

Morphology of Midlatitude Summer Nighttime Anomaly in NmF2 above Alma-Ata

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The morphology of the midlatitude summer nighttime anomaly in the diurnal behavior of the electron concentration maximum in the F2 layer (NmF2) over Alma-Ata in various seasons and at various solar activity levels was studied on the basis of the ionospheric vertical sounding over seven months of 2011 and the summer months of 1999, 2008, 2011, and 2012. The vast majority of data of the analyzed electron concentration measurements was obtained under low magnetic activity ($Dst > -50$ nT). Measurements during which moderate and high magnetic activity ($Dst < -50$ nT) was observed were rejected from the analysis. It was shown that the anomaly is not seen in the equinox months. The maximum effect of the anomaly is seen in the summer months (July–August). The maximum value of the electron concentration in the evening peak corresponds to the solar zenith angles, when the ionizing radiation almost ceases to reach the heights of the F2 layer maximum.

The anomaly is distinctly manifested in the solar activity minimum but scarcely seen in the solar maximum. It was shown that the parameters of the summer anomaly at the boundary of the north-eastern Asia zone (Alma-Ata, 76.9 deg E) change insignificantly as compared to the parameters at its center (Japan, 130.0 deg E). The mechanisms of the formation of the anomaly and of its diurnal and seasonal behavior are discussed.

Two factors determining the anomaly formation in the summer months are considered. First, the meridional wind changes its direction from polarward to equatorward much earlier in summer (around 14.30 LT) in the middle latitudes than in other seasons, when the photoionizing radiation flux is still high. That is why photoionization, in combination with the rise of the ionosphere to the heights where the recombination rate is low, leads to the formation of an evening increase in NmF2. Second, in addition to the factor of an early change in the thermospheric wind direction, seasonal variations in the meridional wind velocity are manifested in the fact that the equatorward meridional wind has the maximum and minimum velocities in the summer and winter hemispheres, respectively, at night. In the equinox periods, the velocity of the equatorward neutral wind has intermediate values.