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Demonstration of Greenhouse Gas Sounding by IR-Laser Occultation by a Ground-Based Crosslink Experiment at the Canary Islands

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The new climate satellite mission concept ACCURATE is based on inter-satellite sounding between Low Earth Orbit (LEO) satellites and employs LEO-LEO microwave and infrared-laser occultation (LMIO) for profiling of greenhouse gases (GHGs), thermodynamic variables and wind in the free atmosphere. The GHG profiling is estimated to achieve a climatological r.m.s. error of $<$0.15 to 0.5 % over the upper troposphere and lower stratosphere at $\sim$1 km vertical resolution (e.g., CO_2 $<$1 ppm, $CH4_4$ $<$7 ppb; residual biases estimated less than half these r.m.s. values). LMIO is designed to deliver this performance as an independent, self-calibrated remote sensing technique with highly accurate GHG profiling capability.

These promising prospects of LMIO (introduced by Kirchengast and Schweitzer, GRL, 38, L13701, 2011; www.agu.org/pubs/crossref/2011/2011GL047617.shtml) led to a first ground-based demonstration experiment in July 2011 at the Canary Islands (ESA-funded experiment project by Bernath et al.; Univ. York, Univ. Graz, Univ. Manchester, MPI Jena). A ground link of $\sim$144 km range between observatories on La Palma and on Tenerife at altitudes of $\sim$2.4 km was realized. With transmitter and receiver breadboard equipment built for four infrared-laser signals, we aimed in this campaign at CO_2, CH_4, and H_2O measurements under field conditions somewhat akin to a space-based link. A well-visible green laser served as supporting source to accurately point the IR-lasers towards the receiver telescope. Despite the practical challenges of such long-range observations, especially related to the needed fine adjustments of laser beam pointing under windy high-altitude conditions, we achieved first good data for retrieving the GHGs so that the basic demonstration of the experimental feasibility of IR-laser occultation was successful. In this presentation we discuss GHG results retrieved from the experimentally recorded IR-laser spectra in comparison to in-situ GHG measurements (based on cavity ring-down spectrometers) taken at both the transmitter and receiver sites for validation purposes.