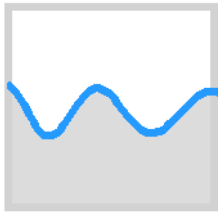
2013 International SWAT Conference - Toulouse, France
17. - 19.07. 2013



Groundwater as the dominant control process to model recession and baseflow phases in lowland catchments

M. Pfannerstill, B. Guse and
N. Fohrer

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Outline

- Groundwater processes in lowlands
- Representation of recession and low flow
- Groundwater module in SWAT
- Extension of the groundwater module
- Modelled discharge
- Conclusion
- Perspectives

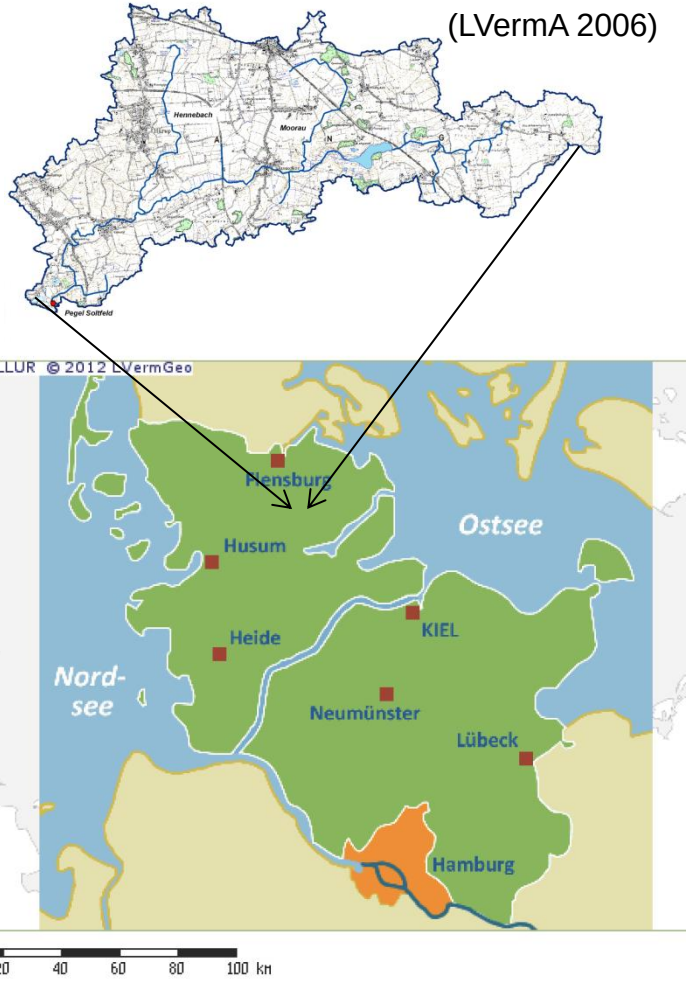
Groundwater processes in lowlands

- Shallow groundwater tables
- Strong interaction between groundwater and river
- Winter: high discharge
- Summer: distinct low flows
- Groundwater as the main contributor to discharge

SWAT application in lowlands

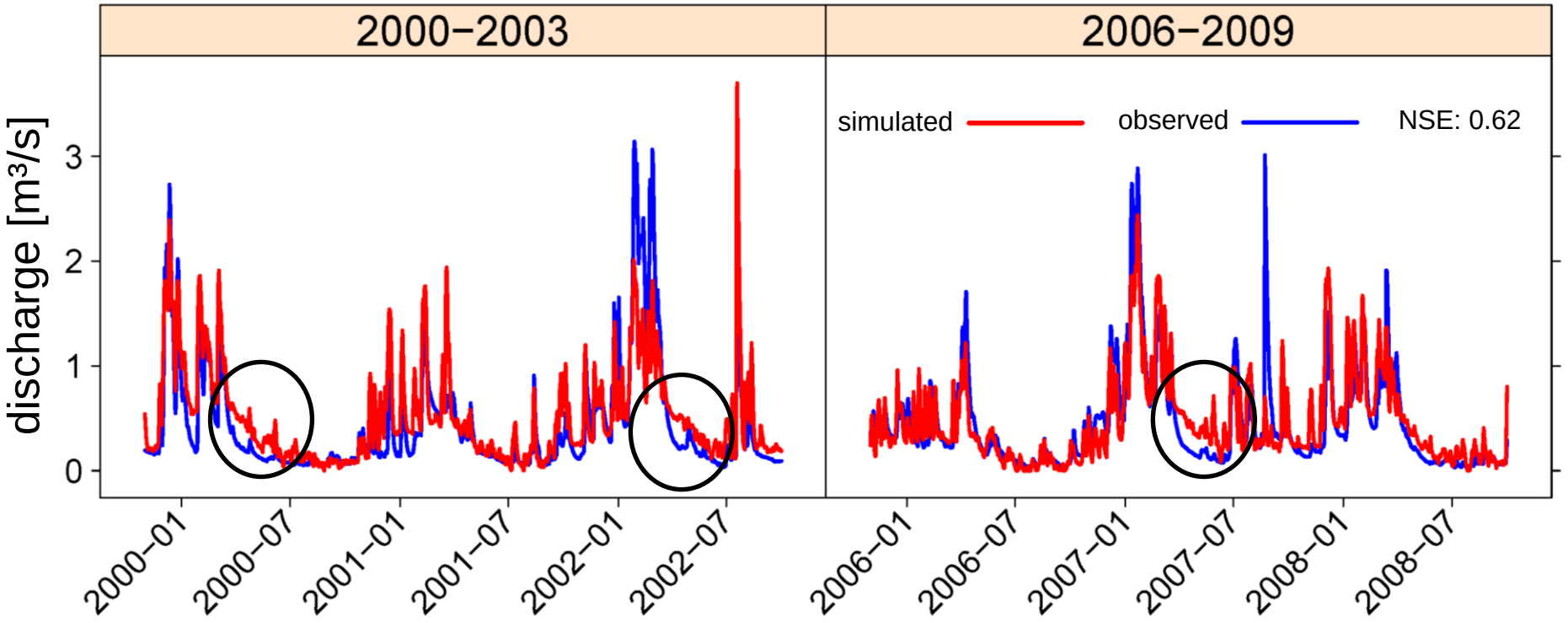
Kielstau catchment (UNESCO Ecohydrological Demonstration Site)

