NOAA SWPC Use of 3-views to Forecast CME Arrival and A NOAA-Funded JHU/APL L5 Concept

Douglas Biesecker

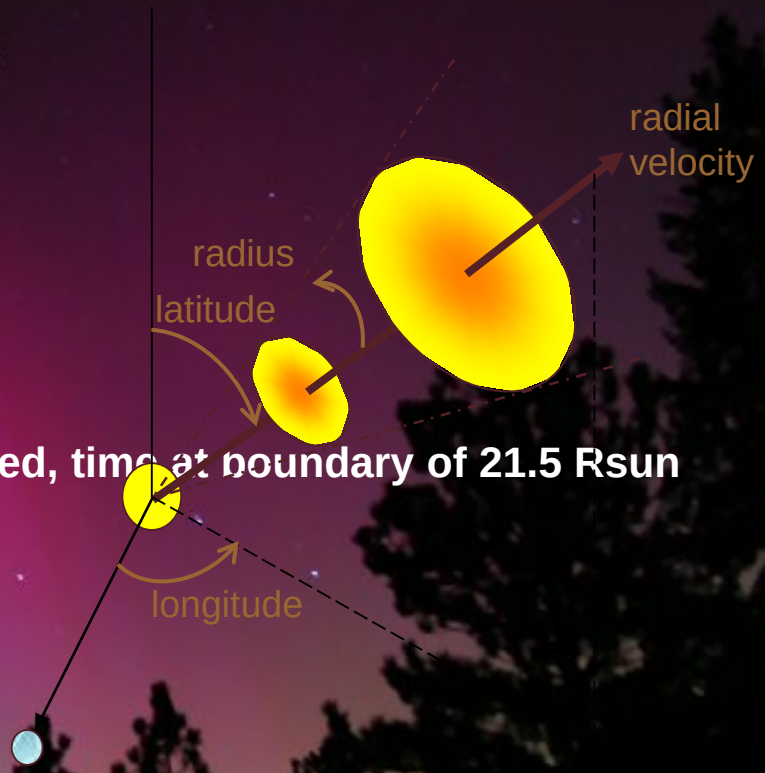
NOAA/Space Weather Prediction Center (NOAA/NWS/NCEP/SWPC)

With slides from Larry Zanetti

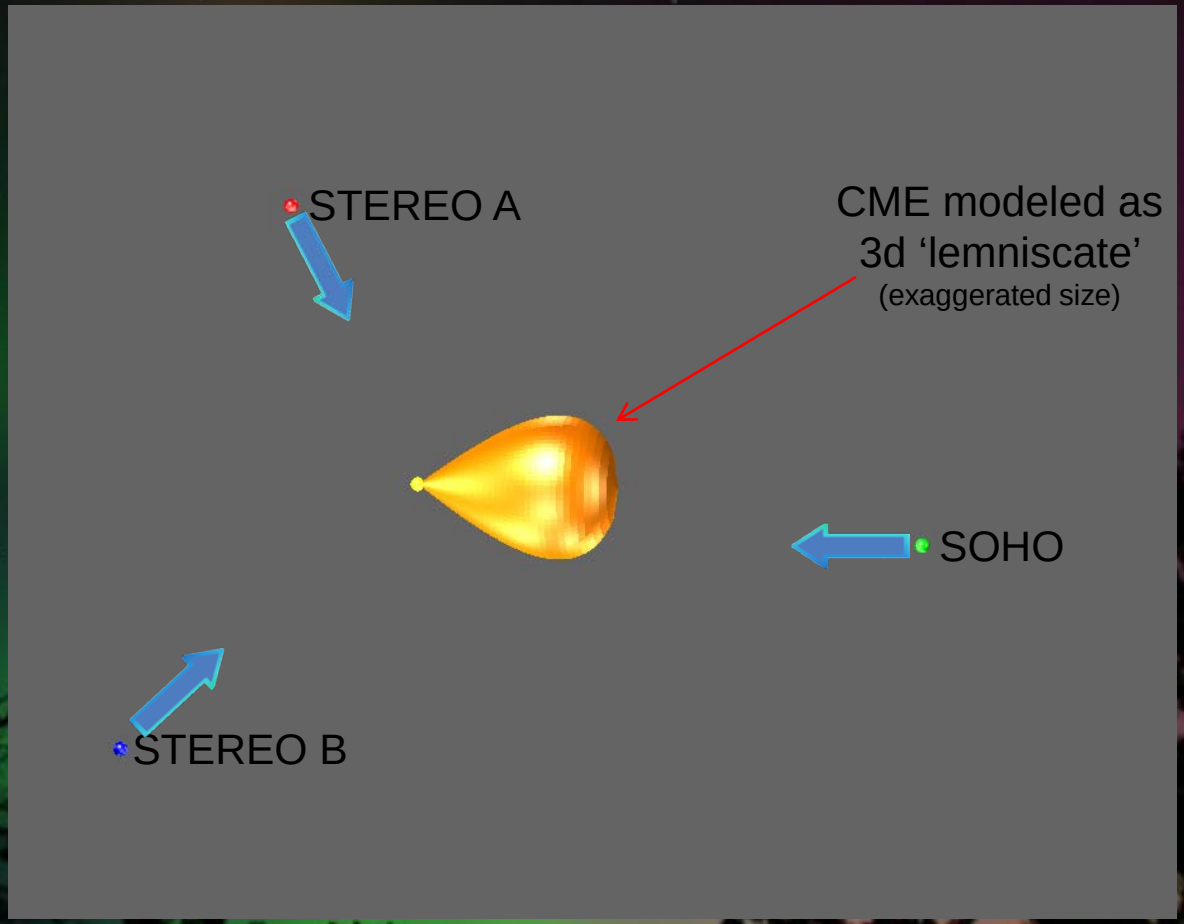
(JHU/APL)

