NESDIS Space Weather Update

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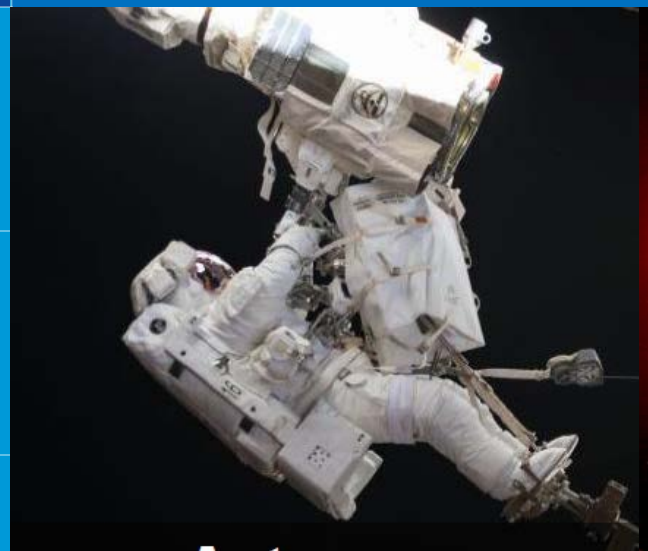
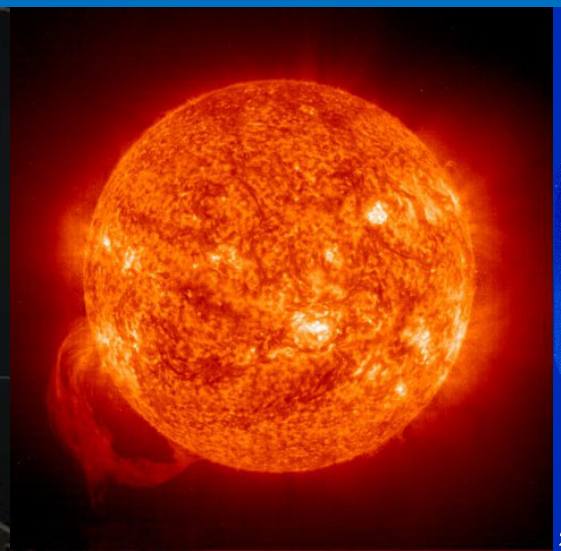
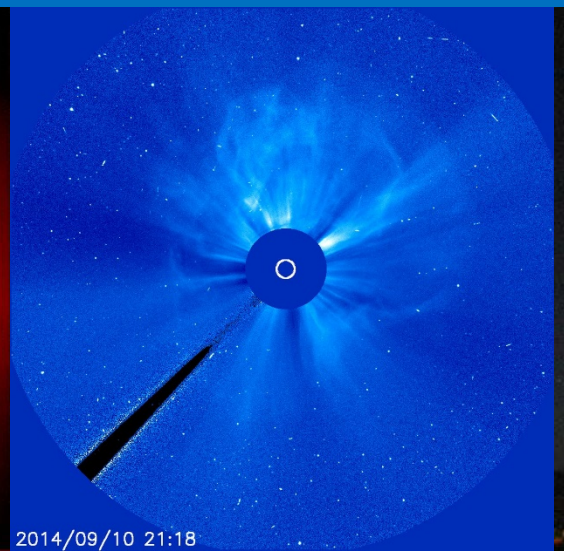
October 19, 2020







Bottom Line Up Front

- NOAA NESDIS Vision for Space Weather
- SWFO – L1 planned for launch in 2024 to maintain continuity of upstream solar wind measurements and coronal imagery
- *Space Weather - Geomagnetic Storm Warning Gap Mitigation Plan for Space-Based Observations* – June 2020
  - Identifies several partial mitigations ahead of SWFO-L1 launch and opportunities for resiliency in the system
- NESDIS Space Weather (SWX) Program planning was initiated in May 2020
  - New program is the third pillar in the NESDIS Observing Systems
  - Mission will encompass all space weather observational needs including LEO, GEO, HEO and extended orbits

NESDIS Vision in Space Weather

NESDIS 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.

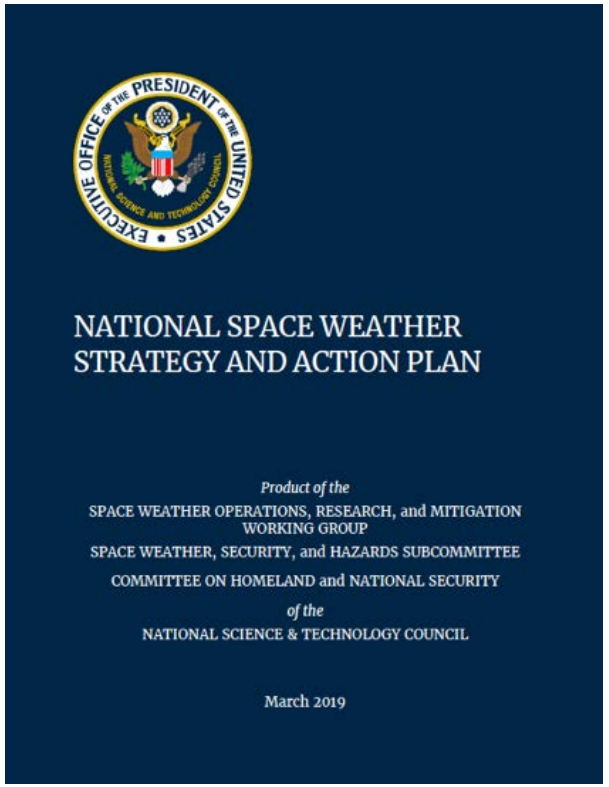
Space Weather Strategic Objective:

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

Space Weather Roles:

- *Maintain and extend space weather observations*
- *Improve and expand our product suite*
- *Collaborate with partners to collect, process, and deliver relevant data to our users*
- *Interpret and provide data in a manner that users can readily access and understand*

