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Interactive comment on "Electromagnetic field observations by the DEMETER satellite in connection with the 2009 L'Aquila earthquake" *by* Igor Bertello et al.

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We thank the Reviewer who appears to agree with the significance of our results and comments our work as suitable for publication after major revisions. In the revised version, that we attached here (bold text indicates the text changes), all her/his suggestions have been considered, namely:

Main points:

1. How unique is the 4 April 2009 anomaly? Were other 3-sigma+ anomalies in the considered epicentral region? What about analyzing a close but different region, in or-

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der to make an objective comparison? By the way, an analogous figure of Fig.2 (made for February 11, 2009) but for the 4 April 2009, when the major anomaly has been found, is missing. The April 4, 2009 is the only 3-sigma+ anomaly that our method detected during a real solar quiet period. In fact, it was not only characterized by a geomagnetic solar quiet period and a ionospheric quiet condition for the entire day, but it happened exactly when the satellite flew over L'Aquila geographic position. The other anomalies detected by our method were found in correspondence of medium/active solar conditions or in positions that are close to L'Aquila but are not exactly over L'Aquila. Concerning the analysis of a close but different region, we are not sure that it is a correct way to make an objective comparison. In our opinion, Italy is characterized by different soil and magnetotelluric peculiarities that cannot be compared. Anyway, our 1°x1° cell (corresponding to 220km x 160km at L'Aquila geographic position) should be enough large to incorporate different regions. Finally, we added a new figure (new figure 5) in which we put the April 4, 2009 observations (like in figure 2) and the DEMETER orbit.

2. It is not clear the precise size and location of the area of analysis considered in the paper (pag.3, line 14-15), apart from expecting it was surrounding the L'Aquila earthquake epicenter. Neither the interval of time of the data. Apparently, it seems that all orbits from 2004 to 2010 passing over L'Aquila area were considered. We modified the text explaining the size and the location of the analysis considered in the paper and the time interval considered (as shown in the new figure 5). Concerning the environmental and the instrumental background, we considered all the orbits from 2004 to 2010 passing over 1°x1° cell centred in L'Aquila geographic position. However, as expressed in the text, for the April 4, 2009, for the background we considered only the corresponded Solar Quiet background, that has been evaluated with 73 orbit, as expressed in the text.

3. From the direction of the Pointing vector the Authors affirm that the perturbations producing the found anomalies (on 11 February and 4 April 2009) come from the ground.

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However it is very strange that the corresponding lithospheric regions at the origin of the two perturbations are quite different (see the different angles). Could the authors explain this difference? We thank the reviewer for the comments, through which we found a typing error in the February 11, 2009 Pointing vector angles. We corrected the φ direction. In the first version of the paper we wrote a negative number, while it was positive. As you can see, the S values are comparable and probably they came from the same lithospheric region. In this case, the possible explanation of the little difference in the two S values could be related to the different orbit of DEMETER satellite passing through our cell: the April one is exactly over L'Aquila (see the new Figure 5), the other one is more eastward with respect to L'Aquila position. Anyway, as expressed in the paper, we stressed that these events cannot be comparable because, as stated in the paper, the February event was characterized by different solar conditions that prevent any possible lithospheric explanation (as you also stated in the next objection).

4. The only geomagnetic index used in the analysis for discriminating the level of external magnetic activity is Kp. Although this is a good index to understand the overall level of activity, it is only partial. I would suggest to take into account more stringent conditions considering also Dst and AE indices (these indices – Dst in terms of its proxy Sim-H index- are just mentioned at the end of pag.7, the beginning of pag.8, for the case of the 4 April anomaly). In addition, also the behavior of the same indices in the previous 5-6 hours should be considered, because the magnetic activity could be at the stage of recovery phase, after some perturbation affecting initially auroral regions. For instance, Perrone et al. (2018) do not limit their attention only to the 3-hour period of interest, but they also consider AE for all the previous 6 hours in their work (and a daily Ap less than 15), otherwise the possible anomaly is rejected as internal origin. We again thanks the reviewer for the interesting suggestion. We calculated again both the environmental and instrumental background using both Sym-H and AE indices for the evaluation of the geomagnetic conditions. We added a full explanation in the text. As you can see, we used very restrictive conditions for the SQ identification, corresponding to Sym-H= [10 nT, -10 nT) and AE<100 nT. Anyway, our results did not changed and the

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April 4, 2009 anomaly was found again. We added the Perrone et al.[2018] reference in the paper.

5. No reasonable and clear model of the generation of the 330 Hz frequency at the earthquake preparation is given, and how much it could be related to the L'Aquila main-shock fault and the composing rocks. From the supposed conductivity structure under L'Aquila area, this frequency seems to be largely attenuated by the skin-depth penetration condition avoiding to cross all lithospheric medium from the fault rocks and be transmitted above in the atmosphere. In general we agree with the Reviewer. In fact, we proposed a possible explanation of the 333 Hz EME detected by our algorithm, if it was related to the earthquake preparation. But we are not sure about it, and we stressed it in the paper. The problem is that both our explanation and your "counter-hypothesis" depend on the conductivity structure. The attenuation model of the frequency under a focal area strictly depends on the conductivity values, that needs to be measured through magnetotelluric observations. In fact, this is final remark of our paper (pag. 8, lines 26-28 and pag. 9, lines 3-5). We are sure that only through a multi-instrumental and multi-disciplinary approach, a reliable disentangle of the earthquake effects from changes due to the physical processes that govern the ionosphere dynamic and to natural EME can be obtained.

Minor points:

Pag.1, Abstract. Doubts on the use of the term "noise" in this context. Line 13 (also pag.2, line 24) : Cicone et al, 2017 is missing in the references list: We changed the term "noise" into background and we added Cicone et al., 2017 in the reference list.

Pag.1 Line 24. "dynamics" better than simply "dynamic": Change made.

Pag.1 Line 25. Bell et al., 1982 is not a complete and appropriate reference for the first sentence of the paper. Use other more specific references: We added more references.

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Pag.2 line 4. “between internal and external components”: Change made.

Pag.3 Line 20. Incongruence between citation Piersanti et al. 2018 and the references indicated as Piersanti line 24): We fixed the incongrunce in the reference list.

Pag.3 Line 23. The reference Cohen 2001 is missing: reference added.

Pag.3, line 29. SM Test is not defined in this section: we modified the section title in order to define the acronym SM.

Pag.3 Line 31. Correct “proprieties” in “properties”: Change made.

Pag.4 Line 6. I do not find any Flandrin et al. 1998. Do you mean just Flandrin 1998?: Change made.

Pag.4 Line 20. Please correct “measure” in “measures”: Change made.

Pag.7, Line 22. Please define “BANT noise”: We added in the revised text the meaning of BANT, that is: Boîtier Analogique et Numérique de Traitement. It is equivalent to the Analog Processing Unit.

Pag.9 Line 27. Buzzi 2007 is not available at the given link: We added Buzzi 2007 in the reference list.

Pag.15, Line 7. Please correct “componets” in “components”: Change made.

Additional Reference: Perrone et al., Ionospheric anomalies detected by ionosonde and possibly related to crustal earthquakes in Greece, Ann. Geophysicae, 36, 361–371, 2018: We added the reference in the paper.

Please also note the supplement to this comment:
https://www.ann-geophys-discuss.net/angeo-2018-67/angeo-2018-67-AC3-supplement.pdf

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