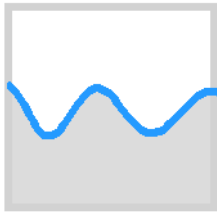2014 International SWAT Conference
30.07. - 01.08. 2014

INR

Improving the groundwater process representation by using SWAT$_{3S}$ and a multi-metric based model evaluation

Aprimorando a representação dos processos de água subterrânea utilizando SWAT$_{3S}$ e uma avaliação de Modelo baseada no Conceito Multimétrico

M. Pfannerstill, B. Guse and N. Fohrer
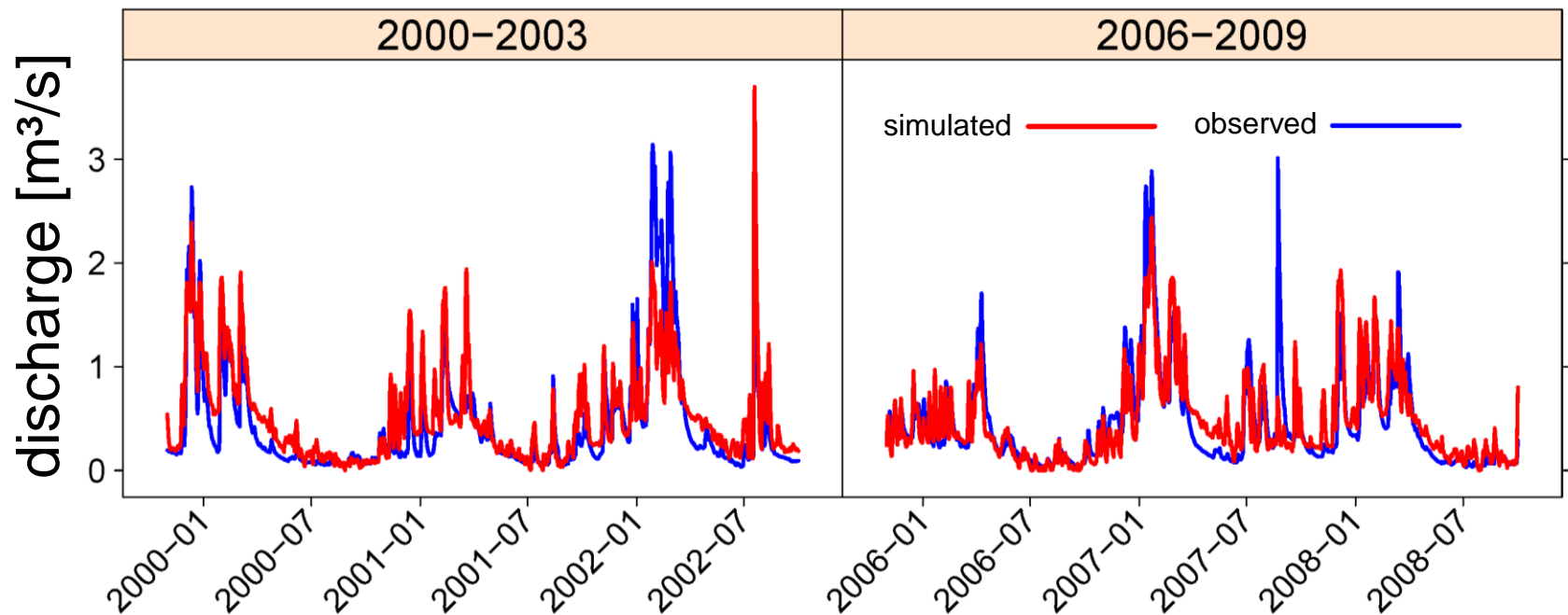
Motivation
Motivação

SWAT model evaluation example:

- Discharge dynamics well represented (NSE 0.62)

