

Interplay between magnetic reconnection and flapping instabilities in the magnetotail: global hybrid-Vlasov simulation of the Earth's magnetosphere

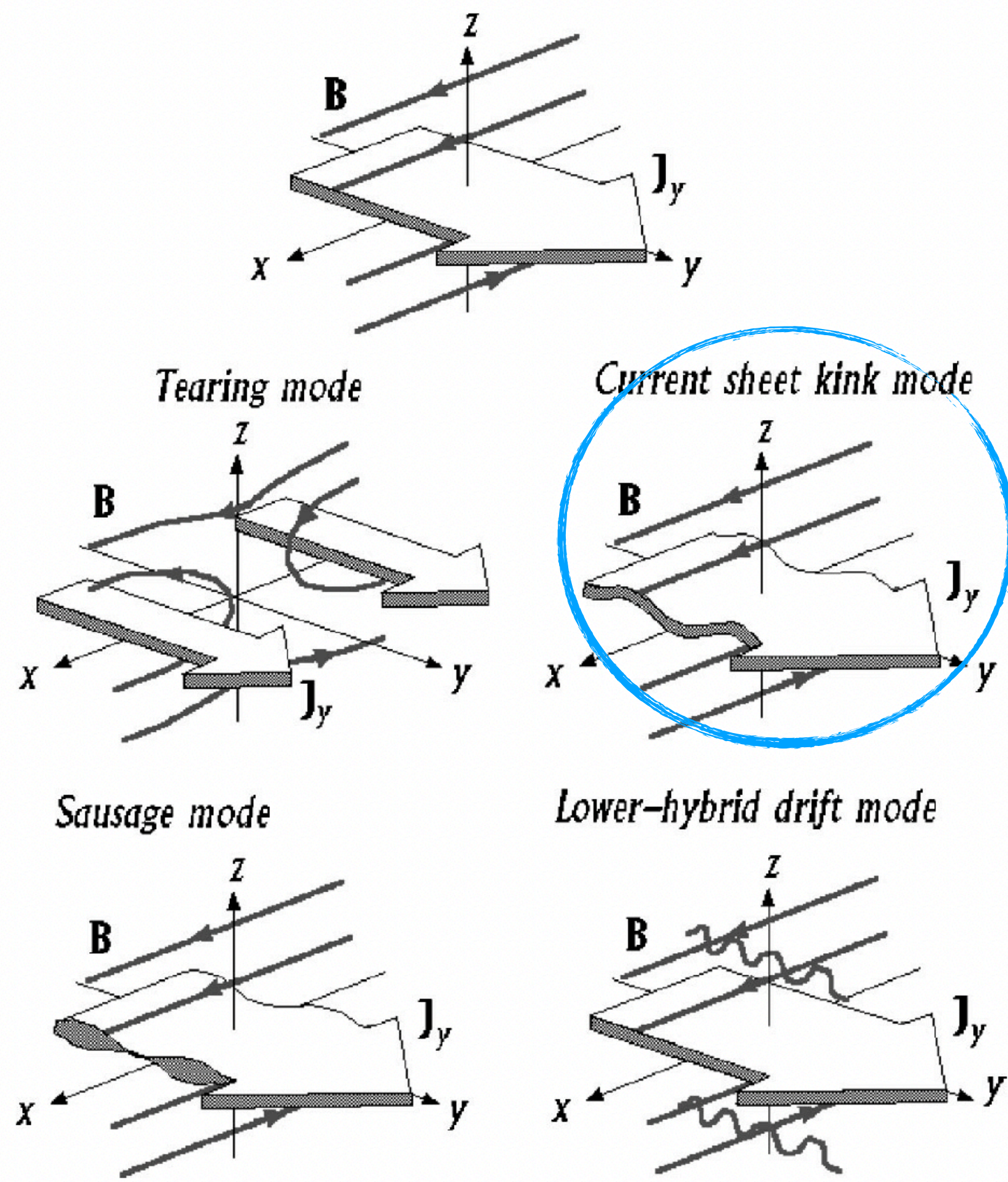
Giulia Cozzani

Department of Physics, University of Helsinki, Helsinki, Finland

Collaborators: U. Ganse, Y. Pfau-Kempf, M. Alho, J. Suni, M. Grandin, L. Turc, I. Zaitsev, M. Bussov, M. Dubart, H. George, K. Horaite, T. Manglayev, K. Papadakis, V. Tarvus, H. Zhou, and M. Palmroth

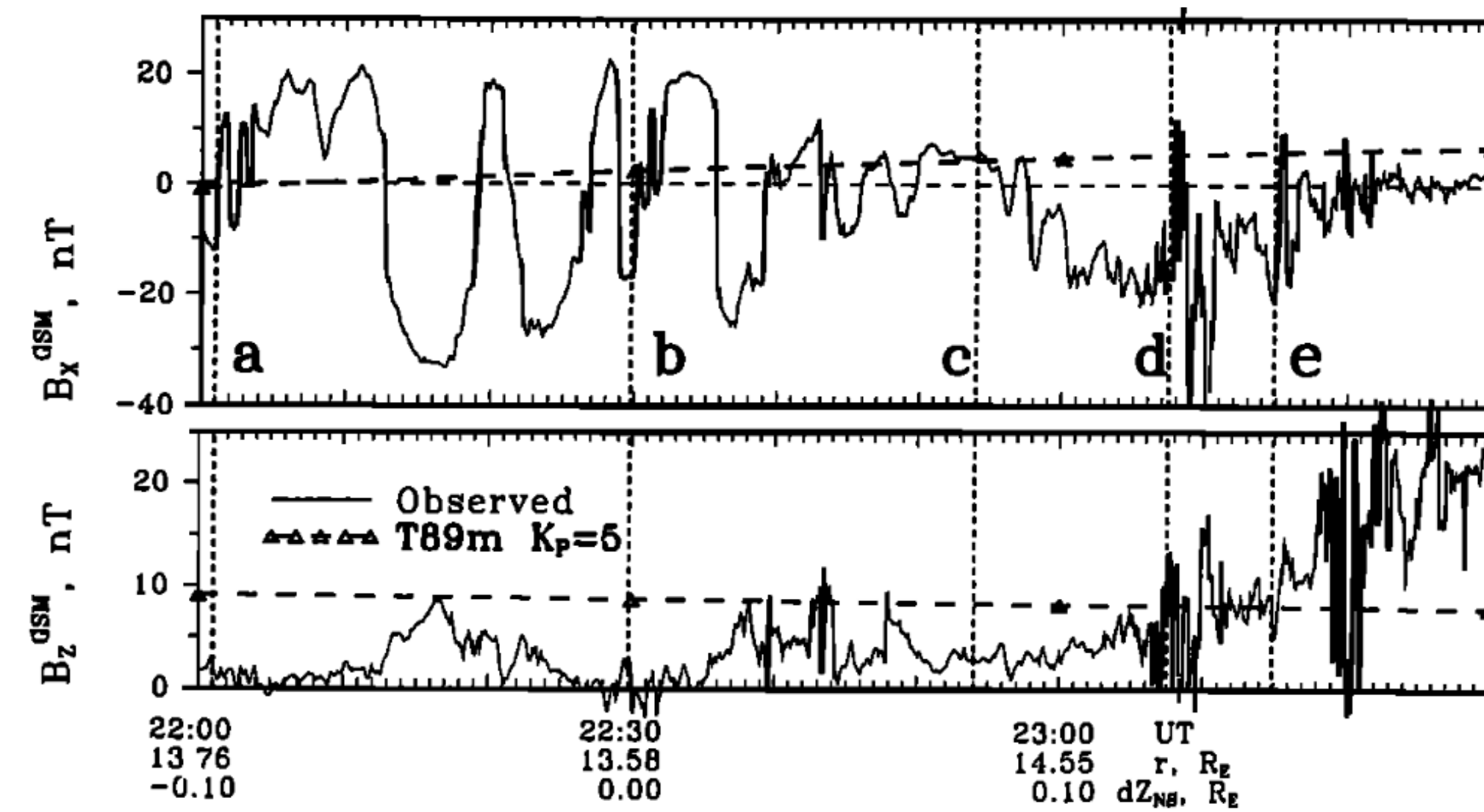
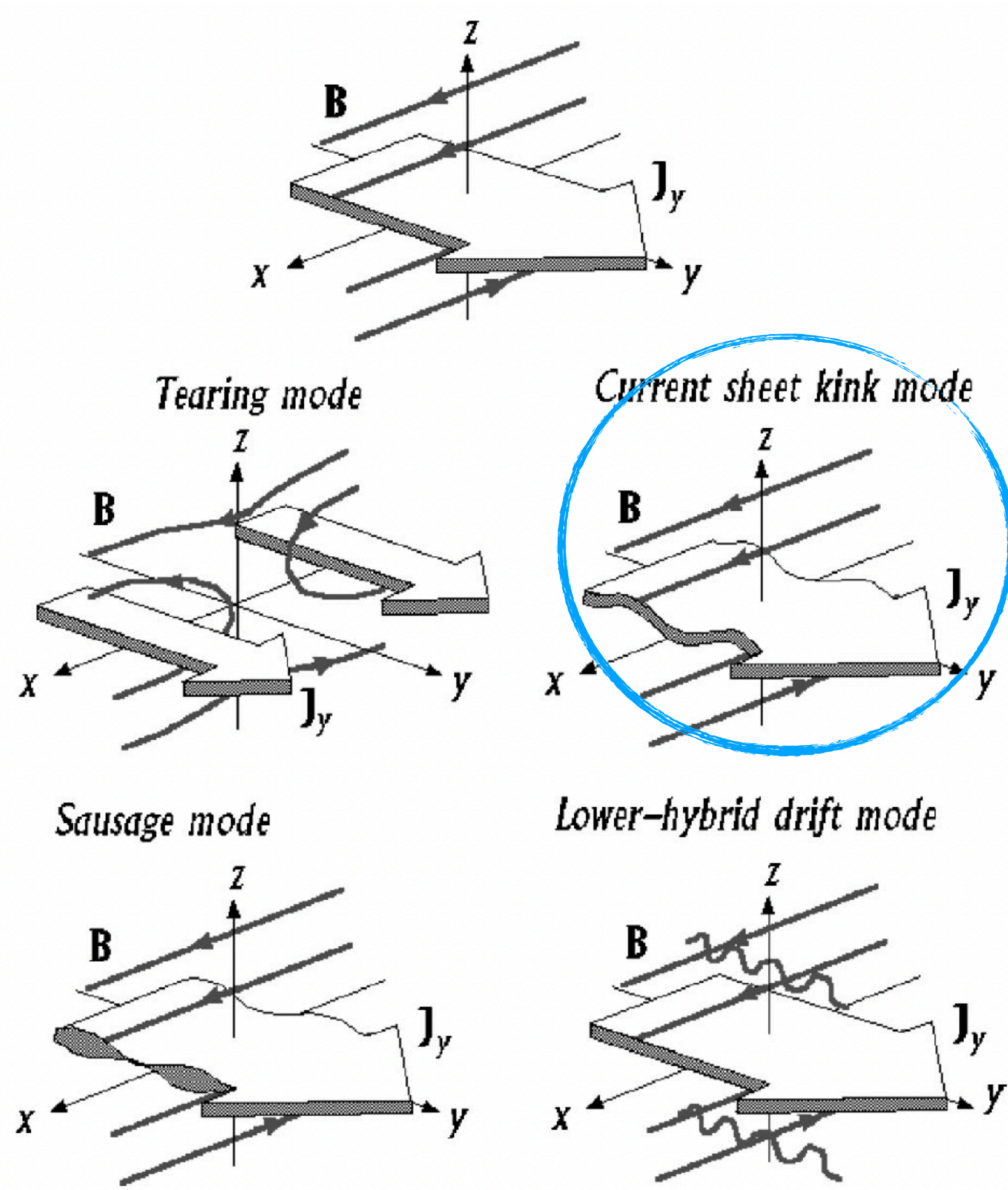