Driving WSA-Enlil to Forecast CME's

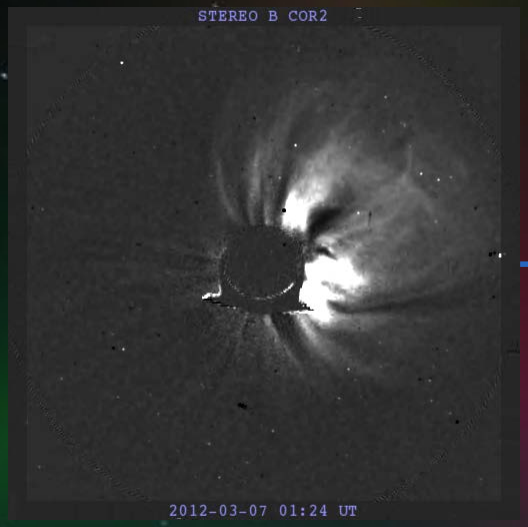
- **Solar Cycle 23 – accepted errors in forecasting CME arrival time ~±12-15 hours.**
- **SWPC has reduced this to ~±7 hours**
  - **WSA-Enlil**
  - **STEREO**
- **WSA-Enlil driven by inputs**
  - **WSA-Enlil requires CME**
    - **Direction (lat/lon), width (half-angle), speed, time at boundary of 21.5 Rsun**
  - **CME Analysis Tool (CAT)**
    - **aka swpc_cat in solarsoft**