- Poor model performance in recession and low flow phases
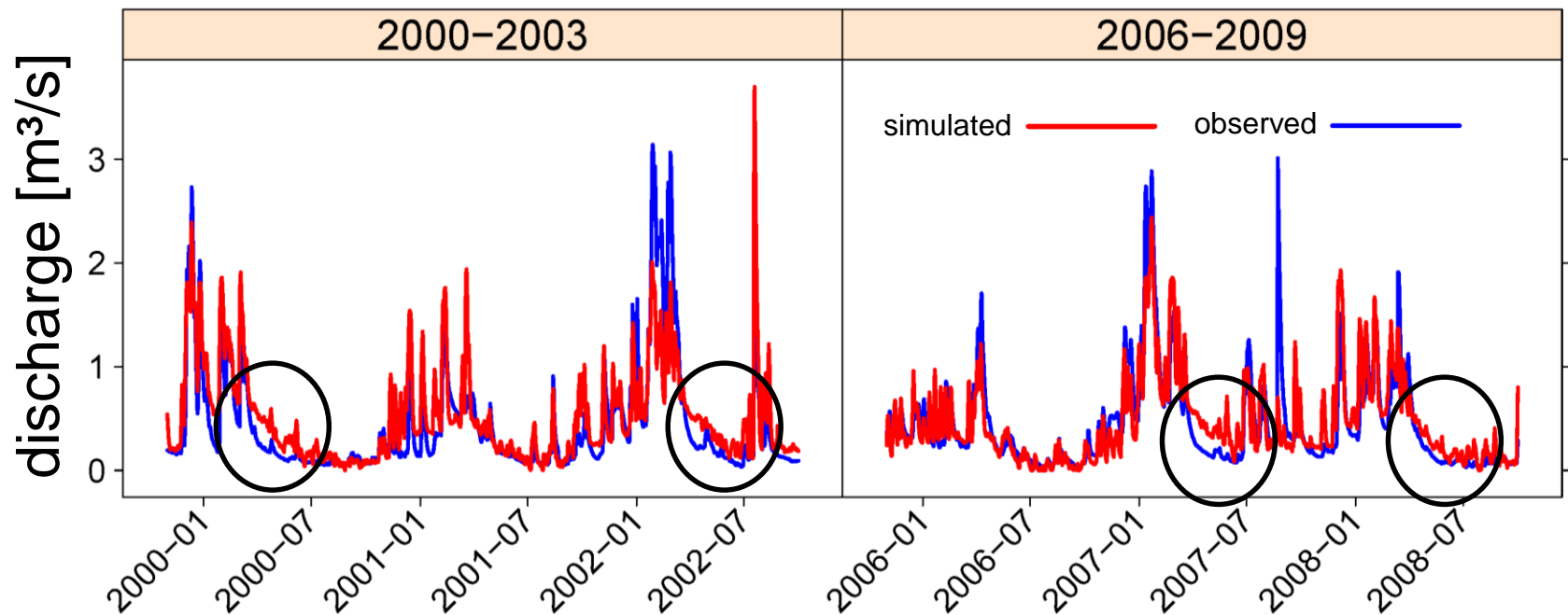
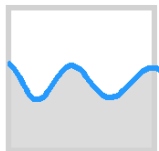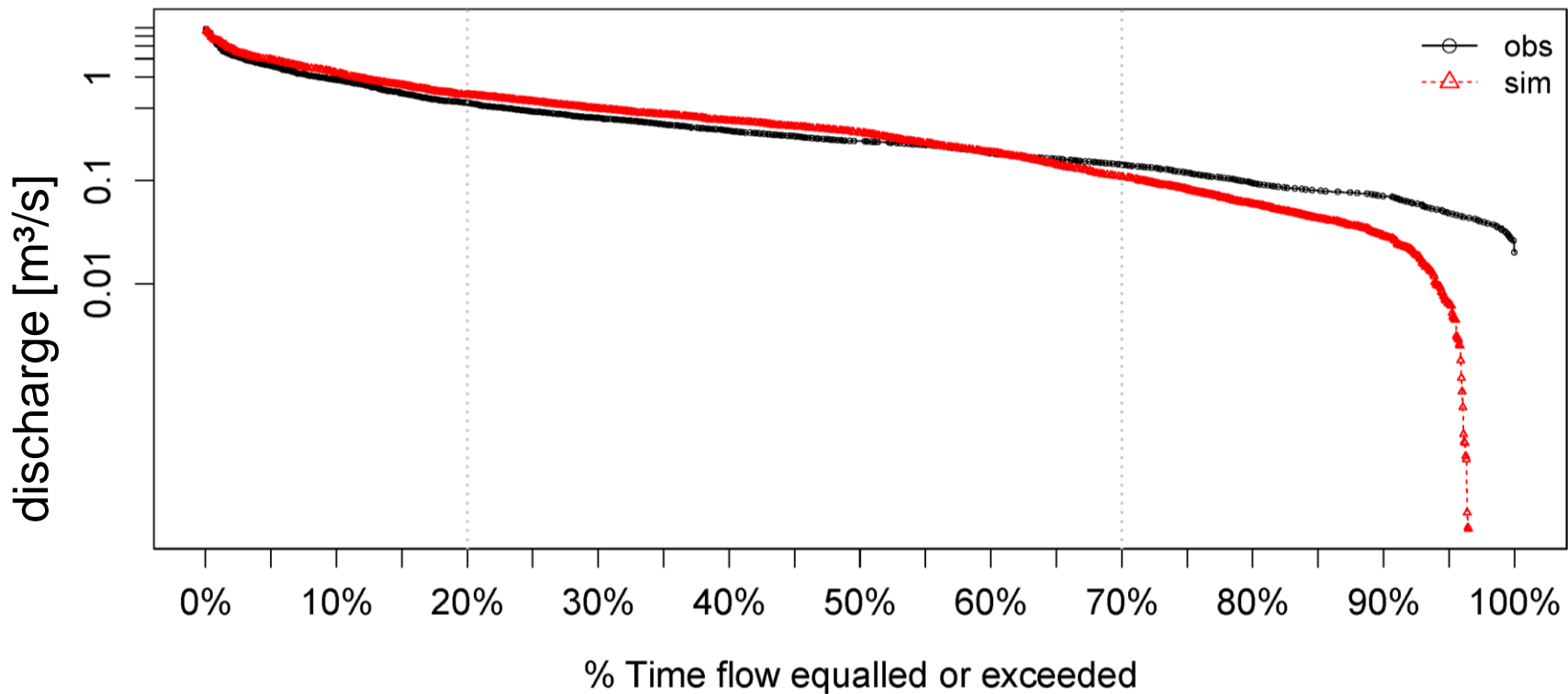# Motivation
Motivação

SWAT model evaluation example:

- Discharge dynamics well represented (NSE 0.62)

- Poor model performance in recession and low flow phases

Discharge magnitudes
Magnitudes da vazão

Flow duration curve (FDC): detection of underestimation in low flow segment

Possible improvements?
Possíveis aperfeiçoamentos?

Improvement of overall discharge reproduction?

