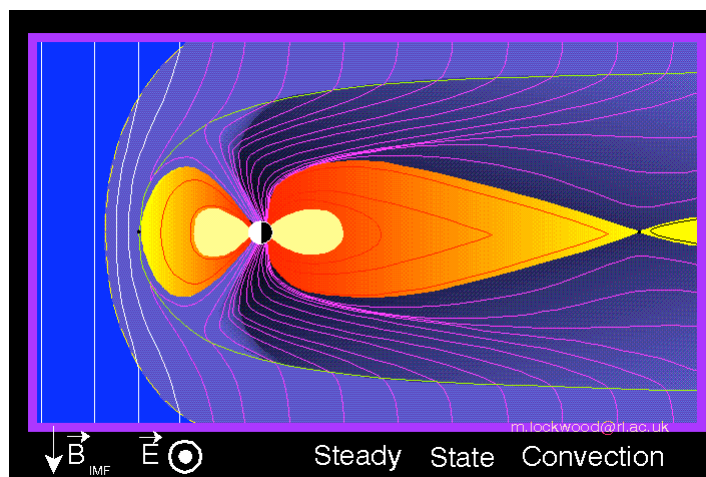


Lesson 4: Magnetospheric substorms

AGF-351
Optical methods in auroral physics research
UNIS, 24.-25.11.2011

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IMF $B_z < 0$ (southward) \Rightarrow idealized steady reconnection + plasma convection



Energy to drive magnetospheric plasma convection, field-aligned currents and aurora comes from the solar wind

A part of the energy carried with the solar wind can penetrate into the magnetosphere, especially when IMF has a southward component. One widely used estimate for the energy input is the **epsilon parameter** by Akasofu:

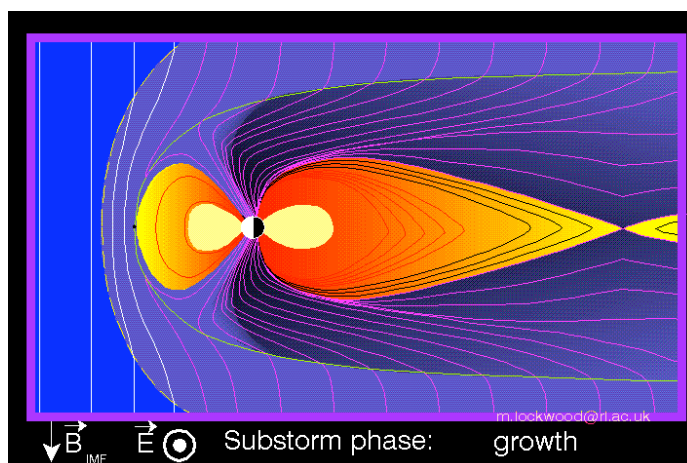
$$\epsilon = 10^7 v B^2 \sin^4(\theta/2) l_o^2$$

where the unit of ϵ is W, l_o is a length of $7 R_E$, v and B are the solar wind speed and magnetic field, respectively, and θ is the clock angle of the IMF defined as $\theta = \arctan(B_y/B_z)$.

Several other coupling functions exist and these have been compared to different indices of geomagnetic activity, especially to AE, AL and Dst (e.g. Newell et al, 2007).

Magnetospheric substorms

When IMF $B_z < 0$, some energy is stored as magnetic energy in the nightside magnetotail. The explosive release of this energy is called magnetospheric substorm. This animation shows formation of the near-Earth neutral line (NENL) in the tail.



Aurora during substorm

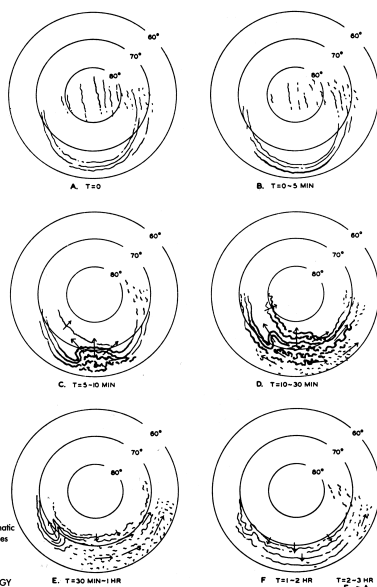
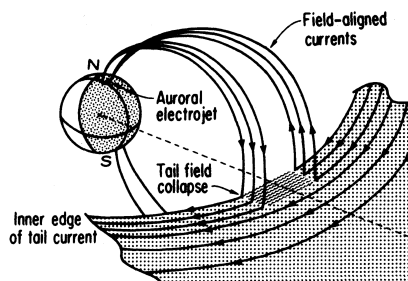
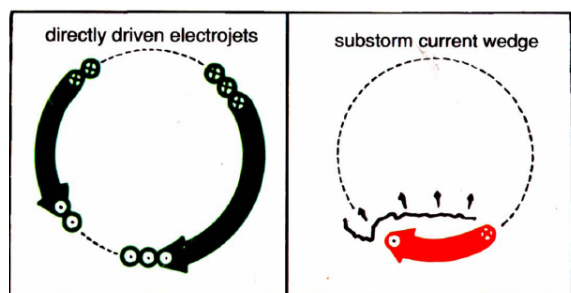


FIG. 13.15. Schematic representation of six stages in the development of an auroral substorm, as determined from all-sky camera data during the IGY (1957). (From Akasofu, 1964.)

- **Growth phase (A):** arcs are drifting equatorward.
- **Substorm onset (B):** the most equatorward arc brightens.
- **Expansion phase (C):** auroral bulge expands poleward, towards east and west => westward traveling surge, WTS.
- **Late expansion phase (D):** Omega bands travel eastward.
- **Recovery phase (E):** at the equatorward edge of the eastern region, dim pulsating patches of aurora appear, drifting eastward. The WTS degenerates. Aurora recovers to lower latitudes.
- **Late recovery phase (F):** in the morning sector pulsating aurora proceeds for some time.

Currents during substorm



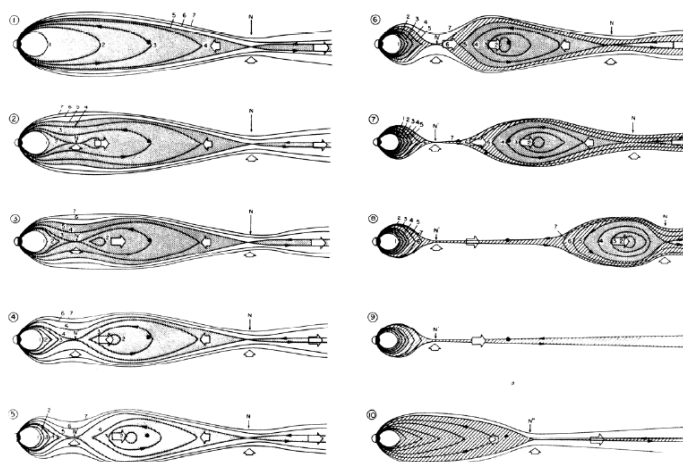
Clauer and McPherron (1974)

Group task 4: What happens during substorm phases in the magnetosphere and the ionosphere?

Fill in the form.

Extra question: Which magnetic index is a good measure of substorm activity?

Configurational changes in the magnetosphere



Hones (1979)

