TECHNISCHE UNIVERSITÄT DRESDEN

Faculty of Environmental Sciences, Department of Forest Sciences, Institute of Soil Science and Site Ecology

The impact of load estimation procedures on the simulation of nitrogen fluxes in a small mountainous watershed in Germany.

Stefan Julich,
Raphael Benning, Karl-Heinz Feger

TU Dresden, Germany

DRESDEN concept
Exzellenz aus Wissenschaft und Kultur

Research area

Leibniz-Institut für ökologische Raumentwicklung

TECHNISCHE UNIVERSITÄT DRESDEN

Dresden.

BERGAKADEMIE TECHNISCHE UNIVERSITÄT FREIBERG

ift LEIBNIZ-INSTITUT FÜR TROPOSPHÄRENFORSCHUNG

Stadtentwässerung Dresden WIR KLÄREN DAS FÜR SIE

Dresdner Grundwasserforschungszentrum

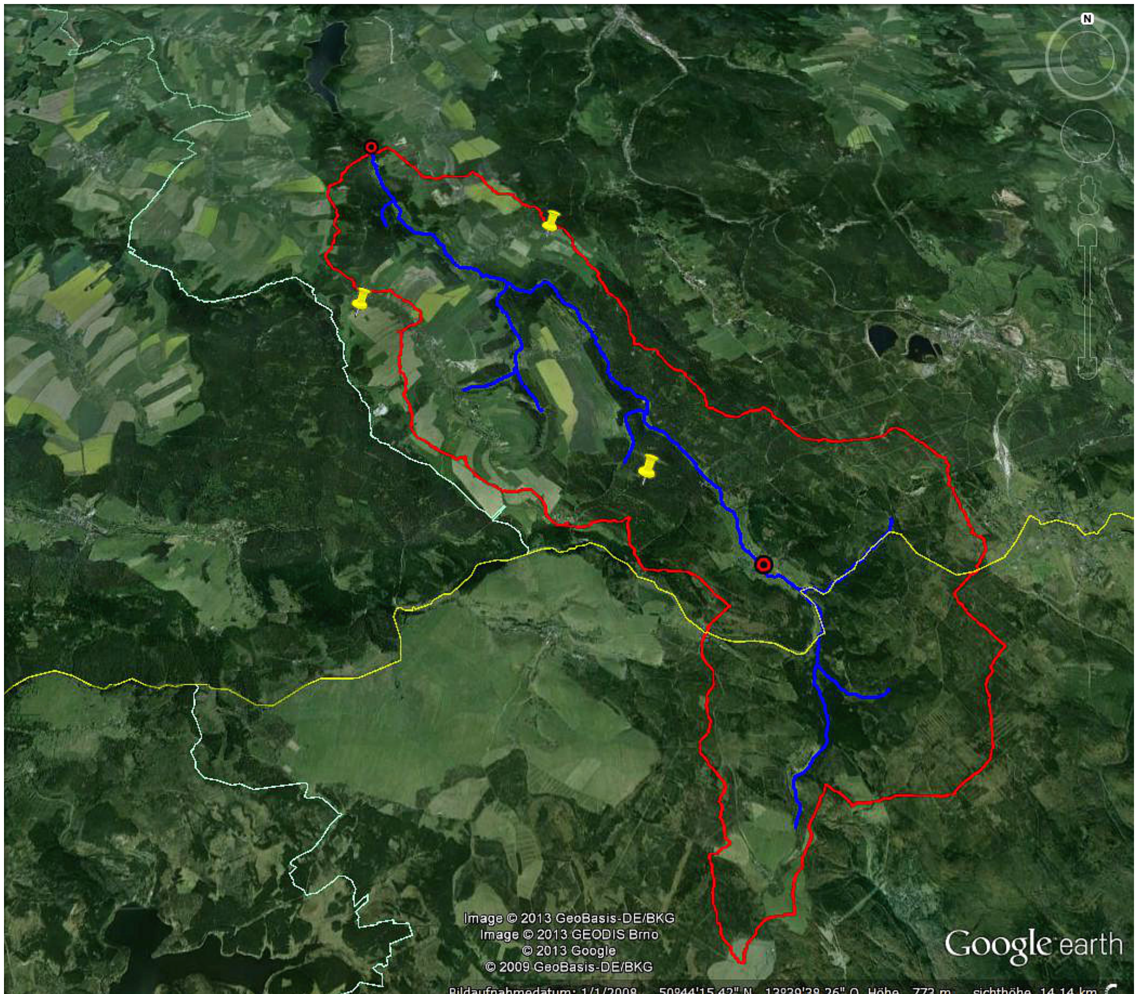
Funded by: FKZ 01 LR 0802

Bundesministerium für Bildung und Forschung

Project management agency:

DLR

Research area - Ammelsdorf catchment



Climate

(period 1961 – 1990)

