

Interactive comment on “The VLF transmitters’ radio wave anomalies related to 2010 Ms 7.1 Yushu earthquake observed by DEMETER satellite and the possible mechanism” by Shufan Zhao et al.

Anonymous Referee #1

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The article “The VLF transmitters’ radio wave anomalies related to 2010 Ms 7.1 Yushu earthquake observed by DEMETER satellite and the possible mechanism” presents a detailed study of possible VLF precursor signals detected from satellite data. Various parameters are investigated: signal power at satellite location, vertical large scale TEC anomalies and a full wave model is used to investigate the effects in transmitted power by electron density variations in the E region. The authors point out many of the uncertainties in understanding this complex phenomenon and indicate the need of further studies, especially with the new CSES satellite. Some part of the text are difficult to understand, due to poor English sentences, therefore I have to indicate now major revisions, need to clarify and correct many important points.

The major scientific limitations, that should be discussed deeper, are, in my opinion:

- the day-to-day variability of the ionosphere, not separable from the average signal in the revisit cycle of DEMETER satellite.
- the lack of ground-based ionosonde data to support the hypotheses of the full wave simulations. These could also be from stations outside of the study area, that could provide an indication of the large-scale characteristics of the ionosphere.
- the effects of the geomagnetic storms occurring during April 2010 could also be studied on experimental data in the region nearby the event.
- Some explanation about how a positive TEC anomaly could be linked to a reduction in SRN, while the full wave model is limited to electron density profile in the E region. Most of the TEC seen by GPS is around the peak of F2 layer.
- Ducted VLF propagation paths could be studied in the region around the epicentre, to understand if the observed TEC anomaly on April 13, 2010 can have an impact of the VLF SNR.

I indicate in the following suggestions of corrections/improvements. This list is not exhaustive, additional careful check of the whole text is needed.

line 26: I suggest to change “utilising” into “used”

line 27 correct "the wave energy can" into "the wave energy that can"

line 28: I would use the word “absorbed” in the case when the signal is not propagated but absorbed through collisions between particles. In the case it is “refracted into”

line 31: Cohen and Marshall (2012) should not be cited in this sentence: the paper deals with ground observation, while this paragraph discusses VLF observed by LEO. It can be cited in this article, but in a different context.

line 35: Change “recorded by such as ionosonde and GPS-TEC” into “recorded by various instruments like ionosondes or GPS receivers measuring TEC”

line 41 and 52: avoid to use the word “abnormality” “abnormity”, a better word can be “anomaly”.

line 46: the Wenchuan earthquake is not studied in this paper. It could be explained that only the Yushu earthquake has been chosen for this study

line 99: correct “to the over the same” into “over the same”.

line 105: the measurement unit for ρ should be added.

line 109: figure 3 is referred before figure 2. I suggest to change the order of figures

line 112: add “and” between “averaged shown”

line 125: correct in the formula w into ω

line 136-139: add references to IRI and IGRF versions used for this study and possibly also a reference to the electron collision frequency model.

lines 145-147: the concept of numerical “swamping” could be explained in a few words, to illustrate the difficulties of full-wave modelling.

line 154: add the year to the calendar dates to avoid ambiguities, since in the previous sentence it was stated that data between 2007 and 2010 were considered.

line 155: add references and doing citations for Dst and Kp indices.

line 165: from the figures it seems that also during March 27 the VLF transmitter were not active.

line 193 correct the typo “(ndicate”

lines 220-224: I cannot access Kong et al, 2018 article, therefore I cannot see its Figure 7. I think it's better to avoid citing details of figures of another article, because readers

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who can't access it, cannot follow the explanations. It also does not seem relevant to compare at that level the Nepal earthquake and Yushu earthquake.

lines 227-229: the work of Marshall et al. (2010) should be put in its context of simulation study and indicating the locations under consideration. The link between lightning activity and earthquake precursor electron density variations is not clear to me.

237: is 20 km a bandwidth or the sigma of the Gaussian curve?

244: correct "filed" into "field".

280: correct "In additional" into "In addition"

405: correct "gound" into "ground" and the page numbers in Marshall et al., 2010 reference.

Figure 3: since this figure is composed by many panels, their labels cannot be read without enlarging it on the screen. I suggest to use a bigger font size for the titles of each panel. The date of each track overlaps the longitude axis, making them difficult to read. This figure would benefit from plotting it full page in landscape mode, if this is possible on Annales Geophysicae. On this figure I do not understand if the range 0-5, which does not have a specified shape in the legend, indicates that there are no data, or if the SNR is so low that it is not clear if the signal is above the background noise level.

I suggest also to indicate in the caption that each row corresponds to a specific frequency and night-time observations. Add also that the date is indicated on the frame near the initial (or final?) point of the orbit pass. The passes when the VLF transmitters are not operating could also be indicated using a different graphical representation.

An additional comment out of curiosity: how the orbits during the geomagnetic storm are degraded with compared with the others? They could have been plotted on the figure, or on a supplementary material, by changing the graphical representation (e.g. by plotting the orbital path in grey and fading the color of measured points).

Caption of figure 5, line 498: I suggest to add that the procedure to compute LB and UB is described in the text.

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