Resolution dependence of magnetosheath waves in global hybrid-Vlasov simulations

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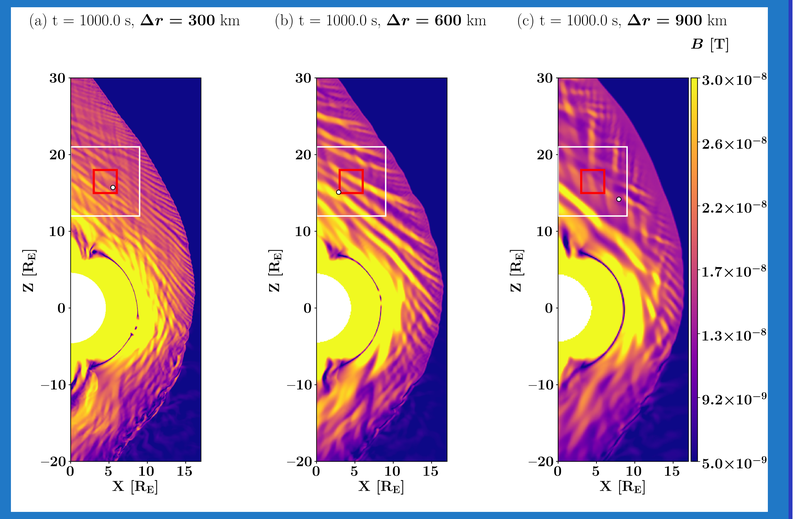
Simulations set-up

- Global hybrid-Vlasov model: VLASIATOR [1]
- Cartesian 2D spatial grid
- Cartesian 3D velocity grid
- Protons described as velocity distribution functions (VDFs)
- Electrons as a cold massless charge neutralizing fluid
- Closure of the system: generalised Ohm's law with Hall term

- Noon-midnight meridional plane (X-Z)
- Inner boundary at 4.7 RE from the centre of the Earth
- Solar wind: flowing in -X direction, 750 km/s
- IMF: 5 nT, 45 degrees angle with respect to X, southward
- Temperature: 0.5 MK
- Density: 1 cm^{-3}

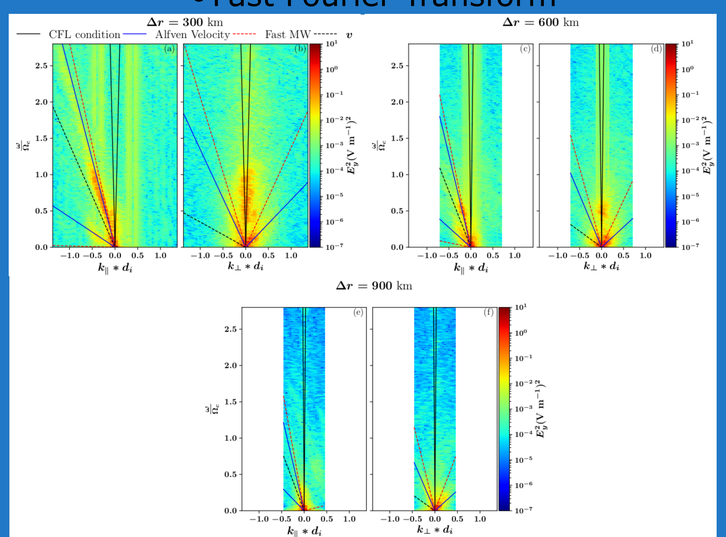


Three different spatial resolutions

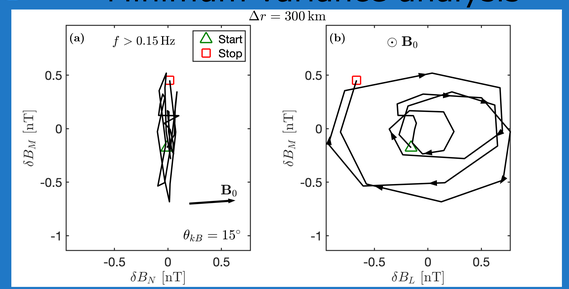
Δr = 300 km = 0.76 di | Δr = 600 km = 0.38 di | Δr = 900 km = 0.25 di

