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Interactive comment on "Emergence of a localized total electron content enhancement during the G4 geomagnetic storm of September 8, 2017" *by* Carlos Sotomayor-Beltran

C. Sotomayor-Beltran

carlos.sotomayor20@gmail.com

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Response to Referee #2

Firstly I would like to sincerely thank the referee for his/her valuable comments in an effort to improve my article.

In the revised version I have already addressed all the concerns of referee #2:

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Discussion paper

1) Abstract A common response to geomagnetic storms due to the southern vertical interplanetary magnetic fiel (Bz) is the enhancement of the electron density in the ionosphere. This statement general is incorrect. Not all ionospheric storms start with a positive phase. The storm pattern depends on season, longitudinal sector, the intensity of a geomagnetic storm, LT of a magnetic storm commencement.

Yes the statement as it is, is incorrect. On the other hand, I am well aware that the storm pattern depends on season, longitudinal sector and the intensity of a geomagnetic storm. Thus to properly express the statement, I have changed "A common response to ..." to "One of the responses to ..."

2) Looking at the figure 2 I see that the increase of TEC is more extended versus the mid-latitude in the Southern hemisphere but it is possible to see it also in the northern hemisphere. So for my point of view is not a localized enhancement .Looking at the paper by Lei et al. (2017 - 0.1029/2017JA02516) that analyze the same event with TEC and ionosonde data and in their figures it can be seen an increase of differential TEC for all latitudes in the first hours of 8 September, that corresponds to the storm main phase, in the northern hemisphere and in the southern also(but they arrive at 24 degree in latitude)that correspond to a positive ionospheric storm. In the following days a negative ionospheric storm occurred from higher to lower latitude. So it is a typical ionospheric storm with a positive and negative phase , the physical mechanism for the positive phase occurred at 02UT(daytime) that the author identify as a localized event seeing only the figure at 2UT could be due to an expanded convection electric field dur- ing geomagnetic storms in these cases frequently it is observed dTEC enhancements in the mid latitude dayside ionosphere but more investigations are necessary.

As you are pointing out more investigations are necessary for the "expanded con-

vection electric field dur- ing ...". I am also indicating in the very last sentence of the conclusion section that further observations are necessary because the mechanism I am putting forward (a contribution of the super-fountain effect) is not my definite conclusion. Based on Fig.3 from Edemskiy et al. Ann. Geophys. vol 36, pp. 71-79, 2018, if you could observe at the LTE (plume) located at 35°S„ this LTE has an extended shape along the mid-latitude as well, which is similar to the one I am indicating for the September 8, 2017 storm. Hence, following the published results from Edemskiy et al.2018, it is my point of view that the extension south of the EIA during the September 8, 2017 storm is a LTE.

3) L 6 P1 What is “the G4 storm”? G4 should be explained

I removed G4 from L6 P1 and the title and explaining what it is in the first paragraph of the "Results and discussion" section.

4) L8 P1 what it is was unexpected Grammar

Thank you very much I corrected this to: what it was unexpected

5) L26 P1 Global Navigation Satellite System (GNSS) receivers, due to its global cover- age, are used as one of the main tools for ionospheric studies. This is not so. The whole morphology of ionospheric storms has been obtained and understood using the world-wide ground-based ionosonde network observations. Only vertical ionospheric sounding gives directly electron concentration in the ionospheric layers. VTEC on one hand is obtained from slant TEC observations on the other hand it in- cludes the plasma- spheric part which is not related to the underlying ionosphere. For this reason VTEC may be only considered as a complementary source of information

for such type of analysis.

Yes, I am aware that the ionosondes provide directly electron concentration in the ionospheric layers. However I guided myself from the paper of Hernandez-Pajares et al, J Geod vol 83, pp. 263-275, 2009: "The IGS VTEC maps: a reliable source of ionospheric information since 1998". I have then changed in L26 P1: ".. are used as one of the main tools for ionospheric .." to " .. are used as one of the tools for ionospheric .."

