Magnetospheric response to interplanetary shocks: summary of MHD simulations and observation

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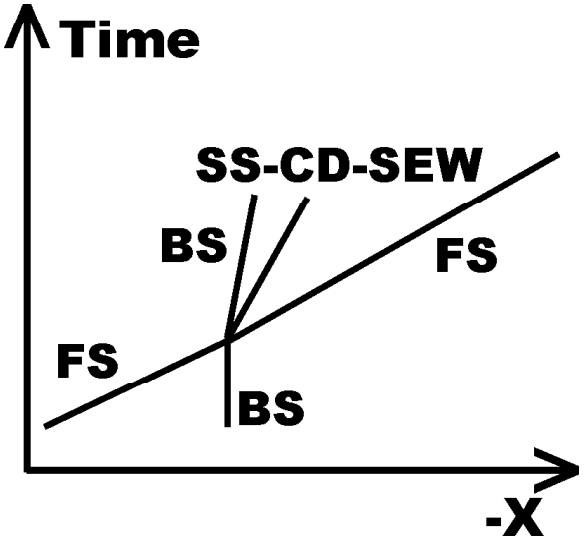
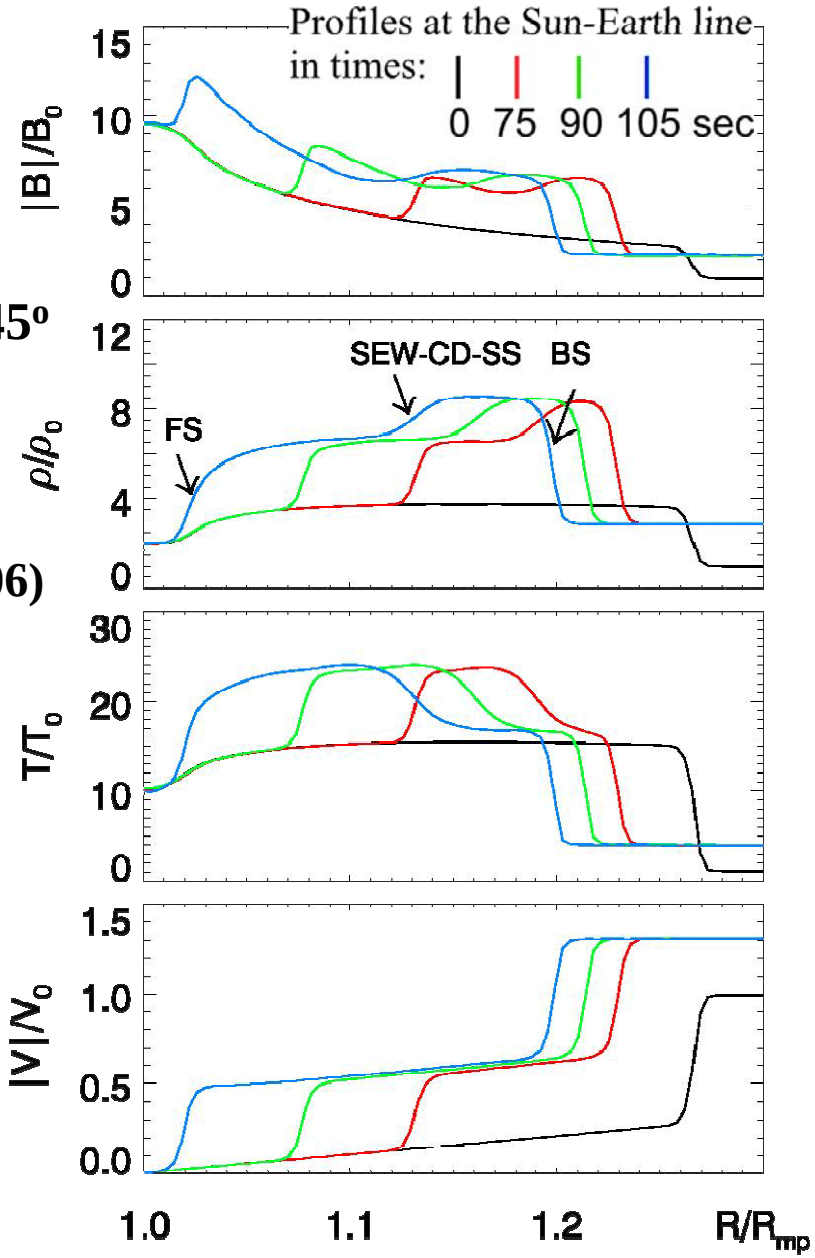
INTERPLANETARY (FAST) SHOCK + BOW SHOCK

