Ring current development in the strongly compressed magnetosphere

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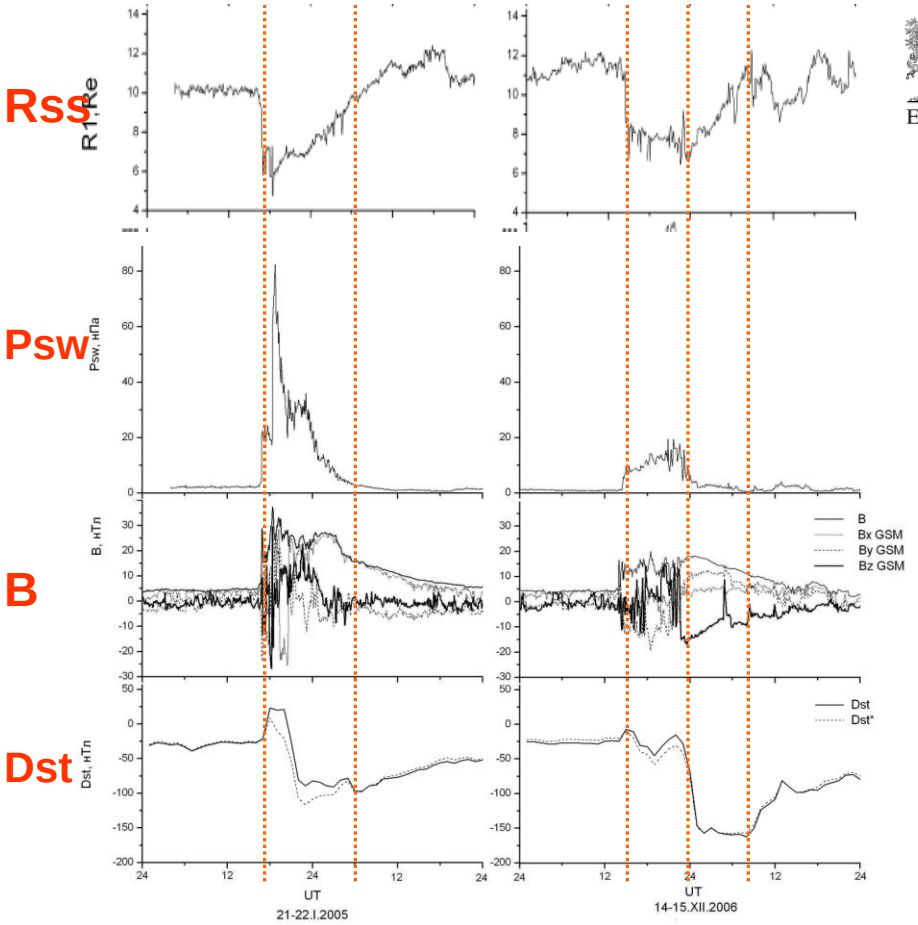
21-22.01.2015

14-15.12.2016

January 2005 and December 2006 magnetic storms



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Magnetosphere response to the 2005 and 2006 extreme solar events as observed by the Cluster and Double Star spacecraft

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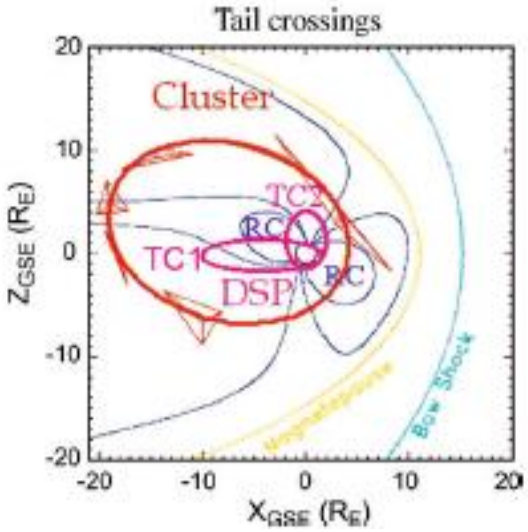
Cluster
Double Star



