The SWFO Program and its Science Objectives

Space Weather Follow On – Lagrange 1 (SWFO-L1)
Pre-Launch Science Meeting
September 21, 2025

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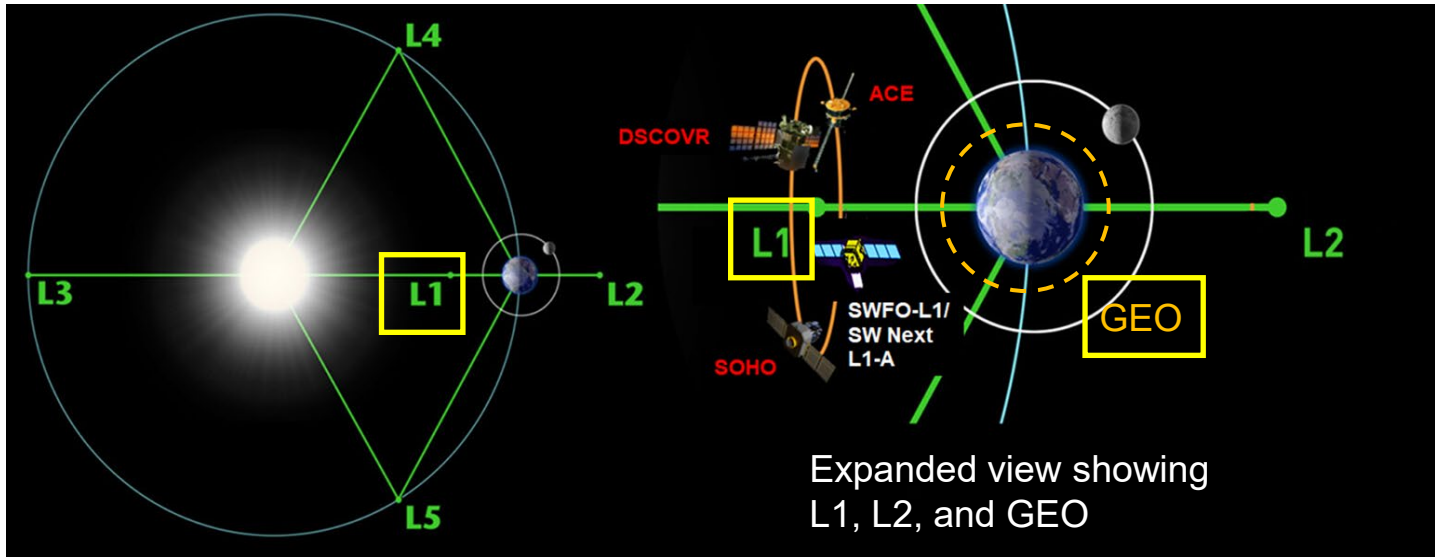
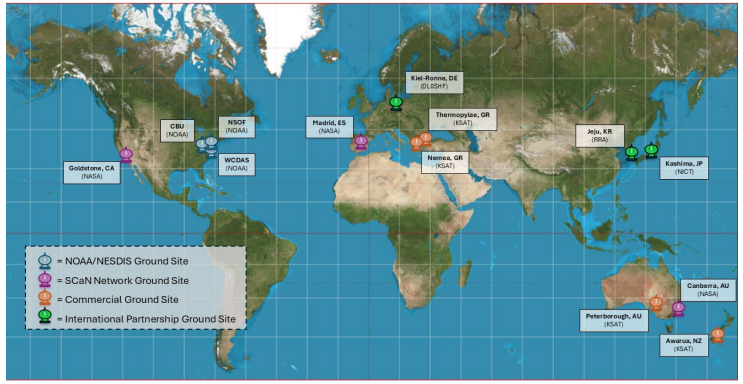
The Space Weather Follow On Program

