

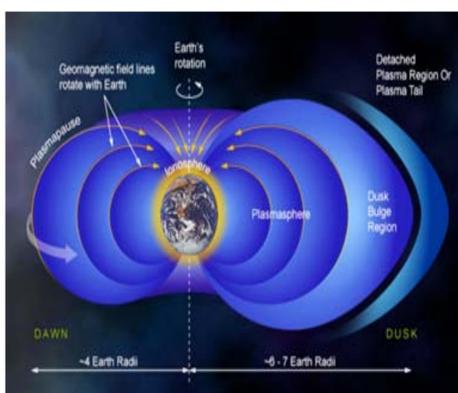
## Abstract

At the High Altitude Observatory Thermosphere Ionosphere Electrodynamics General Circulation Model (TIE-GCM) was developed, and coupled to the plasmasphere model Global Ionosphere Plasmasphere Model (GIP) The plasmasphere is a region of cold plasma above the earth's ionosphere and inner magnetosphere. We will test and examine the new coupled model GIP-TIEGCM by comparing with TIE-GCM to see the effects of including a plasmasphere model. We are also using the International Reference Ionosphere (IRI) which is an empirical standard model of the ionosphere based on all available data sources to make comparisons. Since this is the first time the coupled GIP-TIEGCM is tested we focus on the geomagnetic quiet time and the low and mid latitude region.

## Introduction

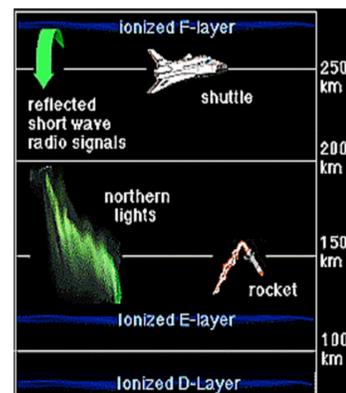
The ionosphere is a layer of electrons and ions which stretches from around 80 km to over 1000 km. The ionosphere is highly variable even under geomagnetic quiet time conditions. It consists of different layers due to solar radiation acting on different compositions starting with the D-region about 50-90 km, the E-region approx. 90-120 km, and the F-region around 120-400 km. The F-region is the top layer and is responsible for radio wave propagation, and is therefore extensively studied. The thermosphere interacts with the ionosphere by neutral winds pushing the conducting medium through the Earth's magnetic field, which creates an electromotive force driving current and setting up an electric field. During the daytime an eastward electric field at the equator is present which will generate an upward drift,  $E \times B/B^2$  where E is the electric field and B is the magnetic field, moving the ionosphere up.

### The Plasmasphere



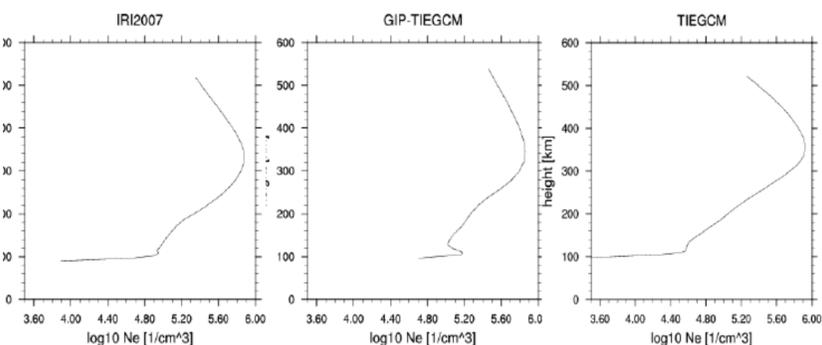
[http://www.windows.ucar.edu/janet/earth\_plasmasphere\_sm.jpg]

### The Ionosphere



[http://science.nasa.gov/headlines/y2003/images/TMAclouds/ionosphere\_med.gif]

