

Interactive comment on “A relation between the locations of the polar boundary of outer electron radiation belt and the equatorial boundary of the auroral oval” by Maria O. Riazantseva et al.

Anonymous Referee #1

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General comments

This paper investigates the location of the external boundary of the outer radiation belt (ORB) relative to the equatorward edge of the auroral oval during quiet or moderately unsettled geomagnetic conditions. The study is based on precipitating electron flux data from the METEOR-M No 1 satellite at auroral (0.03–16 keV) and > 100 keV energies, collected between November 2009 and March 2010. Three types of situations are exemplified in the paper: (i) external ORB boundary inside the auroral oval during moderately disturbed conditions, (ii) external ORB boundary equatorward from the auroral oval during quiet conditions, and (iii) external ORB boundary inside

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the auroral oval during quiet conditions. This gives motivation to carry out a statistical study by looking at the distribution of the separation between the external ORB boundary and the equatorward auroral oval boundary, named $d(\text{lat})$ in the paper, as a function of geomagnetic activity. The distributions are plotted separately for quiet conditions ($AE < 150$ nT or $PC < 1$) and moderately disturbed conditions ($AE > 150$ nT or $PC > 1$). It is found that, during moderate geomagnetic activity, the ORB boundary is located within the auroral oval, whereas during quiet conditions its location can be either inside or outside the auroral oval.

Specific comments (major)

The title of the article is somewhat misleading, as it contains the word “relation” which leads one to expect to find an equation (be it empirical) linking the positions of the two studied boundaries. Since no such relation is obtained in the paper, the title should be modified to better reflect the conclusions of the study.

The caption of Figure 1 should be expanded to describe each panel in more detail. It is currently not easy for the reader to understand the data which are plotted, especially what the vertical dashed lines represent. I have not found in the text what the blue and red lines represent, for instance. Moreover, there are many of these lines which seem to be superposed on top of one another, but since the alignment is not perfect, I am not sure whether this is coincidental or done on purpose (same issue with Figure 3). Would it be possible to clarify this and improve the legibility of the figure? Also, it is not so clear why, in the lower panel, the flux energy is plotted, since (if I understood correctly) the criterion for determining the ORB boundary is the > 100 keV flux. Unless the blue curve is the integrated version of the fluxes displayed in the top panel? Please clarify this too, since I am not sure whether my guess is correct without additional information in the figure caption (or at the very least in the text describing the figure).

I did not manage to understand the reasoning exposed on p. 3 l. 2–8 (and also mentioned on p. 8 l. 10–14). Why is it so that the energetic electron detector becomes less

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sensitive when it is outside of the auroral oval? Since we are here considering a same detector measuring fluxes in one given energy range (> 100 keV), why should it not be possible to compare the measurements when they are made inside or outside the auroral oval? To my mind, if such a comparison were not possible to make, this would question the validity of the entire study, since it would be difficult to conclude anything from the data analysis! Could you please explain in more detail or rephrase the idea behind your reasoning in this paragraph?

On p. 8 l. 5–6: “Our analysis shows that the differences in the positions of both boundaries are typically smaller than the statistical scattering in the position of each boundary.” I think this statement should be justified with numbers, since currently the “statistical scattering in the position of each boundary” is not quantified in the paper. This should be easy to add, as you already have made a statistical study of the boundary locations, and there are certainly many references in the literature that could be cited to support the said statement.

The conclusions presented on p. 9 (“there [is] strong evidence that [the] trapping boundary of energetic electrons [...] is located inside the auroral oval”) do not reflect the interpretation of Figures 4 and 5. One cannot neglect the relatively high number of events for which this trapping boundary is situated equatorwards from the auroral oval, so the quoted statement is misleading.