Space Weather is a National Priority

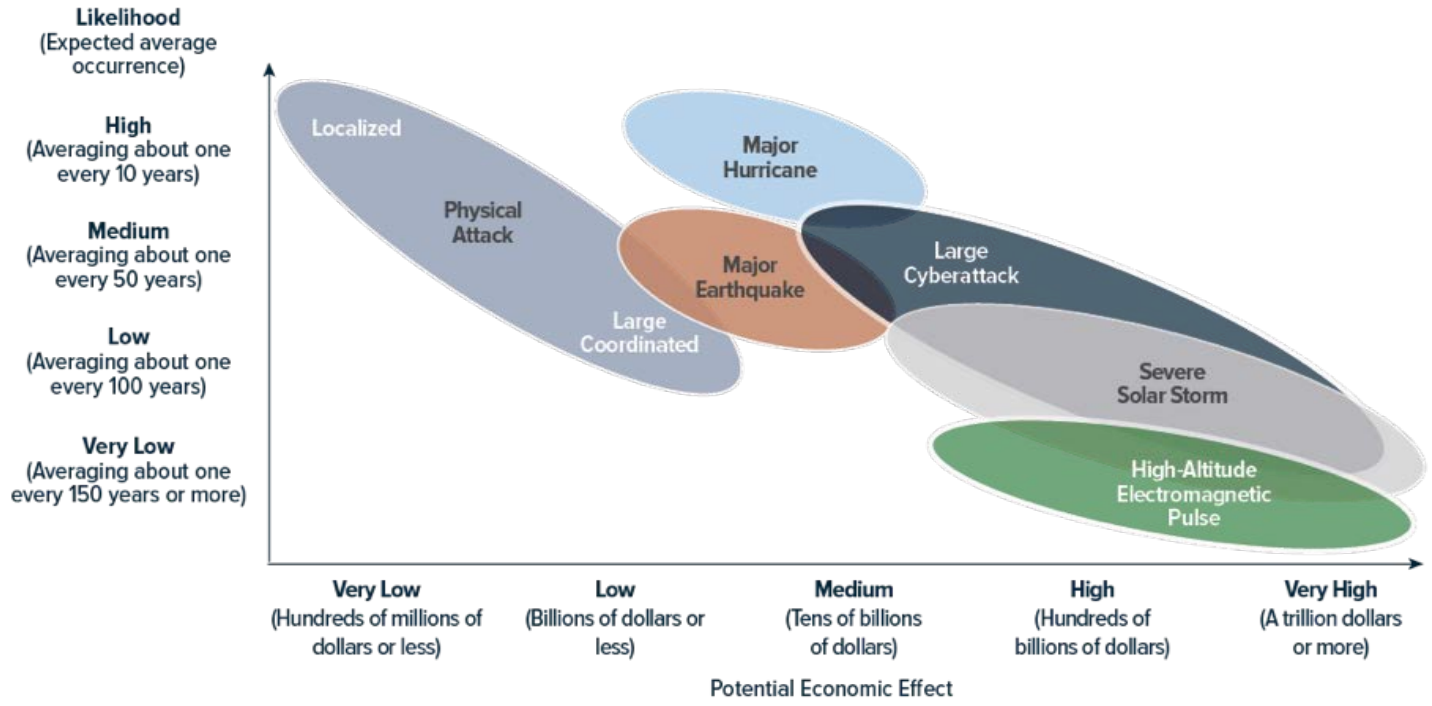


2019 National Space Weather Strategy and Action Plan

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

2020 Enhancing the Security of the North American Electric Grid

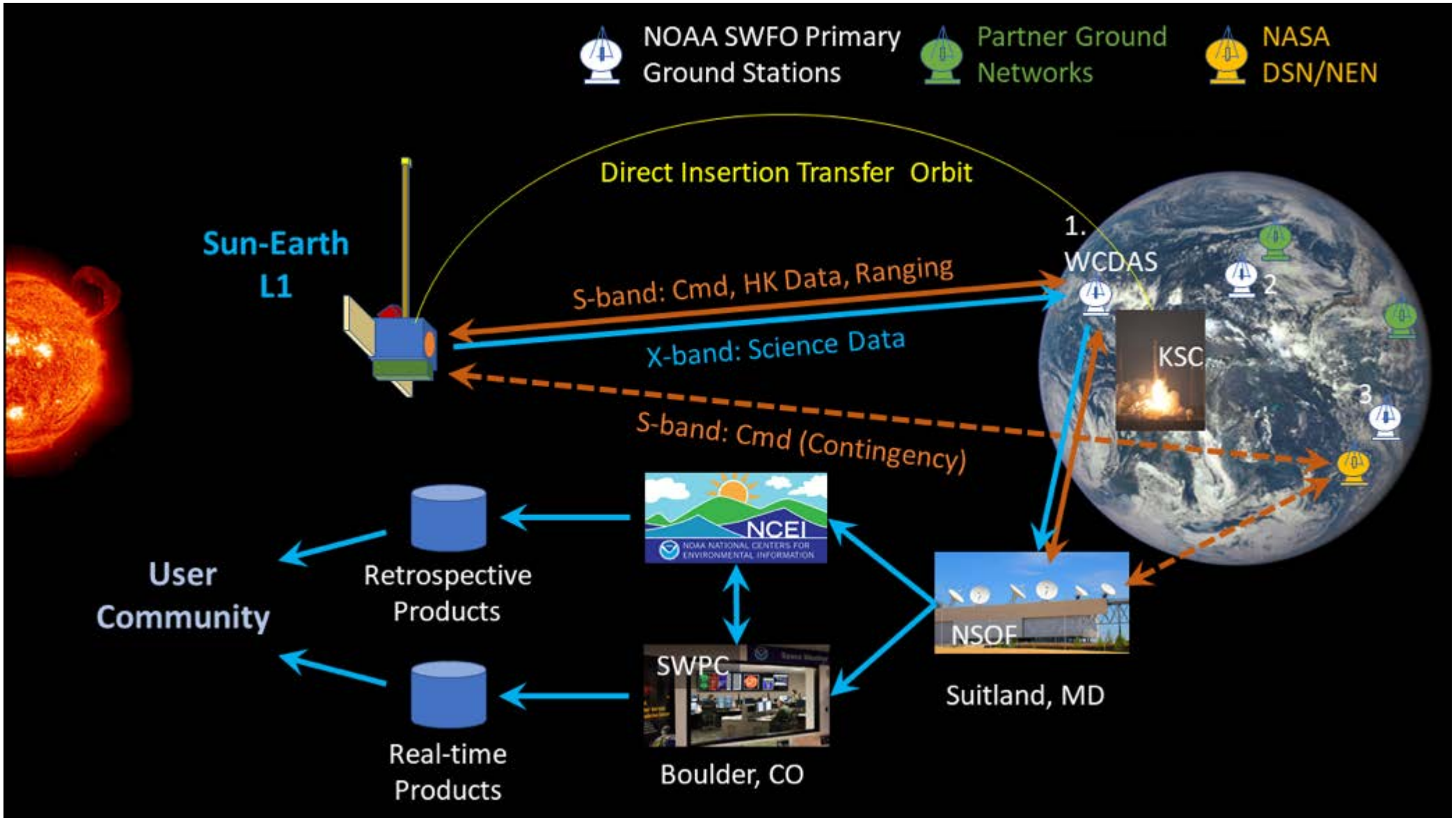
Congressional Budget Office



"Space Weather Ready Nation" - PROSWIFT Act (2020)

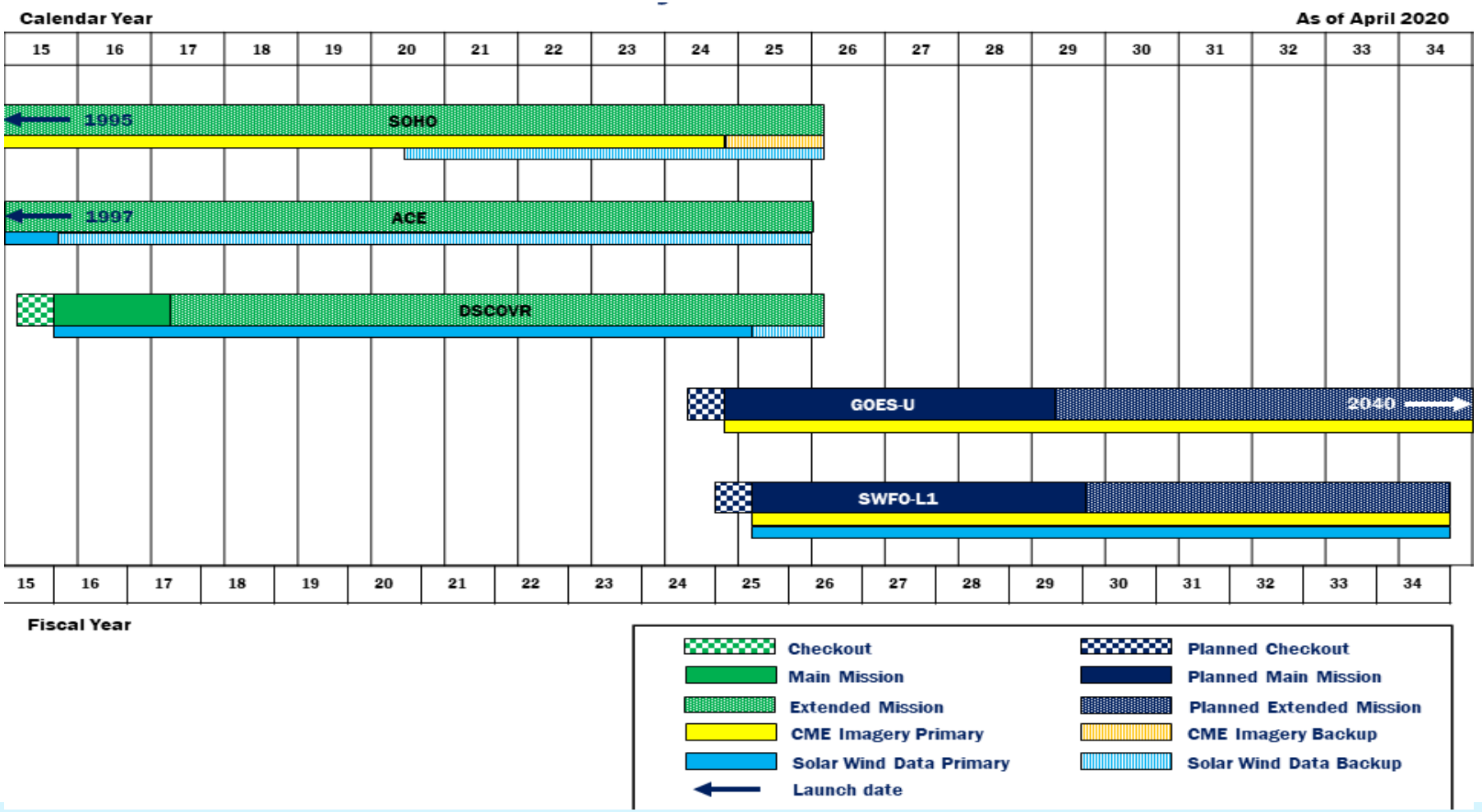
- **Passed Senate 7/27/2020; passed House 9/16/2020**
- **Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow Act or the PROSWIFT Act**
  - Sec. 60601. Space Weather, (2) Roles of federal agencies: "The National Oceanic and Atmospheric Administration provides operational space weather monitoring and forecasting for civil applications, maintains ground-based and space-based assets to provide observations needed for space weather forecasting, prediction, and warnings, provides research to support operational responsibilities, and develops requirements for space weather forecasting technologies and science."
  - Sec. 60603. Sustaining Space-Based observations: "The Administrator of the National Oceanic and Atmospheric Administration shall maintain current space-based observational assets… in coordination with the Secretary of Defense, shall work with Federal and international partners in order to secure reliable backup capability for near real-time coronal mass ejections imagery, solar wind, solar imaging, coronal imagery, and other relevant observations required to provide space weather forecast… in coordination with the Secretary of Defense should develop options to build and deploy space-based observational capabilities that … improve space weather measurements and observations."

