A NEW GAS-DINAMIC MODEL OF LIGHTNING RETURN STROKES

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Abstract:

Development of gas-dynamic models of return strokes is necessary for understanding physical processes in the lightning channel, for estimating correctly percentage of input lightning energy converted to the kinetic, internal energy, and electromagnetic radiation, for different technical applications. At the moment there are some models, which allows calculating such physical parameters of the lightning channel as temperature, pressure, density as functions of time and channel radius in assumption of axial symmetry of the channel (see [1] for review). They predict percentage of input lightning energy converted into light radiation, kinetic and internal energy [2,3], but these predictions vary substantially from one model to another, and agree only partially well with experimental measurements.

In the present paper after a brief analysis of existing gas-dynamic models we suggest a new one. Our model includes hydrodynamic equations with Joule and light heating, the equation of radiation transport, and the equation coupling the electric current, conductivity and the magnetic field. The latter equation has been derived specially. The state equation (which gives the internal energy, pressure and composition of the plasma if temperature and density are given), the total current as a function of time, the initial profiles of gas temperature and density, the absorption index as a function of radiation frequency and air state were assumed to be known.

The numerical code has been developed which calculates the temperature, density, pressure, gas velocity, electric charge, light intensity profiles in dependence of time, the resistance of a channel length unit, the total input, kinetic, and internal energies, and the spectral power of output radiation. Numerical solution is found using the standard Runge – Kutta method. The importance of influence of self-generated magnetic field onto the dynamics of the plasma channel, and necessity of calculation of the spectrum intensity of the output radiation are recognized. The two-order difference between the values of input lightning energy predicted by the gas-dynamic models and the values measured by E.P. Krider et al. [4] is discussed and explained. Several differences between our results and others are discussed. Some ideas about further progress of gas-dynamic models are offered.

REFERENCES

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