Longitudinal, UT, and LT Variations in the Ionosphere *F*-Region and Plasmasphere at Minimum of Solar and Geomagnetic Activity: Similarities and Differences

Maxim V. Klimenko[1,2], Vladimir V. Klimenko[1], Irina E. Zakharenkova[1,3], Artem M. Vesnin[4], Yury V. Yasyukevich[5], Iurii V. Cherniak[6], Ivan A. Galkin[4] and Konstantin G. Ratovsky[5]

[1]West Department of Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation RAS, Kaliningrad, Russia
[2]Immanuel Kant Baltic Federal University, Kaliningrad, Russia
[3]Institut de Physique du Globe de Paris, Paris, France
[4]UML Center for Atmospheric Research, University of Massachusetts Lowell, MA, USA
[5]Institute of Solar-Terrestrial Physics SB RAS, Irkutsk, Russia
[6]University of Warmia and Mazury, Olsztyn, Poland

Theoretical Model - GSM TIP

Thermospheric parameters:
T_n, O_2, N_2, O, NO, $N(^4S)$,$N(^2D)$
densities; vector of velocities;
(from 80 km to 500 km)

Ionospheric/plasmaspheric parameters:
O^+, H^+, Mol^+ densities;
T_i and T_e;
Vectors of ion velocities
(from 80 km to 15 Earth radii)

Electric field:
The model is added by the new block of electric field calculation
Klimenko et al., 2006, 2007.

Global Self-consistent Model of the Thermosphere, Ionosphere and Protonosphere (GSM TIP) was developed in West Department of IZMIRAN. The model GSM TIP was described in details in ***Namgaladze et al.*, 1988.**

Case study: 22 December 2009

Empirical Model – IRTAM

IRTAM - IRI-based Real-Time Assimilative Mapping (IRTAM) [*Galkin et al*., 2012]

International Reference Ionosphere model
+
Global Ionosphere Radio Observatory (GIRO) measurements

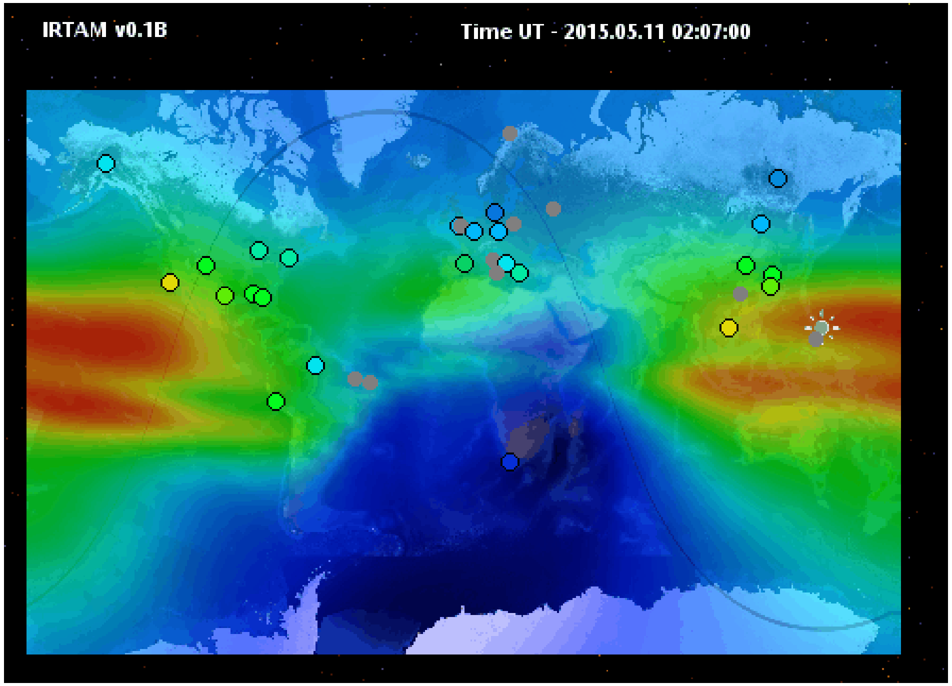
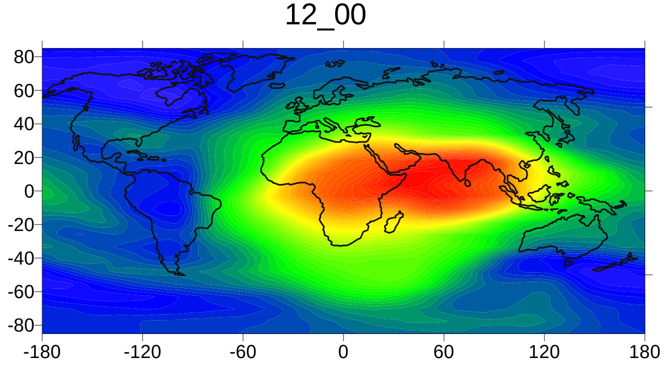


