Solar and Heliospheric Models at the Community Coordinated Modeling Center

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NASA GSFC
What is CCMC?

US multi-agency activity to

- Provide access to state-of-the-art research models to the scientific community
- Aid in the development of space weather prediction models
- Bridge the transition from research to operations
CCMC Activities

- Provide access to space science models for researchers
- Execute Runs on Request
- Disseminate model output through advanced visualization tools
- Transfer Models to the Operational Community
- Perform Model Validation
- Perform Metric Studies
- Perform Model Data Format Studies
Solar and Heliosphere Models

- MAS Solar Corona (J. Linker, Z. Mikic et al., SAIC)
- Source Surface Model (J. Luhmann et al., UCB)
- Heliospheric Tomography (B. Jackson et al., CASS/UCSD)
- Exospheric Solar Wind (Lamy, Pierrat, IASB, Belgium)
- Heliospheric MHD Model (next step, D. Odstrcil)
Runs on Request

The Community Coordinated Modeling Center

Step 1: Fill in the Form and Generate a Registration Number for each Requested Run.

The Registration Number is composed of your first name (FirstName), your last name (LastName), date (mddyy), model type (GM - Global Magnetosphere, IT - Ionosphere/Thermosphere, SH - Solar Heliosphere), and run identification number (RunNumber):

FirstName_LastName_mddyy_ModelType_RunNumber, e.g., George_Siscoe_00001_SH_1.

At the present time you are allowed to make up to 4 different submissions on the same date (mddyy) for each model type. For each new submission made on the same date for the same model type you need to choose a new Run Number ("1", "2", "3", or "4"). Multiple submissions made on the same date with the same Run Number and Model Type will overwrite the previous submission. You can use this feature to resubmit the request on the same date. If you decide to cancel or modify your submission at later date, please contact the CCMC staff:

e-mail: requests@ccmc.gsfc.nasa.gov
tel: Martha Kuznetsova (301-386-9371), Lutz Rostetter (301-386-1085).

Please have registration numbers when making inquiries about your requests. You will need your registration number to view the results when the simulations have finished.

First Name: [blank] (required)
Last Name: [blank] (required)
Address: [blank]
Telephone: [blank] (required)
E-mail: [blank] (required)

Run Number: 1

Submit | Reset

http://ccmc.gsfc.nasa.gov
Step 3: Set The Simulation Time Interval

Choose Carrington rotation or date of interest

Select:
- Carrington rotation number between 1625 and 2007: 2007
- Date (MM/DD/YYYY) between 02/18/1973 and 08/29/2003: 08/29/2003

Selection of Carrington rotation numbers and dates is subject to change.

Specify the duration of the run

40 hours

Maximum duration of the run is 80 hours of real time.

Minimum duration of the run is 5 hours of real time.

Step 4: Set The Simulation Grid

Select grid resolution (NRxNtxNP) from predefined list:
- low-resolution (6x6x32)

Continue

Step 5: Set The Boundary Conditions

Confirm selection of Carrington Rotation based on available data


Select coronal base temperature and density

- Coronal base temperature: $1.6 \times 10^6$ [K]
- Coronal base density: $2 \times 10^8$ [particles cm$^{-3}$]
  (density range: $(1.0 - 4.0) \times 10^8$ [particles cm$^{-3}$])

Select filter parameters for magnetogram data

- Selected simulation grid: medium resolution (85x81x64)
- Recommended maximum longitudinal mode number: 8
- Recommended number of latitude filter passes: 3

Recommendations and ranges for filter parameters are based on grid resolution.

- Maximum longitudinal mode number (Range: 1 - 9): 8
- Number of latitude filter passes (at least 2): 3

Filtered Kitt Peak Magnetogram

Filter Parameters:
- Maximum longitudinal mode number: 8
- Number of latitude filter passes: 3

Radial Magnetic Field Magnitude [Gauss]

Latitude (deg)

Longitude (deg)

-50  0  50  100  150  200  250  300
Visualization Tool

3D Simulation Results: Model: MAS
Run: Kristi_Keller_011204_SH_1 CR=1901, T=1.6 K, N=2e8/cm³

This is the web interface for the visualization of results of a three-dimensional simulation of the Sun's environment.

Please review the default selections below and make your changes.

To start the graphics program click the Update Plot button. The resulting image will be displayed at this location of the page.