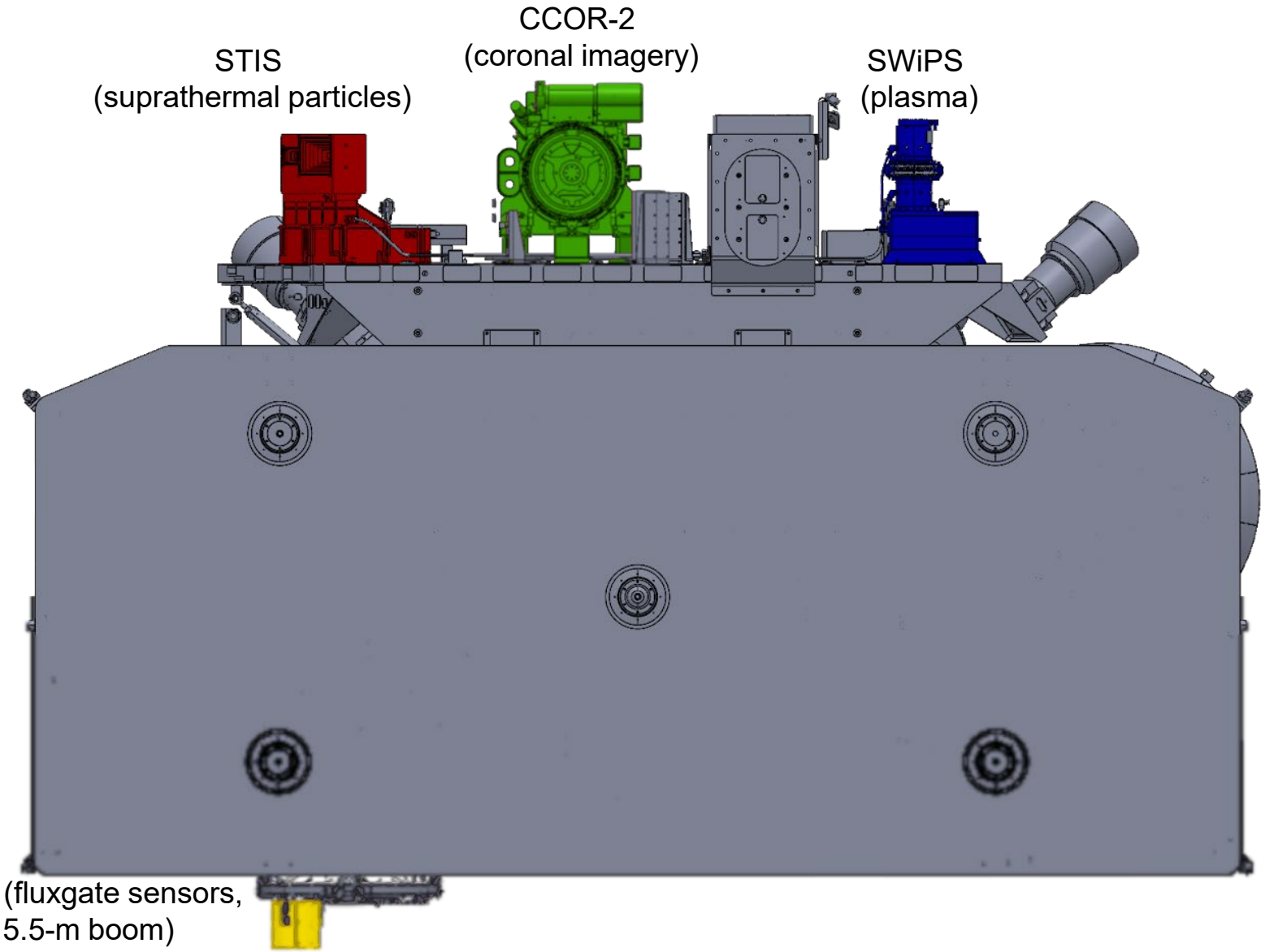
- SWFO is designed to provide critical solar and heliospheric data to users: both to operational users (forecasters, satellite operators, others), and retrospective users (scientists, other developers).
- SWFO will be operating from two orbits:
  - GEO: The Compact Coronagraph-1 (CCOR-1) on the GOES-19 satellite (launched on June 25, 2024)
  - Sun-Earth Lagrange 1 (L1) point: The SWFO-Lagrange 1 (SWFO-L1) Observatory with a planned launch of September 23, 2025 as a rideshare with IMAP.
- SWFO will be providing the following products:
  - Coronal imagery to enable early situational awareness for forecasting
  - Solar wind and interplanetary magnetic field (IMF) measurements to be used as inputs to geospace models.
  - Suprathermal particle flux measurements to be used to improve estimates of CME arrival times.



