Response to reviewer #2

We thank the reviewer for his/her detailed review and comments. All the comments raised by the reviewer have been taken into account, and we hope that the reviewer will now find the paper acceptable for publication. The responses and revisions to the manuscript are as following:

Comment 1 and **Response** see the **Partial response to reviewer #2**

Comment 2: A success in the understanding often depends much on proper methods and proper choice of the reference system. This is often neglected throughout this study. The examples are: (a) Considerable part of paper contains discussions of magnetic curvature variations. However both current and magnetic field (also curvature) are displayed in GSM coordinates, neglecting such things as the large tilts of current sheet normals (towards dusk or dawn,etc), tail flaring effects (with magnetic field planes diverging downtail) etc. LMN-type coordinate systems could be a better choice (but they may vary between subsequent neutral sheet crossings). GSM is not a proper reference system in such kind of analyses, the observed GSM variations are not easily interpreted, and they are hard to compare with any model predictions. (b). Previous studies of current carriers showed that protons are not typically the main current carriers, and that electric drifts are important players in this game (see e.g. Runov et al. AnnGeo 2005, Artemyev et al AnnGeo 2009, etc). Therefore, it is important to analyze the ion distributions in the plasma frame. This was already discussed in the comment 1, and another example is your finding of ion population moving dawnward, which was exposed as specific new result of this study but really it can be related to the dawnward plasma convection in this particular episode. Note also that theoretical models are always formulated in the plasma frame.

Response: The reason that field line curvature variations are displayed in GSM-system is to be consistent with the ion distributions since the guiding field effects on the asymmetric scattering of nonadiabatic ions can be more conveniently investigated. According to the reviewer's suggestion, we plot the guiding field hodograph in the LMN-system for the first event in the time interval 06:35-06:55UT. The change is especially noticeable in Bm, which reverses its sign between adjacent crossings.

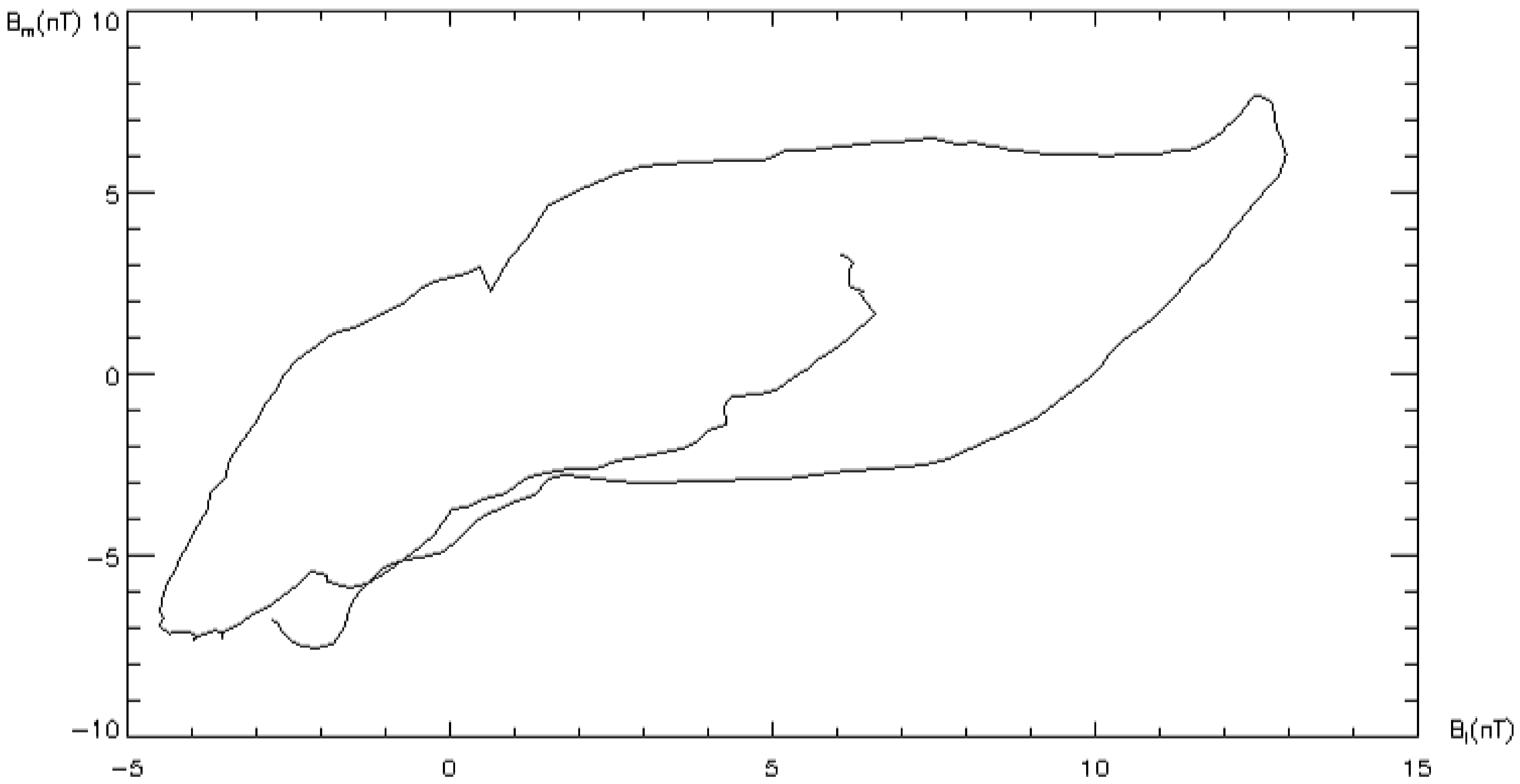
The frame shift has already been taken into account to analyze the ion distributions (see also the **Partial response** to comment 1). As for the population moving dawnward, it is indeed exclusive to the bifurcated current sheet and exactly corresponds to the platform profiles in Bx in the sheet center. As one can see, comparable dusk-dawn plasma convections exist in all the presented events, while the population moving dawnward is unique to the bifurcated current sheet event. Thus, this population seems not to be related to the dusk-dawn plasma convection.

