

AFOSR SPACE SCIENCES

Investments in Solar Physics

7 July 03



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AFOSR Basic Research Partnering in Space Sciences



- AFOSR routinely transfers research results to operational DoD and NOAA space weather forecasters and Rapid Prototyping Centers (RPCs) in Boulder, CO, and Omaha, NE, and collaborates with the Office of Naval Research (ONR) and NSF in space weather research
- AFOSR shares funding for the Sacramento Peak National Solar Observatory in New Mexico with the NSF Astronomy Division (20% AFOSR, 80% NSF)
- AFOSR and two NSF divisions have collaborated on funding the USAF's AEOS Telescope on Maui for cutting-edge astronomy, astrophysics, advanced instrumentation development, upper atmospheric physics, and aeronomy
- AFOSR leverages NASA's new Living With A Star (LWS) solar physics initiative through participation in the LWS Targeted Research and Technology Working Group, as well as by sponsorship of two solar physics MURIs and a modeling center at NASA's Goddard Space Flight Center in Greenbelt, MD



NOAA SEC





AEOS: A Collaboration With the NSF



Joint AFOSR-NSF research in astronomy and ionospheric physics with the AEOS telescope at the Air Force Maui Optical & Supercomputing (AMOS) site

- *The Advanced Electro-Optical System (AEOS) telescope develops technologies for deep space surveillance and space situational awareness*
- *Using lidars, radars, and all-sky imagers with the AEOS telescope, researchers also study the dynamics and chemistry of the atmosphere at the edge of space*

**Paul Kervin,
AMOS Chief Scientist**



<http://www.maui.afmc.af.mil/>

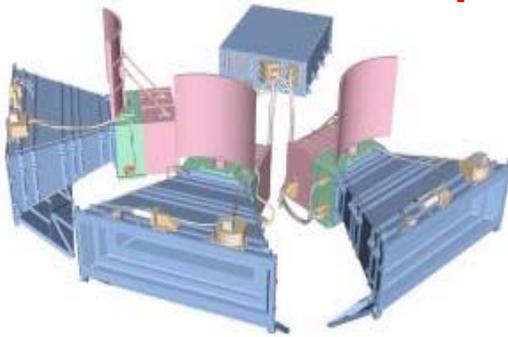


Solar Mass Ejection Imager (SMEI)

Janet Johnson, AFRL; Bernie Jackson, UCSD; George Simnett, U Birmingham, UK



<http://www2.bc.edu/~kuchar/aas197/>



SMEI, launched on 6 Jan 03, consists of three baffled cameras, each with special optics and a CCD detector.

Each camera views a 3 x 60 degree slice of sky so that, together, they image nearly a 180 degree slice of the sky.



This image shows the “first light” from SMEI obtained on February 2-3, 2003. The ecliptic plane is aligned with the horizontal axis of the image, with the Sun at the center. Successful operation of SMEI will improve our ability to track CMEs and make accurate space weather forecasts.

The image above is an equal-area projection map, so the stars are increasingly blurred or stretched near the edges because of distortion. The Milky Way is the circular off-centered band, with the bright Galactic center region just to the right of center.



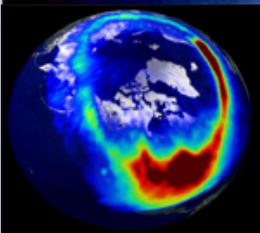
NSF Science & Technology Center Enabled by AFOSR



CISM: Center for Integrated Space Weather Modelling

CISM Vision:

To Understand Our Changing Sun
And
Its Effects on the Solar System,
Life, and Society



