Christian-Albrechts-Universität zu Kiel

Modeling hydrologic extremes with SWAT+

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EXDIMUM

Department of Hydrology and Water Resources Management

Motivation: extreme dry conditions

- Tree mortality, soil erosion

Photos: P. Wagner 2022

Motivation: extreme wet conditions

- Flood event in Goslar

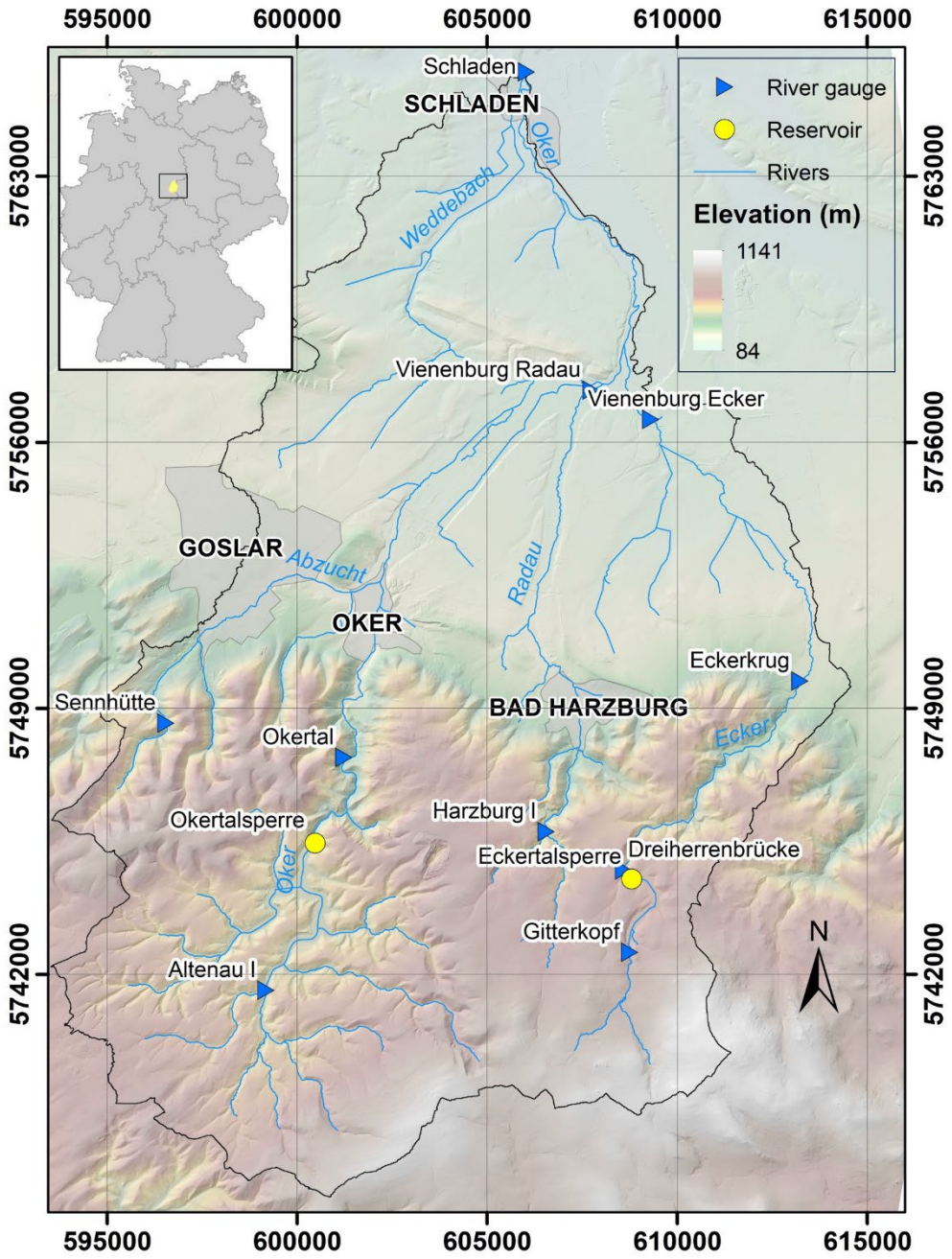
  26 July 2017

  205 mm rainfall in 3 days

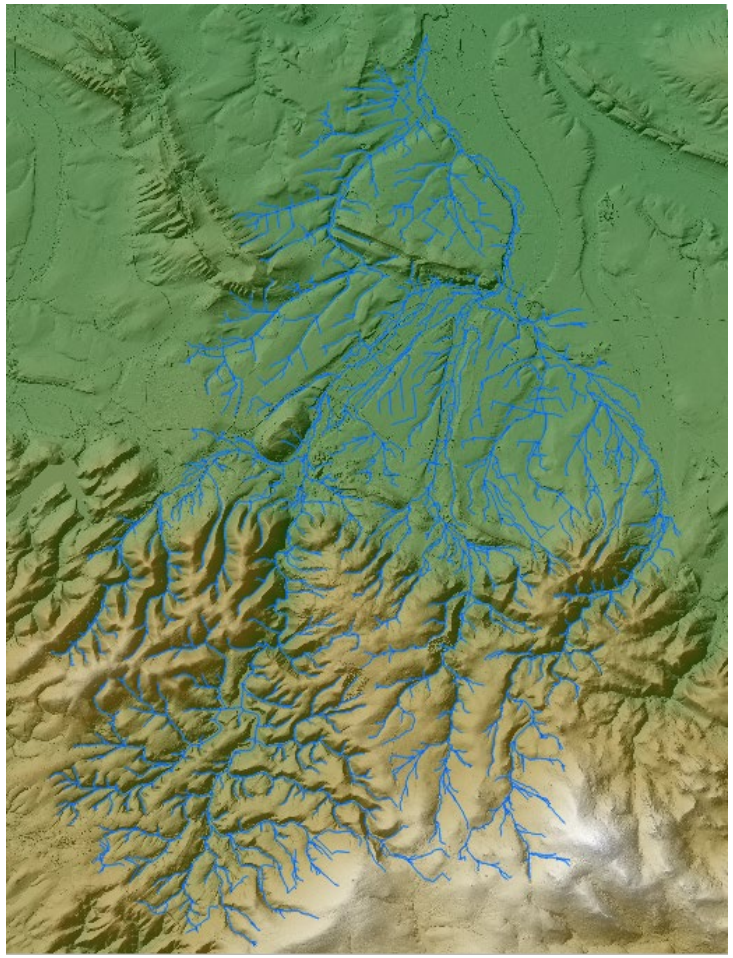
Source: https://www.goslarsche.de/lokales/goslar_artikel,-hochwasser-2017-als-die-flut-nach-goslar-kam-_arid,2587078.html

