AN MHD MODELING WEB SITE FOR SECCHI AND IMPACT SUPPORT

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SCIENCE APPLICATIONS INTL. CORP.
SAN DIEGO

SUPPORTED BY SECCHI AND IMPACT

Presented at the STEREO SWG and Science Workshop
Observatoire de Paris, Meudon, April 20–22, 2008

WEB SITE FEATURES

- http://iMHD.net/stereo
- Our intent is to facilitate the interpretation of STEREO data
- MHD solutions: coronal ($1R_S$ – $20R_S$) and heliospheric ($20R_S$ – 1AU)
- Currently: polytropic model
- Currently: medium spatial resolution
  (corona: 61 × 71 × 65; heliosphere: 71 × 81 × 129)
- Coming soon: improved energy equation model, higher resolution
- All Carrington rotations in the STEREO era (CR2048–)
- Comparisons with images and *in situ* STEREO A and B data, plus Earth data
- Magnetic field lines, heliospheric current sheet (HCS)
- Solar wind sources mapped back to the Sun
- *In situ* solar wind comparisons
- Coronal hole maps

MHD EQUATIONS
(POLYTROPIC MODEL)

$$\nabla \times \mathbf{B} = \frac{4\pi}{c}\,\mathbf{J}$$

$$\nabla \times \mathbf{E} = -\frac{1}{c}\frac{\partial \mathbf{B}}{\partial t}$$

$$\mathbf{E} + \frac{1}{c}\,\mathbf{v} \times \mathbf{B} = \eta\,\mathbf{J}$$

$$\frac{\partial \rho}{\partial t} + \nabla\cdot(\rho\mathbf{v}) = 0$$

$$\rho\left(\frac{\partial \mathbf{v}}{\partial t} + \mathbf{v}\cdot\nabla\,\mathbf{v}\right) = \frac{1}{c}\,\mathbf{J} \times \mathbf{B} - \nabla p + \rho\mathbf{g} + \nabla\cdot(\nu\rho\nabla\mathbf{v})$$

$$\frac{\partial p}{\partial t} + \nabla\cdot(p\mathbf{v}) = -(\gamma - 1)p\nabla\cdot\mathbf{v}$$

$\gamma = 1.05$ in the corona

MHD EQUATIONS
(IMPROVED ENERGY EQUATION MODEL)

$$\nabla \times \mathbf{B} = \frac{4\pi}{c}\,\mathbf{J}$$

$$\nabla \times \mathbf{E} = -\frac{1}{c}\,\frac{\partial \mathbf{B}}{\partial t}$$

$$\mathbf{E} + \frac{1}{c}\,\mathbf{v} \times \mathbf{B} = \eta\,\mathbf{J}$$

$$\frac{\partial \rho}{\partial t} + \nabla\cdot(\rho\mathbf{v}) = 0$$

$$\rho\left(\frac{\partial \mathbf{v}}{\partial t} + \mathbf{v}\cdot\nabla\,\mathbf{v}\right) = \frac{1}{c}\,\mathbf{J}\times\mathbf{B} - \nabla p - \nabla p_w + \rho\mathbf{g} + \nabla\cdot(\nu\rho\nabla\mathbf{v})$$

$$\frac{\partial p}{\partial t} + \nabla\cdot(p\mathbf{v}) = (\gamma - 1)\left(-p\nabla\cdot\,\mathbf{v} - \nabla\cdot\,\mathbf{q} - n_e n_p Q(T) + H\right)$$

$$\gamma = 5/3$$

$$\mathbf{q} = -\kappa_{\parallel}\hat{\mathbf{b}}\hat{\mathbf{b}}\cdot\nabla T \qquad \text{(Close to the Sun, } r \lesssim 10R_S\text{)}$$

$$\mathbf{q} = 2\alpha n_e T\,\hat{\mathbf{b}}\hat{\mathbf{b}}\cdot\mathbf{v}/(\gamma - 1) \qquad \text{(Far from the Sun, } r \gtrsim 10R_S\text{)}$$

+ WKB equations for Alfvén wave pressure p_w evolution

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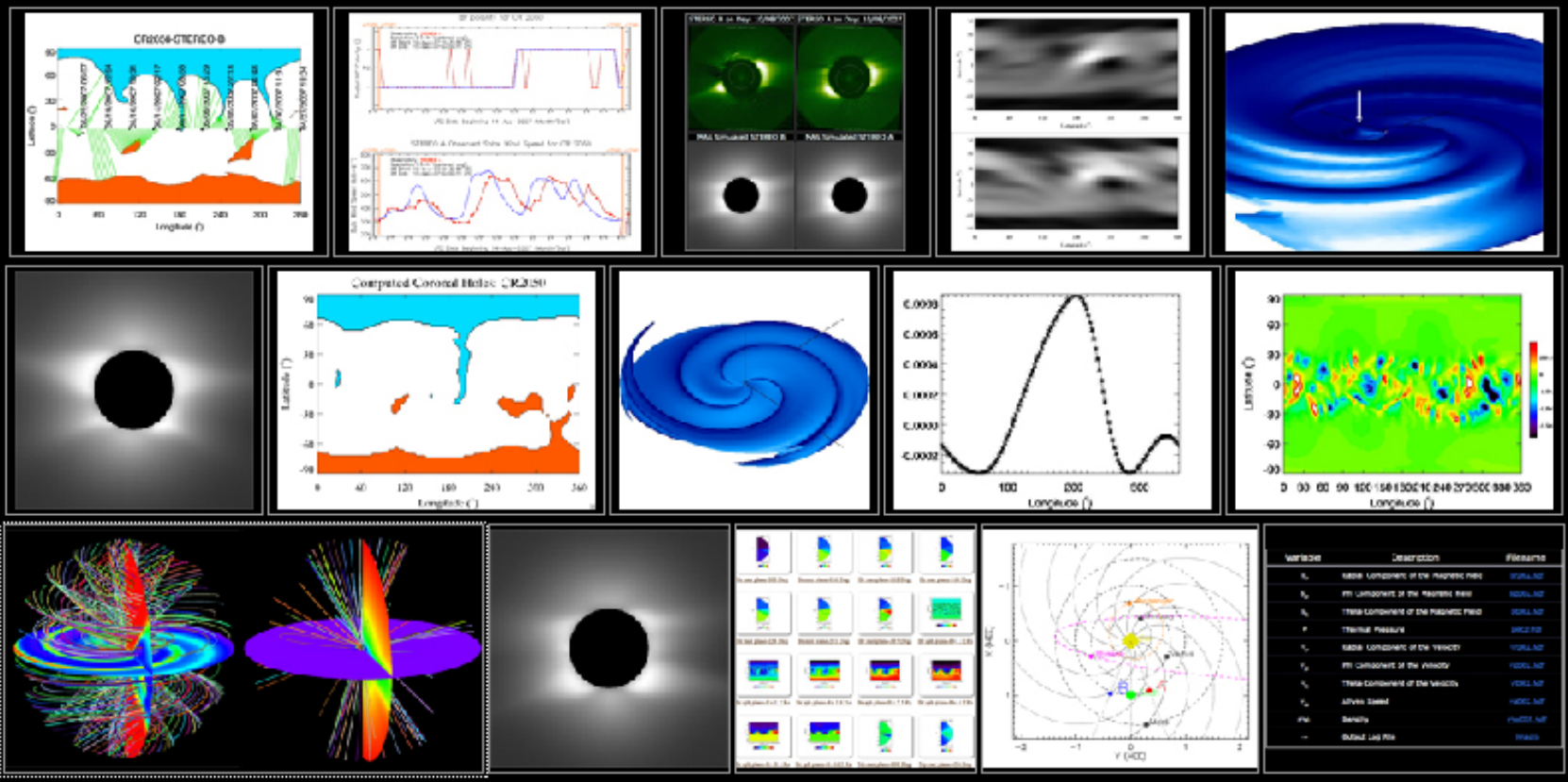