Image credit: http://giro.uml.edu/IRTAM/

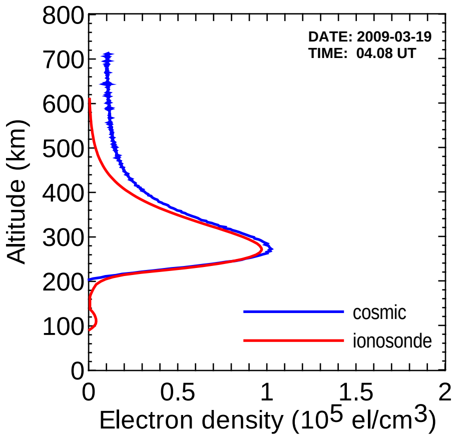
Observations

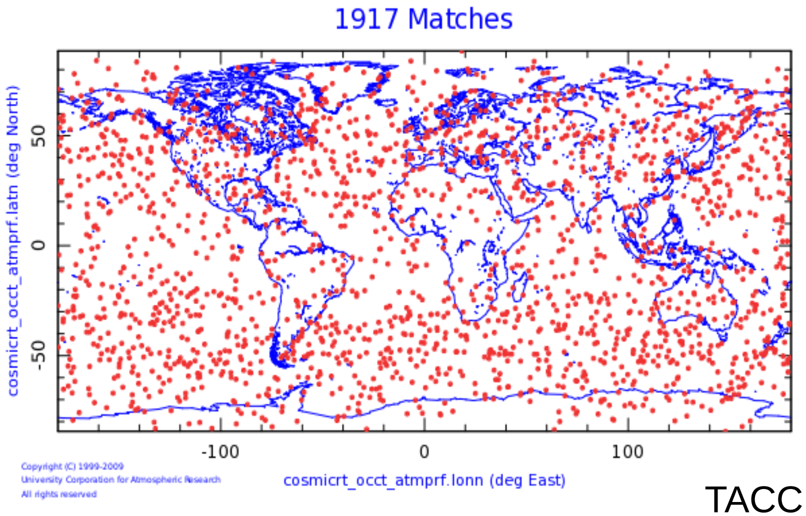
1) Global Ionospheric Maps (GIM) of TEC



IGS final product

2) Electron density profiles derived from FORMOSAT-3/COSMIC RO



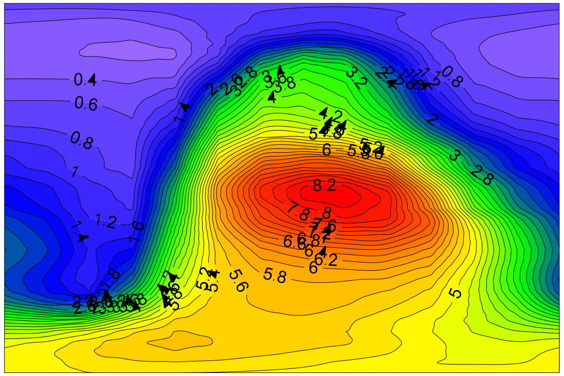


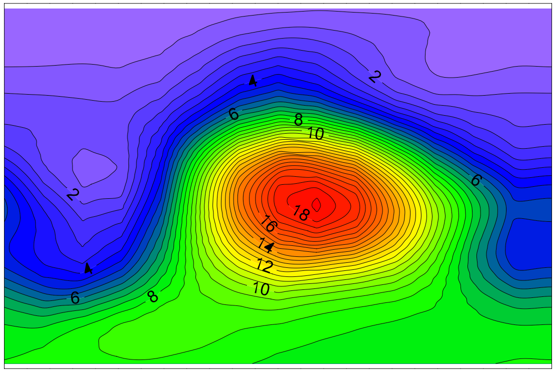
TACC

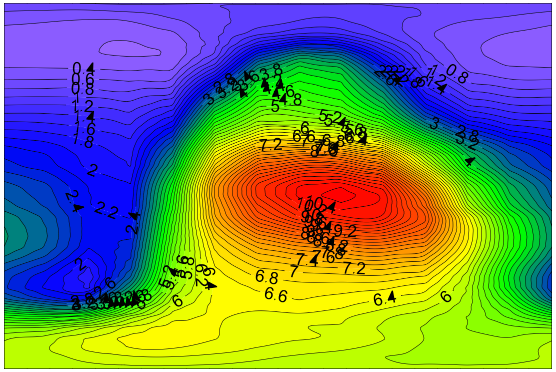
