



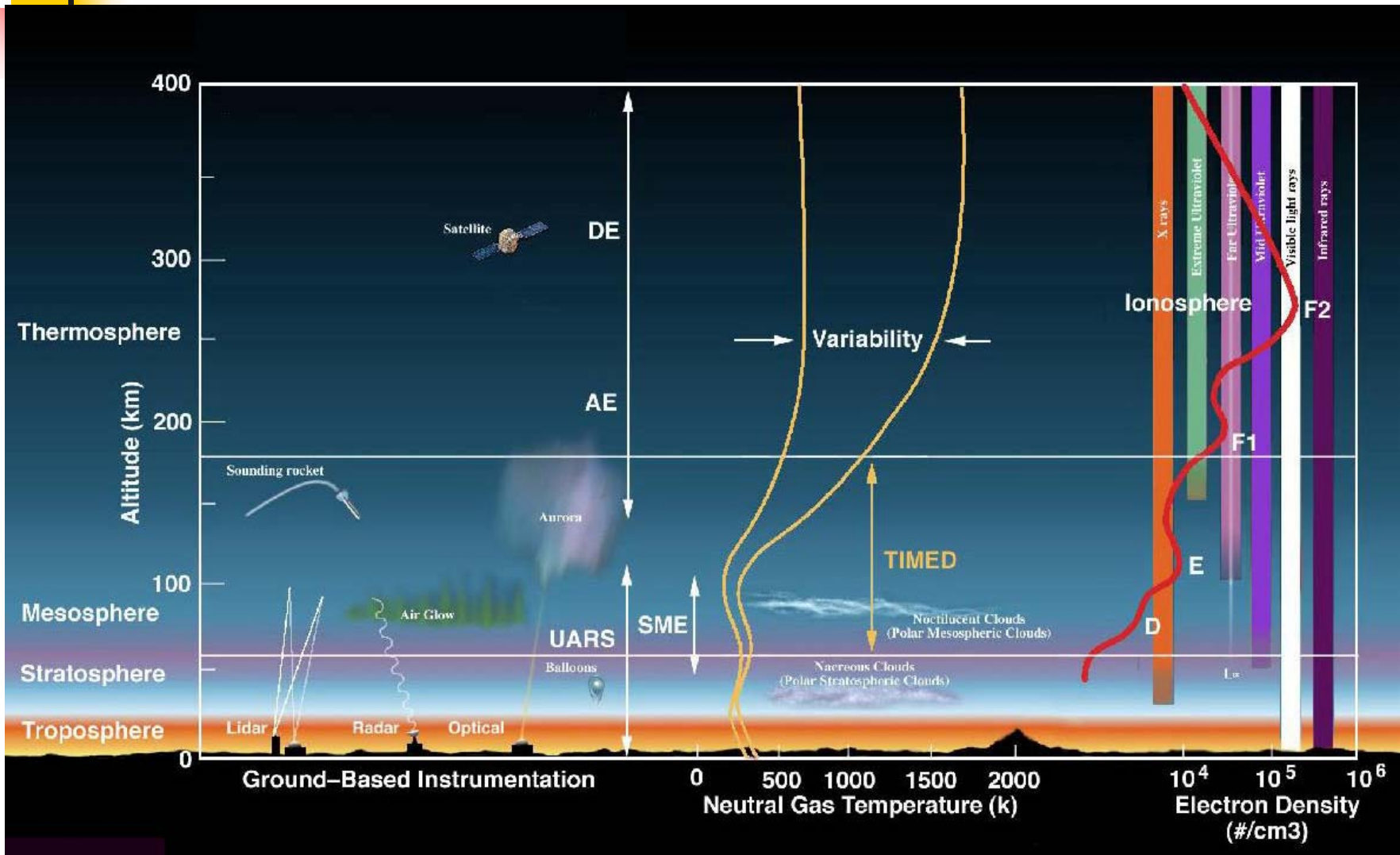
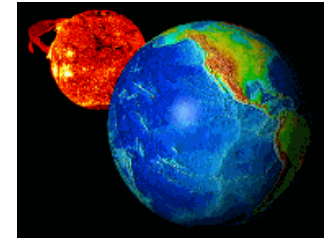
Coupling between the thermosphere and the ionosphere and with other regions

A. G. Burns, S. Solomon and W. Wang

NCAR

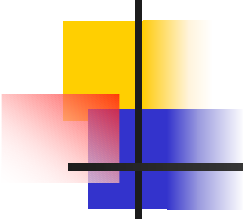
**Thanks: M. Wiltberger, J. Lyon
Dartmouth**

