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P1.4007 3-dimensional modelling of lightning strike waveform C

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See the full abstract here:
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It is estimated that a commercial aircraft will experience a lightning strike event once per year. This poses a significant risk to poorly conducting, carbon-fibre composite aircraft structures. The most widely adopted approach of providing lightning strike protection, on composite aerostructures, is through the embedding of a metallic mesh on the aircraft's aerodynamic surfaces. This adds weight and maintenance costs and the aerospace industry is seeking alternative solutions. The objective of this research is to develop the computational tools required to simulate the physics and environment of the thermal plasma channel formed during a lighting strike. This will yield accurate boundary conditions for the virtual testing of composite structures subjected to a lightning strike, enabling a more accurate assessment of potential damage arising.
A numerical approach using OpenFOAM for the modelling of atmospheric thermal plasma was undertaken. The custom built solver couples Maxwell's equations to the Navierstokes equations through the Lorentz body force, before solving the energy equation with thermal contributions from resistive heating in the air gap. The solver is capable of both steadystate and transient simulation of 3-dimensional, incompressible, laminar flows. The model replicates the experimental configuration for laboratory strike testing and uses the Society of Automotive Engineers (SAE) standard current waveform C as the basis for the simulation.
Temperature dependent properties for the air mixture is calculated up to a maximum temperature of 24,000 K and integrated into the solver. The air composition for 11 different species is equilibrated for a range of temperatures and pressures through the open-source software package Cantera [1]. Electron swarm parameters are then calculated through a Boltzmann equation solver, BOLSIG+[2], from the composition fractions.
The solver's capability is benchmarked against electromagnetic problems from literature and presented are the surface profiles generated by a waveform C strike test.

[1] D. G. Goodwin, H. K. Moffat, and R. L. Speth, "Cantera: An object-oriented software toolkit for chemical kinetics, thermodynamics, and transport properties." 2017.
[2] G. J. M. Hagelaar and L. C. Pitchford, "Solving the Boltzmann equation to obtain electron transport coefficients and rate coefficients for fluid models," Plasma Sources Sci. Technol., vol. 14, no. 4, pp. 722-733, 2005.

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