Partial response to reviewer #2

We thank the reviewer for his/her detailed review and comments. For the sake of an interactive discussion to clarify the N-S asymmetry problem, this partial response is dedicated to **Comment 1**. A full response to all the comments and revision to the manuscript are preparing and will be presented later.

Comment 1: A trivial consequence of flapping plasma sheet is that , in the presence of up/dawn kink motions of the plasma sheet , an alternative up/down net flux of the plasma ions exists, related to corresponding VZ component of the bulk flow. (Alternating convective VZ have been demonstrated many times since first Cluster studies of flapping phenomenon, e.g., Sergeev et el., 2003 etc). Neither in previous paper (Wei et al. GRL 2015) nor in the submitted paper, I was able to find any proofs that demonstrated ion flux asymmetry is related to smth else but VZ-related shifts of the ion distributions, or that it is related to some specific localized ion sub-population. No real analyses of distribution functions is provided, and the flux asymmetry effect is actually very weak (which is due to small VZ amplitude, I suppose). The authors have to demonstrate explicitely that a specific ion population exists on top of up/down convecting plasma sheet distributions, otherwise this is a mere

speculation and discussion of non-existing things.

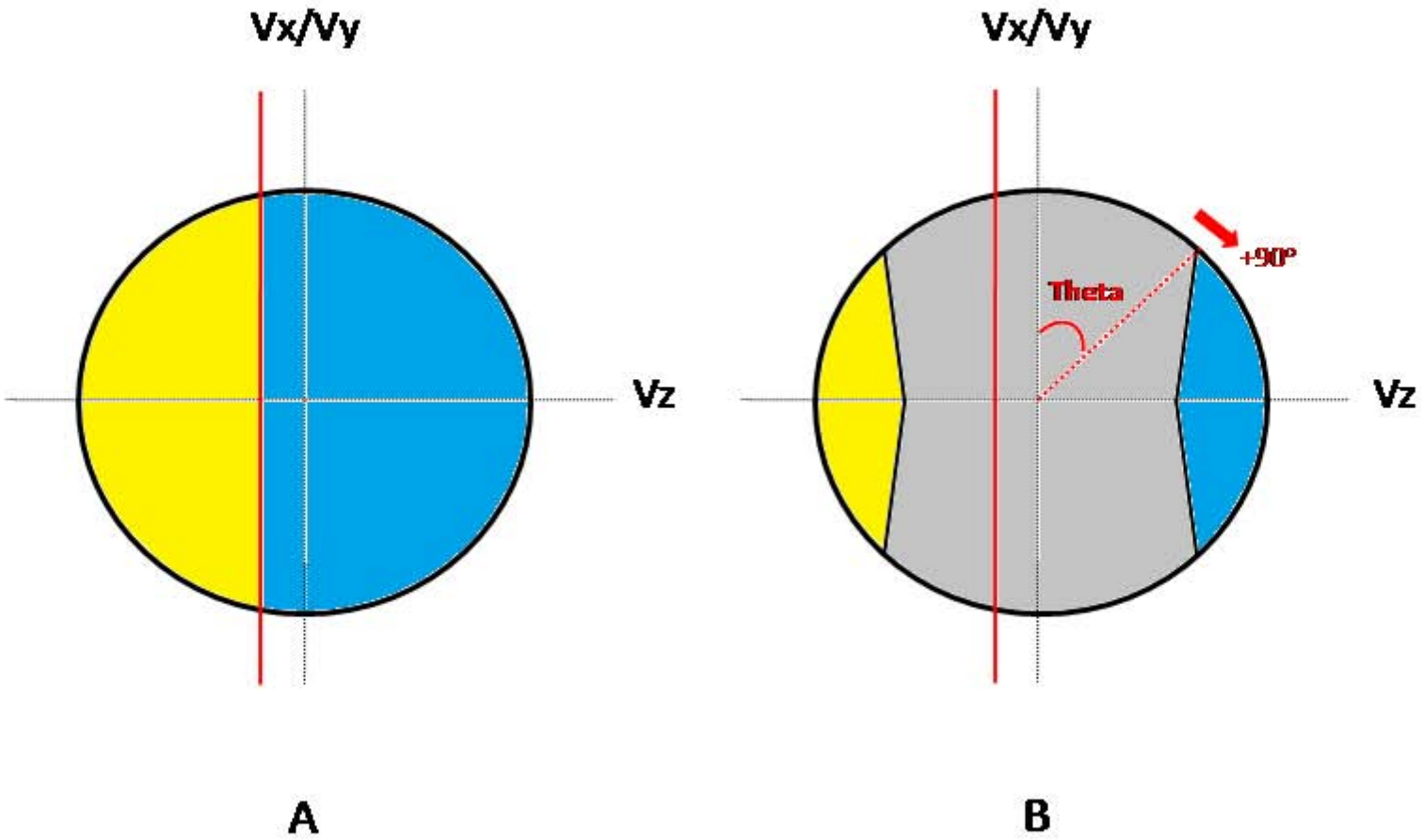
Response: It seems that the explanation of the asymmetrical theta distribution by the reviewer can be shown as **Schematic 1A**, if we didn't misunderstand the reviewer's statement. In that case, original symmetrical distributions become asymmetrical between the left and right parts due to a reference frame shift (even small). The asymmetry will be more prominent in the smaller velocity and/or theta domain. However, the observational theta distribution is shown as **Schematic 1B** (see also **Fig.2** and **Fig.3** below). In this situation, symmetrical distributions in the larger velocity and theta domain (the yellow and blue parts) will maintain the original distributions, even though there is a rather small reference frame shift (<50km/s). The population in the smaller velocity and/or theta domain (gray part) is excluded automatically in the comparison of the symmetry between the theta distributions concentrated on $+90^0$ and -90^0. A slight distribution difference between the yellow and blue parts due to the frame shift is only in theory and is out of the instrument resolution.

