SECS reconstruction of flow fluctuations with SuperDARN data

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We further analyze detailed properties of two-dimensional (2-D) structures of the ULF-like, ionospheric flow fluctuations during a short (~2 hours) break of the main phase of the March 2015 storm. Line-of-sight (LOS) Doppler velocities observed by two SuperDARN radars in the early morning sector were used to deduce the 2-D horizontal flows by means of the spherical elementary current system (SECS) expansion. Similar to results deduced by the conventional map potential technique, the SECS reconstruction shows that ionospheric plasma in the subauroral region flows primarily in the geomagnetically eastward direction before and after the period of the ULF-like fluctuations. The reconstructed flow pattern shows that, during the first half of the ULF event interval, background convection subsides and circular/elliptically polarized flow fluctuations pass over the field-of-view of the radars as they propagate westward. Multiple flow bursts likely associated with small injections occur concurrently during the second half period, while the westward-propagating flow fluctuations still continue regardless of the bursts until a major substorm activity starts later on. Some eastward-propagating flow fluctuations are seen in the early morning sector upon onset of the major substorm, which is strongly suggested by the fact that multiple injections are seen around midnight by Van Allen Probes and the SYM-H and AL indices resume growing. A new finding from the reconstructed flow then is that the eastward-propagating structures are also dominated by a poloidal component. The common feature of poloidal-dominant fluctuations implies that the westward- and subsequent eastward-propagating fluctuations are both caused by a similar mechanism.

Keywords: ionosphere, ULF, SuperDARN

