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Aspects of Ionospheric measurements and Latitude Dependent Discrepancy of foF2 extracted from Ionosondes and COSMIC satellites

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ABSTRACT

This study presents aspects of collocated ionospheric measurements by FORMOSAT-3/COSMIC satellites in terms of GPS radio occultation technique and ionosondes performing vertical soundings over certain regions all over the globe. The purpose of this investigation is to explore the electron density discrepancy in the bottomside and topside ionosphere as measured by these two different techniques and the conditions that give rise to this discrepancy. Furthermore scintillation measurements measured by COSMIC satellites are also contradicted to digisonde ionograms to verify any ionospheric conditions that may give rise to scintillation events. A latitude dependent discrepancy between the critical frequency of the F2-layer (foF2) measured by FORMOSAT-3/COSMIC Radio Occultation (RO) technique and digisondes (DIAS- European Digital Upper Atmosphere Server) over certain regions in Europe is concluded. Values of foF2 were obtained using NmF2 values from electron density profiles as measured by FORMOSAT-3/COSMIC over Europe. These studies are based on a dataset of several thousands of ionograms obtained by digisondes as part of DIDBase (Digital Ionogram Database) as well as DIAS in the period 2007-2015. The cases considered correspond to COSMIC radio occultation measurements within 2.5^{o} of digisonde position at less than 15 min time difference in the F2 layer peak measurement.

Key words: FORMOSAT-3/COSMIC, Ionosonde, Scintillation, GNSS, foF2, NmF2

Results:

Figure 1(a) and 1(b) show sample plots of good profiles observed over Rome on April 16, 2015 and from Nicosia on September 1, 2009 respectively. It is clearly evident that there some good correlations were observed in topside as well as in bottom side profiles which have indicated limited discrepancy in electron density between the two types of systems. Similar analysis has been performed during the period of 2007 through 2015 from 48 stations around the world with evidence of significant discrepancy in electron density as well as in scintillations during the low solar activity year 2007-2010; moderate to intense solar activity year 2011-2013 and beyond upto 2015.

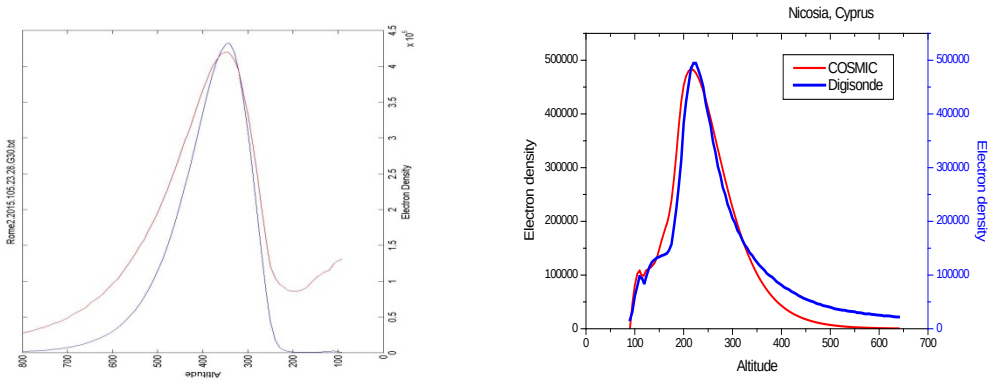

Figure 1 . Electron density profiles observed from (a) Rome, Italy on April 16, 2016 and (b) Nicosia, Cyprus on September 1, 2009.

It is clearly evident that there is a marked correlation between DIAS foF2 nowcasting and COSMIC for all years under consideration. The most interesting feature comes out of Figure 2 (a) and 2 (b) which depicts the spatial characteristics of the relative error between DIAS and COSMIC. These diagrams demonstrate that there is a definite latitude dependence of the relative error with a clear underestimation of COSMIC measurements at high latitudes and overestimation at European low latitudes. The best approximation to COSMIC measurements is at middle European latitudes due to decreased ionospheric variability and because of the fact that most ionosondes in the DIAS system operating in this region, provide better coverage and as a result of more accurate ionospheric representation. This holds for all years and there does not seem to be dependence with longitude. The underestimation at high latitudes is expected taking into account the high ionospheric variability in this region combined with the limited ionosonde coverage. The variation of foF2 measured by COSMIC RO technique and DIAS generated foF2 during the year 2007 is shown in Figure 2(c).

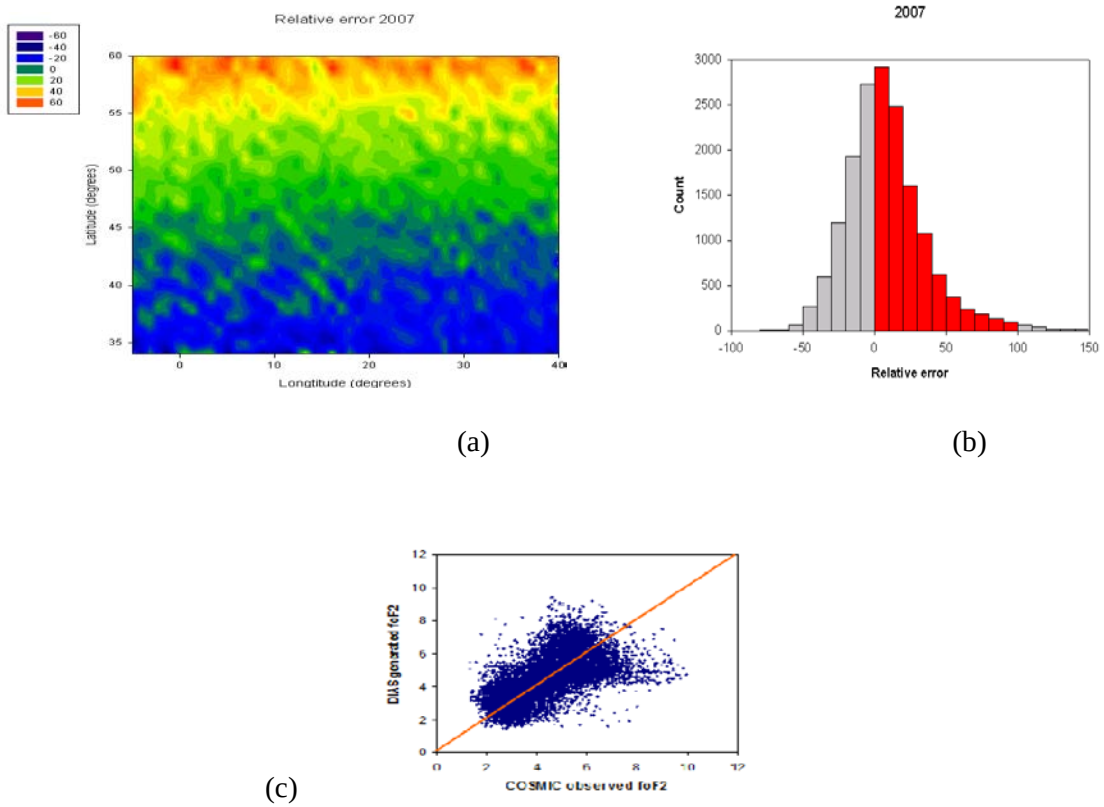

Figure 2. (a) The relative error observed between DIAS and COSMIC during 2007 over the European sector, (b) measured relative error over the number of count during 2007, (c) Variation of observed COSMIC foF2 and DIAS generated foF2 during 2007.

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