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Topside Ionosphere Plasma bubbles seen as He+ Density Depletions: Estimations and Comparisons

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He+ density depletions, considered as originating from equatorial plasma bubbles, were involved in this study. They are usually detected in the topside ionosphere (∼1000 km) deeply inside the plasmasphere (L∼1.3-3) [1-3].
a) Since there are some questions about the survival possibilities of the topside plasma bubbles, the characteristic times of the main processes, in which plasma bubbles are involved, were compared. It was suggested that the plasma bubbles are produced by Rayleigh-Taylor instability at the bottomside of ionosphere and transported up to the topside ionosphere. It was found that it takes about 3-4 hours for plasma bubbles to reach the topside ionosphere altitudes. It was revealed that ambipolar diffusion transport is the most fast (some minutes). The estimation of the Bohm (cross-field) diffusion time shows that topside plasma bubbles can exist up to 100 hours. It was concluded that there is enough time for the plasma bubbles to survive and to be detected (for example, in minor species of ion composition inside the bubble like He+) at the topside ionosphere altitudes.
(b) It was revealed that the topside plasma bubbles can be easily detected as He+ density depletions during high and maximal solar activity. The convenient conditions for observations appear because the strong depleted in He+ density bubbles, reaching the topside ionosphere, most well contrast with the He+ density background layer very well developed in the topside ionosphere during high solar activity [4].
(c) He+ density depletions were considered in connection with equatorial F-region irregularities (EFI), equatorial F-spread (ESF) and equatorial plasma bubbles (EPB). Their longitudinal statistics, calculated for all seasons and both hemispheres (20-50 deg. INVLAT), were compared with EFI statistics taken from AE-E [5], OGO-6 [6], ROCSAT [7] observations. ESF, EPB statistics taken from [8, 9] based on ISS-b and Hinotori spacecraft data were also used for comparison. It was revealed that the main statistical maxima of the equatorial F-region irregularities are well enough reflected in the statistical plots of the He+ density depletions of the both hemispheres. The best conformity was obtained for equinoxes, the worst one was obtained for solstices, when the most dramatic insolation differences take place in the different hemispheres. Hence, it was validated once again that He+ density depletions may be considered as an indicator of topside plasma bubble presence or as fossil bubble signatures.

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