Coordinate Study of the Ionospheric Stratification at Low Latitude: Results from the COSMIC and GIRO

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Outline

- **Background** of the ionospheric stratification
- **Data** and method description
- **Features** obtained from the COSMIC and GIRO
- **Explanation** for the observed features
Introduction

Early observations: 1950s ground ionosonde

- Sen, 1949, JGR;
- Ratcliffe, 1951, JGR;
- Bailey, 1949

“Spur”

D, E, F and
“G-layer”
1995-1997, Balan renamed "G-layer" to "F3-layer"

What has been achieved for the ionospheric F3 layer feature? Most probably appears at

**Where**
within magnetic ±10°

**Local time**
morning-noon (09-12LT)

**Season**
Summer hemisphere

**Solar activity**
Low solar activity

**Magnetic activity**
Strong magnetic storms

Limitation: ionosonde station ≠ Global distribution?
2. COSMIC electron density profile (EDP)

3 millions! EDP (2006.111-2012.240)

COSMIC: 6 satellites, ~800 km, 72° inclination, ~2000 profiles of electron density and neutral temperature/day.
F3 layer occurrence rate

\[ \text{Prob (DoY, LT, Mlat, Lon)} = \frac{\text{Count}}{\text{Total}} \]

totally \( \sim 720,000 \) EDPs within ±30° magnetic latitude
Data selection criterion

**Step 1: EDP quality control**

a. $185 < max\_alt < 460$;

b. $MD = \frac{\sum_{i=1}^{N} |(x_i - \bar{x})/\bar{x}|}{N} < 3\%$ (all) and 1.5\%(bottom);

- Remove the Physical abnormality in EDP

**Step 2: Track control**

- $Track\_lat < 3^\circ$
- $Track\_lon < 15^\circ$
- $Track\_angle < 45^\circ$

- Remove the False stratification due to Latitude horizontal gradient of Ne

Lei et al. 2007 JGR
2. Data selection criterion

Step 3: F3 layer judgment

Double Peaks in the differential EDP (dNe/dh)

Comparison between the EDP and ionosonde Profile

COSMIC EDP  Kwajalein ionosonde
COSMIC EDP

Tangent point trajectory

6 examples
Global feature of the F3 layer Occurrence

- **Latitude dependence**
  1. Peaks at ±7 - 8° dip latitude (10-12%)
  2. Occurrence Southern hemisphere more than Northern one
Global feature of the F3 layer Occurrence

- **Longitude dependence**
  Seems to be correlated with wavenumber 4 (WN4) in May-August

Equatorial Daytime upward drift
From **ROCSAT-1**

- May-Aug
- Nov-Feb
Global feature of the F3 layer Occurrence

- **Local time dependence**
  1. Main Peak at 10-12 LT
  2. Second Peak at post-sunset period 20 LT (seldom reported)
2. Post-sunset F3 layer (19-22LT)

Mainly at equatorial area (-5 ~ 5°)
Relatively higher at South America and Africa
There are more cases in -75°E than -45°E? Real? ground?
 GIRO observation

<table>
<thead>
<tr>
<th>Station</th>
<th>Magnetic Dip Lat. deg</th>
<th>Data Coverage</th>
<th>Solar flux</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jicamarca</td>
<td>0.7</td>
<td>2006.1~2006.12</td>
<td>86</td>
</tr>
<tr>
<td>Sao Luis</td>
<td>-2.0</td>
<td>2006.5~2006.12, 2010.1-2010.4</td>
<td>92</td>
</tr>
</tbody>
</table>
Higher occurrence rate in Jicamarca than in Sao Luis at post sunset. Why?
Magnetic meridian wind \((U)\) from HWM 93

\[ U = u_E \sin D + u_N \cos D \]

**Explanation:**
When upward drift maximize, the equatorward wind develops quickly and maintains the formation of the F3 layer in Jicamarca, while the situation reverses in Sao Luis.
Conclusion:

- It is the first time the stratification structure of the F2 region is investigated by the COSMIC EDPs. The location of the F3 layer occurrence on a global scale are presented.

- These results indicate that the RO soundings are of sufficient high accuracy to differentiate the variation of very local and subtle structure.

- High occurrence of the sunset F3 layer should be distinguished from the traditional morning-noon F3 layer feature. The high occurrence of sunset F3 layers, longitude, which appear mainly at Jicamarca, is clearly dependent on the magnetic latitude as well as longitude.
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