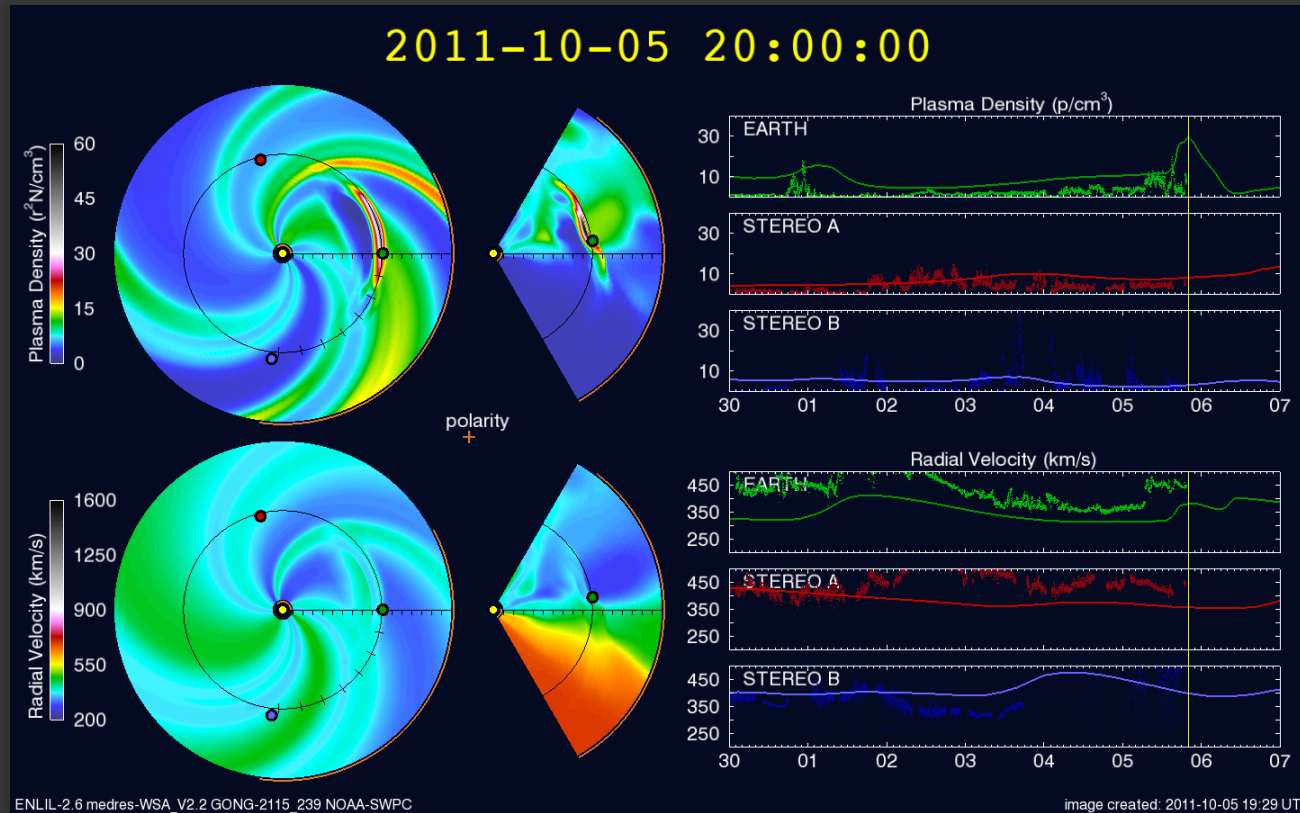


WSA-Enlil in Operations at the National Weather Service: Experiences, Results and Developments

George Millward (CU/NOAA)

Vic Pizzo, Doug Biesecker (NOAA), Curt de Koning (CU/NOAA)

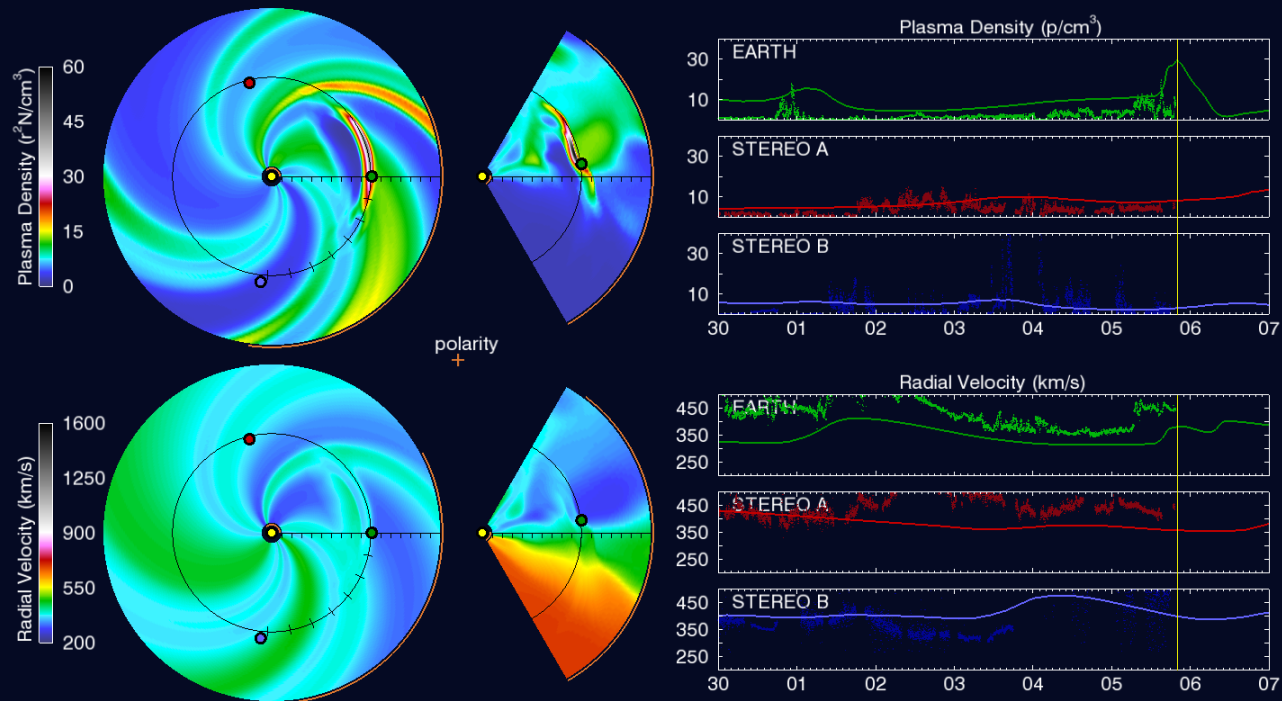


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2011-10-05 20:00:00



Transition to Operations

Transition to Operations
VALLEY OF DEATH

Transition to Operations

VALLEY OF DEATH



Transition to Operations
VALLEY OF DEATH

Transition to Operations

RUBBER HITS THE ROAD

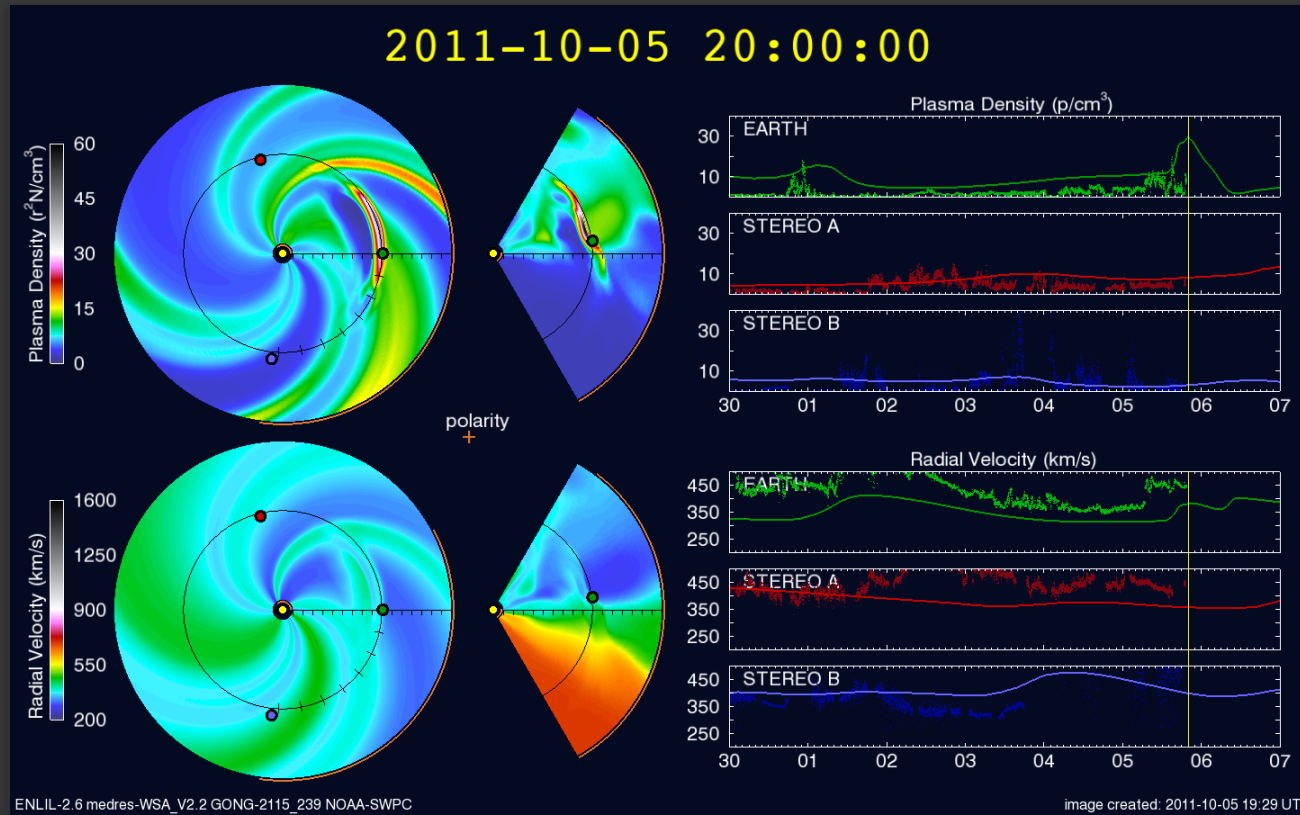
Transition to Operations
RUBBER HITS THE ROAD



WSA-Enlil in Operations at the National Weather Service: Experiences, Results and Developments

George Millward (CU/NOAA)

Vic Pizzo, Doug Biesecker (NOAA), Curt de Koning (CU/NOAA)



Intended Space Weather Benefits

- Provide improved warning of Co-rotating Interacting Regions (CIRs)

 - General “situational awareness”

 - Time of arrival at Earth

 - Geomagnetic storm response

- Provide 1 to 4 days advance warning of oncoming CMEs

 - General “situational awareness”

 - Probability of an interaction with Earth (“direct hit very probable”, “possible glancing blow”)

 - Time of arrival at Earth (Aiming for accuracy of +/- 6 hours)

 - Storm intensity (Tricky, modeled CME has no information about B field magnitude or orientation)

 - Storm duration

- Pave the way for future space weather model transitions:

 - Geospace

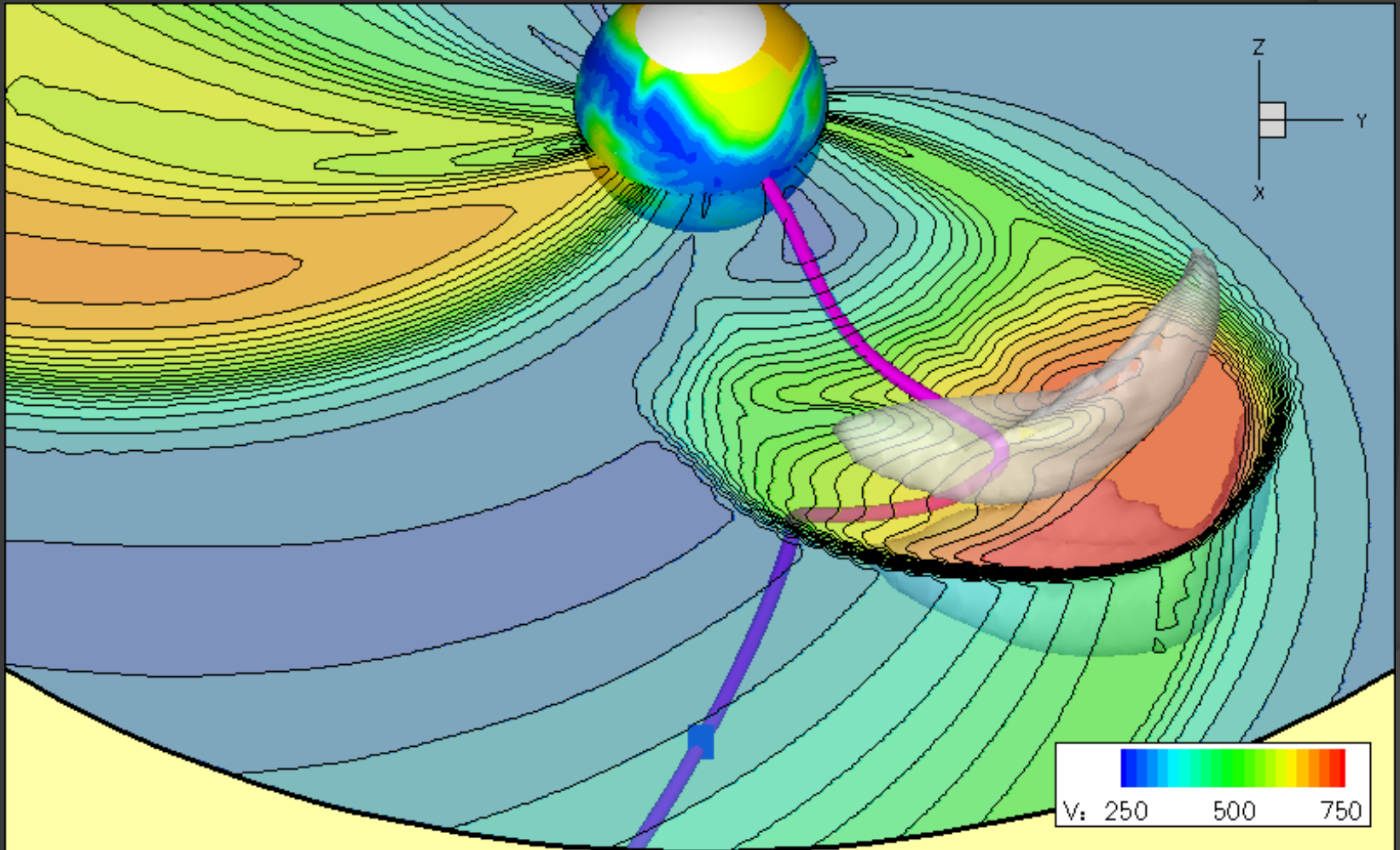
 - Upper atmosphere / ionosphere

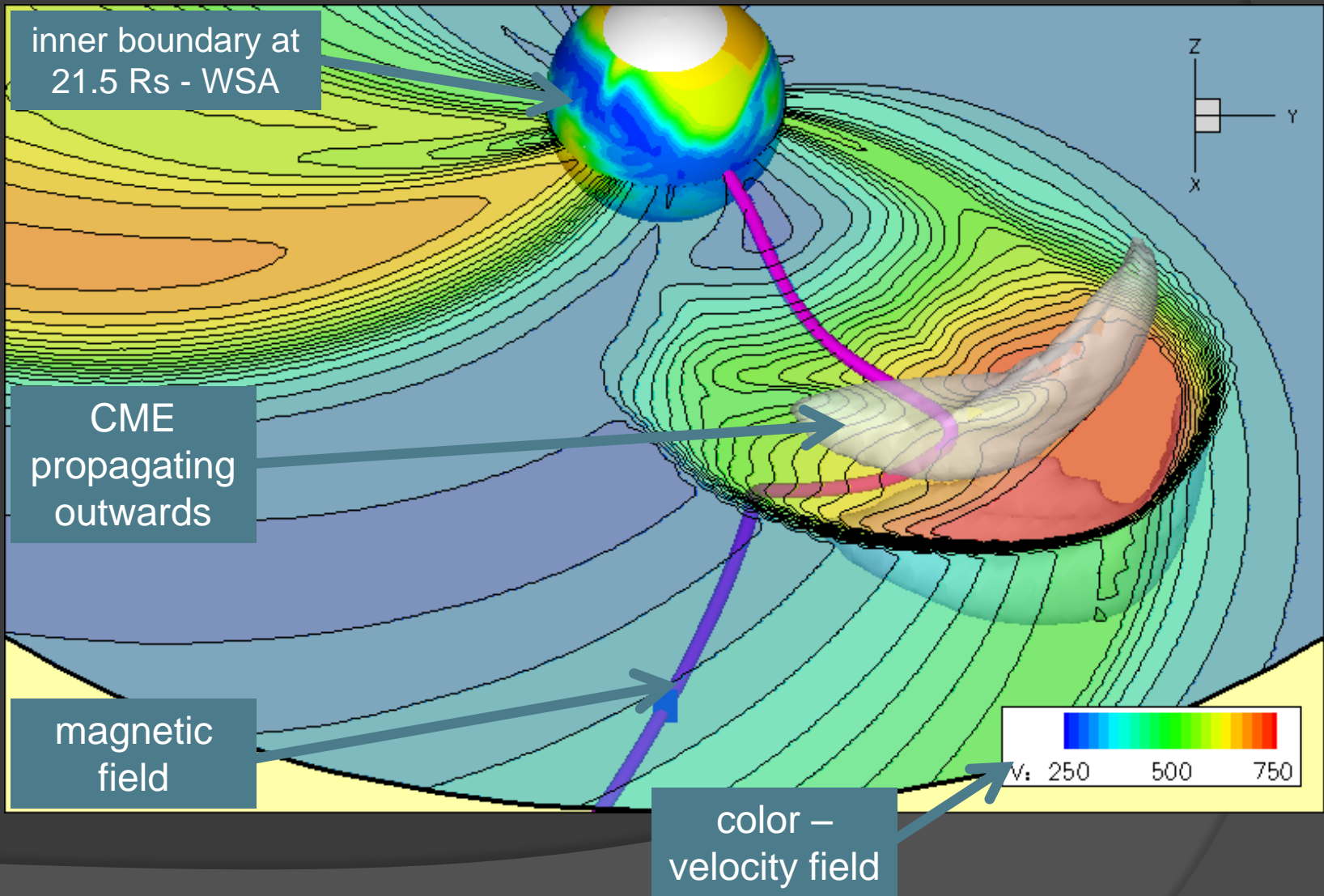
WSA-Enlil at NWS: Timeline

- October 2009 : Begin Transitioning project
 - Design of WSA-Enlil CONOPS
 - Development / testing of CME 'cone' tools
 - Installation of WSA-Enlil on DEVCCS
 - Model run scripts / networking (etc.)
 - Development of Solar Predictions Interface (SPI)
 - Post-processing / output products
- October 2011 : WSA-Enlil in 'parallel operations' at NWS
- December 2011 : WSA-Enlil fully operational on NCEP supercomputers
- April 2012 (ie, Now) : Deployment of SPI and Analysis tools into SWPC Forecast Office
- March – September : Forecaster Training
- October 2012 : Fully Operational (SWFO in full control)
- 2013 : Version 2 development (SWPT)

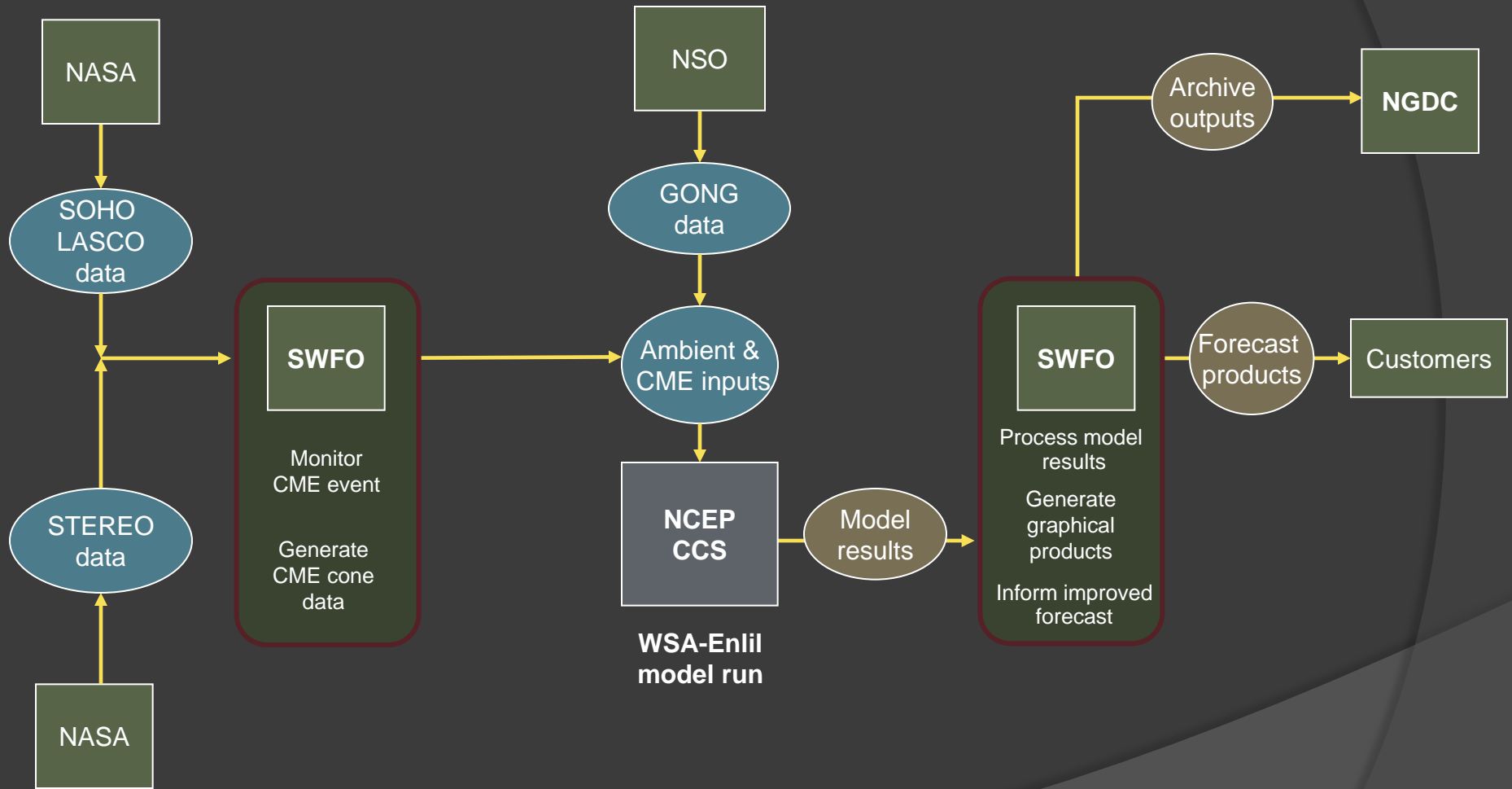
WSA-Enlil

A comprehensive, 3D, MHD, time-dependent, forecast model of the Heliosphere (solar wind)



