HF digital ionosonde and TIGER backscatter radar observations of magnetospheric electric fields penetrating the southern-hemisphere mid-latitude ionosphere

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When the interplanetary magnetic field (IMF) is roughly steady and B_z is not strongly southward the large electric fields driving magnetospheric convection are usually confined to the high-latitude ionosphere. Under these circumstances the weaker mid-latitude electric fields are generated by the tidally-driven ionospheric dynamo. Atmospheric gravity waves also generate short-period variability (<3 h) in the ionospheric dynamo. However, when the IMF suddenly changes and especially if B_z becomes strongly southward, the magnetospheric convection is no longer stationary and large magnetospheric transients can penetrate the plasmasphere. These "prompt penetration fields" last ~30 mins and their amplitudes decay with decreasing latitude in the ionosphere. Subsequent changes in the mid-latitude dynamo fields lasting many hours have been attributed to the disruption of the quiet thermospheric wind system driven by Joule heating in the high-latitude ionosphere. The quiet mid-latitude dynamo, the perturbations generated by geomagnetic storms, and sub-auroral ion drift events (SAIDs) are all well known to have a strong westward component during the night (in the co-rotational frame). The same basic responses have been found in incoherent scatter radar and satellite measurements, and more recently using Doppler velocities measured with a digital ionosonde located at Bundoora, Victoria (145.1°E, 37.7°S, geographic, 49°S magnetic).

The Tasman International Geospace Environment Radar (TIGER) (147.2°E, 43.4°S geographic) is the most equatorward of the SuperDARN radars, measuring Doppler velocity at magnetic latitudes of 57°S and greater. Hence TIGER is also useful for studying sub-auroral and plasmaspheric ion motions. The signature of the sub-auroral drifts is striking in the early magnetic morning when an analysis of the 16-beam full-scan data reveals a latitudinal shear between the sunward (eastward) drifts equatorward of the convection reversal boundary, and the westward drifts of the plasmaspheric convection. This signature is coincident with a sharp decline in the magnitudes of the Doppler velocities and spectral width, and helps to fix the location of the plasmapause. Moreover, TIGER observations are used to identify the time of IMF-driven changes in the high-latitude convection and subsequent Doppler velocity responses in the sub-auroral range gates. These are compared with impulsive increases in Doppler velocity measured by the digital ionosonde at Bundoora to estimate the propagation delay and duration of prompt penetration fields.

Summary < 100 Words

The Tasman International Geospace Environment Radar (TIGER) (147.2°E, 43.4°S geographic) was used to measure IMF-driven convection changes simultaneously with Doppler velocity measured using the Digisonde located at the mid-latitude station Bundoora, Victoria (145.1°E, 37.7°S, geographic, 49°S magnetic). The data were used to estimate the propagation delay and duration for large magnetospheric convection fields to penetrate the plasmasphere. TIGER full-scan data were also used to distinguish the boundary between the high-latitude magnetospheric and plasmaspheric convection, and thereby its relationship to a sharp decline in Doppler velocity width and other signatures of the plasmapause and main trough.