Response to Referee #2 :

Response to the comments on amt-2021-195 by the Referee #2.

1. The manuscript describes the data and products from an ionospheric photometer (IPM). The IPM measures FUV emissions, such as O 135.6 nm and N_2 LBH bands. It is a sensitive instrument. The data products include TEC, NmF_2 and O/N_2 column density ratio. They are useful data products. However, it lacks of details on the methods for estimating these products. The O/N_2 product is not validated or compared with existing O/N_2 data from other missions. Some of the O/N_2 features, likely artifacts, are not discussed.

Answer: Thanks for the constructive comments. We added details on estimating NmF2, TEC and O/N2 column density ratio. And we added the result of O/N2 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."

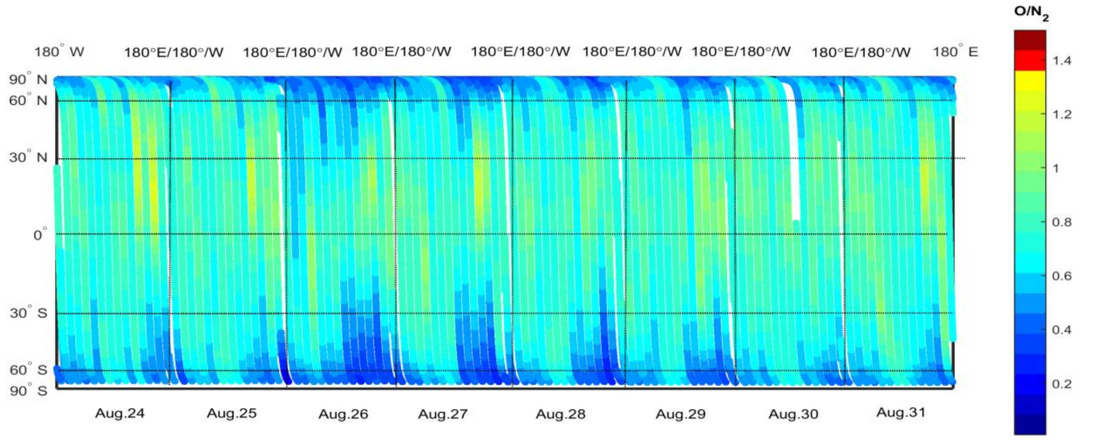


Figure 9a: Column O/N_2 from IPM around the magnetic storm of Aug.26, 2018.

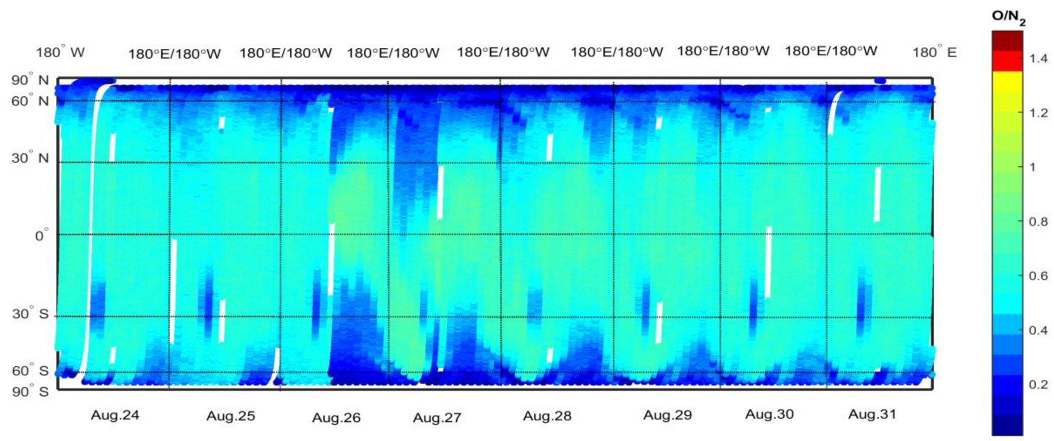


Figure 9b: Column O/N_2 from GUVI around the magnetic storm of Aug.26, 2018.

2. Specific comments

- Are the IPM data open to public for an independent evaluation since that data in published papers are usually required to be accessible by public?

  [Yes, the IPM data is available at http://satellite.nsmc.org.cn/PortalSite/Default.aspx.]

- IPM calibration was done on ground. Was IPM calibrated in orbit?

  [No, the IPM aboard on the Feng Yun 3D meteorological satellite couldn’t calibrated in orbit.]

