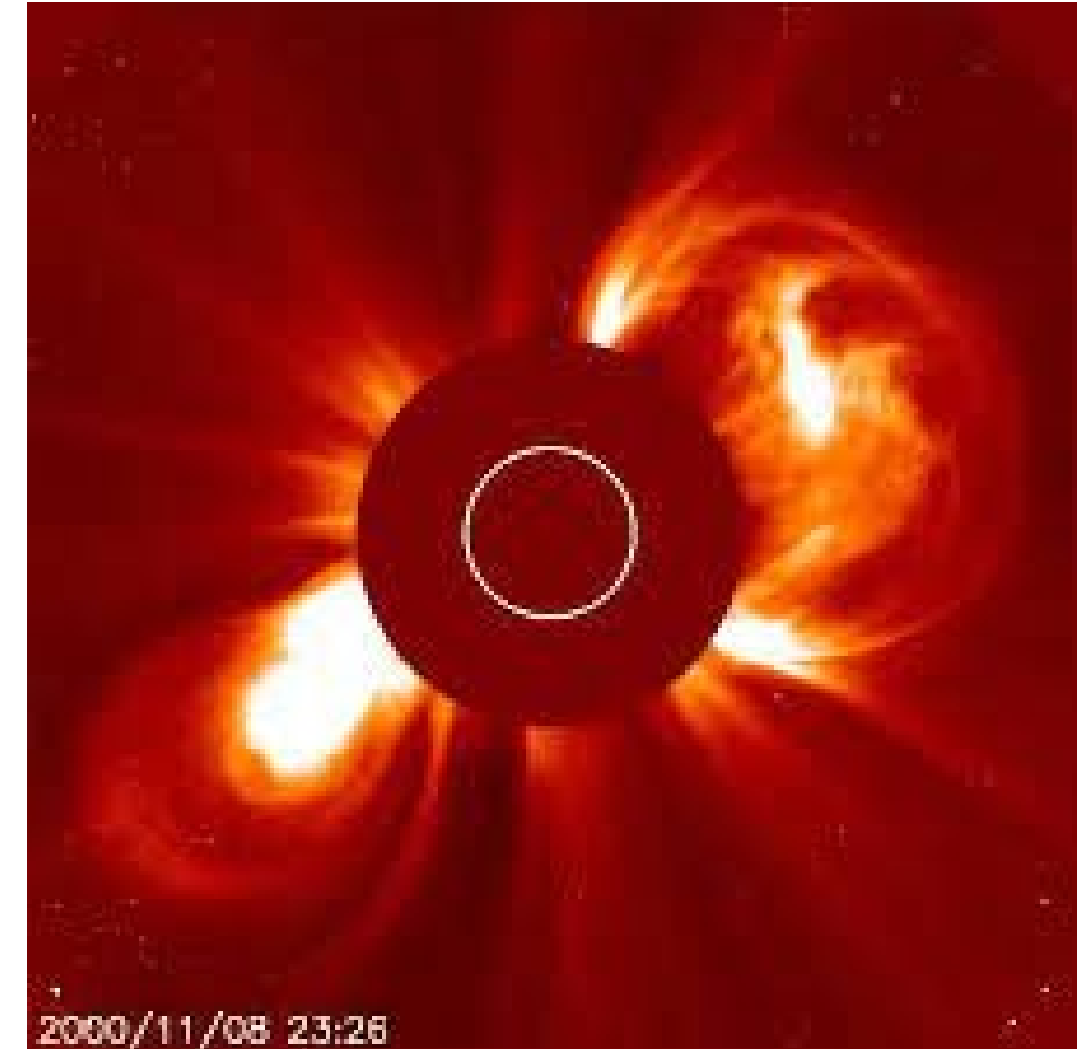


Introduction to coronal science: CCOR-1 and -2

Jeff Newmark, L5 Project Scientist

CCOR-1,2, SOLAR: Coronal Mass Ejections (CMEs)