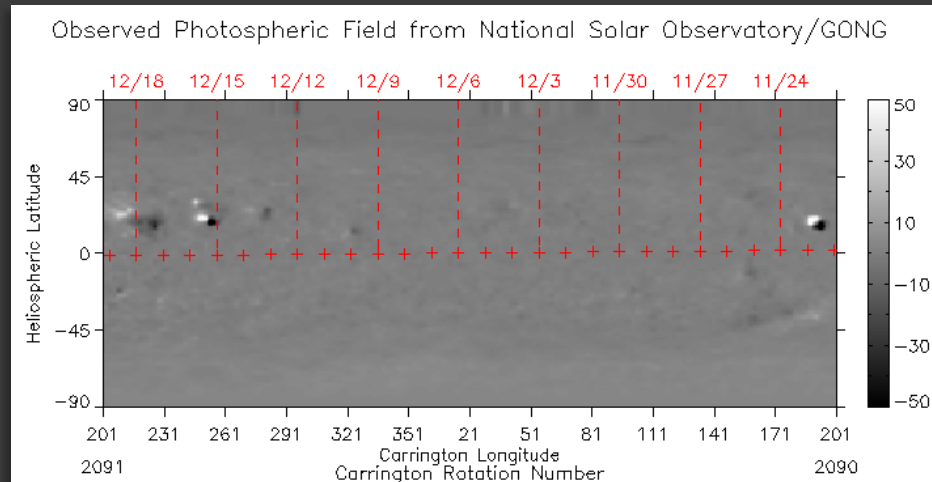


WSA-Enlil CONOPS



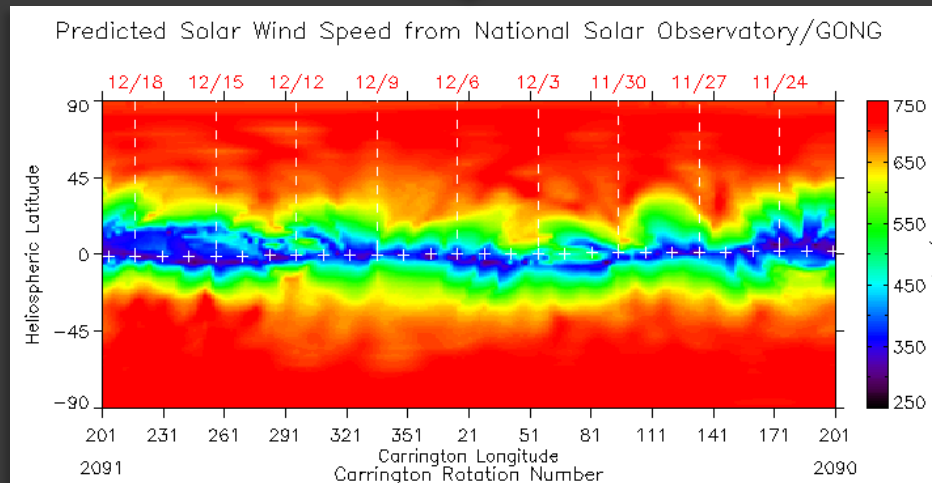
Wang-Sheeley-Arge (WSA) model:

INPUT:
Solar photospheric
magnetic field
(NSO, GONG)



WSA

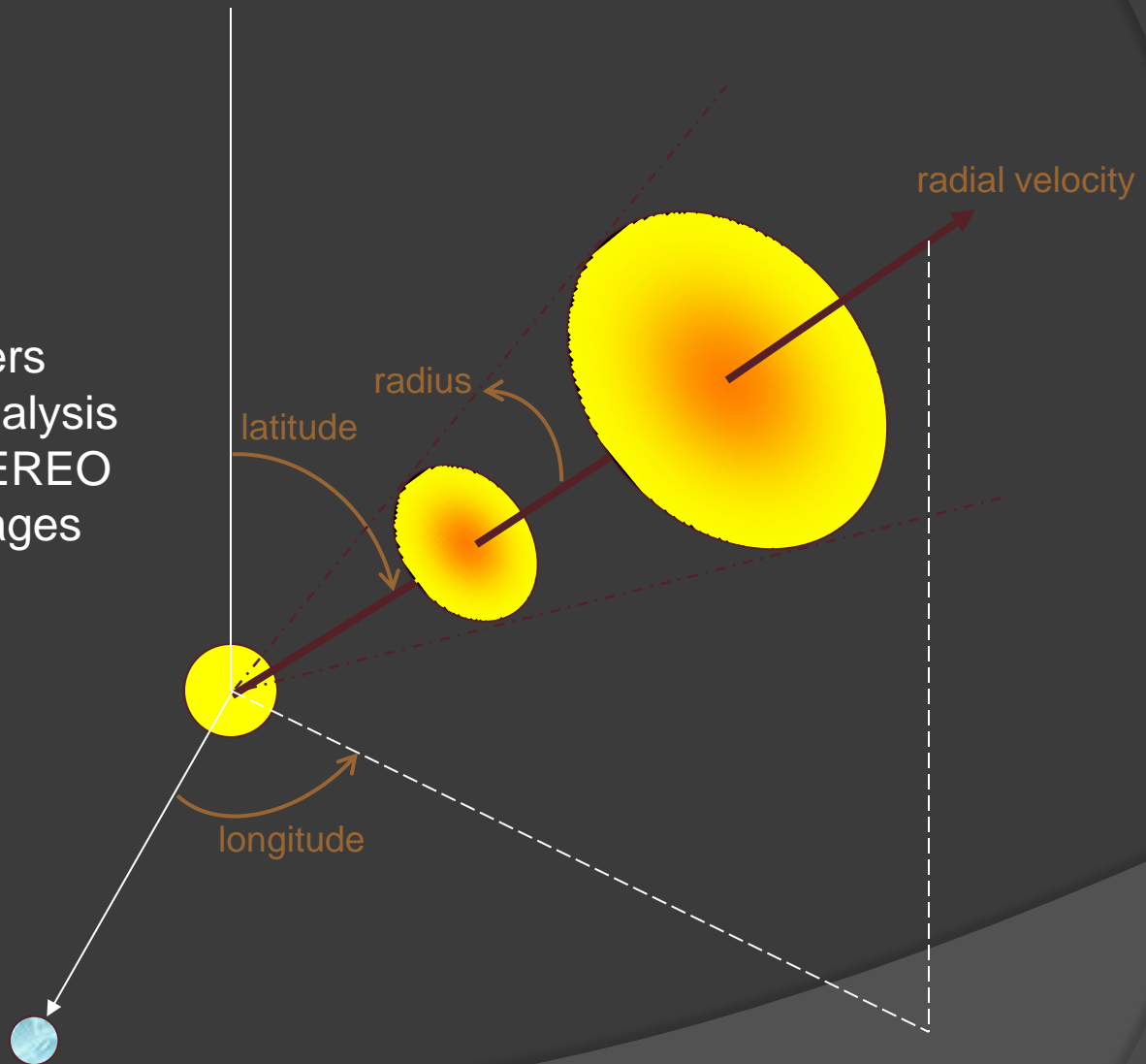
OUTPUT:
Global velocity and
magnetic polarity



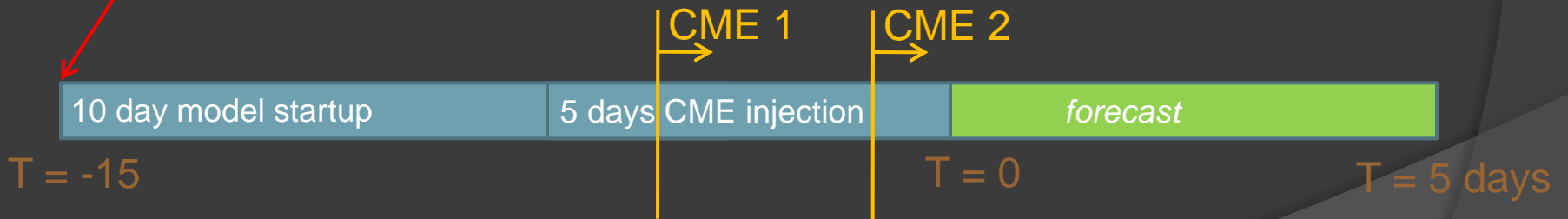
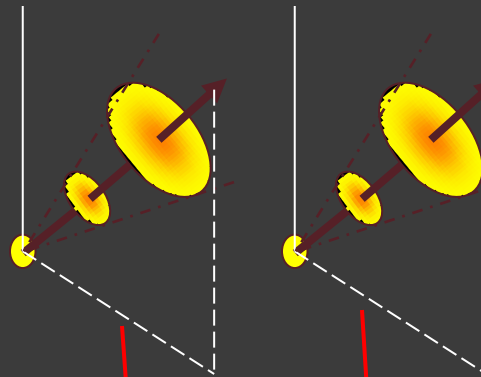
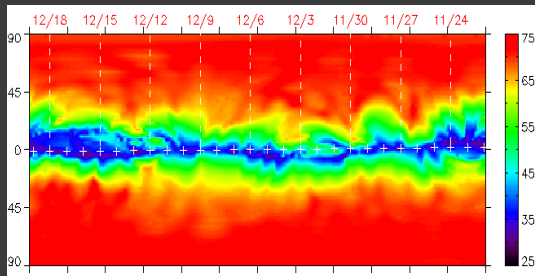
Steady, co-rotating
“ambient”
background flow at
21.5Rs

CME 'Cone' Geometry

CME parameters
calculated from analysis
of SOHO and STEREO
coronagraph images



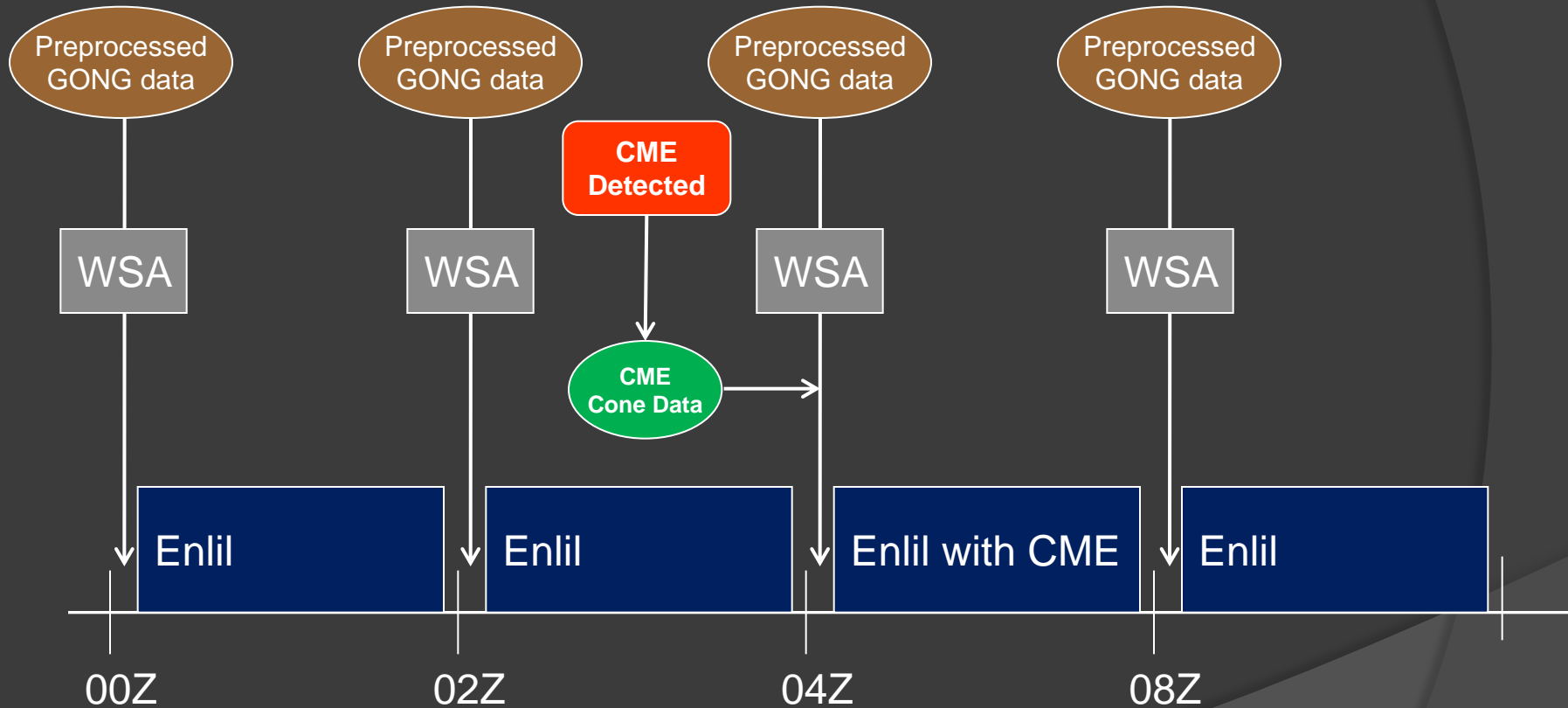
WSA-Enlil Model Run Schematic



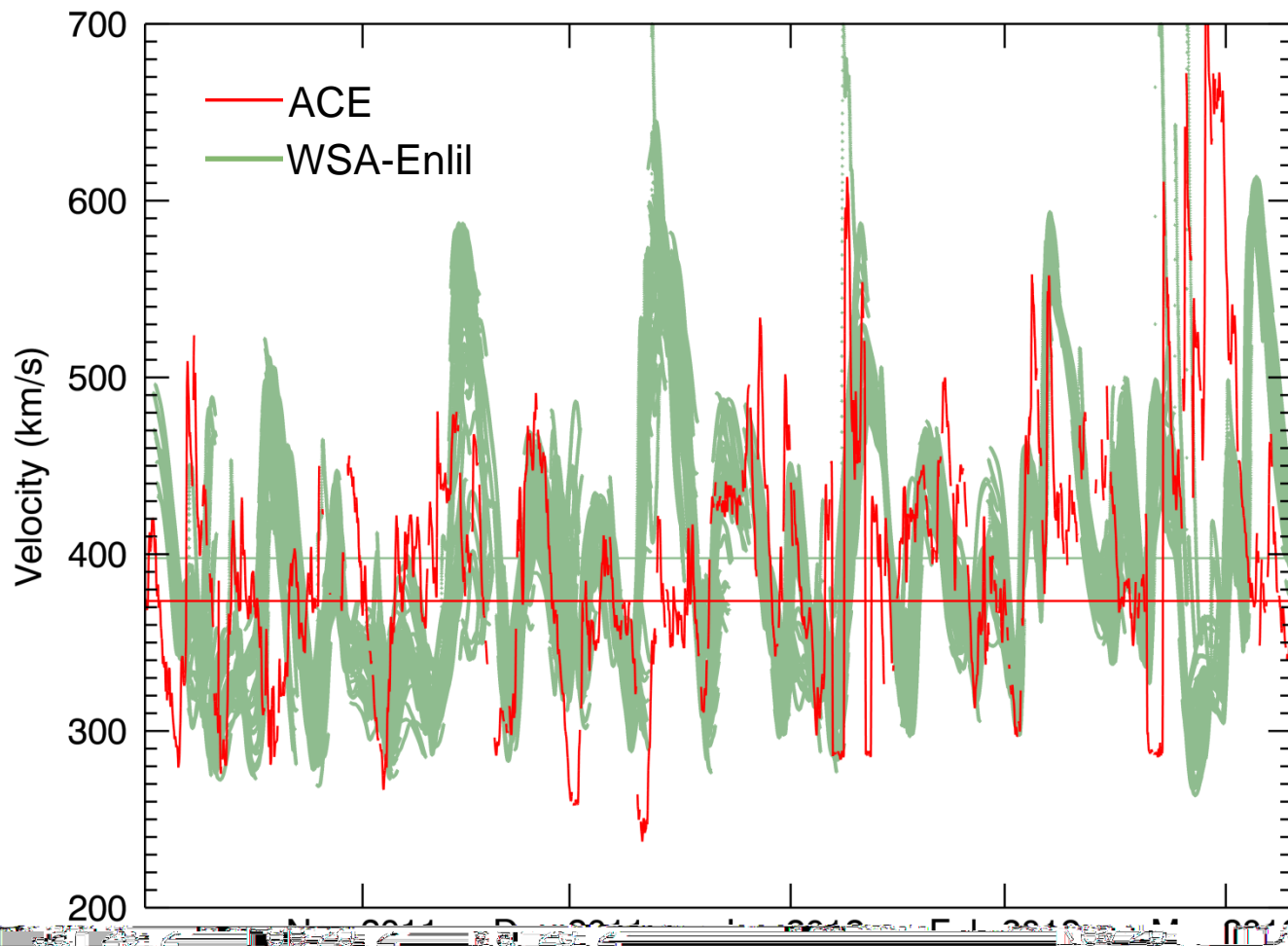
1.5 hours Wallclock time on NWS CCS

WSA-Enlil production run cycle at NCO

model runs every 2 hours

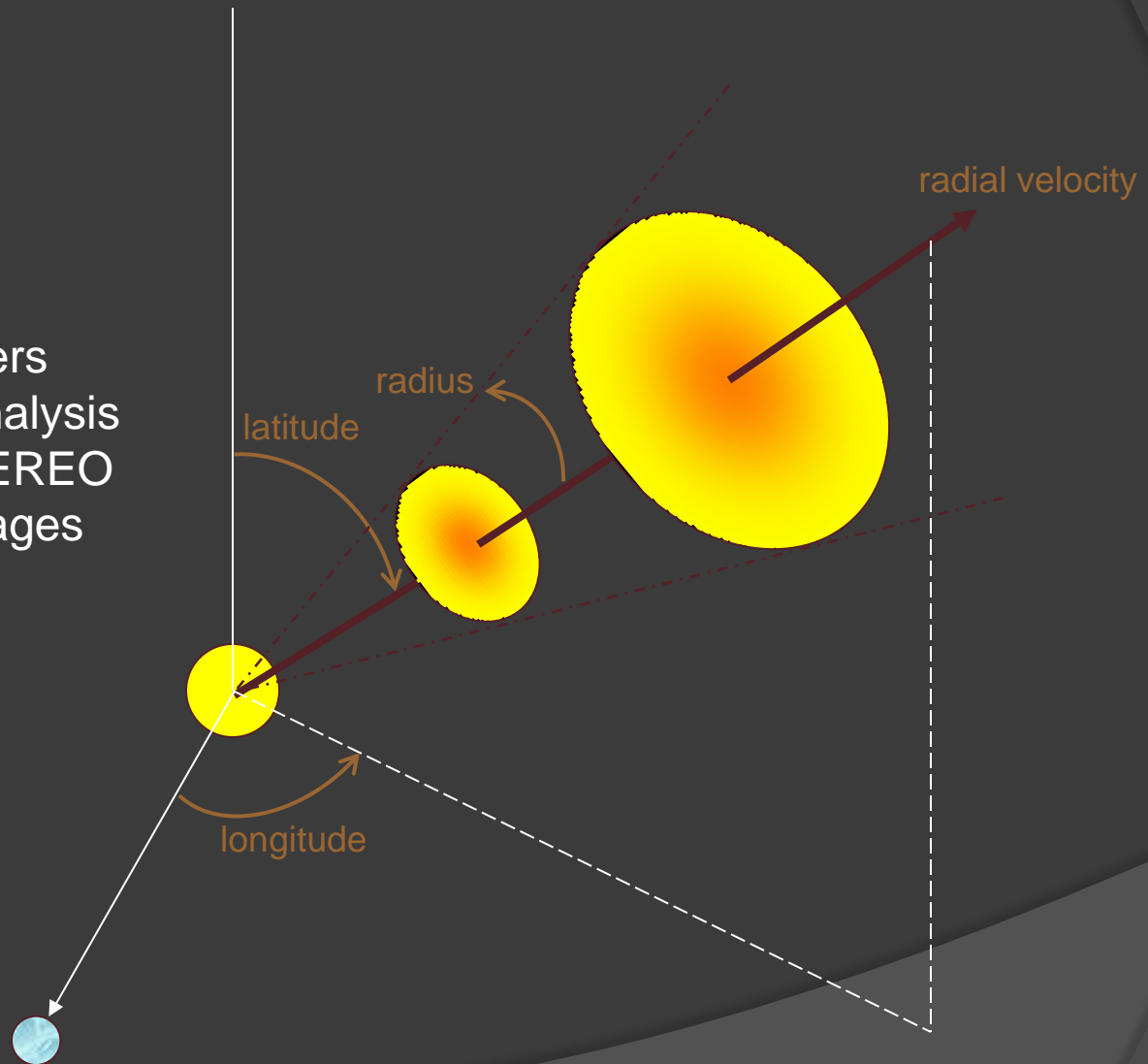


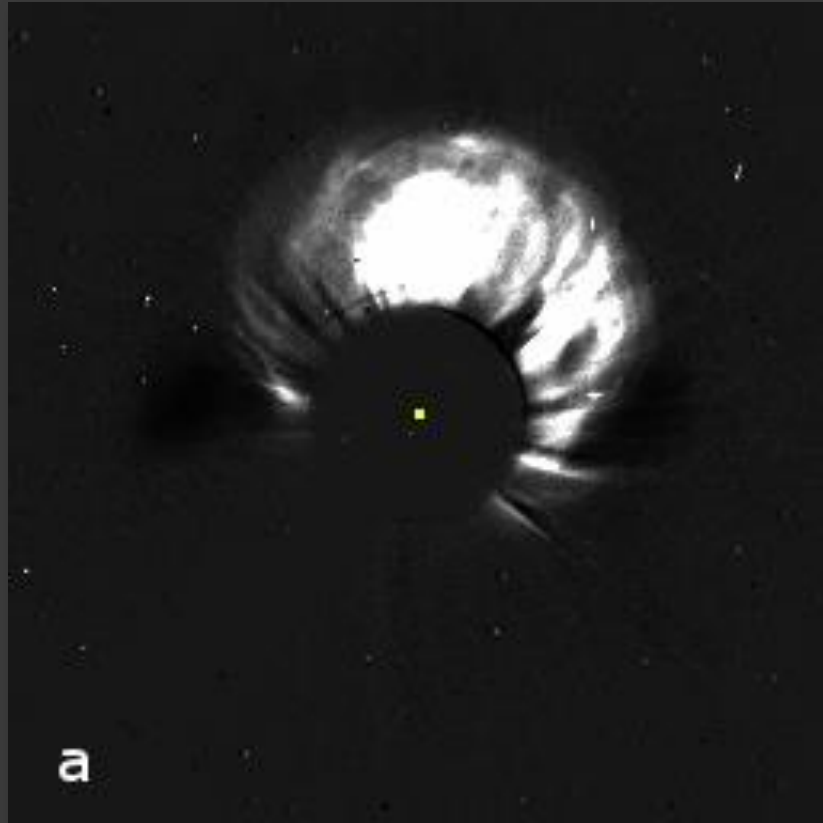
SWPC WSA-Enlil OPS: 4 to 5 day ahead forecast of SW velocity