Revision: The Bm-Bl hodograph Fig.1 is inserted as an additional figure to the manuscript.

Comment 3: This is a brief comment to your partial response. I don’t think that by drawing simple two-color cartoons or showing some particular slices of distribution function you can prove that a specific ion population exists on top of up/down convecting plasma sheet distributions (VZ-shifted Maxwellian ot Kappa). When analysing shifting Maxwellian for realistic temperature/density/flow one can understand that measurable angular asymmetry due to the flow appears in the high-energy part of spectrum, where the energy flux drop fast with the increasing energy. This was known for a long time, particularly Roelof et al JGR 1976(https://doi.org/10.1029/JA081i013p02304) used the instrument, only capable to measure the ions above 50keV, to detect rather weak flows of 50km/s or comparable (this is due to rather soft proton spectra at those energies, so that a 20-50km/s shift of velocity distribution causes a measurable angular anisotropy). No such effect would be seen at smaller energies near the peak of E-flux distribution near the thermal energy. Particularly, this explains your Phi/Theta plots. I believe this is a very probable explanation of your NS asymmetric particle flux plots.

Again, I reiterate that in order to demonstrate “a specific ion population existing on top of up/down convecting plasma sheet distributions" you need to work with the distribution functions. Ideally you have to show that a significant (asymmetric??) population remains after subtraction of the shifted Maxwellian/kappa (with realistic n,T,V) from the measured distribution. The error analyses should be important part of the story, you also may try E-field observations at Cluster to evaluate/confirm the true convective velocity. Without such analyses the paper is a discussion of non-existing phenomenon.

Response: In the first event, some plasma parameters are T~5600eV, V_{zMax} ~ 40km. Thus, the anisotropy parameter $\alpha = V_{zMax} * V_{criteria} / V_{thermal}^{*2}$ ~ 0.04, where the $V_{criteria}$ ~ 1200km/s, is the criteria velocity of the population that displays asymmetric theta distribution, as can be seen in Fig.2 in the **Partial response**. The observational asymmetric profile $\ln(J(\theta=90^0)/J(\theta=0^0))$ ~ln(11000/7100) ~0.44. Thus, a theoretical anisotropy estimation using realistic plasma parameters is one order smaller than that of the observational profile.


B_m(nT)
10
5
0
−5
−10
−5
0
5
10
15
B_l(nT)