Anonymous Referee #2

Chiang et al. demonstrate the influence of meridional wind and neutral temperature to the intensity of 630.0 nm nightglow around the equatorial midnight, altering the SAMI2 model for the resulting plasma density and temperature with the inputs from NRLMSISE-00 for neutral densities and the HWM-93 for neutral wind vectors. The work is potentially interesting and novelty to the community, particularly the finding with respect to the neutral temperature. However, the literature survey by the authors seems to be hasty, the major lacking is that the role of meridional wind to the midnight 630.0 nm airglow enhancement seeing by ISUAL Imager has been studied and published (Rajesh et al.(2014) doi 10.1002/2014JA019927). In addition, the manuscript requires an editing for English before it can be published in the peer-review journal. Given the interesting result and a very valuable dataset, I encourage the authors in extending the content in greater detail that be able to deliver the science finding clearly. Please see further comment below. Summary: Consider for publication after substantial revision Major points:

We thank the Reviewer for reading our article carefully and providing many valuable suggestions for improving the manuscript. We revise the manuscript by taking into account the Reviewer's comments. We also extend the contents and include the observation results in this manuscript in accordance with the Reviewer's suggestions.

(1) Observation data Since the satellite data are used, it would be appropriate to cite Frey et al.(2016) (doi 10.1002/2016JA022616) for the instrument details and the first results of the limb imaging of 630.0 nm airglow using ISUAL by Rajesh et al. (doi 10.1029/2009JA014087). The authors put the observation data in the Supplement for some reasons, but it could be nicer if move the section to the main content. The observation data deserve more attention and discussion.

The main purpose of this study is to understand the influence of temperature and meridional neutral wind on the 630.0 nm nightglow by calculating the volume emission rates. The observations by ISUAL can help us realize the tendency in typical solstice condition. In our previous manuscript, we merely wanted to state that our simulations can easily reproduce the selected short-period cases of the brightness patterns observed by ISUAL. But case-study results are not our main points. Considering the observational data that we can access, we suggest that statistical analyses are a more appropriate method to unveil the midnight brightness mechanism.

So in the previous manuscript, we put the observation data in the Supplement. Since Referee #2 thinks that the observation data deserve more attention and discussion, we agree to move them to the main contents. Moreover, we also add the two references suggested by Referee #2 in our manuscript.

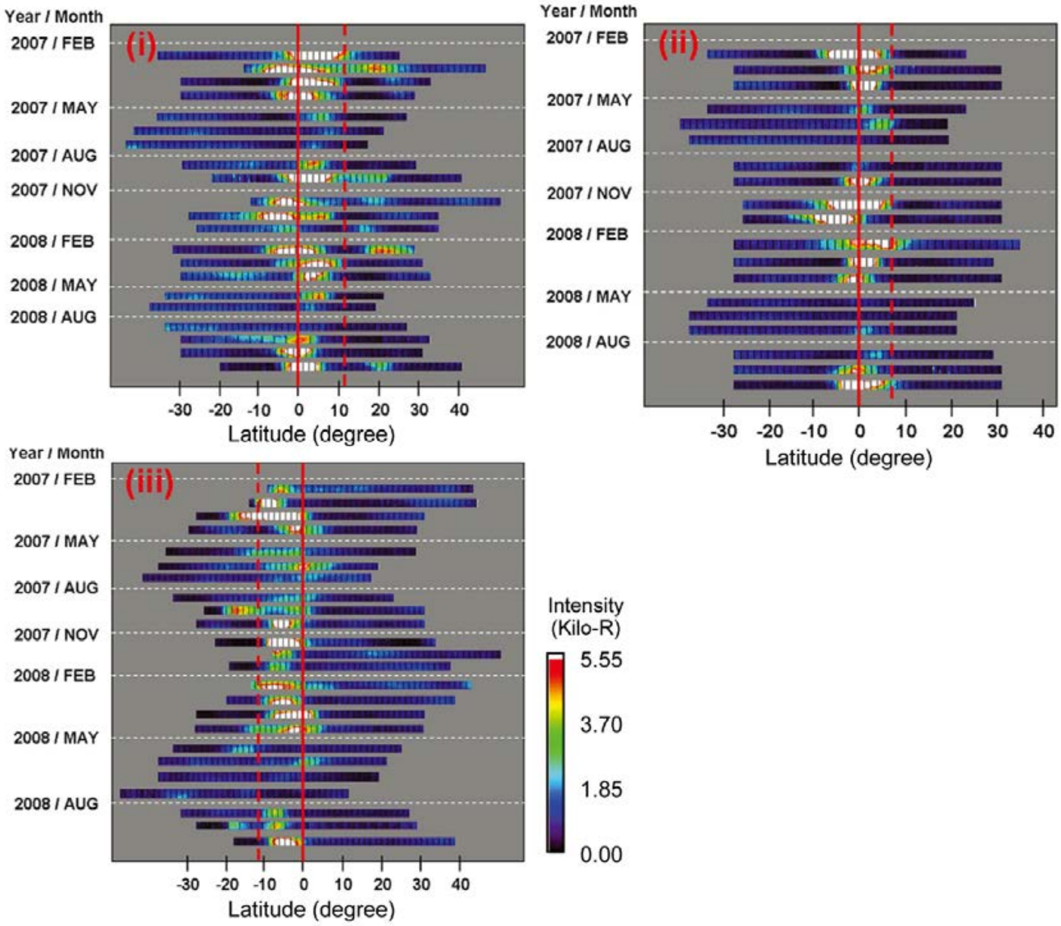
(2) The effect of meridional winds to the 630.0 nm midnight brightness By reading this work and Rajesh et al. (2014), I happened to find many similarities in between. Both of the groups modulate the HWM-93 meridional winds on the SAMI2 model and apparently find that the meridional wind utilizes the location and intensity of the airglow brightness. What is the novelty of this work out of Rajesh et al. (2014) in the effect of meridional winds to the midnight brightness? The authors should include the comparison in the content and give the credit to the previous work properly.