- Application of flexible, nonlinear groundwater routine of SWAT$_{3S}$

→ Improved reproduction of recession and low flow phases

- Evaluation of model performance with multi-metric based framework

→ Improved identification of model performance for recession and low flow phases
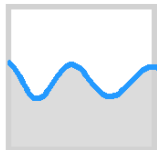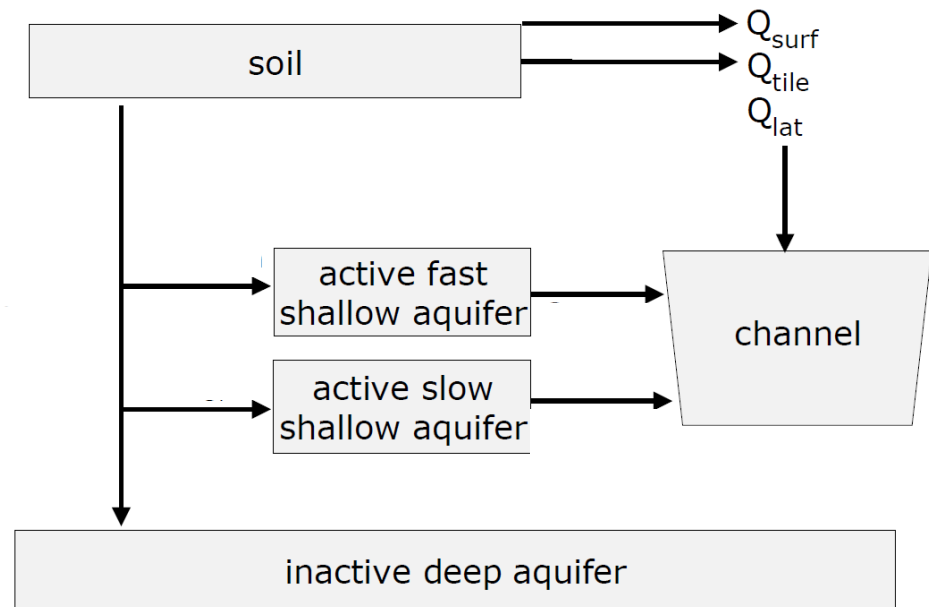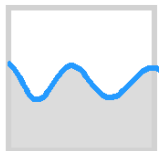
Idea of SWAT$_{3S}$
Ideia do SWAT$_{3S}$

Flexible, strongly nonlinear groundwater module of SWAT$_{3S}$

- Fast shallow aquifer for fast groundwater response (recession)

- Slow shallow aquifer for slow groundwater response (base flow)
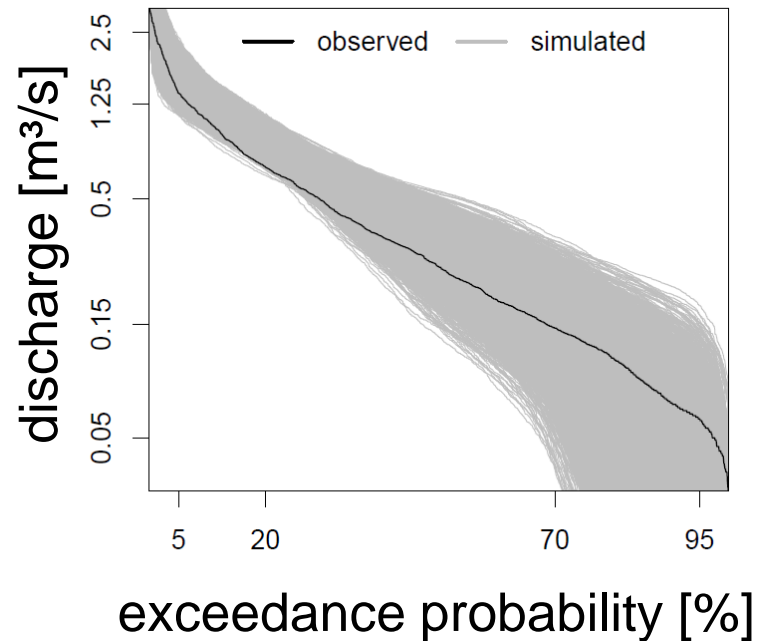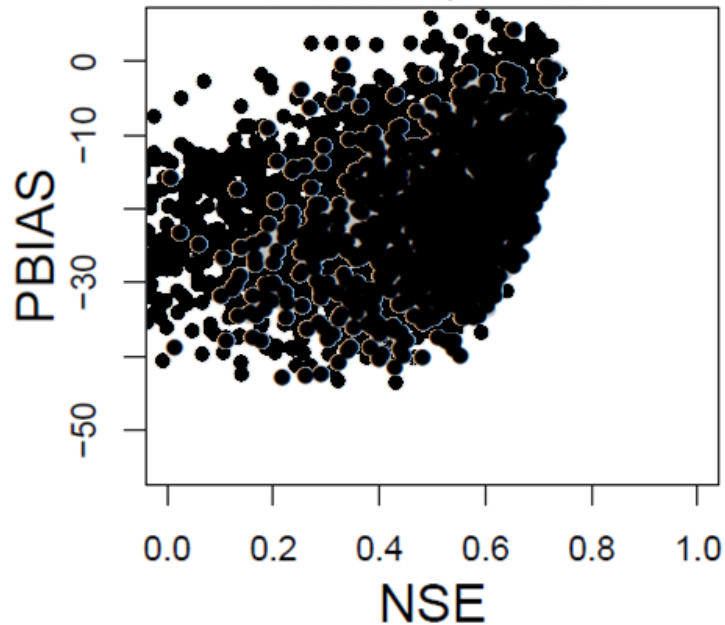
- Deep aquifer for deep percolation
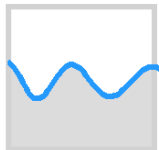

