Bill Abbett and George Fisher continued their work with the photospheric boundary condition problem that was pointed out in Abbett & Fisher 2003 (ApJ, 582, 475), namely, the need for a fully self-consistent (yet not over-specified) velocity field to be associated with a given time-series of vector magnetograms so that these observations can be used to drive 3D MHD models of the corona. Brian Welsch and George Fisher have obtained (and written) a number of simple codes which find flow fields based on widely accepted techniques such as Local Correlation Tracking and Feature Tracking, and have obtained an implementation of Dr. Longcope’s Minimum Energy Fitting method. Each of these velocity determination techniques are being tested against the known flow fields of newly generated, high cadence, ANMHD subphotospheric simulations. We will characterize each empirical velocity determination method against the new runs, which presently describe a photosphere with large-scale structure (an simple emerging active region), small scale structure (quiescent magnetic field characteristic of magneto-convection in the absence of active region fields), and a combination of large and small scale structure (an emerging active region interacting with supergranular-scale convective turbulence.

Fisher, Kuhn (UH) and others organized a MURI workshop on measuring coronal magnetic fields that was held in Waikiki and at the Institute for Astronomy in Manoa in November of 2002. Experts on coronal magnetic fields attended from a large variety of institutions. A plan of action (powerpoint format) to facilitate research in this important area was formulated, and can be downloaded from this URL: [http://solarmuri.ssl.berkeley.edu/~fisher/public/documents/muri-mini-workshops/coronal-b-nov-2002/](http://solarmuri.ssl.berkeley.edu/~fisher/public/documents/muri-mini-workshops/coronal-b-nov-2002/).

A joint MURI team meeting was held at the Space Sciences Laboratory December 4-5, including members of both the Berkeley and Michigan MURI teams. On December 5th, the Solar and Heliospheric members of the CISM team also met at SSL, in order to have some interaction between members these two space-weather efforts. Copies of most of the talks (in powerpoint format) given by the members of the Solar MURI team at that meeting can be downloaded from this URL: [http://solarmuri.ssl.berkeley.edu/~fisher/public/presentations/muri-team-dec2002/](http://solarmuri.ssl.berkeley.edu/~fisher/public/presentations/muri-team-dec2002/)

Luhmann and Fisher co-chaired the joint session of the Solar MURI and Solar CISM teams. The synergies between these two activities were discussed, as well as agreement to adopt the May 12, 1997 event as a common goal for simulation of a real event by both groups. The existing MURI web site of links to observations of this event will provide a resource for the CISM effort. Luhmann is working with Yan Li and CISM collaborator Nick Arge to better characterize the solar wind and coronal context of the May 12 eruption using magnetogram-based models of the corona and solar wind.
Just before the joint team meeting, we held a brief workshop on active region 8210 (May 1, 1998) which is one of the MURI selected events. A brief summary of that workshop can be found in the file ar8210-summary.ppt in the URL directory link above.

A research article, submitted by Luhmann et al. for publication to Solar Physics (Coronal Magnetic Field Context of Simple CMEs Inferred from Global Potential Field Models, by Luhmann, Lee, Zhao and Yashiro) has been accepted for publication.

Luhmann has participated on the organizing committee for the Tucson MURI SEP modeling workshop, and will attend that workshop in March.

Dr. Welsch resubmitted a paper to the Astrophysical Journal (ApJ) entitled, "Magnetic Helicity Injection by Horizontal Flows in the Quiet Sun: I. Mutual Helicity Flux," and it was accepted for publication this May. He also attended the AGU meeting, where he presented a poster entitled "Magnetic Helicity Injection by Horizontal Flows in the Quiet Sun: II. Self Helicity Flux," and made substantial progress on the manuscript of this work for submission to ApJ.

In addition, at the joint MURI and CISM team meetings at UC-Berkeley held in December 4-5, Dr. Welsch gave a talk summarizing the Berkeley-based group's work in developing techniques to drive coronal MHD simulations with vector magnetogram data.

Report from BBSO/NJIT: Sent by Yong-Jae Moon

1. New 1.6M Telescope Project: BBSO is planning to replace the 65-cm vacuum telescope by an open, off-axis 1.6 m solar telescope--the NST (New Solar Telescope) with first light being early in 2006. More detailed information is available at http://www.bbso.njit.edu/newtelescope/index.html.

2. Instrument Development Progress: We have made a lot of progress with the control software, and we are continuing to work on scanning procedures and communication with the telescope control computer. The telescope control software is being modified so that newer instruments will communicate with it using TCP network sockets instead of RS-232 serial connections.

