Statistical view of the electric field distribution in the inner magnetosphere-2

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Since a large-scale electric field acts as a significant role for transport and loss of ring current and radiation belt particles in the inner magnetosphere, knowledge of the distribution and structure of the electric field in these regions is important for understanding of the plasma dynamics. In order to investigate the spatial structure of the electric field in the polar region during geomagnetic storms, we have performed the statistical analysis of the long-term electric field data of the Akebono satellite within a period from March 1989 to December 1995.

During a magnetically quiet condition, the large-scale electric field distribution in the polar cap region shows that the dawn-to-dusk electric field appears with the averaged magnitude of 6.0-12.0 mV/m. From this analysis result, the equatorward boundary of the polar cap region is located at the invariant latitude of 70-75 degrees. Considering the polar cap size and the electric field intensity, we can estimate the polar cap potential as about 20-40 kV. On the other hand, there can be seen the enhanced electric field region within an invariant latitude range from 60 to 75 degrees in the poleward electric field. This enhanced electric field region seems to correspond to the auroral oval region where the Pedersen ionospheric current flowing to the meridional direction connects between the region-1 and region-2 field-aligned currents. The potential drop in the two sectors can be estimated as about 20-30 kV.

During the main phase, the poleward and azimuthal electric field distributions indicate that the polar cap region expands to the equatorward region from the magnetic latitude from 75 to 70 degrees. The electric field intensity in this region also increases up to more than 12.0 mV/m. Then, in this case, we can also estimate the polar cap potential as about 53.4-106.8 kV. On the other hand, the enhanced poleward electric field distributes in the equatorward region of the polar cap boundary within an invariant latitude range from 60 to 70 degrees. The equator boundary of the enhanced electric field region is located in the invariant latitude of more than 60 degrees. Moreover, it is interesting that the poleward electric field appears with the large magnitude of more than 12.0 mV/m within a sub-auroral latitude region from 50 to 60 degrees in the magnetic local time sector between 18 and 02 hours. The poleward electric field is generated by the charge separation of the plasmasheet electrons and ring current ions in the inner magnetosphere. The potential drop associated with the enhanced electric fields in both the dawn and dusk sector can be estimated as about 53.4-106.8 kV. It is noted that this value of the potential drop is almost consistent with that of the polar cap potential.

During the recovery phase, the poleward and azimuthal electric field distributions indicate that the size of the polar cap and auroral regions reduces into the high-latitude region with decreasing of the intensity, compared with that during the main phase. In this case, the polar cap potential can be estimated as about 26.7 -53.4 kV. The value of the polar cap potential decreases up to a half value during the main phase. On the other hand, the enhanced poleward component of the electric field located in the equatorward region between 50 and 60 degrees appears with the magnitude of 6.0-12.0 mV/m in this period as well as in the main phase. Moreover, the potential drop associated with the enhanced electric fields in both the dawn and dusk sector can be estimated as about 26.7-53.4 kV. In the azimuthal component, the eastward electric field is enhanced with the averaged magnitude of about 6.0-7.0 mV/m in the post-midnight sector between 00 and 03 hours. As an interesting feature of the electric field distribution, the location tends to move into the low-latitude ionosphere with increase of the magnetic local time.