(Pfannerstill et al., 2013)

Calibration
Calibragem

Calibration data set with 5000 model runs:

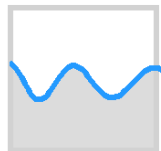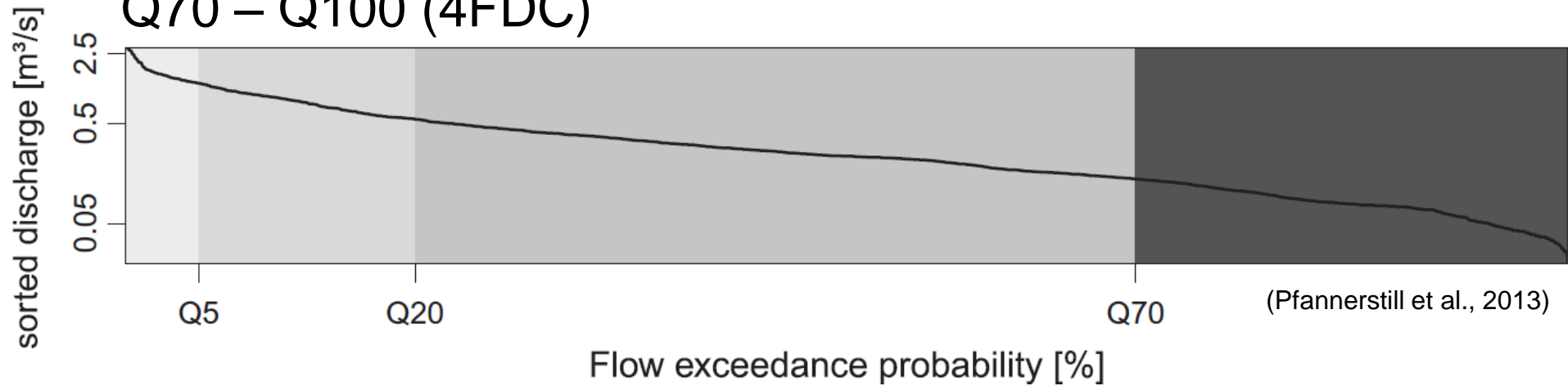→ How to find model runs with satisfying overall model performance?

Flow duration curve segmentation
Segmentação da curva de permanência

Traditional FDC segmentation covers wide low flow from Q70 – Q100 (4FDC)

(Pfannerstill et al., 2013)

Flow duration curve segmentation
Segmentação da curva de permanência

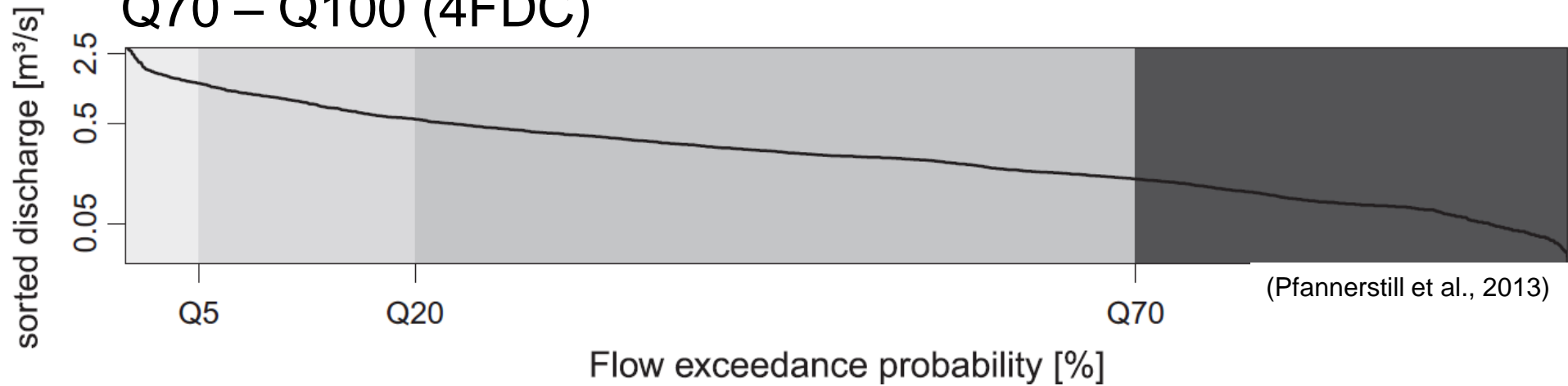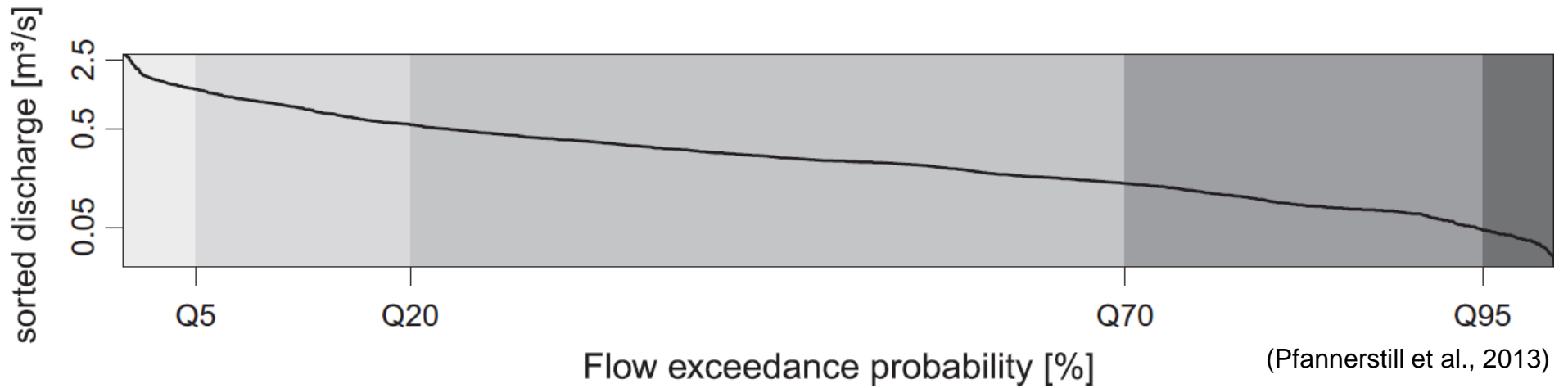Traditional FDC segmentation covers wide low flow from Q70 – Q100 (4FDC)

