M07a Formation of a magnetic flux rope in complex active region in MURaM simulation

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Magnetic flux ropes (MFR), qualitatively identified as a group of helical magnetic field lines that wind around a common axis, is the key magnetic structure in solar eruptions. Therefore, research on the formation of MFR can help to improve the understanding of solar eruptions. Theories about MFR formation can be divided into two categories: (1) formed in convection zone and emerging into atmosphere; (2) formed directly in atmosphere by photospheric motions (shearing, converging, and rotation) and magnetic reconnection. Based on a radiative magnetohydrodynamic (RMHD) simulation conducted with the MURaM code, we try to analyze the roles of these two mechanisms quantitatively. We calculate two main components of helicity injection rate on the photosphere: advection term related to emerging or submerging horizontal magnetic field, and shear term related to photospheric motions. The shear term is mainly located at edges of polarities, while the advection term is concentrated near the PIL region. When integrating the injection rate within whole AR, we notice that the shear term always dominates. However, if only focusing on MFR region, two terms make comparable contribution in early period; when close to eruption, the shear term increase quickly and dominate. We also calculate the helicity injected into the flux rope through different heights and find that as height increase, the distribution from advection term also increase, indicating there may be magnetic reconnection occurring above photosphere, which can generate rising horizontal magnetic field and provide additional advection term.