Plasma Transport Processes at the High Latitude Magnetosphere observed by Cluster

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Abstract

Cluster four spacecraft data is used to study the spatial-temporal characteristics in/near the high and mid-altitude cusp under northward IMF. In our previous work a transition layer equatorward of the cusp was observed, which is suggested to be the entry layer during northward IMF. From event study and a further survey tailward of the Cusp, some transport processes of sheath-like ions in the magnetosphere are studied. Possible (dual) lobe reconnection model in the northward IMF condition are applied to explain these observations.

1. Introduction

Understanding plasma transport processes from the magnetosheath to the magnetosphere is very important in space physics. At the high latitudes, there is an entry layer [1-3] located on the magnetospheric field lines just equatorward of the cusp. Previously it was recognized as a region of diffusive, turbulent entry of magnetosheath plasma onto closed field lines [4] during southward IMF [5;ISSI volume]. In our previous work [6], we have studied a case that Cluster traversed all the four boundariesnear the high altitude cusp. We have analyzed the HLTR/cusp (and HLTR/sheath) boundaries and identified some transition layers near them. The scale of different regions and boundaries has been estimated, and the field line topology was examined for different regions. We discussed the relationship of our observations to the double reconnection model [7] and the formation of the LLBL. Since the closed field line topology suggests that this layer is the newly formed part of the magnetosphere, we suggested that it is an 'Entry Layer' during northward IMF. In this layer, we found step-like structures in plasma parameters without significant turbulence and diffusive properties, which is different from the cases in southward IMF. So our observations provided a strong observational support for the Song and Russell [1992]'s model [7] at the high latitude dayside regions. In this work, Cluster four spacecraft data is used to study the spatial-temporal characteristics in/near the high and mid-altitude cusp under northward IMF. In another event and a further survey tailward of the Cusp, some transport processes of sheath-like ions in the magnetosphere are studied. Possible (dual) lobe reconnection model in the northward IMF condition are applied to explain these observations.

2. Observations

For the event shown in Figure 1, Cluster have traveled from the dayside to the cusp and then to the lobe at the high latitudes. In addition to the normal cusp region, Cluster four spacecraft have seen another region that is very similar to the normal cusp. The order of the four spacecraft crossing this region is C2, C1, C4, and C3. This order is consistent with the spacing of the four spacecraft configuration, which indicates that this is a spatial region that is stably existing during about one hour. From Figure 1 we find that the IMF Bz is positive, that is, the IMF is northward.

To see how this 'second cusp' region is formed, we have made a global MHD simulation using the NASA CCMC (Community Coordinating Modeling Center) system. Inflow Boundary Conditions are Time-Dependent. The dipole is update with time. Initial Solar Wind (SW) Parameters in GSM Coordinates is that: SW Density is 20.95 n/cc, SW Temperature is 37129.53 Kelvin, SW Velocity Vx is -344.04 km/sec, SW Velocity Vy is -11.13 km/sec, SW Velocity Vz is -14.53 km/sec, IMF Bx is -3.70 nT, IMF By is 1.32 nT , IMF Bz is 9.70 nT, IMF |B| is 10.47 nT, and IMF Clock Angle is 7.7 degree.

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Figure 1. Magnetic field observed by ACE and Wind, and density of ions, protons and electrons observed by Cluster.

The results of the simulation can be seen in Figure 2. We find that this simulation seems to reproduced the 'double cusp' regions. From 11:00 to 11:30 UT, a normal cusp in the simulation results is found. From 14:00 to 15:00, the 'second cusp' is observed.

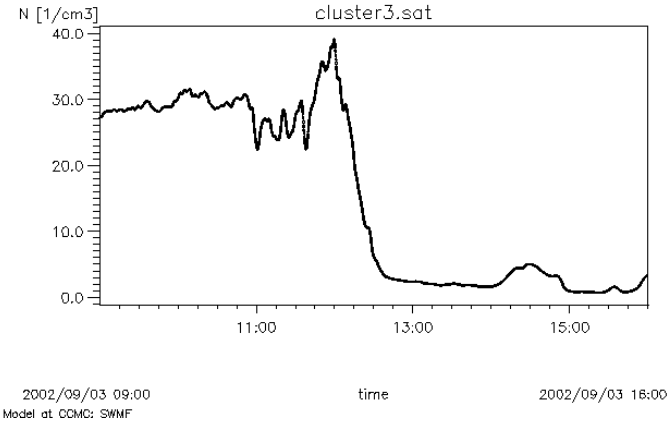

Figure 2. Density profile along the C3 orbit in the simulation results.

Then we have made a statistical work to study these kinds of events. Although the event shown here is during a relatively extreme time of solar wind conditions, we have find many events that during normal conditions. Possible lobe reconnection model in the northward IMF condition are applied to explain these observations. The details of this survey will be shown in our talk of this meeting.

3. Conclusion

Cluster four spacecraft data is used to study the spatial-temporal characteristics in/near the high and mid-altitude cusp under northward IMF. From event study and a further survey tailward of the Cusp, we have studied some transport processes of sheath-like ions in the magnetosphere. Possible dual lobe reconnection model in the northward IMF condition are applied to explain these observations. The details of this work will be shown in our talk of this meeting.

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5. References

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