(Pfannerstill et al., 2013)

Refinement of FDC for the low flow segment: Q95 (5FDC)
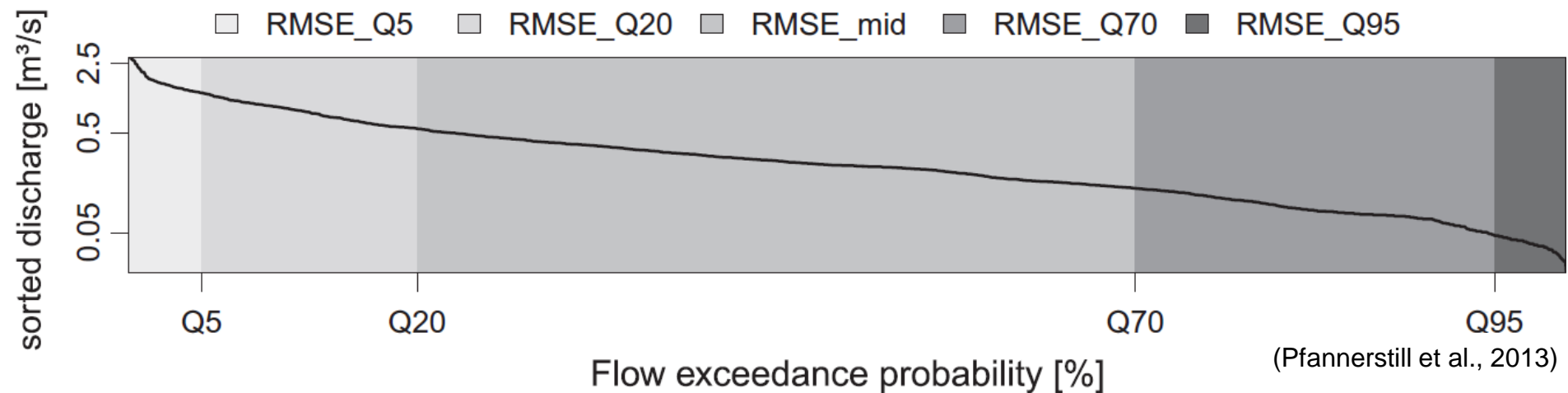

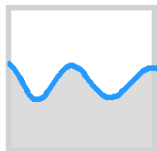(Pfannerstill et al., 2013)

Multi-metric framework evaluation
Conceito de Avaliação Multimétrica

Combining peak and dynamics with volume control:

- NSE → peak and timing

- RMSE of 5 FDC segments → volume of 5 different hydrograph phases
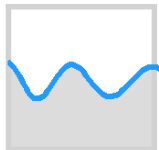

(Pfannerstill et al., 2013)

