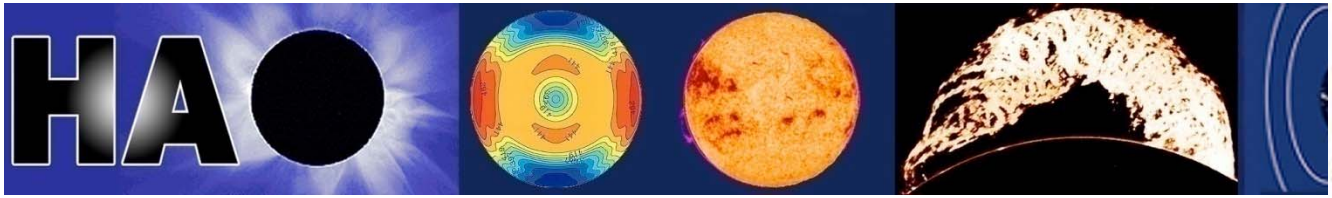


Comparing the Low-- and Mid Latitude Ionosphere and Electrodynamics of TIE-GCM and the Coupled GIP TIE-GCM

Clarah Lelei

Bryn Mawr College

Mentors: Dr. Astrid Maute, Dr. Art Richmond and Dr. George Millward

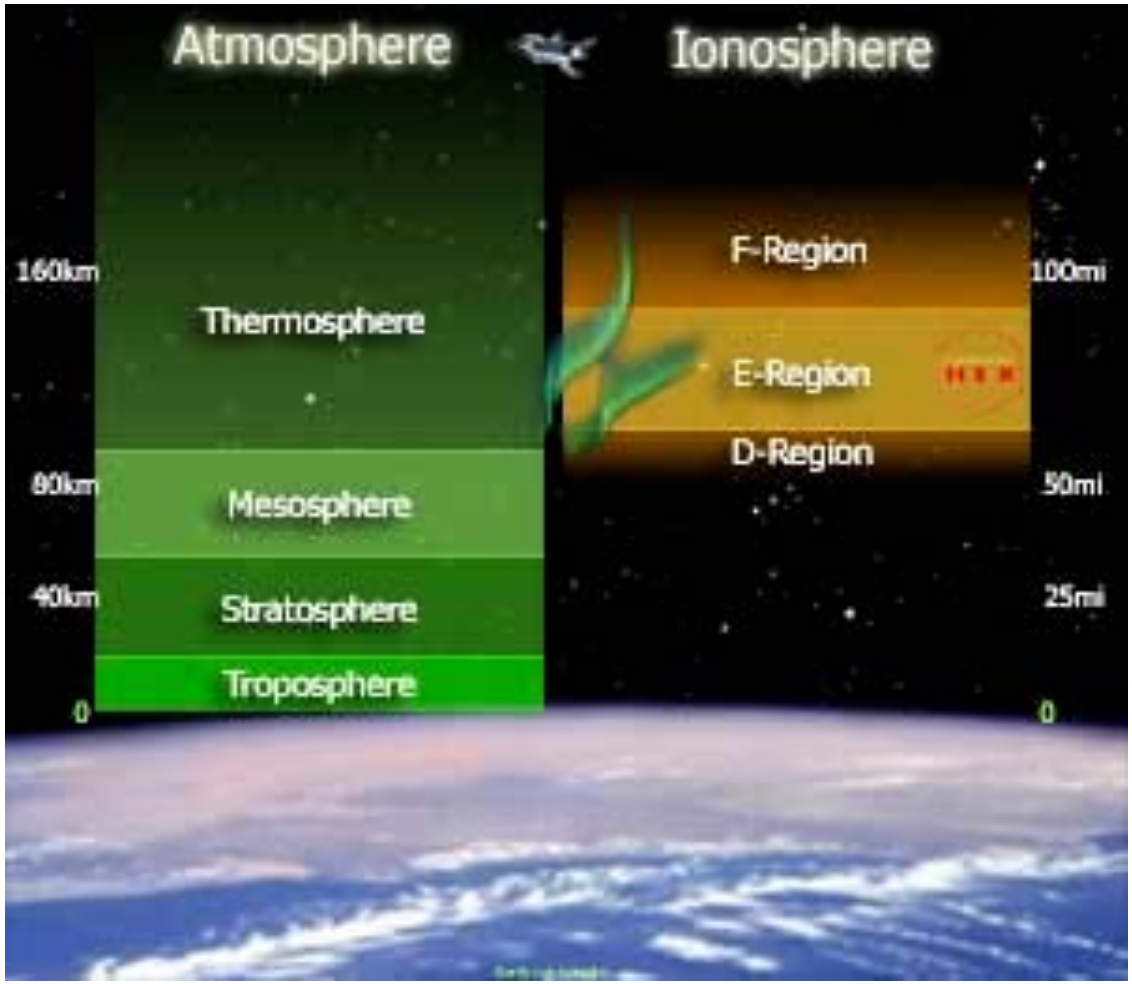
High Altitude Observatory / NCAR

High Altitude Observatory (HAO) – National Center for Atmospheric Research (NCAR)

The National Center for Atmospheric Research is operated by the University Corporation for Atmospheric Research under sponsorship of the National Science Foundation. An Equal Opportunity/Affirmative Action Employer.

REU: Summer 2009

Introduction



[http://www.uaf.edu/asgp/hex/images/fixin-sm.jpg]

TIEGCM, GIP and IRI

- The Global Ionosphere Plasmasphere model (GIP) is a new modular Fortran-90 code which calculates time-dependent ionospheric and plasmaspheric densities, temperatures and velocities on a global, three-dimensional, grid

- International Reference Ionosphere model (IRI) is an empirical standard model of the atmosphere based on all the available data sources i.e. from satellites, radars,

- TIEGCM is a time dependent, three-dimensional model of the thermosphere and ionosphere that solves the fully coupled, nonlinear, hydrodynamic, thermodynamic, and continuity equations of the neutral gas self-consistently with the ion energy, ion momentum, and ion continuity equations using a finite differencing scheme for spatial and temporal variations (Roble et al., 1988, Richmond et al., 1992). It has 25 constant-pressure levels in the vertical extending from approximately 97 km to 500 km in altitude and a 50 x 50 degree latitude and longitude grid in its base configuration.