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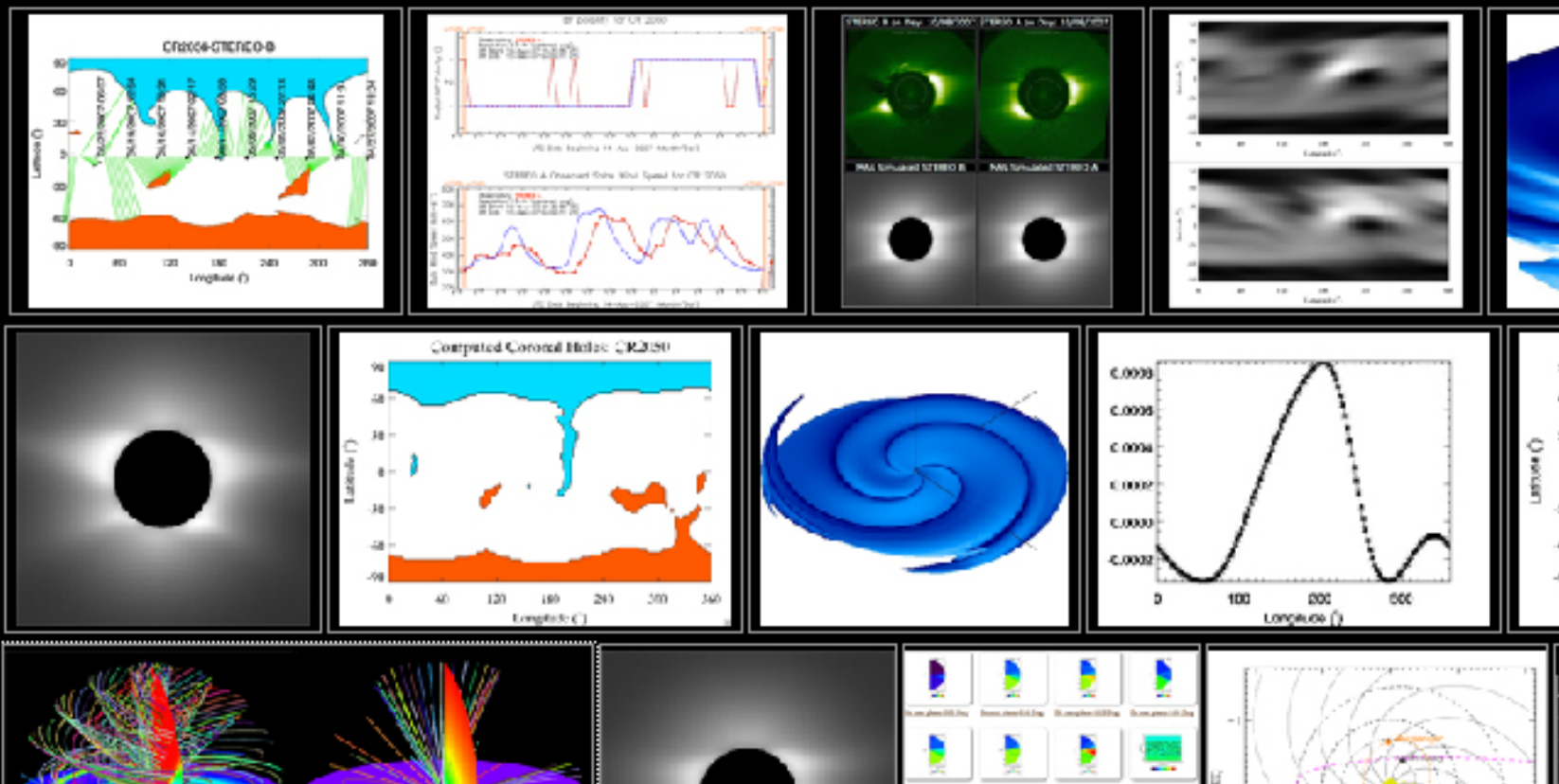

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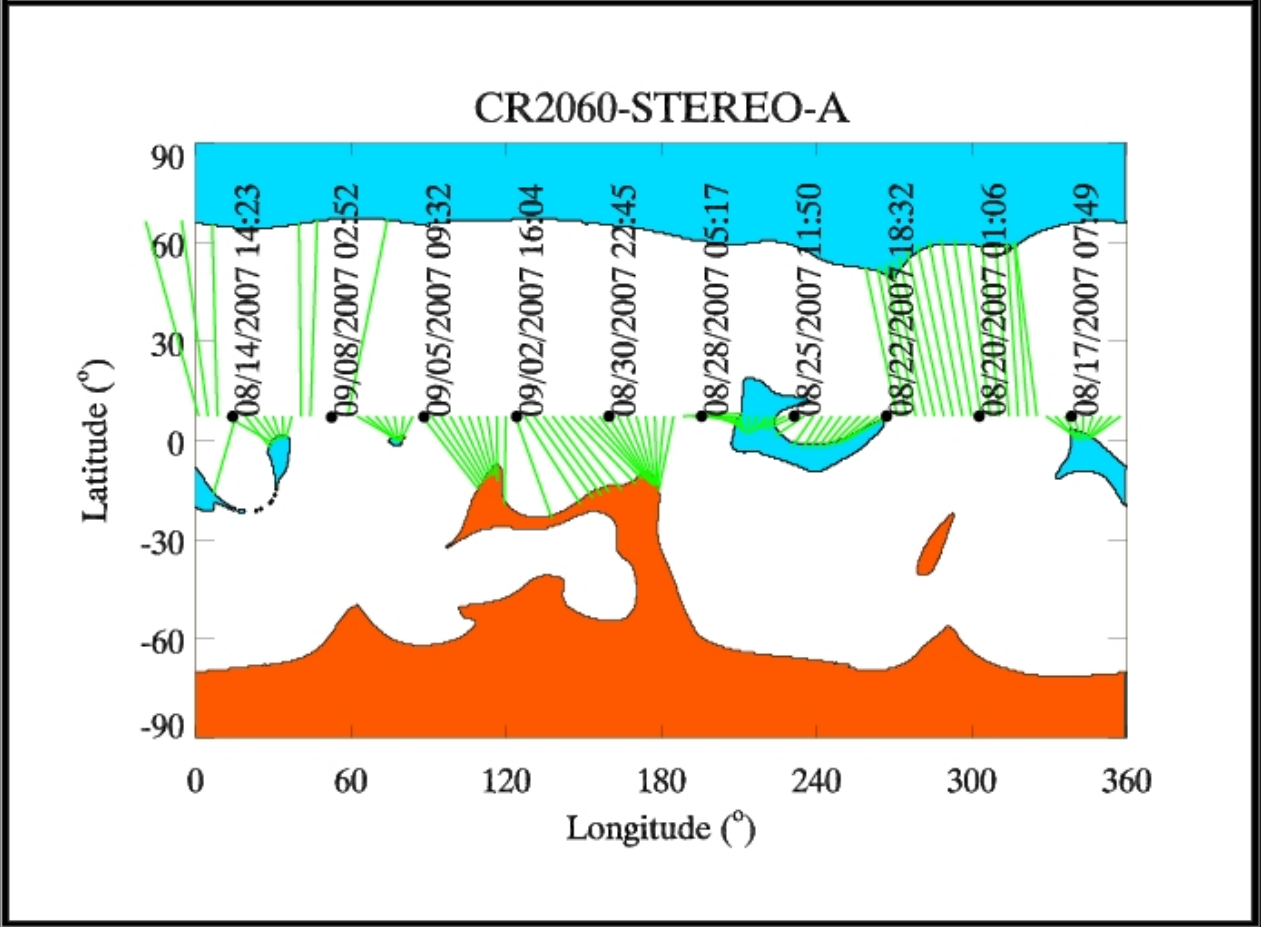
◄◄ CR 2060 ►►