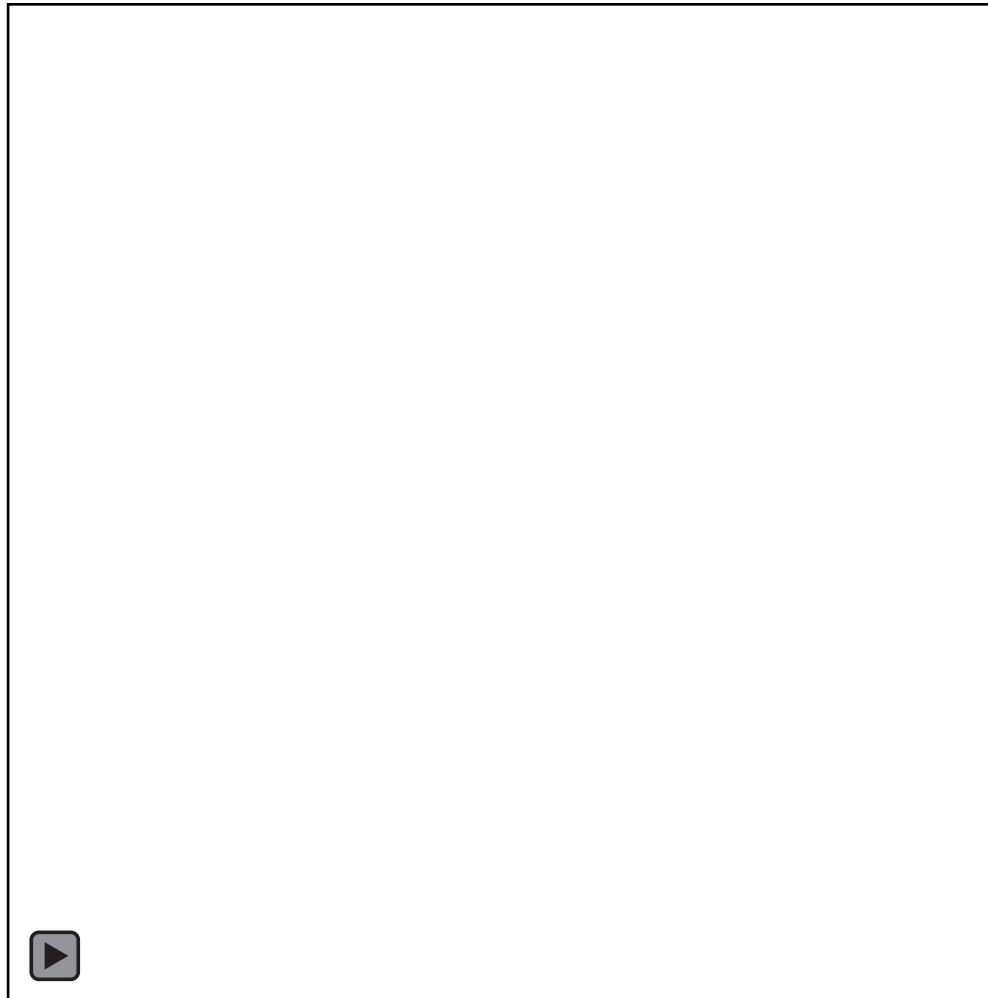
- CMEs are optically thin large-scale solar phenomena that are traditionally observed by white-light coronagraphs as enhanced intensity structures. The intensity increase is due to photospheric light that is Thomson scattered off the electrons forming the CME body and integrated over the line-of-sight (Hundhausen, 1993).
- Due to strong projection effects, CMEs' morphology greatly depends on the viewpoint. This makes CMEs a rather tricky object to measure (Burkepile et al., 2004; Cremades and Bothmer, 2004).



