

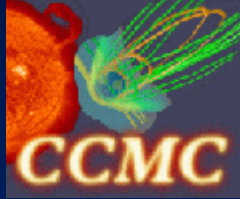


Solar and Heliospheric Models at the Community Coordinated Modeling Center

Kristi Keller, Michael Hesse, Masha
Kuznetsova, Lutz Rastaetter, Ayris
Falasca, Judy Johnson

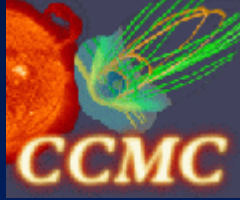
NASA GSFC

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

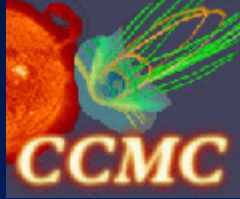


Solar and Heliosphere Models

- **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



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 (mmddyy), model type (GM - Global Magnetosphere, IT - Ionosphere/Thermosphere, SH - Solar/Heliosphere), and run identification number (RunNumber):

FirstName_LastName_mmddyy_ModelType_RunNumber, e.g., George_Siscoe_060601_SH_1.

At the present time you are allowed to make up to 4 different submissions on the the same date (mmddyy) 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: Masha Kuznetsova (301-286-9571), Lutz Rastaetter (301-286-1085).

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: (required)

Last Name: (required)

Address:

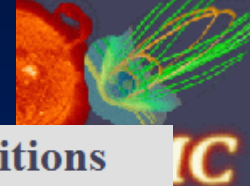
Telephone: (required)

E-mail: (required)

Run Number:

- ▶ [Concept of Operations](#)
- ▶ [Agency Partners](#)
- ▶ [Steering Committee](#)
- ▶ [GSFC Staff](#)
- ▶ [Workshops and Meetings](#)
- ▶ [Presentations and Publications](#)
- ▶ [Space Weather Models](#)
- ▶ [Simulation Results](#)
- ▶ [Special Sun-Earth Connection Events](#)
 - [New October 2003 Events](#)
- ▶ [New Experimental Real-time Simulations](#)
- ▶ [Runs on Request](#)
- ▶ [Submit Model](#)
- ▶ [Space Weather Metrics](#)
- ▶ [Frequently Asked Questions](#)
- ▶ [Comments and Questions](#)
- ▶ [Discussion Forum](#)

Runs on Request



IC

Step 3: Set The Simulation Time Interval

Choose Carrington rotation or date of interest

Select:

Carrington rotation number between 1625 and 2007:

or

Date (MM/DD/YYYY) between 02/18/1975 and 08/29/2003 / /

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

Specify the duration of the run

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:

Step 5: Set The Boundary Conditions

Confirm selection of Carrington Rotation based on available data

Rotation: 2007 Start: 08/29/2003 End: 09/26/2003

Select coronal base temperature and density

Coronal base temperature: x 10⁶ [K]

Coronal base density: x 10⁸ [particles cm⁻³]
(density range: (1.0 - 4.0) x 10⁸ [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

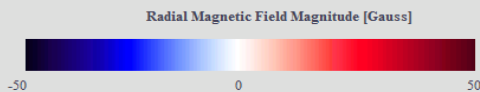
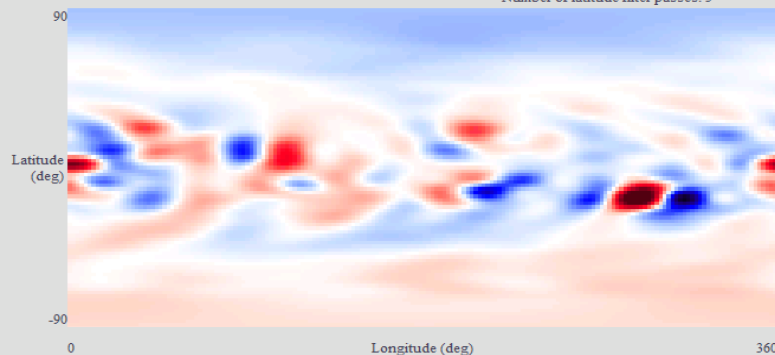
Recommendations and ranges for filter parameters are based on grid resolution.

