Abstract Submitted
for the DPP19 Meeting of
The American Physical Society

Limitations of approximate Boltzmann solutions for atmospheric combustion with high-frequency electric fields[1] JOEL LYNCH, TRAVIS SIPPEL, SHANKAR SUBRAMANIAM, Iowa State University — Efforts to enhance combustion with non-equilibrium plasma have become increasingly diverse, with a variety of electric field configurations and flame environments relying on a network of transport, kinetic, and thermal enhancement pathways. Out of necessity, models of these effects typically make broad simplifications, avoiding detailed solutions of the Boltzmann equation in favor of two-fluid models or two-term expansions. For the case of high-frequency fields in atmospheric combustion, these approximations often fail; the ratio of collision to field frequency becomes velocity dependent and varies throughout the density function. This incoherence results in nuanced electron transport. Additionally, electron attachment can introduce anisotropy that further alters transport behavior. To assess the impact of these effects, we review plasma-flame experiments and identify the range of gas mixtures, reduced frequencies and fields of greatest relevance. We then employ a custom Monte Carlo program alongside BOLSIG+ to solve the Boltzmann equation across the parameter space. The results are then detailed, including deviations in electron mobility, diffusion, and kinetics incurred across models. Finally, we compare the electron density functions and discuss options for future models.

[1]Naval Surface Warfare Center - Crane

Joel Lynch
Iowa State University

Date submitted: 03 Jul 2019 Electronic form version 1.4