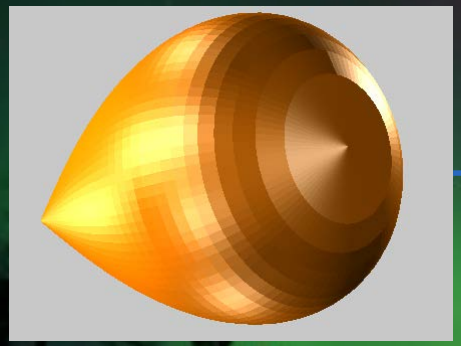


3D Graphics modeling

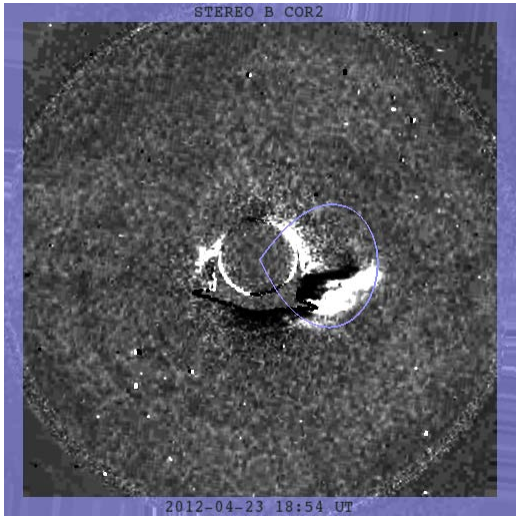


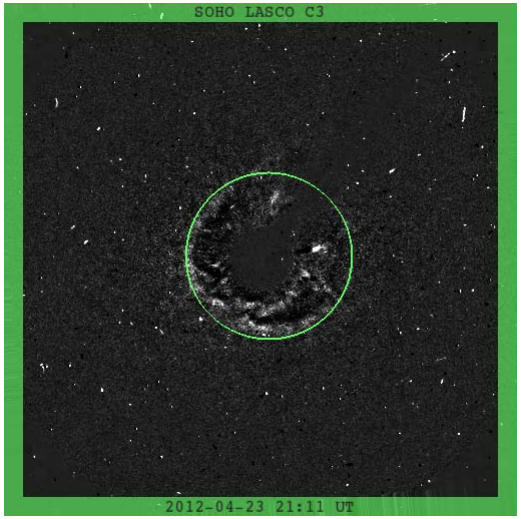
Overlay 3D model on coronagraph image

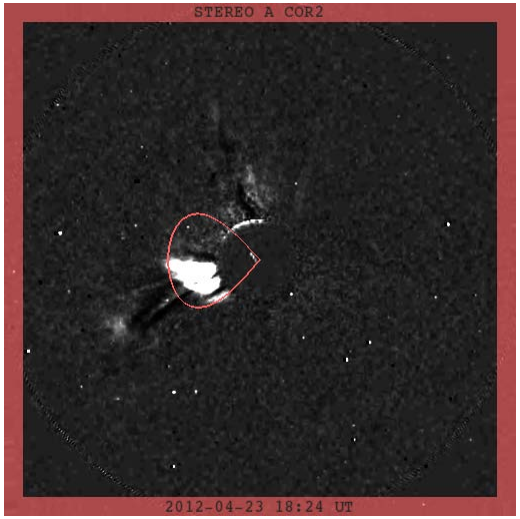


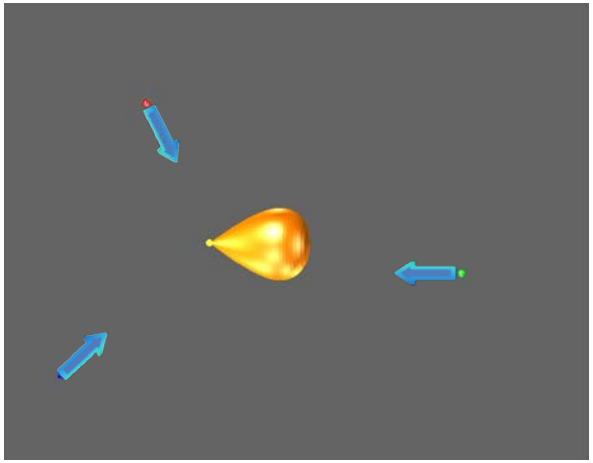


‘3 view’

