

Ionospheric New Findings and Space Weather by FORMOSAT-3/COSMIC Radio Occultation Sounding

J.Y. Liu*¹ and TIGER (Taiwan Ionospheric Group for Education and Research)¹

¹ Institute of Space Science, National Central University, Chung-Li, TAIWAN.
(E-mail: jyliu@jupiter.ss.ncu.edu.tw, tigerjyliu@gmail.com)

ABSTRACT

FORMOSAT-3/COSMIC (F3/C) constellation launched on 15 April 2006, which consists of six micro-satellites in the low-earth orbit, is capable of monitoring the ionosphere by using the powerful technique of radio occultation (RO). With more than 1500 observations per day, it provides an excellent opportunity to monitor three-dimensional (3D) structures and dynamics of the electron density. Fluctuations on the electron density profile triggered earthquakes, tsunamis, solar eclipses, magnetic storms, etc, are scanned by the RO sounding. The 3D global electron density allows us having new findings on the ionospheric plasma caves [1] and ionospheric depletion bays, as well as better understandings on the equatorial ionization anomaly, mid-latitude trough, and high-latitude Weddell Sea/Yakutsk anomaly. The F3/C tropospheric/stratospheric, and ionospheric RO soundings provide a unique chance to study the solar-ionosphere-atmosphere coupling processes due to solar storms, atmospheric tides, and stratospheric sudden warming. The RO data also demonstrate that an improvement in ionospheric space weather of the global electron density specification is achieved by assimilating the F3/C observations into existing ionospheric physics and/or empirical models to develop ionospheric monitoring, nowcast, and forecast models. Meanwhile, by using F3/C ionospheric observation, an empirical model of ionospheric S4 [2] scintillation has been accomplished, which could be used to evaluate/predict the quality of the communication, positioning, and navigation of GPS L1 band. Finally, impact of the F3/C follow-on, FORMOSAT-7/COSMIC-2, which consists of twelve (six, low inclination 24-deg, 550 km altitude and six, high inclination 72-deg, 800 km altitude) small-satellites [3] and will be launched in 2016 and 2017, mission on ionospheric weather and climate will be briefed. F3/C constellation has provided ionospheric electron density profiles with high vertical resolution through radio occultation measurements, while F7/ C2 constellation will further provide more than 4 times the number of the F3/C occultation soundings [4]. Nevertheless, F7/C2 RO observations can reconstruct 3-D ionospheric structure with a data accumulation period of 1 hour, which can advance studies of small spatial/temporal scale variation/signatures in the ionosphere.

Key words: FORMOSAT-3/COSMIC, Ionospheric Space Weather, Plasma Cave, Scintillation, FORMOSAT-7/COSMIC-2.

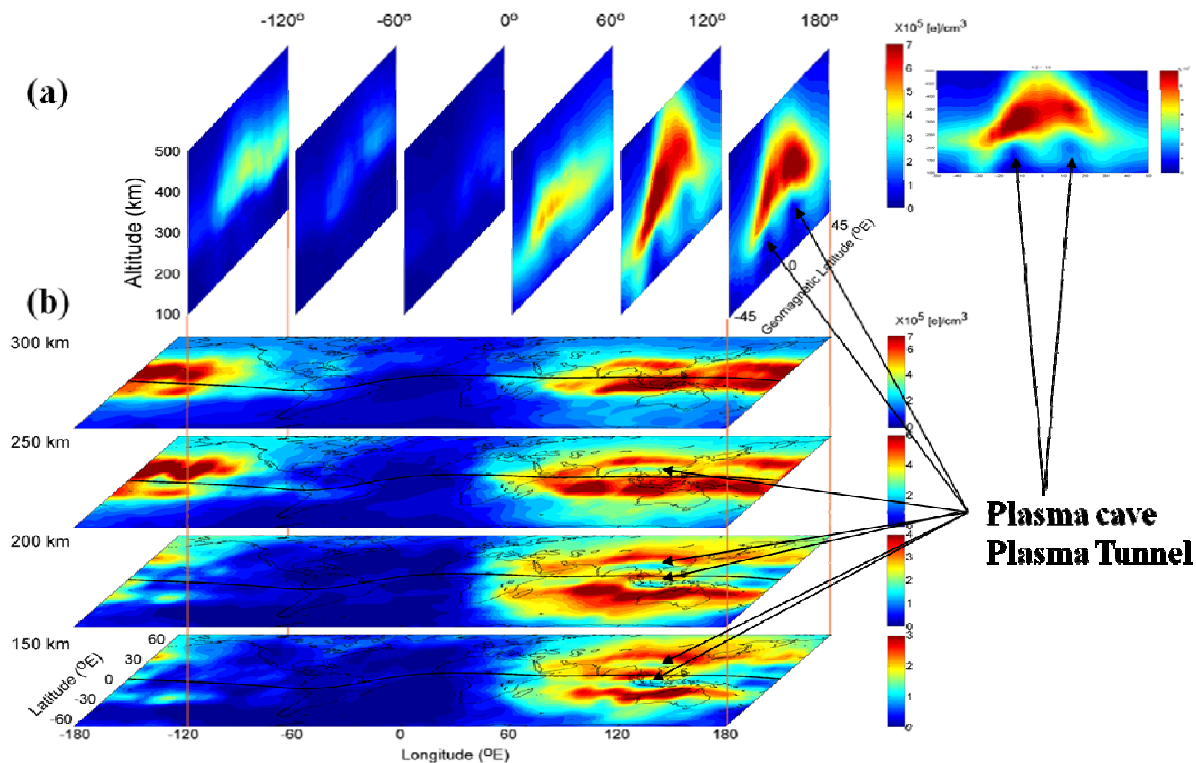


Figure 1. Three-dimensional electron density structure observed by the FORMOSAT-3/COSMIC at 0600 UT during April–June 2008. The longitudinal slices in every 30° longitude shown at the top are from -120°E to 120°E geographic longitude. The feature of the plasma caves is shown at below 250 km in 90°E and 120°E longitudes. [1]

References:

- [1] Liu, J.Y., C.Y. Lin, C.H. Lin, H.F. Tsai, S.C. Solomon, Y.Y. Sun, I.T. Lee, W.S. Schreiner, and Y.H. Kuo, (2010). Artificial plasma cave in the low-latitude ionosphere results from the radio occultation inversion of the FORMOSAT-3/COSMIC, *Journal of Geophysical Research*, doi:10.1029/2009JA015079.
- [2] Liu, J.Y., S.P. Chen, W.H. Yeh, H.F. Tsai, P.K. Rajesh, (2015). Worst-case GPS scintillations on the ground estimated from radio occultation observations of FORMOSAT-3/COSMIC during 2007-2014, *Surveys in Geophysics*, doi: 10.1007/s10712-015-9355-x.
- [3] Liu, J.Y., C.Y. Lin, H.F. Tsai, (2015). Electron density profiles probed by radio occultation of FORMOSAT-7/COSMIC-2 at 520 and 800 km altitude, *Atmospheric Measurement Techniques*, doi:10.5194/amt-8-3069-2015.
- [4] Lee, I.T., H.F. Tsai, J.Y. Liu, C.H. Lin, T. Matsuo, L.C. Chang, (2013). Modeling impact of FORMOSAT-7/COSMIC-2 mission on ionospheric space weather monitoring, *Journal of Geophysical Research: Space Physics*, doi:10.1002/jgra.50538.

Acknowledgements: The data for this study are available at Taiwan Analysis Center for COSMIC (TACC) and COSMIC Data Analysis and Archival Center (CDAAC). Dataset name: ionPrf.