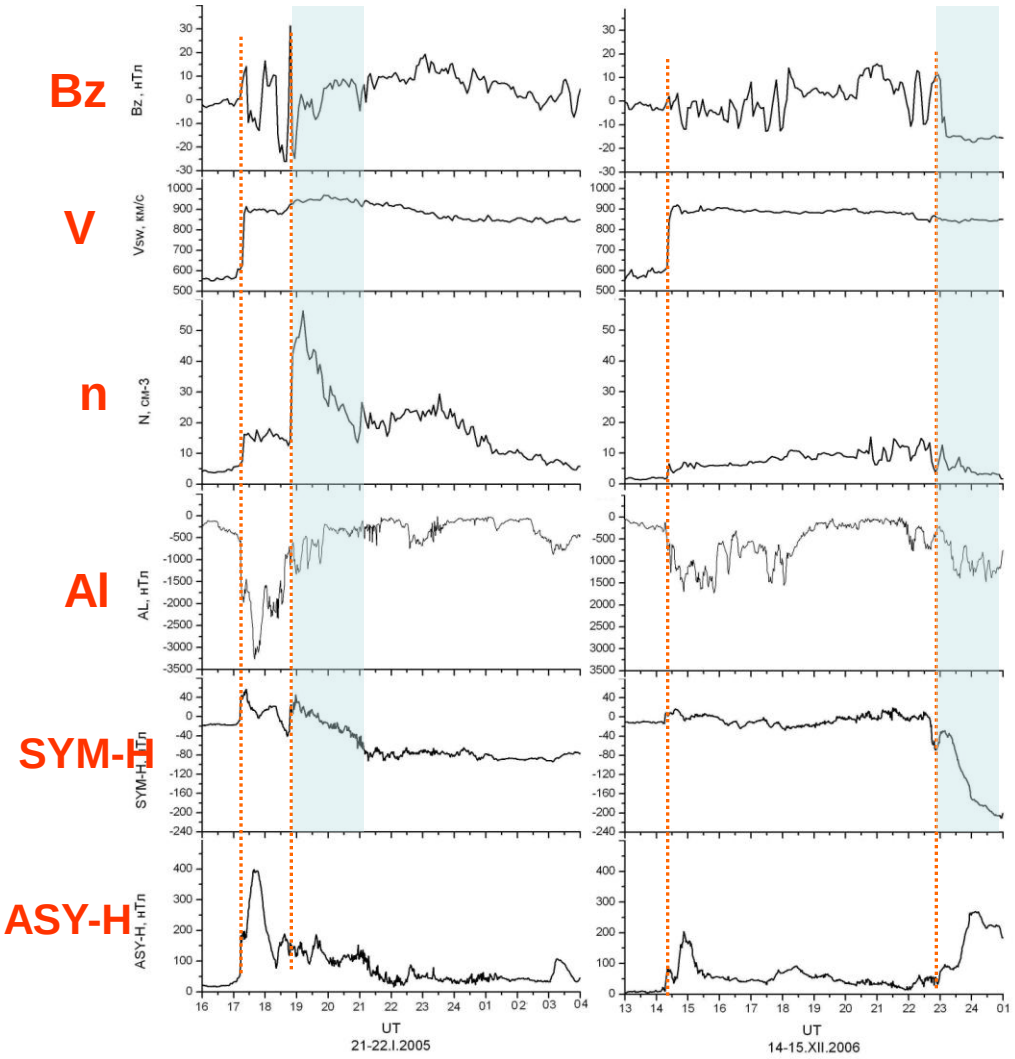
Conditions in space

21-22.01.2005

- Bz>0 during main phase
- SW Velocity: 600-900 km/s
- Max. Pressure ~80nPa
- Dst~SYM-H