The eruption of two CMEs on Nov. 8, 2000, recorded from NASA's LASCO coronagraph

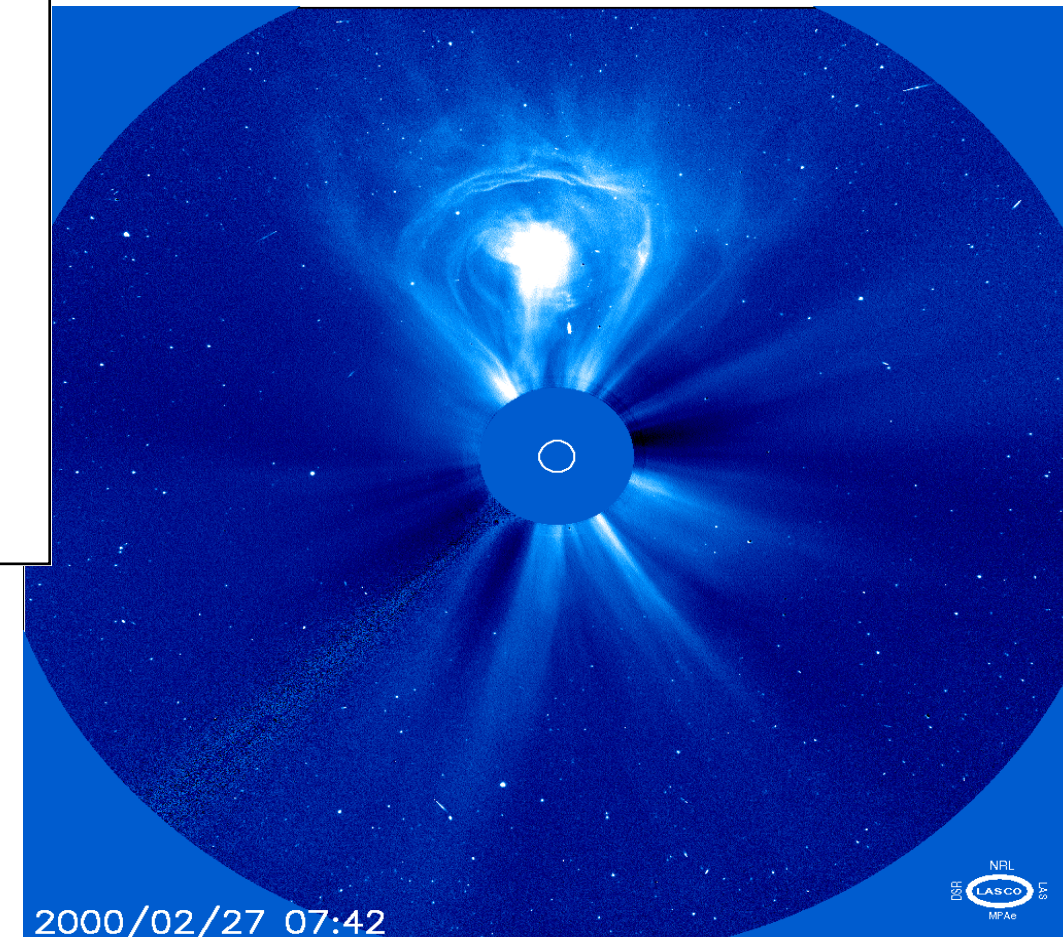
Coronal Mass Ejections (CMEs)– Cont.

- Speed ~300-3400 km/s
- Mass $\sim 10^{11}$ - 10^{16} grams
- Halo events show a ring of excess brightness and move either directly towards or directly away from the Earth
- Limb events are all other events. They generally miss the Earth and thus do not cause any space weather activity in its vicinity.