- 50 km²
- Shallow groundwater tables
- Flat topography
- Interaction between river and groundwater
- High fraction of agricultural land use



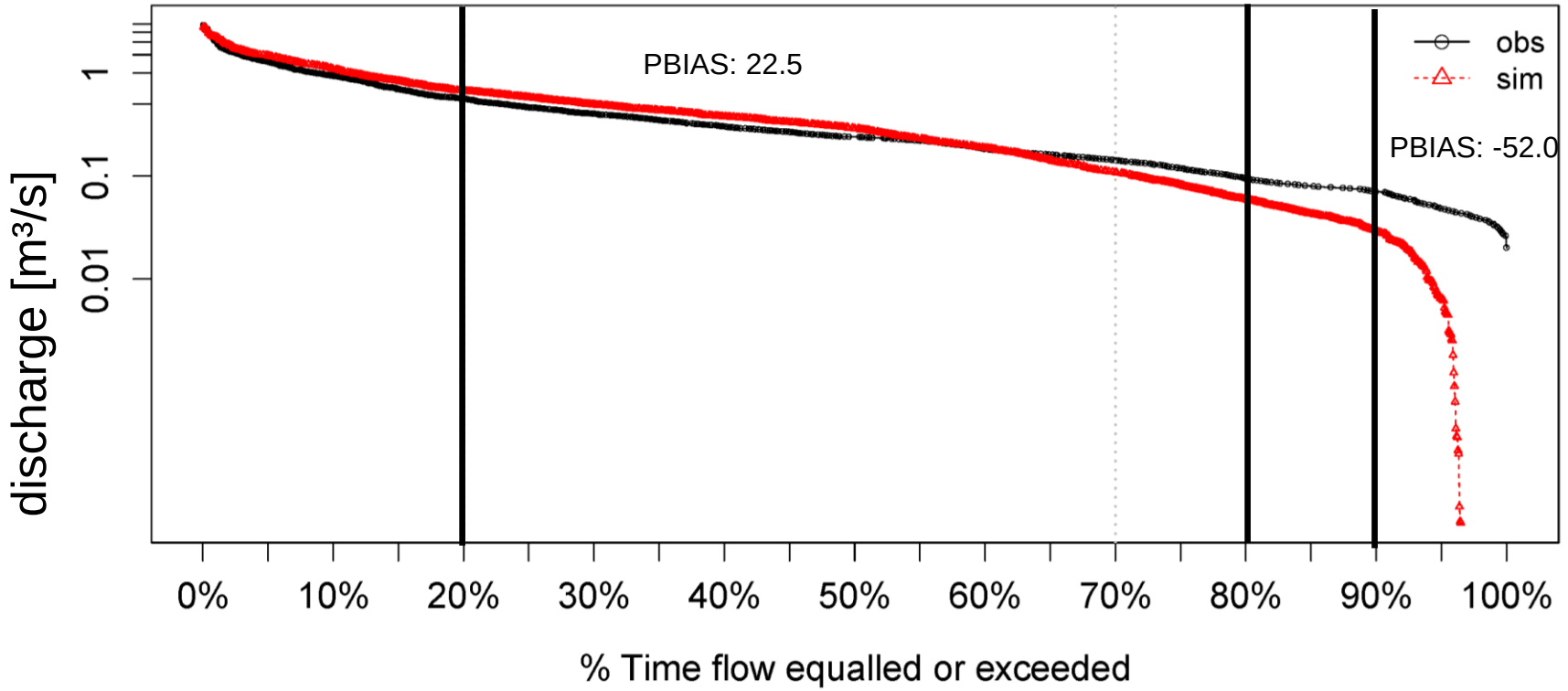
SWAT application in lowlands

Problems in simulating recession



SWAT application in lowlands

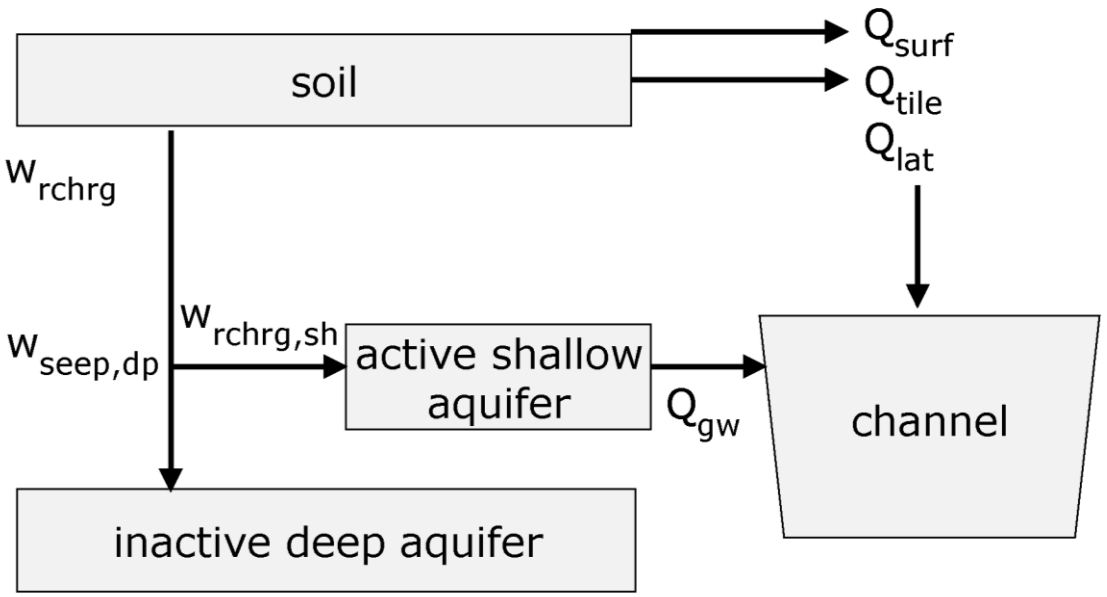