Precipitation

1096 mm a^{-1}

Mean annual temperature

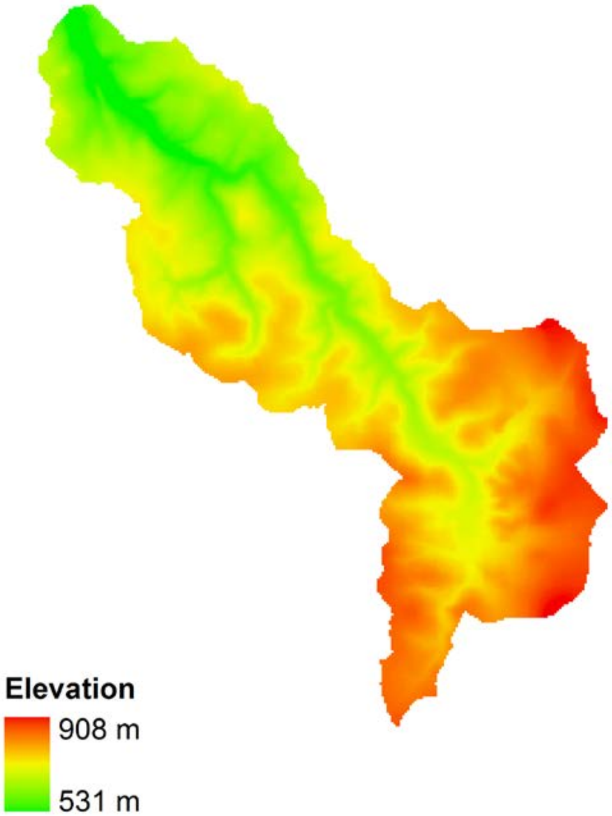
4,3 °C

(Bernhofer et al., 2009)

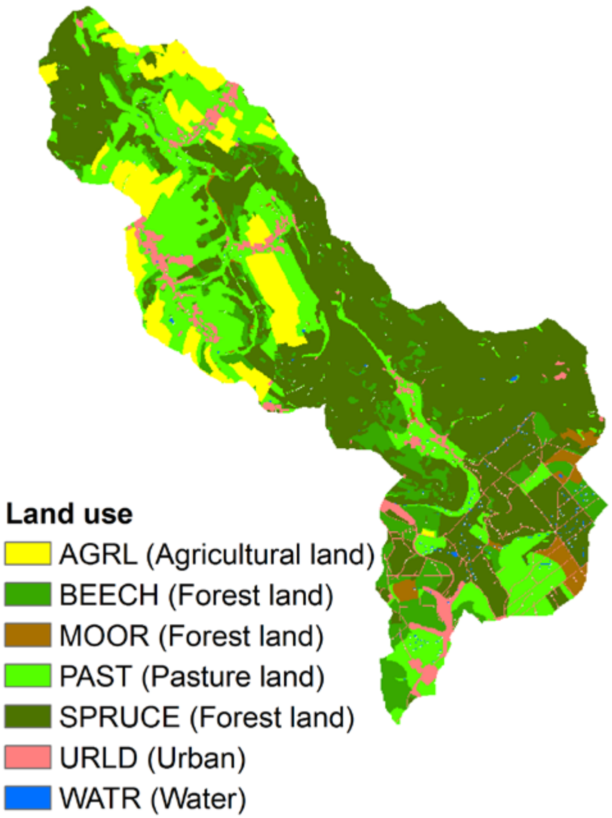
Size

51 km²

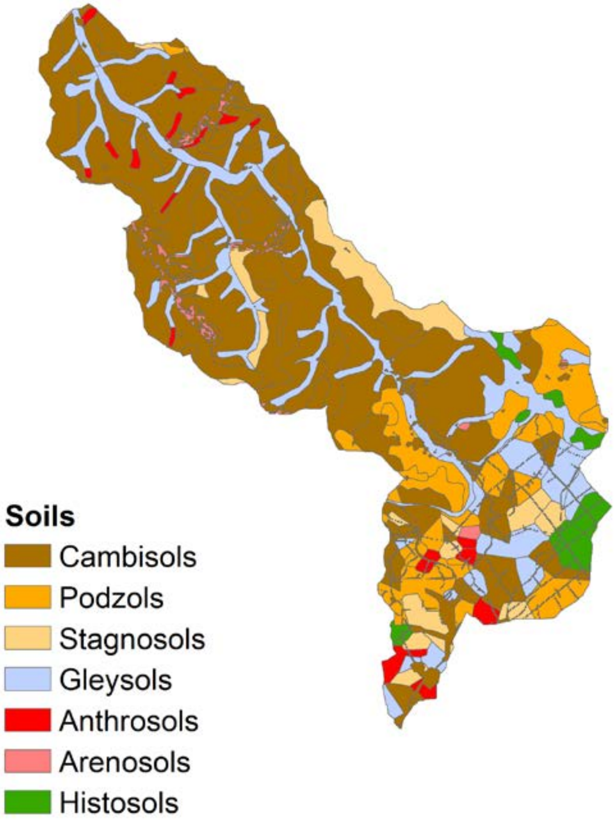
Input data for Ammelsdorf catchment



20 m resolution DEM
(GeoSN, 2010)

