Role of fast flow channels in aurora and tail-inner magnetosphere interaction

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Plasma transport in the plasma sheet and auroral oval is known to involve a significant amount of transient fast flows that are longitudinally localized. Recently, using a combination of the THEMIS satellites, all-sky imagers and SuperDARN radars, those fast flow channels are found to play a crucial role in triggering substorm auroral onset, whose pre-onset sequence has been in strong debate in the community for decades. Those pre-onset flows originate from the far downtail several minutes before the auroral onset, and can also be seen as auroral poleward boundary intensifications (PBIs) and subsequent roughly north-south aligned auroral streamers that reach the equatorward portion of the auroral oval. The precursor aurora was found very commonly (~80% of events) in THEMIS ASI observations.

Furthermore, we found that those fast flows are a critical element of tail-inner magnetospheric interactions. Some of those flow bursts penetrates into the inner magnetosphere, and increases the ring current pressure, EMIC wave intensity, and proton auroral luminosity. This process can occur in a few tens of minute time scale, which is much more rapid than by slowly varying convection driving, and suggests that flow bursts from the plasma sheet give rapid modulation of the ring current. When SuperDARN echoes are available, SAPS flow enhancements were also seen to occur as equatorward (earthward at the equator) extension of the fast flow channels. Those responses in the inner magnetosphere and subauroral ionosphere can be seen both during non-storm and storm-time events, suggesting that flow bursts in the plasma sheet have a high impact on plasma and energy transport into the inner magnetosphere and subauroral ionosphere.