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Discussions

Interactive comment on "Estimating the fate of oxygen ion outflow from the high altitude cusp" *by* Patrik Krcelic et al.

Patrik Krcelic et al.

patrik.krcelic@gmail.com

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[12pt,a4paper]article xcolor

Answers to referee

We thank the reviewer for careful reading of the manuscript, and for providing valuable suggestions for improvement. Straightforward changes such as grammar, are changed in manuscript, and are not additionally commented. In following sections we firstly repeat the comments from reviewer, and than in section "Authors response" provide our response to the comments.

1 Comments and Authors response

1.1 Major

The only major comment I have is related to the choice of Dst values used in the data separation according to geomagnetic activity. Indeed, positive values of Dst can be associated with so-called sudden commencement, which is generally triggered by solar wind pressure pulses (see for instance $https://doi.org/10.1029/2006JA012141$; $https://doi.org/10.1029/2011JA017255$). This seems consistent with the fact that, in Table 1, the solar wind dynamic pressure has its highest average value for the $Dst > 0$ condition. Therefore, it seems a bit strange to me to call this category "quiet conditions" since they may include sudden commencement events. On the other hand, the threshold of $Dst < --20\,nT$ to define "active" conditions would need to be justified. Indeed,

$Dst = --20\ nT$ is considered bysome authors to belong to the category of "quiet conditions" (see for instance $https://doi.org/10.1029/2008JA013095$ paragraph [30] in sect. 5.3.1).I would therefore recommend to either modify the Dst thresholds when studying the effects of geomagnetic activity on the fate of oxygen ions, or to add a justification for choosing these values as well as a discussion on potential effects of sudden commencements in the $Dst > 0$ situation.

We did not take the sudden commencement into account in our Dst separation, but rather looked for the average behaviour for various Dst range. For instance the average convection velocities and oxygen fluxes are lower for $Dst > 0\ nT$ than for negative Dst values and thus we have named it the "quiet" condition. The sudden commencement toes indicate the beginning of a storm and should not be classified as "quiet", but the convection (and thus most of the effects of the storm on ion outflow, like centrifugal forces etc) has not yet been set up, so this can be justified. If needed the classification name "quiet conditions" can be changed in manuscript. The short discussion on the sudden commencement with your recommended references and it effects on the results are now added into the manuscript under the section "Discussion". For "active" conditions the main reason for choosing the $Dst = -20\ nT$ threshold is in the statistics. If we chose the lower value for the Dst threshold we have considerably less data to make our analysis, and a lot more gaps occur. The average Dst value in our "active" dataset is -41, because of the extreme values going up to $-200\ nT$. But again the average convection velocities and the oxygen fluxes are higher than for our "average" conditions and therefore we have named it "moderate" conditions. The short explanation for $Dst = -20\ nT$ threshold is now added into the manuscript in section "Results" where the storm separation of the data is first introduced.

1.2 Minor

p. 2, l. 21: It could be helpful for the reader to give a range of values for “high altitudes”, since it is a recurring concept in this paper.

High altitude cusps do not have a defined boundary, but in this paper we used values with $R > 6\ R_E$, and are added into the text.

Figure 2: Perhaps it would be nice to add the lines showing the boundaries ofcusp and plasma mantle from Fig. 1 on both panels of Fig. 2, for the reader to be able to relate it to the discussion on p. 5, l. 3.

In this figure are the data taken from cusps and plasma mantle over a long period of time (4 years for CODIF and 14 years for EDI data). The boundaries are constantly changing due to a dynamic nature of the cusps, and adding the some average boundaries might be a confusing to some readers, since much of the data would be outside of this average boundaries.

p. 8: I would suggest that, whenever writing acceleration units, a space be added(m s−2) to avoid any possible confusion with "per squared millisecond”.

I agree and have changed it.

Figure 4: I would recommend slightly increasing the line thickness as well as the font size to improve the legibility of this figure.

Line thickness and font size are now increased.

p. 12, l. 8–9: Strictly speaking, the lower (upper) quartile is not defined as one standard deviation below (above) the average. I would therefore recommend to rephrase the corresponding sentence.

The sentence is changed and we do not mention the quartiles at all, only standard deviations.

Figure 9: I am intrigued by the isolated black pixel in the right panel (nearX = 1.5RE, R = 8.5RE). It is mostly curiosity, but would it be possible to briefly explain the reason why the oxygen from this bin reaches the dayside magnetosheath rather than the plasma sheet?

The isolated pixel in the figure 9, is an error in our code which occurred in the ploting part of the code. Thank you for pointing it out, the code has been fixed. The results and conclusions are the same.

p. 14: Would it be possible to add, perhaps as supplementary material, a figure showing the coverage of EDI and CODIF data for each of the three geomagnetic activity conditions, in a similar way as shown in Fig. 2? This could prove useful when discussing the results shown in Fig. 11. While the rather poor coverage for "quiet" and "active" conditions is unlikely to affect the overall results (as stated on p. 14, l.3), it would be valuable to discuss to what extent conclusions on the oxygen fate under those two types of conditions might be affected by the lack of data.

The requested figures are now added to the appendix. The gaps in the coverage are in the region that is almost entirely convected in "neutral" condition panel. We assume that if we do not have this gaps the results might favour the "capture" by few percent. This comment is now added into section "Results" of the changed manuscript.

p. 18, l. 1: The third point given in conclusions has not been mentioned above.I think it would be better to introduce the corresponding result and explain how itwas obtained in one of the previous sections (Results or Discussion).

The third point in conclusion is now added into section "Results" in the changed manuscript.