Event-scale concentration-discharge relationships across catchments

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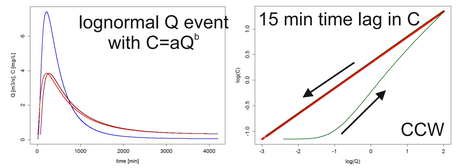
1 Background

- Emergent concentration - discharge (C-Q) relationships obtained at the catchment outlet can be used as a powerful tool to characterize dominant processes shaping water quality dynamics
- C-Q is applicable to inter-annual, seasonal and event scale
- At event-scale C-Q hysteresis hinders the application of the usual power-law relationship between C and Q
- Quantifying hysteresis in a framework consistent with seasonal to inter-annual analyses allows for additional insight into catchment functioning

2 Approach, methods and data

Theory of C-Q hysteresis

- Time-shifts of C against Q create distinct hysteresis patterns

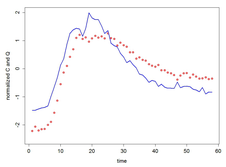


usual approach:
$HI=mean(C_{rise}-C_{fall})$

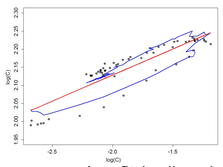
our approach:
$C=aQ^b+c(dQdt)$
with dQdt divided by its range (positive on rising, negative on falling limb of the hydrograph)

C-Q model performance

- Test case with 60 events and high frequency C_{DOC} and Q
- Mean R^2 improved from 0.54 to 0.83 compared to simple power law C-Q
- *b* still maintaining „classical“ logC-logQ slope (R^2 0.88, slope 0.89)
- *c* good substitution for HI (R^2 0.53, slope 0.87)
- Full event loop not needed!



event example

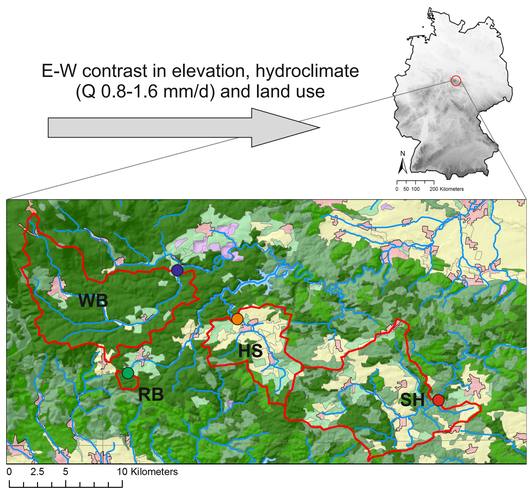


power law fit (red) and dQdt fit (blue)

Application

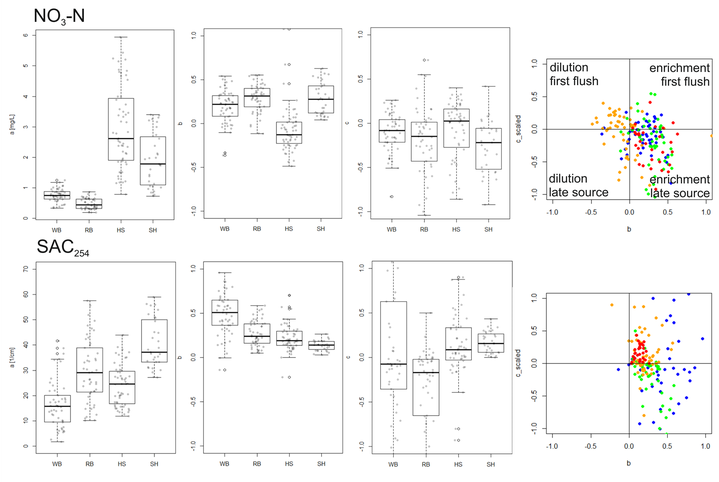
- Four neighbouring TERENO-catchments with 2 years of in-situ measured SAC_{254}, NO_3-N, EC and Q (every 15 min, 56000-70000 measurements)
- Probes used: Scan spectrolyser and Trio ProPS
- Fouling correction and global calibration to lab values
- Events separated based on Dupas et al. (2016)

- *Characterize nutrient mobilization*
- *Explain variability between solutes, catchments, events*



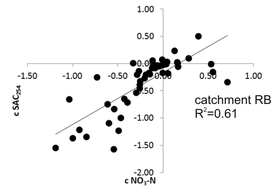
3 Results

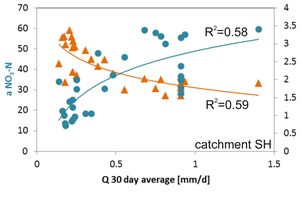
Event characteristics of NO_3-N and SAC_{254}



- 55 to 31 events separated from a two year study period
- NO_3-N concentration increases from east to west, while C-Q slope *b* differs in HS only
- 81% ccw NO_3-N hysteresis in agricultural catchment HS
- SAC_{254} increases from east to west, while C-Q slope *b* is always positive and consistently decreases in median and variance
- Agricultural catchments with dominant cw hysteresis and less variance between the events

Explaining variability





- NO_3-N and SAC_{254} model coefficients closely coupled in small pristine catchment
- Antecedent conditions (7 day mean T_W) explain variability between events
- *Riparian shallow soil as a joint near-stream source activated at the falling limb of the hydrograph*
- Coefficients decoupled and less explainable in larger catchments independent of land use
- *a* well predictable in agri-cultural catchments by antecedent Q and W_T
- Stronger homogeneity of *b* and *c* with more intensive agriculture

4 Conclusions

- Modeling approach integrates C-Q slope and hysteresis into a consistent framework
- Coefficients vary between solutes, catchments and events
- Coefficients explainable by antecedent conditions in small catchment but not in larger ones
- Larger catchments may integrate differing subcatchment signals hindering interpretation
- Exception: Intersect (~average event concentration) *a* biogeochemically controlled with strong seasonality in most intensively managed agricultural catchment

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References:

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TERENO TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

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