TRANSITIONING EEGGL TO THE CCMC.

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Transients in the Solar Wind and Their Simulation in Real Time

- We present and demonstrate a new tool, EEGGL (Eruptive Event Generator using Gibson-Low configuration) for simulating CMEs Coronal Mass Ejections).
- CMEs are among the most significant space weather events.
- Some of these effects may be efficiently simulated using the "cone model" (as we heard) The cone model provides a capability to predict the location, time, width and shape of the hydrodynamic perturbation in the upper solar corona (at ~0.1 AU), which can be used to drive the heliospheric simulation (with the ENLIL code, for example).
- At the same time the magnetic field orientation in this perturbation is uncertain within the cone model, which limits the capability of the geomagnetic activity forecast.

Eruptive Event Generator (Gibson-Low): EEGGL

- The new EEGGL tool recently developed at the CCMC in collaboration with the University of Michigan, provides a capability to simulate the magnetic field evolution at 1 AU too
- Based on the magnetogram and evaluation of the CME initial location and speed, the user may choose the active region from which the CME originates and then the EEGGL tools provides the parameters of the Gibson-Low magnetic configuration to parameterize the CME.
- The recommended parameters may be used then to drive the CME propagation from the low solar corona to 1 AU using the global code for simulating the solar corona and inner heliosphere.
- At the CCMC The Community Coordinated Modeling Center (CCMC) provides the capability for CME runs-on-request, to the heliophysics community.
- EEGGL is a new animal in the CCMC Zoo, which is well integrated with the other animals (Donki, STEREOCat).

Demo for CME 2012-07-12

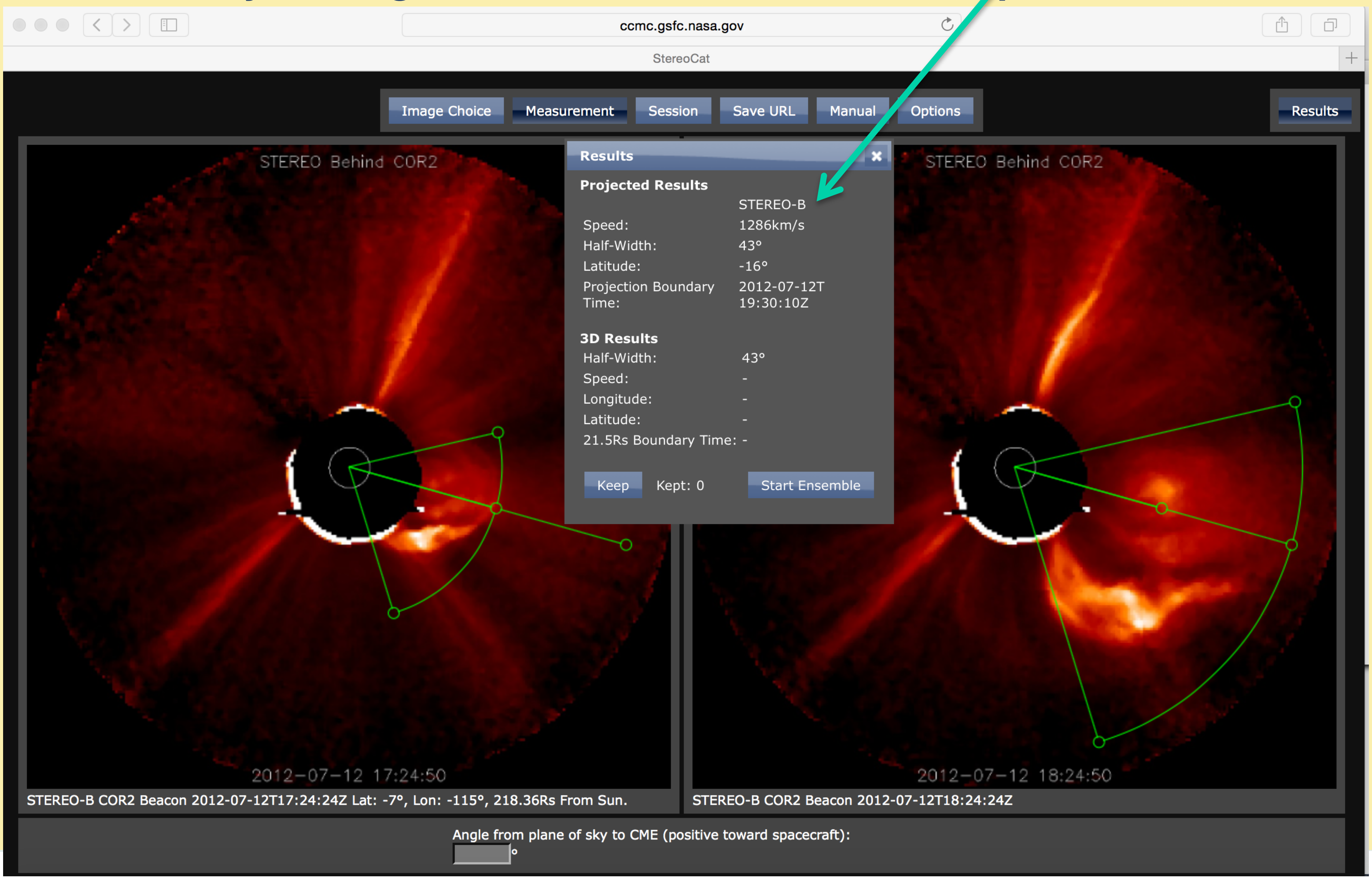
- **We demonstrate how the new tools are used to simulate a halo CME 2012-07-12 (https://kauai.ccmc.gsfc.nasa.gov/DONKI/view/CME/14/1)**

