Abstract
The Ionosphere-Thermosphere modeling component of the CISM project is responsible for development of general circulation models of the upper atmosphere system and their coupling to the magnetosphere. Initial construction of the Coupled Magnetosphere-Ionosphere-Thermosphere model (CMIT) was accomplished using the NCAR Thermosphere-Ionosphere Nested Grid (TING) model; transition to the more complex NCAR Thermosphere-Ionosphere-Electrodynamics General Circulation Model (TIE-GCM) is now accomplished. Several improvements are being made to the TIE-GCM, which is in transition to community model status. We are working on extending ionospheric models into the plasmasphere, collaborating with data assimilation activities, conducting an extensive validation effort, and including ion outflow in the feedback to the magnetosphere.

The Coupled Magnetosphere-Ionosphere-Thermosphere Model (CMIT)
The CMIT model has progressed from one-way to two-way coupling, and now includes neutral wind feedback to the magnetosphere. Transition to the TIE-GCM is represented by the simplified schematic diagrams below.

Wind-Driven Current Coupling
CMIT versions 1.1 and onward include neutral-wind-driven current feedback to the magnetosphere through the construct of \( J_z \), the effective field-aligned current caused by collisions of the neutral gas with ions in the auroral region. This "flywheel" effect can become significant in the aftermath of significant geomagnetic disturbances.

\[
J_w = \frac{1}{\sin I} \int_{z_1}^{z_2} \left[ s_p (\vec{U} \cdot \vec{B}) + s_h b (\vec{U} \cdot \vec{B}) \right] dz
\]

Where:
- \( I \) is the magnetic field inclination angle
- \( \vec{B} \) is the magnetic field vector
- \( b \) is the magnetic field unit vector
- \( z_1 \) and \( z_2 \) are min and max model altitudes
- \( s_p, s_h \) are the Pedersen and Hall conductivities
- \( \vec{U} \) is the neutral wind velocity

Magnetosphere-Ionosphere-Thermosphere Coupling During the May 1997 Storm
These figures illustrate the geospace response to the 12-17 May 1997 event. From left to right: summary plot of solar wind parameters and the magnetosphere/ionosphere response; magnetospheric simulation; ionosphere model parameters; neutral atmosphere parameters.

Key solar wind parameters at L1 as a function of model time, and the simulated global response (NH). Top to bottom: solar wind density, cm\(^{-3}\); solar wind velocity x-component, km s\(^{-1}\); IMF y, z components, nT; cross-tail potential, kV; hemispheric Joule heating, GW; hemispheric power, GW; simulated AU and AL indices, nT. Start time is UT=0 on 14 May 1997.

Configuration of the magnetosphere at 14 UT on May 15 (hour 38 of the model run) as simulated by the CMIT model. Plasma density is plotted as a color image with selected magnetic field lines superimposed.

Response of the thermosphere/ionosphere system calculated by the CMIT model at 14 UT on 15 May (hour 38 of the model run). Left: E-region electron densities at ~250 km with the ion drift pattern superimposed. Right: F-region neutral temperatures at ~250 km with the neutral winds superimposed.

Ionospheric Data Assimilation
A collaborative effort in ionosphere modeling with the USU GAIM group has been established. These figures demonstrate the effect of model initialization with assimilated electron density fields.

Plans and Goals
ITM Goals:
- Plasmasphere extension to TIE-GCM
- SEP fluxes and ionization
- High-resolution TIE-GCM in coupled models
- Transition to TIME-GCM in coupled models
- NCEP analysis fields at lower boundary
- Systematic ionospheric updates from GAIM
- Near-real-time solar irradiance inputs
- Short-term forecast of solar irradiance inputs

Cross-Thrust Goals:
- Inclusion of auroral acceleration module
- Specification of ion outflow rates
- Plasmaspheric coupling from RCM:
  - Electric Fields
  - Precipitation