Space Weather Prediction Through the Observation and Modeling of Coronal Magnetism

FA9550-15-1-0030

Year 3 Report

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The goal of our project is to develop a new methodology for assimilating coronal magnetic diagnostic data into magnetohydrodynamic (MHD) models in order to establish not only the magnetic structure of the source region of coronal mass ejections, but also the global field into which it erupts. Our project name is **Data-Optimized Coronal Field Model**, or **DOCFM**.

During this year we have explored sensitivities of Coronal Multichannel Polarimeter (CoMP) linear polarization measurements to the coronal magnetic field. Gibson was lead author (along with Dalmasse, de Toma, Fan, and Tomczyk) on a paper on CoMP observations of so-called ``pseudostreamers'' in which magnetic nulls were directly observed for the first time. These are significant because they are locations of likely reconnection and possible destabilization leading to solar eruptions. In addition, this work demonstrated that CoMP data could be used to quantify the expansion of magnetic flux tubes into the solar wind in a model-independent fashion. This is significant because magnetic expansion is related to solar wind speed, and needed as input into space-weather models. This work was presented by Gibson at the SolarNet 4 meeting in Lanzarote, Spain, in January 2017, at an invited talk at the National Solar Observatory in Boulder, Colorado in May 2017, and at the IAGA-IAMAS-IAPSO meeting in Capetown, South Africa in August 2017.

Dalmasse has made progress on applying ROAM to flux-rope-insertion models with the goal of finding the best fit to the synthetic test bed, presenting progress at colloquiua in Toulouse and Meudon, France, and this work will soon be submitted as a paper. Meanwhile, Savcheva and Tassev have worked on topological analyses of coronal magnetic structures, with two publications and a presentation at the SPD meeting. Savcheva has also worked with Karna at CfA to fit a flux rope model to the pseudostreamer of the Gibson et al. (2017) paper; Karna has presented progress at the SPD meeting, and is currently writing the results of this analysis as a paper, also to be submitted. Gibson also supported one of the other AFOSR-funded Bz efforts by forward modeling radio emission for a paper by McCauley et al., and was lead author on an editorial on Coronal Magnetometry for the journal Frontiers in Space Science. Finally, Fan continues to work on modeling coronal flux ropes, with a presentation at the SPD meeting, and a publication in the Astrophysical Journal this year. She has also nearly completed a paper quantifying the effects of noise on CoMP-like data.

This summer we had two summer undergraduates working on DOCFM-related projects. Marcel Corchado Albelo of the University of Puerto Rico forward modeled a simulation of an emerging and erupting flux rope to demonstration correlation between CoMP-type observations and magnetic free energy. Kenzie Nimmo of the University of Glasgow used a complex simulation of an emerging active region to look at polarimetric signatures of CMEs and flares, and explore sensitivities of these data to high temperatures and velocities. In addition, University of Colorado undergraduate Nathaniel Mathews is applying machine learning techniques to develop a statistical regression representation of the coronal boundary magnetic field based on photospheric input.

Our original intention was to have our full team meeting in Scotland in Year 3, but, due to team member schedule conflicts we have delayed this to Year 4. It is currently scheduled for August 22-24, 2018, in St. Andrews, U.K. We did have a partial team meeting in July, 2017, involving Gibson, Dalmasse, Fan, Savcheva, and Karna.

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