A Miniaturized Laser Heterodyne Radiometer for a Global Ground-Based Column Carbon Monitoring Network

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We present progress in the development of a passive, miniaturized Laser Heterodyne Radiometer (mini-LHR) that will measure key greenhouse gases (CO_2, CH_4, CO) in the atmospheric column as well as their respective altitude profiles, and O_2 for a measure of atmospheric pressure. Laser heterodyne radiometry is a spectroscopic method that borrows from radio receiver technology. In this technique, a weak incoming signal containing information of interest is mixed with a stronger signal (local oscillator) at a nearby frequency. In this case, the weak signal is sunlight that has undergone absorption by a trace gas of interest and the local oscillator is a distributive feedback (DFB) laser that is tuned to a wavelength near the absorption feature of the trace gas. Mixing the sunlight with the laser light, in a fast photo-receiver, results in a beat signal in the RF. The amplitude of the beat signal tracks the concentration of the trace gas in the atmospheric column.

The mini-LHR operates in tandem with AERONET, a global network of more than 450 aerosol sensing instruments. This partnership simplifies the instrument design and provides an established global network into which the mini-LHR can rapidly expand. This network offers coverage in key arctic regions (not covered by OCO-2) where accelerated warming due to the release of CO_2 and CH_4 from thawing tundra and permafrost is a concern as well as an uninterrupted data record that will both bridge gaps in data sets and offer validation for key flight missions such as OCO-2, OCO-3, and ASCENDS.

Currently, the only ground global network that routinely measures multiple greenhouse gases in the atmospheric column is TCCON (Total Column Carbon Observing Network) with 18 operational sites worldwide and two in the US. Cost and size of TCCON installations will limit the potential for expansion. We offer a low-cost (<\$30K/unit) solution to supplement these measurements with the added benefit of an established aerosol optical depth measurement. Aerosols induce a radiative effect that is an important modulator of regional carbon cycles. Changes in the diffuse radiative flux fraction (DRF) due to aerosol loading have the potential to alter the terrestrial carbon exchange.