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The upper transition height over the Kharkiv incoherent scatter radar before, during and after the extreme minimum of the solar activity: Observational results and comparison with the IRI-2012 model

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Variations in the diurnal minimum of upper transition height (height at which total light ions fraction is 50%) over Kharkiv, Ukraine are considered for vernal and autumnal equinoxes from 2006 to 2010. The data were obtained using the incoherent scatter radar of the Institute of ionosphere [1]. It was found that the decrease of daily F10.7 values approximately by 22 % (from 82 for spring 2006 to 67 for autumn 2007) was accompanied by a decrease in the upper transition height approximately by 19% too (from 518 km to 436 km). The linear correlation coefficient between the upper transition height and daily F10.7 was approximately 0.81. It should be noted that according to our knowledge such low values of upper transition height is the minimum ever recorded. In 2008-2009, the upper transition height over Kharkiv was up to 40 km lower than over the equator [2] and even up to 10-15 km lower than over Arecibo [3]. A comparison of the observational results with the IRI-2012 model [4] was made. It was found that the IRI-2012 model overestimates upper transition height up to 100 km in 2006, and 2010. The model also overestimates the upper transition height up to 150 km during the extreme solar minimum (2008-2009). It is clearly seen that for solar minimum under consideration latitudinal dependence of upper transition height according to observational data have decreasing character in contrast to the model dependence. Such behavior can be called latitudinal inversion of upper transition height. Strong dependence of upper transition height on Ap index was found for the conditions under consideration. It is suggested that model values for 2006 and 2010 are overestimated due to a higher geomagnetic activity during the satellite measurements (1974) underlying the model for the low level of solar activity compared with geomagnetic conditions for 2006 and 2010. Perhaps this led to the fact that the model does not show latitudinal inversion, which occurs only at very low geomagnetic activity. However, this hypothesis requires further careful checking. In 2008 and 2009, the decreasing of the upper transition height has been apparently caused by a prolonged general cooling of the thermosphere and ionosphere [5].

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