- Fig 2 (nightside channel). The non-zero responsivity around and below (likely) 130 nm suggests it is possible to pick up bright Lyman α emission around 121.6 nm. A discussion on this will be helpful. Fig 3. Dayside. Both bright 130.4 and 121.6 nm emissions could contribute the 135.6 channel.

[A BaF_2 flat filter is used for short-wavelength cut, the transmittance shorter than 131nm is less than 2%, and it can cut 121.6nm radiation completely.]

- Figure 4. The LBH band includes emission of N-1493, NO ε band, etc. Does the algorithm ignore the impact of none N2 LBH emissions?

[At present our algorithm can't ignore the impact of none N_2 LBH emissions.]

- Fig 5. It is necessary to show the data from the red leak channel. Furthermore, what is the responsivity of the red leak channel?

[We added two panels in Fig. 5 in order to show the count of the red-leak channel.]

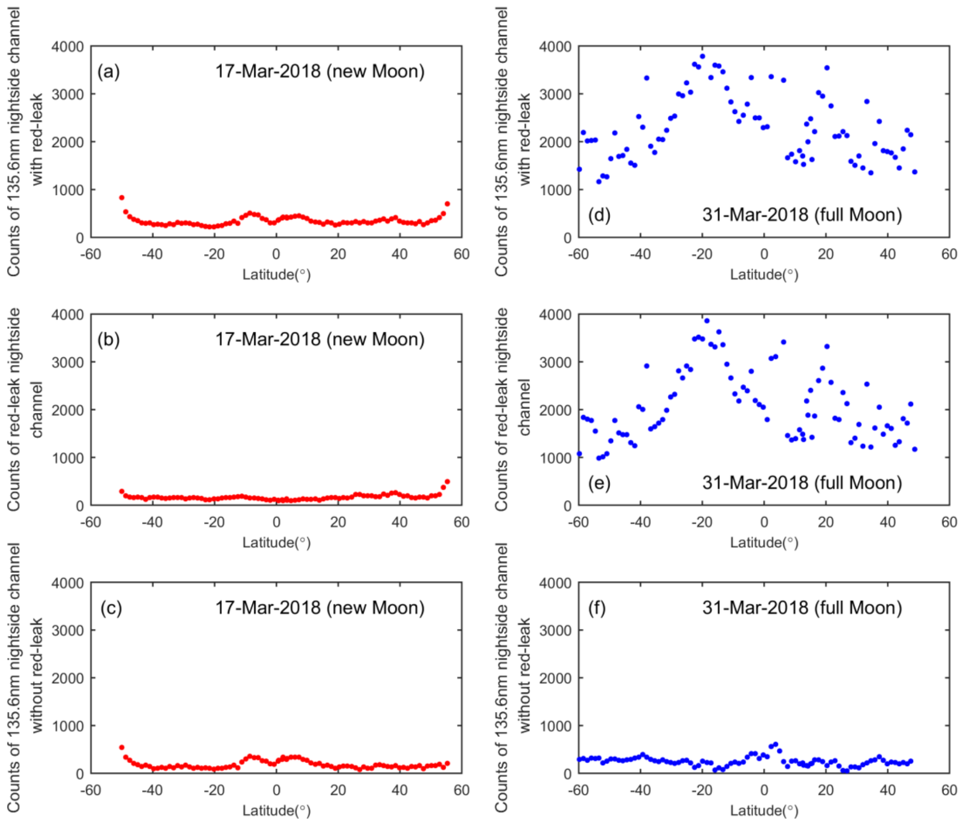


Figure 5: The count of the 135.6nm nightside channel with red-leak (top), without red-leak (bottom), and the count of the red-leak nightside channel (middle) for new Moon (left) and full Moon (right) situation, respectively. March 17, 2018 is new Moon day, and March 31, 2018 is full Moon day.

- Fig 6b. Change the color bar to show the equatorial arcs.

[We have changed the color bar in Fig 6b. in order to show the equatorial arcs.]