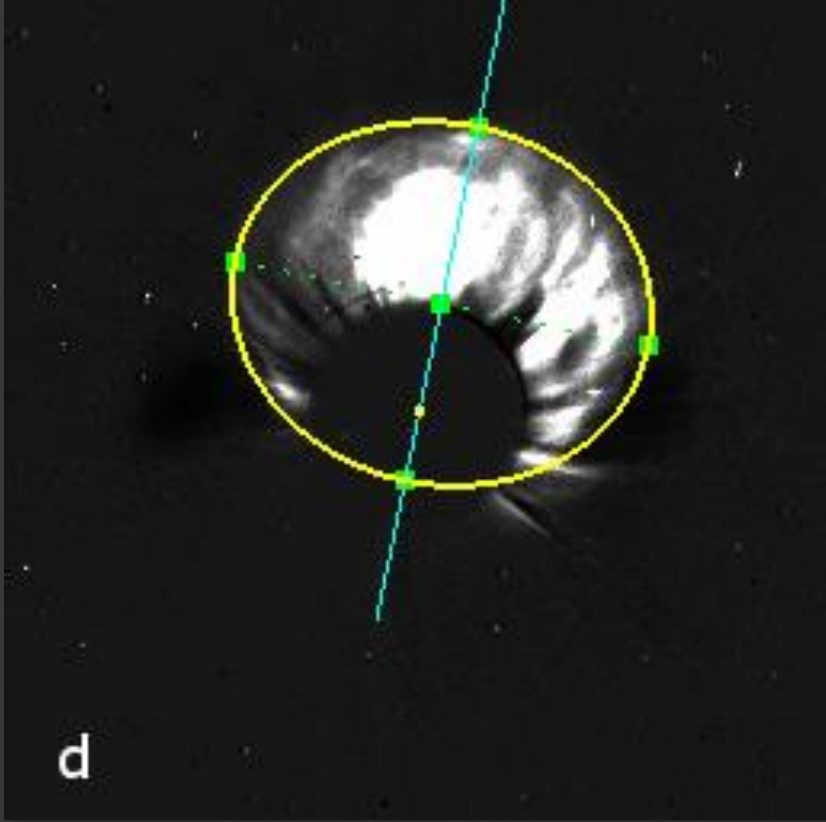


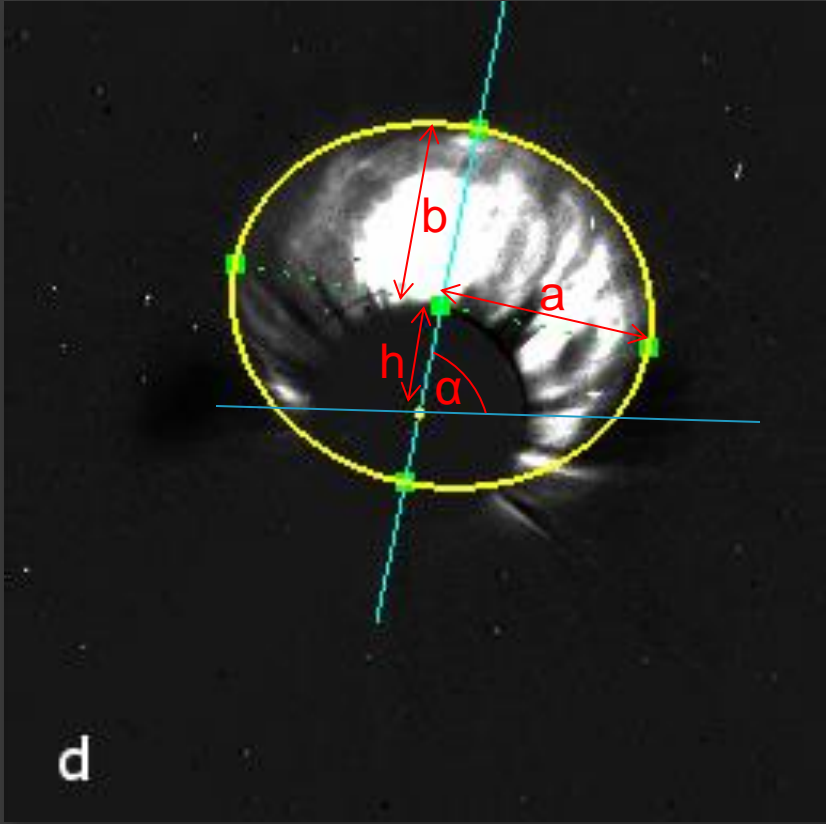
CME 'Cone' Geometry

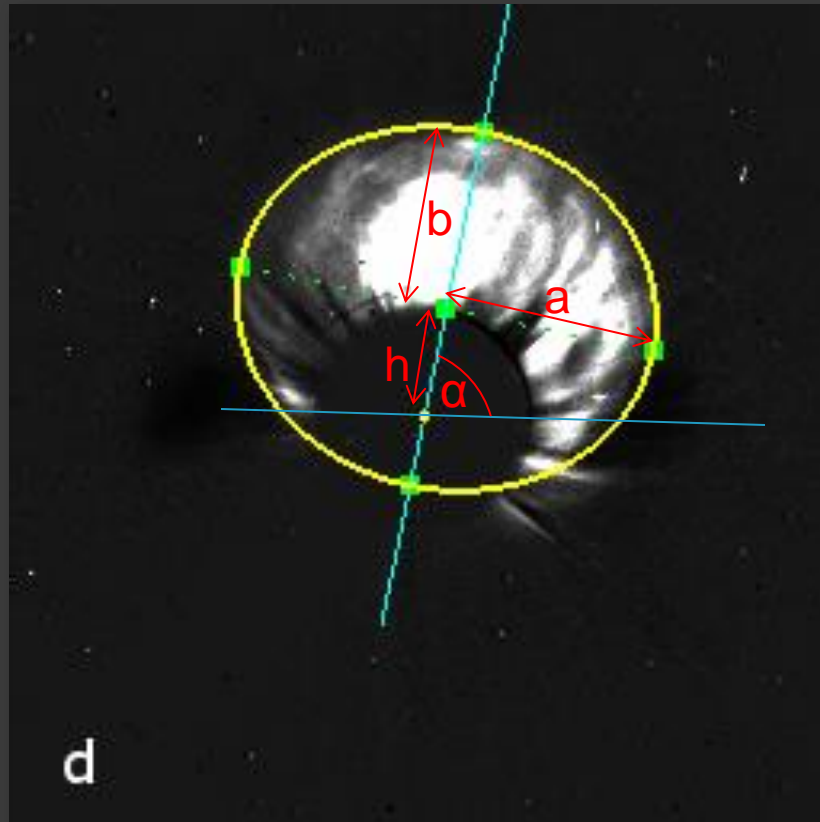
CME parameters
calculated from analysis
of SOHO and STEREO
coronagraph images





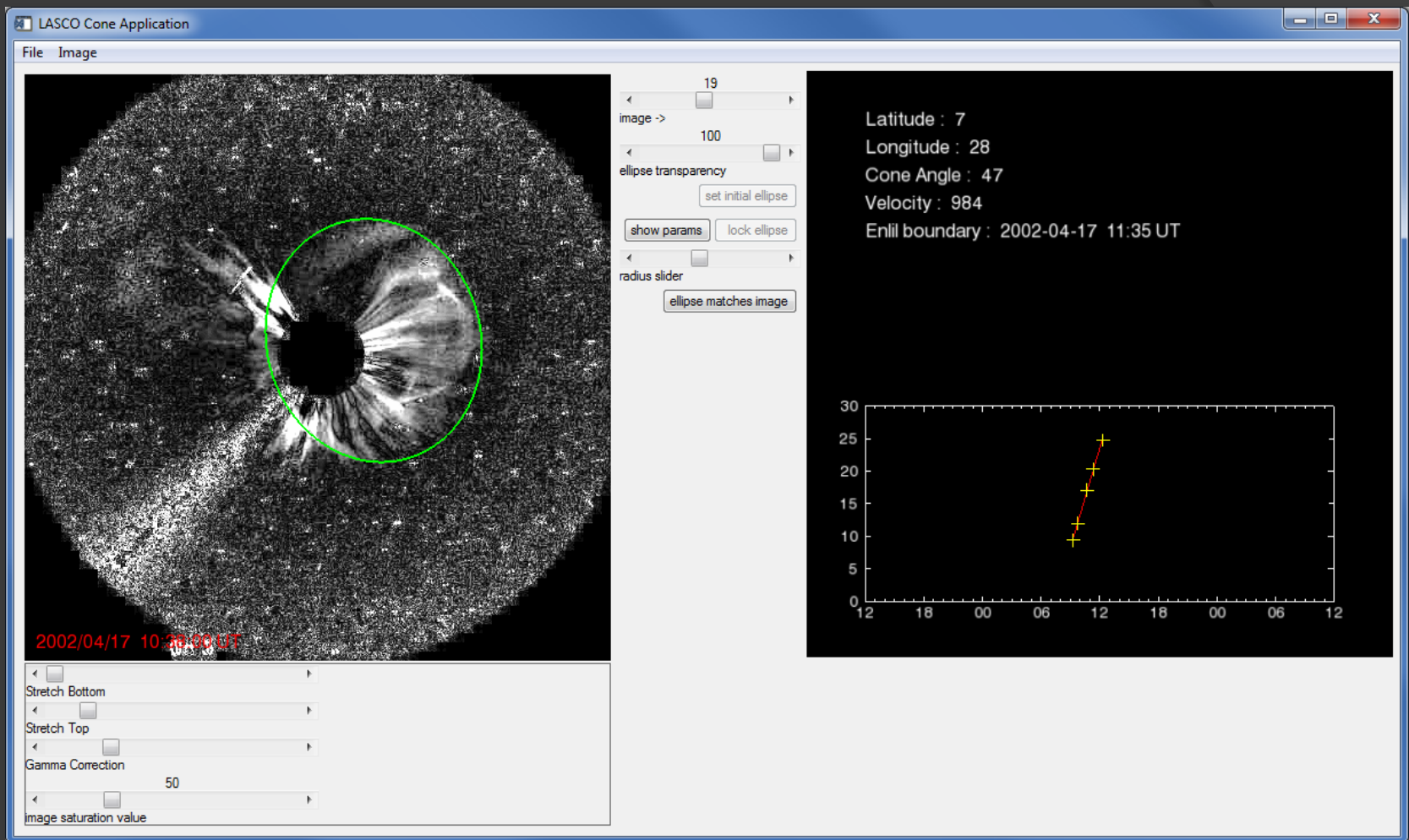






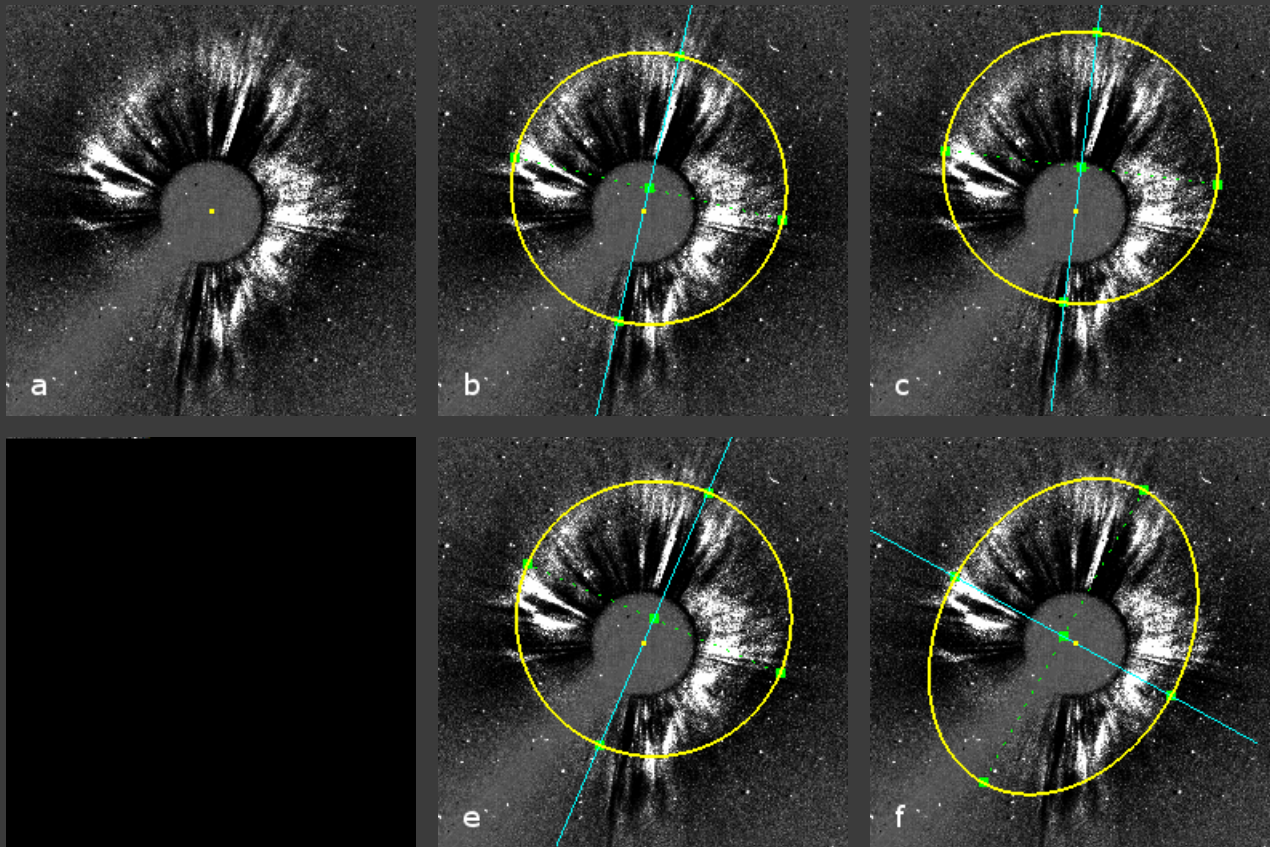
Ellipse parameters gives CME propagation direction and cone angle.

A second coronagraph image yields propagation velocity.



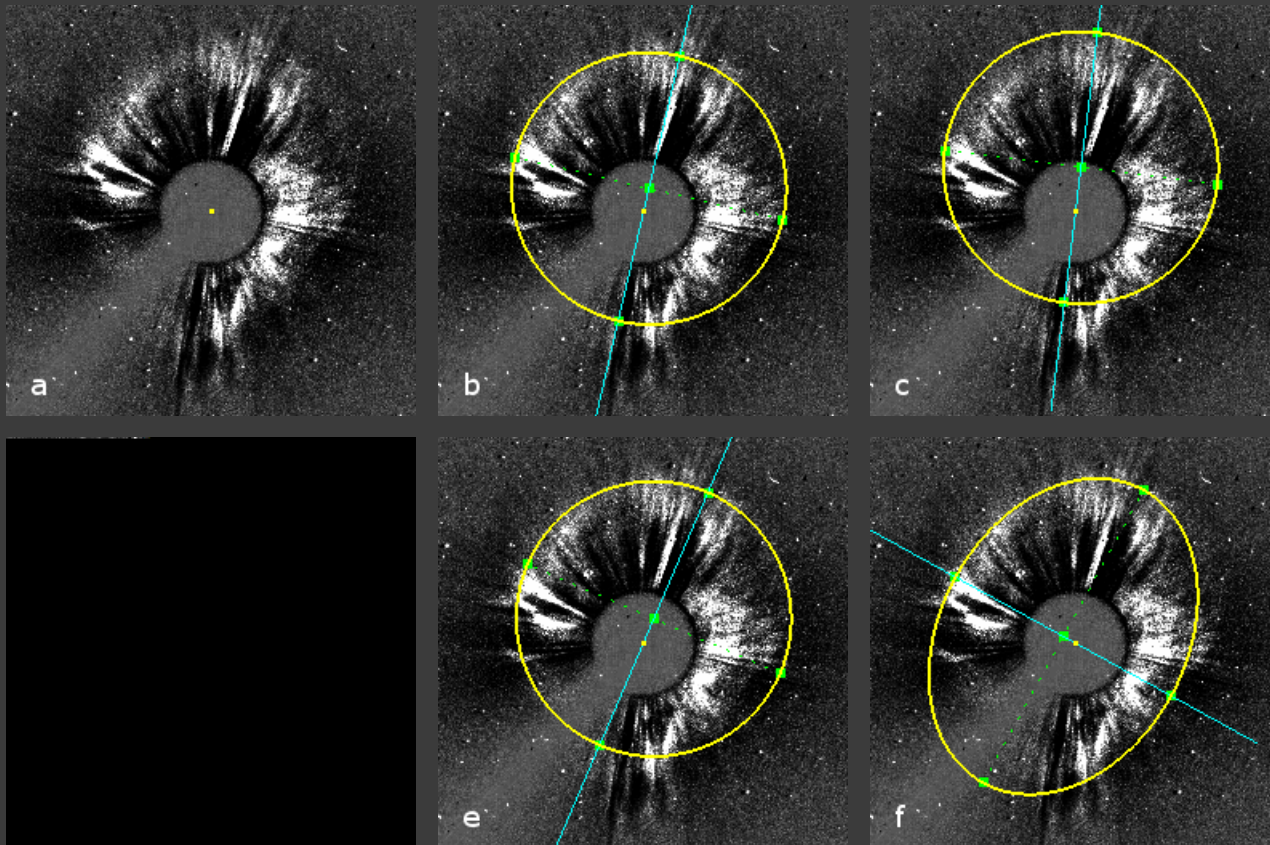
- Built the ellipse formulation into an operational tool.
- Subsequent V&V studies revealed the technique to be highly problematic in many real world situations.

Problem: Which ellipse ?



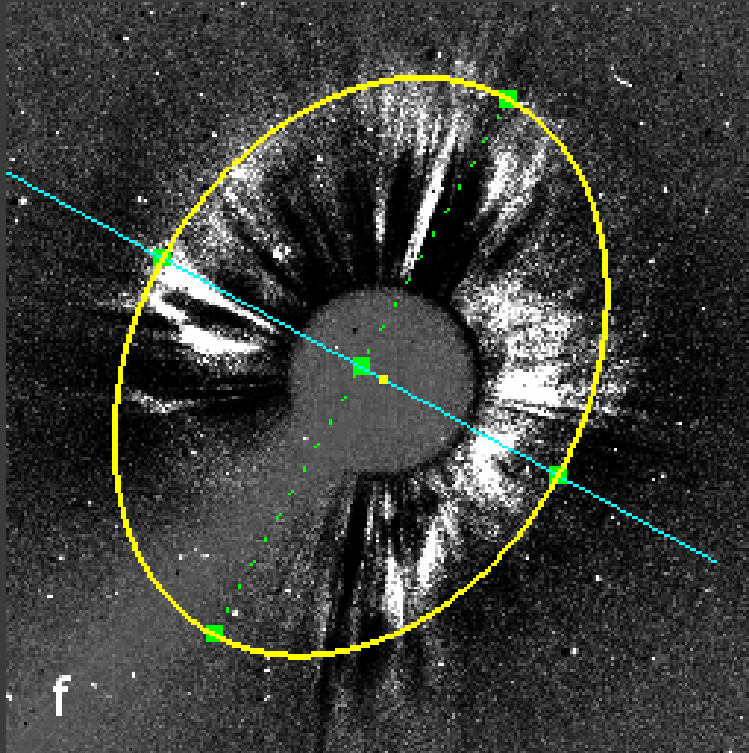
	Latitude (deg)	Longitude (deg)	Cone $\frac{1}{2}$ Angle (deg)	Radial distance (Rs)
b	9.1	2.3	43.2	14.7
c	9.4	1.3	26.9	22.3
d	0.7	0.2	4.4	132.4
e	3.8	1.7	20.3	29.0
f	20.8	-37.8	83.0	12.3

Problem: Which ellipse ?

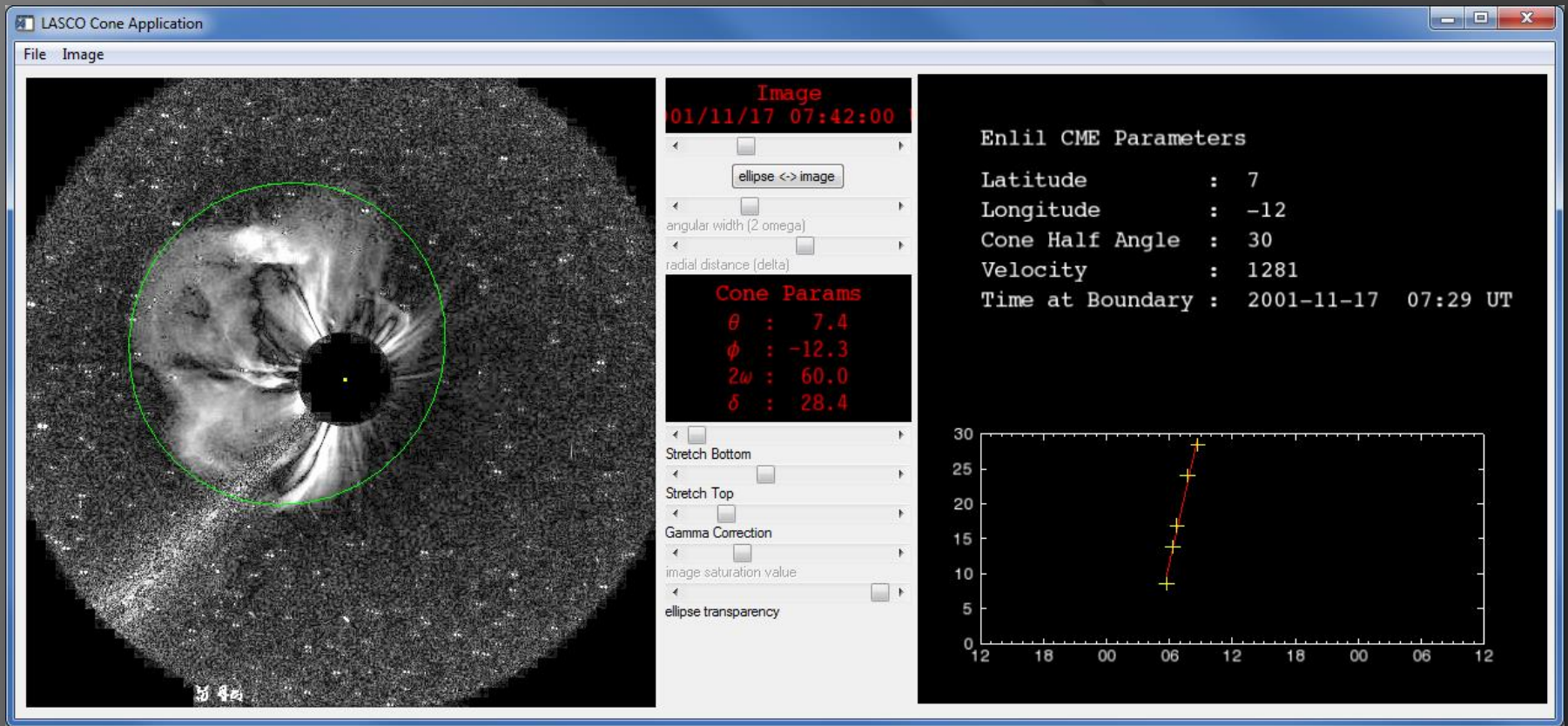


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b	9.1	2.3	43.2	14.7
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d	0.7	0.2	4.4	132.4
e	3.8	1.7	20.3	29.0
f	20.8	-37.8	83.0	12.3

Problem: Ellipses are “freeform” – no constraints on eccentricity vs offset



Cone $\frac{1}{2}$ Angle = 83 degrees (full Angle 166 !!)

