Mid-Latitude Summer Nighttime Anomaly of the Ionospheric Electron Density Observed by FORMOSAT-3/COSMIC

RO Inversion Simulation

IRI

IRI Inversion

Difference (%)

09:00 LT

13:00 LT

20:00 LT
Real F3/C Observation

09:00 LT

13:00 LT

20:00 LT
Global ionospheric structure imaged by FORMOSAT-3/COSMIC 24:00LT in December 2007

[Lin, et al., 2009]
-90°E longitude where WSA feature is seen.
10:00~24:00 LT
30°E longitude where WSA feature is not seen. 10:00~24:00 LT
The similar-to-WSA feature seen in the North

June 2007 LT:20:00
The similar-to-WSA feature seen in the North

June 2007 LT:22:00

Similar to WSA
A stronger nighttime ionospheric plasma density than day time

Southern hemisphere summer

Northern hemisphere summer

Mid-Latitude Summer Nighttime Anomaly: Northeast summer anomaly

[Lin et al., 2009]
June 2007

The Northeast Asia Anomaly is seen at 135°E

10:00-22:00 LT

Before 18:00 LT, stronger densities are seen at equatorward but at poleward after 20:00 LT.
Schematics diagram of possible mechanism of MSNA formation

New plasma formed due to remaining sunlight

Map showing geographic latitude with labels "ExB" and "Ionizations".
Longitudinal distribution of the MSNA – 20:00/14:00 LT
Longitudinal distribution of the MSNA – 22:00/14:00 LT
Longitudinal distribution of the MSNA – 20:00/14:00 LT
CHAMP is-situ observation of the MSNA - from Liu et al., JGR 2009

Ne at 430 km altitude

Effective meridional wind
MSNA: Southern hemisphere

Height: 200km

No MSNA

Height: 250km

MSNA appearing

Height: 300km

MSNA

Height: 350km

MSNA

Height: 400km

MSNA

Height: 450km

MSNA

Electron Density (#/cm²)
MSNA: Northern hemisphere

Height: 200km
No MSNA

Height: 250km
MSNA appearing

Height: 300km
MSNA

Height: 350km
MSNA

Height: 400km
MSNA

Height: 450km
Weakly MSNA
MSNA observed by CHAMP – Liu et al., JGR 2009
COSMIC Tri-band beacon (TBB) Tomography

GRBR network over the 135-136°E longitude

Algebraic Reconstruction Technique (ART)

\[ x^{k+1} = x^k + \lambda_k \frac{y_i - \langle a^i, x^k \rangle}{\|a^i\|^2} a^i \]

\[ \lambda \quad \text{Relaxation parameter} \]
\[ Y_i \quad \text{TEC measurements} \]
\[ a^i \quad \text{geometry matrix elements} \]
\[ X^k \quad \text{electron density values at iteration \# k} \]
TBB Tomography at 135°E geographic longitude: Temporal evolution average of July-August, 2008
COSMIC RO

COSMIC TBB Tomography from Thampi and Yamamoto.

2008-JUL-20 Day

Altitude (km)

2008-JUL-20

2008-JUL-11

Altitude (km)
Ne(300 km) at 2200 LT, 2007
Summary:

1. The Mid-latitude Summer Nighttime Anomaly (MSNA) consists of the Weddell Sea anomaly and the Northeast Asia anomaly, since they both show very similar electron density structure in viewing aspect of latitude/altitude.

2. The anomaly shows much greater electron density in the southern hemisphere than that in the northern hemisphere.

3. The MSNA observed by the F3/C agree with the CHAMP observation at 430 km altitude.

4. The MSNA shows longitudinal structure, however, the locations are different from F3/C and CHAMP observations.

5. The vertical structure of the MSNA seen by the FORMOSAT-3/COSMIC is confirmed by the tomographic results of the tri-band beacon (TBB) observations during July 2008.

6. The day-to-day vertical structure observed by TBB helps to explain why the MSNA is clearer when viewing at a fixed altitude than viewing from the NmF2.

7. The F3/C observation provides important information for understanding of the MSNA formation mechanism.