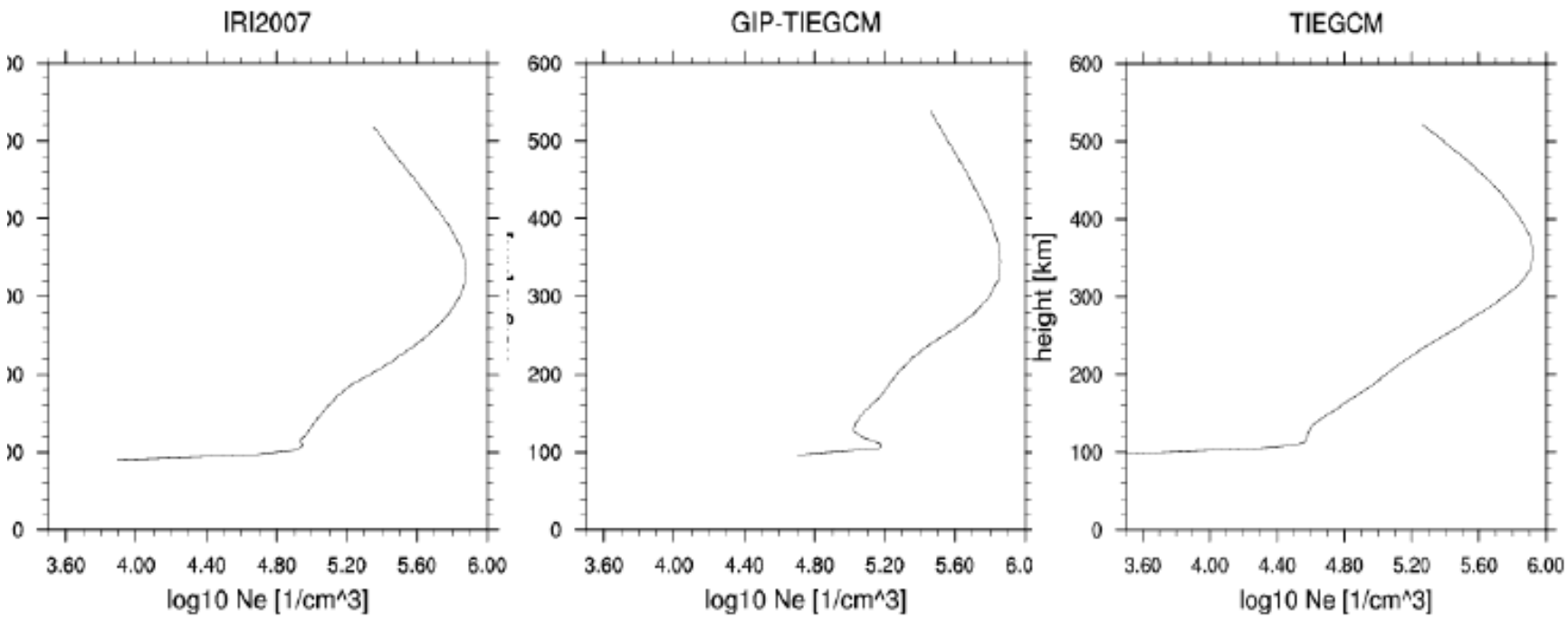
Ionization Sources

- Solar UV and X-radiation
- Precipitation of energetic charged particles from the magnetosphere
- Star light
- Cosmic rays
- The Ionization rate depends on
    - The intensity of ionization radiation
