trajectories in the parameter space. Informative parameters are marked as thick lines.

Step 2, a power function (g in Fig. 2) is fitted to the EE obtained from these five trajectories. The value of g, where the increment of g is one, is determined as cutoff (Fig. 2a). All parameters with an EE above the cutoff are identified as informative and removed from the sampling. Step 2 is repeated with the remaining parameters until no additional informative parameter is found (Fig. 2b). This method [1] is very efficient as it requires only 10 model evaluations per parameter (see also Poster **H31J-0763**).

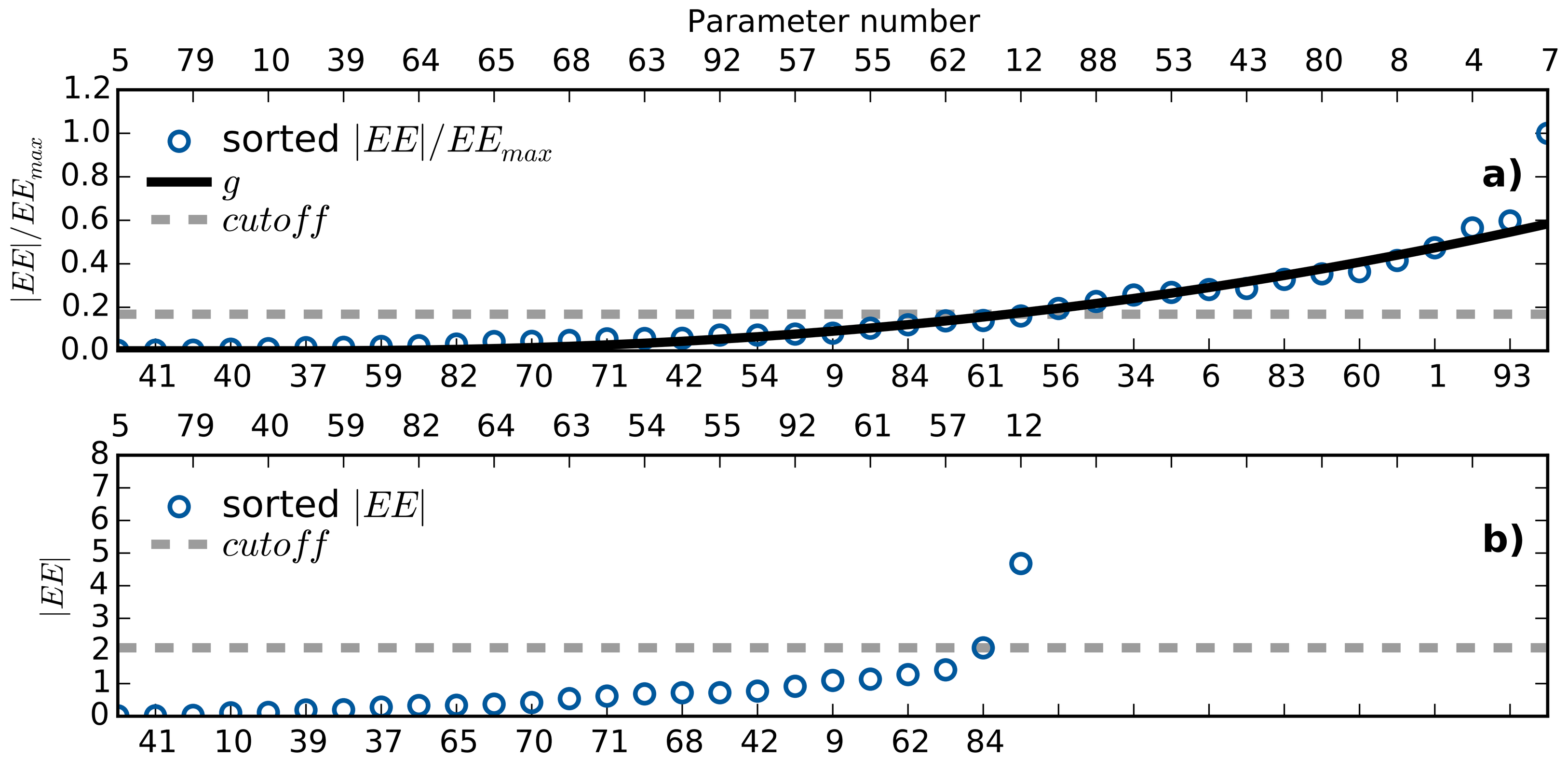

Fig. 2: First two steps within the sequential screening for non-informative parameters