We thank the Referee's suggestion. We discuss the differences in detail between the work by Rajesh et al. [2014] and our study. In our manuscript, we include the following discussion to compare the two studies.

Rajesh et al. [2014] showed their simulation results and claimed that using merely the background meridional winds could reproduce the observed brightness. They selected a few cases of ISUAL image data and compared those data with the simulation results by the SAMI2 model. Nevertheless, using such a method by Rajesh et al. [2014], one should be very careful about the details when it comes to physical insights or conclusions drawn from the study. This is because ISUAL only provided optical data and there was not any instrument on the satellite to directly observe the relevant conditions (temperature, wind field, etc.) in the environment. Without such observations to provide constraints for modeling, one can easily reproduce similar-looking results of selected short-period data by adjusting modeling parameters in simulations. However, images seemingly similar to that of an ISUAL observation could be produced from simulation results using considerably different parameter values, which may correspond to different dominant mechanisms. Thus, when there are few constraints for the parameter values, roughly comparing a short-period case of ISUAL image data with simulation results without paying attention to details may lead to an interpretation of brightness production mechanisms that is different from the real situation.

The production mechanisms of 630-nm bright spot around midnight from ISUAL observations have been explained by Adachi et al. [2010]. Adachi et al. [2010] suggested the midnight temperature maximum (MTM) effect can well explain the bright spot based on the observation timing and brightness locations. Our previous research (Chiang et al. [2013]) also reached similar conclusions based on statistical studies using two years of ISUAL data. The brightness region tends to appear between the geographic equator and magnetic equator as Fig. 5 in Chiang et al. [2013] indicates (see figure below). This figure shows the sequencing data observed from different longitudinal regions by ISUAL. The dotted red lines indicate the geomagnetic equator; the solid red lines indicate the geographic equator. Rajesh et al. [2014] claimed that the production mechanism of midnight brightness can be explained by meridional winds. The brightness region in their simulation results, however, basically appeared on the winter side of the magnetic equator in the solstices due to the summer-to-winter wind, regardless of where the geographic equator was. Thus, with the consideration of the location of the geographic equator, which is a significant physical factor associated with the MTM effect, the observation results of Fig. 5 in Chiang et al. [2013] indicated that the real situation would actually be different from the case simulated by Rajesh et al. [2014]. Thus the production mechanisms of midnight brightness require different interpretations from those provided by Rajesh et al. [2014].

