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Design of and initial results from a Highly Instrumented Reactor for Atmospheric Chemistry (HIRAC)

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Abstract. The design of a Highly Instrumented Reactor for Atmospheric Chemistry (HIRAC) is described and initial results obtained from HIRAC are presented. The ability of HIRAC to perform in-situ laser-induced fluorescence detection of OH and HO_2 radicals with the Fluorescence Assay by Gas Expansion (FAGE) technique establishes it as internationally unique for a chamber of its size and pressure/temperature variable capabilities. In addition to the FAGE technique, HIRAC features a suite of analytical instrumentation, including: a multipass FTIR system; a conventional gas chromatography (GC) instrument and a GC instrument for formaldehyde detection; NO/NO_2, CO, O_3, and H_2O vapour analysers. Ray tracing simulations and NO_2 actinometry have been utilized to develop a detailed model of the radiation field within HIRAC. Comparisons between the analysers and the FTIR coupled to HIRAC have been performed, and HIRAC has also been used to investigate pressure dependent kinetics of the chlorine atom reaction with ethene and the reaction of O_3 and t-2-butene. The results obtained are in good agreement with literature recommendations and Master Chemical Mechanism predictions. HIRAC thereby offers a highly instrumented platform with the potential for: (1) high precision kinetics investigations over a range of atmospheric conditions; (2) detailed mechanism development, significantly enhanced according to its capability for measuring radicals; and (3) field instrument intercomparison, calibration, development, and investigations of instrument response at a range of atmospheric conditions.

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