3. Experimental Setup

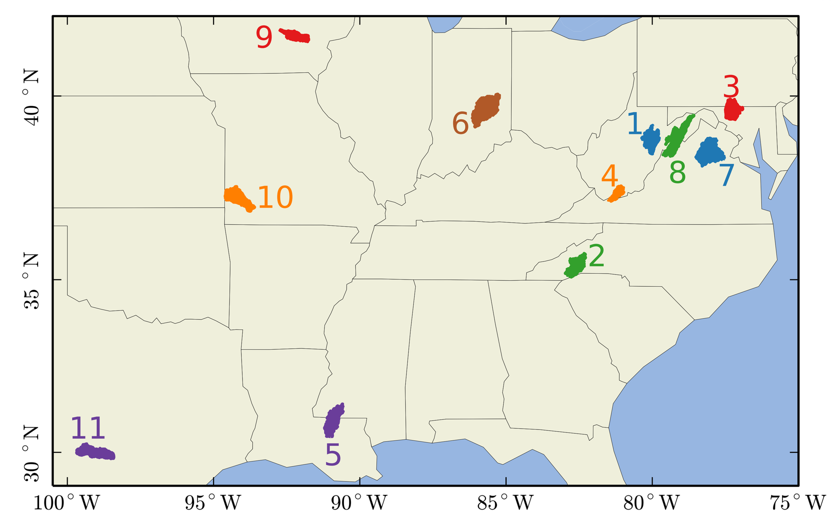

Fig. 3: Location of 11 considered MOPEX catchments within continental United States

NOAH-MP is applied in 11 MOPEX catchments (Fig. 3). Meteorological forcings are obtained from NLDAS-2 and static data (e.g. soil type) from LDAS. The spatial resolution is 0.125° and the simulation period is from 1979 until 1999, with the first five years discarded as spin-up.

Table 1: Catchment Characteristics (sorted by runoff coefficient)

No	Name	Runoff Coefficient*	Rainfall* (mm)	Runoff* (mm)	Fraction of Daily Runoff Below* 1 mm	Mean Annual Temperature ($^{\circ}C$)	Bowen Ratio**	Dominant Land Cover
1	Tygart Valley River	0.61	1198	735	0.47	9.8	0.62	Dec BroadLf Forest
2	French Broad	0.56	1413	800	0.16	12.5	0.60	Mixed Forest
3	Monocacy River	0.40	1050	420	0.69	11.7	0.59	Dec BroadLf Forest
4	Bluestone River	0.40	1036	416	0.67	11.2	0.58	Dec BroadLf Forest
5	Amite River	0.38	1563	609	0.66	19.6	0.80	Evg NeedlLf Forest
6	East Fork White River	0.37	1013	377	0.71	11.7	0.47	Grasslands
7	Rappahannock River	0.36	1037	377	0.70	13.0	0.56	Mixed Forest
8	South Branch Potomac	0.32	1055	341	0.74	10.3	0.64	Dec BroadLf Forest
9	English River	0.29	900	267	0.83	10.2	0.30	Grasslands
10	Spring River	0.27	1075	298	0.83	14.0	0.53	Dec BroadLf Forest
11	Guadalupe	0.15	763	116	0.95	20.0	0.69	Vegetation Mosaic