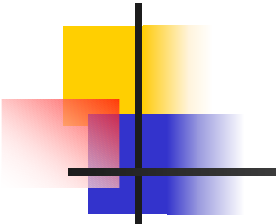
The Thermosphere/Ionosphere



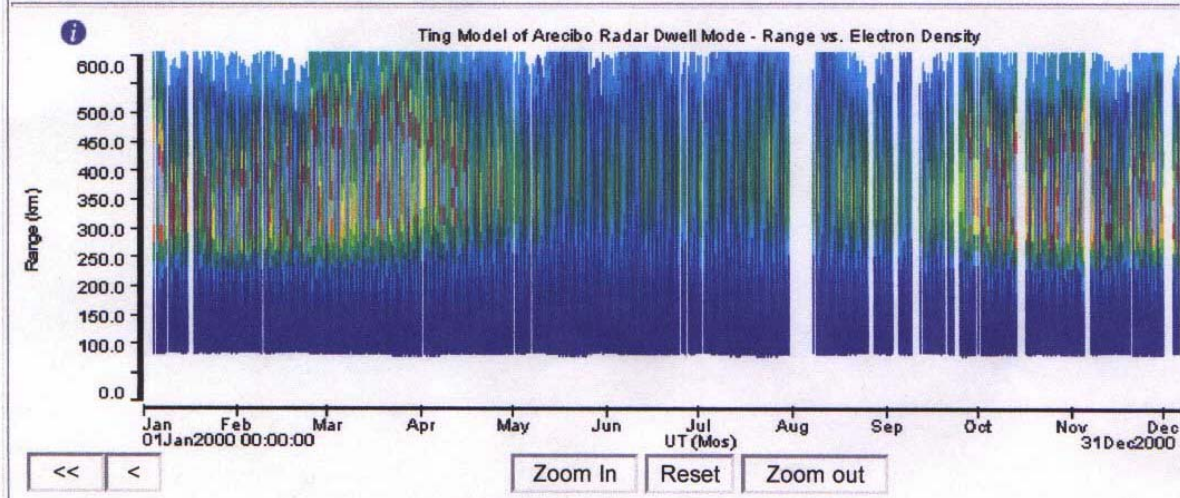
Courtesy, S. Yee

The TING Model

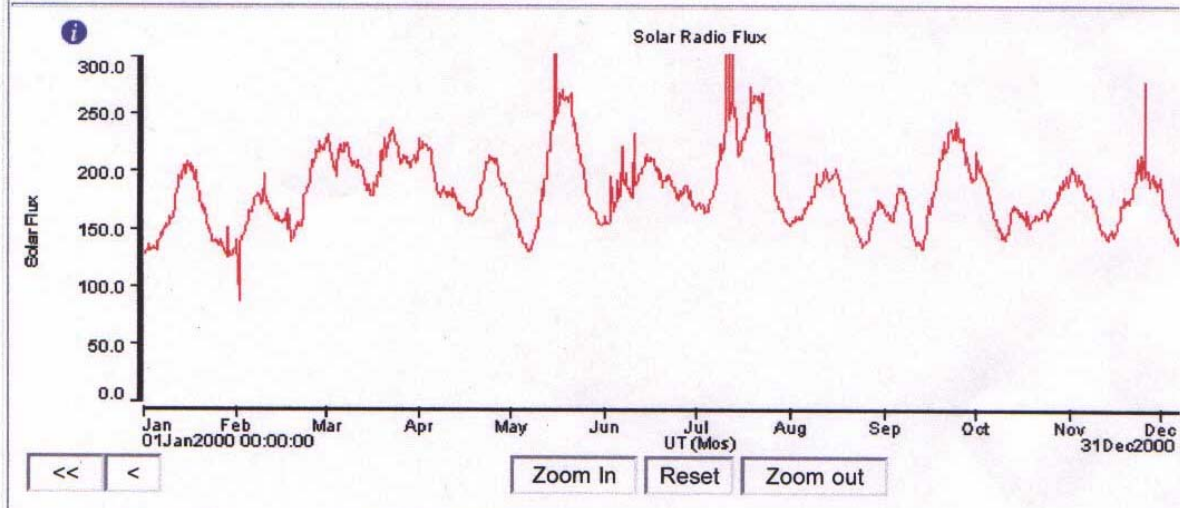
- 
- The high-resolution, three dimensional, time dependent, Thermosphere-Ionosphere Nested Grid (TING) model has been developed to study mesoscale processes in the thermosphere-ionosphere system. The TING model uses the same physical and chemical scheme as the the NCAR-TIEGCM to obtain solutions of the coupled equations of momentum, energy, and mass continuity for neutrals, and O^+ .
 - **Input Parameters:** are F10.7, auroral particle precipitation, the imposed magnetospheric electric field, and tides from the lower atmosphere.
 - **Output Parameters:** Neutrals: U_n , V_n , T_n , $[O]$, $[O_2]$, $[NO]$, $[N^4S]$, $[N^2D]$ Plasma: T_e , T_i , N_e , $[O^+]$, $[NO^+]$, $[N^+]$, $[O_2^+]$, $[N_2^+]$



Q ZOOM EDIT TING Ne Arcibo

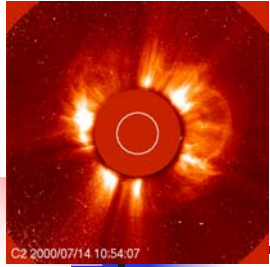
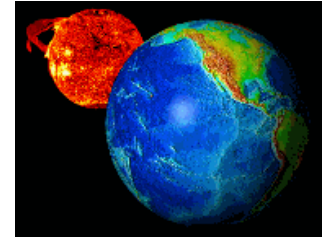


