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Discussions

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Interactive
comment

Interactive comment on "Spatial gradient of total electron content (TEC) between two nearby stations as indicator of occurrence of ionospheric irregularity" *by* Teshome Dugassa et al.

Anonymous Referee #1

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General comments

The study attempts to show how the difference between the TEC of two close GNSS stations can be used as a precursor of ionospheric irregularities in the post sunset period over both stations. The study being the first of its kind in the African sector is worthy of interest couple with the fact that it is well written and it gives insight about a possible relation between electric field and irregularities in the post sunset period. However, the authors first need to give a good justification why they want to use TEC gradient between two stations as a proxy of irregularities. Giving the fact that ROTI which can be easily estimated is already an indicator of irregularities why use the gra-

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dient between two stations to do same work? What if the constraints "over the same latitude, but separated by a longitude of about 5 degree" is removed what happens to the relation?

Specific comments

The first issue I have with this paper is the way the relationship is established between TEC gradient and ROTI. Presenting variations of two quantities side by side does not give us any quantitative information about the nature of the relation. One will wish to know how that relation has been quantified in terms of correlation or ratio between the quantities. (For example we know in quantitative manner how ROTI relates to Scintillation index S4 and how this relationship varies depending on certain factors). It would have been interesting to have such quantitative information in this study. The abstract mentioned "observe the correlation between the spatial gradient of TEC and the occurrence of ionospheric irregularities" but there is no such correlation in the whole texts. Another concern is that the study never really specified or took into consideration the quietness and/or disturbed nature of the days used and if it did little information is given on this. We know the study covers year 2014 which is about 365 days. But we do not know how many days were used. If they were days without data, how many days were quiet and disturbed. As such, one is forced to assume that the relation between TEC gradient and ROTI was given for all dyasof year 2014 and was unaffected by magnetic activity. This could be misleading given the fact that both TEC gradient and ROTI are severely affected by magnetic activity. True the authors talk about quiet time but failed to tell us how and which criteria were used to segregate/ isolate these days and how many of them were used in the computation of TEC gradient and ROTI in both stations simultaneously. In establishing a relation between equatorial electric field and spatial gradient, the authors used only four days in year 2014. I don't think this is sufficient enough to show any kind of relationship between both quantities. In justifying the magnetic data gap (the H component of the Earth's magnetic field) in 2014, the authors performed a correlation between the equatorial electrojet (ΔH) and equatorial

electric field (EEF) for quiet days in 2012. Again no information is given on these days and how they were selected and how many they were. Another problem here is that the authors assumed that the correlation between (ΔH) and EFF as obtained in 2012 (0.7) will be the same in 2014. (they actually did the correlation to justify the use of EEF in 2014 in the absence of ΔH data). We have 2 years between 2012 (Average F10.7 $\sim$ 120 s.f.u) and 2014 (Average F10.7 $\sim$ 146 s.f.u). Based on this I believe the solar effect will affect the correlation and this need to be mentioned if not evaluated for the sake of accuracy. (I am sure there will be variations even in the modeled EEF values in 2012 and 2014).

Listing of technical corrections

Abstract Line 9. Change correlation to relation. I didn't see any correlation study between both variables in this work. Line 11 maximum positive/depletions Why not use maximum enhancement and reduction. The spatial gradient will either be positive of negative. A negative gradient means reduction in electron density. Let's avoid using the word depletion since it can be mistaken for TEC depletion. Line 15-16. The spatial gradient of TEC between the two nearby stations could be used as an indicator of the occurrence of ionospheric irregularities. Is it over both stations or it is a general statement?

1. Introduction

Page 2 Line 8. Attests Line 14. Remove mechanism Line 18. ESF write in full. First time used. Line 30. GPS write in full. The GPS scintillation index, S4 is not an instrument. The GPS is. Line 31. Global Navigation Satellite System (GNSS). Use either GNSS or GPS.

Page 3 From lines 1-2, a mention of some work done over Africa has been made. However nothing was said about the scope of such studies, their limitations/gaps and how they relate to this study. Kindly address. Line 26. "and see". Change to as well as study Line 27 "A closely found" change to closely located Line 28. I am not

comfortable with the word 'longitudinal'. Change to spatial for uniformity with title. Line 27-28. What is the justification for the study of the relation between longitudinal (in this case spatial) gradient of TEC derived from two GPS receivers and occurrence of ionospheric irregularities still using GPS? Line 29. Same as in line 28.

Page 4 2. Data and methods Line 2-3 Kindly read that statement and adjust for easy flow. Line 5. Why year 2014 only? Is there any particular justification for the choice of this year? Line 6. Remove "of" Lines 7-8. Change the first average to "mean" Line 10 change were to "was" Line 10 "then analyzed to show the possible indicator of". This statement is not correct. Adjust Line 11 "The spatial gradient of TEC between the two nearby stations are located nearly along the same". Adjust statement. May be you should delete "are". Line 14. Any reference for equation 1? Line 16-17. I am not satisfied with your definition of ΔH the way it is and the way you associate it to the EEJ in these particular lines. In addition you need to add how the H was processed and corrected for baseline value and non cyclic variations. Line 22. ...is a transfer function model which to models the daily variations...Check the sentence.

Page 5 Line 1. "which are mapped from interplanetary electric field (IEF) data". Change to ...which are mapped in the interplanetary electric field (IEF). Line 5. I think you need to clearly explain the various options that the model provides and then proceed to tell us exactly which of the three options you used and why. Line 16, add "s" to station. Line 23. Put a comma after reliable. Line 24. Change "from the model" to 'it' Line 32. Was ROTI introduced to quantify the ROT measurements or ionospheric irregularities? Clarify please.

