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On the current reduction by cold ions in magnetic reconnection: PIC simulations and MMS observations

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Magnetic reconnection occurs at the dayside magnetopause and it is believed to be the primary coupling mechanism between the shocked solar wind and the magnetosphere. Cold ions that escape from the ionosphere populate the magnetosphere and can reach the reconnecting magnetopause. When this occurs, they mass-load the magnetospheric side of the boundary and reduce the reconnection rate. In addition, cold ions introduce new microphysics effects owing to their small gyroradius that allow them to remain magnetized at smaller scales. One of the reported effects concerns the reduction of the perpendicular currents associated to the Hall effect and the JxB/en term in the Ohm's law. In this work, we use full PIC simulations with and without cold ions to study the effect at large scales of the current reduction. We compare the Ohm's law terms that balance the Hall electric field along the magnetospheric separatrix region, and confirm the ubiquity of the current reduction owing to cold ion presence. Finally, we compare the simulations to MMS observations of the reconnecting magnetopause with different amounts of cold ions.