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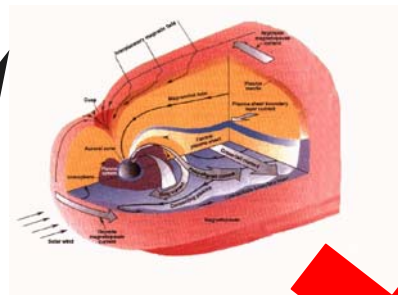
The CISM Framework



Corona (Soho)

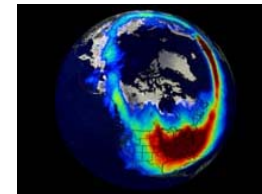


Solar Wind (Lund University)



Magnetosphere
(Rice University)

Thermosphere/
Ionosphere

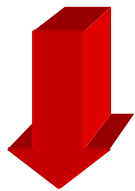


Magnetosphere-Ionosphere Coupling

A simple circuit?

Magnetosphere

Energy



*Field-aligned
currents*

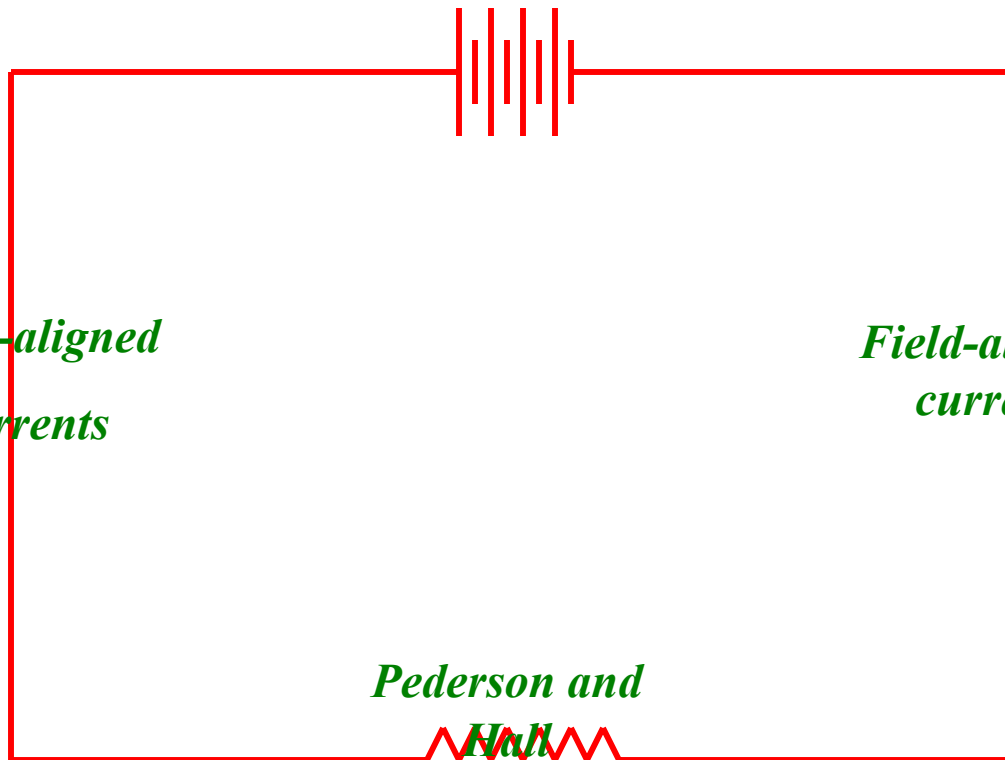
Energy



*Field-aligned
