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

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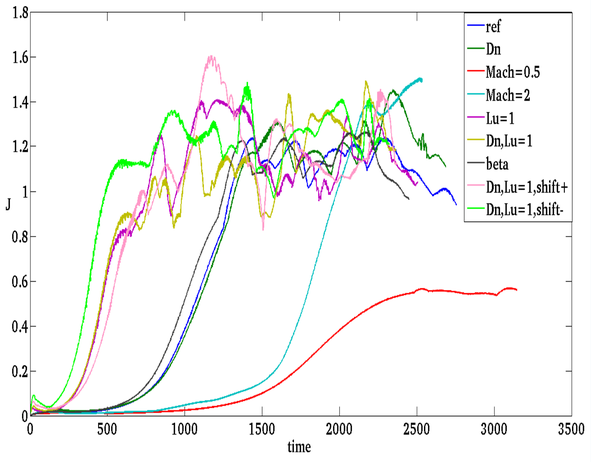
1. MOTIVATION

- 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]

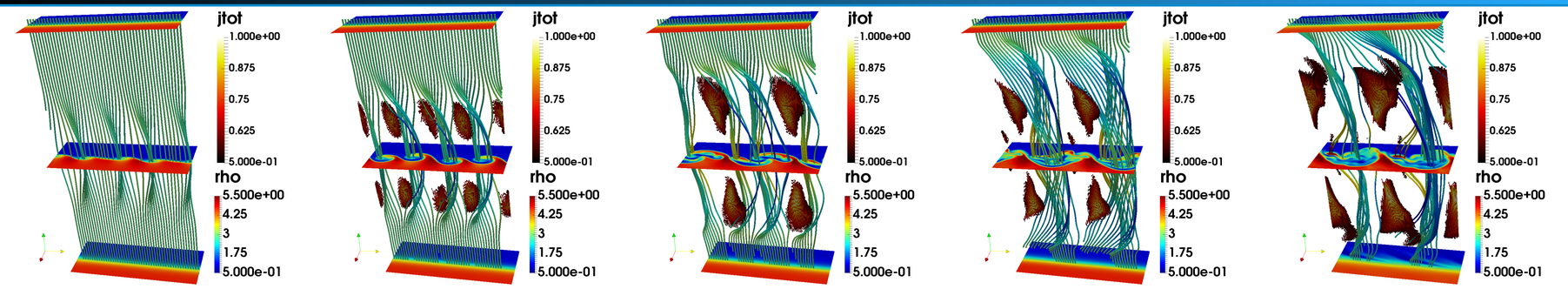
2. PARAMETERS EXPLORATION

- 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.

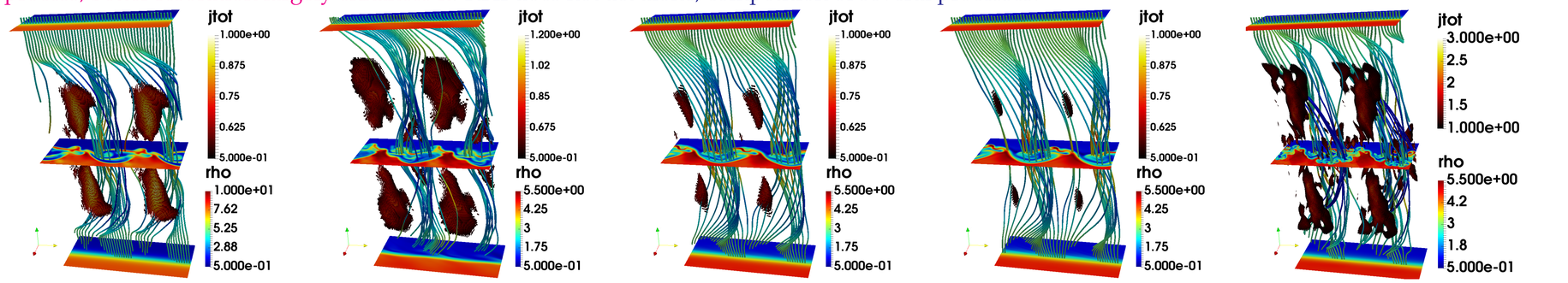


3. RESULTS



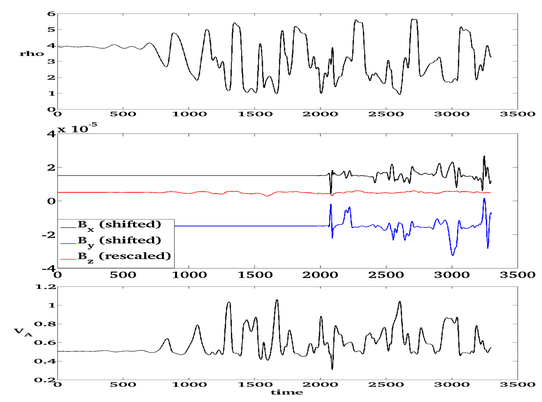
t=1000 t=1300 t=1700 t=2000 t=2300

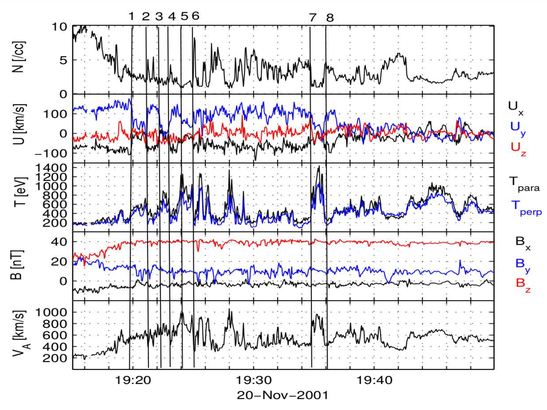
Above : Reference simulation (cf [2]). Apparition and pairing of vortices⇒ twisting and compression of fields lines ⇒ current sheets + reconnection sites. The flow depend heavily on physical parameters (cf 2 and [1]). **Below** : Influence of modified paramters, Hall term and resolution. Hall the term inhibits the process, better resolution largely enhances it. KHI does not act alone, competition of several processes.



t=2000, Δn=7 t=2000, L_u=1 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