    - Atmospheric density and composition
    - Ionization cross sections of the atmospheric constituents

-The primary ions produced are N_2^+, N^+, O_2^+ and O^+

-The dominant ions are NO^+, O_2^+ , O^+

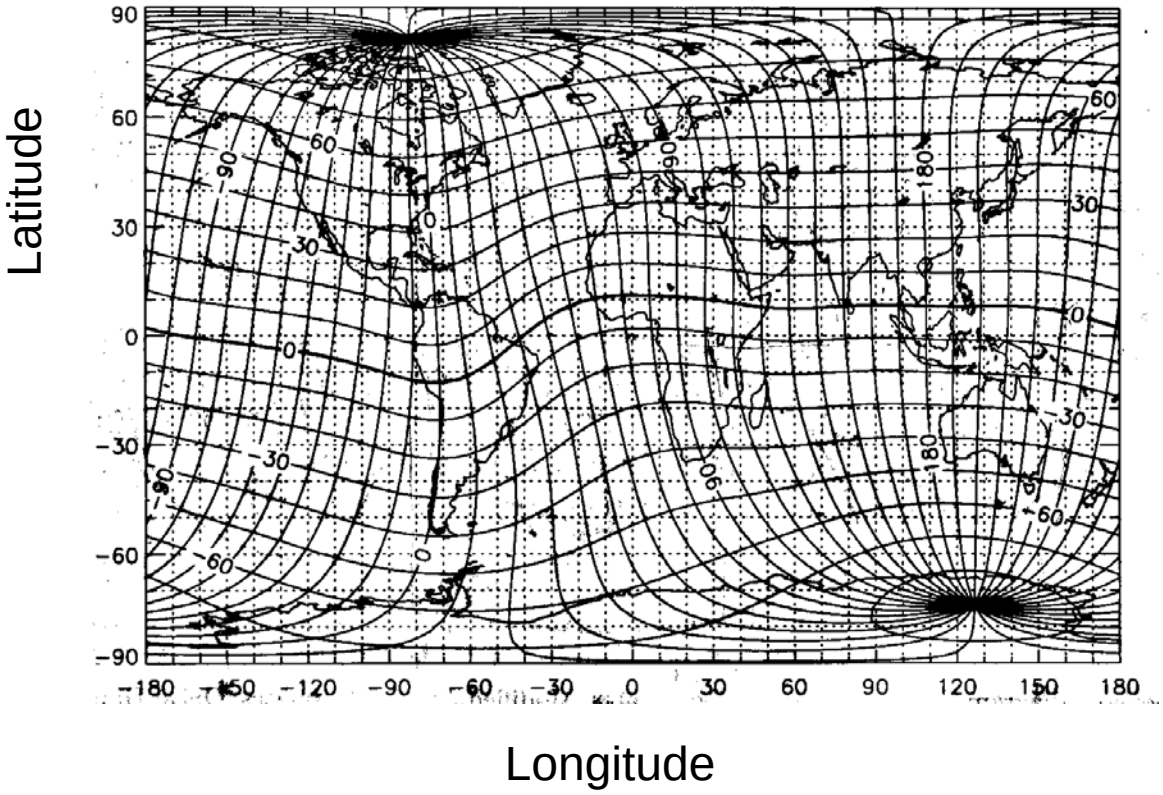
Electron Density Profile : June 21 LT 16