Dr. Jeff Hughes, Director, BU



Colorado - Dartmouth - Stanford - Rice

NCAR/HAO - NOAA/SEC - SAIC

Alabama A&M - Boston U. - UC Berkeley - U Texas El Paso

<http://www.bu.edu/cism/>

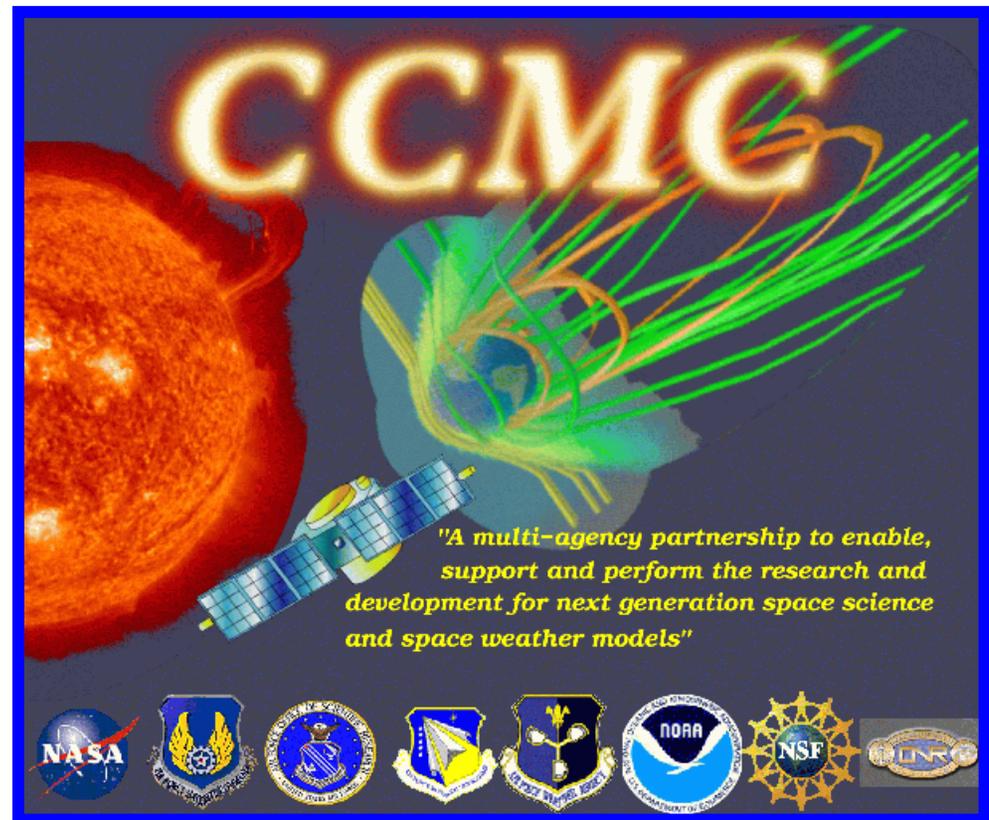


The CCMC: An Innovative Multi-agency Collaboration



Dr. Michael Hesse directs a new space weather modeling facility at NASA's Goddard Space Flight Center

- *The Community Coordinated Modeling Center (CCMC) is an innovative multi-agency collaboration aimed at improving operational USAF and NOAA space environment forecasting*
- *The CCMC exploits the computational resources of the MHPCC in Kihei*
- *AFOSR support will help bring a solar physicist to the CCMC by the end end of calendar year 2003*



<http://ccmc.gsfc.nasa.gov>



AFOSR Has Two MURI Partners



<http://solarmuri.ssl.berkeley.edu>

**“Understanding
Magnetic Eruptions
On the Sun and Their
Interplanetary
Consequences”**



**PI: Dr. George Fisher
UC Berkeley
9-University Team**



**“Comprehensive Solar-Terrestrial Environment Model (COSTEM)
for Space Weather Predictions”**



<http://csem.engin.umich.edu>

**PI: Dr. Tamas Gombosi
University of Michigan
6-University Team**



UC Berkeley MURI Progress: Modeling eruptive solar active region AR-8210



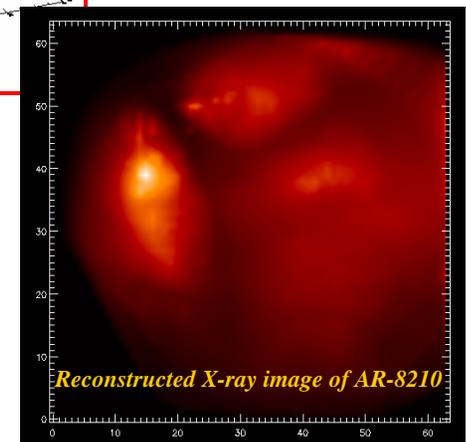
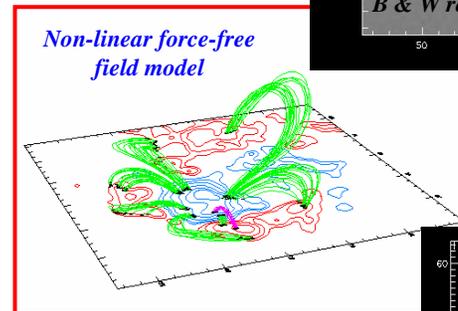
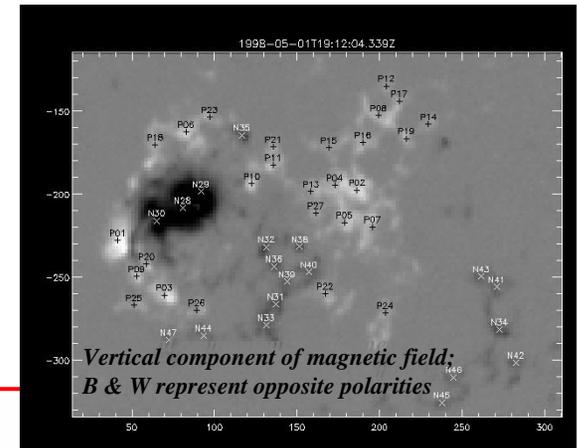
Space weather is driven by magnetic changes on the Sun...

