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Supporting Information for

Magnetosphere-ionosphere coupling via prescribed

field-aligned current simulated by the TIEGCM

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Introduction

In the following, we will provide some details about the parametrization used for the different presented model simulations.

Text S1.

The parametrization of the transition latitude from the high latitude region with prescribed electric potential or FAC to the low latitude dynamo driven region differs between the simulations. The potential or FAC is specified poleward of the magnetic colatitude θ_{cp}, ignored equatorward of the magnetic colatitude θ_{ce}, with a linear transition between θ_{cp} to θ_{ce}. For simulations with prescribed electric potential the transition colatitude is parametrized by the convection reversal radius θ^N and θ^S in the northern and southern hemisphere, respectively. For the Weimer-POT simulations

$$\theta_{cp} = max\left(15^o; \frac{\theta^N + \theta^S}{5} + 5^o\right)$$
$$\theta_{ce} = \theta_{cp} + 15^o$$

For the AMIE-POT simulations

$$\theta_{cp} = max\left(20^o; \frac{\theta^N + \theta^S}{5} + 5^o\right)$$
$$\theta_{ce} = \max(35^o;\ \theta_{cp} + 15^o)$$

For the OIM-FAC simulations, the transition colatitude only affects step 3 and not the calculation of the symmetric potential in step 1.

$$\theta_{cp} = 45^o$$
$$\theta_{ce} = 50^o$$

In the default TIEGCM, the location and strength of the aurora oval is parametrized by the solar wind conditions and the cross polar potential drop. For the Weimer-POT simulation, the cross polar potential drop is given by the Weimer empirical model. For the OIM-FAC case, we employ an empirical approximation of the potential drop $\Delta\Phi_{HL}$ already implemented in the TIEGCM based on the 3-hourly global geomagnetic activity index K_p with $\Delta\Phi_{HL}$=15+15 K_p +0.8 $K_p^{\,2}$. The complete aurora oval parametrization including energetic particle precipitation parametrization is complex and we focus in Table S1 only on the parts which have been changed in the OIM-FAC simulation.
The hemispheric power *hp* is in GW and the factor p_{hp} depends on hemispheric power with p_{hp} *=2.09 ln hp* if *hp* > 1 GW otherwise p_{hp} *=0*. In the Weimer-POT and OIM-FAC simulations the hemispheric power is parametrized by the solar wind conditions using

$$hp = \begin{cases} 6.6 + 3.3|B_z| + (0.05 + 0.003|B_z|)[min(s_w; 700) - 300], & if\ B_z < 0 \\ 5. + 0.05[min(s_w; 700) - 300], & if\ B_z \geq 0 \end{cases}$$

Table S1. Modified part of TIEGCM aurora parametrization.

variable	default	Weimer-POT	OIM-FAC
Aurora oval offset toward midnight [deg]	1^o	4.2^o	2.5^o
Aurora oval offset toward dusk [deg]	0^o	-1^o	-2.5^o
Energy flux in noon sector [ergs/cm²/s]	$e_{1d}=max(0.50;-2.15+0.62p_{hp})$	e_{1d}	$max(0.5;0.5e_{1d})$
Energy flux in midnight sector [ergs/cm²/s]	$e_{2d}=1.+0.11p_{hp}$	e_{2d}	$0.5(e_{2d}+1)$
Gaussian width at noon [deg]	$h_{1d}=min(2.35;0.83+0.33p_{hp})$	h_{1d}	$1.5h_{1d}$
Gaussian width at midnight [deg]	$h_{2d}=2.5+0.025max(hp;55.)+0.01min(0.;hp-55.)$	h_{2d}	$1.5h_{2d}$