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FieldSpec: A field portable mass spectrometer prototype for high frequency measurements of δ^2H and δ^{18}O ratios in water

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Hydrological studies relying on stable water isotopes to better understand water sources, flowpaths and transit times are currently limited by the coarse temporal resolution of sampling and analysis protocols. At present, two kinds of lab-based instruments are used : (i) the standard isotope ratio mass spectrometers (IRMS) [1] and (ii) the laser-based instruments [2, 3]. In both cases, samples need to be collected in the field and then transferred to the laboratory for the water isotopic ratio measurements (even further complex sample preparation is required for the IRMS). Hence, past and ongoing research targets the development of field deployable instruments for measuring stable water isotopes at high temporal frequencies. While recent studies have demonstrated that laser-based instruments may be taken to the field [4, 5], their size and power consumption still restrict their use to sites equipped with mains power or generators. Here, we present progress on the development of a field portable mass spectrometer (FieldSpec) for direct high frequency measurements of δ^2H and δ^{18}O ratios in water. The FieldSpec instrument is based upon the use of a double focusing magnetic sector mass spectrometer in combination with an electron impact ion source and a membrane dual inlet system. The instrument directly collects liquid water samples in the field, which are then converted into water vapour before being injected into the mass spectrometer for the stable isotope analysis. δ^2H and δ^{18}O are derived from the measured mass spectra. All the components are arranged in a vacuum case having a suit case type dimension with portable electronics and battery. Proof-of-concept experiments have been carried out to characterize the instrument. The results show that the FieldSpec instrument has good linearity (R^2 = 0.99). The reproducibility of the instrument ranges between 1 and 4 ‰ for δ^2H and between 0.1 and 0.4 ‰ for δ^{18}O isotopic ratio measurements. A measurement frequency of less than 60 minutes per sample has been achieved. We intend to further increase the measurement frequency in the near future. In this presentation, we will describe the instrument, present experimental data reflecting its performance and discuss applications.

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