Numerical study of solar prominence formation: the reconnection-condensation model

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We propose a model in which magnetic reconnection triggers radiative condensation for solar prominence formation and demonstrate it by three-dimensional magnetohydrodynamic (MHD) simulations including anisotropic nonlinear thermal conduction and optically thin radiative cooling. Solar prominences are cool dense plasma clouds in the hot tenuous corona. Because prominences suddenly erupt and evolve into coronal mass ejections, they have potential to give an impact on the solar-terrestrial plasma environment. The formation mechanims of prominences as well as the eruption mechanism is still unclear. We propose a reconnection–condensation model in which the topological change of a coronal magnetic field via reconnection triggers radiative condensation for prominence formation. Previous observational studies suggested that reconnection at a polarity inversion line of a coronal arcade field creates a flux rope sustaining a prominence; however, the origin of the cool dense plasmas of a prominence was not clear. Using three-dimensional MHD simulations including anisotropic nonlinear thermal conduction and optically thin radiative cooling, we demonstrate that reconnection leads not only to flux rope formation but also to radiative condensation under a certain condition. This critical condition in our model is described by the Field length, which is defined as the scale length for thermal balance between radiative cooling and thermal conduction. This critical condition has a weak dependence on the artificial background heating. The extreme ultraviolet emissions through the filters of the Solar Dynamics Observatory Atmospheric Imaging Assembly synthesized with our simulation results have good agreement with observational signatures in previous studies.