The magnetotail current sheet is often perturbed by kinking motions



[Yoon et al., Phys. Plasmas, 2002]

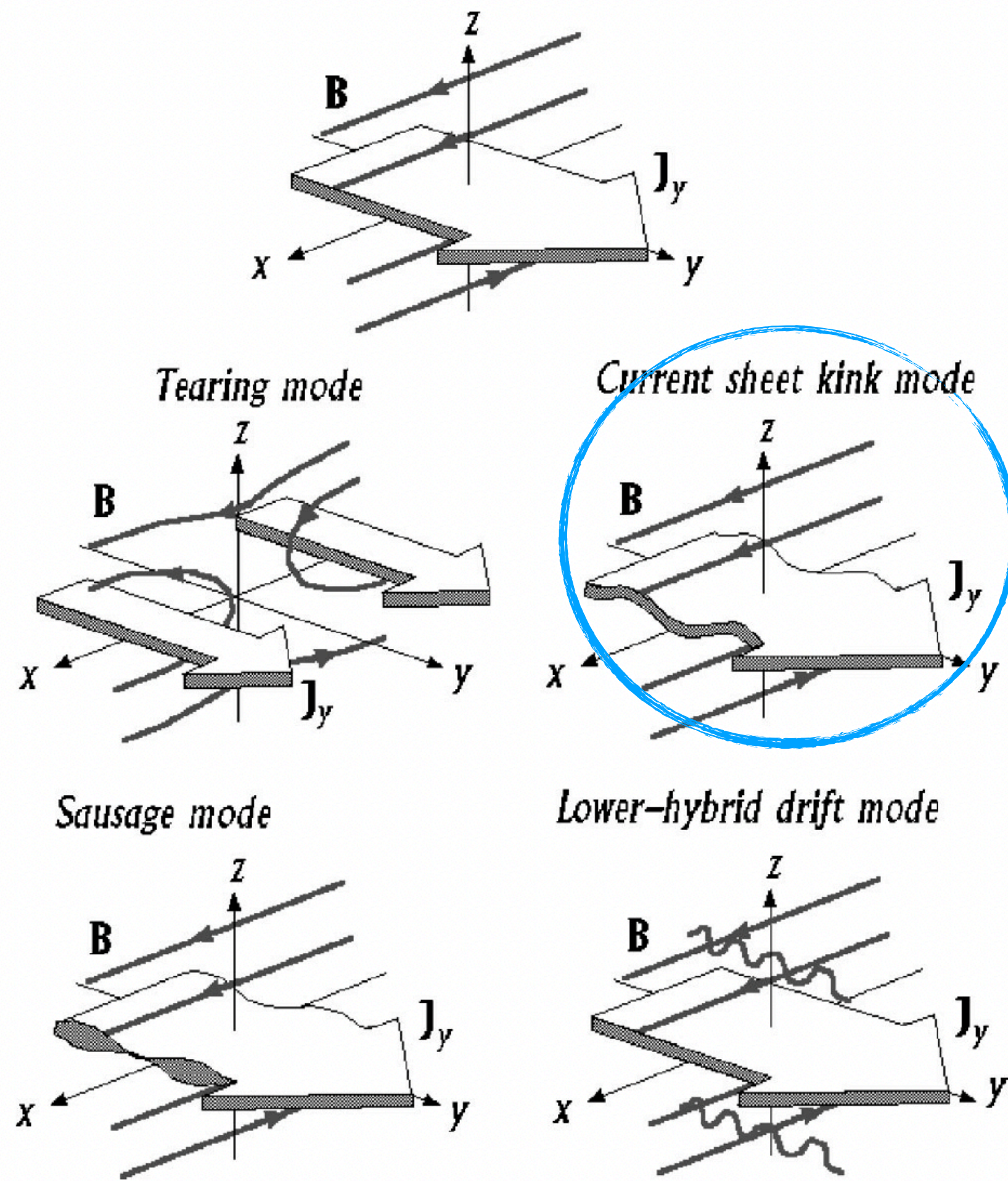
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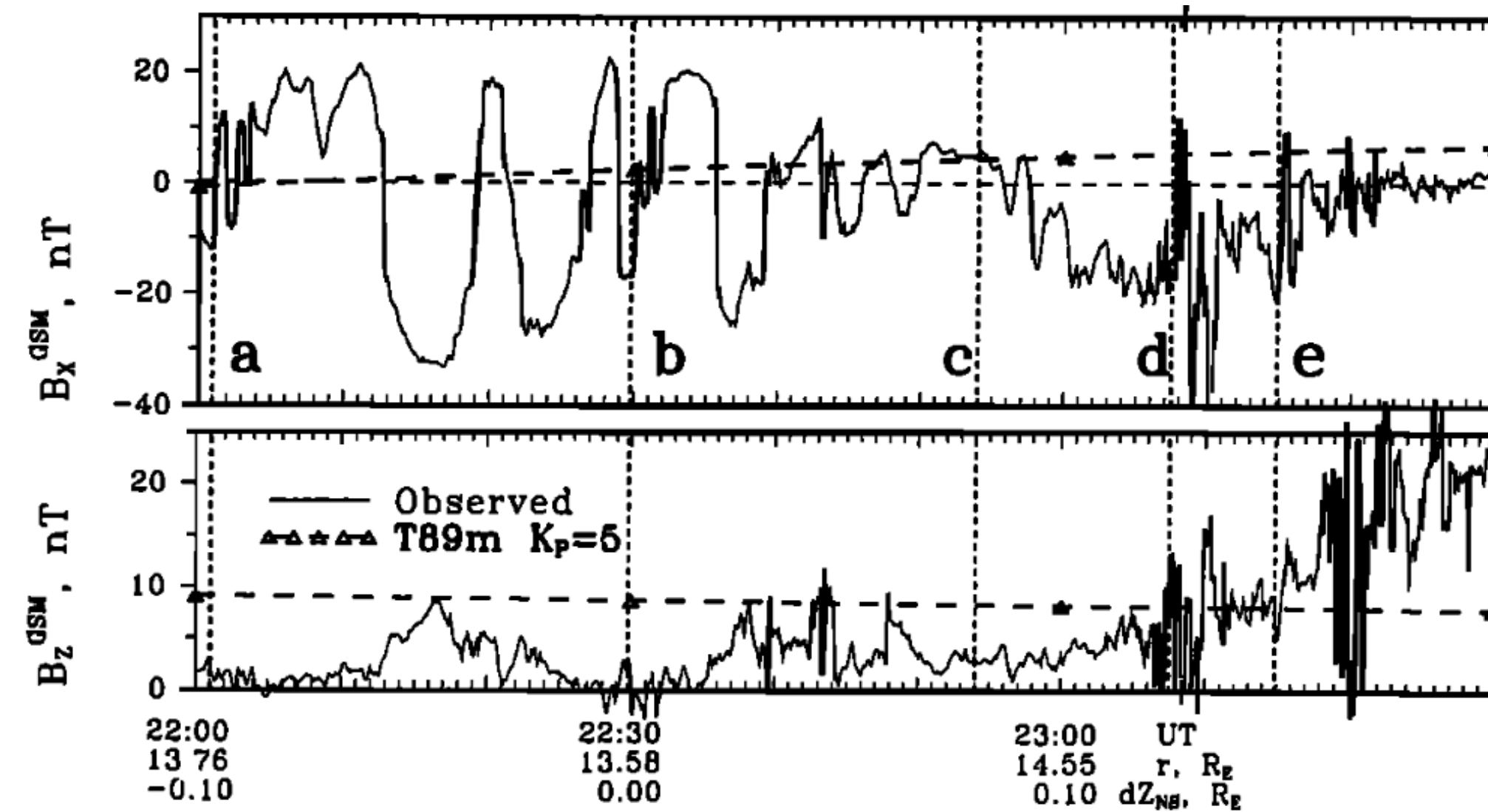
[Sergeev et al., JGR, 1998]

