**Annales
Geophysicae
Discussions**

**ANGEOD**

Interactive
comment

# *Interactive comment on* "Variability of TEC and improvement of performance of the IRI model over Ethiopia during the high solar activity phase" *by* Yekoye Asmare Tariku

**Y.Â ăA. Tariku**

yekoye2002@gmail.com

Received and published: 10 July 2018

Response to reviewers' comments and suggestions The author is very pleased and thankful for editor's and referees' constructive comments and suggestions as I have got the comments, questions, and suggestions helpful in improving my work. Hence, I have presented the replies in the following manner. If the author is referring to improvement based on different versions of the IRI model, then a sufficient background about the determination of TEC within IRI 2007, IRI 2012 and IRI 2016 should have been provided.

Response: the necessary corrections and amendments have been made based on the

suggestion (see lines 60-66).

3 In the abstract, the author mentions "The results reveal that both the measured and modeled seasonal diurnal VTEC values start increasing at 03:00UT (06:00 LT) and attain their peak values (mostly in the time interval of 09:00-13:00 UT or 12:00-16:00 LT)". I do not find this information new to be included in the abstract. The same can be said for the text in lines 22-26. Response: Some changes have been done (see the abstract section). ──────────────────────────────────────── It is difficult to find new findings in this paper. Most of the results over this region using the same data set have been reported, and even compared to the IRI model. In fact, the same author has reported most of them and so he/she is presenting something that he/she knows has been published. For example in the abstract of Tariku (2015), EPS (paper number 3 below), there is a statement in the abstract " It has been found that the diurnal variability of VTEC has shown minimum values at around 0300 UT (0600 local time (LT)) and maximum values nearly between 1000 and 1300 UT (1300 and 1600 LT) during both the low and the high activity phases": How different is this from the text in lines 14-16 in this submitted manuscript?

Response: In connection with model validation over low and equatorial regions, of course, a lot of researches have been conducted using the old versions, including IRI 2012 version. However, latest findings that can show the improvement of the model performance from the relatively old to new versions for long lasting period are lacking though the model has been steadily improved and arrived at IRI-2016, which incorporates some new input parameters that did not exist in the previous versions. In addition, only few researches have been conducted to validate the IRI 2016 version of the model over the low and equatorial regions So, to give answer for the question "what is new in the latest versions (especially IRI 2016) of the model in relation to TEC estimation over the region while observing the improvement of the model in general?" this study plays a great role. In short, the study enables to show the improvement of the model from the old to the new version in TEC estimation; and the performance of the most recent

version (IRI 2016) in estimating TEC over the region. This is because; validating the new versions of the model enables the model developer to further improve the model. Indeed, here the main purpose is to see the improvement of the IRI model in the estimation of TEC employing IRI 2007, IRI 2012 and IRI 2016 in the same plane using large data for a better accuracy of the results obtained. The past studies might have tested the performance of the model using a single version, either IRI 2007 or IRI 2012. But, few researches have been conducted using IRI 2016. Moreover, as the past studies noted, there are common results obtained in relation to model validation in different version of the model. This shows that the model performance has not been significantly improved. This is one of the basic findings of this study entitled"Assessment of the variability of TEC and improvement of the IRI model. . .". Because the main aim of the study is to show whether the model performance is improved or not. Hence, to further encourage the model developers so that they can significantly improve the model, this study is supposed to give a clear understanding about the improvement of the model performance from the past to the present, especially during the solar maximum phase.

Of course, some modifications have been made (see the revised manuscript to see some new findings that were not discussed in the old manuscript)

Entire subsection 2.1: TEC from dual frequency GPS receiver has been published as many times as the author has published the paper about this topic. In fact equations 1-6 are almost in the same order in the published papers. Examples of the author's papers are provided below where this information appears.

Response: Of course the same equation or similar concepts might have been used for different purposes. For those published papers, the study mainly focuses on the TEC variability or validation of a single version of IRI model (IRI 2012). However, the purpose of the current study is somewhat different from the past studies as it mainly focuses on assessment of the improvement of the IRI model by considering relatively old (IRI 2007) to relatively new model (IRI 2016). The study tries to answer, how the

model is showing improvement in TEC estimation from version to version. This is done to make the model developers fill the observed gaps in the model when it is improved from one version to the next one. Here, emphasis has also been given for the most recent version, IRI 2016 as its performance has rarely been observed so far. To see the validation of the model, experimental data have to be used. Hence, in the study GPS data have been used to test the improvement of the model. So, if the GPS data have to be used, GPS related concepts must be raised, including the mechanism of obtaining and utilizing the data. Of course, driving the objectives and the conclusion with that concept (improvement of the performance of the model) may be somewhat lacking. As a result, improvements have been made based on the given suggestions and comments.

* In addition, in the described published papers only sample days' data from each month have been considered, but in this paper, complete monthly and seasonal data have been used to extensively see the variability of TEC and improvement of the model.

Other comments are âĂć In line 171, an elevation threshold of 10 degrees was used. In addition to data being prone multipath errors, I find this low threshold given that the author is performing analysis in low latitude region where electron density gradients are significant.

Response: Multipath effect errors are not that much problems as the receivers are installed at locations far from tall buildings and forests that are supposed to cause poor GPS service (Multipath effect errors). So, calibrating the data at 10o is not a problem.

Lines 197-202: This text appears in some of the author's papers above and is essentially a repetition or simply some sort of self plagiarism Response: some modifications have been made (see the results and discussion section)

Lines 287-304: I think the STORM option is effective for mid-latitudes; Please con- sult Araujo-Pradere et al., (2002): STORM: An empirical storm-time ionospheric correction model, 2, Validation. Radio Science 37 (5), 1071, doi:10.1029/2002RS002620 and

Araujo-Pradere et al., (2004): Time empirical ionospheric correction model (STORM) response in IRI2000 and challenges for empirical modeling in the fu- ture. Radio Science 39, RS1S24, doi:10.1029/2002RS002805. Araujo-Pradere et al., (2002): STORM: An empirical storm-time ionospheric correction model, 1, Model description. Radio Science 37 (5), 1070, doi:10.1029/2001RS002467. The author missed these important references about the STORM option model development.

Response: Here, the main point is to see the performance of the IRI model in esti- mating TEC variation using three versions (IRI 2007, IRI 2012 and IRI 2016) in storm time condition. Because in all versions of the IRI model there is storm time option embedded in the model. So, the objective is to validate the performance of the model during storm time, not to find models used to estimate TEC in storm time condition. The described storm time option models may be tested in other studies. But, now this is beyond the scope of the study. Moreover, it is better to use references related to IRI model rather than using concepts in the described storm time empirical models.

In section 3, subsections 3.1 and 3.2, even the headings are almost the same, with minor editing in the text reported in Tariku (2015), ASR. Response: The pur- pose of this study is different from the past studies as described above Of course, some modifications have also been made here (see the results and discussion section)

Please also note the supplement to this comment:
https://www.ann-geophys-discuss.net/angeo-2018-48/angeo-2018-48-AC1-supplement.pdf