Thus, we propose that the production of midnight brightness should not be explained by considering merely the effect of meridional neutral wind. Both temperature change and meridional neutral wind can lead to variations of the 630.0 nm nightglow intensity while the latter is more effective. These two effects should be taken into account in the study of midnight brightness.



Note: Fig. 5 in Chiang et al. [2013] shows the observations from three different longitudinal regions [(i), (ii) and (iii)] that correspond to the different declination angles. Orbit (i) was in the longitudinal region (between -15° ~ +150° longitude) where the geomagnetic equator is northward of the geographic equator with the declination angle around 0°. Orbit (iii) was in the region (between -85° ~ -60° longitude) with the geomagnetic equator southward of the geographic equator and the declination angle around 0°. Orbit (ii) was in the geographic region between -60° ~ -15° longitude, with a declination angle around -20° (westward). The solid lines and dashed lines indicate the geographic equator and geomagnetic equator, respectively.

Line 116-117 What is special of O+ density along the magnetic line with apex altitude between 265 and 315 km ? Can you show the model result between altitude 150 to 315 km for all latitude?

Sorry for our typo. We have modified this sentence to “Figure 1 shows the O+ density along the magnetic lines with altitudes between 150 and 315 km in the latitude-altitude plane at the time and longitude described above.”

Line 214-226 Again, what is the new finding out of fig.3 in Rajesh et al. (2014) ?

Figure 3 in Rajesh et al. [2014] shows statistical results of midnight brightness for different seasons using all the ISUAL images. They collected all the airglow mode data to consider the occurrence of the brightness region but they did not separate the situations for different longitudinal regions.

As we explained in our response to the previous question, Fig. 5 in Chiang et al. [2013] indicates that the latitudinal locations of brightness observed from 3 different orbits (different longitudes) are quite different. We need to consider both temperature change and meridional neutral wind such that the production of midnight brightness in different longitudinal regions can be appropriately addressed. Thus, the statistical results of Fig. 3 in Rajesh et al. [2014] can be considered preliminary work to address the production of midnight brightness, but a broader study to include more relevant physics, such as one also considering the physical factors related to the longitudes, is warranted so as to improve our understanding on the topic. This is also the reason why our Fig. 4 in this manuscript just focuses on the specific longitudinal regions.

Figure 1 has to be modified, what is the reason that the authors didn't convert [O+] density to volume emission rate of 630.0 nm nightglow while the observation images are the airglow intensities?

The effects of neutral wind and temperature on the volume emission rate of the 630.0 nm nightglow are shown in Fig. 2 in our manuscript. The volume emission rate of the 630.0 nm nightglow in the F2 region can be derived as follows:

$$I_{630} = \frac{A_{1D}\mu_D\gamma[\mathrm{O_2}][\mathrm{O^+}]}{k_1[\mathrm{N_2}] + k_2[\mathrm{O_2}] + k_3[\mathrm{O}] + A_{1D} + A_{2D}}$$

It shows that the volume emission rate is associated with neutral and charged densities. Charged density can be shifted along the field line by neutral wind. On the other hand, most of the items, including charged density, neutral densities and chemical reaction rates, can be affected by temperature variation. Here we would like to explain the thread of thoughts in describing Fig. 1 and Fig. 2. In the context, we first let readers understand the neutral wind effect on charged densities (as shown in Fig. 1), and subsequently we show the effects of neutral wind and temperature on the volume emission rate of the 630.0 nm nightglow (as shown in Fig. 2). Referee #2 suggested that we plot volume emission rate instead of [O+] density in Figure 1. If we plot volume emission rate as suggested, that means both the neutral wind effect and temperature effect need to be considered in Figure 1. Thus it will require lots of figures to show the results because temperature changes need to be considered. We are afraid that readers would be confused by the large number of plots in such an early part of the manuscript, and thus it might not be easy for them to understand our points. Therefore, we tend to keep Fig. 1 as it is shown in the previous manuscript.

