Response to Referee #1 :

Response to the comments on amt-2021-195 by the reviewer 1.

General comments:

1. The most significant issue is that some information how the reported O/N2 values (and the brightness of the O and N2 emissions used in deriving the O/N2) compare with other observations, as was done form the NmF2 observations, is needed. The lack of such information is a major shortcoming of the current paper. Such information is needed for others to understand the value of the observations and their limitations.

Answer: Thanks for the constructive comments. We added details on deriving the O/N_2 from the brightness of the O and N_2 emissions, and added the result of O/N_2 product compared with GUVI.

"Giving an N_2 depth of 10^{17} cm^{-2}, column O and N_2 ratio is derived from the value of at a given SZA by two dimensional interpolation. The retrieval algorithm could refer in relevant paper (Strickland et al., 1995; Zhang et al., 2004). The brightness of 135.6 nm emission and N_2 LBH emission on dayside were derived from observations of the 135.6 nm dayside channel and the N_2 LBH dayside channel respectively. In order to further deducting the red-leak from the cloud top, we used a Butterworth filter in data processing. The improved AURIC model (Wang and Wang, 2016) was used to produce a simulation. The simulation provided the coefficient of deriving O/N_2 from a measured pair of 135.6 and LBH. The column O and N_2 ratio during the magnetic storm of Aug. 26, 2018 was presented in Fig. 9a. On 24 August 2018 and most of 25 August 2018, Kp index was not more than 3. It abruptly rises to 7 in 26 August 2018. From 29 to 31 August 2018, Kp index was not more than 3. The column O/N_2 on 24 and 25 August was relatively quiet, and significant changes in column O/N_2 occurred on 26 and 27 August. The reduction of O/N_2 extended from the high-latitude region to mid- and low- latitude regions in the Northern and Southern Hemisphere. On 30 and 31 August, the column O/N_2 returned to quiet.

The column O and N_2 ratio derived from GUVI during the magnetic storm of Aug. 26, 2018 is presented in Fig. 9b.Fig. The GUVI column O/N_2 data (Strickland et al., 2004) was obtained from GUVI website (http://guvitimed.jhuapl.edu/data_fetch _l3_on2_ idlsave). The column O/N_2 from GUVI on 24 and 25 August was relatively quiet, and significant changes in column O/N_2 occurred on 26 and 27 August. The reduction of O/N_2 also extended from the high-latitude region to mid- and low- latitude regions in the Northern and Southern Hemisphere. On 30 and 31 August, the column O/N_2 of GUVI also returned to quiet. The features of column O/N_2 of IPM and GUVI during the magnetic storm of Aug. 26, 2018 were similar. These results showed that the IPM data could provide a good monitoring of O/N_2 changes during the magnetic storm."

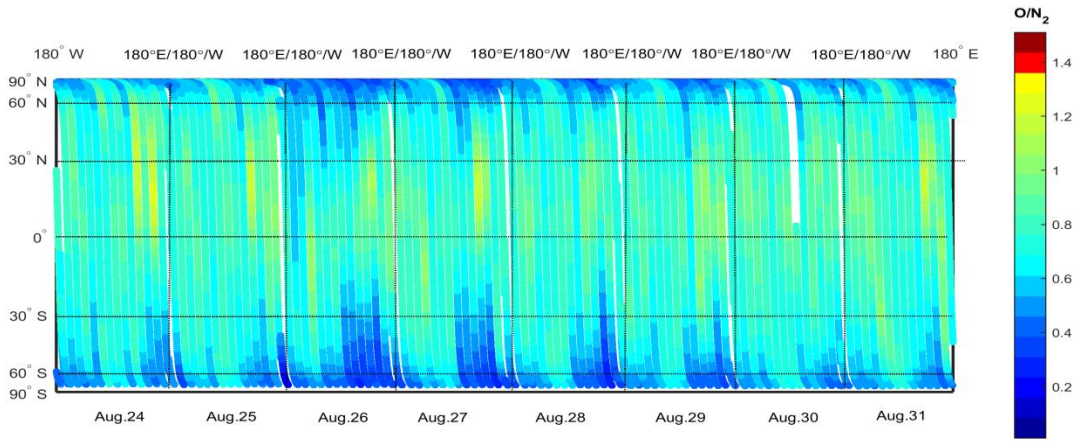

Figure 9a: Column O/N2 from IPM around the magnetic storm of Aug.26, 2018.

