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Automated high resolution rain water sampler for stable water isotope monitoring

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With global change, one of the largest short-term threats to our societies comes from changes in the hydro-meteorological cycle: droughts, flooding and potentially increasing extreme rain events may have far greater direct impact on humans than rising temperatures alone. These changes often have sever consequences and widespread impact on society and ecosystems, yet they are difficult to track, trace and measure in order to fully understand the underlying process of delivering moisture and recharging water reservoirs. Only through the comprehensive monitoring of precipitation waters in space and time can we improve our process understanding and better predict the direction and magnitude of future hydro-meteorological changes, in particular on regional spatial scales. However, no commercial automated sampling solution exists, which fulfills the quality criteria for sophisticated hydrochemical water analysis.

Here, we present an new developed automatic precipitation water sampler for stable water isotope analysis of precipitation. The device is designed to be highly autonomous and robust for campaign deployment in harsh remote areas and fulfills the high demands on sampling and storage for isotope analysis (i.e. sealing of samples from atmospheric influences, no contamination and preservation of the sample material). The sampling device is portable, has low power consumption and a real-time adaptable sampling protocol strategy, and can be maintained at distance without any need to visit the location. Furthermore, the obtained water samples are not restricted to isotope analysis but can be used for any type of environmental water analysis. The current configuration can obtain 165 discrete rainwater samples with a minimum timely resolution of 5min or volume wise 2mm of rainfall.

The device was tested in several evaluation and benchmarking cycles. First lab tests with dyed waters and waters with strongly differing isotopic signature demonstrate that the device can obtain, store and conserve samples without cross contamination over long periods of time. The device has been tested so far under several conditions, e.g. heavy summer thunderstorms with more than 50mm/24h of rainfall, sustained winter rainfall and in cold conditions involving melting of snow. Furthermore, we run a benchmark test with several devices in parallel. Finally, in October 2020, we had installed six devices, in collaboration with Germany's National Meteorological Service (Deutscher Wetterdienst DWD), in a South-West to North-East transect across the Harz mountains

in Germany. The transect covers ~ 100km distance along the main orographic gradient.

This automated rainwater sampler provides an economic and sophisticated technological solution for monitoring moisture pathways and water transfer processes with the analytical quality of laboratory standard measurements on a new level of temporal and spatial resolution.