Final Technical Report

Date:	August 30, 2001
Project title:	Investigation of High-Latitude Phenomena Using Polar Data and Global Simulations
Principal Investigator:	Prof. C. T. Russell (IGPP/UCLA)
Project Period:	05/15/00 - 05/14/01
Agency:	NASA
Award Number:	NAG 5-9299

1 Progress Summary

The goal of this one-year project was to use data from the Polar satellite in conjunction with global simulations of Earth's magnetosphere to investigate phenomena in the high-latitude magnetosphere. Specifically, we addressed reconnection at the cusp during periods of northward interplanetary magnetic field (IMF), and the effects of substorms on the high-latitude magnetosphere.

1.1 Cusp reconnection

On April 11, 1997 Polar made an excursion through the northern cusp and briefly encountered the magnetopause proper tailward of the cusp. The IMF, monitored by the Wind satellite, was during this period (about 4 hours) steady and strongly northward. However, the solar wind dynamic pressure was steadily increasing. The resulting compression of the magnetosphere caused Polar's encounter with the magnetopause. At its magnetopause encounter Polar observed several signatures of reconnection tailward of its position; in particular, the flow was stagnant. Although our interpretation of the data was that Polar had encountered the magnetopause proper on the sunward site of a reconnection region, there had also been other interpretations of this and similar events. We performed a simulation with the UCLA global magnetosphere - ionosphere code using the Wind solar wind and IMF data as input to the model. The model output was directly compared with the in situ Polar data. Overall, there was an excellent agreement between the data and the simulation results. The simulation clearly showed reconnection occurring

tailward of Polar's position. According to the simulation Polar never entered the magnetosheath proper, but remained in the magnetopause reconnection layer. The stagnant flow was caused by a balance between the tailward momentum flux of the magnetosheath flow and the sunward $\mathbf{j}\times\mathbf{B}$ force exerted by reconnection [*Le et al.*, 2001].

1.2 High-latitude substorm effects

In a separate effort in collaboration with Prof. Hedi Kawano (Kyushu University, Japan) we investigate the effects of substorms on the high-latitude magnetosphere, in particular the region tailward of the cusps at high altitude, i.e., roughly between 5 and 9 R_E from Earth. With Prof. Hedi Kawano we conducted a statistical study of substorm signatures in the polar magnetosphere. We have found that the magnetic field becomes significantly deflected during the growth phase. This deflection persists about 10-20 min into the expansion phase until it begins to subside. As in the previous study, we ran global simulations with measured solar wind parameters for selected events and compared the results with Polar observations. Since there was a significant delay between the substorm onsets and the subsistence of the magnetic field deflections at high altitudes we speculated that the ionospheric conductance might play a role here by pinning down the field lines at ionospheric altitude. We tested this hypothesis by varying the ionospheric conductance in the simulations. We found that there is indeed a noticeable effect in that the line tying of the ionosphere alters the substorm timing at high latitudes significantly [*Kawano et al.*, 2000].

2 Publications

Le, G., J. Raeder, C. T. Russell, G. Lu, S. M. Petrinec, and F. S. Mozer, Polar Cusp and Vicinity Under Strongly Northward IMF on April 11, 1997: Observations and MHD Simulations, *Journal of Geophysical Research*, in press, 2001.

3 Abstracts

Kawano, H., G. Le, C. T. Russell, J. Raeder, G. Rostoker, R. Yamaguchi, and K. Yumoto, Magnetosphere–ionosphere coupling effects during substorms in the polar magnetosphere, *First S-RAMP Conference*, Sapporo, Japan, 2000.

4 Inventions and Patents

None.