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Washington, D.C. | 10–14 Dec 2018

H23K-2095: Coupled flow and heat transport modelling of the hyporheic zone based on high resolution temperature and geophysics datasets.

Tuesday, 11 December 2018
13:40 - 18:00
Walter E Washington Convention Center - Hall A-C (Poster Hall)

Modeling flow and heat exchanges between the stream and the underlying hyporheic zone is essential for the study of the physical, chemical and biological hyporheic processes. The quantification of the spatial patterns of these flows within the hyporheic zone remains a challenge for the traditional flow and transport models particularly if based on point measurements. Distributed sensing techniques may contribute significantly to overcome this difficulty, thereby providing valuable information to make modeling more effective.

In particular, the spatial temperature patterns at the sediment-water interface observed with Fiber Optic Distributed Temperature Sensing allows defining more accurate boundary conditions to the heat transfer model domain. In addition, Electromagnetic Induction geophysics allow to map the distribution of electrical conductivity and through petrophysical relationship, or inverse modeling, infer hydraulic property variations, whose impact on flow and heat transport patterns can be significant in heterogeneous sand bed streams such as the study site River Schlaube (Germany).

The present study proposes a fully distributed three-dimensional modelling approach to estimate hyporheic flows based on a validated multiphysics flow and heat transfer model applied to the densely monitored reach of the Schlaube River. We apply MODFLOW-MT3DS through the python suite FloPy, whose flexibility facilitates the complex geometric definition of the upper thermal boundary condition provided by the Fiber Optic Distributed Temperature Sensing as well as the heterogeneity of hydraulic properties recognized by the geophysics.

The objective of the present work is to investigate hyporheic processes by a proper combination of distributed three-dimensional Multiphysics modeling and distributed sensing as provided by accurate Fiber Optic Distributed Temperature Sensing and Electromagnetic Induction geophysics surveys. The high resolution of the model discretization and data input enables a detailed identification of the sediment-water interface exchange patterns while allows the evaluation of the influence of the input's spatial resolution in the validity of the model as well as the impact of size of the model discretization on modelling the different scales of exchanges.

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