

Modeling the Earth's Magnetosphere as a Current Circuit

Austin Brenner^a, Tuija Pulkkinen^b and Qusai Al Shidi^b

(a) University of Michigan, Aerospace Engineering (aubr@umich.edu)

(b) University of Michigan, Climate and Space Science and Engineering (tuija@umich.edu, qusai@umich.edu)

WINDMI is a low dimensional model that represents the space environment around earth as an electrical circuit as shown in figure 1 and can be used as a prediction tool via the outputs of the region 1 current and ring current values which correlate to geomagnetic indices of Auroral Electro-jet (AL) and Disturbance Storm Time (Dst) respectively. This model approximates the plasma in geospace regions as circuit elements that store or transform electromagnetic energy. This work investigates the circuit component approximations of several of the WINDMI model elements by comparing to high fidelity 2-way coupled MHD simulation, the Space Weather Modeling Framework (SWMF)[2].

A two day event of February 18-19 2014 is simulated using both SWMF and WINDMI. Python is used along with Tecplot 3D visualization software to identify the appropriate spatial re-gions and integrate field data output from SWMF to make one-to-one comparisons of power and energy quantities over time with the WINDMI circuit elements. By making direct comparisons it can be seen where low dimensional approximations can accurately capture the plasma dynamics and where these approximations fall short.

References

- [1] Spencer, E., Horton, W., Mays, M. L., Doxas, I., and Kozyra, J. (2007), Analysis of the 3–7 October 2000 and 15–24 April 2002 geomagnetic storms with an optimized nonlinear dynamical model, *J. Geophys. Res.*, 112, A04S90, doi:10.1029/2006JA012019.
- [2] Tóth, G., et al. (2005), Space Weather Modeling Framework: A new tool for the space science community, *J. Geophys. Res.*, 110, A12226, doi:10.1029/2005JA011126. [2] S. Taylor and P. Pix, *J. Appl. Phys.* **101**, 2389 (2009).

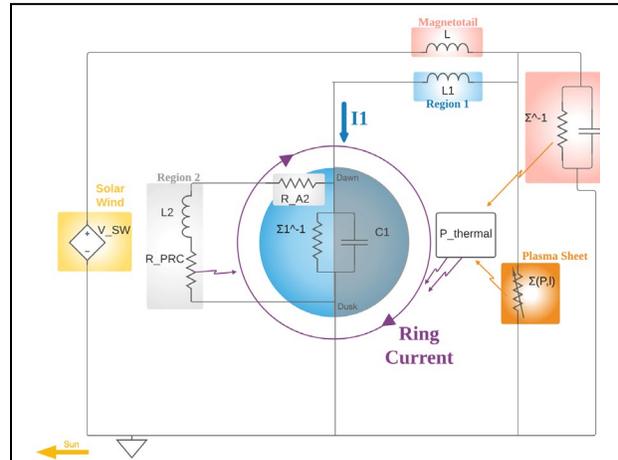


Figure 1 - WINDMI circuit representation.

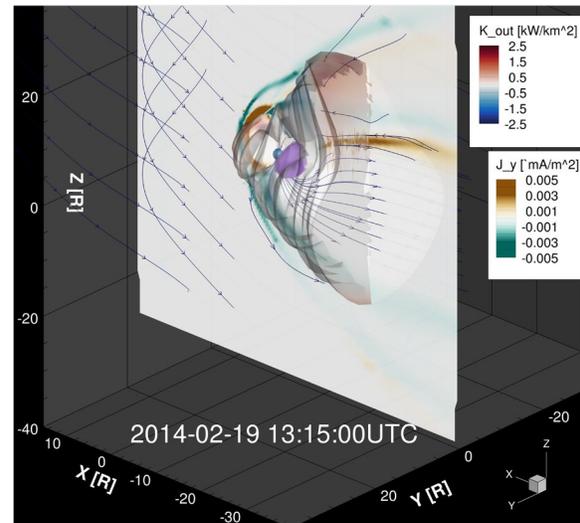


Figure 2 - SWMF 3D Magnetopause with energy flux and mid-plane current densities.