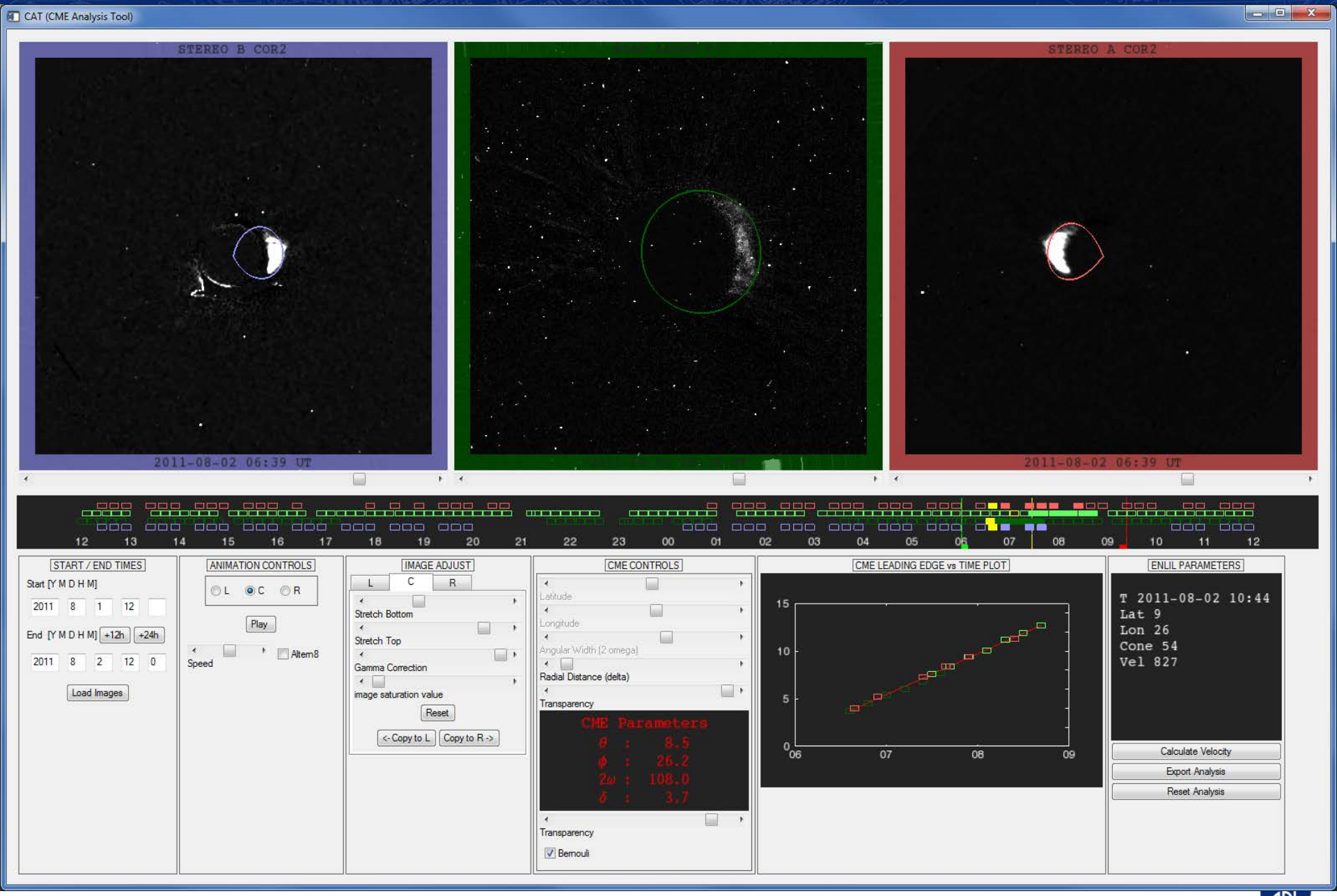

STEREO B COR2
2012-04-23 18:54 UT


SOHO LASCO C3
2012-04-23 21:11 UT