SWFO Mission Architecture

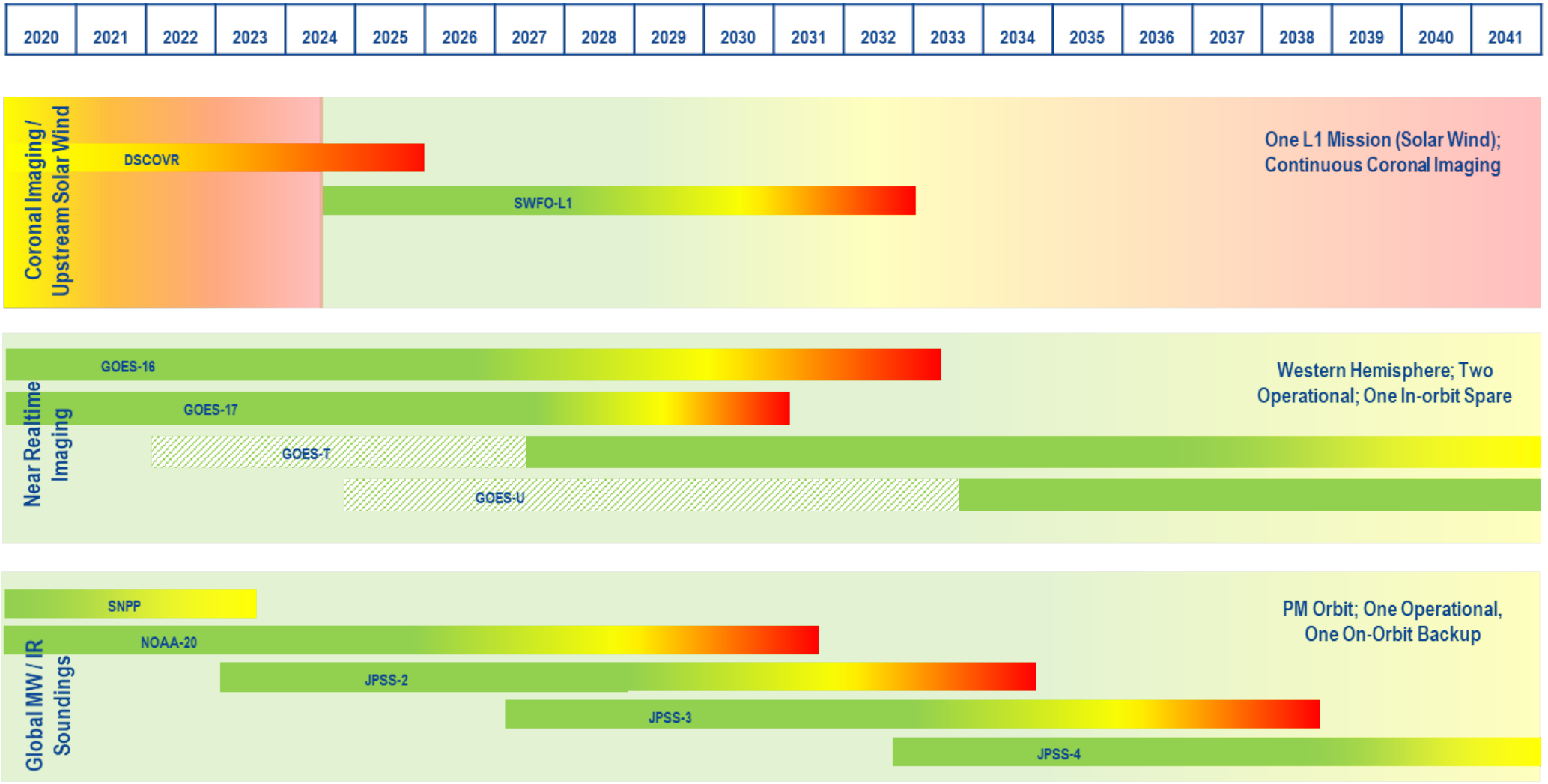


Continuity of Operational Space Observations

A potential reduction in legacy mission functionality prior to 2024 poses a risk of an observational gap



Constellation Risk for Key NESDIS Observations (Programs of Record)



Reducing the Risk of an Observational Gap

To mitigate the observational gap risk at L1, NOAA recently identified observational solutions summarized in the SpWx Gap Mitigation Plan (2020). The main solutions include:

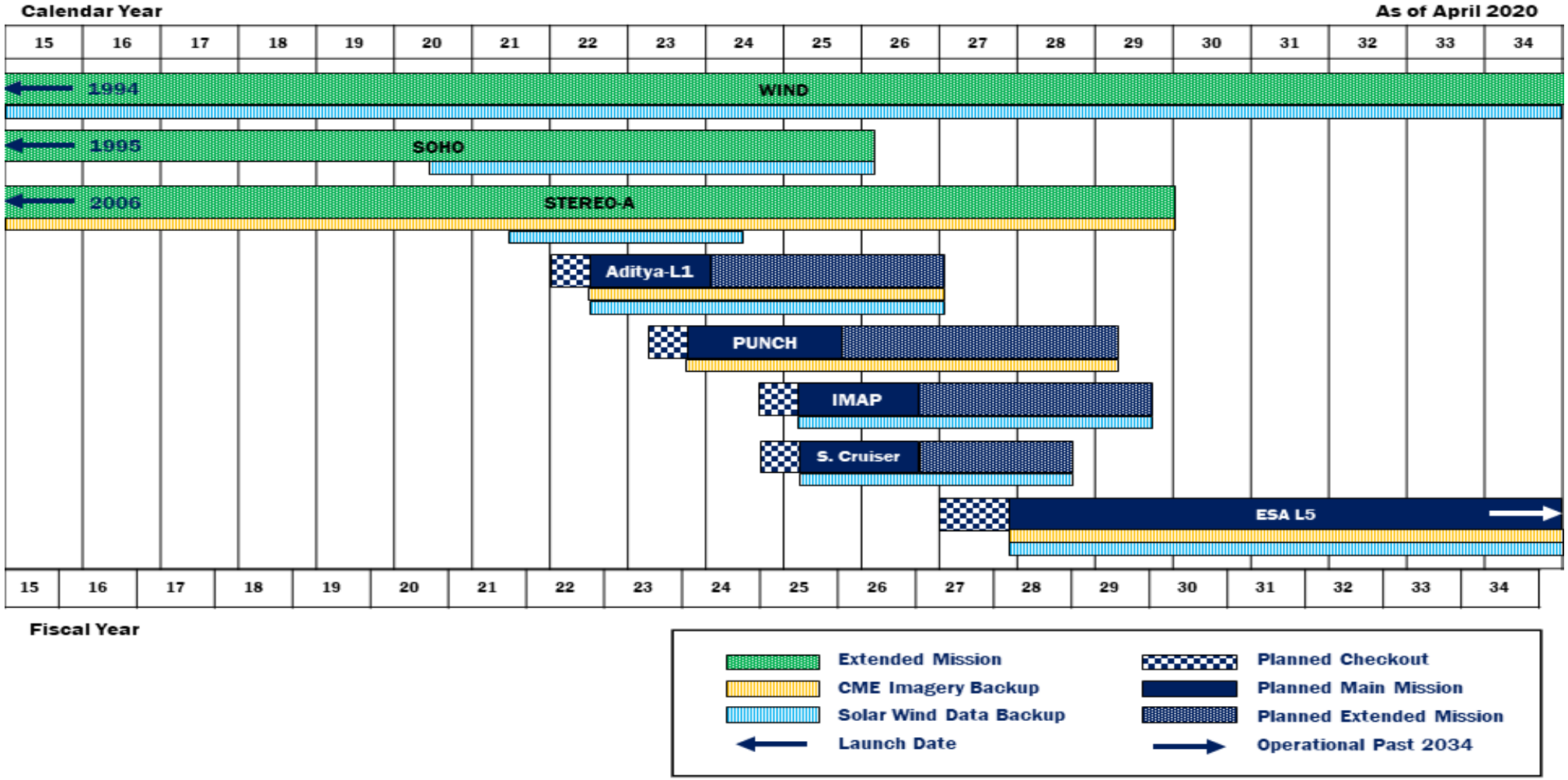
Spacecraft/ Capability	Agency	Launch	Main Objectives	Limitations
Aditya-L1	ISRO(1)	2022	In situ plasma/mag field	24/7 coverage: possible gap
PUNCH(2)	NASA	2023	Coronagraph, helio	Latency; FOV; R2O
IMAP	NASA	2024*	In situ plasma/mag field	Beacon data rates
Solar Cruiser	NASA	2024*	In situ plasma/mag field	In competition; orbit; payload
GOES-U	NOAA	2024*	Coronagraph	Eclipse, FOV
STEREO-A	NASA	2006	Coronagraph, helio, in situ plasma/mag field	Primarily useful while near Sun-Earth line
Lagrange 5	ESA	2027*	Coronagraph, helio, in situ plasma	Off the Sun-Earth line