Study area

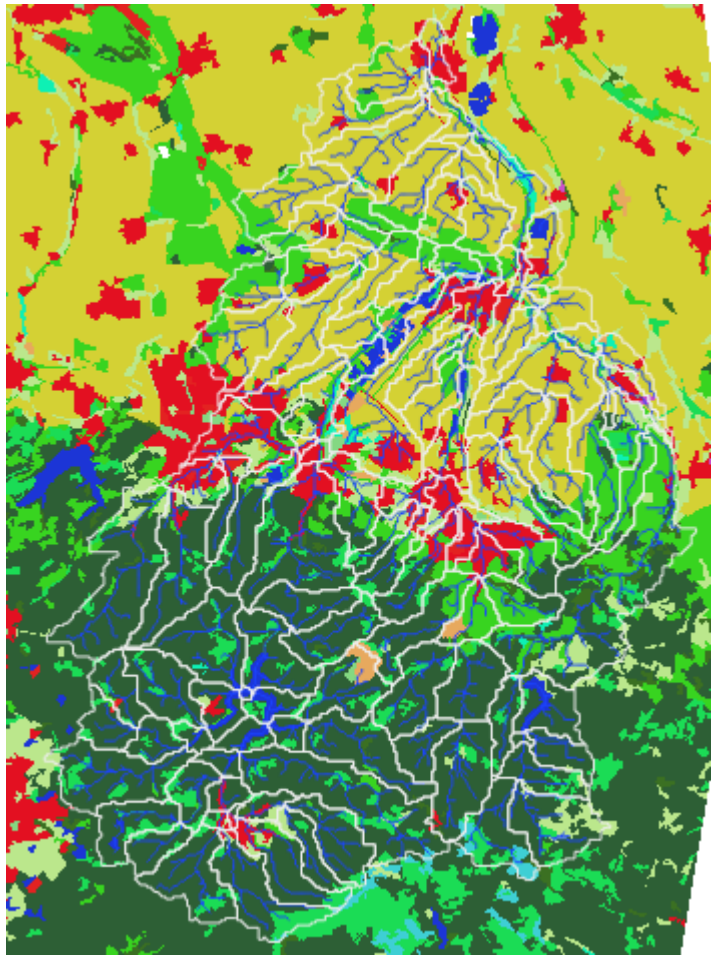
- Harz mountains, Germany
- Catchment of the Oker upstream of the gauge Schladen
- Area: 361.6 km²
- Elevation: 89 m – 1141 m
- 55% forest, 28% agriculture, 8% urban



