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Formation and evolution of plasmoid and flux-rope in the Earth's Magnetotail

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The observation of plasmoids and flux-ropes in the Earth's magnetotail was crucial to establish the simultaneous presence of multiple x-lines in the tail, and has become the basis for the Near Earth Neutral Line (NENL) model of substorms. While the "classical" NENL model envisions x-lines that extend across the entire tail, recent observations have shown that neither do the x-lines and resulting plasmoids encompass the entire tail, nor do the x-lines have to lie along the y-axis. The fragmentation of the tail by spatially and temporally limited x-lines has important consequences for the mass and energy budget of the tail. Recent ARTEMIS observations have shown that the plasmoids in the distant tail are limited in the Y direction and some flux ropes are tilted during their tailward propagation. Understanding their formation and evolution during their propagation through the magnetotail shall shred more light on the general energy and flux transport of the Earth's magnetosphere. In this study we simulate plasmoids and flux-ropes in the Earth's magnetotail using the Open Global Geospace Circulation Model (OpenGGCM). We investigate the generation mechanisms for tail plasmoids and flux-ropes and their evolution as they propagate in the magnetotail. The simulation results show that the limited extend of NENL controls the length or the Y scale of tail plasmoid and flux rope. In addition, by studying their 3D magnetic topology we find that the tilted flux rope forms due to a progressive spreading of reconnection line along the east-west direction, which produces and releases two ends of the flux rope at different times and in different speeds. By constructing a catalogue of observational signatures of plasmoid and flux rope we compare the differences of their signatures and find that large-scale plasmoids have much weaker core fields than that inside the small-scale flux ropes.