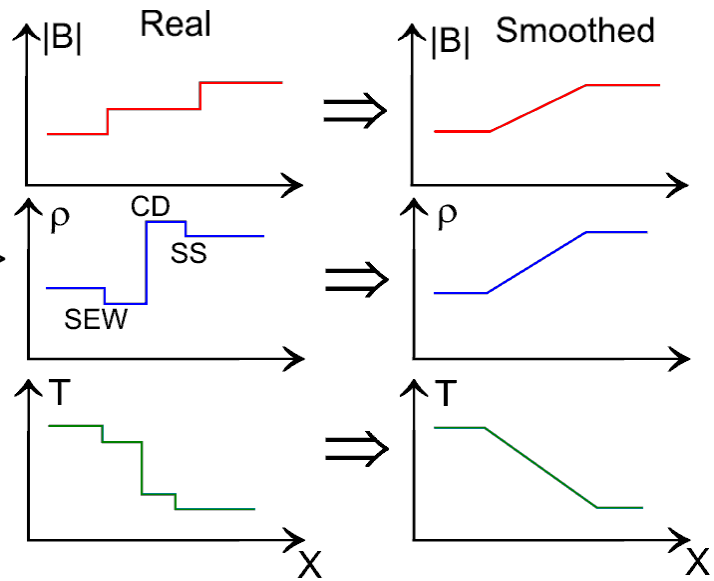


$\angle(B_{IMF}, OX)=45^o$

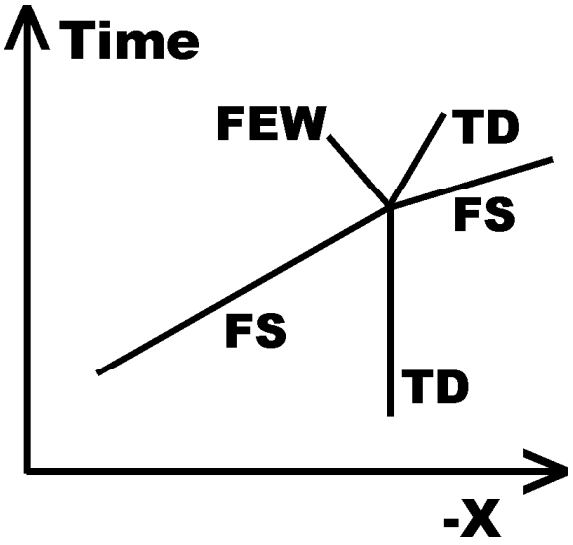


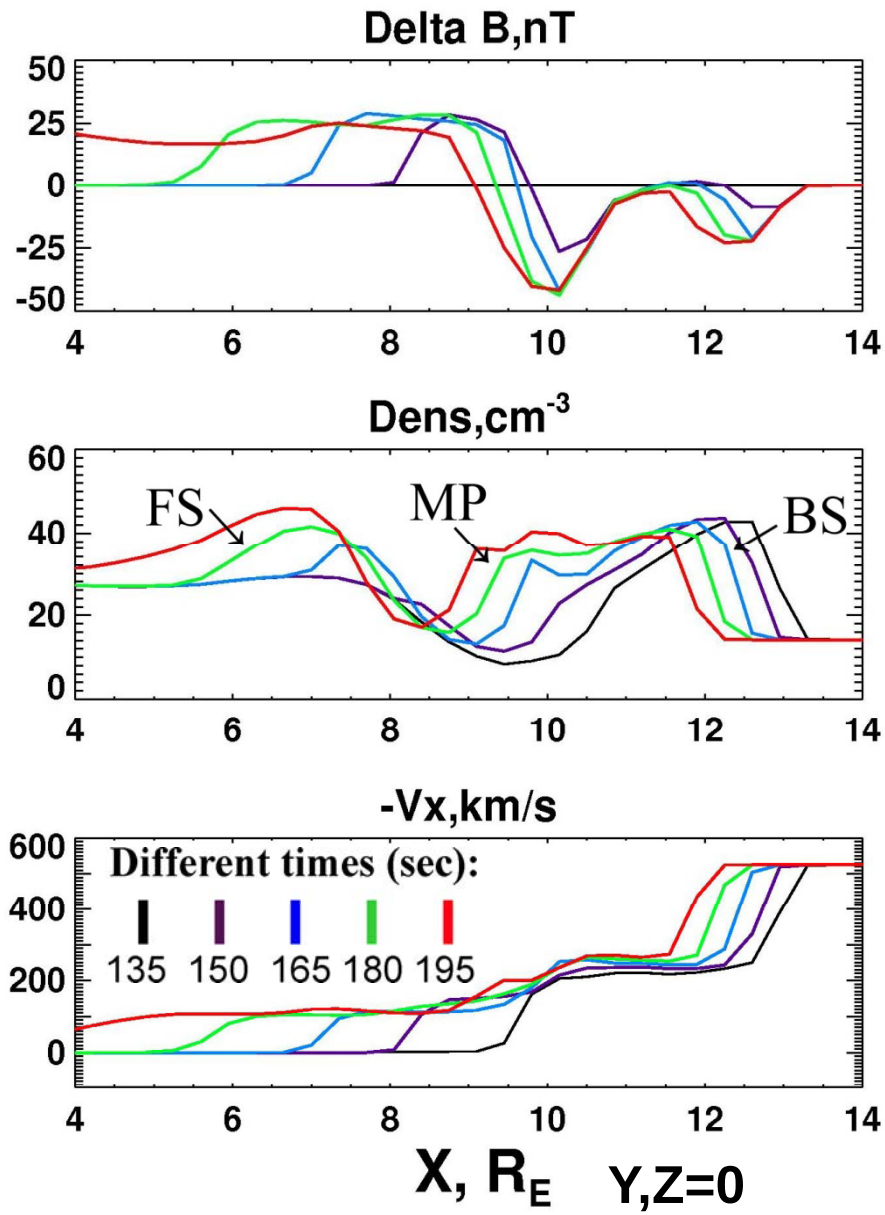
Profiles at the Sun-Earth line (Samsonov et al., 2006) and a sketch (Samsonov et al., 2007)

SEW-CD-SS=>



FAST SHOCK + MAGNETOPAUSE (TD)

