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The in situ measurement of H_2O, CO_2 and their isotopes in the Martian atmosphere using laser absorption spectroscopy: laser testing and TDLAS prototype.

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Laser absorption spectroscopy is highly efficient to provide in situ trace-gas measurements at high temporal and spatial resolutions and with a high selectivity in the analyzed species. It is used in the SDLA spectrometer, developed by Service d'Aéronomie with the support of the CNES and CNRS, to monitor H_2O, CH_4 and CO_2 in the middle atmosphere from stratospheric balloons. Based on the developed laser probing technique, we are developing with the support of CNES the TDLAS laser sensor for studying the Martian atmosphere. The Martian atmospheric composition and pressure conditions enable the realization of a compact and lightweight instrument. The main objectives are to determine water vapor and carbon dioxide fluxes and to study boundary layer properties. The sensor will provide in situ daily, diurnally resolved measurements of near-surface H_2O and CO_2 concentration over seasonal time scales. The additional isotopic measurements will provide quantitative constraints on the evolution of atmospheric composition and on the history of water on Mars.

The TDLAS laboratory prototype uses a Distributed Feedback InGaSb laser diode at 1877nm to monitor simultaneously H_2O and CO_2 over a 120cm folded optical path length. The line strengths which are needed to retrieve the concentration from the in situ spectrum have been revisited in our laboratory to improve accuracy. We have also tested a laser diode at 2042nm which can measure simultaneously the carbon dioxide isotopes $^{13}CO_2$ and $^{16}O^{12}C^{18}O$. Regarding the water isotopes, HDO, $H_2^{18}O$

and $H_2^{17}O$, a third laser diode is needed to reach strong molecular transitions in the 2.6 μm spectral range. This laser is under development with the support of the CNES by the Centre d'Electronique et Micro-Optoélectronique de Montpellier (CEM2, CNRS, France) and will be tested at the end of 2005.