14-15.12.2006

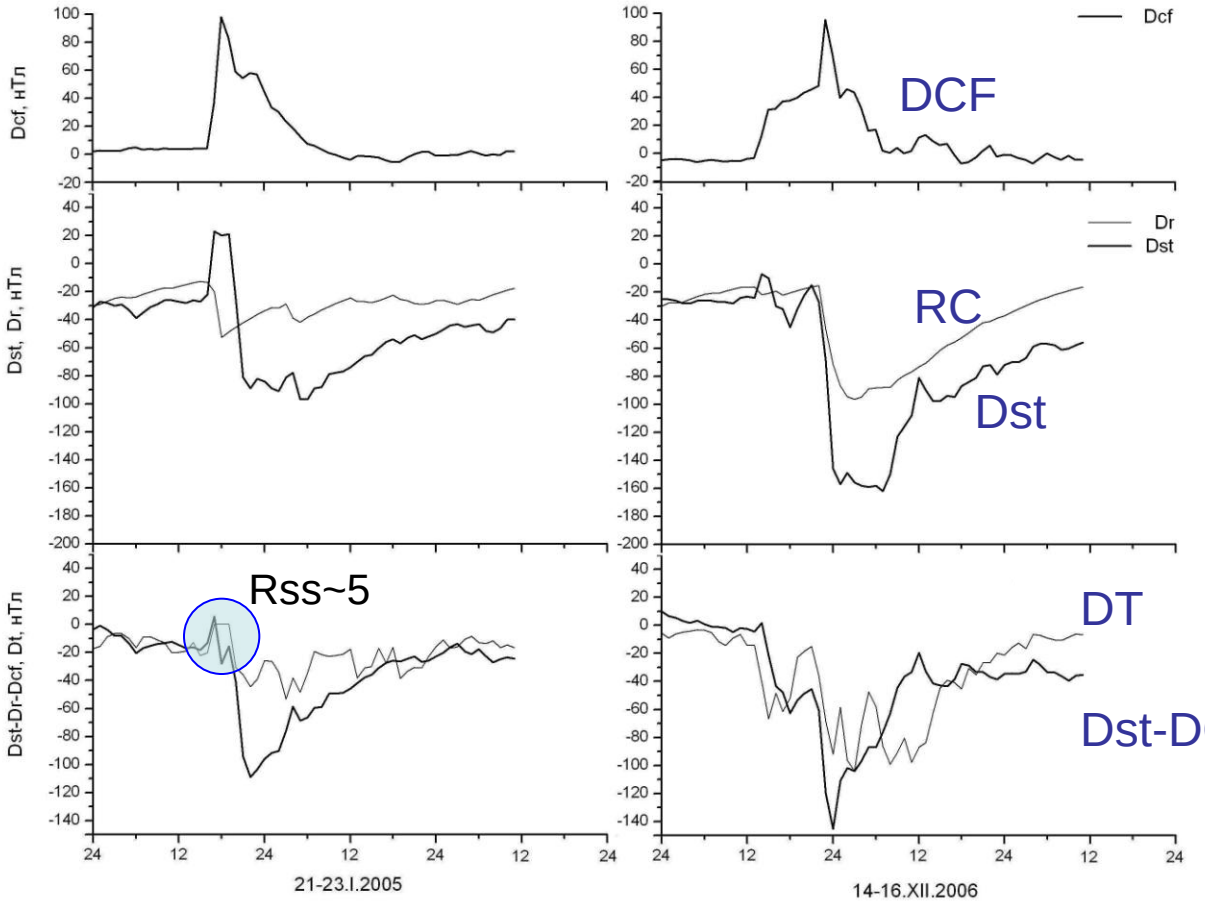
- Bz<0 during main phase
- SW Velocity: 600-900 km/s
- Max. Pressure ~20nPa
- 7 hours delay
- Dst<SYM-H



Magnetospheric Currents Dynamics

A2000 (paraboloid) magnetospheric model: $B_m = B_{CF}(\psi, R_1) + B_t(\psi, R_1, R_2, \Phi_\infty) + B_r(\psi, b_r)$

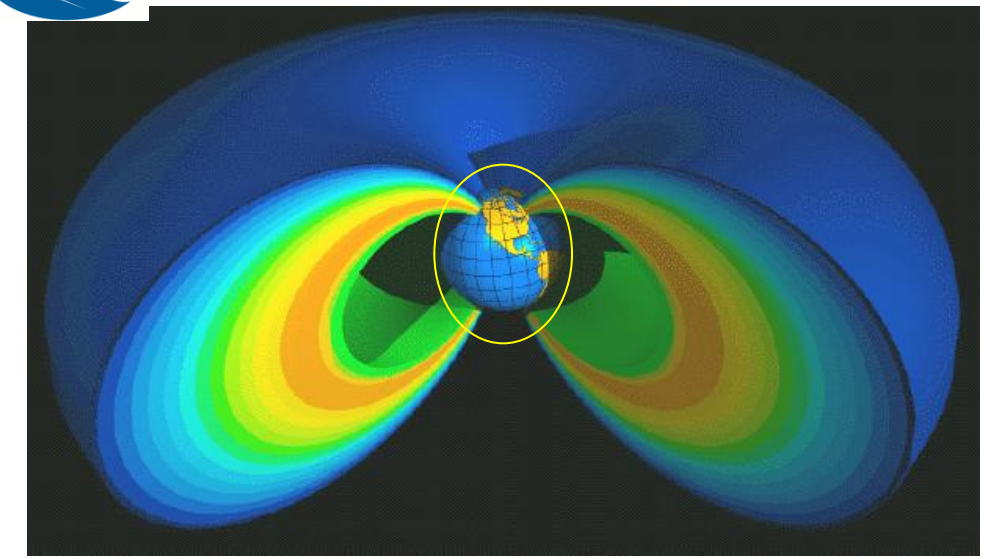
$$Dst = \delta H_{RC} - \delta H^q_{RC} + \delta H_{TC} - \delta H^q_{TC} + \delta H_{CF} - \delta H^q_{CF} = DR + DT + DCF$$



