MAGIC

A Magnetogram Interpolation and Composition tool

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http://einstein.physics.drexel.edu/~solarweather/m_index.html

NASA LWS TR&T and AISR Programs
GENESIS
LWS Strategic Capability Call

• 2006 LWS TR&T Strategic Capability solicitation
  – Need for a community model suite to study pre-flare build up of magnetic energy in coronal field of active regions
  – To be driven by a time series of vector magnetic field data
  – And their implied photospheric flows
Motivation

• Models driven by time series of photospheric magnetograms need to modify the magnetograms to,
  
  1. Match magnetogram data to the model’s spatial and temporal grid  
      • resolution and field of view issues  
  2. ‘Propagate’ magnetograms to the desired height in the atmosphere  
  3. Manage the induction equation constraint  
      • Determine surface flows consistent with magnetogram time series and constraint equations
Grid Mismatch

- Model algorithms and their solutions dictate the grid resolution and timestep requirements
- In general these do not match the properties of the magnetograms
  - Best HMI vector magnetogram cadences are 12 minutes (for limited field of view – so called HMI SHARPs)
  - MHD codes may require integration timesteps of order 1 second or less for accurate time evolution
- No guarantee that a single magnetogram source will match the field of view of the model
  - Probably need to combine magnetogram sources and types
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Magnetogram Height and Model
Inner Boundary

[Diagram showing various layers and phenomena in the solar atmosphere, with labels such as corona, transition region, chromosphere, photosphere, network, internetwork, supergranulation, fibril, wave guiding, current sheets, weak fields, shock waves, small-scale canopies, HIFs, p-modes, g-modes, and model components like Specule I and Specule II.]
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The Message

- All models consuming magnetograms need to process them.
- MHD models need to do EXTENSIVE processing.
- Much of this processing has yet to be defined.
- Magnetogram processing MUST be under the control of the model user!!
- The infra-structure to do this needed its own Strategic Capability.
- We have created the initial framework.
MAGIC – A Tool Suite for Preparing Magnetograms for Model Use

• GUI Driven
• Incorporates
  • Magnetogram Database
  • Extensive List of the more obvious tools
  • Simple interface to 3rd party programs to support yet-to-be-defined heavy duty processing needs
  • DAVE4VM surface flow analysis tool
  • Non-Linear Force Free Model
• Uses CCMC’s KAMELEON libraries for internal file formatting and interpolation
• Visualization Tool
• Beta Version delivered Jan 2013.
MAGIC
MAGIC

Embed SDO/HMI vector magnetogram in MDI synoptic map

- Inserts limited FOV magnetograms into global magnetograms
- Adjusts field in border region using minimization of user defined integrals that balance
  - smoothness
  - agreement with original field
  - user defined integrals of current density or helicity
Surface flow analysis

SDO/HMI vector magnetogram time series for AR11117 analyzed using DA VE4VM optical flow analysis tool.

Schuck $t = 04:10$, Oct 26, 2010
Supporting Efficient Model Execution

- MAGIC is a GUI driven application.
- You cannot stop a large parallel MHD code every timestep to get a new boundary state.
- Solution – process entire magnetogram time series in advance.
  - Return B-spline coefficients of a temporal fit to B and v at each node of the model’s surface grid
- Only need to pause and rerun MAGIC if surface grid changes
Supporting all Models

• MAGIC supports all grid types in use in current coronal models!
  – ADAPT3D – unstructured tetrahedral
  – NLFFF – evenly spaced
  – MAS – lat/lon with uneven spacing
  – SWMF – block adaptive
  – ARMS – block adaptive
  – WSA - evenly spaced
• AR11117

• HMI Vector magnetogram time series

• Grids
  1. MAS
  2. Uniform spacing
  3. SWMF, ARMS

• B-spline timeline reconstruction at grid nodes for $\mathbf{B}, v$
MAGIC

- Interface supporting third party applications
  - Any third party program, provided it can read from, and write to, our Kameleon file format.
  - We provide sample read and write routines in both C and Fortran.
Web Page

http://einstein.physics.drexel.edu/~solarweather/m_installation.html

Site Under Construction

MAGnetogram Interpolation and Composition (MAGIC)

Description

Models of the Solar Corona and Inner Heliosphere use measurements of the magnetic field at or near the solar surface. MAGIC is a powerful tool developed to enable the synthesis of solar magnetic field data for use in models of the Solar Corona.

Quick Links

- MAGIC Project Overview
- Active Region Evolution Model
- Surveys
- Determining Surface Flux
- Magnetogram Database
- Living With A Star
- SWMAP

Acknowledgments

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Bringing Solar Magnetic Fields into Coronal Models

A GUI driven suite of tools

Currently working to update content!

Posted by Peter McIntosh on April 16, 2013 • No associated article

We are currently updating the material on this website in preparation for posting the beta release version. This update should be complete by May 1, 2013.

Content in a preliminary state and subject to regular revision!

Posted by Peter McIntosh on May 14, 2012 • Comments (0) • No associated article

This is the initial skeleton of the web page. Expect revisions on an ongoing basis.
Web Page
http://einstein.physics.drexel.edu/~solarweather/m_installation.html
Status

• Beta version delivered Jan 2013
• Latest version downloadable from web site
  – Tested on both Linux and OS X
• Building extensive set of tutorials
• Collaborating with NSO
• Collaborating with U.Michigan Strategic Capability

http://einstein.physics.drexel.edu/~solarweather/m_index.html
CCMC Specific Applications

- Customized synoptic map creation
- NLFFF Code will feed ISWA estimates of free-energy build up in active regions
The End