○STEREO-B ○EARTH ◉STEREO-A ○Show All

External Formats: PDF | PS



Enter Carrington Rotation: 2060 (2049 - 2066)

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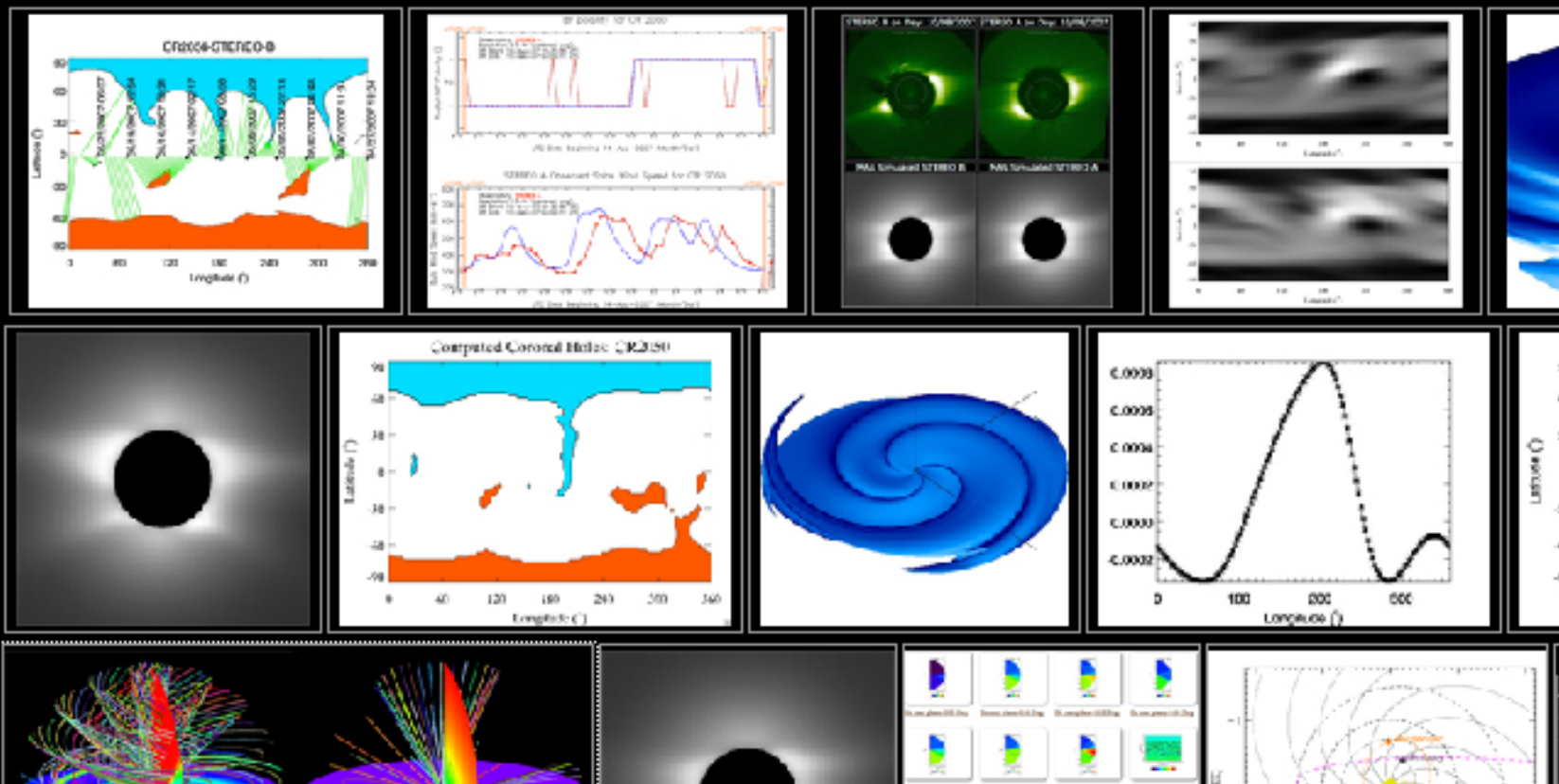

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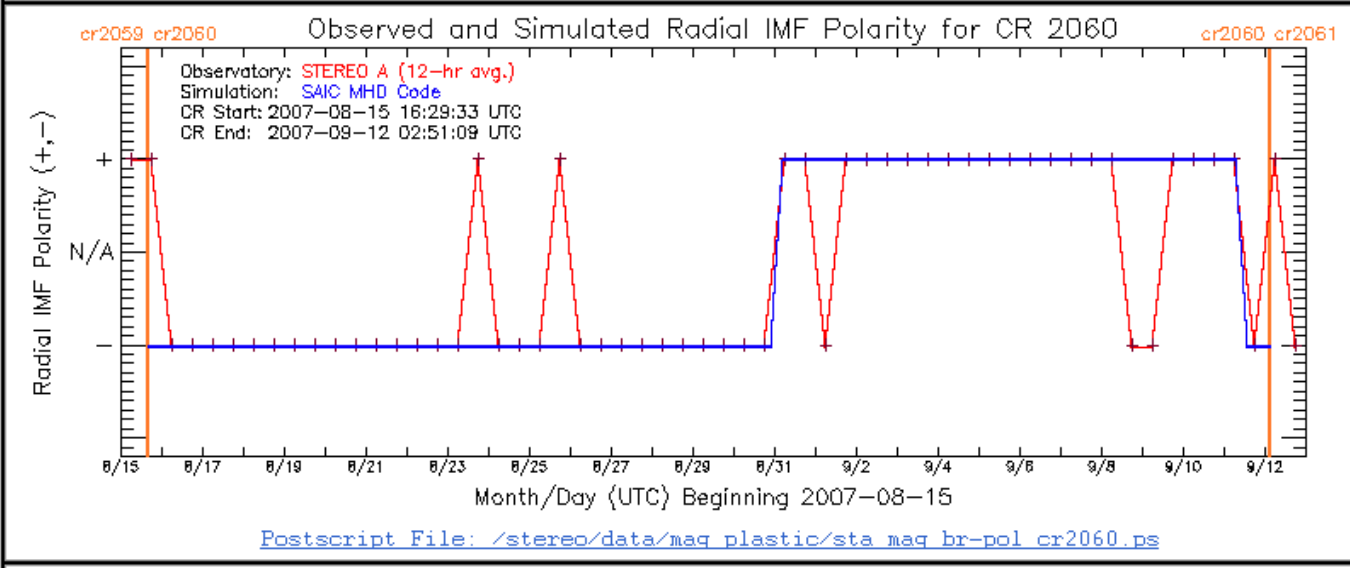
◀◀ Carr. Rot. **2060** ▶▶