3. Sympathetic Coronal Mass Ejections: We address the question whether there exist sympathetic coronal mass ejections (CMEs),which take place almost simultaneously in different locations with a certain physical connection. For this study, the following three investigations are performed:

- First, we have examined the waiting-time distribution of the CMEs that were observed by SOHO/LASCO from February 1999 to December 2001. The observed waiting time distribution is found to be well approximated by a time-dependent Poisson distribution without any noticeable overabundance at short waiting times.
Second, we have investigated the angular difference distribution of successive CME pairs to examine their spatial correlations. A remarkable overabundance relative to background levels is found within 10 degree of the position angle difference, which supports the existence of quasi-homologous CMEs. The above results both indicate that sympathetic CMEs are far less frequent than independent CMEs. Third, we have examined the EIT running difference images and the LASCO images of quasi-simultaneous CME pairs, and found a good candidate of the sympathetic CME pair, of which the second CME may be initiated by eruption of the first CME. (Moon et al., ApJ, accepted)

4. Publications:

Moon et al., "Sympathetic coronal mass ejections" accepted for ApJ

Moon et al., "Magnetic helicity change rate associated with three eruptive x-class flares" accepted for Advances in Space Research

Moon et al., "Impulsive variation of magnetic helicity change rate associated with eruptive flares" in ApJ, 580, 528


Wang et al., "Sudden disappearance of a small sunspot associated with the 2002 February 20 M2.4 flare" in ApJ, 580, L177

Report from Colorado/CIREs: Sent by Dusan Odstrcil

In collaboration with Steve Ledvina and Ilan Roth (both UCB), we have selected data from numerical simulations of 3-D interplanetary shock propagation in ambient solar wind with a heliospheric streamer belt. We have prepared some reading and visualization procedures and Ilan Roth realized the first study of acceleration of protons at the interplanetary shock. A similar study has been realized with Marek Vandas (Astronomical Institute, Prague, Czech Republic), who used our high-resolution 2-D AMR simulations of a shock passing through a magnetic flux rope (computations realized earlier with Peter MacNeice) to study acceleration of electrons at distorted shocks. In this case, enhanced magnetic field in the flux rope and helical structure of field lines favored acceleration of electrons at the shock by fast-Fermi process. Both results were reported at the MURI team meeting in Berkeley, and the second study was presented also at the Fall AGU Meeting in San Francisco.

Papers


Presentations
Odstrcil D., and V. J. Pizzo, Modeling 3-D solar wind structure, 34th COSPAR Scientific Assembly, Houston, TX, October 10-19, 2002 (invited talk).

Vandas, M., and D. Odstrcil, Acceleration of electrons by interacting CMEs, Fall AGU Meeting, San Francisco, December 6-10, 200 (poster).

Report from Drexel University: Sent by Peter MacNeice

Drexel University personnel: Dr. Peter MacNeice, Dr. Andrew Phillips, Mr. Jimin Gao

In summary, we continued development work on our existing CME `breakout' model code, continued development work on a High Order Godunov version, and continued to upgrade version 3.0 of the Paramesh AMR package.

The basic FCT modules in our code have been rewritten to make them easier to work with. These new routines are now fully debugged and operational.

We have studied the influence of spatial resolution on the results from our CME ‘breakout' model. Runs have been completed at 4 different resolutions, and we are analyzing the implications. We have begun designing a helicity calculator to post-process the results from these runs. We have also added explicit physical diffusion in an effort to quantify the numerical diffusion inherent in the code.

We are analyzing the low resolution runs obtained for the non-symmetric initial field configuration in the breakout model. First indications suggest that a simple flux rope is not being formed as was the case in the runs with equatorial symmetry.

We have added a selection of strategies for divergence-free field interpolation to the PARAMESH package. We are now debugging these routines. We have also begun testing the support for curvilinear coordinates which we added previously. We are still awaiting NASA permission to release PARAMESH V3.0 through SourceForge.

Report from Hawaii: Sent by Jeff Kuhn

Mees continues to observe with the IVM, MCCD, H-Alpha Coronagraph, and white light telescopes. We are co-observing with the Max Millennium effort.

Addition of a filter wheel to the IVM, to permit comfortable switching between observations at H alpha, Fe I 630.25, and Na D1, has been completed. An additional broad-band blocking filter was needed, and has been procured. One of the IVM LC retarders failed and has been replaced.
A method for precise alignment of the Fabry-Perot plates in the IVM has been devised and implemented. It utilizes the IVM polarimeter to increase sensitivity to the small asymmetry in photospheric and telluric lines, caused by a slight wedge in the Fabry-Perot. The parallelism of the FP plates changes slightly during the observing day, likely due to the changing gravity vector.

The Haleakala Stokes Polarimeter has been off-line during most of the period, but an effort is under way to restore it to operation. This instrument has been used for decades and is getting pretty crotchety, but it has provided a valuable continuous sequence of vector magnetic field observations since 1990.

