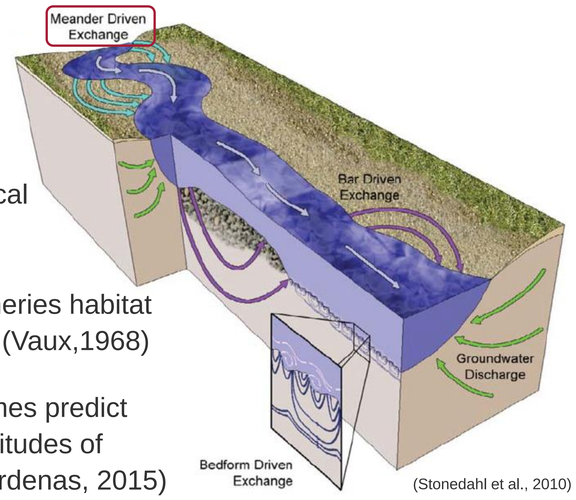
Integrated Modelling of Meander-Driven Hyporheic Exchange

Reynold Chow[1,2,3], Jeremy Bennett[1], Jürnjakob Dugge[1], Evan McLaughlin[1,3], Thomas Wöhling[4], Wolfgang Nowak[2]

(1) Center for Applied Geosciences, Universität Tübingen, Tübingen, Germany; (2) Institute for Water and Environmental Systems Modeling, Universität Stuttgart, Stuttgart, Germany
(3) Department of Earth and Environmental Sciences, University of Waterloo, Waterloo, Canada; (4) Department of Hydrology, Technische Universität Dresden, Dresden, Germany

Why is Hyporheic Exchange Important?

- Biogeochemical hotspots
- Useful for fisheries habitat management (Vaux,1968)
- Residence times predict relative magnitudes of reactions (Cardenas, 2015)

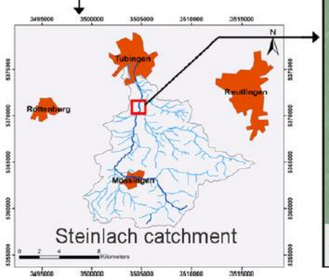


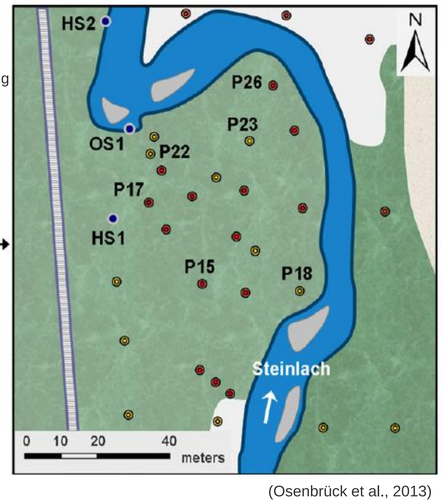
(Stonedahl et al., 2010)

Steinlach River Meander Test Site

Legend
- 1-in. well
- 2-in. well

HS: Hillslope Spring
OS: Outlet Spring



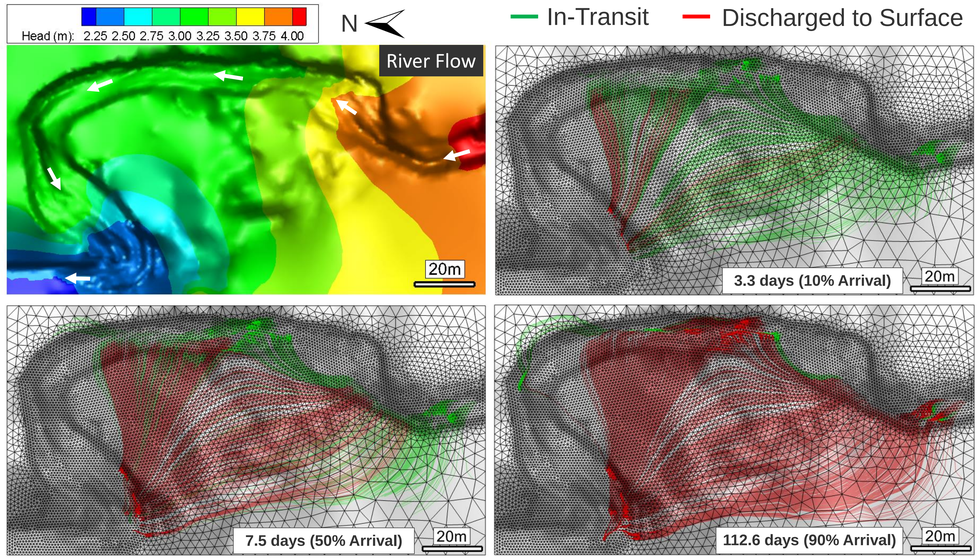


(Osenbrück et al., 2013)