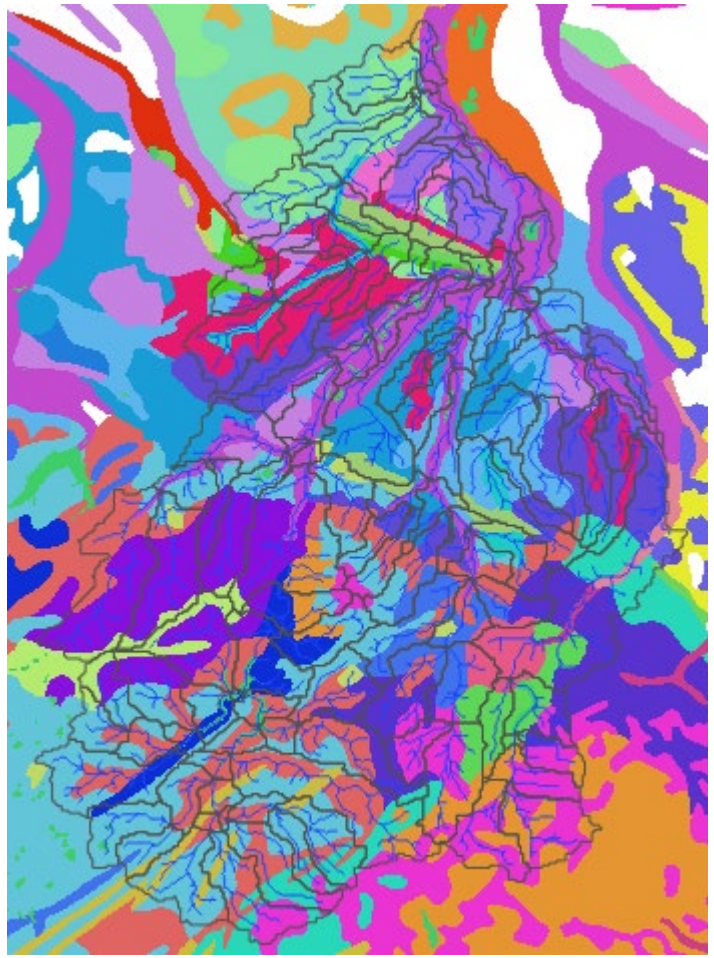
Spatial input data



DEM 1 m, upscaled to 5 m + Stream network NI



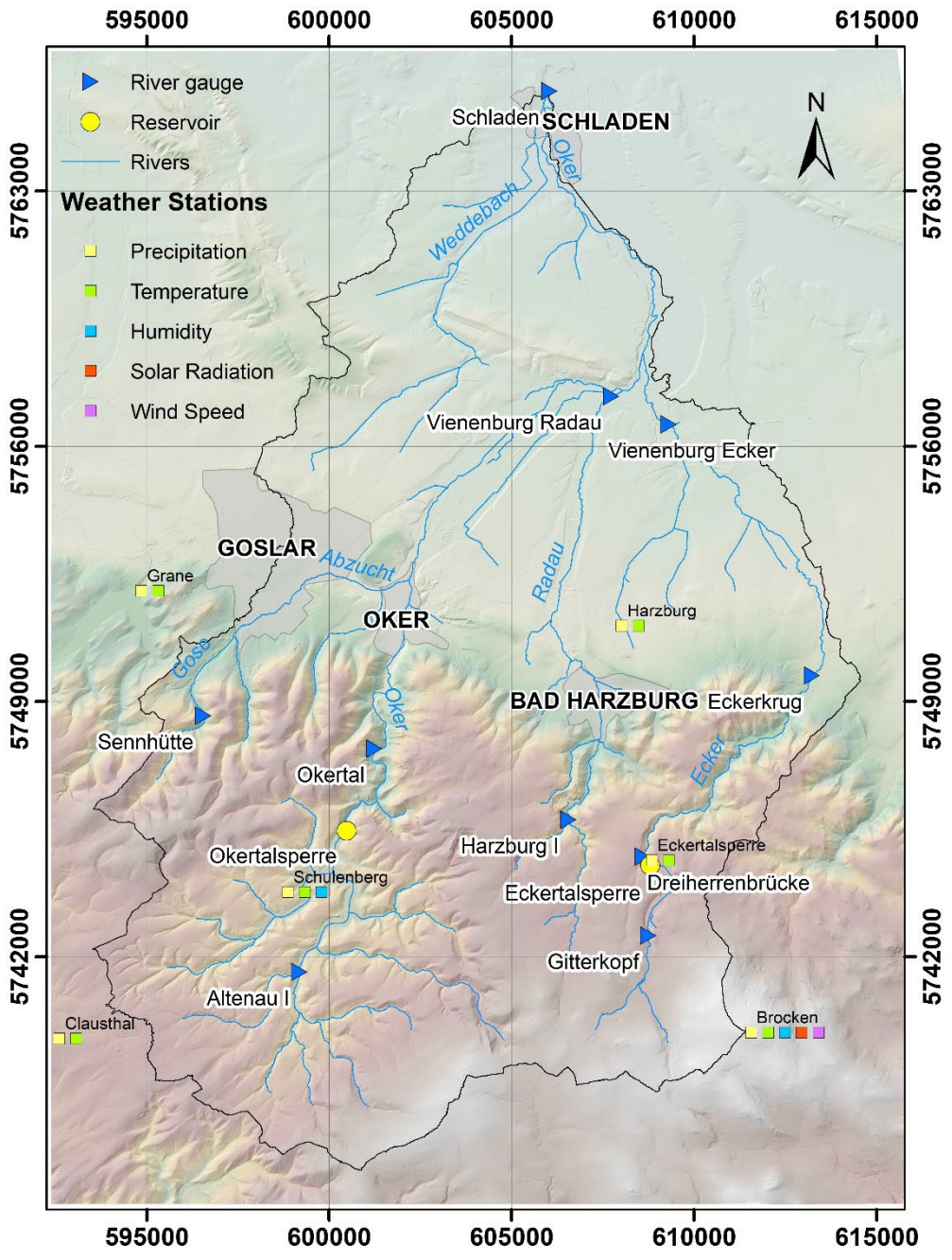
Land use Corine (5 ha)



Soil map BÜK 200

Weather and river gauges

- 10 river gauges
- 6 rain and temperature gauges
- 2 humidity stations
- 1 solar radiation and wind speed gauge



Methods

Simulation period:

- 1 Jan. 2016 - 31 Dec. 2019

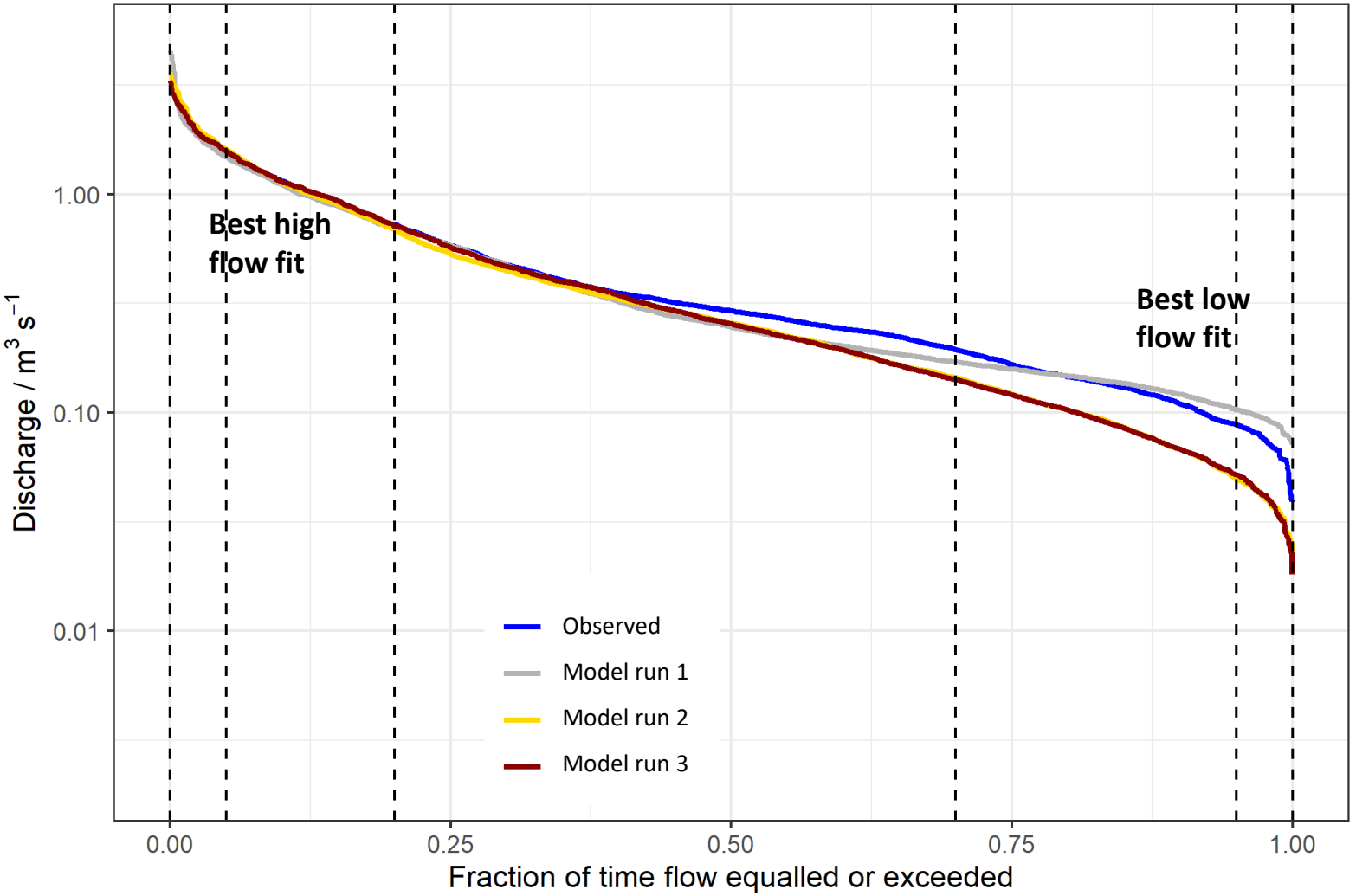
Calibration technique:

- Latin Hypercube Sampling to derive 200 parameter sets
- Best parameter sets selected:
  - Best Kling-Gupta efficiency
  - Best low flow model
  - Best high flow model

Best high flow and low flow models

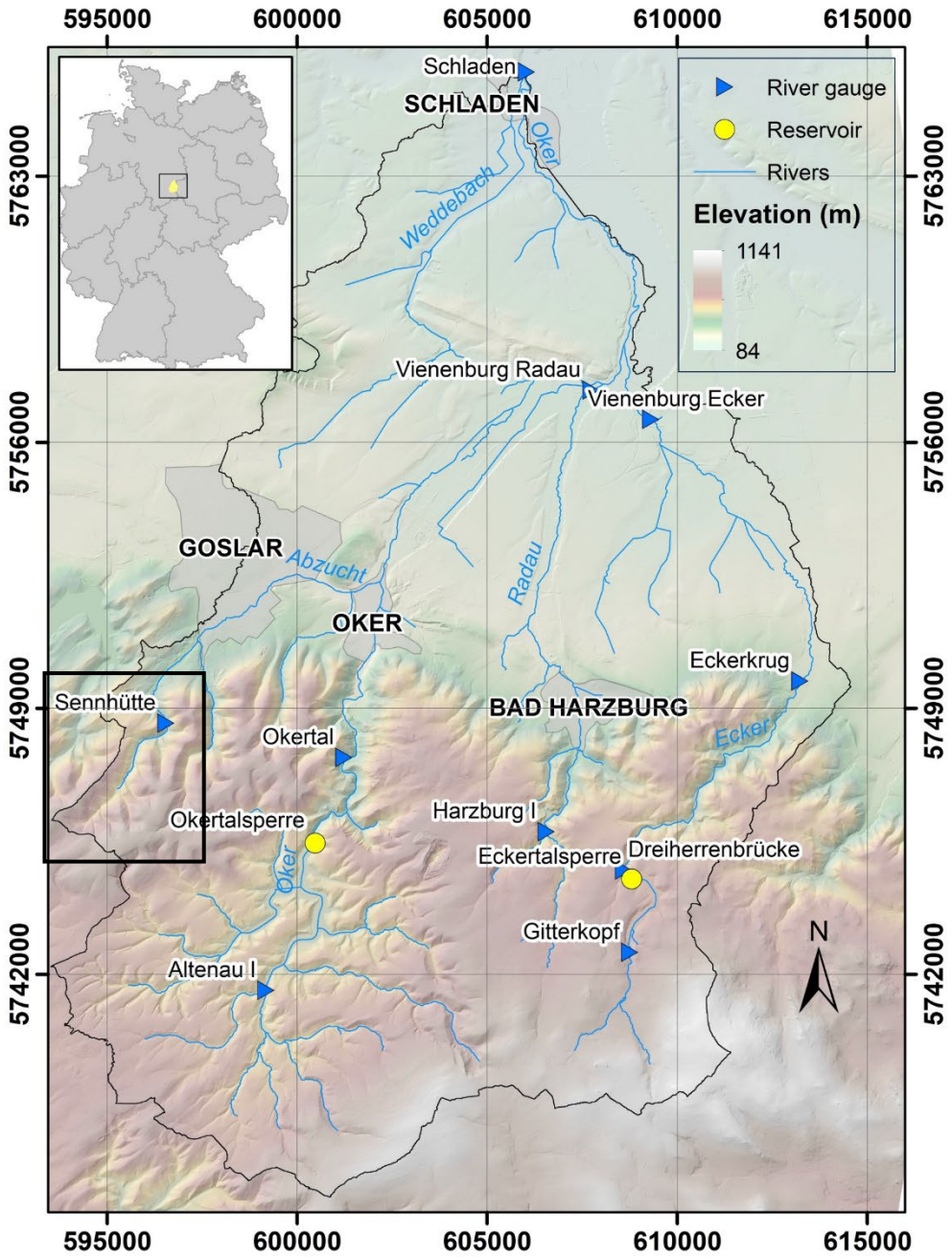
- Based on the RSR* applied to the respective segment of the FDC