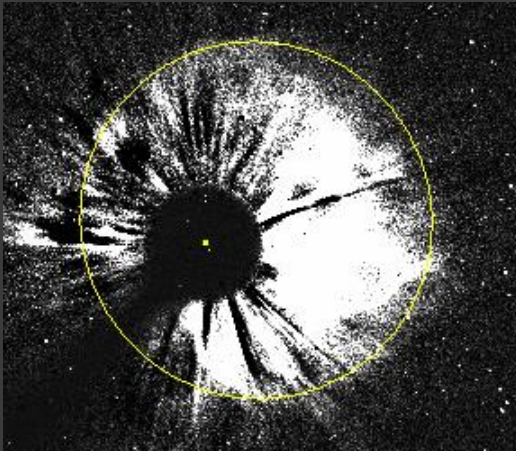


- Full 3D graphics solution – can only represent ‘correct’ cones originating at the Sun
- Need to know the cone angle
- Big problem since cone angle inversely proportional to *velocity (roughly)*

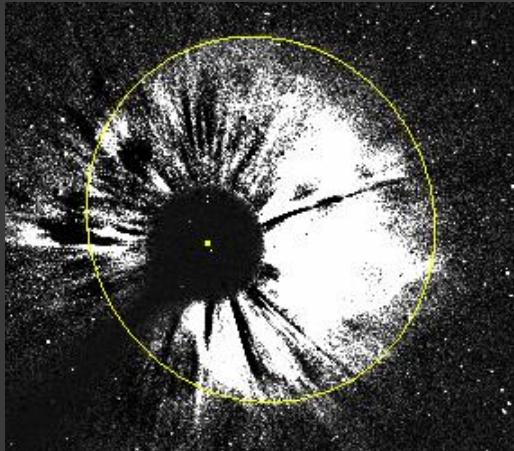
Again: Which ellipse ?

Cone $\frac{1}{2}$ Angle

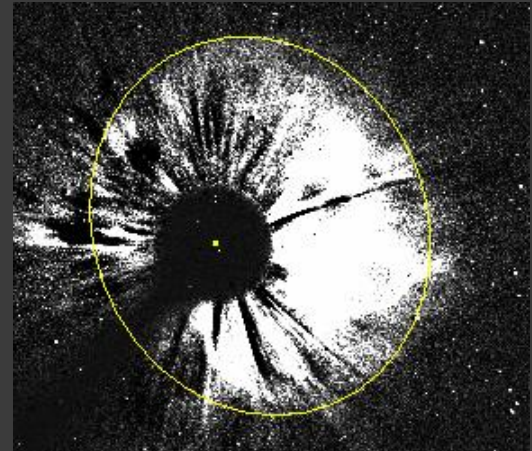
30 degrees



45 degrees

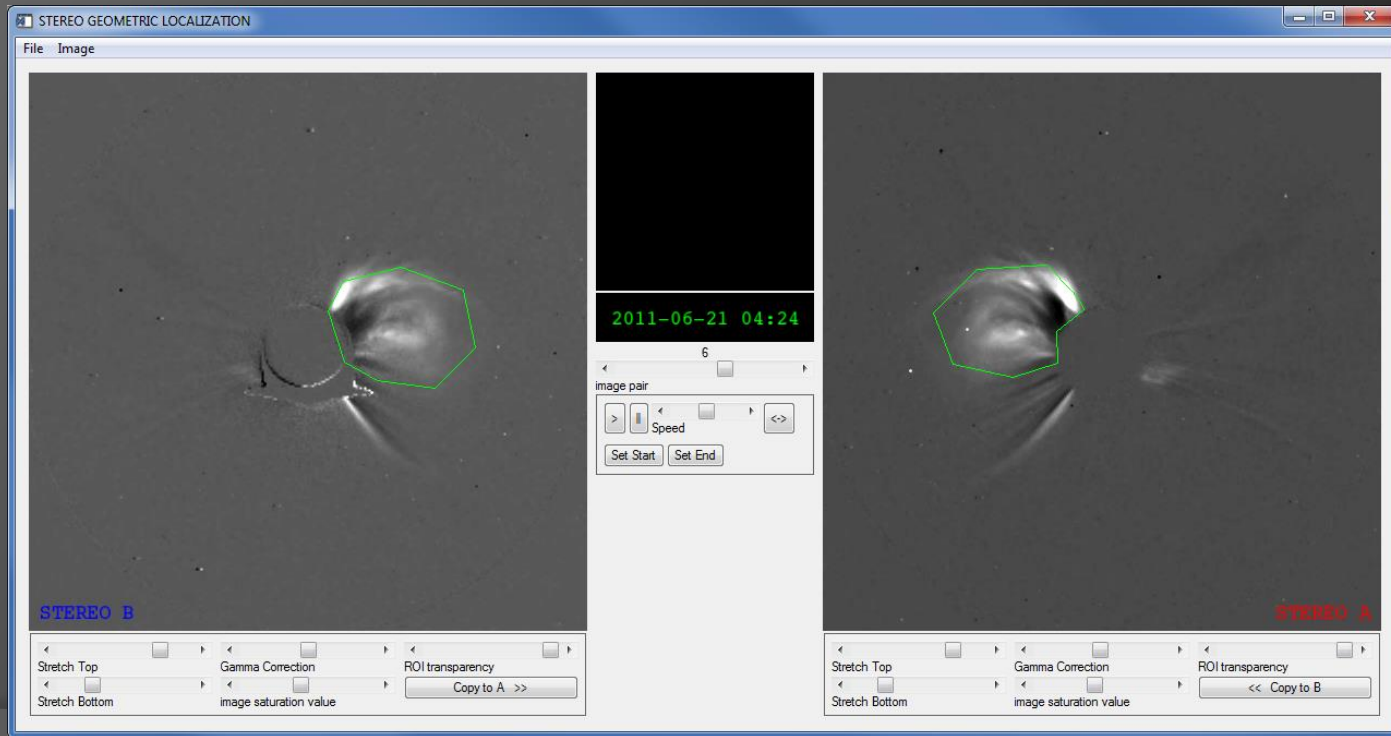
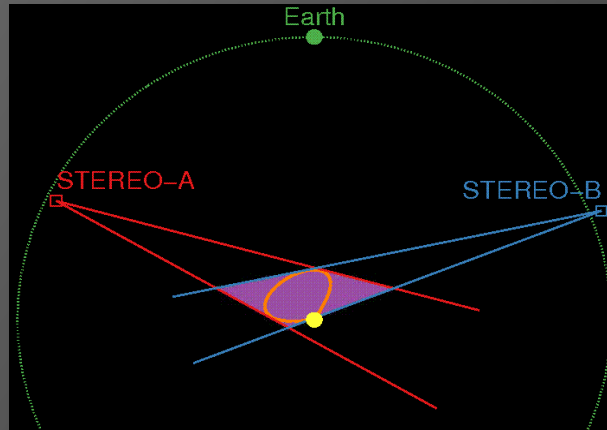


60 degrees

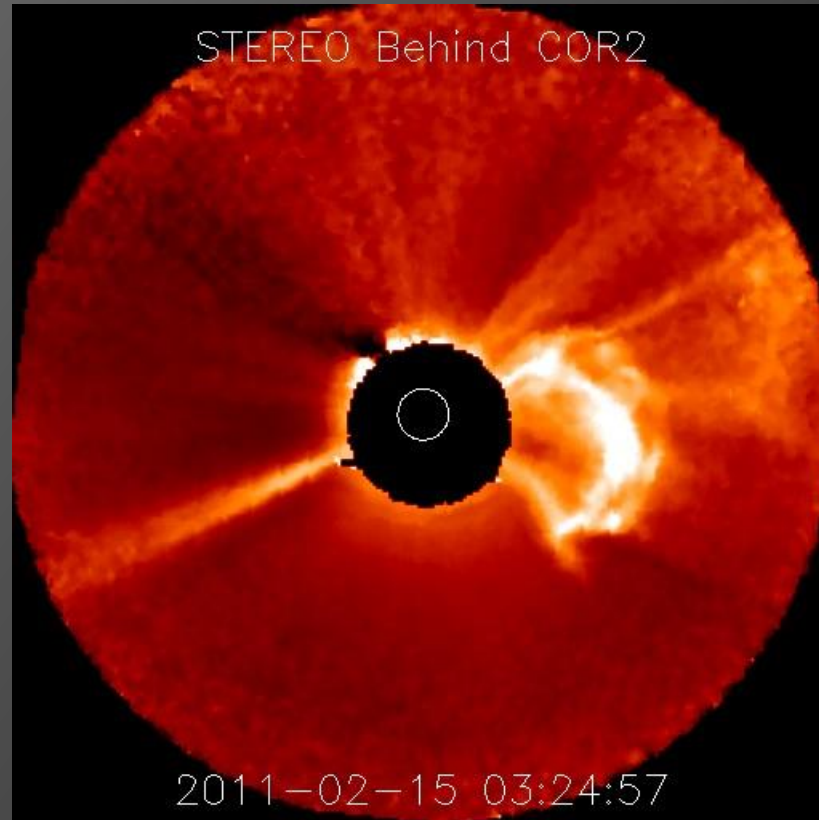


factor 2 difference
in velocity

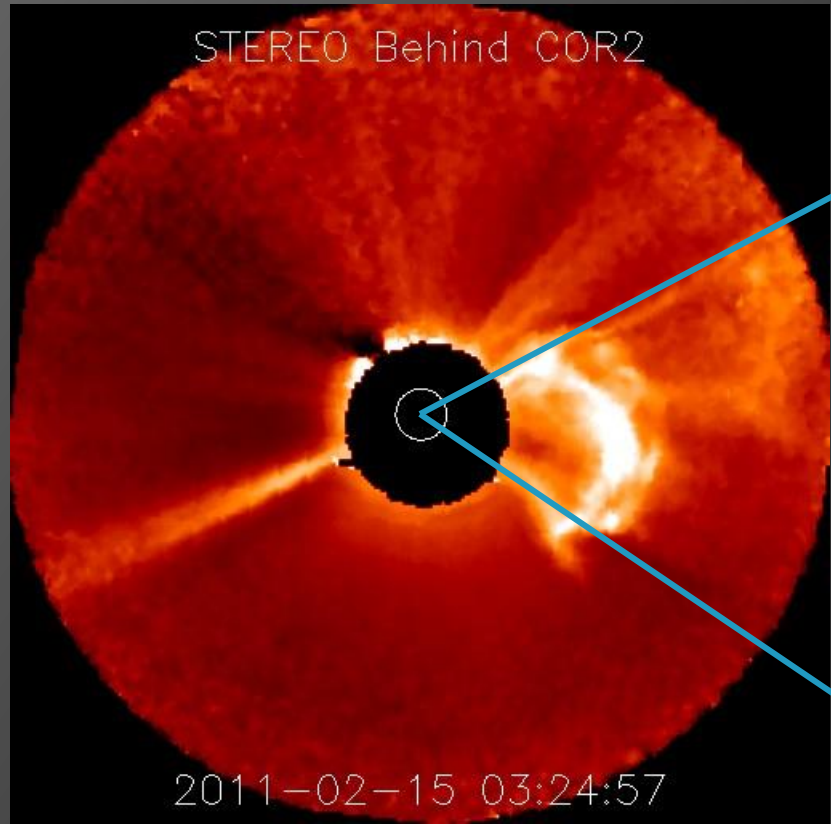
STEREO geometric localization Tool



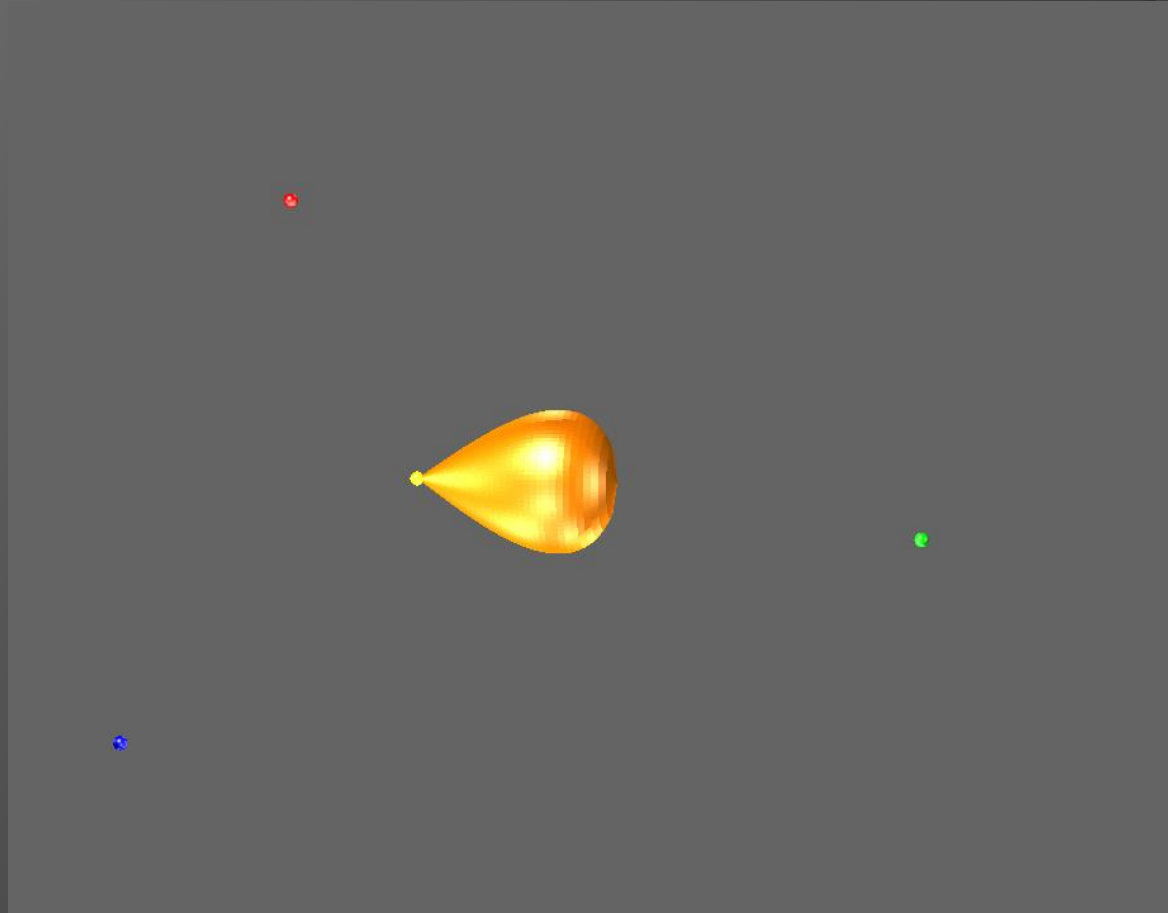
Estimation of Cone Angle from a side view (STEREO B)



Estimation of Cone Angle from a side view (STEREO B)



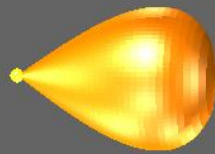
3D Graphics modeling



3D Graphics modeling

• STEREO A

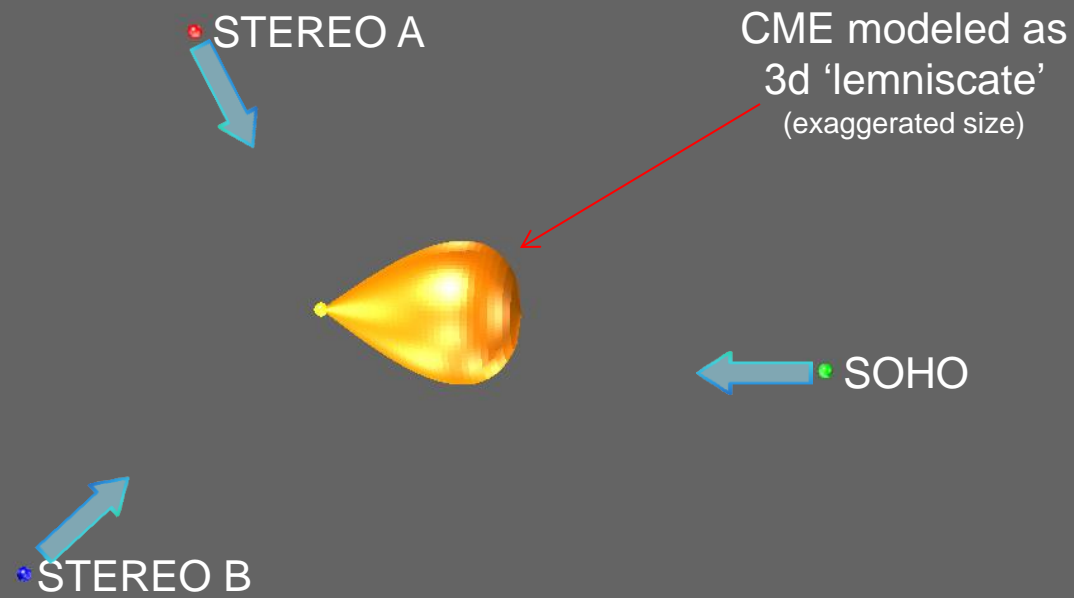
CME modeled as
3d 'lemniscate'
(exaggerated size)



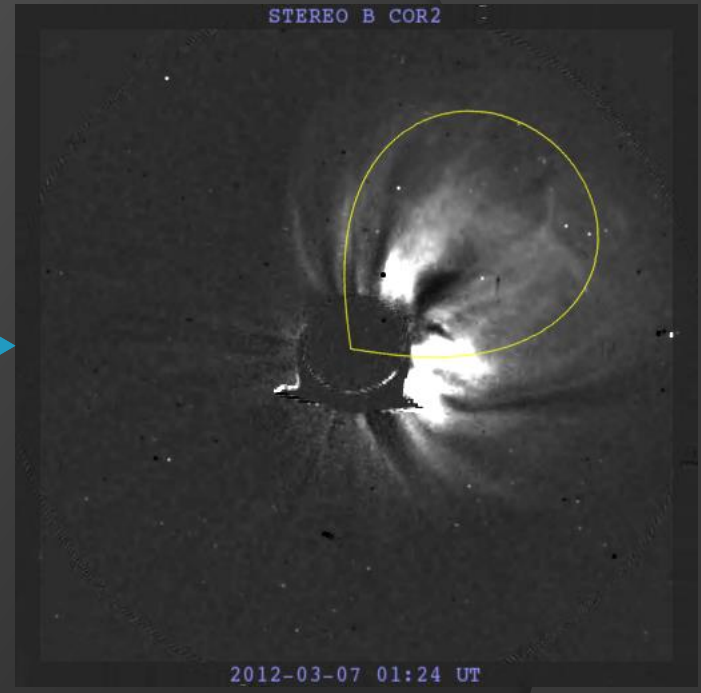
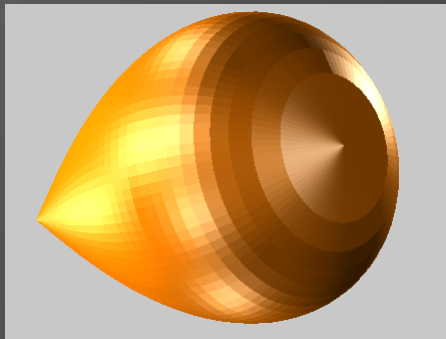
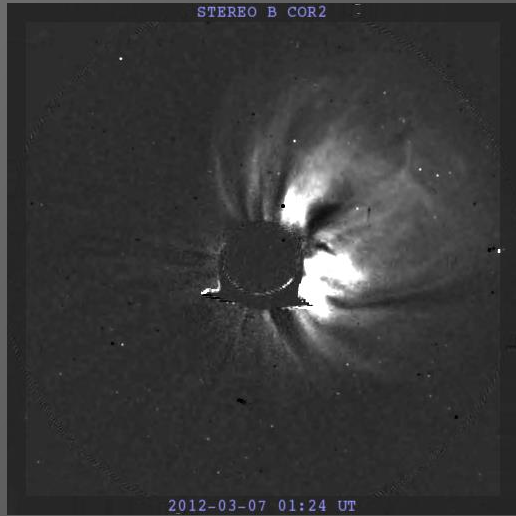
• SOHO

• STEREO B

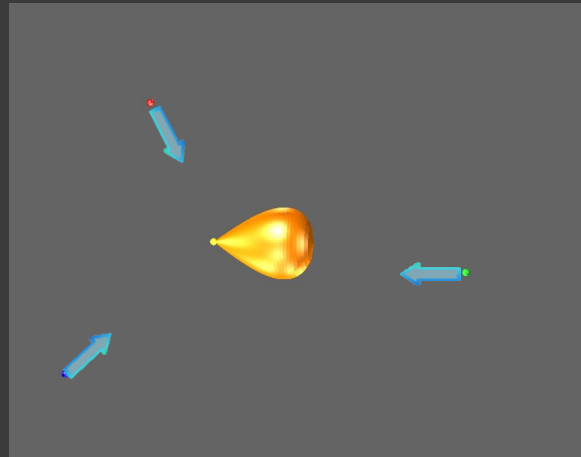
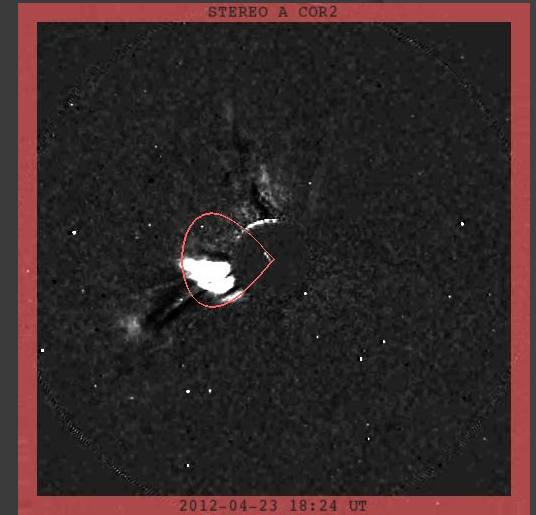
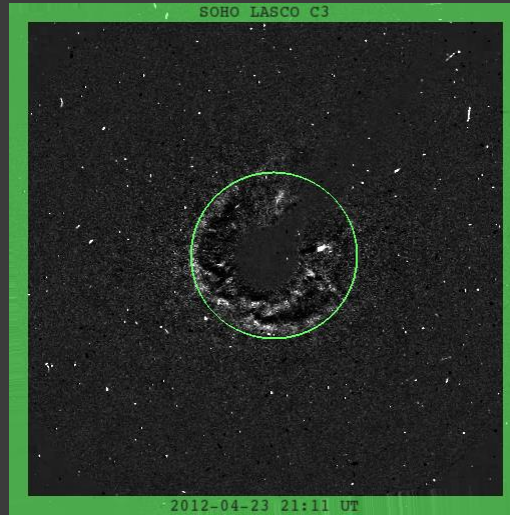
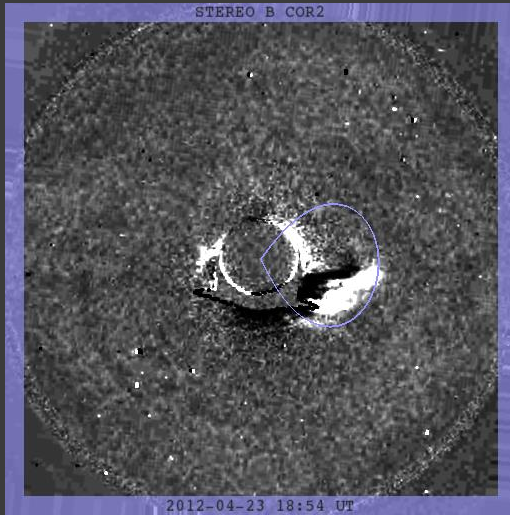
3D Graphics modeling



