



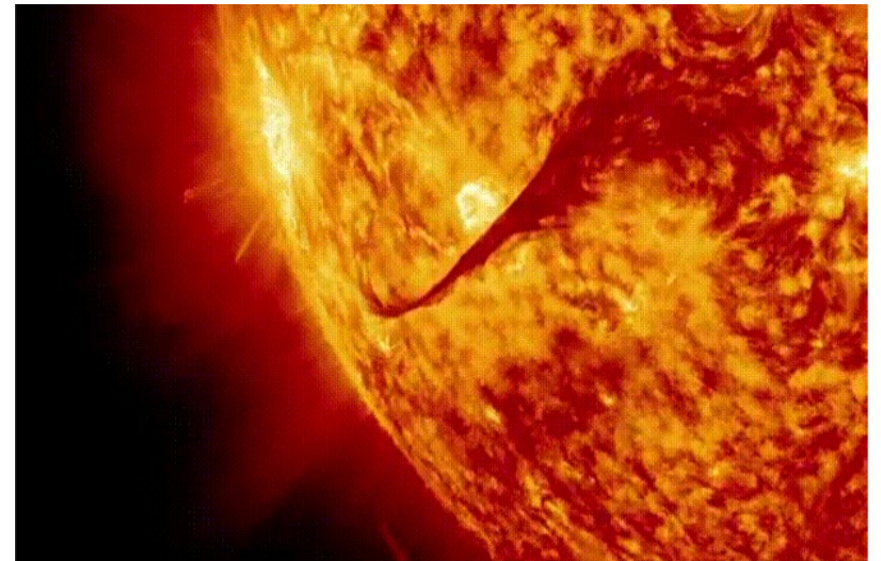
SWO: NOAA's Next Generation of Space Weather Observations

Elsayed Talaat
Director, Office of Space Weather Observations

NOAA's Space Weather Role

NOAA's responsibilities include:

- provide operational space weather monitoring, forecasting, and long-term data archiving and access for civil applications,
- maintain ground-based and space-based assets to provide observations needed for space weather forecasting, prediction, and warnings,
- provide research to support operational responsibilities, and
- develop requirements for space weather forecasting technologies and science.



Space-Based Monitoring at NESDIS

NESDIS's Vision:

A truly integrated digital understanding of our earth environment that can evolve quickly to meet changing user expectations by leveraging NOAA's own capabilities and partnerships.

Space Weather Strategic Objective:

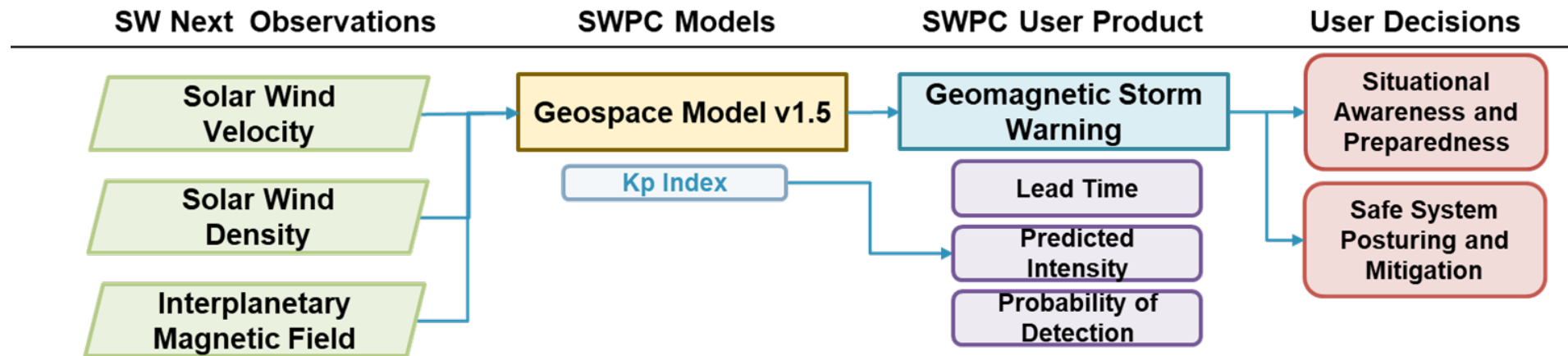
Advance Space Weather observational leadership in LEO, GEO, and extended orbits consistent with the agency's responsibilities within the National Space Weather Strategy and Action Plan.