○ Behind ◉ Ahead

○ MAG ○ PLASTIC ◉ Both



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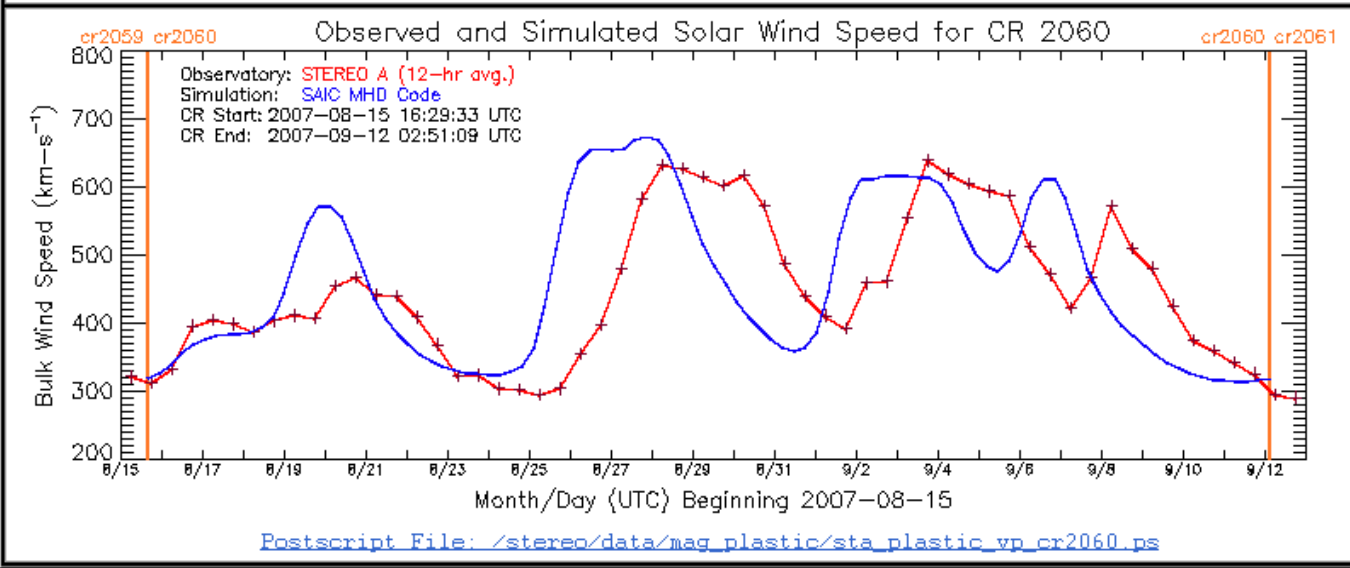

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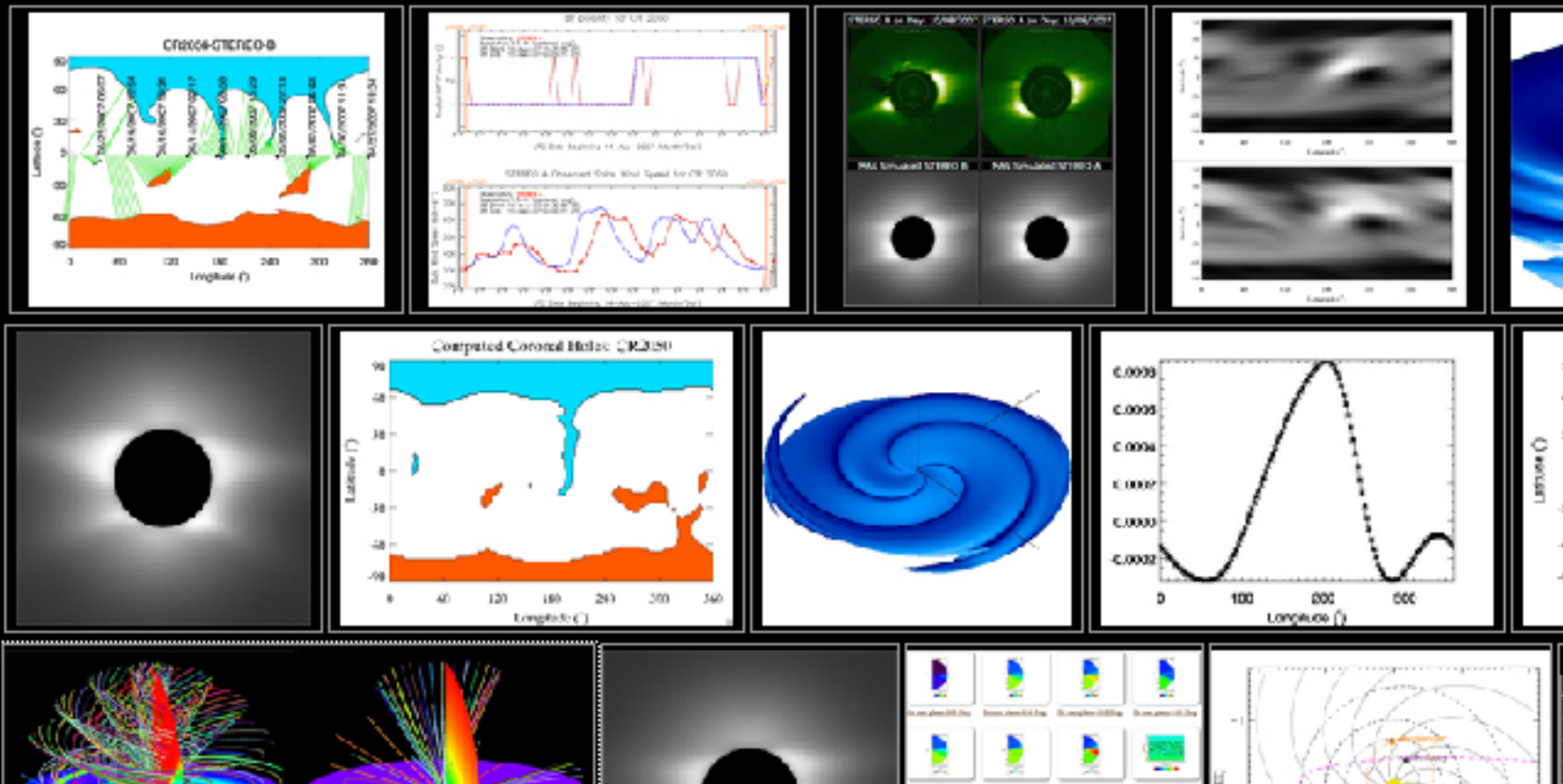

