More tools….

StereoCAT

Stereo CME Analysis Tool

http://ccmc.gsfc.nasa.gov/analysis/stereo/

Demo link

Tutorials and Resources link

Space Weather Web Tools from CCMC/SWRC:
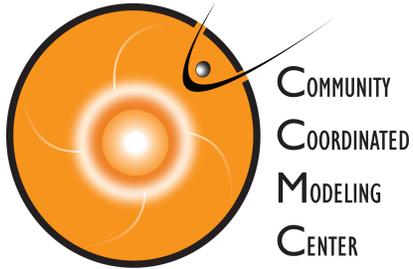

Space Weather Scoreboard

Space Weather DONKI

WSA-ENLIL Cone Fast Track

Stereo CAT

http://kauai.ccmc.gsfc.nasa.gov/

WSA-ENLIL+Cone FastTrack run submission through CCMC

Provide:
- your contact information,
- Run Number (you can submit a limited number of runs per day and they will be distinguished by this number)
- the number of CMEs in your simulation (limit 5)

Your contact information:

Your run results will be published online under your

First Name (Given): [   ] (required)
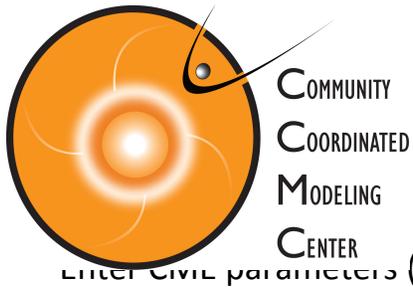
Last Name (Family): [   ] (required)

E-mail: [   ] (required)

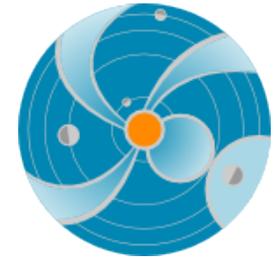Run Number: [1 ÷] ←

Specify the number of CMEs for this run:

Number of CMEs: [1 ÷] (up to 5 CMEs allowed)

[Continue] [Reset]

WSA-ENLIL

Fast Track

Enter CME parameters (e.g., parameters derived in a StereoCAT session):

CME # 1:

CME Detection Date/Time:	2014-06-04 *(YYYY-MM-DD)*	03:45
Date/Time at 21.5 Rs:	2014-06-04 *(YYYY-MM-DD)*	10:15
Velocity:	1200	
Latitude:	12	
Longitude:	30	
Half Angle:	45	

SUBMIT Run

Dear Aleksandre Taktakishvili,

Your request has been submitted on: June 4, 2014, 3:00 pm.
The registration number for the run you submitted is:
Aleksandre_Taktakishvili_060414_SH_1.

You will receive an e-mail when the simulation(s) have finished.

We appreciate your interest in the CCMC.

Sincerely,

The CCMC staff
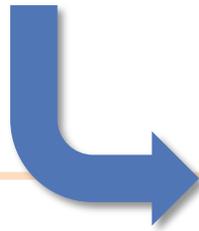
Run results are usually ready in 40 mins (for events within the last 3 months)

WSA-ENLIL

Fast Track

Run completion notification

Run completion notification emails contain:

- Estimate of the CME arrival at Earth

- Estimate of the CME arrival at planets (and satellites)

- Link to the run results available on the CCMC website

```
**********************************************
Estimate issued on  2014/06/04,  11:10:37  EST
**********************************************


Arrival time(year/month/day, hr:min UT) =2014-06-07T05:15Z
(confidence level +-7 hours)

Duration of the disturbance (hr) = 24.6
(confidence level +-8 hours)

Minimum magnetopause standoff distance: Rmin(Re)=6.1
(under quiet conditions:  Rmin(Re)=10;
R_geosynchr(Re)=6.6)

Kp index for three possible IMF clock angles
(angle 180 gives the maximum possible estimated Kp):
(Kp)_90=4
(Kp)_135=6
(Kp)_180=6
```

```
Inner planets:

Experimental ICME estimate
*************************
Stereo A
*************************
Arrival time(year/month/day,
hr:min UT) =2010-04-22T15:03Z


*************************
Stereo B
*************************
CME did not hit the StereoB.
or
CME impact is very weak.
```

