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Interactive comment on "Comparison of CSES ionospheric RO data with COSMIC measurements" *by* Xiuying Wang et al.

Anonymous Referee #1

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The paper is devoted to a comparison of Radio Occultation (RO) observations from newly launched CSES satellite to analogist COSMIC RO observations. The observations demonstrate an excellent coincidence for NmF2 and hmF2 and this may be considered as an important result. The main scientific objective is declared to monitor earthquake related disturbances in the ionosphere. Keeping in mind good results of the undertaken comparison the authors have concluded that the CSES RO data are applicable for most ionospheric-related studies. There are no objections concerning the comparison itself and a good coincidence with COSMIC observations indicate that CSES provides reliable observations at the level of COSMIC. This may be considered as the main result of the paper. However whether RO observations provide real Ne(h) profiles which may be used for ionospheric studies and applications is a question. The

authors give a long list of papers confirming the reality of RO Ne(h) profiles as well as NmF2 and hmF2 read from such profiles. However there are publications expressing doubts in relation with RO Ne(h) observations and comparisons with ground-based ionosonde and ISR data tell us the situation with RO is not that straightforward. The main problem is the spherical symmetry assumption used in the method which is not valid in many real situations: the periods of sunrise and sunset, low latitude and subauroral ionosphere where equatorial crests and the main ionospheric trough create spatial asymmetry. They have absolutely correctly selected 1400LT and 0200LT for their comparisons as these periods are the most stable in the ionosphere and the spatial asymmetry is supposed to be the least. However any monitoring implies 24-hour observations and problems will appear inevitably. A more extended comparison of COSMIC RO profiles with Arecibo ISR observations in June 2006 was presented by Kelly et al. (2009). This comparison included 32 profiles in overall, which were obtained by using the Abel transform method that was developed in two versions independently at UCAR and JPL. An interesting result is that the two methods of Abel transformation may give quite different EDP telling us that the data processing methods are not straightforward. Both NmF2 and hmF2 scatterplots (their Fig. 10 and 11) manifest large scatter, but NmF2 is seen to be determined better than hmF2. The SD of the former is 1x105 cm-3, while no statistical results are given for hmF2. It is pointed out that the best agreement between hmF2 RO values with the ISR ones was obtained near 300 km, but RO values are lower than ISR values below this height and higher than ISR values above it.

Similar but more representative results can be found in Tsai et al. (2009) who made a comparison of COSMIC observations with 49 worldwide distributed ionosondes for the period of 20 June-27 September, 2006. Their Fig. 6 exhibits a large scatter of COSMIC foF2 versus ionosonde values with mean relative deviation 20% (40 % in NmF2). This coincides with earlier estimates by Schreiner et al. (1999) and Tsai et al. (2001). A comparison on hmF2 has shown that "the FS3/COSMIC hmF2s do not coincide well with the ionosonde hmF2s". Their Fig. 9 shows that COSMIC hmF2s are much lower than ionosonde values.

Schreiner et al. (2007) analyzing the precision of GPS RO from FORMOSAT-3/COSMIC mission concluded: “Thus retrieved electron density profiles are expected to have rather poor accuracy when interpreted as actual vertical profiles”. According to Schreiner et al. (2007) the largest error in the GPS IRO retrieved electron density profiles is due to strong horizontal gradients disrupting the assumption of spherical symmetry. This assumption, in cases with large NmF2 values, can result in either positive or negative errors larger than 105 cm-3 at the bottom of the retrieved profiles [Syndergaard et al., 2006].

Summarizing the results of the previous comparisons between RO Ne(h) observations with both ionosonde and ISR measurements it is possible to conclude the following. The agreement between RO retrieved and ionosonde foF2 values is within 10-20% (20-40% in NmF2).

Coming back to the reviewed paper and considering it in the light of its title “A Comparison. . .” I may conclude that this is an interesting paper where good results were obtained. It is clearly written and well-organized. After some minor corrections it may be recommended for publication in AG.