Flow duration curve: detection of underestimation in low flow segment



Groundwater module of SWAT

- One single active shallow aquifer to describe groundwater contribution to channel

- Inactive deep aquifer to describe groundwater not contributing to channel

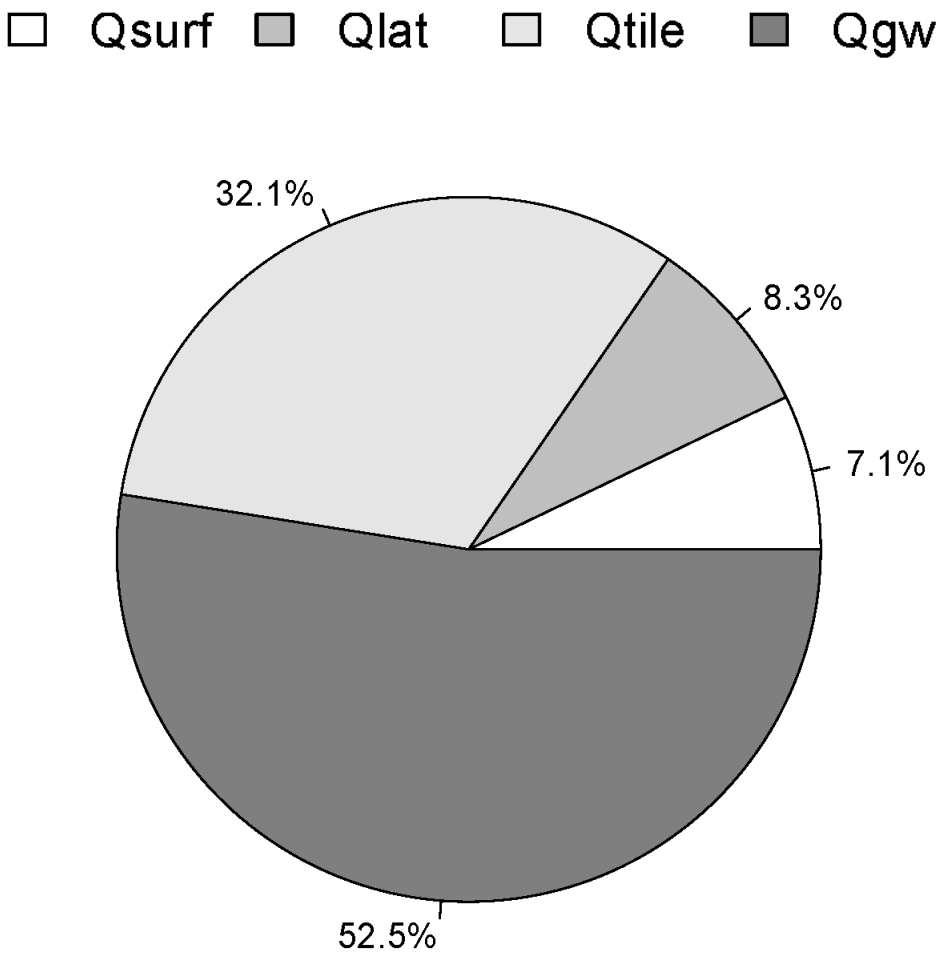


(Pfannerstill et al., under review)

