of typical frontside magnetograms. Here we generate farside solar magnetograms from STEREO/Extreme UltraViolet Imager (EUVI) 304-Å images using a deep learning model based on conditional generative adversarial networks (cGANs). We train the model using pairs of Solar Dynamics Observatory (SDO)/Atmospheric Imaging Assembly (AIA) 304-Å images and SDO/Helioseismic and Magnetic Imager (HMI) magnetograms taken from 2011 to 2017 except for September and October each year. We evaluate the model by comparing pairs of SDO/HMI magnetograms and cGAN-generated magnetograms in September and October. Our method successfully generates frontside solar magnetograms from SDO/AIA 304-Å images and these are similar to those of the SDO/HMI, with Hale-patterned active regions being well replicated. Thus we can monitor the temporal evolution of magnetic fields from the farside to the frontside of the Sun using SDO/HMI and farside magnetograms generated by our model when farside extreme-ultraviolet data are available. This study presents an application of image-to-image translation based on cGANs to scientific data.

이 논문은 2019년도 정부(과학기술정보통신부)의 재원으로 정보통신기술 진흥센터의 지원을 받아 수행된 연구임 (2018-0-01422,태양흑점폭발 분석 및 예측기술연구)

[구 SS-09] Application of Deep Learning to Solar Data: 6. Super Resolution of SDO/HMI magnetograms

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The Helioseismic and Magnetic Imager (HMI) is the instrument of Solar Dynamics Observatory (SDO) to study the magnetic field and oscillation at the solar surface. The HMI image is not enough to analyze very small magnetic features on solar surface since it has a spatial resolution of one arcsec. Super resolution is a technique that enhances the resolution of a low resolution image. In this study, we use a method for enhancing the solar image resolution using a Deep-learning model which generates a high resolution HMI image from a low resolution HMI image (4 by 4 binning). Deep learning networks try to find the hidden equation between low resolution image and high resolution image from given input and the corresponding output image. In this study, we trained a model based on a very deep residual channel attention networks (RCAN) with HMI images in 2014 and test it with HMI images in 2015. We find that the model achieves high quality results in view of both visual and measures: 31.40 peak signal-to-noise ratio(PSNR), Correlation Coefficient (0.96), Root mean square error (RMSE) is 0.004. This result is much better than the conventional bi-cubic interpolation. We will apply this model to full-resolution SDO/HMI and GST magnetograms.

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[구 SS-10] Generation of global coronal field extrapolation from frontside and AI-generated farside magnetograms

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Global map of solar surface magnetic field, such as the synoptic map or daily synchronic frame, does not tell us real-time information about the far side of the Sun. A deep-learning technique based on Conditional Generative Adversarial Network (cGAN) is used to generate farside magnetograms from EUVI 304Å of STEREO spacecrafts by training SDO spacecraft's data pairs of HMI and AIA 304Å. Farside(or backside) data of daily synchronic frames are replaced by the Ai-generated magnetograms. The new type of data is used to calculate the Potential Field Source Surface (PFSS) model. We compare the results of the global field with observations as well as those of the conventional method. We will discuss advantage and disadvantage of the new method and future works.

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[구 SS-11] Relative Contribution from Short-term to Long-term Flaring rate to Predicting Major Flares

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We investigate a relative contribution from short to long-term flaring rate to predicting M and X-class flare probabilities. In this study, we consider magnetic parameters summarizing distribution and non-potentiality by Solar Dynamics Observatory/Helioseimic and Magnetic Imager and flare list by Geostationary Operational Environmental Satellites. A short-term rate is the number of major flares that occurred in an given active region (AR) within one day before the prediction time. A mid-term rate is a mean flaring rate from the AR appearance day to one day before the prediction time. A long-term rate is a rate determined from a relationship between magnetic parameter values of ARs and their flaring rates from 2010 May to 2015 April. In our model, the predicted rate is given by the combination of weighted three rates satisfying that their sum of the weights is 1. We calculate Brier skill scores (BSSs) for investigating weights of three terms giving the best prediction performance using ARs from 2015 April to 2018 April. The BSS (0.22) of the model with only long-term is higher than that with only short-term or mid-term. When short or mid-term are considered additionally, the BSSs are improved. Our model has the best performance (BSS = 0.29) when all three terms are considered, and their relative contribution from short to long-term rate are 19%, 23%, and 58%, respectively. This model seems to be more effective when predicting active solar ARs having several major flares.

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[구 SS-12] Application of a non-equilibrium ionization model to rapidly heated solar plasmas

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We apply a non-equilibrium ionization (NEI) model to a supra-arcade plasma sheet, shocked plasma, and current sheet. The model assumes that the plasma is initially in ionization equilibrium at low temperature, and it is heated rapidly by a shock or magnetic reconnection. The model presents the temperature and characteristic timescale responses of the Atmospheric Imaging Assembly (AIA) on board Solar Dynamic Observatory and X-ray Telescope (XRT) on board Hinode. We compare the model ratios of the responses between different passbands with the observed ratios of a supra-arcade plasma sheet on 2012 January 27. We find that most of observations are able to be described by using a combination of temperatures in equilibrium and the plasma closer to the arcade may be close to equilibrium ionization. We also utilize the set of responses to estimate the temperature and density for shocked plasma associated with a coronal mass ejection on 2010 June 13. The temperature, density, and the line of sight depth ranges we obtain are in reasonable agreement with previous works. However, a detailed model of the spherical shock is needed to fit the observations. We also compare the model ratios with the observations of a current sheet feature on 2017 September 10. The long extended current sheet above the solar limb makes it easy to analyze the sheet without background corona. We find that the sheet feature is far from equilibrium ionization while the background plasma is close to equilibrium. We discuss our results with the previous studies assuming equilibrium ionization.

[구 SS-13] Oscillation of a Small Hα Surge in a Polar Coronal Hole

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Hα surges (i.e. cool/dense collimated plasma ejections) may act as a guide for a propagation of magnetohydrodynamic waves. We report a high-resolution observation of a surge observed with 1.6m Goody Solar Telescope (GST) on 2009 August 26, from 18:20~UT to 18:45UT.