*ratio of the root mean square error to the standard deviation of measured data

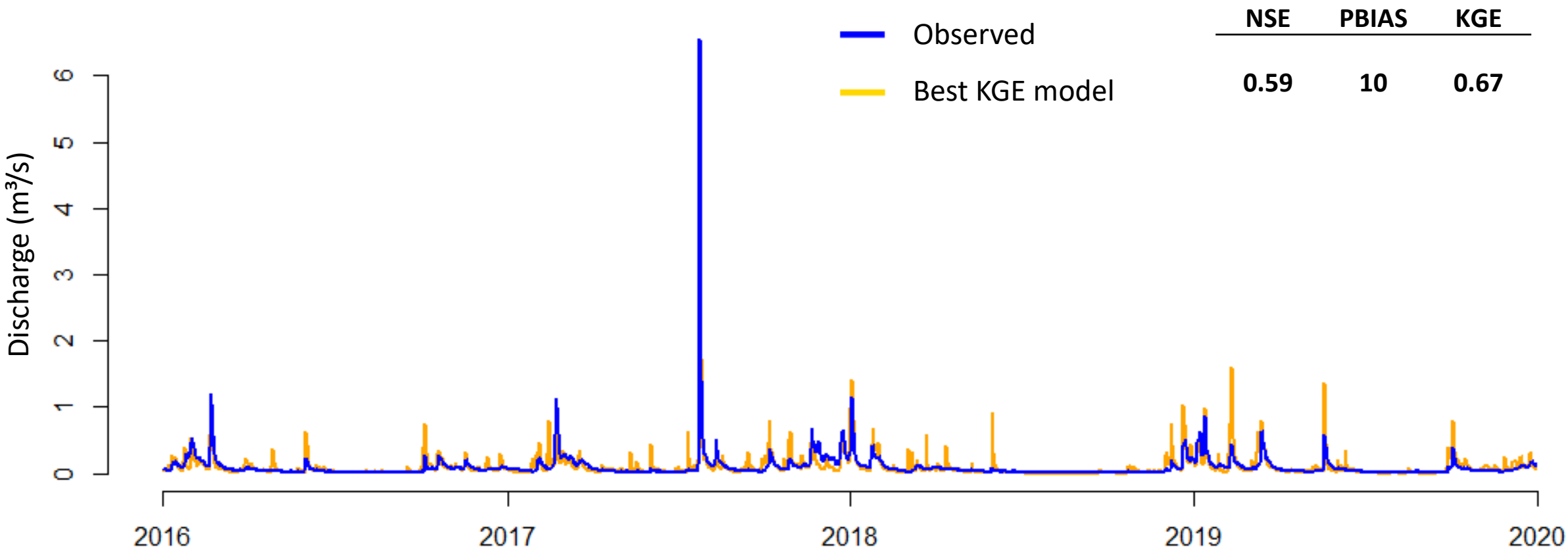


Headwater catchment

- Gauge Sennhütte
- Area: 6.1 km²
- Elevation: 359 m – 763 m
- 96% Forest, 4% Shrubland
- Steep slopes

