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An Auroral Westward Flow Channel (AWFC) and its Relationship to Field-Aligned Current, Ring Current, and Plasmopause Location Determined Using the Cluster and Iridium[®] Satellites

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An auroral westward flow channel (AWFC) is a latitudinally narrow channel of F-region plasma with intense westward drift in the dusk to midnight sector ionosphere. AWFCs tend to overlap the equatorward edge of the auroral oval, and their life cycle is often synchronised to that of substorms. Here we define for the first time the relationship between an AWFC, large-scale field-aligned current (FAC) sheets, the ring current, and plasmopause location. The Tasman International Geospace Environment Radar (TIGER) observed a jet-like AWFC during ~08:35 to 13:28 UT on 7 April 2001. Unlike previous AWFCs, this event was not associated with a distinct substorm surge; rather it occurred during an interval of persistent, moderate magnetic activity characterised by AL ~ -200 nT. The initiation of the AWFC was preceded by a band of equatorward expanding ionospheric scatter (BEES), probably indicative of an Earthward migration of plasma sheet thinning during the substorm growth phase. The Cluster spacecraft had perigees within the dusk sector plasmasphere, with trajectories magnetically conjugate to the radar observations. The WHISPER instruments on board Cluster were used to identify the plasmopause location. The Cluster fluxgate magnetometers provided successive measurements specifying the relative location of the ring current and filamentary plasma sheet current. The AWFC was located just poleward of the plasmopause, yet just equatorward of the plasma sheet. An analysis of Iridium spacecraft magnetometer measurements provided estimates of large-scale ionospheric FAC in relation to the AWFC evolution. The AWFC was bounded by Region 2 downward (Region 1 upward) current sheets on its equatorward (poleward) edge. These observations enabled the construction of a self-consistent electrodynamic model for AWFCs relating field-aligned and Pedersen currents to gradients in ionospheric conductance, electric field, and westward drift.