Minor points line by line:
Line 43 enhancement > increase

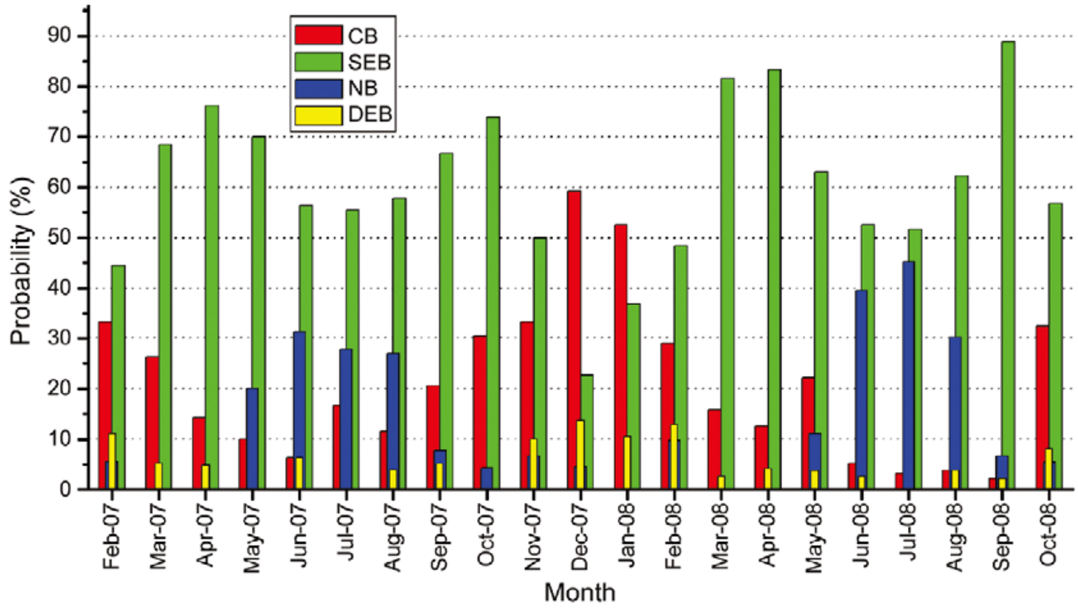
Thank you. We have revised it.

Line 45-46 ": : :.first reported the MTM: : : " should be ": : :reported the MTM phenomenon first"

Thank you. We have revised it.

Line 61 What are the different mechanisms addressed in Chiang et al. (2013)? The readers would be pleased to learn the relevant work leading by the same author.

The following figure is Fig. 6 in Chiang et al. [2013]. In the paper, our major goals are to investigate the different patterns of midnight brightness observed by ISUAL and to consider the possible mechanisms for all kinds of cases. Occurrence rates of the four brightness types from all the orbits in each month are shown in the figure: single equatorial brightness (SEB) cases are in green, double equatorial brightness (DEB) in yellow, conjugate brightness (CB) in red, and no brightness (NB) in blue. We found that midnight brightness was controlled by different sources at different locations. First, NB was associated with the ionospheric annual anomaly during May to July. Second, we suppose that SEB and DEB were associated primarily with the MTM effect and the featured temperature variation. Third, the CB case, however, was associated largely with the winter anomaly which the neutral wind plays a role in its formation. It is necessary to take into account the locations and seasons when explaining the mechanisms of midnight brightness occurrence. Overall, the global midnight brightness can be contributed by several effects including the influence of the MTM effect, summer-to-winter neutral wind and ionospheric anomaly.



Line 142-143 Rewrite the sentence please.

Thanks for the Reviewer's comment, we have rewritten the sentence as follows:

"In order to explore the effects of temperature change, we modify the codes of SAMI2 by increasing 50 K per run as the inputs, and perform the simulations to calculate the emission intensity values associated with different temperature conditions."

Line 193-195 Rewrite the sentence please.

Thanks for the Reviewer's comment, we have rewritten the sentence as follows:

"Therefore, we suggest that the low-latitude emission enhancement in the winter hemisphere be achieved by plasma accumulation brought about by the summer-to-winter neutral wind."

Line 202-203 Rewrite the sentence please.

Thanks for the Reviewer's comment, we have rewritten the sentence as follows:

"In comparison, the change due to temperature variation is just 0.015 photon/cm^3/sec for every K. The ratio of the two numbers is 46. Consideration of other conditions, such as those cases shown in Fig. 2, may reduce the corresponding ratio, but it should still be at least 20."