Occurrence Statistics and Driving Mechanisms of Ionospheric ULF Waves Observed by SuperDARN Radars

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Ultra-low frequency (ULF; 1 mHz - 5 Hz) waves are known to play an important role in the transfer of energy from the solar wind to Earth's magnetosphere and ionosphere. The Super Dual Auroral Radar Network (SuperDARN) is an international network consisting of 35 low-power high frequency coherent scatter radars at middle to polar latitudes that look into Earth's upper atmosphere and ionosphere. In this study, we use Doppler velocity measurements obtained by the SuperDARN radars and coordinated spacecraft observations to investigate the occurrence statistics and driving mechanisms of ionospheric ULF waves. Pc3-5 band (1.7-40.0 mHz) ULF waves were surveyed using high time resolution radar data from 2010 to 2016. Specifically, we have investigated the wave spatial occurrence, frequency characteristics, seasonal factors, and dependence on solar wind and geomagnetic conditions. We note two particular findings: (i) an internal wave-particle interaction source is responsible for Pc4 waves at high latitudes in the duskside ionosphere; and, (ii) a source associated with the magnetotail dynamics during active geomagnetic times is suggested for Pc3-4/Pi2 waves at midlatitudes in the nightside ionosphere. A few interesting ULF wave events will be further analyzed for their driving mechanisms via coordinated observations from spacecraft. Collectively, these research findings provide better constraints on where and when ionospheric ULF waves occur and how they might affect magnetospheric and ionospheric dynamics.

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