Magnetopause standoff position and response time changes due to solar wind conditions: Models and Observations

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MHD and Empirical Models Used

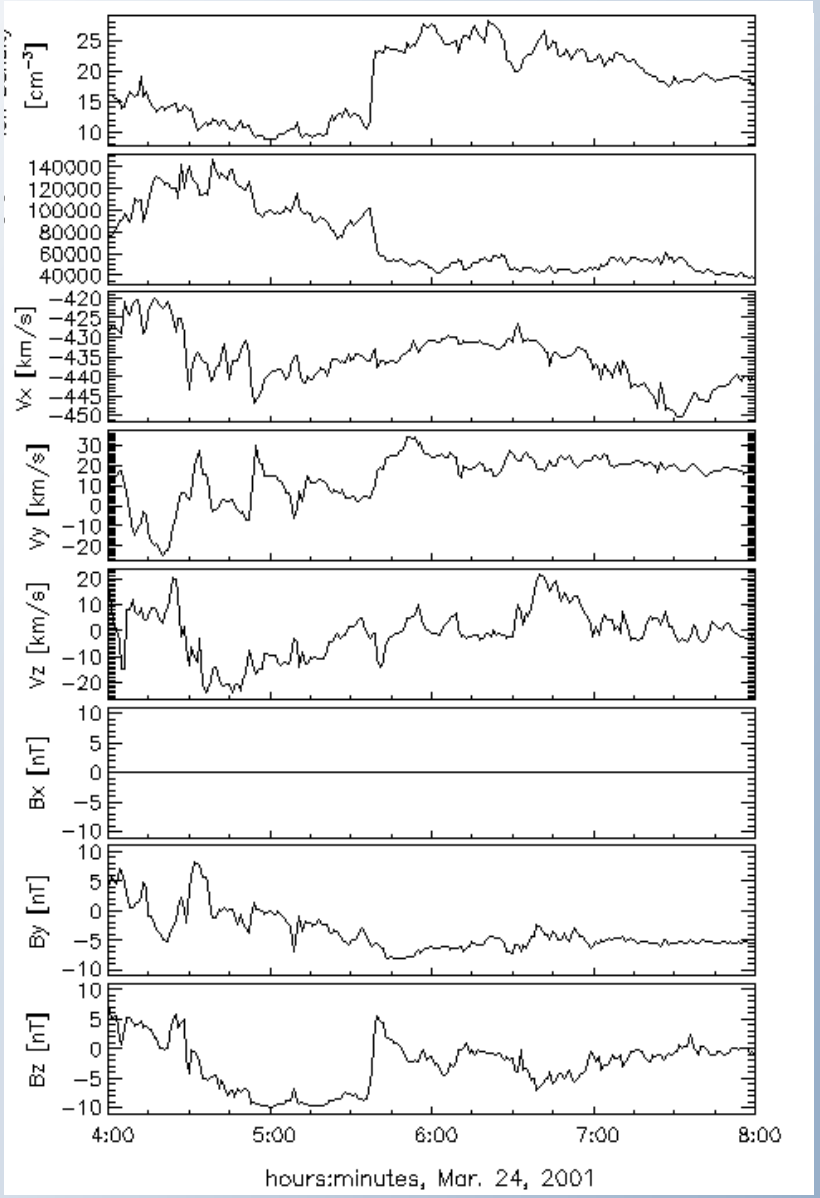
MHD Model	BATS-R-US T. Gombosi, et al.	OpenGGCM J. Raeder & T. Fuller-Rowell	LFM J. Lyon, et al.	GUMICS P. Janhunen et.al.
Version	v20110131	4.0	LTR-2_2_0	4-HC-20140
Coordinate System	GSM	GSE	SM	GSE
Update dipole	Yes	Yes	Yes	No
Conductance Model	Auroral	Auroral	Auroral	Constant
Corotation	Real	Real	Real	No
Grid	Cartesian, rectangular blocks-refined	Cartesian, cell-refined	Cylindrical, not refined	Cartesian-not refined

$$r_0 = \begin{cases} a_1 (D_p)^{-\frac{1}{a_4}} & B_z \geq 0 \\ (a_1 + a_2 B_z)(D_p)^{-\frac{1}{a_4}} & -8\text{nT} \leq B_z < 0 \\ (a_1 + 8a_3 - 8a_2 + a_3 B_z)(D_p)^{-\frac{1}{a_4}} & B < -8 \text{ nT} \end{cases}$$

This empirical model has the same functional form as Shue et al. 1997, but the way r_0 (standoff distance) depends on B_z and D_p (dynamic pressure) is different.

