A Possible Formation Scenario of the Transpolar Arcs with the Nightside End Distortions: Role of Field-Aligned Currents

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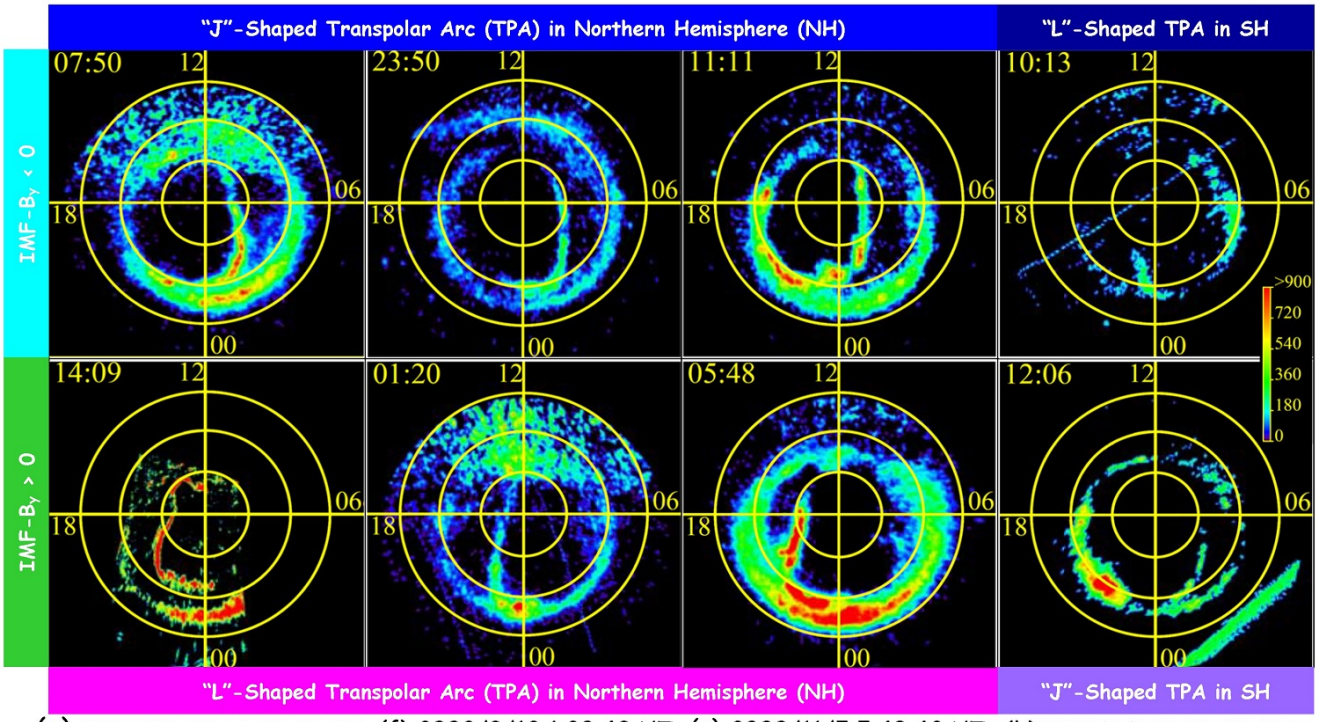
Since we discovered the newly morphological transpolar arc (TPA), whose nightside end got distorted toward pre- or post-midnight, identified as “nightside distorted TPAs”, their fundamental characteristics have been revealed based on investigations of the space-borne auroral imager data and corresponding solar wind conditions. Nightside distorted TPAs had two types; “J”- and “L”-shaped TPAs, and their locations of appearance (dawn or duskside of the polar cap) were governed by the polarity of the B_y component of the Interplanetary Magnetic Field (IMF). Furthermore, we found that the nightside distorted TPAs have antisymmetric morphologies in the Northern and Southern hemispheres, also depending on the IMF-B_y orientation.
In this presentation, we show that that the electric currents flowing aligned to the magnetic field lines which connect between the magnetotail and the ionosphere, that is, Field-aligned currents (FACs) play an essential role in the formations of the “J”- and “L”-shaped TPAs. They are induced by significant plasma flow velocity difference (plasma flow shear) between the fast plasma flows associated with nightside magnetic reconnection and slower background plasma flows in the magnetotail. The current vortex structures with the counterclockwise rotation are also clearly seen in the ionospheric current vectors derived from fluctuations of the geomagnetic field measured at the ground observatories beneath and in close proximity of the growth regions of the nightside distorted TPA. This result suggests that the FACs were flowing out of the ionosphere toward the magnetotail (upward FACs) near the TPA.
Furthermore, based on the geomagnetic field variations and the SuperDARN HF radar data, we obtained evidence in which the locations of magnetotail magnetic reconnection, which persisted even during northward IMF-B_z intervals, that is, the TPA durations, retreated further down tail as the TPA grew to the dayside. Taking into account these observational results, we finally show a model to illustrate the nightside distorted TPA (particularly, “L”-shaped TPA) formation.

Keywords: Nightside distorted transpolar arc: “J”- and “L”-shaped TPAs , Solar wind-magnetotail-ionosphere coupling, Magnetospheric diagnosis , Magnetotail magnetic reconnection, Plasma flow shear, Field-aligned currents

(a) 2000/9/22 7:50:26 UT (b) 2000/12/27 23:50:07 UT (c) 2001/12/31 11:11:49 UT (d) 2004/6/5 10:13:40 UT



(e) 2003/10/28 14:09:42 UT (f) 2002/3/12 1:20:43 UT (g) 2000/11/5 5:48:42 UT (h)2005/6/1 12:06:09 UT