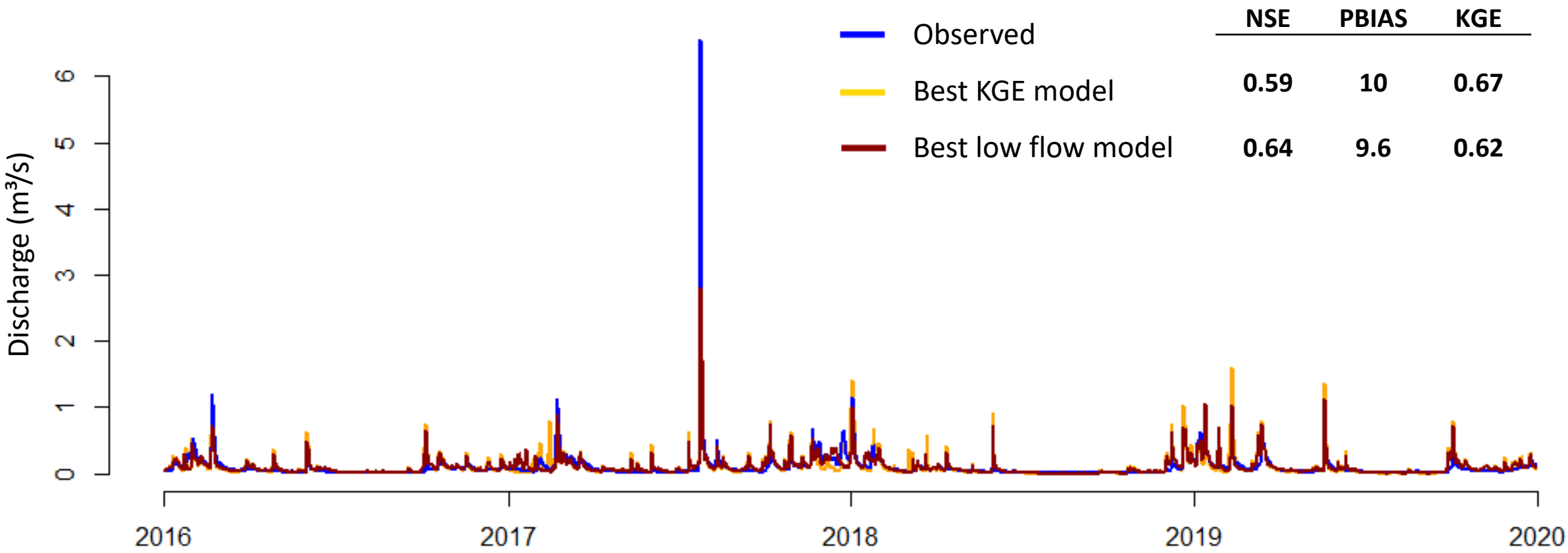


Overall model evaluation



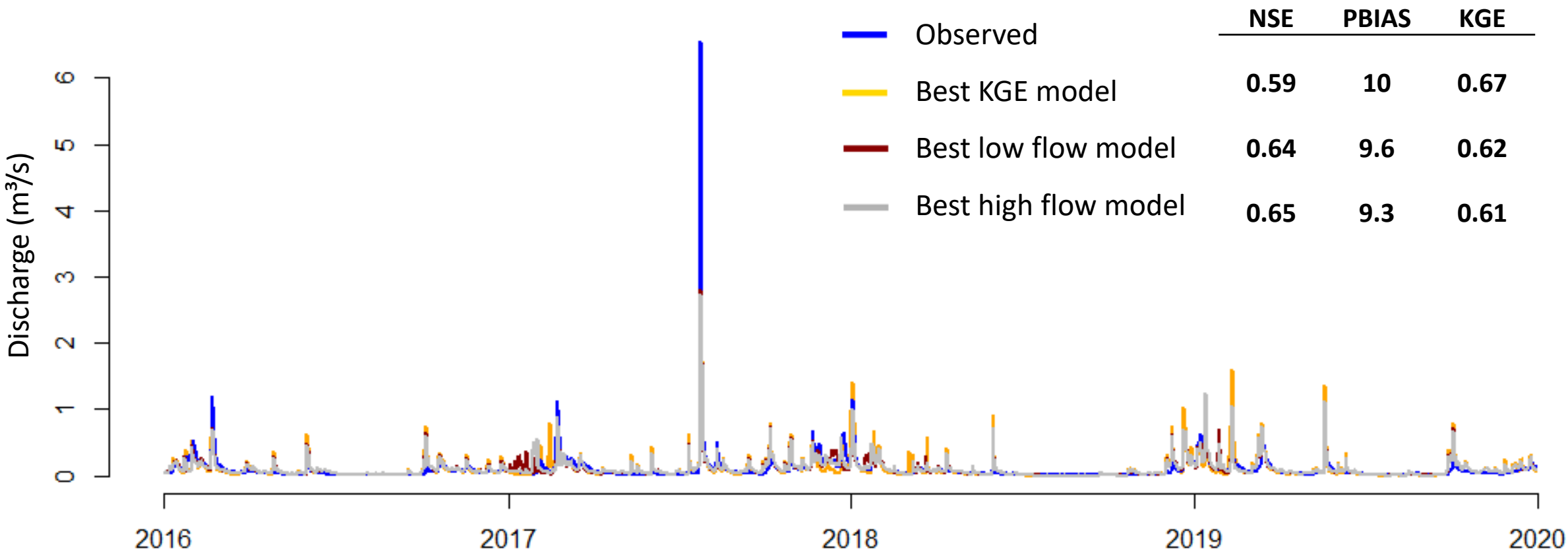
NSE	PBIAS	KGE
0.59	10	0.67

Overall model evaluation



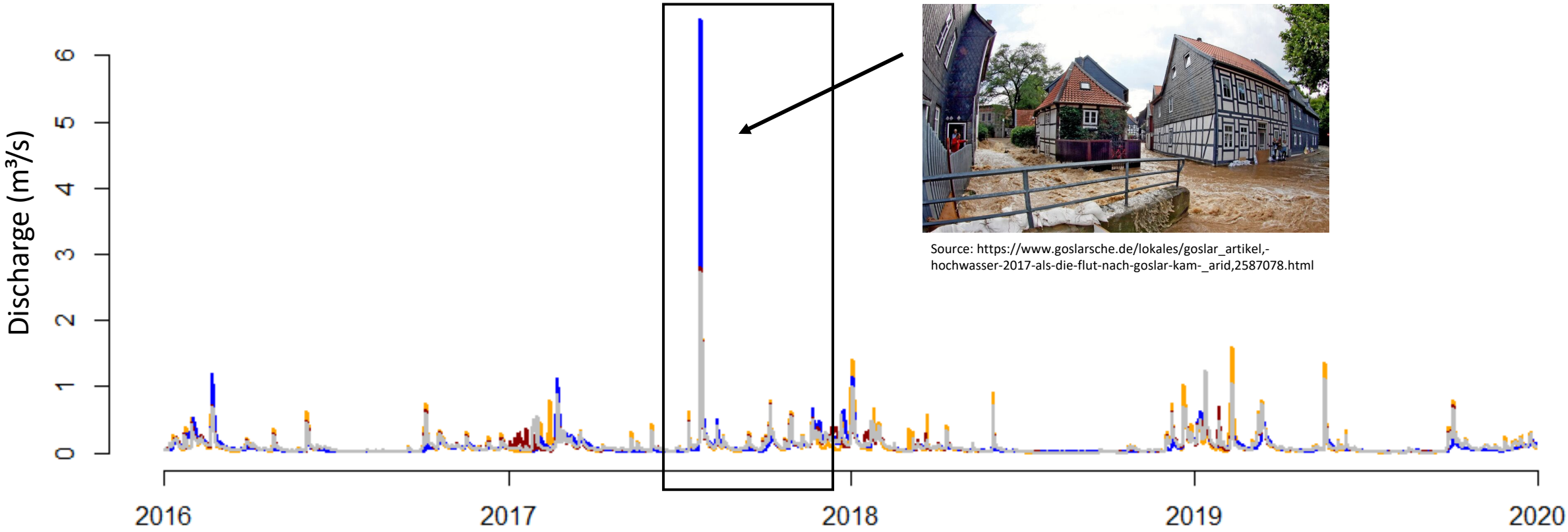
	NSE	PBIAS	KGE
Best KGE model	0.59	10	0.67
Best low flow model	0.64	9.6	0.62

Overall model evaluation



	NSE	PBIAS	KGE
Best KGE model	0.59	10	0.67
Best low flow model	0.64	9.6	0.62
Best high flow model	0.65	9.3	0.61