LT variation

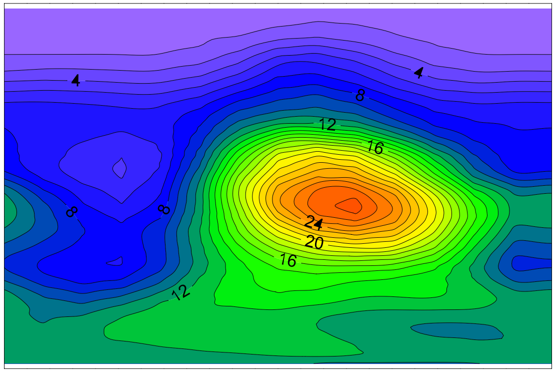
Model

Observations





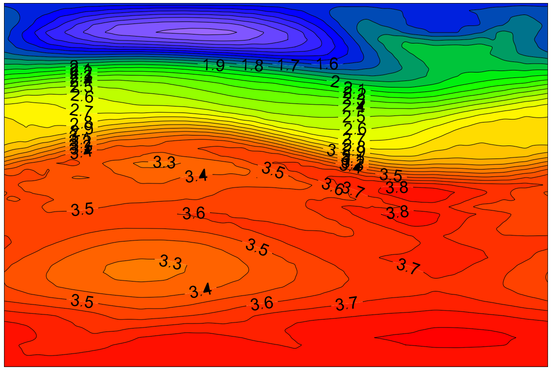




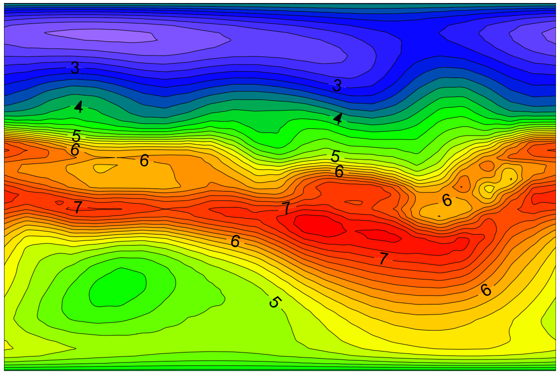
- Main reason of LT variation is the solar ionization
- Qualitative agreement between model simulations and observations
- GSM TIP underestimates foF2 and TEC due to overestimation in neutral density