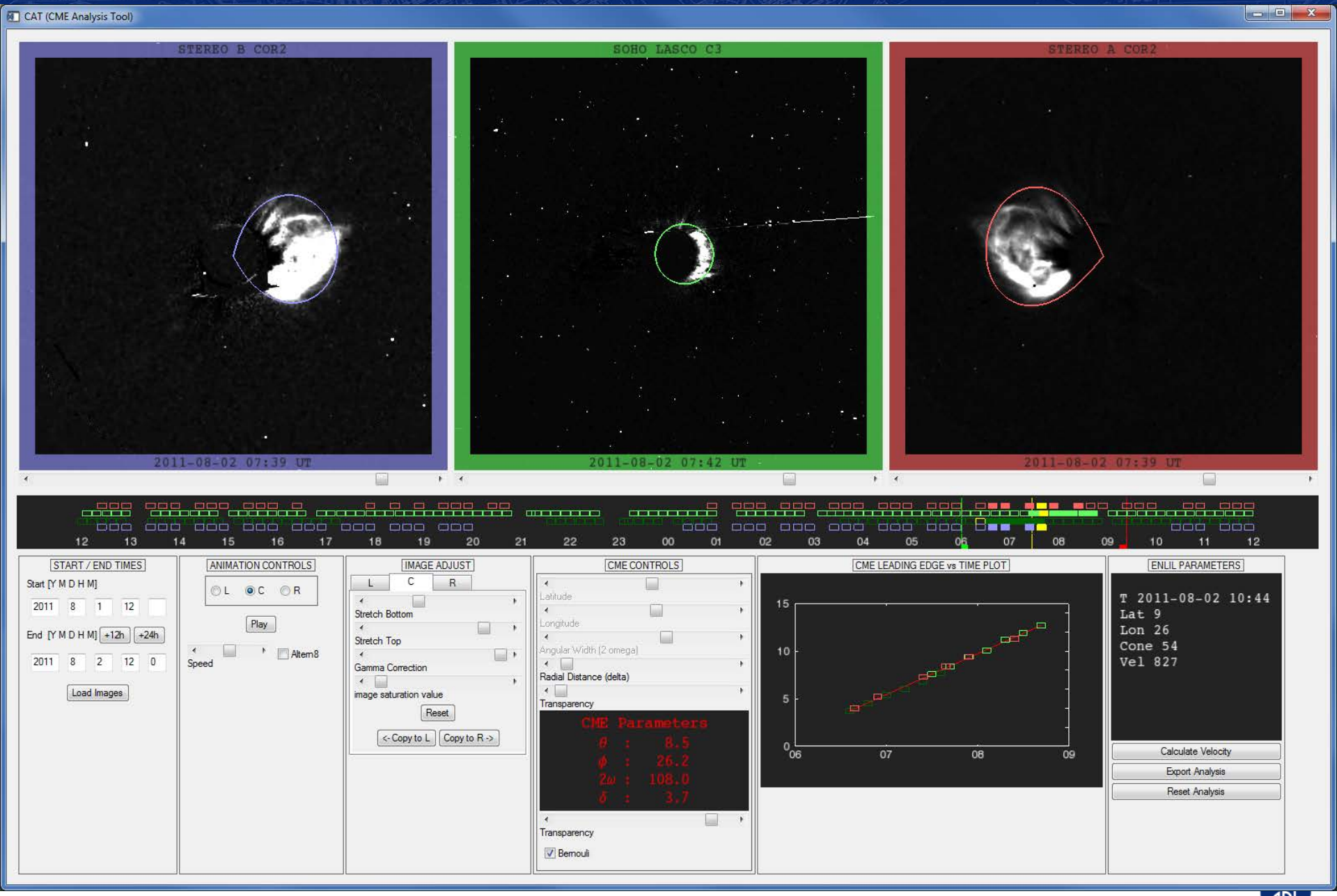

STEREO A COR2
2012-04-23 18:24 UT



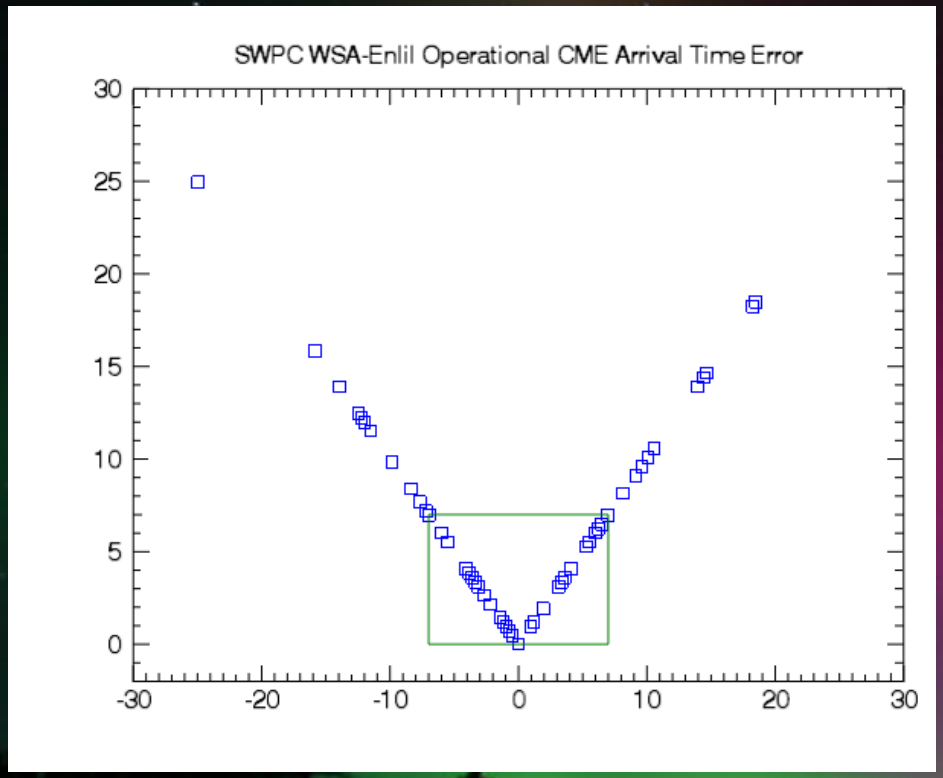
CME Analysis Tool (CAT)



