Measurement of Species Correlations in Flare Plumes - Implications for Field Sampling

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Abstract

Plumes of real-world flares are inhomogenous, turbulent, and unconfined, which complicates field measurements. Nevertheless, single-point sampling approaches to measure flare conversion efficiency and emission factors generally rely on the assumption that individual species concentrations are uniformly correlated. Aircraft or drone sampling techniques performing plume transects also rely on this assumption. If species are consistently correlated, then relative concentrations can be reliably used to close a mass balance and estimate conversion efficiency and pollutant emission rates. If, however, the species are not well-correlated spatially or temporally, the derived emission factor could be highly biased. The objectives of this work are to directly measure species correlations within a plume of a flare to assess implications for potential field mesaurement techniques.

An optical system has been developed to measure in-situ, path-averaged H_2O vapour and black carbon to inspect species correlations in lab-scale turbulent flares. The system relies tunable diode laser absorption spectroscopy (TDLAS) and line-of-sight attenuation (LOSA) techniques in the near infrared. Direct absorption laser scanning allows for the resolution of two distinct absorption peaks of H_2O molecules. Through a spectral profile-fitting scheme which decouples temperature and concentration effects on light absorption, these absorption peaks can be used to yield path-averaged H_2O vapour concentrations. Simulation results and optical system design are discussed.