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Geoscientific Model Development Discussions

Interactive comment on "Development of high-resolution Thermosphere–Ionosphere Electrodynamics General Circulation Model (TIE-GCM) using Ring Average technique" *by* Tong Dang et al.

Anonymous Referee #1

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Summary: The manuscript introduces a new application of the Ring Average technique to be used in Global Circulation Models (GCMs). With this new technique, the numerical constraints imposed on the timestep could be eased, especially at the polar regions where azimuthal grid dimensions become very small. The paper demonstrates the feasibility of the method first in a simpler problem, in which the advection equation is solved on a spherical domain. The results from the Ring Average technique applied solution are compared with the Fast Fourier Transform (FFT) filter applied solution and a 4th order numerical solution. Ring Average method had a better performance re-

quiring a smaller time step, further establishing its feasibility in improving the numerical resolution around the polar region. The second application was conducted by applying FFT Filter to the TIE-GCM results and using the Ring Average technique implemented version of TIE-GCM for the 17 March 2013 storm. The results showed that the Ring Average technique was able to preserve the directions of vector properties and didn't introduce numerical artifacts that are seen in the polar region with the FFT applied simulation results. The Ring Average technique is a non-intrusive method to increase spatial resolution without suffering from small timestep limitations for convergence and stability in GCMs.

General Comments: The manuscript does a commendable job in presenting the new Ring Average method. The need for remedying the resolution problem in GCMs at the polar regions is sufficiently laid out with proper referencing to the literature. The derivation and the implementation of the technique are intuitive and coherent. The results from the introduced model are evaluated in two different examples and clearly demonstrated an advancement in performance with a strong potential to further the science. In addition, the code repositories are provided in the "Code Availability" section and the codes are presented in a user-friendly and self-explanatory manner. Overall, the paper is exceptionally well-written and organized.

Specific Comments: 1. Please consider revising Key Point 2 to clarify what is meant by "more complicated geoscientific models". The paper only discusses the application to TIE-GCM and WACCM-X models and it is not immediately clear how these models compare geoscientifically. 2. Please consider adding "forward" to Line 134 to read as "a central difference forward Euler".

Technical Comments: 1. Please consider replacing "On the other hand" with "In addition" or "Furthermore" on Line 171. 2. Please extend Figure 1 caption to include how the information in Lines 123-124 about the number of "chunks".

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