Letter to the Editor

Dear Dr. Fontes, dear co-authors,

Thank you for the substantive answers to the opponents' comments and for the modifications made to the text in accordance with the recommendations of both referees. Recently the manuscript has undergone the second revision and one of the referees come back to us with some specific comments (please, see below). Please, consider the comments and send us back your response and the revised version of the manuscript with indicated changes. At the current stage the manuscript still needs revision.

Kindest regards

Yours cordially

Dra. Buresova.

Dear Editor Dra. Buresova,

We are glad to send our review of the article entitled "Effects of the terdiurnal tide on the Sporadic-E layers (Es) development at low latitudes over the Brazilian sector". We included the suggestions that the Reviewer addressed.

Best Regards,

Pedro Fontes et al.

Responses to the Comment and/or Suggestions from Referee 3

Sporadic-E layers (Es) are thin and dense layers in the ionospheric E region. Es can significantly affect the propagation of radio waves in the ionosphere, therefore has an important impact on the radar, satellite communication, and navigation. This manuscript investigates the terdiurnal tidal periodicity in the Es layer and a simulation is conducted to study the terdiurnal tidal effect on the Es formation.
I have some points to help the discussions. Thus, I invite the authors to clarify before the publication.

Thank you very much for the revision given by the referee. We have carried out a revision of the manuscript considering all the referee's comments.

Comments:

1. I confuse about the statement "In summer and autumn, we see three well-defined peaks in a superimposed summation of the Es layer types per hour. We also observed that the modulation of the terdiurnal tide on the Es occurrence rates minimizes in December, the beginning of the summer season" in the abstract part.

Response to the reviewer: Figure 3a shows the three peaks in the total percentage (black line) of summer that indicates a terdiurnal oscillation, so we mentioned that "we see three well-defined peaks in the overlapping sum of Es per hour layer types in summer". However, for the summer, specifically in December, the increases in Es occurrence rates associated with amplitude modulation due to terdiurnal tides are smaller than in the other summer months. It can be seen in Fig. 3(a) by comparing the amplitude modulation for the three months used in the summer season analysis. We changed the sentence in the abstract for a better understanding.

2. The information about how different types of *Es* layer are defined should be provided in the Methodology part. And the method of calculating *Es* occurrence rate should be added.

Response to the reviewer: Thank the reviewer for pointing out this fact. We added a phrase in lines 113-116 to mention that the different *Es* layer types are defined according to their format in ionograms, meaning which the physical formation mechanism is acting, as seen in the U.R.S.I. Handbook of Ionogram Interpretation and Reduction (Piggott and Rawer, 1972).
Finally, a description of periodogram analysis by the Lomb-Scrage method (Lomb, 1976; Scargle, 1982) performed with the fbEs parameter for the four seasons of the year 2008/09 was added in the last paragraph of Section 2.1 (lines 129-135).

3. Line 175: The description about Figure 1 is not accurate. For instance, I only see the peak of the Es occurrence rate at 01-02 UT UT during Autumn. Besides, the authors state "a sharp decrease occurs near dawn at 08 UT", however, I only notice that there was a drop at 07-08 UT.

Response to the reviewer: Thanks to the reviewer for pointing out this statement. We modified the description of Figure 1 in Sect. 3.1 to facilitate the understanding these nighttime percentages as suggested by the reviewer.

4. Line 185: I cannot see a clear 8-h periodicities in Figure 1 (a), I will recommend that the author can add more data to conduct this statistical analysis.

Response to the reviewer: Due to the doubt of the reviewer, we added a new technique to be clearer. Thus, in Figure 6 is shown a statistical periodogram analysis with the Lomb-Scargle method (Lomb, 1976; Scargle, 1982), also described in the methodology. This analysis clearly shows the periodicity of the terdiurnal component (8 h) in all seasons of 2008/09, in addition to the 6-hour oscillation in the autumn, winter, and spring seasons (lines 330-344).

5. The label of x-axis is a little confusing.

Response to the reviewer: Ok. We changed the hourly interval of the x-axis in Figure 1 to just hours (1-24 hours), standardizing with the x-axis of the other figures for easier interpretation.

6. Why the authors conclude that “The slight increase in the occurrence rate between around 03-04 UT during the spring season might suggest that besides the dominant terdiurnal tidal periodicities, there was also a weaker quarterdiurnal (6-h) oscillation affecting the Es layer development”.

Response to the reviewer: We observed a weak 6-hour oscillation in the spring (Figure 3). This behavior is visible more clearly in Figure 6, which we added in this new version. Figure 6 shows that the quarterdiurnal (6-hour) tidal component is present in the autumn, winter, and spring seasons (lines 330-344).

7. Lines 255-260: Why the authors make this conclusion “This is probably related to the tendency for the amplitude of the migrating terdiurnal tide with zonal wavenumber 3 (TW3) to increase, generally from January to March 260 within ±10° of latitude”.

Response to the reviewer: We suggest this behavior since we found in the literature some studies that indicate this tendency of the TW3 tide to increase its amplitude between January and March by ±10° of latitude, as described in Moudden and Forbes (2013) and Pancheva et al. (2013). In addition, there is also a study at the latitude of São João do Cariri (Guharay et al., 2013), a region near Palmas in the Brazilian sector, which shows the oscillation of the terdiurnal tide of the zonal and meridional winds are present, agreeing to the conclusions of the above authors mentioned here. We included a paragraph with these citations to the works mentioned above in lines 273-285.

References:

Guharay, A., Batista, P. P., Clemesha, B. R., Sarkhel, S., and Buriti, R. A.: On the variability of the terdiurnal tide over a Brazilian equatorial station using meteor radar observations, *Journal of Atmospheric and Solar-Terrestrial Physics*, 104, 87–95, https://doi.org/10.1016/j.jastp.2013.08.021, 2013.

Lomb, N. R.: Least-squares frequency analysis of unequally spaced data, *Astrophysics and Space Science*, 39, 447–462, https://doi.org/10.1007/BF00648343, 1976.

Moudden, Y., and Forbes, J. M.: A decade-long climatology of terdiurnal tides using TIMED/SABER observations, *Journal of Geophysical Research: Space Physics*, 118, 4534–4550, https://doi.org/10.1002/jgra.50273, 2013.

Pancheva, D., Mukhtarov, P., and Smith, A. K.: Climatology of the migrating terdiurnal tide (TW3) in SABER/TIMED temperatures, *Journal of Geophysical Research: Space Physics*, 118, 1755–1767. https://doi.org/10.1002/jgra.50207, 2013.

Scargle, J. D.: Studies in astronomical time series analysis. II - Statistical aspects of spectral analysis of unevenly spaced data, *The Astrophysical Journal*, *263*, 835-853, https://doi.org/10.1086/160554, 1982.

Finally, we would like to take this opportunity to thank the reviewer for kindly evaluating our paper helping to greatly improve its quality.