High-resolution (noble) gas time series for environmental research

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The miniRUEDI [1] is a new portable mass spectrometer for the unbiased on-site quantification of gas concentrations (He, Ar, Kr, N_2, O_2, CO_2, CH_4, etc.) in terrestrial gases and, using the gas-equilibrium membrane-inlet technique (GE-MIMS), for the first time also in water bodies [2]. In contrast to conventional sampling and subsequent lab analysis, the miniRUEDI provides real-time and continuous time series of gas concentrations with a time resolution of a few seconds. Such high-resolution time series open up new opportunities for environmental research. We present the miniRUEDI and some new applications of tracking gas dynamics related to rapid, short-term processes in aquatic systems.

(1) We recorded the dissolved gas concentrations in a managed groundwater system where drinking water is produced by artificial groundwater recharge. The responses of the gas concentrations to changes in the recharge provide useful information on the groundwater dynamics and mixing with potential contaminant sources.

(2) We monitored the gas concentrations in groundwater pumped from a deep observation well in a fractured aquifer. The gas concentrations were highly variable not only during initial purging of the well, but throughout the entire duration of the test (6 h). We attribute this to variable mixing of water derived from different fractures of the heterogeneous aquifer.

(3) We analysed the atmospheric gas concentrations in shallow surface waters with the goal of quantifying air/water gas exchange. The (diurnal) variation of the water temperature causes disequilibria in the air/water partitioning of atmospheric gases. The responses of the observed concentration time series relative to the equilibrium concentrations determined by the water temperature are expected to reflect the air/water exchange rates and biogeochemical turnover of the different gas species.

[1] Gasometrix GmbH, gasometrix.com
[2] Brennwald, M.S., Schmidt, M., Oser, J., and Kipfer, R. (2016). Environmental Science and Technology, 50(24):13455–13463, doi: 10.1021/acs.est.6b03669