On the lifetime and extent of an Auroral Westward Flow Channel (AWFC) observed during a magnetospheric substorm

M. L. Parkinson¹, M. Pinnock², H. Ye³, M. R. Hairston⁴, J. C. Devlin³, P. L. Dyson¹, R. J. Morris⁵, and P. Ponomarenko⁶

(1) Department of Physics, La Trobe University, Melbourne, Victoria 3086
(2) British Antarctic Survey, NERC, Cambridge, CB3 0ET, U.K.
(3) Department of Electronic Engineering, La Trobe University, Victoria 3086
(4) William B. Hansen Center for Space Sciences, Univ. of Texas at Dallas, U.S.A.
(5) Australian Antarctic Division, Kingston, Tasmania 7050, Australia
(6) Department of Physics, University of Newcastle, New South Wales 2038
What’s this talk about?

Here we use TIGER Oz 1-min resolution, common mode observations, combined with ground-based magnetometer and DMSP satellite measurements to investigate:

- the behaviour of an ~2° wide *Auroral Westward Flow Channel (AWFC)* located near ~22 MLT and −65°Λ, and overlapping the equatorward edge of the auroral oval during ~0953 to 1110 UT on 27 February, 2000;

- its growth near the onset of a nearby ~190-nT ionospheric substorm, and subsequent decay at the end of recovery phase;

- its similarity to a *Polarisation Jet (PJ)* or *Sub-Auroral Ion Drift (SAID)*;

- a step-like increase (decrease) in the power (spectral) widths at the end of the main *AWFC*, and the subsequent appearance of narrow, trough-like spectral widths.
The Magnetospheric Substorm


(a) Global auroral distribution.

(b) Electric currents in the equatorial plane.

(c) Plasma turbulence arising from current disruption.

(d) Magnetotail magnetic reconnection geometry.
**Polarisation Jets or Sub-Auroral Ion Drifts (PJ/SAIDs)**

\[ J_\perp = \sum_p E_\perp \]

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**Figure 1.** Schematic view of the current sheet connecting the nightside ionosphere where a PJ/SAID is observed to the magnetosphere. The ionospheric magnetic field \( B_{\text{iono}} \) points down, the ionospheric drift \( V_{\text{iono}} \) is westward, and the electric field \( E_{\text{iono}} \) is directed poleward. The arrows indicate the direction of the field-aligned and ionospheric currents.
Morphology of the Main Ionospheric Trough

Solar-Wind Conditions, IMP8 Satellite

\[ \text{GSM}_{x,y,z} = (-2.7, -36.5, -18.8) \text{ Re} \]

Delay \approx 0 \text{ mins}
$\Sigma K_p = 22$

Substorm 1

0958 UT

Substorm 2

1050 UT

1335 UT

1424 UT
Auroral Westward Flow Channel (AWFC), 27 Feb. 2000

Beam #15

(a) Power (dB)
(b) LOS Doppler Velocity (m/s)
(c) Spectral Width (m/s)
Gradient drift waves, $\gamma \propto \mathbf{v} \cdot \nabla n_e / n_e$ where $\mathbf{v} = \mathbf{E} \times \mathbf{B} / B^2$
Gradient drift waves, $\gamma \propto v \cdot \nabla n_e/n_e$ where $v = \mathbf{E} \times \mathbf{B}/B^2$
2-D Beam-Swinging Velocities, 27 February, 2000

The diagram shows the variation of velocities over time and space, with specific fields labeled as F13, F12, F14, and F15. The velocity scale ranges from 100 m/s to 550 m/s, with color coding indicating different velocity ranges. The graph also includes a time axis from 9 to 14 hours in Universal Time (U.T.) and a magnetic local time (M.L.T.) axis from 21 to 02 hours.
2-D Beam-Swinging Speeds, 27 February, 2000

0956 1040 1108 UT  "VLPTM"

MLAT (Deg)

2 km s\(^{-1}\)

Universal Time (Hours)
\[ v_{w, i, j} = (v_{LOS i, j} - v_{eq})/\sin(\theta_i - \phi), \quad v_{eq} \approx 80 \text{ m s}^{-1}, \quad \phi \approx 1^\circ \]
Unexplained Westward Drift Expanding Equatorward

Speculation:

1. Equatorward-propagating auroral disturbance?
2. For example, another minor AWFC?
3. Field-perpendicular electric field carried by AGW?
4. Prompt penetration or disturbance dynamo field propagating to mid-latitudes?
5. Any other ideas?
Bundoora (37.7°S geo.; 49°S mag.)
Digital Ionosonde Zonal Drifts

Westward Perturbation Drifts (c.f., PJ/SAID)
Some Questions:

- Why was there no clear growth-phase signature before the onset of the storm?
- Why did our AWFC commence at substorm onset, yet PJ/SAIDs do not commence until during recovery phase?
- What caused the step-like change in the character of the ionospheric scatter at the end of the main AWFC?
- How many substorms are accompanied by PJ/SAID or AWFC, and under what conditions?
- Were the conditions of Substorm 1 specific to the requirements for the occurrence of an AWFC?
Some More Questions:

- Are PJ/SAIDs, Substorm Associated Radar Auroral Surges (SARAS), Flux Depletion Regions (FDR) (Sanchez et al., J. Geophys. Res., 101, pp. 19,801–19,837, 1996), AWFC, prompt penetration fields, etc. all manifestations of the same, basic, underlying phenomenon?

- That is, was the AWFC an immature PJ/SAID?

- Was the ionosphere-magnetosphere feedback mechanism part of the process triggering the substorm?

- How does the response of the mid-latitude ionosphere change when there is a PJ/SAID?