Reply to "Comment on Ionospheric and Magnetic Signature of a Space Weather Event on August 2018: CME and HSSWs by Kader et al. (2023)"

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REPLY
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Reply to "Comment on Ionospheric and Magnetic Signature of a Space Weather Event on August 2018: CME and HSSWs by Kader et al. (2023)"

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This article is a reply to a comment by Kader et al. (2023), https://doi.org/10.1029/2022ja030701.

Key Points:

- A detailed response to Kader et al. (2023, https://doi.org/10.1029/2022ja030701) provided
- A better depiction of GUVI data is made with information about UT
- A correction is made in Figure 2 of Kader et al. (2023, https://doi.org/10.1029/2022ja030701)

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Writing – review & editing: Waqar Younas, Majid Khan

Abstract We agree with Kader et al. (2023, https://doi.org/10.1029/2022ja030701) to the extent that longitudinal axis was flipped, by mistake, in Figure 5a of Younas et al. (2020, https://doi.org/10.1029/2020ja027981). However, claiming that this leads to wrong interpretation of main finding of the work is not true. This only affects one sentence in the Result section of Younas et al. (2020, https://doi.org/10.1029/2020ja027981). Moreover, the claimed corrected figure of Kader et al. (2023, https://doi.org/10.1029/2022ja030701) still has a scaling error which may lead to wrong interpretation of GUVI data. For setting a benchmark for future studies, we propose that either scaling should not be done, or it must be the same for all the considered days. Moreover, Kader et al. (2023, https://doi.org/10.1029/2022ja030701) showed that by taking mean of data points leads to different results, which is possible however it cannot be considered as an error in our work. If they believe that their method gives better explanation, they should publish it as an independent article. The statement of Kader et al. (2023, https://doi.org/10.1029/2022ja030701) about the error in our TEC data is also exaggerated. The article by Bolaji et al. (2021, https://doi.org/10.1029/2020ja029068) provided more insight about latitudinal variations in two sectors and used different GPS stations. Obviously, it is not possible to put all data sets in one study. Hence, stating that Bolaji et al. (2021, https://doi.org/10.1029/2020ja029068) found errors in our TEC results is a misleading statement. Although Kader et al. (2023, https://doi.org/10.1029/2022ja030701) also pointed out an error in Bolaji et al. (2021, https://doi.org/10.1029/2020ja029068), however in their title they only comment about Y20.

First, we thank Kader et al. (2023) who have revisited our study and tried to reproduce some of the results, actually they did find an error in one of the figures (Figure 5a), however their comments afterward are too generic and exaggerated. Here we provide a detailed reply to each of the concerned comment.

1. Comment # 1 (On Figure 5a)

Lines 82–86: As mentioned above, the first error is found in the results given in Figure 5a of Y20 which shows the variations in the [O/N_2] ratio mapped over the latitude-longitude path of the satellite over globe during 25–28 August 2018. The maps are centered at 0° latitude and 0° longitude in all four panels of Figure 5a of Y20, which is generally a practice for the GUVI data set (see e.g., Nava et al., 2016).

1.1. Response

We have revisited the data of Figure 5a and agree with the author's comment. Indeed, there was an error and maps were filliped over the longitude. However, the consequences (as stated by Kader et al., 2023) of this mapping on the main findings are much exaggerated. These maps (Figure 5a) were added to the article in connection with Figure 5b. In response to comment #2, we will show that there is no error in the calculation of Figure 5b.

The only difference that will result—due to this flipping—is one sentence in Section 4.1, that is, "The northern midlatitude regions of American and Pacific sectors show enhancement in [O/N_2] ratio, whereas southern midlatitudes of the Asian sector show an increase on the same day."

