Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2018-1025-RC1, 2018

Atmospheric Chemistry and Physics Discussions

Interactive comment on "The intensification of metallic layered phenomena above thunderstorms through the modulation of atmospheric tides" *by* Bingkun Yu et al.

Anonymous Referee #1

Received and published: 22 December 2018

The authors reported a multi-instrument experiment to study the effects of tropospheric thunderstorms on Sporadic E layer activity and on the sodium (Na) layers at the the mesopause region. Furthermore, an Na chemistry model was used to simulate the dynamical and chemical coupling processes in the mesosphere and ionosphere above thunderstorms. The topic is relevant since the exact coupling mechanisms between sporadic E layers and the underlying thunderstorms is still an open question. The study is interesting and a lot of effort have been made to disclose the thunderstorms related processes that act on the Es and Na layers. However, the deduced conclusions from the analysis are too strong. I suggest to write them more carefully.

Thus, I suggest to answer the following questions and comments before acceptance of the manuscript to publish.

Comments in connection with introduction:

1/ I miss a very important review paper of the topic from the introduction which has been published by Haldoupis in 2018: Haldoupis, C. (2018). Is there a conclusive evidence on lightning-related effects on sporadic E layers?. Journal of Atmospheric and Solar-Terrestrial Physics, 172, 117-121.

2/ Page 2. line 15.: Barta et al. 2015 performed Superposed Epoch Analysis (SEA) Barta, V., Pietrella, M., Scotto, C., Bencze, P., Sátori, G., (2015) Thunderstorm-related variations in the sporadic E layer around Rome, Acta Geodaetica et Geophysica, 50:261–270 However, Barta et al. 2017 reported two case studies which was based on highly sampled ionosonde data, Doppler measurement, and ligthning and TLE records. Thus it was a different type of analysis than the previously reported studies, which based on Superposed Epoch Analysis. Please, write it in the introduction more carefully. Barta, V., Haldoupis, C., Sátori, G., Buresova, D., Chum, J., Pozoga, M., Berényi, K. A., Bór,J., Popek, M., Kis, A. and Bencze, P. (2017). Searching for effects caused by thunderstorms in midlatitude sporadic E layers. Journal of Atmospheric and Solar-Terrestrial Physics, 161, 150-159.

Comments to the section 2, Data and Observation

3/ Page 3, line 10 How did you determine the 0 time for SEA? What is the number of lightning at 0 time of the SEA? I suggest to plot the lightning distribution versus time on Fig. 1. as well.

4/ Page 3, line 15 There is a strong enhancement right before the time of lightning.

5/ Page 3, line 15 Generally, the 85-83 km height is too low to observe the Es activity by ionosondes. Comments to Fig. 2. and to the part between line 19 and 30.

6/ What does it mean that hours after lightning? How do you determine the 0 time?

7/ Which territory was take into account for the analysis? How did you estimate the size of this area?

8/ The occurrence rate of Es is the average occurrence of Es during the 28 nights? Please, define the occurrence rate more correctly. What does it show the error bar at the occurrence rate on Fig 2.?

9/ fˆ– is the averaged background frequency of foEs, but how did you define exactly? Which time period did you take? Did you take into account the seasonal variation of Es during averaging?

10/ Comment to Fig. 2. In caption: All the time series of the 28 nights? Please, define it more carefully.

11/ Page 3, line 20: misspell: . . .per hour as an indicator

12/ Page 3 Line 33. I can not see good agreement between Davis and Johnson 2005 and this study. In this study it seems that the foEs and Es occurrence rate increasing with the thunderstorm/lightning activity. There is no 6 or 30 hours time delay between the thunderstorm activity and the response of the Es like in the case of Davis and Johnson 2005.

13/ Page 3 line 33: "Both the occurrence rate and relative change of Es vary with the development of the underlying thunderstorm." Please write it more carefully, e.g. Both the occurrence rate and relative change of Es seems to vary with the development of the underlying thunderstorm.

14/ Page 4 line 1: "foEs=5.03 MHz" what is this value? The relative foEs at the peak?

15/ Page 4 line 8-10: Please, write the text more carefully.

16/ Page 4 line 9-10: "the DGS-256 digisonde ionograms from Fuke were automatically scaled" The automatic scaling of foEs parameter is not reliable. I suggest to check the ionograms manually. Especially, because the occurrence rate of Es measured at Fuke

reaches its maximum before the peak of the lightning activity, which is not consistent with the previous states.

Comments in connection with section 3, chemical simulation:

17/ Page 5 line 15-18: "then the ionospheric observations of digisonde at Fuke, near the Na lidar, from t=0 to 25 h are input to drive the Na model." The ionograms measured at Fuke have not been manually checked, so I suggest to check them manually before use them as an input of the model.

18/ Page 5 line 18-19: "Profiles of e and Na + (4% of metallic ions measured by in-situ rocket flights (Kopp, 1997)) are input according to the ionospheric Es observation." How do you determine the e and especially the Na+ profile from Es observation? Please, write more details about this method.

19/ Page 6 line 15-16: "The intensification of Es layer and Na layer are associated metallic layered phenomena through the modulation of atmospheric tides during thunderstorms." Please, write this sentence more carefully, e.g. The intensification of Es layer and Na layer seems to associate with metallic layered phenomena through the modulation of atmospheric tides during thunderstorms.

20/ Page 6. line 17-18: "As mentioned above, the statistical results of various studies using the SEA method have exhibited lightning discharges effect on Es layers." Not directly the lightning, more other processes connected to the thunderstorm activity can affect the Es layer.

21/ Page 6 line 22-23: "Figure 2 shows the similar lag time that the peak of relative foEs occurs 8 h after lightning, comparable to 6 h." Looking at the Fig. 2a. carefully it seems that the time of the Es's occurrence rate is in good agreement with the peak of the lightning activity, there is no 8 h time delay.

Questions and comments related to session 4, Discussion and conclusions:

22/ General comment: Please, try to explain more precisely what you observed and

your proposed coupling mechanisms between the thunderstorm and the Es based on the observations. Please, write more details about the mosulation of tides by GWs. What is the time period necessary for the modulation process? Is it consistent with the time delay reported by Davis and Johnson 2005 or detected in this study?

23/Page 6. line 29.: "hypothesized that the metal atoms may be related to thunderstorms." I can not understand this part of the sentence. Please, write it in a different way.

24/ Page 6. line 30: "It remains possible that the observed lightning-induced ionization enhancement in the Es is associated with the TLEs (Johnson and Davis, 2006)." It is hard to explain the reported 6 and 30 hours time delay of the ionospheric response (Davis and Johnson 2005) by the action of the TLEs.

25/ Page 7. line 11: "The results presented here show robust evidence that the thunderstorm electrical effects accelerate and reinforce this process from metallic Na + ions to neutral Na atoms." It is a very strong state. I can not see any robust evidence based on this study. Please, write it more carefully.

General comment to the figures: The size of the text on the figures should be larger.

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2018-1025, 2018.