On the lifetime and extent of an auroral westward flow channel observed during a magnetospheric substorm

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Abstract. A –190-nT negative bay in the geomagnetic *X* component measured at Macquarie Is. (–65°Λ) showed an ionospheric substorm occurred during 0953 to 1110 UT on 27 February, 2000. Signatures of an auroral westward flow channel were observed nearly simultaneously in the backscatter power, los Doppler velocity, and Doppler spectral width measured using the Tasman International Geospace Environment Radar (TIGER), a southern hemisphere HF SuperDARN radar. Many of the characteristics of the event were similar to those occurring during a polarisation jet (PJ), or subauroral ion drift (SAID) event, and suggest that it may have been the failed precursor to a fully developed, intense westward flow channel satisfying all of the criteria defining a PJ/SAID. A beam-swinging analysis showed the westward drifts (poleward electric field) associated with the flow channel were very structured in time and space. The smoothed velocities grew to ~800 m s^{-1} (47 mV m^{-1}) during the 22-min substorm onset interval 0956 to 1018 UT. Maximum westward drifts of >1.3 km s^{-1} (>77 mV m^{-1}) occurred during an ~5-min velocity spike peaking at 1040 UT during the expansion phase. The drifts decayed rapidly to ~300 m s^{-1} (18 mV m^{-1}) during the 6-min recovery phase interval 1104 to 1110 UT. Overall, the flow channel event had a lifetime of 74 min, and was located near –65°Λ in the evening sector west of the Harang discontinuity. The large westward drifts were confined to a geographic zonal channel of zonal extent of >20° (>1.3 h magnetic local time), and latitudinal width ~2°Λ. Using a half-width of ~100 km in latitude, the peak electric potential, probably associated with the polarisation of ring current ions and electrons, was >7.7 kV. However, a transient velocity and potential of >3.1 km s^{-1} and >18.4 kV, respectively, was observed further poleward at the end of recovery phase. Determination of auroral oval boundaries made using nearby transits of the Defence Meteorology Satellite Program (DMSP) satellites suggest the main flow channel was aligned parallel to the equatorward boundary of the diffuse auroral oval. During the ~2-h interval following the flow channel, a ~3°Λ wide band of scatter was observed drifting slowly toward the west, with speeds gradually decaying to ~50 m s^{-1} (3 mV m^{-1}). The scatter was observed extending past the Harang discontinuity, and had Doppler signatures characteristic of the main ionospheric trough, implicating the flow channel in the further depletion of *F*-region plasma. This scatter contrasted with the higher latitude scatter drifting toward the east. Total electron content (TEC) measurements made at Macquarie Is. (–65°Λ) and Hobart (–54°Λ), and ionograms recorded at the same stations and Bundoora (–49°Λ), helped to validate our interpretation.