Page 6 Line 6. Adjust to (Ma and Maruyama, 2006). Line 23. I thought the scope of the study was 2014. Why use data from 2012? Have you accounted for the yearly variation and solar activity influence in juxtaposing your 2012 and 2014 data? Please could you clarify this? 3 Results and Discussions Line 22. For some of selected. Remove of Lines 22-23. How did you select those quiet days? How many where there? What is the temporal resolution of both ΔH and EEF. Is the correlation obtained from "some

selected quiet days" be an adequate representation of all other quiet days in year 2012? Check Figure caption in Figure 1 and harmonize. Let's know whether you use some days or quiet days of month of year 2012.

Page 7 Lines 2-5. You gave us a beautiful description of how ΔH can be derived between the two magnetometers just for you to come and tell us that the data were not available for year 2014. I think it should have been the other way round. Line 3. Correct Adegrat to Adigrat Line 4-5. To solve this data gap we used the daytime information of equatorial electric field derived from the real-time prompt penetration electric field model as an option. Did you use the real time model of Ionospheric electric fields of the real-time prompt penetration electric field model? In Page 6 lines 21-23 the authors claimed the relation is for some selected quiet days of months of year 2012 but in Page 7, lines 5-7 they state that the same relation is for year 2012. This may be extremely misleading.

We need a clear explanation on how you wish to use correlation result for 2012 to support some of your results in 2014. You must be aware of the solar activity influence on vertical drift. It will not be totally accurate to say that the correlation in 2012 will be the same as those in 2014. May be you did that as an indication of something. You need to clarify.

Page 8 Line 5. Be consistent. Is it Figure or Fig? (check in all texts and harmonize). Line 7. Replace "but lags' with " but after ''…... Line 8. The depletions in the gradient. I am not comfortable with the word depletion. Kindly use the reduction in the gradient. Line 9. ….maximum positive of the spatial gradient of… Replace with " the peak of spatial gradient" or "the maximum spatial gradient". Line 11. Change depletion with reduction Lines 16-19. Why over Asab only?

Page 9 30 March 2014, 10 April 2014, 20 September 2014, 10 October 2014. Where these days selected randomly? The caption in Figure 3 should be self explanatory and should tell us the stations (Asab and Debark) that were used for the ROTI.

Page 10 Line 1. Do you have any reference for this? Line 1. From the figure,…. Which Figure? Specify. Lines 2-3. A convincing and quantitative way to demonstrate inferences in lines 3-4 is by performing correlation between spatial gradient and irregularities. Lines 7-8. An ionosphere gradient of 518 mm/km was discovered, generated by a plasma bubble. Read the statement and rephrase. Line 14. (see., Fig. 5). Change to as seen in Figure 5. Line 17. Change "a" by "the" Line 18. Change "indicates" to "shows" Line 19. …….in section (2)… which section 2? Change to as stated earlier. Line 23. Put 's' to period Line 23-24. Equation (1) was applied to all days of the year 2014? Including disturbed days? This is where it is important to separate disturbed days from quiet ones. We know that gradients can be significant during geomagnetic storms. Line 28 – 32. Most of the observed features have not been discussed and plausible answers not given to explain them. Line 32. Change depletions to reductions. Figure 4. a) Diurnal variation of the spatial gradient of TEC over ASAB and DEBK , b) Daily maximum value of the spatial gradient of TEC variation, c) Diurnal variation of ROTIave over ASAB station and d) Daily maximum value variation of ROTIaave over ASAB station in the year 2014. Check this Figure caption and adjust according to your Figures (e) and (f) are missing.

Page 11 Lines 1-2. If you can show it don't say it. Lines 10-11. "The trend they show has similarity with" The trend is already a similarity. Adjust the statement. The caption of Figure 4 is misleading. Please check and let it conform with what you have in the texts. Why not add a correlation plot between spatial gradient and ROTI over each station? This is a better way of obtaining quantitative information between both quantities.

Page 12 Line 3. What about Debark? Why is it not presented? Besides, is this Figure for quiet and disturbed periods? How did you segregate the effect of transient disturbances? Line 26. Basu et al., the year is missing.

Page 13 Line 6. Change "has not been seen" to something suitable. 4 Conclusions

Page 14 Lines 2-3. This is inconclusive and cannot feature in this section given the fact the relation between EEF and TEC gradient was investigated for just for 4 days (Figure 2).

5. Acknowledgments Page 14, line 6. Remove and. Page 14, lines 7-8. We acknowledge http://www.geomag.org/models/PPEFM/RealtimeEF.html for providing the data the Prompt penetration equatorial electric field model. Give proper acknowledgement please.

Page 14, line 8. Provide adequate acknowledgement for using the AMBER data (Visit AMBER website for adequate acknowledgement).

References Page 15. Line 31-32. Incomplete reference. Page 16. Line 16-20. Arrange references chronologically. Page 16. Line 36. Adjust the initials. Page 17. Line 1-5. Arrange references chronologically. Also consider the reference in P.16 line 36-37 in the chronological arrangement.

Please also note the supplement to this comment:
https://www.ann-geophys-discuss.net/angeo-2018-131/angeo-2018-131-RC1-supplement.pdf

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Interactive comment on Ann. Geophys. Discuss., https://doi.org/10.5194/angeo-2018-131, 2018.