# Measuring Correlations of Line-of-Sight $H_2O$ Vapour and Soot through Flare Plumes

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Combustion plume sampling techniques often rely on a fixed correlation between species concentrations to derive emissions rates, however, this assumption might not always be valid for a turbulent flare. An optical system has been developed to test this assumption on a turbulent flare by measuring time-resolved path-averaged $H_2O$ vapour concentration and soot volume fraction (SVF) along a line-of-sight through a combustion plume. The system is based on tunable diode laser absorption spectroscopy (TDLAS) and line-of-sight attenuation (LOSA) techniques employing two distributed feedback (DFB) lasers. By scanning the first DFB laser, plume transmissivity is inspected near 1428 nm where both narrowband absorption by $H_2O$ vapour and broadband attenuation by soot occur. Two distinct $H_2O$ absorption peaks are resolved in the scan whose linestrengths have opposing temperature dependencies within the target temperature range. A second DFB laser, fixed at 1654.3 nm, measures light attenuation due to soot alone. The second laser yields an estimate of SVF and isolates the effect of $H_2O$ vapour absorption on the first DFB laser signal. Temperature and concentration effects on $H_2O$ vapour absorption peak heights can then be decoupled through a spectral fitting technique to yield path-averaged $H_2O$ vapour concentration. The time-resolved species measurements are used to inspect the assumed correlation of soot and $H_2O$ vapour. Preliminary simulation results and design of the optical system are discussed.