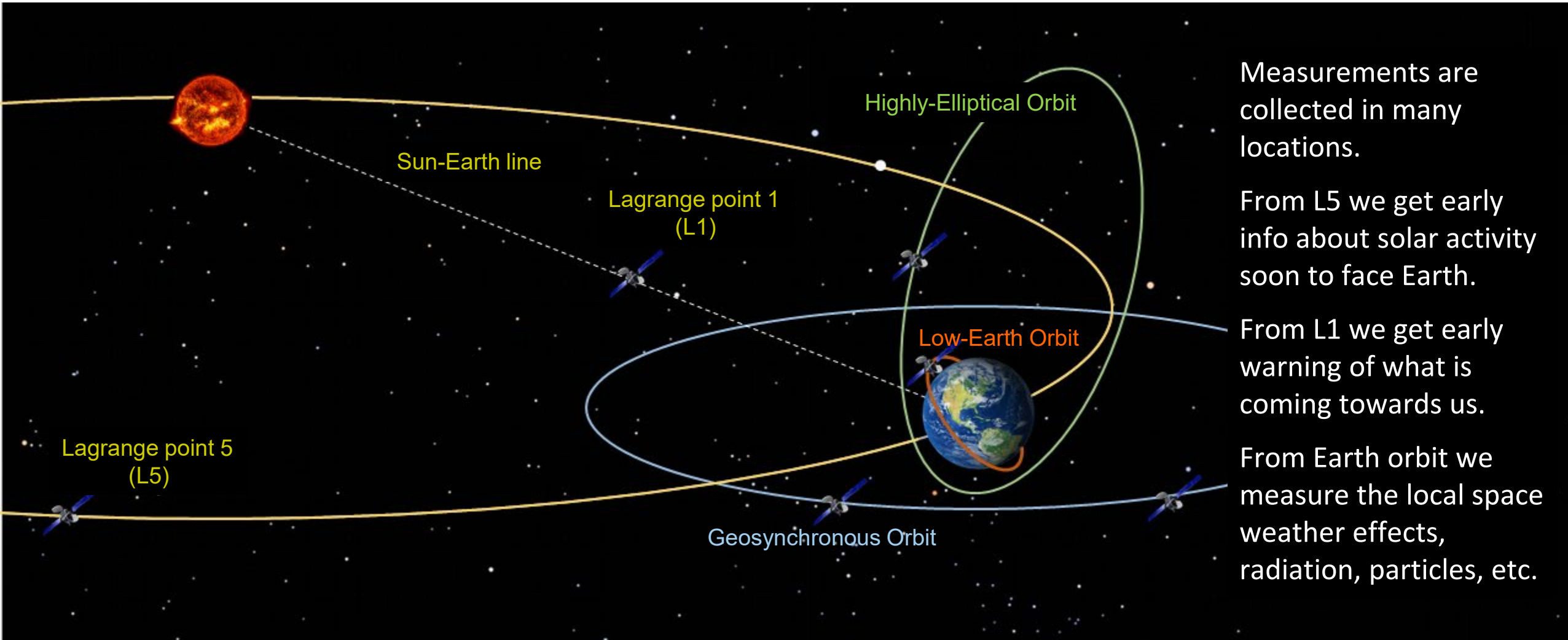
Space Weather is a strategic priority for NOAA/NESDIS

Primary Product User: NWS/Space Weather Prediction Center

- The **Space Weather Prediction Center (SWPC)** provides 24x7 real-time monitoring and forecasting of solar and geophysical (space weather) events and effects.
- SWPC uses space weather observations from multiple sources to develop a variety of forecasts, warnings, and alerts.
- One **example** of a sensor data trace to products that meet user needs:



We collect space weather data to know what is happening and to predict the effects and issue warnings and alerts.



Measurements are collected in many locations.

From L5 we get early info about solar activity soon to face Earth.

From L1 we get early warning of what is coming towards us.

From Earth orbit we measure the local space weather effects, radiation, particles, etc.

