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Impact of varying Solar Wind Mach Number conditions on the Formation of High Speed Jets through the Quasi-Parallel Terrestrial Shock

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Experimental observations from CLUSTER space mission (and more recently MMS) have clearly evidenced high speed jets (HSJ) in the downstream region of the quasi-parallel terrestrial bow shock (Hietala et al., 2009; Plaschke et al. 2013). Previous 2D hybrid numerical simulations have evidenced quantitatively the key role of the shock front inhomogeneity and nonstationarity (front rippling) in the dynamics of quasi parallel shock and the formation of HSJs. A scenario has been proposed in which ion flows can be deflected (instead of being decelerated) at locations where ripples are large enough to play the role of local « secondary » shock (Hao et al., 2016). Therefore, the ion bulk velocity is different locally after ions are transmitted downstream, and local high-speed jets patterns can be formed somewhere downstream. This scenario has been established for a reasonable Mach number regime (Ma=5-6).

The present work is an extension of previous studies via a parametric analysis based on the variation of the solar wind regime. In addition, a much higher spatial resolution is now used in order to analyze the impact of a stronger front steepening. Higher Ma regime leads to a higher level of turbulence (i) in the inhomogeneous upstream plasma flow carried by the solar wind and passing through the shock front, and (ii) in the shock front rippling itself; both effects have a strong impact on the re-organisation of HSJs formation. A possible relationship is analyzed between the nonlinear steepened structures forming upstream and the occurrence of HSJs in the downstream region.