As a result of the model calculation and the SEALION data analysis, the mechanism of the F3 layer was suggested as follows: The F3 layer corresponds to the density enhanced region associated with the equatorial anomaly. This enhanced region moves upward and to a higher latitude region due to the **E** × **B** drift and the field aligned diffusion. When it reaches the altitude sufficiently separated by the F2 layer at a lower altitude, the plasma density enhanced region becomes observable from the ground as the F3 layer. The density enhanced region continues to move to a higher altitude and a higher altitude latitude region, so that the F3 layer is shifted to a latitude region. The meridional neutral wind moves the density enhanced region at a higher altitude region in the windward hemisphere and at a lower altitude region in the leeward hemisphere. As a result, the formation of the F3 layer is promoted in the windward hemisphere and suppressed in the leeward region by the meridional neutral wind.

On the other hand, as a result of the model calculation and the topside sounder data analysis, the mechanism of the ionization ledge was suggested as follows: The plasma density enhanced flux tube was generated through the photo-chemical process at the altitude just above the F2 peak over the magnetic equator in the early morning local time. This flux tube rises upward by the **E** × **B** drift. When the altitude of this flux tube is sufficiently separated by the F2 layer (highest density peak) at a lower altitude, the ionization ledge becomes observable from the topside ionosphere. The ledge field line becomes separated from the magnetic field line passing through the equatorial anomaly crest during the night local time due to the faster loss of plasma in the equatorial anomaly crest at the higher latitude. Since the plasma density structure becomes asymmetrical by the meridional neutral wind, the meridional neutral wind suppresses the formation of the density enhanced region at a high altitude. Then, the formation of the ionization ledge is suppressed by the meridional neutral wind.

The dynamics of these phenomena can be understood in the two dimensional frame of the whole magnetic meridional plane connected by the magnetic field lines. Based on the different mechanisms of each phenomenon, it is concluded that it is not necessary for the ionization ledge to accompany the F3 layer.

F3 layer during penetration electric field

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The occurrence of an additional layer, called F3 layer, in the equatorial ionosphere at American, Indian and Australian longitudes during the super double geomagnetic storm of 07-11 November 2004 are presented using observations and modeling. The available observations show the occurrence, reoccurrence and quick ascent to the topside ionosphere of unusually strong F3 layer in Australian longitude during the first and second super storms (08 and 10 November) and in Indian longitude during the second super storm (10 November), all with large simultaneous reductions in peak electron density (Nmax) and total electron content (GPS-TEC); the F3 layer also occurred in Australian longitude on the comparatively less active day (09 November) though of a different character. The modeling studies conducted using the Sheffield University Plasmasphere Ionosphere Model (SUPIM) indicate that the unusual F3 layers during

the super storms might have been caused mainly by unusually large double peaked equatorial upward **E**x**B** drift (or eastward electric field). The indication is supported by the simultaneous observations of the strongest daytime eastward prompt penetration electric field (PPEF) ever recorded (at Jicamarca) and large depletions in Nmax (at Jicamarca and Sau Luis) at American longitude; the depletions are also modeled by incorporating the PPEF. The large depletions in Nmax that occurred during the afternoon-evening hours (14-17 LT) are also followed by unexpected unusally large increases in Nmax (greater than daytime Nmax) during the following evening hours (17-23 LT) due to the large downward **E**x**B** drift or reverse plasma fountain.

Modeling low-latitude ionosphere using GAIM assimilating GPS data

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Assimilative ionospheric modeling is a developing technique that images ionospheric weather by assimilating observations into physics-based numerical models. Studies are conducted for modeling the weather of low-latitude ionospheric dynamics and electron densities using the JPL/USC global assimilative ionospheric model (GAIM). Our purpose is to investigate the effectiveness of estimating the variability of multiple model drivers, and imaging the ionospheric state, by assimilating GPS data into GAIM and applying four-dimensional variational (4DVAR) and Kalman filter (KF) approaches. The targeted drivers include the zonal electric field and magnetic meridional wind simultaneously for all longitudes, as well as solar EUV flux. The GPS data include both ground-based and space-borne occultation measurements, the latter made using GPS receivers on board low-Earth orbiters including 6 COSMIC satellites. In the assimilative modeling, minimization of the difference between the modeled state and observations is attempted by either adjusting the model drivers or through recursive filtering. In this presentation, we will describe 4DVAR observation system simulation experiments (OSSEs) conducted recently based on realistic GPS observation distributions, and show the KF modeling results of electron density profiles compared to incoherent scatter radar measurements made at low latitudes. The potential impact of such assimilative modeling on equatorial aeronomy research and applications will also be discussed.

Assimilation of ROCSAT equatorial electric field data into the AFRL C/NOFS model

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A key parameter to be assimilated into the Air Force effort to predict convective equatorial ionospheric storms is the electric field measured on the associated satellite. As a precursor to this era, the interplanetary electric field has been successfully used to predict conditions an hour ahead (Kelley and Retterer, *Space Weather Quarterly*, 2008). Here we report on the use of ROCSAT equatorial electric field data to drive the model and compare the results to a number of other observations, including satellite