Investigation of statistical relationships between loop structures in X-ray coronal image and CME using automatic recognition of coronal loops

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We investigate the statistical relationships between the various parameters of loop structures in X-ray images taken by Hinode/XRT and coronal mass ejection using automatic recognition of loop structures.

It is known that the presence of the S-shaped loop structures (Sigmoid) in the X-ray image correlates with the occurrence of coronal mass ejection (CME). Kawabata et al. (2018) investigated 211 flare events observed by the Hinode satellites to reveal the statistical relationships between Sigmoid, flare and CME. They found that and the absence of Sigmoid has good correlation with no occurrence of CME, which mean that loop structures, especially Sigmoid, in X-ray images are probably useful for the CME prediction. However, the loop structures were automatically extracted and the Sigmoids were visually determined and it is difficult to explore the further statistical investigation. To this end, we develop the automatic recognition code of loop structures including the Sigmoid detection.

The method is developed based on the OCCULT-2 algorithm (Aschanwden+, 2010; 2013) and we change several limitations of the loop tracing algorithm for the recognition of Sigmoidal structures. The developed code is applied to the X-ray data of 211 flare events (~50,000 X-ray images) analyzed in Kawabata et al. (2018). We found the significant correlations between the absence of the Sigmoid and no occurrence of CMEs, which is confirmed by Kawabata et al. in the visual analysis. Further, it is newly found that the maximum, average and mean intensity of loop structures are DARKER in the CME occurring active regions than those in the non-CME active regions. We will show our interpretation of the result and discuss the further application for CME prediction.

Keywords: Coronal mass ejection, Solar corona, Image recognition, Big data