Additional options involve repurposing a number of current missions. NOAA is implementing a number of actions.

(1) **Indian Space Research Organization**
(2) **Polarimeter to Unify the Corona and Heliosphere**
(*) **Resiliency to SWFO-L1, rather than DSCOVR/SOHO, functionality**

Potential Gap Mitigation Options: Timeline

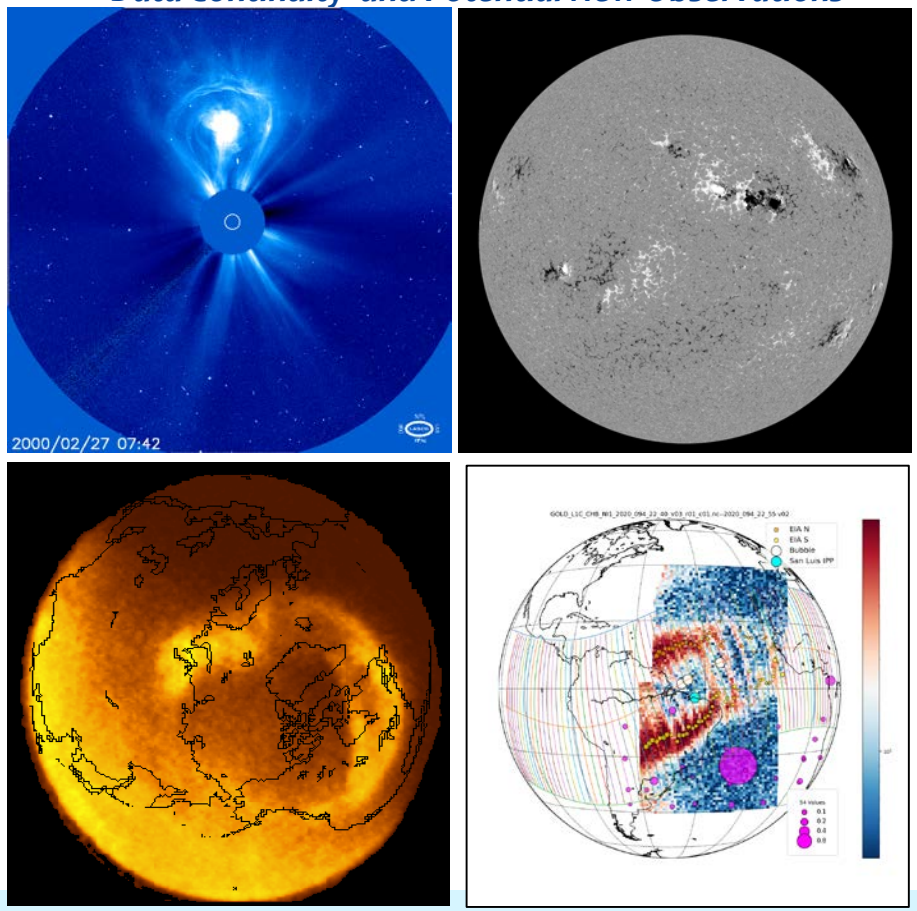
NOAA exploring agreements with NASA and international partners to reduce the likelihood and impact of a potential observational gap at L1



Space Weather Program Overview

- Diverse observing requirements must be made from diverse vantage points (LEO, GEO, HEO, L1 and off the Sun-Earth line)
- Would subsume the Space Weather Follow-on program and continuity of hosted space weather instruments on GOES-R and LEO satellites such as COSMIC-2
- Continuity and anticipated product improvement need dates are varied
  - Long Lead Instrumentation
  - Next Generation L1 & off-Sun-Earth-axis
  - Space Weather Ground System Operations
  - Geostationary Observations
  - Tundra/High Elliptical Orbit Observations
  - Low Earth Orbit Observations
- Program operational in the 2024 -2040 timeframe:
  - Currently in pre-formulation:
    - Instrument and constellation studies underway
    - User needs assessment underway
    - Requirements definition underway
  - Program of Record in 2025