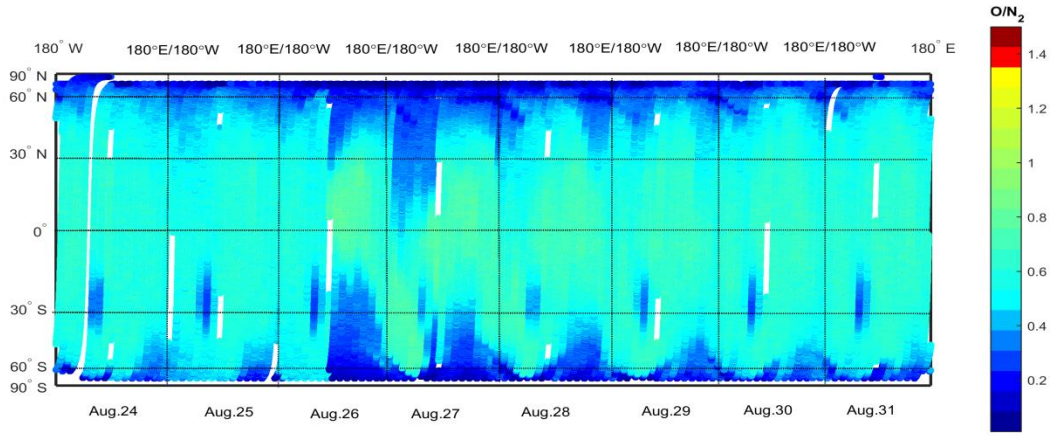

Figure 9b: Column O/N2 from GUVI around the magnetic storm of Aug.26, 2018.

2. A minor issue is that substantial editing for clarity is also needed the paper. Some specific suggestions are included below.

Answer：We re-edited the whole paper according to the referee's comments.

The observations described are potentially very valuable for understanding the effects of geomagnetic activity on the composition of the thermosphere and worthy of publication if their relative differences from and consistency with other O/N2 observations can be quantified.

3. Specific comments and technical corrections:

- Line 19: delete "properly".

[It is corrected according to the referee's comments.]

- Line 21: change "designed requirement" to "design requirements"

[It is corrected according to the referee's comments.]

- Line 26: "can present" doesn't work well, perhaps "represents the" or "is representative of the"?

  [It is corrected according to the referee's comments.]

- Line 27: add space between "N_2" and "LBH" (also throughout the paper) and "can be" to "is". Wording of the sentences could be more concise ("FUV radiation" is repeated).

  [We added a space between "N_2" and "LBH" throughout the manuscript. We have reworded the sentence: "The Earth's atmosphere is opaque to the FUV radiation due to the lower atmosphere absorption.".]

- Line 28: delete "characteristics of"

  [It is corrected according to the referee's comments.]

- Line 29: Delete the sentence that begins on this line or reword to combine with previous sentence. It's redundant with the previous sentence.

  [We have reworded the sentence: "The Earth's atmosphere is opaque to the FUV radiation due to the lower atmosphere absorption.".]

- Line 31-33: move "based on satellites" to after "ionosphere" and reword slightly ("from satellites" perhaps). Also, delete comma after "as" and "2003)"

  [We have reworded the sentence: "In past decades, FUV spectrography has been used extensively in studying the thermosphere and ionosphere from satellites, such as GUVI (the Global Ultra-Violet Imager) on the NASA TIMED (Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics) satellite (Christensen et al., 2003) and the Far Ultraviolet Imager (FUV) on the NASA IMAGE (Imager for Magnetopause-to-Aurora Global Exploration) satellite (Sagawa 35 et al., 2005).".]

- Line 35: If the photometer is being used for the thermosphere also, why is it an "ionospheric photometer"? change "equipment" to "instrument".

  [Good suggestion! But the instrument has been named and we can't change it. Maybe we can use this name for the next generation.]

  [We have reworded the sentence: "The other useful instrument is ionospheric photometer, which is compact and high-sensitive."]

- Line 36: Photometer suitable for observations of the nighttime ionosphere were made and flown decades before NRL's instrument (e.g., https://doi.org/10.1029/JA085iA05p02201, and there are probably earlier examples).

[Thanks. We added "The photometer on the polar-orbiting Department of Defense satellite S3-4 was used in measuring of the airglow, aurora, and solar scatter radiance of the earth's atmosphere (Huffman et al., 1980).".]

[We deleted "firstly".]

- Line 46: "leak" to "leaks"

  [It is corrected according to the referee's comments.]

- Line 52: suggest changing "and designed" to "and is designed"

  [It is corrected according to the referee's comments.]

- Line 57: delete "parameters"

  [It is corrected according to the referee's comments.]