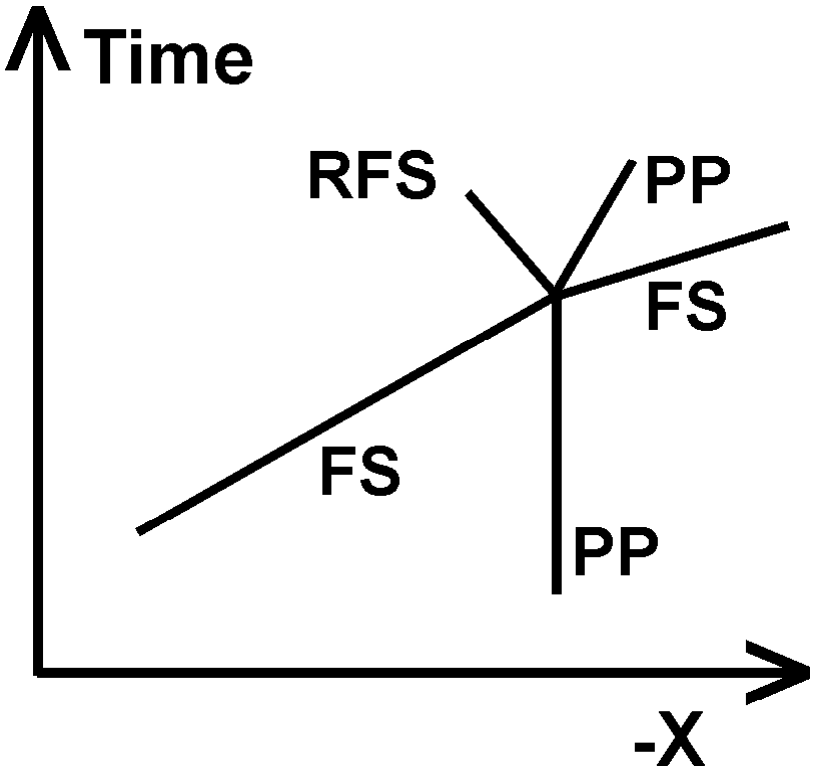




Fast shock penetrates into the magnetosphere, reflected discontinuity is a fast expansion wave (which is rather weak), the magnetopause moves Earthward.

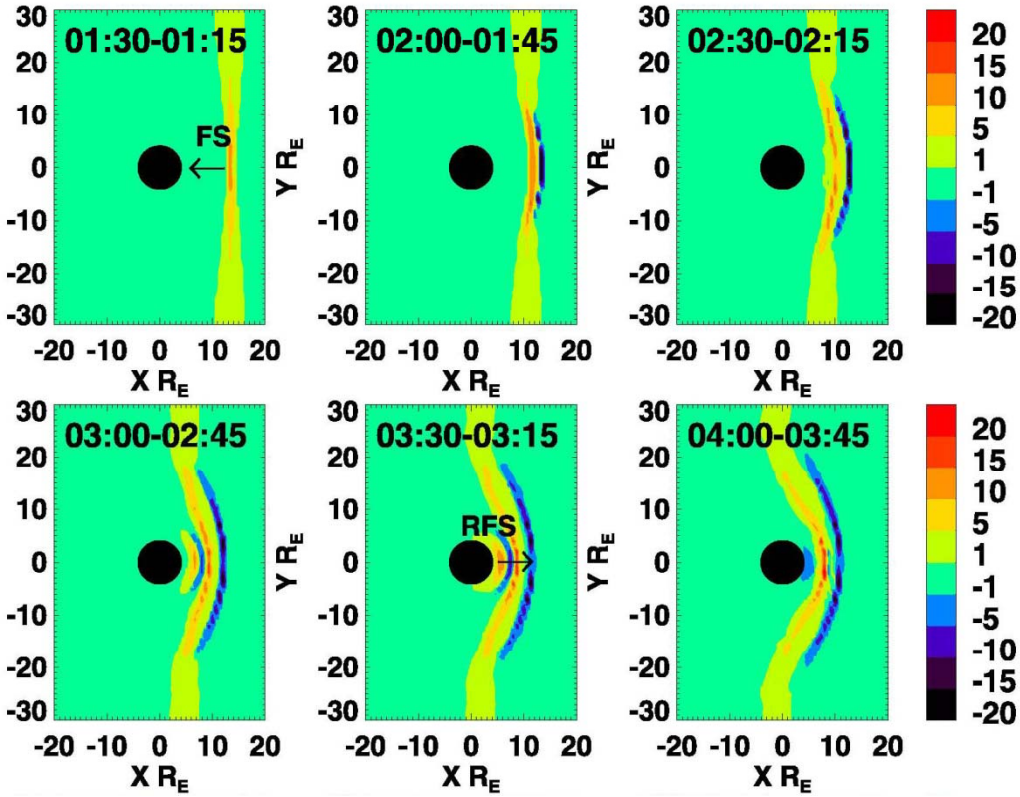
FAST SHOCK + PLASMAPAUSE (CD)

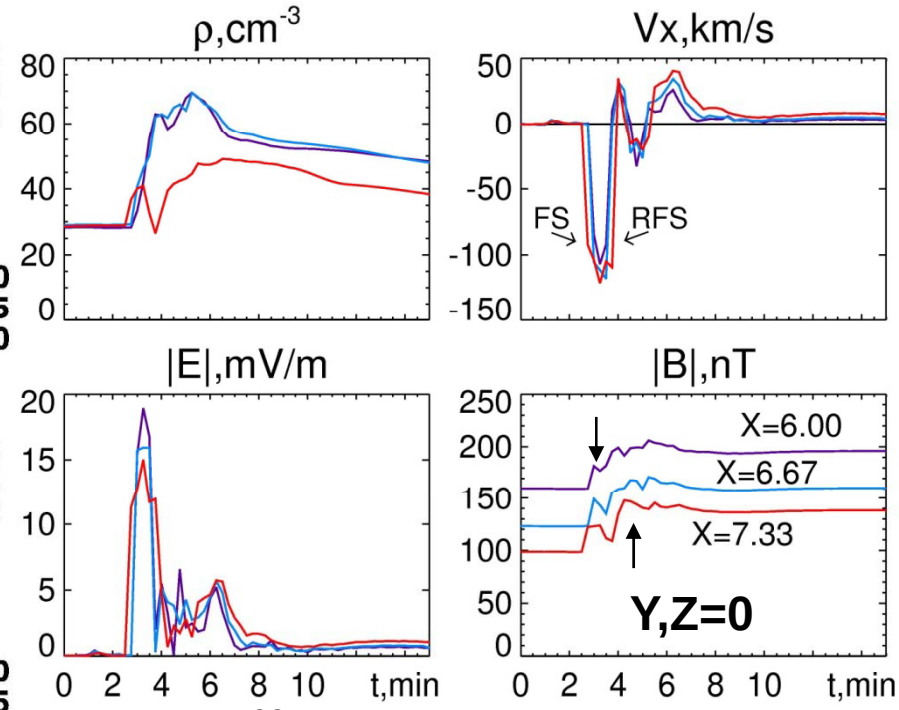
According to 1-D MHD simulation in Samsonov et al. (2007), ~70 % of the incoming FS energy penetrates into the plasmasphere.