Expanded view showing L1, L2, and GEO



SWFO-L1 Instrumentation

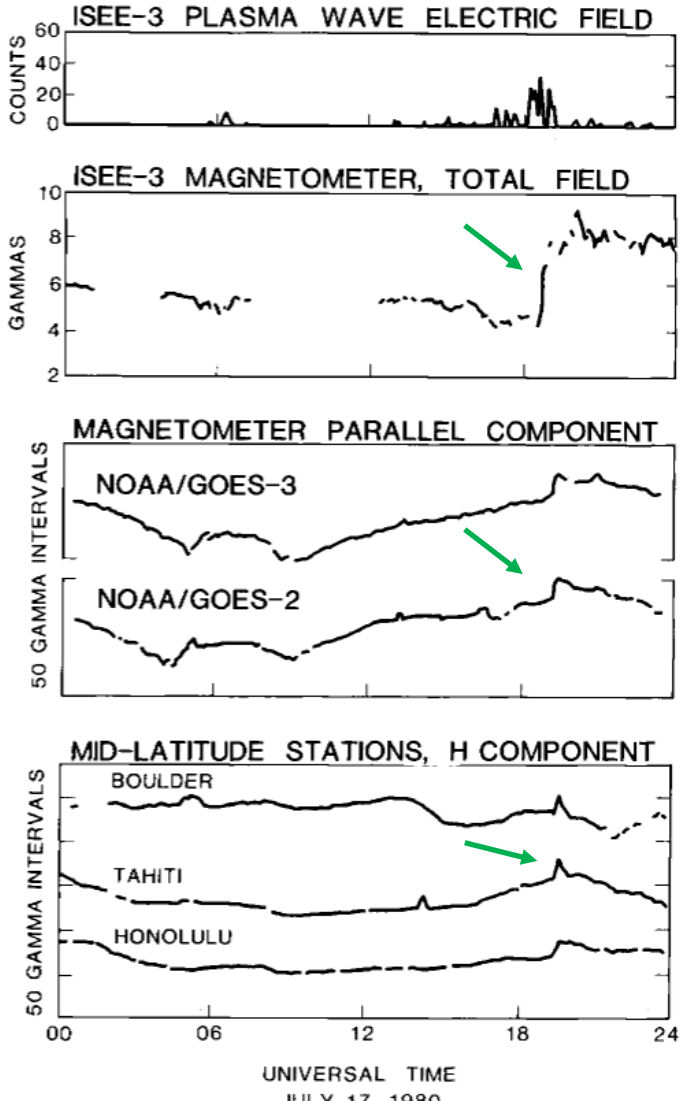


[Acevedo, 2025]

Solar Wind L1 Monitors: a NASA-NOAA Collaboration from More than 45 Years Ago

- SWFO-L1 is part of a historic line of real-time solar wind monitors at L1 that started with a NASA mission in the 1980s.
- Excerpt from "ISEE 3 in real time: an update" by Joselyn et al. of the Space Environment Laboratory (now SWPC) [AGU Eos 62, 32, Aug 1981]:
  - *In the October 9, 1979 issue of Eos, Tsurutani and Baker [1979] expressed the tangible benefits of obtaining selected interplanetary data from the ISEE 3 spacecraft in real time.*
  - *… ISEE 3 is positioned between the earth and the sun in a halo orbit about the sun-Earth libration point. This location is well suited to provide advanced warning of the onset of geomagnetic disturbances. Although the data were not originally intended for real-time use, NOAA and NASA began to cooperate early in 1979 to solve the technical and administrative problems requisite to acquiring the raw data before editing and transmission to the experimenters. In March 1980 the data stream began arriving at the Space Environment Services Center (SESC), Boulder, Colorado. Daily data coverage varies but averages near 80%. The data are now being routinely used to support SESC military and civilian customers and the scientific community at large.*
- The ISEE 3 real-time data provision ended in October 1982, but eventually led to the concept of ACE as a solar wind monitor.

Measuring an interplanetary shock at L1 and resulting SpWx effects at GEO and on the ground [Joselyn et al., 1981]



