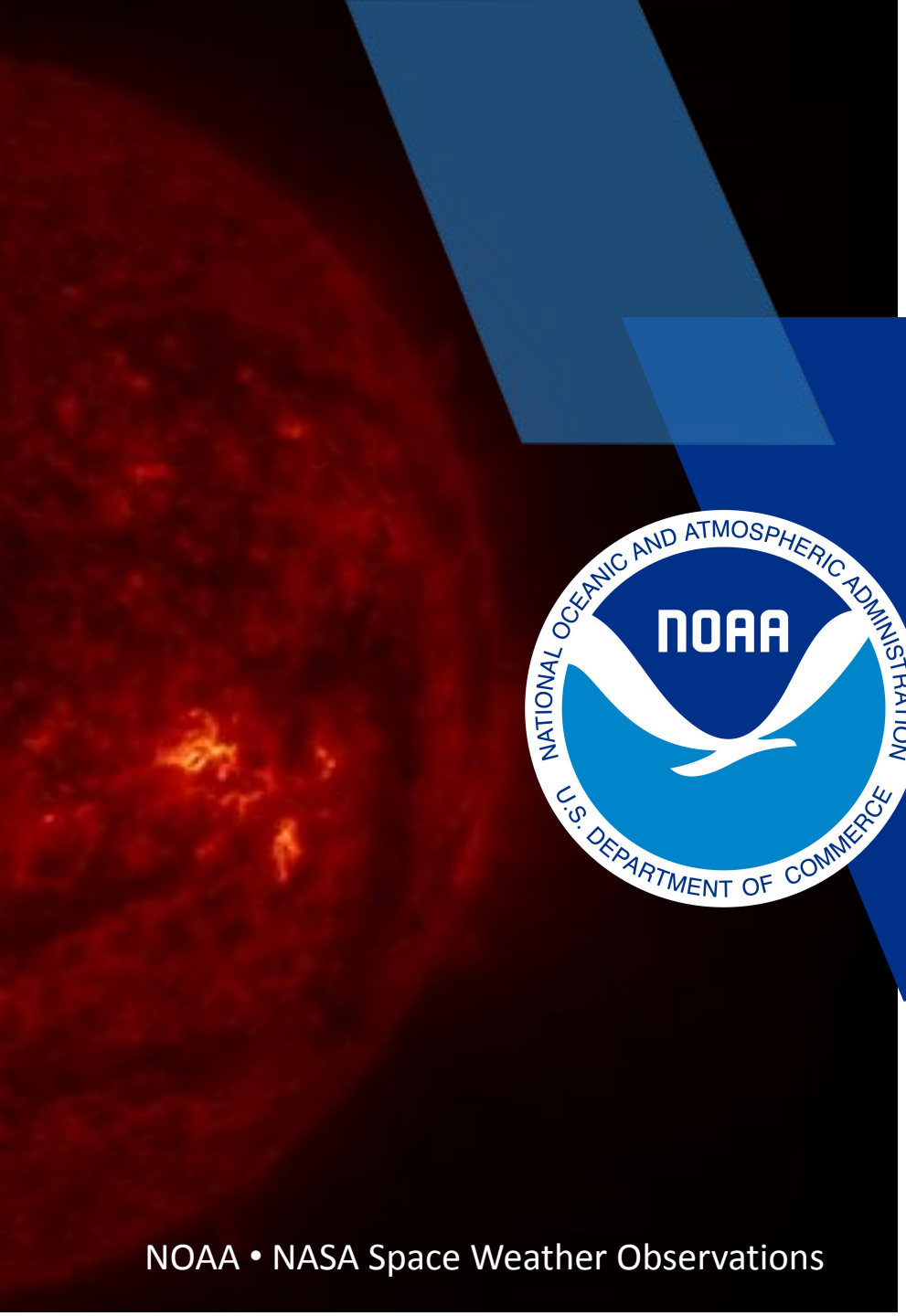
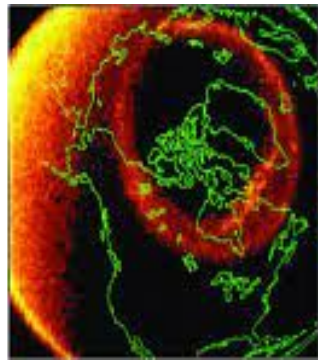