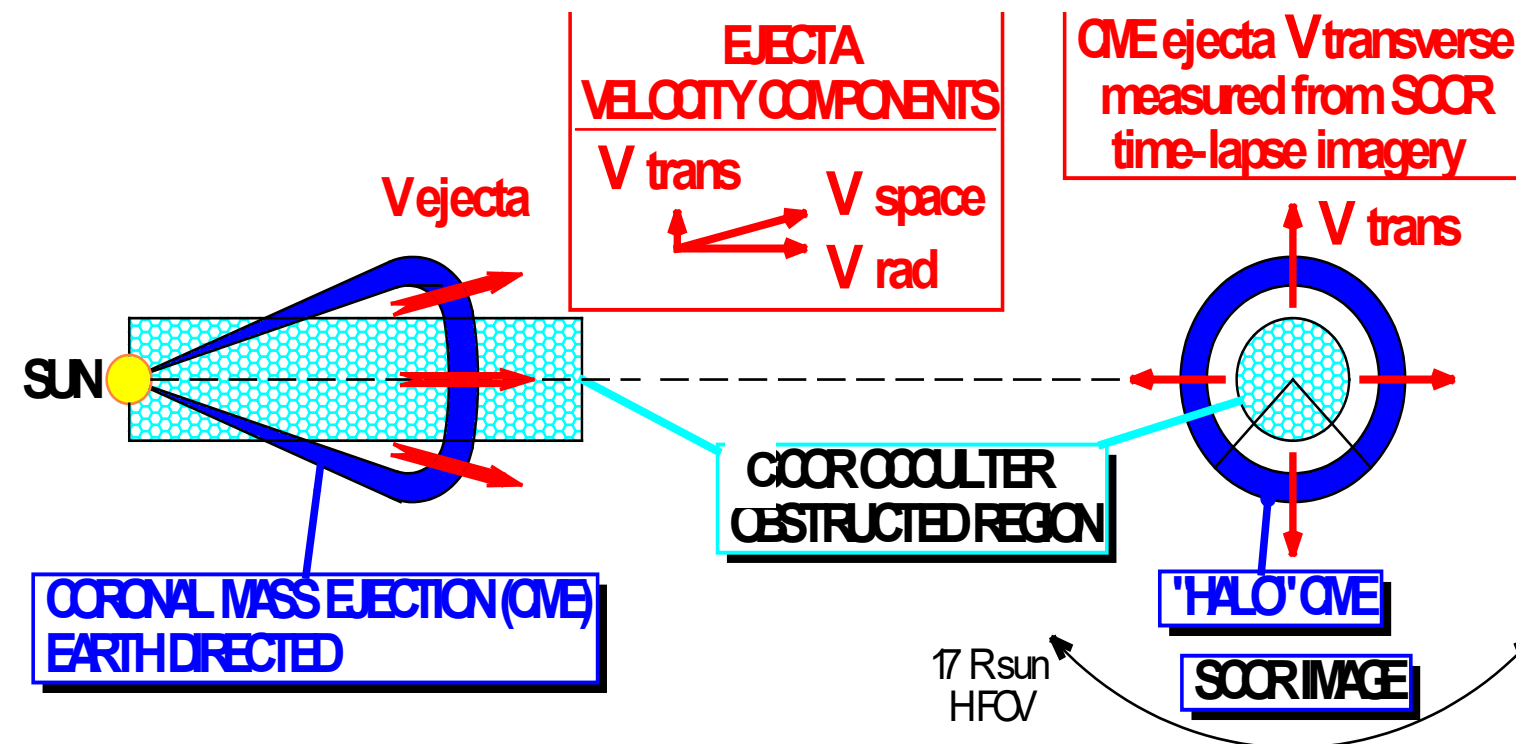
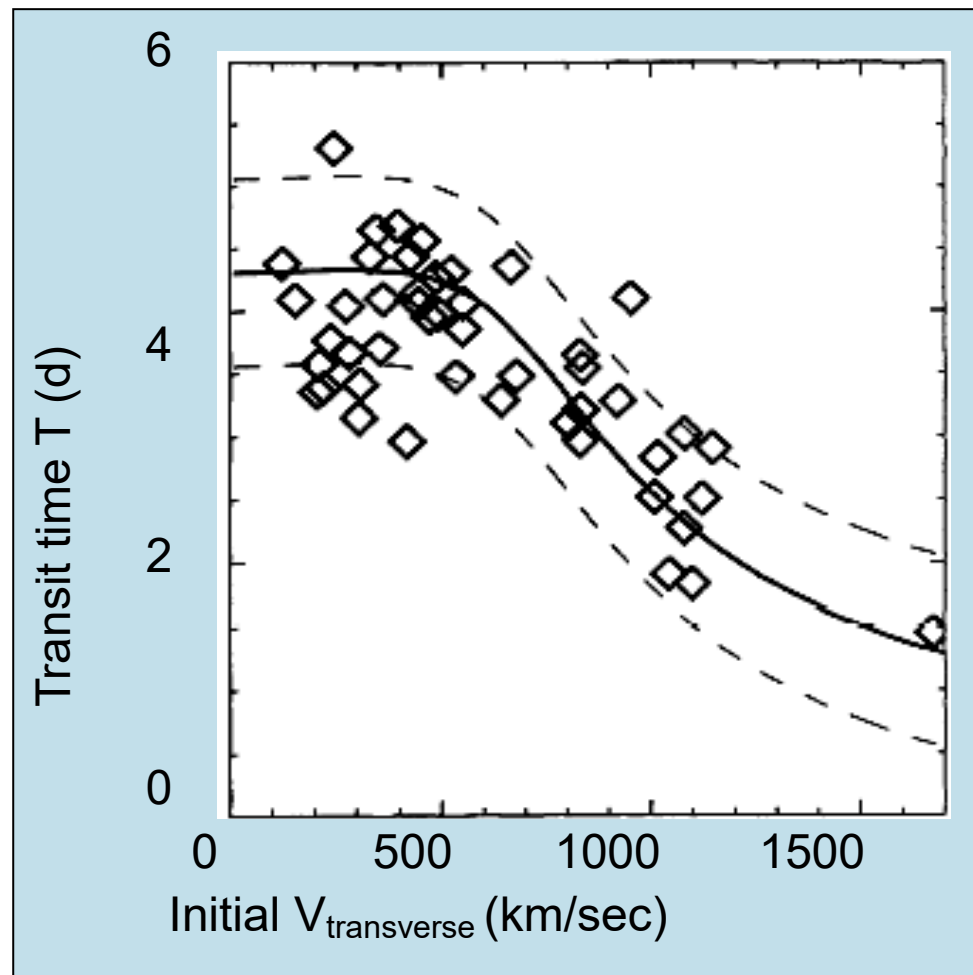


