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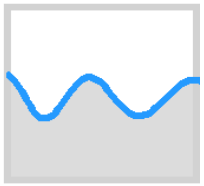

Using expert knowledge of the hydrological system to constrain multi-objective calibration of SWAT models

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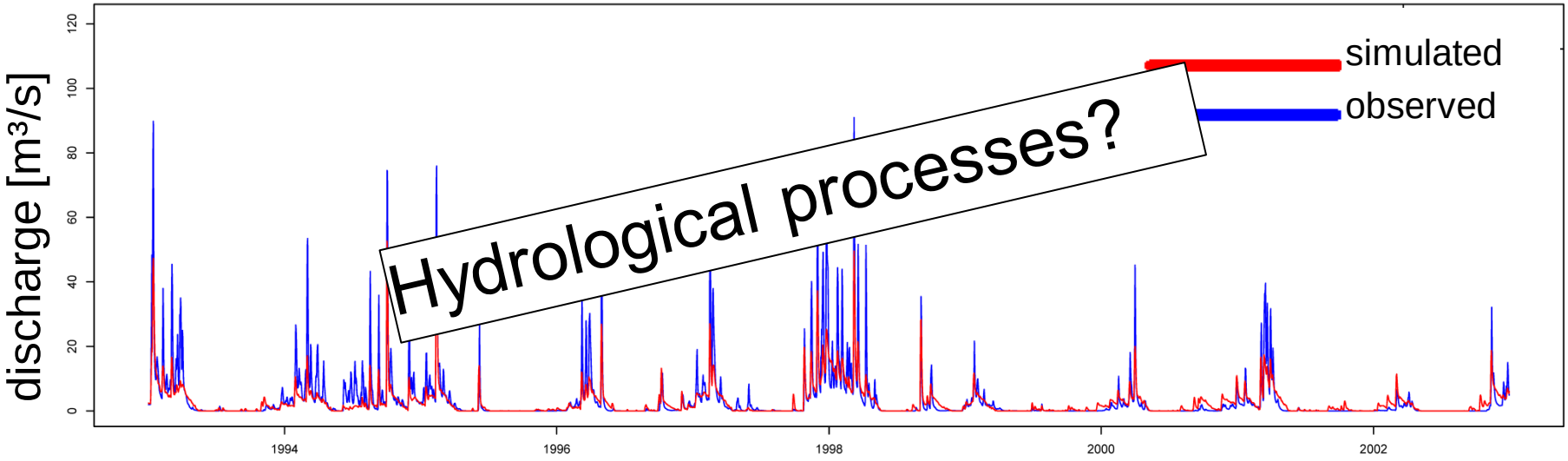
Motivation

Simulation of hydrological processes to predict discharge at the outlet of study catchment



Reliability of discharge simulation: Good model results for right reasons?

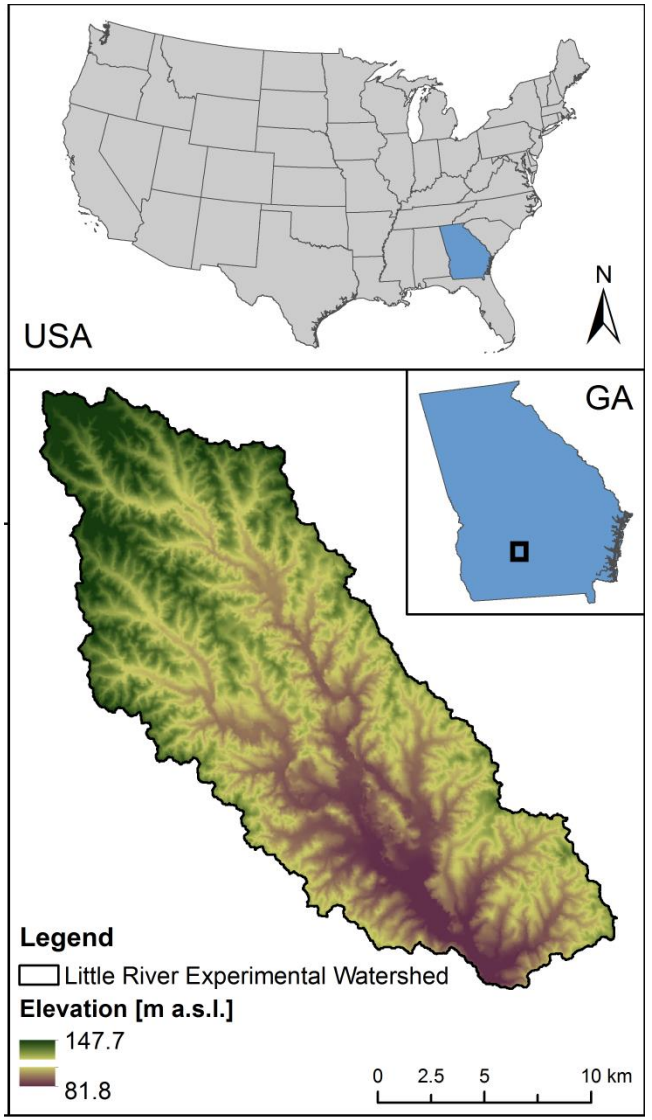
Research questions

1. How can we make sure that a reasonable simulation of hydrological processes is considered during calibration?

2. Can we use soft data to select model runs that provide good simulations of streamflow and hydrological processes in the watershed?