*adapted from Evin et al., 2014, WRR **obtained from NOAH-MP reference run

4a. Latent Heat

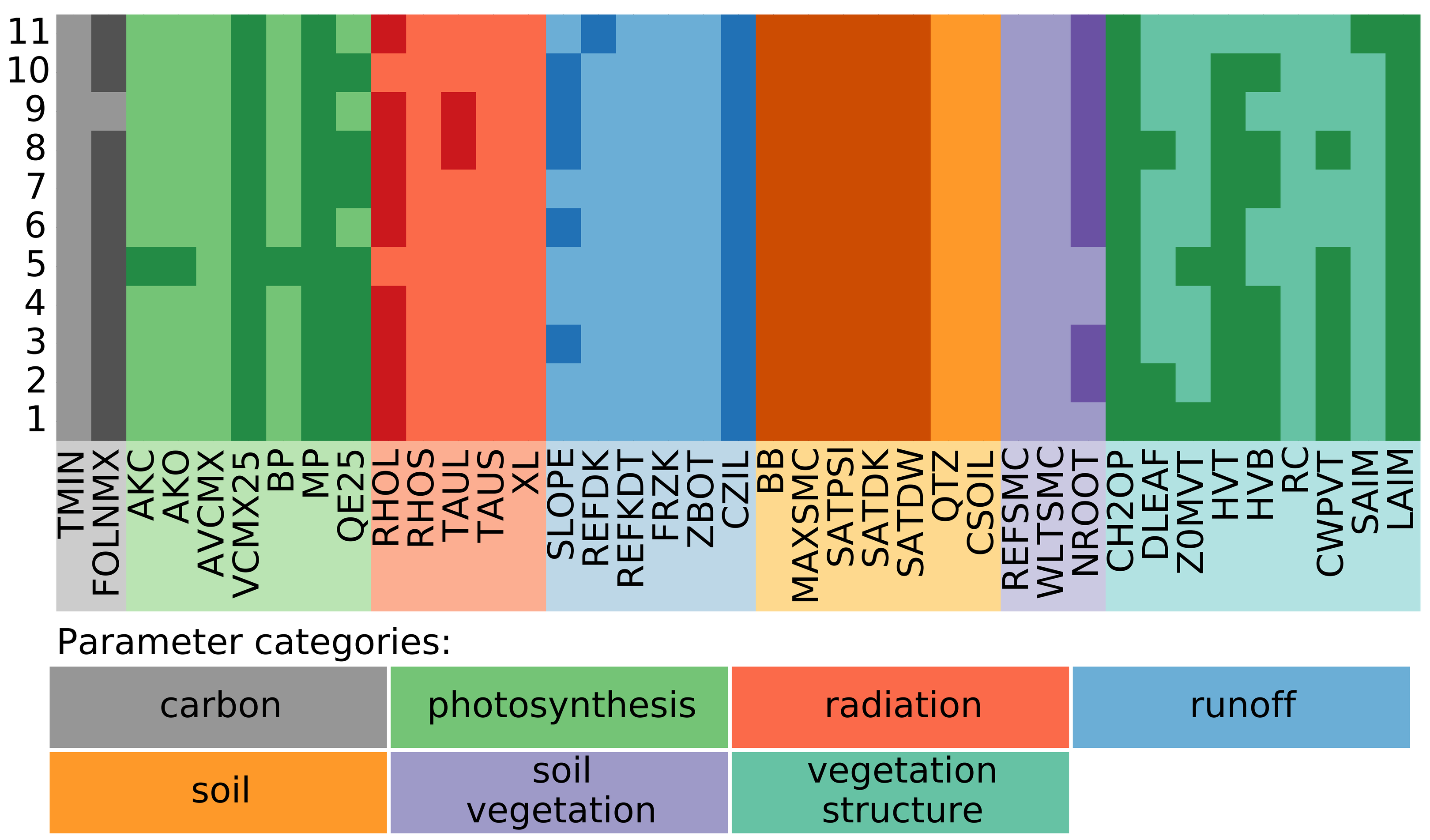

Fig. 4: Informative parameters (columns) for **Latent Heat** flux for 11 MOPEX catchments (rows). Dark (light) cells mark informative (non-informative) parameters.