The List of CME Analysis already entered:

Event Type	Catalog	Data Level	Prime?	Long	Lat	Speed	Type	Half Width	Time 21.5	Note	WSA-ENLIL+Cone Result(s)	Submitted By
CME Analysis	SWRC_CATALOG	0	true	6.0	-13.0	1300.0	O	65.0	2012-07-12T19:29Z	remeasured using the GCS model	Not modeled	Leila Mays on 2015-06-01T19:02Z
CME Analysis	SWRC_CATALOG	0	false	-6.0	-17.0	1400.0	O	70.0	2012-07-12T19:35Z		1: Result 1 (2.0 AU) Earth = 2012-07-14T10:20Z (PE: -7.1 h) Mars = 2012-07-16T00:55Z MESSENGER = 2012-07-13T10:04Z Spitzer = 2012-07-14T13:56Z	Leila Mays on 2013-07-11T21:36Z
CME Analysis	SWRC_CATALOG	0	false	6.0	-9.0	1480.0	O	75.0	2012-07-12T19:31Z		1: Result 1 (2.0 AU) Earth = 2012-07-14T09:17Z (PE: -8.2 h) Mars = 2012-07-16T05:07Z MESSENGER = 2012-07-13T09:59Z Spitzer = 2012-07-14T15:06Z	Anthony Pritchard on 2013-08-08T20:48Z

