Experimental radial profiles of early time (< 4 μs) neutral and ion spectroscopic signatures in lightning-like discharges

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The GrAnada Lightning Ultrafast Spectrograph (GALIUS) is a portable, ground-based slit spectrograph designed and developed at the Instituto de Astrofísica de Andalucía, in Granada, Spain. It is able to record spectra of natural and triggered lightning or lightning-like plasmas with submicrosecond time resolution in a spectral range from 380 nm to 854 nm. Our work shows GALIUS radial-resolved slit spectroscopy of 20 laboratory produced lightning-like discharges of 30 mm length and 8 ± 2 mm mean width, generated with an automated Wimshurst machine, being their mean peak voltage and current 32.70 kV and 149.58 A, respectively. We analyze the visible (645.0 - 663.0 nm) region operated at 900 kfps with 0.79 µs exposure time, spectral resolution better than 0.38 nm and spectral dispersion of 0.58 mm/px, that allows us to experimentally quantify the profiles of electron density and electron/gas temperature along the radial dimension of the lightning-like plasma channels and their temporal dynamics. To do so, we analyze the rows of the 2D spatial-spectral images of the heated channel of every lightning-like discharge, to follow the radial and temporal variation of neutral (atoms and molecules) and ion spectroscopic signatures. From these measurements we also estimate the evolution of the radial profiles of electrical conductivity, overpressure and populations of key chemical species(N₂, NO, O₂, OH, H₂, N₂O, NO₂, HO₂, O₃ and H₂O) produced along the radius of the plasma channel.