$$\frac{db_r}{dt} = F(E_y) - \frac{b_r}{\tau}$$

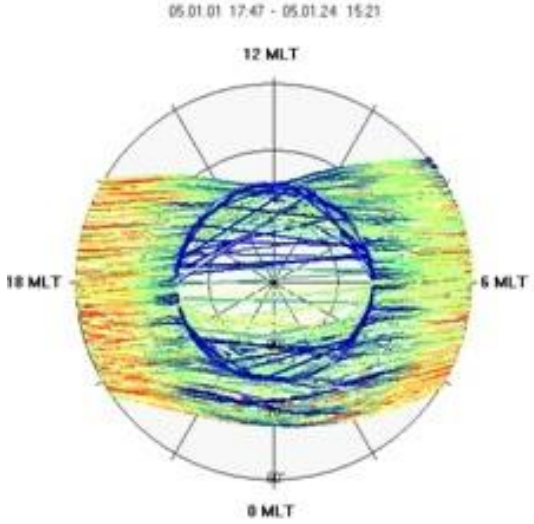
$$Ey = -V \cdot Bz$$

Burton model is not quite reflects typical RC development 21-22.01.2005



NOAA/POES satellites

POES 15



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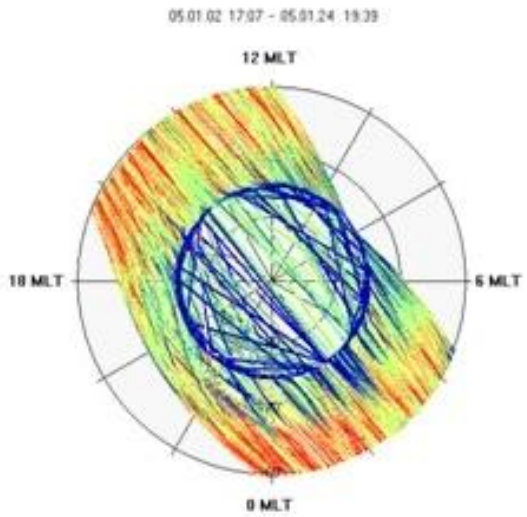
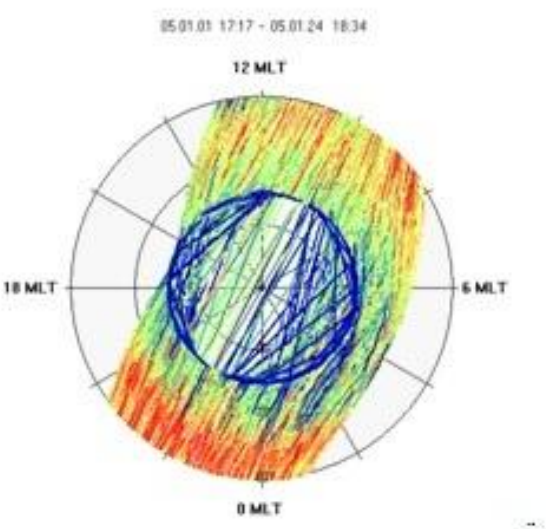
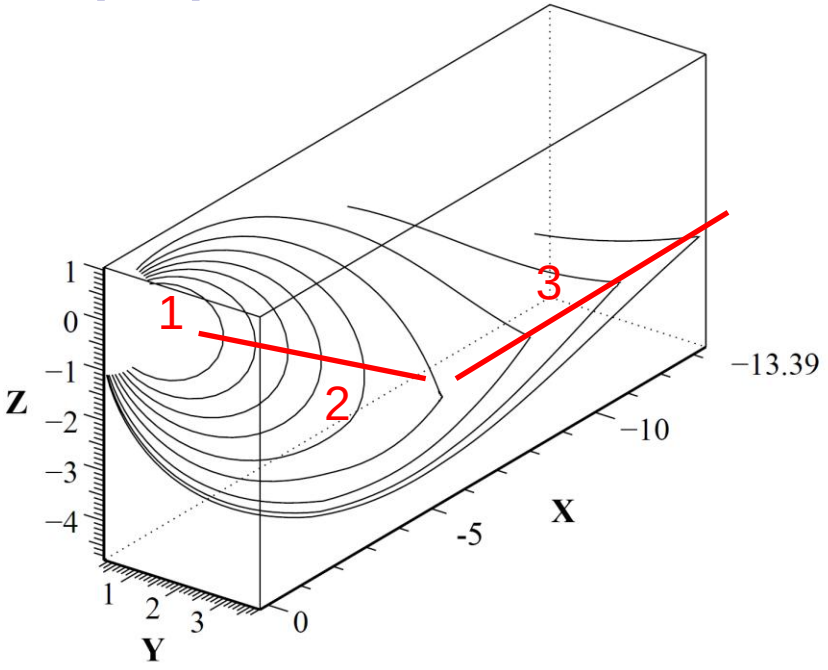
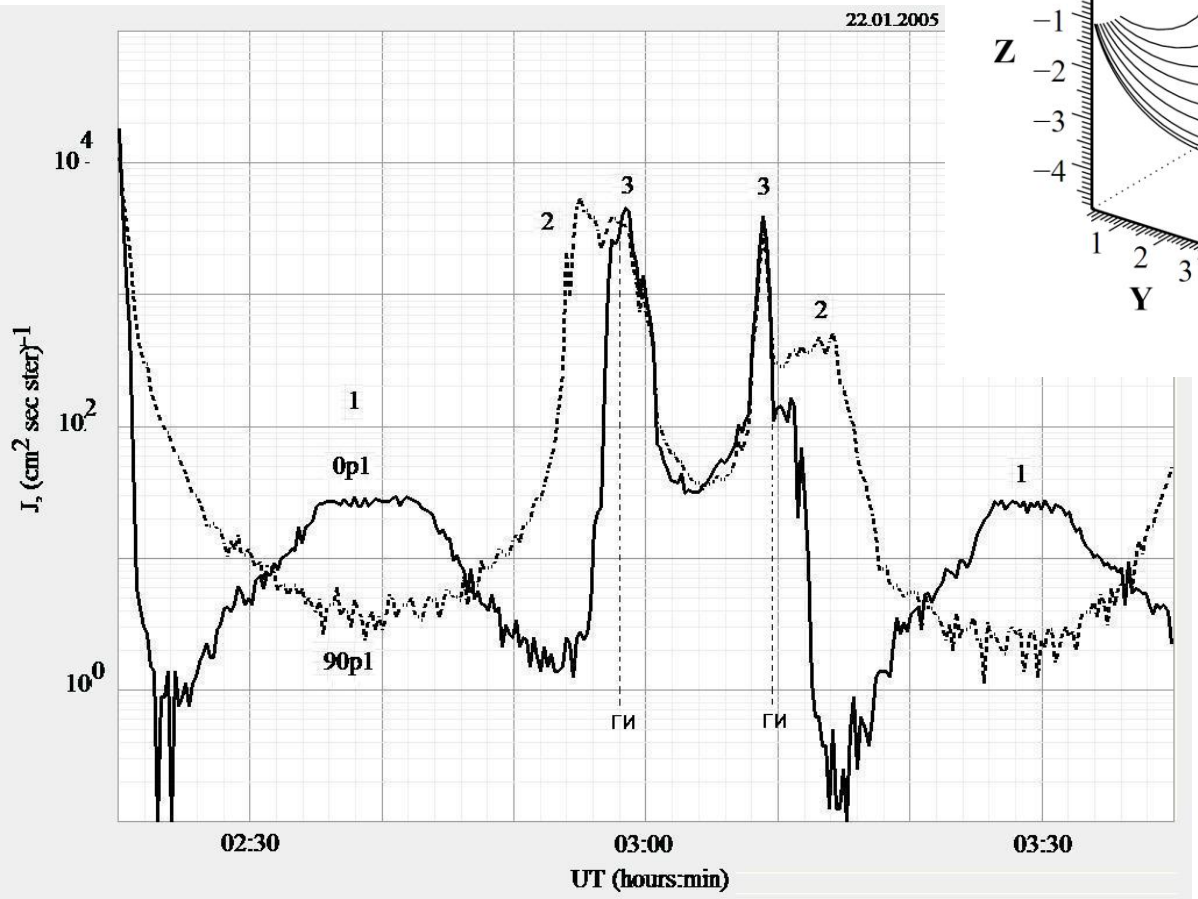