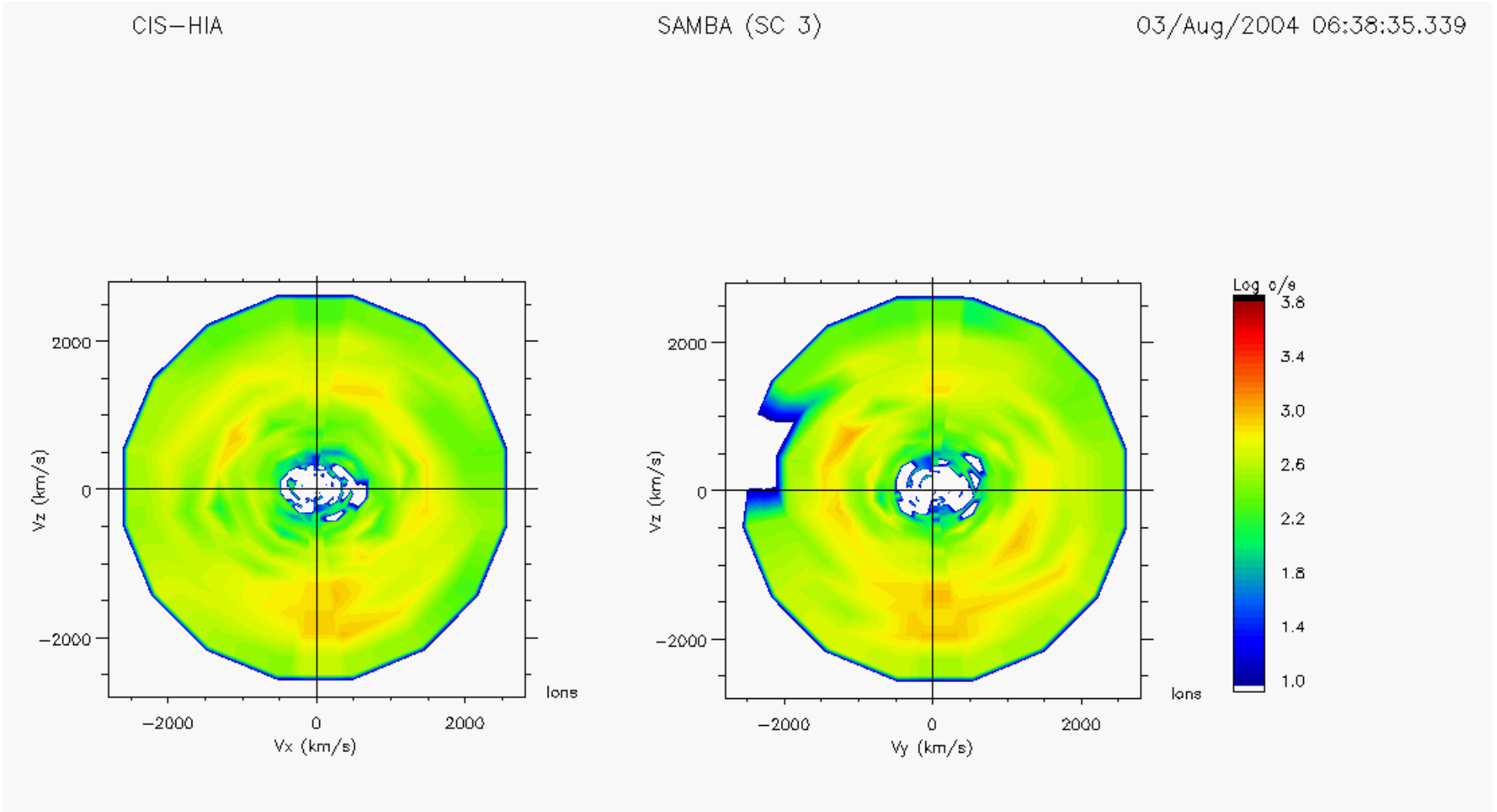
Fig.2 shows the ion distributions in the sheet bulk motion frame at the first sheet center crossing in the first event (03/08/2004). It can be seen that there is a distribution asymmetry between the top and bottom of the V_z-axis, which correspond to the blue and yellow part in **Schematic 1B** respectively. The asymmetric fluxes are $\sim 8\times10^4$ vs. $\sim10^5$ count/spin, as