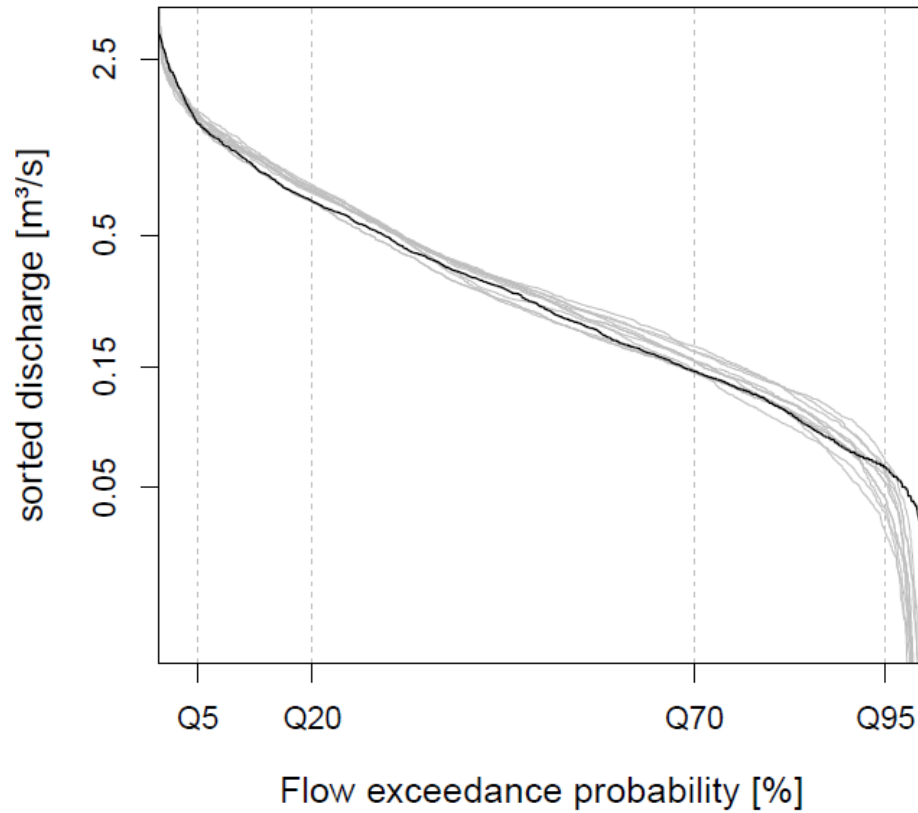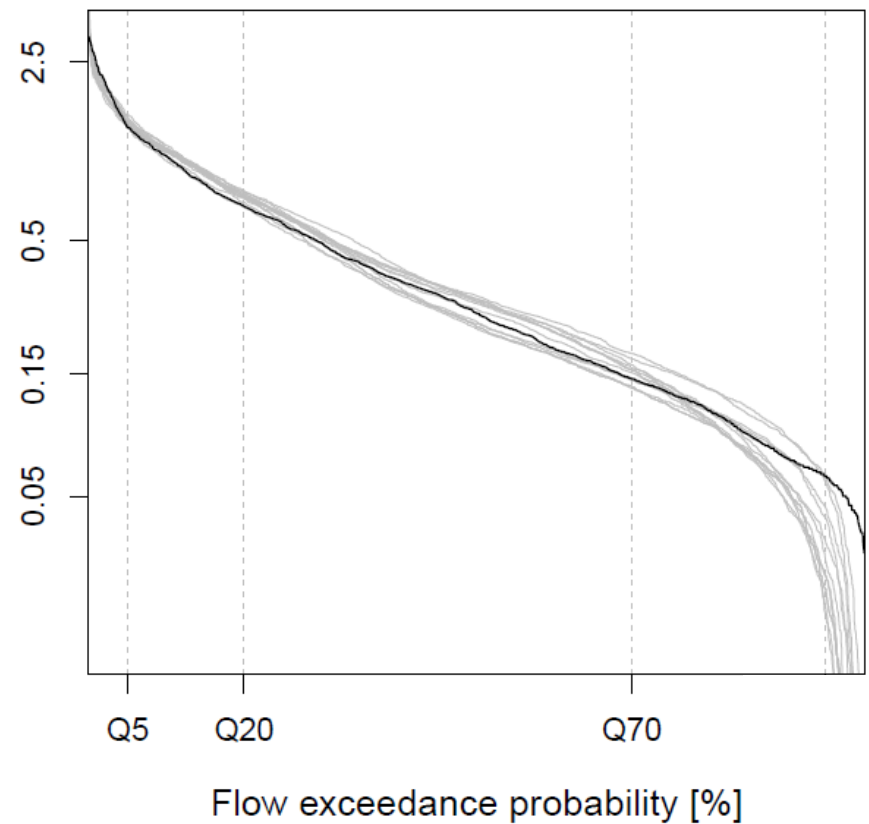What are the differences to traditional 4 part FDC segmentation?