Evaluation of high flows: 2017



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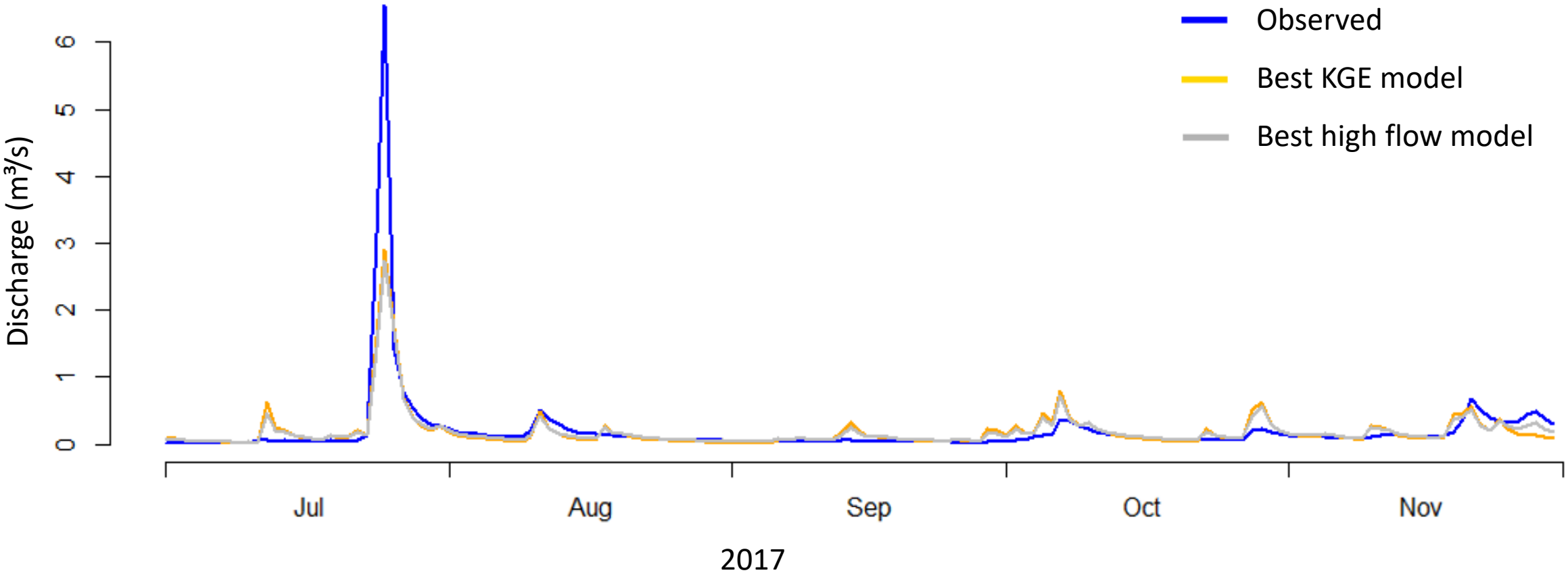
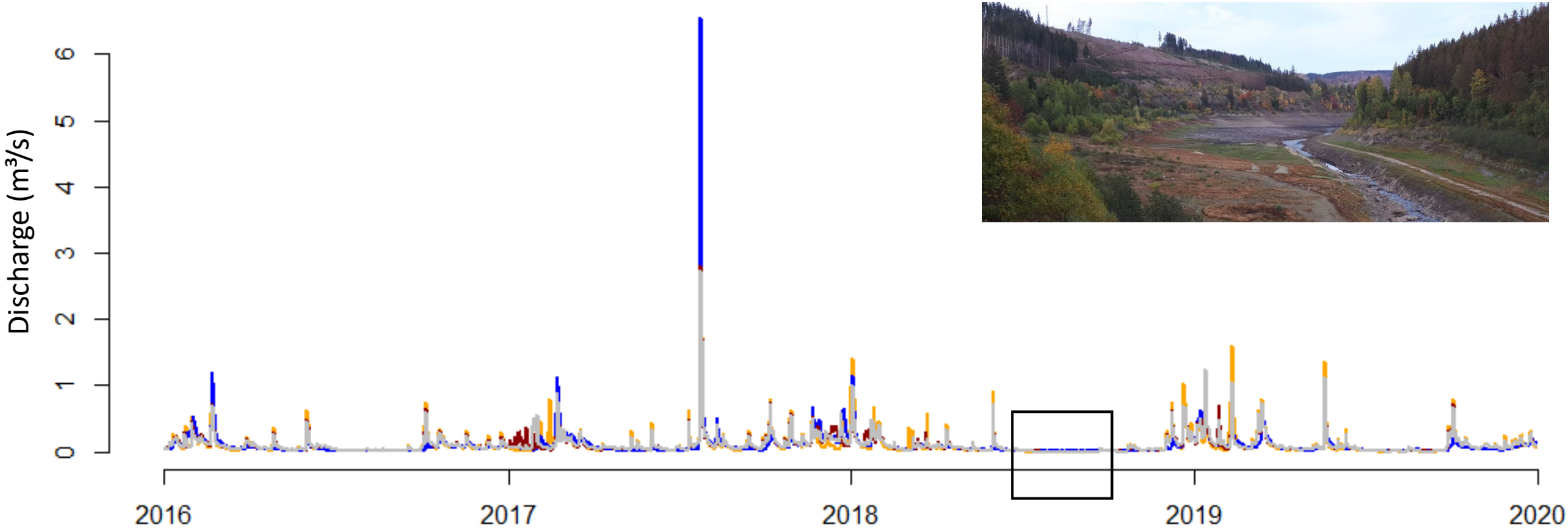


