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CO2 RADIATION IN EXPANDING FLOWS UNDER VIBRATIONAL NON-EQUILIBRIUM CONDITIONS

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ABSTRACT. The aim of this paper is to develop a line by line model for CO2 vibrational nonequilibrium radiation and to investigate non-equilibrium effects in the case of an expanding mixture flow in a simple conical nozzle. A vibrational specific collisional relaxation model is developed and is incorporated in a multi-temperature thermodynamic description of the gas mixture, in order to compute vibrational level populations along the expanding flow. The HITEMP-2010 spectroscopic database is employed with a model for level energy splitting to provide line by line absorption and emission total and per-vibrational mode specific spectra. The specific spectra allow us to derive the radiative source terms to be used in the multi-temperature model if a coupled approach is required. It is shown that, for the considered nozzle conditions, the partial freeze of vibrational excitation in the expanding flow increases significantly the radiative intensity escaping from the mixture.