WSA-ENLIL

Fast Track
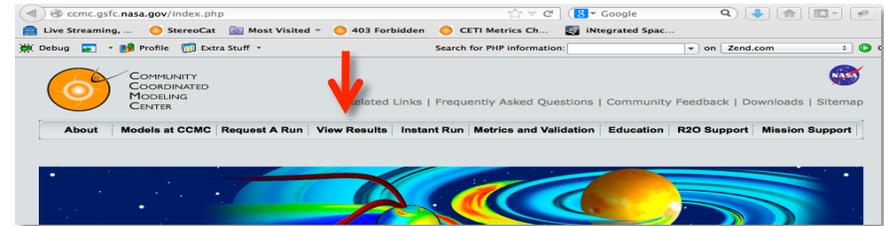
Run results on the CCMC website

The link in the run notification email will take you to your run results page on the CCMC website.

CME(s) parameters
CME arrival at 21.5 Rs time(s): 2014-06-03T10:15
latitude: 12
longitude: 30
half angular width: 45
velocity: 1200

- View 3D Data
- View control file with input parameters for the run.
- View quick look graphics for the run
  Note: Quick look graphics has been designed by the model developer
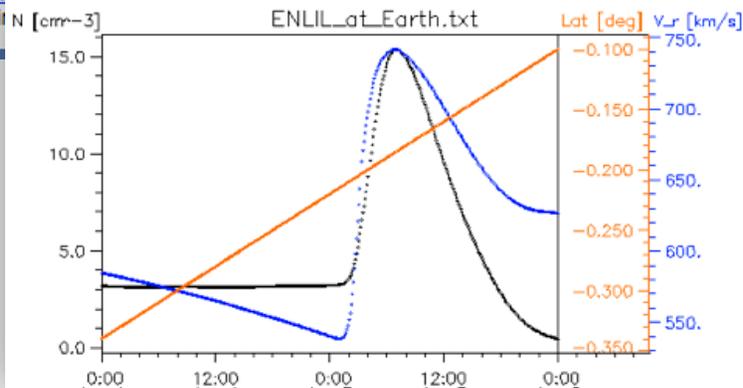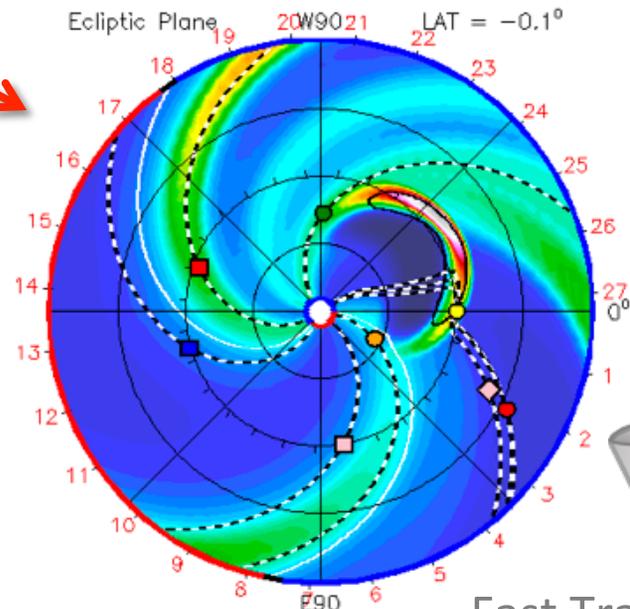 find more information regarding this option please contact the CCMC

ENLIL_at_Earth
ENLIL_at_Mars
ENLIL_at_Mercury
ENLIL_at_Stereo_A
ENLIL_at_Stereo_B
View estimate of the CME arrival time at Earth
View estimate of the CME arrival time at Earth for GICs
CME_estimate_AFWA_Mars
CME_estimate_AFWA_Messenger
CME_estimate_AFWA_Spitz
CME_estimate_AFWA_STA

View esti

Example of run results link

View all Heliosphere Runs
(find link to your request)

Fast Track

WSA-ENLIL
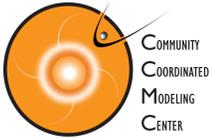
Ensemble Modeling

Ensemble Modeling

Ensemble modeling estimates the spread/uncertainty in CME arrival time predictions due to uncertainties in CME input parameters:

- Produce a set of **N** CME input parameters with the CME triangulation analysis tool. Routine cases have been run with N=48. This number can be increased.

- Run an ensemble of **N** runs of WSA-ENLIL cone model.

