Sprite Streamer Initiation due to Ionization of Metallic Species at Sprite Altitudes

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We propose the idea that electrons resulting from the ionization of mesospheric and lower thermospheric Fe, Mg, Si, Na, Ca, and K metallic species [Plane et al., Chem. Rev., 115, 4497, 2015; Space Sci. Rev., 214, 23, 2018, Silber et al., MNRAS, 469, 1869, 2017; and references therein] may be the origin of plasma inhomegeneities necessary for the inception of sprite streamers [Qin et al., Nat. Comm., 5, 3740, 2014]. These metallic species ablate from meteoroids and have ionization cross sections orders of magnitude greater and ionization potentials lower than air's main constituents N_2 and O_2. We study the effect of these metals by inputting published ionization cross section data [e.g., Boivin et al., J. Phys. B: At. Mol. Opt. Phys., 31, 2381, 1998, Kim et al., J. Phys. B: At. Mol. Opt. Phys., 40, 1597, 2007] to Bolsig software [Hagelaar et al., Plasma Sources Sci. Technol., 14, 722, 2005] and calculating ionization rate coefficients. Furthermore, we compare streamer initiation from a gas mixture including various densities of these metals with previous works which artificially assumed high electron density regions in the simulation domain [e.g., Qin et al., GRL, 40, 4777, 2013; JGR, 118, 2623, 2013] using a plasma fluid model of sprite halo. Finally, we compare the electron impact ionization results with photoionization modeling for air mixed with these metals, calculating photoionization rates of metallic species due to specific emission bands of N_2 and O_2.