Longitudinal variation

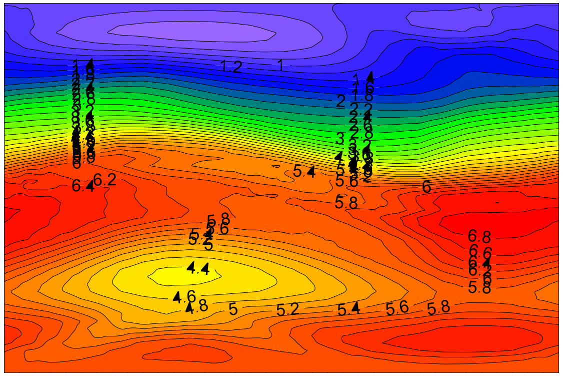
Model

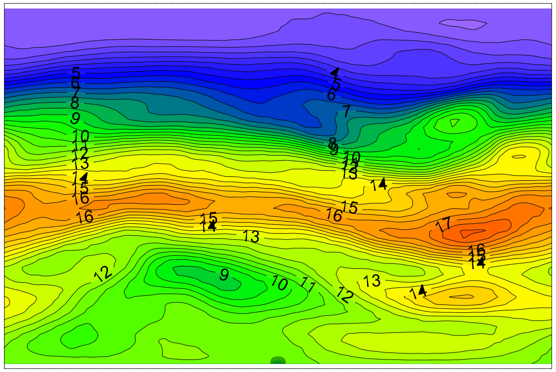


IRTAM



Observations

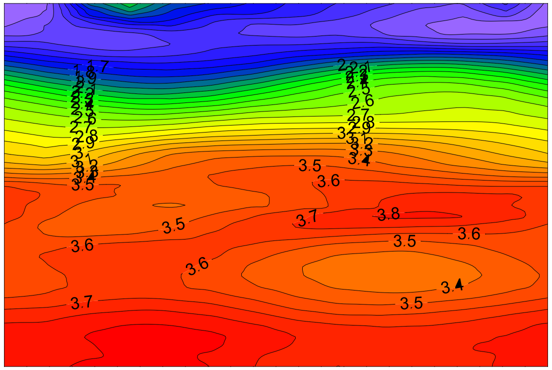




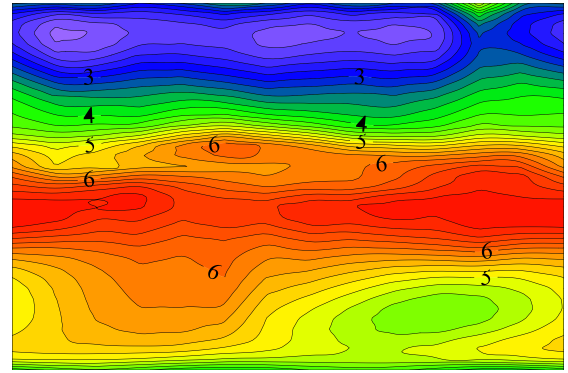
- Main reason of UT and longitudinal variations is discrepancy between geographic and geomagnetic axis
- Agreement between IRTAM foF2 and GPS TEC
-The qualitative differences with data possibly relate to the insufficient data coverage in the SH

