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Results of vertical ionospheric sounding at the Ukrainian Antarctic Station Akademik Vernadsky

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The results of processing and interpretation of long-term data obtained from vertical sounding of the ionosphere performed at the Ukrainian Antarctic Station (UAS) Akademik Vernadsky for several decades as well as current state and development prospects of the ionospheric sounding system are presented. Vertical HF sounding has been continuously performed at UAS (former Faraday Station, UK) since the 1950s using the Union Radio Mark II ionosonde that was replaced with IPS-42 in 1983. Derivation of ionospheric layer characteristics was initially performed by filming ionograms and further manual processing by an operator. After upgrading the IPS-42 in 2001, ionograms have been collected in digital form. In 2017, a new digital ionosonde was installed at UAS and since then two instruments have been working together sharing a common antenna system. The new instrument was developed and manufactured in collaboration between the Abdus Salam International Centre for Theoretical Physics, Institute of Radio Astronomy of the NAS of Ukraine and University of New Brunswick. The device takes advantage of using a phase-coded pulse sequence and is based on the software-defined radio technology, which offers benefits of low power, low cost, small form factor, and modification flexibility. It is capable of measuring the Doppler frequency shift (DFS) of reflected signals thus allowing to estimate the vertical component of plasma velocity in a wide range of heights.

In this work, we present ionograms from both instruments and results of their processing: height-time diagrams of plasma frequencies and vertical plasma velocity. We discuss a technique for estimating the median height-time diagrams and potential areas of application of this technique that provide informative and comprehensive visualization of monthly averaged characteristics of the ionosphere. This technique has been applied to study the Ionospheric Weddell Sea anomaly (an inversion of the electron density diurnal variation). The response of the ionosphere to changes in solar and geomagnetic activity during the Weddell Sea anomaly is also discussed. Examples of variations in the virtual heights of reflection and Doppler frequency shift induced by TIDs will be presented as well.

A forthcoming upgrade of the hardware and the software of the digital ionosonde at UAS in order to improve ionogram quality, simplify their processing, and increase the amount of obtained ionospheric information, including ionogram scaling using Machine Learning, is discussed.