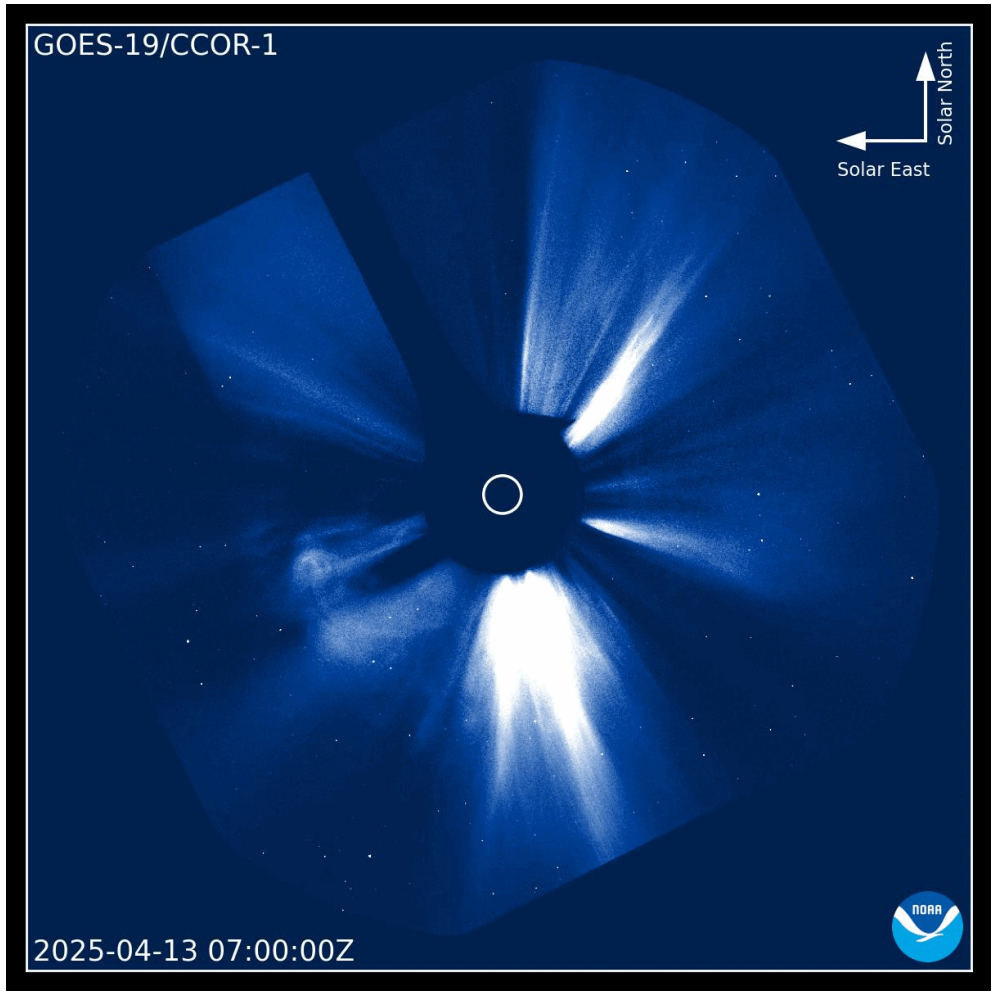
At L1

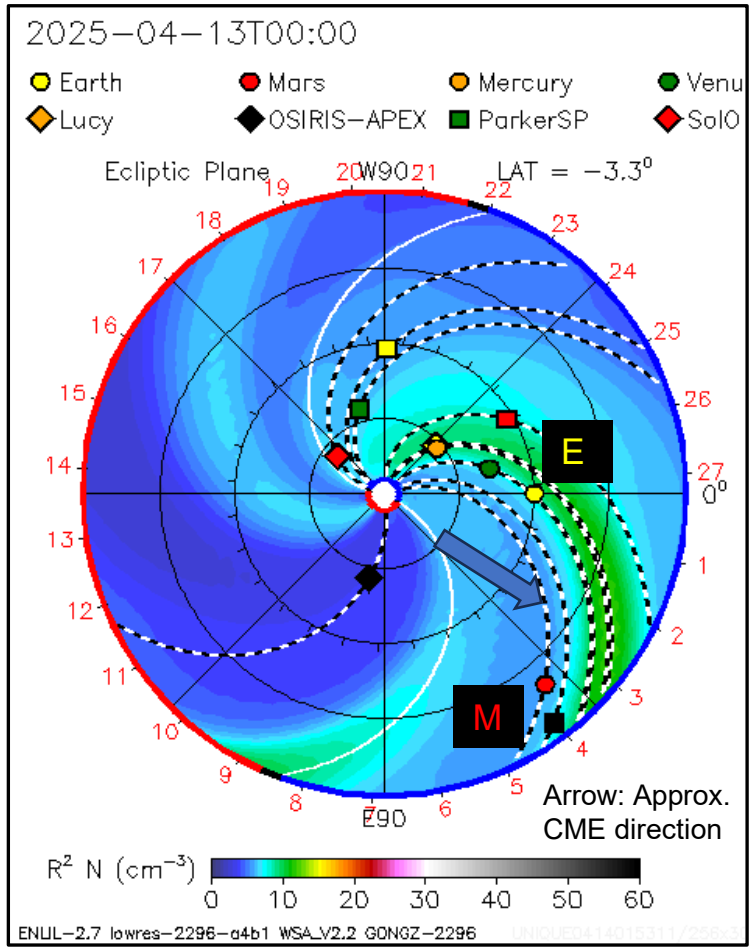
At L1

Shock signature at GEO

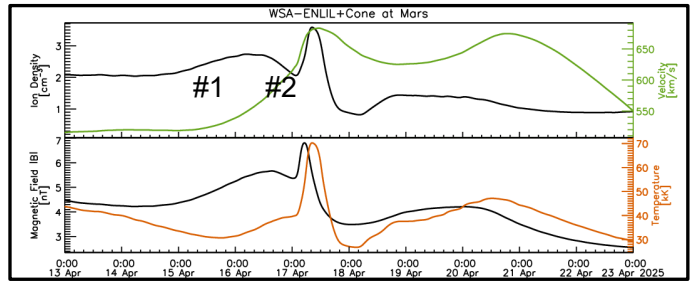
Shock signature on the ground

Integration of CCOR-1 Coronal Imagery in SWPC and M2M Operations: Halo CMEs of April 13, 2025