6) L 18 P2 . . .we apply a running window of 8 days. . . Why 8 day window? What is the idea for such choice? What to do with such background if these 8 previous days were disturbed?

What I have seen in several works is a 10 day window (Liu et al., Ann Geophys., 2004; Hasbi et al., NHESS 2011; Li et al., Geodesy and Geodynamics 2015; Sharma et al., Quaternary International 2017). I have actually ran my software for 8, 9, 10 ,11, and 12 days and the results of the maps were quite indistinguishable. I have chosen a 8 day window due to the quantity of IONEX files I downloaded from CODE, and which allowed me to see the behaviour of the ionosphere in DVETC maps up to 4 days after the storm. If it is a wish of the referee I could changed the maps to the result I get from a 10 day window, but as I mentioned there won't be a noticeable change.

7) L 17 P3 Figure 1 shows that Kp = 8 during the last 3 hours (UT) of March 7 and the first three hours of March 8. March has not been discussed yet in the paper.

Thank you very much for pointing that out. I corrected from "March" to "September". It was also one of the concerns from referee #1.

8) A positive storm phase (the first phase) of a two-phase ionospheric storm is a normal reaction of the day-time mid-latitude ionosphere to a strong geomagnetic storm (started in the daytime sector). Some examples and mechanisms may be found in J. Atmos. Solar-Terr. Physics., 81-82, 59-75, 2012." Two types of positive disturbances in the daytime mid-latitude F2-layer: Morphology and formation mechanisms".

L 1 P 5 Looking at the figure 2 I see that the increase of TEC is more extended versus the mid-latitude in the Southern hemisphere but it is possible to see it also in the northern hemisphere. So for my point of view is not a localized enhancement .Looking at the paper by Lei et al. (2017 - 0.1029/2017JA02516) that analyze the same event with TEC and ionosonde data and in their figures it can be seen an increase of differential TEC for all latitudes in the first hours of 8 September, that corresponds to the storm main phase, in the northern hemisphere and in the southern also(but they arrive at 24 degree in latitude)that correspond to a positive ionospheric storm. In the following days a negative ionospheric storm occurred from higher to lower latitude. So it is a typical ionospheric storm with a positive and negative phase , the physical mechanism for the positive phase occurred at 02UT(daytime) that the author identify as a localized event seeing only the figure at 2UT could be due to an expanded convection electric field dur- ing geomagnetic storms in these cases frequently it is observed dTEC enhancements in the mid latitude dayside ionosphere but more investigations are necessary.

This concern is basically the same as concern 2) in page C2 of your interactive comment. Hence, I give the same reply that I give to comment 2):
As you are pointing out more investigations are necessary for the "expanded convection electric field dur- ing ...". I am also indicating in the very last sentence of the conclusion section that further observations are necessary because the mechanism I am putting forward (a contribution of the super-fountain effect) is not my definite

conclusion. Based on Fig.3 from Edemskiy et al. Ann. Geophys. vol 36, pp. 71-79, 2018, if you could observe at the LTE (plume) located at 35°S, this LTE has an extended shape along the mid-latitude, which is similar to the one I am indicating for the September 8, 2017 storm. Hence, following the published results from Edemskiy et al.2018, it is my point of view that the extension south of the EIA during the September 8, 2017 storm is a LTE.

In general the paper does not present either any new morphological effect or physical interpretation. I cannot recommend this paper publication.

As in the paper of Edemskiy et al. Ann. Geophys. vol 36, pp. 71-79, 2018, my work presents a new result in the area of LTEs, so I am convinced that it can provide further insights to the community working in this field. I believe as well there is some physical interpretation to my results. One of them, is that looking into Fig. 3 for the day of the storm (September 9, 2018) the EIA increases, as a consequence of the super-fountain effect, and the crests expand towards the poles. Thus, once again I believe there is a physical interpretation in my work.

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