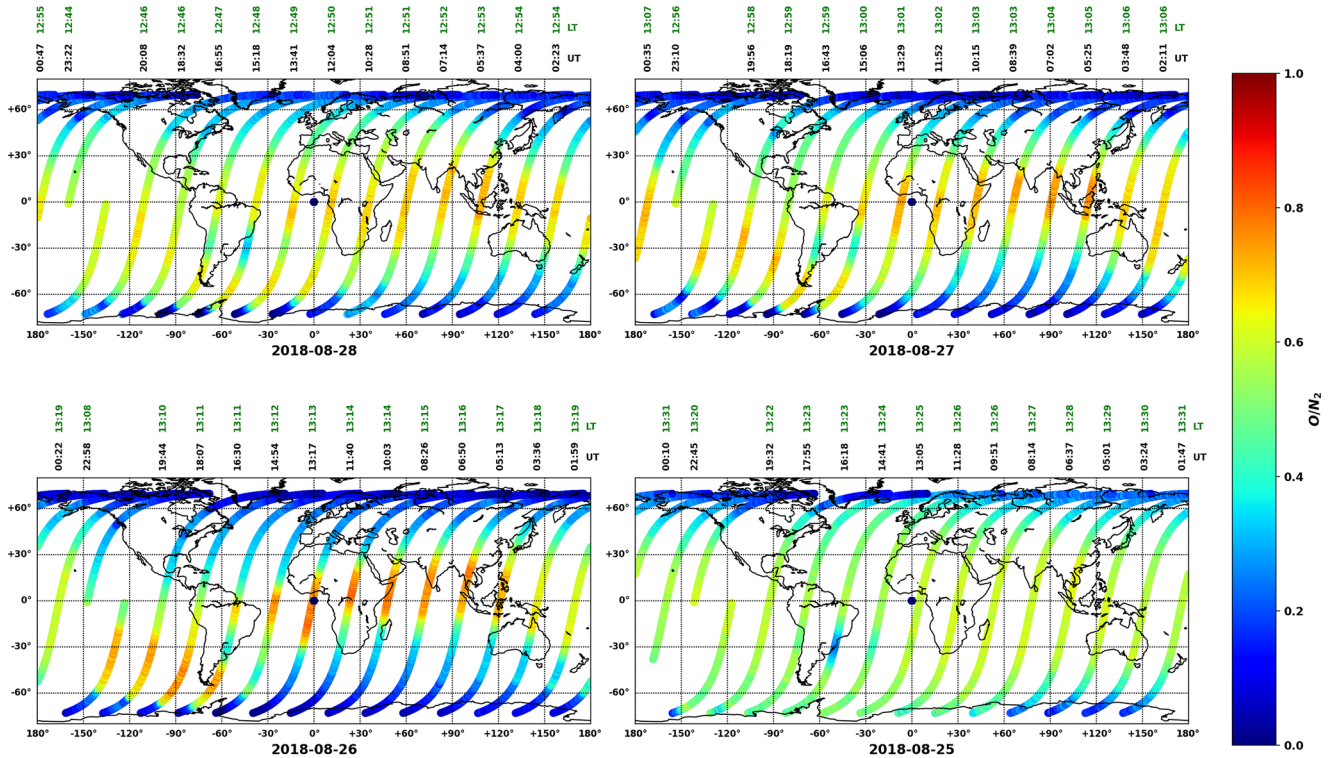

Figure 1. Correct plot of GUVI O/N_2 from 25 to 28 August 2018.

1.2. Now This Should be Read as

"The southern midlatitude regions of American and Pacific sectors show enhancement in [O/N_2] ratio, whereas northern midlatitudes of the Asian sector show an increase on the same day.

Hence, the statement in comment by Kader et al. (2023) "Thus, it is concluded that Figure 5a of Y20 misrepresenting the data set and hence grossly misleading the interpretation." is not true at all. Moreover, as the GUVI data also has information about UT time of measurement. Thus, to avoid such error in future studies, it is suggested that one must also plot time (preferably equator-crossing) during each orbit. This will help to analyze the O/N_2 with reference to UT time along with latitude and longitude. See the corrected Figure 1 (correction to Figure 5a).

However, Figure 2 shows different O/N_2 levels as compared to Figure 2 of Kader et al. (2023). Our investigation indicates that Kader et al. (2023) did a miscalculation while correcting our error. In Figure 2 of Kader et al. (2023) there is a scaling problem. They have normalized each day separately which gives a wrong impression about O/N_2 while comparing different days. Figure 2 shows a reproduction of Kader et al. (2023), by normalizing each day separately. For setting a benchmark to plot O/N_2 data, we suggest that either normalizing should not be performed, or done in the same manner for all the considered days. Moreover, Kader et al. (2023) stated that this flipping of axis has also been repeated in the article by Bolaji et al. (2021), however they correspond to our work only, namely Y20.

2. Comment # 2 (On Figure 5a)

Kader et al. (2023) stated that Figure 5b of Younas et al. (2020) has been reproduced and results contradicts if method of data analysis is changed. They have computed O/N_2 variation by taking mean of available data whereas Younas et al. (2020) used number of data points method.

2.1. Response

This looks inappropriate to comment if different methods give different results. Indeed, if Kader et al. (2023) think their method of data analysis gives better results than Y20, they are encouraged to publish it as an independent article and explain the new (or better) explanation (if any) it can provide to enlighten the community.