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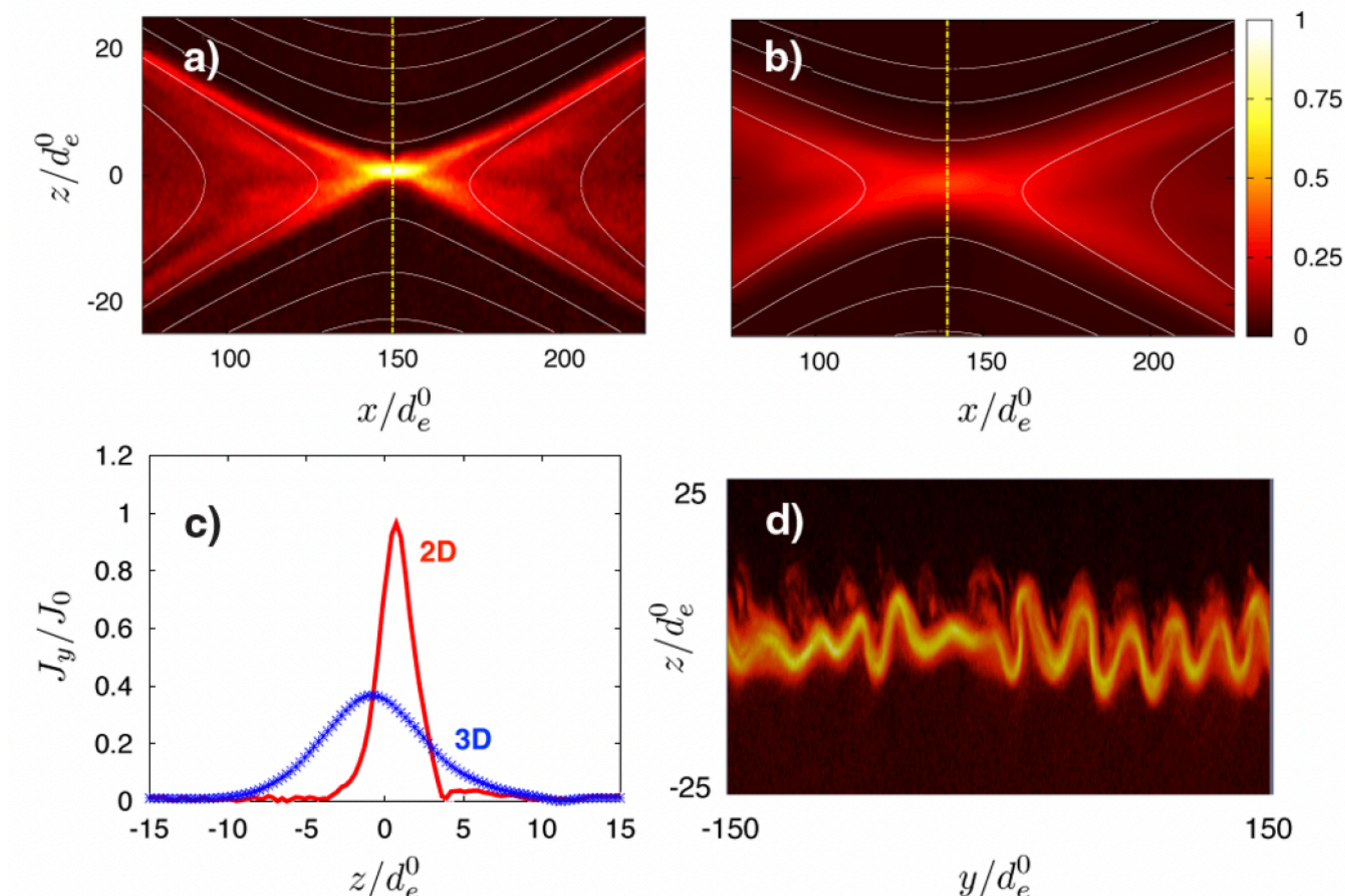
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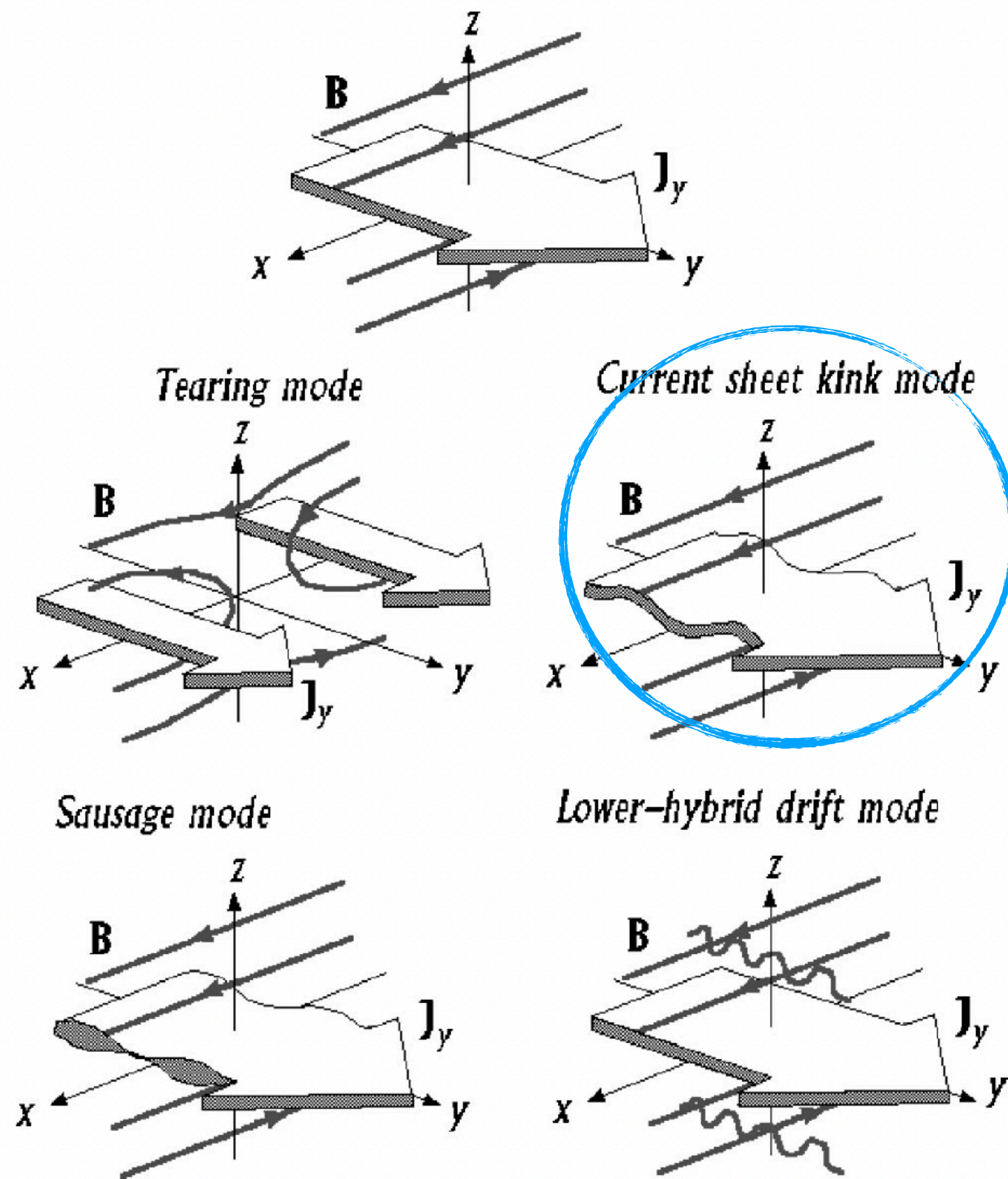


[Sergeev et al., JGR, 1998]

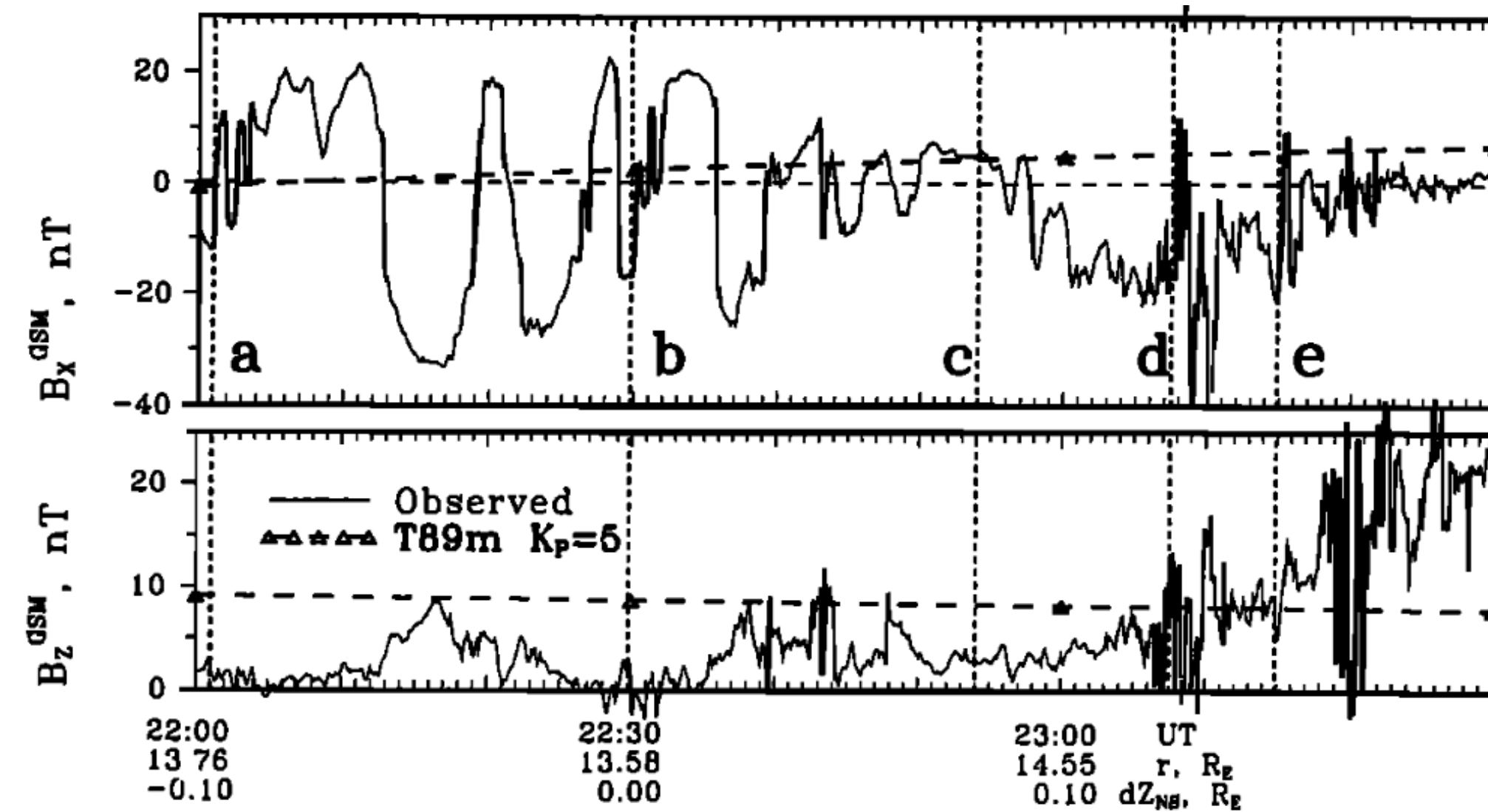


[Roytershteyn et al., PRL, 2012]

