Spatiotemporal variability of stream water infiltration in a lowland river

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Résumé

Characterizing the spatiotemporal variability of groundwater fluxes at the stream/groundwater interface is extremely challenging, especially because of streambed heterogeneities that control hyporheic flow paths at different scales. Here, we are using Active-Distributed Temperature Sensing (DTS) methods for quantifying and mapping stream water infiltration in a lowland stream. By burying heatable Fiber-Optic (FO) cables within streambed sediments along few hundred of meters and by performing measurements under different hydrological conditions, we assess the variability of both groundwater fluxes and thermal conductivities of sediments at high spatial resolution. Experiments were conducted in a large meander located in the lowland part of the Sélune River (France), where permanent stream-losing conditions are observed across the neck. Since the temperature elevation measured during heating periods depends on both the natural stream temperature variations and the induced temperature variations resulting from the heat injection, we propose a new methodology to filter ambient temperature variations, extending the application of active-DTS to losing streams. After data processing, results show the lack of any correlation between groundwater fluxes and streambed topography variations, suggesting that the groundwater fluxes variability is mainly controlled by local streambed heterogeneities. Therefore, in the present case, the spatiotemporal variability of groundwater fluxes appears as a marker of the spatiotemporal variability of streambed hydraulic conductivities. Thus, the relatively low spatial and temporal groundwater fluxes variability suggests a relatively small variability of streambed properties, which is an interesting outcome for calibrating models assessing hyporheic processes. Interestingly, measurements made at different times during three years lead to very similar estimates showing the excellent reproducibility of measurements, but also, in the present case, the remarkable stability of hyporheic flows through times.

Mots-Clés: Lowland river, Hyporheic zone, Thermal conductivities and groundwater fluxes variabilities, Distribted Temperature Sensing

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