currents*

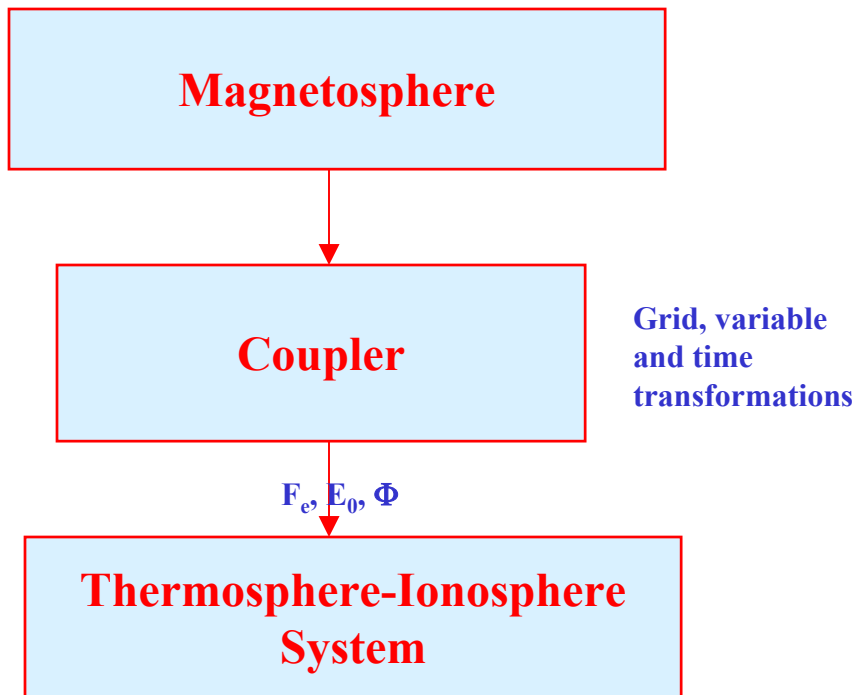
*Pederson and
Hall
currents*

Lower ionosphere



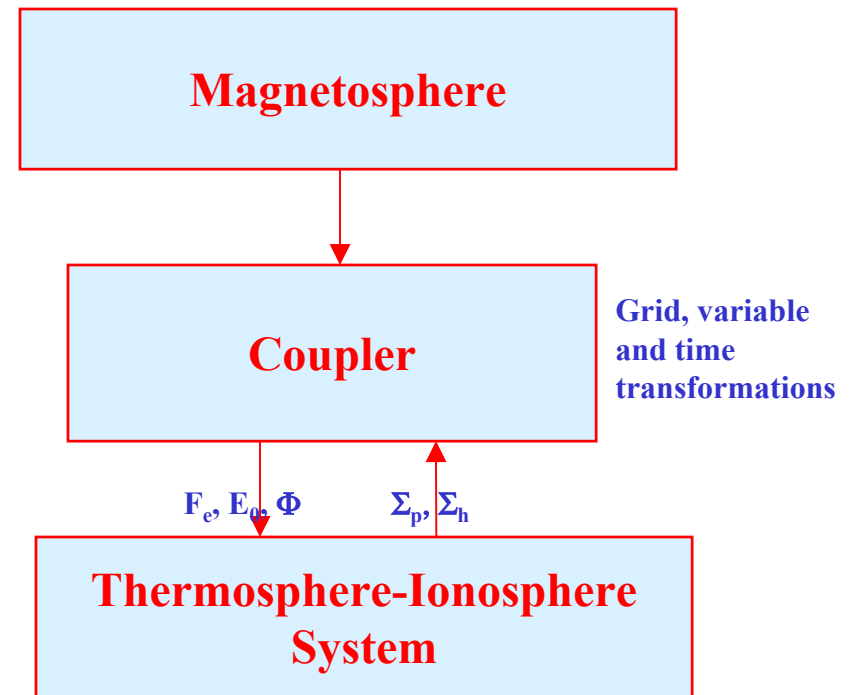
Magnetosphere-Ionosphere-Thermosphere Coupling

One-Way



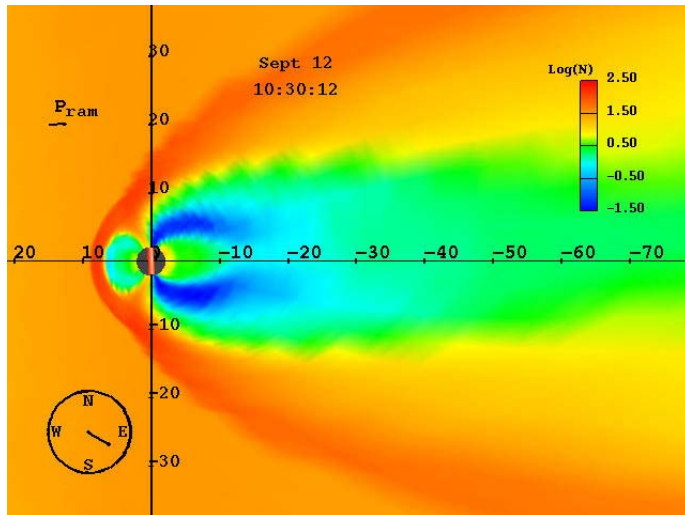
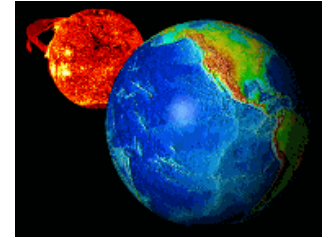
Notes: No feedback from TI system to magnetosphere,
simplified conductivity model for magnetosphere,
no mass transfer, simple plasmaspheric heat flux calculation
No high-latitude dynamo winds.

