Reply to Reviewer 3

Thank you for your attention and useful comments.

The aim of the paper is to present characteristics of ionospheric irregularities near the EIA crest from GPS observations during 2003, 2008, and 2014. In this manuscript major modifications are as following: (1) Another GPS receiver located at (31.10 ℃N, 121.20 ℃E) was also used to study the irregularity. According to the latitudes of the IPPs, five latitudes belt are divided. The characteristics of the irregularity in the five latitude belts are studied and the latitude dependence is analyzed. (2) The figures from the two stations are plotted. The descriptions to the figures and the results from them are revised according to the new figures. (3) Discussion and conclusion are modified according to the results and the figures. (4) In addition, we improve the English writing.

After the modification, the major contributions of this paper are summarized as: (1) Local occurrence rate (LOR) is proposed to describe the spatiotemporal range of the irregularities. (2) The monthly occurrence rate (MOR) is generally large in May/June than that in the equinox months. (3) LOR is the larger in the equinox months than in June for the lower latitudes. But for the higher latitudes, LOR is larger in June. (4) MOR and LOR in March and September/October decrease with the latitudes. But in June, they are large in the higher latitudes and small in the lower latitudes. (5) The characteristics of the irregularities in 20~23 ℃N and 23~26 ℃N are similar to the EPBs. But in the higher latitudes, they are different from the EPBs.

The responses to the comments are presented in Table 1.

Table 1 Response to the comments

No.	Comments	Modification/explanation
1	The geomagnetic latitude of the station is 18.20 ℃N north, which cannot always be called the crest location under varying levels of solar activity. The crest of EIA has been used as a misnomer in several studies before, however, in reality this crest is a dynamic latitudinal peak in TEC that varies even day-to-day, season-to-season and moves grossly towards dip equator during low solar activity periods. The peak in NmF2 may again differ from what one observes from TEC. Hence, for year 2008, the location cannot be granted for the crest of EIA. Authors shall mention this and carry necessary corrections in the manuscript.	The EIA did vary with the solar activity. TWTF is not always located in the EIA crest. It is more accurate to mention it as near the EIA. In the modified manuscript, we change “in the EIA crest” to “near the northern EIA”.

No.	Comments	Modification/explanation
2	5-minute ROTI index has been calculated using estimated TEC. However, it has not been shown how TEC is estimated? If the GPS carrier phase data is used then how cycle slips are corrected which is an oft occurring event due to equatorial plasma bubbles passing over the site. Thus, ROTI itself can be ill-defined index to present the statistics. Result then become doubtful. Authors must clarify this issue by detailing.	The method to obtain relative slant TEC is stated in the manuscript. During the calculation of ROTI, the difference between two adjacent slant TECs is used. The relative slant TEC and ROTI are calculated in every continuous arc. The cycle slip will cause ROTI outage in 5 minutes, but it does not affect the value of ROTI. The method to get ROTI referred the paper by Pi et al (1999).
3	Coming to the criterion used to declare traverse (occurrence) of EPB is not established by any means. Authors must provide 3-4 examples of estimation of TEC from RINEX data, then estimation of ROTI in panel below and then the criterion plotted along with the threshold. Thus, they may establish the validity for using it for all the data sets.	The criterions to calculate the threshold and detected the irregularity are described in the revised manuscript. An example is presented in the left panel of Figure A-1 to show the traverse irregularity event detected by ROTI.
4	What are the physical rationales behind choosing 1-hr gape to reset the counter of EPB event? This seems gross qualitative measure. Now I cannot understand the statistics what it really represents?	This is a good question. I agree with you. Sometimes the irregularity events are intermittent as shown in Figure A-1. 1 hour gape is based on a lot of examples. Whether other time gape is suitable is a question worth studying. In this manuscript we choose 1 hour to distinguish the irregularity after sunset or post midnight.
5	MOR and LOR are ill-defined. There must be a plot to showcase how many days of observations were made in each month for all 3 years. Then MOR shall statistically significant and this must be quantified. At this level, nothing is known. In case of LOR, the number of irregularity counters are already proven wrong because of ill-defined criteria as mention in point 3 above. So how LOR is significantly true ?	The definition of the MOR and LOR are presented by equations. The data outage is declared in the new manuscript.

No.	Comments	Modification/explanation
6	I have studied several years of GPS observations using scintillation S4 index as well as ROTI index. The start time of irregularities can never be uniquely defined using a gross averaging index like ROTI? How much accurate will be this and this must be clarified?	As you mentioned, ROTI has been used to study the irregularity popularly in these years. The accurate starting time is difficult to be determined by one way of observations for any event. Here we get the start time in statistics of hundreds of irregularity events. The coarse statistic is enough for analyzing the staring time in hour scale.
7	Coming to the seasonal changes in variation of LOR and MOR, what is new that authors provide to a reader. All such variations are known. Amplitudes may vary that also is known. What is contribution of authors to add to existing knowledge is nowhere established.	The main contribution of this paper is described in the first paragraph of the document.
8	How an average index of daytime solar radio F10.7 cm flux is related with ROTI amplitude?	The published paper showed that the occurrence of EPBs is related to the solar activity. Under magnetically quiet conditions, higher solar activity implies greater pre-reversal eastward electric field, earlier occurrence and earlier decay of EPBs (Fejer et al., 1999; Hysell et al., 2002). Solar flux number and the sunspot number have been as the input to the global ionospheric scintillation model (GISM) and the WBMOD ionospheric scintillation model. In this manuscript, we tried to analyze the relation between the F10.7 and ROTI maximum near the northern EIA.

No.	Comments	Modification/explanation
9	Discussion section is highly flimsy. With help of some previous reports from very different durations than the present study covers, the discussion claims to the effect of solar activity of production of EPBs. This cannot be allowed in any sane scientific report. Production of EPBs depends upon two major physical processes that occur in post sunset duration over dip equator. One is triggering of EPB with seed perturbation and then non-linear growth of EPB. Then only it will be traversing over the low latitudes. Again, the fate of EPB depends upon background zonal drift, space weather events and electric field within the bubbles along with some secondary processes that produce a break the irregularity turbulence spectrum.	The effect of solar activity on EPBs is described as stated above.

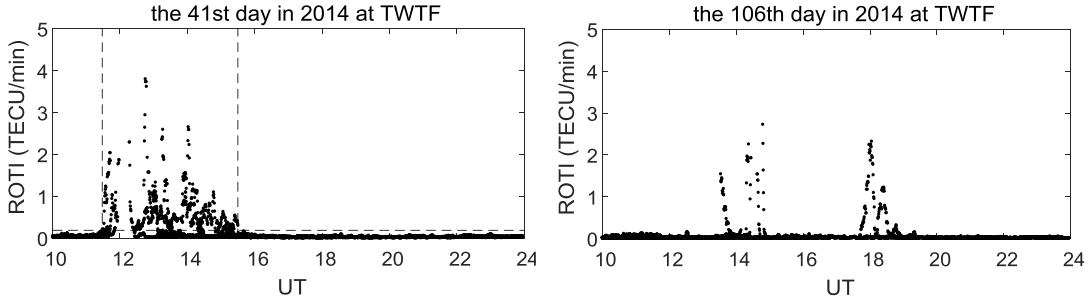

Figure A-1