Project Details

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Program Element: Focused Science Topic

Topic: Focused science topic for Strategic Goal 1 (Solar storms): Exploring the magnetic connection between the photosphere and low corona

Project Title:
Evolving Nonlinear Force-Free Magnetic Models of the Solar Corona

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Summary:
Despite considerable progress in observing the structure and evolution of the solar corona, the root causes of many phenomena remain elusive. The dynamics associated with coronal heating processes, particle acceleration mechanisms, and instabilities that lead to eruptive events such as flares and coronal mass ejections are all not well understood. Lack of progress in advancing our knowledge is a result of our inability to accurately map out the three-dimensional geometry of the coronal magnetic field and to observe its evolution in time. Because the three-dimensional coronal magnetic field does not easily lend itself to direct observation, much recent effort has been put toward modeling the coronal magnetic field using photospheric magnetograms.

We are proposing here to construct an evolving nonlinear force-free model of the three-dimensional coronal magnetic field driven by time series of photospheric magnetogram data. Evolving models represent a complementary approach to standard coronal field modeling, in which extrapolations are performed from a single magnetogram. Instead, our scheme will make use of high-cadence time series of vector magnetogram data derived from instruments such as the Solar Optical Telescope (SOT) on Hinode and the upcoming Helioseismic and Magnetic Imager (HMI) on the Solar Dynamics Observatory (SDO). Such evolving models of the coronal magnetic field enable the dynamics of the solar corona above active regions to be investigated in greater detail, allowing us to investigate questions involving the geometry and topology of the coronal magnetic field, the effects of photospheric flux emergence on this geometry, and the buildup and release of magnetic energy and helicity over time.

Publication References:

Summary: no summary

Reference: Wiegelmann, T.; Thalmann, J. K.; Schrijver, C. J.; De Rosa, M. L.; Metcalf, T. R.; (2008), Can We Improve the Preprocessing of Photospheric Vector Magnetograms by the Inclusion of Chromospheric Observations?, Can We Improve the Preprocessing of Photospheric Vector Magnetograms by the Inclusion of Chromospheric Observations?, doi: 10.1007/s11207-008-9130-y

Summary: no summary

Reference:
Schrijver, C. J.; DeRosa, M. L.; Metcalf, T.; Barnes, G.; Lites, B.; Tarbell, T.; McTiernan, J.; Valori, G.; Wiegelmann, T.; Wheatla nd, M. S.; Amari, T.; Aulanier, G.; Démoulin, P.; Fuhrmann, M.; Kusano, K.; Régnier, S.; Thalmann, J. K.; (2008), Nonlinear Force-free Field Modeling of a Solar Active Region around the Time of a Major Flare and Coronal Mass Ejection, The Astrophysical Journal, Volume 675, Issue 2, article id. 1637-1644, pp, doi: 10.1086/527413

Summary: no summary

Reference:
De Rosa, Marc L.; Schrijver, Carolus J.; Barnes, Graham; Leka, K. D.; Lites, Bruce W.; Aschwanden, Markus J.; Amari, Tahar; Canou, Aurélien; McTiernan, James M.; Régnier, Stéphane; Thalmann, Julia K.; Valori, Gherardo; Wheatland, Michael S.; Wiegelmann, Thomas; Cheung, Mark C. M.; Conlon, Paul A.; Fuhrmann, Marcel; Inhester, Bernd; Tadesse, Tilaye; (2009), A Critical Assessment of Nonlinear Force-Free Field Modeling of the Solar Corona for Active Region 10953, doi: 10.1088/0004-637X/696/2/1780

Summary: no summary

Reference: Aschwanden, Markus J.; Wuelser, Jean-Pierre; Nitta, Nariaki V.; Lemen, James R.; DeRosa, Marc L.; Malanushenko, Anna; (2012), First Three-dimensional Reconstructions of Coronal Loops with the STEREO A+B Spacecraft. IV. Magnetic Modeling with Twisted Force-free Fields, The Astrophysical Journal, Volume 756, Issue 2, article id. 124, 22 pp, doi: 10.1088/0004-637X/756/2/124

Summary: no summary

Reference: Guo, Y.; Ding, M. D.; Liu, Y.; Sun, X. D.; DeRosa, M. L.; Wiegelmann, T.; (2012), Modeling Magnetic Field Structure of a Solar Active Region Corona Using Nonlinear Force-free Fields in Spherical Geometry, The Astrophysical Journal, Volume 760, Issue 1, article id. 47, 14 pp, doi: 10.1088/0004-637X/760/1/47

Summary: no summary

Reference: Gopalswamy, N.; Yashiro, S.; Michalek, G.; Stenborg, G.; Vourlidas, A.; Freeland, S.; Howard, R.; (2009), The SOHO/LASCO CME Catalog, Earth, Moon, and Planets, Volume 104, Issue 1-4, pp. 295-313, doi: 10.1007/s11038-008-9282-7