Overlay 3D model on coronagraph image



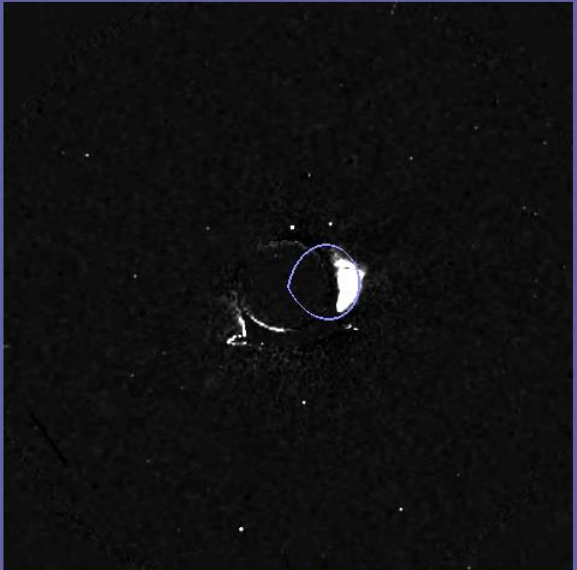
'3 view'



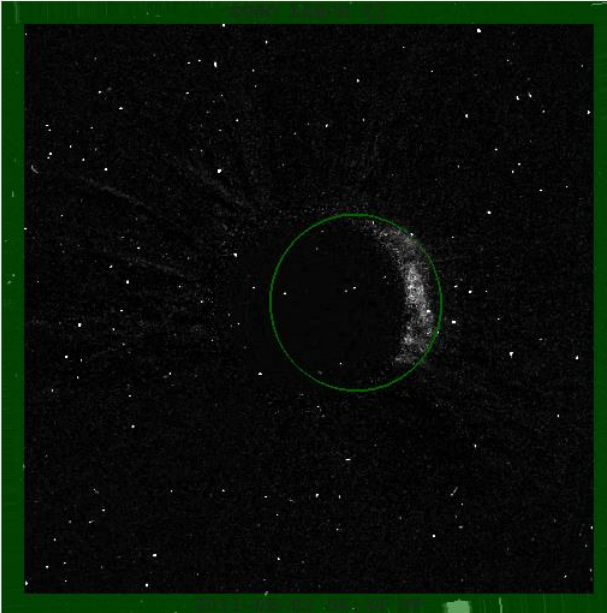
CME Analysis Tool (CAT)

CAT (CME Analysis Tool)

STEREO B COR2




2011-08-02 06:39 UT



2011-08-02 06:39 UT

STEREO A COR2



2011-08-02 06:39 UT

12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12

START / END TIMES

Start [Y M D H M]
2011 8 1 12

End [Y M D H M] +12h +24h
2011 8 2 12 0

Load Images

ANIMATION CONTROLS

L C R

Play

Speed Alt8

IMAGE ADJUST

L C R

Stretch Bottom

Stretch Top

Gamma Correction

image saturation value

Reset

<- Copy to L Copy to R ->

CME CONTROLS

Latitude

Longitude

Angular Width (2 omega)

Radial Distance (delta)

Transparency

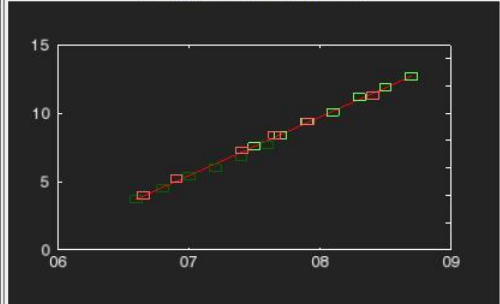
CME Parameters

θ : 8.5
 ϕ : 26.2
 2ω : 108.0
 δ : 3.7

Transparency

Bernoulli

CME LEADING EDGE vs TIME PLOT



15
10
5
0

06 07 08 09

ENLIL PARAMETERS

T 2011-08-02 10:44
Lat 9
Lon 26
Cone 54
Vel 827

Calculate Velocity

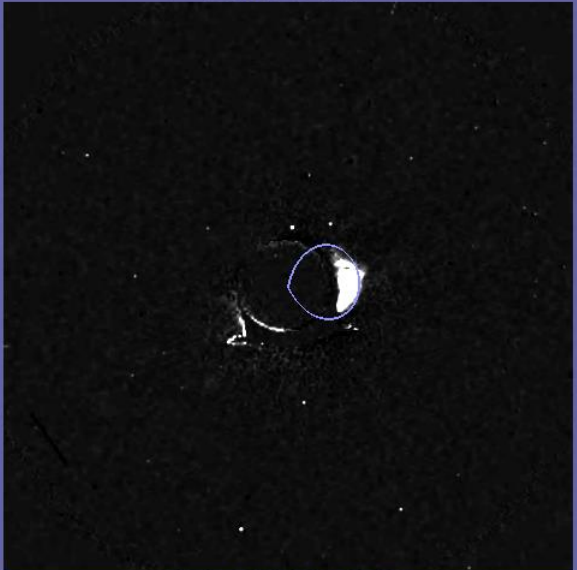
Export Analysis

Reset Analysis

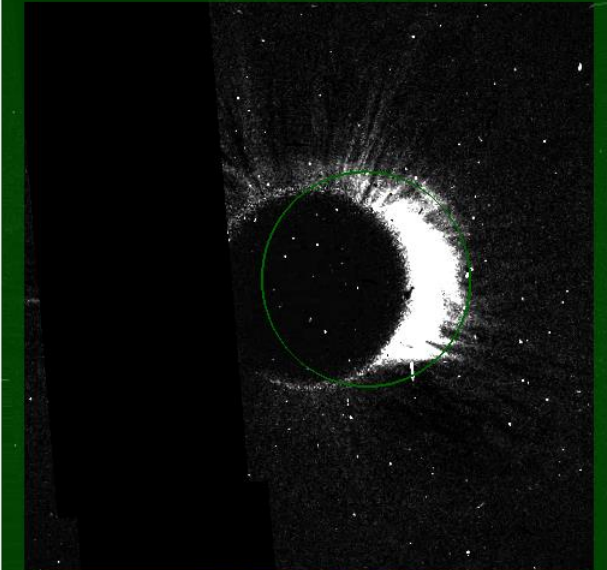
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2011-08-02 06:39 UT



2011-08-02 06:39 UT

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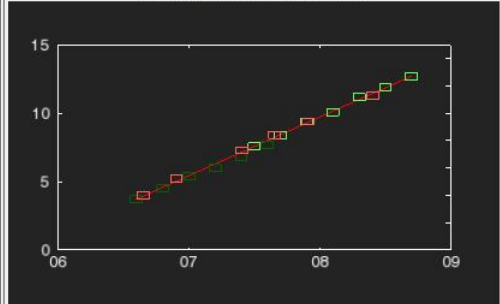
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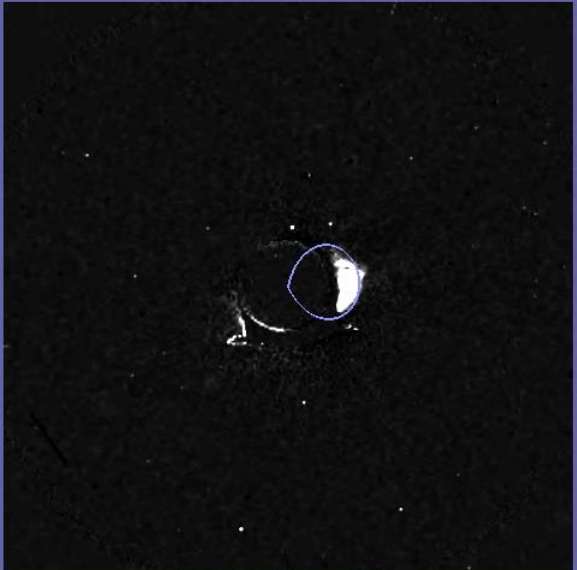
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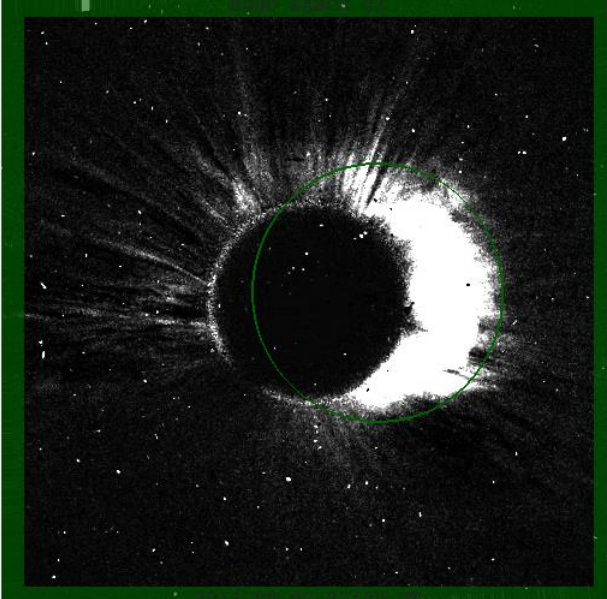
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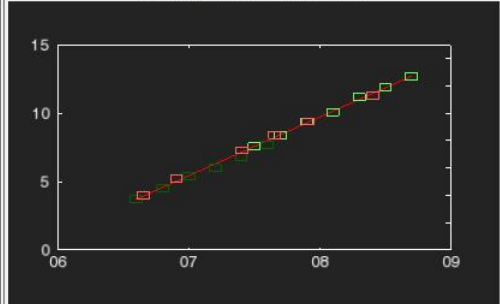
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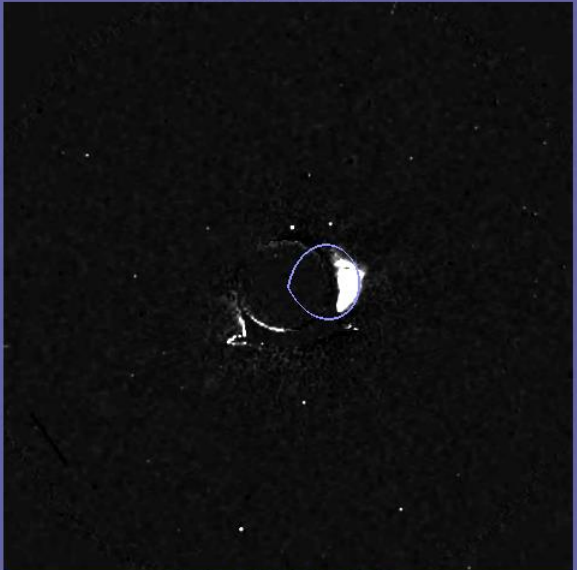
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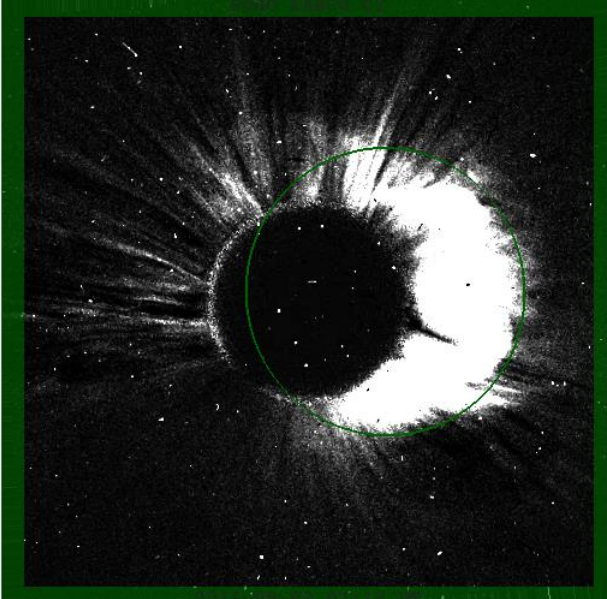
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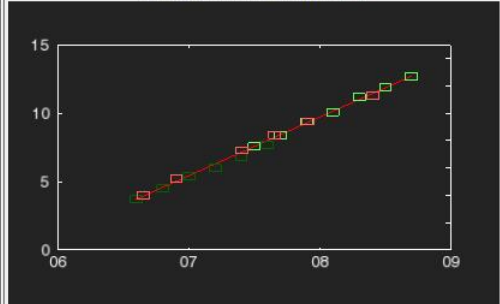
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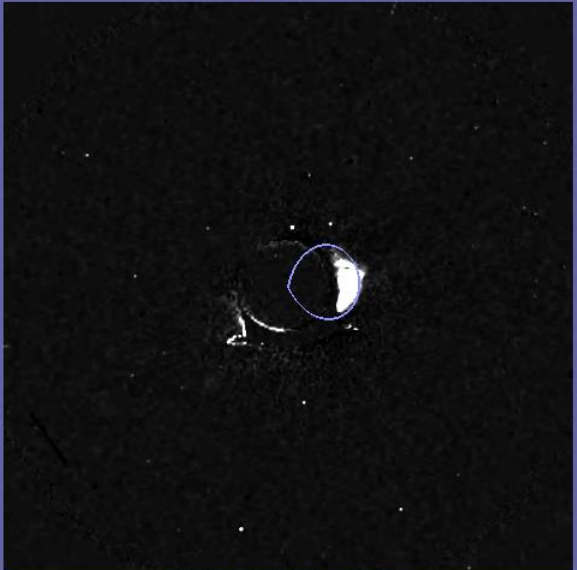
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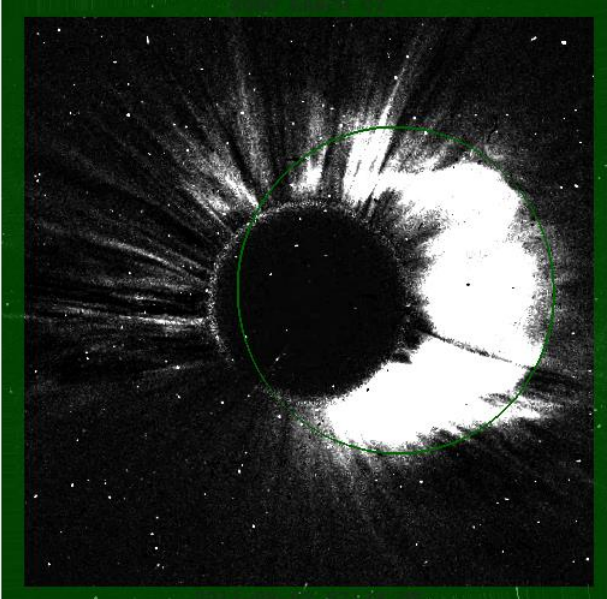
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2011-08-02 06:39 UT

STEREO A COR2



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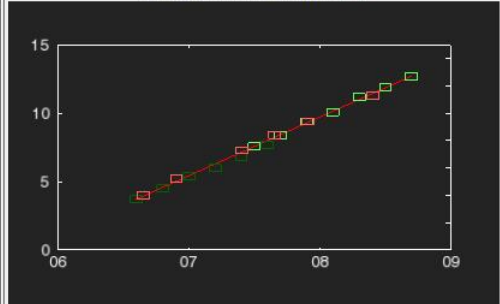
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Vel 827

Calculate Velocity

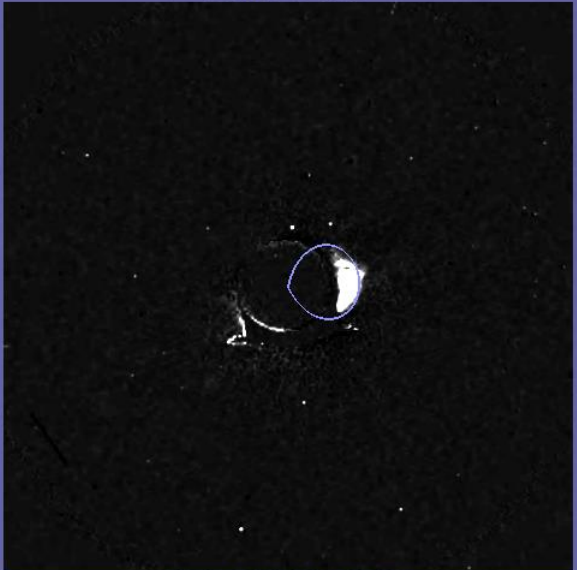
Export Analysis

Reset Analysis

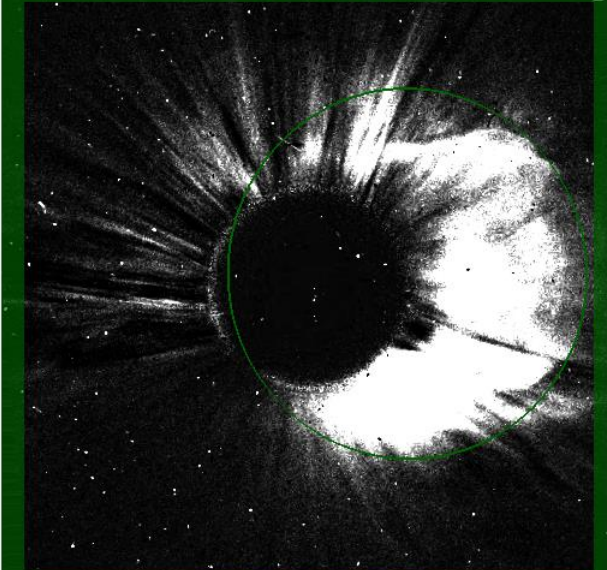
CME Analysis Tool (CAT)

CAT (CME Analysis Tool)

STEREO B COR2




2011-08-02 06:39 UT



2011-08-02 06:39 UT

STEREO A COR2



2011-08-02 06:39 UT

12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12

START / END TIMES

Start [Y M D H M]
2011 8 1 12

End [Y M D H M] +12h +24h
2011 8 2 12 0

Load Images

ANIMATION CONTROLS

L C R

Play

Speed Altern8

IMAGE ADJUST

L C R

Stretch Bottom

Stretch Top

Gamma Correction

image saturation value

Reset

<- Copy to L Copy to R ->

CME CONTROLS

Latitude

Longitude

Angular Width (2 omega)

Radial Distance (delta)

Transparency

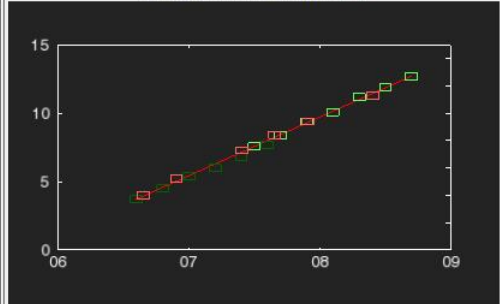
CME Parameters

θ : 8.5
 ϕ : 26.2
 2ω : 108.0
 δ : 3.7

Transparency

Bernoulli

CME LEADING EDGE vs TIME PLOT



ENLIL PARAMETERS

T 2011-08-02 10:44
Lat 9
Lon 26
Cone 54
Vel 827

Calculate Velocity

Export Analysis

Reset Analysis

CME Analysis Tool (CAT)

CAT (CME Analysis Tool)

STEREO B COR2

SOHO LASCO C2

STEREO A COR2

2011-08-02 06:24 UT

START TIME: 2011-08-02 10:44
Lat 9
Lon 26
Cone 54
Vel 827

Calculate Velocity
Export Analysis
Reset Analysis

START TIME: 2011-08-02 10:44
Year (YYYY) MM DD
2011 8 1 12
Panel (YYYY) MM DD
2011 8 2 12 0
Load Images

PLAYBACK CONTROLS
Play

IMAGE PROPERTIES
L C R
Start of Projection
Start of Legs
Camera Cone Size
Reset
<< Copy to L Copy to R >>

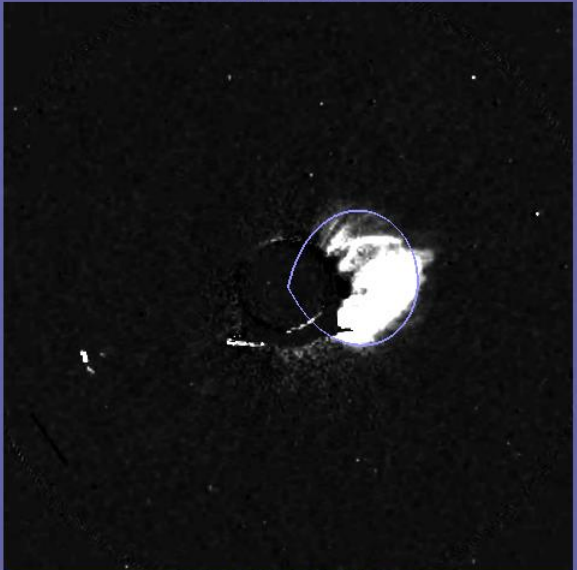
CME PARAMETERS
Latitude
Longitude
Angular Width (2 Omega)
Speed (km/s) @ 1 AU
Inequality
CME Parameters
 θ : 8.5
 ϕ : 26.2
 2ω : 108.0
 δ : 3.7

COMBINED DATA TIME: 10:44
15
10
5
0
06 07 08 09

CME Analysis Tool (CAT)

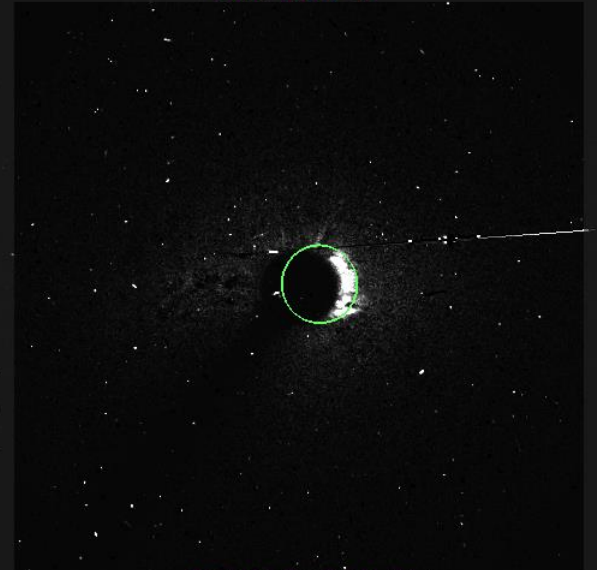
CAT (CME Analysis Tool)

STEREO B COR2



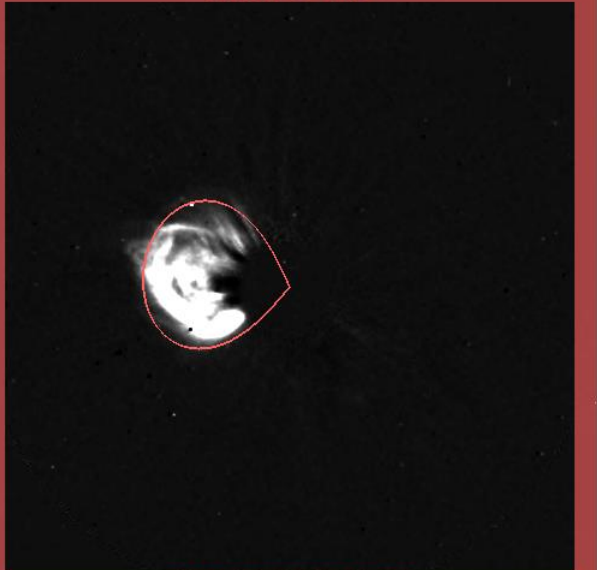
2011-08-02 07:24 UT

SOHO LASCO C3



2011-08-02 07:30 UT

STEREO A COR2



2011-08-02 07:24 UT

12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12

START / END TIMES

Start [Y M D H M]
2011 8 1 12

End [Y M D H M] +12h +24h
2011 8 2 12 0

Load Images

ANIMATION CONTROLS

L C R

Play

Speed Alt8

IMAGE ADJUST

L C R

Stretch Bottom

Stretch Top

Gamma Correction

image saturation value

Reset

<- Copy to L Copy to R ->

CME CONTROLS

Latitude

Longitude

Angular Width (2 omega)