Extension of the conceptual structure for the groundwater module

Extended groundwater module of $SWAT_{3S}$

- SWAT: groundwater main contributor to channel
- Improvement of low flow by groundwater driven baseflow



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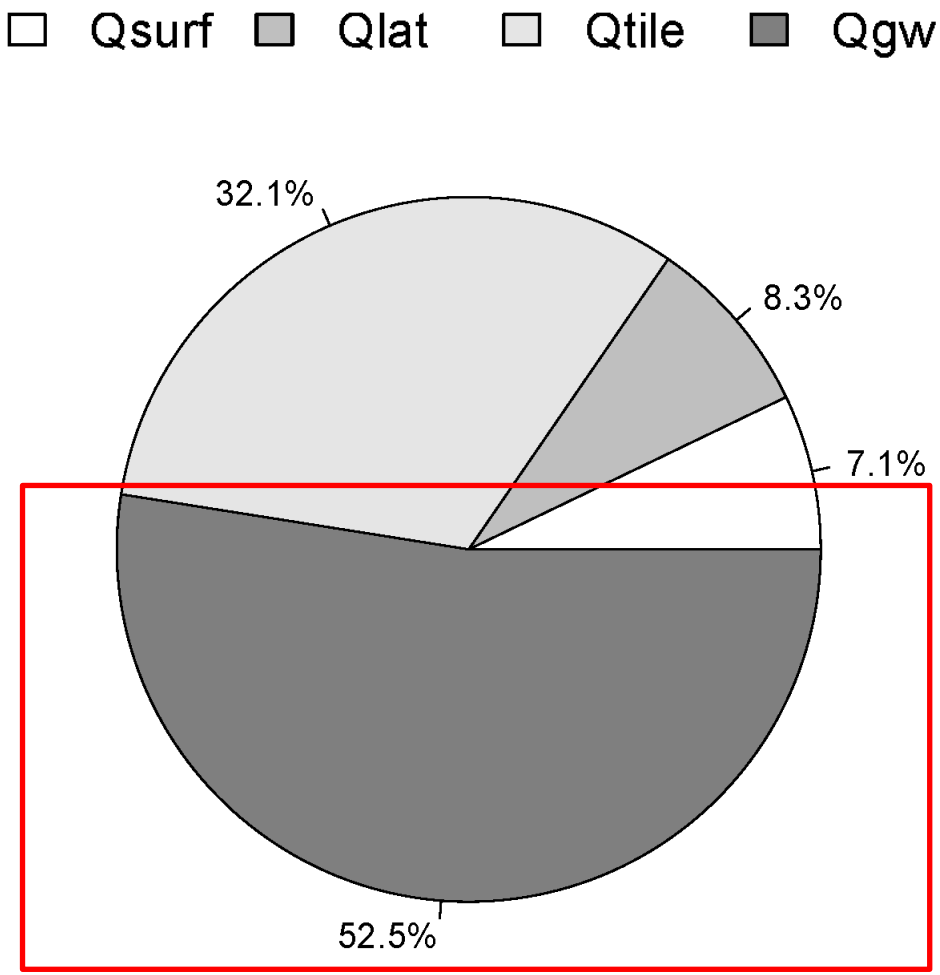


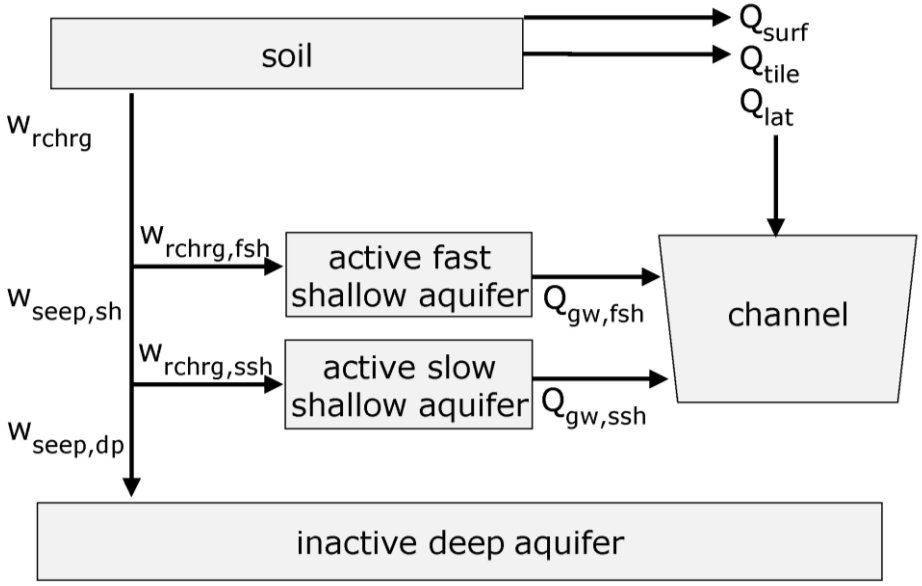
Extended groundwater module of $SWAT_{3S}$