CME Analysis Tool (CAT)



WSA-Enlil Performance 2011-2014



AVERAGE	6:39 hh:mm
RMS	**8:31**
2011 AVERAGE	7:06
2011 RMS	8:25
2012 AVERAGE	7:53
2012 RMS	10:21
2013 AVERAGE	4:57
2013 RMS	6:11
2014 AVERAGE	5:07
2014 RMS	6:13

Significant improvement on Solar Cyle 23

But how much is due to 2+ views?

Need this answer to get NOAA support

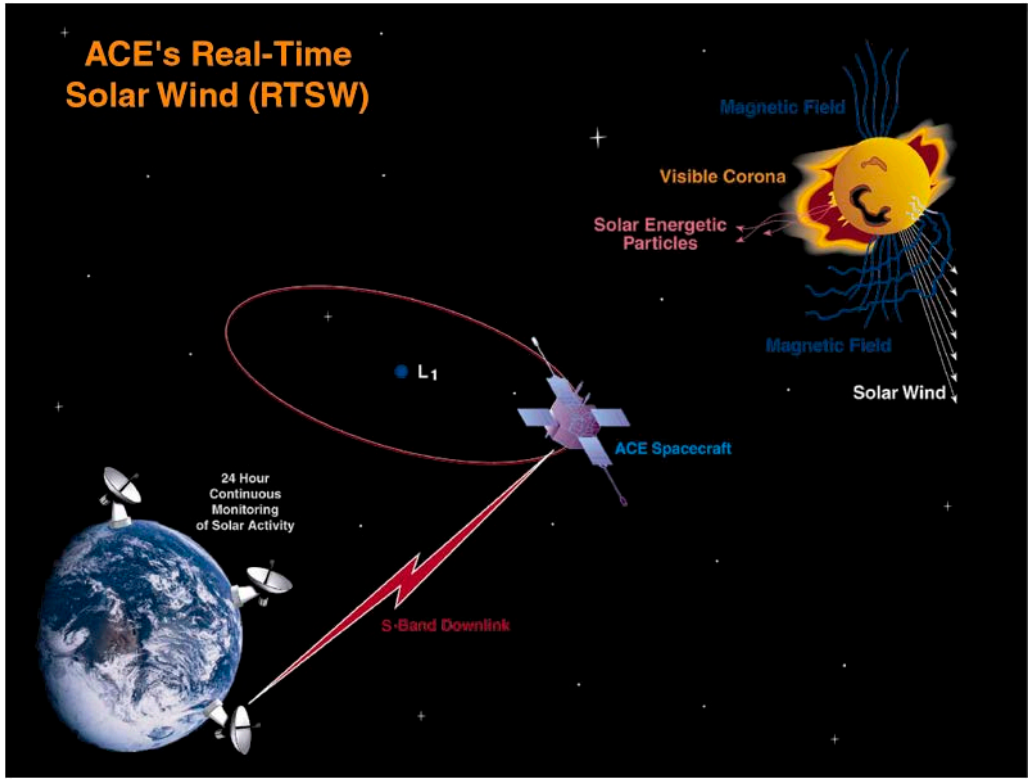
DSCOVR follow-on (NOAA 2020)

- **NOAA has funded many FY14 studies for DSCOVR follow-on**
  - **Planned FY20 launch**
    - **Magnetometer, Thermal Solar Wind Plasma, Low Energy Ions (0.05-1 MeV) and Coronagraph (4-17 Rsun)**
  - **Government Studies**
    - **2 GSFC studies**
      - **MDL, MMS spares**
    - **1 JHU/APL**
    - **1 Ames/Langley**
      - **Sunjammer derived**
  - **Commercial Service Provider RFI**
- **In FY15 NOAA will choose a path forward for the FY20 launch**
- **The JHU/APL study is being shown here because it includes a STEREO-B like orbit option**

ACE Early Warning for Space Weather

- **ACE Real-Time Solar Wind measurements provide early warning capability**
- **NOAA/AFWA use data to provide operational space weather products to civil operations and warfighters**