Two-Way

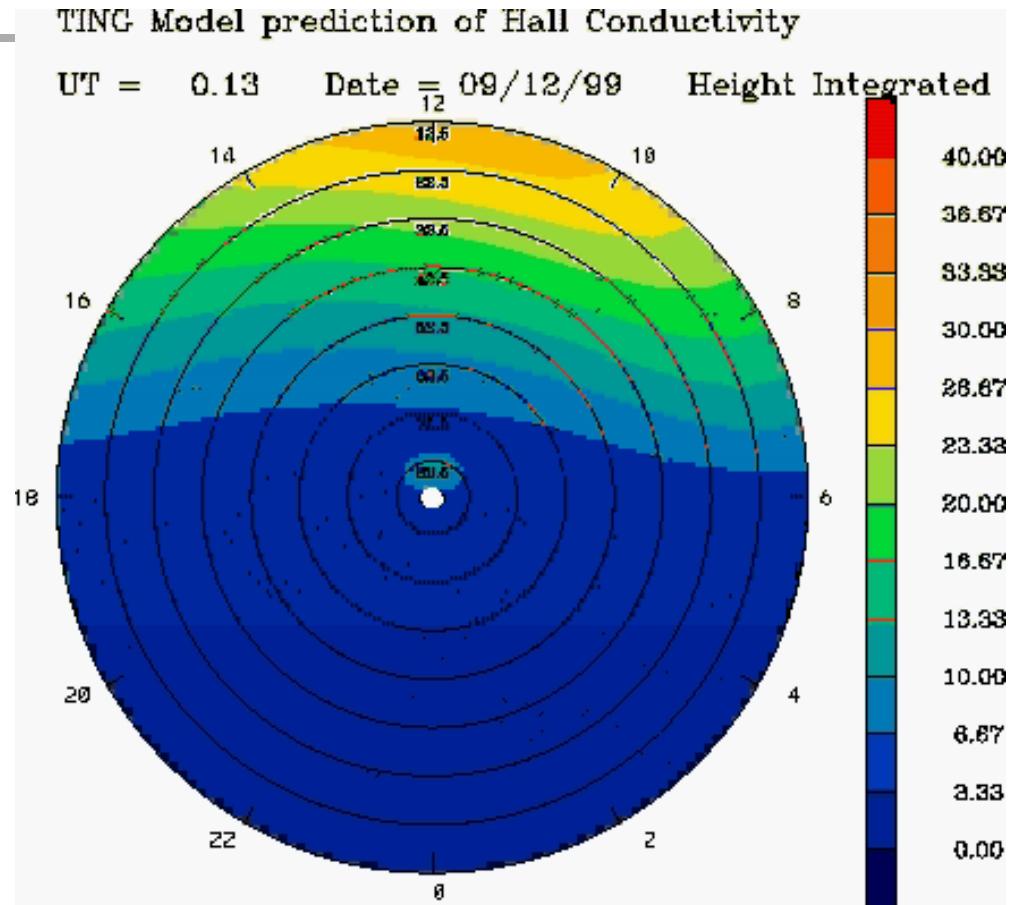
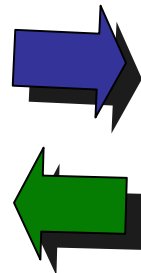


Notes: no mass transfer, simple plasmaspheric heat flux calculation
No high-latitude dynamo winds.

Magnetosphere-Ionosphere Coupling: Two-Way Interaction



Lyon-Fedder-Mobarry
Global MHD Model



Thermosphere-Ionosphere Coupling

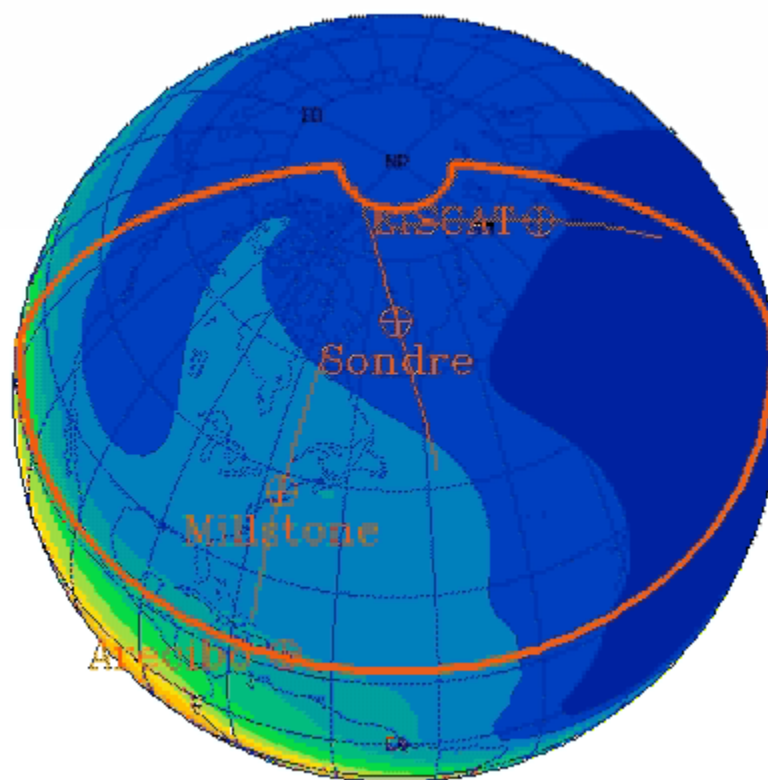
- **Two possible methods:**
 - 1) **Integration of ionosphere with the thermosphere**
 - 2) **Separate ionosphere and thermosphere linked by a coupler**
- **Our experience has been with the former.**
- **The rationale in the former case is that there are numerous fields that are tightly integrated in this region, the result of the ionosphere being an embedded plasma in a dominant neutral atmosphere**
- **The rationale in the latter case is that the two models can be replaced individually, and that this allows the plasma and the neutral gas dynamics to be calculated in coordinate systems that are appropriate for their particular dynamics**