-Electron peak changes with time of the day due to the changes in the solar radiation.

-From the plots, the structure and the magnitude of the peak in GIP-TIEGCM looks close to IRI.

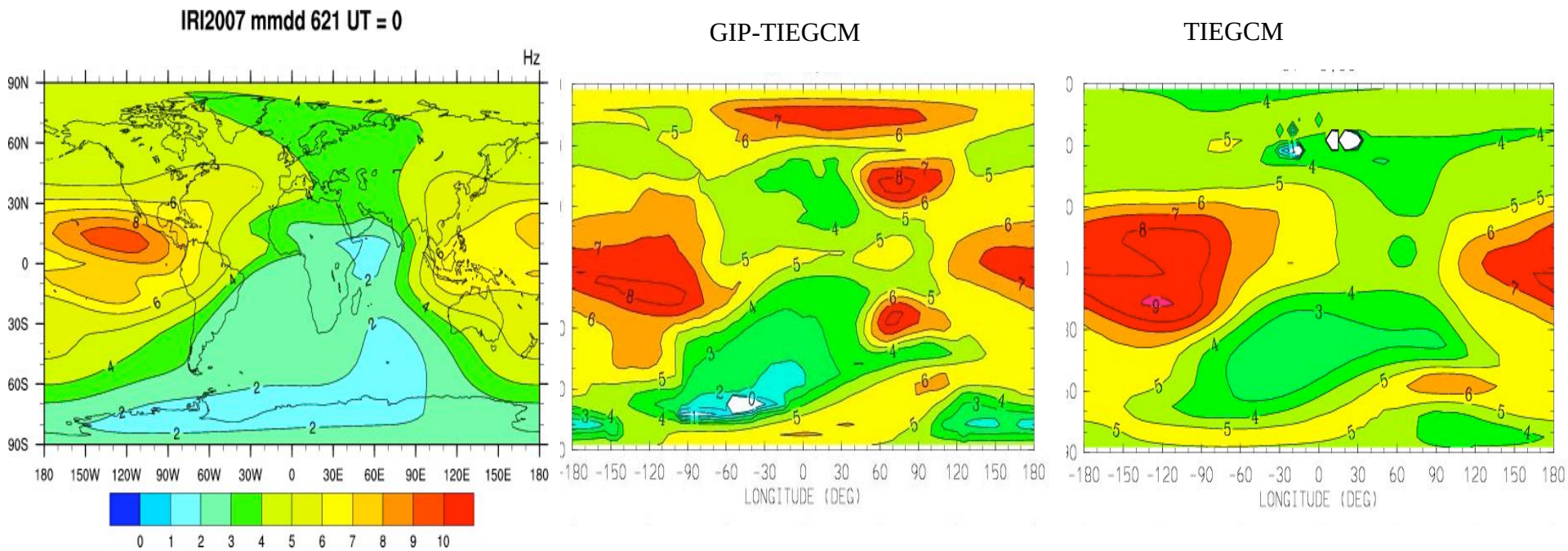
The relationship between magnetic coordinate and geographic coordinate system



-Since the plots in TIEGCM and GIP-TIEGCM are on the geographic grid, it is important to have the magnetic grid for accurate comparisons with IRI.