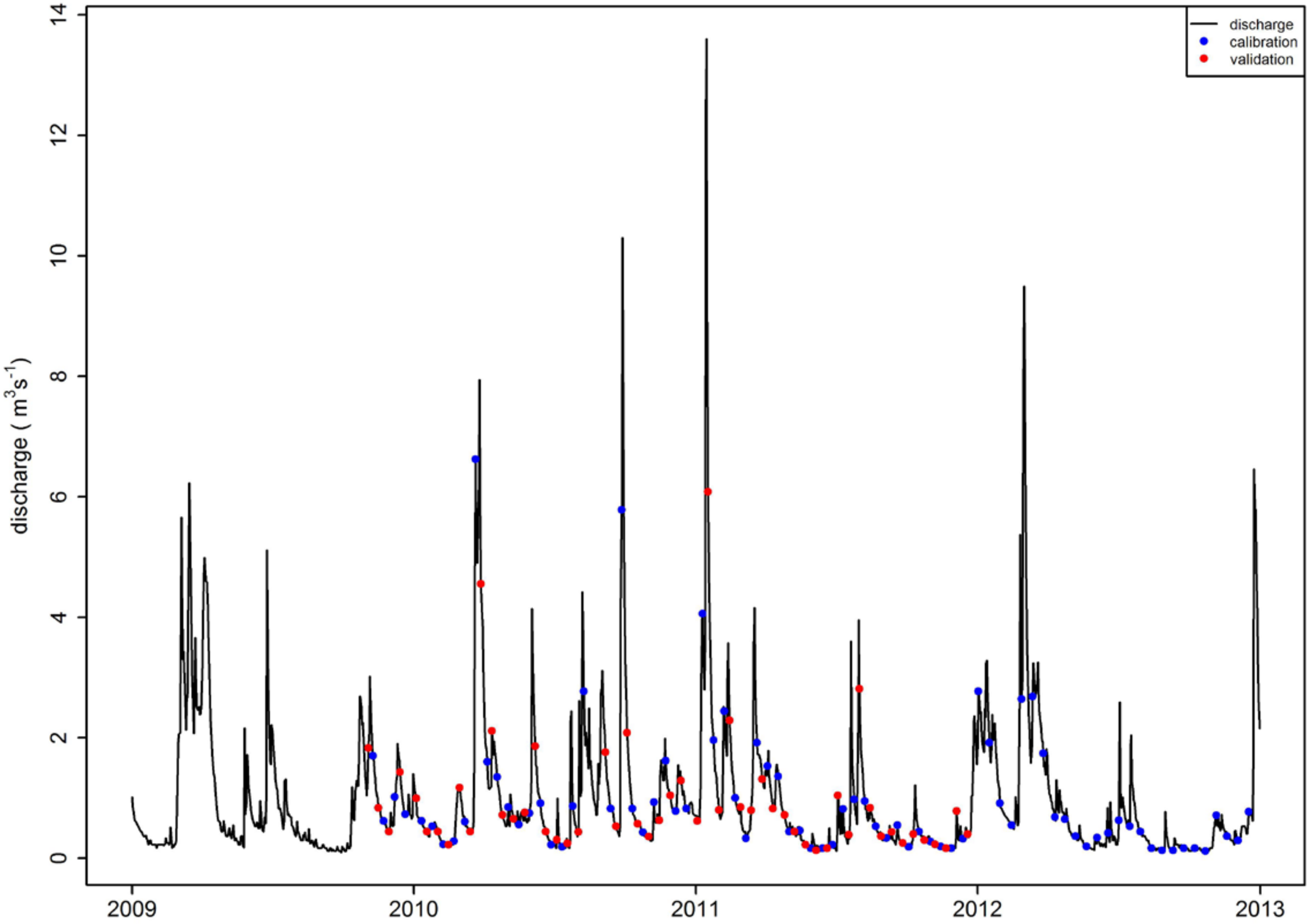


Land use, CIR 2005
(LfULG, 2010)



Soil map BK50
(LfULG, 2011)

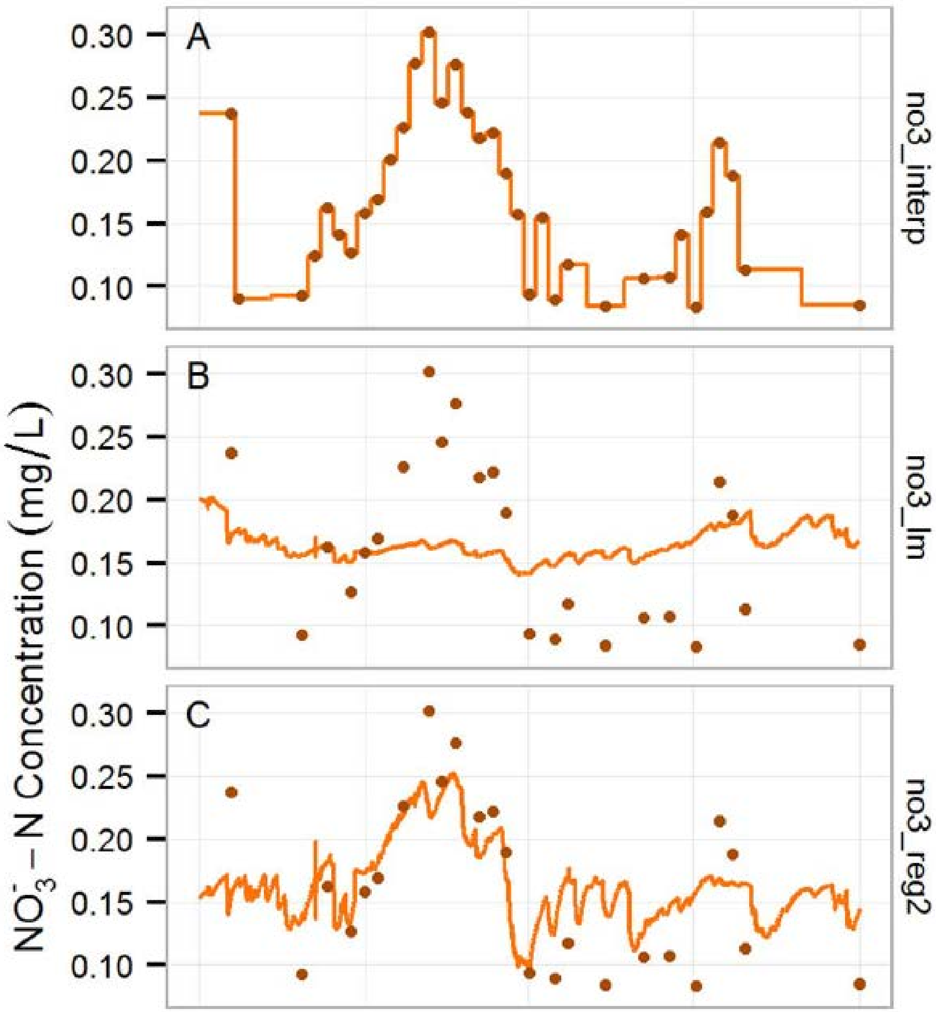
Introduction



NO_3-N [mg/l]