SWFO CCOR on GOES-U Mission

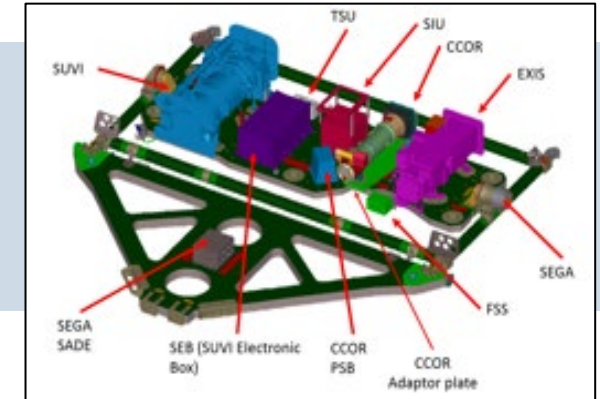
Launch: 2024

Orbit: GEO

Instrument: CCOR on GOES-U solar-pointing platform

Command & Data Flow: GOES-R Ground System

CCOR +
SUVI +
EXIS



Purpose: Establish operational capability and continuity of CME imaging observational requirements

Primary operational objectives:

- Observe CME parameters, shape, density and velocity
- Produce CME characteristics for input into operational heliospheric propagation code
- Enable space weather watches, warnings, forecasting and predictions

Updates:

- CCOR-1 integrated onto GOES-U
- On track for 2024 Launch



CCOR-1 integration onto GOES-U

Image Credit: Lockheed Martin

SWFO-L1 Mission

Launch: 2025 (*ride share with NASA IMAP*)

Orbit: Lagrange Point 1 (L1)

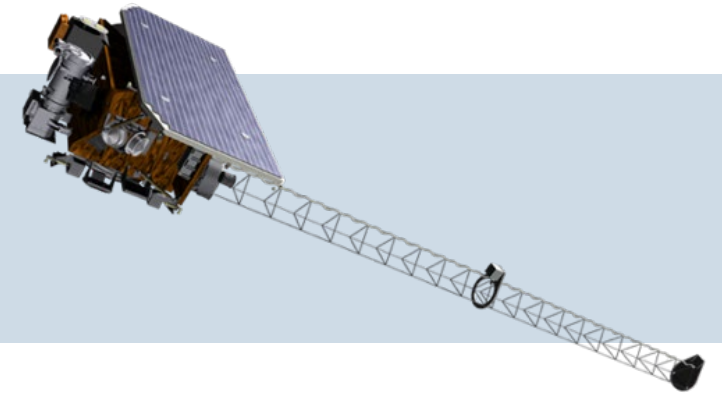
Instruments: CCOR, Solar Wind Instrument Suite (SWiPS, MAG, STIS)

Command & Data Flow: SWFO Ground System

Purpose: Establish operational capability and continuity of space weather observational requirements

Primary operational objectives:

- Coronal White Light Images for detection of CMEs
- Observe CME parameters, shape, density, velocity
- Produce CME characteristics for input into operational heliospheric propagation code
- Measure solar wind magnetic field, thermal plasma, and energetic particles



Credit: Ball Aerospace

Updates:

- Spacecraft assembly is underway
- On track for 2025 rideshare with NASA IMAP



Spacecraft assembly underway in Ball cleanroom

Image credit: Ball Aerospace

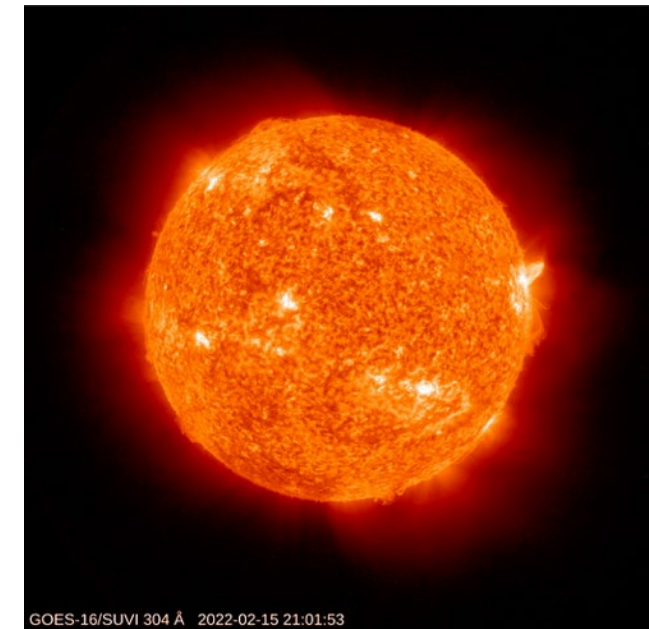
SWFO Next Steps

| SWFO Event/Activity | Status |
|---|-----------|
| NOAA-European Space Agency (ESA) Agreement Signed | Completed |
| SWFO Program Critical Design Review | Completed |
| Flight Project Critical Design Review | Completed |
| CCOR-1 Pre-Ship Review | Completed |
| CCOR-2 Pre-Environmental Review | Completed |
| Construction of new ground antennas at Wallops Command and Data Acquisition Station and consolidated backup in Fairmont, WV | Ongoing |
| Ship CCOR-2 FM to Spacecraft | Q4 FY23 |
| MAG, SWiPS, and STIS Pre-Environmental Reviews | Q3 FY23 |
| Mission Operations Review (MOR) | Q4 FY23 |

Space Weather Next (SW Next) program

SW Next will **maintain and extend** space weather observations from a range of different observing points, selected to most efficiently provide comprehensive knowledge of the Sun and the near-Earth space environment.

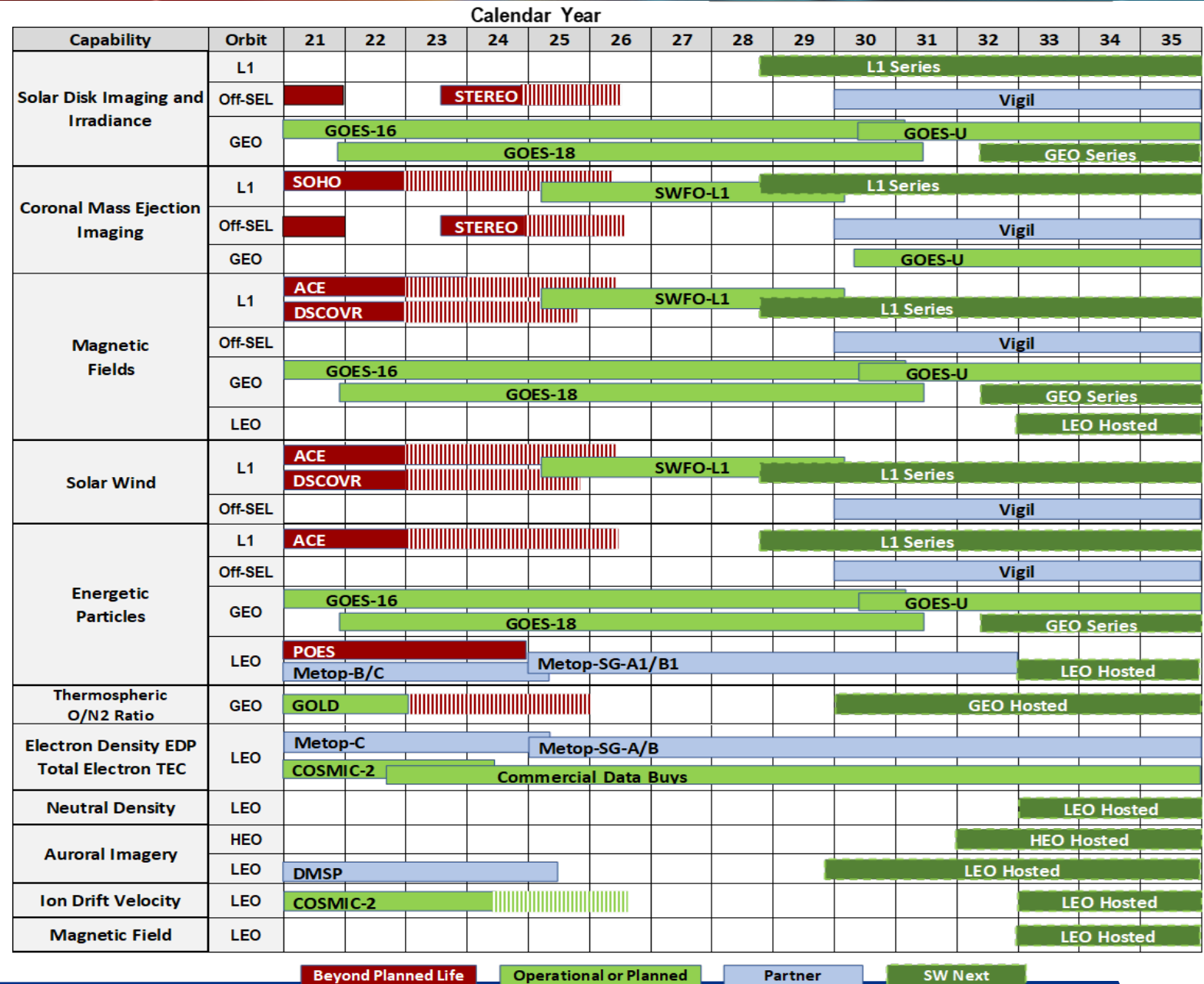
- Planning for **continuity of observations** from:
 - L1 and L5 Orbits
 - Geostationary Orbit
 - Low Earth Orbit
 - Space Weather Ground Support Networks
- Program and L1 Series Project are in formulation phase
- Engaging stakeholders through:
 - **User outreach** targeting civil aviation, electric grid, and satellite operator communities
 - **Partnerships** for observational support and exchange of space weather observational data
 - **RFIs and RFPs** for L1 Series Project instruments and observatory