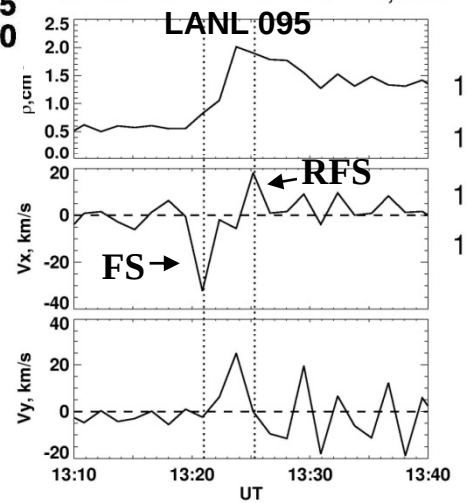


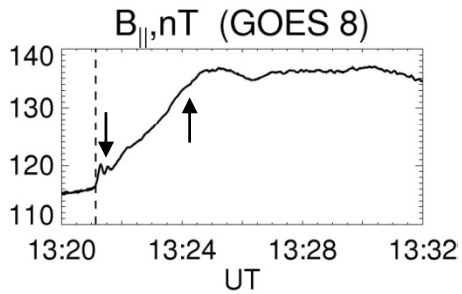
REFLECTION AT INNER BOUNDARY

$\Delta \rho = \rho_{t1} - \rho_{t0}$









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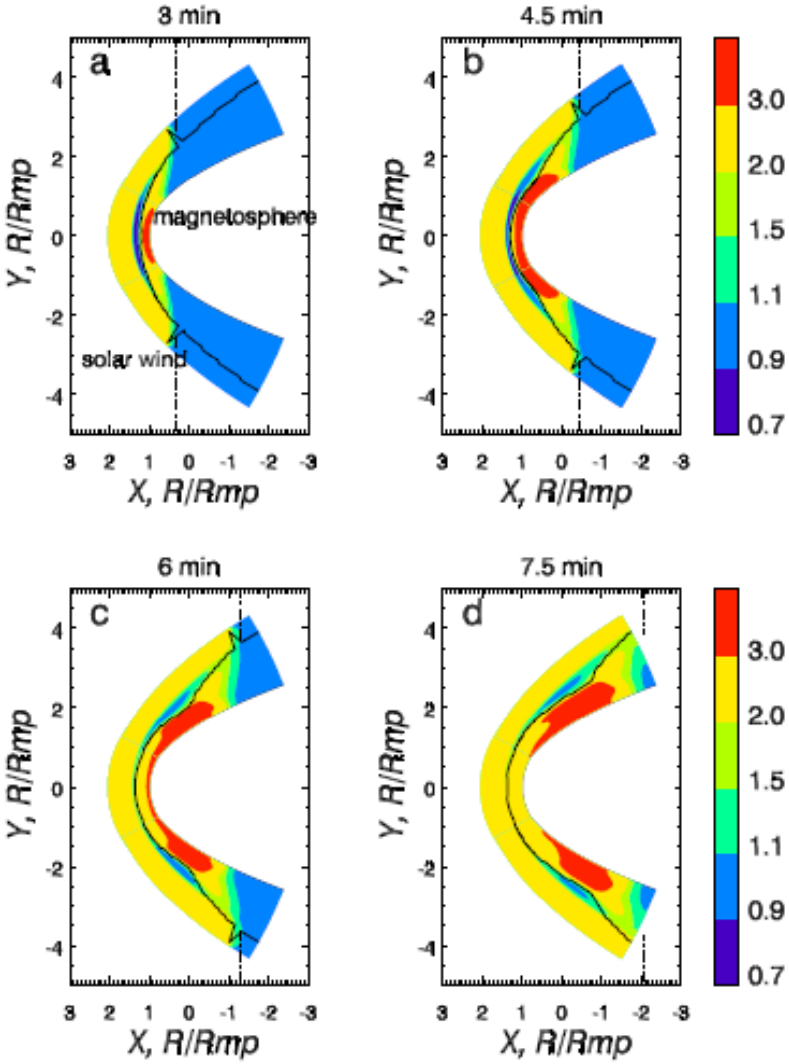
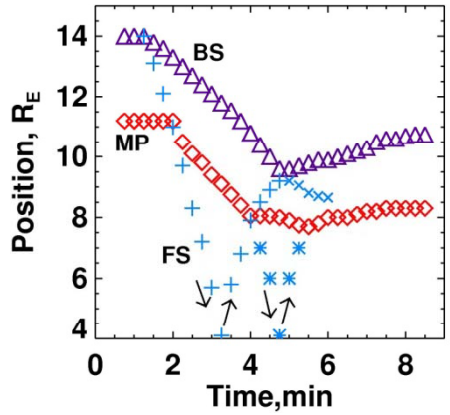
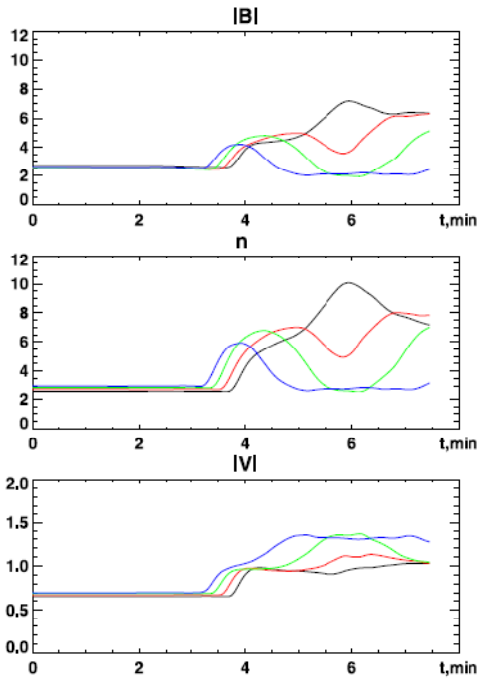
In global MHD: FS reflects from the inner boundary.

