

## ***Interactive comment on “A source mechanism for magnetotail current sheet flapping” by Liisa Juusola et al.***

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>Anonymous Referee #2

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>Using the 2-D global hybrid-Vlasov model Vlasiator, authors studied the response of magnetotail at the tail center to the magnetopause perturbation, created by subsolar magnetopause reconnection. Authors declared that the appeared oscillation of tail Bx component should be the kink-like flapping motion propagating towards both tail flanks. Nonetheless, the simulation is 2-D, The variation of this oscillation in Y direction can't be investigated, it is still hard to convince readers that the oscillation of Bx component is indeed associated with the kink-like flapping propagating azimuthally. I will explain

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my reasons in the following.

We thank the Referee for their comments and drawing our attention to the fact that some clarification of the text is needed: our intent was not to declare that the simulated oscillations are the kink-type wave that propagates in the dawn-dusk direction but waves in the x-z plane. It was an item of discussion that these waves could maybe act as a source for the waves that propagate in the y direction. Please see below for our detailed replies to the comments and suggested modifications to the text.

>Major comment >As stated in the introduction, Rong et al.(2015) found that the different flapping modes can yield a same flapping sequence of Bx component. How can you differentiate these flapping modes in your simulation? In my view, only the 3-D simulation can unambiguously answer it.

As the simulation is 2D in the x-z plane it cannot contain the kind of waves that propagate in the y direction. Rong et al. (2015) mention two kinds of waves in the x-z plane. It should be possible to analyze the normal directions of the waves to separate these, but we do not consider this to be relevant to our conclusions. We analyze the wave signatures in the x-z plane, determine a mechanism that can start and maintain these waves, and then discuss the possibility that in 3D our suggested mechanism could function in the midnight sector. We suggest that, in 3D, these waves could act as a source for the waves that are emitted from the midnight sector and propagate in the dawn-dusk direction. In order to make this more clear, we would suggest to modify page 2, lines 27-29 to: “Because the simulation is 2D, we concentrate on the characteristics and source of the waves in the center of the tail (i.e., waves in the x-z plane). We also discuss to possibility that in 3D, they could drive the kink-like waves that are emitted from the center of the tail and propagate downward and duskward (i.e., waves in the y-z plane).” We have also suggested some further clarifications in the abstract and conclusions in response to the comments by Referee #1.

>Specific comments >1. Line 16 of page 2, the paper of Shen et al.[2008,AG] and

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Forsyth et al.,(2009,AG) should be cited when referring the disturbance of solar wind flow as the flapping source. Shen, C., Z. J. Rong, X. Li, M. Dunlop, Z. X. Liu, H. V. Malova, E. Lucek, and C. Carr (2008), Magnetic configurations of tail tilted current sheet, *Ann. Geophys.*, 26, 3525–3543. Forsyth, C., M. Lester, R. C. Fear, E. Lucek, I. Dandouras, A. N. Fazakerley, H. Singer, and T. K. Yeoman (2009), Solar wind and substorm excitation of the wavy current sheet, *Ann. Geophys.*, 27, 2457–2474.

We can add these references.

>2. The joint observation of flapping event by TC-1 and Cluster (Zhang et al., 2005,AG) showed that the kink-like flapping waves propagate longitudinally with the same flapping phase at different X coordinates. However, it can not be characterized in your 2-D simulation, e.g. Fig1. Zhang, T. L., et al. (2005), Double Star/Cluster observation of neutral sheet oscillations on 5 August 2004, *Ann. Geophys.*, 23, 2909–2914.

Considering the 1 min temporal resolution and relatively small (5 RE) separation in x direction between the satellites in the study by Zhang et al. (2005), we do not see that there would be a discrepancy between our results and theirs.

>3. Fig.3 predicts a dispersive flapping waves with time-increased frequency. To my knowledge, there is no observation evidence to back up it. Careful comparisons are needed.

We agree with the Referee and indeed suggest further studies to validate the simulation results against observations (page 7, lines 25-26).

>4. Even your 2-D simulation is valid to explain the triggering of kink-like flapping, the magnetopause disturbance is not the unique source. What I mean is that, the sources result in the pressure imbalance over tail current sheet could be multiple.

We agree with the Referee. It is quite likely that occasionally there would be multiple hemispherically asymmetric signatures that could all result in a displacement of the current sheet. The result would probably be more irregular flapping signatures, which

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is not in disagreement with observations. We suggest to add on page 7, line 23: “Any hemispherically asymmetric magnetopause perturbation could cause tail flapping as shown here, but the shown perturbation initiated by subsolar magnetopause reconnection is a good example of a simulationally confirmed perturbation which indeed does cause this.”

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