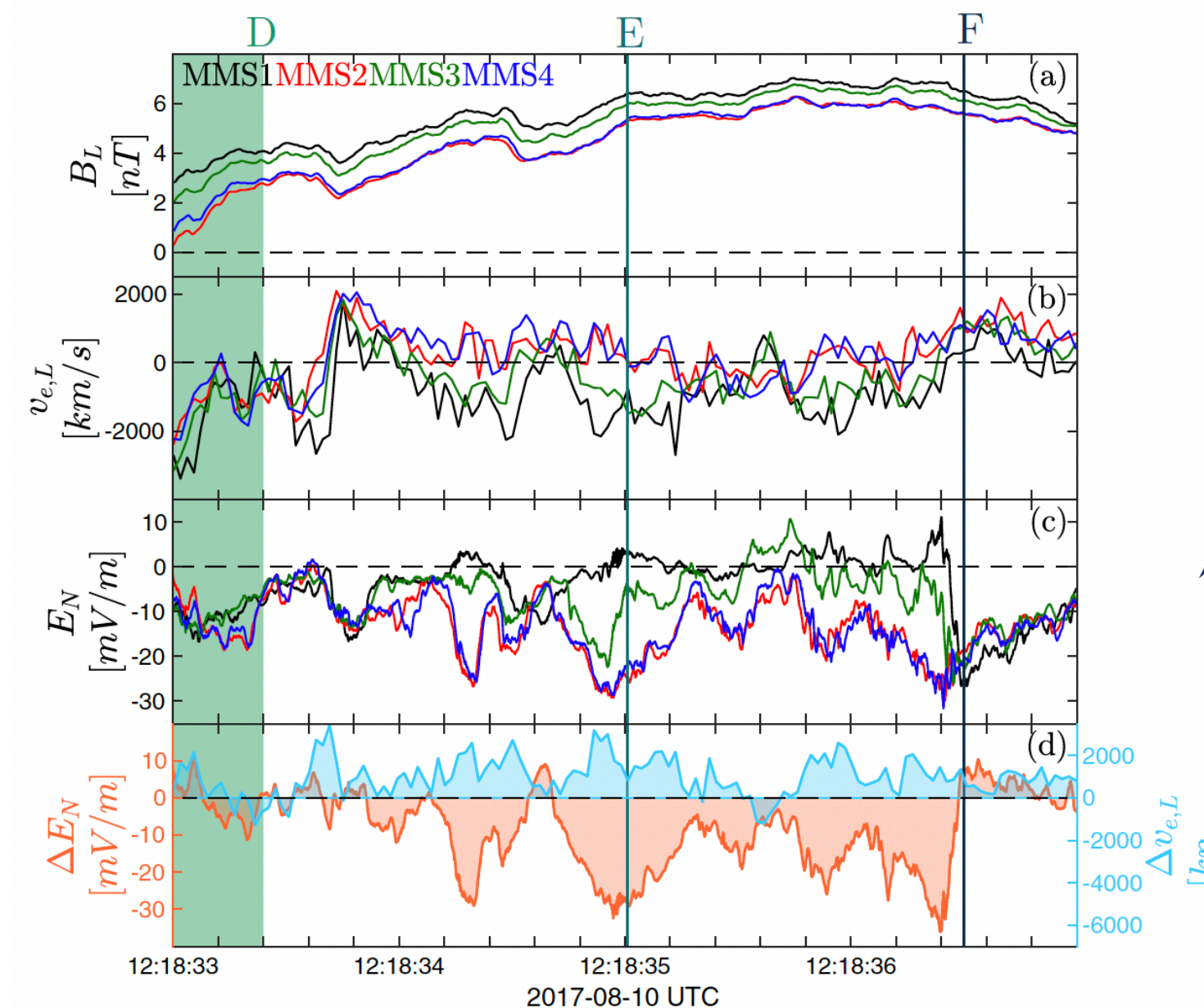
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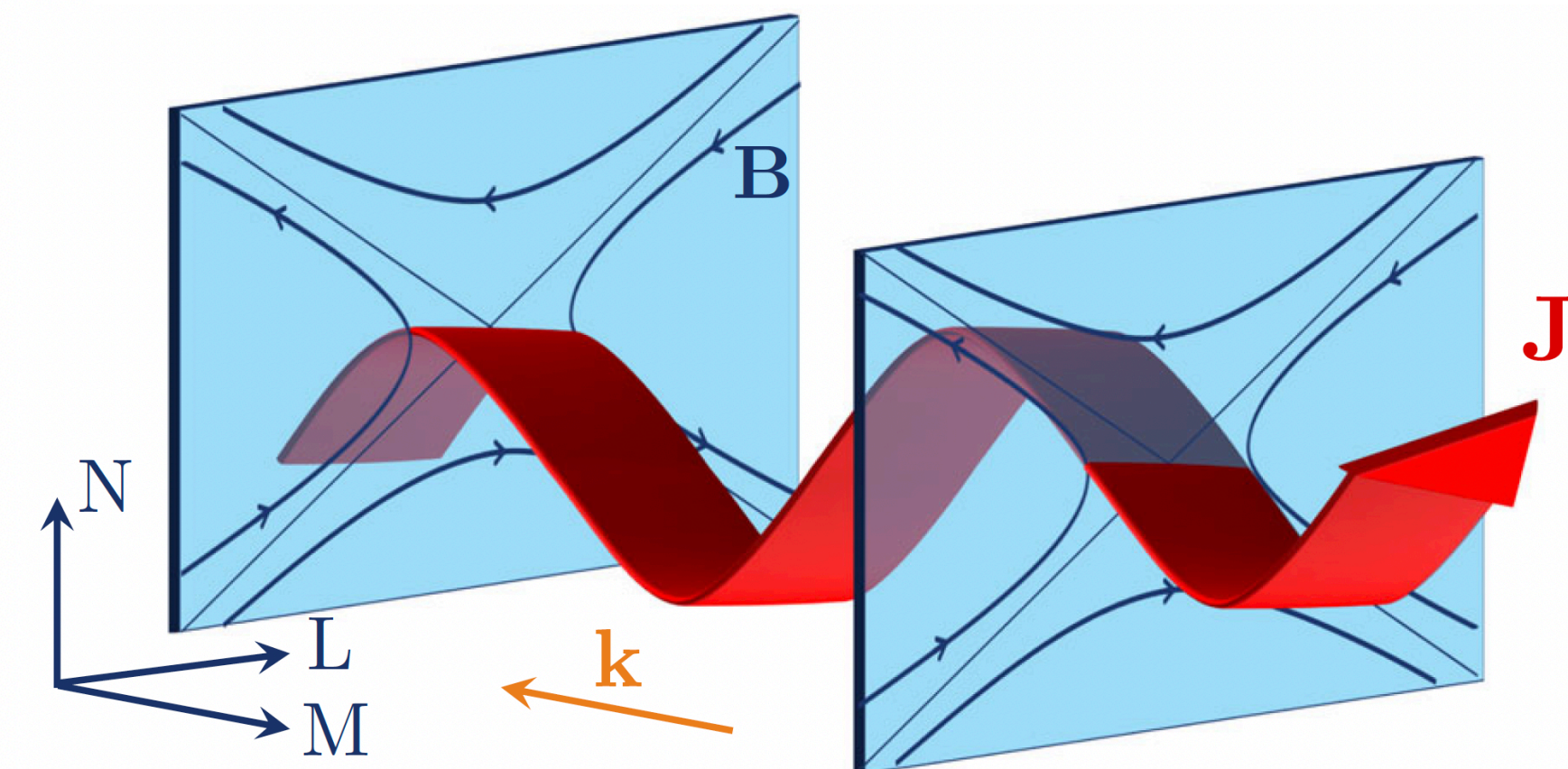
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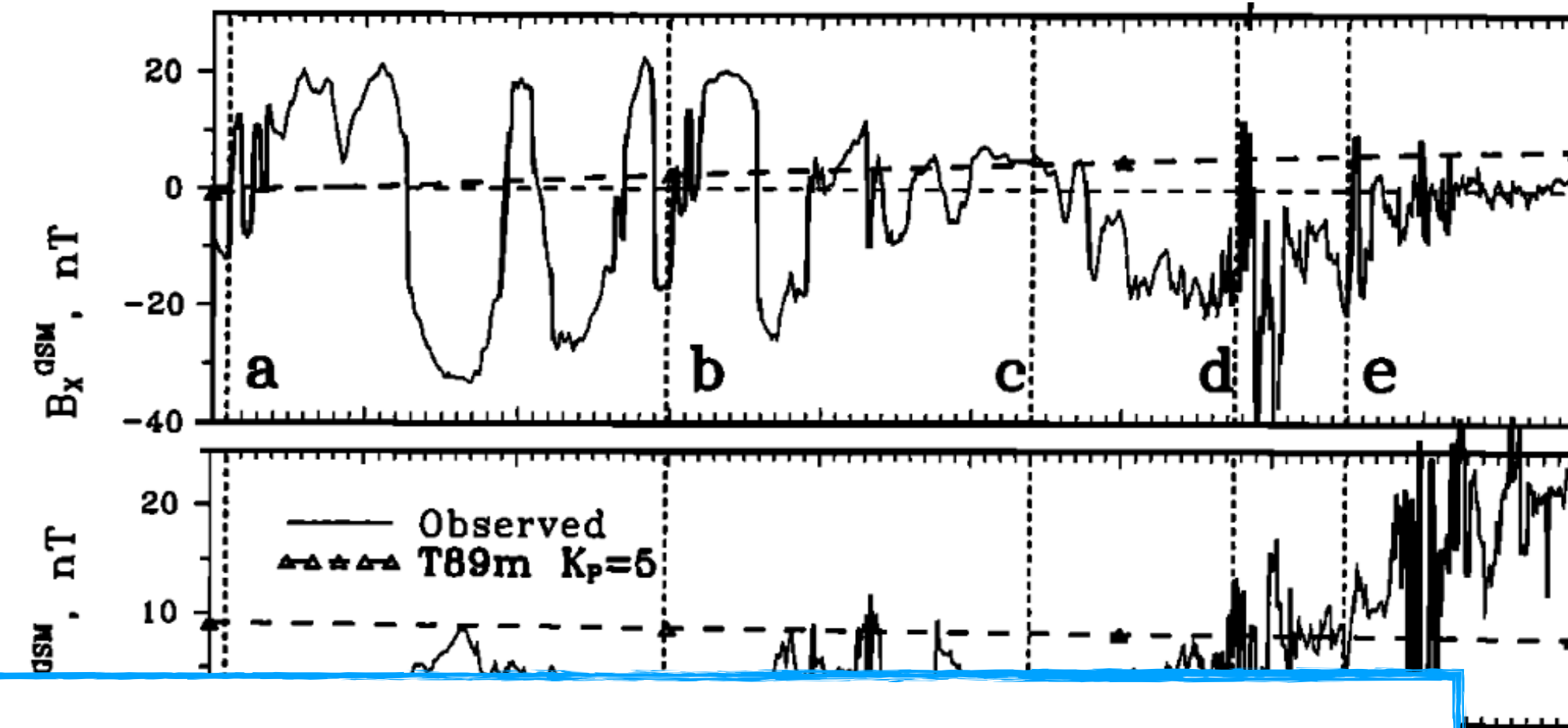
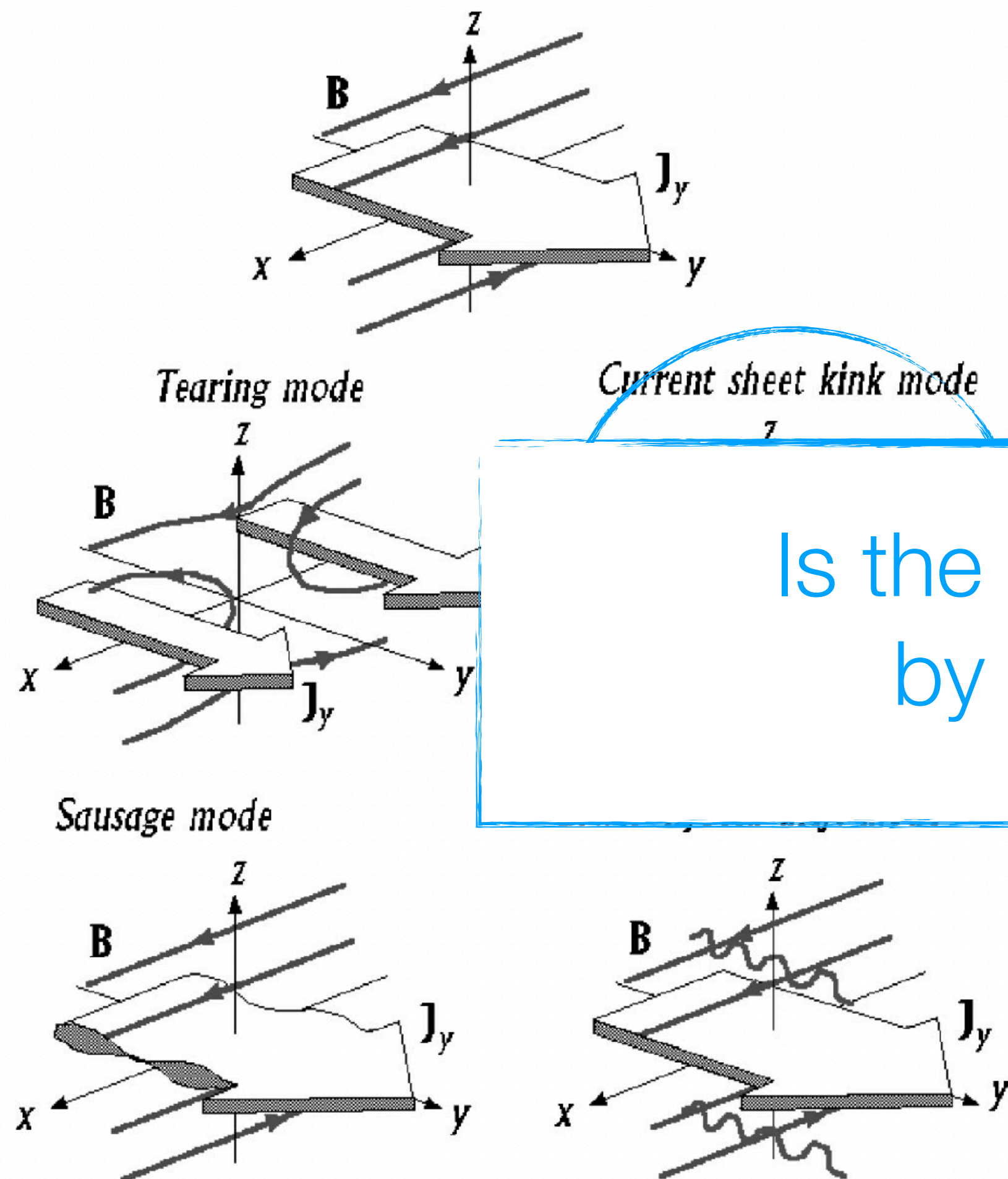
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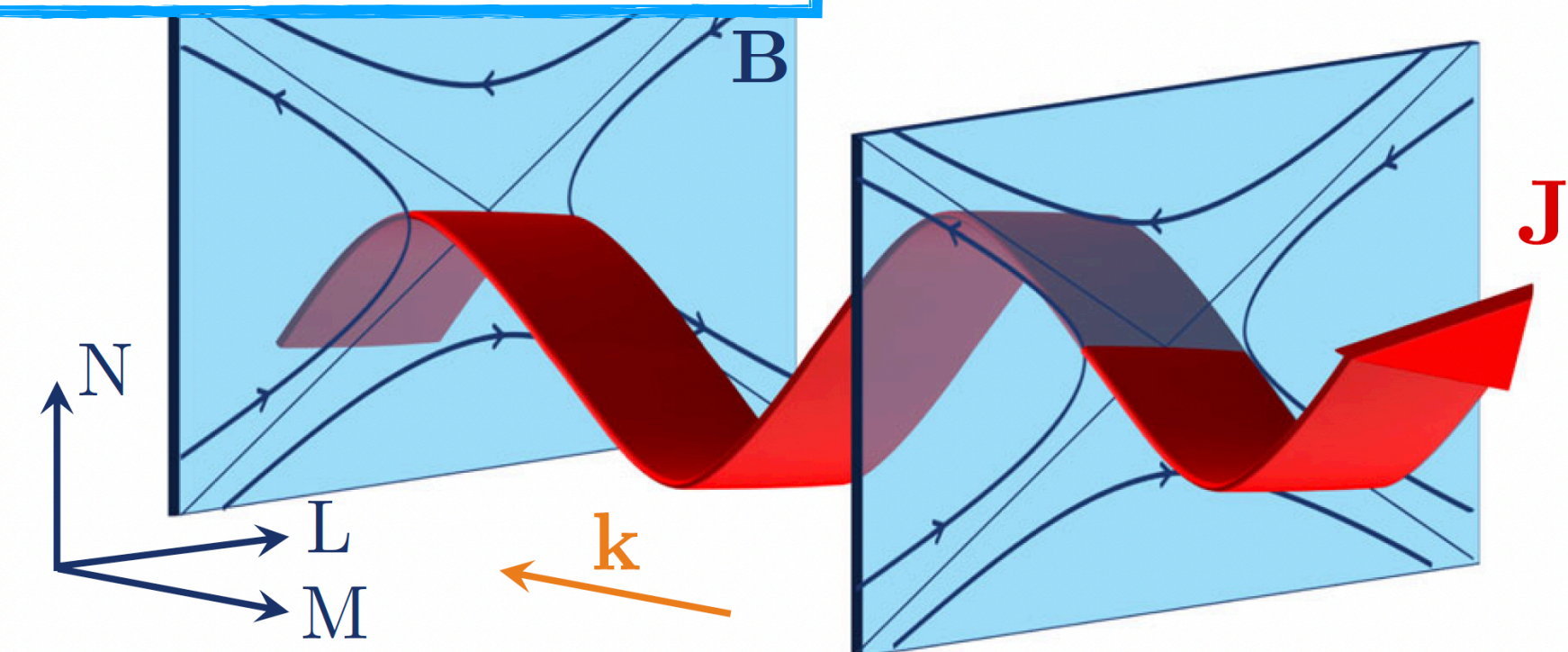
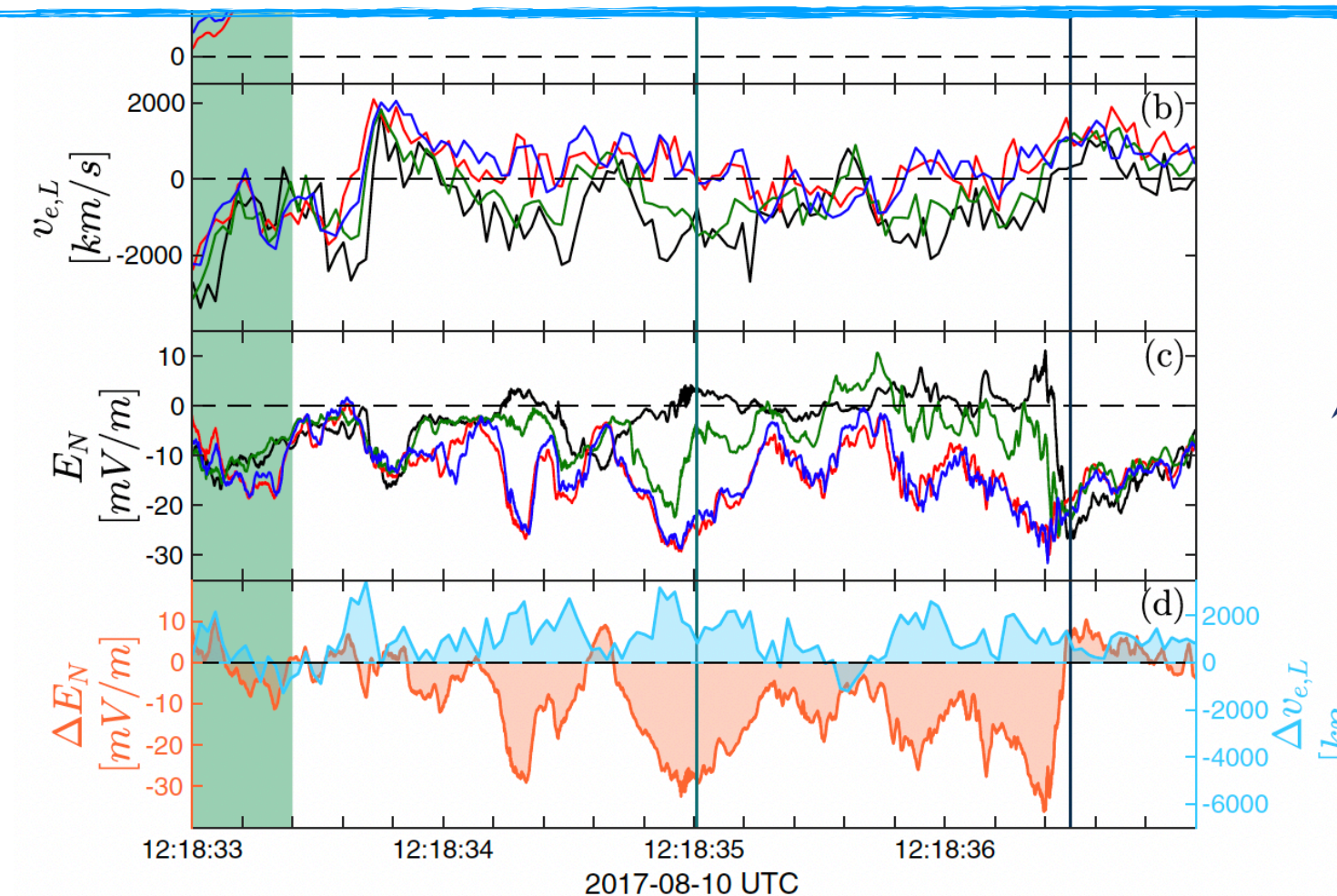
[Cozzani et al., PRL, 2021]



