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Plasma bubbles in the topside ionosphere: solar activity dependence

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The present study deals with the He+ density depletions, observed during a high solar activity at the topside ionosphere heights. There are the indications that plasma bubbles, produced by Rayleigh-Taylor instability at the bottomside of ionosphere, could rise up to the topside ionosphere and plasmasphere. Maryama and Matuura (1984), using ISS-b spacecraft data (high solar activity - F10.7=200, 1978-80), have seen the plasma bubbles in Ne density over equator at 1100 km heights in 46 cases in 1700 passes (3%). However, there is distinctly another picture in He+ density depletions according to ISS-b spacecraft data for the same period. They occur in the topside ionosphere over low- and middle- latitudinal regions (L=1.3-3) in 11% of the cases (Karpachev, Sidorova, 2002; Sidorova, 2004, 2007). The detailed study of the He+ density depletion characteristics was done. It was noted that the He+ density depletions are mostly seen in the evening-night sector (18-05 LT) from October till May. It was like to the peculiarities of the Equatorial Spread-F (ESF), usually associated with plasma bubble. The monthly mean He+ density depletion statistics, plotted in LT versus month, was compared with the similar plots for ESF statistics, obtained by Abdu and colleagues (2000) from ground-based ionograms over Brazilian regions for the period of the same solar activity. It was revealed good enough correlation (R=0.67). Also depletion values as function of LT were compared with the vertical plasma drift velocity variations, obtained for the same period from AE-E spacecraft and IS radar (Jicamarca) data. Striking similarity in development dynamics was revealed for the different seasons. It was concluded, that the He+ density depletions should be considered as originating from equatorial plasma bubbles. It seems the plasma bubbles, reaching the topside ionosphere altitudes, are mostly seen not in electron density but in He+ density as depletions. According to publications, many cases of the He+ density depletions were revealed on OGO-4, OGO-6, Oreol-1 and DE-2 spacecraft data. The most of these cases occur during high and maximal solar activity periods, when the He+ density layer is very well developed at the topside ionosphere heights (Wilford et al., 2003). Using the model of the plasma bubble formation as suggested by Woodman and La Hoz (1976), it was shown that the topside plasma bubbles, seen in He+ density, are rather typical phenomena for the topside ionosphere for high solar activity epoch.

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