Evaluation of low flows: 2018



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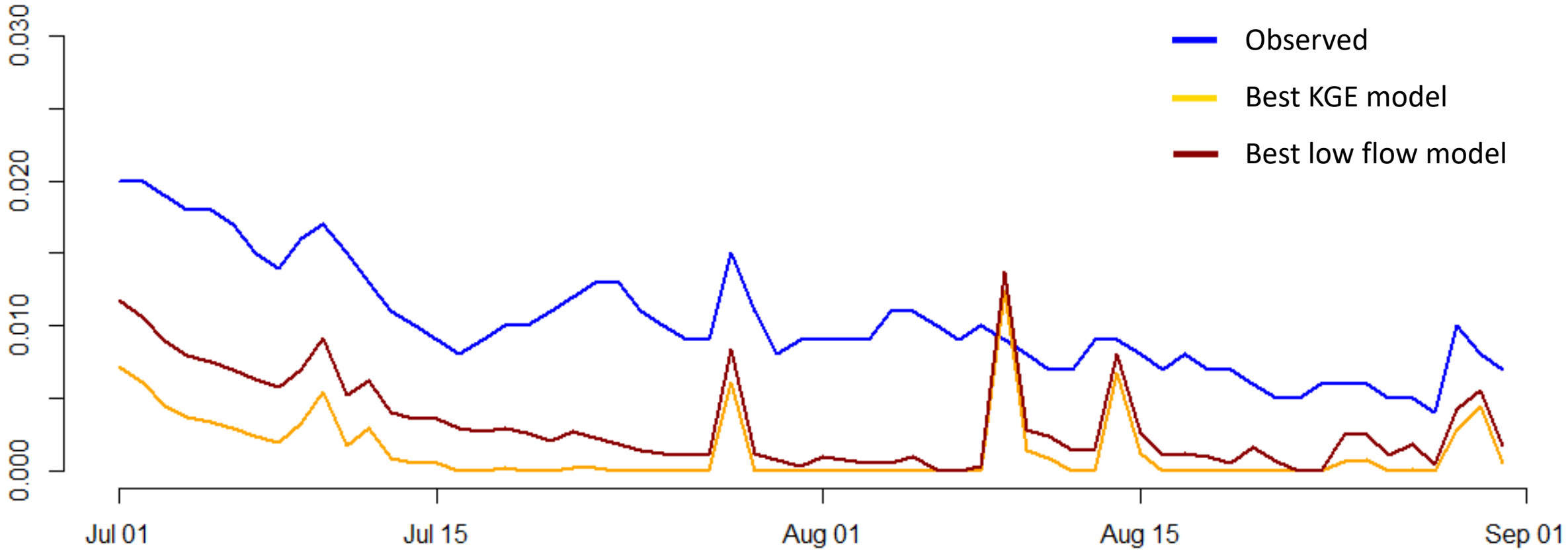


Summary and Conclusion

- Similar performance of all ‚best' models (diff. ≤0.06 in KGE and NSE)
- Extreme flood event 2017 not influenced by parameterization
- Uncertainty in the observation of the extreme flood peak
- Other peak flows better represented in high flow model
- Low flow model better than KGE model

- Preliminary results: small number of model runs

Outlook

- Peak flows: Improve rainfall representation by spatial interpolation
- Low flows: Add a 2nd shallow groundwater layer
- More model runs:
  - more robust results
  - best model for high and low flows (?)

- Use remotely sensed ET or soil moisture to add plausibility

Thank you very much for your attention!

EXDIMUM

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

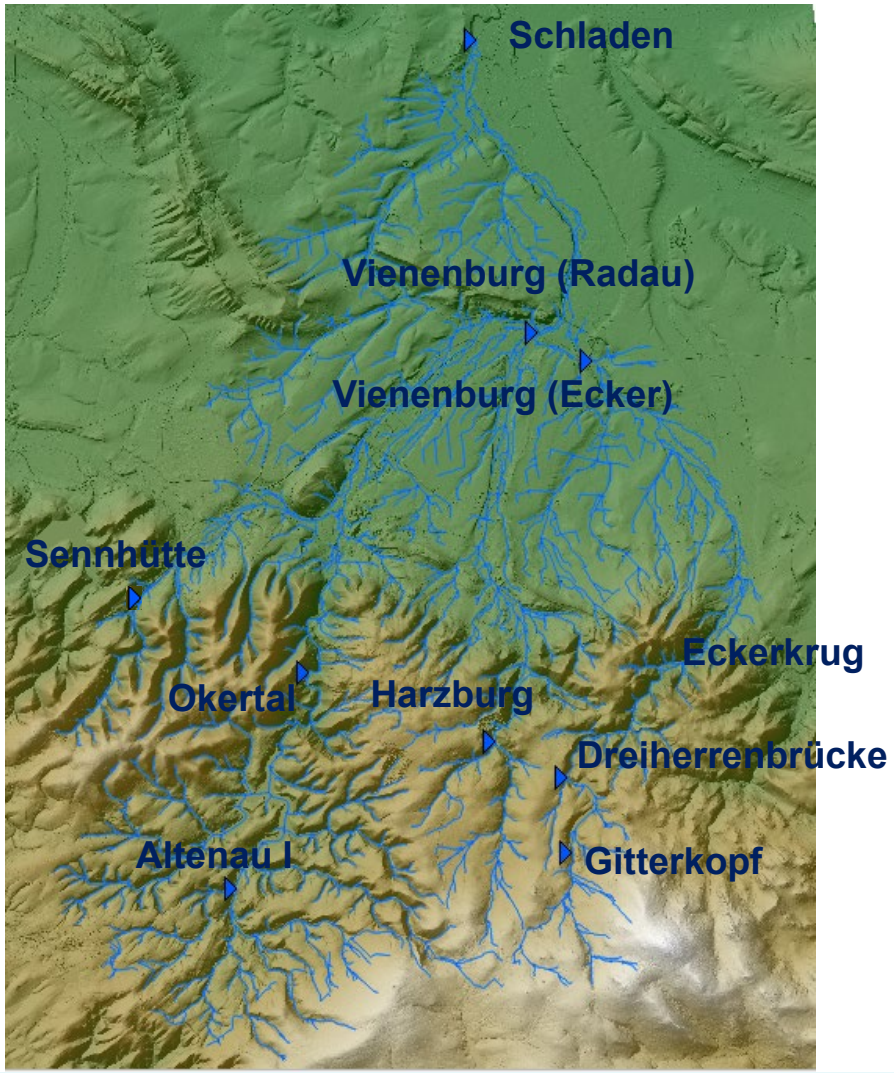
FONA
Forschung für Nachhaltigkeit

WaX
Wasser-Extremereignisse

Contact: pwagner@hydrology.uni-kiel.de

Parameter ranges

par	min	max	
CN2	-15	5	
SURLAG	0.4	1.4	
RCHRG_DP		0.03	0.17
ESCO	0.05	1.0	
PERCO	-20	5	
CN3	-20	20	
EPCO	0.05	0.5	
ALPHA_BF		0.5	1.0
SOL_AWC	0.04	0.2	
LATQ_CO	-20	20	
SNOMELT_TMP		-4	2

Weather and river gauges

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