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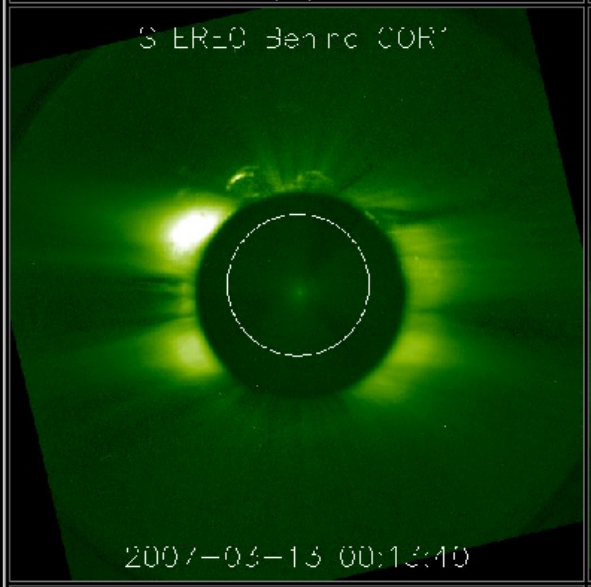	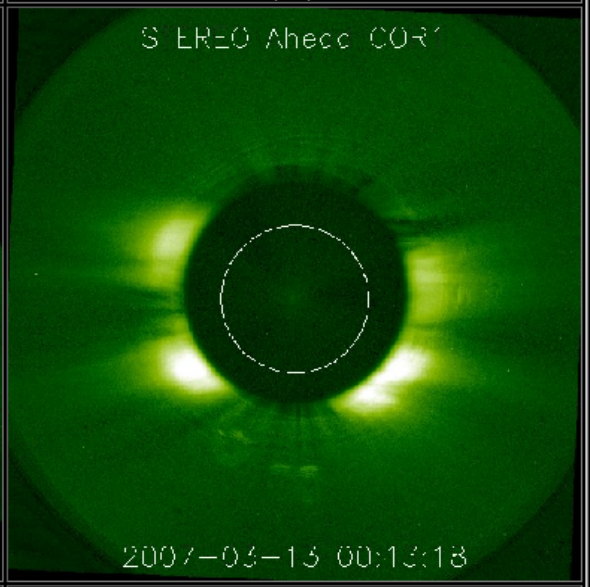
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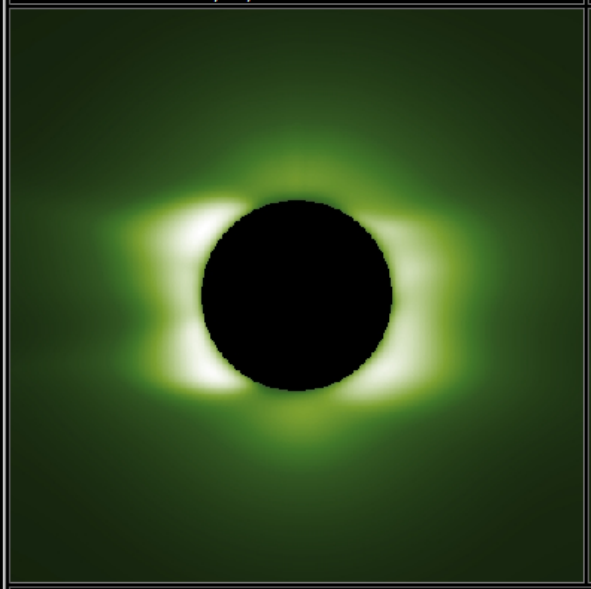	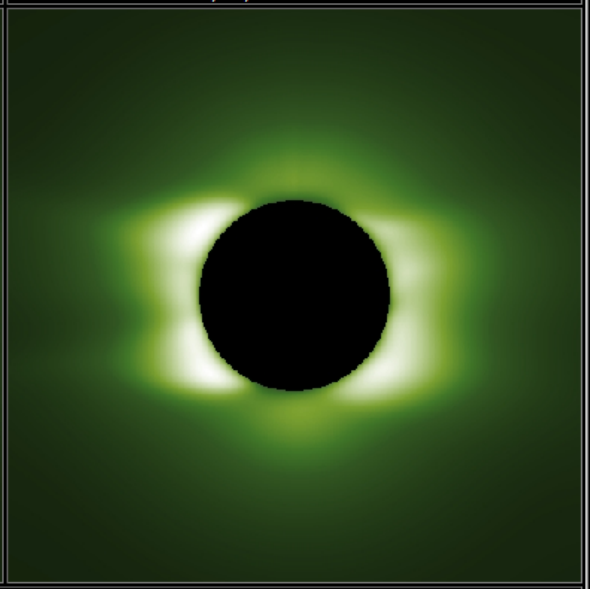

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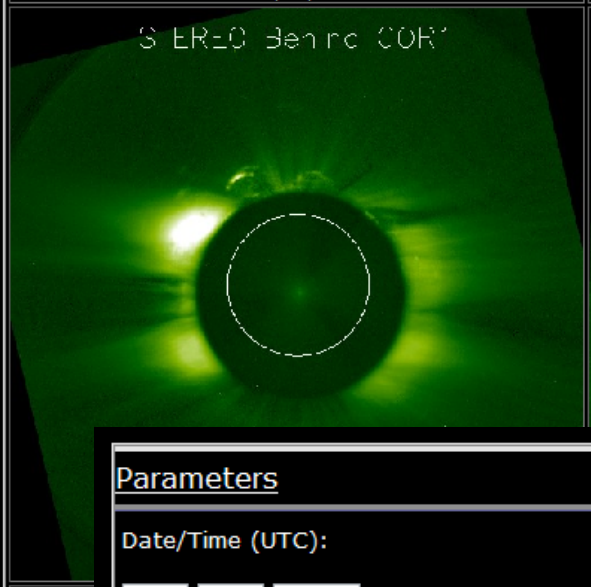	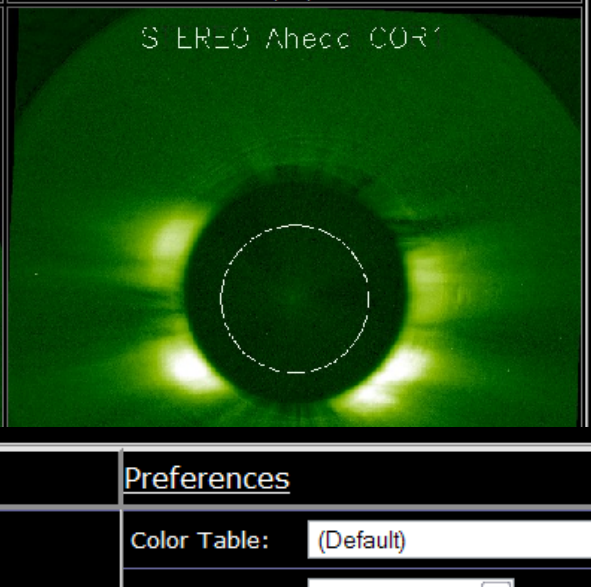
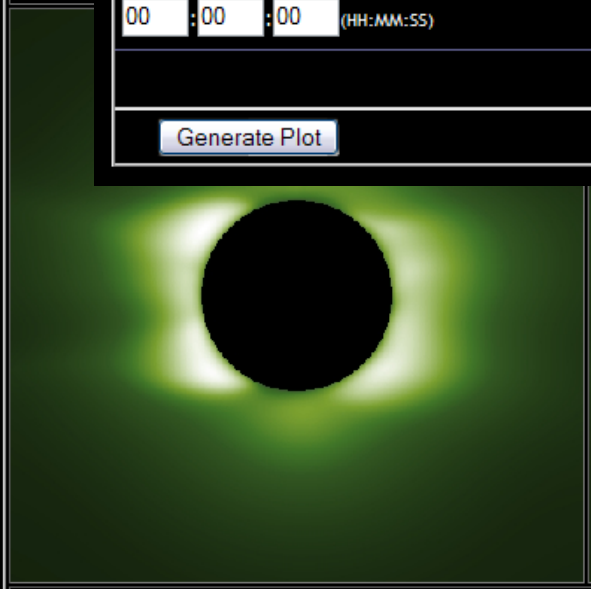	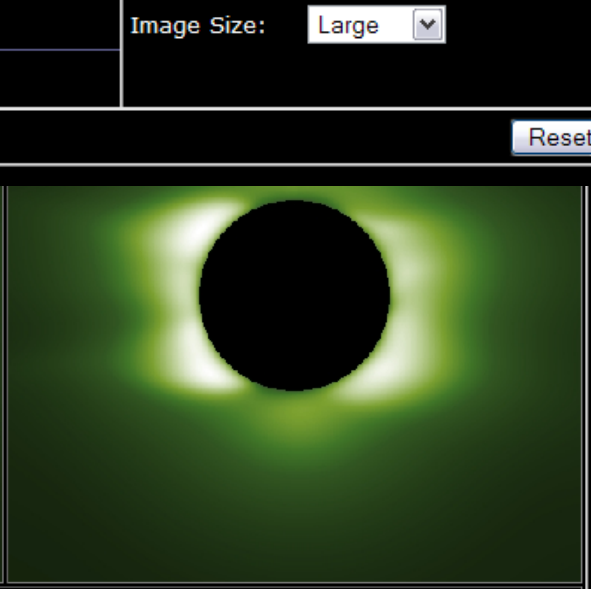

