Geophysical Research Abstracts
Vol. 16, EGU2014-11686, 2014
EGU General Assembly 2014

Temporal and spatial variability of oxygen concentrations during stream water infiltration into a shallow alluvial aquifer

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Stream-groundwater interaction is believed to significantly contribute to the retention and degradation of pollutants by means of associated biogeochemical processes in the hyporheic zone. In this study we present high frequency time series of oxygen concentrations derived from automatic probes in the stream and in groundwater of the adjacent alluvial aquifer. The main objective was to interrelate the variability of oxygen concentrations with microbial community fingerprints and travel times during infiltration of stream water into the shallow aquifer.
The study is located at the Steinlach Test Site near Tübingen in Southern Germany, consisting of a river bend of about 0.6 ha underlain by a sandy gravel aquifer. The site is equipped with more than 30 piezometers, most of them containing automatic water level, temperature, and specific electrical conductivity probes, which were used to delineate flow paths and travel times of water between the stream and the piezometers. Additionally, in-situ microcosms were used to investigate microbial community dynamics and water samples were taken for the analysis of major ions and DOC from March 2012 to December 2013.
Concentrations of dissolved oxygen showed seasonal variations as well as short-term fluctuations related to flood events. Although no clear relationship between travel times (ranging from 0.2 to 8 days) and oxygen (and nitrate) concentrations could be observed for the test site in total, we found an increase in oxygen consumption and nitrate reduction with increasing travel time for a small subregion of the test site. The microbial community based on 16S DGGE fingerprinting also revealed seasonal variations. In contrast to this, the fingerprinting based on the functional gene of the nitrite reductase as indicator of potential denitrifiers did not show a relation with season. We attribute this different biogeochemical behaviour of the otherwise relatively uniform sediments to different exposure times to zones with bioavailable organic matter.