Project Details

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Project Title:
Evolution of the photospheric and chromospheric magnetic fields and dynamics of the lower solar atmosphere during flares

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Summary:
This proposal will target Science Analysis for the Solar Dynamics Observatory (SDO) special initiative in Heliophysics Living With a Star science.

Flares are often seen as a tumultuous breakup of a previously stable configuration leading to release of a significant amount of energy, material eruption, particle acceleration, and restructuring of magnetic configuration. This magnetic restructuring may be a key for understanding the physics of processes taking place throughout the solar atmosphere in response to flares: magnetic field supplies energy to flares, and serves as a trigger and as a conduit of energy transport. The main objective of this proposal is to investigate the magnetic restructuring associated with flares and its effects on thermodynamic processes in the low solar atmosphere. The changes in the magnetic field will be evaluated in respect to two alternative models: coronal implosion and twist removal model. Either of these scenarios may take place in flares, but the two models can be distinguished based on expected magnetic field changes. The proposed research is based on full vector magnetic field data from two NASA missions, SDO and Hinode, and supplemented with observations from two ground-based instruments, GONG (line-of-sight only) and SOLIS (vector data). These two auxiliary data sets will enhance the interpretation of SDO data, strengthen the statistics. The auxiliary data sets could be critical in finding the proper interpretation in cases when the magnetic field derivations may be affected by the poor spectral resolution of HMI, or hampered by the poor temporal cadence of SOT/SP. These data sets will also allow including flares prior to SDO launch for greater statistical sample, if needed. SOLIS Ca II 854.2 nm line-of-sight (LOS) magnetograms will expand the study to the chromosphere. Using SDO vector magnetograms we will investigate the changes in orientation and strength of the magnetic field and the associated changes in Lorentz force. For selected cases, we will also derive pseudo-vector fields using high-cadence SDO/HMI and GONG line-of-sight (LOS) magnetograms based on the approach of azimuthal averaging. Evolution of the derived pseudo-vector fields during flares will be investigated and validated with the result from SDO/HMI vector magnetograms.

To investigate changes in thermodynamic parameters associated with flares, we will use existing observations of flaring regions with the Stokes Polarimeter on Hinode. In addition, we will use existing flare observations with SOLIS for a few selected flares and conduct new observations if needed. As a proof-of-concept, several successful SOLIS observational flare campaigns were conducted in the past. The use of SOLIS data will enhance the interpretation of SDO/HMI spectral data as SOLIS/VSM has higher spectral sampling as compared with SDO/HMI data. Changes in thermodynamic parameters will show the effect of flares through the formation height range of the Fe I 630.1-630.2 nm photospheric and Ca I 854.2 nm chromospheric spectral lines. Finally, we will compare the location of footpoints of flare loops derived from RHESSI observations in an energy range of 50-300 keV with the locations that show significant topological changes in the magnetic field. We will examine the rate of flux loss in the reconnection events associated with flares.

We expect that the results of this study will bring a better understanding of physics of flare processes in active regions and constrain some existing flare models.

Publication References:

Summary: no summary

Reference: Tadesse, T.; Wiegelmann, T.; Gosain, S.; MacNeice, P.; Pevtsov, A. A.; (2014), First use of synoptic vector magnetograms for global nonlinear, force-free coronal magnetic field models, Astronomy & Astrophysics, Volume 562, id.A105, 8 pp, doi: 10.1051/0004-6361/201322418

Summary: no summary

Reference: Tadesse, Tilaye; Wiegelmann, T.; MacNeice, P. J.; Inhester, B.; Olson, K.; Pevtsov, A.; (2014), A Comparison Between Nonlinear Force-Free Field and Potential Field Models Using Full-Disk SDO/HMI Magnetogram, Solar Physics, Volume 289, Issue 3, pp.831-845, doi: 10.1007/s11207-013-0364-y