Should the result be a blank image, then the graphics program encountered a programming error. Please report the set of input parameters used.

Update Plot
Update Plot will update (generate) the plot with the chosen time and plot parameters below.
This will take some time (typically 10-30s) as data is read in and processed.

Choose data time:
24:00:14
- or -
Change time by moving
-1 output steps

Plot Options:
- Exclude region around the Sun up to [ ] Rg
- Allow variable plot image size (2D plots, aspect ratio (ratio dxy of plot) between 0.3 and 4)
- Show simulation grid (disabled with 3D-Surface)
- Interpolate data onto equidistant grid (available with 3D-Surface and Vector recommended for plots with Vector)

Choose Plot Mode:
ColorContour

Plot Options for selected
3D-Surface, 3D-Flowlines
View angles:
AX [-90. 90]: 30
AZ [ 0.180]: 30

3D Flowlines: flowline start positions
Choose Flowline Setup Mode:

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Visualization Tool

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Plot Options for selected Plot Modes:
3D-Surface, 3D-Flowlines View angles:
AX [90, 90]: 30
AZ [0, 180]: 30
Color Contour:
- Color bar (Cellbar use original values > 0)
- Max: 1
- Min: -1
- Log scale: (N/Rho, En, P, most fluxes)
- Log scale: (N/Rho, En, P, most fluxes)

Choose Plot Area:
All Plot Modes except Line Plot: Select lower left corner of plot area on the left, and the upper right corner on the right.
Line Plot: Select start point of line on the left, the end point on the right.

Choose Cut Plane:
Radius r=constant
Lon. p=constant
Lat. t=constant

Reset Form
Update Plot

List Data (check to get any of the following outputs):
- At positions specified: enter positions in Radius r, Lon. p, Lat. t, (within the allowed range) as comma-separated lists.
- Radius positions: 0.0, 0.0, 0.0
- Lon. p positions: 0.0, 0.0, 0.0
- Lon. t positions: 0.0, 0.0, 0.0

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Examples of Output

Color Contour Plots
Vector Plots
Fieldlines
Line Plots
Solar MAS

- MHD equations
- Photospheric magnetic field data is used for the boundary condition on Br.
- Solved to steady state
- Input at Photosphere
  - Magnetic field (CCMC web site user enters date)
  - Density
  - Temperature
- Output
  - Magnetic field
  - Velocity
  - Density
  - Temperature
Potential Source Surface Model

- The model calculates the magnetic field of the corona from the radius of the sun to the source surface radius assuming that there are no currents in this region.

- The code uses spherical harmonic coefficients calculated by Wilcox Solar Observatory using observed photospheric fields (magnetograms) as input.

- User input:
  - Date
  - Source Surface Radius \((1.6 – 3.25 \ R_\odot)\)
  - Number of spherical harmonic coefficients

- Output – Magnetic Field Mappings
Heliospheric Tomography

- Kinematic model using conservation rules
- Density and velocity specified on source surface
- Using kinematic model, IPS velocity and g-level data are calculated by the model and compared with observations. Using an iterative least-squares algorithm, the source surface is updated to obtain the best model for the solar wind.
- Input for CCMC web site user: Date
- Output
  - Radial Velocity
  - Density
Heliospheric Tomography

Velocity

Density

Interval 1

Red: Model
Black: ACE data

Interval 2

Red: Model
Black: ACE data
Exospheric Solar Wind Model

- One-dimensional kinetic model developed for coronal holes
- Uses quasi-neutrality to obtain a radial distribution of the electrostatic potential.
- Calculates the moments of the electron and proton velocity distribution function (VDF) using the electrostatic potential.
- Input
  - Radial distance of exobase
  - Temperature of the electrons and protons at the exobase
  - Kappa index for electrons VDF
  - Radial distance of end point
- Output
  - Density
  - Flux of particles
  - Bulk velocity of solar wind
  - Temperature of electrons and protons
  - Electric potential
Odstrcil Heliosphere Model

- Next model to be implemented at CCMC
- MHD equations solved from 20 to 220 $R_s$
- Input at inner boundary
  - MHD parameters
- Output
  - Magnetic field
  - Velocity
  - Density
  - Temperature
Summary

• CCMC endeavors to provide strong services to the research community
• CCMC provides access to modern Solar and Heliospheric Models
• CCMC invites Runs-on-Request for individual research and campaigns
• CCMC actively looking for community feedback to improve service