HALL-MHD SIMULATIONS OF THE KELVIN-HELMHOLTZ INSTABILITY AT THE SOLAR WIND/MAGNETOSPHERE INTERFACE

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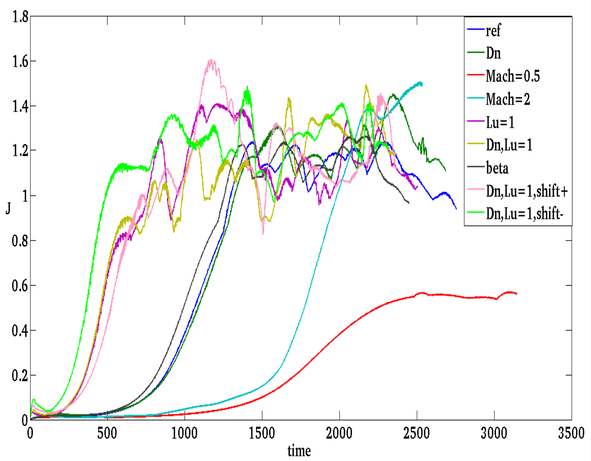
1. MOTIVATION

- Solar wind matter enters the magnetosphere :
  - -southward IMF, SW/MS anti-parallel
    - → reconnection
  - -northward IMF, SW/MS parallel
    - → reconnection not efficient
- Plasma sheath gets thicker for northward IMF
  - ⇒ SW still penetrating the MS[3]
- Hypothesis :
  - North+south cusps reconnections
  - KHI enhancing mixing
  - Double reconnection at mid-latitude [2]

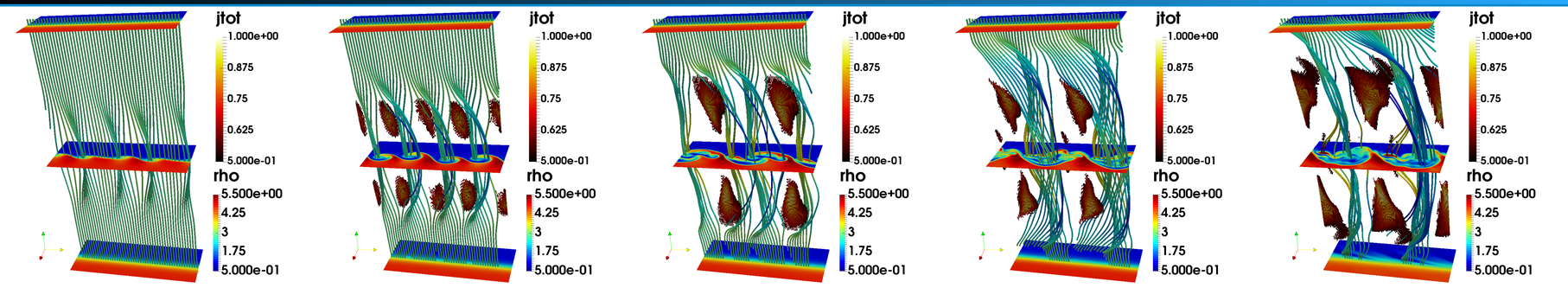
2. PARAMETERS EXPLORATION

- Exploration of various parameters to try to ascertain their influence on the development of the KHI instability.

- Volume averaged current → Apparition of current sheets linked to *twist and compression of magnetic field lines by differential advection depending on the latitude* (z-coordinate) → Magnitude of current hint to the magnetic reconnections happening at mid-latitude.