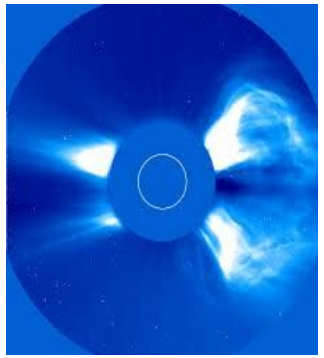
SWO Strategy for Sustaining and Enhancing Space Weather Observations from Space

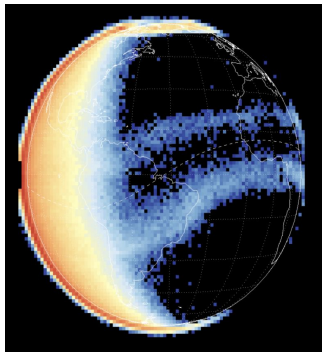
Irfan Azeem
Office of Space Weather Observations (SWO)
NOAA/NESDIS

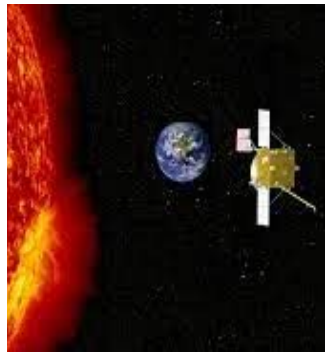
NOAA • NASA Space Weather Observations

NOAA is a Trusted Source of Operational Space Weather Data & Services









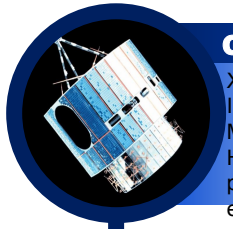
NOAA provides:

- Observational Data
- Storm Forecasting
- Data Management

L1

GEO

LEO

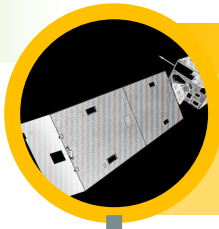


GOES 1-3

X-ray
Irradiance
Magnetic Field
High-energy
protons and
electrons

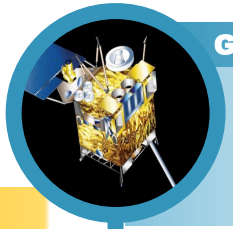
GOES 4-7

X-ray Irradiance
Magnetic Field
High-energy
protons and
electrons



GOES 8-12

X-ray Irradiance
Magnetic Field
High-energy protons
and electrons

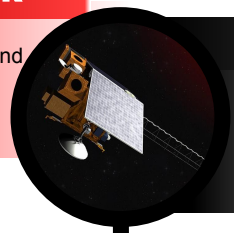


GOES 13-15

X-ray Irradiance
Magnetic Field
High-energy protons
High-energy electrons
EUV Irradiance
X-ray/EUV Imagery

DSCOVR

Solar Wind
IMF



SWFO-L1

Solar Wind
Interplanetary magnetic
field
Suprathermal Ions
Coronagraph Imagery

GOES 16-19

X-ray Irradiance
Magnetic Field
High-energy + low-energy
protons and electrons
EUV Irradiance
Improved EUV Imagery
Coronagraph Imagery