POES 17

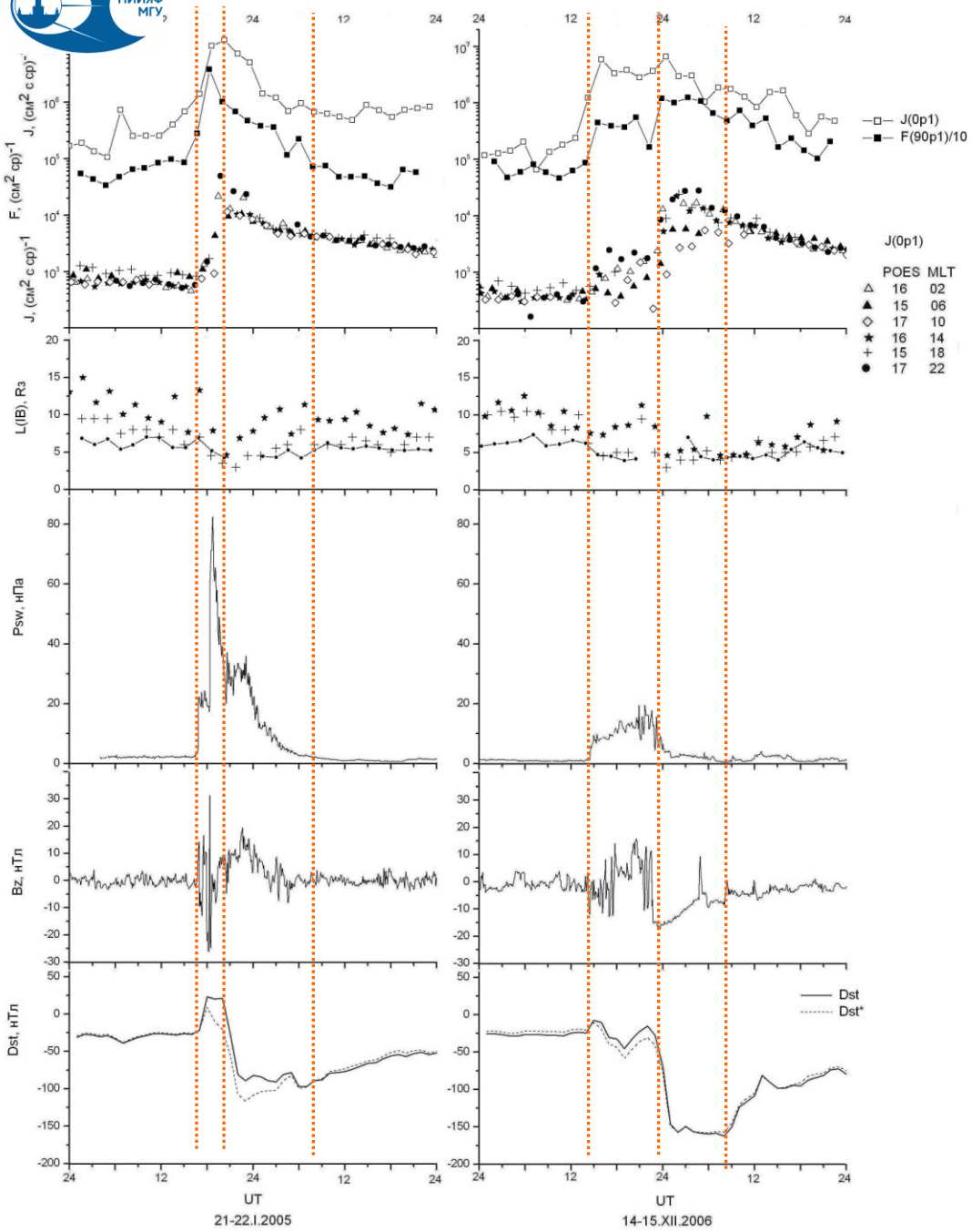


Particle populations at LEO





1. Trapped
2. Quasy-trapped
3. Precipitating



21-22.01.2005

- Symmetrical RC (except SSC)
- Under SW control
- Lowest IB at L=3
- RC development after pressure pulse