The SOLARC coronagraph prime focus and heat stop assembly was modified to replace the fixed light trap with a beam dump to the dome. This reduces the non-specular background significantly so that IR sky background measurements are now limited only by the thermal background to within about 30 arcsec of the solar limb. The IR sky on Haleakala is indeed dark.

The infrared (flourite) fiber spectrograph and 4 micron IR camera are now assembled at the telescope. First-light observations of the mid-IR photosphere spectrum have been obtained. Mechanical improvements to the grating and fiber positioning mounts are now needed and have been ordered.

The 4 micron camera is being modified to allow chopped/synchronous high cadence observations. This software effort should be completed by next quarter.

Jing Li continues to work on the white light flare data from July 15 2002. The flare occurred at 20:04 UT. The Mees observatory was taking the data during the whole day from 16 UT to 01:00 UT. The magnetograms obtained by the Imagine Vector Magnetograph (IVM) and MCCD H-alpha multiple wavelength imagery had excellent temporal coverage. Prior to the WLF, double bright features developed in both TRACE and H-alpha images. The features were not classical two ribbon flares, but they were probably caused by the magnetic reconnection in the higher corona and reconnection energy was transported down to the footpoints. The WLF occurred while the bright feature reached the WLF site. Following the WLF, a coil was seen in TRACE movies taking off immediately. This suggests that WLF energized the filament, probably by heating. A CME was seen around 20:20 UT, which could be the material from the filament. The attached imagery shows TRACE/1600 and H-alpha images overlaid on IVM magnetograms at the WLF maximum. The "coil" was about to take off as determined by the TRACE data. Note that it overlaps with the negative polarity region above the bright feature in the bottom of the negative polarity field region.
Report from Montana State University: Sent by Dana Longcope

During the fourth quarter of 2002, Stephane Regnier (SR) worked on describing the eruptive process within the active region 8210. The main step was the determination of the velocity field on the photosphere using the method developed by D. Longcope. Comparison between a high-cadence movie and the computed velocity field shows good agreement. In addition to the vector magnetic field, the velocity field was used to determine the energy injection rates and the helicity injection rates into the corona.

SR contributed to the progress of the MURI project by providing the vector magnetic field and the velocity field on the photosphere and the non-constant-alpha force-free equilibrium which are used by Bill Abbett and George Fisher to run a MHD code (the first attempt was successfully done).

R.C Canfield, P. Jibben and SR analyzed the correlation of the Halphal MCCD images and the 3D magnetic configurations. At this time, they have found a good agreement between Halphal flares at two locations and the location of separatrix surfaces (it's not new but it will be useful to describe the eruptive event).

SR participated to the annual MURI meeting in Berkeley. During a special session on AR 8210, SR made a summary of the progress on the 3D magnetic structure of this active region (non-linear force-free reconstruction, helicity injection, velocity field) and on the Halphal data (blueshift events) provided by the MCCD instrument (MSO/Hawaii). SR also participated to the joint MURI-Michigan-CISM meeting.

SR worked two weeks at the IAS (Institut d'Astrophysiqe Spatiale) and at the Ecole Polytechnique on the filament-prominence oscillation study using 2D datasets and on the reconstruction methods (boundary conditions, spherical coordinates, ...). SR gave a talk at the IAS on the complexity and topology of active regions and a talk at the LESIA (Obs. Meudon) on the active region 8210 (energy budget, 3D magnetic field and helicity injection rate)."

Piet Martens nearly completed the paper with Paul Wood on "Measurements of Flux Cancellation During Filament Formation". It is taking longer than expected because they keep on finding additional items to be included, and because of my time-consuming my involvement with two SMEX proposals.

Martens participated in the MURI consortium meeting, December 5, Berkeley. Presented talk, also entitled "Measurements of Flux Cancellation During Filament Formation", which was received well.

Paul Wood participated in the yearly PROM meeting, this time in Washington DC, on November 11 and 12, and presented their paper, under the title "Flux Cancellation in Prominence Formation".
Martens volunteered to host and co-organize the yearly PROM meeting (a consortium of scientists involved with prominence research, led by Sara Martin), next winter at MSU.

Martens submitted the invited review of the October COSPAR meeting, "YOHKOH-SXT OBSERVATIONS OF RECONNEXION", author P.C.H. Martens, to Advances in Space Research. It contains one section on the formation of sigmoids and prominences through flux cancellation, and a discussion of alternatives, i.e. emergence of complete flux tubes – concluding that both may actually be occurring on the Sun, the former in older decaying regions, including the polar crown, and the latter in newly emerging bipolar regions.