1970s | 1980s | 1990s | 2000s | 2010s

SWX

NOAA 1-5

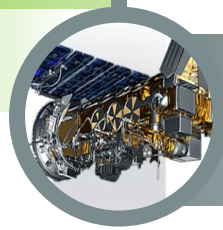
Solar
proton
flux

NOAA 6-7

Med.
Energy Protons and
electrons

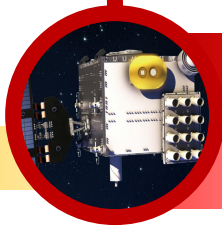
NOAA 8-14

Medium energy
Protons and
electrons



NOAA 15-19

Medium and high energy
Protons and electrons

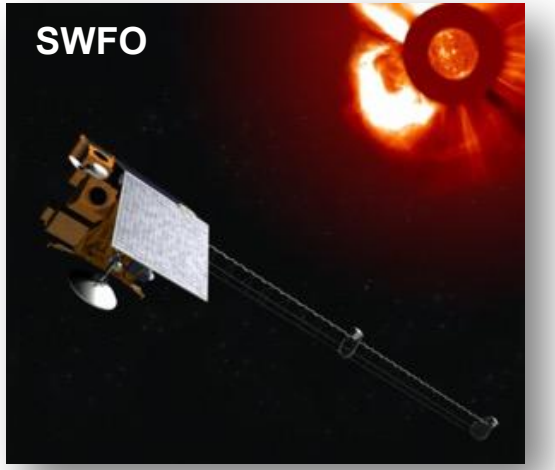


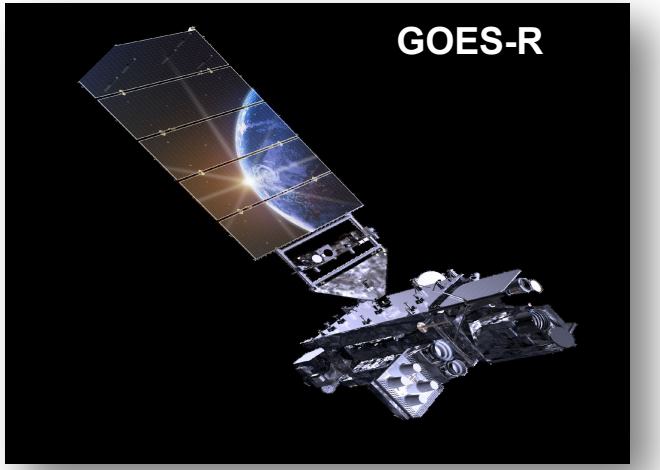
COSMIC-2

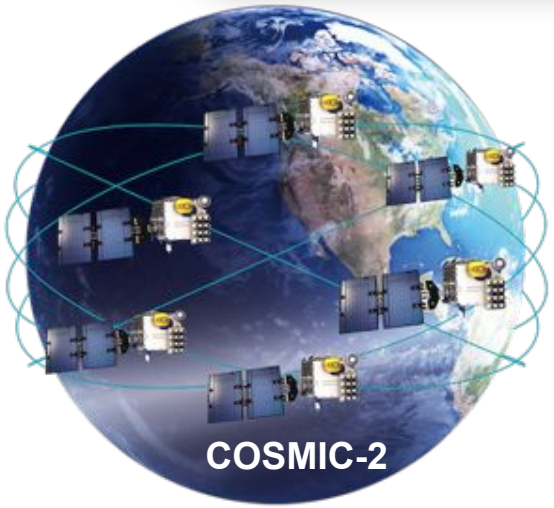
Total electron content
Electron Density Profiles
Scintillation
Ion Drift Velocity

Current Observational Infrastructure

- NOAA's current observations comes from multiple sources:
  - ❑ NOAA DSCOVR, NASA ACE
  - ❑ ESA/NASA SOHO
  - ❑ NOAA GOES-R
  - ❑ NASA SDO
  - ❑ NOAA-TASA COSMIC-2
  - ❑ NOAA SWFO
  - ❑ EUMETDAT Metop – C, SG A1, SG B1
  - ❑ *ESA Vigil – L5*





