NOAA's QuickPUNCH Project

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NOAA Organization

National Weather Service

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Space Weather Prediction Center

National Environmental Satellite, Data, and Information Service

- National Centers for Environmental Information
- Office of Projects, Partnerships, and Analysis (Space Weather Office)
- Office of System Architecture and Advanced Planning

NOAA Organization

- Produces space weather forecasts
- Develop forecasting tools

Space Weather Prediction Center

- Develop and maintain data pipelines
- Calibration and trending

National Centers for Environmental Information

Office of Projects, Partnerships, and Analysis (Space Weather Office)

- Forward looking analysis on NOAA capabilities and assets

NOAA needs a Coronagraph

- Currently, SPWC is solely reliant on SOHO/LASCO/C3 data for CME identification and tracking
- Given the critical nature of coronagraph data in the forecasting system, NOAA has been active in preparing for post-SOHO era (current estimate is LASCO will turn off Dec 2025)
- Since 2018, NOAA has been preparing to commission their own coronagraphs
  - Two instruments, built by NRL, on GOES-U (geostationary) and SWFO-L1 (Sun-Earth Lagrange Pt 1)

Gap Mitigation Strategy

- Internal NOAA study in 2019 identified critical gaps in space environment observations
- How else can we detect CMEs?:
  - Using NOAA assets: off-point one of the Solar UltraViolet Imagers (GOES-R series)
  - Using NASA assets: STEREO-A and **PUNCH**
  - Looking ahead: Aditya or ESA Vigil

What is QuickPUNCH?

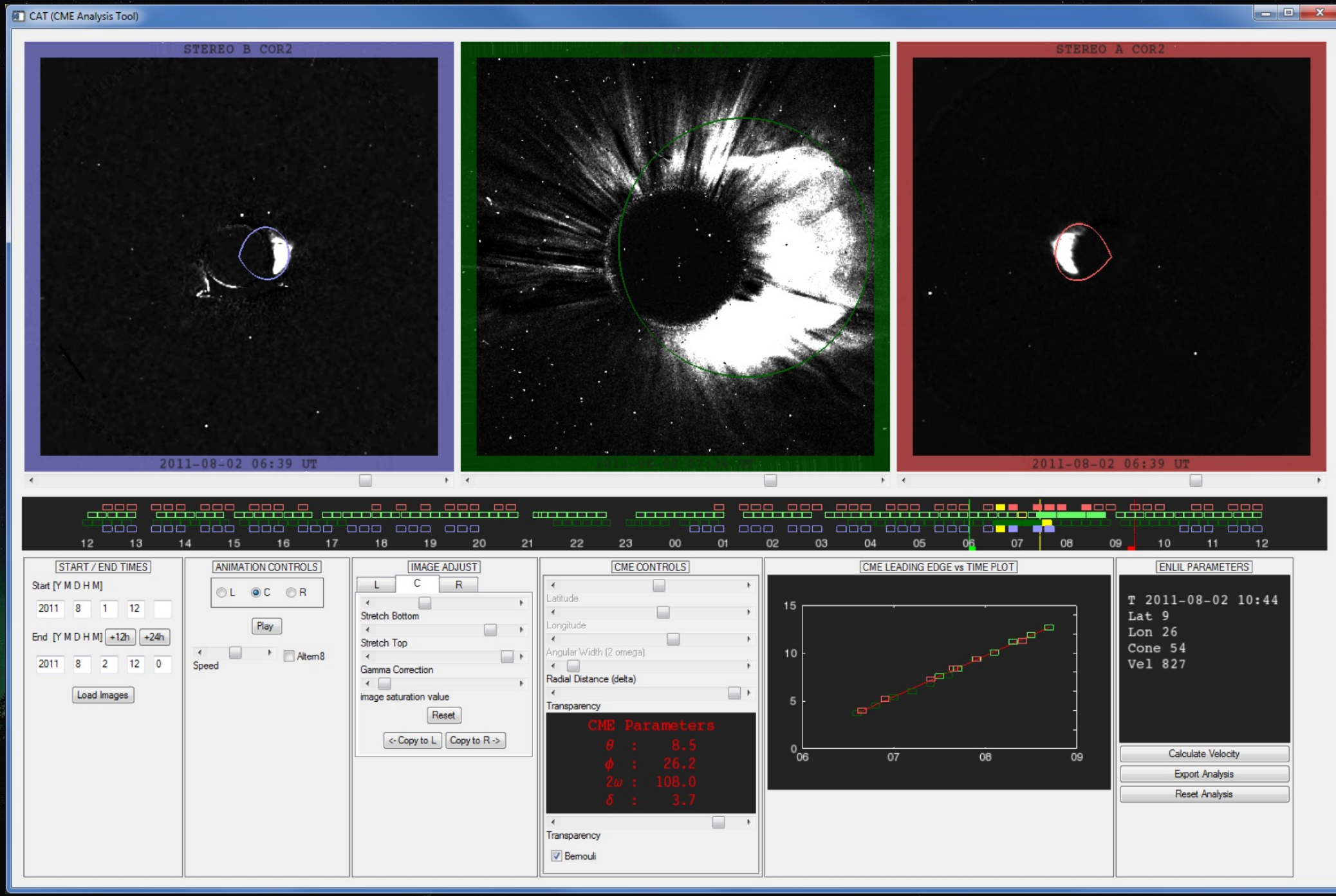
- Study to produce “proof of concept” deliverables: can SWRI deliver data to SWPC that meet operational requirements?
  - Processing Latency
  - Data reliability
  - Calibration quality
  - Compatibility with SWPC tools
- Contingency: The bottleneck is the downlink schedule. If SWPC needed to rely on PUNCH data, is there a way to reduce the total data latency and meet reliability requirements?

QuickPUNCH Data Specification

- **NFI**
  - 5.4-32 Rs FOV, 1024x1024 px, 4 minute cadence, total brightness
- **WFI mosaic**
  - 5.4-80 Rs FOV, 1024x1024 px, 8 minute cadence, total brightness
- Data are produced by the PUNCH Data Center
  - Latency to not exceed 2 hour from data arriving at ground station
  - Data are not proprietary to NOAA

How is coronagraph data used at SWPC?

- Stack of images converted to fixed difference movie in CAT tool
- The CME shape in each image is fit to a cone
- A linear fit is calculated for the radial expansion of the cone
- Output: eruption start time, lat./lon. of CME base, expansion angle, velocity
- CME parameters are feed into a heliosphere model (WSA-Enlil) to propagate CME to Earth: impact or no-impact?
- Heliosphere models are updated every two hours and propagate ten days into the future


CAT (CME Analysis Tool)
STEREO B COR2
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
Bernouli
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

Where do we go from here?

- Can WFI data be a high-impact tool for forecasting?
- Can polarization information be exploited for forecasting? (Matt West)
- Observations are leading the models. What is the next detail of CME (or solar wind) structure that is important to incorporate into forecasting models?

WSA-Enlil Pipeline

- **Runs on WCOSS every 2 hours**
  - Forecasters get results 2 hours after run initiated
- **Starts with the most recent photospheric magnetogram**
  - Currently GONG zero-point corrected
  - Soon to be replaced by 12-member ADAPT/GONG ensem
- **WSA model for ambient wind**
  - PFSS/SCS B
  - semi-empirical expressions for v, density, T, P
  - 1 – 21.5 Rsun
  - IC for Enlil as Lower BC, then relaxed for 10 days
- **CMEs superposed on ambient wind**
  - Spherical pressure pulses at 21.5 Rsun based on CAT Cone fits
  - Propagated with Enlil to 1AU