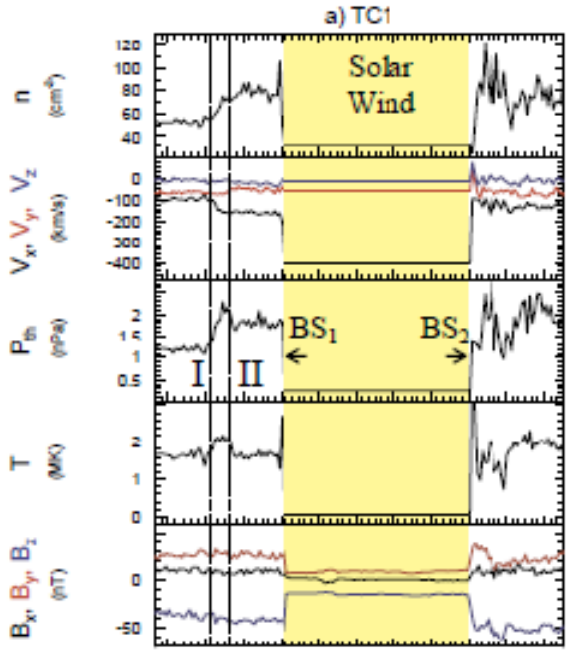
In reality: FS may reflect from the ionosphere.

SUNWARD BOW SHOCK/MAGNETOPAUSE MOTION







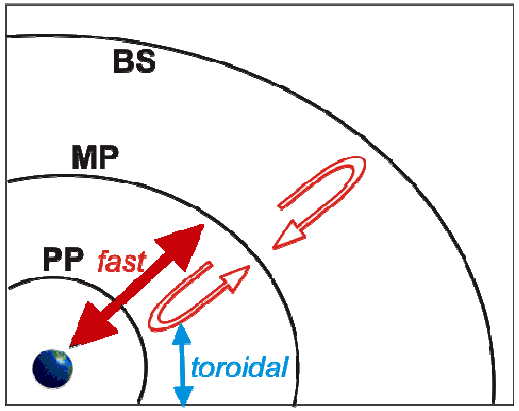


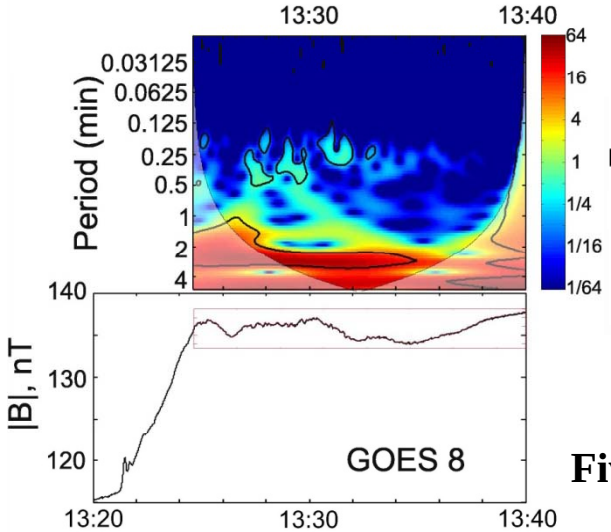
A confirmation (Pallocchia et al., 2010)

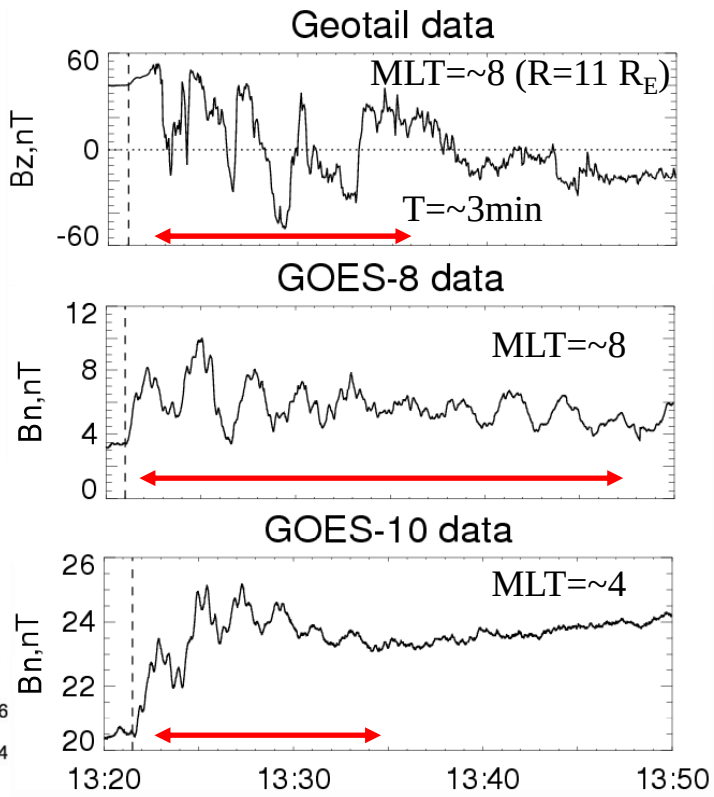
Propagation of bow shock indentation (Safrankova et al. 2007)