Ion-scale waves

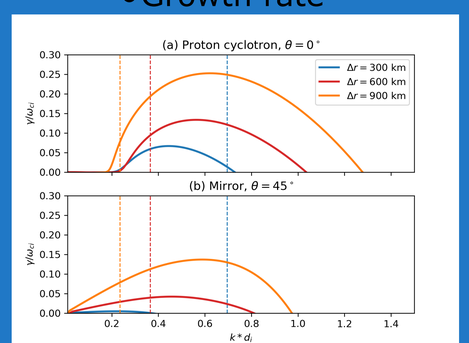
- Fast Fourier Transform



- Minimum variance analysis



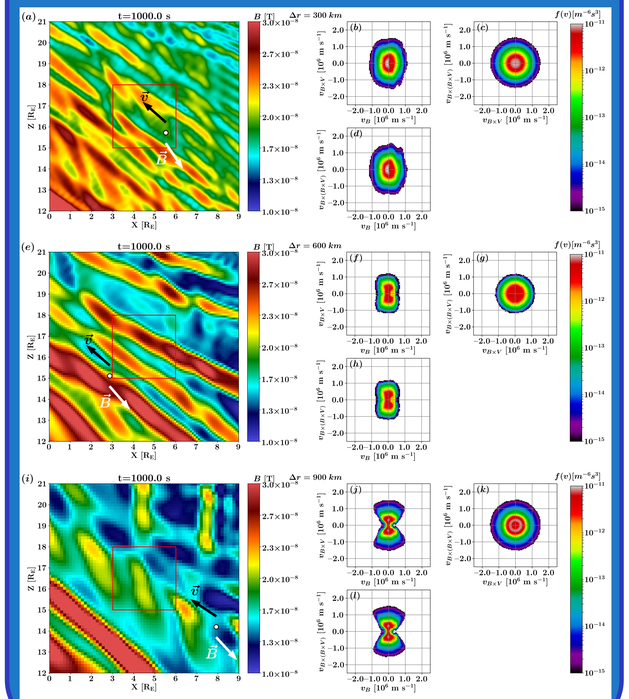
- Growth rate



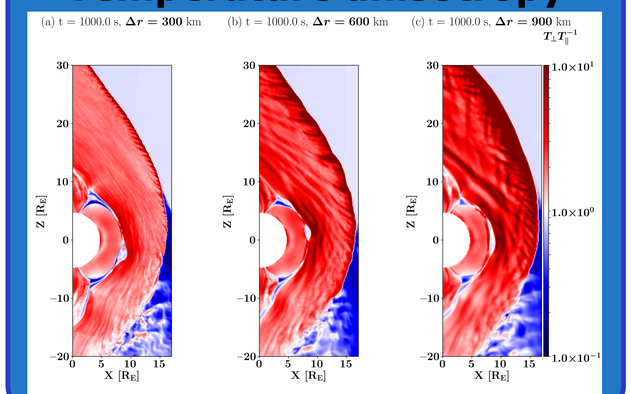
Left-handed circularly polarised → **Alfven Ion Cyclotron waves**

Mirror Modes [2]

Velocity Distribution Functions



Temperature anisotropy



- **Proton cyclotron and Mirror instabilities well resolved at Δr = 300km. Sufficient maximum resolution**
- **Proton cyclotron instability not resolved at Δr = 900km**
- **Temperature anisotropy increases at low resolution due to not resolving AIC waves**
- **Δr = 440km = 0.6 di presents an acceptable minimum resolution for study of magnetosheath waves in global hybrid-Vlasov**

[1] Palmroth, M. et al., Vlasov methods in space physics and astrophysics, LRCA, 4, https://doi.org/10.1007/s41115-018-0003-2, 2018
[2] Hoilijoki, S. et al., Mirror modes in the Earth's magnetosheath: Results from a global hybrid-Vlasov simulation, JGR, 121,https://doi.org/10.1002/2015JA022026, 2016.

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