[Richmond 1995]

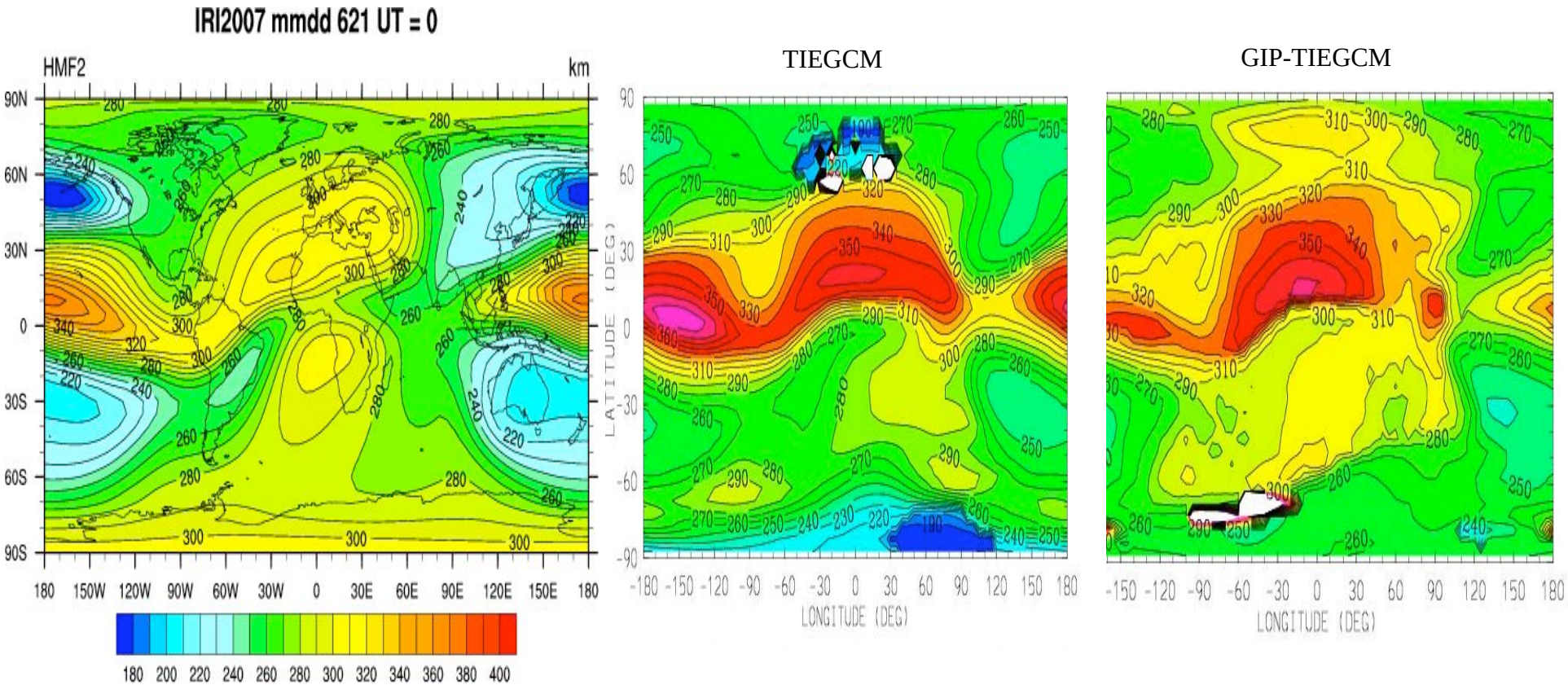
FOF2: Critical Frequency of the F2 Peak June 21, 0UT



-The density of the ionosphere determines what frequency waves can penetrate it without being reflected, therefore, we can use the critical frequency to determine the maximum electron density.

