Dear Editor,

Please find below the review of the manuscript “Response of low to mid latitude ionosphere to the Geomagnetic storm of September 2017” submitted to Annales Geophysicae by Nadia Imtiaz, Waqar Younas and Majid Khan.

The manuscript presents a study of the influence of a geomagnetic storm on the Earth ionosphere. Authors use GNSS derived total electron content data and the horizontal component of the Earth magnetic field measured on the ground as well as O/N2 ratio obtained by the GUVI instrument to analyze the response to the geomagnetic storm of September 7-8, 2017. They use TEC data from global GNSS networks to estimate global and regional total electron content values.

**General comments:**

The paper is well written and structured. The data set used in the paper is publicly available and widely used by other scientists in their studies. In general, every geomagnetic storm is unique, taking into account the combination of space weather parameters preceding and during the storm time. Therefore, the work done by the authors represents an interest and might be considered a novelty. At the same time, the authors do not provide any theoretical background of the processes that cause the ionosphere response. Especially when it comes to the differences in the response delay for different longitudinal sectors. A big amount of work has been done to model the ionosphere response to a geomagnetic storm by the scientific community. E.g. works done by Fuller-Rawell, Vasyliunas, Blanc and Richmond, Fejer and many others provide an inside to the physics behind the scene. Comparison of the experimental data discussed in the paper with the existing theoretical works is essential and has to be performed before the paper can be published. Moreover, some other important information about the details of the data processing is missing in the manuscript.

**Specific comments:**

1. Specify which exactly GIMs have been used in the study. IGS gives access to GIMs created by different providers (CODE, IGS, ESA, JPL etc.)
2. Specify what was the calibration technique used to obtain TEC data for individual GPS stations.
3. Provide the criteria on how the quite days were selected and what were these quite days when computing the difference for REC and GEC and for vTEC from individual GPS stations.
4. Fluctuations in Asia REC show a regular pattern with a local maxima at the beginning of the day (e.g. 5, 7, 8, 9 and 11 September). It should be discussed/explained. A proper selection of the quite days might affect the results in this respect.
5. To understand better the fluctuations of REC and their influence on GEC, please extend Figure 2 plot with the REC computed for the fourth sector.
6. The behavior of vTEC at BAKO station should be discussed/explained. 8 out of 9 days show a significant deviation from a quiet day behavior. Again, the proper selection of quite days might affect this result.
7. For the sake of comparison purposes, please shrink the bottom panel of Figure 4 so that is has the same width as vTEC plots (without colorbar).
8. Provide information on the technique how magnetic field disturbances (D) was computed. At the same time, how daily quite variation (Sq) was computed.

**Targeted comments:**

P.1 L.7 “It is observed that the storm time response of the TEC over the pre-noon sector (Asia) is earlier than Africa and America.” This sentence has to be modified, as it might be confusing when it comes to the time reference the authors refer to. It can be changes to e.g. “It is observed that the storm time response of the TEC over the pre-noon sector (Asia) is smaller than over Africa and America.”

P.1 L.14 “In the modern space era, the strength of the geomagnetic storm is characterized by the minimum Dst”. It is not clear how space era is related to Dst index, as it is based on ground based measurements. Please change/rephrase the sentence.

P.4 L.7 Explain index “*l*” of vTEC (*Iil*) in the formula. Provide information on how vTEC value is computed for a cell, having 4 vTEC values (4 vertices of the rectangle).

P.5 L.5-10 Please make sure you use the correct SYM-H data. According to OmniWeb, the minimum SYM-H was -146nT at 01:08 UT (not -148nT at 2 UT) and the second minimum was -115nT at 13:56 UT (not -122nT at 15 UT). Correct also the statement that two AE maxima of 2000nT and 2500nT coincide with the two peaks in SYM-H. It is not correct. As at the times of SYM-H minima, (01:08 UT and 13:56 UT), AE (according to OmniWeb) equal to 784nT and 1259nT correspondingly. At the same time, the two maxima around that time in AE were 2447nT at 23:43 UT (September 7th) and 2677nT at 14:06 UT (September 8th). Therefore, only the second peak might be considered as “coinciding”, while the first one is definitely not.

P.6 L.10 It would be beneficial to present the vTEC subplot from the fourth sector too.

P.7 L.3 Please explain why disturbed part of H component of the magnetic field has index ‘l’, is it supposed to be ‘i’?

P.7 L.3 Indicate the time of the beginning of the initial phase of the storm.

P.7 L.5 Please specify the time of the beginning and the end of the main phase of the storm.

P.7 L.15 It should be indicated that at the same time as an enhancement in O/N2 ratio is observed at low to equatorial latitudes, it decreases significantly at mid to high latitudes.

