Geophysical Research Abstracts
Vol. 15, EGU2013-57-1, 2013
EGU General Assembly 2013

Propagating Spectroscopic Effects through WPL Terms when Using a Fast Laser-Based Open-Path CH_4 Analyzer

George Burba, Dayle McDermitt, Tyler Anderson, and Anatoly Komissarov
LI-COR Biosciences, Advanced R&D, Lincoln, United States (george.burba@licor.com)

Eddy flux is computed using a covariance between fast changes in gas density and vertical wind speed. The measured changes in gas density happen due to gas flux itself, thermal expansion and contraction of the sampled gas, water vapor dilution, and pressure-related expansions and contractions. These are standard processes described by the Ideal Gas Law and by the Law of Partial Pressures, and are often called density effects. The gas flux is usually corrected for such density effects using Webb-Pearman-Leuning terms (WPL).

When gas density is measured by laser spectroscopy, there are also spectroscopic effects affecting measured gas density depending on fluctuations in temperature, water vapor and pressure, in addition to the density effects. The spectroscopic effects are related to changes in the shape of the absorption line due to changes in gas temperature, pressure and the presence of water vapor. These effects are specific for each specific absorption line, and the measurement technique.

The majority of density effects and spectroscopic effects are reduced or eliminated in the closed-path analyzers, when: (a) intake tube is very long, (b) gas sample is dried, and (c) pressure fluctuations are very small. However, the use of long intake tubes and drying of the air sample also lead to a significant increase in power demand, and to increased uncertainties due to excess attenuation of the fluctuations of the gas in the drier. Not drying the air sample leads to a need for applying a density correction for dilution, and spectroscopic corrections for gas absorption due to fast fluctuations in water vapor pressure. For both of these corrections water vapor should be measured accurately at high-speed inside the closed-path device, which increases measurements costs.

In addition, current fast closed-path analyzers based on laser spectroscopy have to operate under significantly reduced pressures, and require powerful pumps and grid power (400-1500 Watts). Power demands may be why these instruments are often deployed at locations with infrastructure and grid power, and not where the gas is produced.

Open-path gas analyzers can require very low-power (e.g., 5-10 Watts), permitting solar-powered deployments, cost-effectively permitting an addition of a single new gas measurement to the present array of CO_2 and H_2O measurements, and avoiding attenuation of gas fluctuations in the intake tube. These features enable long-term deployments of permanent, portable or mobile open-path flux stations at remote locations with high production of the gas of interest. However, in open-path analyzers, density and spectroscopic effects cannot be neglected.

Here we propose a new way to account for spectroscopic effects due to fast fluctuations in air temperature, water vapor and pressure in the same manner as Webb et al. (1980) proposed a way of accounting for respective density effects. Since both density effects and spectroscopic effects are known from Gas Laws and HITRAN, respectively, they can be incorporated into the WPL correction. We use an example of a fast open-path CH_4 gas analyzer, the LI-7700, yet the proposed approach would also apply to any closed-path design where fluctuations in temperature, water vapor and pressure are not fully eliminated.