Introduction: A terrestrial lightning stroke, the fireball produced by the impact of a large bolide, and the hypersonic flows around spacecraft reentering Earth’s atmosphere reach temperatures of 10,000 – 50,000 K \[1,2\]. The effective temperatures of O and B stars are in the 11,000 – 30,000 K range \[3\]. We have enhanced our CONDOR chemical equilibrium code \[4\] and thermodynamic database to allow thermochemical equilibrium computations at these high temperatures.

Methods: The CONDOR code is a mass balance, mass action algorithm that also considers thermal ionization of atoms, radicals, and molecules \[4,5\]. Originally only singly ionized species were considered. Enhancements allow consideration of multiply ionized species. Database enhancements include computation of thermal functions via statistical mechanics, so that we are not limited by the temperature range of compiled data. The JANAF Tables typically compile thermodynamic data for gases to 6,000 K. But extrapolation of the tabulated data to higher temperatures generally leads to errors (e.g., see \[6\] or another text).

Results and Discussion: We validated results from the enhanced code and database by comparison with published data on the degree of ionization, electron number density, relative abundances of NI, NII, and NIII, and chemical equilibrium abundances of dry air species in terrestrial lightning strokes \[1\]. Our results agree with all the published diagnostics. Figure 1 displays results for dry air heated to 30,000 K at one bar total pressure. We will use our results to discuss some of the interesting equilibria in very high temperature environments such as lightning and fireballs from impacts of large bolides.


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