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Constraints on fluid modeling of magnetized collisionless plasmas

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It is well known that a complete description of the solar wind requires a kinetic description and that, particularly at sub-proton scales, kinetic effects cannot be ignored. It is nevertheless usually assumed that, at scales significantly larger than the proton gyroscale, MHD or bifluid models with isotropic pressures provide a satisfactory description. We demonstrate that in order to accurately capture, even at large scales, the low-frequency dynamics of a collisionless plasma, a fluid model should actually include kinetic effects such as Landau damping and finite Larmor radius corrections. Indeed, the usual polytropic bi-fluid models strongly overestimate the magnetic compressibility of oblique Alfvén waves. Retaining pressure anisotropy and Landau damping partially corrects this deficiency, but an accurate description of the Alfvén wave polarization and of the mirror instability growth rate actually requires to take into account the finite-Larmor corrections to all the retained moments. These remarks lead us to use the so-called FLR Landau fluid model (Phys. Plasmas, 19, 082113, 2012), for which a three-dimensional parallel code has been developed. Preliminary simulations in the turbulent regime will be presented, showing the reduction of the fluid compressibility and the inhibition of the parallel energy transfer. We will also report on the development of temperature anisotropy, associated with non-resonant perpendicular ion heating and constrained by the onset of the mirror instability.