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Mapping Solar X-Ray Images from SDO/AIA EUV Images by Deep Learning

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The full-Sun corona is now imaged every 12 s in extreme ultraviolet (EUV) passbands by Solar Dynamics Observatory/Atmospheric Imaging Assembly (AIA), whereas it is only observed several times a day at X-ray wavelengths by Hinode/X-Ray Telescope (XRT). In this paper, we apply a deep-learning method, i.e., the convolution neural network (CNN), to establish data-driven models to generate full-Sun X-ray images in XRT filters from AIA EUV images. The CNN models are trained using a number of data pairs of AIA six-passband (171, 193, 211, 335, 131, and 94 Å) images and the corresponding XRT images in three filters: "Al_mesh," "Ti_poly," and "Be_thin." It is found that the CNN models predict X-ray images in good consistency with the corresponding well-observed XRT data.

In addition, the purely data-driven CNN models are better than the conventional analysis method of the coronal differential emission measure (DEM) in predicting XRT-like observations from AIA data. Therefore, under conditions where AIA provides coronal EUV data well, the CNN models can be applied to fill the gap in limited full-Sun coronal X-ray observations and improve pool-observed XRT data. It is also found that DEM inversions using AIA data and our deep-learning-predicted X-ray data jointly are better than those using AIA data alone. This work indicates that deep-learning methods provide the opportunity to study the Sun based on virtual solar observation in future.

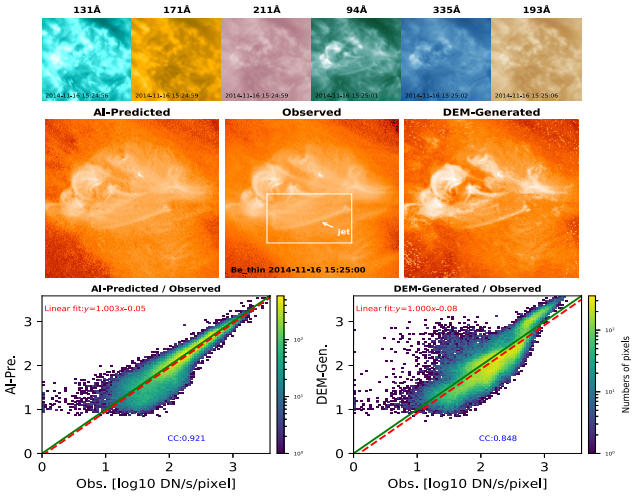

Figure 1. Comparison of the XRT Be_thin image with the AI-predicted Be_thin image and the DEM-generated one.

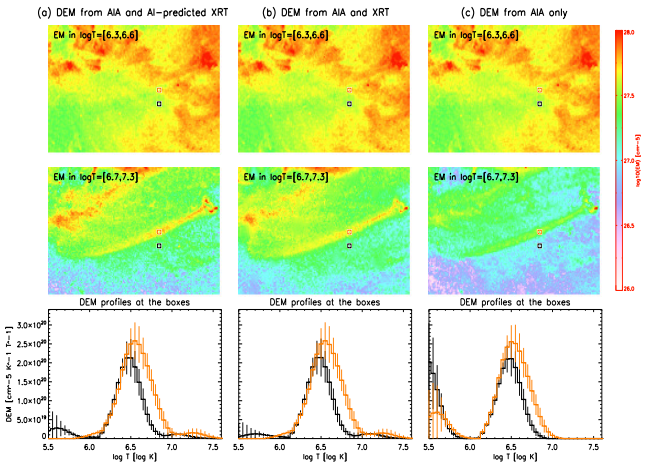

Figure 2. Comparison of DEMs derived from AIA and AI-predicted Be_thin images (left column), AIA and observed Be_thin images (middle column), and AIA images only (right column).