14-15.12.2006

- Symmetrical RC (except SSCand main phase)
- Under IMF control
- Lowest IB at L=3
- No RC development after pressure pulse

The same fluxes of all the populations

The same ring currents

Mechanism of RC development

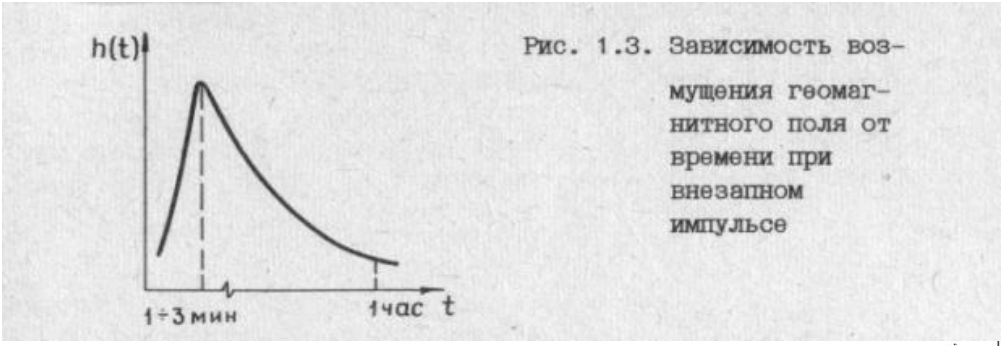


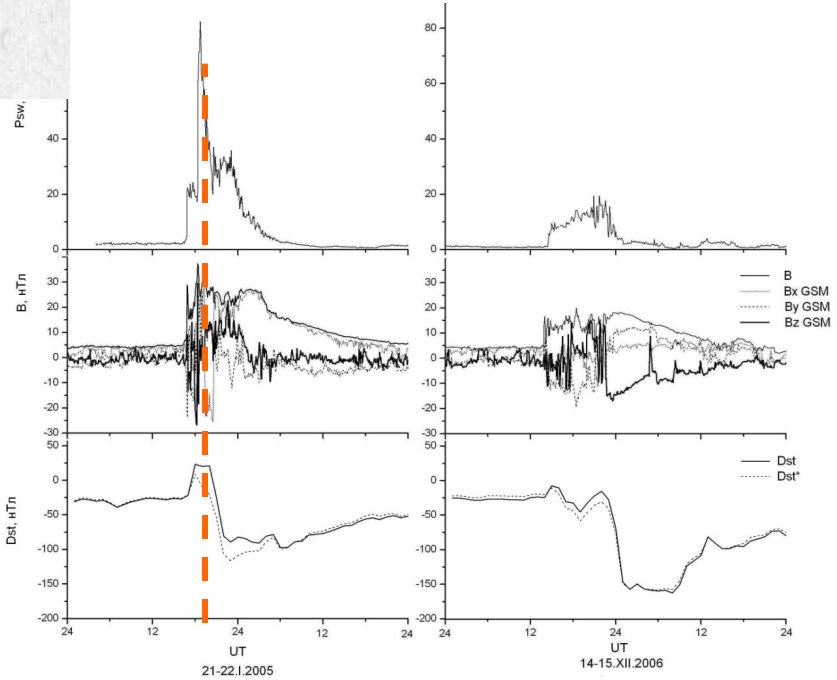
Рис. 1.3. Зависимость возмущения геомагнитного поля от времени при внезапном импульсе

[Tverskoy, 1972]:

Particle radial diffusion under sudden pulses: non-adiabatical particle transport to lover L-shells

21-22.01.2005

- Drift periods at *L*=3
  - ~3 hours for 80 keV protons
  - ~8 hours for 30 keV protons
- Temporal development:
  - 10-20 min – initial phase
  - 12 hours – recovery



