Structure and dynamics of the ionization ledge in the equatorial ionosphere observed by using the topside sounder satellites

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Since the initial ground-based observations of the equatorial anomaly (Appleton, 1946), the equatorial ionosphere has been extensively studied by observational and theoretical methods. Recently, an additional layer above the F2 peak, called the F3 layer, was predicted based on the simulation study applying SUPIM model and observations by using the bottom side sounder for the equatorial ionosphere. It has been suggested that the F3 layer was generated during the local time period from morning to noon in the equatorial region where plasma flow was driven by the combination effects of the E x B drift and the trans-equatorial neutral wind. On the other hand, a ledge of ionization above the F2 peak in the equatorial topside ionosphere has been found by using the topside sounder on-board the Alouette satellite and named as 'ionization ledge'. However, the seasonal dependence of the occurrence probability, the longitudinal dependence, the maintain mechanism to keep the ledge structure until local midnight period of the ionization ledge structure and the relation between the F3 layer and the ionization ledge have not been understood.

For the purpose of clarifying the structure and occurrence characteristics of the ionization ledge, the topside sounder data observed by the Ohzora (EXOS-C) and the ISIS-2 satellites in the equatorial ionosphere were analyzed. We analyzed topside ionograms of 19 and 430 passages observed by the Ohzora satellite in March and May, 1987 and the ISIS-2 satellite in 1973-1979, respectively. Also the variations of the geomagnetic field were analyzed in order to deduce the electric field.

The ionization ledge were found in a dip latitude range from –13.5 to 19.3 [deg.], at the limited region around the dip equator. The ionization ledge appears in the local time sector from 9-11 LT to 0-2 LT. The occurrence probability is highest in the noon sector and tends to decrease gradually with the local time. These results are consistent with the previous studies of the ionization ledge.

The seasonal dependence of the occurrence probability of the ionization ledge is higher at equinox season and lower at solstice season. Comparing with the seasonal dependence of the vertical drift velocity observed by AE-E satellite, the result of the seasonal dependence of the occurrence probability has a consistent manner with the seasonal variation of the upward plasma drift. Comparing with the eastward electric field deduced by the variations of the horizontal component of the geomagnetic field, the ionization ledge tends to occur when the time integrated electric field shows a large value. These results indicated that the upward drift caused by the E x B term is the major source of the generation mechanism of the ionization ledge as reported in the previous studies.

On the other hand, the present data analysis revealed the following important character of the ionization ledge. The ledge altitude has no clear dependence on the local time. However, the magnitude of the plasma density enhancement tends to become higher depending on the local time. The ionization ledge sometimes occurred even when the magnitude of the time integrated electric field variation was small. Therefore, in addition to the electric field effect, another control mechanism is possibly affecting the generation or containment of the ionization ledge structure.

Majority of the character of the ionization ledge is basically the same with the character of the F3 layer in terms of the local time dependence of occurrence (Balan et al. (1998)). However, the seasonal dependence of the occurrence probability has a tendency contrary to that of the F3 layer reported by Balan et al. (2000).

To clarify the generation mechanism of the ionization ledge and to identify the relation to the F3 layer, the simultaneous observation from the bottom side and topside ionosphere is needed in future experiments.