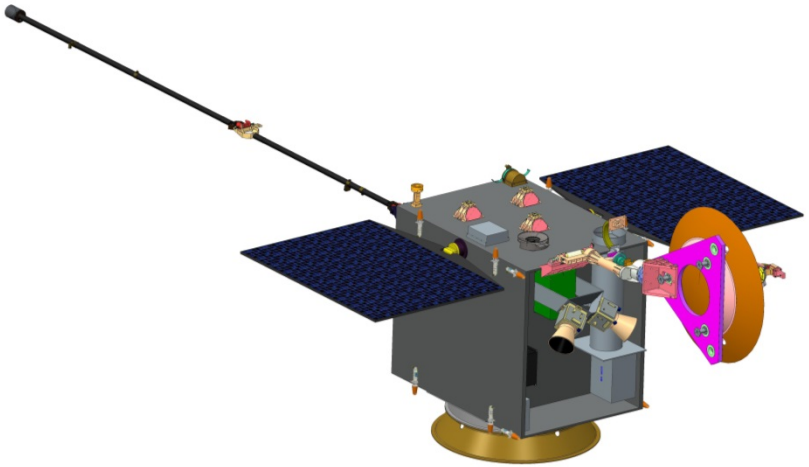
Over the past 16 years, these data have become critical to the user community, in particular the electric power grid, communications and GPS operators; these data have been labeled a "single point failure" in the space weather prediction system.

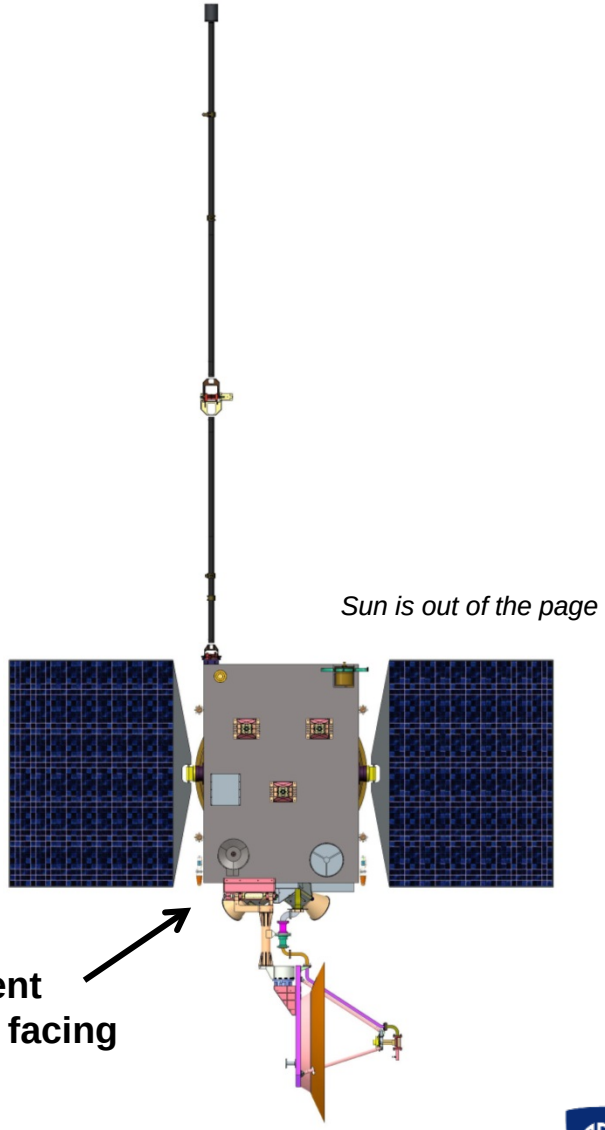


ACE Satellite Reaches End of Life in 2022 and DSCOVR (Launch 2015) Reaches End of Life in 2020. NOAA Tasked APL to Study Follow On for Potential Small Satellite Solution.