Bastille Day Storm

TING Model Prediction of Electron Density

Jul 14 2000

UT = 00h. 00m Pressure Level = 2.0



GEOGRAPHIC COORDINATES



Where Ionosphere-Thermosphere Coupling Occurs

From the Ionosphere to the Thermosphere:

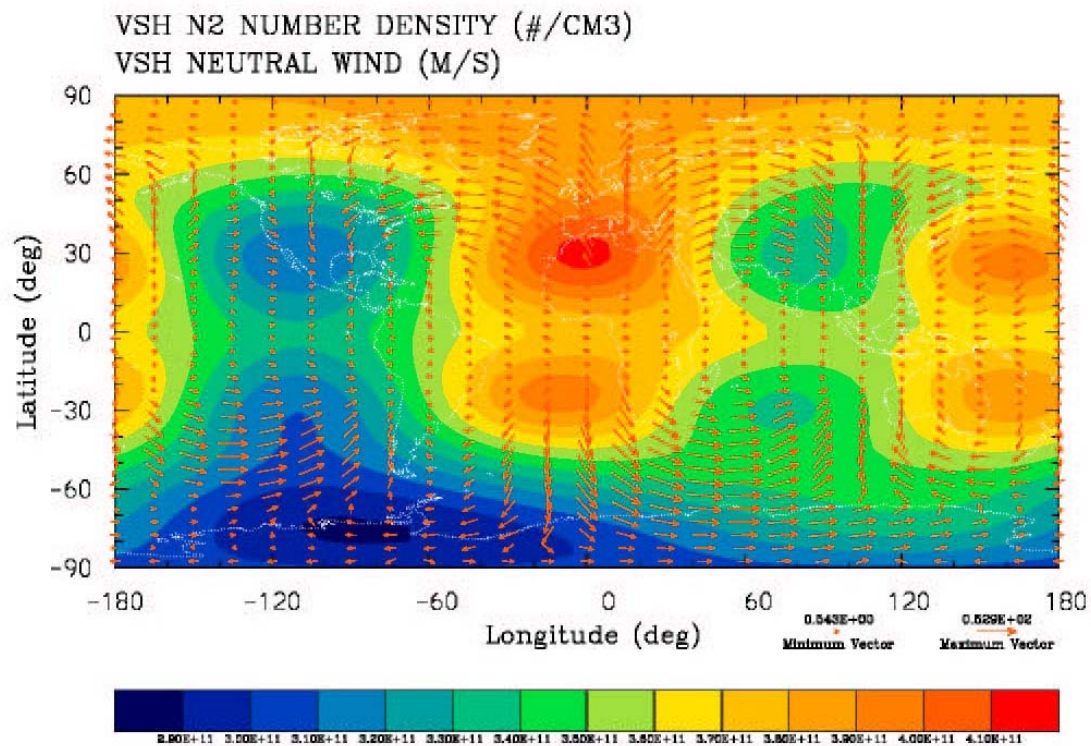
Ion drag, heating of neutrals through thermal collisions with ions; heating of neutrals through thermal collisions with electrons; heating of neutrals by photoelectrons, heating of neutrals as a by product of ion-ion and ion-neutral chemical reactions; production and loss of odd-nitrogen species as a result of reactions between neutrals and ions

From the Thermosphere to the Ionosphere:

Production of ions from neutrals by photoionization; production of ions from neutrals by auroral precipitation; **driving ion circulation by the low and middle latitude neutral wind dynamo**; changes in ion density and composition as a result of ion-neutral chemical reactions, changes in neutral temperature causing changes in ion and, to a lesser extent, electron temperature