- Groundwater processes are strongly nonlinear
- Emphasizing nonlinearity with multiple groundwater storages
- Splitting one single aquifer into a fast and a slow reacting aquifer

Groundwater module of SWAT$_{3S}$

- Two active shallow aquifers for a fast and a slow groundwater contribution to the channel

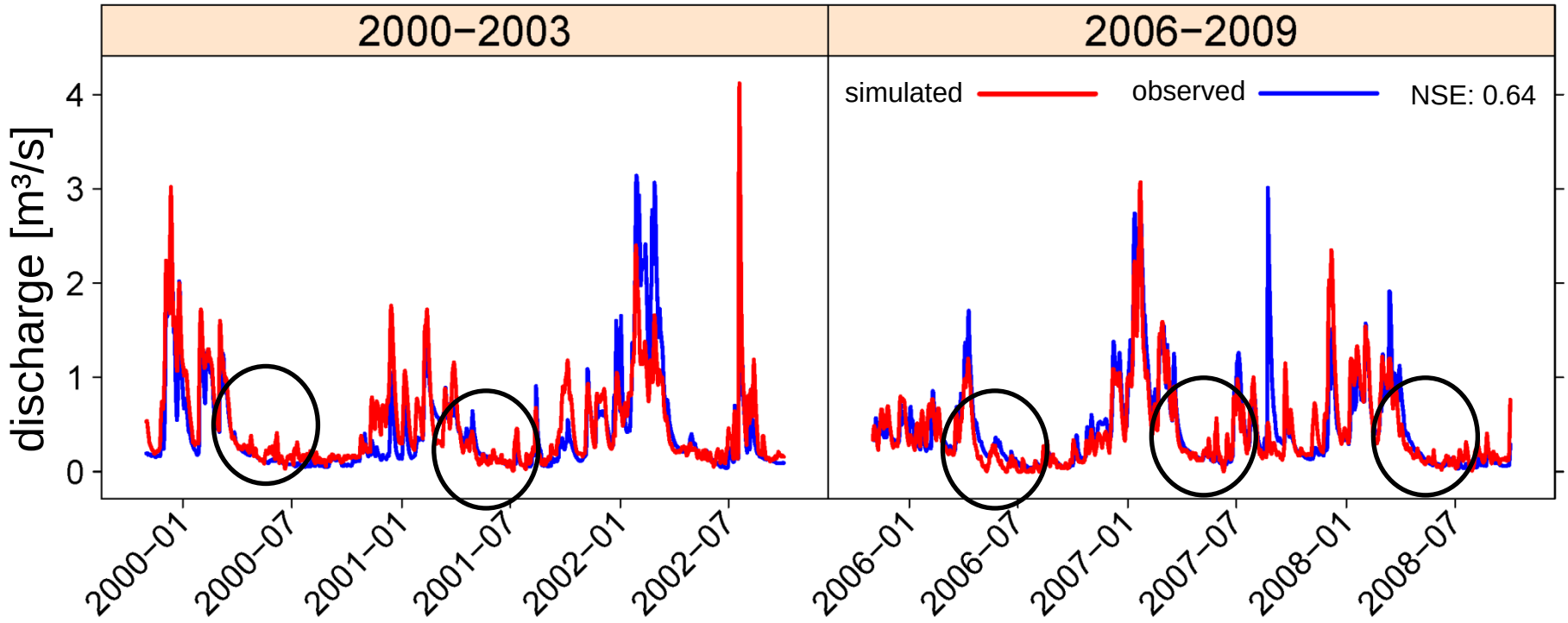
- Two recession constants for independent control of slow and fast shallow aquifer



(Pfannerstill et al., under review)

