

Ann. Geophys. Discuss., referee comment RC2
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Comment on angeo-2021-49

Anonymous Referee #2

Referee comment on "Finite-difference time-domain analysis of ELF radio wave propagation in the spherical Earth-ionosphere waveguide and its validation based on analytical solutions" by Volodymyr Marchenko et al., Ann. Geophys. Discuss., <https://doi.org/10.5194/angeo-2021-49-RC2>, 2021

The aim of this paper is to analyze the effect of lightning ELF waves propagation in the spherical Earth-ionosphere waveguide. The manuscript is well written and easy to follow, but there are several problems with the methods section which must be addressed, and some references need to be added to improve the completeness of the paper.

Major comments:

Line 115-116, I don't really understand this part, what do you mean "extend the simulation time by adding the values of fields at the last time step of FDTD simulation"?

Line 120 – 130, please add more details for the filter used in the lightning source and add the comparison results between the original source and the filtered one.

Line 131, instead of mention "a finite speed", please give the value of the velocity used in the calculation.

The Schumann resonance spectrum figures corresponding to the table 1-3 are suggested to present in the paper.

In section 3.3, I don't really understand why the authors used the "two-layered" waveguide since there are different exponential profiles which are capable to describe the features. For example, the traditional Wait and Spies' exponential profile gives a

reasonable approximation for the electron density profile below 90-km altitude compared to the IRI model. How did you deal with the conductivity located at the boundary between the different two layers?

In section 4, I am also confused, instead of the entire IRI model, why did the authors use the partial profile proposed in Kudintseva et al, 2016] and partial IRI model? Please add more comments for this part.

Minor comments:

Line 25, add the reference:

Marshall, R. A. (2012), An improved model of the lightning electromagnetic field interaction with the D-region ionosphere, *J. Geophys. Res.*, 117, A03316, doi:10.1029/2011JA017408

Line 42, the full-wave method (FWM) based on finite element approach need to mention in the introduction part:

Lehtinen, N. G., and U. S. Inan (2008), Radiation of ELF/VLF waves by harmonically varying currents into a stratified ionosphere with application to radiation by a modulated electrojet, *J. Geophys. Res.*, 113, A06301, doi:10.1029/2007JA012911

Lehtinen, N. G., and U. S. Inan (2009), Full-wave modeling of transionospheric propagation of VLF waves, *Geophys. Res. Lett.*, 36, L03104, doi:10.1029/2008GL036535

Line 44, if I understand here correctly, the authors want to mention the "Q bursts" in the Schumann resonance:

Ogawa, T., Y. Tanaka, M. Yasuhara, A. C. Fraser-Smith, and R. Gendrin. "Worldwide simultaneity of occurrence of a Q-type ELF burst in the Schumann resonance frequency range." *Journal of geomagnetism and geoelectricity* 19, no. 4 (1967): 377-384.

Line 142, please explain the parameters in the equation there.