Previous Studies

- Natural tracer experiment (Osenbrück et al., 2013)
- Geophysics: resistivity surveys (Doro et al., 2013)
- MODFLOW model (Wöhling et al., 2016)

Hyporheic Exchange Particle Tracks



Equal vs. Flux-Weighted Particles

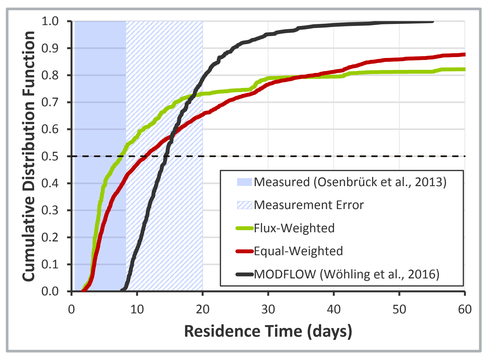
$$Equal-Weighted\ (EW)\ CDF = \frac{P_S}{P_T}$$

$$Flux-Weighted\ (FW)\ CDF = \frac{\sum_{i \in S}\left[\frac{(q_z)_i \cdot A_i}{N_i}\right]}{\sum_{j \in T}\left[\frac{(q_z)_j \cdot A_j}{N_j}\right]}$$

Modelled vs. Measured Residence Times

Median Residence Times

- Equal-Weighted: 11.3 days
- Flux-Weighted: 7.5 days
  - 38% decrease from EW to FW
- MODFLOW: 14.3 days



Initial Findings

- HGS model FW residence times in-line with measurements
- Significant increase in skewness for late-time HGS particles

Integrated Hydrogeological Model

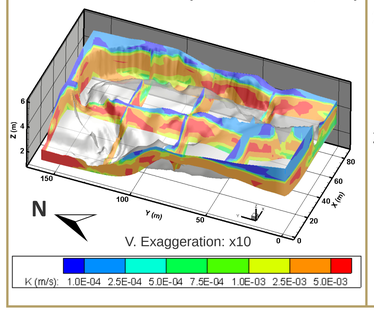
HydroGeoSphere (Aquanty Inc., 2017)

Model Parameters and Boundary Conditions (BCs)

Manning's Roughness

$n = 0.02\ ^{s}/_{m^{1/3}}$ **(Chow, 1959)**

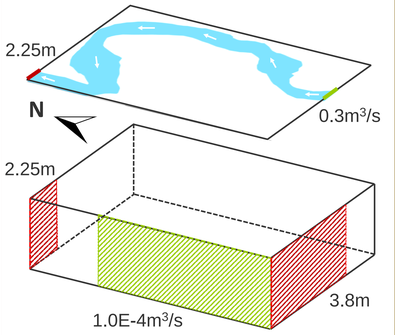
Hydraulic Conductivity (K) Multiple-Point Geostatistics
(Straubhaar et al., 2011)



Surface BCs
- Constant Q
- Constant H

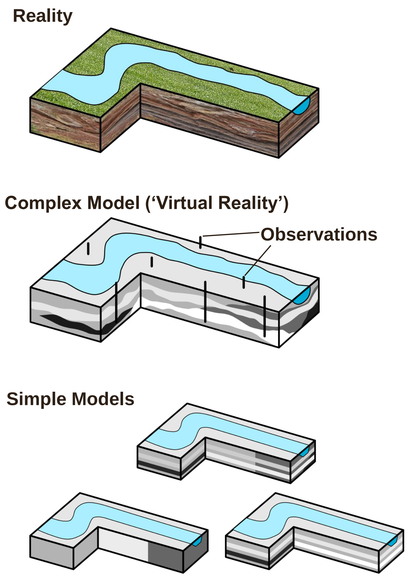
Subsurface BCs
- Constant Q
- Constant H

Q = Flux (m^3/s); H = Head (m)



Prioritizing Model Uncertainty

- How do individual sources of uncertainty influence model?
- Complex as benchmark for simpler models
- Monte Carlo based model uncertainty analyses
- Apply to catchment scale



(Dugge, 2013)

reynold.chow@uni-tuebingen.de

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