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Magnetopause Challenge: SWIFF benchmark of the magnetized Kelvin-Helmholtz instability

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The Earth Magnetopause is of primary importance for space weather modeling and forecasting since it is the boundary that separates the Earth's magnetosphere and the solar wind environment. In this region, the Kelvin-Helmholtz instability is driven by the velocity shear between the Magnetosheath and Magnetospheric plasma at low latitude.
We present a benchmark activity, in the context of the European SWIFF network, focused on the problem of the development such Kelvin-Helmholtz vortices, which evolution represents an archetype of non-linear, cross-scale, collisionless plasma dynamics. Different models [namely an MHD (UCPH), a two-fluid (UNIPI), a hybrid PIC (ASI) and an implicit PIC (KULEUVEN) code] are used in a 2D configuration to compare the linear stage of the Kelvin-Helmholtz instability.
Important deviations are found between the fluid and the kinetic approaches. One relies on the difficulty of finding an initial kinetic Vlasov equilibrium, now taken as fluid-like, for kinetic simulations in order to avoid relaxations that could deform the initial velocity profile or causing anisotropies on the distribution function, and thus modifying the linear evolution. Another problem stands in the difficulty to find relevant fluid closures to the fluid models, in order to get, as in the kinetic models, the correct plasma compressibility, known to play a key role in the development of the Kelvin-Helmholtz instability.
The insights gained from these modern intra code comparisons give an important feedback between fluid and kinetic plasma modeling, of great interest for the physics-based modeling of space physics dynamics.