Coupling with the Lower Atmosphere

The Semi-Diurnal Tide

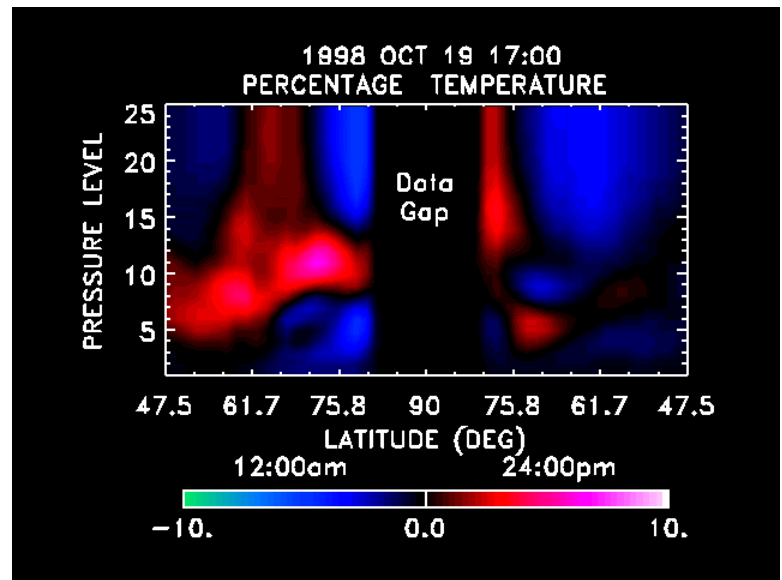
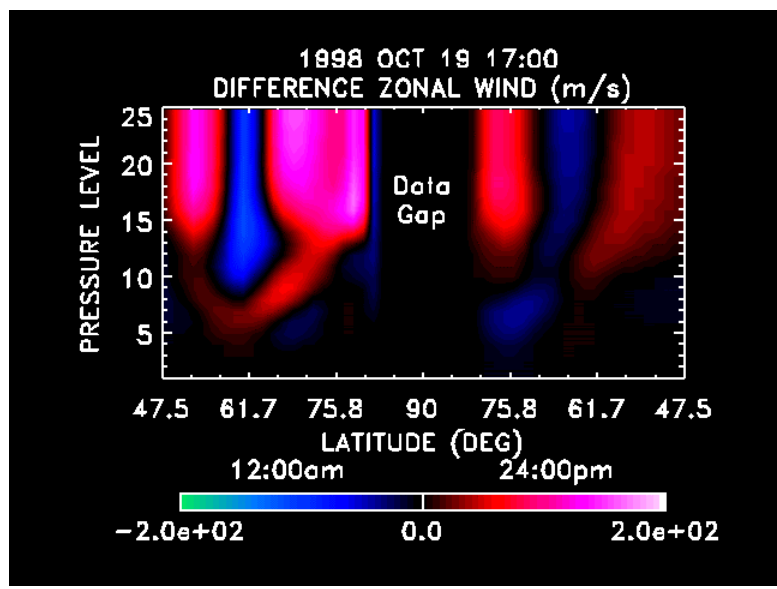
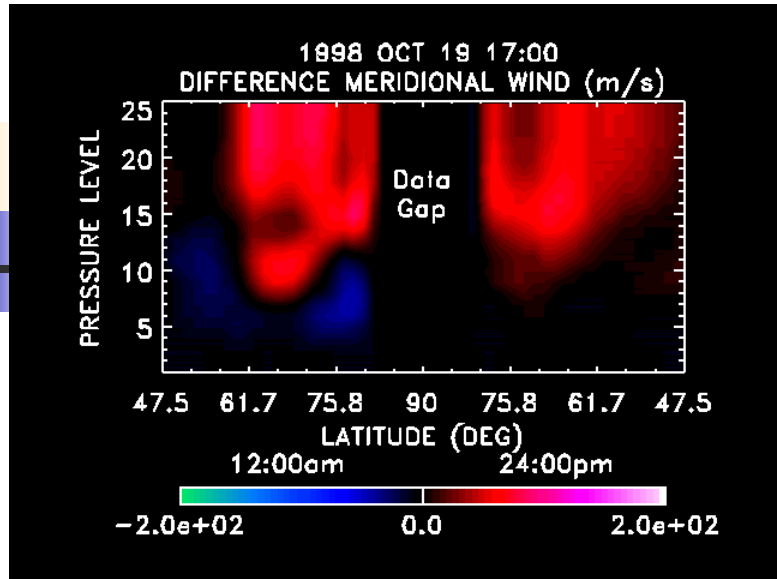


ALT=118.0 AP= 3.0 F10.7=190.0 F10.7A=190.0 JDAY= 90 UT=12.0



How do you Couple the Thermosphere-Ionosphere with the Lower Atmosphere?

- **Boundary Conditions.** Tides and planetary waves are used to “shake” the lower boundary of the model. This is currently the most common method of coupling the thermosphere and ionosphere with the lower atmosphere
- **Flux coupler.** An experiment has been performed to couple the lower boundary of the NCAR-TIMEGCM with meteorological data. This coupling was successful, but it is neither possible nor desirable to implement this coupling for Space Weather studies in its present form.
- **WACCM.** The Whole Atmosphere Community Climate Model is an initiative to develop a climate model from the ground to the exosphere. Its application for weather studies is limited as it is designed primarily to perform climate investigations.