A classic limb CME

The halo CMEs of May 2024



Halo CME Transit Time Prediction

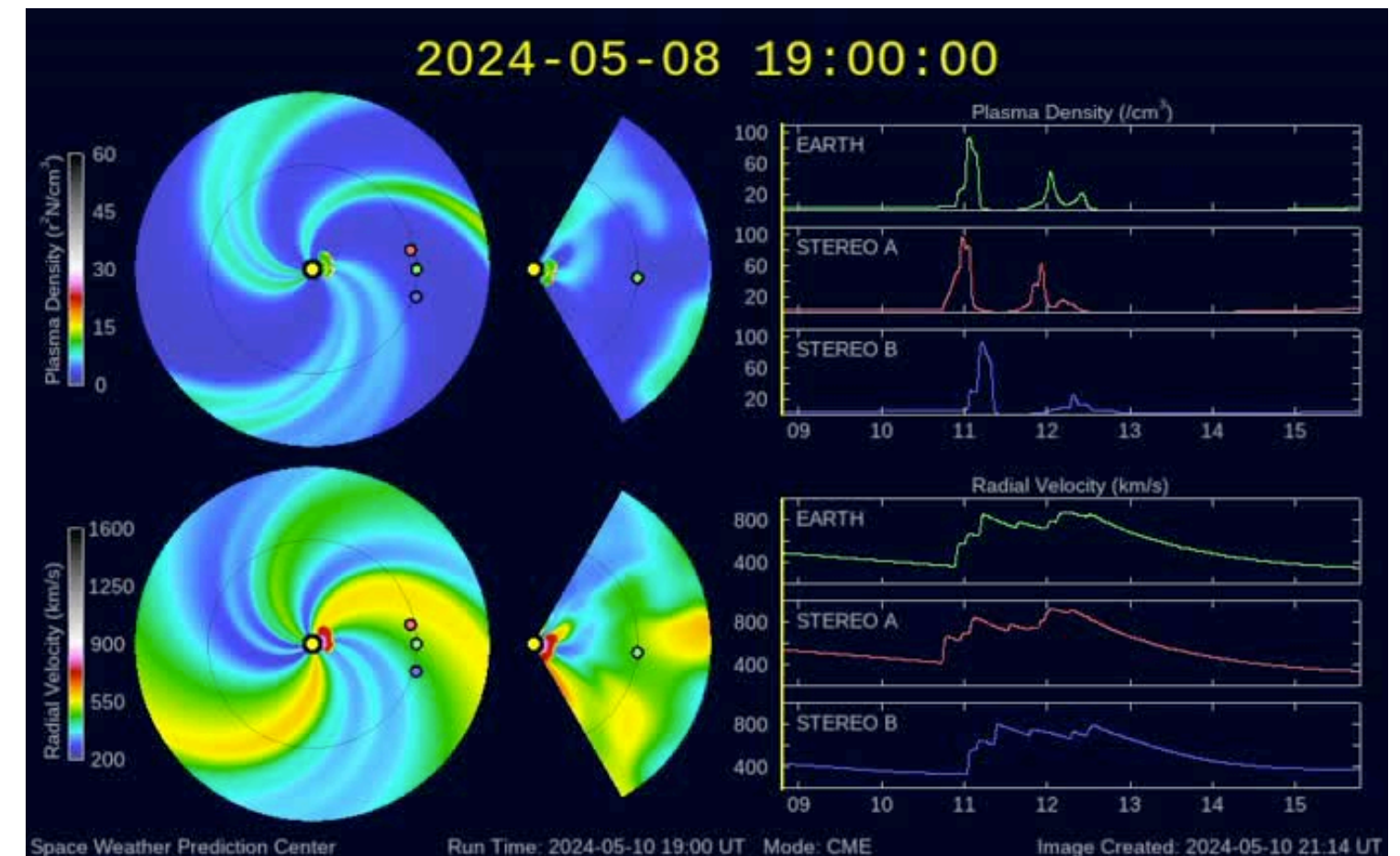
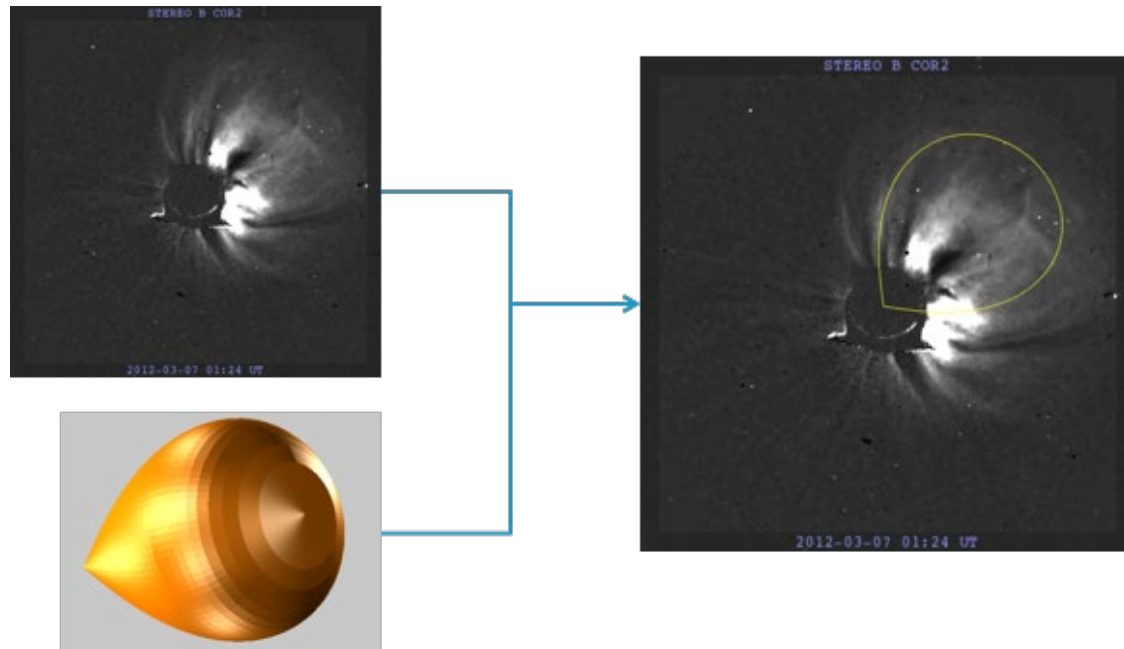


