URSI GASS 2023, Sapporo, Japan, 19 – 26 August 2023

Lightning, Evolution and Biology

Colin Price*[(1)], Earle Williams [(2)], Nikolay Ilin[(3)], Evgeny Mareev[(3)], Marina Grinberg[(4)], Vladimir Sukhov[(4)], Vladimir Vodeneev[(4)]
(1) Tel Aviv University, Geophysics, Tel Aviv, Israel, e-mail: cgprice@gmail.com
(2) Parsons Lab, MIT, Cambridge USA
(3) Institute of Applied Physics, Nizhny Novgorod, Russia
(4) University of Nizhny Novgorod, Nizhny Novgorod, Russia

The natural electromagnetic fields in the atmosphere have many origins, but in the extremely low frequency (ELF) range, the natural fields occur primarily due to lightning activity in our atmosphere. And these ELF fields have existed for billions of years. Due to the Earth-ionosphere waveguide on Earth, and the extremely low attenuation of ELF waves in the atmosphere, there exists an electromagnetic resonance phenomenon in the atmosphere called the Schumann resonances. The atmospheric ELF fields have characteristic frequencies around 8, 14, 20, 26 and 32 Hz, and are known as the Schumann resonances. It is also interesting that most electrical activity in vertebrates and invertebrates occurs at extremely low frequencies (ELF), with characteristic maxima below 50Hz. The origin of these *frequency* maxima is unknown and remains a mystery. We propose that over billions of years during the evolutionary history of living organisms on Earth, the natural electromagnetic resonant frequencies in the atmosphere, continuously generated by global lightning activity, provided the background electromagnetic fields for the development of cellular electrical activity [1]. To check this hypothesis we performed controlled lab experiments to see if ELF fields at the characteristic frequencies impact the regular functioning of animal and plant cells. In the past few years, we have carried out laboratory experiments on both animal tissues and plants. In all experiments we find significant impacts of these weak ELF fields on biological systems [2, 3, 4]. The magnetic fields in the experiments ranged from 20 pT to 20 μT. The common findings between the animal cell and plant cell experiments were that the Schumann resonances appear to protect cells from various types of stress. We also note that the frequency used in the experiments appears to be more important than the amplitude of the ELF fields. In this paper we present evidence for the link between the natural ELF fields and those found in many living organisms, including humans [1, 2]. We will also show the results related to the impact of the Schumann resonances on plant photosynthesis [3, 4].

References

[1] Price, C., E. Williams, G., Elhalel and D. Sentman, 2020: Natural ELF Fields in the Atmosphere and in Living Organisms, *Int. J. Biometeorology*, https://doi.org/10.1007/s00484-020-01864-6.

[2] Elhalel, G., C. Price, D. Fixler and A. Shainberg, 2019: Cardioprotection from stress conditions by weak magnetic fields in the Schumann Resonance band, *Scientific Reports*, doi: 10.1038/s41598-018-36341-z.

[3] Sukhov, V., E. Sukhova, Y. Sinitsyna, E. Gromova, N. Mshenskaya, A. Ryabkova, N. Ilin, V. Vodeneev, E. Mareev and C. Price, 2021: Influence of magnetic field with Schumann resonance frequencies on phontosyntheic light reactions in wheat and pea, *Cells*, 10, 149, doi:10.3390/cells10010149.

[4] Grinberg, M., M. Mudrilov, E. Kozlova, V. Sukhov, F. Sarafanov, A. Evtushenko, N, Ilin, V. Vodeneev, C. Price and E. Mareev, 2022: Effect of extremely low-frequency magnetic fields on light-induced electric reactions in wheat, *Plant Signalling and Behavior*, https://doi.org/10.1080/15592324.2021.2021664.