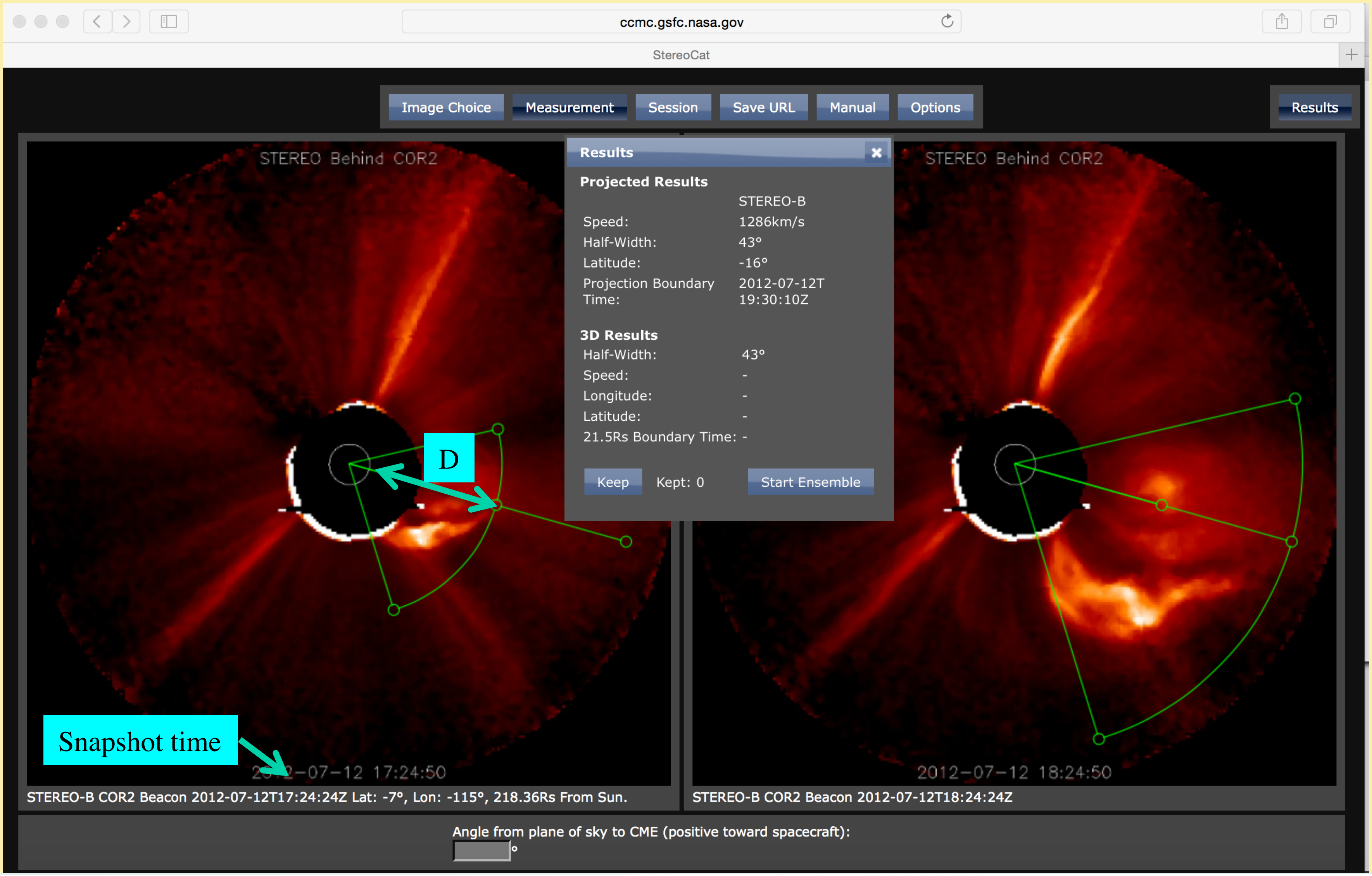
StereoCAT is used to find CME Speed

- StereoCAT (http://ccmc.gsfc.nasa.gov/analysis/stereo/) is developed at the CCMC. By tracing the CME front, we find CME Speed=1300km/s.



