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Carbon isotope analysis of discrete CO_2 samples ranging from 300 ppm (ambient levels) to 100% (pure) using Cavity Enhanced Laser Absorption

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Fast, precise, and accurate measurement of $\delta^{13}C$ ($^{13}C/^{12}C$ in CO_2) of carbon dioxide is desirable for a number of applications including atmospheric chemistry and carbon sequestering. Recent advances in laser absorption spectroscopy, such as cavity enhanced techniques, have enabled field portable instruments which have a number of advantages over traditional, laboratory-based mass spectroscopy systems. We report on the recent developments of an analyzer, based on a patented laser absorption technique (off-axis integrated cavity output spectroscopy or Off-Axis ICOS), which measures CO_2 concentration and $\delta^{13}C$. The analyzer operates at 1 Hz and achieves an isotope precision of 0.25‰ (standard deviation) with less than 1 minute of averaging. Besides free-flow (continuous flow) operation, the instrument can also analyze discrete gas samples. For ambient levels of CO_2 (300 ppm to 1000 ppm), the analyzer operates with a gas volume of 120 ml (standard). With appropriate dilution, smaller sample volumes of higher concentration CO_2 may be analyzed. In the case of pure (100%) CO_2 samples, only 100 micro-liters of sample is required. For each sample injection, the instrument automatically pumps down and preps the measurement cell before recording data. Sample-to-sample measurement time is roughly 6 to 7 minutes. The instrument is low-power ($\sim$ 150 watts) allowing for easy measurements in the field. Details concerning instrument performance, operation, sample dilution procedure, and calibration will be presented.