During this quarter Canfield studied active region AR 8210 using H-alpha spectra and spectroheliogram movies from the Mees CCD Imaging Spectrograph (MCCD) at Mees Solar Observatory. Bursts of moving blue-shift events, indicative of reconnection of disparately twisted flux systems, were found in two different locations and time periods, roughly 1700-1800 UT and 2000-2200 UT. When time sequences of helicity emergence maps are completed by Regnier, they will be compared with the results of the MCCD study.

Report From Stanford University: Sent by Yang Liu

In the period from October 2002 to December 2002, we continued to collect and analyze solar magnetic field data; we continued to produce and distribute daily synoptic charts using both WSO and MDI data; we continued to produce a variety of synoptic frames used in others' analyses and produced daily updates of synoptic charts using MDI data from longitudes other than central meridian. We also presented our current research in the 2002 AGU Full Meeting, and have finished writing two pieces of work on solar active regions and solar activity.

Using the magnetograms taken at the Wilcox Solar Observatary, Zhao et al. (2002) studied the north-south offset of the heliospheric current sheet, and explored the cause of this asymmetry; Liu, Zhao and Hoeksema (2002) described their algorithm for correction of the offset of MDI magnetograms in the AGU full meeting.

In a work submitted to Advances in Space Research (Tian, Liu, Yang, 2002), we studied evolutionary characteristics of four active regions, which produced the largest proton events in the 23rd cycle. We saw notable increase of tilt angle, writhe, and decrease of polarity separation before the events. It is also found that the average twist and the writhe possess the same handedness.

We also measured the magnetic flux for twelve solar active regions in the 23rd cycle, which produced the strongest solar events (Tian, Liu, 2002). It is observed that the fluxes of these regions were appreciably imbalanced when they moved past the central meridian, where reliable measurements were obtained. In addition, it is found that, for
seven of these 12 regions for which the vector magnetic field was observed, the vertical electric currents were out of balance. The net fluxes of seven active regions, which were associated with the severest solar storms, significantly decreased within 2 or 3 days prior to the major flares, and tended toward zero before the onsets of the flares. We thus suggest that one might forecast major events by looking for the decreases of major flux imbalance.

In the coming months, we plan to test reliability and effectiveness of our algorithm for polar field interpolation; and we will reproduce the global force free field for Carrington Rotation CR1922 and 1935, which contains the events that MURI groups are corporately studying.

PUBLICATIONS:


Report from UCSD: Sent by Bernie Jackson

During this report period, we began to incorporate magnetic field available at SEC NOAA into our tomographic analysis using the CSSS magnetic field model (Zhao and Hoeksema, 1995). Figure 1b is an example of these analyses for the radial component of the magnetic field during the July 14, 2000 Bastille Day CME time period. Tangential component analyses give a similar correlation for this time period. We will place these analyses on our Web site as soon as they are debugged become available in real time. The STELab IPS array analysis with which we make our tomographic analysis to date ceased operating this year on December 8, 2002. The arrays will begin operating in the spring of 2003.

The Solar Mass Ejection Imager (SMEI) was ready for launch on December 15, 2002, but this and two following launch attempts were scrubbed because of weather.

References:

Figure 1. a) Time-dependent reconstruction at 12 UT on 15 July 2000. Shown is the same view as in Figure 3a. The heliospheric current sheet is presented using the UCSD IPS time-dependent tomography model projection outward from a source surface at 15 Rs formed by the CSSS magnetic model at that surface. The Bastille Day (July 14, 2000) CME near Earth is shown along with the heliospheric current sheet present at this time of the solar cycle. b) A comparison of the tangential magnetic field component for Carrington Rotation 1965 including (a) from the tomographic modeling extrapolation and omni spacecraft in situ analyses near Earth.
T.G. Forbes in collaboration with the University of Michigan team has submitted a paper to *ApJ Letters* titled: *A three-dimensional flux rope model for coronal mass ejections based on an Ideal Loss of equilibrium.* The authors are: I.I. Roussev, T.G. Forbes, T.I. Gombosi, I.V. Sokolov, D.L. DeZeeuw, and J. Birn. The abstract for this paper follows:

A series of simulation runs are carried out to investigate the loss of equilibrium of the 3D flux rope configuration of Titov & Demoulin as a suitable mechanism for the initiation of coronal mass ejections. All numerical experiments are fully 3D and use compressible magnetohydrodynamics. By running a series of simulations, we are able to determine the conditions for which stable equilibria no longer exist. Our results show that it is possible to achieve a loss of equilibrium even though the ends of the flux rope are anchored to the solar surface. However, in order to have the flux rope escape, it is necessary to modify the configuration by eliminating the arcade field, but this greatly increases the field line twist within the flux rope.