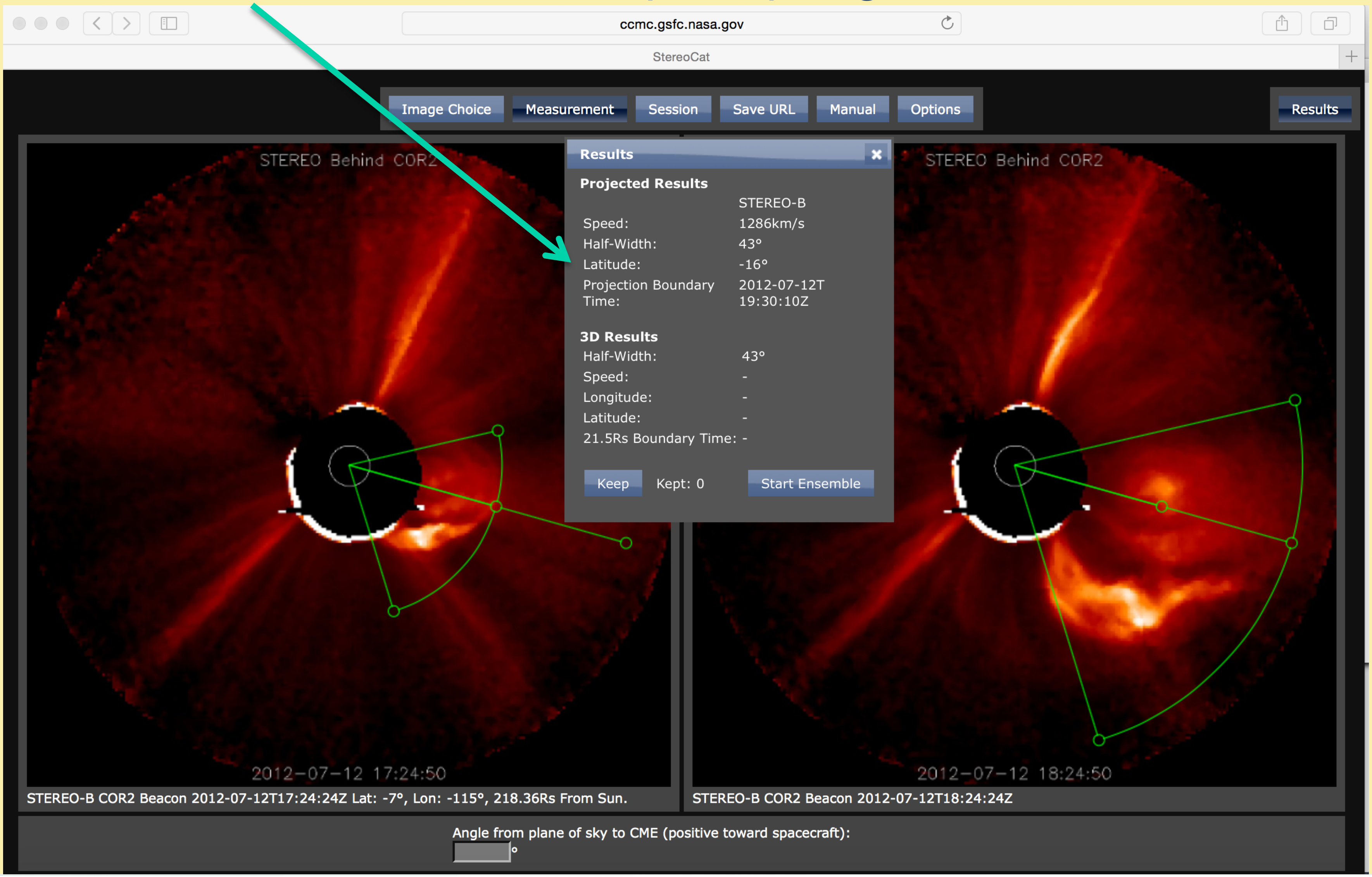
StereoCAT finds CME Start time

- CME start time = Snapshot Time – D/(CME speed) = 13:51



StereoCAT guesses CME place of birth

- Latitude is -20º. Estimates for (HEEQ) longitude are +/- 6º



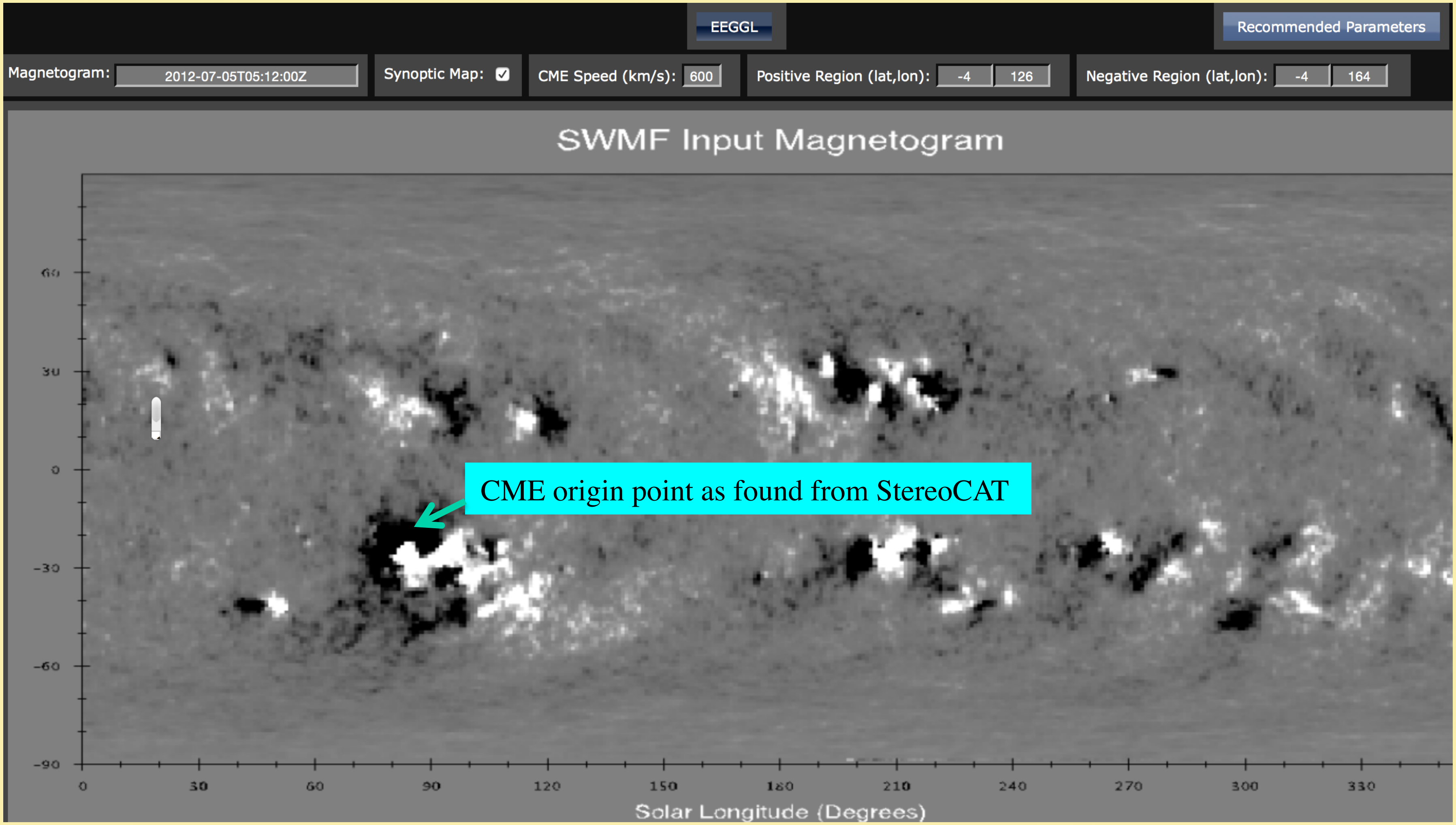
Newly Developed EEGGL tool

- **The new tool, EEGGL (Eruptive Event Generator using Gibson-Low configuration – see Splash page http://ccmc.gsfc.nasa.gov/analysis/EEGGLInfo/EEGGL.html**

  and the tool itself: http://ccmc.gsfc.nasa.gov/analysis/EEGGL/) has been recently developed at the CCMC (Goddard Space Flight Center) in collaboration with the University of Michigan.
- **Based on the magnetogram and evaluation of the CME initial location, speed, and start time the user may**
  - choose the active region from which the CME originates;
  - then the EEGGL tools provides the parameters of the Gibson-Low magnetic configuration to parameterize the CME;
  - the recommended parameters may be used then to drive the CME propagation from the low solar corona to 1 AU using the global code for simulating the solar corona and inner heliosphere. To achieve this, the EEGGL has a link to the run submission web page, which helps the user to fill in the request form for a simulation run.