- This gives an ensemble of **N** CME arrival times and impact estimates.

- For N=48, a average run takes ~130 min on 24 nodes *(4 processors/node) on our development system*. We estimate that the same run will take ~80 minutes on the production system *(16 processors/node)*.

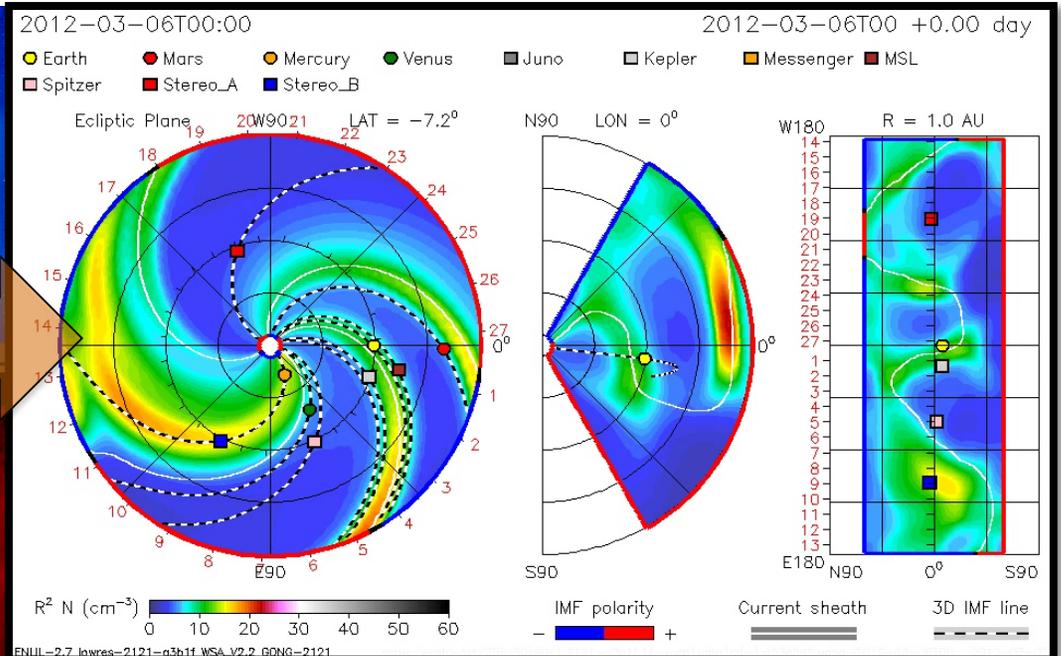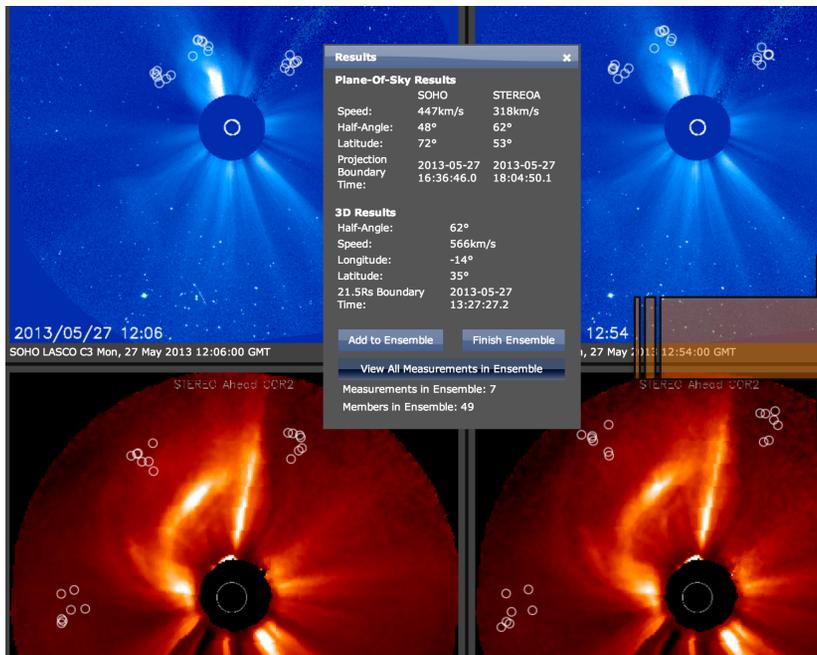# Ensemble Modeling Workflow:

Cone Model Concept

Zhao et al, 2002, Cone Model:
- CME propagates with nearly constant angular width in a radial direction
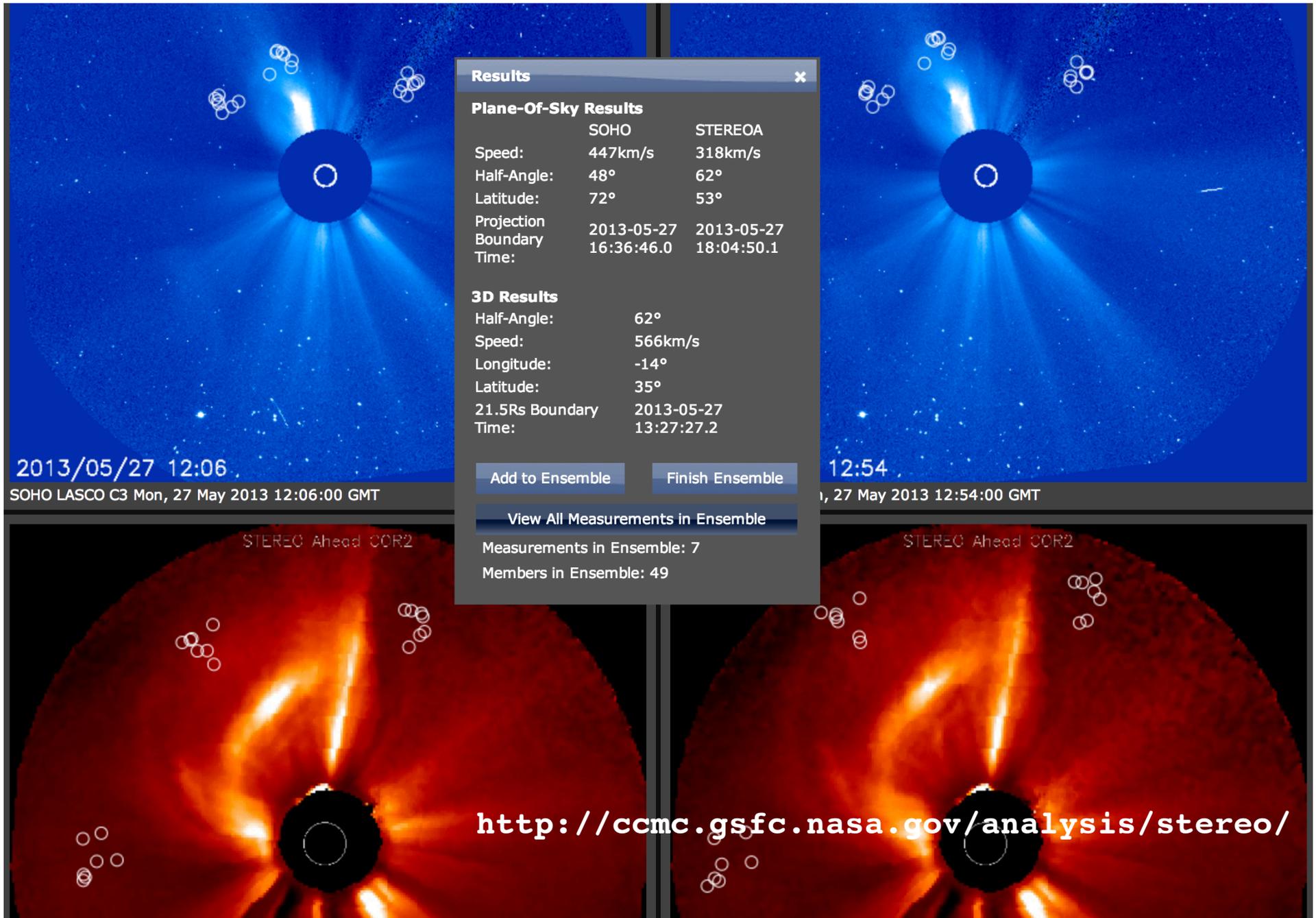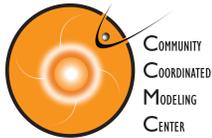- CME bulk velocity is radial and the expansion is isotropic
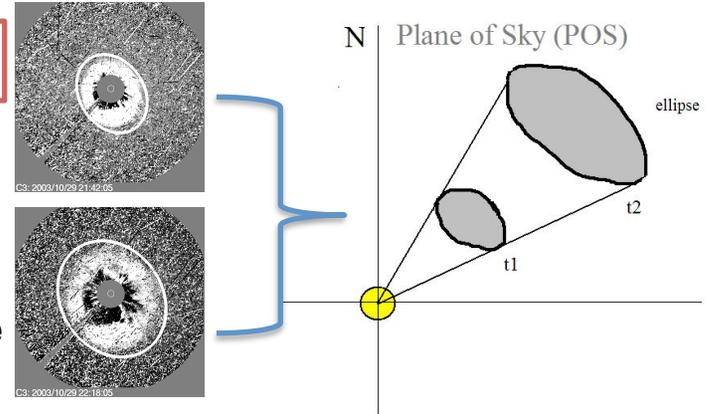
Parameters Defined with StereoCAT (CCMC CME Triangulation Tool)