Min: 0.71
Max: 8.14
Mean: 1.85

The Loadflex-R Module



Relationship established via interpolation between measurments

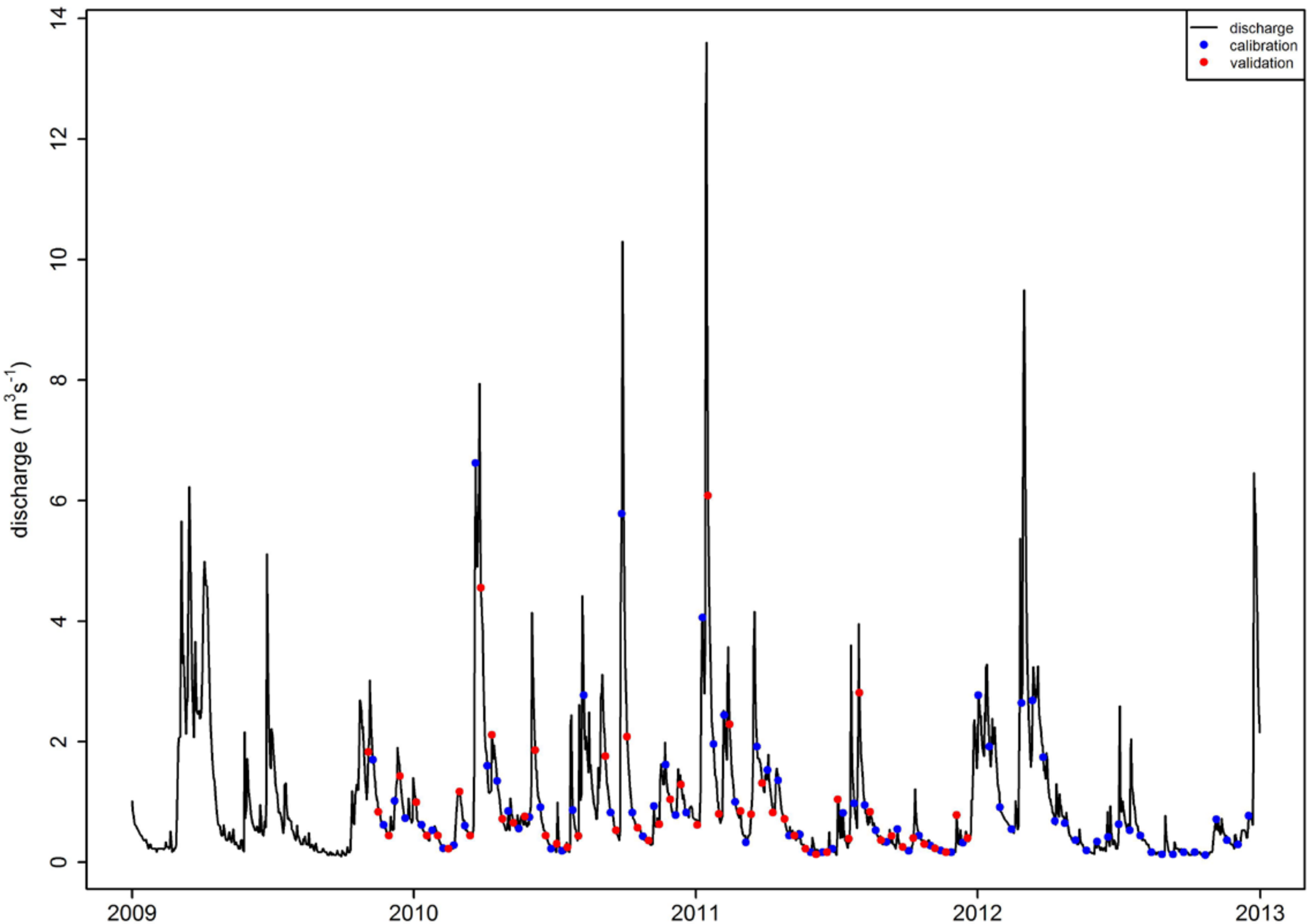
Relationship established via linear model between measured discharge and solute concentration

Relationship established via linear regression model between measured discharge and solute concentration based on Loadest (Runkel et al. 2015)

Methods Load calculation with Loadflex

Method	
Linear Interpolation	
Triangular Interpolation	
Rectangular Interpolation	
Spline Interpolation	
Smooth Spline Interpolation	
Distance Weighted Interpolation	
Linear Regression Model	
Loadest Regression Model 1	$a0 + a1 \ln Q$
Loadest Regression Model 2	$a0 + a1 \ln Q + a2 \ln Q2$
Loadest Regression Model 3	$a0 + a1 \ln Q + a2dtime$
Loadest Regression Model 4	$a0 + a1 \ln Q + a2 \sin(2\pi dtime) + a3 \cos(2\pi dtime)$
Loadest Regression Model 5	$a0 + a1 \ln Q + a2 \ln Q2 + a3dtime$
Loadest Regression Model 6	$a0 + a1 \ln Q + a2 \ln Q2 + a3 \sin(2\pi dtime) + a4 \cos(2\pi dtime)$
Loadest Regression Model 7	$a0 + a1 \ln Q + a2 \sin(2\pi dtime) + a3 \cos(2\pi dtime) + a4dtime$
Loadest Regression Model 8	$a0 + a1 \ln Q + a2 \ln Q2 + a3 \sin(2\pi dtime) + a4 \cos(2\pi dtime) + a5dtime$
Loadest Regression Model 9	$a0 + a1 \ln Q + a2 \ln Q2 + a3 \sin(2\pi dtime) + a4 \cos(2\pi dtime) + a5dtime + a6dtime2$

