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A multi-instrument study of nightside backscatter detected by TIGER: Mapping the Doppler velocity signatures to ionospheric and magnetospheric regions

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The Tasman International Geospace Environment Radar (TIGER) is the most equatorward of the SuperDARN radars, both geographically and geomagnetically, imaging the latitude interval 57°S to 88°S (geomagnetic hereafter). Hence its location is favourable for the detection of echoes from field-aligned irregularities forming in the nightside auroral and subauroral ionosphere. The geomagnetic conditions were fairly quiet near magnetic midnight on 10 December, 1999 when a sharp latitudinal decrease (~90 km) in line-of-sight Doppler velocity and spectral width was observed at ~68°S. We investigate the relationship between this boundary and familiar ionospheric and magnetospheric regions by comparing TIGER data with dynamic spectra of precipitating particles measured on board the Defence Meteorology Satellite Program (DMSP) satellites, total electron content (TEC) measurements made at Macquarie Is. (65°S) and Hobart (54°S), and ionograms recorded at Macquarie Is., Hobart, and Bundoora (49°S). The region poleward of the Doppler boundary was characterised by bursty, meridional flows (>300 m s^{-1}) and high spectral widths (>200 m s^{-1}). These numerous echoes were from irregularities forming on the open (but soon to be reconnected) field lines threading the polar cap ionosphere to the southern tail lobe. Hence the spectral width boundary was a reasonable proxy for the open-closed field line boundary. The region equatorward of the Doppler boundary was characterised by slower, more zonal flows (<300 m s^{-1}) and very low spectral widths (<50 m s^{-1}). These more transient echoes were from irregularities forming on the closed field lines threading the discrete and diffuse auroral oval to the plasma sheet boundary layer (PSBL) and central plasma sheet (CPS). However, sometimes these echoes extended sufficiently equatorward to be classified as true subauroral echoes from irregularities forming in association with subauroral ion drift events (SAIDs) (and westward perturbation drifts) occurring in proximity to the main ionospheric trough and plasmapause. Examination of multi-instrument data recorded on various nights showed how the main trough (plasmapause) resided poleward of Macquarie Is. during the early evening under very quiet conditions (ΣK_p<10), but passed above Macquarie Is. earlier in the evening for increasing levels of geomagnetic activity (ΣK_p~20). Under very disturbed conditions (ΣK_p>40) the main trough even passed above Hobart early in the evening, reaching the latitude of Bundoora (49°S) early in the morning.