SW Next projects and partnerships will provide necessary continuity.

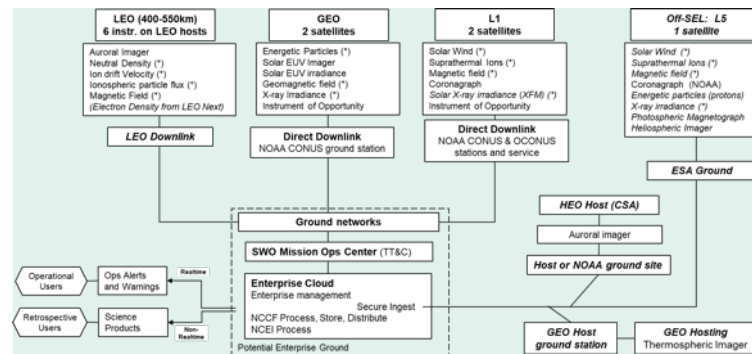
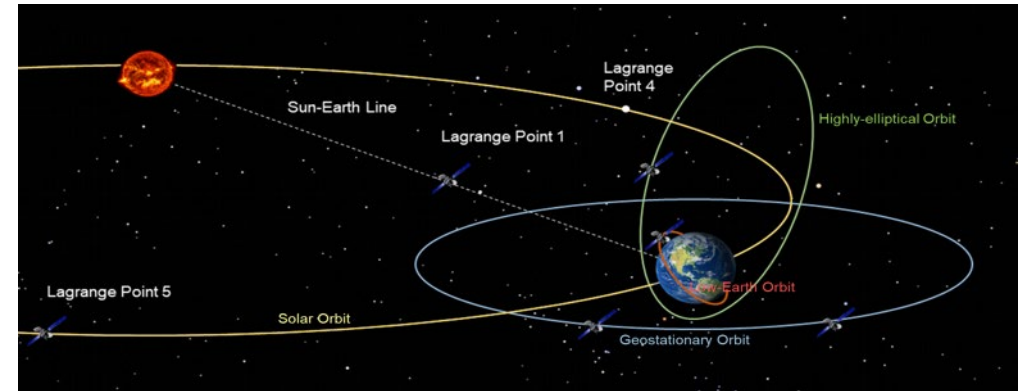
NOAA and partner missions collect and exchange space weather observations needed by SWPC.

Many current platforms are beyond predicted end of life, and some new missions have lifespans short of 2030.



From Strawman to Program Architecture

- The SW Next Program “initial” architecture contained assumptions:
 - about the location of some measurements (e.g., either L1 or GEO could satisfy a Sun-Earth Line measurement requirement)
 - about the implementation of space-ground communications and data handling systems
- Analysis of Alternatives (AoA) recommends instrument allocations and physical implementation options.