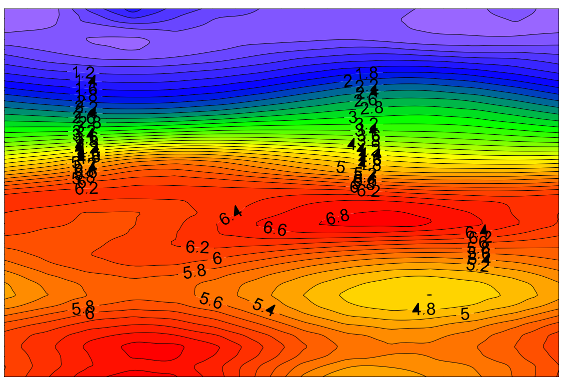
UT variation

Model

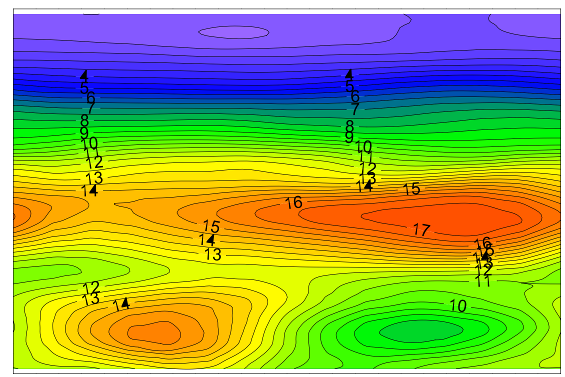


IRTAM





Observations



- Main reason of UT and longitudinal variations is discrepancy between geographic and geomagnetic axis
- High-latitude maximum is observed near 06 UT, low-latitude one – 18 UT

Results demonstrate that

- longitudinal, UT and LT variations of *foF2* and *TEC* are of the same order except for equatorial region;

- In equatorial ionosphere *foF2* and *TEC* are the largest around local noon and do not exceed values at different locations by the order of magnitude;

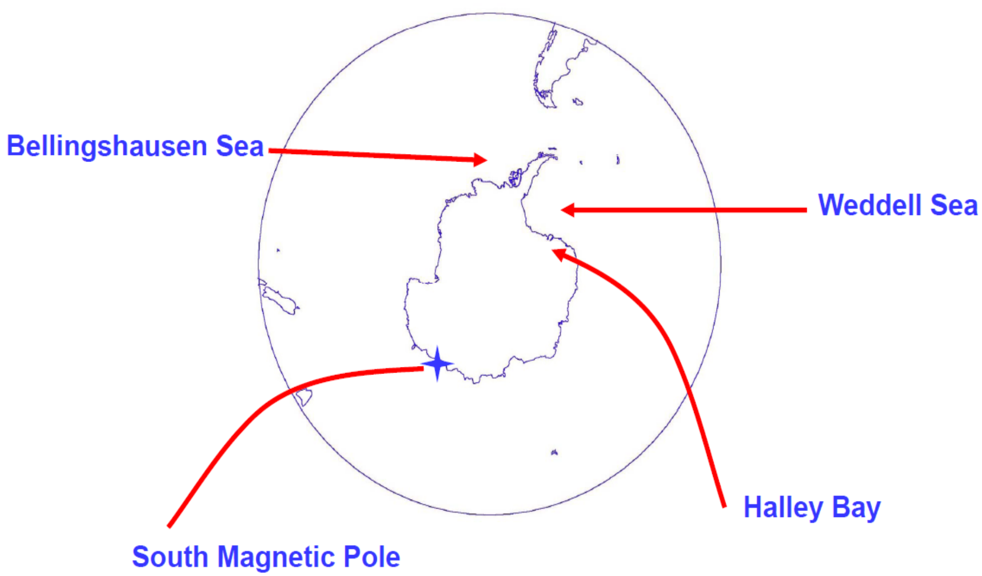
- Morphological features of *foF2* and *TEC* are in agreement with each other;