18 out of 39 parameters are on average informative for latent heat. These are mostly vegetation structure and photosynthesis, but also soil parameters. Little variability in informative parameters can be observed for the different basins.

4b. Surface Runoff

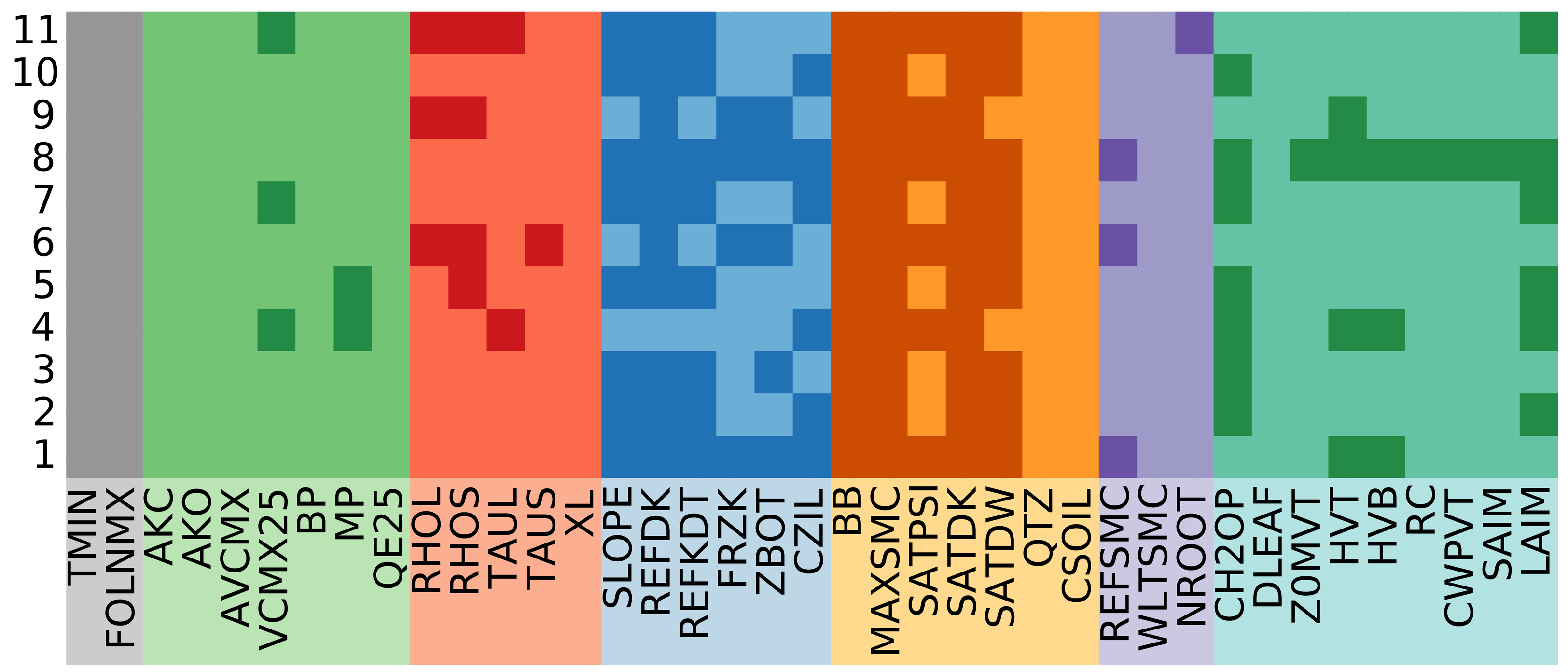

Fig. 5: Informative parameters (columns) for **Surface runoff** for 11 MOPEX catchments (rows). Dark (light) cells mark informative (non-informative) parameters.