Radial Distance (delta)

Transparency

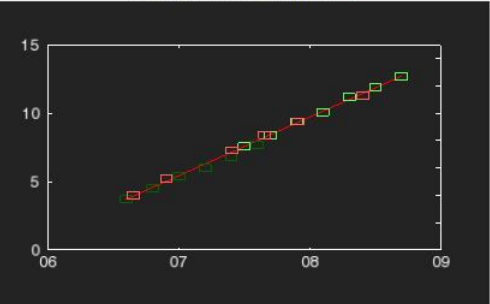
CME Parameters

θ : 8.5
 ϕ : 26.2
 2ω : 108.0
 δ : 3.7

Transparency

Bernoulli

CME LEADING EDGE vs TIME PLOT



06 07 08 09

ENLIL PARAMETERS

T 2011-08-02 10:44
Lat 9
Lon 26
Cone 54
Vel 827

Calculate Velocity

Export Analysis

Reset Analysis

CME Analysis Tool (CAT)

CAT (CME Analysis Tool)

STEREO B COR2

2011-08-02 07:39 UT

SOHO LASCO C3

2011-08-02 07:42 UT

STEREO A COR2

2011-08-02 07:39 UT

Timeline: 12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12

START / END TIMES

Start [Y M D H M]: 2011 8 1 12

End [Y M D H M]: +12h +24h
2011 8 2 12 0

Load Images

ANIMATION CONTROLS

L C R

Play

Speed Altern8

IMAGE ADJUST

L C R

Stretch Bottom

Stretch Top

Gamma Correction

image saturation value

Reset

<- Copy to L Copy to R ->

CME CONTROLS

Latitude

Longitude

Angular Width (2 omega)

Radial Distance (delta)

Transparency

CME Parameters

θ : 8.5

ϕ : 26.2

2ω : 108.0

δ : 3.7

Transparency

Bernoulli

CME LEADING EDGE vs TIME PLOT

15

10

5

0

06 07 08 09

ENLIL PARAMETERS

T 2011-08-02 10:44

Lat 9

Lon 26

Cone 54

Vel 827

Calculate Velocity

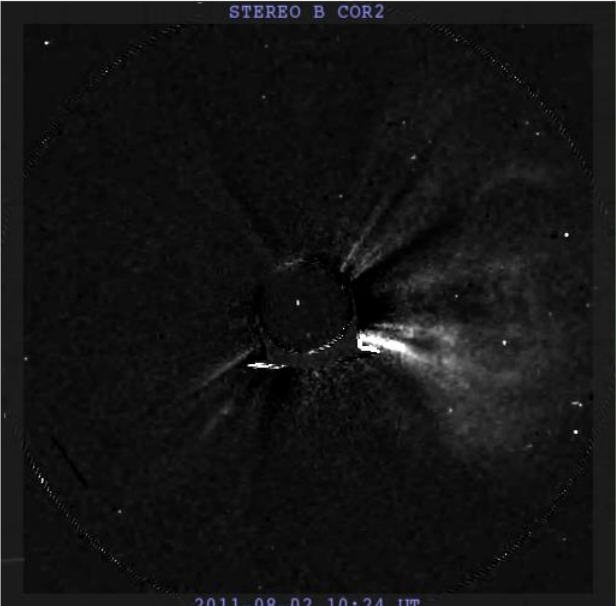
Export Analysis

Reset Analysis

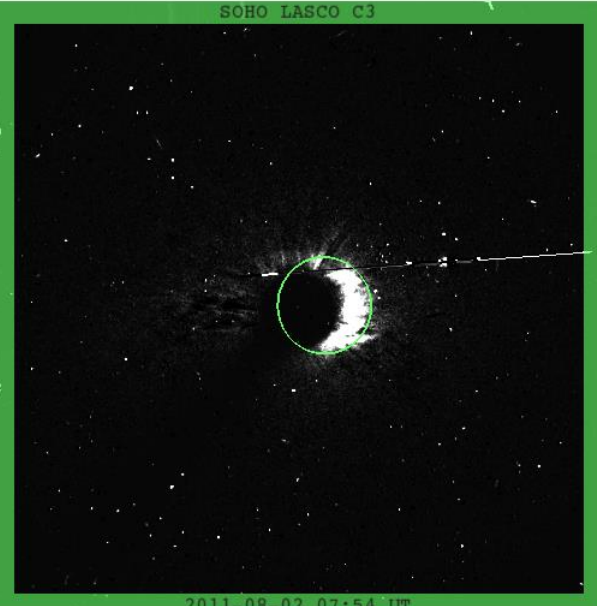
CME Analysis Tool (CAT)

CAT (CME Analysis Tool)

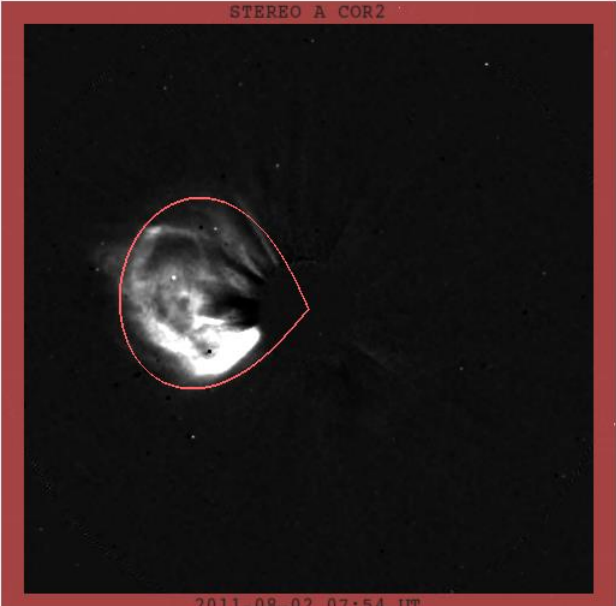
STEREO B COR2
2011-08-02 10:24 UT



SOHO LASCO C3
2011-08-02 07:54 UT



STEREO A COR2
2011-08-02 07:54 UT



12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12

START / END TIMES

Start [Y M D H M]
2011 8 1 12

End [Y M D H M] +12h +24h
2011 8 2 12 0

Load Images

ANIMATION CONTROLS

L C R

Play

Speed Alt8

IMAGE ADJUST

L C R

Stretch Bottom

Stretch Top

Gamma Correction

image saturation value

Reset

<- Copy to L Copy to R ->

CME CONTROLS

Latitude

Longitude

Angular Width (2 omega)

Radial Distance (delta)

Transparency

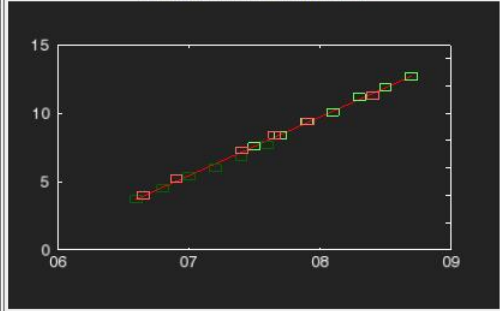
CME Parameters

θ : 8.5
 ϕ : 26.2
 2ω : 108.0
 δ : 3.7

Transparency

Bernoulli

CME LEADING EDGE vs TIME PLOT



Time (UT)	Latitude
06:30	4.0
07:00	5.0
07:30	7.0
08:00	8.5
08:30	10.0
09:00	12.0

ENLIL PARAMETERS

T 2011-08-02 10:44
Lat 9
Lon 26
Cone 54
Vel 827

Calculate Velocity
Export Analysis
Reset Analysis

CME Analysis Tool (CAT)

CAT (CME Analysis Tool)

STEREO B COR2
2011-08-02 10:24 UT

SOHO LASCO C3
2011-08-02 08:06 UT

STEREO A COR2
2011-08-02 08:24 UT

12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12

START / END TIMES

Start [Y M D H M]
2011 8 1 12

End [Y M D H M] +12h +24h
2011 8 2 12 0

Load Images

ANIMATION CONTROLS

L C R

Play

Speed Alt8

IMAGE ADJUST

L C R

Stretch Bottom

Stretch Top

Gamma Correction

image saturation value

Reset

<- Copy to L Copy to R ->

CME CONTROLS

Latitude

Longitude

Angular Width (2 omega)

Radial Distance (delta)

Transparency

CME Parameters

θ : 8.5
 ϕ : 26.2
 2ω : 108.0
 δ : 3.7

Transparency

Bernoulli

CME LEADING EDGE vs TIME PLOT

Time (UT)	Position
06.5	4.0
07.0	5.5
07.5	7.5
08.0	9.5
08.5	11.5
08.8	13.0

ENLIL PARAMETERS

T 2011-08-02 10:44
Lat 9
Lon 26
Cone 54
Vel 827

Calculate Velocity
Export Analysis
Reset Analysis

CME Analysis Tool (CAT)

CAT (CME Analysis Tool)

STEREO B COR2
2011-08-02 10:24 UT

SOHO LASCO C3
2011-08-02 08:18 UT

STEREO A COR2
2011-08-02 08:39 UT

12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12

START / END TIMES

Start [Y M D H M]
2011 8 1 12

End [Y M D H M] +12h +24h
2011 8 2 12 0

Load Images

ANIMATION CONTROLS

L C R

Play

Speed Alt8

IMAGE ADJUST

L C R

Stretch Bottom

Stretch Top

Gamma Correction

image saturation value

Reset

<- Copy to L Copy to R ->

CME CONTROLS

Latitude

Longitude

Angular Width (2 omega)

Radial Distance (delta)

Transparency

CME Parameters

θ : 8.5
 ϕ : 26.2
 2ω : 108.0
 δ : 3.7

Transparency

Bernoulli

CME LEADING EDGE vs TIME PLOT

ENLIL PARAMETERS

T 2011-08-02 10:44
Lat 9
Lon 26
Cone 54
Vel 827

Calculate Velocity
Export Analysis
Reset Analysis

CME Analysis Tool (CAT)

CAT (CME Analysis Tool)

STEREO B COR2
2011-08-02 10:24 UT

SOHO LASCO C3
2011-08-02 08:42 UT

STEREO A COR2
2011-08-02 08:39 UT

12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12

START / END TIMES

Start [Y M D H M]
2011 8 1 12

End [Y M D H M] +12h +24h
2011 8 2 12 0

Load Images

ANIMATION CONTROLS

L C R

Play

Speed Alt8

IMAGE ADJUST

L C R

Stretch Bottom

Stretch Top

Gamma Correction

image saturation value

Reset

<- Copy to L Copy to R ->

CME CONTROLS

Latitude

Longitude

Angular Width (2 omega)

Radial Distance (delta)

Transparency

CME Parameters

θ : 8.5
 ϕ : 26.2
 2ω : 108.0
 δ : 3.7

Transparency

Bernoulli

CME LEADING EDGE vs TIME PLOT

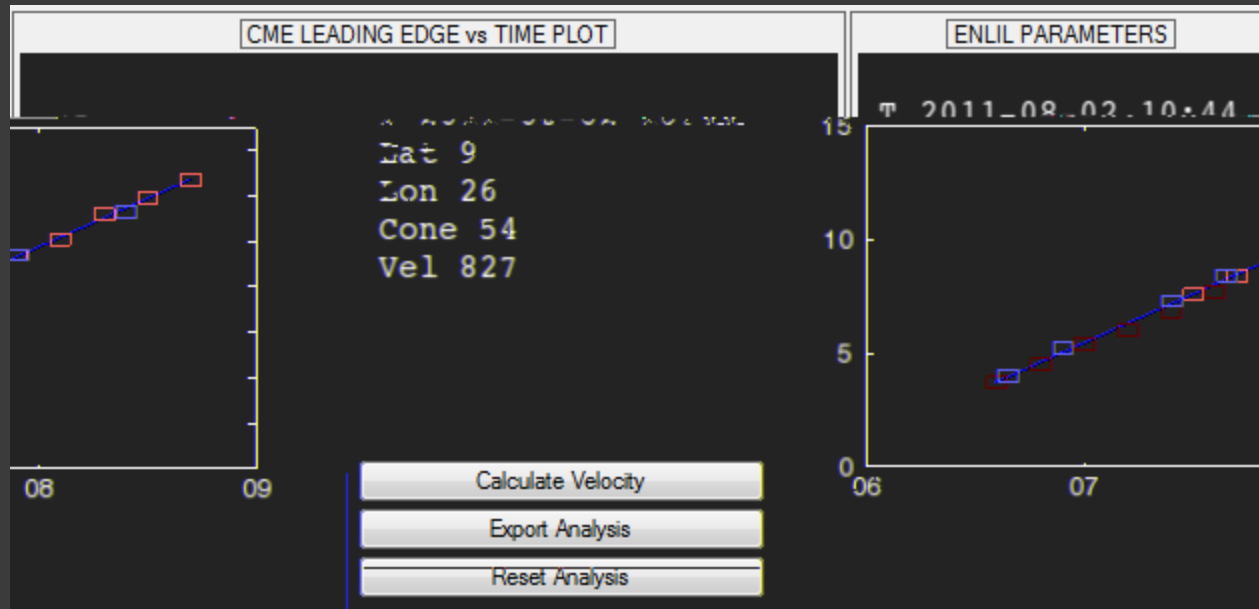
Time (UTC)	Position
06:30	4.0
07:00	5.0
07:30	7.0
08:00	8.5
08:30	10.0
08:45	11.0
09:00	12.0

ENLIL PARAMETERS

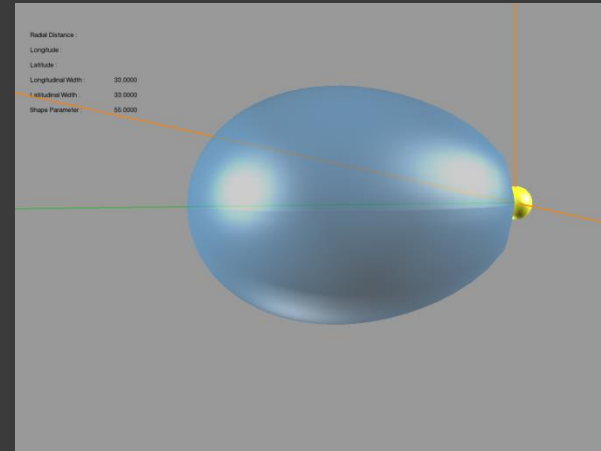
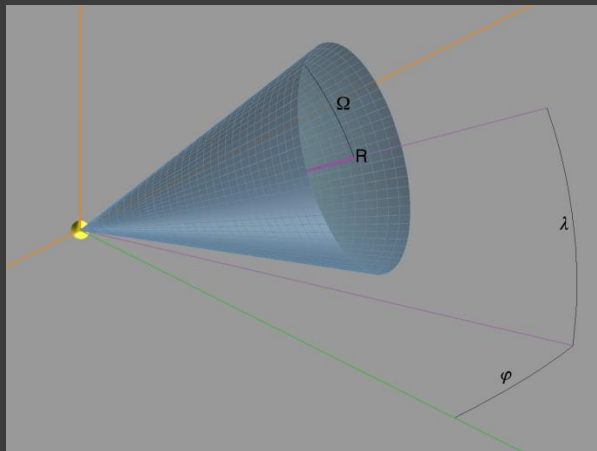
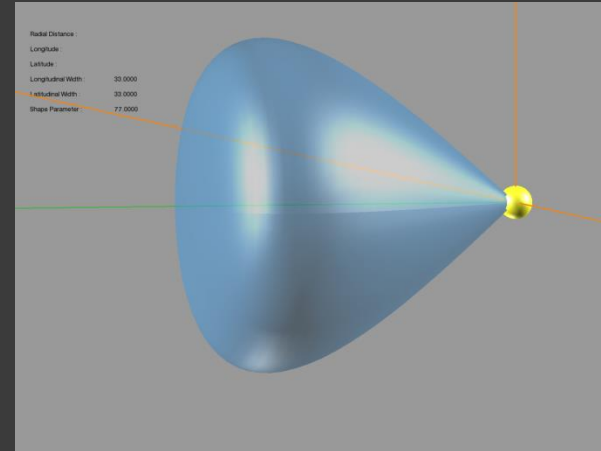
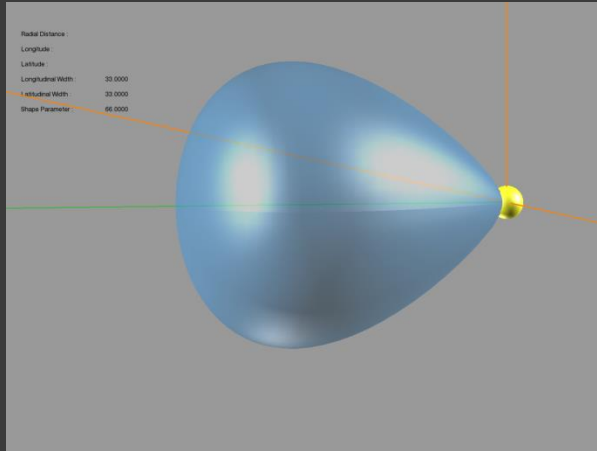
T 2011-08-02 10:44
Lat 9
Lon 26
Cone 54
Vel 827

Calculate Velocity
Export Analysis
Reset Analysis

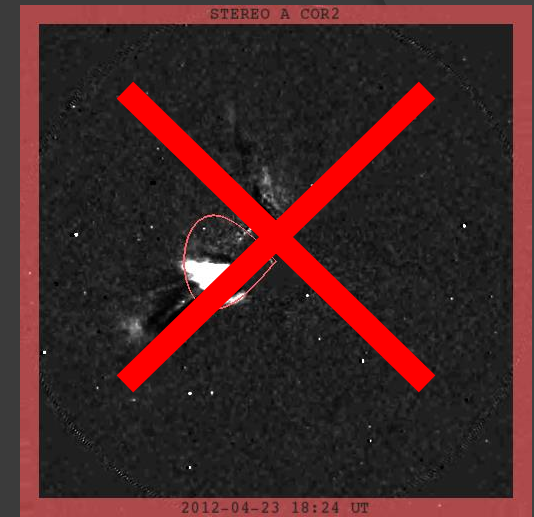
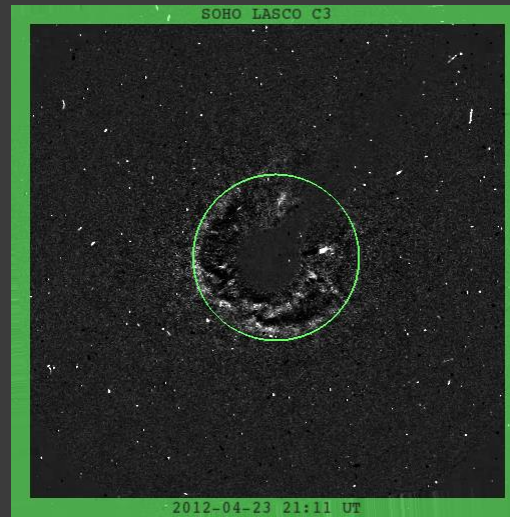
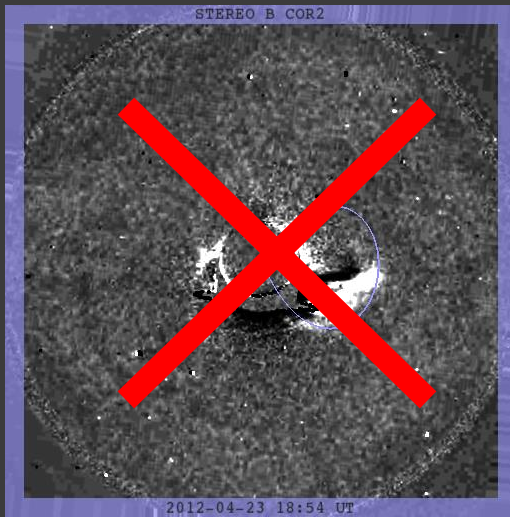
The result: CME parameters for Enlil



Researching different CME objects (Curt de Koning)

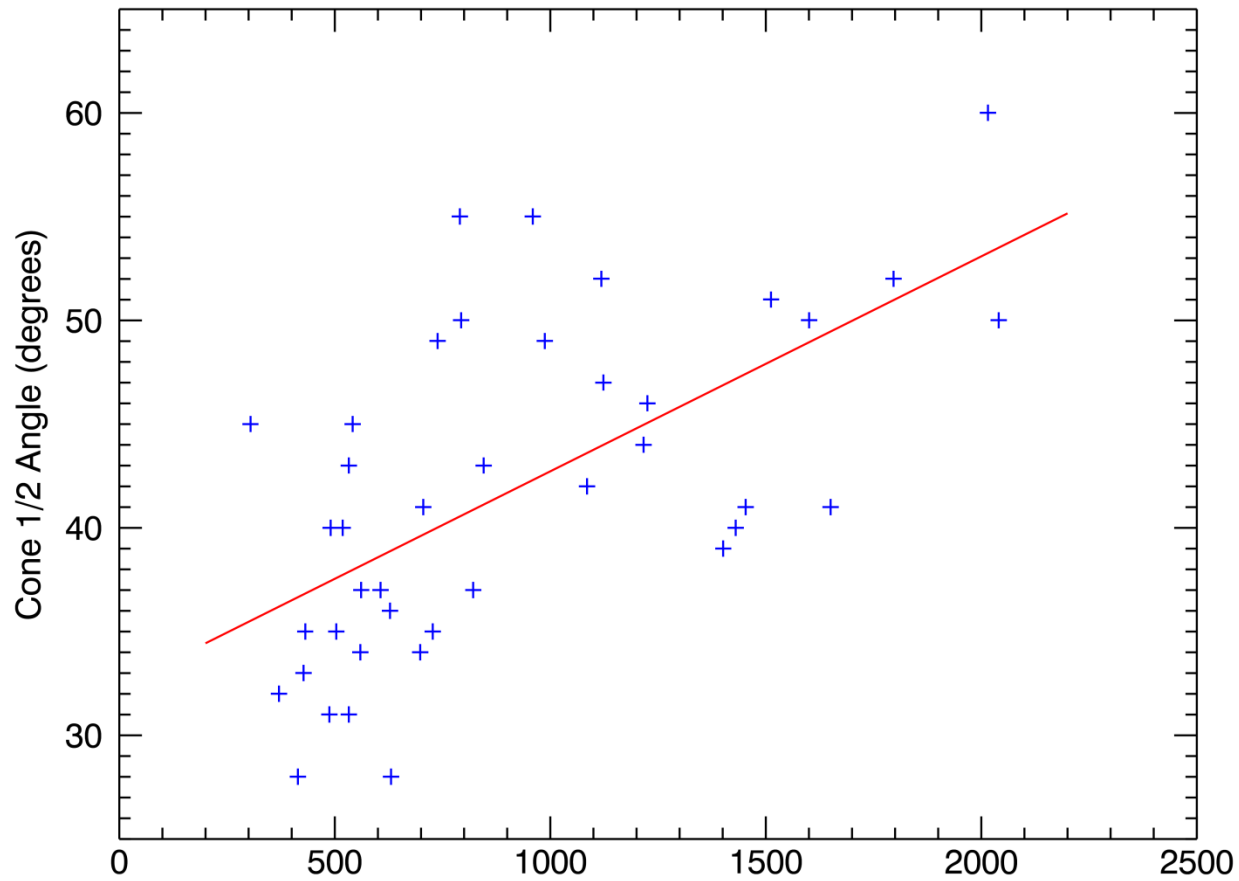


What if we only have one Coronagraph ?



