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The Source Locations of Major Flares and CMEs in the Emerging Active Regions

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Major flares and coronal mass ejections (CMEs) tend to originate from the compact polarity inversion lines (PILs) in the solar active regions (ARs). Recently, a scenario named as “collisional shearing” is proposed by Chintzoglou et al. (2019) to explain the phenomenon, which suggests that the collision between different emerging bipoles is able to form the compact PIL, driving the shearing and flux cancellation that are responsible to the subsequent large activities. In this work, through tracking the evolution of 19 emerging ARs from their birth until they produce the first major flares or CMEs, we investigated the source PILs of the activities, i.e., the active PILs, to explore the generality of “collisional shearing”. We find that none of the active PILs is the self PIL (sPIL) of a single bipole. We further find that 11 eruptions originate from the collisional PILs (cPILs) formed due to the collision between different bipoles, 6 from the conjoined systems of sPIL and cPIL, and 2 from the conjoined systems of sPIL and ePIL (external PIL between the AR and the nearby preexisting polarities). Collision accompanied by shearing and flux cancellation is found developing at all PILs prior to the eruptions, with 84% (16/19) cases having collisional length longer than 18 Mm. Moreover, we find that the magnitude of the flares is positively correlated with the collisional length of the active PILs, indicating that the intenser activities tend to originate from the PILs with severer collision. The results suggest that the “collisional shearing”, i.e., bipole-bipole interaction during the flux emergence is a common process in driving the major activities in emerging ARs.