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Variations of Ionospheric Lagrangian Coherent Structures in Modeled Polar Convection

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The high latitude F-region ionosphere frequently exhibits dramatic variability in the form of polar cap patches and tongues of ionization, which we generally refer to as "sporadic F." Background plasma supply levels, high-latitude convection and energetic particle precipitation may all variously contribute to this effect. The seasonal variability of sporadic F is anticipated to be observed more easily in the winter hemisphere [1], yet recent observations showed that in both hemispheres sporadic F appeared more frequently in January than in July [2,3]. In this work, we aim to identify monthly average variations in convection, and to understand their implications for plasma material transport.

In a time-varying flow field, fluid coherent structures demarcate regions of persistent flow behavior. These structures are observer-independent when analyzed in the Lagrangian frame, i.e., the frame that advects with the fluid. Lagrangian coherent structures (LCSs) are regions of maximal separation in a flow. In a 2-d flow they are ridges separating regions of flow that undergo qualitatively different motion. Previous work showed that the high-latitude ExB convection produces LCSs that are U-shaped ridges open to the nightside, and that these might determine the source regions of plasma that make up high-latitude sporadic-F, as well as indicating channels of transport over the polar caps [4].

In this work, we use the physics-based ionospheric model SAMI3 [5] to map the LCSs in the northern hemisphere in the northern hemisphere winter. We present case studies of LCSs over the period studied. We generate an average modeled LCS position for each season and hemisphere for comparison. We look for day-of-year changes in the LCSs, and compare to Multi-Instrument Data Assimilation System (MIDAS) [6] GPS-derived images of total electron content convecting over the polar caps.

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