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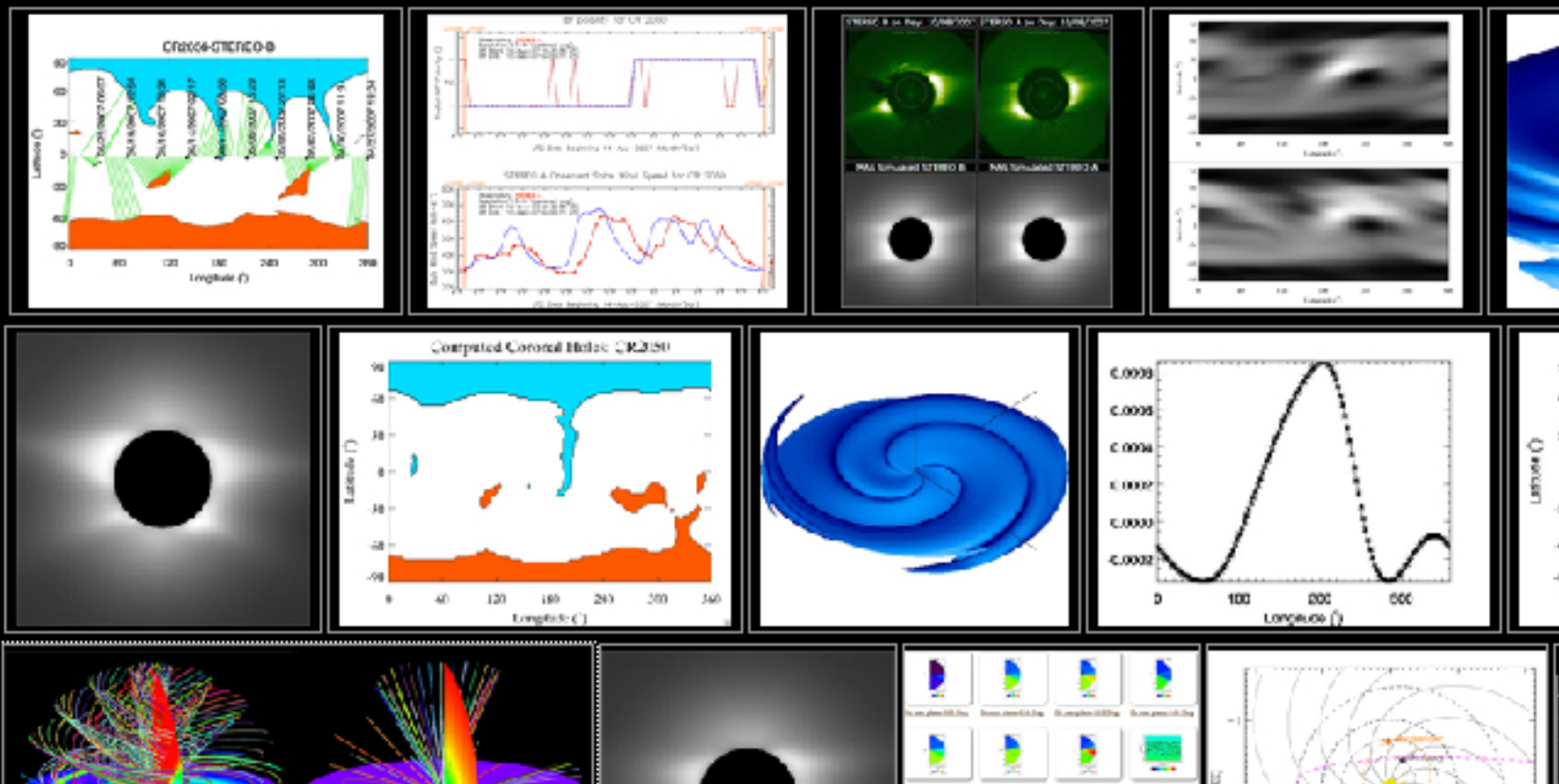

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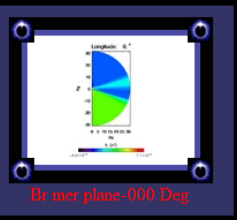
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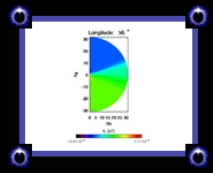
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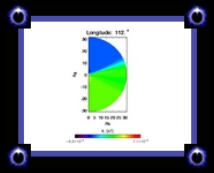
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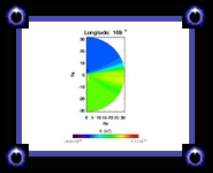
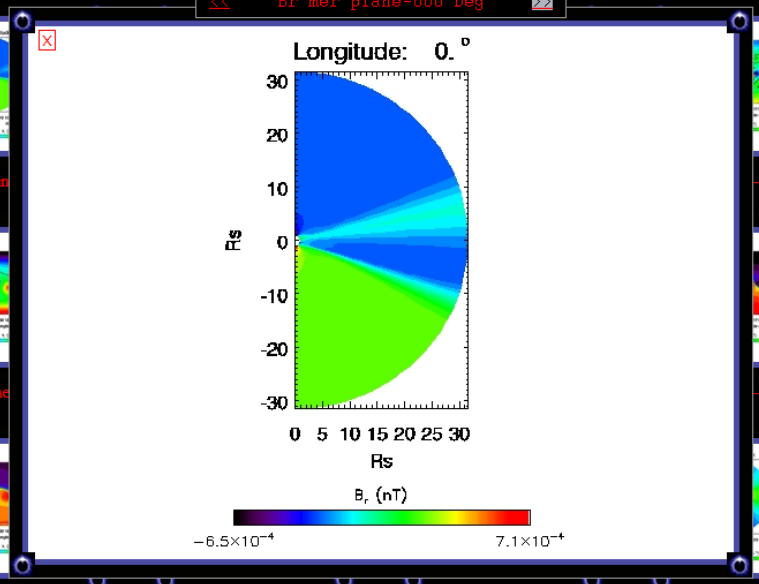
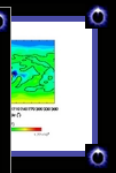

Br mer plane-168 Deg

<< Br mer plane-000 Deg >>



Br mer plan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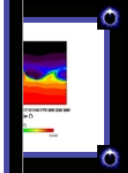
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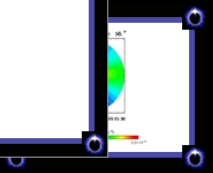
Br sph plane-R= 8 1 Rs

Br sph plane-R=16 5 Rs

Np mer plane-000 Deg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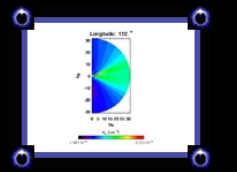
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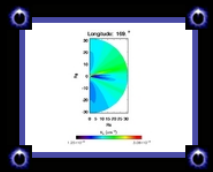
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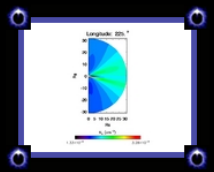
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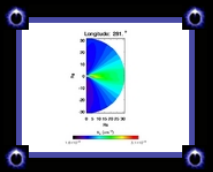
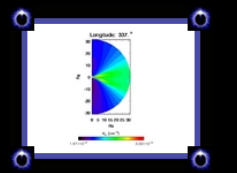
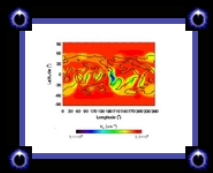
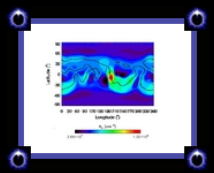
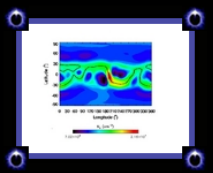
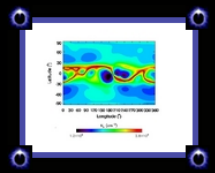