The UC Berkeley MURI team has modeled active region AR-8210, which produced several Coronal Mass Ejections (CMEs) around 1 May 1998, and for which there are extensive vector magnetic field measurements.

This data has been reduced and analyzed at Montana State University, then used as initial conditions for MHD models that are being run at UC Berkeley. The model output is depicted here, with a few of the magnetic field lines drawn in red and blue, and the coronal field lines shown in green.

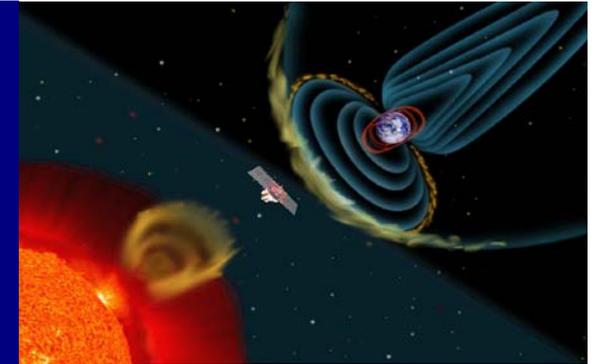
The bottom frame shows a reconstructed X-ray image of AR-8210 developed at UC Berkeley, using the Montana State analysis. The modeled reconstruction compares favorably to an actual image of the Sun obtained by the Yohkoh spacecraft at about the same time.

<http://solarmuri.ssl.berkeley.edu>





The Michigan space weather MURI team is developing a modular, adaptive, computational magnetohydrodynamics (MHD) model of the Sun-Earth system.



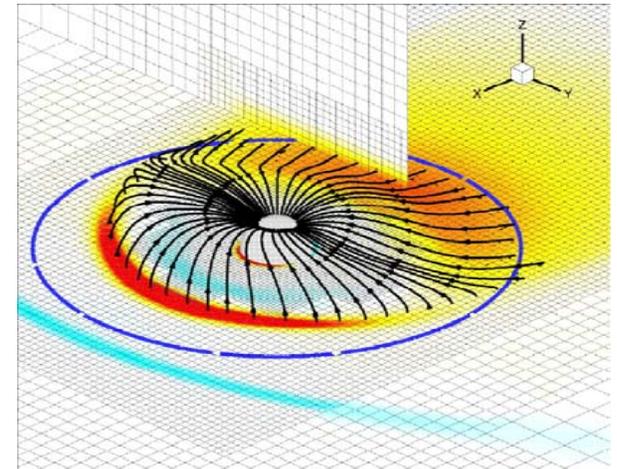
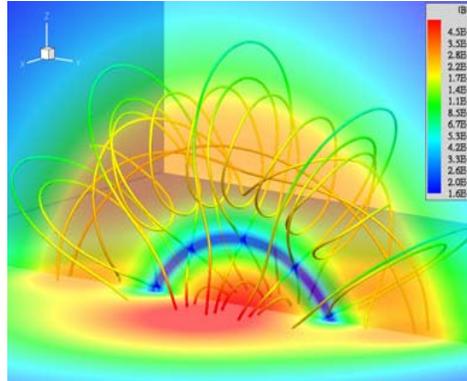
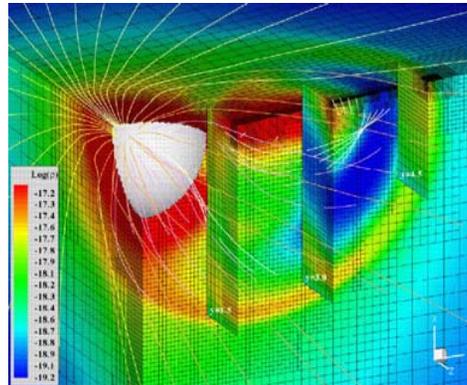
... And is manifested by the response of the terrestrial magnetosphere!

Technology Relevance to DoD

- First space MHD simulation using solution adaptive mesh refinement (AMR)
- Highly portable code that runs on most available computers (IBM SP series, PC clusters, Cray T3E, Compaq, etc.)
- First global MHD code transferred to Air Force Space Command for space weather forecasting operations at Omaha

Scientific Highlights

- First prediction of a closed terrestrial magnetosphere with an interplanetary magnetic field of northward polarity, an unanticipated result
- First simulations to produce an erupting solar magnetic flux rope configuration, matching actual observations



First-ever simulation of the magnetospheric effects of the largest space storm in history (the 1859 "Carrington event"). The magnetopause (black lines) is pushed well inside geosynchronous orbit (blue circle). Many telecommunications and reconnaissance satellites would be destroyed or disabled if a similar event were to happen today!

■ ■ ■ The University of Michigan

<http://csem.engin.umich.edu>

Space Weather MURI



The Sun is the Source of All Space Weather



Simplified Depiction of a Coronal Mass Ejection