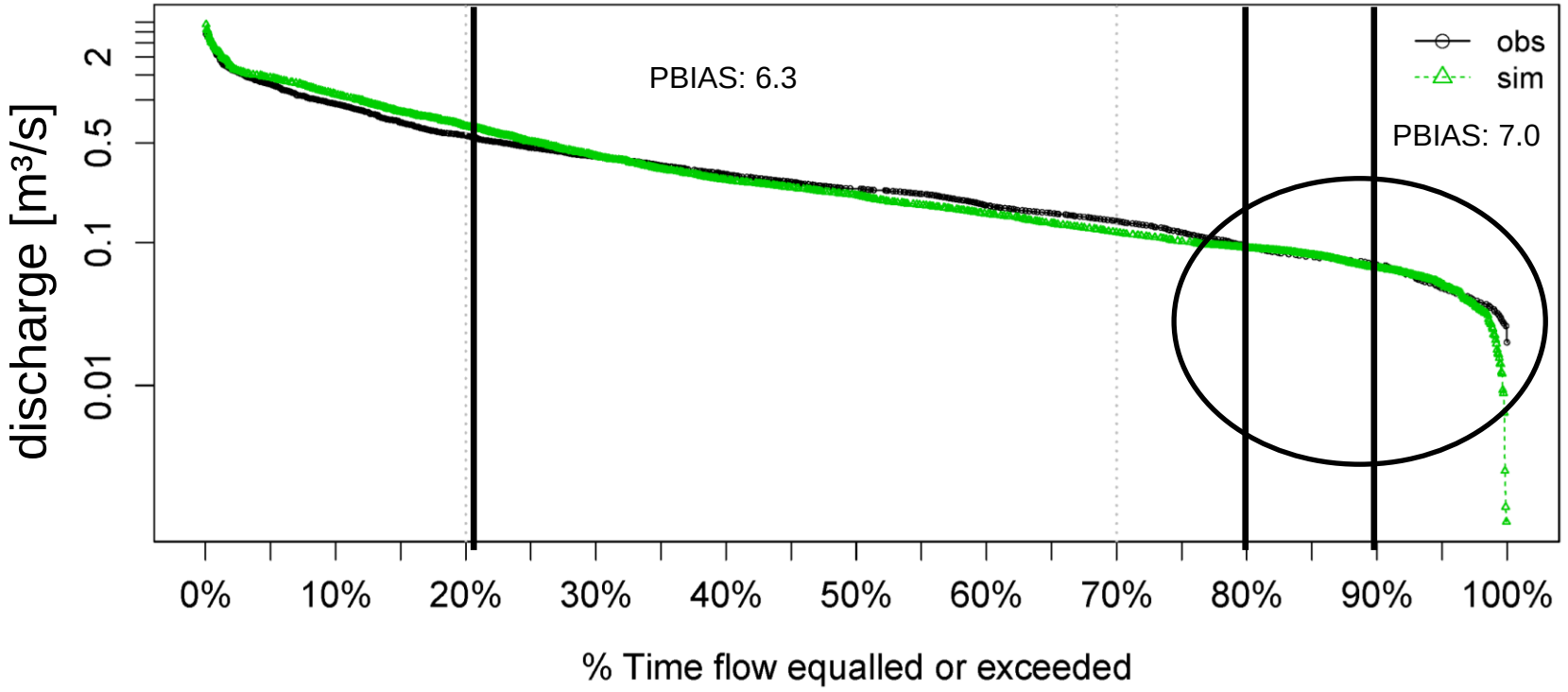
$SWAT_{3S}$ application

Improved simulation of recession and low flow



$SWAT_{3S}$ application

Flow duration curve: improved discharge reproduction in low flow segment

