We thank the reviewer for the comments. Answers are given below in red. Changes in the revised version of the paper are also in red.

Reviewer #3

This manuscript deals with modelling of low-frequency electric fields and currents caused by an underground current element in the lithosphere, atmosphere and ionosphere. This model is used in order to explain electric perturbation of about 1.3 mV/m observed during the Wenchuan earthquake at Gaobeidian Station at a distance of 1.440 km from the ep icenter of the earthquake.

The authors found that an underground source with a liner current of the order of 10^5 - 10^6 kA and a length of 150 km needs to produce this electric perturbation at such a great distance. The electric field on the earth's surface, calculated from this model, was used as an input parameter for another model describing the penetration of an electric field through the atmosphere into the ionosphere. The perturbation of the electric field in the ionosphere was shown to decrease to a value of 0.1 mV/m, while the TEC variations should be 0.01%.

The authors focuses on the electric field produced by the underground electric current. Meanwhile, this current produces not only an electric but also a magnetic field. Away from the currents source, this magnetic field can be roughly estimated using Bio-Savart law: $B \sim \mu_0 IL/(4\pi r^2)$. where μ_0 is the magnetic constant; I denotes the underground current; L stands for the length of the current; and r is the distance from the current element to the observation point.

Certainly, this law leaves out of account the influence of the boundary between the Earth and the ionosphere. Nevertheless, this law allows us to obtain an order-of-magnitude estimate. Substituting the author's parameters: I = 1.5 10^5 - 3.4 10^6 kA and L = 150 km as well the distance r = 100 km into the above equation, we obtain that B=(0.23 - 5.1) 10^{-3} T; that is, a value of one or two orders of magnitude greater than the Earth's magnetic field! At the distance r=1440 km (Wenchuan event) we obtain that B= (0.1 - 2.5) 10^{-5} T; that is, a value of the order of the Earth's magnetic field. Such strong magnetic perturbations never observed both before and after seismic events!

It seems likely that such a fantastically big value of the underground electric current is unrealistic. This means that the authors model cannot explain either electrical field registered at 1440 km Gaobeidian station during the Wenchuan earthquake or the ionospheric effects possibly related to this earthquake.

It makes no sense to dwell on another disadvantages of this model, since the drawback noted above is fatal. That is why I recommend, unfortunately, to reject this manuscript.

About produce mechanism of electromagnetic emissions before earthquakes, up to now, no clear explanation has been given although several physical mechanisms have been proposed to interpret the generation of EM emissions and electrical currents observed either during seismic activity or in the laboratory experiments. These include the electrokinetic and magnetohydrodynamic, piezomagnetism, stress-induced variations in crustal conductivity, microfracturing, etc. (Draganov et al.,1991; Park, 1996; Fenoglio et al., 1995; Egbert, 2002; Simpson and Taflove, 2005). Whatever the physical mechanism of electromagnetic generation is, it is well established that, during rock experiments conducted under laboratory conditions, a strong electrical current is produced when rocks are stressed, especially at the stage of the main rupture (Qian et al., 1996, 2003; Hao et al., 2003; Freund and Wengeler, 1982; Freund, 2002, 2009, 2010; Freund and Sornette, 2007; Scoville et al., 2015). So, to establish a physical or mathematical model is an effective way to interpret the observed electromagnetic emissions. In this research, we use a finite length current source beneath the Earth as an equivalent current induced by the Wenchuan event to interpret observed electric signal of 1.3 mV/m at 1440 km Gaobeidian station.

The reviewer mainly focused on the estimated current of $I = 1.5\ 10^5 - 3.4\ 10^6$ kA and thinks that the induced magnetic field of $B = (0.1 - 2.5)\ 10^{-5}$ T in the light of Bio-Savart law is unreasonable.

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Table 1. Seismic P wave and geomagnetic disturbances

Station	Epicentral distance (km)	First arrivalof P wave (hh:mm:ss)	Time of M wave (hh:mm:ss)	Time difference of M and P wave (s)	Amplitude of geomagnetic disturbance			
					D (°)	H (nT)	Z (nT)	F (nT)
CD2	34	06:28:06	06:28:17	11	154.75	1044.86	983.76	16.11
LZH	565	06:29:19	06:30:33	74	2.59	8.32	9.22	0.32
GYA	597	06:29:21	06:29:32	11	13.03	87.7	89.56	–
LCH	644	06:29:13	06:29:47	34	40.24	239.33	317.49	–
TOH	769	06:29:41	06:31:31	110	0.37	0.63	0.97	–
YCH	875	06:29:58	06:31:21	83	113.96	993.2	665.46	0.87
SHY*	995		06:30:06		7.04	91.32	103.9	3.68
GOM*	995		06:31:58		1.19	0.97	0.52	0.2
NNS	1017	06:30:13	06:32:07	114	4.59	30.97	42.42	–
JFE*	1060		06:33:32		5.29	73.92	66.50	–
JYG	1086	06:30:26	06:33:34	188	0.73	0.89	0.63	–
JIC	1113	06:30:25	06:31:49	84	81.85	655.16	403.16	–
WJH	1218	06:30:38	06:31:57	79	53.84	372.63	241.98	0.85
LSA	1188	06:30:35	06:30:42	7	3.17	7.04	7.3	–
TCH	1462	06:31:07	06:31:13	6	6.57	54.33	49.28	–
QZN	1480	06:31:08	06:34:00	172	1.49	12.17	25.36	–
JHA*	1506		06:34:54		6.43	14.29	9.79	–
BBS	1523	06:31:16	06:31:20	4	7.66	110.52	62.91	–
HAZ	1598	06:31:26	06:31:28	2	6.31	73.73	82.81	–
QZH	1633	06:31:27	06:31:35	8	1.16	0.77	0.44	–
DL2	1872	06:31:59	06:32:01	2.5	2.42	21.38	13.76	–
HTB	2070	06:32:21	06:39:04	403	0.36	1.07	0.57	–
SQH*	2206		06:39:26		0.17	–	–	–
SGA*	2372		06:32:58		4.48	42.95	30.16	–
MZL	2374	06:32:48	06:33:00	12	6.31	36.35	13.99	–
KSH	2666				–	–	–	–
DED	2740	06:33:21	06:33:26	5	8.67	63.68	24.58	–