-It is important in satellites communication and sending radio waves for long distance communication

Height of the F2 Peak: June 21, 0 UT

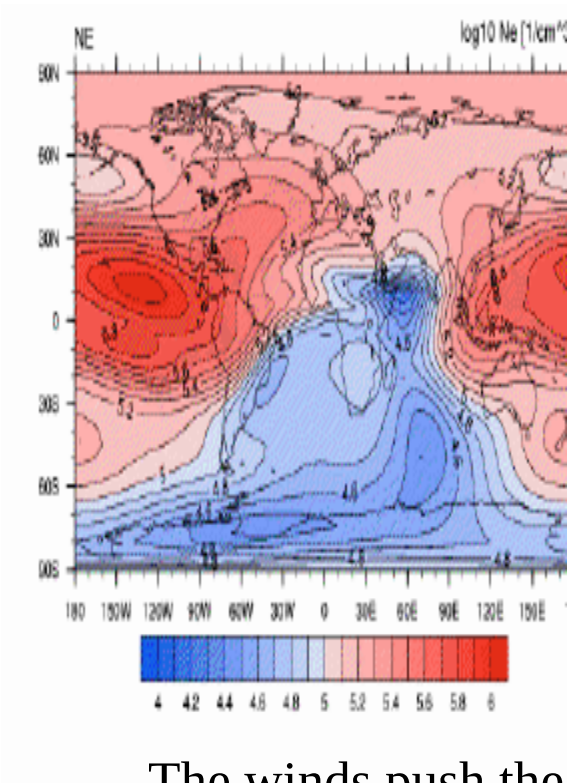


-At low latitudes during the day, the electron density peak is high due to upward drift and it persists into the night.

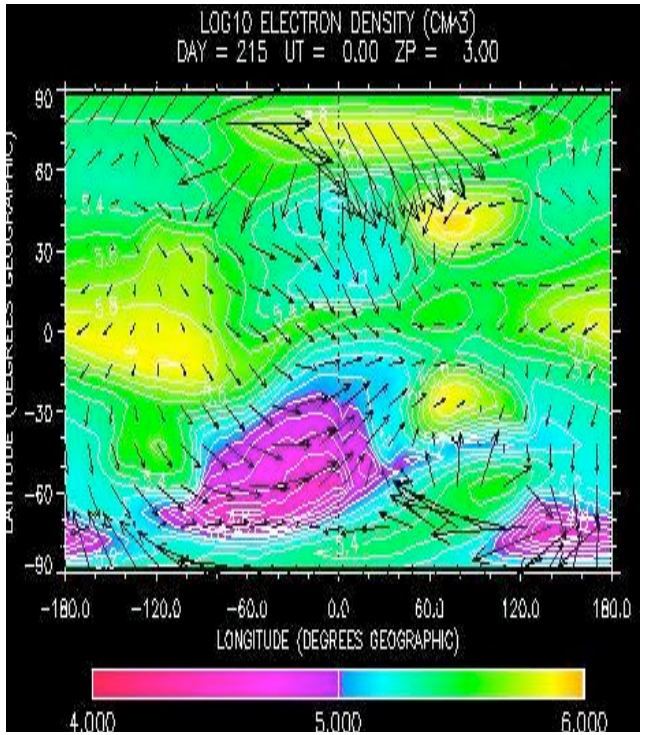
-There is a close resemblance in structure in GIP-TIEGCM

