

Reply to Reviewer 2

Thank you for your valuable and useful suggestions. We made major modification by adding another GPS receiver located at (31.10 N, 121.20 E). The data from the two stations can prove the results in the last manuscript better. In addition, we improve the English writing.

Table 1 shows the responses to the major comments one by one. Table 2 presents the minor corrections.

Table 1 Response to the major comments

No.	Comments	Modification/explanation
1	-first of all the authors couldnot explain clearly how the parameters MOR and LOR are able to point out the irregularity characteristics and to differentiate irregularities from equatorial origin from those with non-equatorial origin;	<p>The definition of the MOR and LOR are given as equation (7) and (8) in this revised manuscript.</p> <p>The EPBs-induced irregularities can reach different latitudes from the dip equator in different events; therefore, the occurrence of these irregularities must decrease with latitudes in statistics. Otherwise, the irregularities are not from the EPBs, which are referred as non-equatorial process.</p> <p>By adding SHAO station (31.10 N, 121.20 E), obvious latitude dependence of MOR and LOR can be observed. The corresponding results and discussion are modified.</p>
2	- the authors didn0t provide the position of the EIA crest in relation to the 3 latitude sectors for the 3 years. This EIA position depends of solar flux level.	<p>I agree with you that the position of EIA crest depends on the solar flux level. It is closer to dip equator in 2008 than in 2003 and 2014. The aim of this paper is to present the characteristics of the ionospheric irregularities near the north EIA. As accurate description, we change the phase “in/near the north crest of EIA” to “near the north EIA”.</p>
3	-the time of occurrence of the non-equatorial irregularities is not provide;	<p>SHAO station is located at (31.10 N, 121.20 E). The irregularities from this station were also studied from the occurrence time, occurrence rate, and the strength of TEC fluctuation. The irregularities at this station is not similar the EPBs’, called non-equatorial irregularities.</p>

No.	Comments	Modification/explanation
4	- the physical mechanisms, mainly for the non-equatorial irregularities are vaguely presented;	We focus on the characteristics of the irregularities in the low latitudes. By analyzing the latitude dependence of irregularities, the EPB and non-equatorial process are supposed as two contributions to the low latitude irregularities. The physical mechanisms is worthy to be studied, but not in the scope of this paper.
5	-are the proposed parameters MOR and LOR created by the authors? This could be an original contribution from the paper, however at line 240 they mention that Kumar (2017) “also reported maximum MOR in June..”. The authors should clarify this point.	LOR is proposed in this paper. MOR has been used by many researchers. We revise the manuscript and describe this clearly.
6	--at line 261-262 the authors stated: “Due to the day to day variability, the plasma bubble occurrence rate should decrease with latitude”. Why?	I am sorry for the unclear description. This sentence is modified as “The EPBs-induced irregularities can reach different latitudes from the dip equator in different events; therefore, the occurrence of these irregularities must decrease with latitudes in statistics.”
7	MOR and LOR behaviors are presented repetitively at the “Results and discussion” section and at the “Discussion” section and this should be avoided to have a more objective paper;	By adding SHAO station’s data, the results and discussion are improved to be reliable.
8	the authors should discuss, at lines 295 to 300 as a suggestion, that even for high solar activity there are no irregularity events if the season is not favorable;	The phrase “necessary condition” was changed to “necessary but not sufficient condition” considering other mechanisms triggering the irregularities.

Table 2 Response to the minor comments

Comments		Modification/explanation
line	Corrections/suggestions	
02	Inform dip latitude for Taoyuan	Dip latitude are added in the manuscript
06	..around the equatorial Ionization Anomaly (EIA)	Accept the correction
06-15	The text should be improved since MOR and LOR are not defined yet 15 near the EIA crest. . .	The definition has been added in the abstract.

Comments		Modification/explanation
26	..Differential Global Positioning System (DGPS)	Accept the correction
28	Zheng et al., 2008 or 2009?	2008
35	bubbles can easily reach even much more than 1000 km. Pls check this statement	We change “1000 km” to “hundreds of the kilometers” according to the reference.
44	equatorial ionization anomaly or use just EIA.	Accept the correction
74	If the authors intend to describe GPS system, actually there are other frequencies	This paragraph has been removed because it is not necessary.
95	Aarons	Accept the correction
104-106	Pls rewrite explaining better how the authors determine the threshold for the irregularity	We give the definition of threshold.
105	average and 10 times. . .	Accept the correction.
107-109	Clarify the sentence Another irregularity. . .preceding event	How to determine one irregularity traverse event is described in the revised manuscript.
117	Explain how: Higher local occurrence rate means the irregularity tends to exist with larger spatial and temporal scales.	The definition of LOR is presented in equation. And the relation between LOR and the spatiotemporal range is described.
120	Authors should use traverse irregularity (also along the paper)	Accept the correction
127-128	Improve this phrase since it is not necessary to repeat 18:00-24:00 LT	Section 3 is modified according to the results from the two stations. The description was improved.
131	The information that there are 38 traverse irregularities mostly from Feb. and Mar. cannot be seen from Figure 2. The authors should mention from which Figure they based to make this statement	The figure did not show the number. We try to describe the results quantitatively. But in the new manuscript, the results have been described according to the figures from the two stations.
132	Any reason to have less post-midnight irregularities during low solar activity?	In 2008, the number of the irregularity events is 40. And 18% events were after midnight, a little less than 19% in 2014 and 25% in 2003. It is a good question but now we cannot give reasonable explanation to the slight difference.
137	Are the latitudinal bins in geographic coordinates? Please clarify	In geographic coordinates. Manuscript has been modified according to the suggestion.
141	...2003. In this year the value of. .	Accept the correction.

Comments		Modification/explanation
157-159	Revise this statement since it is well known that frequency and spatial and temporal Scales are solar flux dependent. Also MOR and LOR should clarify this statement and not to give origin to doubts: "suggests whether". Figure 4 shows low ROTI values for low solar flux	This statement is inaccurate. We revised this section according to the new figures based on the two stations.
162	Variation of Maximum ROTI	Accept the correction.
164	Was a careful TEC data quality control done? If not false maximum ROTI could be generated.	Yes, cycle slip and loss of lock are detected during the calculation of the relative slant TEC.
172	..in March and it decreases with. . .	Accept the correction.
175	Any reason for maximum ROTI decreasing with latitude in Feb/Mar in 2014 when it Increases during 2003?	The dependence of ROTI maximum on latitudes (20~29N) is poor, and a good explanation has not been supposed. After adding another station to this paper, obvious difference of ROTI maximum can be found between the higher two latitude belts and the three lower ones. This is caused by the different strength of the irregularities in different latitudes.
184	ROTI maximum variation with solar flux	Accept the correction.
186-187	Here the radio flux at 10.7 cm (F10.7) was used as an . . .	Accept the correction.
203	Where are Nishioka et al (2008) data from?	The data are from the stations around the dip equator. This has been added to the manuscript.
219-221	Rewrite sentence since it is confusing	This sentence has been rewritten.
224	the EIA crest..	Accept the correction.
228	Fig. 3 instead Fig. 2	Accept the correction.
231	and EIA crest	Accept the correction.
245	medium and minimum years.	Accept the correction.
249	Fig. 3 instead Fig. 2	Accept the correction.
250	in June when the largest. . .	Accept the correction.
253	February and November or February and October?	February and October. It has been corrected.
312	26-29 or 23-26.	26~29.