Maximum longitudinal mode number (Range: 1 - 9)

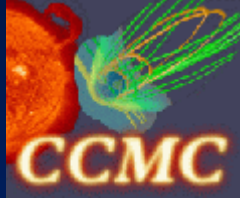
Number of latitude filter passes (at least 2):

Filtered Kitt Peak Magnetogram

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



Visualization Tool



The Community Coordinated Modeling Center
CCMC NASA AFMC AFOSR AFRL AFWA NOAA NSF ONR

- Concept of Operations
- Agency Partners
- Steering Committee
- GSFC Staff
- Workshops and Meetings
- Presentations and Publications
- Space Weather Models
- Simulation Results**
- Special Sun-Earth Connection Events
 - New October 2003 Events
- New Experimental Real-time Simulations
- Runs on Request
- Submit Model
- Space Weather Metrics
- Frequently Asked Questions
- Comments and Questions
- Discussion Forum

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 black image, then the graphics program encountered a programming error. Please report the set of input parameters used.

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.

Plot Options:

Choose data time:
24:00:14

- or -

Change time by moving
-1 output steps

Exclude region around the Sun up to 1 R_S

Allow variable plot image size (2D plots, aspect ratio (ratio dx/dy 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)

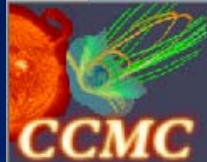
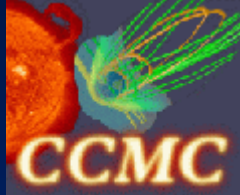
Choose **Plot Mode**: ColorContour

Choose **quantity** to be displayed (some Plot Modes require up to three choices)
Q 1: N Q 2: N Q 3: N

Plot Options for selected Plot Modes: 3D-Surface, 3D-Flowlines View angles:
AX [-90..90]: 30 AZ [0..180]: 30
Color Contour: Use Grayscale

3D-Flowlines: flowline start positions
Choose [Flowline Setup Mode](#):

Visualization Tool



The Community Coordinated Modeling Center

CCMC NASA AFMC AFOSR AFRL AFWA NOAA NSF ONR

- ▶ [Concept of Operations](#)
- ▶ [Agency Partners](#)
- ▶ [Steering Committee](#)
- ▶ [GSFC Staff](#)
- ▶ [Workshops and Meetings](#)
- ▶ [Presentations and Publications](#)
- ▶ [Space Weather Models](#)
- ▶ [Simulation Results](#)
- ▶ [Special Sun-Earth Connection Events](#)
 - [New October 2003 Events](#)
- ▶ [New Experimental Real-time Simulations](#)
- ▶ [Runs on Request](#)
- ▶ [Submit Model](#)
- ▶ [Space Weather Metrics](#)
- ▶ [Frequently Asked Questions](#)
- ▶ [Comments and Questions](#)
- ▶ [Discussion Forum](#)

Plot Options 3D-Surface, 3D-Flowlines View angles:

for selected Plot Modes: AX [-90..90]: 30 AZ [0..180]: 30

Color Contour: Use Grayscale

Lock color range: (Log scale: use original values > 0)

Min.: -1 Max.: 1

Log scale (N/Rho, En. P, most fluxes F...)

Contour:

show values with contour levels

Vector: length of arrows: 1.0

3D-Flowlines: flowline start positions

Choose [Flowline Setup Mode](#):

predefined in 3D (V,B,other)

user-defined flowline start positions:

Radius r: 9.0, 9.5, 10.0, 10.5, 11.0, 11.5

Lon. p: 0, 0, 0, 0, 0, 0

Lat. t: 0, 0, 0, 0, 0, 0

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_1 1 Radius r_2 30 Range: 1 ... 30 R_S

Radius r=constant 15.5

Lon. p_1 0 Lon. p_2 360 Range: 0 ... 360 deg.

Lon. p=constant 180

Lat. t_1 -90 Lat. t_2 90 Range: -90 ... 90 deg.

Lat. t=constant 0

Reset Form will reset changes to the defaults specified by the previous run of this script.

Update Plot will update (generate) the plot with the chosen time and plot parameters above.

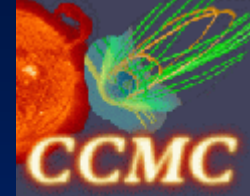
List Data (check to get any of the following outputs):

At positions specified: enter positions in Radius r, Lon. p, Lat. t, (within the allowed range) as comma-separated lists.

