Geophysical Research Abstracts
Vol. 14, EGU2012-5054, 2012
EGU General Assembly 2012

CHARM-F: An airborne integral path differential absorption lidar for simultaneous measurements of carbon dioxide and methane columns

A. Amediek (1), H.-C. Büdenbender (1), G. Ehret (1), A. Fix (1), C. Kiemle (1), M. Quatrevalet (1), M. Wirth (1), D. Hoffmann (2), J. Löhring (2), and V. Klein (3)

(1) Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institut für Physik der Atmosphäre, Oberpfaffenhofen, 82234 Weßling, Germany, (2) Fraunhofer Institut für Lasertechnik (ILT), Steinbachstr. 15, D-52074 Aachen, Germany, (3) Kayser-Threde GmbH, Wolfratshauser Straße 48, 81379 München, Germany

CHARM-F (CO_2 and CH_4 Atmospheric Remote Monitoring – Flugzeug) is DLR's airborne Integral Path Differential Absorption (IPDA) lidar for simultaneous measurements of the column-weighted average dry-air mixing ratios of atmospheric carbon dioxide and methane, designed to be flown on DLR's new High-Altitude, LOng-range research aircraft, HALO. It is meant to serve as a demonstrator of the use of spaceborne active optical instruments in inferring atmospheric CO_2 and CH_4 surface fluxes from total column measurements by inverse modeling. As it will be shown, this is enabled by HALO's high flight altitude and its range of 8000 km, which will make it possible to produce real-world data at truly regional scales with a viewing geometry and vertical weighting function similar to those enabled by a space platform. In addition, CHARM-F has the potential to be used as a validation tool not only for active but also passive spaceborne instruments utilizing scattered solar radiation for remote sensing of greenhouse gases.

Building on the expertise from CHARM, a helicopter-borne methane IPDA lidar for pipeline monitoring developed in collaboration with E.ON, and WALES, DLR's water vapour differential absorption lidar, CHARM-F relies on a double-pulse transmitter architecture producing nanosecond pulses which allows for a precise ranging and a clean separation of atmospheric influences from the ground returns leading to an unambiguously defined column. One pulse is tuned to an absorption line of the trace gas under consideration, the other to a nearby wavelength with much less absorption. The close temporal separation of 250 μs within each pulse pair ensures that nearly the same spot on ground is illuminated. The ratio of both return signals is then a direct function of the column-weighted average dry-air mixing ratio. The two laser systems, one for each trace gas, use highly efficient and robust Nd:YAG lasers to pump an optical parametric oscillator (OPO) level which converts the pump radiation to the desired wavelengths.

Because typical surface CO_2 and CH_4 sources and sinks alter the total column only by a few percent, the required precision and accuracy are very stringent. This puts particularly challenging requirements on the spectral properties of the emitted pulses. To achieve single mode operation with very high spectral purity, both pumps and OPOs are injection seeded. Absolute stability of the emitted wavelengths is achieved by locking the seed lasers to the same absorption lines as those used in the atmosphere by means of a single absorption cell filled with a mixture of CO_2 and CH_4, and monitoring the wavelength deviations between each outgoing laser pulse and the corresponding seed laser to detect and correct for possible mode pulling effects. Another key requirement is the monitoring of the relative outgoing pulse energies with high accuracy, which is based on a specifically designed optical architecture. Assembly and laboratory tests of the instrument are on-going, the first ground tests are planned for summer 2012.