

Possible Formation Mechanism of “Reverse L” -Shaped Transpolar Arc and Associated Ionospheric Flows: A Multi-Event Study

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We found six events of the interesting shape of Transpolar Arc (TPA) among a large database of IMAGE and POLAR during 5 years between 2000 and 2005. The two events out of six events were observed in northern hemisphere, and the rests were seen in southern hemisphere. A shape of the observed TPA was just like a reversal of the alphabetical letter of “L”, that is, a part of the nightside end of the TPA is “bending” toward the midnight sector. The “bending” polar arc, which is only growing from the nightside main auroral oval, is well-known as “bending arc”, but the TPA, having a bending part at the nightside end, completely grew toward the dayside auroral region. When this “Reverse L” -shaped TPA was observed, the B_z component of the Interplanetary Magnetic Field (IMF) was dominantly northward in almost of cases, and the TPA’s location was determined by the orientation of the IMF- B_y component; the dawn(dusk)side of TPA in northern (southern) hemisphere was seen during the negative B_y component, and under the positive B_y component, the TPA was observed in dusk(dawn)side in northern (southern) hemisphere, which are consistent with the result of a statistical survey for the TPA locations as reported previously. Particularly, on the “Reverse L” -shaped TPA event observed in the northern hemisphere on 22, September, 2000, the SuperDARN radar had detected the ionospheric fast flows, whose range was larger than 0.7 km/s, on the pre-midnight sector of the main auroral oval since, at least, about 2 hours prior to the TPA appearance. Even during the “Reverse L” -shaped TPA brightening, these fast flows persisted. These plasma flows seen in the ionosphere are identified as ionospheric fast flows associated with “Tail Reconnection during IMF Northward Non-substorm Intervals (TRINNI)” , supporting that this interesting TPA would be formed by nightside magnetic reconnection. However, we also found the case where the TPA separated into the dayside and nightside parts after its appearance, that is, the middle part of the TPA had a “void” structure. These characteristic signatures on the TPA might suggest that formation of “Reverse-L” -shaped TPA would not be addressed by the nightside magnetic reconnection model alone.

We have proceeded further in analysis of these interesting “Reverse L” -shaped TPA events based on both ground- and space-based observations, and supportive global MHD simulations. In this paper, we will discuss the features of ionospheric TRINNI’s flows, whose triggering mechanism is suggestive of nightside magnetic reconnection, and a possible formation mechanism of the “Reverse L” -shaped TPAs based on the results obtained through the detailed analyses.

Keywords: Transpolar Arc, Magnetotail Reconnections, Ionospheric Flows, TRINNI