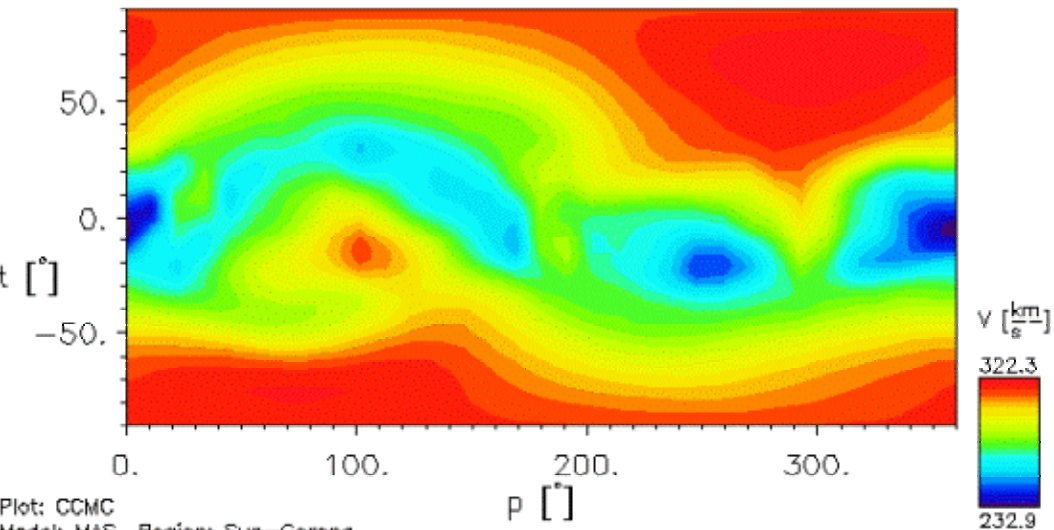
Radius r positions: 0.0, 0.0, 0.0

Lon. p positions: 5.0, 7.5, 10.0

Examples of Output



Time = 1:16:00:28 $r = 20.0R_s$



Color Contour Plots

Vector Plots

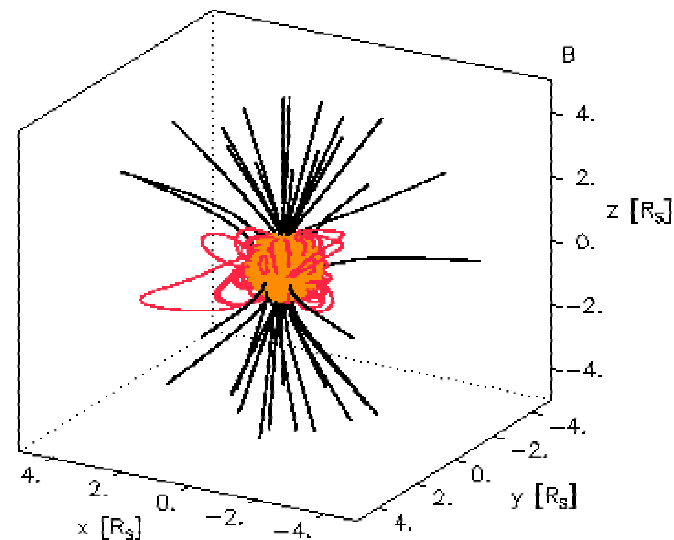
Fieldlines

Line Plots

Time = 1:16:00:28

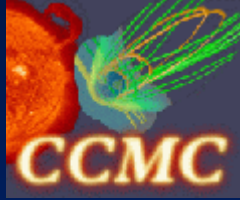
Fieldlines:

- coronal hole
- closed
- user selected

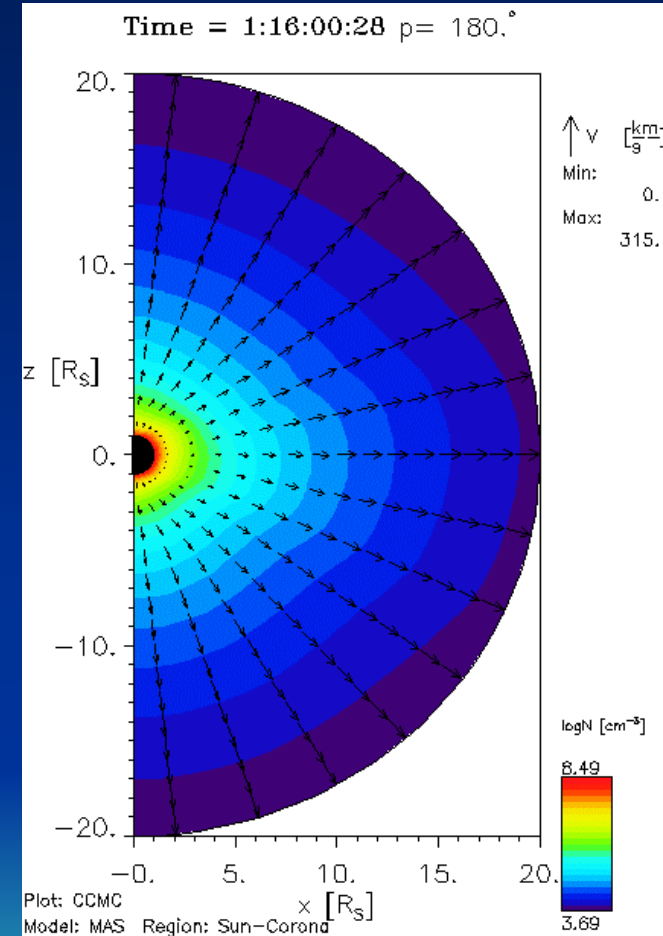


Plot: CCMC
Model: MAS Region: Sun-Corona

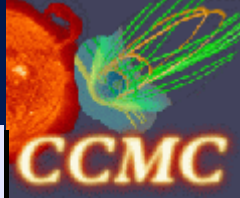
Solar MAS



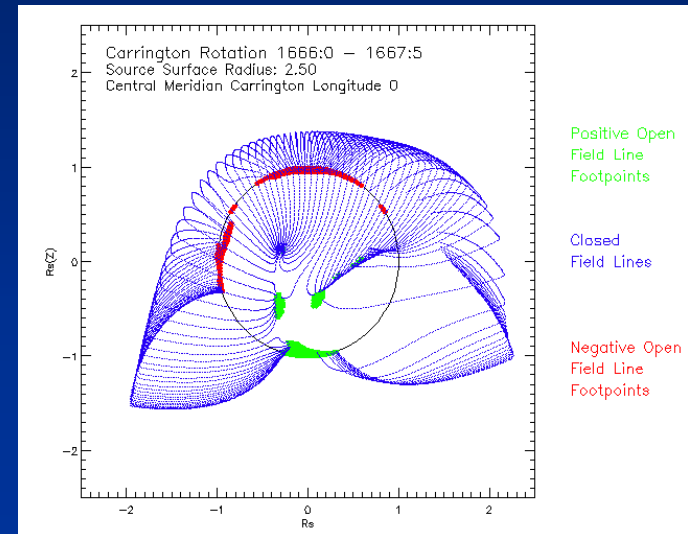
- MHD equations
- Photospheric magnetic field data is used for the boundary condition on B_r .
- Solved to steady state
- Input at Photosphere
 - Magnetic field (CCMC web site user enters date)
 - Density
 - Temperature
- Output
 - Magnetic field
 - Velocity
 - Density
 - Temperature



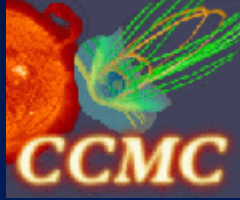
Potential Source Surface Model



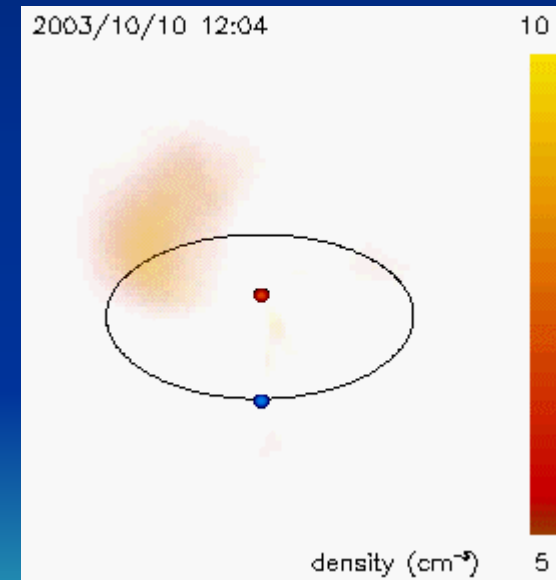
- The model calculates the magnetic field of the corona from the radius of the sun to the source surface radius assuming that there are no currents in this region.
- The code uses spherical harmonic coefficients calculated by Wilcox Solar Observatory using observed photospheric fields (magnetograms) as input.
- User input:
 - Date
 - Source Surface Radius ($1.6 - 3.25 R_s$)
 - Number of spherical harmonic coefficients
- Output – Magnetic Field Mappings