Data Continuity and Potential New Observations



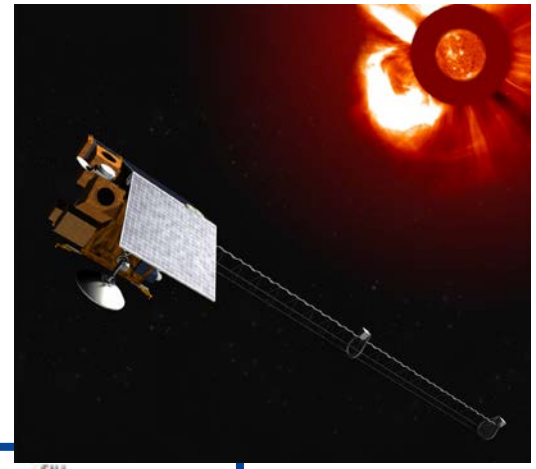
Clockwise from top left:
a) Coronal imagery (LASCO),
b) Magnetograph imagery (HMI),
c) Thermospheric imagery (GOLD),
d) aurora (POLAR).

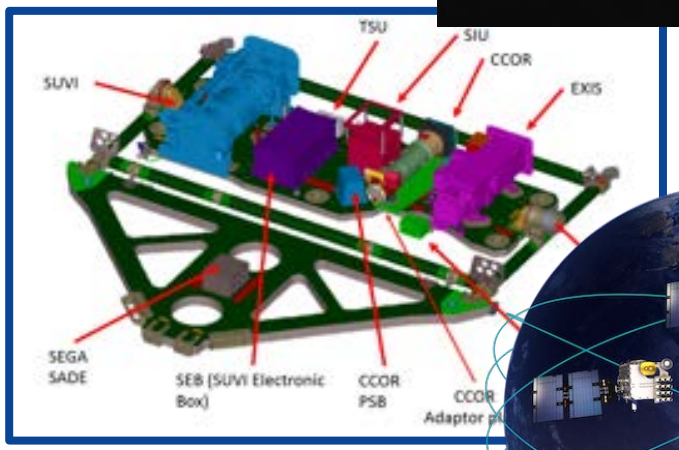
Starting Point – 2025 Program of Record

2025 NOAA Space Weather
Observing Program of Record

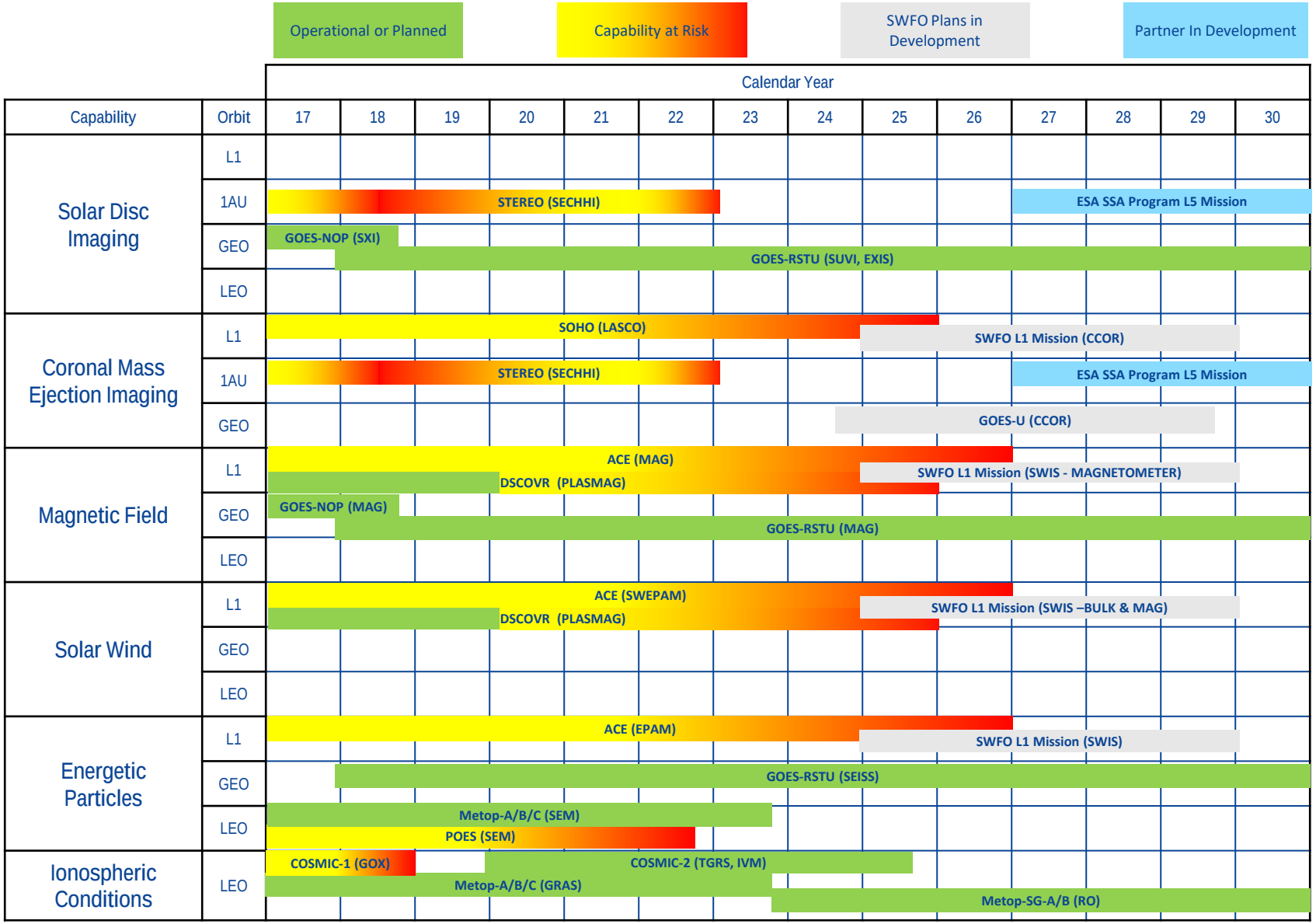
- SWFO – L1
- GOES–East, GOES–West (CCOR1 on 1)
- COSMIC-2
- GOLD
- Metop – C, SG A1, SG B1
- *ESA – L5 (2027)*

