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Low-cost miniaturized laser heterodyne radiometer for highly sensitive detection of CO₂ and CH₄ in the atmospheric column.

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We present a new passive ground-network instrument capable of measuring carbon dioxide (CO₂) at 1.57 microns and methane (CH₄) at 1.62 microns – key for validation of OCO-2, ASCENDS, OCO-3, and GOSAT. Designed to piggy-back on an AERONET sun tracker (AERONET is a global network of more than 450 aerosol sensing instruments), this instrument could be rapidly deployed into the established AERONET network of ground sensors. Because aerosols induce a radiative effect that influences terrestrial carbon exchange, this simultaneous measure of aerosols and carbon cycle gases offers a uniquely comprehensive approach. This instrument is a variation of a laser heterodyne radiometer (LHR) that leverages recent advances in telecommunications lasers to miniaturize the instrument (the current version fits in a carry-on suitcase). In this technique, sunlight that has undergone absorption by the trace gas is mixed with laser light at a frequency matched to a trace gas absorption feature in the infrared (IR). Mixing results in a beat signal in the RF (radio frequency) region that can be related to the atmospheric concentration. By dividing this RF signal into a filter bank, concentrations at different altitudes can be resolved. For a one second integration, we estimate column sensitivities of 0.1 ppmv for CO₂, and <1 ppbv for CH₄.