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A mobile and self-sufficient lab for high frequency measurements of stable water isotopes and chemistry of multiple water sources

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Technical advances over the last years have made instruments for stable water isotope and water chemistry measurements smaller, more durable and energy efficient. It is nowadays feasible to deploy such instruments in situ during field campaigns. Coupled to an automated sample delivery system, high temporal resolution online measurements of various sources are within the bounds of economic and technical possibility. However, the day to day operation of such equipment still requires either a lot of man power and infrastructure or the implementation of a quasi-self-sufficient system. The challenge remains on how to facilitate and remotely operate such a system.

We present the design and implementation of the Water Analysis Trailer for Environmental Research (WATER), an autonomous platform consisting of instruments for stable water isotope and water chemistry analysis. The system takes and measures samples in high temporal resolution (<15 min) of up to 12 sources. To ensure an unmanned operation of up to one week several issues need to be addressed. The essential topics are:
- self-sufficient power supply,
- automated sample delivery and preparation, and
- autonomous measurements and management interfacing all instruments.

In addition to the basic requirements we implemented:
- communication of all system states, alarm messages and measurement results to an internal as well as an external database via cellular telemetry,
- automated storage of up to 300 frozen reference samples (100 mL, stored at -18°C),
- climate control for temperature sensitive equipment (±1°C),
- a local and remote (up to 20 km using radio telemetry) sensor network (i.e. to record states of the hydrological system and climate and soil conditions), also suitable to trigger specific measurements
- automatic fire suppression and security system.

The initial instrumentation includes a UV spectrometer (ProPs, Trios GmBH, Germany) to measure NO_3-, COD, TOC and total suspended sediments, multiparameter water quality probe (YSI600R, YSI, USA) to measure electrical conductivity and pH, and a stable water isotope analyzer (L2130-i, Picarro, USA) coupled to a continuous water sampler (A0217, Picarro, USA). Fourty soil moisture, temperature and electrical conductivity sensors (5TE, Decagon, USA) are connect to the remote sensor network (A850, Adcon, Austria) and rain gauges and a climate station (WXT520, Vaisala, Finland) are connected to the local sensor network via SDI-12.

In a first field trial starting in March 2017 the mobile laboratory will be used to study the hydrological processes in the developed landscape of the Schwingbach catchment (Germany). We are confident, that the unprecedented degree in detail, the measurements promise, will further accelerate our hydrological understanding and the interaction of various discharge generating sources.