Specific comments

L8 to inverse electron density related parameters. Maybe to retrieve of to infer

L13,17 what is NmF2s and hmF2s ? Not explained

L30 for both the 3-D earthquake observation and geophysical field measurement

Poor phrase. On one hand the authors can only speak about possible ionospheric precursors of earthquakes as this is still only a suggestion statistically not confirmed, moreover having two observations per day at a given location hardly one can follow the development in time of the earthquake preparation process. On the other hand what does mean “geophysical field measurement”? Which parameters are meant?

P2 L32 show that the CSES RO NmF2 data are generally consistent with data from other measurements. What does this mean “consistent” to which extent? – a quantitative estimate should be given.

P2 L38 from vertical ionosondes Incorrect term. “Ionospheric vertical sounding” exists.

P2 L41 most located on inland and fewer in the oceans Ground-based ionosondes of ionospheric vertical sounding are located on the continents and islands in the oceans but not in the oceans.

P3 L15 to check the consistency and reliability of CSES profiles except for NmF2 and hmF2 parameters.

How to understand this phrase? NmF2 and hmF2 are the main ionospheric parameters and the authors do not want to check them?

P3 L27 to inverse Maybe to retrieve or to infer

P5 L6 it should be pointed out here that RO retrieved electron density profiles cannot be interpreted as actual vertical profiles because both the LEO and GPS are in motion during the occultation process. If RO Ne(h) profiles are not real ionospheric electron density profiles (this has been formulated by Schreiner et al. (2007) then how these RO observations can be used for ionospheric investigations? If RO Ne(h) profiles are not real then any comparisons with ground-based NmF2 and hmF2 observations are senseless.

P6 L6 The ionospheric spatial correlation distance depends on geophysical conditions (McNamara, 2009) - solar minimum or maximum, magnetically quiet or disturbed conditions. At middle latitudes for practical applications during quiet conditions may be used ïĄ¿ 500 km in latitudes and ïĄ¿ (700-1000) km in longitude. So 2 x 6 deg correlation distances selected by the authors may be considered as reasonable.

P5 29 NmF2 appearing below 150km

The height of 150 km is unreal for F2-layer. Even under the deep minimum of solar activity in 2008-2009 daytime hmF2 according to ISR observations never was lower than 200-210 km. Therefore all RO hmF2 lower than 200 km should be considered as erroneous ones.

P6 L7 the over a year temporal segment Poor style

P6 L12 Special attentions should be paid on the local time issue when CSES and COSMIC RO data are combined together. The phrase is not clear.

P6 L29 The RO Ne(h) profiles very often are not smooth at all. How such cases were developed?

P7 P13 also L13 as hollow circles Open circles

P8 L15 This is usual MRD (mean relative deviation) –there is no need to invent new definitions

P9 Table 1 Hardly real accuracy of NmF2 determination requires 5 digits.

P9 L27 There is another point to point out. Poor style.

P10 L6 CSES RO derived peak values are in very good agreement with COSMIC and ground based measurements. No comparisons with ground-based NmF2 observations are done in the paper.

P10 L 28 As we know, the nighttime data has a more complex spatial distribution pattern compare to daytime data although daytime data are affected by solar radiation during day time.

Not "although" but namely due to solar ionization NmF2 variations are smoother during daytime hours.

P10 L36 They suggested that COSMIC measurements are acceptable under geomagnetic disturbed conditions when comparing COSMIC RO data with observations from

Sanya, a lower latitude ionosonde in China. Hardly one can agree with this statement. The equatorial anomaly introduces a spatial asymmetry especially during storm periods. This asymmetry should affect RO results.

Part 3.2 and Table 2 indicate excellent results RMSE <15 km This is a difference within the RO method obtained by two similar devices. But it should be stressed that the difference between RO hmF2 and real hmF2 may be different. The most accurate hmF2 provide ISR observations and only such comparisons may give a real estimate of RO hmF2 accuracy.

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