Effects of Winds on Electron Density Distribution

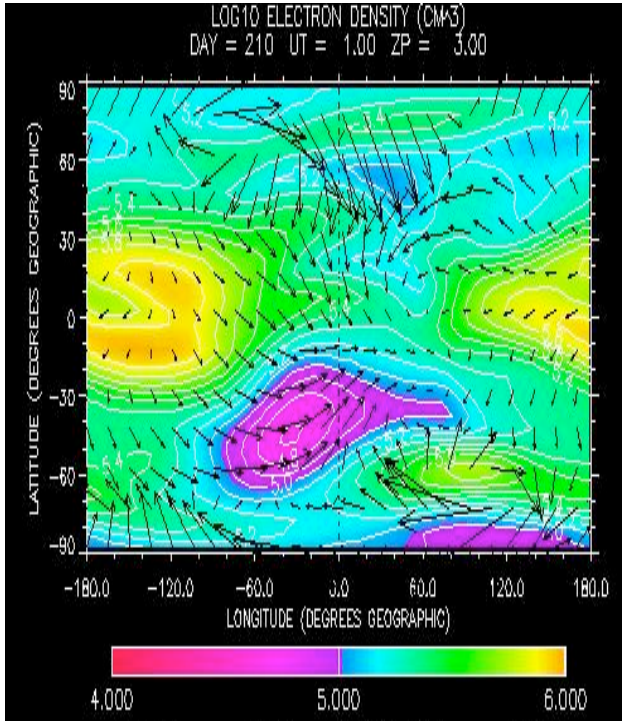
IRI



GIP-TIEGCM



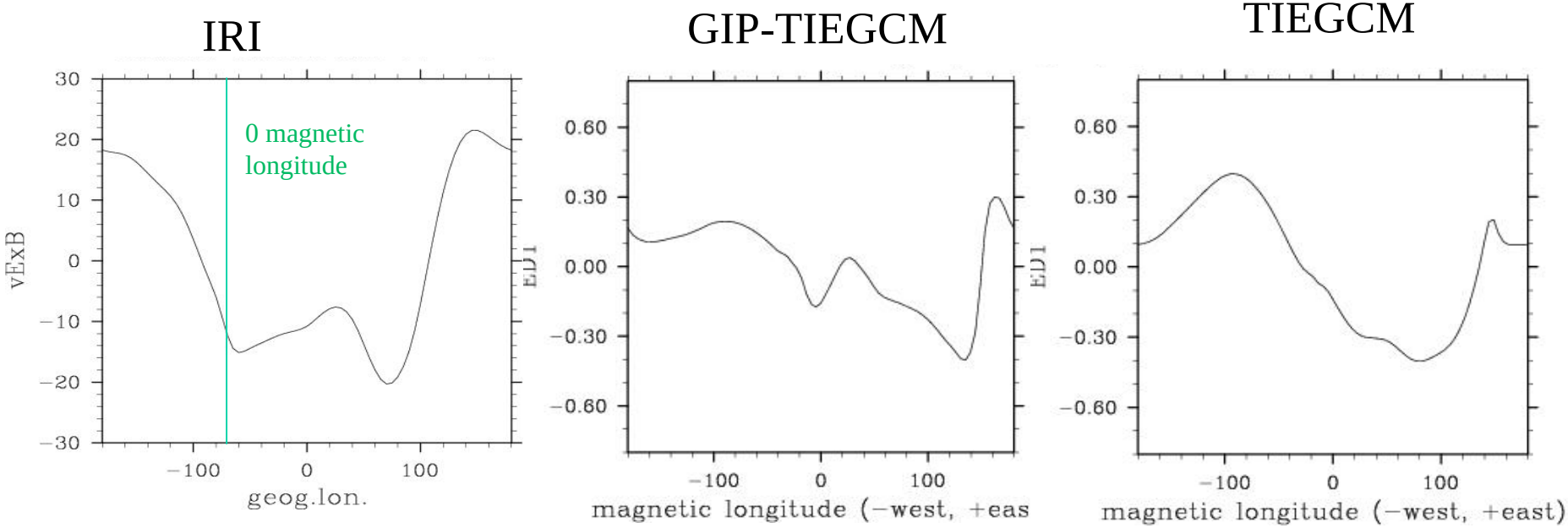
TIEGCM



-The winds push the plasma in the direction of the magnetic field line

-When the electrons are drifted upwards, it diffuses back along the magnetic field line