CME Parameters: Input To WSA-ENLIL+Cone Model

An ensemble of input CME parameters are obtained by measuring the same feature using StereoCAT which employs geometric triangulation techniques. "Custom" input parameters obtained using other measurement methods can also be added to the final ensemble of input

Results ✕

Plane-Of-Sky Results
	SOHO	STEREOA
Speed:	447km/s	318km/s
Half-Angle:	48°	62°
Latitude:	72°	53°
Projection Boundary Time:	2013-05-27 16:36:46.0	2013-05-27 18:04:50.1

3D Results
Half-Angle:	62°
Speed:	566km/s
Longitude:	-14°
Latitude:	35°
21.5Rs Boundary Time:	2013-05-27 13:27:27.2

Add to Ensemble   Finish Ensemble

View All Measurements in Ensemble

Measurements in Ensemble: 7

Members in Ensemble: 49

2013/05/27 12:06
SOHO LASCO C3 Mon, 27 May 2013 12:06:00 GMT

12:54
n, 27 May 2013 12:54:00 GMT

STEREO Ahead COR2

STEREO Ahead COR2

http://ccmc.gsfc.nasa.gov/analysis/stereo/

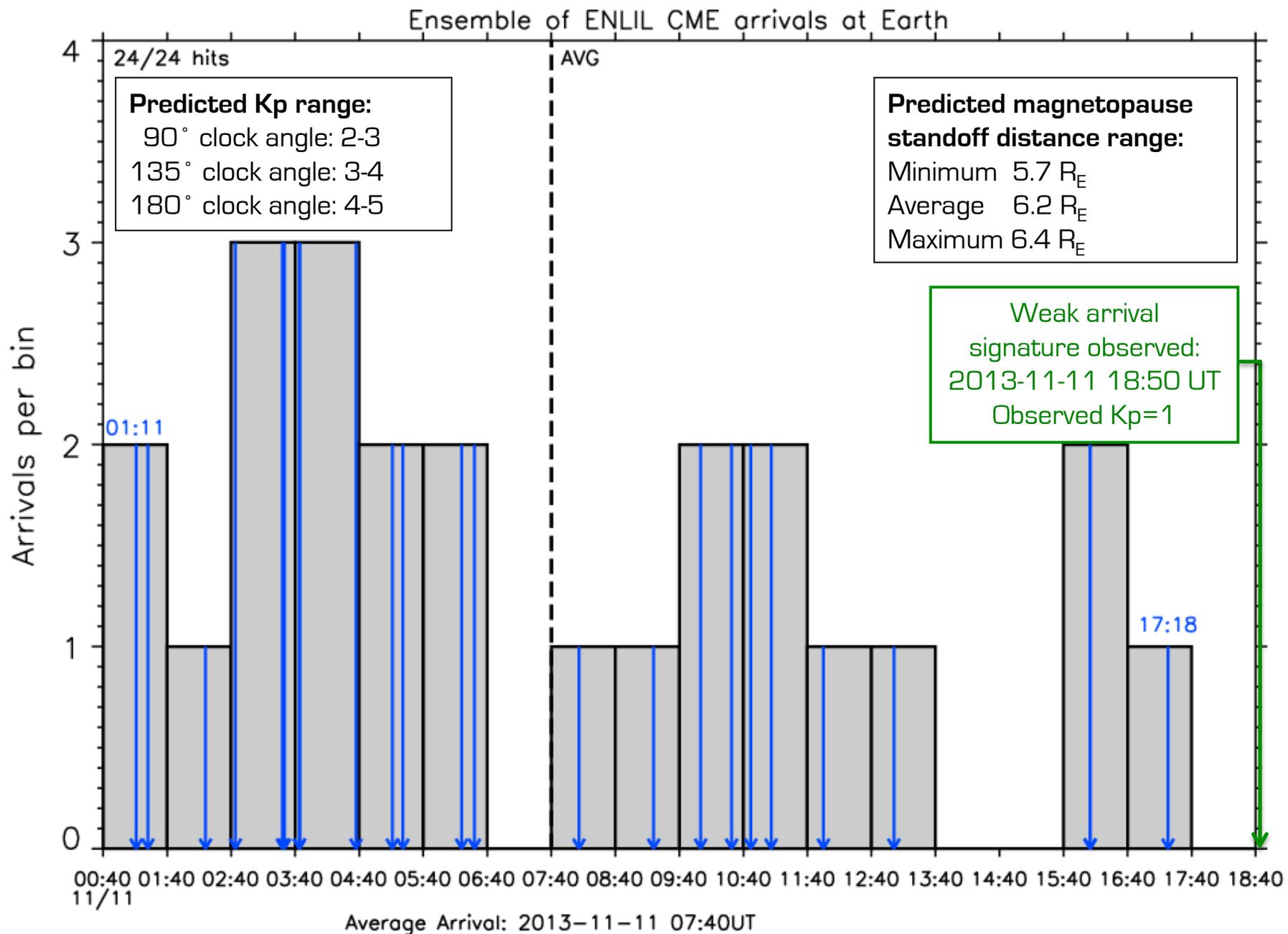# WSA-ENLIL+Cone model: Automated Ensemble Pipeline

