Project Details

ROSES ID: NNH16ZDA001N
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:
Implementing and Evaluating a Vector-Magnetogram-Driven Magnetohydrodynamic Model of the Magnetic Field in the Low Solar Atmosphere (NASA GSFC)

PI Name: James Leake
PI Email: atn@g.ucla.edu
Affiliation: Naval Research Laboratory
Summary:
We propose to develop, evaluate, and implement, for the first time, a data-driven magnetohydrodynamic (MHD) model above solar active regions (ARs) that uses photospheric vector-magnetograms and derived quantities, and includes the physics of the low solar atmosphere. Knowledge of the coronal field is vital in solar physics, not only for the investigation of outstanding science questions, but for the development of real time modeling of the corona, solar wind, and heliosphere, and to predict geo-effective space weather events. Unfortunately the best measurements of the solar atmospheric field lie at the photosphere, and coronal field models must bridge the gap between the high-beta, weakly ionized photosphere and the low-beta, fully ionized corona, including the relevant physical mechanisms in the layers between. To solve this problem we will develop, evaluate, and implement techniques to use the time-evolving observed photospheric vector magnetic field from NASA's Helioseismic and Magnetic Imager (HMI) to accurately evolve the plasma and magnetic field from the photosphere up through the chromosphere and into the corona. Our proposed methodology is: - Analyze photospheric HMI vector magnetic field observations to derive the photospheric velocity, density and temperature necessary to drive MHD models of the atmosphere above ARs. - Develop and implement a data-driven MHD model using this data to predict the coronal field. Supply coronal field predictions to other FST team models and answer science questions.

- Evaluate the accuracy and uncertainty inherent in the resulting solution, using previously run AR simulations. Investigate propagation of errors from various sources into the coronal field prediction, such as reduced temporal/spatial cadence and instrument bias and noise. Proposed Contributions to the FST Effort: This proposed study addresses the Focused Science Topic "Advances Toward a Near Real Time Description of the Solar Atmosphere and Inner Heliosphere" by "directly addressing the innovative use of sequences of magnetograms and/or magnetic maps in combination with other data products for the purposes of predicting the state of the solar atmosphere and/or solar wind parameters." In particular we are focusing on "Studies that innovatively use magnetograms/magnetic maps, either space or ground-based, to drive models," and "Studies that develop mathematical techniques for incorporating data into solar atmosphere/solar wind models (e.g., assimilation, data driving, etc.)."

Our proposed model is a vital component to this FST, providing coronal field predictions, driven by the photosphere and processed by the physics of the low atmosphere, to FST team members' models which do not include such physics. We will work with the FST team to determine how to inform these various models, and determine which observed ARs to focus on. Overarching Science Goal: What accuracy can we achieve in an MHD model of the coronal magnetic field above ARs using the state of the art photospheric data? Science Objectives: Use data-driven MHD models of the low solar corona to answer the following science questions: How much of the observed magnetic flux in active regions emerges into the corona? How are free magnetic energy and helicity injected into the corona in ARs? How forced is the coronal field, and above what height is it primarily force-free?

Publication References:

no references