- Line 59: use plural "photometers"

  [It is corrected according to the referee's comments.]

- Line 81: "added in" to "added in the"

  [It is corrected according to the referee's comments.]

- Line 82: Rewording is needed. Airglow at longer wavelengths is the problem, the wording "airglow below 180 nm" indicates that it is the shorter wavelengths. May be clearer to say whether it is longer or shorter wavelengths.

  [We have reworded the sentence: "Based on the design of dayside or nightside channel, a SiO_2 filter is added in red-leak channels in order to eliminate emission longer than 180 nm.".]

- Lines 91-93: delete "times" and use plural "observations" for cases with >1 observation.

  [It is corrected according to the referee's comments.]

- Line 96: first "ground" to "the" and delete "in the ground laboratory".

  [It is corrected according to the referee's comments.]

- Line 101-102: The deuterium lamp is completely with a vacuum environment, and the monochromator? That's what the wording indicates. Seems unlikely and at least unnecessary. A more accurate description may be needed. Typical facility would have vacuum only within the monochromator.

  [We have reworded the paragraph: "The optical calibration facility in ground has a deuterium lamp, a monochromator, a collimator, a diffuser, a standard detector and a vacuum chamber assembled in a modular pattern（Fig. 2）. The deuterium lamp (L11798) with a MgF_2 window has 150W power and provides a bright, stable source of

FUV radiation. The source of FUV radiation is wavelength-selected by the monochromator (234/302) which has a *f*/4.5 0.2 m 100 Czerny-Turner with a 1200 grooves/mm grating. A collimator ensures that the beam consists of parallel rays. The standard detector (AXUV-100G) traced from NIST provides a reference for calibrating IPM.”]

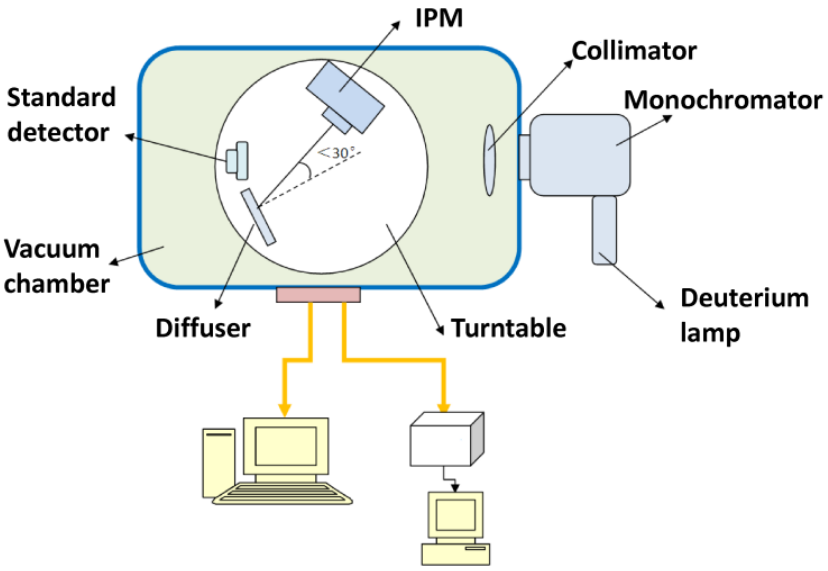

Figure 2: The optical calibration facility in ground

[We deleted the sentence “The entire facility is installed in a vacuum environment which allows the propagation of radiation in the far ultraviolet.”.]

- Line 106: delete “following” and “from a” to “from the” (unless multiple lamps are attached at the same time).

  [It is corrected according to the referee’s comments.]

- Lines 107, 108, 109, 110, 111: “wavelength-selected light” to “wavelength selected”?

  [Yes, It is corrected according to the referee’s comments.]

- Line 109: “counts”, plural, or “signal”; possible “for” rather than “of”. ????

  [Yes, It is corrected according to the referee’s comments.]

- line 126: “red-leak in daytime” to “red-leak contributions in the daytime”?

  [Yes, It is corrected according to the referee’s comments.]

- line 127: “red-leak in daytime” to “red-leak contributions”?

  [Yes, It is corrected according to the referee’s comments.]

- Line 137: < 10 per second, or what time interval?

  [Yes, It is corrected according to the referee's comments.]

- Line 138: delete "a peak" and "high".

  [It is corrected according to the referee's comments.]

- 2000 counts for what time interval?

  ["2000 counts" should be "2000 counts per second". It is corrected according to the referee's comments.]