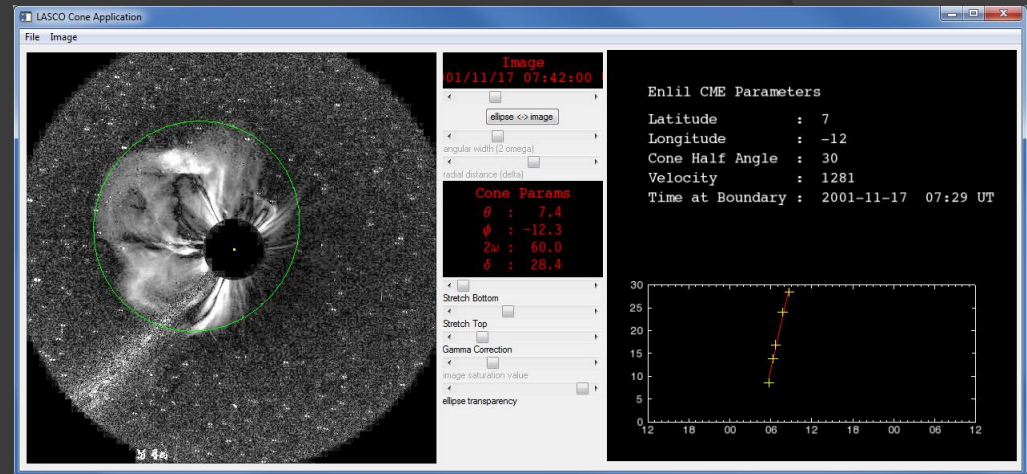
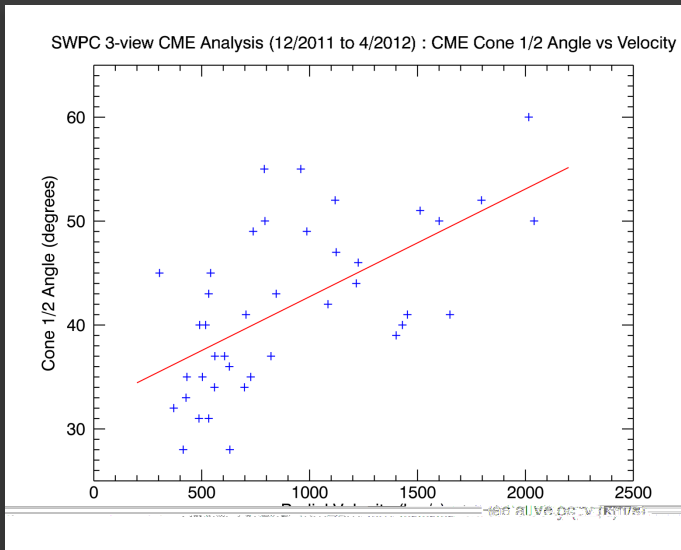
What if we only have one Coronagraph ?

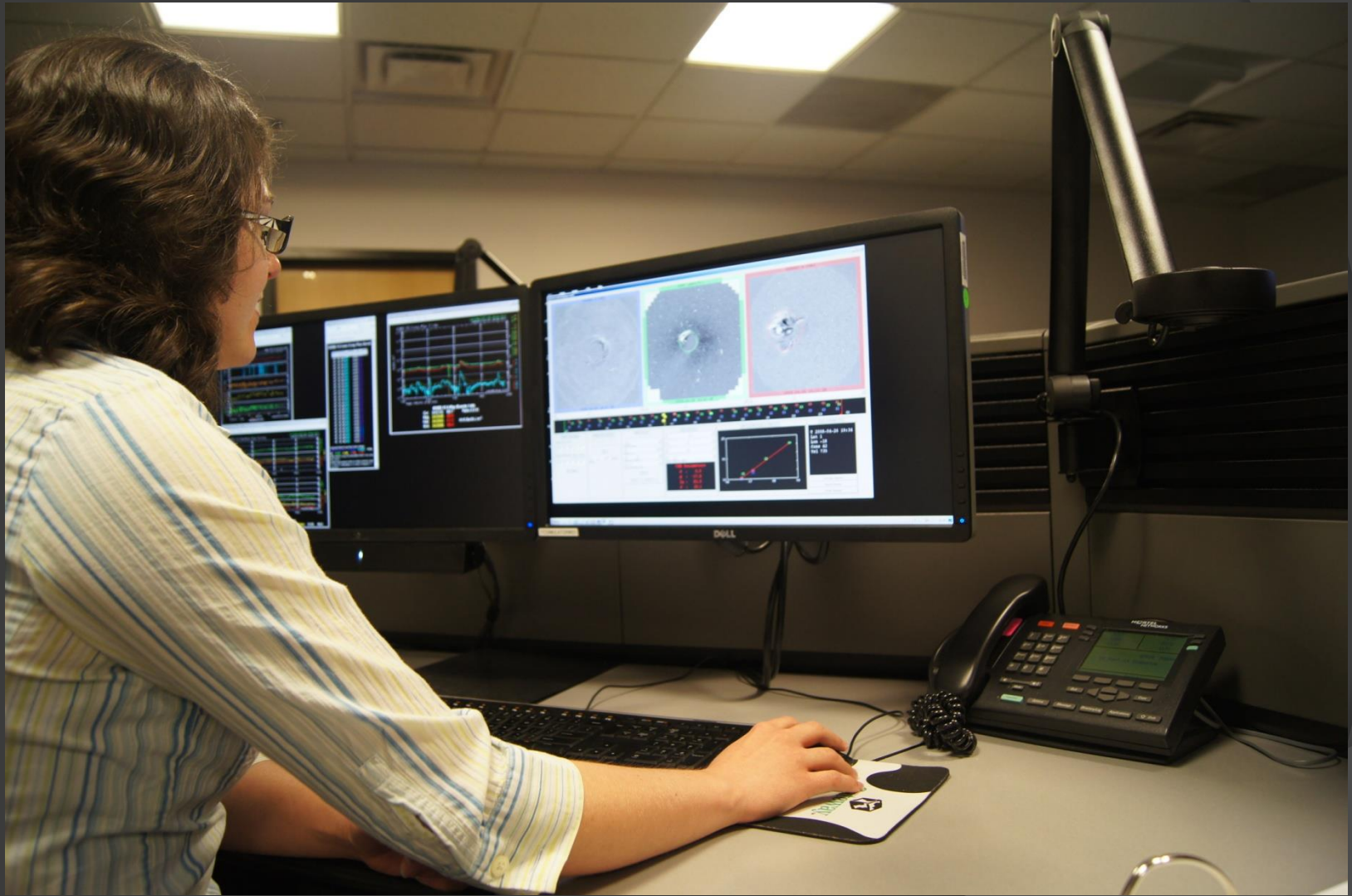
SWPC 3-view CME Analysis (12/2011 to 4/2012) : CME Cone 1/2 Angle vs Velocity



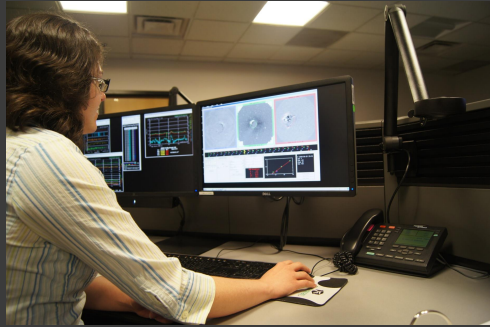
live.ccmr.gsfc.nasa.gov

What if we only have one Coronagraph ?





CME Naming / Cataloging



WSA-Enlil : CME Cataloging

File Image

2012-04-25 02:48:06 UT

Image Sequence >

Stretch Bottom

Stretch Top

Gamma Correction

Image Saturation

CME 20120425T0125-054-03-SC2

You are about to catalog the CME :
20120425T0125-054-03-SC2
Are you sure?

Yes No

Full Halo

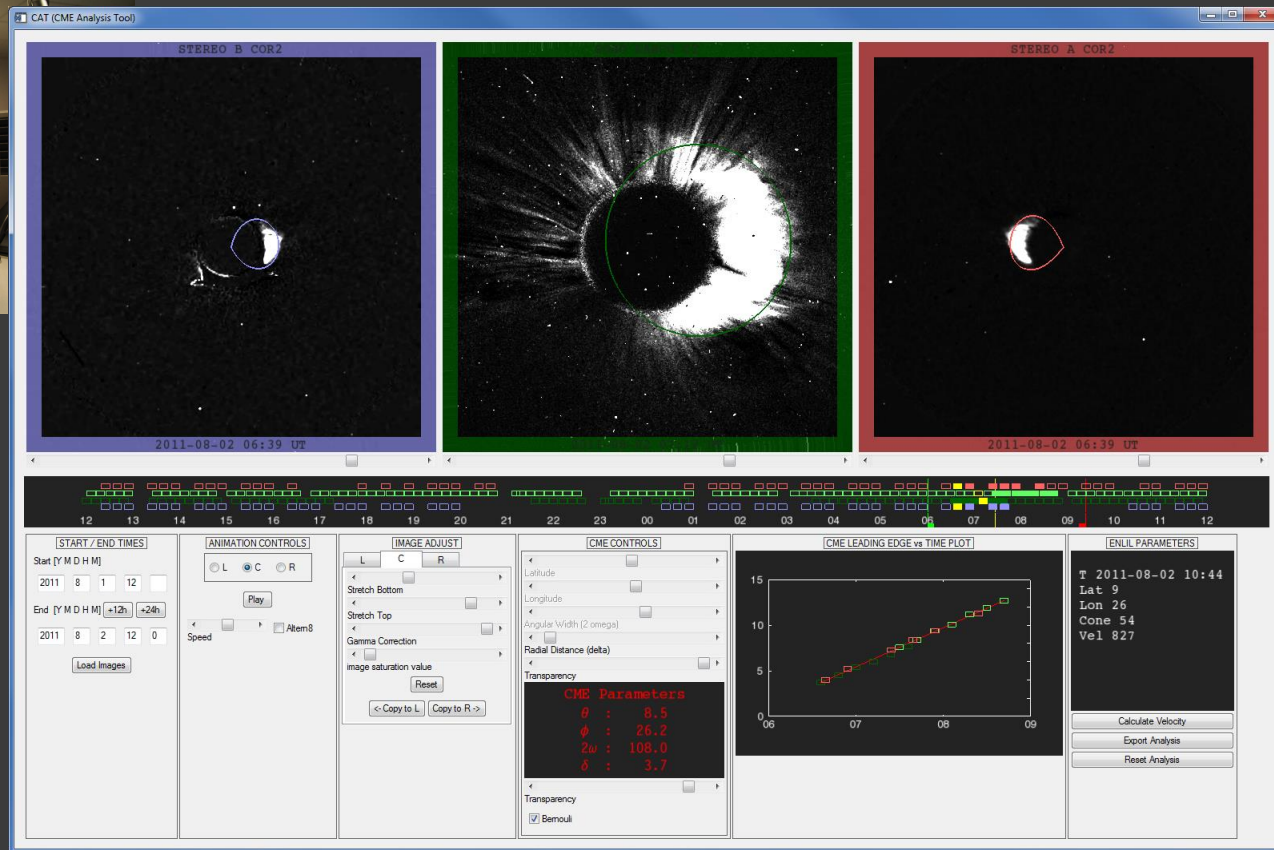
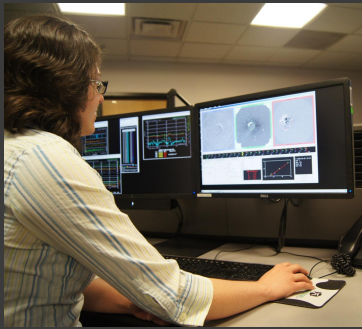
Define CME Name

Define Representative Image

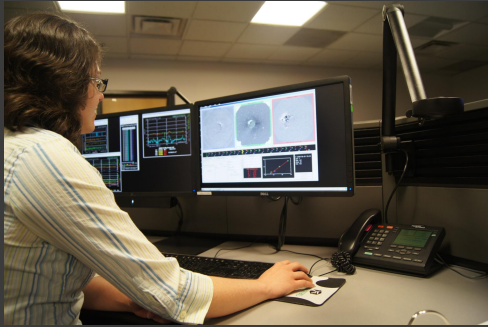
Save Catalogued CME

20120425T0125-054-03-SC2
image time : 2012-04-25 02:48

CME Analysis



Solar Predictions Interface (SPI)



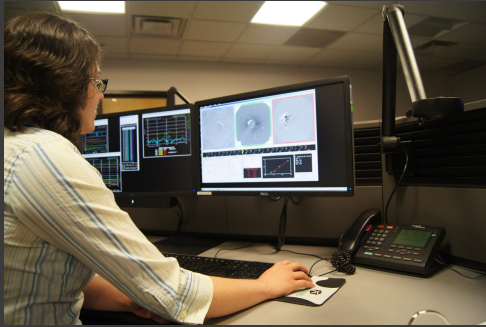
The screenshot shows the Solar Predictions Interface (SPI) web application in a browser window. The browser address bar shows the URL `solarwinds.ncs.swpc.noaa.gov/spi/`. The page features a sun icon and the text "SPI" in a large font. Below the header, there is a navigation bar with "Home | Help" and the current date/time: "Current Date/Time: 2012-04-25 17:51:15 UTC".

The main content area is divided into two columns. The left column is titled "WSA-Enlil Model Status" and contains a "Next Model Run" section with a circular progress indicator showing 9 minutes remaining until the next scheduled model run. Below this, it lists the "Run Cycle: 1800 UTC", "Run Name: 20120425T1800", and "Type: Ambient", with a link to "Edit Model Run Setup". The "Previous Model Run" section lists "Run Cycle: 1600 UTC", "Run Name: 20120425T1600", "Type: Ambient", and "Total Run Time: in progress...".

The right column is titled "Functions Menu" and contains three items: "View and Add Active CMEs", "Model Run Setup", and "Browse Past Model Runs".

At the bottom of the page, there is a blue footer containing a disclaimer: "Disclaimer: This product is currently in beta and should not be relied upon operationally." Below the disclaimer, it states: "NOAA's National Weather Service. This product is produced by the Space Weather Prediction Center located in Boulder, CO. For assistance, contact SWPC.Webmaster@noaa.gov."

Solar Predictions Interface (SPI)



The screenshot shows a web browser window titled "SPI - View CME". The address bar contains the URL `solarwinds.ncs.swpc.noaa.gov/spi/view_cme.shtml`. The browser's address bar shows several tabs: "SPI vm-plasma", "SPI-ops", "WSA-Enlil Ambient", "george.millward@n...", "Google", and "OPR.html".

The main content area features the SPI logo (a sun icon with "SPI" text) and the text "Solar Predictions Interface". A status bar shows "Current Date/Time: 2012-04-25 18:04:24 UTC" and "Home | Help".

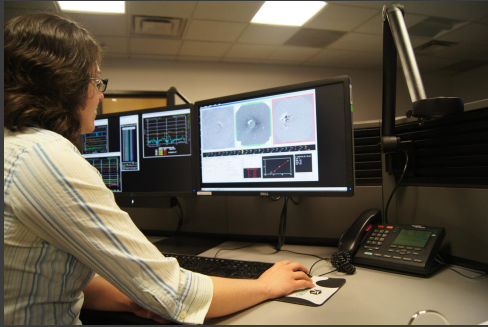
The interface is divided into two main sections:

- Active CMEs:** This section contains a list of active Coronal Mass Ejections. The first entry is a solar image with the ID `A0323-20120423T1848-360-04-SC2` and an [Edit](#) link below it. To the right of this entry is a large grey plus sign with the word "Add" below it, and a blue [Add](#) link below that.
- Functions Menu:** This section contains three links: "View and Add Active CMEs", "Model Run Setup", and "Browse Past Model Runs".

At the bottom of the page, there is a blue footer containing a disclaimer: "Disclaimer: This product is currently in beta and should not be relied upon operationally." Below the disclaimer, it states: "NOAA's National Weather Service. This product is produced by the Space Weather Prediction Center located in Boulder, CO. For assistance, contact SWPC.Webmaster@noaa.gov."

View catalogued CMEs: (available for CME analysis)

Solar Predictions Interface (SPI)



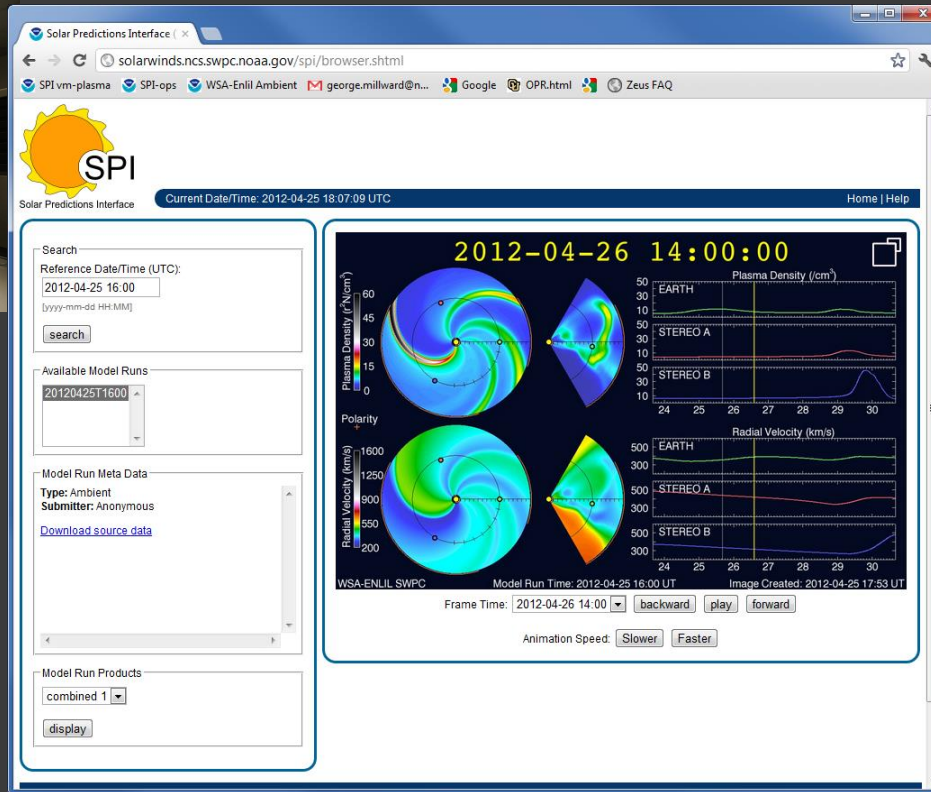
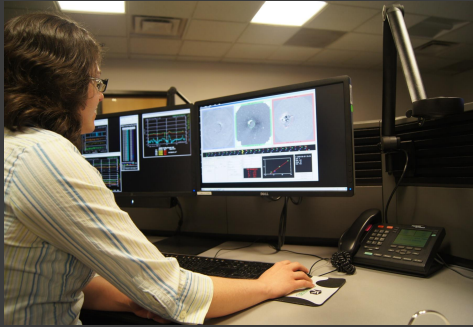
The screenshot shows the Solar Predictions Interface (SPI) web application. The browser address bar displays `solarwinds.ncs.swpc.noaa.gov/spi/index.shtml`. The page features a sun icon and the text "SPI Solar Predictions Interface". A status bar indicates the current date and time: "Current Date/Time: 2012-04-25 18:05:44 UTC".