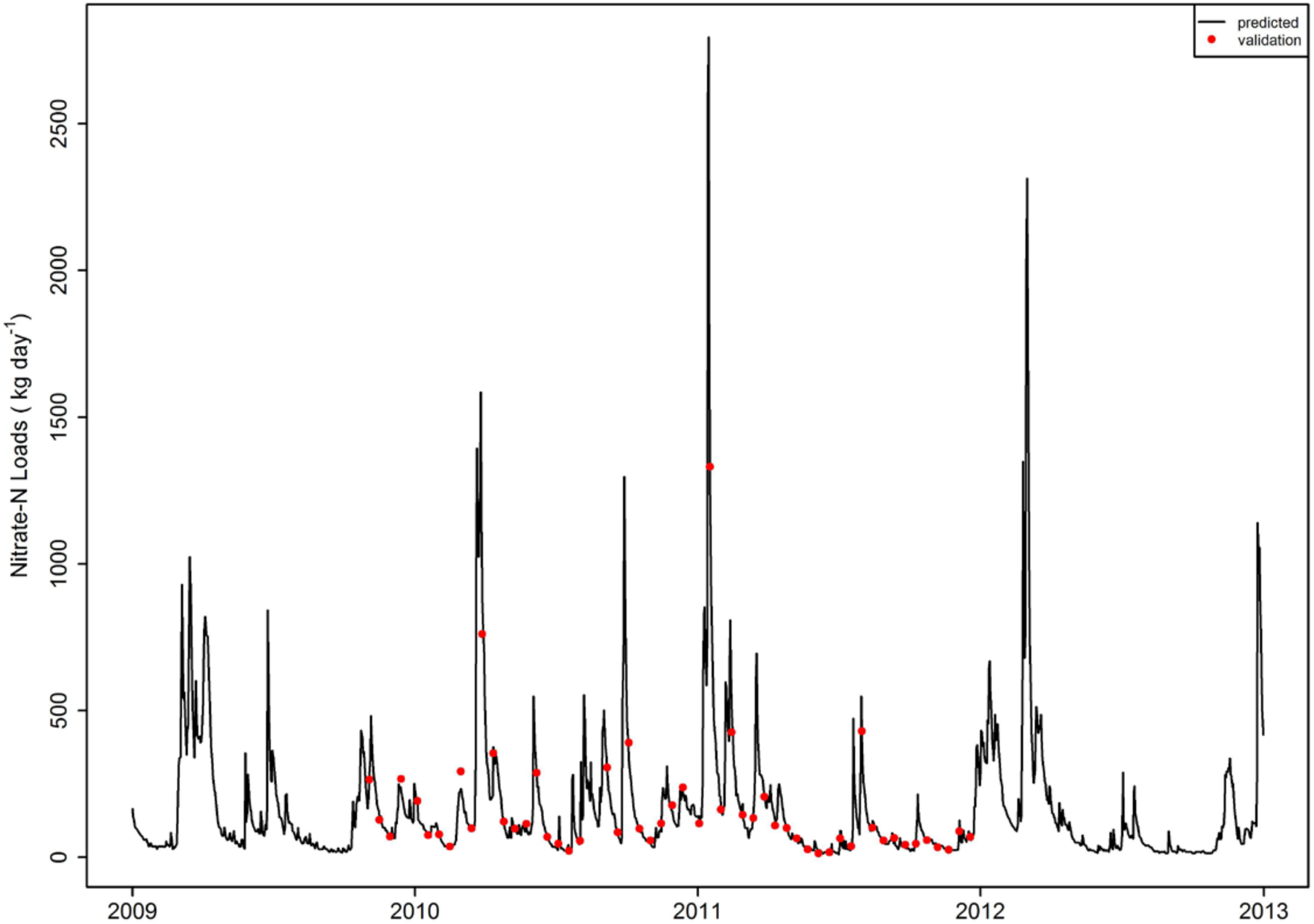
Loadflex Application



NO_3-N [mg/l]