Sensor to Benefits Tracing

1. High level operational and economic benefits

Power Grid:

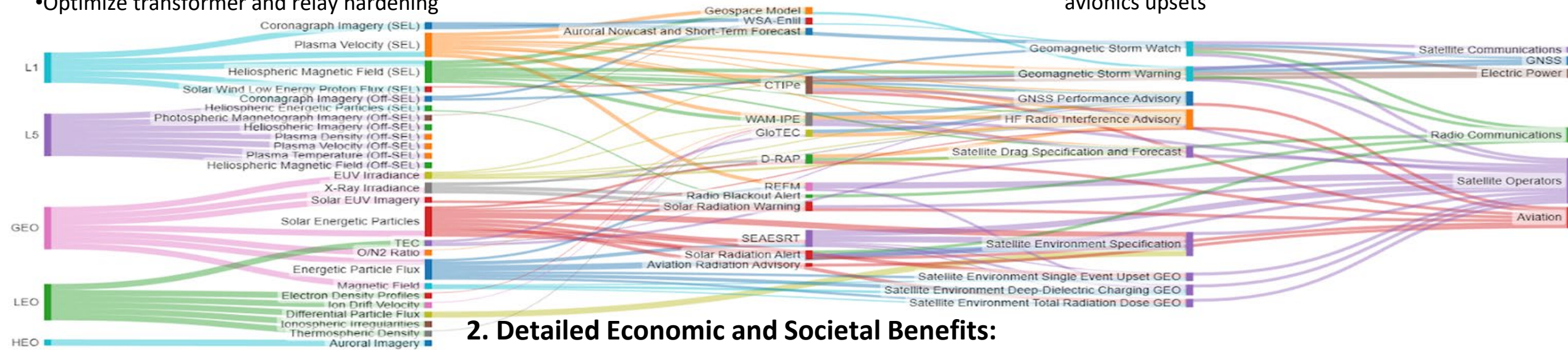
- Avoid and mitigate blackouts from protective relay and transformer failures
- Manage reactive power consumption, power imbalances, and loss of precision timing
- Assess transformer deterioration due to overheating
- Optimize transformer and relay hardening

Satellite Operation:

- Awareness and attribution of performance issues
- Monitor device degradation
- Correct loss of altitude and drag on satellite
- Mitigate satellite link disruptions

Aviation:

- Mitigate communication disruptions
- Correct navigation errors
- Monitor radiation exposure especially for flight crew
- Defensive investments and situational awareness against single point of failure avionics upsets



2. Detailed Economic and Societal Benefits:

- Chief Economist Office developing user uses to benefits trace.
- Initial based on previous benefits studies to be refined in the future to support project formulations

Joint NOAA/NASA Office

Space Weather Observations Programs Division
GSFC Code 490
System Program Director (SPD): Elsayed Talaat, NOAA
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Deputy SPD: Gene Martin, NASA
Chief of Staff: Argelia Gonzalez, NOAA

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Contracts:
Tammy Seidel, NASA; Keith Long, NOAA

Program Support & IT Services:
Support Contractor

Senior Scientist:
In process NOAA

Program Systems Engineering:
Charles Zakrzewski, NASA GSFC Code 599

Mission Assurance:
David Bogart, NASA GSFC Code 383

SW Ground Services
Code 492

* Acting

SWFO Program

SWFO-L1 Flight Project Code 491.1

PM: J. Morrissey (NASA)
dPM: G. Yoblin (NASA)
dPM: G. Comeyne (NOAA)
Proj Sci: D. Vassiliadis (NOAA)

SWFO-L1 Ground Project Code 491.2

PM: A. Fox (NOAA)
dPM: C. Strickland (NASA)

L1 Series Project Code 493

PM: T. Van Sant (NASA)
dPM: G. Dell (NASA)
dPM: J. Silva (NOAA*)
Proj.Sci: I. Azeem (NOAA*)

