Formation of polar cap patches measured by the RISR radar pair

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Recently a new incoherent scatter radar located at Resolute Bay, Canada (RISR-C), started its science operation. In combination with the existing north-facing radar (RISR-N), the pair of radars provides 3-d volumetric imaging of plasma density around the cusp. The radar pair also gives ~10 degrees of latitudinal coverage, allowing to cover the dayside subauroral ionosphere, cusp and polar cap simultaneously. We use the RISR radar pair to address where polar cap patches originate and what determines timing of patch formation. We also identify how the high-density structures relate to plasma flows and heating.

We identified two types of polar cap patch formation. High-density plasma in the first type originates in the subauroral ionosphere and propagates into the polar cap. The poleward propagation was highly correlated with enhanced ionospheric convection. This sequence fits to the traditional idea that polar cap patches form as a consequence of large-scale convection evolution. The high density region extended upward at the cusp, indicating that heating in the cusp substantially contribute to density enhancements in the topside ionosphere. In the second type, large-scale convection does not show substantial changes but high-density plasma forms in the cusp region and propagates poleward in association with localized fast flows. We suggest that this type of events occurs in response to localized magnetopause reconnection that results in transient cusp heating. We also discuss IMF dependence and relations with tongue of ionization detected in GPS TEC.