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Determination of sporadic E radio wave propagation parameters based on vertical and oblique sounding

O.N. Sherstyukov, A.D. Akchurin, R.O. Sherstyukov *

Kazan Federal University, Institute of Physics, Kremlevskaya Street 18, Kazan, Tatarstan 420008, Russia

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Abstract

Sporadic E layer is often determined for HF radio communication. We have to deal with oblique radiowave propagation in the radio practice. The limiting frequencies at oblique propagation depend heavily on the transmitter power and the receiver sensitivity. The reason for this, as in the case of vertical propagation, is the dependence of Es reflection coefficient, ρEs (reflection loss $R(dB)$), on Es operation frequencies. This paper describes the characteristics of HF Es propagation in relation to foEs obtained from ionospheric vertical observations. It was found that characteristics of Es propagation depend on the type and height of the Es layer. Also the foEs diurnal variation at definite $R(dB)$ was detected. This investigation allows improving the prediction of limiting frequencies for HF radio propagation.

Keywords: Sporadic E layer; Reflection loss; Reflection coefficient; foEs; HF radiowave propagation

1. Introduction

To consider the influence of sporadic E-layer on HF radio wave propagation, it is important to review occurrence and reflection ability of the Es layer. The probability of occurrence of sporadic-E (PEs) at midlatitudes follows some well-defined seasonal and diurnal variations (Whitehead, 1989). Sporadic E-layer temporal variations have a complex structure which is determined by many solar and terrestrial factors. The Earth's atmosphere greatly affects the Es layer variations by tidal, gravity and planetary waves (e.g., see Akchurin et al. (1997), Fahrutdinova et al. (2001), Sherstyukov and Ryabchenko (2004), and Sherstyukov and Ryabchenko (2005). Long-term periodicities in D, E, and F region ionization in the middle- and low-latitude ionosphere were measured and attributed to planetary waves. (e.g., see Pancheva et al. (1991), Lastovicka et al. (1994), Lastovicka (2001). Haldoupis and Pancheva (2002) have obtained and analyzed, the sporadic E "critical frequencies" (foEs) time series from eight midlatitude ionosonde stations covering a large longitudinal zone from 58 E to 157 W. The analysis revealed that all eight station foEs data showed a strong 7-day periodicity, occurring concurrently with the 7-day planetary wave. Maksyutin and Sherstyukov (2005) found that sporadic-E layer parameters response to solar and geomagnetic activity level. Obtained variations can be both positive (foEs and PEs values increase) or negative (foEs and PEs values decrease). Stocker and Warrington (2009, 2011) compared nighttime PEs observed on oblique propagating HF radio waves at sunspot maximum and minimum and found that PEs was greater at sunspot minimum which is consistent with the results of Maksyutin and Sherstyukov (2005). Investigation of the Es layer occurrence allows making some corrections in parameters of radio wave propagation on radio path. However, the Es layer

* Corresponding author. Tel.: +7 8432 92 81 92.
E-mail addresses: Oleg.Sherstyukov@kpfu.ru (O.N. Sherstyukov), adel.akchurin@kpfu.ru (A.D. Akchurin), sher-ksu@mail.ru (R.O. Sherstyukov).

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