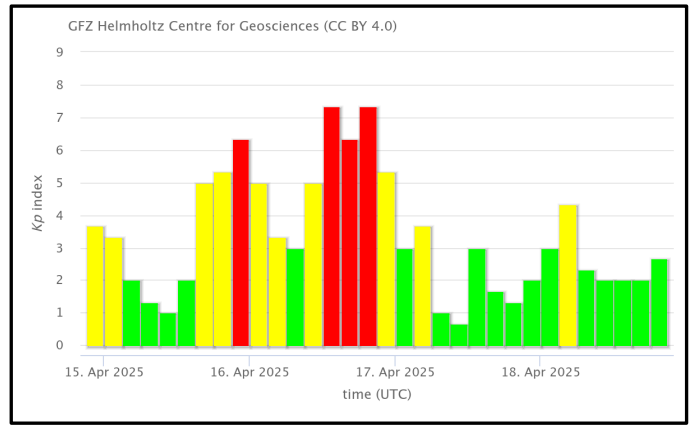




Mars: the two CMEs speeding past the planet

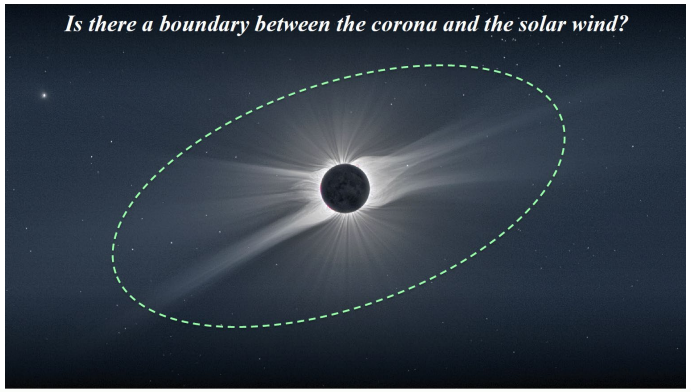


Earth: G4 geomagnetic storm observed.
Below: K_p index of planetary-level disturbance



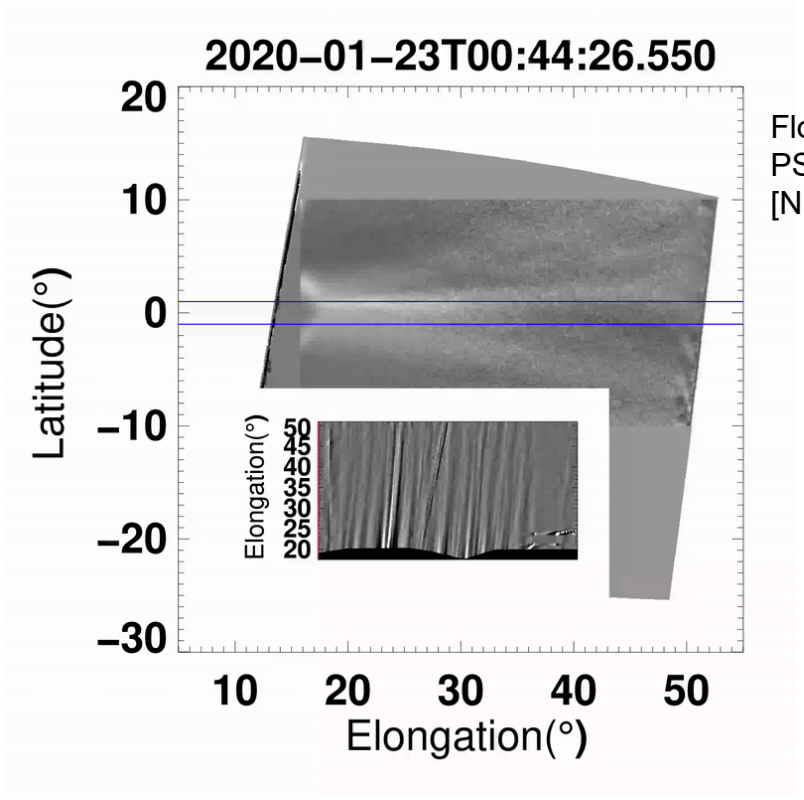
CCOR Imagery: Feature Tracking Applications for Modeling and Theory

- CCOR-1 (and soon, CCOR-2) images are summarily used to detect large-scale CME features. However, their applications may be extended to measure the 1D or 2D velocity fields of much smaller density structures. The resulting velocity maps will be useful for informing high-resolution models of outer corona.
- Examples from the recent literature are shown.

