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Plasma Flow Along Transpolar Arcs

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Transpolar arcs (TPAs) are often assumed to lie on closed field lines that map to the tail plasma sheet or its boundary layer and connected to sunward convecting plasma. We present now a study looking at the plasma flow pattern within TPAs in much detail and comparing it to Earth dipole tilt, solar wind and IMF conditions as well as substorm phases. The study is based on DMSP measurements of 73 TPA crossings. The selected DMSP orbits are approximately along the dawn-dusk meridian.

We find that the flow characteristics changes drastically between dark (negative Earth dipole tilt) and sunlit (positive tilt) TPA passages. In darkness the flows vary much stronger with large sunward and anti-sunward flow peaks. In sunlit cases, the flows are in general small and do not vary much.

A clear solar wind and IMF dependence is found only for positive dipole tilts: plasma flows on sunlit passages are only high for a strongly northward IMF and high solar wind energy fluxes. Even the flow direction correlates with dipole tilt. The dark passages contain more cases with anti-sunward flow than the sunlit passages.

Another parameter that influences the flow direction is connected to the substorm evolution. Nearly all TPA passages during the substorm growth phase show anti-sunward flow on the TPA, while TPAs during many hours quiet times are in general on sunward flow.

The results are discussed with respect to effects of UV illumination of the ionosphere, magnetospheric topology changes during transpolar arcs, and plasma convection patterns during substorms and quiet times.