P.8 L.2 (also on P.6 L.17) “*Most of the TEC is confined to the equatorial and low latitude regions.*” Please clarify what exactly part of the TEC is discussed in this sentence. It is a regular ionosperic feature to have most of the TEC in low and equatorial latitude regions.

P.8 L.7 It is difficult to understand why the authors acknowledge some of the data centers, but not the others in the acknowledgment section. Please do acknowledge all data centers or only those that are not already mentioned in the ‘Data Sets’ section.

**Typo/language comments:**

Change “SYM – H” to “SYM-H” throughout the manuscript.

Please specify the titles of the papers in the ‘References’ section. It might be challenging for the reviewer to find the corresponding paper based on the information given.

P.1 L.20 Change “to investigate” to “to investigation of”

P.2. L.4 Change "is seasonal dependent" to “"is season dependent"”

P.2 L.7 Introduce abbreviation for the term “International Ground Station”

P.2 L.9 Change “inter planetary” to “interplanetary”

P.2. L.10 Change “The author” to “The authors”

P.2 L.16 Change “clear evidence of a” to “clear evidences of”

P.2 L.20 Change ”Momani” to “Momani (2012)”.

P.2 L.27 Remove “Momani (2012)”

P.2 L.30 Introduce abbreviation for the terms “Global and Regional electron content”

P.2 L.33 Change “and magneto-meter data” to “of the magnetometer data”

P.2 L.34 Change “disturbance Dynamo” to “disturbance dynamo”

P.2 L.34 Change “Crustal movement network of China” to “Crustal Movement Observation Network of China”

P.2 L.35 Change “distort” to “distorts” or “distorted”

P.3 L.3 Change “<<” to “<”, correct subscript “st” to have “Dst”

P.3 L.5 Define abbreviation “CME” for “coronal mass ejections”

P.3 L.14 Change “multi instruments” to “multi-instrument”

P.3 L.16 Change “pulsation” to “pulsations”

P.3 L.18 Start sentence “This paper…” from a new line

P.3 L.18 Change “This paper” to “Present work”

P.3 L.23 Change “Section 2 deals with the” to “Section 2 presents a”

P.3 L.23 Change “data sets and the GPS” to “data sets, GPS”

P.3 L.24 Change “describe” to “describes”

P.3 L.29 Remove “the coronal mass ejection” or “CME”, as it was already defined earlier.

P.3 L.30 Remove “the high speed solar wind stream” or “HSSWS”, as it was already defined earlier.

P.4 L.2 Remove “the interplanetary magnetic field” or “IMF”, as it was already defined earlier.

P.4 L.5 Change “energy transferred from storm” to “energy transfer from the solar wind”

P.4 L.7 Change “450Km” to “450 km”

P.4. L.13 Change “summation is restricted” to “summation being restricted”

P.4 L.17 Please explain term “quasi-definite data” or rephrase.

P.4 L.18 Change “inter-magnet.com” to “<http://intermagnet.org>”

P.4 L.18 Change “shows the geographic location” to “shows geographic locations”

P.4 L.23 Remove “Coronal Mass Ejection”

P.4 L.24 Change “solar flares” to “solar flare”

P.4 L.24 Change “reached on the Earth” to “reached the Earth”

P.4 L.25 Change “CMEs” to “CME”

P.5 L.3 Change “rapid variation” to “rapid variations”

P.5 L.4 Remove “to the value” (from “reaching to the value”) or change to “reaching the value of”

P.5 L.5 Remove “to” (from “reach to the value”)

P.5 L.6 Remove “its” from “to the its”

P.5 L.8 Remove “to” from “reaching to the value”

P.5 L.5-10 Please harmonize “≤” signs in the text. Minimum value of -148nT is not “≤” to -150nT, also -122nT is not “≤” than 130nT. Should it be an “approximately” sign instead?

P.5 L.15-16 Remove “GEC”, “REC” and “vTEC” as they were defined above.

P.5 L.17 Remove “Regional Electron Content” and “Global Electron Content”, leave “REC” and “GEC”

P.5 L.19 Change “by using the five quiet days before the storm” to “by subtracting the quite time variation from the value itself. The quite time variation is computed using five quiet days before the storm…”. Explain what the criteria to select quite days were and what days they were.

P.5 L.24 Change “the individual station” to “individual stations”

P.5 L.25 Change “the panels first to third represent” to “the first to third panels represent”

P.6 L.4 Change “vTEC increases” to “vTEC increase”

P.6 L.14 Change “irregular pattern” to “irregular patterns” or to “an irregular pattern”

P.6 L.19 Change “magnetometer variations” to “magnetometer data variations”

P.6 L.20 Change “Asian” to “Asia”

P.9 L.5 ‘Blagoveshchenskya’ change to ‘Blagoveshchensky’

P.13 “ionosphere disturbance current (blue)” change to “ionosphere disturbance current (red)”