RESULTS

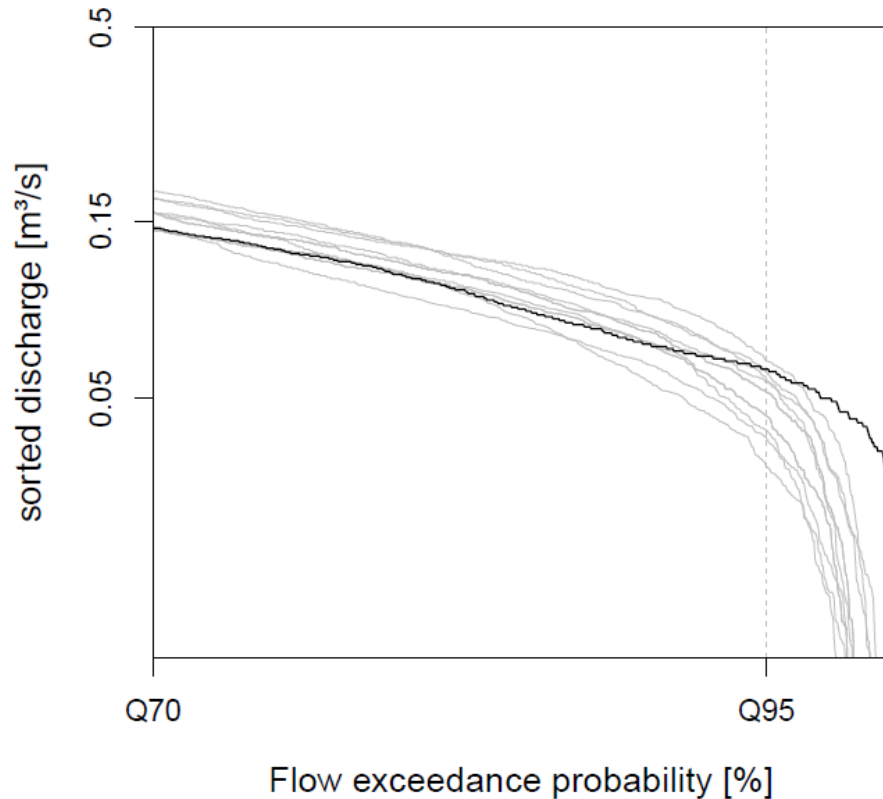# RESULTADOS

Overall FDC
FDC Total

5 FDC segmentation

4 FDC segmentation
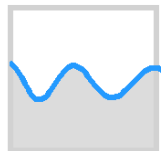
Low flow part FDC
Segmento de baixa vazão da FDC

5 FDC segmentation
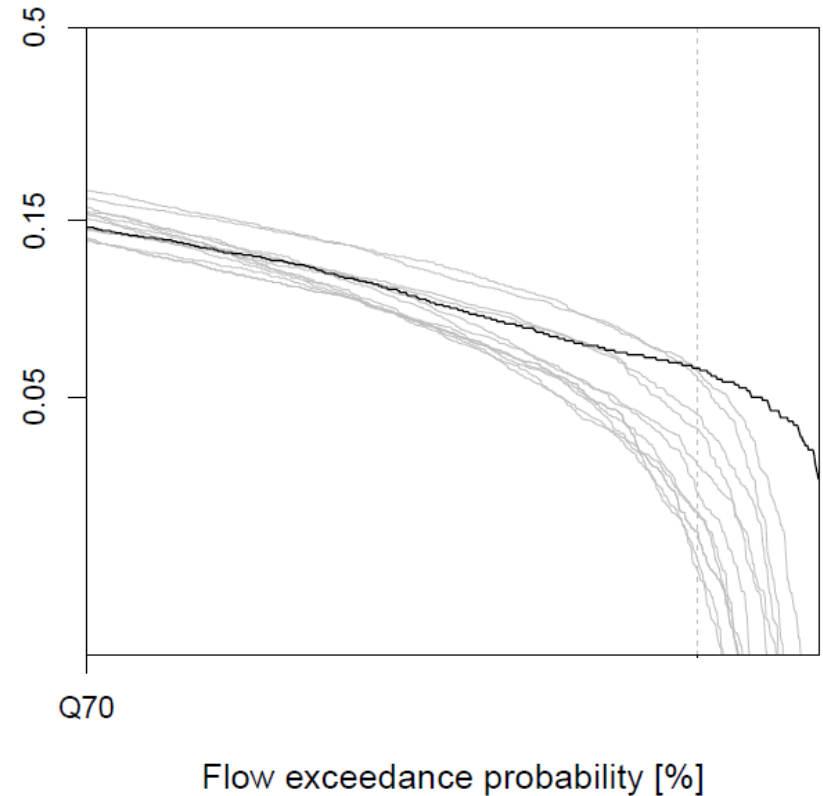
4 FDC segmentation

Hydrograph
Hidrograma

Validation of best model run for 5 FDC segmentation:

Improved reproduction of recession and low flow
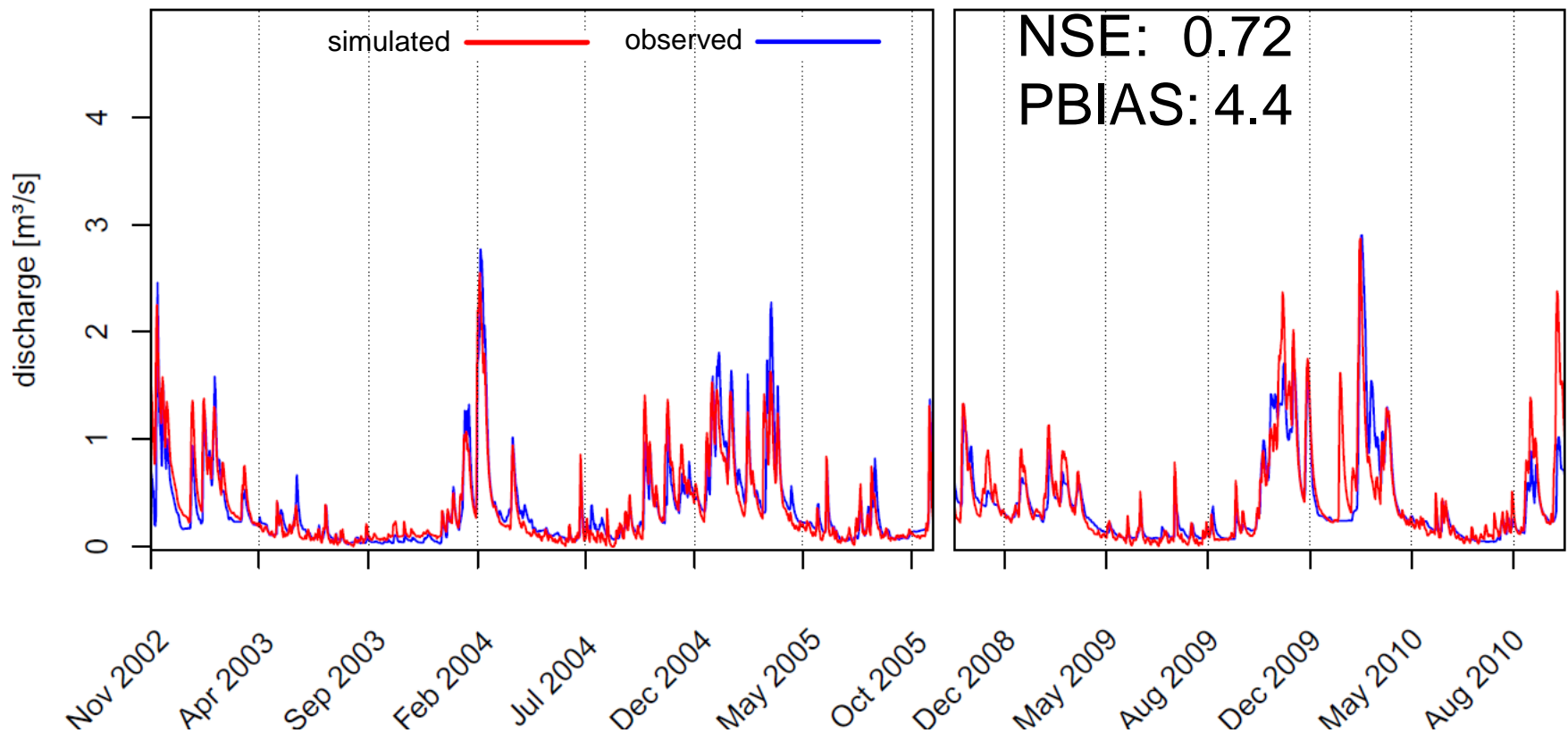
Discharge components
Componentes da vazão

