Global Navigation Satellite System (GNSS) Radio Occultation Data Analysis and Interpretation

By

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Citations

The presentation is based on the following articles:

Mungufeni, P., Samireddipalle, S., Migoya-Orué, Y., and Kim, H.-Y., (2020). Modeling Total Electron Content derived from radio occultation measurements by COSMIC satellites over the African Region, Annales of Geophysicae, 38, 1203 – 1215, doi:10.5194/angeo-2019-160.

Mungufeni, P., Migoya-Orué, Y., Habarulema, J. B., Radicella, S. M. (2019a). Estimation of equivalent ground-based total electron content using CHAMP-based GPS observations, Adv in Space Res. 64, 199 – 210, doi: 10.1016/j.asr.2019.03.039.

Mungufeni, P., Rabiu, A. B., Okoh, D., Jurua, E. (2019b). Characterisation of Total Electron Content over African region using Radio Occultation observations of COSMIC satellites, adv. In space Res. 65, pp: 19–29.

Mungufeni P, Migoya-Orué Y, Matamba T. M, & Omondi G, 2022. Application of Classical Kalman filtering technique in assimilation of multiple data types to NeQuick model. J. Space Weather Space Clim. 12, 9. https://doi.org/10.1051/swsc/2022006.

P. Mungufeni1, Y. Migoya-Orué, S. Aol, G. Omondi, 2023. Comparison of Ionospheric Irregularities Observed by the COSMIC satellites with Ground-based Scintillation Observations over the Low Latitude African Region. Under Review in: Radio Science.

Presentation outline

1. Importance of Low Earth Orbit (LEO) satellite missions in Ionospheric studies
2. Ionospheric Data obtained from LEO satellite missions
3. Data of the CHallenging MiniPay load (CHAMP) satellite mission
4. Data of Constellation Observing System for Meteorology, Ionosphere and Climate (COSMIC) satellite mission

Importance of LEO satellite missions in Ionospheric studies

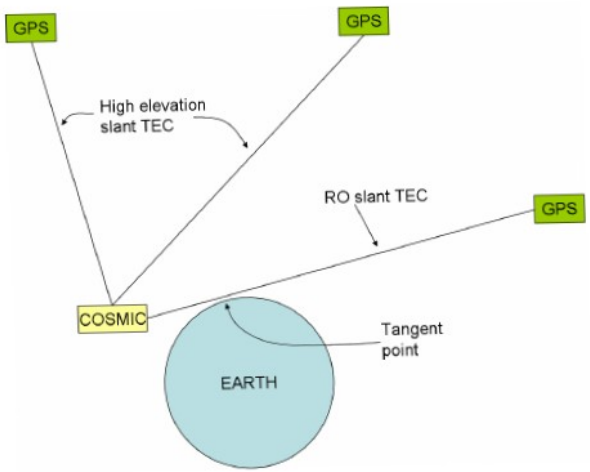
The Global Navigation Satellite System (GNSS) technique of measuring Total Electron Content (TEC) can be used to produce real-time global ionosphere maps (GIMs) and regional ionosphere maps (RIMs).

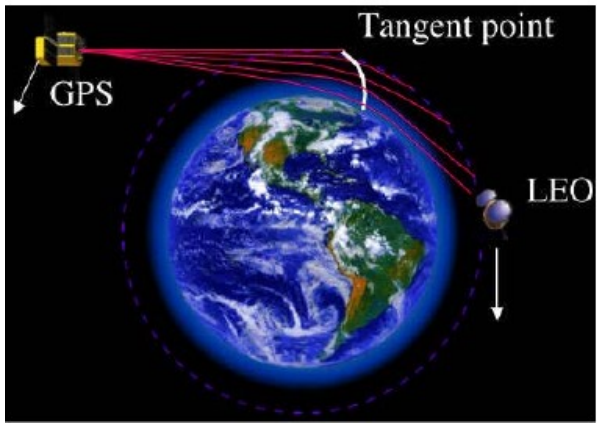
The TEC from the ground-based receivers is provided mainly over continental regions, resulting in the GIMs TEC with better accuracy over the land than ocean or deserts.

The problem of data gaps over deserts and oceans has been tackled by using space borne GNSS observations. The space borne GPS observations offer new opportunities of ionospheric sounding and monitoring on global scale.

Ionospheric Data obtained from LEO satellite missions (1/3)

1. Precise Orbit Determination (POD) antenna observations of Slant TEC (STEC).
2. The Radio Occultation (RO) technique can be used to obtain vertical electron density profiles as well as $NmF2$ or ($foF2$).





3. In situ electron density obtained from Langmuir probes.
4. The S4 data observed by the GPS receiver onboard the satellites satellites

Ionospheric Data obtained from LEO satellite missions (2/3)

- The podTec and ionPrf files for CHAMP and COSMIC missions as well as scnLv1 files for COSMIC mission can be freely downloaded from the COSMIC Data Analysis and Archive Center.

- The PodTec Files for Swarm satellites and In situ electron density measured by the satellites can be down loaded from the website of European Space Agency.

Ionospheric Data obtained from LEO satellite missions (3/3)

Hands-on session

Go to: https://cdaac-www.cosmic.ucar.edu/

See information about: COSMIC-1, COSMIC-2, and other missions:
https://www.cosmic.ucar.edu/what-we-do/cosmic-1/data
https://www.cosmic.ucar.edu/what-we-do/cosmic-2/data
https://www.cosmic.ucar.edu/what-we-do/data-processing-center/data

See File formats:
https://cdaac-www.cosmic.ucar.edu/cdaac/doc/formats.html

Obtain data of any of the missions:
https://data.cosmic.ucar.edu/gnss-ro/

Data of the CHAMP satellite mission

Assignment 1

From the podTec files of CHAMP mission in a particular day, extract (i) STEC observations of a particular GPS satellite, (ii) information about the elevation angle of the GPS satellite as observed by the CHAMP satellite, (iii) cartesian coordinates of CHAMP and GPS satellites.

Data of the COSMIC satellite mission

Assignment 2

From the ionPrf files of COSMIC mission in a particular day, extract TEC observations and the geographic coordinates of TEC being observed.

Assignment 3

From the scnLv1 files of COSMIC mission in a particular day extract S4 observations of a particular GPS satellite. Enter the results in another file. In this same file, also enter the cartesian coordinates of the COSMIC and GPS satellite.

The End

Thanks for your Attention