URSI GASS 2021, Rome, Italy, 28 August - 4 September 2021

Using Radio Noise from the Electrical Grid to Image Sporadic E Structures

K.S. Obenberger[(1)], J. Dowell[(2)], C.T. Fallen[(1)], J.M. Holmes[(1)], G.B. Taylor[(2)], S.S. Varghese[(2)]
(1) Air Force Research Laboratory, Kirtland AFB, NM
(2) University of New Mexico, Albuquerque, NM

We show that sporadic E (E_s) can be passively geolocated and imaged, where the unintentional anthropogenic radio emissions from overhead power lines and other electrical devices act as an illumination source. Here the radio noise undergoes a mirror-like reflection off of overdense E_s layers. Using the all-sky imaging capabilities of the Long Wavelength Array (LWA) radio telescopes in New Mexico, we are then able to observe the illuminated E_s layers as they form and propagate. We present high time resolution data that show the emissions originate from micro-arcs on power lines, where the emission is modulated at 120 Hz, which is twice the grid operating frequency in North America. Moreover, statistical analysis of two years of data reveals that the brightest emissions originate in the direction of large metropolitan centers, although rural regions still contribute significantly.

Because the electrical grid is spread over much of the continental United States, E_s structures are often continuously illuminated, allowing for triangulation and tracking of their position. Furthermore, we detect brightness and positional variations that are consistent with modulations caused by atmospheric gravity waves. As others have shown (e.g. [1, 2, 3]) we observe E_s to be arranged with a front-like morphology. However, unlike other methods for imaging E_s this new technique may allow for estimates of the electron density, where the broadband nature of power line emissions enable measurements of the maximum observable frequency (MOF). Combining the MOF with the zenith angle we can then estimate the peak plasma frequency and therefore the electron density. We note that on rare occasions plasma frequencies have been observed above 30 MHz.

References

[1] Maeda, J. and Heki, K. (2013), Two-dimensional observations of midlatitude sporadic E irregularities with a dense GPS array in Japan, Radio Science, 49, 1, 28-35

[2] Maeda, J. and Heki, K. (2015), Morphology and dynamics of daytime mid-latitude sporadic-E patches revealed by GPS total electron content observations in Japan, Earth Planets and Space, 67, 89

[3] Yamamoto, M., Komoda, N., Fukao, S., Tsunoda T., Ogawa T., & Tsuda T. (1994), Spatial structure of the E region field-aligned irregularities revealed by the MU radar, Radio Sci., 29, 337-347