Planning for 2025 and beyond





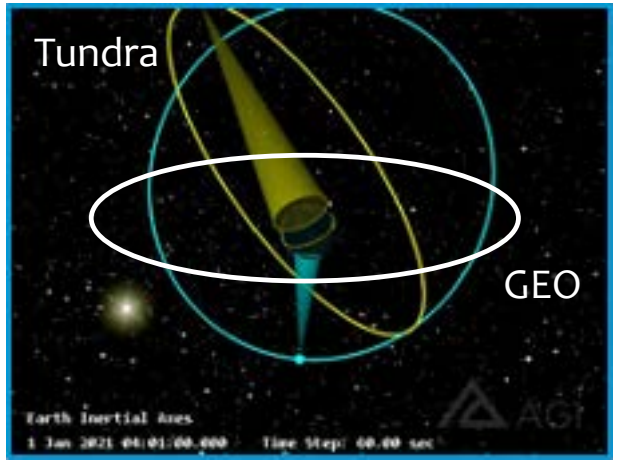
Space Weather is Inherently Disaggregated

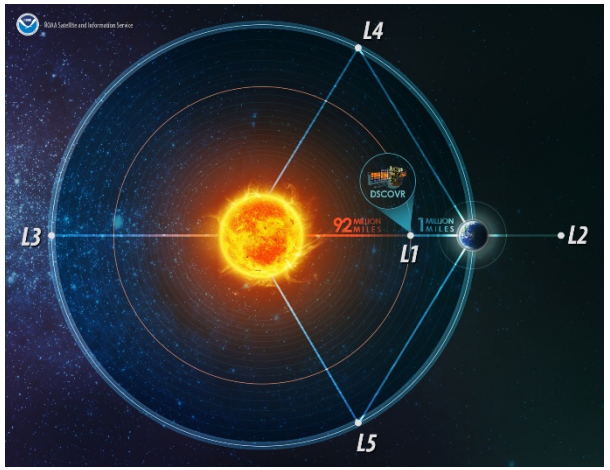


Plans for a Program CONOPS

The SWX Program will require a comprehensive observational capability for several orbital regimes

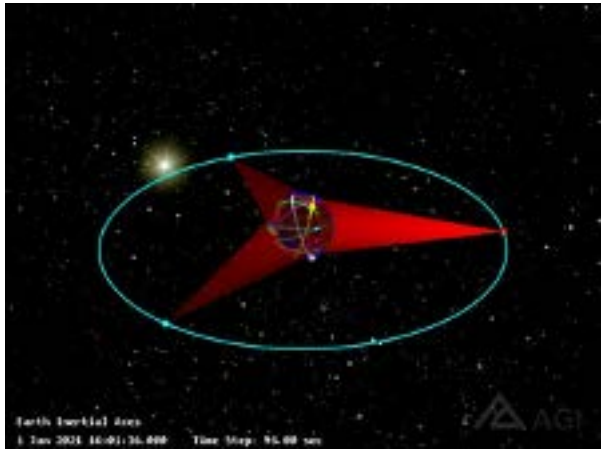
For the magnetosphere, in situ measurements from GEO and HEO can combined with auroral imaging





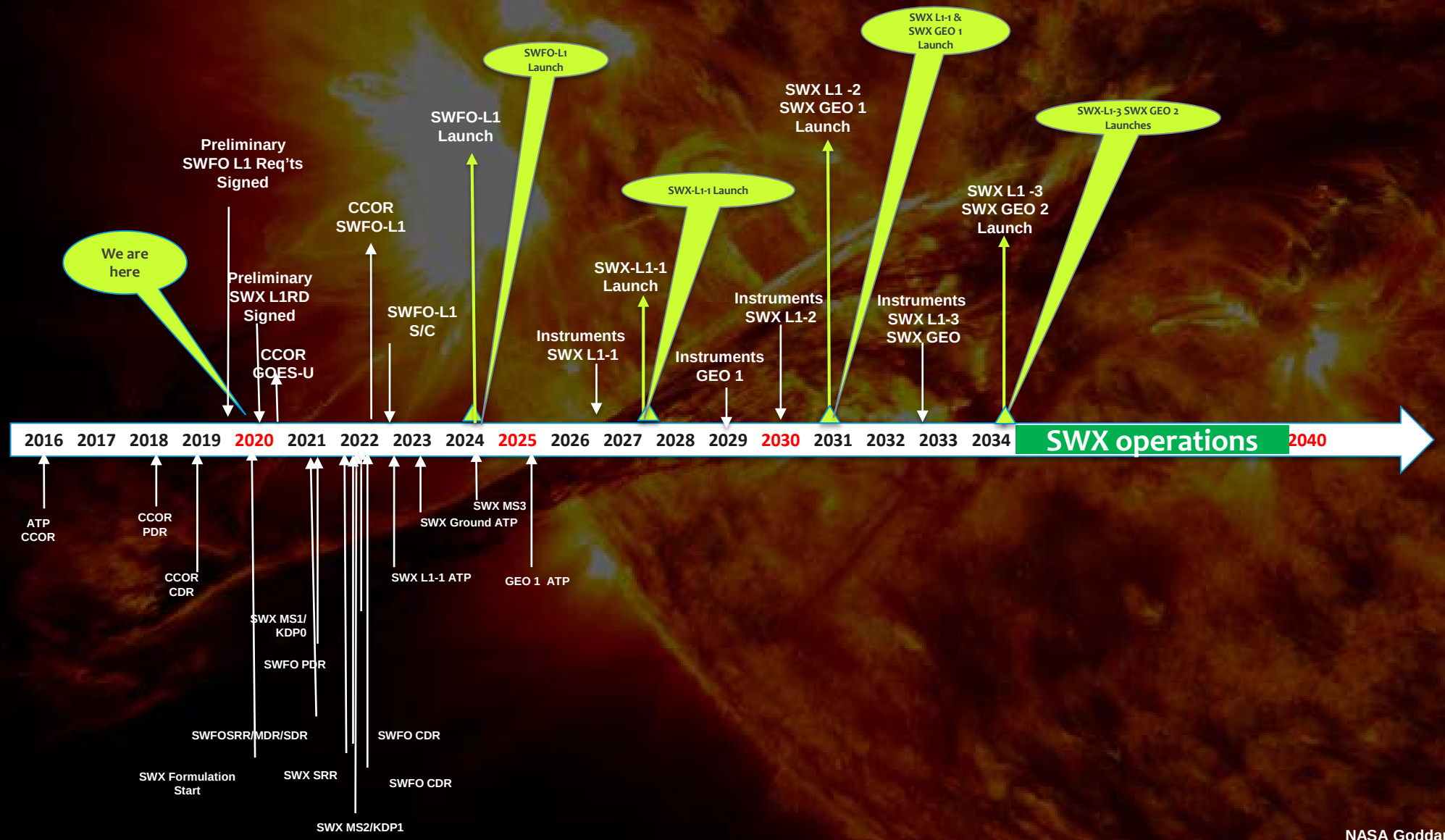
Coronal and photospheric imagery from L1 and L5 can be used for stereoscopic analysis. In situ plasma/field data will drive heliospheric models

