Project Details

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Project Title:
Application of Machine Learning to Improve the Detection of Active Regions in the Sun's Far Hemisphere

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Summary:
Scope and Goal: The measurement of magnetic activity on the solar surface has multiple applications, especially in space weather forecasting. The near-side regions of high magnetic concentration (known as active regions) can be directly observed while for the far-side regions, at present, we mostly rely on indirect methods based on the technique of local helioseismology. In this technique, we map the phase shift (travel time delay) between acoustic waves traveling into a region and its echo. This technique is being used for last two decades and shows/indicates the presence of active regions on the backside of the Sun. However, the detection of the active regions so far is mostly limited to big regions, though there are numerous examples of smaller active regions producing severe space weather events. In the proposed work, we plan to improve the detection of solar active regions on the far-side of the Sun by developing a Machine Learning (ML) tool for application to the helioseismic phase-shift maps. The goal is to lower the threshold of the required strength of the seismic signal for detecting active regions of different sizes. This will be done by reducing the noise and enhancing the seismic signal in farside phase-shift maps.

Methodology and Data: The proposed work is based on the following steps:

(1) Compile a database of GONG helioseismic maps of the Sun's far hemisphere from archives available at the National Solar Observatory (https://nso.edu/data/nisp-data/) concurrent with periods during which NASA STEREO had full EUV coverage of the same. (NSO/GONG has been posting twice-daily synoptic helioseismic maps of the Sun's far hemisphere at this website since 2006 from 24-hr time series of Dopplergrams. These are archived as open-source datasets (https://farside.nso.edu) and can be easily accessed through the internet.)

(2) Design and train ML-based parameterized algorithms that, applied to the helioseismic phase-shift maps and STEREO-EUV images, propose to recognize and characterize the signatures of active regions.

(3) Formulate an analogous system for validation of the algorithm for application to the helioseismic maps based upon the agreement of its identifications and characterizations derived from the STEREO EUV maps.

(4) Determine the parameter set of the algorithm that optimizes the validation formulated in (3).

(5) Implement the algorithm in the existing pipeline for improved detection of active regions on the farside.

Relevance: The proposed work is directly relevant to one of the NASA's Living With A Star objectives, i.e., ``to quantify the physics, dynamics, and behavior of the sun-Earth system over the 11-year solar cycle'' and contributes significantly to advances in operational space weather forecasting. Our work will improve the use of heliophysics data to immediately benefit users of science data and will enhance the overall experience of the users of science data.

The Archive: We plan to deliver the Machine Learning Trained Active Region Recognition Algorithms (MLTARRA) tool developed in this work and a detailed README file to NASA's Community Coordinate Modeling Center (CCMC) within three months of the completion of this project. The near-real-time forecast and the related data products will be posted at the National Solar Observatory's website (www.nso.edu).

Publication References:

no references