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Surrogate Models of Electrical Conductivity in Air NICHOLAS BISEK, MARK KUSHNER, IAIN BOYD, University of Michigan, JONATHAN POGGIE, US Air Force Research Laboratory — Accurately determining the electrical conductivity of a gas is essential when estimating its electromagnetic effects. These effects are important in ionized flows, a condition typically observed in hypersonics because the high kinetic energy partially ionizes the gas as it passes through a strong shock or in regions were plasma-based control devices increase and/or utilize existing ionized flows-fields. Several existing semi-analytic electrical conductivity models are investigated and found to be deficient for the range of conditions present in a representative hypersonic flow that could benefit from these plasma-based technologies. This work utilizes surrogate modeling techniques to develop a general model (response surface), of solutions to Boltzmann's equation, an exact method which uses an extensive list of real collision cross-section data to determine the electrical conductivity of weakly ionized air. The optimal surrogate model, along with existing semi-analytic models, are coupled to a 3D flow solver in order to simulate hypersonic flow around a representative geometry that is utilizing a plasma-based flow control device. This effort helps quantify the importance of using a highly accurate electrical conductivity model (the surrogate model) and provides a framework for modeling solutions to Boltzmann's equation for a flow-field with arbitrary species.

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