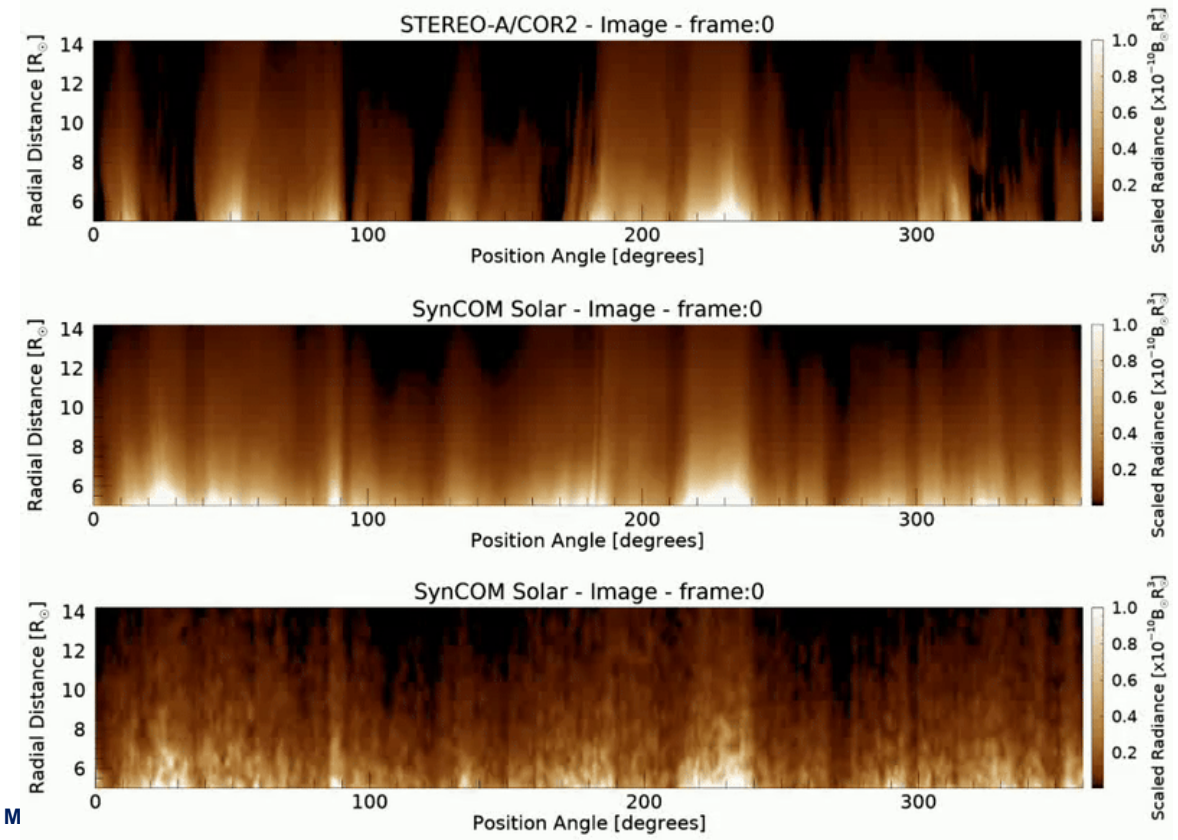


Research challenge: identifying the corona-solar wind boundary

[Cranmer, SHINE 2025; background image: M. Druckmueller]