- Might also substitute "in" for "over" since the satellite is flying through region containing energetic particles.

  [It is corrected according to the referee's comments.]

- Line 145: by "without red-leak" you mean "with the red-leak signal subtracted"?

  [Yes.]

- Line 146: delete "which deducted the count of red-leak"? (phrase seems redundant)

  [Yes, It is corrected according to the referee's comments.]

- Line 149: "deduct"? ???

  [We have replaced "deduct" with "eliminate".]

- Line 150: "The" to "An"

  [It is corrected according to the referee's comments.]

- Line 153: "condition kept quiet relatively" to "conditions were relatively quiet"

  [It is corrected according to the referee's comments.]

- Line 154: "The example" to "An example", unless these are the only data collected.

  [It is corrected according to the referee's comments.]

- Line 155: "oneither" needs a space between words.

  [It is corrected according to the referee's comments.]

- Line 156: "EIA has" to "The EIA has"?

  [Yes, it is corrected according to the referee's comments.]

- Line 163: "have been" to "have also been"?

  [Yes, it is corrected according to the referee's comments.]

- Line 166: “further” rather than “furtherly”

  [It is corrected according to the referee’s comments.]

- Line 187: “2014).”? Something seems to be missing.

  [Yes, one sentence was missing. We added “Similarly, the brightness of the nighttime OI 135.6 nm emission is also used to calculate ionospheric TEC by the ratio between TEC and the nighttime OI 135.6 nm emission (Jiang et al., 2014).”.]

- Line 181-190: is this agreement you give with NmF2 and TEC typical when observations are compared?

  [Yes, it is.]

- Lines 194-195: wording in the phrase “that the…F2-layer” doesn’t make complete sense, it almost does but something seems off.

  [We have reworded the sentence: “There is diurnal interchange between the ionosphere and the plasmasphere, the downward diffusion from the plasmasphere helps to maintain the nighttime F_2-layer.”]

- Line 196-198: wording, “at day the contribution…of the ionosphere.” Needs some rewording to be clear (unclear what “less than one of the ionosphere” means) and somewhat odd use of prepositions (“at day the contribution” to “on the dayside, contributions” perhaps).

  [“The results of Jason-1, Metop-A, and TerraSAR-X (Yizengawa et al., 2008; Zakharenkova and Cherniak, 2015; Klimenko et al., 2015) show the plasmasphere contribution at night can’t be neglected.”]

  [“MIT TEC is intergraded from ground to 20200Km. It includes plasmasphere contribution and ionosphere contribution. IPM TEC is intergraded from ground to 830Km, it only includes ionosphere contribution.”]

- Line 201: “Auroral emission can be derived from the 135.6…”? But 135.6 nm is an auroral emission, nothing to derive, just observe it.

  [We deleted the paragraph about aurora after considerations.]

- Lines 203-205: Unclear why the sentence that begins on line 203 is included. This is the only mention of the WAI instrument in the paper. If it is included, more relevance to the current paper should be added.

  [We deleted the paragraph about aurora after considerations.]

- Lines 210-213: The two sentences, immediately following the auroral discussion, may give an incorrect impression. Column O/N2 derivation would be from dayglow observations, but not from auroral.

  [We deleted the paragraph about aurora after considerations.]

- Line 219-220: Needs some minor rewording for clarity, unless the 135.6 nm brightness can be derived from either channel. Maybe just say the 135.6 nm brightness can be derived "using" the dayside 135.6 nm and N2 LBH channels?

  [Sorry, we missed some words. We added "The brightness of 135.6 nm emission and N_2 LBH emission on dayside can be derived from observations of the 135.6 nm dayside channel and the N_2 LBH dayside channel respectively.".]

- Line 221: "cloud top" to "cloud tops"

  [It is corrected according to the referee's comments.]

- Line 223-224: "result of column O and N_2 ratio", simplify to "column O/N_2 ratio"?

  [It is corrected according to the referee's comments.]

- Line 230: suggest spelling out the name of the satellite (FY3D) the first time it's mentioned in the conclusions, then using the abbreviation (as on line 231) if desired.

  [It is corrected according to the referee's comments.]

- Line 235: How do the changes seen in O/N2 compare with other observations? There are probably TIMED/GUVI observations available to compare against. Later storms could possibly be compared with O/N2 observations from the GOLD mission, in addition to GUVI. Some comparison of the reported O/N2 values with other observations, as was done form the NmF2 observations, is needed in the paper.

  [**We have added the result of O/N_2 product compared with GUVI. Please refer to the first item of our response.**]