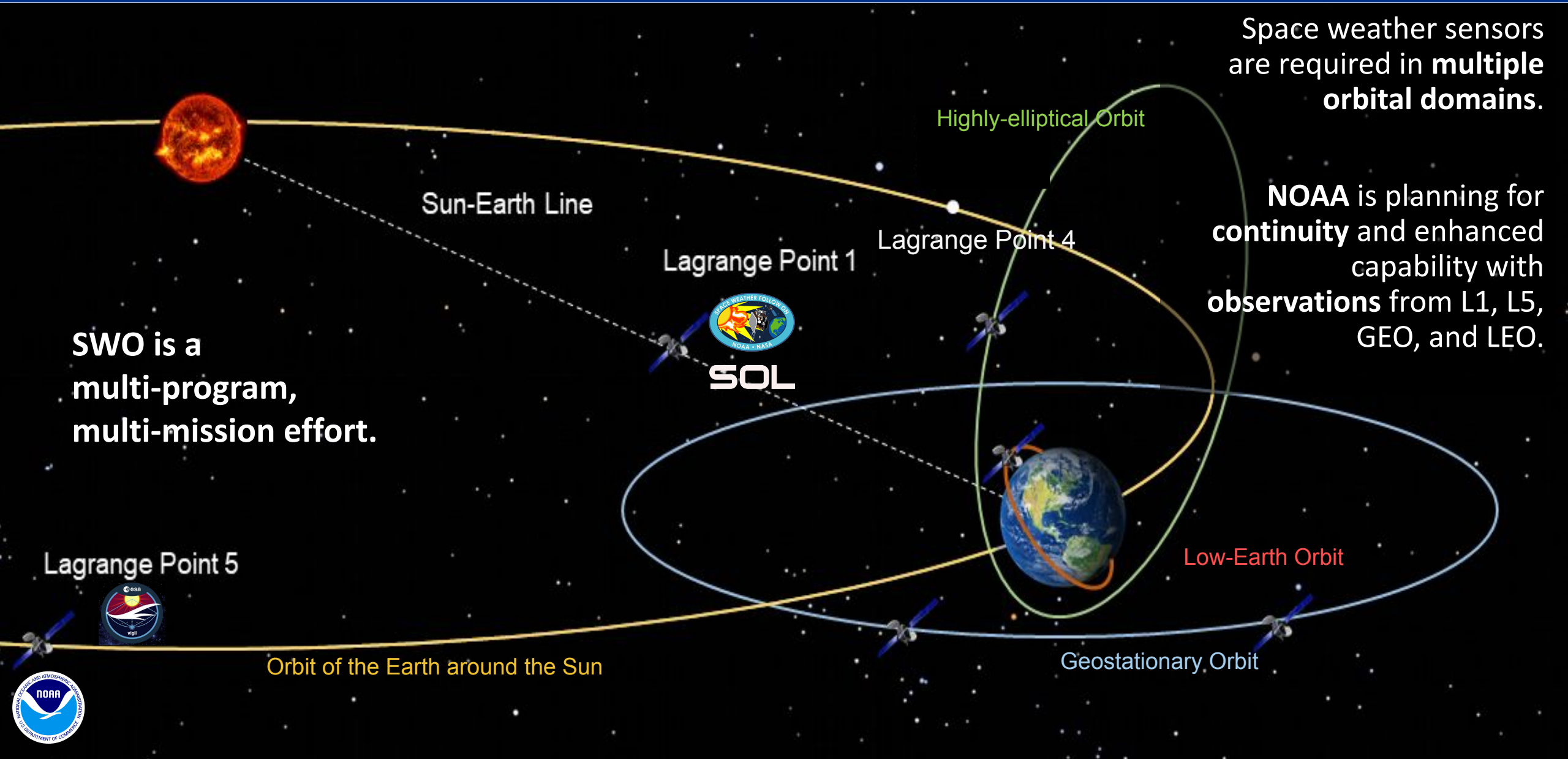


SWO Strategic Plan for Space Weather

- **Continuity of Observations:** SWO aims to continuously monitor solar events like solar flares, coronal mass ejections (CMEs), and solar wind to predict and understand their potential impact on Earth's space environment.
- **Enhanced Space Weather Observations:** By deploying advanced space weather instruments aboard satellites, NOAA seeks to improve the accuracy and timeliness of SWPC's space weather forecast products.
- **Collaboration with Partner Agencies and the Commercial Sector:** NOAA collaborates with NASA, the Department of Defense, and international space agencies and the commercial sector to enhance space weather observation and data sharing.

