Project Details

ROSES ID: NNH13ZDA001N
Selection Year: 2013
Program Element: Solar Dynamics Observatory

Project Title:
SDO/EVE Irradiance Observations as a Diagnostic of Energy Transport During Solar Flares

PI Name: Ryan Milligan
PI Email: atn@g.ucla.edu
Affiliation: Catholic University of America/GSFC
Project Member(s):
- Chamberlin, Phillip C; Co-I; NASA
- Allred, Joel C; Co-I; NASA/GSFC

Summary:
The extreme ultraviolet (EUV) component of radiation emitted during solar flares is known to be a major driver of ionospheric fluctuations in the terrestrial atmosphere. The bulk of this emission originates in the chromosphere, and is believed to be driven by a beam of high-energy electrons accelerated from an energy release site in the corona, although the details of how this energy is transferred are still poorly understood. The numerical simulations of Allred et al. (2005; RADYN) suggest that chromospheric emission is energetically dominated by various recombination continua, in particular, the Lyman, Balmer, and Paschen continua of hydrogen, and the He I and He II continua, as opposed to line emission. Assuming thick-target interactions, we aim to use HXR imaging and spectroscopy from RHESSI observations to obtain the location, flux, and distribution of nonthermal electrons deeded to be responsible for driving chromospheric enhancements. These parameters can be used to generate a heating function in the RADYN code with which to heat an ambient model solar atmosphere. The resulting synthesised line and continuum emission will then be directly compared to observations taken with the EVE instrument onboard SDO, which is now routinely observing time-resolved measurements of the recombination continua of H and He during flares as well as prominent emission lines such as He II 304A and Lyman-alpha (Milligan et al. 2012a).

Lightcurves of isothermal emission from EVE can be generated using the methods described in Chamberlin, Milligan & Woods (2012). From these it has been seen that plasma at a several megakelvin can peak both during the impulsive phase and during the main phase of a flare. By examination of the corresponding AIA images, the the chromospheric component of this high-temperature emission can be determined. This will establish the temperature to which the chromosphere was heated during the impulsive phase, allowing a comparison to be made with the model predictions of RADYN. It has also been shown that EVE data can be used to determine plasma densities at high (>10MK) temperatures using emission line ratio techniques (Milligan et al. 2012b). By applying these techniques to lines formed over a range of lower temperatures a more comprehensive picture will be made of the density structure of flaring plasma. Comparisons can then also be made with the density of the simulated atmosphere as predicted in the RADYN models.

Understanding how different continua contribute to the overall energy of flares, as well as the temperature and density of the heated plasma, are therefore crucial for corroborating current solar flare models. This allows the mechanism(s) by which the associated emission is generated to be determined, as well as the depth of the atmosphere at which it is emitted. Although the EVE instrument onboard SDO was primarily designed to monitor the Sun s EUV irradiance over multiple timescales, we have been pioneering the use of its data to understand the physics behind some of the most fundamental processes during solar flares. The overarching goal of this proposal is therefore to improve our understanding of the processes responsible for EUV irradiance variations and determine the energy balance in dynamic phenomena in accordance with the Science Analysis for SDO Initiative.

Publication References:

no references