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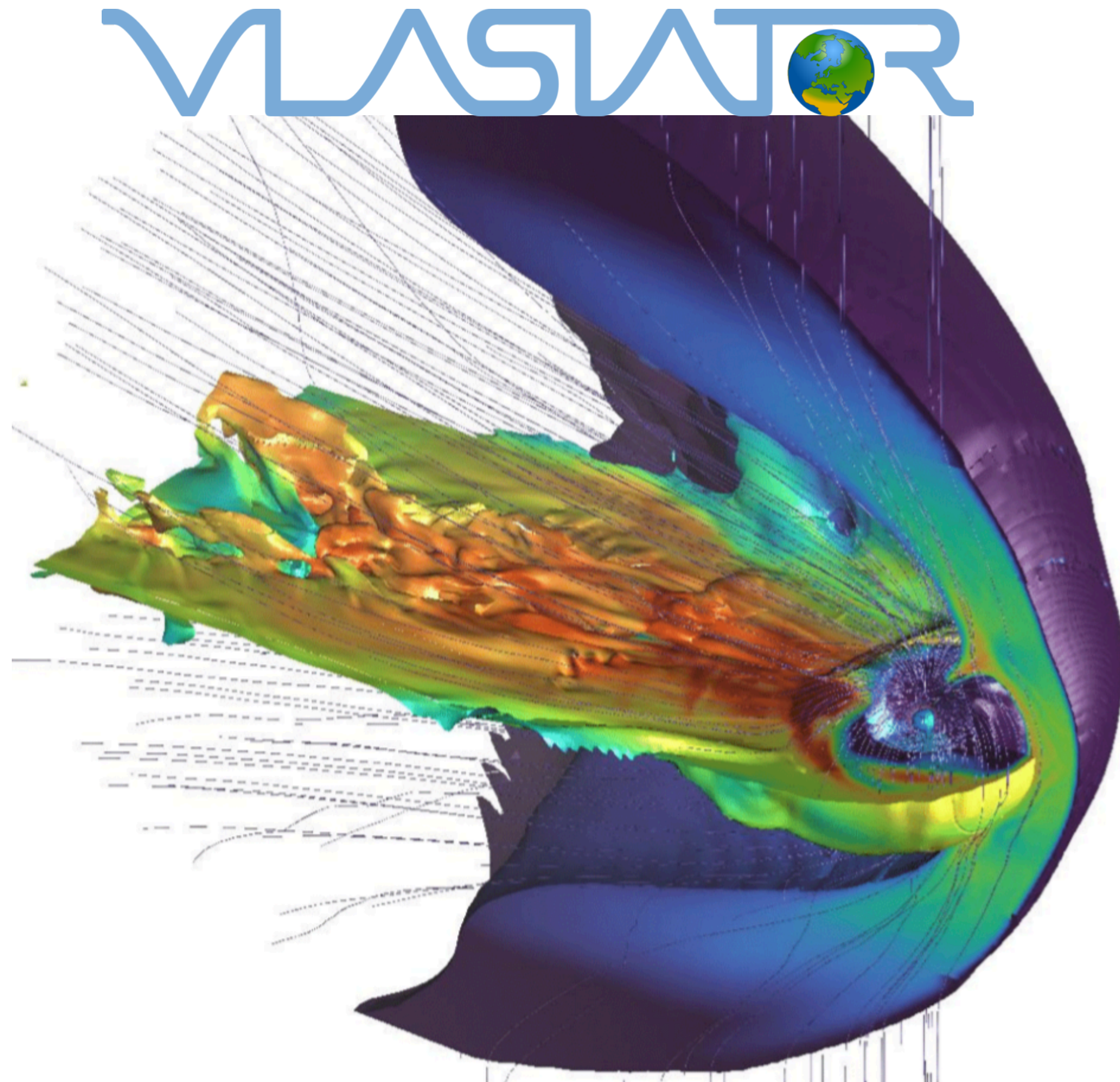
Is the reconnection process influenced by the current sheet kink mode?



