Supporting Information for "The substorm cycle as reproduced by community-available global MHD models"

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Introduction

As a supplement to the paper, here we present two additional tables and one gif movie file.

The Table S1 contains the summary of the main numerical details of the used global MHD simulations.

The Table S2 collects the input solar wind and interplanetary magnetic field components for 19 simulations as well as their names. All simulation results can be found at NASA Community Coordinated Modelling Center webpage [http://ccmc.gsfc.nasa.gov/] under the names shown in the table.

The Figure S1 (gif movie) contain supplementary movies demonstrating the dynamics of magnetospheric configuration and main parameter distributions in the meridional (top row) and equatorial (botom row) planes during the artificial event. Three different GMHD

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models (from left to right: BATSRUS, LFM, Open GGCM) are used with the same corresponding solar wind input #02: 2 hour northward $B_z = +3nT$ followed by 2 hours southward $B_z = -5nT$, other parameters are: IMF $B_x = +4nT$, $B_y = -2nT$, solar wind speed $V_x = -400km/s$, $V_y = V_z = 0$, temperature $T = 1e5K$, and density $N = 7cm^{-3}$. Each plate of the top row shows the meridional view of magnetic field lines, logarithm of plasma pressure (color) and plasma velocity (arrows). Each plate of the botom row shows the equatorial view of logarithm of magnetic field magnitude (isocontour lines), logarithm of electric field (color, to characterize the amplitude of magnetic flux transport) and plasma velocity (arrows). There are also three panels at the top wich demonstrate the variation of (from left to right): IMF Bz, lobe magnetic field and cross-tail electric potential.

Table S1. Summary of features and settings of global MHD models used in this study, see the text for details

	BATS-R-US v20110131	**GUMICS** 4-HC-20140	**LFM** LTR-2_2_0	**OpenGGCM** 4.0
General properties:				
MHD equations	Ideal, conservative, $B_0 + B_1$	Ideal, conservative, $B_0 + B_1$	Ideal, semi-conservative, $B_0 + B_1$	semi-conservative with resistivity
Solver notes	Eight-wave approximate Riemann	Mostly Roe, subcycling, divB cleaning	Total variation diminishing (TVD), constrained transport (CT)	TVD, CT
Order of MHD discretization spatial/temporal	2/2	1/1	8/2	4/2
MHD grid type	Cartesian, static, block-refined	Cartesian, dynamic, cell-refined	Distorted spherical, static, not refined	Stretched Cartesian, static, not refined
Characteristics of our set of runs:				
Spatial grid resolution, $[R_E]$	~2M cells SS point - -0.25 PS (X=-10) - -0.25 MP (X=-15) - -1.0	~100K cells SS point - -0.5 PS (X=-10) - -0.5 MP (X=-15) - -2.0	~160K cells SS point - -0.3x**x0.8 PS (X=-10) - -0.9x**x0.8 MP (X=-15) - -1.0x**x1.5	~3.5M cells SS point - -0.25x0.3x0.3 PS (X=-10) -0.2x0.3x0.3 MP(X=-15) -0.25x0.35x1.5
Ionospheric conductance	Constant	Auroral $F_{10.7} = 150 \cdot 10^{-22}$ $Wm^{-2}Hz^{-1}$	Constant	Constant
Ionospheric grid resolution, [deg]	Lat=1^o Lon=2^o	Triangular adaptive min=0.9^o max=3.6^o	Lat=2^o Lon=2^o	Lat=0.5^o Lon=3^o

Comments: Simulations with enhanced spatial resolution does not show significant changes in results for the set of used system parameters.

Table S2. Parameters of 19 standard input data sets and their run names in the CCMC simulation database

	Standard Solar Wind & IMF inputs								**Name extensions of CCMC runs:** Full name of the run is Gordeev_[extension]		
	V_x, [km/s]	N, [cm^{-3}]	T, [$10^3\cdot$ K]	P_d [nPa]	B_x, [nT]	B_y, [nT]	(B_{z0},B_{z1},B_{z2}), [nT]	M_A,	E_{y1}/E_{y2}	**BATSRUS**	**Open GGCM**	**LFM**
01	-400,	7,	100,	1.87	+4,	-2,	(-5,+3,-2)	10.6	-1.2/+0.8	120314_32	120314_13	120314_41
02	-400,	7,	100,	1.87	+4,	-2,	(-5,+3,-5)	7.8	-1.2/+2.0	120314_33	120314_14	120314_42
03	-400,	7,	100,	1.87	+4,	-2,	(-5,+3,-8)	5.7	-1.2/+3.2	120314_34	120314_15	120314_43
04	-400,	7,	100,	1.87	+4,	-2,	(-5,+6,-5)	7.8	-2.4/+2.0	120314_35	120314_16	120314_44
05	-600,	4,	250,	2.41	+4,	-2,	(-5,+3,-2)	12.1	-1.8/+1.2	120314_36	120314_17	120314_45
06	-600,	4,	250,	2.41	+4,	-2,	(-5,+3,-5)	8.8	-1.8/+3.0	120314_37	120314_18	120314_46
07	-600,	4,	250,	2.41	+4,	-2,	(-5,+3,-8)	6.5	-1.8/+4.8	120314_38	120314_19	120314_47
08	-600,	4,	250,	2.41	+4,	-2,	(-5,+6,-5)	8.8	-3.6/+3.0	120314_39	120314_20	120314_48
09	-300,	12,	35,	1.80	+4,	-2,	(-5,+3,-5)	7.6	-0.9/+1.5	120314_40	120314_21	120314_49
10	-800,	2,	350,	2.14	+4,	-2,	(-5,+3,-5)	8.3	-2.4/+4.0	120314_10	120314_22	120314_50
11	-400,	4,	100,	1.07	+4,	-2,	(-5,+3,-5)	5.9	-1.2/+2.0	120314_1	120314_23	120314_51
12	-400,	10,	100,	2.68	+4,	-2,	(-5,+3,-5)	9.3	-1.2/+2.0	120314_2	120314_24	120314_52
13	-600,	2,	250,	1.20	+4,	-2,	(-5,+3,-5)	6.2	-1.8/+3.0	120314_3	120314_25	120314_53
14	-600,	6,	250,	3.61	+4,	-2,	(-5,+3,-5)	10.8	-1.8/+3.0	120314_4	120314_26	120314_54
15	-450,	5,	50,	1.69	+4,	(-2,-2,-8),	(-5,+3,-6)	4.6	-1.4/+2.7	120314_5	120314_27	120314_55
16	-450,	5,	50,	1.69	+4,	(-2,-2,-10),	(-5,+3,-10)	3.4	-1.4/+4.5	120314_6	120314_28	120314_56
17	-450,	5,	50,	1.69	+4,	(-2,-2,-16),	(-5,+3,-10)	2.6	-1.4/+4.5	120314_7	120314_29	120314_57
18	-700,	6,	500,	4.92	+4,	-2,	(-5,+3,-5)	12.6	-2.1/+3.5	120314_8	120314_30	120814_58
19	-900,	5,	500,	6.77	+4,	-2,	(-5,+3,-5)	14.8	-2.7/+4.5	120314_9	120314_31	120814_59

The results of simulations can be found at CCMC website, http://ccmc.gsfc.nasa.gov/.

Indices used with B_z and E_y: 0 - preconditioning ($\approx$ 1h), 1 - next 2h of northward B_z, 3 - next 2h of southward B_z.