4c. Subsurface Runoff

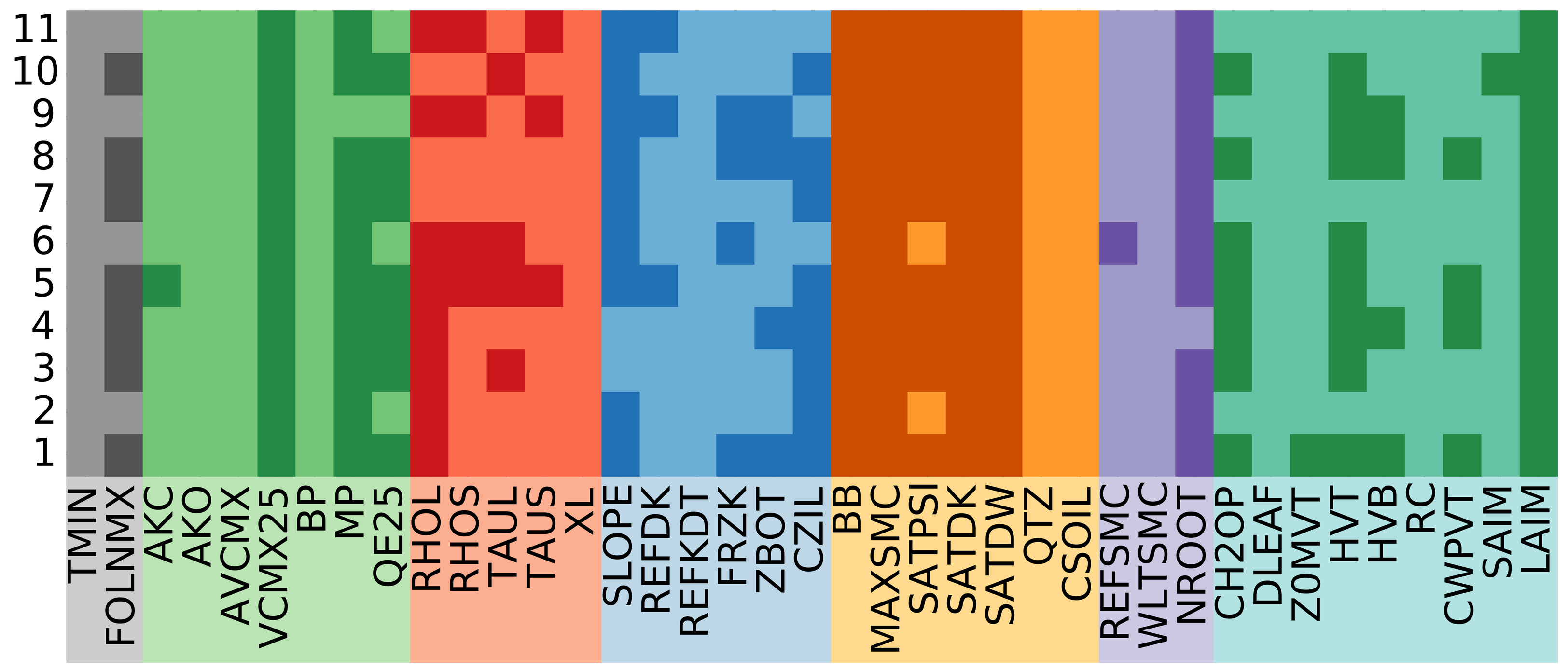

Fig. 6: Informative parameters (columns) for **Subsurface runoff** for 11 Mopex catchments (rows). Dark (light) cells mark informative (non-informative) parameters.

On average, **14** and **18** out of 39 parameters are informative for surface and subsurface runoff (Sec. 4b and 4c), respectively. For surface runoff, soil and runoff parameter are informative. For subsurface runoff, informative parameters are more similar to those of latent heat and include photosynthesis and vegetation structure parameters. This indicates that both of these two model outputs (subsurface runoff and latent heat) are very dependent on the modeled soil water content.

5. Conclusions

Less than half of the parameters are informative on average. The informative parameters are depending strongly on the model output considered and less on single catchment characteristics. This might be related to the fact that some processes can not be adapted to local conditions (e.g. snow parameters are hard coded in NOAH-MP). Ongoing work should also include these hidden parameters, which are expected to have a substantial impact on model outputs [3].

References

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