contribution to stream [mm]

Jan Apr Jul Oct Jan

■ Q_{surf} ■ Q_{lat} ■ Q_{tile}
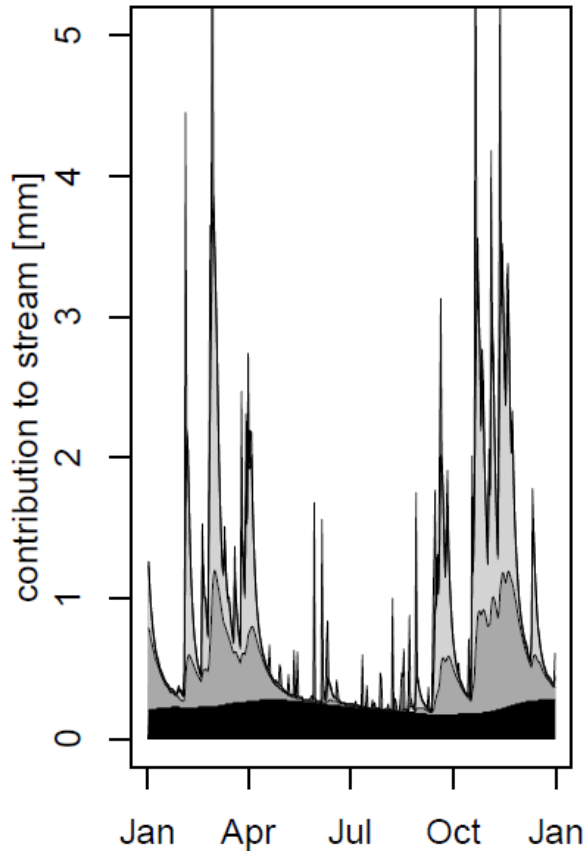
■ $Q_{gw,fsh}$ ■ $Q_{gw,ssh}$

Plausible contribution to discharge:

- Fast reacting shallow aquifer highly dynamic, controls recession ($Q_{gw,fsh}$ ■)

- Slow reacting shallow aquifer with low amplitude, controls baseflow ($Q_{gw,ssh}$ ■)
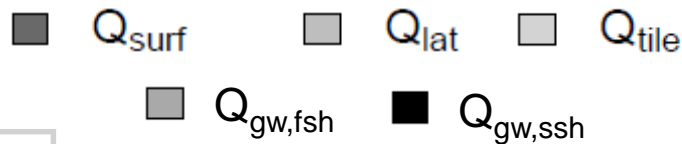
Summary
Resumo

- SWAT$_{3S}$ is favourable to reproduce strong non-linear groundwater dynamics by two active shallow aquifers and one deep aquifer for deep percolation

- Multi-metric framework evaluation with NSE and 5 FDC segments leads to selection of model runs with satisfying overall model performance

- Q95 - Q100 segment is appropiate to detect poor model performance in the low flow segment

Conclusion
Conclusão

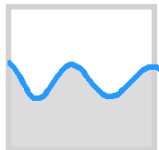- SWAT$_{3S}$ leads to improved reproduction of the recession and low flow phases

- Reliability of model performance is improved with very low flow metrics within evaluation process

- Coarse segmentation of the FDC is insufficient to detect poor model performance in the very low flow phase

- Performance metrics for very low flows are recommendable to analyze the model behaviour in all phases of the hydrograph
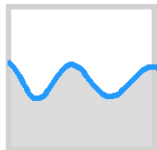
Conclusion
Conclusão

- SWAT$_{3S}$ leads to improved reproduction of the recession and low flow phases

- Reliability of model performance is improved with very low flow metrics within evaluation process

- Coarse segmentation of the FDC is insufficient to detect poor model performance in the very low flow phase

- Performance metrics for very low flows are recommendable to analyze the model behaviour in all phases of the hydrograph

Further information:

PFANNERSTILL, M., GUSE, B. & FOHRER, N. (2013): A multi-storage groundwater concept for the SWAT model to emphasize nonlinear groundwater dynamics in lowland catchments. Hydrological processes, in press.

PFANNERSTILL, M., GUSE, B. & FOHRER, N. (2014): Smart low flow signature metrics for an improved overall performance evaluation of hydrological models. Journal of Hydrology 510.: 447–458.

mpfannerstill@hydrology.uni-kiel.de