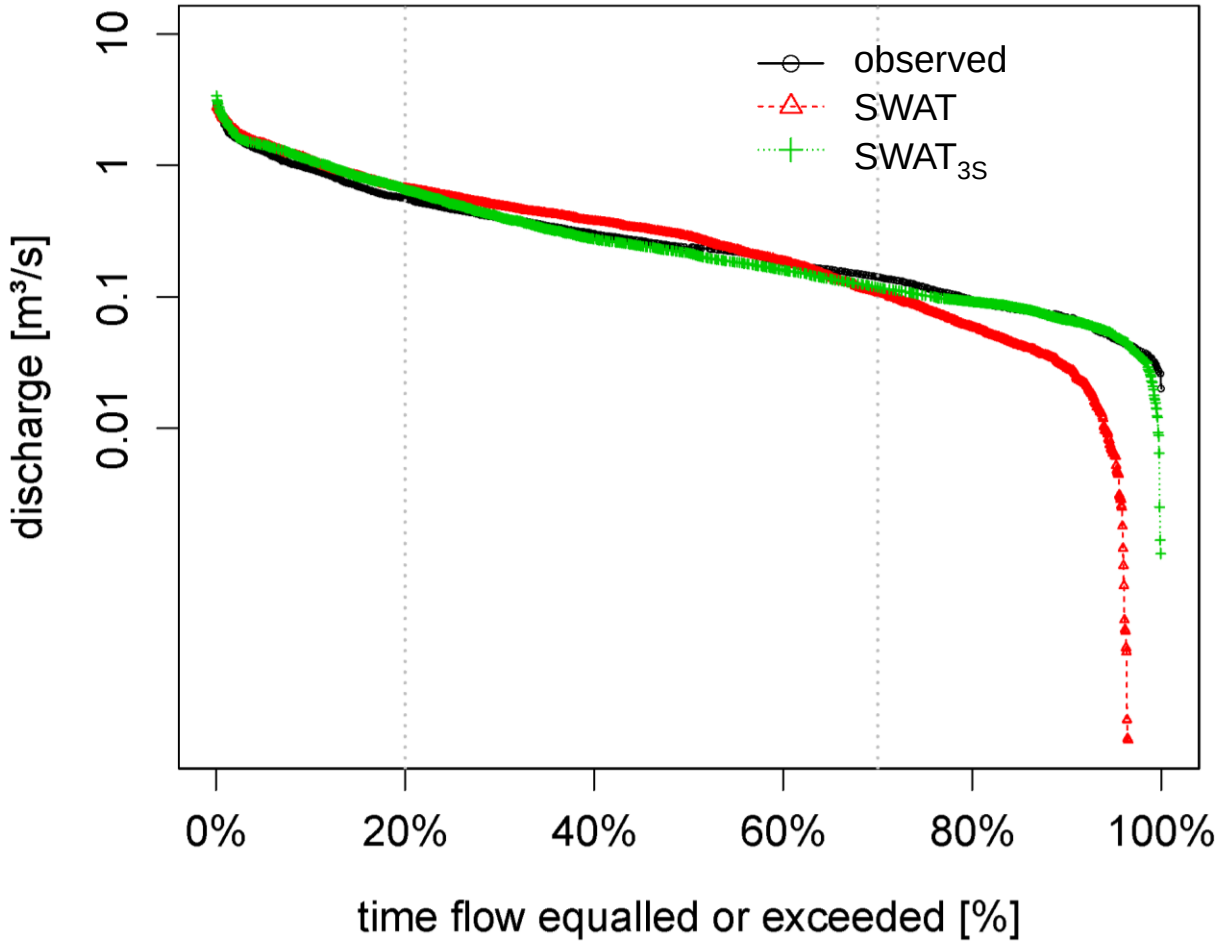


Comparison: SWAT and $SWAT_{3S}$

$SWAT_{3S}$ performes much better

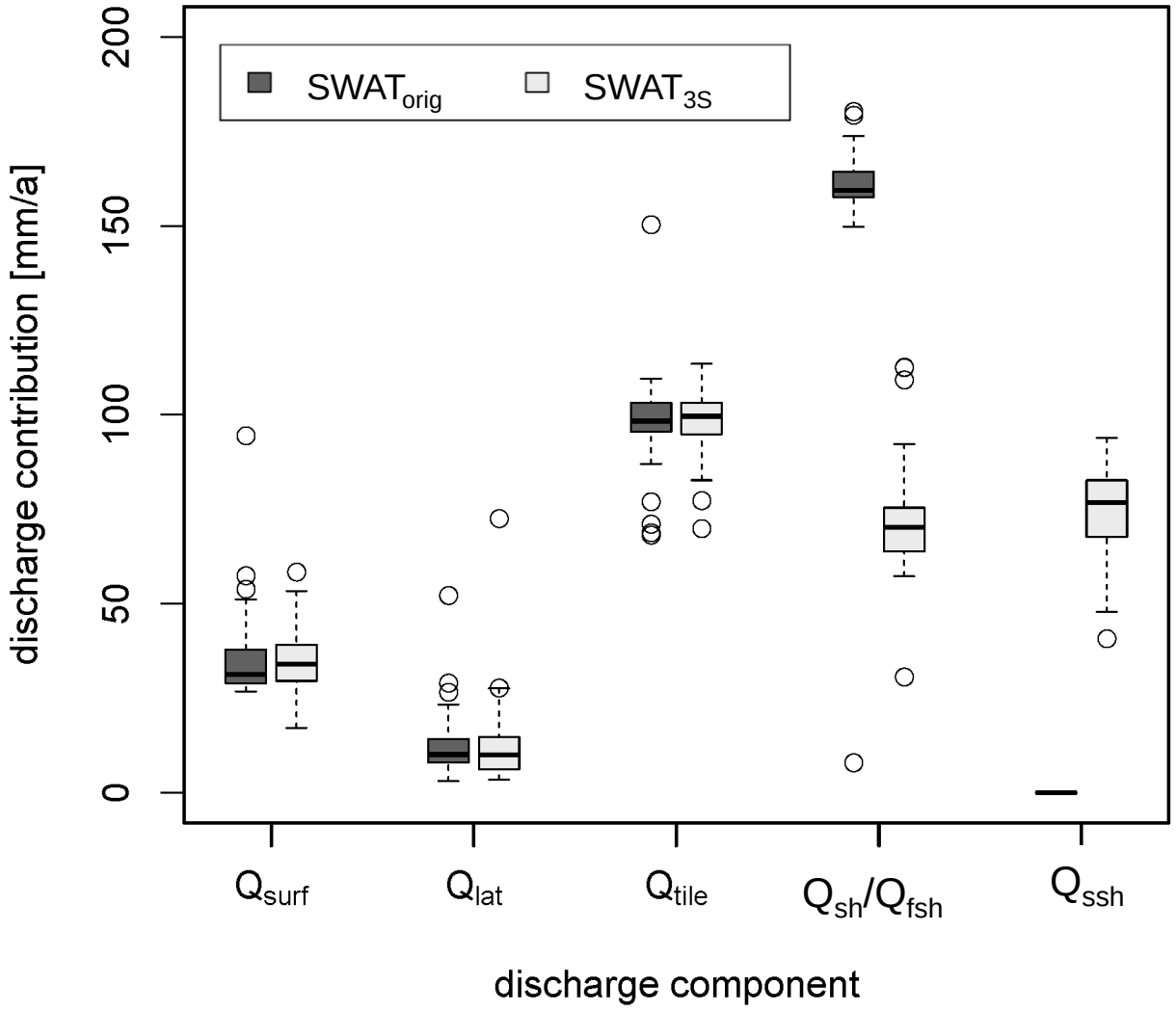
in low flow (PBIAS 7.0 vs. -52.0) and

in mid flow segment (PBIAS 6.3 vs. 22.5)