[Yoon et al., Phys. Plasmas, 2002]

[Cozzani et al., PRL, 2021]

Global hybrid-Vlasov simulations are a powerful tool to investigate this topic



[Courtesy of M. Palmroth]

- 3D-3V hybrid-Vlasov simulations of the whole magnetosphere
- Ion are treated kinetically, electrons are modelled as a massless charge-neutralising fluid
- Static adaptive mesh refinement with max resolution 1000 km (0.16 RE)

sim domain = $[-111, 50]R_E \times [-58, 58]R_E \times [-58, 58]R_E$

$B_{IMF} = [0, 0, -5] \text{ nT}$

$n_{SW} = 1 \text{ cm}^{-3}$

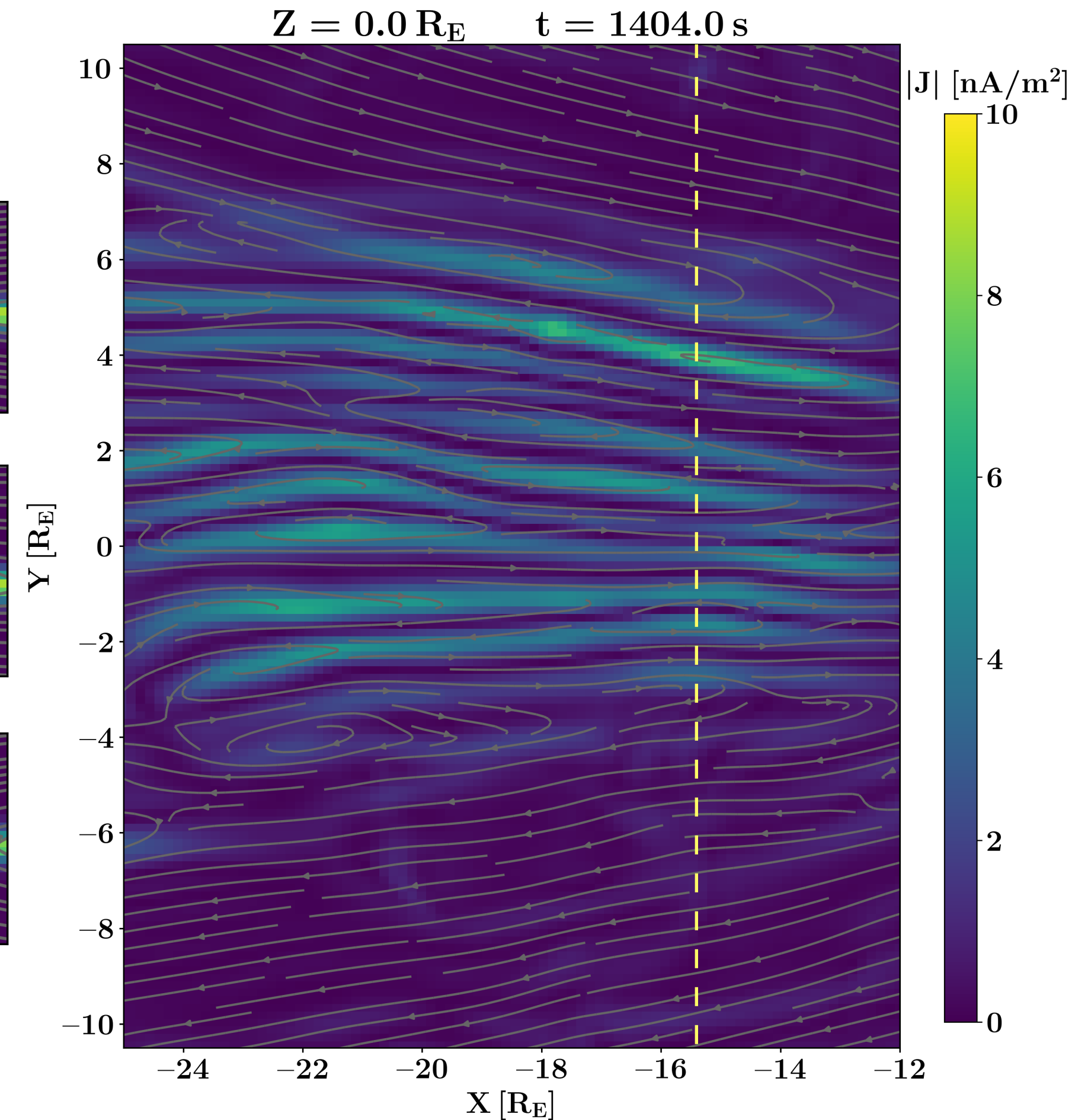
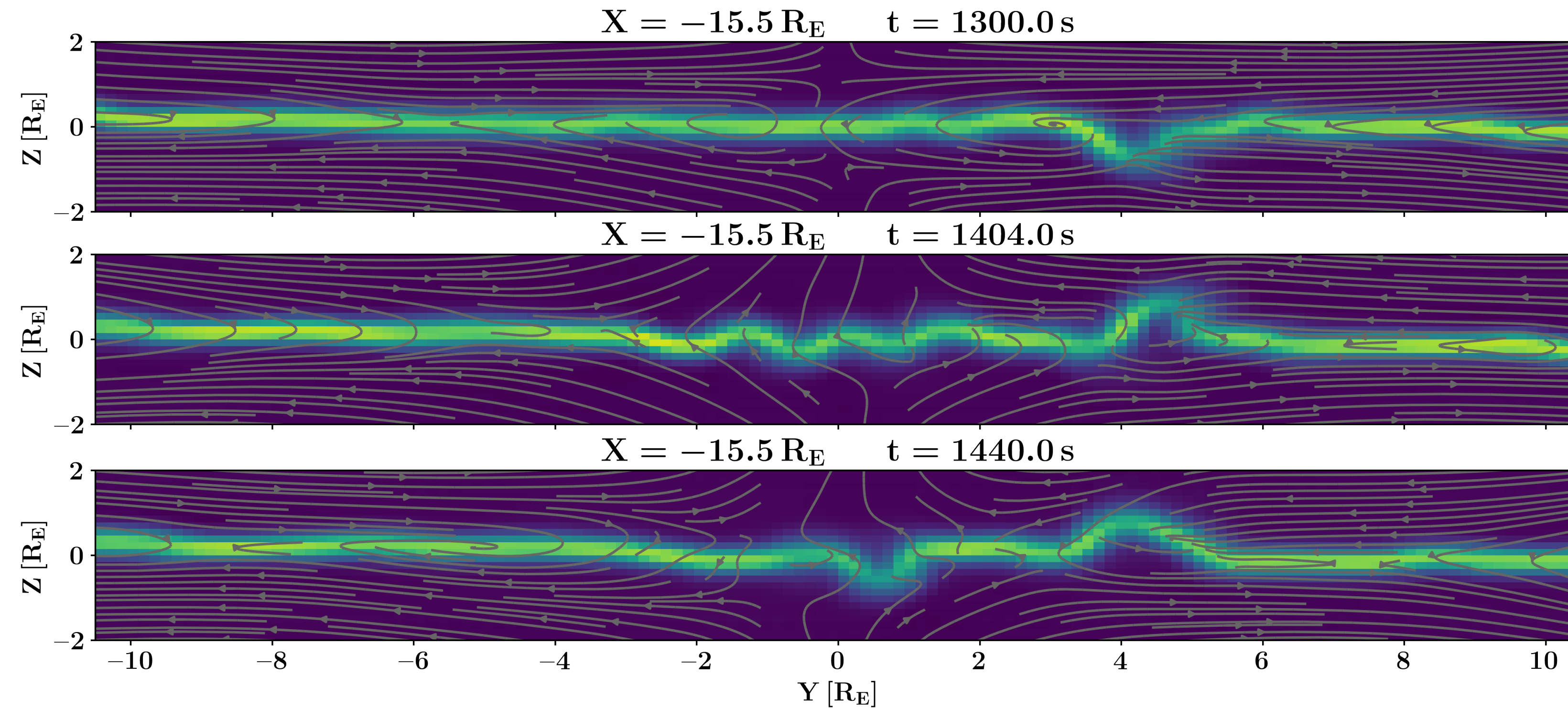
$v_{SW} = [-750, 0, 0] \text{ km/s}$

$T_{SW} = 0.5 \text{ MK}$

$\Delta v = 40 \text{ km/s}$

A current sheet kink instability develops in the magnetotail

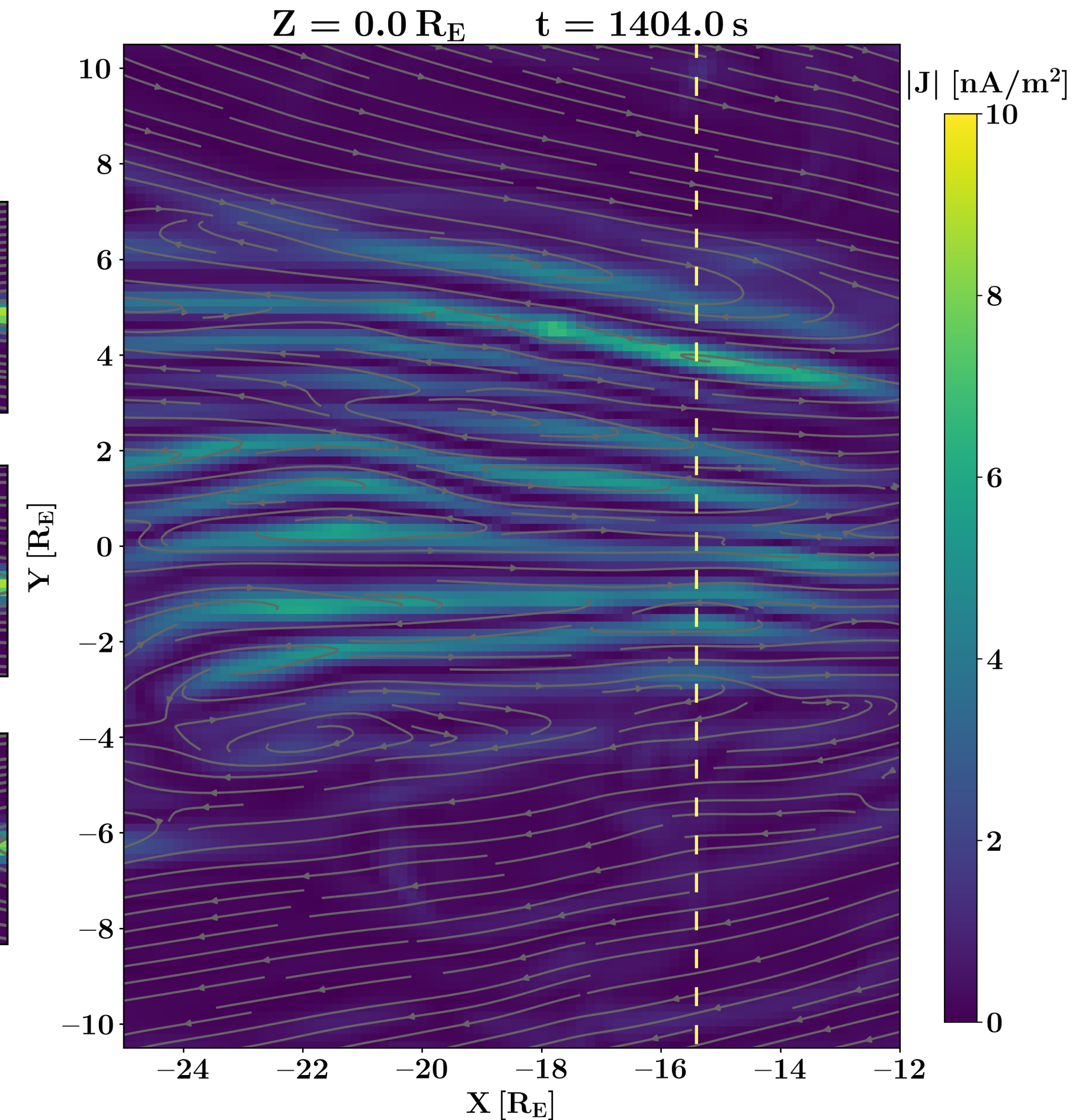
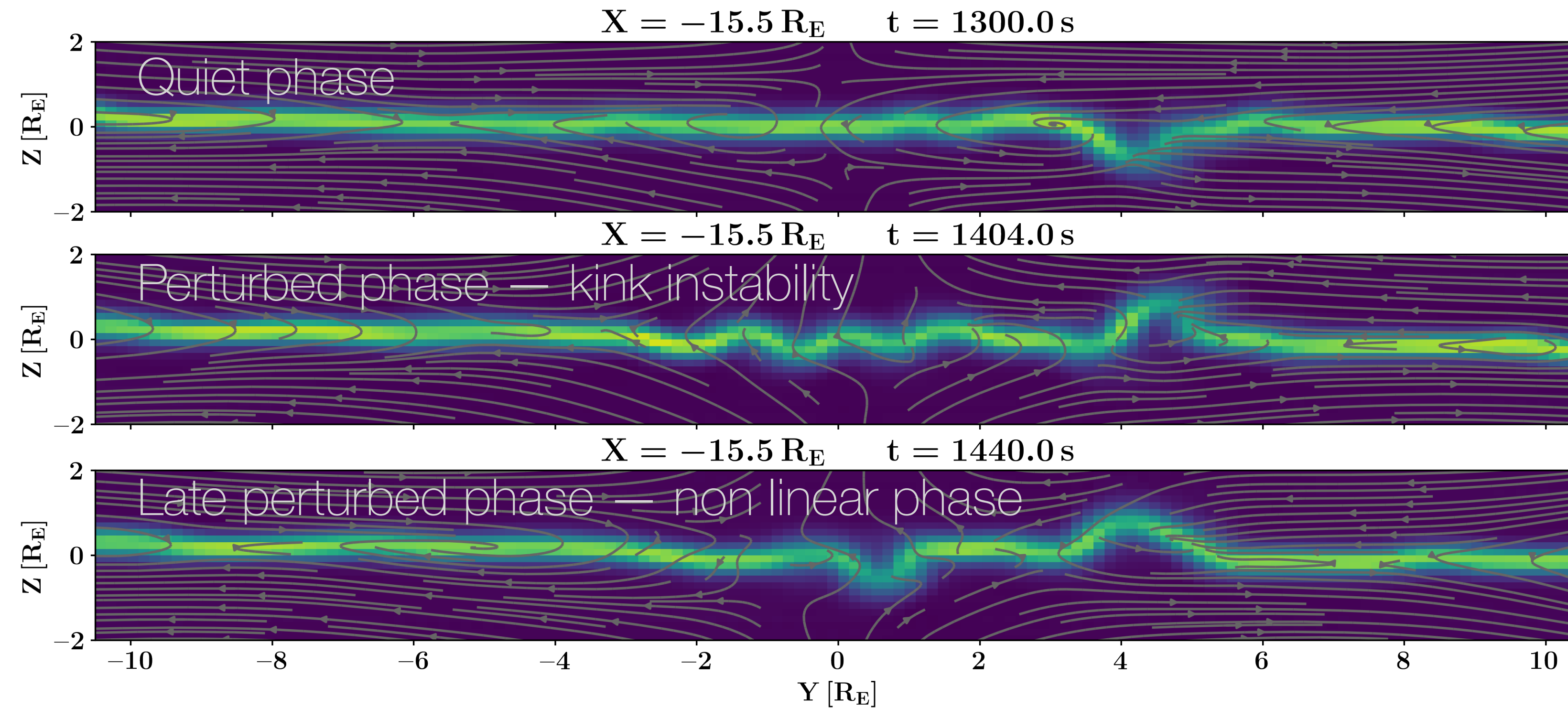
current density magnitude $|\mathbf{J}|$ [nA/m²]