Coefficients used with our analysis:
a_1=11.646, a_2=0.216, a_3=0.122, and a_4=6.215

Solar Wind Conditions: March 24, 2001



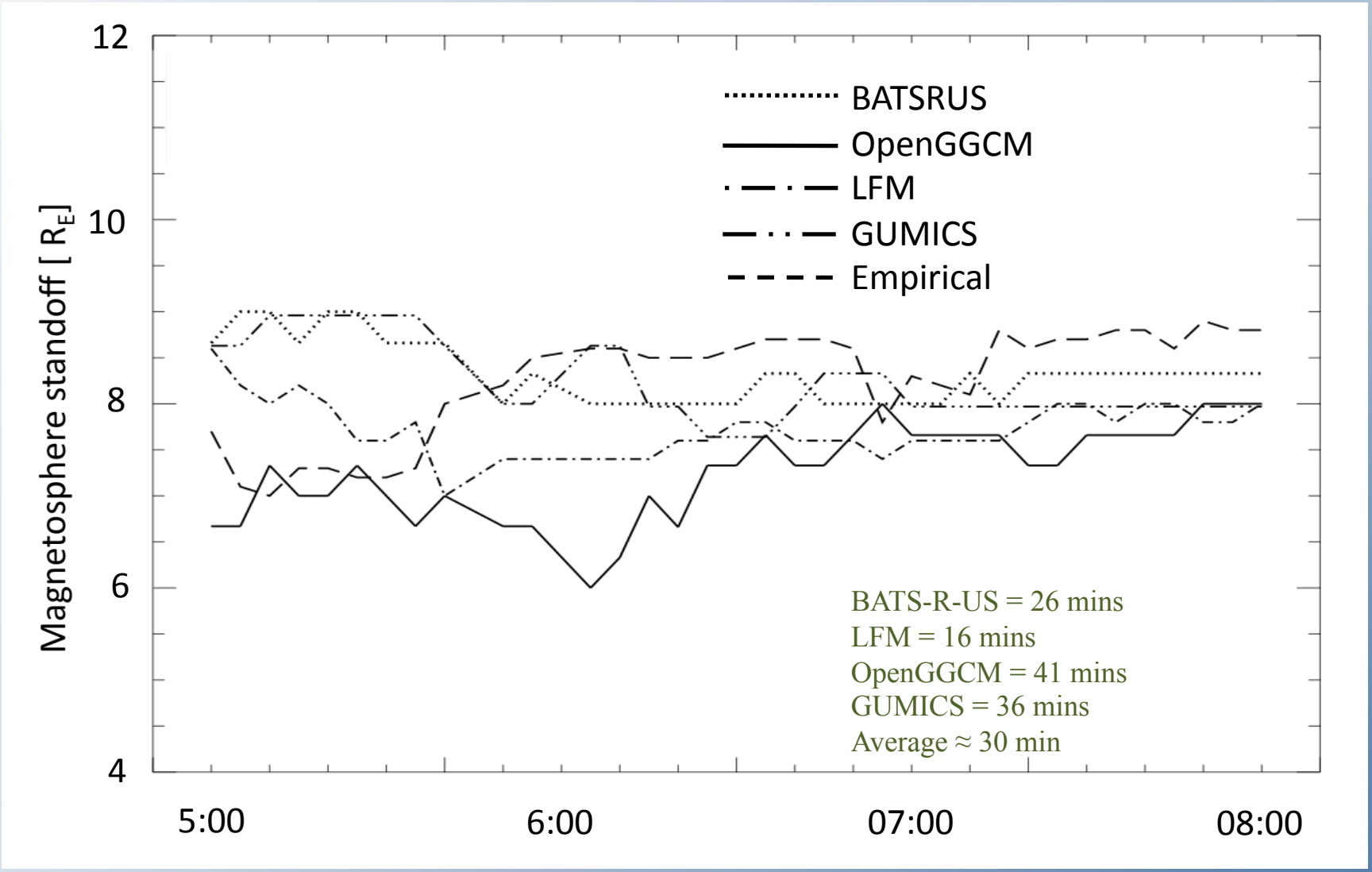
Disturbed conditions:

N between 10 and 25cm^{-3}

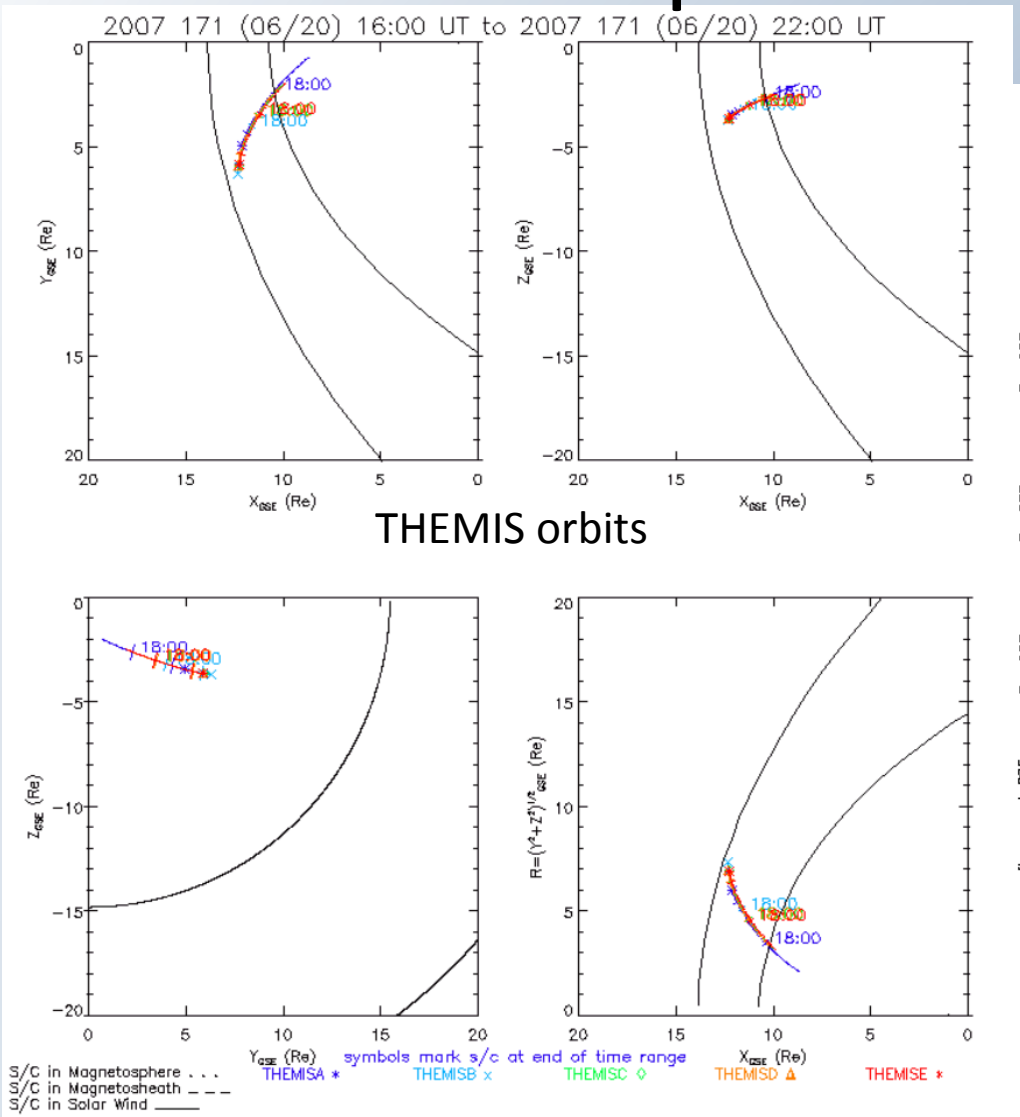
V_x between -420 and -450 km/s

B_y between +5 and -5 nT
B_z between +5 and -10nT

Results: March 24, 2001

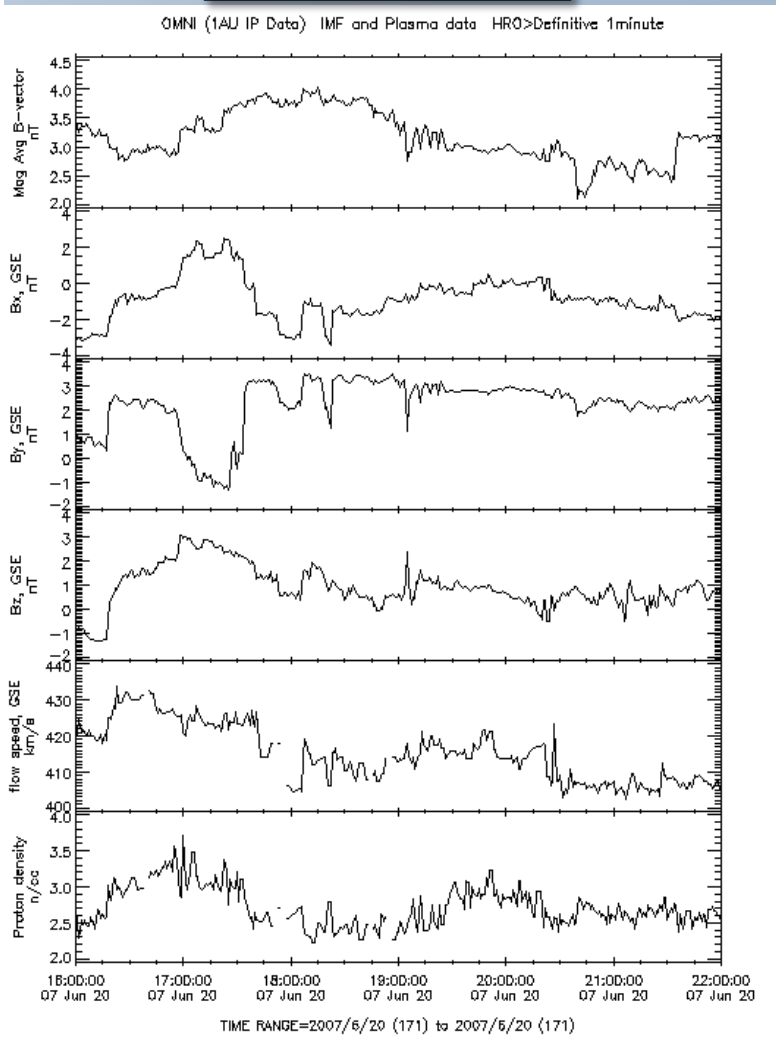


Magnetopause Observations near the sub-solar point: June 20, 2007



