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Towards high-precision isotopic analysis of CO_2 from ice-core gas bubbles using quantum cascade laser spectroscopy

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The paleo-climate archive provided by gas stored in bubbles in the ice provides a powerful means to study the $\sim$40% increase in the atmospheric CO_2 concentration between glacial and interglacial climates, in combination with numerical modeling studies, to elucidate the underlying physical mechanisms. Of particular interest is, considering the strong correlation between the carbon cycle and climate, and in light of the post-industrial revolution anthropogenic increase of the CO_2 concentration. The source of the CO_2 released into the atmosphere during previous deglaciations can be constrained from $13CO_2$ isotopic measurements on CO_2 gas stored in bubbles in the ice-cores by the fact that the different CO_2 reservoirs (terrestrial biosphere, oceans) and associated mechanisms (biological or physical) have different isotopic signatures. Unfortunately, conventional IRMS measurements on the small quantity of gas available are difficult, tedious, and time-consuming.
We report here on the design of an alternative method based on Optical Feedback Cavity Enhanced Absorption Spectrometry (OF-CEAS) using a quantum cascade laser operating near 4.36 μm. The aim of this instrument design is to achieve the measurement of the 13C/12C isotopic ratio (δ13C) with a precision better than 0.05 ‰ on small quantities of the trapped atmospheric CO_2. We describe the instrument and show preliminary results.