Little River Experimental Watershed

- Coastal Plain near Tifton, GA
- Watershed area: 334 km^2
- Average annual precipitation: 1208 mm
- Average temperature: 18.7 °C
- Average streamflow: 2.95 m^3/s



Model calibration

Parameter sampling with FAST-method (Reusser et al., 2011):

- efficient sampling of parameter space
- 403 model runs

Discharge evaluation:

- NSE
- PBIAS

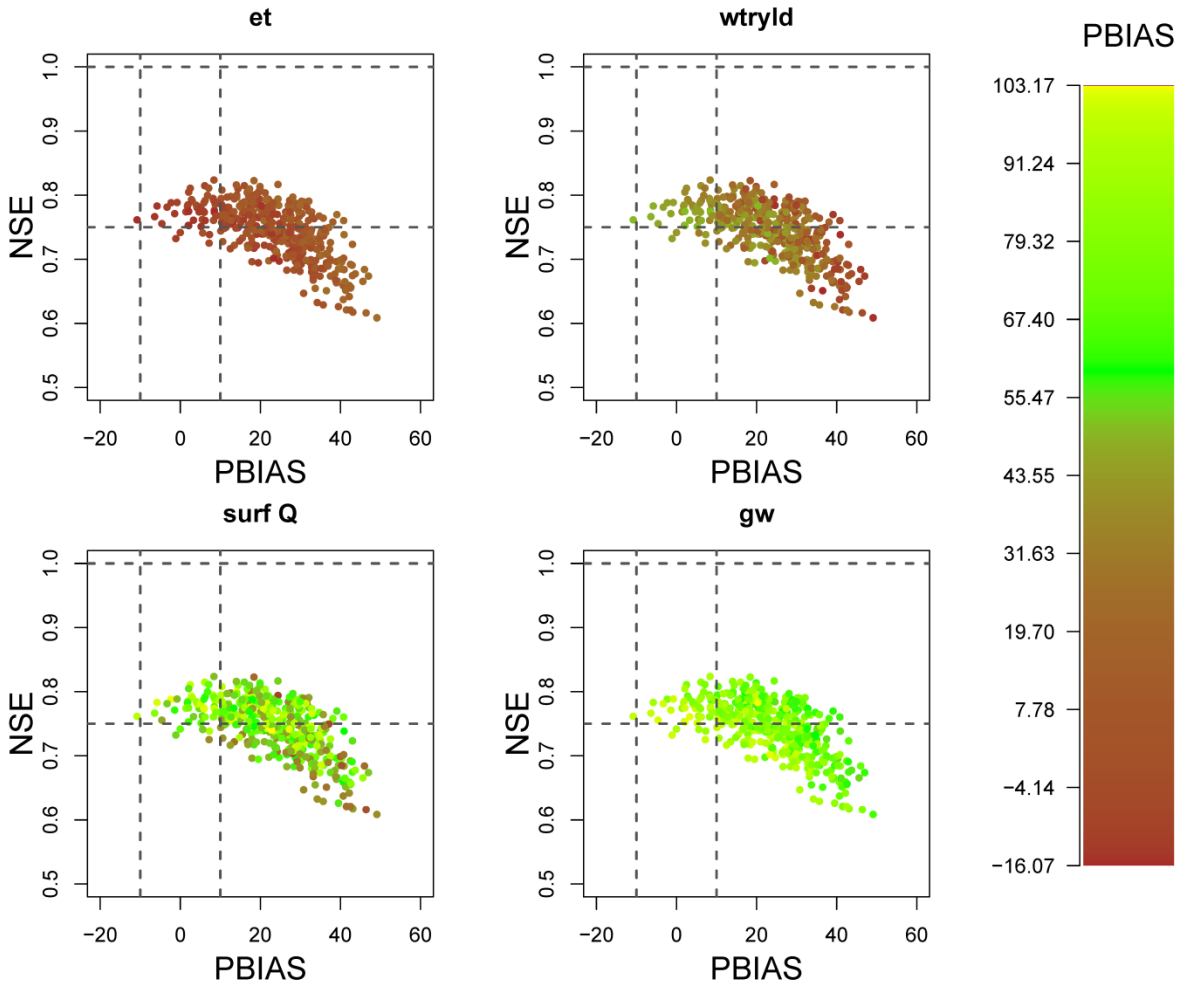
Evaluation of water balance components:

- PBIAS

Water balance component	Amount [mm]
Evapotranspiration	***840***
Surface runoff	***57.5***
Groundwater flow	***148***
Water yield	***310***

Results: Water balance components

- Satisfactory PBIAS of average annual ET within window of good NSE and PBIAS for streamflow
- PBIAS indicates underestimation of average annual water yield
- PBIAS indicates strong underestimation of average annual surface runoff and groundwater flow



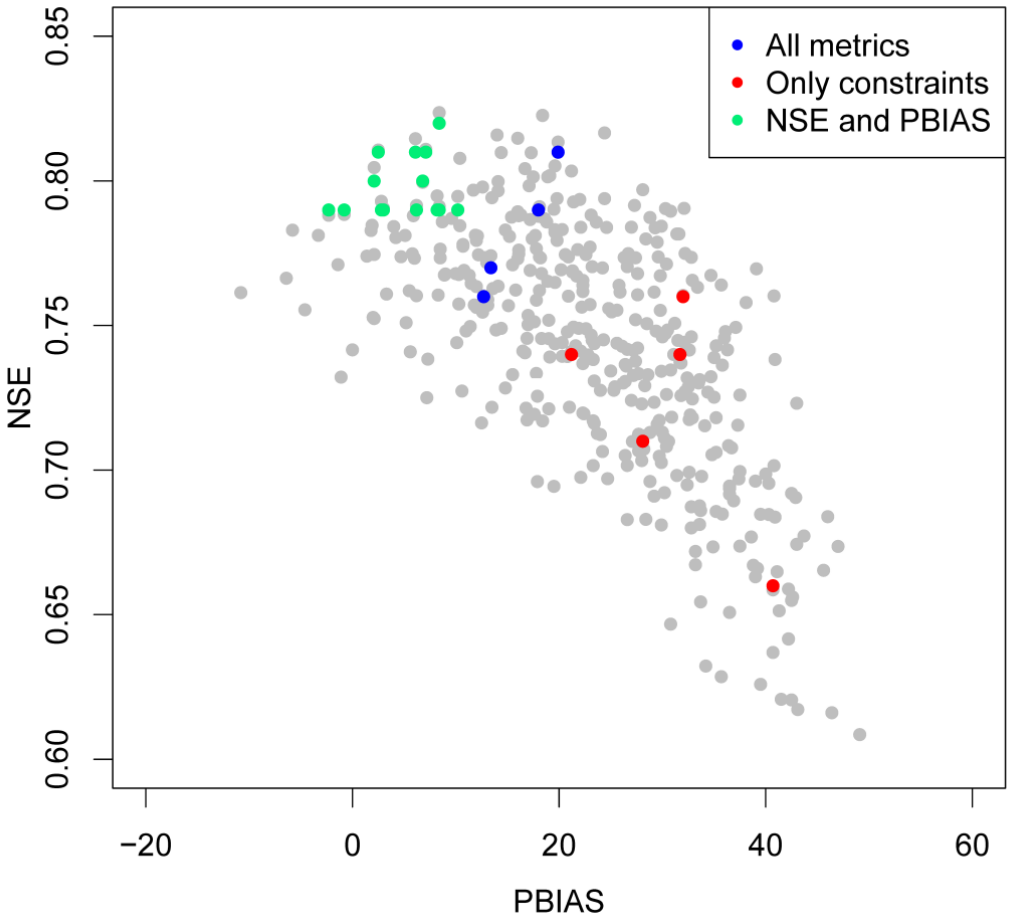
Results: Best model runs

- **PBIAS:** best values in combination with medium high NSE values
- **NSE:** highest NSE with positive PBIAS
- **ET:** high variability of NSE values, high positive PBIAS values
- **Water yield:** medium variability of NSE values, relatively high positive PBIAS values
- **Surface runoff:** high variability of NSE values, positive PBIAS values
- **Groundwater:** high variability of NSE values, positive PBIAS values

1. Each performance criterion leads to the selection of different model runs
2. Optimizing water balance components comes at the expense of NSE and PBIAS for streamflow

Results: Combination of constraints

- Considering only the NSE and PBIAS for streamflow leads to the selection of high NSE and low PBIAS values, but the highest NSE values do not coincide with the lowest PBIAS values
- The lowest PBIAS values for the water balance components occur over a wide range of NSE and PBIAS
- Satisfying all criteria is possible even if at the expense of optimal NSE and PBIAS values for streamflow



Summary

- The evaluation of streamflow not sufficient to ensure a realistic simulation of water balance components
- Average annual values can be used as additional constraints during calibration
- Evaluating both streamflow and constraints leads to most plausible results

Thank you!

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