Thermospheric and ionospheric objectives will require in situ measurements from LEO as well as imaging capabilities from GEO



- Balancing requirements with communications, orbit design, hosting, and data buys options is based on feedback from all stakeholders

Notional SWFO to SWX Timeline



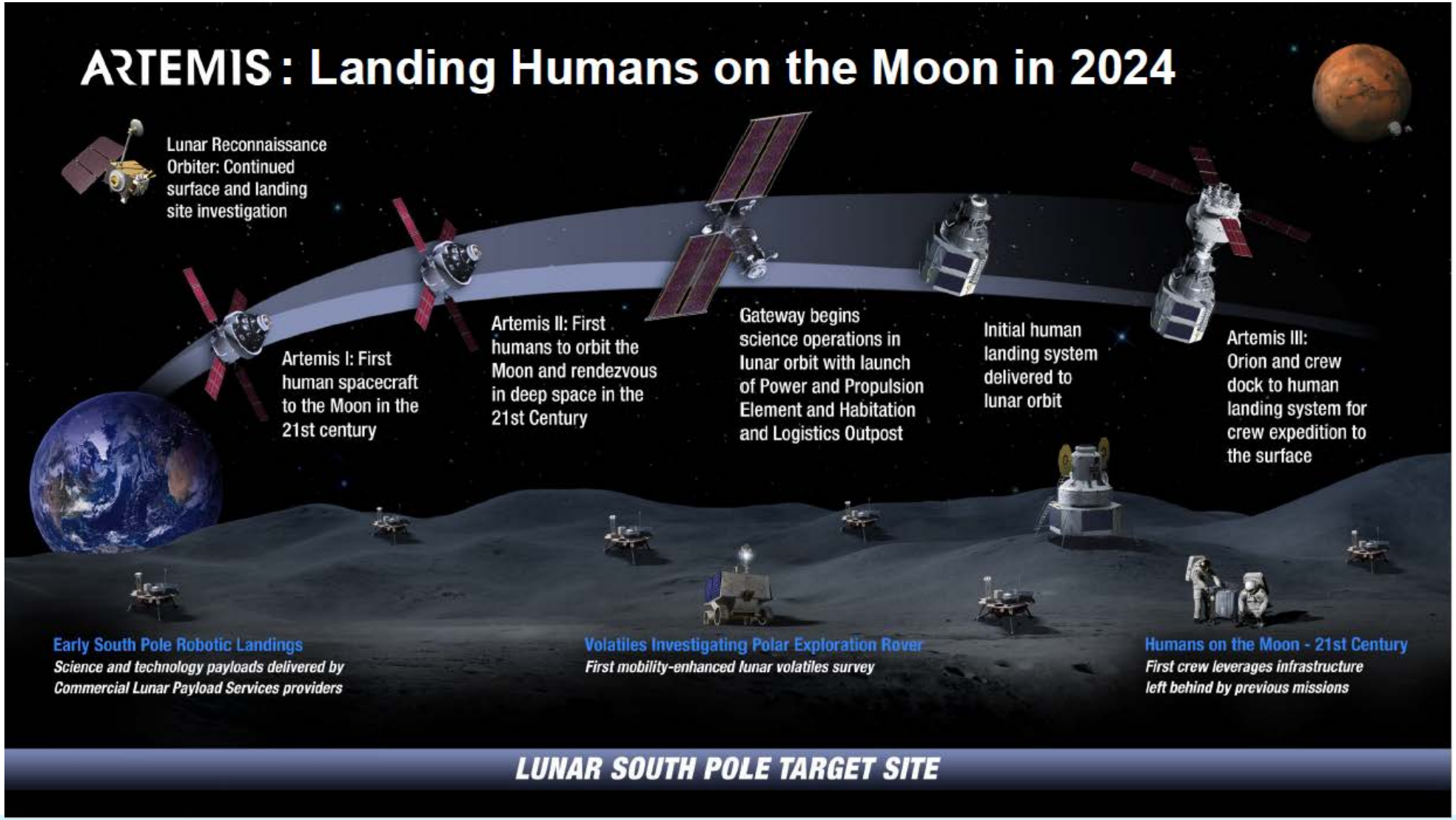
NASA Goddard SFC

Space Weather Operations and Research Future Infrastructure Workshop - October 2020 Status

- The National Academies of Science, Engineering and Medicine (NASEM) has conducted the *Space Weather Operations and Research Future Infrastructure* Workshop
- Charter summary: maintain and improve critical observations as input to the space weather prediction and notification system
- The NASEM ad hoc organizing committee developed the agenda and organized the space weather experts' participation
- The workshop was conducted in two parts (100+ participants in each part):
  - Part 1 – 16 -17 June 2020 (virtual, records and notes provided)
  - Part 2 – 9 -11 September (virtual, notes in progress)
- Report (only, no recommendations) is expected by the end of 2020
- A follow-on workshop (NASA- and NSF-supported), planned to be held in Spring 2021, will be conducted to address out-of-scope issues encountered in the first workshop, as well as R2O2R and to address knowledge and research gaps with regard to the advanced understanding of the Sun-Earth system.

Example from Infrastructure Workshop Part 1 – 16 June 2020

Example from Infrastructure Workshop Part 2 – 9 September 2020



Summary

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