Np mer plane-281 Deg


Np mer plane-337 Deg


Np sph plane-R= 1 0 Rs


Np sph plane-R= 1 2 Rs


Np sph plane-R= 1 6 Rs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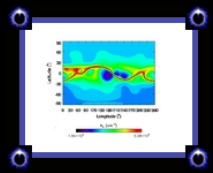
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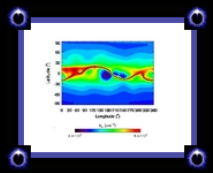
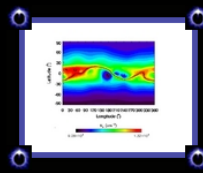
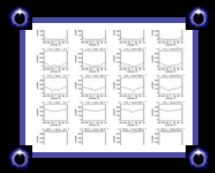
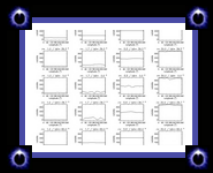
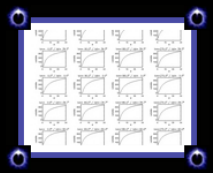
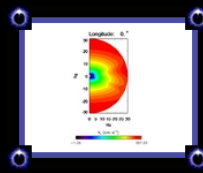

Np sph plane-R= 8 1 Rs


Np sph plane-R=16 5 Rs


Vr Latitudinal slices


Vr Longitudinal slices


Vr Radial slices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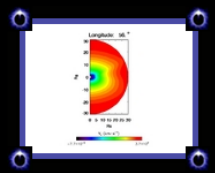
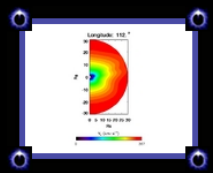

Vr mer plane-056 Deg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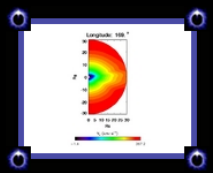
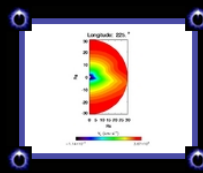
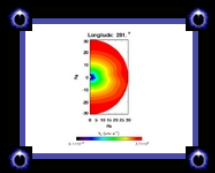
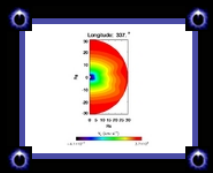
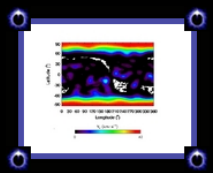
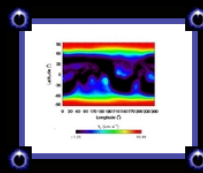

Vr mer plane-168 Deg

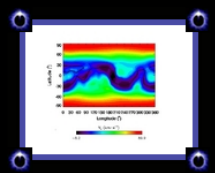

Vr mer plane-224 Deg

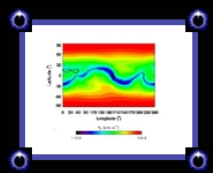

Vr mer plane-281 Deg

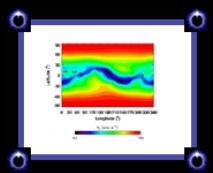

Vr mer plane-337 Deg


Vr sph plane-R= 1 0 Rs


Vr sph plane-R= 1 2 Rs


Vr sph plane-R= 1 6 Rs


Vr sph plane-R= 2 5 Rs


Vr sph plane-R= 4 3 Rs

Vr sph plane-R= 8 1 Rs

Vr sph plane-R=16 5 Rs

histories 1

histories 2

histories 3

Enter Carrington Rotation: 2060 (2048 - 2066)

Solution Type: Coronal Heliospheric

Retrieve Plots Reset Form

Send comments/suggestions to: webmaster@iMHD.net

Last updated February 18, 2008 @ 12:57:07 PDT

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SAIC Modeling Support for SECCHI and IMPA

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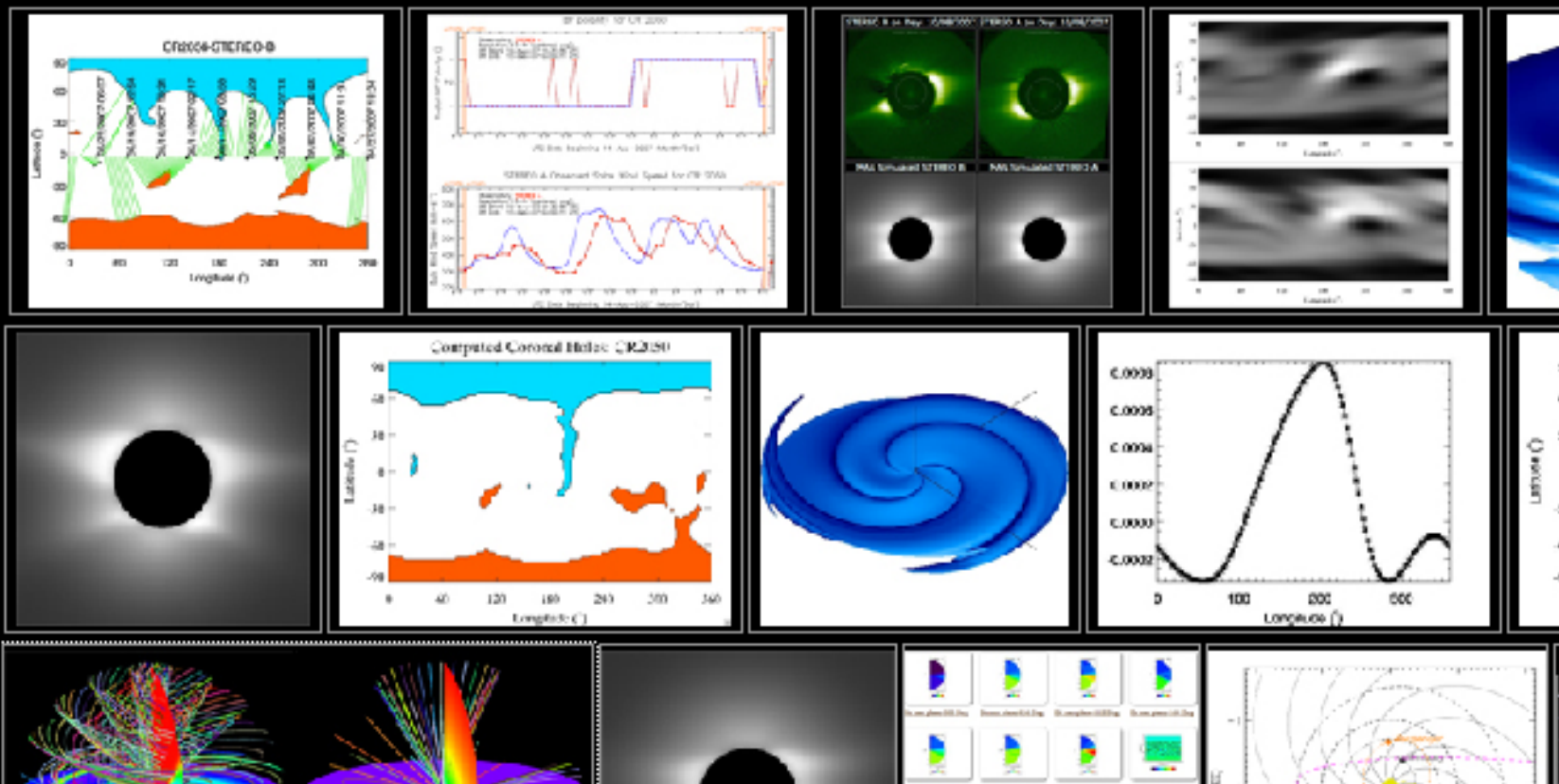
- TS Comparisons