Office of Space Weather Observations

Advancing the Future of Space Weather Information



Space weather sensors are required in **multiple orbital domains**.

NOAA is planning for **continuity** and enhanced capability with **observations** from L1, L5, GEO, and LEO.

SWO is a multi-program, multi-mission effort.

Space Weather Observations (SWO) Portfolio

Space Weather Follow On (SWFO)

- Two program elements
  - SWFO-L1 mission and GOES-U coronagraph
- GOES-U launched on June 25, 2024
- All space weather instruments providing science data
- All SWFO-L1 instruments delivered and integrated on the spacecraft
- SWFO coordination with NASA IMAP

Space Weather Next (SW Next)

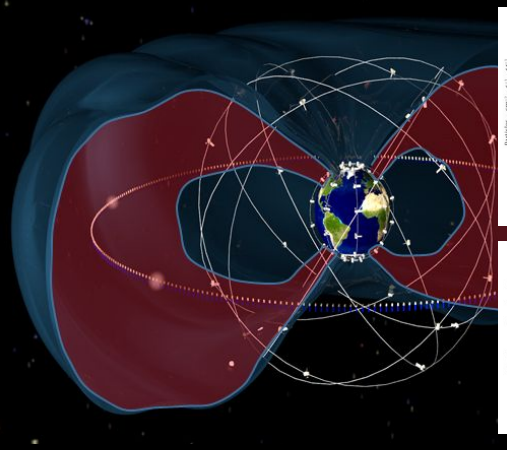
- Expands NOAA's space weather data products by developing capabilities for L1, L5, GEO, HEO, and LEO
- SOL Series received KDP-B approval on December 17, 2024
- The SOL Series consists of two independently launched spacecraft (L1-A and L1-B) targeting launch of L1-A in 2029 and L1-B in 2032
- Instrument and spacecraft awards completed

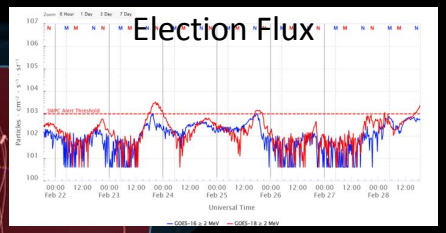
SW Next GEO is in Pre-Formulation to provide continuity for critical measurements and transition new capabilities to operations

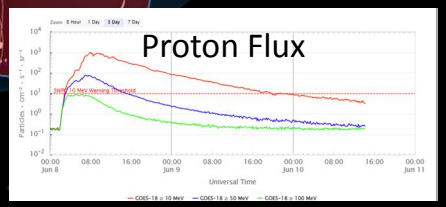
Pre-formulation activities:

- Instrument studies to assess technology readiness
- Spacecraft RFI released
- Analysis of alternatives to assess requirements and develop mission concept

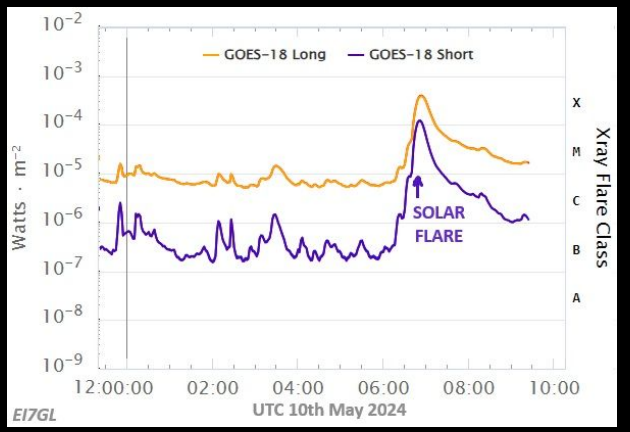
In situ energetic particles and magnetic fields for characterizing radiation environment



