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F-region ionosphere effects on the mapping accuracy of SuperDARN HF radar echoes

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Structured particle precipitation in the cusp is an important source for the generation of F-region ionospheric irregularities. The equatorward boundaries of broad Doppler spectral width in Super Dual Auroral Radar Network (SuperDARN) data and the concurrent OI 630.0 nm auroral emission are good empirical proxies for the dayside open-closed field line boundary (OCB). However, SuperDARN currently employs a simple virtual model to determine the location of its echoes, instead of a direct calculation of the radio wave path. The varying ionospheric conditions could influence the final mapping accuracy of SuperDARN echoes. A statistical comparison of the offsets between the SuperDARN Finland radar spectral width boundary (SWB) and the OI 630.0 nm auroral emission boundary (AEB) from a meridian-scanning photometer (MSP) in Longyearbyen from December 1995 to January 2014 in wintertime is performed. By restricting the location of the OI 630.0 nm data to be near local zenith, where the MSP has the highest spatial resolution, the mapping errors were significantly reduced for the AEB. The variation of the SWB – AEB offset confirms that there is a close relationship between the mapping accuracy of the HF radar echoes and solar activity. The asymmetric variation of the SWB – AEB offset versus magnetic local time suggests that the intake of high density solar extreme ultraviolet ionized plasma from post-noon at sub-auroral latitudes could result in a stronger refraction of the HF radar signals in the noon sector. The changing HF radar operating frequency also has a refraction effect that contributes to the final location of the HF radar echoes.