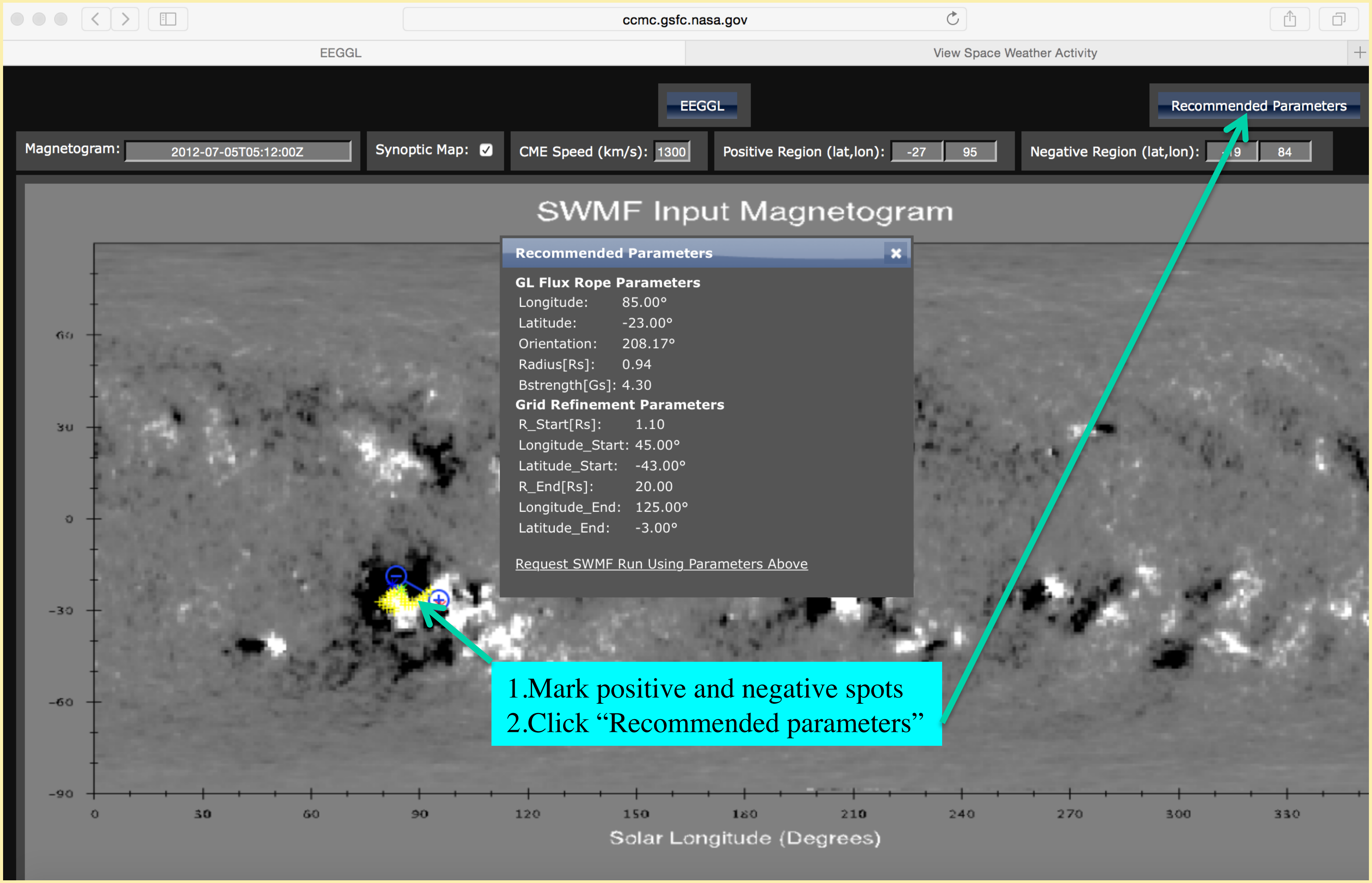
EEGGL tool (historic events): chose AR

- For a start time, 2012-07-12.13:51 calculate CR number 2125 and Carrington longitude 83. Find AR in the synoptic magnetic map for CR2125 near the point with longitude 83+/-6^o and latitude -20^0



