Advances in the on-site and remote-controlled analysis of dissolved (noble) gases in water bodies

Y. TOMONAGA[12], M.S. BRENNWALD[1], R. RÜSSEL[1],
R. KIPFER[13]

[1]Eawag, Swiss Federal Institute of Aquatic Science and Technology, Switzerland (tomonaga@eawag.ch)
[2]Atmosphere and Ocean Research Institute, The University of Tokyo, Japan
[3]ETH, Swiss Federal Institute of Technology Zurich

The gas concentrations in water bodies are controlled by air/water exchange, sources/sinks in the water, and mixing of different fluids. Atmospheric gases originate from air/water partitioning at the water surface and (partial) dissolution of air bubbles entrained/entrapped in the water (excess air, EA). The EA dissolved-gas concentrations are commonly substantial in groundwaters. The noble gas concentrations in water allow EA quantification, which provides a robust basis for quantitative interpretation of reactive gases.

We developed a membrane-inlet mass spectrometer system (MIMS) for quasi-continuous on-site gas analysis in the field (He, Ar, Kr, N_2, O_2, CO_2, CH_4, etc.; Mächler et al., 2012, ES&T). Most recently, we miniaturized this instrument and significantly reduced power consumption to allow battery operation in the field. The instrument yields gas concentration time series, which provide the data basis for robust interpretation and quantification of gas dynamics in terms of physical and biogeochemical processes.

Until now our mass spectrometer systems has been controlled using a powerful and flexible software developed at Eawag/ETH. However, as this software runs in a MS Windows environment, the host computer must fulfill minimum hardware requirements, energy consumption is rather high, and in general system customization is not straightforward. These and other reasons make the use of the present MIMS control difficult to implement in case studies where energy and connectivity resources are limited. To further facilitate the remote operation of the MIMS, we are currently developing a new approach based on the credit card-sized Raspberry Pi single-board computer which runs a free optimized Linux system. Some of the advantages of such a simple solution are extremely low hardware costs, low energy consumption, access via mobile/satellite networks using low bandwidth data channels, on-board serial connectivity (e.g., for deep-sea deployment using remotely operated vehicles). With the present contribution we would like to stimulate a discussion about the future developments of on-site remote-controlled gas analysis.