Improvements:

• CME input parameters measured with StereoCAT are automatically fed to the WSA-ENLIL model to digest.

• Multiple CME capability: up to five CMEs in a single simulation.

• The total number of N simulations is variable.

• Capability of real-time or historical CME run option introduced.

• Detailed results text shows a table of model results (arrival times, Kp estimates, etc) alongside each CME input parameter to allow for easy comparison.

• Results are automatically ingested into the integrated Space Weather Analysis system (iSWA)

• Next steps: perform more real-time runs to collect more model validation statistics


A total of 38 ensemble runs, 1,955 simulations, were performed

---

• 38 ensemble runs for CME events were performed (1478 total simulations).
  • 28 of these runs were performed in real time (before observed CME arrival).
  • 10 runs were performed after the CME arrival.
• 10 additional runs for a single event were performed for a parametric study

Histogram of CME Arrival Times for an Ensemble of Input Parameters

Ensemble of ENLIL CME arrivals at Earth

24/24 hits

Predicted Kp range:
90° clock angle: 2-3
135° clock angle: 3-4
180° clock angle: 4-5

Predicted magnetopause standoff distance range:
Minimum 5.7 R_E
Average   6.2 R_E
Maximum 6.4 R_E

Weak arrival signature observed:
2013-11-11 18:50 UT
Observed Kp=1

Arrivals per bin

AVG

01:11

17:18

00:40 01:40 02:40 03:40 04:40 05:40 06:40 07:40 08:40 09:40 10:40 11:40 12:40 13:40 14:40 15:40 16:40 17:40 18:40
11/11

