Project Details

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

Project Title:
Investigation of the Magnetic Causes of Coronal Heating in Solar Active Regions

PI Name: Amy Winebarger
PI Email: amy.r.winebarger@nasa.gov
Affiliation: NASA Marshall Space Flight Center
Summary:
Previous work has shown that the coronal X-ray luminosity of an active region increases roughly in direct proportion to the total photospheric flux of the active regions magnetic field. This observation is consistent with the present paradigm for coronal heating in active regions: the coronal heating is powered by convective mixing in and below the photosphere, with the building-up and burning-down of the free magnetic energy being in roughly steady-state balance on average over the active region.

It is also observed, however, that the coronal luminosity of active regions of nearly the same flux content can differ by an order of magnitude. This indicates that there are other conditions in active regions in addition to the flux content that together constitute a stronger determinant of the coronal heating. From preliminary work, we have found evidence suggesting that the main determinant of an active regions coronal heating in addition to the flux content may be the total free energy in the active regions coronal magnetic field. The free magnetic energy is the energy stored in the deformation of the field from its zero-free-energy potential-field configuration. The proposed study will empirically explore the strength of the free-magnetic-energy content as a determinant of the heating that sustains the coronal luminosity of active regions.

We will measure the magnetic flux content and a proxy of the free magnetic energy from whole-active-region vector magnetograms from SDO/HMI for a few hundred sunspot active regions. From SDO/AIA and Hinode XRT images of these active regions, we will obtain each active regions coronal differential emission measure, of which an integral over temperature is the active regions coronal luminosity. We will determine if the coronal luminosity of active regions of nearly the same flux content is strongly correlated with the free-energy proxy; this will imply that the free-energy content is a stronger determinant of active-region coronal heating than the flux content. This would challenge the present paradigm for active-region coronal heating by raising the possibility that in many active regions most of the free energy burned in coronal heating is stored in the field by convective deformation before and during the fields emergence into the corona. This outcome would suggest that at most times in the life of an active region the rate of burning-down of free magnetic energy by coronal heating is not nearly in balance with the rate of building-up of free energy in the active-regions coronal field.

Publication References:

Summary: no summary

Reference: Tiwari, Sanjiv K.; Alexander, Caroline E.; Winebarger, Amy R.; Moore, Ronald L.; (2014), Trigger Mechanism of Solar Subflares in a Braided Coronal Magnetic Structure, The Astrophysical Journal Letters, Volume 795, Issue 1, article id. L24, 6 pp, doi: 10.1088/2041-8205/795/1/L24

Summary: no summary

Reference: Tiwari, Sanjiv K.; Falconer, David A.; Moore, Ronald L.; Venkatakrishnan, P.; Winebarger, Amy R.; Khazanov, Igor G.; (2015), Near-Sun speed of CMEs and the magnetic nonpotentiality of their source active regions, Geophysical Research Letters, Volume 42, Issue 14, pp. 5702-5710, doi: 10.1002/2015GL064865

Summary: no summary

Reference: Tiwari, Sanjiv K.; Thalmann, Julia K.; Panesar, Navdeep K.; Moore, Ronald L.; Winebarger, Amy R.; (2017), New Evidence that Magnetoconvection Drives Solar–Stellar Coronal Heating, The Astrophysical Journal Letters, Volume 843, Issue 2, article id. L20, 7 pp, doi: 10.3847/2041-8213/aa794c