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Ridley, Aaron, J.

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University of Michigan, 2455 Hayward, Ann Arbor, MI, 48109-2143

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14. ABSTRACT
The main goal of this research grant was to couple the SAMI-3 ionosphere model with the GITM ionosphere/thermosphere model. This was accomplished over the period of the grant. Below, we describe some of the modifications that were needed to accomplish this.

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The main goal of this research grant was to couple the SAMI-3 ionosphere model with the GITM ionosphere/thermosphere model. This was accomplished over the period of the grant. Below, we describe some of the modifications that were needed to accomplish this.

- Reorganized the SAMI-3 code into a format that would better lend itself to coupling with other codes, including: (a) reorganizing the code to have distinct initialization and advance routines, allowing SAMI-3 to advance for a certain amount of time before returning to the main coupling code; (b) using output file logical units that don't collide with other codes so that files do not get overwritten; (c) reorganizing the directory structure by moving source files into a sub-directory, creating run directories as need using the Makefile, having input and output directories that are distinct; and having share and util sub-directories that have libraries that are used by GITM and SAMI-3 together.

- Created a SAMI-3 to GITM coupler that collects all of the SAMI-3 data on the main processor, message passes it to GITM, and redistributes it onto the GITM processors. An 8-point linear interpolation method was created to go from the SAMI-3 domain to the GITM domain. This coupler took a long time to implement, since the amount of information that was message passed turned out to be an issue on the NASA Pleiades machine. We ended up having to message pass the information in smaller chunks as the number of processors became larger on the GITM side. This has been tested on up to 200 processors for GITM, which is a resolution of 1° latitude by 4° longitude, which is a standard (nominal resolution) run for GITM.

- Created a GITM to SAMI-3 coupler that collects all of the GITM data on the main processor, message passes it to GITM, and redistributes it on the SAMI-3 processors. The interpolation scheme for this was complicated in that SAMI-3 extends below GITM and above GITM. Since GITM uses MSIS and HWM for boundary conditions on the lower boundary, SAMI-3 simply uses these below the GITM domain. Above the GITM domain, SAMI-3 uses a scheme where is assumes that the winds and temperatures are constant in a lat/lon wedge above GITM (using its top cell to extrapolate) and assumes that the neutrals are in hydrostatic balance above this. The first revision of this coupler did not make this assumption, using MSIS both above and below GITM, and the results were strange, so this new method was implemented.

- Modified SAMI-3 so that it uses the index reading functionality of GITM, even when it is run independently. For example, SAMI-3 can now read in the IMF, Hemispheric Power, F10.7, and several other files that GITM uses. It can then update these indices dynamically in SAMI-3, allowing the brightness of the EUV and the MSIS boundary conditions to change as a function of

time.

- Modified SAMI-3 so that it can use the Weimer electrodynamic potential within the model run. Before, Weimer had to be run before the run and potential files had to be created to be read in. Indeed, now SAMI-3 can use Weimer dynamically from within it. It can also use AMIE and SWMF output files to drive the high-latitude potential.

While these changes are a long way towards being able to completely model the IT region, the following modifications are still needed to improve this modeling:

- SAMI-3 needs to be modified to use either a tilted offset dipole field and/or the APEX magnetic field coordinate system.

- SAMI-3 will need to have the aurora added to it. The coupling described above (with the Weimer code) allows a specification of the total energy flux and average energy of the precipitation. GITM has an energy deposition code coupled in, which can be used by SAMI-3. This should be straightforward to implement, but still needs to be done.

- For efficiency, the coupling between GITM and SAMI-3 should be processor-to-processor based, as opposed to collect-transfer-and-redistribute. This will allow the GITM to SAMI-3 coupling to be extendable to any resolution, while it is currently limited by the amount of memory on the machines. This is more complicated and will several weeks to implement and test. This does not affect the performance of the GITM and SAMI-3 codes at all, but just the scale-ability and message-passing time of the coupled code when they are run with higher resolutions.