Species Correlations in Flare Plumes - Implications for Field Sampling

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Abstract

Plumes of industry flares are inhomogeneous, turbulent, and unconfined, which complicates field measurements. Despite this, single-point sampling techniques to establish flare conversion efficiency or pollutant emission factors often assume that combustion-derived species are well correlated. This means that these techniques assume combustion species occur in characteristic ratios that are relatively constant spatially and temporally. If this is not true, however, flare measurements based on single-point or single-transect samples may yield unrepresentative conversion efficiency or pollutant emission factors.

An optical system has been developed and used to measure in-situ H_2O vapour and black carbon fractions in lab-scale turbulent flare plumes to assess the assumption of correlated species. The optical system relies on tunable diode laser absorption spectroscopy (TDLAS) and line-of-sight attenuation (LOSA) techniques to obtain path-averaged species concentrations. Results suggest that although there is some general correlation between H_2O vapour and black carbon, mean values are heavily weighted by short, infrequent bursts of high black carbon production. In measurements approaches where only a few samples are taken, information about the high soot production events may not be properly captured. This could yield biased estimates of a black carbon emission factors and carbon conversion efficiencies. Characterization of the time- and length-scales on which these high sooting events occur would allow for the development of measurement protocols to set minimum sampling times to reduce bias and uncertainty of flare performance measurements.