Evolution of an MHD-scale Kelvin-Helmholtz vortex accompanied by magnetic reconnection: Two-dimensional particle simulations

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We have performed 2.5-dimensional full particle simulations of an MHD-scale Kelvin-Helmholtz (KH) vortex and accompanying magnetic reconnection process. This is the first study of so-called vortex-induced reconnection (VIR) using kinetic simulations. First, as a key property of the VIR, we found that magnetic reconnection occurs at multiple points in the current sheet compressed by the flow of the KH vortex. The resulting meso-scale multiple islands are carried towards the vortex body along the vortex flow, and then are incorporated into the vortex body via the re-reconnection process. The rates of both the first reconnection and second re-reconnection processes are generally higher than that of spontaneous reconnection; both reconnection processes are of driven nature. Noteworthy is that the high rate of the first reconnection leads to strong magnetic field pile-up within the multiple islands. This characteristic magnetic structure of the islands could be used as new observational evidence for the occurrence of the VIR. Next, as a key kinetic aspect of the VIR, we found that a series of multiple island formation and incorporation processes simultaneously causes efficient plasma mixing and bi-directional electron acceleration along magnetic field lines within the vortex. These kinetic effects of the VIR could account for observed features of the Earth's low-latitude boundary layer (LLBL), where mixed ions and bi-directional field-aligned electrons generally coexist. In this presentation, we will discuss how important the VIR process is for the Earth's magnetopause.