Note: * indicates we do not have seismic data from these observatories; '–' means no apparent disturbance was detected.

However, on one hand, we have already given some explanations on the attained look-like large current in the revised paper in red in Section 5 Discussion:

The first one is that, only one ground-based observing station (Gaobeidian station) is taken part in calculations due to its almost synchronized anomalous emissions with the ionospheric variations three days prior to the Wenchuan main event. And it is 1440 km from the Wenchuan epicenter after all. Besides this, there are no near stations as reference at all. Guan et al. (1994) reported 16.9 mV m^{-1} electric field at the Ningjin station in Hebei network before the 250 km Datong-yanggao M_S6.1 earthquake.

Secondly, electromagnetic signals associated with strong seismic activities are generally characterized by "selectivity" or "sensitive point". The selectivity effect is a complex phenomenon that may be attributed to a superposition of the following three factors: "source characteristics", "travel path" and "inhomogeneities close to the station" (Varotsos and Lazaridou, 1991; Varotsos et al., 2005). In the half-space model employed in this paper, the Earth medium is considered as homogeneous with unique conductivity $\sigma_1 = 1.0 \times 10^{-3}$ S m^{-1}. However, it is the fact that the Earth is inhomogeneous and even lateral discontinuous. Li et al. (2016) have reported that that the observed electric field at 1440 km Gaobeidian station decreases about 20 orders of the magnitude if the conductivity of the Earth medium increases from 10^{-6} S m^{-1} to 1 S m^{-1}. Li et al. (2019) have also reported that obvious geomagnetic anomaly on 8 May and 9 May 2008 in the same area as Gaobeidian station.

In addition, in the controlled-source electromagnetic (CSEM) method, widely used in petroleum exploration or mining, the ionospheric influence on EM fields should be considered when the distance between a large-scale and large-power fixed source and the receiver is up to 1000 km. Li et al. (2016) have attained that the ionosphere can prevent attenuating of the incident wave and the ionospheric influence on electromagnetic recordings at Gaobeidian distance can be up to 1–2 orders, which indicates that the 1.3 mV m^{-1} electric field at this station considered in this research could be an enhanced value.

On the other hand, Wang et al. [2019] have reported 1113 km JIC 403.16 nT, and 1218 km WJH 241.98 nT, coseismic geomagnetic disturbances in vertical Z component, while 1506 km JHA only 9.70 nT and 1523 km BBS 62.91 nT (see above table), and all these station are near and around Gaobeidian station used in our research. These observing stations show their apparent "selectivity" or "sensitivity" to signals. Compared with these really recorded measurements, the values we have attained in this paper seem reasonable. Of course, we can not use a physical model to comply with all these recordings. We also attached this reference:

Wang, Y. L., Xie, T., An, Y. R., Yue, C., Wang, J. Y., Yu, C., Yao, L., and Lu, J. (2019). Characteristics of the coseismic geomagnetic disturbances recorded during the 2008 *M*w 7.9 Wenchuan Earthquake and two unexplained problems. Earth Planet. Phys., 3(5), 435–443. http://doi.org/10.26464/epp2019043.

At the same time, even this large "energy source", the calculated ionospheric variation in the paper is still too low to compared with reported ionospheric varied magnitudes really measured by GPS TEC or other satellites three days before the Wenchuan event at observing f = 0.01 Hz.

However, please note, also in Discussion part of the paper, in the light of observing frequency f = 0.01–10 Hz, we have attained 10%–15% variations on ionospheric parameters at $f = 10$ Hz, and this value keeps the same order as really reported 20%–60% ionospheric variations during the Wenchuan event. We have emphasized two points, one is the recorded signals at Gaobeidian station maybe are with combined frequencies instead of single frequency. Another is, these signals were recorded just 3 days prior to the Wenchuan event, when it is possible that rupture occurred not only in the small area around the hypocenter but also in shallower layer, even near the ground area, so high frequency signals can be easily recorded at that time. Therefore, 10%–15% ionospheric variations are reasonable, although uncertainties still exist.

We advise that the reviewer read the revised version of the paper.