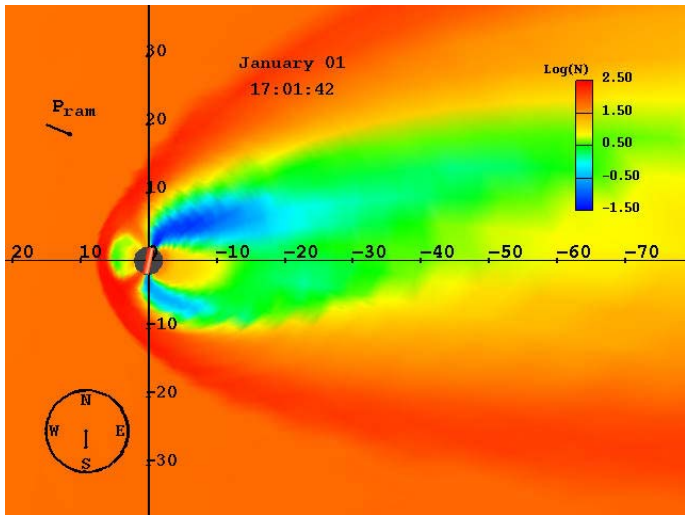
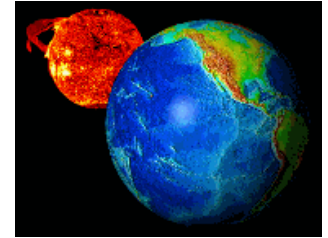


Coupling with the Lower Atmosphere

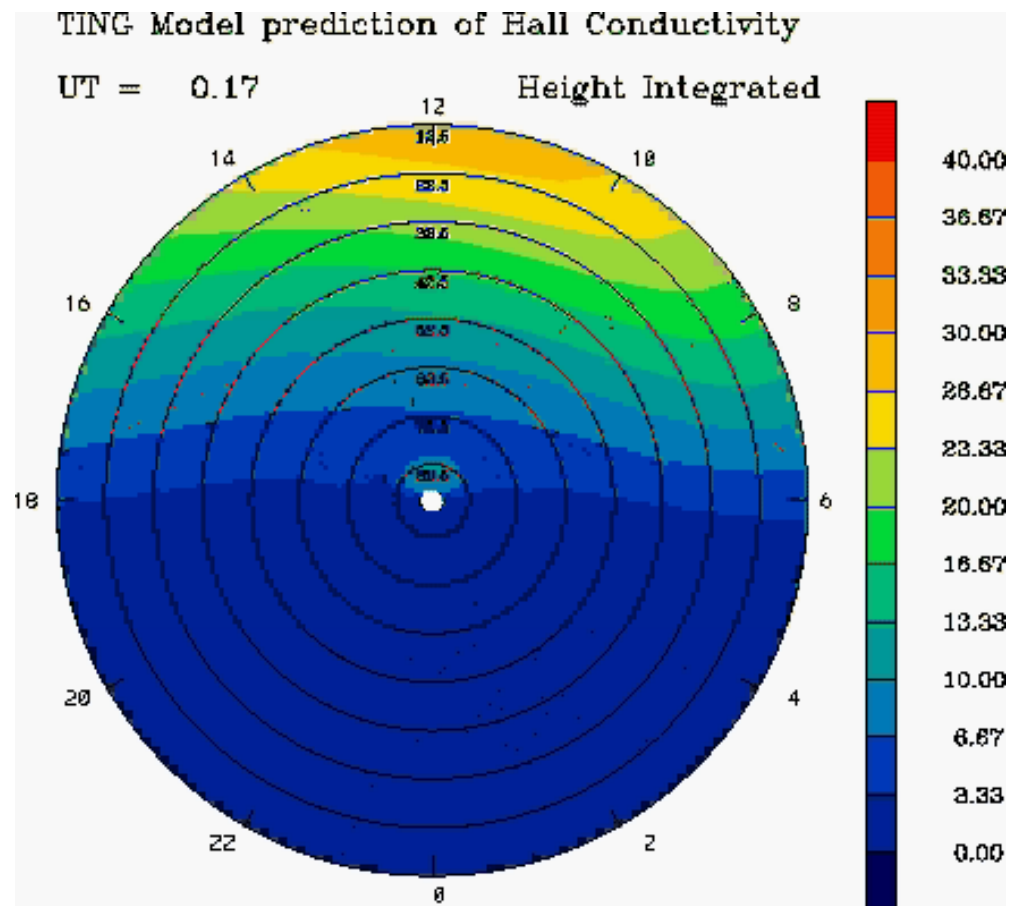
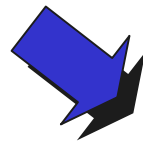
A large variety of waves are produced in the lower thermosphere. Some of them are able to propagate upwards and affect the lower thermosphere and ionosphere. There is evidence that these waves also affect the F_2 region.

The most likely explanation for these F_2 effects involves the low and middle latitude neutral dynamo. The daytime neutral dynamo is driven primarily in the region near 105 km (at the E-region ionospheric peak). Upwardly propagating tides and planetary waves would affect the dynamo, causing changes with similar periods in the F_2 region. A less plausible explanation is gravity wave filtering.

Magnetosphere-Ionosphere Coupling: One-Way Interaction



**Lyon-Fedder-Mobarry
Global MHD Model**





21:39:04 UT 09 Jul 2001
Alan Burns (60 second refresh)
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BUGS
CHAT

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EDIT edit my profile

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- Open all folders
 - Directory of Pages
 - Data Set Directory
 - Demos
 - Reference Materials
 - Administrative Links
 - Public Outreach and Education
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Peter Knoop @ wawa.si.umich.edu

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of Solar-terrestrial
ions
u/sparc/central/page/SPARC

