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Measurement of Temperature and Water Vapor Concentration Using Laser Absorption Spectroscopy in Kilogram-Scale Explosive Fireballs MICHAEL SOO, ADAM SIMS, JAY CEROW, JAMES LIGHTSTONE, Naval Surface Warfare Center Indian Head EOD Technology Division, CHRISTOPHER MURZYN, NICK GLUMAC, University of Illinois at Urbana Champaign, Mechanical Science and Engineering, JAMES OTT, MICHAEL DEMAGISTRIS, NEERAJ SINHA, Combustion Research and Flow Technology, Inc. — The temperature, water vapor concentration, and pressure within a kilogram-scale high-explosive fireball is probed using a custom tunable diode laser absorption spectroscopy setup housed in a ruggedized gauge. An explosive fireball is generated by the detonation of a 2.2 kg spherical charge of C-4 high explosive at one end of a partially enclosed concrete tunnel structure. The 0.3 m fixed path-length absorption gauge is placed at varying stand-off distances from the charge at 6.3 m, 3.7 m, and 2.3 m, over several tests, to show survivability, measurement quality, and a repeatability. Direct numerical simulation of the explosive fireball in the hallway structure is performed using CRAFT computational fluid dynamics code. While the simulation agrees with the model on the overpressure features, the model predicts generally higher temperatures than those measured by the absorption gauge even when corrected for spatial non-uniformities across the line of sight. A method for comparing measurements from limited test data to the model is explored. The results indicate that absorption spectroscopy techniques can be made ruggedized sufficiently to study the complex thermal and species field in turbulent explosive fireballs at larger scales.

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