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The isotopic signature of ecosystem respiration and Eddy Covariance measurements of stable CO_2 isotopologues in a temperate beech forest

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Analyzing the isotopic composition of CO_2 fluxes has provided valuable insights into ecosystem gas exchange. Stable isotopes in CO_2 have been used for example to analyze different influencing factors of ecosystem respiration and to partition CO_2 fluxes into assimilation and respiration e.g. by directly measuring the isotopic composition of CO_2 net fluxes on ecosystem scale.

During a three month measurement campaign in autumn 2015, we measured the isotopic composition of CO_2 in nine different heights using a new, easy-to-use Isotope Ratio Infrared Spectrometer (IRIS) Delta Ray (Thermo Scientific, Bremen) developed for high precision measurements of ^{13}C and ^{18}O in $CO_2$with automatic calibration. Based on a Keeling Plot approach we calculated the isotopic signal of ecosystem respiration in ^{13}C as well as in ^{18}O. Additionally, we performed high frequency (4 Hz) measurements of the isotopic composition of CO_2 in 35 m height using a quantum cascade laser based spectrometer (QCLAS, Aerodyne Research) with thermoelectrically cooled detectors.

The Delta Ray Analyzer had a cell turnover time of approximately 12s and high temporal stability of a target measurement under field conditions as well as high precision. The minimum of its Allan variance was 0.02‰ for $^{13}\delta$C and 0.03‰ for $^{18}\delta$O with averaging times of app. 290s. The high frequency QCLAS was used to perform 4Hz measurements and showed maximum precision for averaging periods of app. 90s with an Allan Deviation of 0.04‰ for $^{13}\delta$C and 0.06‰ for $^{18}\delta$O. The measured isotopic signal of respired CO_2 showed large seasonal variability with nighttime values (taken between 22h and 2h) ranging from -25 to -38‰ for $^{13}\delta$C and from -7.7 to -48.7 ‰ for $^{18}\delta$O. For both δ-values we find large day-to-day variability that exceeds the error of the underlying linear regression. We also show to which extent the two different laser spectrometers which were calibrated completely independently give consistent results and test the correlation with the measured meteorological quantities such as vapor pressure deficit (VPD). Additionally, we plan to present first Eddy Covariance isotopologue fluxes.