Average Arrival: 2013−11−11 07:40UT

Plots in time of the solar wind density, velocity, magnetic field, and temperature at Earth, as predicted by the WSA-ENLIL+Cone model for the entire ensemble of CME input parameters.
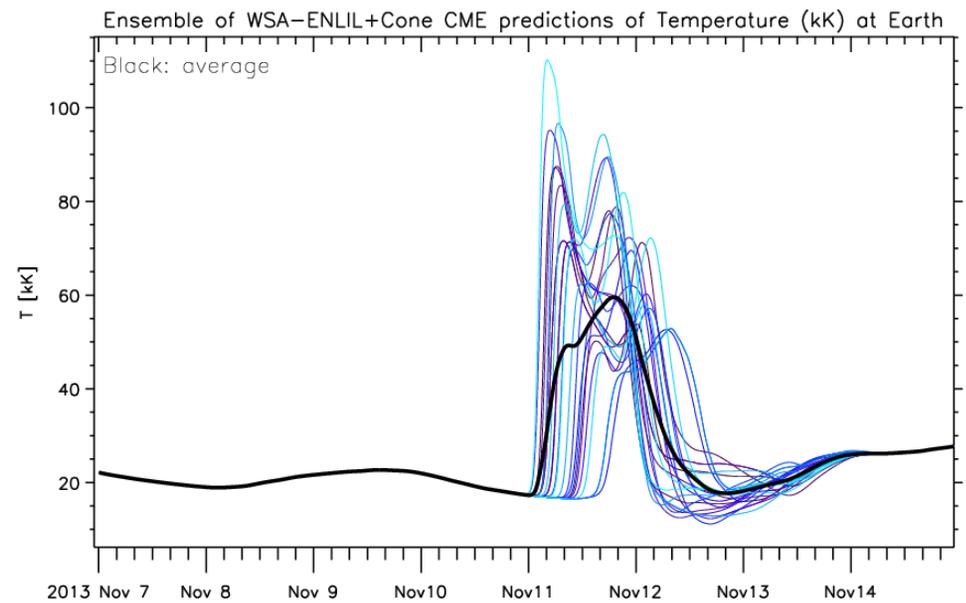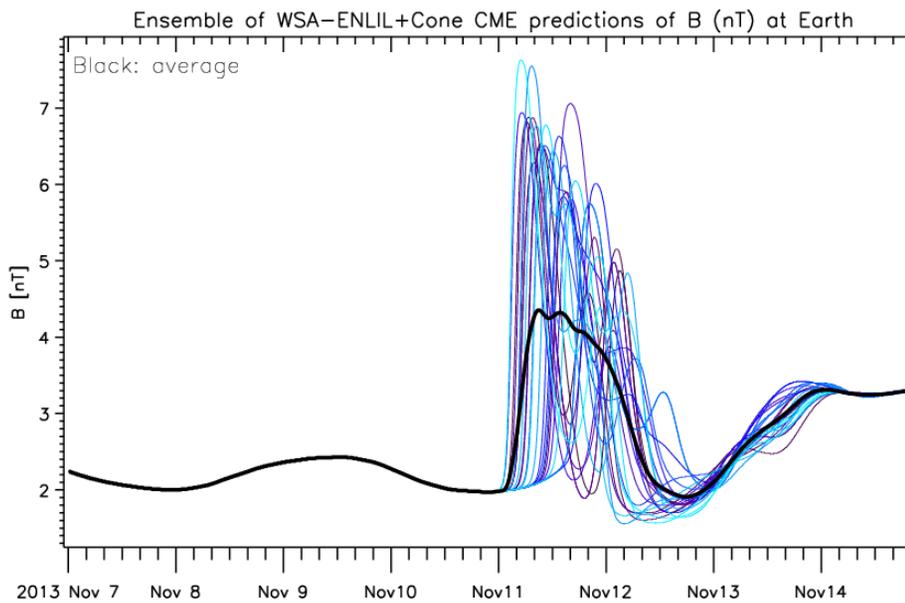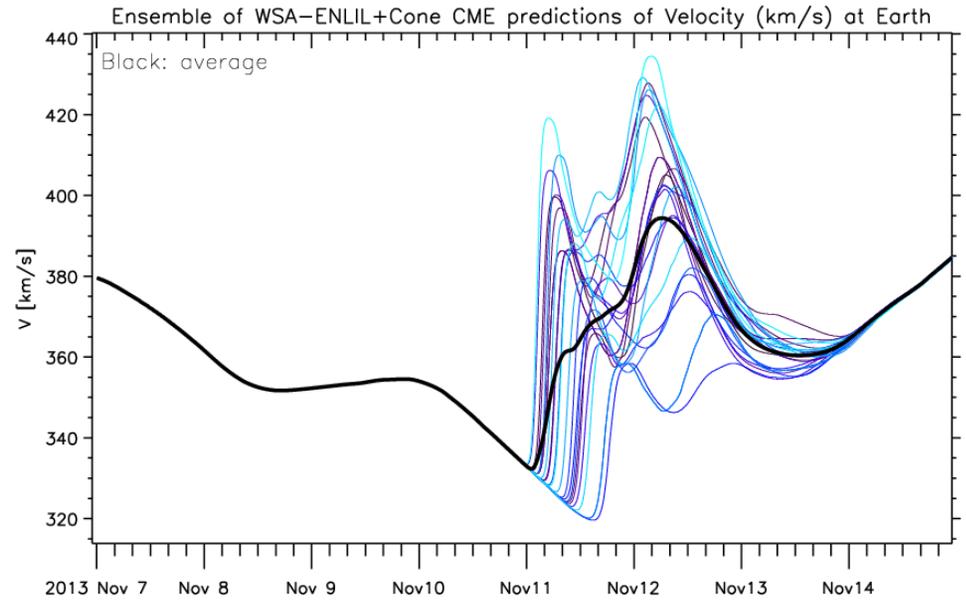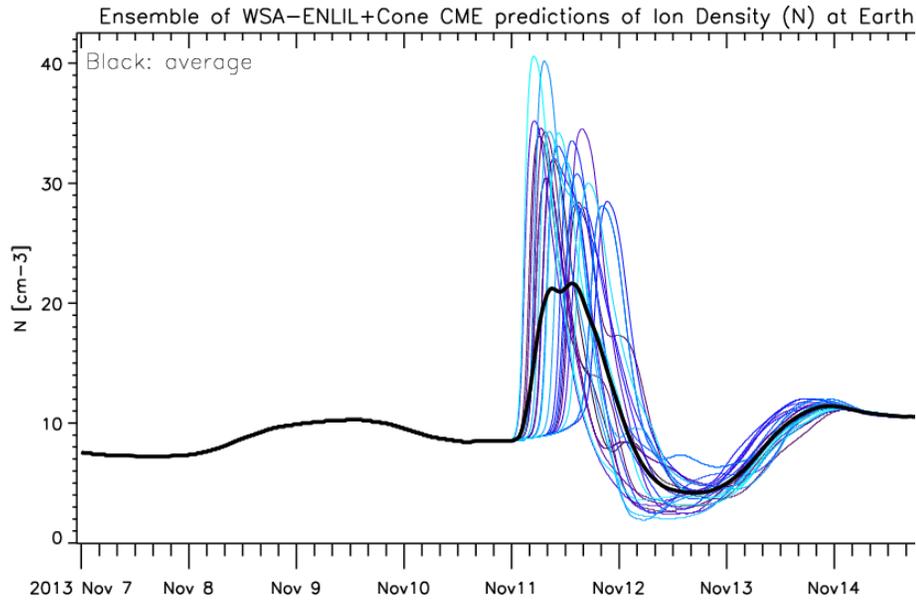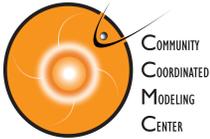
Ensemble Modeling Validation