mentioned in the manuscript. As we clarify above and also the frame shift has already been taken into account, this asymmetry seems not to be caused by the current sheet bulk motion.

To verify the asymmetry signature more clearly, **Fig.3** shows some theta-phi angular distributions in a single energy level (the x-axis is the phi angle from -180^0 to $+180^0$). The theta distribution asymmetries between $+90^0$ and -90^0 can be found in two higher energy levels, as shown in the two panels on the top. As a comparison, no asymmetry is displayed in lower energy levels, as shown in the two panels on the bottom. If it is interpreted by a frame shift according to the reviewer's explanation, the distributions in lower energy levels should also be asymmetrical. From the view of individual particles for these approximate monoenergy populations, the particle movement direction in the z-direction (~1500-2000km/s), both parallel and antiparallel, cannot be changed by a too small frame shift (<50km/s).

Of course, the paper presents a preliminary result on the ion non-adiabaticity. But still, the observational evidences reveal the existence of the N-S symmetrical populations, if the reviewer agrees with this point, which is a direct consequence of nonadiabatic ions interacting with the current sheet. A complete identification of the ion nonadiabatic behaviors may be left to further investigations.


Vx/Vy
Vz
Vx/Vy
Theta
+90°
Vz
A
B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0
−2000
Vz (km/s)
−2000
0
2000
Vx (km/s)
Ions
2000
0
−2000
Vz (km/s)
−2000
0
2000
Vy (km/s)
Ions
Log e/s
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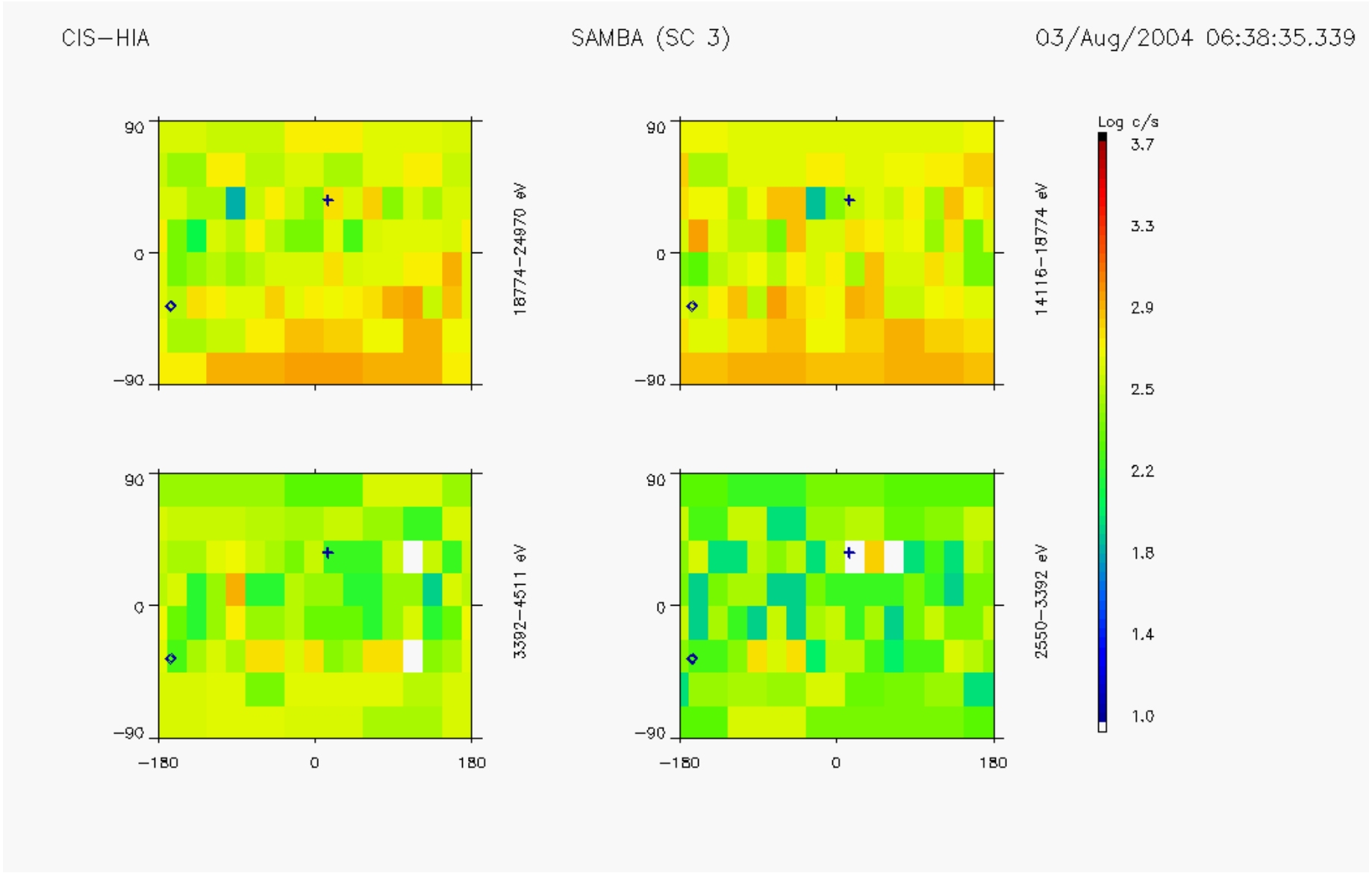
3.4
3.0
2.6
2.2
1.8
1.4
1.0


CIS–HIA
SAMBA (SC 3)
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–90
–180
0
180
18774–24970 eV
14116–18774 eV
3392–4511 eV
2550–3392 eV
Log c/s
3.7
3.3
2.9
2.5
2.2
1.8
1.4
1.0