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High-resolution vertical profiles of stable water isotopes from airborne measurements in the western Mediterranean during HyMeX in October 2012

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Stable water isotopes are useful indicators of meteorological processes on a broad range of scales, reflecting for example evaporation, precipitation and airmass mixing processes. Scientific understanding of water isotope meteorology has long been impeded by the sparsity of observational data. Most measurements of precipitation and water vapour have been made at the surface. Both sampling and isotope measurements had been fairly intricate until recently, and required to transfer samples to a lab environment. With the recent advent of fast laser-based spectroscopic methods it has become possible to measure the isotopic composition of atmospheric water vapour in situ at high temporal resolution, enabling to tremendously extend the measurement data base in space and time.

Here we present the first set of airborne spectroscopic stable water isotopes measurements in the Mediterranean. Measurements have been acquired by a customised Picarro L2130i instrument with enhanced data acquisition rate by a dual-laser system. The instrument was deployed in cooperation with the Karlsruhe Institute of Technology (KIT) onboard the Dornier 128-6 research aircraft D-IBUF of the Institute of Flight Guidance, TU Braunschweig together with a meteorological flux measurement package during HYMEX in Corsica, France. Taking into account memory effects of the pipe system, the typical time resolution of the measurements was about 30s, resulting in an average spatial resolution of about 2 km. Cross-calibration of the water vapour observations with other humidity sensors showed good agreement in most flight conditions but very turbulent ones. In total 23 successful stable isotope flights have been performed.

We report on the measurement setup, calibration procedures and data quality, and a first interpretation of these new airborne observations. A climatological perspective of the vertical stable isotope composition in the vicinity of Corsica during the campaign reveals for the first time vertical structure and variability of the Mediterranean boundary layer at high resolution. A comparison to literature data sets shows principal agreement, yet a tremendous level of detail is added by the new measurements. In a case study where a distinct airmass transition occurred during one flight we demonstrate the potential of the data to provide additional information that is not available from common meteorological measurements alone.