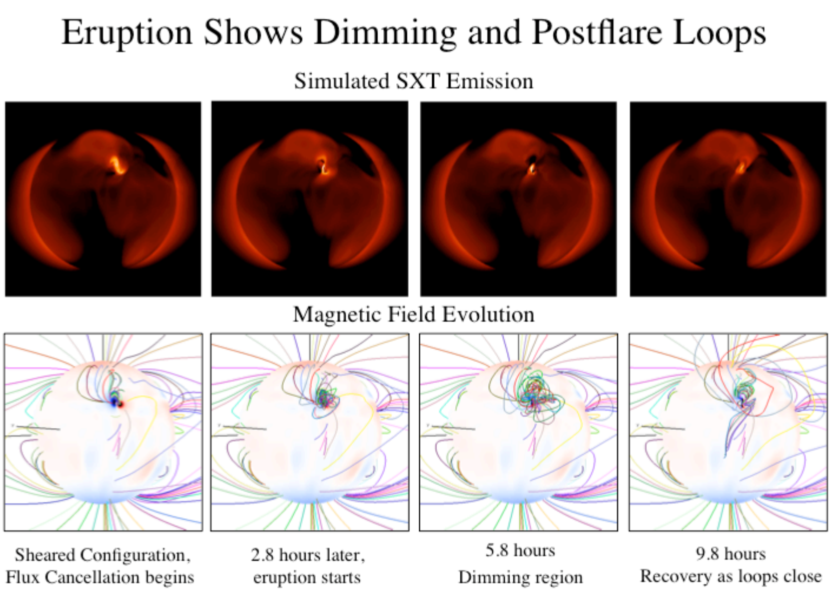
CISM SCIENCE HIGHLIGHT:

MODELING SOLAR ERUPTIONS: THE 12 MAY 1997 EVENT

Solar Physics Group, SAIC, San Diego, California

Coronal mass ejections (CMEs) are arguably the most spectacular transient solar phenomena, yet their mechanism(s) for eruption remains largely unknown. The fastest CMEs, which potentially have the most devastating societal impact, typically originate in active regions (ARs). Modeling these types of events is particularly challenging: Both the localized magnetic field due to the AR and the overlying fields in the large-scale corona are important.

Most current CME models use simple energy equations because the primary focus is on understanding how these eruptions are triggered by magnetic energy release from the coronal magnetic field. However, to develop a realistic model of an AR in the context of the global corona, energy transport processes (radiation, coronal heating, thermal conduction) cannot be ignored. As part of our CISM-directed research, we have developed the first-ever simulation of a specific eruption (the 12 May 1997 event) using a full thermodynamic, global MHD approach. This event is relatively simple and has been well studied in the past. Associated with the event were: a halo CME, a C-class flare, a double-dimming signature, magnetic cloud and moderate geomagnetic storm. Only one AR was visible on the disk, and the observations suggest that the field erupted through significant flux cancellation prior to and during the event.



The simulation was initiated using a filtered MDI magnetogram from 11 May 1997. From this, a steady-state solution of the solar corona was obtained that included both slow and fast solar wind. Since no vector magnetograms were present for this event, we energized the magnetic field by applying a flux preserving vortical flow. Following this, we applied converging flows toward the neutral line (with diffusion at the neutral line). These converging flows increased the shear previously present and initiated the eruption. The Figure on the left summarizes this evolution, and in particular, highlights several features present in the simulations that match the observations remarkably well. These include: (1) the formation of a sigmoidal structure; (2) the formation of dimming regions; (3) the relatively complex eruption of several magnetic structures; (4) the presence of post-flare loops; and (5) the propagation of a coronal wave.

More information about these simulations can be obtained from http://iMHD.net or by contacting Dr. Jon Linker at linkerj@saic.com.