Fluctuations have wavelength $\sim 1.5 R_E$ and amplitude $\sim 0.5 R_E$, propagating duskward with $v_{ph} \sim 470$ km/s [Palmroth et al., submitted]. Properties of the fluctuations are consistent with low-frequency drift instabilities such as the ion-ion kink mode [Karimabadi et al., JGR, 2003].

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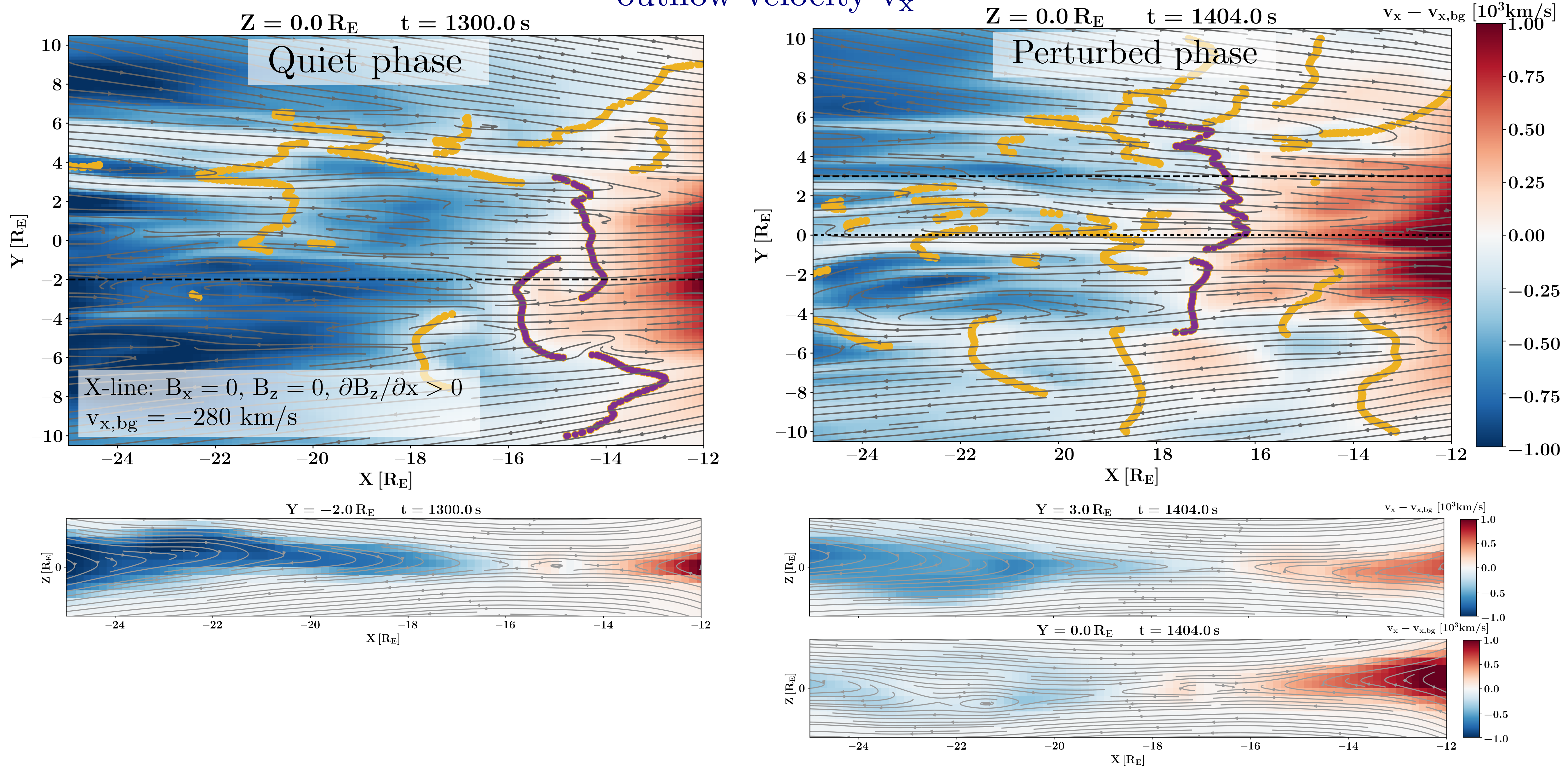
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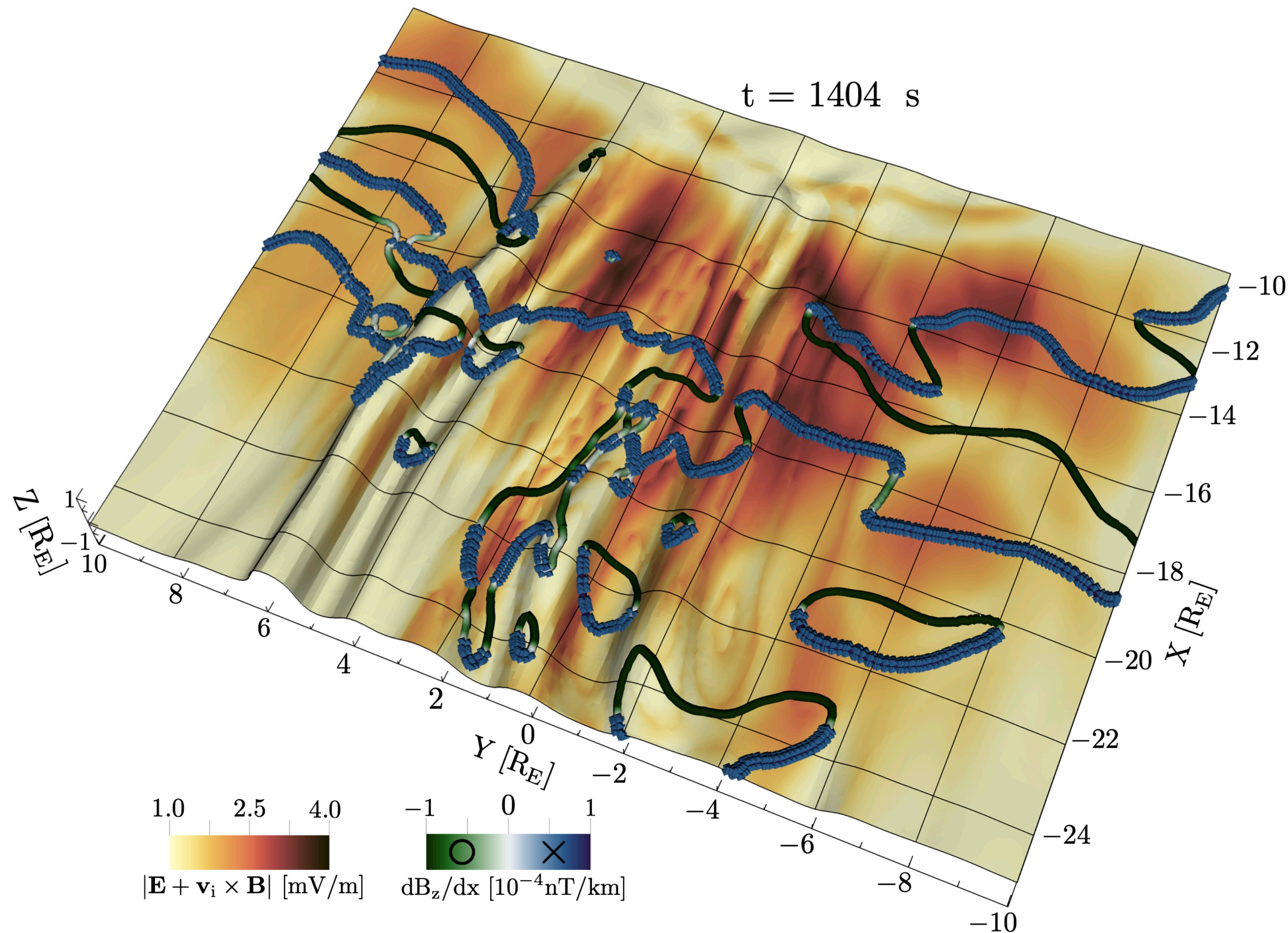
The magnetotail current sheet is continuously reconnecting

outflow velocity v_x



Is the kink instability affecting the reconnection process?

Is the reconnection rate changing in time? Is its evolution associated to the phases of the instability?