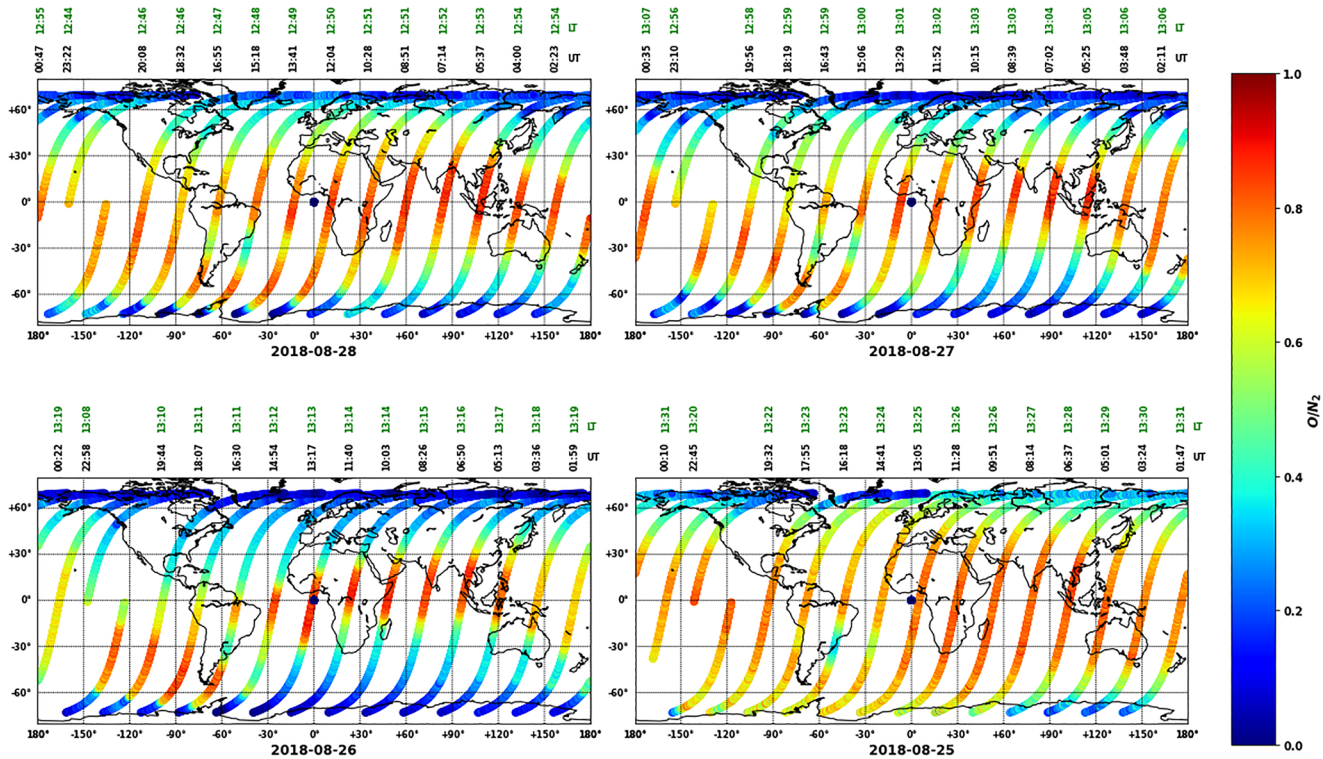

Figure 2. Reproduction of Figure 2 of Kader et al. (2023).

During the peer review of Younas et al. (2020), one of the reviewers has asked to quantify the O/N_2 changes during this storm. We produced Figure 6b in response to that comment. Now, if someone introduced a different scheme, which provides different results, that should not be entitled to a comment on our work.

3. Comment #3 (Bolaji et al., 2021)

Lines 62–63: Their results on TEC (total electron content) from a few stations have already been found to be incorrect, and are corrected by Bolaji et al. (2021).

3.1. Response

Yet again, this is totally false and misinterpreted argument. There is no error in our TEC data. There are more than 500 GPS stations installed around the globe, and it is not possible to add the data from all stations in one study.

We computed GEC/REC and contour maps from GIMs. To further investigate, we have used 09 GPS stations corresponding to three longitudinal sectors. The TEC data at individual station is calibrated by using the method of Ciraolo et al., 2006.

The mentioned article by Bolaji et al. (2021) is titled as "Storm Time Effects on Latitudinal Distribution of Ionospheric TEC in the American and Asian-Australian Sectors: 25–26 August 2018 Geomagnetic Storm." This work presents a more detailed discussion on latitudinal distribution of TEC in two sectors. Figure 3 depicts the locations of GPS stations used by Bolaji et al. (in blue) and Younas et al. (2020) (in green). There would have been error in our work only if Bolaji et al. (2021) had used the same GPS stations and found different results. However, Bolaji et al. (2021) *have used different stations and found some interesting doubly humped peaks*. Thus, it cannot be said that there was an error in results because comparison between identical stations should be made. See the text of Bolaji et al. (2021).