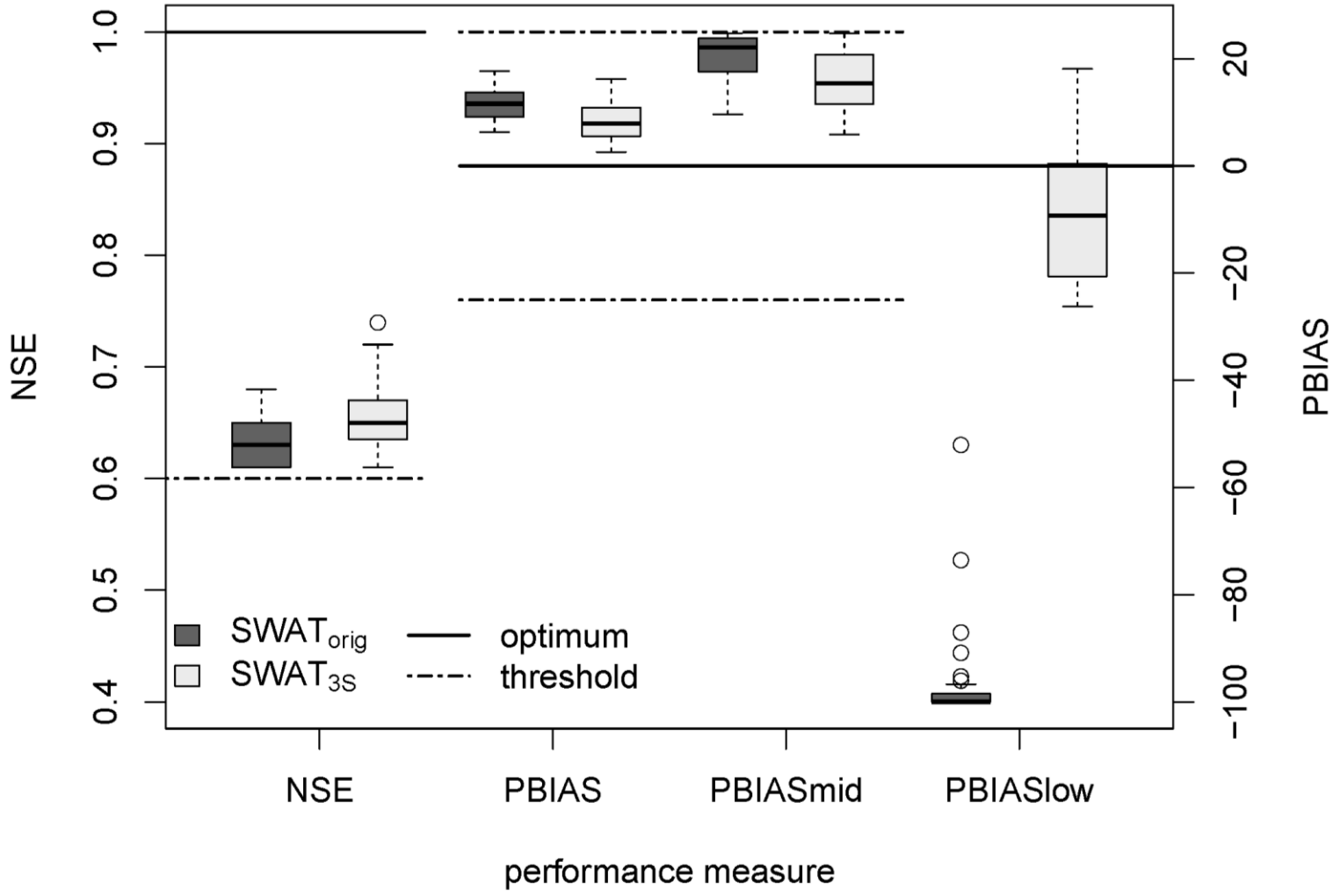


Comparison: SWAT and $SWAT_{3S}$

- Same overall groundwater contribution
- $SWAT_{3S}$: groundwater contribution split into fast and slow component



Comparison: SWAT and SWAT$_{3S}$



Conclusion

- Groundwater contribution as dominant control process for low flows in lowland catchments
- Splitting of shallow aquifer into fast and slow reacting aquifer emphasizes nonlinearity
- Improvement of recession (PBIAS 6.3 vs. 22.5) and low flow (PBIAS 7.0 vs. -52.0) reproduction

Perspectives

- Application of $SWAT_{3S}$ in other lowland catchments
- Consideration of heterogeneous groundwater characteristics (modular application $SWAT_{3S}$)
- Test in large catchments

Thank you!

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