

Answer to the referee #2

We would like to thank the referee for his/her comments. We hereby answer the comments in green.

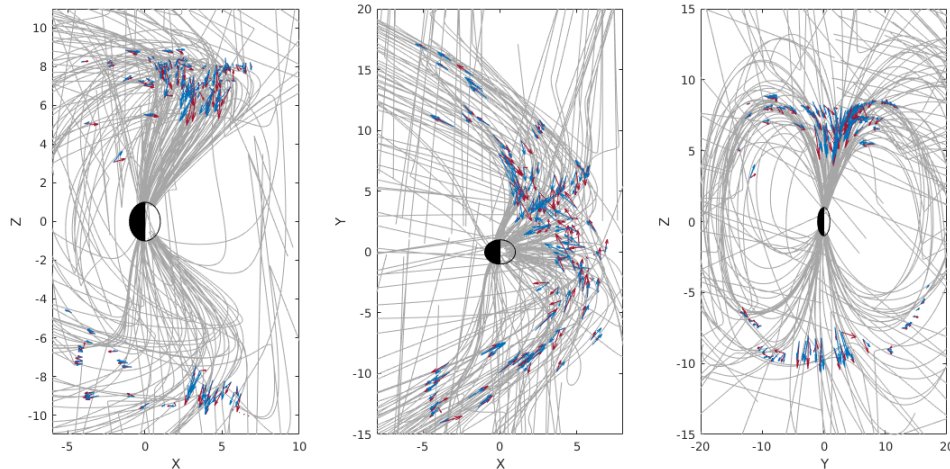
1) Line 170 - I don't understand the statement, "the perpendicular component of the velocity corresponds to the general variability of the data set". Are you saying that it is mainly statistical error represented here? It does seem that the thermal velocity would be more appropriate to use than the bulk 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?

We originally used the bulk perpendicular velocity calculated with CODIF instrument, which is dominated by the ExB drift, which is included in the model and should not have been added to the particles. Just as the reviewer notes, we should have used the thermal velocity. We re-did the whole analysis with the thermal velocity instead. Since the thermal velocities were higher than our initial perpendicular velocity (1st manuscript), the total velocity was slightly underestimated. However, the final result did not change significantly.

See the general comment at the top of the answers and also equation (1) and paragraph 3.2 in the reviewed manuscript.

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?

The trajectories are indeed sensitive to the initial conditions. However, we checked the magnetic field provided by Cluster at the starting positions and the corresponding magnetic field calculated by Tsyganenko model. We found that both magnetic fields correspond pretty well to each other even though an increase in magnitude is observed closer to the Earth, see Fig. below (not shown in the manuscript). The blue and red components correspond to Cluster data and Tsyganenko respectively. We also checked the tracing of the lines individually for each event and we found that 4 events out of the 131 were most probably in the cusp (3%). Consequently, to avoid confusion for the reader, we removed "cusp" from the title and we focused our manuscript on the plasma mantle region.



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).

With our new events (131 instead of 136) the long trajectories are reduced to 5% of the sample. The starting points of the long trajectories do not influence how long the trajectory will be. We choose this particular example for the paper to illustrate the 3 types of trajectories even though long trajectories represent only 5% of the sample. To better illustrate the different trajectories we replace Figure 5 by a similar figure but divided in short, middle and long trajectories instead. We discuss this new figure lines 233 – 237 in the revised manuscript.

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 $R=10 R_E$." I suggest rewording to "An ion is defined to have "escaped the magnetosphere" if its final position is outside $R=10$."

We have added the sentence to clarify our definition of the escaping boundary, see lines 218-219.

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".

Since this parameter was not clear, we rewrote the sentences, see lines 224-227. See also comment #1.4 and #3.3 of referee #1. We defined the minimum X distance as the smallest value in the X direction for each ion trajectory. This parameter help to understand if ions move directly to the magnetopause or experience return flow (and interact with the plasma sheet) starting from the plasma mantle region. Therefore it is not the maximum distance $|X|$.

Lines 281 and 282, Magnetosphere misspelled twice.

Thank you, this has been corrected.