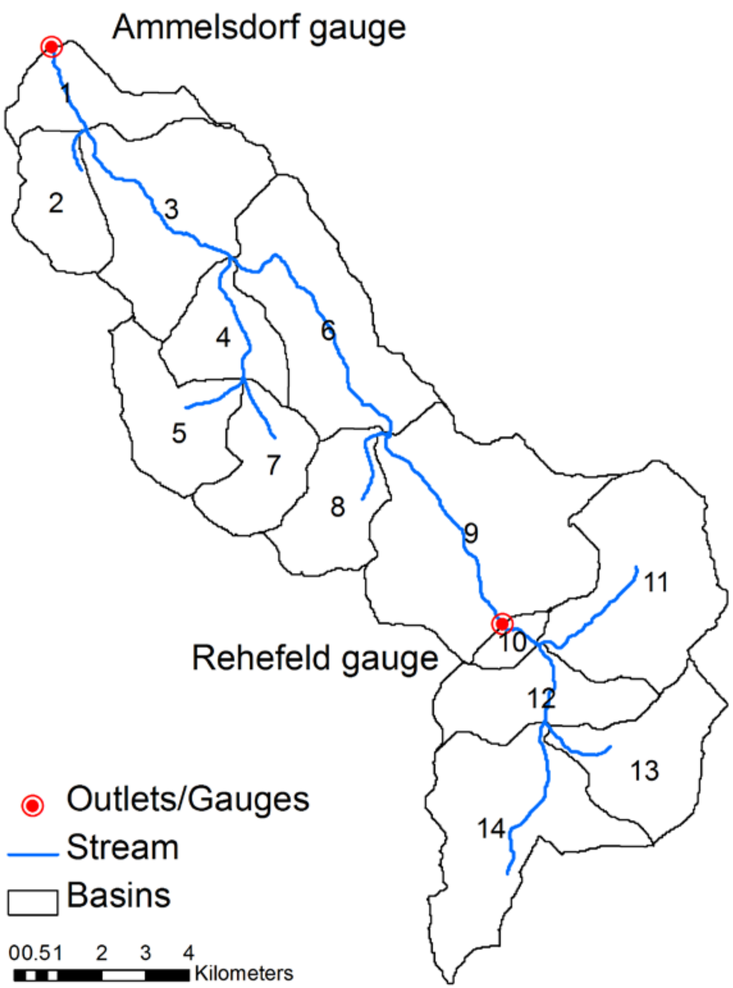
Min: 0.71
Max: 8.14
Mean: 1.85

Loadflex Application



R^2: 0.98
MAE: 17.77

Model setup and measurement data



- 14 Subbasins
- 1312 HRUs
- Discharge data Ammelsdorf & Rehefeld (LHWZ, 2012) 2006-2012
- Water quality data Ammelsdorf (TUD) 2009-2012
- Fertilizer input ~230 kg N $ha^{-1}a^{-1}$