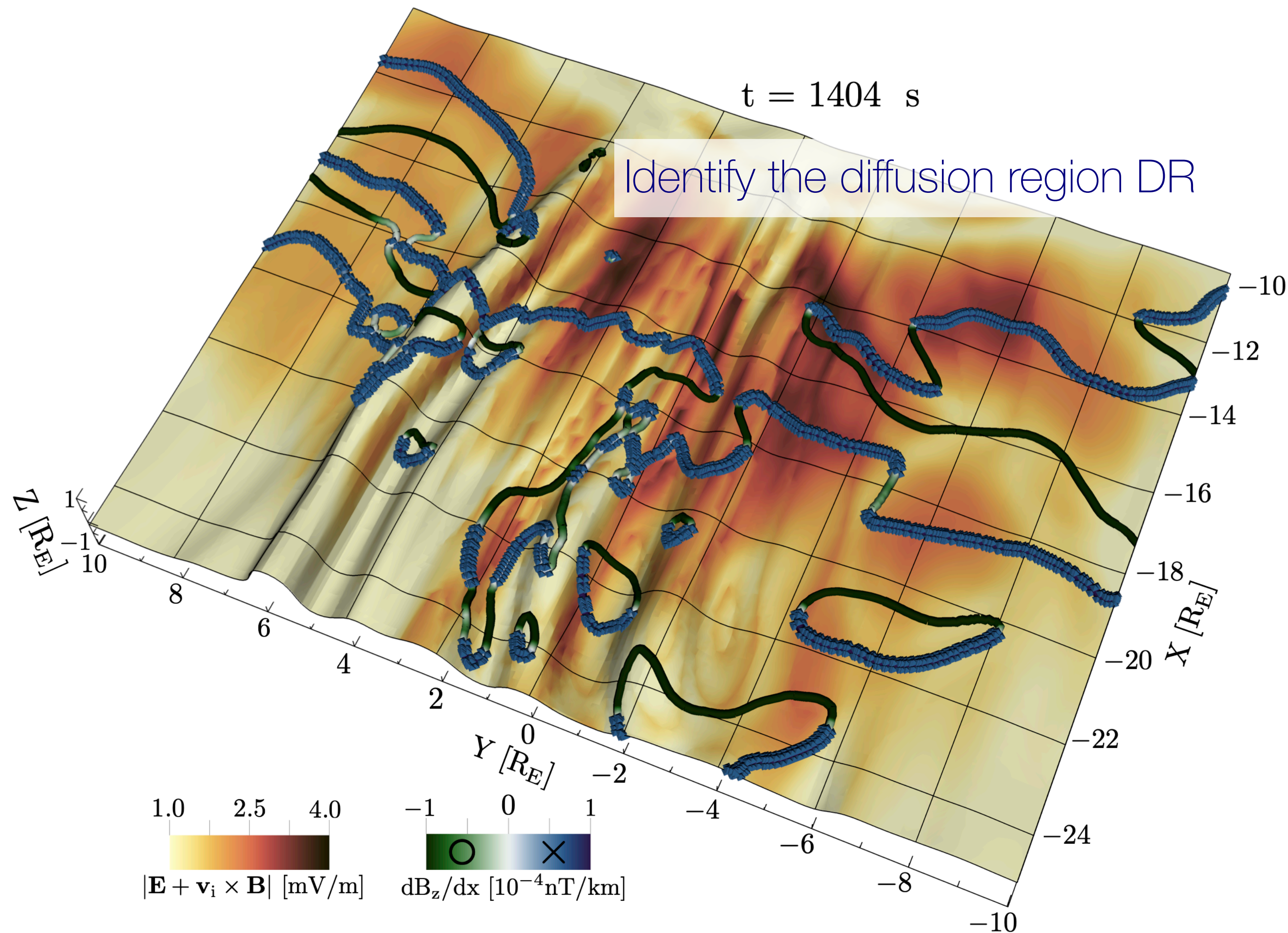


$$\mathcal{R} = \frac{\int_{DR} E_{||} ds}{l_s}$$

[Hesse and Schindler, JGR, 1988]

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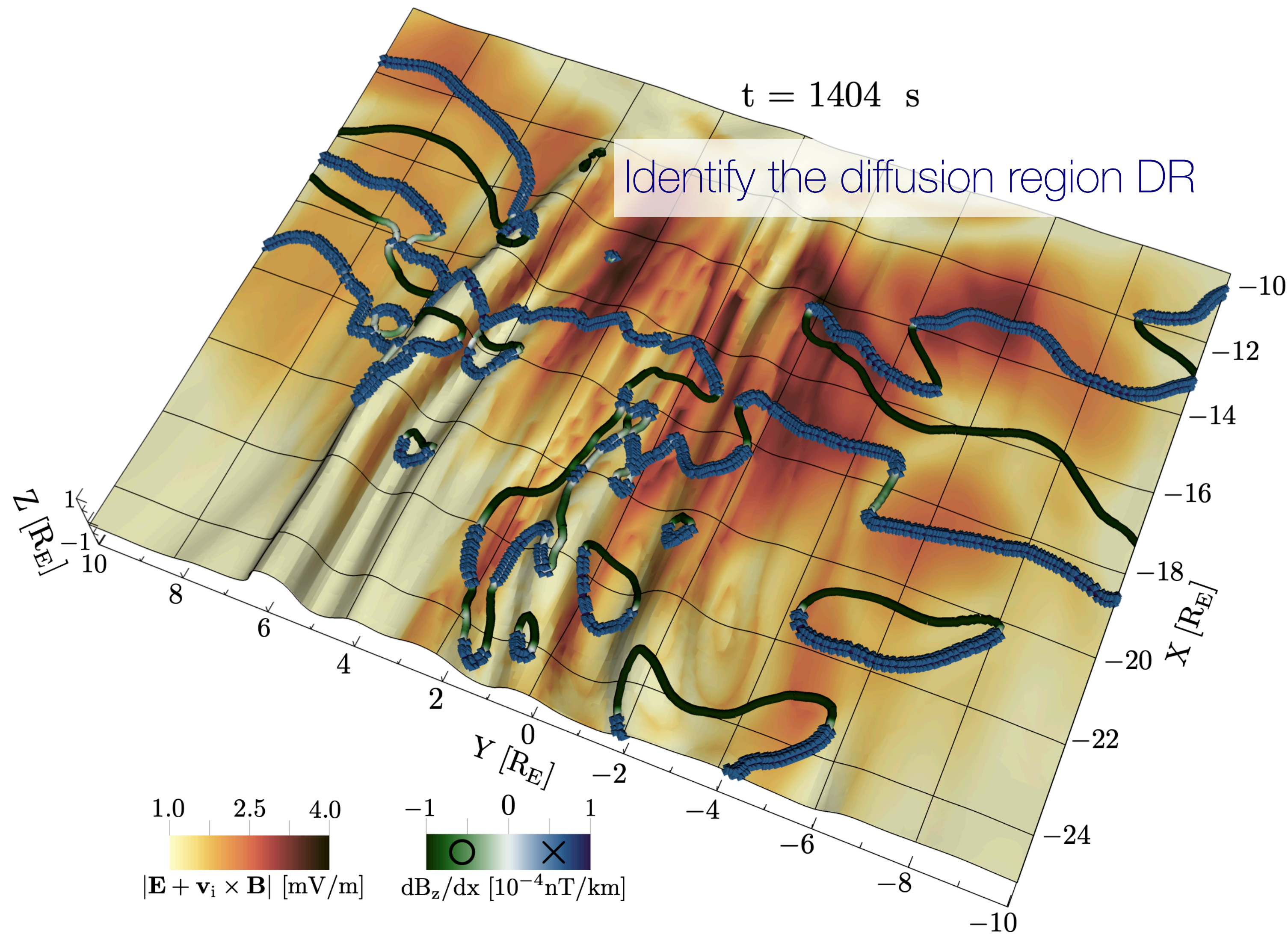


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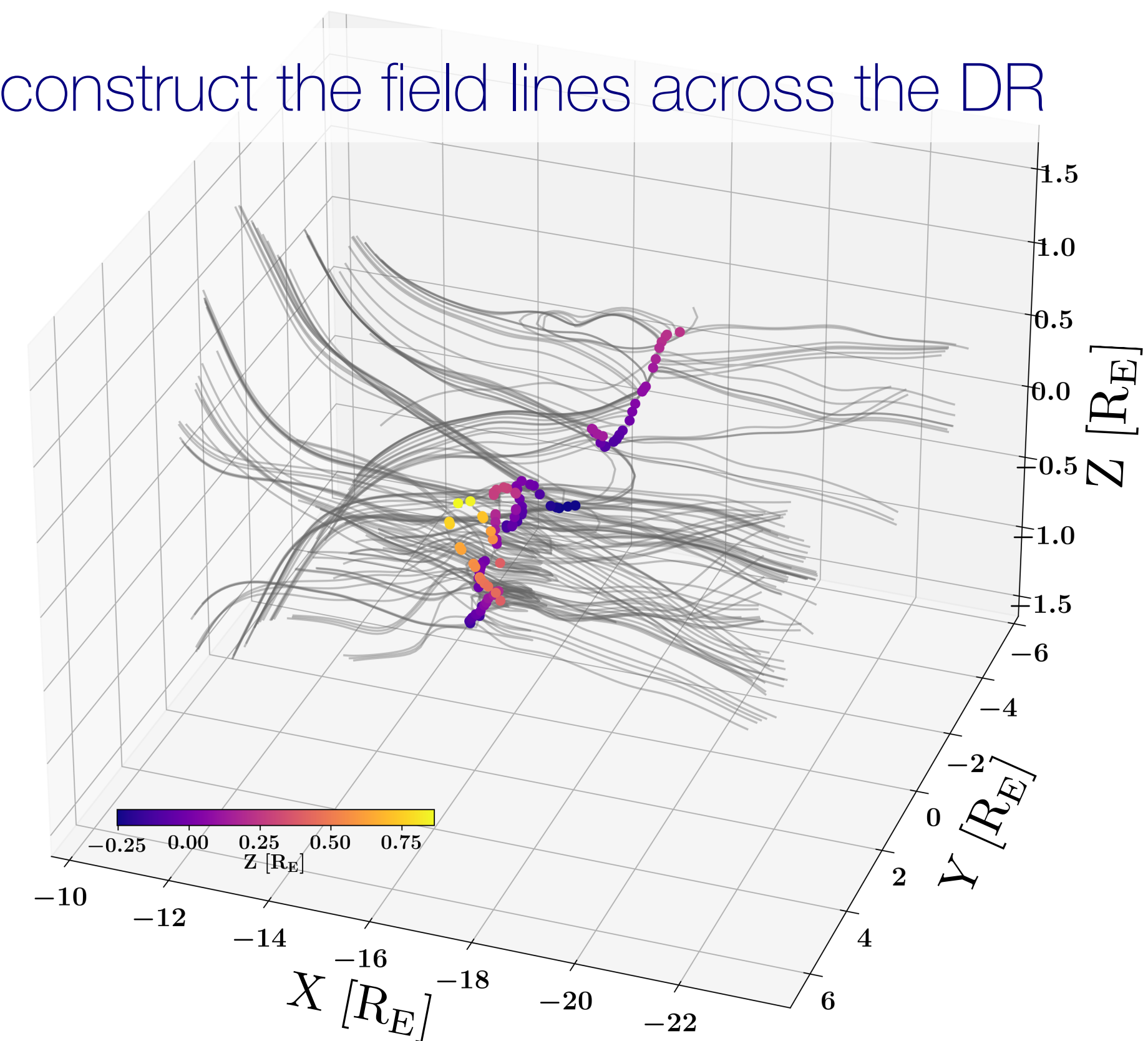
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Reconstruct the field lines across the DR



Thank you for your attention!

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