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Application of a low-cost NDIR sensor module for measurements of in situ soil CO₂ concentration

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We applied the low-cost non-dispersive infrared sensor module K33 (ICB, Senseair, Sweden) for measurements of soil CO₂ concentration. We integrated the sensor module in a new soil probe suitable for in situ measurements of soil gas CO₂ concentration. Therefore, we covered the sensor module with epoxy resin. For continuous measurements, we connected our soil CO₂ probe to a microcontroller (MEGA 2560 Rev3, Arduino.cc, Italy) equipped with a data logging shield (Adalogger FeatherWing, Adafruit, USA). In a laboratory experiment, we evaluated the accuracy and precision of our soil CO₂ probe at changing temperature and humidity by comparison with the often used CO₂ probe GMP343 (Vaisala, Finland) as a reference. In a field experiment, we buried our soil CO₂ probe to test its performance under natural environmental conditions.

The result of the laboratory experiment is that our soil CO₂ probe compares well with the GMP343, even at maximum relative humidity. The accuracy (<0.1 % CO₂) was below the accuracy given by the manufacturer. The field experiment demonstrated that our soil CO₂ probe provides high-quality measurements of soil CO₂ concentrations under in situ soil conditions. After retrieving it, it still measured with the same accuracy and precision as before.

In summary, we used the sensor module K33 for the first time to measure in situ soil CO₂ concentrations by integrating it into a newly developed probe. The cost-efficient availability of our CO₂ probe opens up the opportunity to carry out continuous soil CO₂ measurements over long time periods with simultaneously high spatial resolution.