TECHNISCHE UNIVERSITÄT DRESDEN

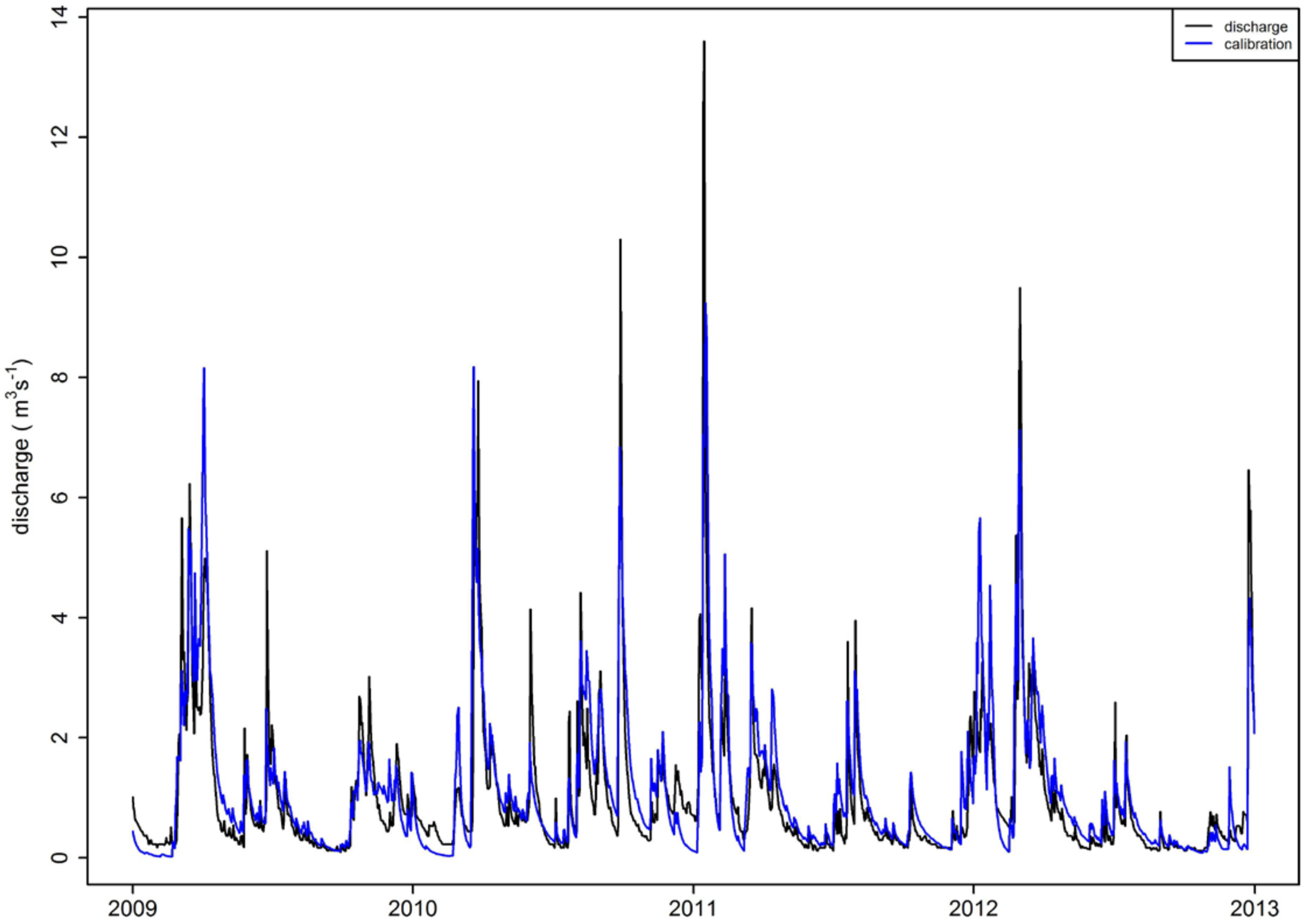
Calibration

Parameter	Min	Max	
SURLAG	0	3	Surface Runoff
SFTMP	-2	0.5	Snow
SMTMP	0	2	Snow
TIMP	0	1	Snow
CMN	0.0001	0.001	Nitrogen
NUPDIS	10	30	Nitrogen
NPERCO	0	1	Nitrogen
RSDCO	0.01	0.1	Nitrogen
CDN	0	2	Nitrogen
SDNCO	0.95	1.01	Nitrogen
AWC	-0.15	0.15	Soil
k_norock	-0.15	0.15	Soil
k_rock	0	200	Soil
CHN	0.01	0.3	Routing
CHK	0.01	30	Routing
ALPHA_BF	0.001	0.99	Groundwater
GW_DELAY	0	31	Groundwater
GW_REVAP	0.02	0.2	Groundwater
GW_QMN	0	100	Groundwater
DEPIMP	1500	3000	Groundwater

- 5000 parameter sets
- Latin-Hypercube-sampling with the FME R-package (Soetaert & Petzoldt, 2010) based on Pfannerstill et al. (2014)