"Interestingly, we observed that a double-humped increase (DHI) seen at a middle latitude station (MGUE, ~22°S) after the MP on the dayside in American sector (Younas et al., 2020, https://doi.org/10.1029/2020JA027981) did

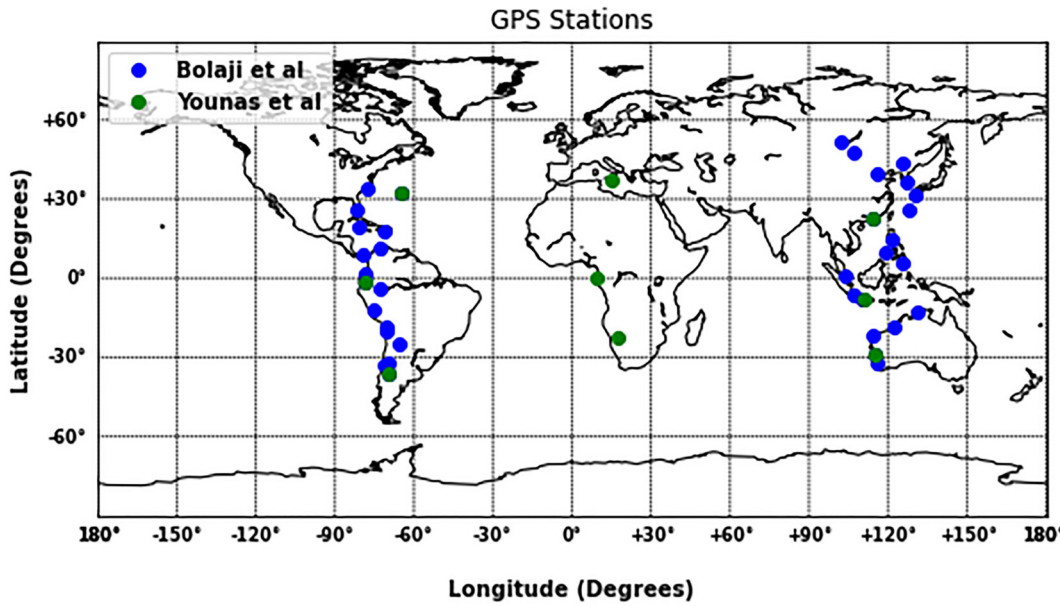

Figure 3. Locations of the GPS stations, used by Bolaji et al. (2021) (in blue) and Younas et al. (2020) (in green), for TEC analysis of August 2020 storm.

straddle ∼23.58°N and ∼22°S. On 25 August 2018, storm commencement was evident in SYM-H (∼−8 nT) around 18:00 UT. It later became intensified (∼−174 nT) on August 26 around 08:00 UT. During storm's MP (after the MP), fountain effect operation was significantly enhanced (inhibited) in Asian-Australian (American) sector."

In fact, Bolaji et al. (2021) have cited our work as a reference and not as a contradiction.

4. Conclusion

Based on the response provided in Sections 1 to 3, we conclude the following:

1. We agree with Kader et al. (2023) to the extent that longitudinal axis was flipped, by mistake, in Figure 5a of Younas et al. (2020). However, claiming that this leads to wrong interpretation of main finding of the work is not true. This only affects one sentence in Result section of Younas et al. (2020).
2. The corrected figure of Kader et al. (2023) still has a scaling error which may lead to wrong interpretation of GUVI data.
3. For setting a benchmark for future studies, we propose that either scaling should not be done, or it must be the same for all the considered days.
4. Kader et al. (2023) showed that by taking mean of data point leads to different results. This is totally possible and cannot be considered as an error in our work. If they believe that their method gives a better explanation, they should publish it as an independent article.
5. The statement of Kader et al. (2023) about the error in our TEC data is exaggerated. In particular, the studies by Bolaji et al. (2021) provided more insight about latitudinal variations in two sectors and used different GPS stations. Obviously, it is not possible to put all data sets in one study. Hence, stating that Bolaji et al. (2021) found errors in our TEC results is a misleading statement.
6. In their comment, Kader et al. (2023) pointed out an error, even in the article of Bolaji et al. (2021) However, their comment is titled about Younas et al. (2020) only.

Data Availability Statement

The authors are thankful to the TIMED/GUVI management team (http://guvitimed.jhuapl.edu/) for providing thermospheric O/N_2 data used in this work.

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