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Plasma circulation inside the polar cap and lobe reconnection

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Energy and momentum transport through the geospace system are facilitated mainly by reconnection. The most efficient mode of the solar wind – magnetosphere coupling is the classical dayside/nightside reconnection cycle, often referred to as opening/closure of magnetic flux. Due to the physical constraint of a divergence free magnetic field, the amount of open magnetic flux is the same in both hemispheres. Hence, the rate of magnetic flux opening and closure is identical in the two hemispheres. However, other reconnection processes can also occur, with no physical restrictions with regard to north-south symmetry, that can significantly contribute to energy and momentum transport in the geospace system. One such example is when draped Interplanetary Magnetic Field lines (IMF) reconnect with the terrestrial field, poleward of the cusp, usually referred to as lobe reconnection. Observational signatures include sunward convection and flow circulation inside the polar cap, and associated field-aligned currents (NBZ) and aurora in the dayside polar cap. For the opening/closure type of forcing, we have empirical relationships between the rate of magnetic flux opening on the dayside given the solar wind and IMF conditions. Yet there are no similar empirical relationships for quantifying lobe reconnection rates. Studies has indicated that there are strong seasonal (and hence hemispheric) differences on the effect on ionospheric convection, attributed to differences in lobe reconnection rates. Furthermore, there is a lack of knowledge about how the lobe reconnection depends on the IMF direction and on the internal state of the magnetosphere (e.g. magnetopause flaring). Determining the controlling parameters for lobe reconnection is a prerequisite to more accurately predict high-latitude plasma convection, and hence also hemispheric differences. In this study we investigate the ionospheric convection by especially focus on the open and closed field-line regions separately. Our goal is to quantify the polar cap plasma circulation, and investigate whether this can be used as a measure of lobe reconnection potential.