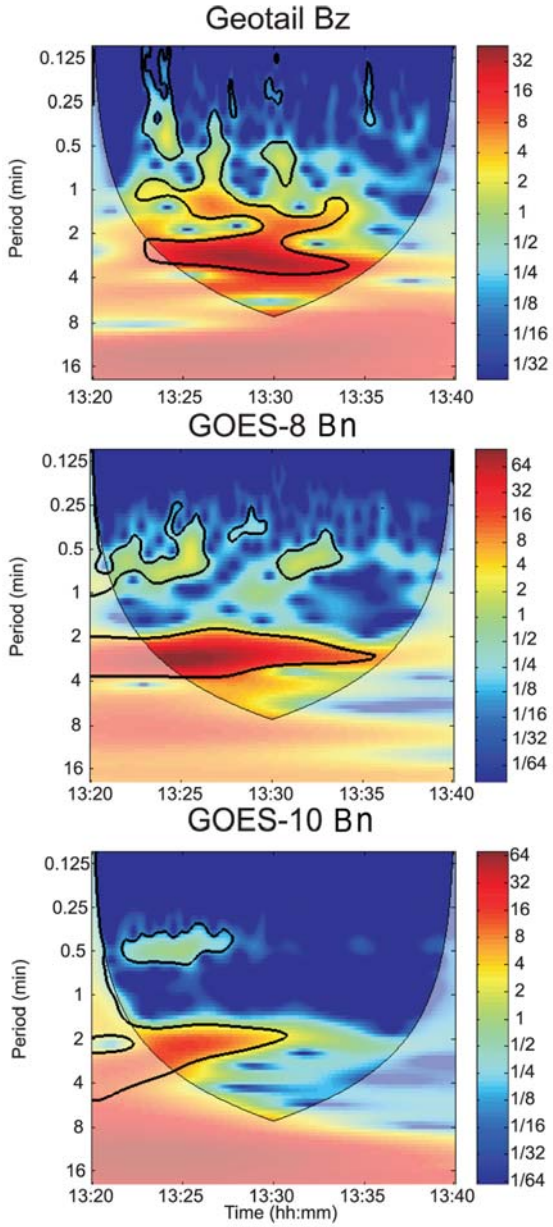
Color - different radial distance

ULF waves (Pc 5)









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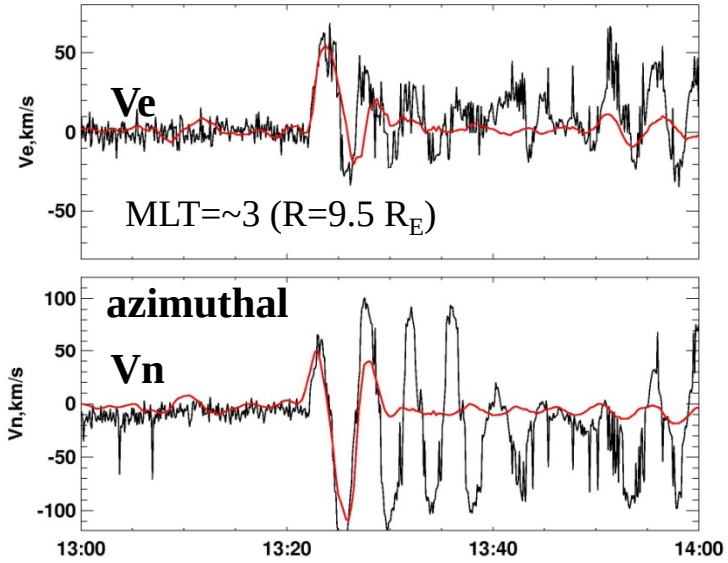
Five spacecraft near the equatorial plane

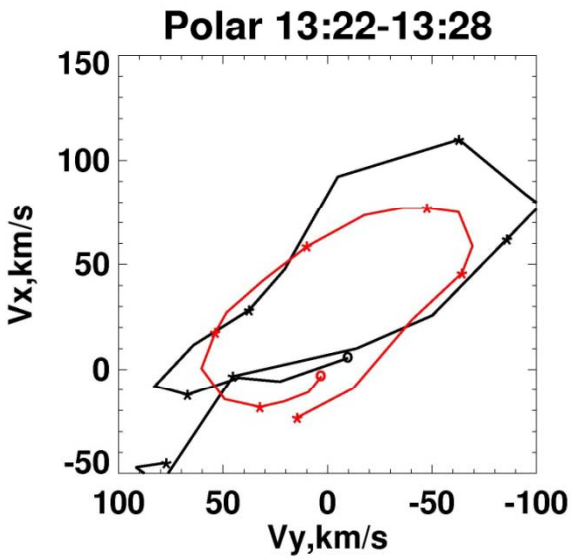
Multiple Reflections of FS (FS ≈ Compressional (Fast) Mode)