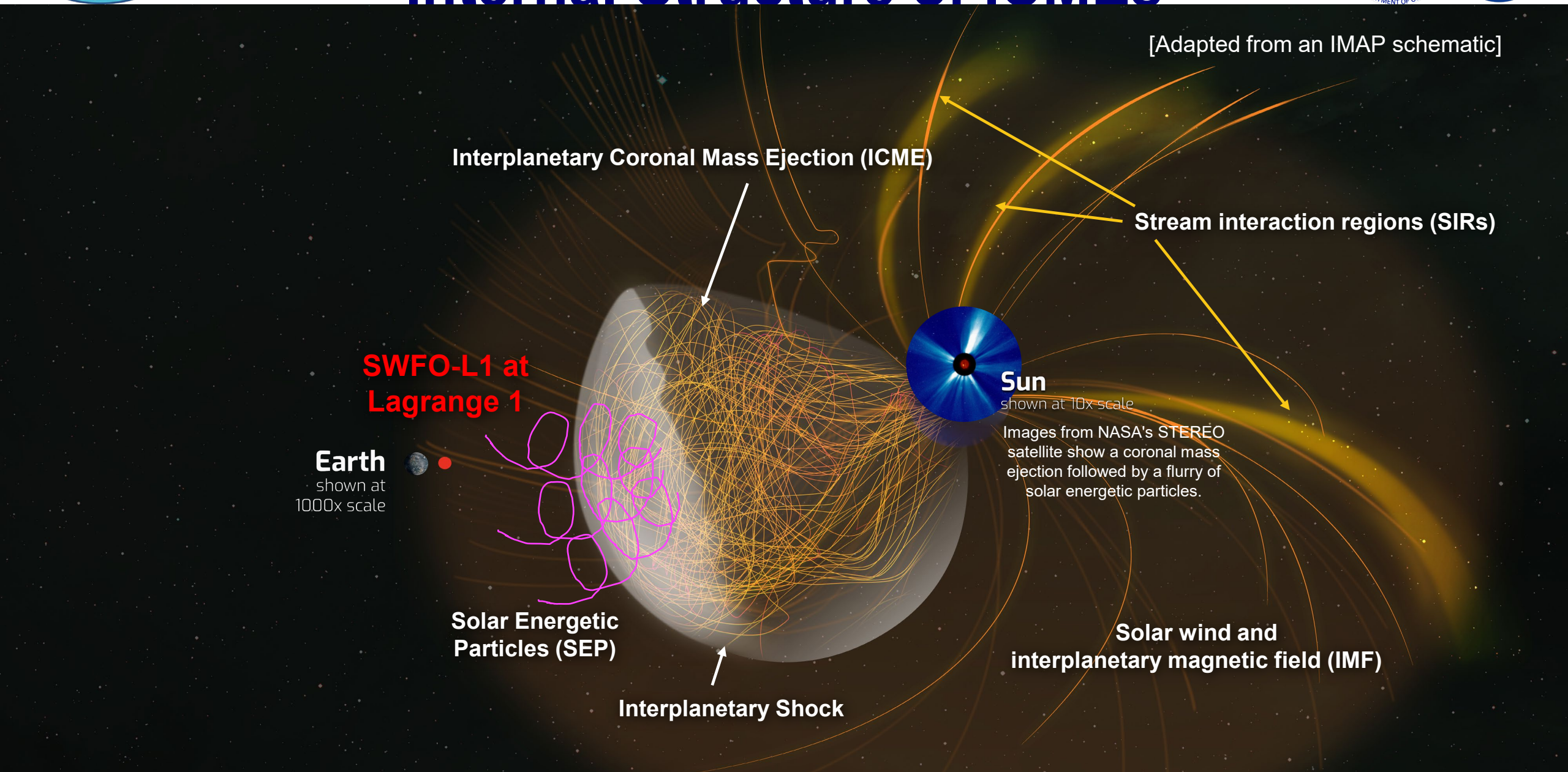


Flow tracking based on PSP heliospheric images [Nindos et al., A&A 2020]



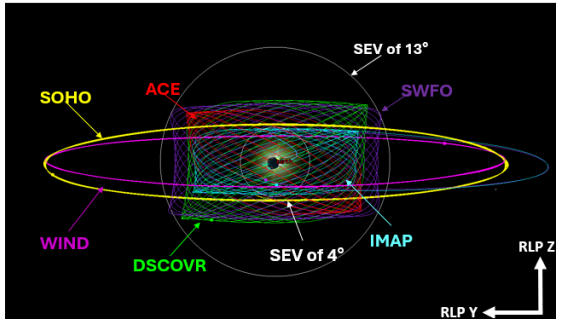
Flow model based on STEREO COR2 images [Moraes et al., ApJ 2024]

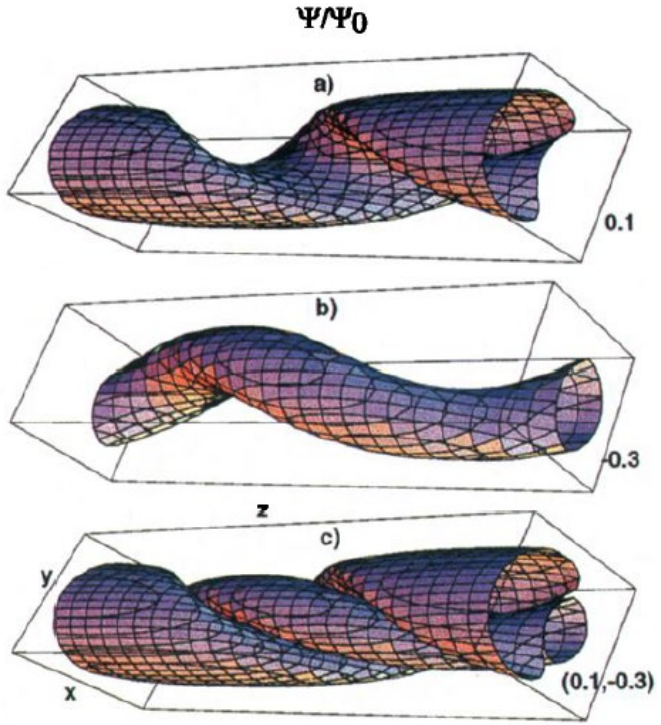
In Situ Measurements: Probing the Internal Structure of ICMEs