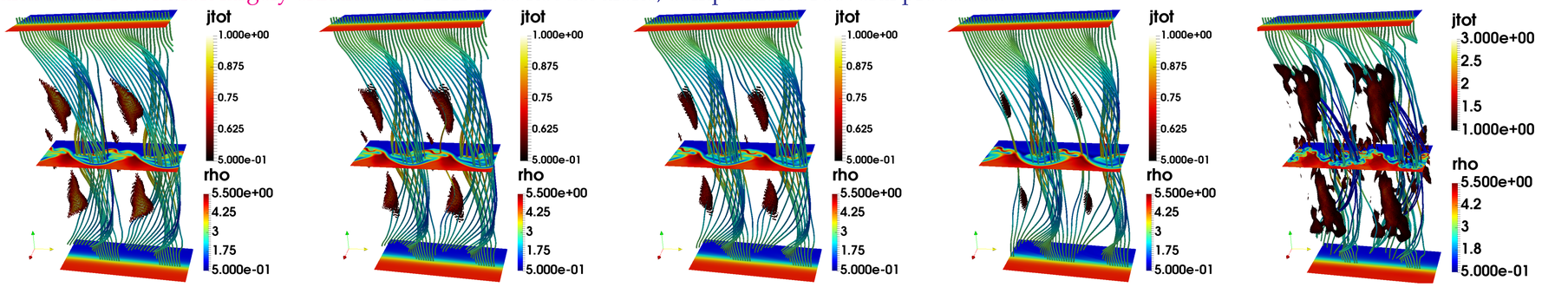


3. RESULTS



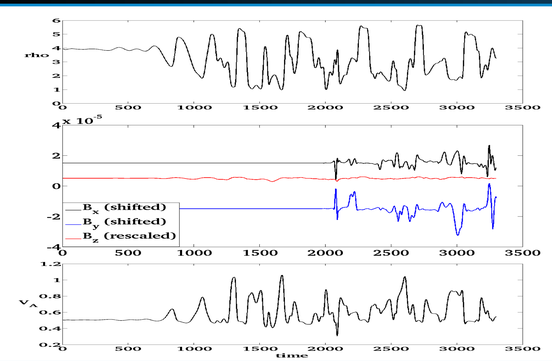
t=1000 t=1300 t=1700 t=2000 t=2300

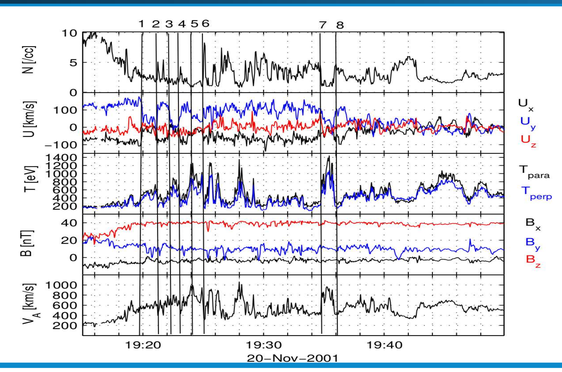
Above : Evolution of our reference simulation (cf [2]). Vortices rapidly roll-up ⇒ twisting and compressing the fields lines, creating current sheets + reconnection sites. *Vortices start pairing* ⇒ Define new process of twisting and reconnecting caused by their flow configuration. The flow configuration can depend heavily on the physical parameters (cf section 4 and [1]). **Below** : Investigation of the influence of Hall term by varying its magnitude (fixed in reality). Last snapshot investigates effect of better resolution on the flow and thus the reconnection process. First conclusion is Hall the term inhibits the present process, and better resolution largely enhances it. KHI does not act alone, competition of several processes.



t=2000, η_H=0.1 t=2000, η_H=0.685 t=2000, η_H=1 t=2000, η_H=2 t=2000, $N^3 = 600^3$

4. SPACECRAFT SIMULATION





- To validate the model identify set of parameters fitting reality the closest.
- Module still in development (for example no velocities or temperature).
- Starting around t=1000, the temporal profiles of the density and magnetic field components approximate well the data coming from consecutive crossing of the magnetopause. (right figure from team of [2])

REFERENCES

[1] K. Nykyri and A. Otto et al. Cluster observations of reconnection due to the Kelvin-Helmholtz instability at the dawnside magnetospheric flank. In *Annales Geophysicae, 24, 10, 2006*
[2] D. Borgogno and F. Califano et al. Double-reconnected magnetic structures driven by Kelvin-Helmholtz vortices at the Earth's magnetosphere. In *Physics of Plasmas, 22, 3, 2015*
[3] H. Hasegawa, M. Fujimoto et al. Transport of solar wind into Earth's magnetosphere through rolled-up Kelvin-Helmholtz vortices. In *Nature, 430, 2004*

SOURCE CODE

The source code, along with examples and user's manual, is available at :
http://gitlab.com/mpi-amrvac/amrvac