Substorm phases

T=0

T=0-5 min

T=5-10 min

T=10-30 min

T=30-60 min

T=1-2 hours
Dynamics of the substorm expansion phase
Auroral and Magnetic Signatures associated with substorm onset
Tail reconnection

**Polar Cap Boundary or (PCB)**

**Open-Closed-Boundary (OCB):**

*Dashed line* = reconnection boundary – plasma flow across this boundary during episodes of reconnection

*Full line* = adiabatic boundary – this boundary is frozen into the plasma movement

From Cowley and Lockwood, 1992
Magnetosphere response to a 1 hour interval of southward IMF

- A simple case when the nightside reconnection voltage follows the dayside reconnection voltage but with a 30-min time delay.
- Note that the open flux area is constant during balanced magnetopause and tail reconnection.
- e) shows the central polar cap voltage assuming a circular expanding or contracting polar cap.

From Cowley and Lockwood, 1992
The principle of flow-free equilibrium

The ionospheric response to an impulse of magnetopause reconnection

The ionospheric response to an impulse of tail reconnection

From Cowley and Lockwood, 1992