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Multi-Scale k-Distribution Model for Gas Mixtures in Hypersonic Nonequilibrium Flows

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A k-distribution model is presented for gas mixtures in thermodynamic nonequilibrium, containing strongly radiating atomic species N and O together with molecular species of N_2, N_2^+, NO and O_2. In the VUV range of the spectrum there is strong absorption of atomic radiation by bands of N_2. For this spectral range, a multi-scale model is presented, where RTEs are solved separately for each emitting species and overlap with other species is treated in an approximate way. Methodology for splitting the gas mixture into scales and evaluation of the overlap parameter between different scales is presented. Accuracy of the new model is demonstrated by solving the radiative transfer equation along the stagnation line flow field of the Crew Exploration Vehicle (CEV).