

Responses to Editor and Reviewers

General Comments:

Dear Dr. Luis Vieira.

Thank you for managing this review process. We have tracked the changes in the manuscript and our point-by-point responses can be found as following.

Referee #2: Dr. Yuichi Otsuka

REVIEWER: **“The paper has been revised, but still further revision is needed. Especially, in discussion section, explanation in some part is not correct. Also, further detailed discussion is needed.”**

AUTHORS: Thank you for reading and suggesting changes in our manuscript again. Based on your comments, we have revised the manuscript again.

REVIEWER: **“- ll. 17-18: It is better to change ‘the EPBs represent plasma irregularities’ to ‘the EPBs contain plasma irregularities’.”**

AUTHORS: Yes, thank you for the suggestion.

REVIEWER: **“- l. 28: It is better to change ‘increase its growth rate’ to ‘initiate the instability’.”**

AUTHORS: Thanks for the suggestion. It has accordingly been incorporated.

REVIEWER: **“l. 115, ‘The zonal drift of the plasma is almost equal to the neutral zonal wind’: The author should describe the reason why the zonal drift of the plasma is almost equal to the neutral zonal wind. The vertical electric field, which induce the zonal plasma drift, is driven through the F region dynamo.”**

AUTHORS: We have added the explanation following the reviewer’s suggestion. The text was modified to “The zonal drift of the plasma is almost equal to the neutral zonal wind because the vertical electric field, which induce the zonal plasma drifts, is driven through the F region dynamo (e.g., Chapagain et al., 2012). In this case, the contribution of the geomagnetic tide seems to be small, primarily after midnight.”.

REVIEWER: **“ll. 131-132, ‘A full explanation for the seasonal variation in the M2 amplitudes in EPB zonal drift is quite complex due to the complexity of the dynamics involved in the motion of the F region plasma and connections with the E region.’: Further detailed explanation is needed. What is ‘connections with the E region’?”**

AUTHORS: We agree with the reviewer that this portion of the manuscript is not clear at all. Thus, we have changed it to “A full explanation for the seasonal variation in the M_2 amplitudes in EPB zonal drift is quite complex due to the complexity of the dynamics involved in the motion of the F region plasma, which is strictly related with the E region dynamo, primarily during the daytime.”. The meaning of the connection of the E and F region is what we write in this new version. Thank you for the comment.

REVIEWER: “l. 132-133, ‘Maybe better conditions for propagation of some non-migrating components could be the reason for the enhancement of the M_2 in zonal and vertical drifts.’: Further detailed explanation is needed. ‘Migrating components’ appears suddenly for discussion. It could mean migrating tide. The authors need to explain how the migrating tide is related to the lunar tide.”

AUTHORS: Again we have changed the text to be more explicit about the ideas, thank you for the suggestion. We have changed the phrase to “The M_2 is mainly composed by the migrating component with a secondary contribution of the non-migrating ones, which can play an important role in the global structure of the lunar tide (Paulino et al., 2013). Maybe better conditions for propagation of some tidal non-migrating components could be the reason for the enhancement of the M_2 in zonal and vertical drifts”. We agree with the reviewer that a confusion could appear relating it with solar tides. However, we believe that now the explanation is consistent. Additionally, we have added the following statement in the Introduction section: “The M_2 is composed of migrating, which follow the motion of the Moon, and non-migrating components, which can propagate to the east or west.”

REVIEWER: “l. 146-152: The authors argue contribution of the E region on the lunar tide. During nighttime, the E region plasma disappears due to the rapid recombination. Consequently, the E region does not affect the lunar tide in the F region, observed in this study. On the other hand, equatorial electro jet can be measured only during daytime. The current result is compared with other papers that study the tide during daytime by analyzing the magnetic field data. The authors need to consider the difference between daytime and nighttime. ”

AUTHORS: Thank you for the important comment. We are aware that our data is poorly affected by the E region dynamo. We included the comparison with the E region works in order to show that the lunar tide has solar cycle dependency in other ionospheric parameters. We have revised the paragraph to avoid a misunderstanding in this meaning. The revised version is “It is expected that our results have weak influence of the E region dynamo because during the nighttime the recombination acts quickly to suppress the E region. Complementarily, it is established that the vertical penetration of the semidiurnal lunar tide into the ionosphere from the E region depends on the solar cycle due to the molecular viscosity, which filters some wave components with small vertical wavelengths (Forbes, 1982; Forbes et al., 2014). Yamazaki and Kosch (2014) showed a clear solar dependence of the geomagnetic lunar tide over the last century and other works have also showed solar dependence of the lunar tide modulation in the Equatorial Electro Jet (e.g., Eccles et al., 2011; Luhr et al., 2012; Yizengaw and Carter, 2017). Additionally, Eccles et al. (2011) showed M_2 oscillation modulation parameters of the F region as well. Those results contribute to understanding that the lunar tide is solar dependent in some ionospheric parameters. Thus, these are reasons to believe that the M_2 in the zonal drifts can also be solar dependent. ”

REVIEWER: “l. 147, ‘due to the molecular dissipation’: How is the molecular dissipation related to this argument?”

AUTHORS: We have changed the statement to ‘...depends on the solar cycle due to

the molecular viscosity, which filters some wave components with small vertical wavelengths...'. We think it is enough to address this point.

REVIEWER: "ll. 153, 'parameters of F as well': What is 'F'?"

AUTHORS: We missed the word region after 'F'. We have fixed it.

Reviewer #3: Dr. Xin Wan

REVIEWER: “I’m satisfied with the authors’ corresponding regards on my major concerns. However, I would suggest the authors to present specific actions they made in the response letter, regarding the reviewers’ minor comments, rather than posting that ‘We have clarified it in the manuscript’ or ‘we have fixed them’.”

AUTHORS: We thank Dr. Wan for revising our manuscript once more. The reviewer is right. Our apologies for that. We tried to shorten the response, but we agree that some words are necessary to explain what was done and it can enhance the debate. We will try to avoid these simple responses next time.

REVIEWER: “**Lines 34-35: present specific information on the ‘seasonal and solar activity dependencies’ A few typo issues still exist. ”**

AUTHORS: Unfortunately, we could not see the typo in these lines. We suppose the typo is in the following line. Additionally, we have revised the whole manuscript for typo as you can see in the tracked changes file.

REVIEWER: “**Line 36: ‘disturb’ should be ‘be totally disturbed’.**”

AUTHORS: The reviewer is right. We have corrected it according to the suggestion.

REVIEWER: “**Line 153: ‘F’ should be ‘F region’.**”

AUTHORS: Yes, the reviewer is correct. You have changed it.