Impact of sporadic E layers on long-distance HF propagation: case study

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Long-distance propagation of HF radio waves is possible due to reflection of waves from the ionosphere and their propagation in the ground-ionosphere cavity with low losses. Since 2010, a continuous Doppler monitoring of HF signals emitted by time service stations located in the Northern hemisphere, namely RWM (55.73 N, 38.21 E) and CHU (45.30 N, 75.76 W) is conducted at the Ukrainian Antarctic Station (UAS) *Akademik Vernadsky* (65.25 S, 64.27 W). This paper is devoted to experimental study of the impact of sporadic E layers (Es) on the characteristics of long-distance HF propagation. We analyzed the parameters of signals with carrier frequency of 9996 kHz, propagating along the RWM-UAS path in June 2010 (the length of the straight path is about 16000 km). Figure 1a shows the averaged daily spectrogram of the signal calculated without taking into account one day, June 24, 2010. There is a feature in the daily spectrogram for June 24, 2010 (Fig. 1b) that the signal is recorded at 2…4 UT, which was not observed on other days of this month (Fig 1a). An analysis of space weather conditions showed that geomagnetic activity at that time was extremely low, Kp = 0, Amp = 1 (with the monthly average value of Amp 15.3 for this time). The ionosphere above the transmitting position showed no features. But over the UAS the intense Es were observed at the heights of 100 ... 200 km (Fig. 1d). As a rule, Es are absent in the night at this season (Fig. 1c). Note also that an active cyclone was operating at the UAS location. Cyclone can impact on the formation of Es by generating of atmospheric gravity waves (AGW), which can propagate to the heights of the ionospheric E region. As we showed earlier [1], at the Antarctic Peninsula area cyclonic activity in winter increases the probability of observations of semi-transparent relatively small-scale Es, similar to those observed on June 24, 2010 (Fig. 1d). Mechanism of impact of Es on long-distance HF propagation is likely to be in input/output of HF signals to/from the interlayer ionospheric waveguide by reflecting or scattering the waves on the horizontal gradients of electron concentration provided by Es. Thus, Es can contribute to improving the conditions of long-distance propagation of HF radio signals. As a result, it could also be concluded that the variability of ionospheric conditions in the vicinity of the transmitter and receiver has a main influence on the variability of long-distance propagation conditions. When propagating between the northern and southern hemispheres, the influence of ionospheric conditions in the winter hemisphere generally is bigger.

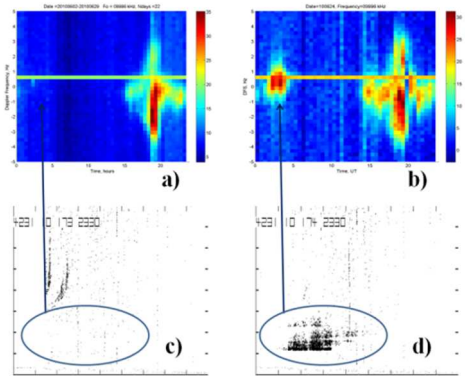

Figure 1. a) Averaged daily Doppler spectrogram of the RWM signals recorded at UAS in June 2010 (without June 24, 2010); b) daily Doppler spectrogram for June 24, 2010; c) Ionogram for 03:30 UT 23 June2010 (typical for this season and time); d) Ionogram for 03:30 UT 24 June 2010 (it is 23:30 LT 23 June 2010)

References

[1] A.V. Zalizovski, "The Role of Tropospheric Processes in Forming the Sporadic Layers of E Ionospheric Region over the Antarctic Peninsula", *Radio Physics and Radio Astronomy,* **13**, 1 2008, p. 26-38 (in Russian).