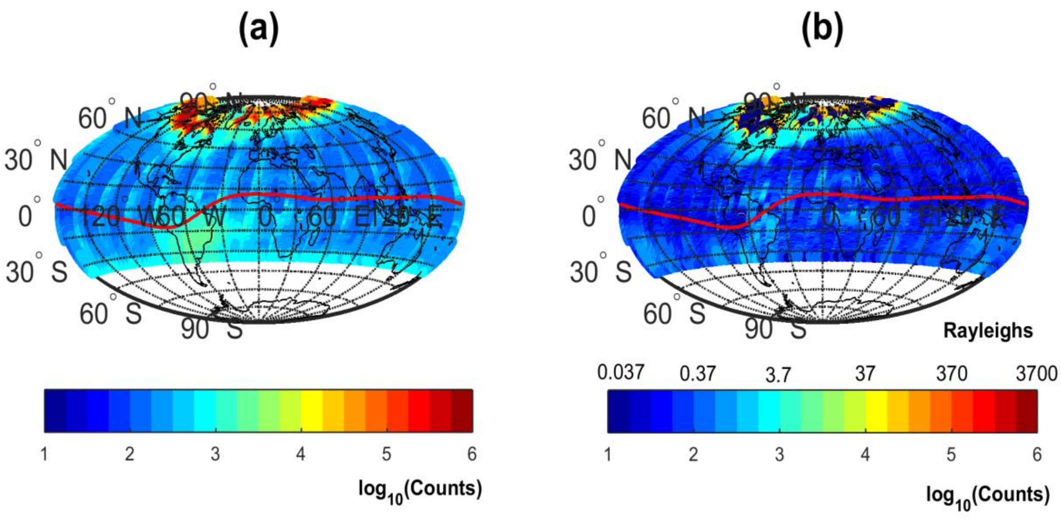


Figure 6: The global count (left) and brightness (right) of the 135.6nm nightside channel from 7 to 11 December 2017. The brightness is without red-leak and the effect of dark count. The red solid line indicates the magnetic dip equator.

Is the SAA contamination removed in the same way as the red leak? If yes, why can it be done this way? If not, describe the method.

[The dark count of the IPM is less than 10 per second generally. The SAA contamination makes the dark count increase significantly. Both the count of 135.6 nm nightside channel and the count of red-leak nightside channel include dark count contribution. The SAA contamination is removed by differencing measurements of 135.6 nm nightside channel and red-leak nightside channel.]

- The plots show that data cover the entire Earth. Does the photometer scan in a cross track direction?

  [No, it doesn't. The plot is a merging map using five days data.]

- Line 175. How can one estimate NmF2 based on the ratio between NmF2 and 135.6 nm intensity? It needs more details on the method.

  [We have reworded the sentence and added more details on the method: "The algorithm of deriving NmF_2 from the night time OI 135.6 nm emission is provided by Rajesh et al. (2011) and Jiang et al. (2014, 2018). The night time OI 135.6 nm emission is calculated based on nighttime OI 135.6 nm airglow radiative and emissive model. The electron density profile, O^+ density profile, and electron temperature profile are calculated using IRI2000 model, and the neutral components are calculated using MSISE90 model. The OI 135.6 nm emission is fitted to the square of NmF_2 linearly. The ratio of the square of NmF_2 to the OI 135.6 nm emission is

obtained. Finally, NmF_2 is retrieved based on the observed OI 135.6 nm emission and the ratio."]

- Figure 8. The derived NmF2 should be plotted in the same format of Figure 6 to show the ionosphere morphology. It also needs a map of errors in the derived NmF2. What is the altitude of the Feng Yun 3-D? If the altitude is around NmF2 or above, the method wouldn't work.

[**The nighttime OI 135.6 nm airglow is proportional to the square of the maximum electronic density of ionospheric F_2 layer(NmF_2). The distribution of NmF_2 is similar to the distribution of the OI 135.6 nm airglow. We added a plot of the relative difference distribution (Fig. 8) between IPM NmF_2 and IGGCAS ionosonde NmF_2. There is a standard deviation of 26.67% between IPM NmF_2 and IGGCAS ionosonde NmF_2.]**

[The FY3D is an afternoon sun-synchronous satellite with an orbit altitude of 830 km. The algorithm of deriving NmF_2 from observed OI 135.6 nm emission is discussed by Rajesh et al (https://doi.org/10.1029/2010JA015686).]

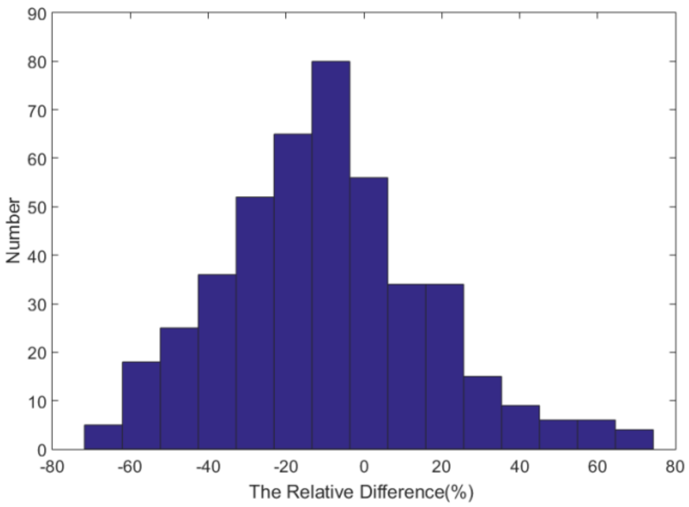


Figure 8: The relative difference distribution between IPM NmF_2 and IGGCAS ionosonde NmF_2

- Line 165. What is the local time of the observations in other studies?

