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Mid-latitude Ionospheric F2 layer at Sunrise

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Ionospheric corrections, calculated from ionospheric models corrected during ground-based or transionospheric sounding, should be applied to up-to-date high-tech wireless devices, including long and superlong base-line radio interferometers and differential GPS navigation systems, in order to improve the accuracy characteristics. The introduced corrections considerably increase at high horizontal gradients of the ionospheric electron density observed at sunrise; therefore, new experimental data on the space-time characteristics of the ionospheric F2 layer, which make it possible to improve the ionosphere description accuracy during this period of the day, are undoubtedly attractive.

The F2 layer behavior at sunrise was studied based on the data of vertical-incidence ionospheric sounding in a 5-min regime, performed at the Almaty Institute of the Ionosphere (76°55′E, 43°15′N) in 2000–2010 using a Parus ionosonde. The primary ionogram reduction included reading virtual heights of reflection h'(t) at several fixed working frequencies and critical frequency values (fF2). The further data processing included obtaining N(h) profiles from the ionograms, using the POLAN conversion program. The sequence of N(h) profiles made it possible to obtain the behavior of several layer parameters, including the electron density at fixed altitudes (N(t)) and at the layer maximum (NmF2) and altitudes of the layer maximum (hmF2) and bottom (hbotF2), and the electron density growth rate (N').

The N(t) variations obtained bear features typical of all measurement sessions, namely, (a) the instants of the beginning of a pronounced increase observed later on the lower altitudes; (b) the electron density growth rates (N') differ at different altitudes, and the growth rate is maximal at altitudes below the layer maximum altitude.

So, based on vertical-incidence ionospheric sounding data, we indicated that the electron density at altitudes of the ionospheric F2 layer increases rapidly at sunrise and a positive correlation exists between the altitude where the growth rate is maximal (h(N'm)) and the layer maximum altitude (hmF2), on the one hand, and between the electron density growth rate at the h(N'm) layer maximum and the maximal electron density growth rate (N'm), on the other hand.

We indicated that the solar zenith angle, corresponding to the instant when the electron density starts increasing pronouncedly, and the corresponding altitude of the blanketing layer upper boundary increase with increasing altitude h where the electron density starts increasing pronouncedly. We established that the slope of the average vertical profile of the zenith angle is identical at a solar activity maximum and minimum and the average χ value at an activity maximum is larger than the corresponding value at an activity minimum by approximately one degree at all altitudes.