THEMIS orbits

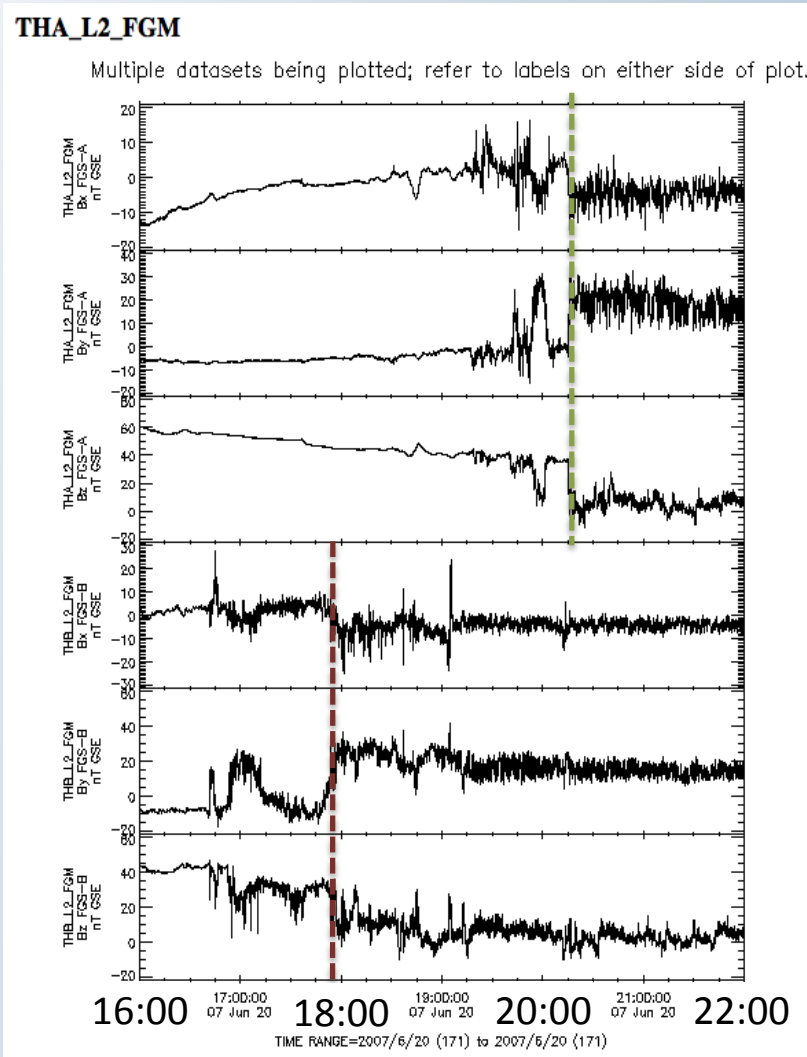
OMNI solar wind



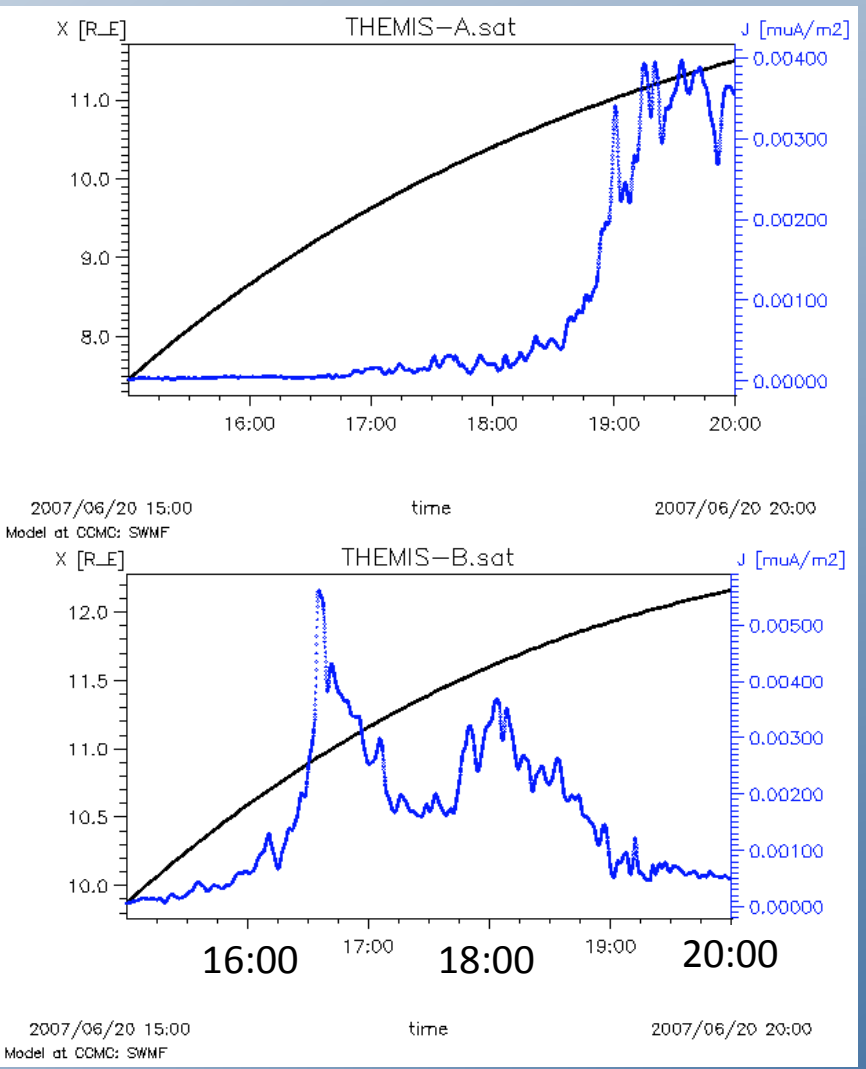
Comparison with model

June 20, 2007

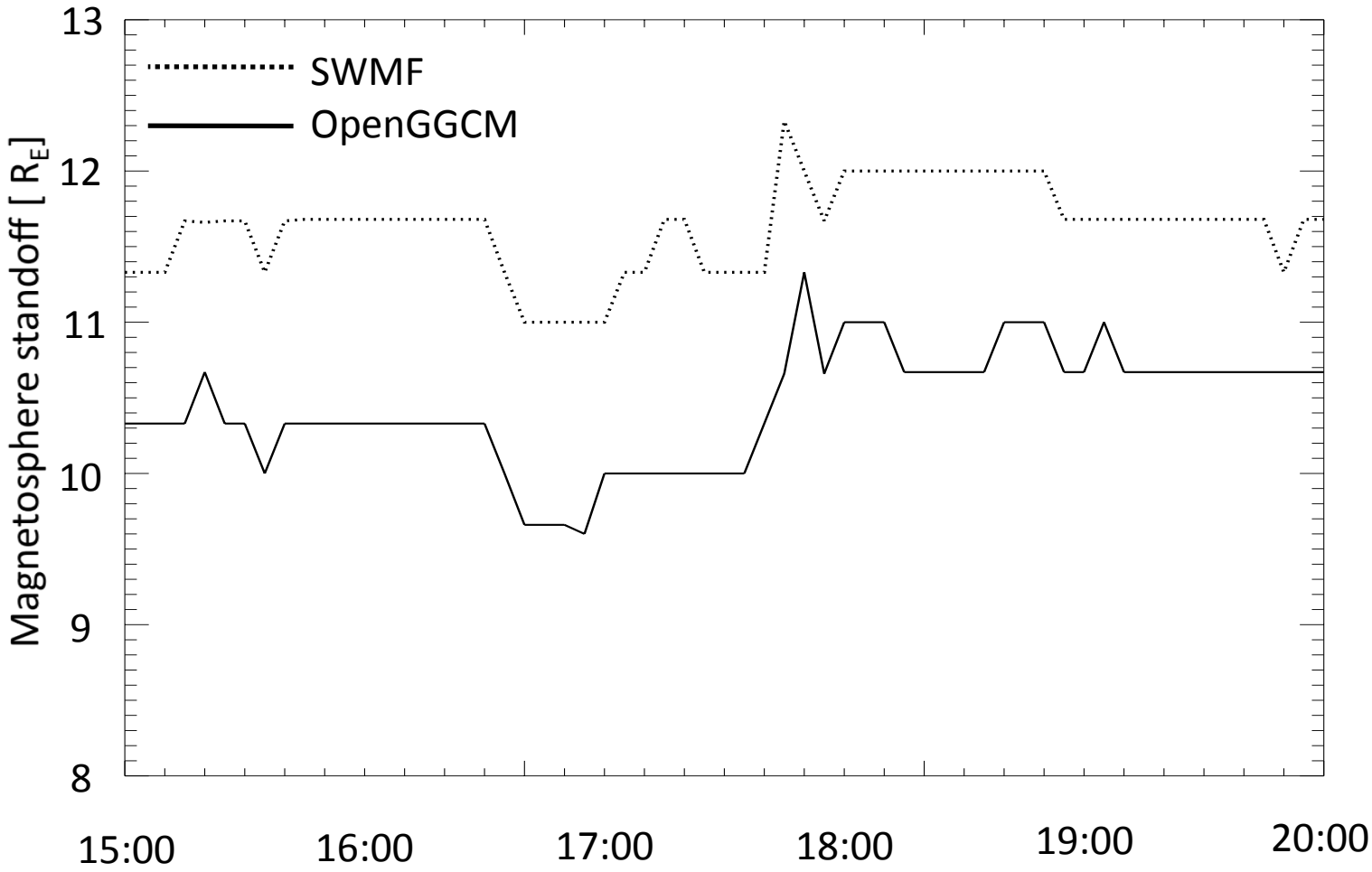
THEMIS-A and B magnetic fields



X position and SWMF current density