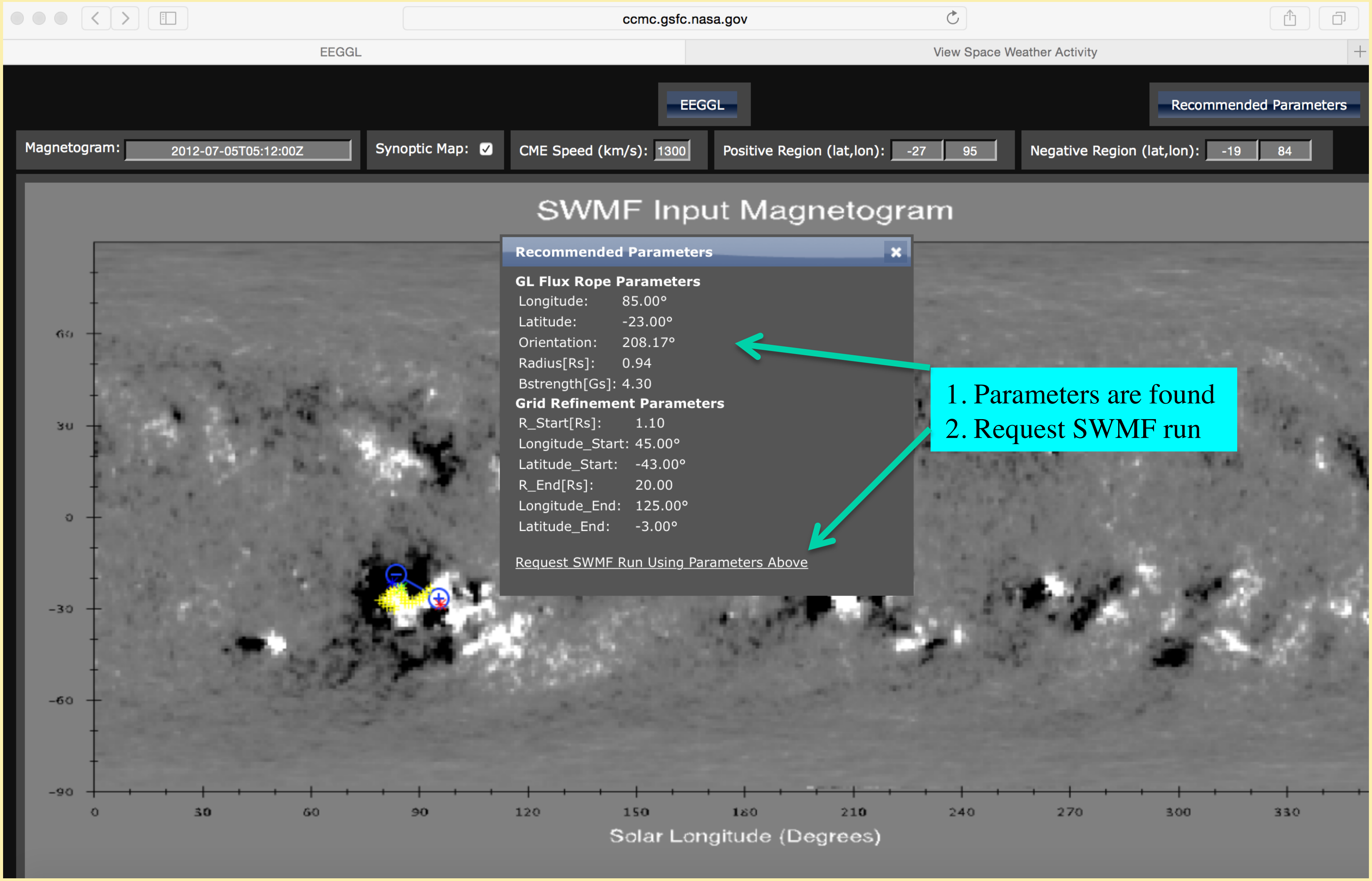
Find Parameters for GL configuration

- Choose and mark bipolar configuration of solar spots in this AR



Fill in Form to Request Simulation Run

- With the found parameters for GL configuration request a run.



Submit Your Run and Wait

ccmc.gsfc.nasa.gov

SWMF AWSoM_R run submission | View Space Weather Activity

-START TIME-	
Year:	2012
Mon:	07
Day:	12
Hour:	13
Min:	51
-GL FLUX ROPE PARAMETERS-	
Longitude:	85
Latitude:	-23
Orientation:	208.17
Radius:	0.94
B Strength:	4.30
-Cone Opening Angle-	
Longitude:	40
Latitude:	20
Special Request:	

BACK CONFIRM

SWMF Run-On-Request with EEGGL

- Simulates Solar Corona (SC) in spherical coordinates (about 3 million cells) and Inner Heliosphere (IH) in Cartesian coordinates, on AMR grid (about 35 million cells) with an improved resolution within the cone in which the CME propagates.
- Superimpose the Gibson-Low configuration with the observationally constrained parameters, to simulate CME
- Steady-state simulation of the state prior to eruption takes approximately 17 hours at 120 CPUs with the CCMC cluster hilo.
- Simulation of 4-10 hours of the CME evolution in the SC and then about 3 days of its evolution in the IH takes approximately 16 hours at 120 CPUs.

The only relevant slide.

