

**Review of the manuscript** entitled “Geomagnetic Conjugate Observations of Ionospheric Disturbances in response to North Korea Underground Nuclear Explosion on 3 September 2017” by Liu et al., submitted for a possible publication in *Annales Geophysicae* [angeo-2018-122]

### **General comment**

The manuscript describes observation of ionospheric disturbances induced by underground nuclear explosion (UNE) in North Korea on 3 September 2017. The ionospheric disturbances were observed both on the northern hemisphere and on southern hemisphere around conjugate point. The manuscript is reasonable well written, the subject is suitable for publication in *Annales Geophysicae*. I think that several points could be addressed more carefully to improve quality of the paper (see the specific comments). I recommend a moderate revision.

### **Specific comments**

a) Section 2, the method of data analysis should be described in more detail. Specifically, the third-order horizontal 3-point derivative should be defined. It should be mentioned why such a derivative was used, and discussed its advantage with respect to standard first derivative. The authors reference to paper by Park et al. (2011) in this respect, however, I have not found a sufficient definition and discussion related to this derivative in their paper. Also, the procedure of removing background noise by using wavelet decomposition should be briefly described.

b)line 113-114 and Figure 3, I suggest comparison with average values calculated for 15 quite days before and after the UNE event rather than for only one day before the event. Also, I would recommend locating the modified text related to current Figure 3 after the text related to current Figure 5 (after line 125), and renumbering Figure 3 to Figure 6 (renumber Figure 4 to Figure 3). Current Figures 2 and 4 and the corresponding texts are closely related. I think that the flow of information will be more logical in the suggested re-organization. In addition, insert explanation of black and green triangles in the text related to Figure 5 (current lines 123-125).

c) Discussion, paragraph related to similarity with earthquakes. It should be mentioned, e.g., after the sentence Klimenko et al (2011)...that there were several studies that showed that co-seismic ionospheric disturbances were caused by long-period infrasound waves that propagated nearly vertically to ionospheric heights (Chum et al., 2016; Liu et al., 2016, Chum et al., 2018 and references therein).

Chum, J., J.-Y. Liu, K. Podolská, T. Šindelářová (2018), Infrasound in the ionosphere from earthquakes and typhoons, *J. Atmos. Sol. Terr. Phys.*, 171, 72-82, doi:/10.1016/j.jastp.2017.07.022

Chum, J., M. A. Cabrera, Z. Mošna, M. Fagre, J. Baše, and J. Fišer (2016), Nonlinear acoustic waves in the viscous thermosphere and ionosphere above earthquake, *J. Geophys. Res. Space Physics*, 121, doi:10.1002/2016JA023450.

Liu et al., (2016) is already in the references

d) lines 180-181, LAIC electric field can be roughly estimated to be 11 mV/m. Specify the method of estimation.

e)Figure 5, related text and discussion. Specify, if the least square fitting was done under assumption that the fitted line goes through the beginning (point [0; 0]) or if an arbitrary offset along the vertical axis was admitted. If the arbitrary offset (preferred in my opinion) is admitted then from the obtained time delay at distance 0, one could say something about the time delay between explosion and ionospheric perturbation just above the explosion. Likely, one should have observation close to the explosion to obtain reliable results (time delay with sufficient precision). Anyway, theoretically, knowledge of this time delay could help to distinguish if the electric fields penetrated from below (from the ground) or if they were generated in the ionosphere. Note that there is a possibility that mechanic perturbations caused by AGWs change the electric conductivity in the lower ionosphere, which in turn, in the presence of (zonal) electric fields can cause horizontal perturbation of these background electric fields and associated currents that can be detected as geomagnetic perturbations (e.g. Liu et al., 2016). A possibility of such a mechanism should be briefly mentioned/discussed for completeness.

**Technical comments (Minor or formal comments and language suggestions)**

-line 45, naturally processes-> natural processes

-lines 46-47, coupled upper atmospheric variations – specify or remove

-line 71, conductivity of the geomagnetic...->conductivity along the geomagnetic

-line 91, ...temporal evolution which consists of...->...temporal evolution. SWARM mission consists of...

-line 153, ...indicated the abnormal...->...indicated that the abnormal...

Also, add a suitable reference after this sentence