[The local time of GUVI on board TIMED satellite is near noon at the equator. The local time of the IPM orbit is about 2:00 am at the night-side equator.]

- Line 180. How is the TEC estimated using the 135.6 nm radiance?

[The algorithm of deriving TEC from the night time OI 135.6 nm emission is provided by Rajesh et al. (2011) and Jiang et al. (2014). The process of deriving TEC based on the ratio between TEC and the night time OI 135.6 nm emission intensity is similar to that of deriving NmF2.]

- Line 215. The net 135.6 nm and LBH radiances are estimated already. What is the reason to use a Butterworth filter to estimate the red leak due to cloud?

  [The IPM monitors 135.6 nm and N_2 LBH emissions in the day-side thermosphere by employing a filter wheel. The 135.6 nm dayside channel and the N_2 LBH dayside channel are asynchronous during observation. Fast varies from cloud tops could enter these channels, and make the count of these channels increase sharply. It leads to some of the O/N_2 features, such as sporadic enhanced O/N_2. We used a Butterworth filter in order to eliminate fast varies from cloud tops.]

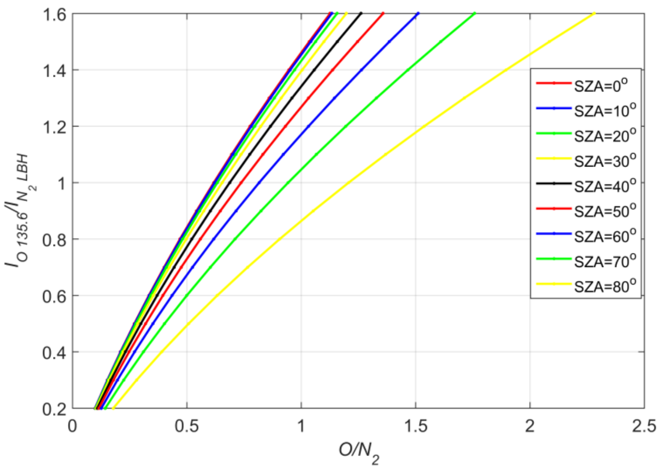
- This reviewer found a reference Wang and Wang 2016. It has the same title " Airglow simulation based on the Atmospheric Ultraviolet Radiance Integrated Code of 2012" and author names. Is this the same to the reference (Wang and Wang, 2015)?

  If they are the same paper, this reviewer couldn't find a AURIC based lookup table for the IPM O/N2 calculation.

  [Yes. The reference (Wang and Wang, 2016) provided an airglow simulation method based on the Atmospheric Ultraviolet Radiance Integrated Code. We used the method to obtain a lookup table that provides the coefficient of deriving O/N_2 from a measured pair of 135.6 and LBH values.]

- Line 220. A plot of the O/N2 look up table should be added in the manuscript.

  [The manuscript focuses on the instrument validity of the IPM. The O/N_2 is provided only as a product sample. The process of deriving the O/N2 from the brightness of the O and N_2 emissions was discussed (Strickland et al., 1995; Zhang et al., 2004), and isn't the focal point of the manuscript. We did not describe it in detail in the manuscript. The following plot is our response to the referee.]



- Since both 1356 and LBH channel include LBH, N-1493, NO ε bands. Are the contributions removed?

[At present our algorithm can't ignore them.]

- Figure 9. How is the O/N2 data product validated? O/N2 depletion was seen on Aug 26, 2018 (storm-time). What are the sporadic enhanced O/N2 (vertical bars in red) over one or two orbits? Are they artifacts? If not, what cause the enhancements? What is the reference N2 column density for the O/N2 ratio?

  [The sporadic enhanced O/N_2 (vertical bars in red) was originated from cloud tops reflection. The 135.6 nm dayside channel and the N_2 LBH dayside channel of the IPM are asynchronous during observation. Fast varies from cloud tops could enter these channels, and make the count of these channels increase sharply. It leads to some of the O/N_2 features, such as sporadic enhanced O/N_2. We optimized our filter algorithm and updated the result of O/N_2 product. And we added the result of O/N_2 product compared with GUVI. Please refer to the first item of our response. The reference N_2 column density is 10^{17} cm^{-2} for the O/N_2 ratio.]