• For 14 out of 28 (half) ensemble runs (containing hits) the observed CME arrival was within the range of ensemble arrival time predictions. There were 5 (out of 38) false alarms, and 5 (out of 38) correct rejections.

• The ensemble arrival time predictions are helpful even if the observed arrival is not within the predicted range. This allows us to rule out prediction errors caused by tested CME input parameters. Prediction errors can also come from model limitations.

• The average arrival time prediction was computed for each of the 28 ensembles. Using the actual arrival time this gives an average absolute error of 10.0 hours for all 28 ensembles, which is comparable to current forecasting errors. *(RMSE=11.4, average error=-5.7).*

• We have learned that the initial distribution of CME input parameters is very important for the accuracy of ensemble CME arrival time predictions. Particularly, the median and spread of the input distribution are important.

Next steps:
• Perform more real-time runs to collect more model validation statistics
• Graphical improvements to allow comprehension of many (N) results at a glance

Demo:
Ensemble Modeling Products Available on iSWA

Example iSWA layout link

Resources and Tutorials

Space Weather Tools page: http://kauai.ccmc.gsfc.nasa.gov/
Scoreboard: http://kauai.ccmc.gsfc.nasa.gov/SWScoreBoard/
DONKI: http://kauai.ccmc.gsfc.nasa.gov/DONKI/
StereoCAT: http://ccmc.gsfc.nasa.gov/analysis/stereo/

Space Weather tutorials including StereoCAT:
http://ccmc.gsfc.nasa.gov/support/SWREDI/tutorials.php

iSWA wiki with Cygnet Descriptions: http://iswa.ccmc.gsfc.nasa.gov/wiki
Glossary of Space Weather Terms: http://iswa.ccmc.gsfc.nasa.gov/wiki/index.php/Glossary