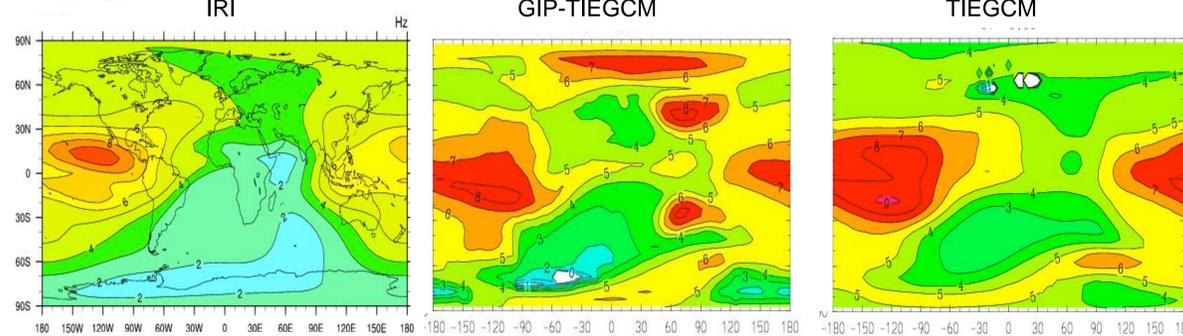
## Electron Density Profile : June 21 LT 16



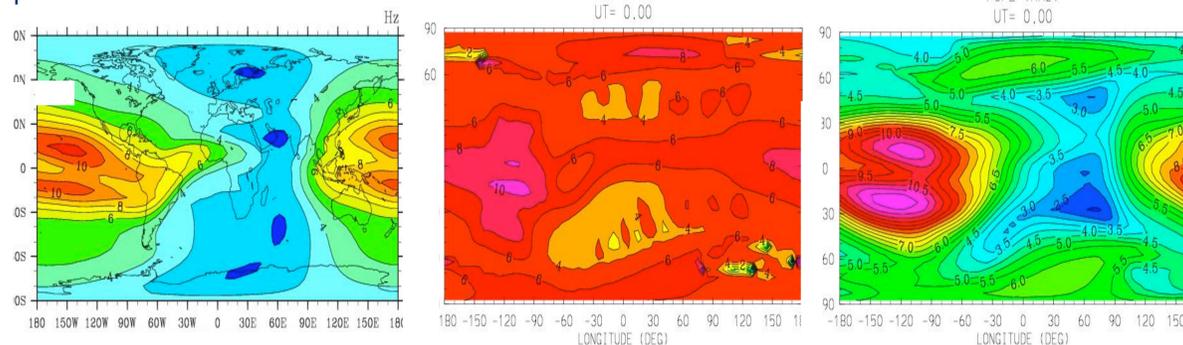
- GIP-TIEGCM has a closer structure and magnitude of the peak to IRI than TIEGCM.
- The height of the peak also correspond in GIP-TIEGCM and IRI ~ 330km