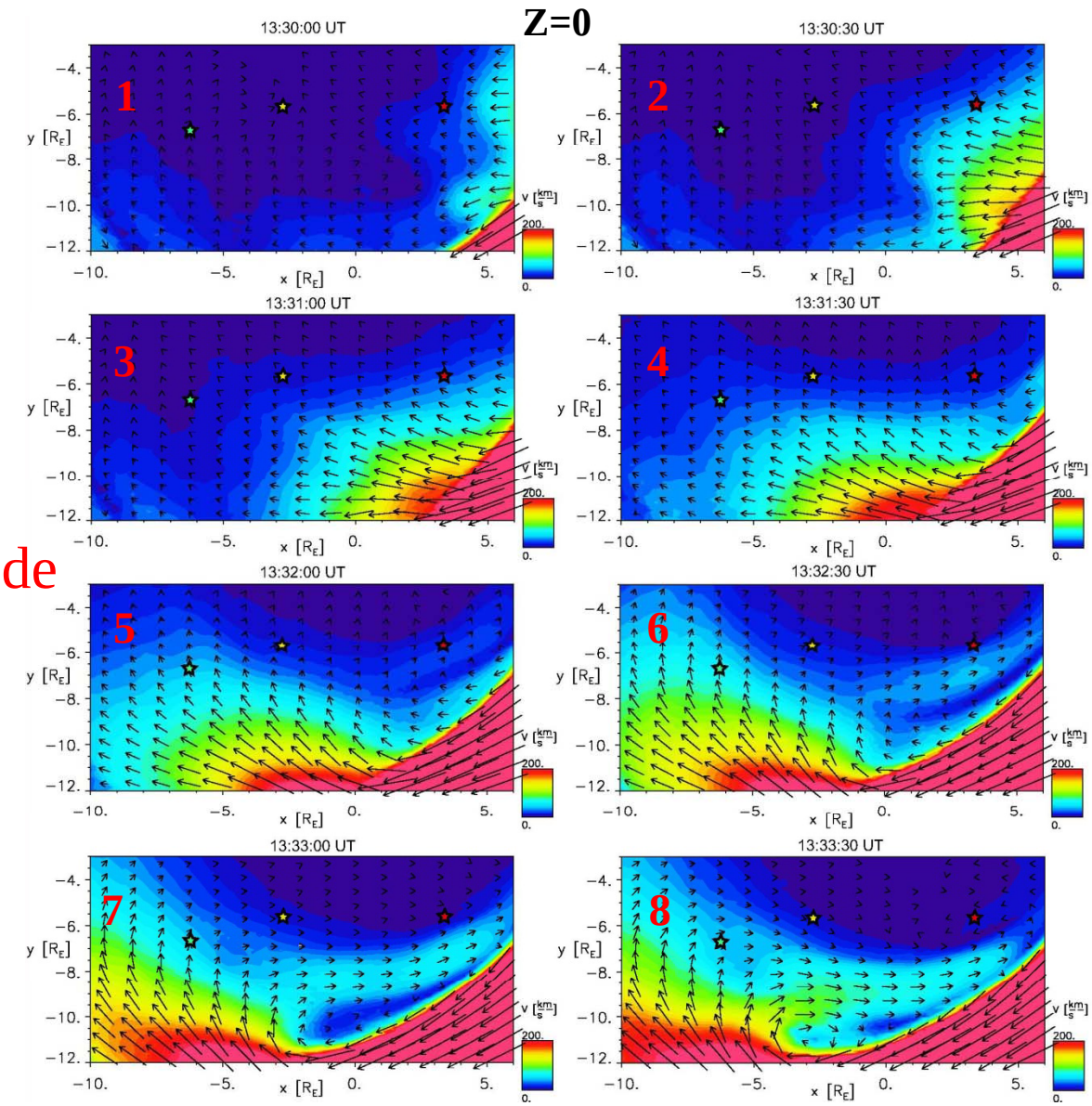
Mode Coupling => Toroidal (Alfvén) Mode

Excitation of Kelvin-Helmholtz Instability

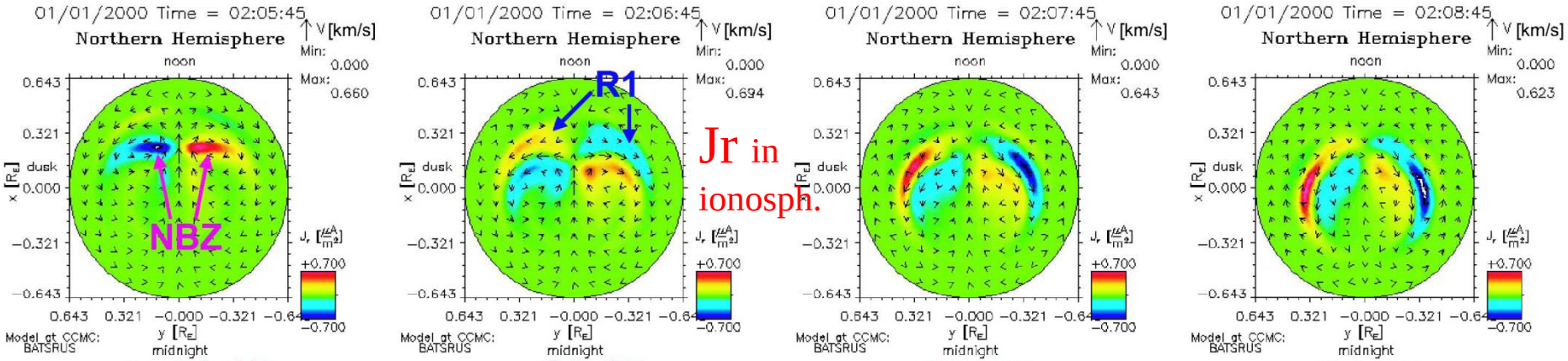


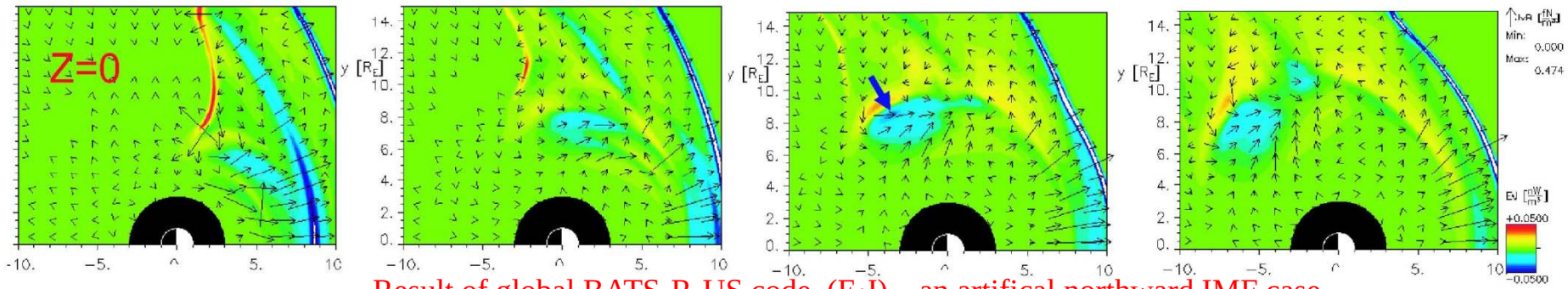
Polar data + LFM global code



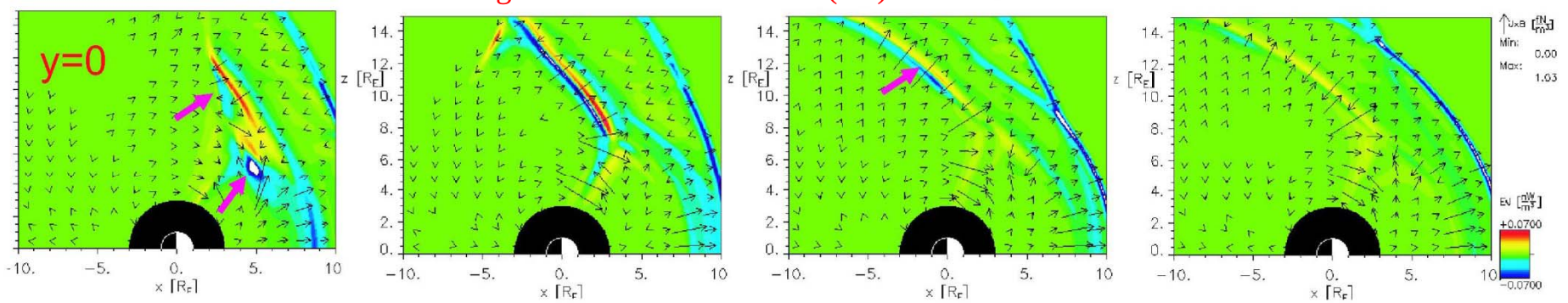


Magnetospheric–Ionospheric Currents

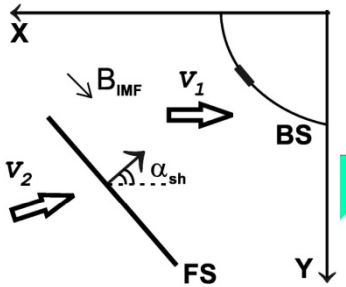




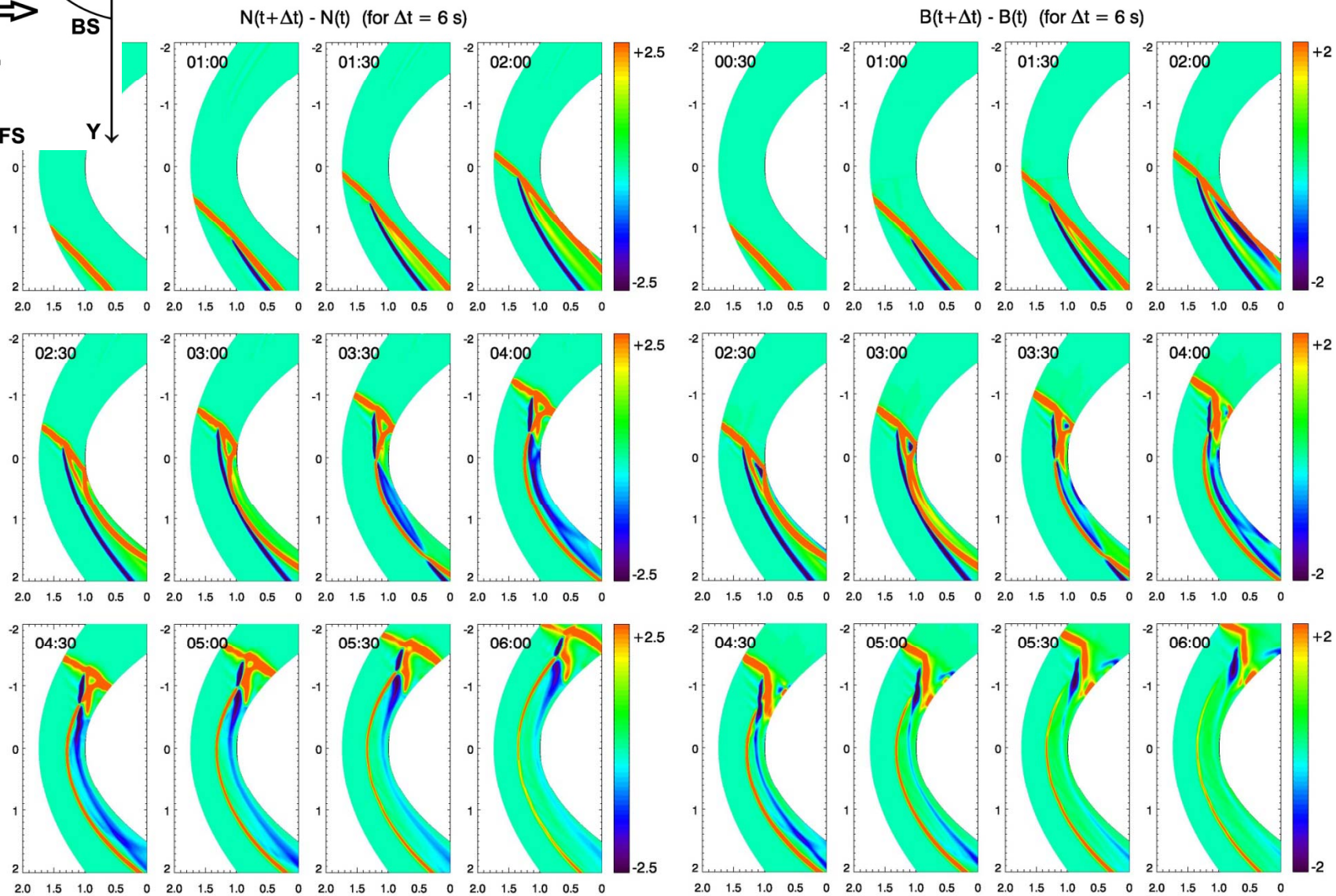
Result of global BATS-R-US code (E·J) – an artifical northward IMF case



INCLINED SHOCKS



Simulation results from Samsonov (2011)



CONCLUSIONS

<u>Magnetospheric response to IP shocks at MHD scales includes:</u>

- **Inward-outward Bow Shock and Magnetopause motion**
- **Oscillations of fast and shear Alfvén waves**
- **Intensification of magnetopause magnetic reconnection**
- **Growth of Kelvin-Helmholtz instability**
- **Intensification of Magnetospheric-Ionospheric currents**
- **And, of course, general magnetospheric compression**