SECCHI
- pB Comparisons
- Interactive pB
- HCS Visualizer

MHDWEB TOOLS
- 1D Plots
- 2D Plots
- Interactive 3D Plots
- *VISUAL* Plotter
- Heliospheric Current Sheet
- Coronal Hole Boundaries
- pB Disc images
- pB Synoptic Maps
- Summary Plots
- Retrieve Data

Welcome to SAIC's STEREO modeling website. On these pages, you can visu
and even download global MHD simulation results of the solar corona and in
for the period coinciding with the STEREO mission. You can also compare ou
with measurements taken by the SECCHI and IMPACT instruments on board



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MHDWEB Tools :: *Visual* 3D Plotter

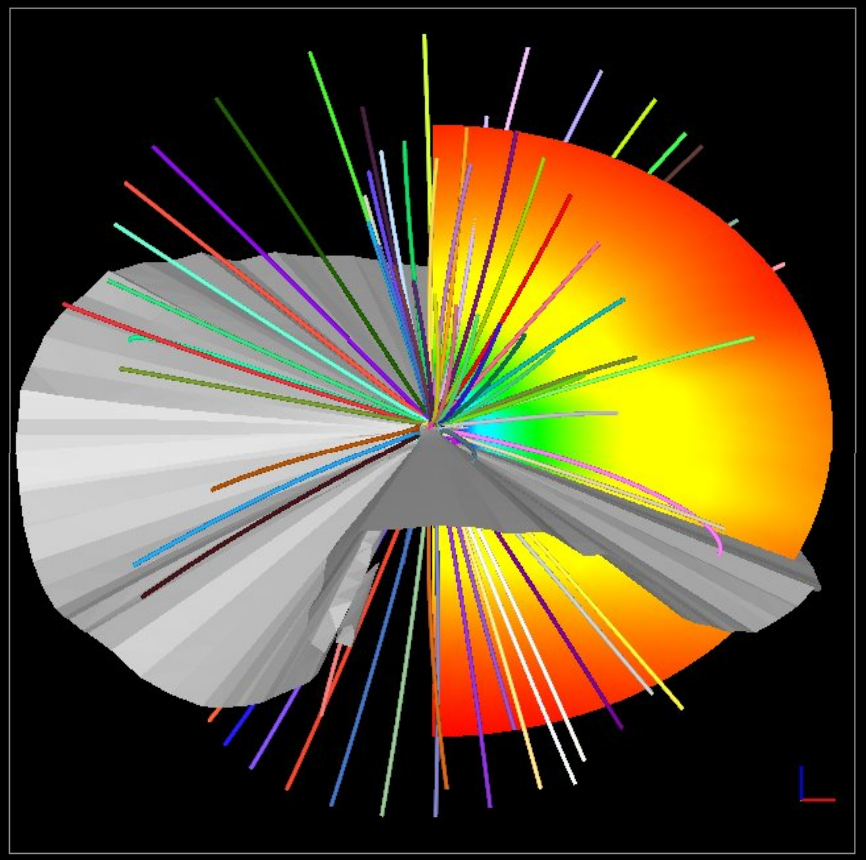
Carrington Rotation: 2067

Solution: Corona (1-30 R_{sun})

$(R/R_{max}, Theta, Phi) = (1, 50°, 270°)$

Field Line Thickness: 2.50

Field Line Quality: MEDIUM



Parameters		Preferences	
Carrington Rotation:	2067 (2048 - 2067)	Image Dimensions:	640 x 640
Solution Type:	(•) Corona ( ) Heliosphere	[x] Trace Field Lines	
Viewer Position:	Radial Distance: 100 %	Field-Line Thickness:	2.50 (default=2.5)
	Theta Angle: 50 °	Field-Line Quality:	Medium
	Phi Angle: 270 °		

Run Visual Reset Form

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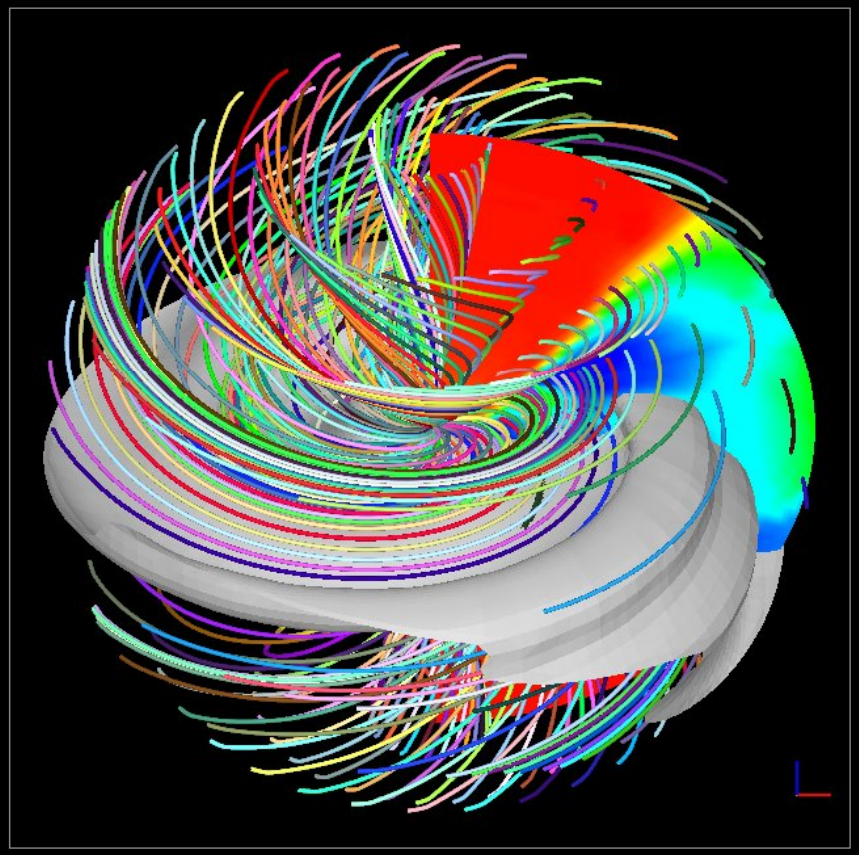
Carrington Rotation: 2067

Solution: Heliosphere (30-1075 R_{sun})

(R/R_{max}, Theta, Phi) = (1, 50°, 270°)

Field Line Thickness: 2.50

Field Line Quality: MEDIUM



Parameters		Preferences	
Carrington Rotation:	2067 (2048 - 2067)	Image Dimensions:	640 x 640
Solution Type:	○ Corona ● Heliosphere	☑ Trace Field Lines	
Viewer Position:	Radial Distance: 100 % Theta Angle: 50 ° Phi Angle: 270 °	Field-Line Thickness:	2.50 (default=2.5)
		Field-Line Quality:	Medium

Run Visual | Reset Form

WEB SITE FEATURES (CONT.)

- Summary plots of fields (meridional, synoptic)
- Interactive plotting (1D, 2D, and 3D)
- Magnetic field line and HCS topology (rotate 3D views)
- pB comparisons with COR1 images
- STEREO spacecraft trajectories
- Ability to download MHD solutions

WARNING

THIS IS A BETA VERSION OF THE SITE, AND MAY CONTAIN INCONSISTENCIES AND ERRORS. PLEASE CONTACT US BEFORE USING THIS DATA FOR APPLICATIONS WHERE ACCURACY IS IMPORTANT.

- Please take this seriously!

PLANNED IMPROVEMENTS

- Improved energy equation model, higher resolution
- Alfvén speed plots and diagnostics
- Comparisons with HI
- Simulations of individual CME events (long term)
- Improved interactive features
- Comparison with source-surface + CS (WSA) model
- Verification and validation