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Impact of lightning on the lower ionosphere of Saturn and possible generation of Transient Luminous Events (TLEs)

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Radio observations [1] and, more recently, optical images from the Cassini spacecraft [2] have clearly established the existence of electrical storms in Saturn and constrained the possible altitude range and total dissipated energy of lightning strokes. Based on these observations, we here investigate the physical effects of lightning on the upper layers of Saturn's atmosphere.

We first study the relevance of the conductivity profile of the lower Saturnian ionosphere and how the Maxwell relaxation time limits the amplitude and duration of the reduced electric fields. We implemented a simple, zero-dimensional model [3] that considers only the most relevant ionization reactions; we then applied this model to two conductivity profiles proposed in the literature [4, 5] and a range of possible amplitudes and durations of the driving stroke.

Then we investigate the possibility that the lightning-induced ionization results in a field that is locally strong enough to ignite streamer discharges and thus form a sprite. A sprite would lead to localized but very intense fields potentially resulting in detectable optical emissions [6]. We model the possible sprite inception with a self-consistent, cylindrically symmetrical 3d transport code [7].

Finally we discuss the chemical impact of lightning-induced electric fields in the upper Saturnian atmosphere. We use a kinetic model where we implemented the most important reactions induced by energized electrons in a H2/He atmosphere. We thus investigate what species densities are significantly enhanced and what are the expected spectroscopical signatures of upper-atmospheric electricity in Saturn.

[1] G. Fischer, M.D. Desch, P. Zarka, M.L. Kaiser, D.A. Gurnett, W.S. Kurth, W. Macher, HO Rucker, A. Lecacheux, W.M. Farrell, et al., Saturn lightning recorded by cassini/rpws in 2004. Icarus, 183(1):135, 2006.
[2] U.A. Dyudina, A.P. Ingersoll, S.P. Ewald, C.C. Porco, G. Fischer, W.S. Kurth, and R.A. West, Detection of visible lightning on saturn. Geophys. Res. Lett., 37:L09205, 2010.
[3] A. Luque and F.J. Gordillo-Vázquez, Mesospheric electric breakdown and delayed sprite ignition caused by electron detachment. Nature Geoscience, 5:22, 2011.
[4] L.E. Moore, M. Mendillo, I.C.F. Müller-Wodarg, and D.L. Murr. Modeling of global variations and ring shadowing in saturn's ionosphere, Icarus, 172(2): 503–520, 2004.
[5] M. Galand, L. Moore, B. Charnay, I. Mueller-Wodarg, and M. Mendillo. Solar primary and secondary ionization at Saturn, J. Geophys. Res., 114(A6): A06313, 2009.
[6] D. Dubrovin, S. Nijdam, E. M. van Veldhuizen, U. Ebert, Y. Yair, and C. Price, Sprite discharges on venus and jupiter-like planets: A laboratory investigation. J. Geophys. Res., 115:A00E34, 2010.
[7] A. Luque and U. Ebert, A. Luque and U. Ebert, Emergence of sprite streamers from screening-ionization waves in the lower ionosphere, Nature Geoscience 2, 757-760, 2009