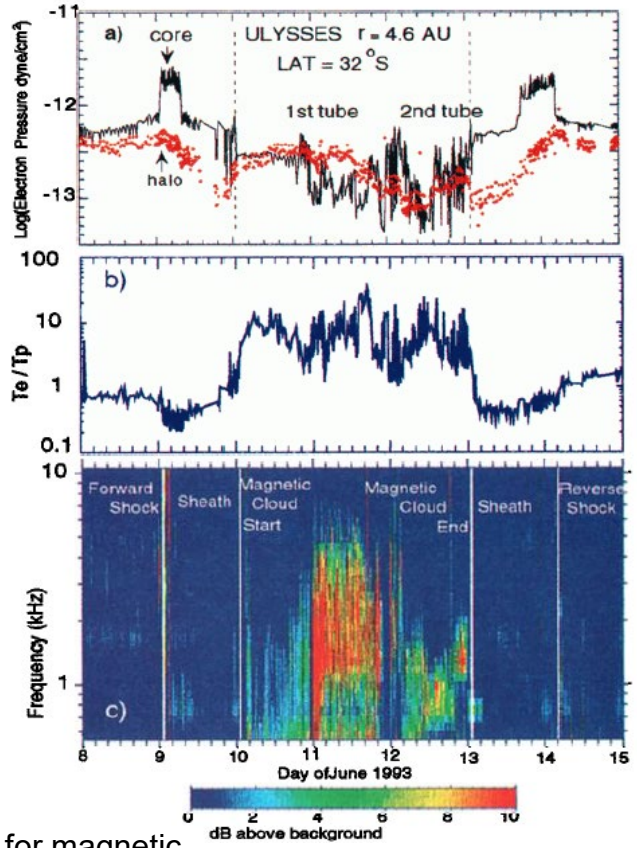


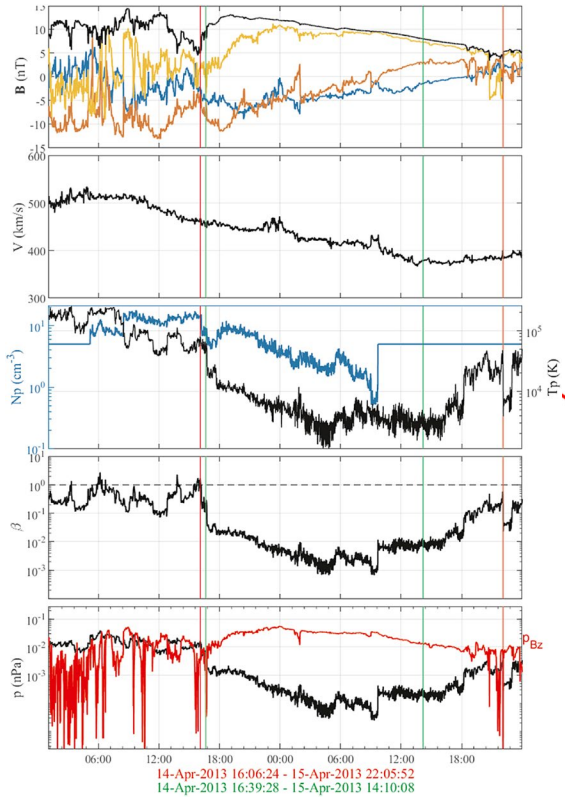
In Situ Measurements: Probing the Internal Structure of ICMEs

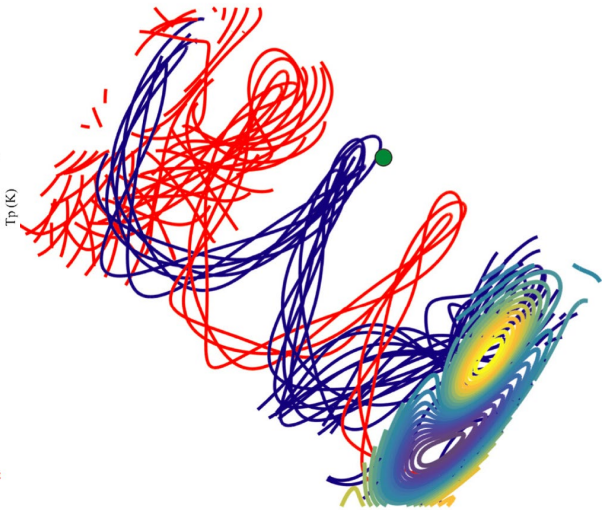
- Magnetic clouds within ICMEs are often modeled as a multiscale helically symmetric system of flux tubes. Force-free models (Lundquist, Freidberg) are obtained from regressions to B-field and plasma data.
- The availability of several solar wind monitors at L1 will enable a detailed look at the magnetic and thermodynamic properties of these equilibria.











Early multi-tube model for magnetic cloud [Osherovich et al., GRL 1999]

Recent model applied to ACE data to obtain a magnetic cloud configuration [Hu et al., GRL 2021]

Summary

- The SWFO Program is designed provide continuity in coronal imagery and solar wind L1 measurements for NOAA's Space Weather Prediction Center. Its data products will have dual use in supporting situational awareness and furthering solar and heliospheric research. The CCOR-1 coronagraph launched as part of the GOES-19 satellite on June 25, 2024 has been recording coronal images since September 19, 2024, which have been validated and released publicly since February 22, 2025.

- The SWFO-L1 observatory is planned to be launched from Kennedy Space Center on September 23, 2025 as a rideshare with IMAP and Carruthers.

- Based on the SWFO-L1 operation from a Lagrange 1 orbit, its data are expected to be used in a wide range of geospace applications including the driving of real-time models of the space environment and supporting model development and analysis. The measurements will provide a key reference for observations from missions in other heliospheric locations.

Go SWFO-L1!