Finally, I think it could be extremely interesting to go a bit further in the analysis before the final publication of the manuscript, by trying to determine why $d(\text{lat})$ changes with increasing geomagnetic activity (from totally quiet to moderate activity). Is it so that only the auroral oval equatorward boundary moves equatorwards, while the ORB external boundary does not change, or does the ORB boundary also migrate equatorwards/polewards when geomagnetic activity is enhanced? If such a result could be obtained, this would to my mind greatly increase the impact of the paper, and this would enable one to deepen the interpretation of the results.

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Specific comments (minor)

- The acronym “ORB”, which first appears on p. 2 l. 24 (and most probably stands for “outer radiation belt”) should be defined in the introduction.
- p. 2 l. 28: “After that we searched for the closest to the pole location of the ORB flux” does not sound very clear to the reader. This should be rephrased.
- p. 3 l. 14: I would suggest to add the reference to Davis and Sugiura (1966) on the AE index, since references are provided for the PC indices.
Davis, T. N., and M. Sugiura (1966), Auroral electrojet activity index AE and its universal time variations, *J. Geophys. Res.*, 71, 785–801, doi:10.1029/JZ071i003p00785.
- p. 4 l. 22–23: “According to the (<http://omniweb.gsfc.nasa.gov/>)...” → There must be several words missing here!
- p. 7: Could you explain in a little more detail why you chose the value of 150 nT for the AE index to separate the events in the analysis? What would happen if you chose, say, AE = 100 nT instead? Would the trend for low geomagnetic activity become clearer? (cf l. 6)
- p. 7 l. 14–15: “using the AE and PC ind[ices] as a measure of geomagnetic activity by separately” → there must be words missing here too!

Technical corrections

- “indexes” → “indices” (p. 1 l. 22; p. 3 l. 13–16; p. 4 l. 18–19; p. 7 l. 2–11–14)
- p. 1 l. 16: “at the absence of” → “in the absence of”
- p. 1 l. 18–19: “to the equator from” → “equatorward from” (same p. 2 l. 3)

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- p. 1 l. 19, l. 22: “auroral precipitations” → “auroral precipitation” (“precipitation” is uncountable)
- p. 1 l. 24: “is discussed” → “are discussed”
- p. 1 l. 25: “the position of the trapping boundary **for** energetic electrons”
- p. 1 l. 26: “sing” → “using”
- p. 1 l. 26: “low orbiting and high apogee” → “low-orbiting and high-apogee” (same l. 28, p. 2 l. 4)
- p. 2 l. 32: remove comma after “it is well known”
- p. 3 l. 9: “location” → “locations” (or change “have” into “has” on l. 11; same l. 11)
- p. 3 l. 17: “high latitude” → “high-latitude”
- p. 3 l. 20: “of GGAK-M set” → “of **the** GGAK-M set”
- p. 3 l. 22: “with the energies from...” → “with energies from...” (twice on this line)
- p. 3 l. 29: “as a polar boundary” → “as **the** polar boundary”
- p. 4 l. 2–3: correct the location of parentheses for the citations
- p. 4 l. 6: “the visual inspection” → “**a** visual inspection”
- p. 4 l. 18–19: remove capitalisation of “Northern” and “Southern” (see guidelines: https://www.annales-geophysicae.net/for_authors/manuscript_preparation.html)
- p. 6 l. 13: “trapping boundary d(lat)” → “trapping boundary, d(lat)” (add comma)
- p. 7 l. 14: “behaviour” → “behavior” (to remain consistent with p. 9 l. 1 and the use of American English spelling throughout the paper)

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- p. 7 l. 16: I think “1.2 Subsection (as Heading 2).” should be deleted.
- p. 8 l. 5: “using the data from” → “using data from”
- p. 8 l. 23: “quite time” → “quiet time”
- p. 8 l. 27: “with another pitch angles” → “with other pitch angles”
- p. 8 l. 29: “can be also” → “can also be”
- p. 9 l. 3: “there are strong evidences” → “there is strong evidence” (“evidence” is uncountable)
- p. 9 l. 3: “that trapping boundary” → “that **the** trapping boundary”

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