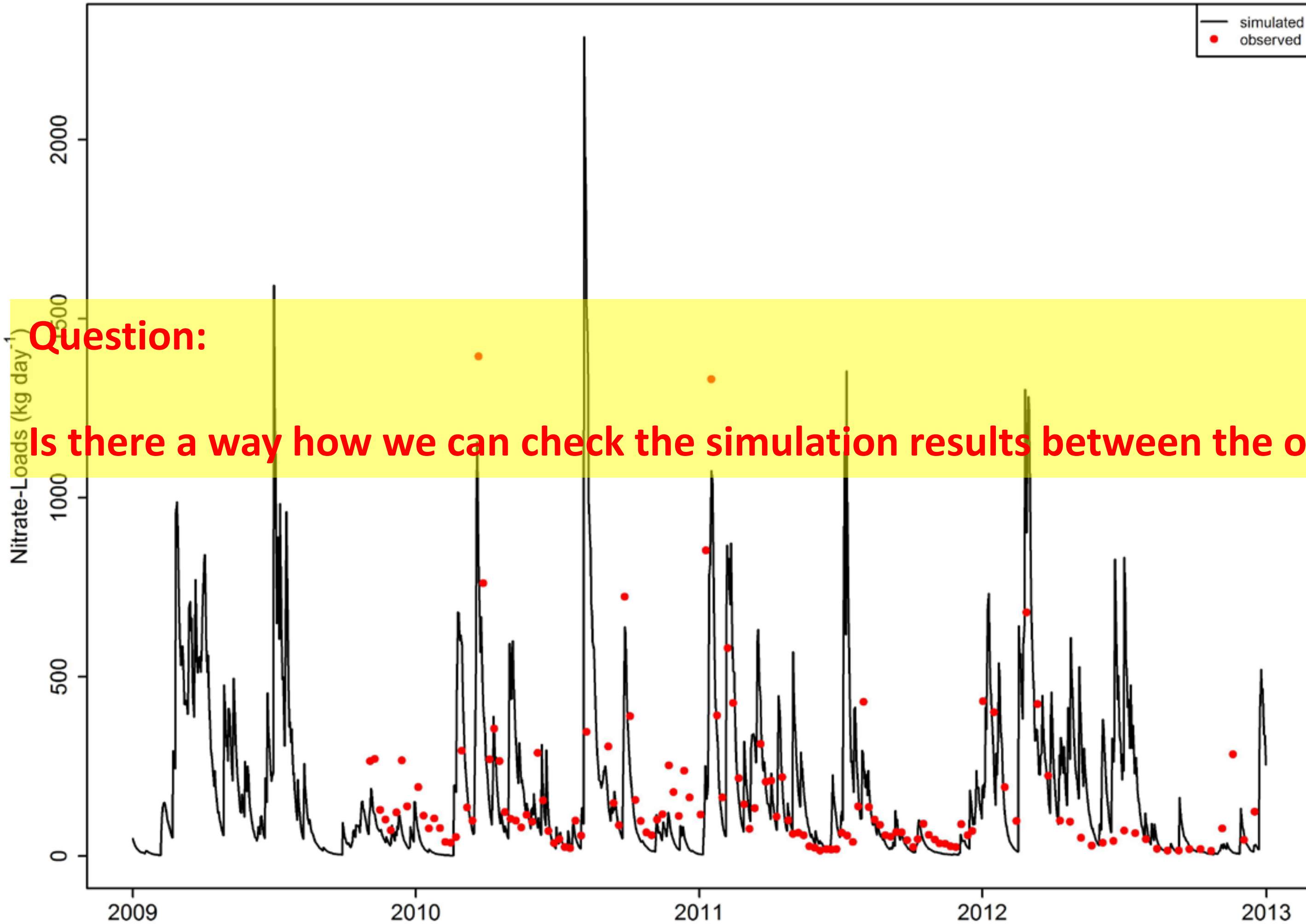
- Best parameter selected according KGE

Results - Hydrology



Objective Function:
NSE: 0.7
KGE: 0.82

Results – comparison simulated and observed loads

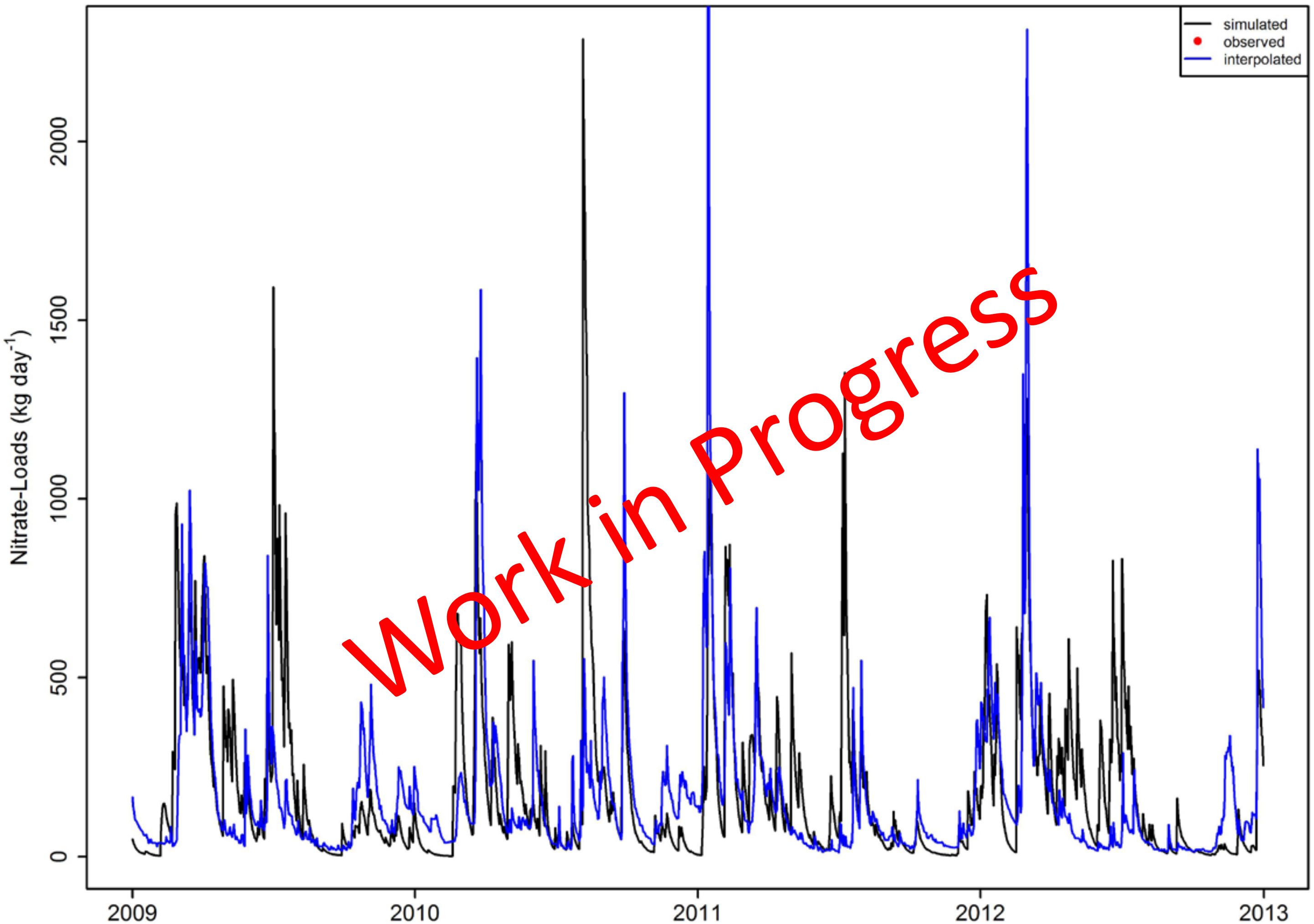


Question:

Is there a way how we can check the simulation results between the observations?

NSE: 0.07
KGE: 0.57
MAE:117.03

Results – comparison SWAT and Loadflex



NSE: 0.04
KGE: 0.54
MAE:126.71

Conclusions

- Discharge could be well captured by the model → weakness during snow melt periods
- Comparison of SWAT simulated Nitrate-Loads and observed Nitrate-Loads show larger uncertainties
- The comparison between the SWAT simulation and the Loadflex Predictions showed similar quality as for observations →but includes more data points
- Simulation reliable for times w/o observations?

Next steps:

- Include event based monitoring data in the Loadflex predictions →see whether this improves simulations quality

TECHNISCHE UNIVERSITÄT DRESDEN

References

Appling, A.P.; Leon, M.C.; McDowell,W.H. Reducing bias and quantifying uncertainty in watershed flux
estimates: The R package loadflex. Ecosphere **2015**, 6, 1–25.

Lorenz, D.; Runkel, R. Rloadest: River Load Estimation; U.S. Geological Survey: Mounds View, MN, USA, 2015.

Pfannerstill, M.; Guse, B.; Fohrer, N. (2014):Smart low flow signature metrics for an improved overall performance evaluation of hydrological models,
J. Hydrol, 510, 447-458, doi: http://dx.doi.org/10.1016/j.jhydrol.2013.12.044.

Soetaert, Karline and Petzoldt, Thomas, 2010: Inverse Modelling, Sensitivity and Monte Carlo Analysis in R Using Package FME. Journal of Statistical Software, 33(3), 1-28. DOI: 10.18637/jss.v033.i03

TECHNISCHE UNIVERSITÄT DRESDEN

Contact:

Stefan Julich

Technische Universität Dresden
Institute of Soil Science and Site Ecology
Pienner Str. 19
01737 Tharandt

Stefan.Julich@tu-dresden.de