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Long-term field performance of a tunable diode laser absorption spectrometer for analysis of carbon isotopes of CO_2 in forest air

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Abstract. Tunable diode laser absorption spectrometry (TDLAS) is gaining in popularity for measuring the mole fraction [CO_2] and stable isotopic composition ($\delta^{13}C$) of carbon dioxide (CO_2) in air in studies of biosphere-atmosphere gas exchange. Here we present a detailed examination of the performance of a commercially-available TDLAS located in a high-altitude subalpine coniferous forest (the Niwot Ridge AmeriFlux site), providing the first multi-year analysis of TDLAS instrument performance for measuring CO_2 isotopes in the field. Air was sampled from five to nine vertical locations in and above the forest canopy every ten minutes for 2.4 years. A variety of methods were used to assess instrument performance. Measurement of two compressed air cylinders that were in place over the entire study establish the long-term field precision of 0.2 μmol mol^{-1} for [CO_2] and 0.35 ‰ for $\delta^{13}C$, but after fixing several problems the isotope precision improved to 0.2\permil (over the last several months). The TDLAS provided detail on variability of $\delta^{13}C$ of atmospheric CO_2 that was not represented in weekly flask samples, as well as information regarding the influence of large-scale (regional) seasonal cycle and local forest processes on [CO_2] and $\delta^{13}C$ of CO_2. There were also clear growing season and winter differences in the relative contributions of photosynthesis and respiration on the [CO_2] and $\delta^{13}C$ of forest air.

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