## Critical Frequency(FOF2): Comparison between the April 1 and June 21 cases

### June 21



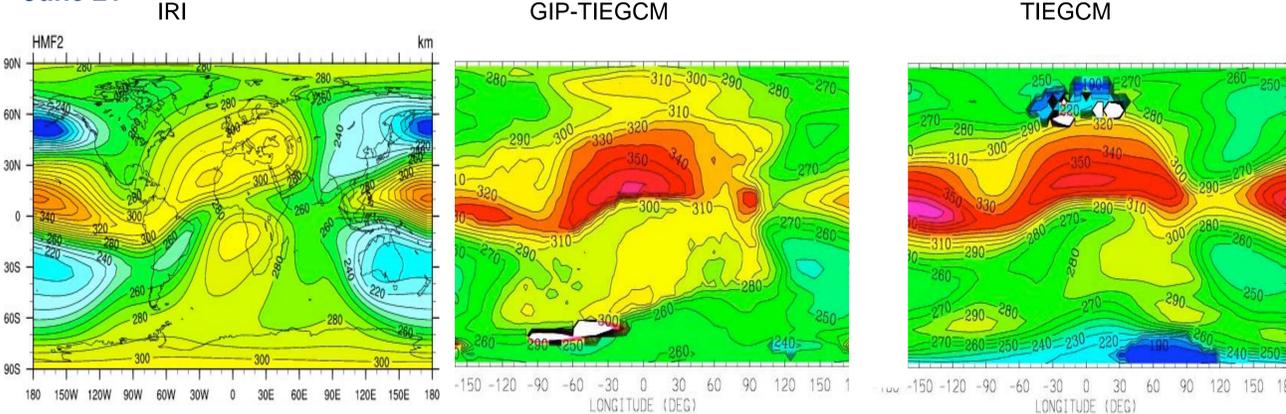
### April 1



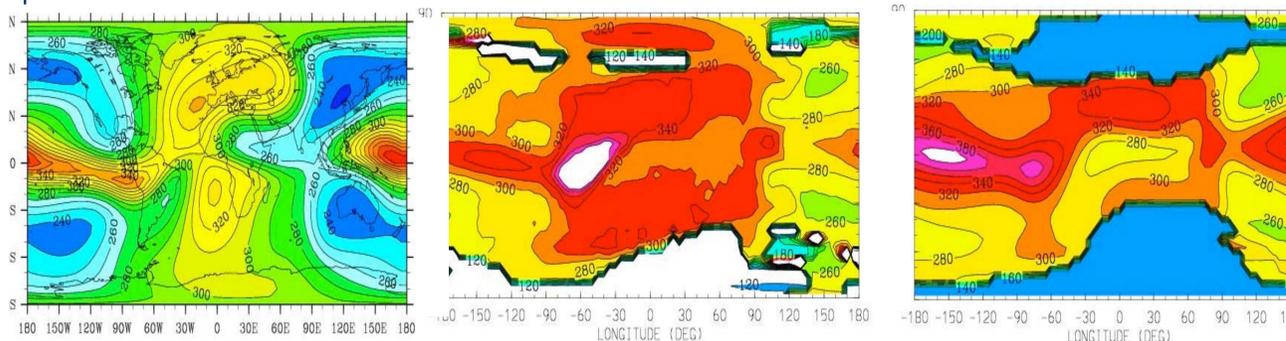
- From the plots, it is evident that the electron distribution is almost symmetrical about the magnetic equator in April(equinox) and it is slightly shifted to the north in June(summer in the Northern Hemisphere)
- Note that the color coding is not the same. You can get the magnitude from the contours

## Height of the F2 Peak: Comparison between the April 1 and June 21

### June 21

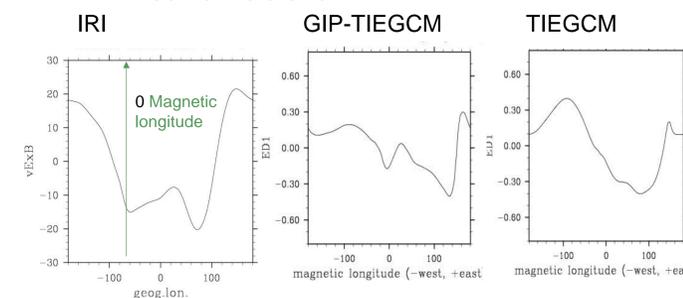


### April 1



- The height of the F2 peak is slightly shifted to the North in June and in April, it is at the magnetic equator,
- There is no much difference in the magnitude of the peak in the two seasons.
- GIP-TIEGCM plot has a distinct structure corresponding to IRI.

## Electric Field and ExB Drift



[Based on Scherliess/Fejer model 1999]

- IRI and TIEGCM profile seems a little different from GIP-TIEGCM, that maybe as a result in an error in the code or some parameters needs to be adjusted. The ExB drift has units of m/s and electric field is mV/s

## Conclusion

We have seen that coupling GIP with TIEGCM has led to improvements in the model. We still need to look at the winds and see how it affects the calculations in the model and also the conductance's because this affects the general plasma distribution. As can be seen in the equation below from Ohm's Law, current density is directly proportional to conductivity and the electric field as shown in the equation below

$$J = \sigma_p E_{\perp}' + \sigma_H b \times E_{\perp}' + \sigma_{\parallel} E_{\parallel}'$$

$$F = q \left[ -\nabla\phi - \frac{\partial A}{\partial t} \right]$$

$$E = -\nabla\phi$$

Phi is obtained in TIEGCM by solving the partial differential equation obtained by combining these three equations (including the equation for Ohm's Law already shown), and that the electric field is then obtained by taking the negative gradient of Phi. J is the current density, b is the unit vector in the direction of the magnetic field, E is the electric field, sigma is conductivity and the subscripts parallel, Hall and Pedersen.

## Reference

- Volland, Hans(1995), Handbook of Atmospheric Electrodynamics, Radioastronomical institute, Bonn, Germany
- Richmond, A.D., Thayer, J.P., Ionospheric Electrodynamics, Geophys M., 131-145

## Acknowledgement

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