L5 Project Code 494

PM: TBD
dPM: TBD
Proj Sci: TBD

GEO Series Project Code 495

PM: TBD
dPM: B. Nowak (NASA)
dPM: G. Comeyne (NOAA)
Proj Sci: TBD

LEO Series Project Code 496

PM: TBD
dPM: TBD
Proj Sci: TBD



493/ L1 Series Project

- Project team completed **Mission Concept Review on March 27-28.**
 - Project Level 1 & Level 2 Requirements documents are in development.
 - KDP-A is planned for June 2023. DOC Milestone 2 planned for Q3 FY2023.
- Acquisition strategy is in review.
- Coronagraph Formulation Studies RFP solicited proposals for Phase A studies.
 - Multiple definition-phase awards with an 8-month period of performance
 - Includes a pre-priced option for four additional months to work towards PDR
- Spacecraft and other instrument procurements are in development.

The L1 Series Project will provide continuity of coronal imagery and upstream solar wind observations beyond SWFO-L1.

494/ L5 Project

NOAA and ESA have a signed partnership agreement for space weather collaboration.
The agreement includes:

- NESDIS provision of a Compact Coronagraph to fly on Vigil mission to L5 Status:
 - Compact Coronagraph (CCOR-3) being built by NRL as a near-copy of the CCOR-2 on SWFO-L1.
 - SW Next is defining CCOR-3 Level 0 data receipt and processing requirements.
- Exchange of data from all Vigil instruments
 - SW Next is defining product interface and distribution requirements.



The L5 Project will manage the CCOR-3 development effort, the integration of the instrument into the ESA mission, and the development of data services.

SW Next Formulation Next Steps (FY22-FY23; *Notional*)

| SW Next Formulation Event/Activity | Status |
|---|-----------|
| Baseline Program Requirements | Completed |
| NOAA Program Mission Concept Review / NASA System Requirements Review - <i>Program Technical Review</i> | Completed |
| DOC Program Milestone 1 - <i>Program Authorization</i> | Completed |
| NOAA/NASA Program Key Decision Point 0 - <i>Program Commitment</i> | Completed |
| Program System Definition Review | Completed |
| NOAA/NASA Program Key Decision Point I | May 2023 |
| NOAA/NASA L1 Series Project Mission Concept Review - <i>Project Technical Review</i> | Completed |
| NOAA/NASA L1 Series Project Key Decision Point A | June 2023 |
| DOC L1 Series Project Milestone 2 - <i>Project Authorization</i> | Q3 FY23 |

Commercial Data Program (CDP)

- On November 10, 2021, a Request for Information (RFI) was posted to SAM.gov soliciting information on existing or planned commercial space weather data and related capabilities that will be available in the 2022 through 2028 timeframe
- On May 19, 2022 a Request for Proposal (RFP) to conduct a Commercial Weather Data Pilot (CWDP) Study of commercial space weather data sources and related capabilities that may help NOAA meet its space weather mission objectives
- On July 14, 2022, NOAA awarded three Commercial Weather Data Pilot (CWDP) space weather contracts to GeoOptics Inc. (Pasadena, CA), Space Sciences and Engineering LLC, dba PlanetiQ (Golden, CO), and Spire Global Subsidiary, Inc (San Francisco, CA)
- These contract awards constitute the next round of NOAA's CWDP studies with a particular focus on space weather data.

NOAA and the 2023/2025 Solar Eclipses

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Partners for the Eclipse



Smithsonian Facilities

Annular Eclipse: October 14, 2023



Credit: beklaus



Credit: Amanda Ogle

Total Eclipse: April 8, 2024



Credit: Michael Fitzgerald Fine Art Photography of Texas



Credit: Richard Sharrocks

NOAA/NESDIS advice needed from Decadal Survey

- Concepts and plans for enhancements of capabilities
- Improved understanding of needed latency of notifications to customers; e.g. L1 observation products to electric power industry is nominally one hour or less
- Advice on operational platform systems in order to address critical observational gaps or potential gaps
- Advice on other agency tech demos on NOAA platforms
- Advice on research, tech demos from other agencies to advance understanding of Sun-Earth interactions and the cause and effect of space weather events
- Develop ways to assess and communicate the value proposition for space weather operational observations
- Advice on how to further develop applications and models that fully exploit observational data
- Advice on how operational observations can be used as part of the research infrastructure

Thank You!

