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Multi-Channel Coronal Hole Detection with Convolutional Neural Networks

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Being the source region of fast solar wind streams, coronal holes are one of the key components which impact space weather. The precise detection of the coronal hole boundary is an important criterion for forecasting and solar wind modeling, but also challenges our current understanding of the magnetic structure of the Sun. We use deep-learning to provide new methods for the detection of coronal holes, based on the multi-band EUV filtergrams and LOS magnetogram from the AIA and HMI instruments onboard the Solar Dynamics Observatory. The proposed neural network is capable to simultaneously identify full-disk correlations as well as small-scale structures and efficiently combines the multi-channel information into a single detection. From the comparison with an independent manually curated test set, the model provides a more stable extraction of coronal holes than the samples considered for training. Our method operates in real-time and provides reliable coronal hole extractions throughout the solar cycle, without any additional adjustments. We further investigate the importance of the individual channels and show that our neural network can identify coronal holes solely from magnetic field data.