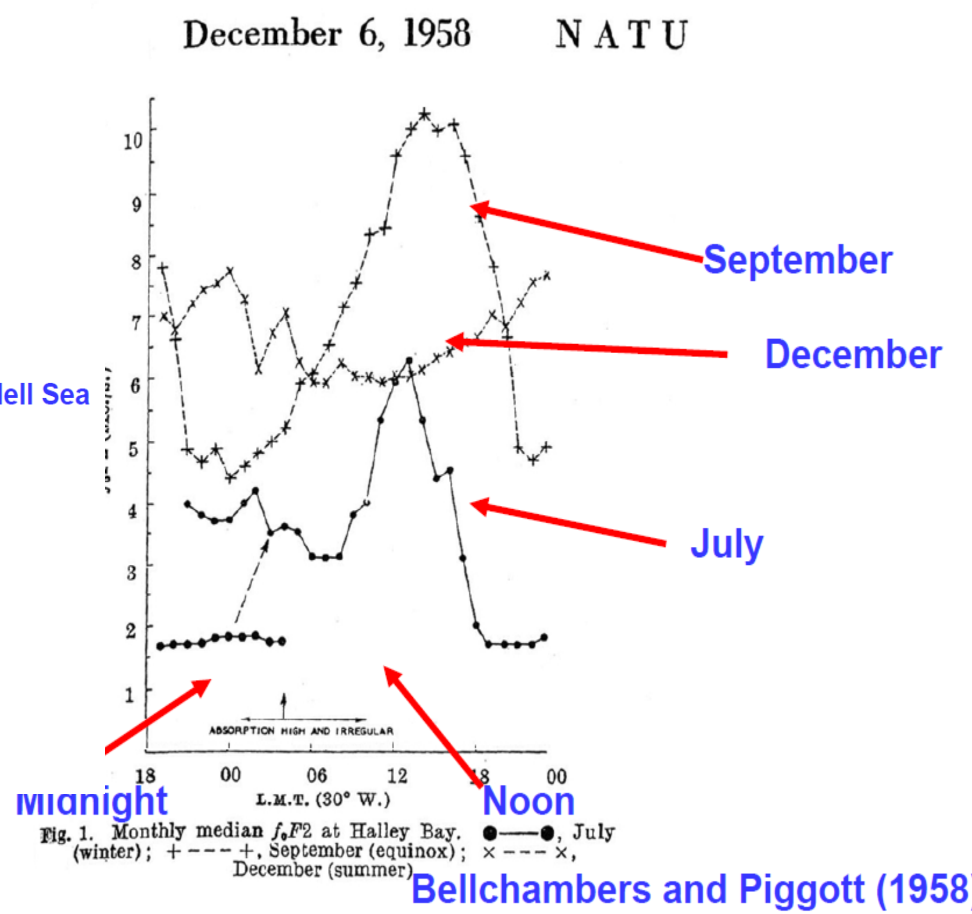
- We conclude that the ionosphere is a main source of *TEC* variations under geomagnetic quiet condition. This is reasonable as the plasmasphere, another contributor to *TEC*, should not vary much under geomagnetically quiet conditions.

Example of longitudinal variation: WSA

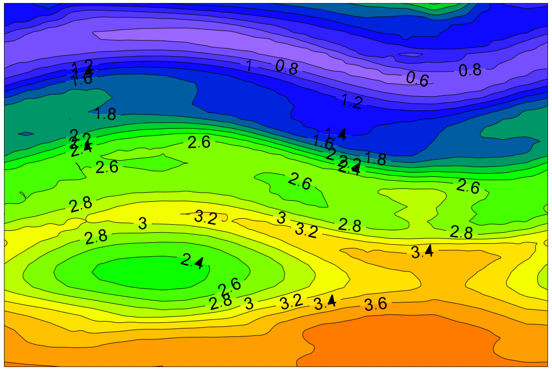
Weddell Sea Anomaly (1958)

