NOAA’s Current and Future Space Weather Architecture

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Spaceborne Space Weather at NOAA

NASA SMS
GOES 1-3

GOES 4-7

GOES 8-12

GOES-NOP Series

NASA SDO

GOES-R Series

TIROS-N

POES

EUMETSAT Metop

COSMIC-1

COSMIC-2

ESA/NASA SOHO

NASA ACE

NASA STEREO

DSCOVR

SWFO-L1
Space Weather as a National Priority

2019 *Space Weather Strategy and Action Plan*

Space Weather Operations, Research, Mitigation Working Group, National Science & Technology Council

2020 *Enhancing the Security of the North American Electric Grid*

Congressional Budget Office
NOAA in the last 2 years (& since June)...

• Established the baseline operational Space Weather Follow On (SWFO) Program
  • Secured funding in the NOAA budget for L1 coverage
  • Begun flight fabrication of the Compact CORonagraph (CCOR) with NRL
  • Secured funding in the NOAA budget for CCOR on GOES-U
  • Established a joint project office with NASA for SWFO
  • Established an agreement with the NASA IMAP mission for a rideshare for SWFO-L1
  • Let contracts out for instruments and spacecraft for SWFO-L1
  • Formulated arrangements with ESA for data sharing with the L5 mission
  • Negotiating with ESA for instrument exchanges

• Launched the COSMIC-2 mission with Taiwan
  • 4 satellites now in final orbit

• NOAA/NESDIS Formulating a Space Weather Program
SWFO Mission Architecture

- NOAA SWFO Primary Ground Stations
- Partner Ground Networks
- NASA DSN/NEN
- Sun-Earth L1
- Direct Insertion Transfer Orbit
- S-band: Cmd, HK Data, Ranging
- X-band: Science Data
- S-band: Cmd (Contingency)
- User Community
- Retrospective Products
- Real-time Products
- WCDAS
- KSC
- NSOF
- Suitland, MD
- Boulder, CO
COSMIC -2 Schedule

- Jul 2019: Instrument Activation
- Aug 2019: Initial Products
- Provisional Data Release (Public)
- Dec 2019: N.A. Validation Data IOC
- Feb 2020: IGRS Iono IOC
- Nov 2020: Constellation FOC
- May 2021: Launch

Orbit Lowering/Precession

Launch and early orbit operations
Checkout and commissioning
Weather Cal/Val
Weather Operations

N.A. = Neutral Atmosphere
Iono = Ionosphere
IOC = Initial Operational Capability
FOC = Full Operational Capability
### Pillars of NESDIS Observing System Implementation

#### Integrated, Adaptable and Affordable: Orbits, Instruments & Systems

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<tr>
<th>GEO</th>
<th>LEO</th>
<th>Space Weather</th>
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<td>Continuous real-time observations supporting warnings and watches of severe weather and hour-by-hour changes. High-inclination orbits to observe northern latitude &amp; polar regions.</td>
<td>Miniaturized instruments on small, affordable and proliferated satellites and partner data improving forecasts through better and additional data. Better precipitation forecasts, wave height predictions, ocean currents, and more.</td>
<td>Reliably monitoring space weather from L1, GEO and LEO can protect the nation’s valuable, vulnerable infrastructure. New capabilities at L5 and HEO can provide additional insight and improve forecasts.</td>
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#### Common Ground Services

Secure ingest of data in different formats from different partners requires a flexible, scalable platform. Common Services approach integrates Cloud, AI and machine-learning capabilities to verify, calibrate and fuse data into new and better products and services.
NOAA/NESDIS Formulating a Space Weather Program

- Diverse observing requirements must be made from diverse vantage points (LEO, GEO, Sun-Earth line, L1 and off the Sun-Earth line)

- Continuity and anticipated product improvement need dates are varied:
  - Long Lead Instrumentation
  - Next Generation L1 & off-Sun-Earth-axis
  - Space Weather Ground Operations
  - Geostationary Observations
  - Tundra/High Elliptical Orbit Observations
  - Low Earth Orbit Observations

- Program formulation will initialize a loosely coupled program with an initial set of projects.

- As new project requirements and concepts are identified through user engagement, approved by NESDIS, and matured by the program, they will be instantiated as projects within the portfolio.
# Space Weather is Inherently Disaggregated

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**Calendar Year**

- **Operational or Planned**
- **Capability at Risk**
- **SWFO Plans in Development**
- **Partner In Development**

- **GOES-NOP (SXI)**
- **GOES-RSTU (SUVI, EXIS)**
- **STEREO (SECHHI)**
- **ESA SSA Program L5 Mission**
- **SOHO (LASCO)**
- **STEREO (SECHHI)**
- **GOES-U (CCOR)**
- **GOES-NOP (MAG)**
- **GOES-RSTU (MAG)**
- **ACE (SWEPAM)**
- **ACE (EPAM)**
- **DSCOVR (PLASMAG)**
- **COSMIC-1 (GOX)**
- **COSMIC-2 (TGRS, IVM)**
- **DSCOVR  (PLASMAG)**
- **ACE (MAG)**
- **GOES-RSTU (SEISS)**
- **POES (SEM)**
- **POES (SEM)**
- **Metop-A/B/C (GRAS)**
- **Metop-SG-A/B (IGO)**
Requirements definition approach

- Requirements Working Group established May 2020, continues through next year
- Start with Program of Record (POR) 2025 – continuity of observations
- Identify and vet architectures that achieve the 2018 NSOSA/SPRWG unmet requirements
- Address POR capabilities at Geostationary Orbit
- Address SPRWG new capabilities at Tundra
- Canvas emerging space weather operational needs with user engagement efforts in cooperation with SWPC and OSTP/SWORM
Starting Point – 2025 Program of Record

2025 NOAA Space Weather Observing Program of Record
Starting point for Infrastructure Workshop

- SWFO – L1
- GOES–East, GOES–West (CCOR1 on 1)
- COSMIC-2
- GOLD
- Metop – C, SG A1, SG B1
- ESA – L5 (2027)

What’s next for 2030 and beyond?
Evolution of Space Weather Architecture
Thank you!

NOAA
Satellite Data & Information Service