Magnetospheric drivers and potential synergies between GDC and European assets

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Night-side magnetospheric processes are essential drivers:

- Magnetic reconnection
- Plasma jets
- Field-aligned currents
- Waves
- Injections

### spacecraft:
- **THEMIS (2007-)** fluid plasma physics
- **Cluster (2001-)** ion plasma physics
- **MMS (2015-)** electron plasma physics

→ Multi-scale processes
→ Cross-scale coupling important
Propagation “along” as well as “across” the tail

- Flow braking/bouncing
- Dipolarization front (dip. flux bundle)
- Magnetic reconnection
- Current sheet flapping

References:
- [Angelopoulos et al., 2013]
- [Panov et al., 2010; Birn et al., 2011]
- [Liu et al., 2013]
- [Nakamura et al., 2002]
- [Torbert et al., 2018]
- [Sergeev et al., 2003]
- [Sergeev et al., 2004]

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Localized earthward fast plasma flows in magnetosphere → localized ionospheric flow & current pattern, field aligned current, aurora

(Birn et al., 2004)

equivalent current

Cluster

MIRACLE network

(Nakamura et al., 2005)

equivalent current

(Juusola et al., 2009)

Aurora & ionospheric flow vorticity

(Grocott et al., 2004)
DIFFERENT MAGNETOSPHERE STATE \( \rightarrow \) DIFFERENT RESPONSE

**Steady magnetosphere convection (SMC)**

Fast flows (or E) do not penetrate near-Earth

![Substorm Expansion](image1)

![SMC](image2)

![E vector](image3)

\[\text{[Kissinger et al., 2012]}\]

**Storm-time substorm**

Earthward intrusion of tail current

\( \rightarrow \) Thin current sheet in partial ring current region

![Noon - midnight](image4)

\[\text{[Pulkkinen et al., 2006]}\]

\[\text{[Knipp et al., 1999]}\]
Cold dense plasma sheet $\rightarrow$ ineffective solar wind driver

- Slower Alfvén velocity
- Less field aligned acceleration (potential drop $\Phi_\parallel \sim j_\parallel T_{e1/2}/N$)

Plasma sheet plasma condition controls ionospheric response to solar wind driver

\[ E_m = V B_{yz} \sin^2(\theta/2) \text{ [mV/m]} \]

$\rightarrow$ Plasma sheet plasma condition controls ionospheric response to solar wind driver

[Sergeev et al., 2014]
Magnetospheric monitor essential for SW/M-IT coupling studies

Credit: V.A. Merkin (from Sitnov et al., 2016)
Magnetospheric monitor essential for SW/M-IT coupling studies

GDC

Substorm current wedge

Localised transients

[Nakamura et al., 2013]

[Nakamura et al., 2018]
Magnetospheric monitor essential for SW/M-IT coupling studies

**MAGNETOSPHERIC ASSETS RELEVANT TO GDC SCIENCE**

- Large scale evolution
- Localized transients

Nakamura et al., 2013
Nakamura et al., 2018