Project Details

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Selection Year: 2016
Program Element: Focused Science Topic

Topic: Advances Toward a Near Real Time Description of the Solar Atmosphere and Inner Heliosphere

Project Title:
Developing Vector Magnetic Maps from SDO/HMI that can Drive Space Weather Models

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Summary:
We propose a comprehensive program of innovative observation, analysis, and theoretical interpretation to attack the central goal of the Focused Science Topic: Advances toward a near real-time description of the solar atmosphere and inner heliosphere. We will make two critically required contributions toward achieving this goal: (1) develop temporally stable, Solar Dynamics Observatory (SDO) Helioseismic Magnetic Imager (HMI) vector magnetograms, and (2) develop accurate, self-consistent photospheric flows in Active Regions (ARs) that can be used to calculate estimates of the energy and helicity transport through the photosphere for characterizing the near real-time state of the corona. The photospheric magnetic fields play a critical role in many models of the solar atmosphere. Therefore, improving photospheric vector magnetograms has a cascading impact on all modeling that depends on this boundary.

There are three major obstacles to implementing HMI vector magnetograms for driving models and computing accurate estimates of the energy and helicity transport: (1) the orbital artifacts that contaminate the observations (Hoeksema, 2014a; Schuck 2016) (2) the temporal stability from image to image of the disambiguation needed to resolve the direction of the transverse magnetic field, and (3) the statistical uncertainties. Our program will address all these issues with the following methodology:

* We will correct the vector magnetograms by utilizing two different methods. We recently discovered that the free-spectral-ranges (FSRs) of the optical elements in were only measured to an accuracy of 1%. Whereas inversion of the HMI filtergrams to produce Dopplergrams and magnetograms (vector and line-of-sight) requires a specification of 0.06% (Scherrer and SDO HMI Team, 2016). We will optimize FSRs of the seven optical elements of HMI by reprocessing the spectra and minimizing the oscillations in the observables. Additionally, we have made a major breakthrough in HMI data analysis by developing a powerful procedure, COADRED, that removes the orbital artifacts in the downstream Dopplergrams produced by the Very Fast Inversion of the Stokes Vector (VFISV) in the HMI Pipeline. We will modify the COADRED procedure to operate on the vector magnetic field inversions (Schuck, 2016).

* We will implement a new disambiguation module that minimizes temporal fluctuations in the direction of the transverse magnetic field from image to image.

* We will use the resulting vector fields combined with the Differential Affine Velocity Estimator for Vector Magnetograms with Doppler Velocities to estimate the photospheric plasma velocities.

* We will compute the energy and helicity transport for an ensemble of both erupting and non-erupting active regions to characterize the coronal state.

* Uncertainties will consistently be propagated from beginning to end through our analysis process.

Proposed contribution to the FST: We will provide modelers with consistent and accurate photospheric boundary conditions, consisting of vector magnetic field and plasma velocities, for near real-time models of the solar corona and inner heliosphere.

This work directly addresses the LWS program objective: "Understand solar variability and its effects on the space and Earth environments with an ultimate goal of a reliable predictive capability of solar variability and response."

Publication References:

no references