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Interactive comment on "The fate of O^+ ions observed in the plasma mantle and cusp: particle tracing modelling and Cluster observations" *by* Audrey Schillings et al.

Anonymous Referee #2

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This paper reports on a particle trajectory study to determine the fate of particles that have been accelerated in the cusp and located in the outer cusp and plasma mantle. They use observations from 136 events measured by Cluster for the initial conditions, and trace the particles in a Tsyganenko T96 magnetic field and a Weimer 2001 electric field. They find that most of the particles escape out the dusk flank. Only a small minority come to the inner magnetosphere. Overall the work is well done. Below I list some specific questions that should be addressed. Although most of these could be considered minor, they could also end up having major consequences, so I have checked "major" above since "minor" implied the paper would not go out for re-review.

1) Line 170 - I don't understand the statement, "the perpendicular component of the velocity corresponds to the general variability of the data set". Are you saying that it is mainly statistical error represented here? It does seem that the thermal velocity would be more appropriate to use than the bulk perpendicular velocity, since it is mainly the pitch angle of the particle that is important for the trajectory, since the convection used is from the Weimer field. A distribution with a large pitch angle, could have net zero perpendicular velocity, but it would certainly lead to a higher parallel velocity along the trajectory, as you state in the next line. Can you explain better why you made the choice you did?

2) How good these trajectories are clearly depends on how good the field models used are. I suspect that the trajectories are quite sensitive to the initial conditions in the "start" location. The paper should include some discussion about how well the T96 model does in this region, and how sensitive the trajectories might be to discrepancies. The paper, Tsyganenko and Russell, 1999 implies that there needs to be additional corrections to correctly model the cusp. Has anything like this been included? Have the fields in the observation location been checked against the Tsyganenko fields, to make sure that they are in reasonable agreement? Has it been checked that the initial positions are in the "cusp" region of the Tsyganenko field?

3) For the example shown in Figure 3, 196 out of 200 are "long trajectories". However, in general, ion with "long trajectories" are only 11% of the sample, implying that the sample shown is not representative. Is this because of the chosen initial position? How much does the type of trajectory depend on the initial location? Perhaps a figure like Figure 5a (maybe blown up around the region of interest) that shows the average trajectory length in each bin would help clarify this? Or a set of 3 figures that show number of long trajectories, number of medium, and number of short in each bin? Or perhaps better would be figures that show the eventual fate of ions from different start locations (down tail, out dusk, into inner magnetosphere).

Line 209-215 - It is not clear what is meant by the statement "We define the escaping limit by the distance of the final position R=10 Re." I suggest rewording to "An ion is defined to have "escaped the magnetosphere" if its final position is outside R=10."

Line 216 - Although this line is technically correct, I suggest rewording to make it clearer. "We determined the MAXIMUM distance in |X| for each trajectory".

Lines 281 and 282, Magnetosphere misspelled twice.

Reference:

Tsyganenko, N. A., & Russell, C. T. (1999). Magnetic signatures of the distant polar cusps: Observations by polar and quantitative modeling. Journal of Geophysical Research, 104(A), 24939–24956. http://doi.org/10.1029/1999JA900279

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