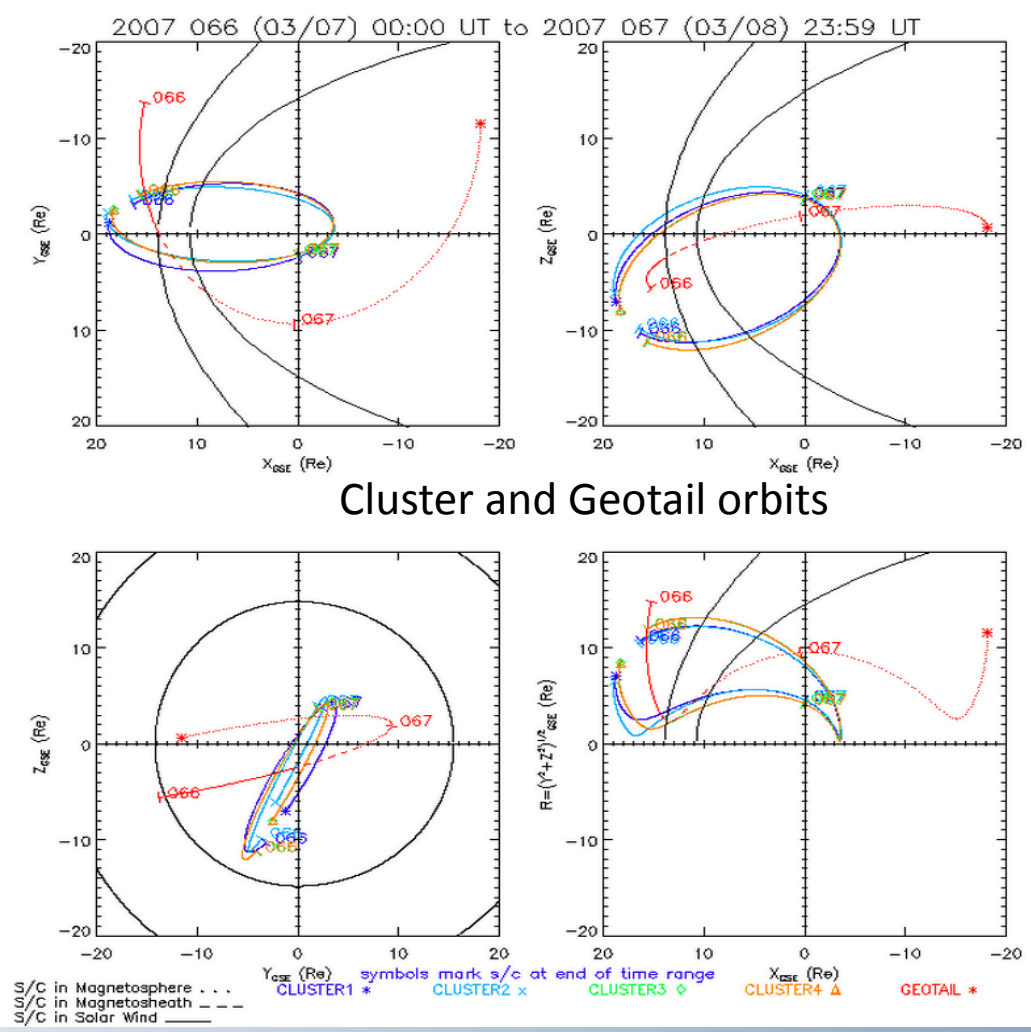


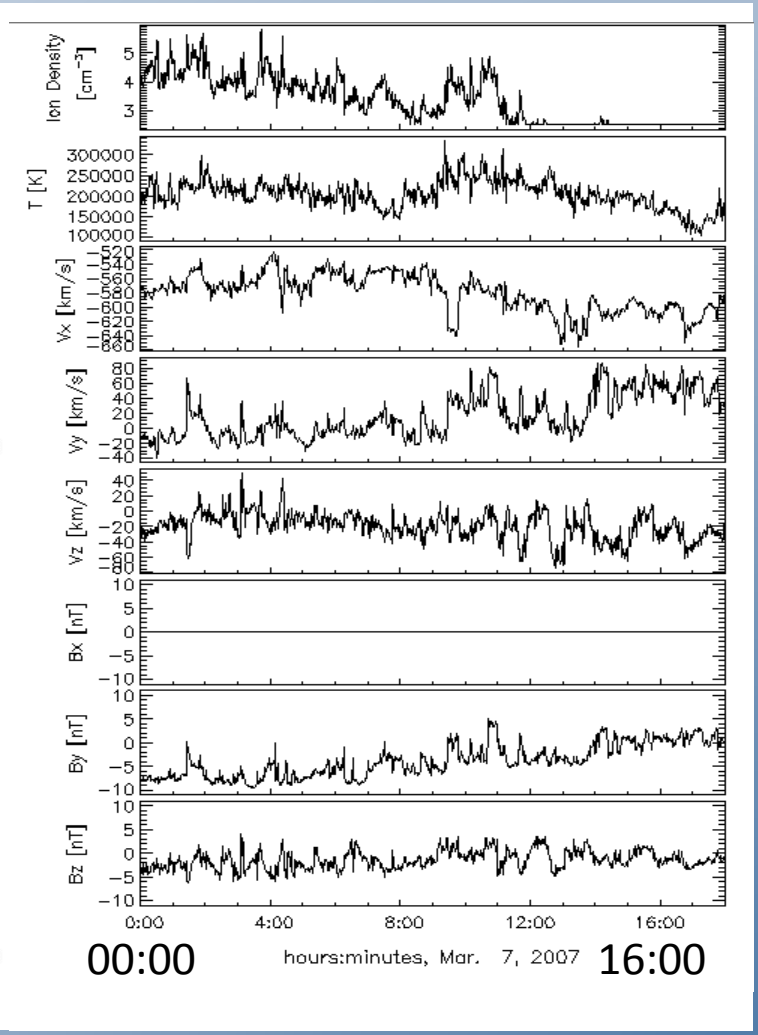
Comparison with models



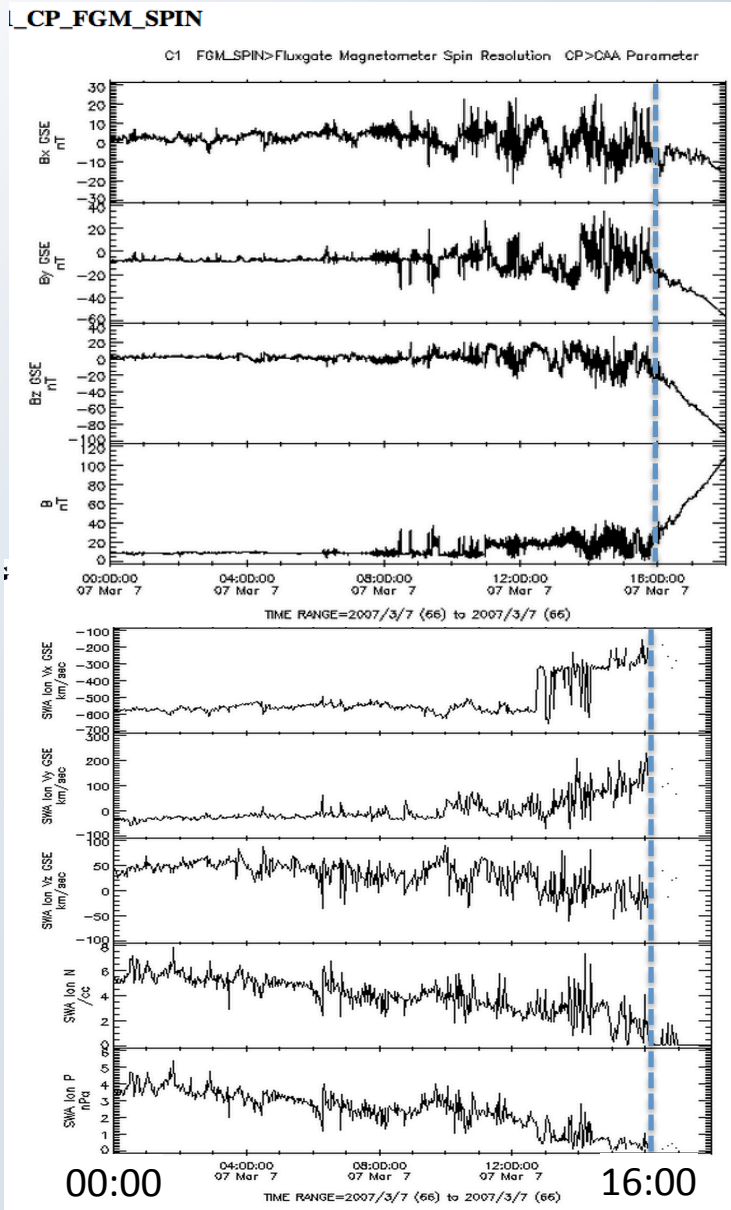
Observations by 2 spacecraft

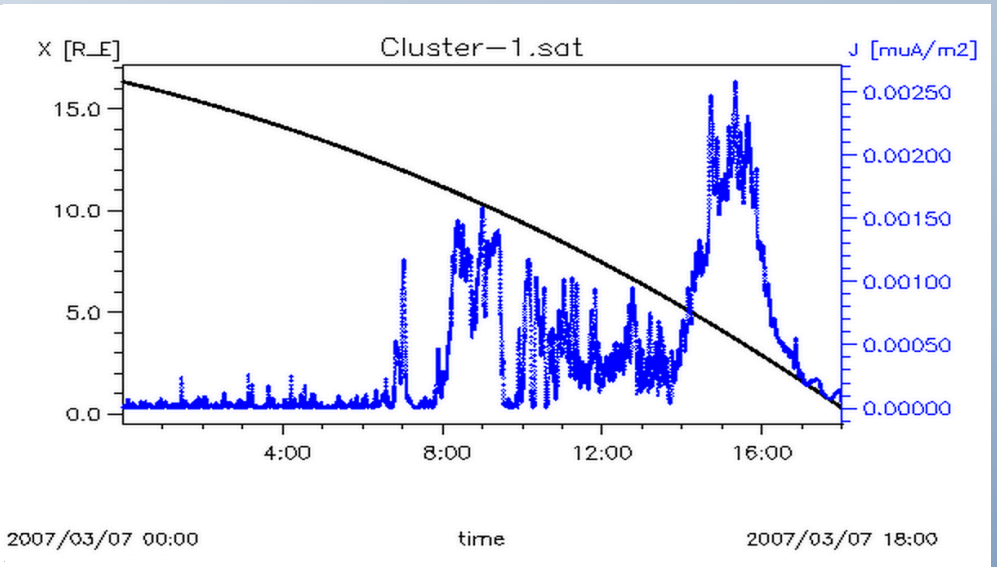
March 7, 2007



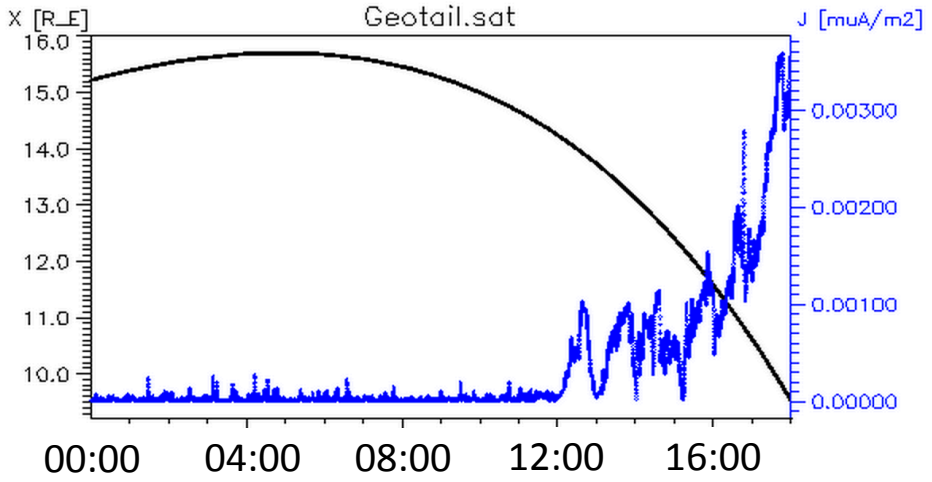


Cluster 1 and Geotail





X position and SWMF current density



Conclusions

- The MHD models give very different standoff positions of the dayside magnetopause for the same solar wind conditions.
- In average the magnetopause takes about half an hour to get to a minimum position distance within all 4 models.
- Magnetopause crossing observations have also been studied, but only times with nominal solar wind conditions have been encountered with one or more spacecraft crossing from one area to the other.
- In the case of June 20, 2007 the 2 models shown, BATS-R-US and OpenGGCM, show different magnetopause standoff position, but similar reaction behavior.
- In two nominal solar wind cases, the BATS-R-US model shows the magnetopause crossing at similar times as the observations for the THEMIS, Geotail and Cluster satellite do.