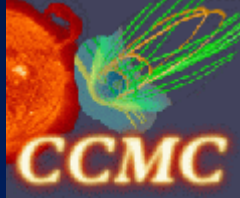


Heliospheric Tomography



- 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



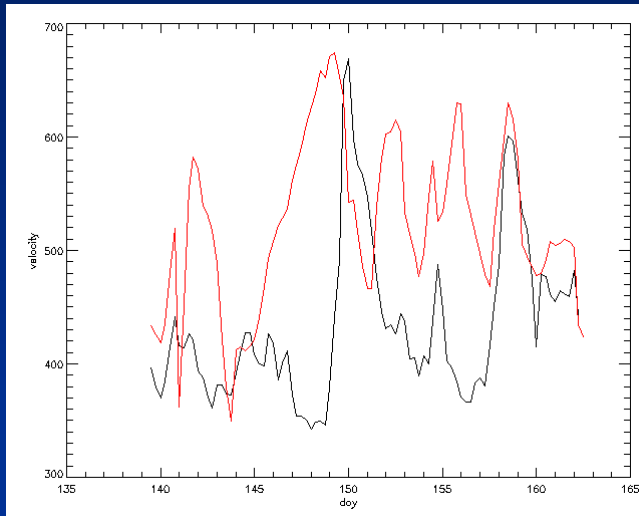


Heliospheric Tomography

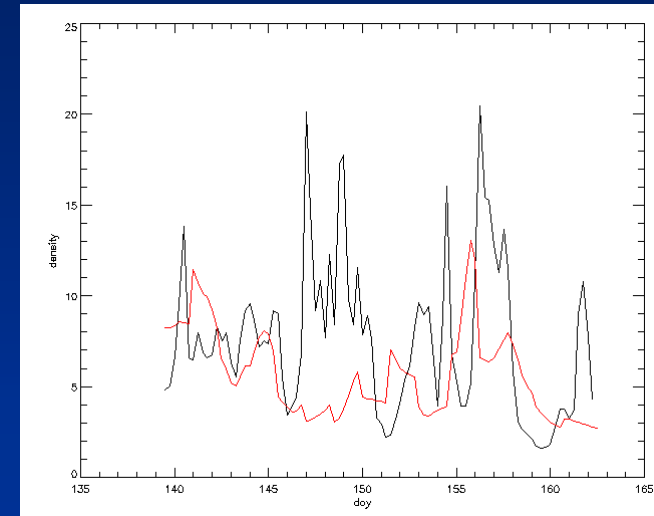
Velocity

Density

700

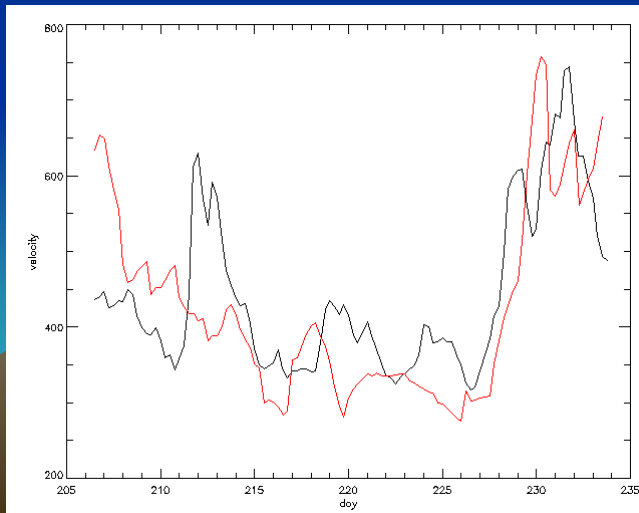


20

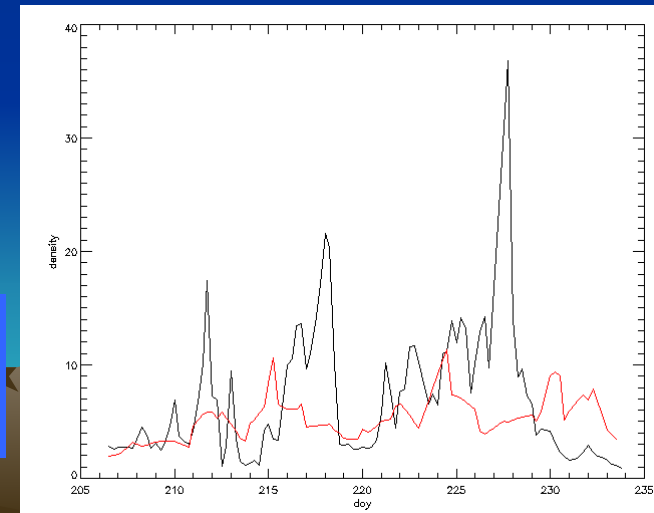


Interval 1

300



40



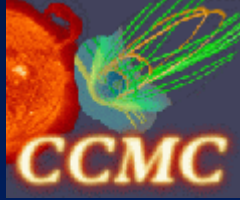
Interval 2

Red: Model

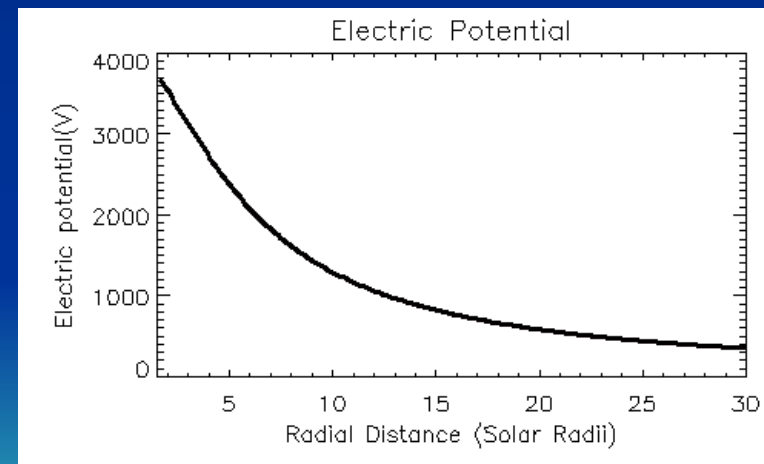
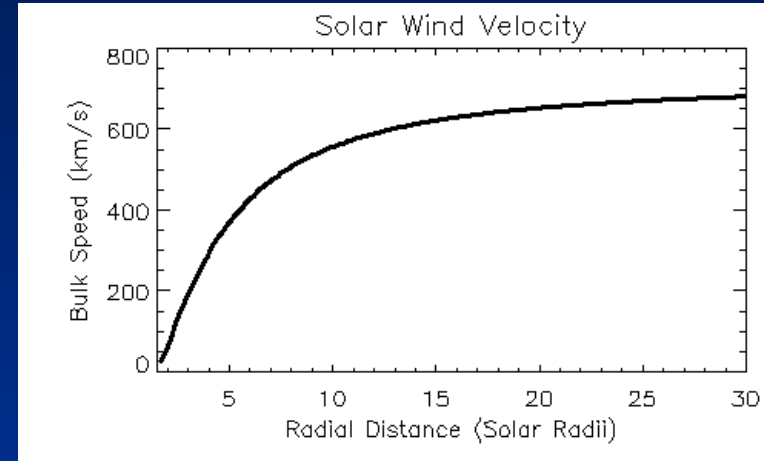
Black: ACE data

300

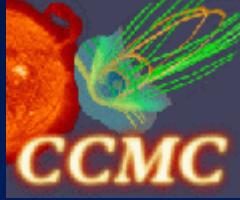
Exospheric Solar Wind Model



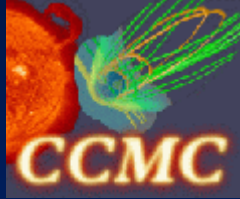
- One-dimensional kinetic model developed for coronal holes
- Uses quasi-neutrality to obtain a radial distribution of the electrostatic potential.
- Calculates the moments of the electron and proton velocity distribution function (VDF) using the electrostatic potential
- Input
 - Radial distance of 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