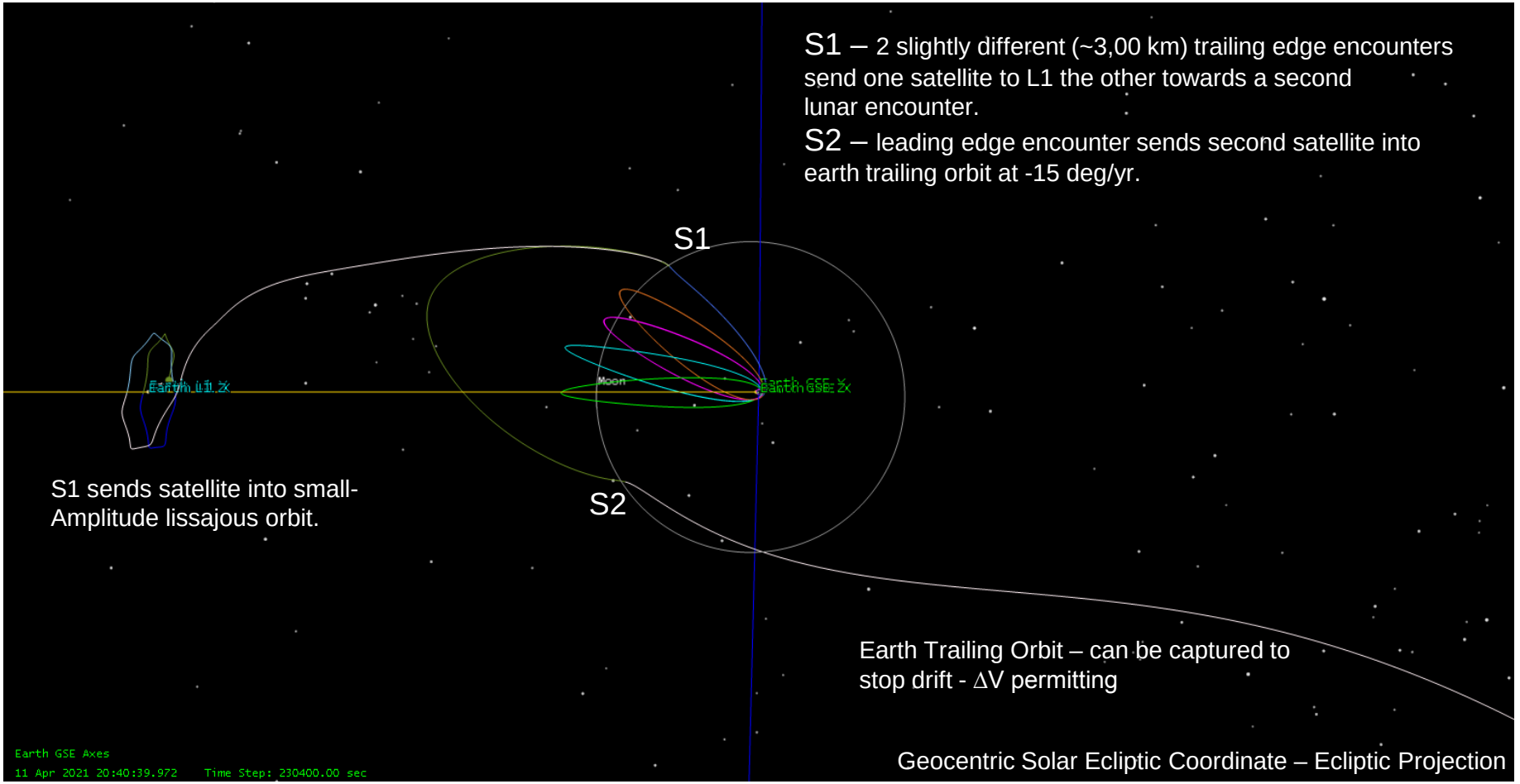
Spacecraft Summary (3-axis, in-situ, coronagraph)

- Spacecraft mass
  - 270 kg CBE
- Athena IIc capability for single
- Antares capability for double
  - Two S/C with a 10% adapter plate
  - 590kg (48% margin)





Trajectory Design – Gravity Assist (STEREO)



Lunar gravity assist is gateway to L1 and heliocentric orbit.

Conclusions

ACE Satellite End of Life Expected in 2022

DSCOVR

- **Launch 2015**
- **Lifetime 5 years**

Follow On (SUM Study) Initiated to Develop Long Term Solution

- **NOAA Sponsored Study**
- **JHU/APL Study Lead**
- **Two Study Options were point designed (L1 and L1 plus Off-Angle)**

Small Satellite Solutions Identified that Address Key NOAA Upstream Monitoring Requirements

Sun - Solar Wind Monitoring System; substantial cost savings for duplicate build (L1 plus Off-Angle)