The main content area is divided into two sections:

- WSA-Enlil Model Status:**
 - Next Model Run:** A circular progress indicator shows that 114 minutes remain until the next scheduled model run.
 - Run Cycle:** 2000 UTC
 - Run Name:** 20120425T2000
 - Type:** CME-based
 - Available CME Analysis:** A section showing a CME analysis image with "Analysis ID: 69" and an "Add" button. Below the image is a checked "Included" checkbox and another "Add" button.
 - Buttons for "OK" and "Cancel" are located at the bottom of this section.
- Functions Menu:**
 - View and Add Active CMEs
 - Model Run Setup
 - Browse Past Model Runs

Add analyzed CME data to next model run

Solar Predictions Interface (SPI)

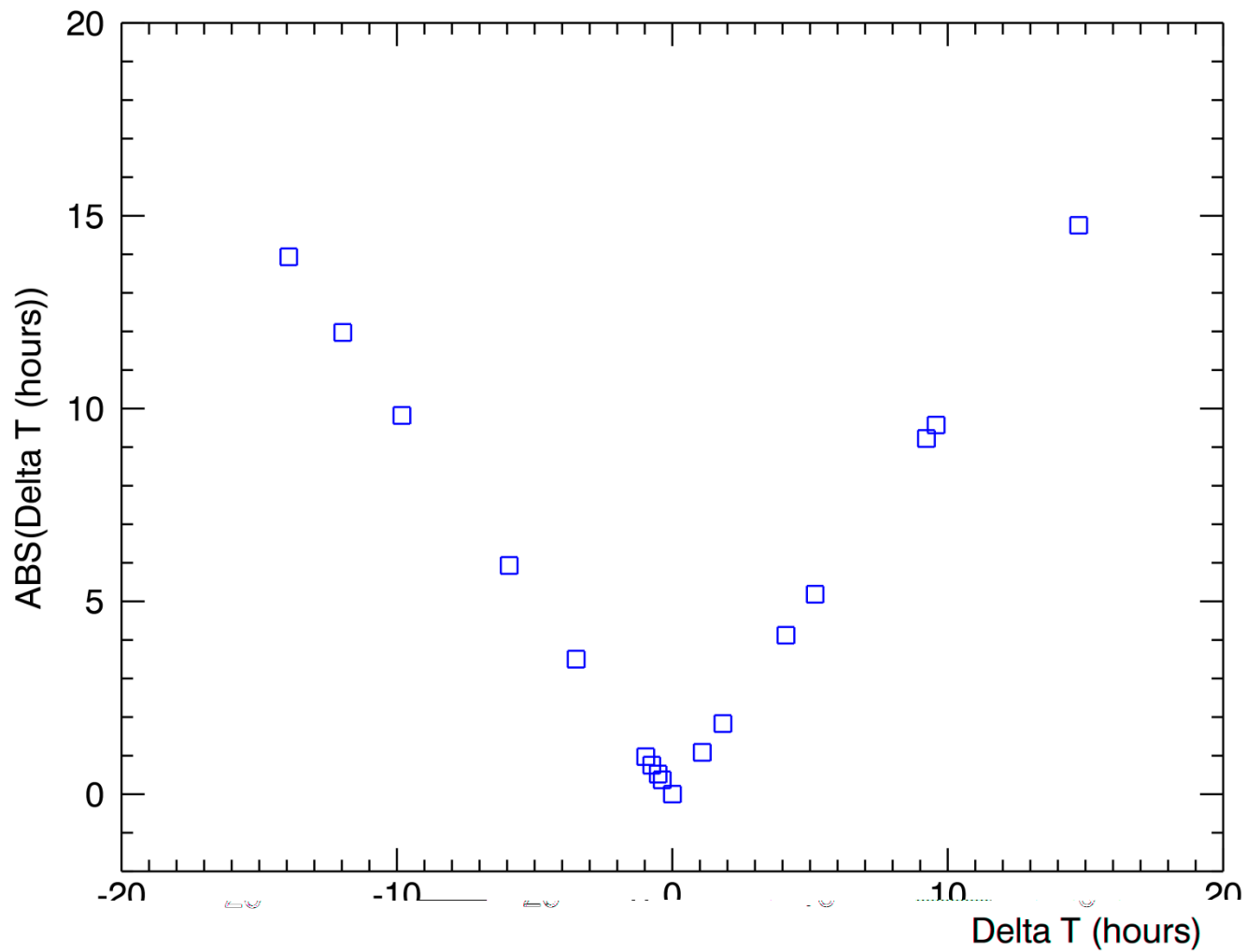


Browse model runs
Select a model run for dissemination on the public webpage
Inform SWFO forecast

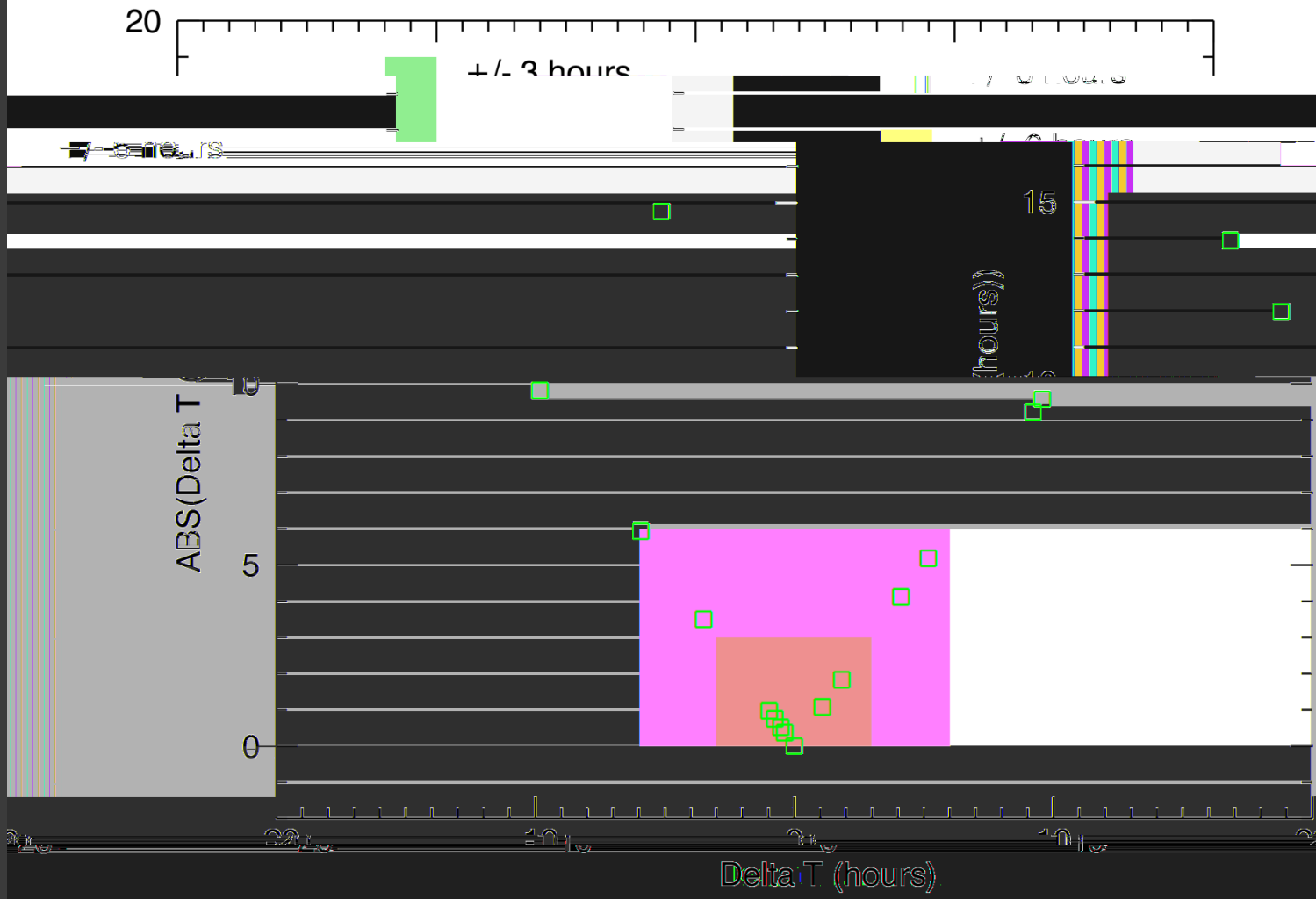




SWPC WSA-Enlil ops: CME arrival time error (wrt ACE)

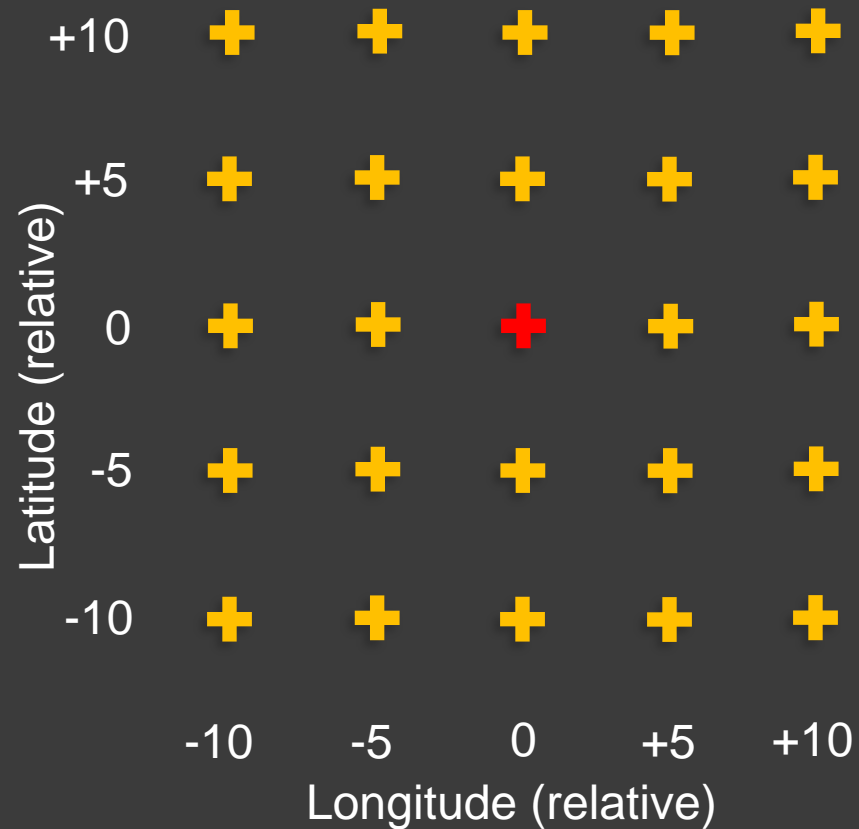




SWPC WSA-Enlil ops: CME arrival time error (wrt ACE)



Ensemble of 25 WSA-Enlil model runs – varying the latitude / longitude of CME propagation direction.

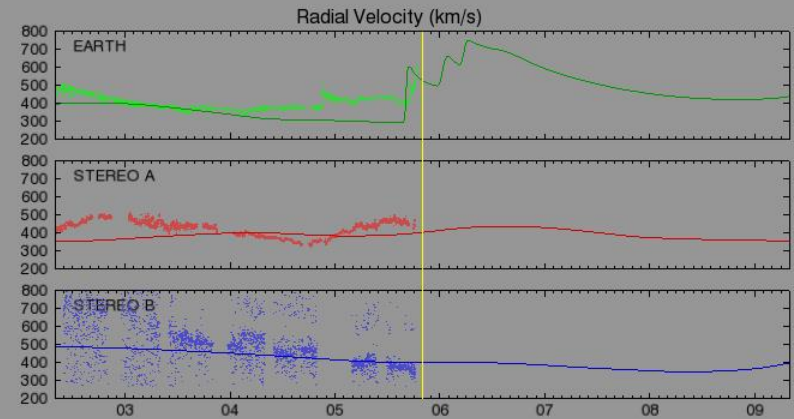
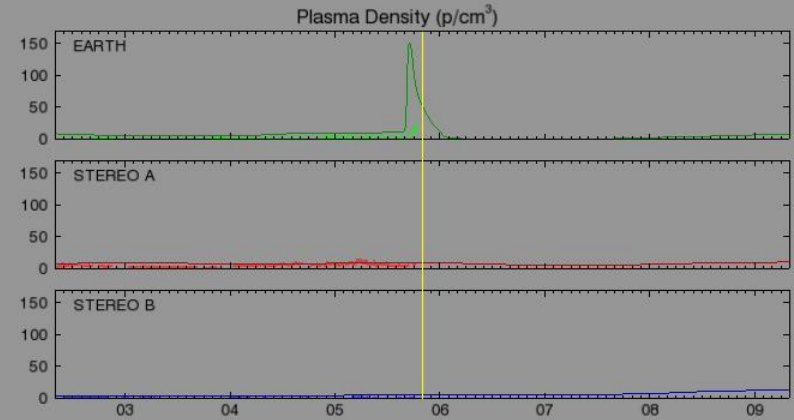
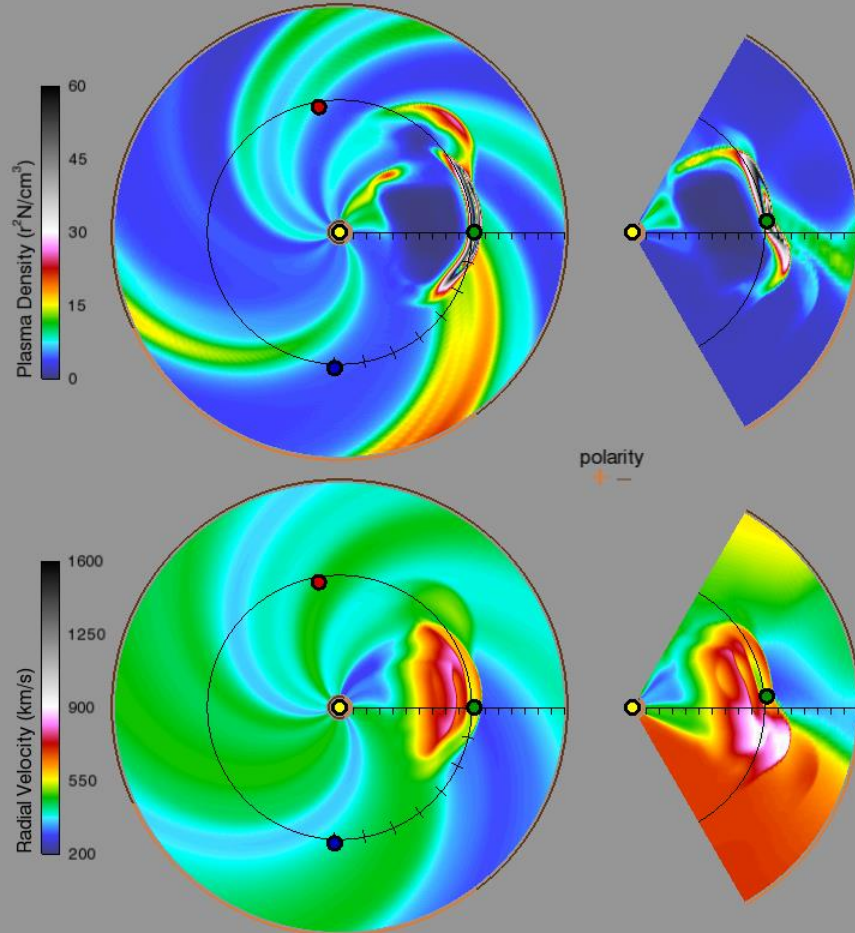
(CME velocity and cone angle kept constant)



 Original model run
 24 Lat Lon ensembles

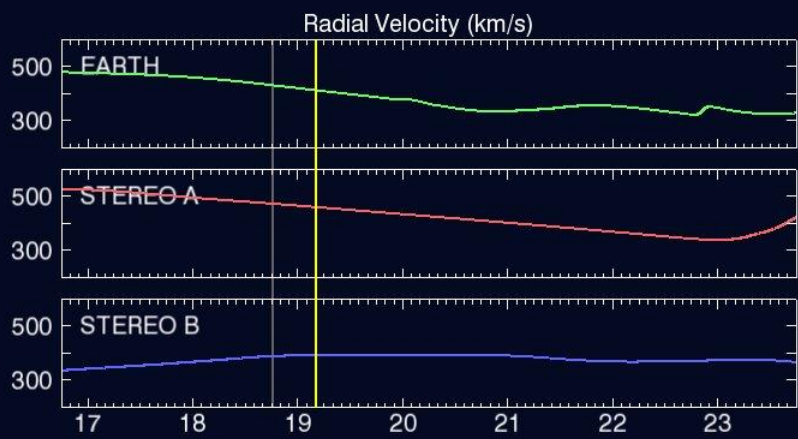
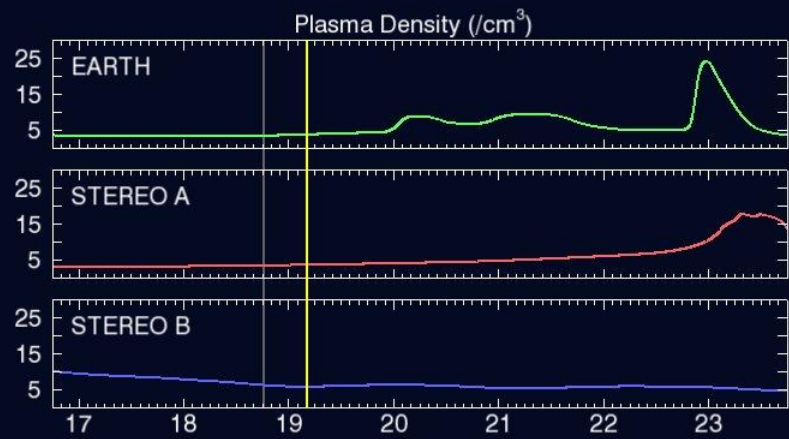
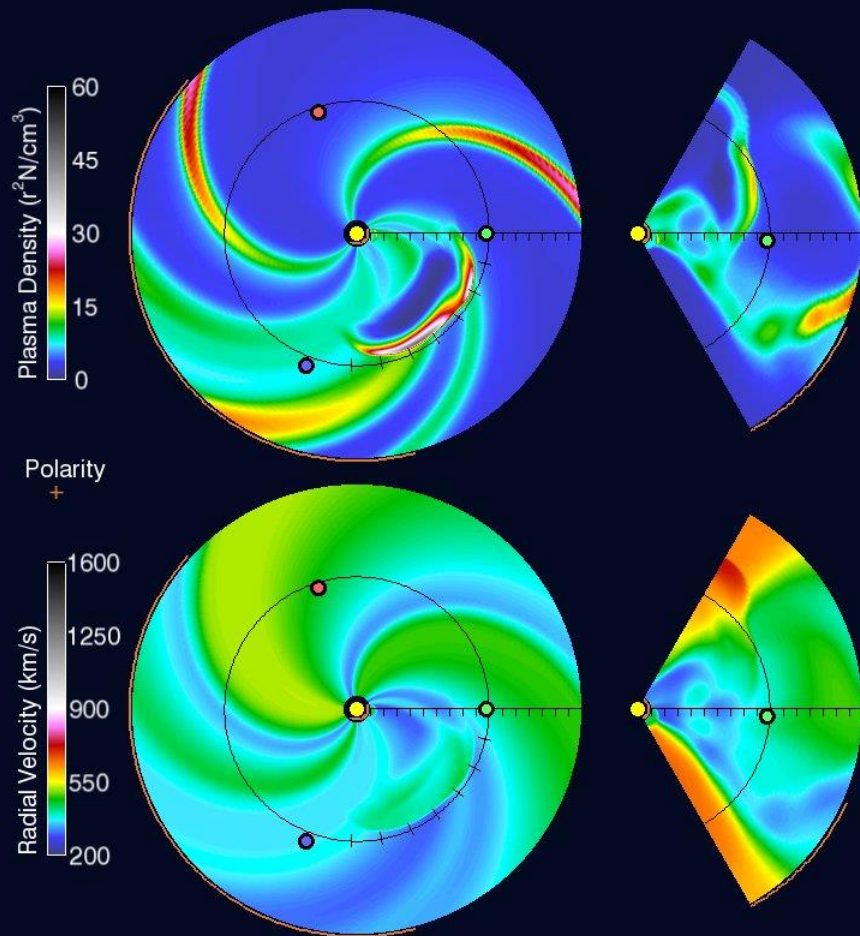
2011-08-05 19:00:00

“Direct Hit”



2012-01-19 04:00:00

“Glancing Blow”

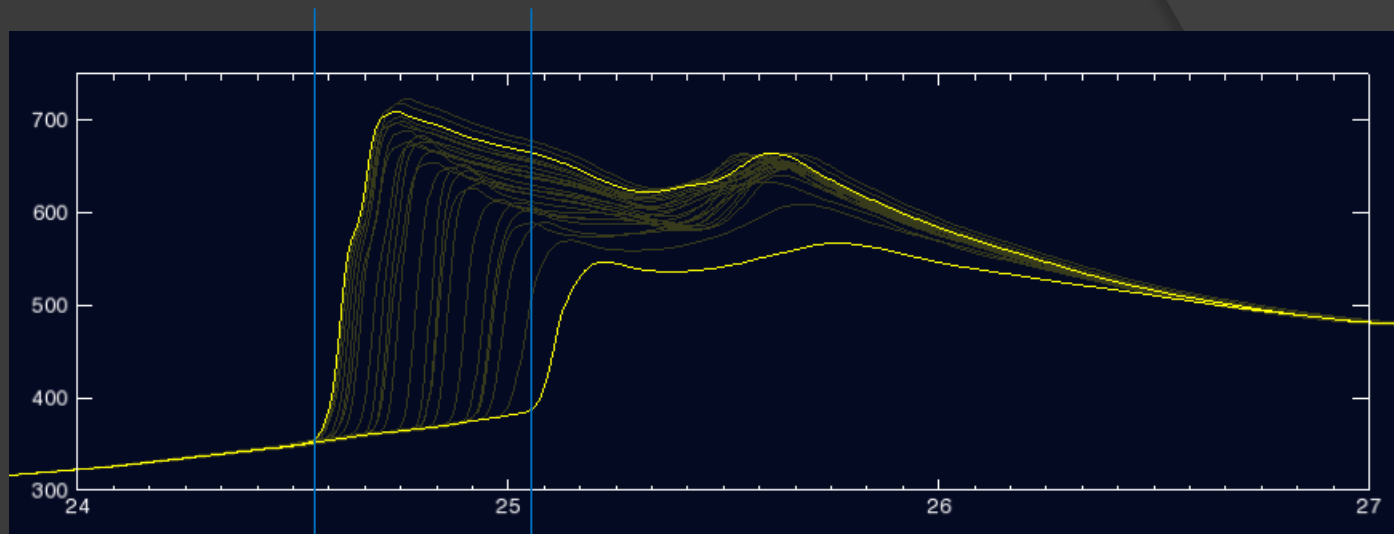
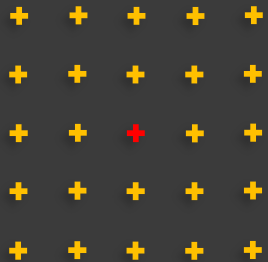


WSA-ENLIL SWPC

Model Run Time: 2012-01-18 18:00 UT

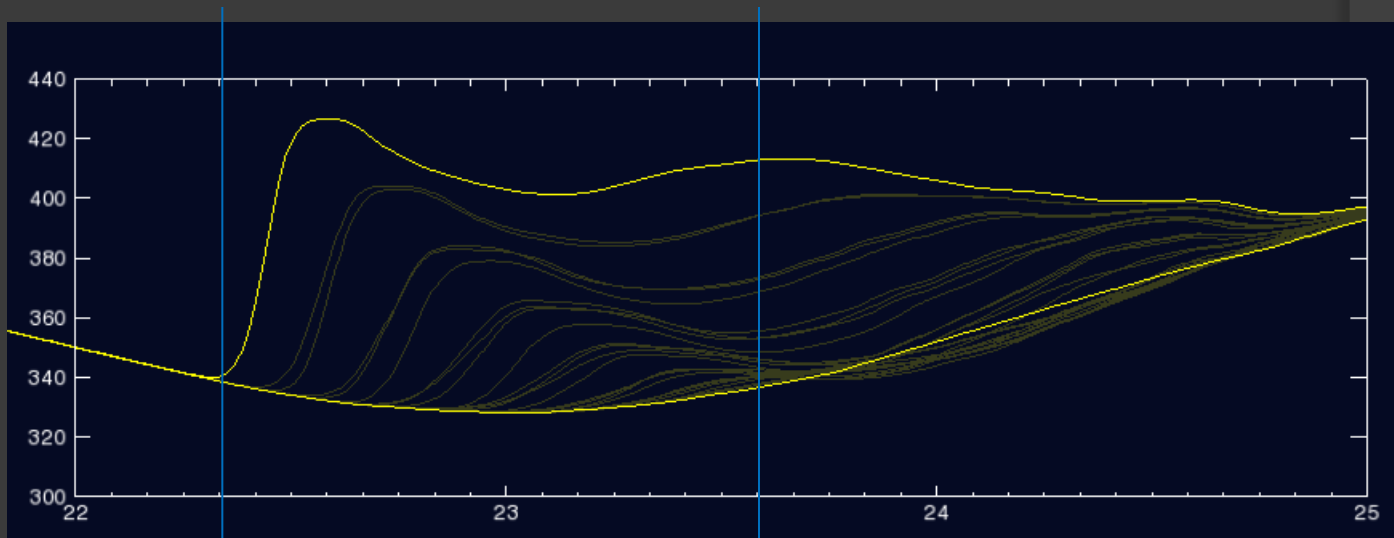
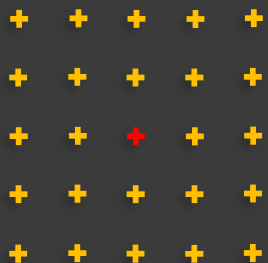
Image Created: 2012-01-18 19:48 UT

“Direct Hit”
ensemble



12 hours (+/- 6)

“Glancing Blow”
ensemble



30 hours (+/- 15)

The Future (2013)

- Continued validation/verification/performance tracking
- System developments
- Transition ADAPT (AFRL) : SWPT activity
- Enlil developments – real time updating : SWPT activity

valley-death.jpg 810x616 pixels



<http://4.bp.blogspot.com/-sJljm6hMMKs/TocqKJq0LDI/AAAAA>



Google



Steinberg forum

Co-op bank

WSA-Enlil Ambient

ACE 6hour

ACE 3day

ACE 7day

Kp

Guardian

SOS