- **Transitioning the EEGGL to the CCMC. Problems:**
  - EEGGL in the CCMC is the web application and the UofM team cannot handle the web application at the CCMC by multiple reasons (classification, network security)
  - EEGGL in the CCMC is the web application while the code development in the UofM is done in languages (f95, C++, IDL) not suited for web application at all.
  - This results in an excessive labor needs when the CCMC has to reshape new versions of the code to get them work at the CCMC
- **Solution of the problems:**
  - Algorithms are implemented in Python. At the CCMC this part of the code one-to-one converts to the server side ("back-end") of the EEGGL
  - The emulator is implemented in Python/IDL/Fortran-executable. This emulator both allows us (UofM) to keep using/developing the EEGGL as standing-alone code and describes, how the browser side ("front-end") of the EEGGL at the CCMC may look like.

Future Work

- We will add a capability to simulate real-time CMEs based on the existing automated real-time simulation system .
- We will add a capability to superimpose the Titov-Demouline flux rope.

Acknowledgement

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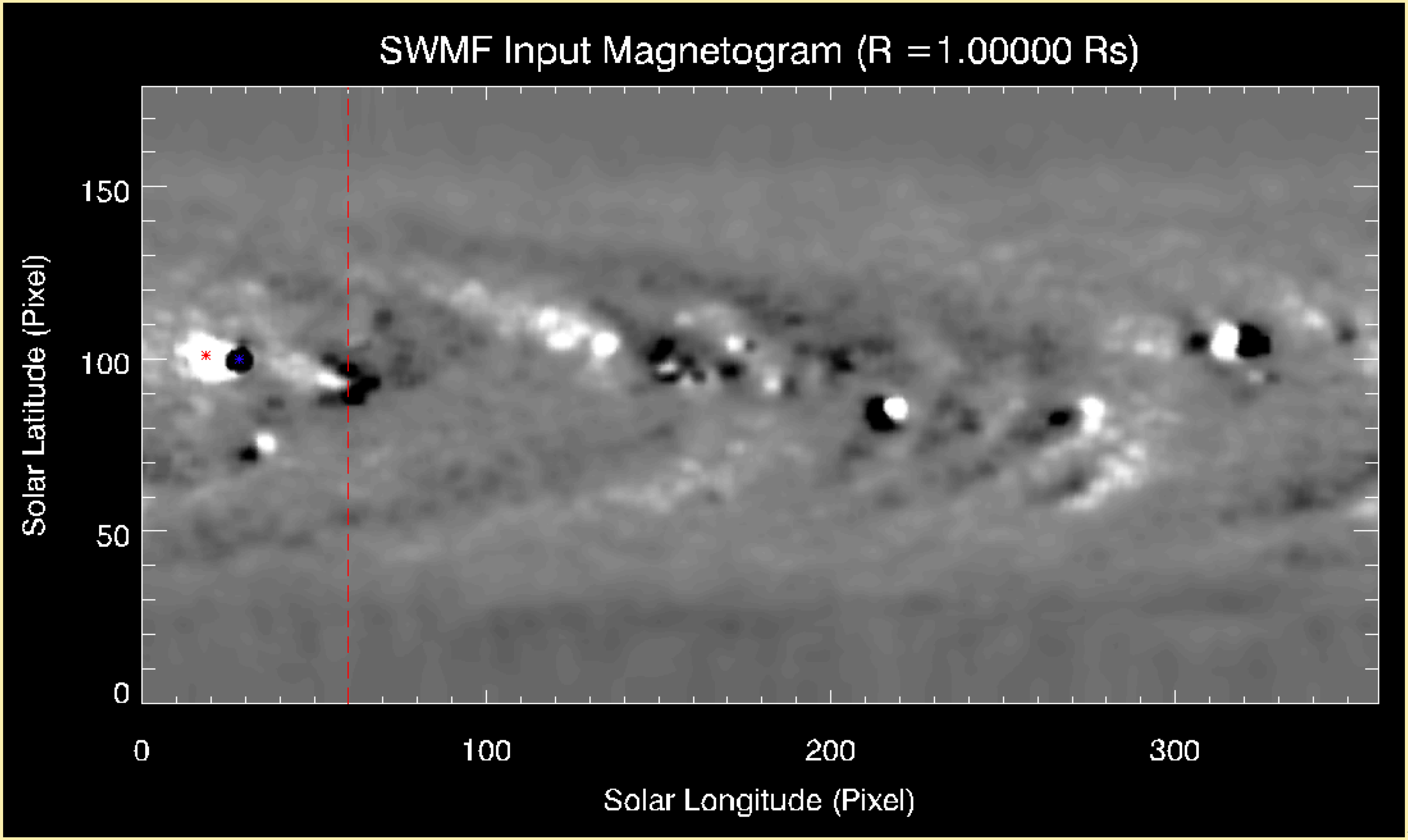
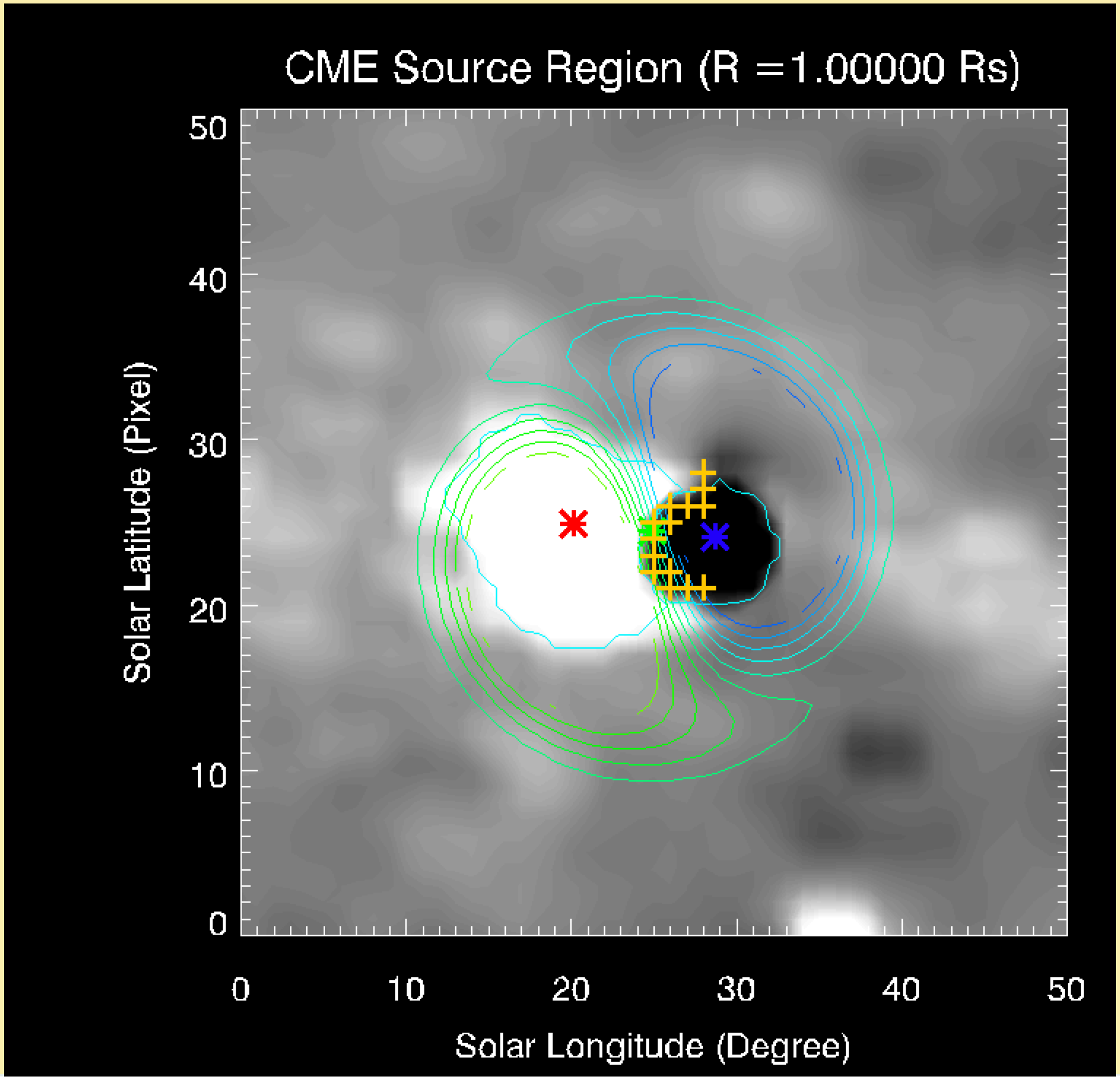
Today's Experience. 1. Start the EEGGL script with the today's noon magnetogram

```
LOADCT: Loading table Rainbow + white
Program caused arithmetic error: Floating illegal operand
Compiled module: GLSETUP2.
Compiled module: READ_MAGNETOGRAM.
LOADCT: Loading table B-W LINEAR
LOADCT: Loading table Rainbow + white
LOADCT: Loading table B-W LINEAR
LOADCT: Loading table Rainbow + white
srblap2015-0085:util/DATAREAD/srcMagnetogram>./GLSETUP.py GNG2176_317.fits -Out=remap -nSmooth=5 -CMESpeed=1000.0
```

Today's Experience.
2. Choose am active region



Today's Experience. 3. Enjoy result (zoom)



Today's Experience.
4. CME parameters.

- #CME
- T UseCme
- T DoAddFluxRope
- 342.50 LongitudeCme
- 10.50 LatitudeCme
- 0.87 OrientationCme
- GL TypeCme
- 0.60 Stretch
- 1.80 Distance
- 0.49 Radius
- -10.15 BStrength
- 0.0 Density
- 1.0 ModulationRho
- 1.0 ModulationP