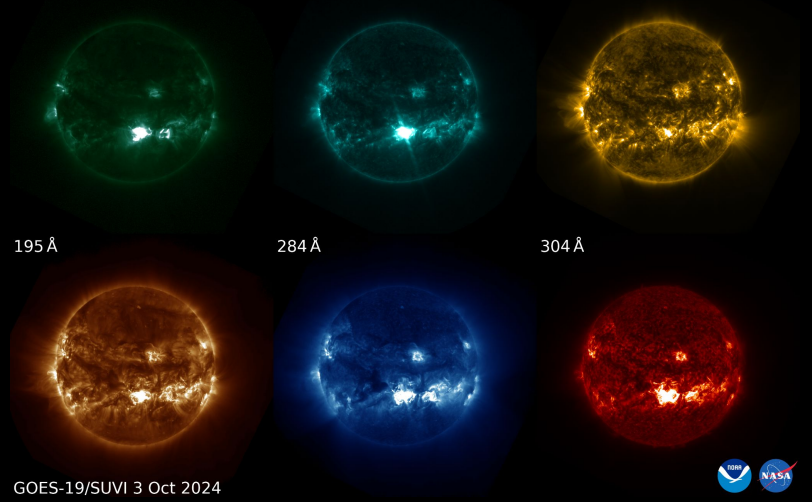




Solar X-ray Irradiance for flare detection

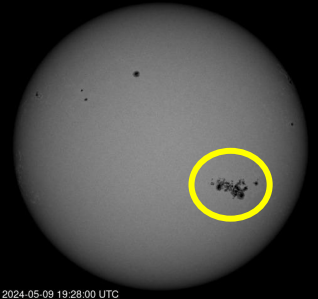


Solar EUV Imagery and Irradiance for monitoring solar activity and driving models