Average error in transit time of fast CMEs: $T = \pm 10.7$ hr (Gopalswamy et al. 2001)

Uses of CCOR-1, -2, SOLAR, Products: Coronagraph Imagery for Heliospheric Models

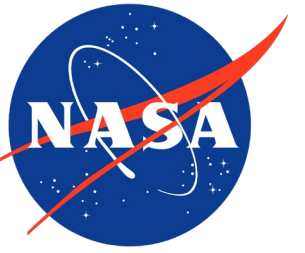
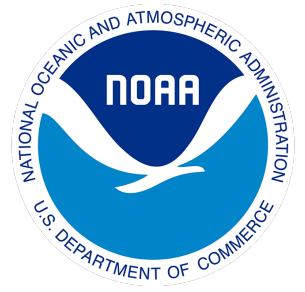
WSA-ENLIL Model

- First numerical space weather model at SWPC
 - Predicts arrival of CMEs at Earth
 - Including coronagraph data reduced error in arrival time from ± 12 hrs to ± 7 hrs
- Requires coronagraph-type data as input
 - This enables Geomagnetic Storm Watch product



Summary

- The Sun-Earth Line (SEL) series of coronagraphs provide continuity observations of coronal mass ejection imagery.
- These are critical observations for improving space weather forecasting and will provide the data needed for many of SWPC's operational models to be able to provide accurate, actionable predictions and resulting watches and warnings.
- The models support a significant user base including users in the aviation, space commerce, energy, and defense sectors.
- SEL observations will be complemented by Vigil CCOR-3 (located at Sun-Earth L5), further enhancing predictive reliability.



BACKUP Slides