Geophysical Research Abstracts
Vol. 15, EGU2013-3319, 2013
EGU General Assembly 2013

Quantum cascade laser based sensor for in situ and real time atmospheric trace gases (CO and N2O) measurements

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In addition to the primary greenhouse gases carbon dioxide (CO_2) and methane (CH4), several other atmospheric trace gases are radiatively active, and thereby can also contribute to a greenhouse warming of the lower atmosphere directly or indirectly. Nitrous oxide (N2O) is a greenhouse gas with a global warming potential about 200-300 times that of CO_2. Carbon monoxide (CO) is not considered a direct greenhouse gas, mostly because it does not absorb terrestrial thermal IR energy strongly enough. However, CO plays an important role in the oxidative chemistry of Earth's atmosphere, since it is a key trace gas for controlling the budget and distribution of the hydroxyl (OH) radical, which exerts a controlling influence on the gas phase chemistry of many atmospheric species [1]. Therefore, there is a critical need to identify sources and sinks of N2O and CO in order to better understand their impact on global climate change [2].

We present a fast, compact, and precise sensor based-on a novel thermoelectrically (TE) cooled quantum cascade laser (QCL) operating at near-room temperature in CW (continuous-wave) mode for simultaneous detection of atmospheric N2O and CO. The technique is based on atmospheric absorption of these trace species in the mid-infrared region near 4.56 μm, using a single QC laser source and two TE-cooled infrared detectors. Wavelength modulation spectroscopy with second harmonic detection technique in conjunction with a compact multi-pass absorption cell has been employed to demonstrate highly sensitive and precise measurements. CO and N2O at ambient concentration levels are detected simultaneously with a high temporal response (< 1s). Preliminary results (Laboratory investigation and field application) of the sensor's performance will be presented. This completely TE-cooled system shows the capability of long-term, unattended and continuous operation at room temperature without complicated cryogenic cooling [3].

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