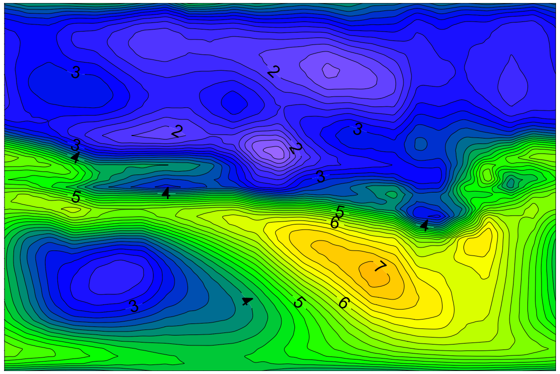
Antarctica





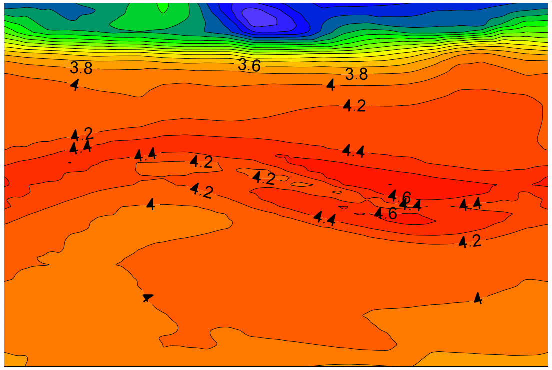
Model IRTAM

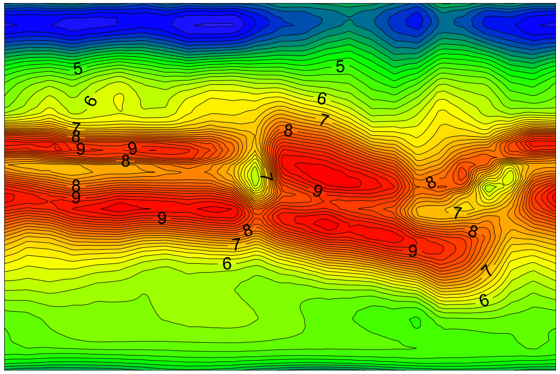




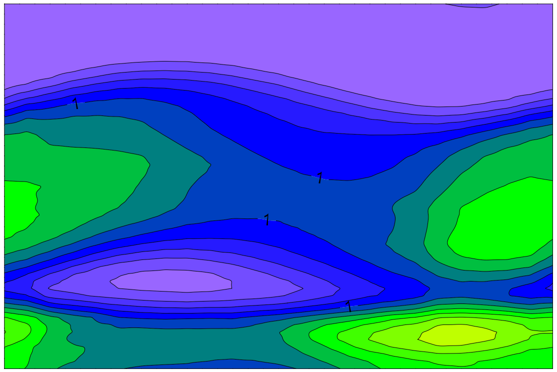
Night Time

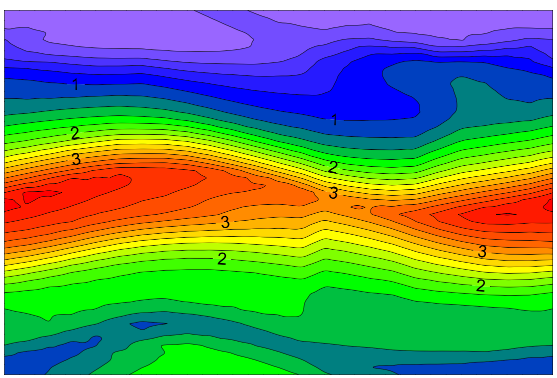
DayTime



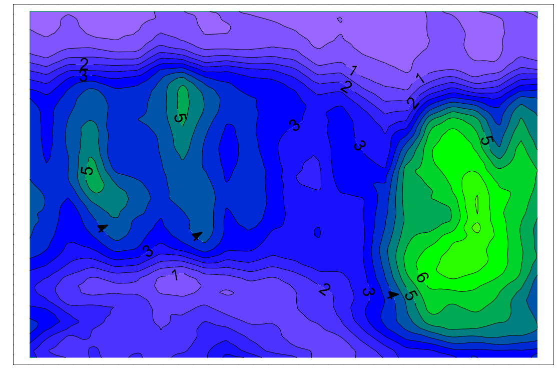


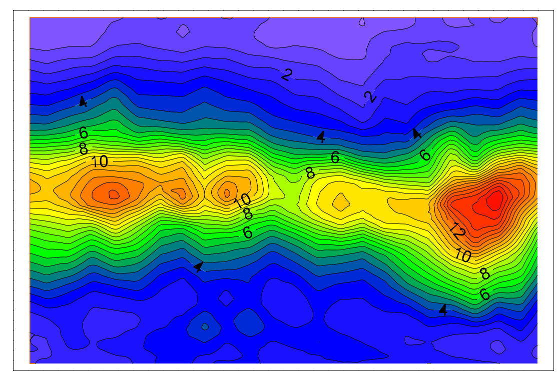
Model





Observations





CONCLUSIONS

- We considered the morphological features of longitudinal variations of electron density in the ionosphere-protonosphere system.

- We reveal the Weddell Sea Anomaly occurrence in the protonospheric electron content.

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