Vertical ExB drift velocity and Eastward electric field: June 21, 0UT

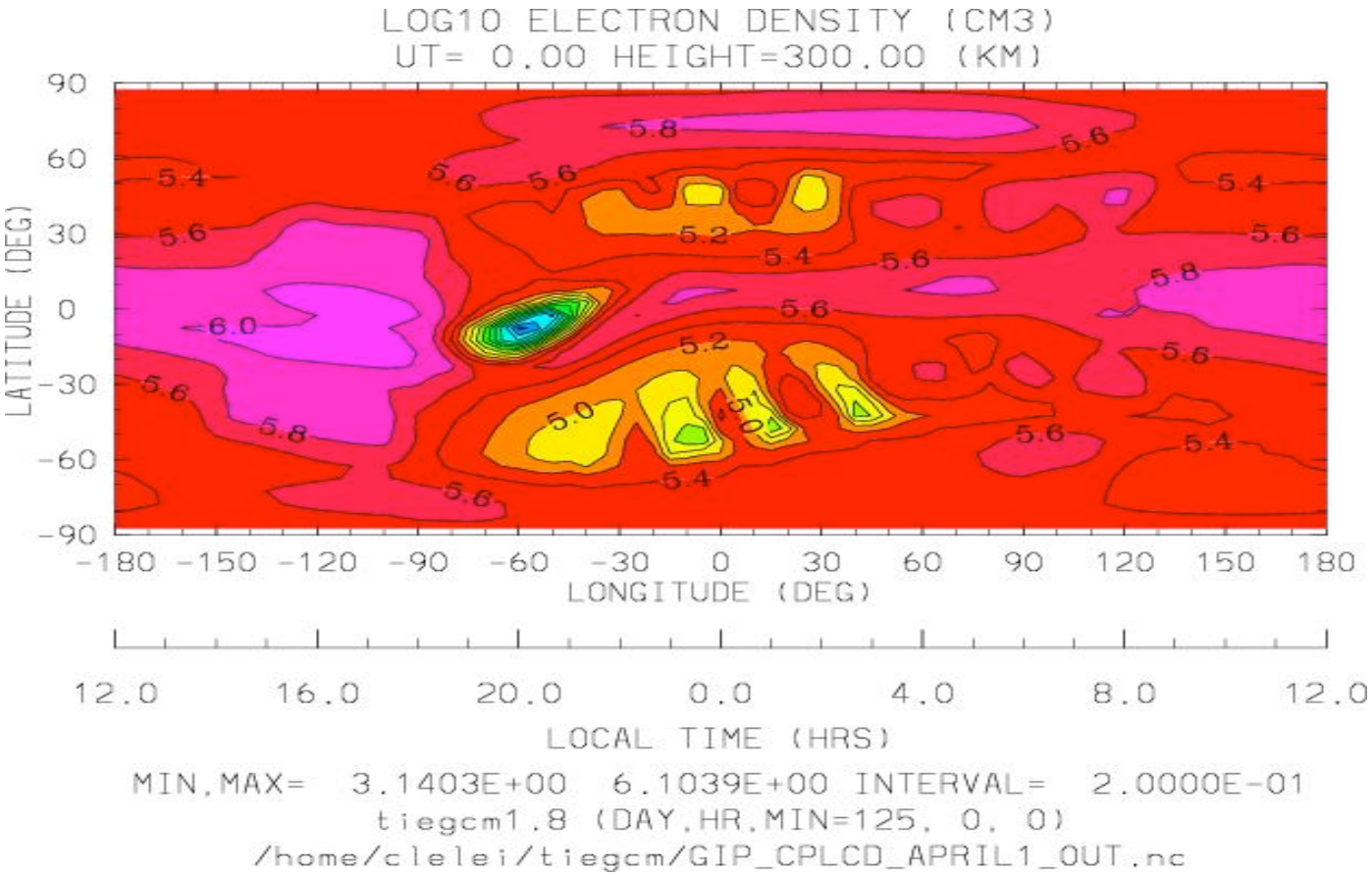


-Drift, m/s and Eastward electric field in mV/m
-GIP-TIEGCM plot appears different in structure and this maybe as a result of winds or conductivities calculation in the model.

Conclusion

- Coupling GIP with TIEGCM has proved to produce results close to the experimental data for example electron distribution profiles.
- We need to fix the error in the GIP code and see what effect that has on the results.
- We also need to explain the difference in the day time electric field
- Examine Conductances i.e. Hall, Pedersen and parallel conductivities.

Some error in the Code



-The peaks observed are not actual peaks but an error in the code. This may have affected the plots in the presentation.

Acknowledgement

Thanks to:

- My mentors, Dr. Maute, Dr. Richmond and Dr. Millward
- HAO/NCAR
- REU organizers
- LASP
- NSF
- Bryn Mawr Physics Department
- My fellow REU students

Thank you.

Questions?@#*&$!

Ion Distribution Profiles