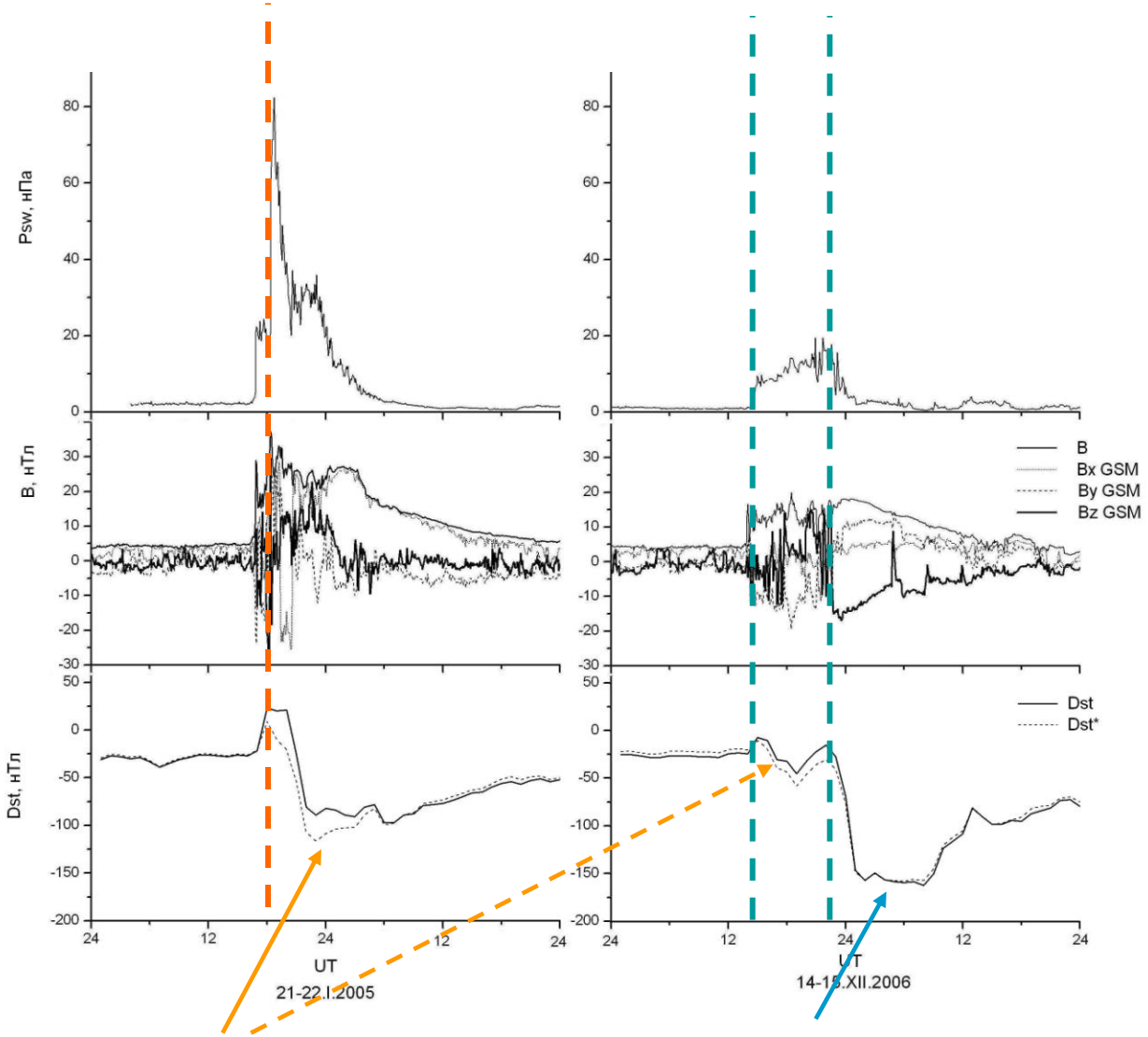
Mechanism of RC development

21-22.01.2005

- Pressure pulse
- Positive B variation behind the magnetopause
- Azimuthal E generation
- Non-adiabatic transport to lower L
- Recovery

14-15.12.2006

- Pressure pulse
- Positive B variation behind the magnetopause
- Azimuthal E generation
- Unsuccessful attempt of RC development



Pressure generated RC

“Burton’s” RC

Conclusions

- 14-15.XII.2006 magnetic storm was controlled by IMF
- 21-22.I.2005 magnetic storm was controlled by solar wind pressure
- RC development during 21-22.I.2005 –non-adiabatical particle transport to lover L-shells under sudden pulses
- RC is dominate source of Dst during 21-22.I.2005: it is influenced by both: solar wind Bz and magnetospheric extreme compression