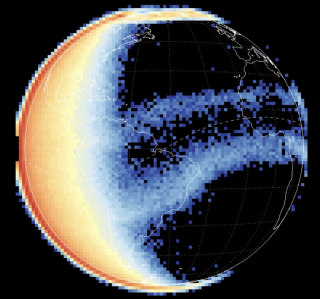


Capability enhancements under consideration

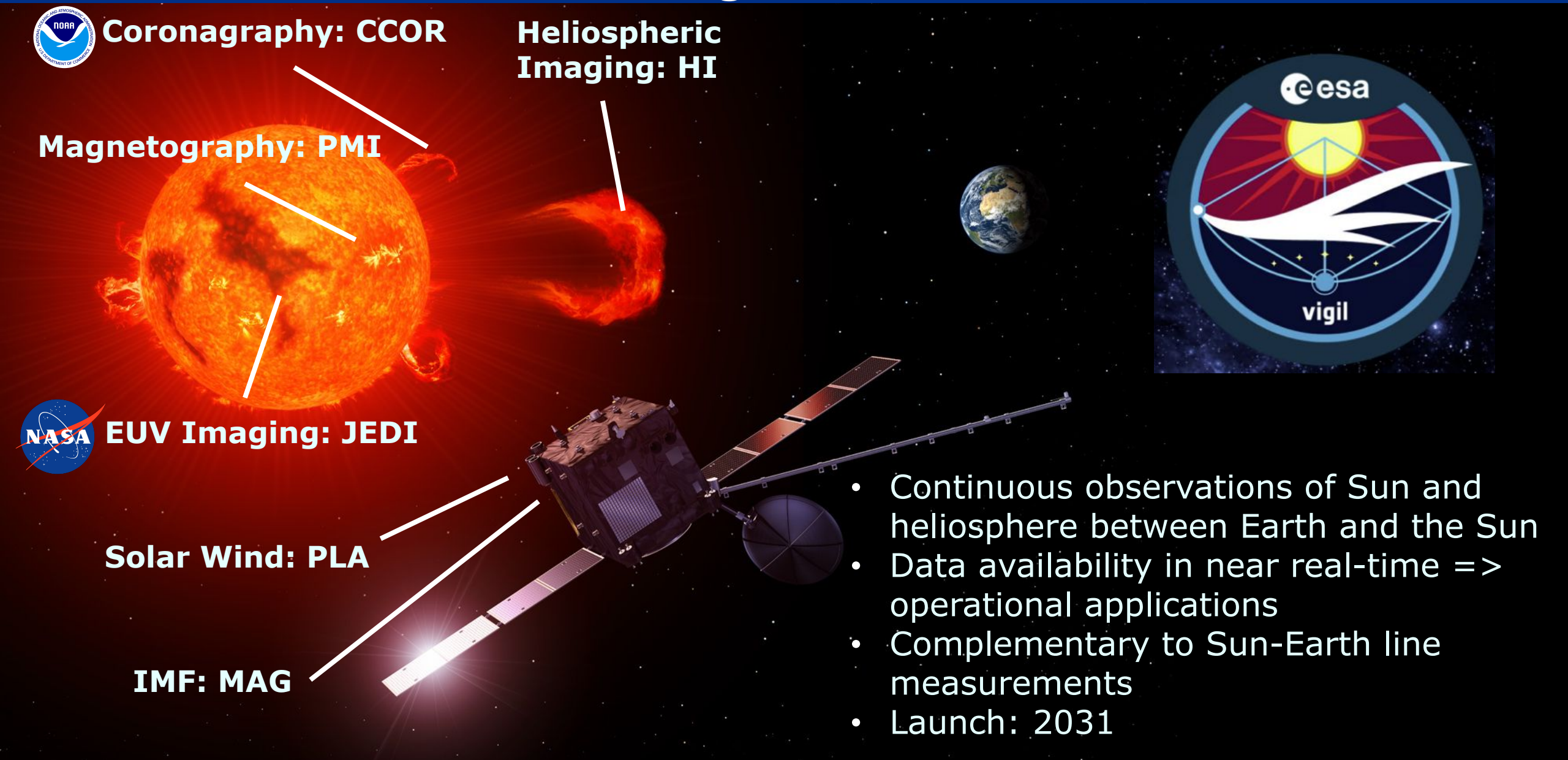
Photospheric Magnetograph Imagery NASA SDO/HMI



Thermospheric O/N2 Ratio NASA GOLD



NOAA is providing a Compact Coronagraph (CCOR-3) to ESA'S Vigil Mission to L5



- Continuous observations of Sun and heliosphere between Earth and the Sun
- Data availability in near real-time => operational applications
- Complementary to Sun-Earth line measurements
- Launch: 2031

NOAA Commercial Data Program

- **Commercial Weather Data Pilots:** Demonstrates the quality and impact of commercial data on weather, climate and space environment applications
  - NOAA concluded a pilot study exploiting commercial GNSS-RO data for space weather parameters. Awarded to Spire Global and PlanetiQ – 1-year contract ended Aug 2023
  - ***The final report is now available***
- **Commercial Data Purchases:** Supports operational weather forecasting and space environment applications.
  - DO4 18 Sept. – 18 Sept. 2025, DO5 and DO6 to follow
- CDP Request for Information: NOAA NESDIS Commercial Satellite Data-as-a-Service (Including Weather and Space Environmental Data)
  - General RFI has been posted. SAM.gov

NOAA SBIR Program

Six critical challenges that highlight important NOAA mission and research priorities, including Effects of Space Weather

AMERICA'S SEED FUND SBIR

POWERED BY NOAA

Concluding Remarks

- **Strengthening Space Weather Forecasting**: NOAA's strategy aims to enhance space weather forecasting capabilities by utilizing advanced space-based instruments that provide real-time data on solar activity and its impact on Earth's space environment.
- **Collaboration with International Partners**: The strategy emphasizes global collaboration, including partnerships with international space agencies, to ensure a coordinated and comprehensive approach to monitoring space weather events and their potential global effects.
- **Enhancing Data Accessibility and Accuracy**: Leveraging Commercial Data as a Service enhances NOAA's space weather strategy by providing real-time, high-resolution data that supplements and complements NOAA’s own observations.