Statistical behaviour of the polar cap, auroral, and subauroral ionosphere imaged with the TIGER HF radar

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HF radar measurements of backscatter power, line-of-sight Doppler velocity, and Doppler spectral width provide valuable information on high-latitude ionospheric and magnetospheric processes, such as the production of decametre-scale irregularities, ionospheric convection, Pc 1-2 hydromagnetic wave activity, and spatial and temporal variability of the plasma drift in the integration period. The statistical behaviour of these parameters in the polar cap, auroral, and subauroral ionosphere (–57°Λ to –88°Λ) has been investigated using echoes detected by the Tasman International Geospace Environment Radar (TIGER), a SuperDARN HF backscatter radar located on Bruny Island, Tasmania (147.2°E, 43.4°S geographic; –54.6°Λ). TIGER is the most equatorward of the SuperDARN radars, both geographically and geomagnetically, but its default range window (180 to 3555 km in 45-km steps) almost extends to the corrected geomagnetic pole. The bore site of the radar points toward geographic south, and under routine operation, it performs 16-beam scans covering 52° in azimuth. In the normal (fast) modes of operation, the radar integrates for 7 s (3 s) from beam 0, the western most beam, to beam 15, the eastern most beam, every 2 min (1 min). We show the occurrence rates of ionospheric echoes and corresponding average parameters derived from all the routine beam 4 and 15 observations made during the first year of radar operation, December, 1999 to November, 2000. Results for beam 4 are compiled because it points south along the magnetic meridian, directly measuring the zonal electric fields. Results for beam 15 are also compiled because it becomes a magnetic zonal beam at its furthest ranges, providing a detailed profile of zonal flow channels in the nightside auroral oval. Our sunspot maximum results were sorted into bins of universal time, range, season, K_p index, and four basic quadrants of the IMF B_y-B_z plane. The peak occurrence rate of echoes was >65% for irregularities forming in the discrete auroral oval near –71°Λ and magnetic midnight (for all data combined), with the peak moving equatorward with increasing K_p. The occurrence rates were lowest during the quietest conditions, grew to a maximum for K_p>4 to 5, and thereafter varied erratically during the most disturbed intervals encompassing a small number of storms. Variations in the statistics can be explained by the combined effects of changes in radar operation; changes in the available propagation channels affected by factors such as *D*-region absorption, and the preferred ranges which best satisfy the backscatter condition of normal incidence relative to the magnetically field-aligned irregularities; and changes in the production, dissipation, and movement of decametre-scale irregularities in the nightside auroral oval controlled by geomagnetic activity and ionospheric conductivity in the radar field-of-view and conjugate ionosphere. Another advantage of TIGER's equatorward location is that it provides routine detection of the sharp decrease in velocity and spectral width in the nightside ionosphere during geomagnetic quiet conditions. This feature is probably a proxy for the open-closed magnetic field line boundary corresponding to the poleward edge of the nightside auroral oval. To consolidate the routine detection of echoes from mid-latitude and subauroral ionospheric irregularities, the establishment of another SuperDARN radar a further ~5° equatorward of TIGER, but with overlapping field of view, would be ideal.