Diagnostic tools to understand hydrological processes in the SWAT model

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Processes in models and catchments

- Hydrological processes are controlled in the SWAT model with different parameters.
- These parameters are adapted to the conditions in the study catchment.
- To obtain realistic process representations, diagnostic model analyses are helpful to investigate the parameter and process dynamic.

3 diagnostic tools for process understanding in SWAT
Study sites: Treene and Saale

Modified from Guse et al. (in prep. for HP)
SWAT – selected processes and parameters

Flowchart modified from Guse et al. (2014, HP)
Diagnostic model tools

Hydrological processes are aimed to be reproduced accurately.
Diagnostic model tools

Hydrological processes

Model parameters

are represented in SWAT by
Diagnostic model tools

Hydrological processes are represented in SWAT by model parameters, which are optimised with performance measures.
Hydrological consistency

Hydrological processes

Parameters should be set to represent the hydrological processes

Performance measures should be used to represent processes

Model parameters

Parameter identification

Process identification

Performance measures
Diagnostic model tools

Hydrological processes

1. Model parameters
2. Parameter identification
3. Process identification

Parameters should be set to represent the hydrological processes.

Performance measures should be used to represent processes.
Sequence of diagnostics

• Step 1: Temporal sensitivity analyses of parameters

• Step 2: Calibration for all flow conditions using FDC
  Select model runs that behave well in all segments of the FDC

• Step 3: Monthly pattern of parameter dominances for the different discharge magnitudes
1. Temporal parameter sensitivity analysis

Method:
- Parameter sensitivity analysis for each day
- Temporal dynamic of parameter sensitivity analysis (TEDPAS)
- Global sensitivity analysis based on factor prioritization using the FAST algorithm
- FAST captures the whole parameter space

Result:
- Shows in which phase of the year a parameter is dominant
- Daily hierarchy of dominant model parameters

Reusser et al. (2011, WRR), Guse et al. (2014, HP)
Temporal parameter sensitivity analysis

- CN2 dominant only for short phases
- At least one groundwater parameter is always dominant
- High temporal variations between the groundwater parameters
Temporal parameter sensitivity analysis

Guse et al. (in prep. for HP)
Parameters should be set to represent the hydrological processes. Performance measures should be used to represent processes.

Hydrological processes

Parameter identification

Process identification

SWAT model parameters

Performance measures
model calibration for different flow conditions

Method:
• Stepwise intersection of good model runs for five segments of the flow duration curve (FDC)
• Evaluation with separate RSR for each segment

Result:
• Calibrated SWAT model reproduce all discharge magnitudes in a similar model performance
Smart model calibration

Pfannerstill et al. (2014b, JH)
Diagnostic model tools

Hydrological processes

3

Process identification

Parameter identification

Process identification

SWAT model parameters

Performance measures
Typical patterns of temporal parameter dynamic

Method:
• Monthly averaging of daily parameter sensitivities separately for the five FDC segments

Result:
• Monthly pattern of parameter dominances for the different discharge magnitudes
Typical patterns of temporal parameter dynamic

Guse et al. (in prep. for HP)
Typical patterns of temporal parameter dynamic

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Saale

Guse et al. (in prep. for HP)
Diagnostic model tools

Hydrological processes

SWAT model parameters

Parameter identification

Performance measures
Summarising process control
Concluding remarks

• Combination of temporal dynamic of dominant model parameters and corresponding processes with different discharge conditions leads to a typical pattern of the hydrological behaviour in the two study catchments

• The three diagnostic tools lead to a better understanding of the process representation in the SWAT model

References:


Contact: Björn Guse (bguse@hydrology.uni-kiel.de)  
Matthias Pfannerstill (mpfannerstill@hydrology.uni-kiel.de)
Modified SWAT-Version with two active shallow aquifers and one inactive deep aquifer

- Pfannerstill et al. (2014, HP)