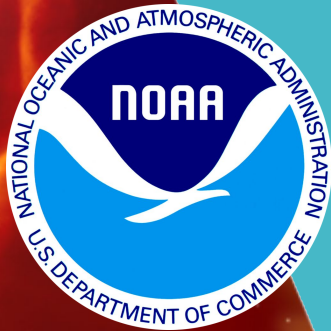




Space Weather Workshop

The Meeting of Science,
Research, Applications,
Operations, and Users

April 17 - 21, 2023 • Boulder, CO



SWFO - National Centers for Environmental Information *Data Stewardship*

National Environmental Satellite,
Data, and Information Service

15 April 2024

Nazila Merati, C. Bethge, J. Darnel, K. Hallock, F.
Inceoglu, B. Kress, P. Loto'aniu, J. Machol, A.
Pacini, L. Rachmeler, R. Redmon, J. Riley, J.
Rodriguez, W. Rowland, D. Schmit, X. Wei, et al.

What is Scientific Data Stewardship?

Scientific data stewardship “encompasses all activities that preserve and improve the information content, accessibility, and usability of data and metadata”. Federally funded digital research data are required to be: preserved and secure; available, discoverable, and accessible; credible, understandable, and interoperable; usable and useful; sustainable and extendable; citable, traceable, and reproducible ¹.

NCEI’s scientific stewardship of GOES-R and DSCOVER space weather products meets all of these guiding principles, with Findable, Accessible and Interoperable being the most efficiently verifiable (e.g. internet discoverable and in internationally standard formats). Reusability and Scientific authority are verified via user feedback and literature reviews.

FAIR: Guiding Principles for scientific data management and stewardship

Findable

Metadata and data should be findable for both humans and computers

F

Interoperable

Data needs to work with applications or workflows for analysis, storage and processing

A

I

R

Accessible

Once found, users need to know how the data can be accessed

Reusable

The goal of FAIR is to optimise data reuse via comprehensive well-described metadata



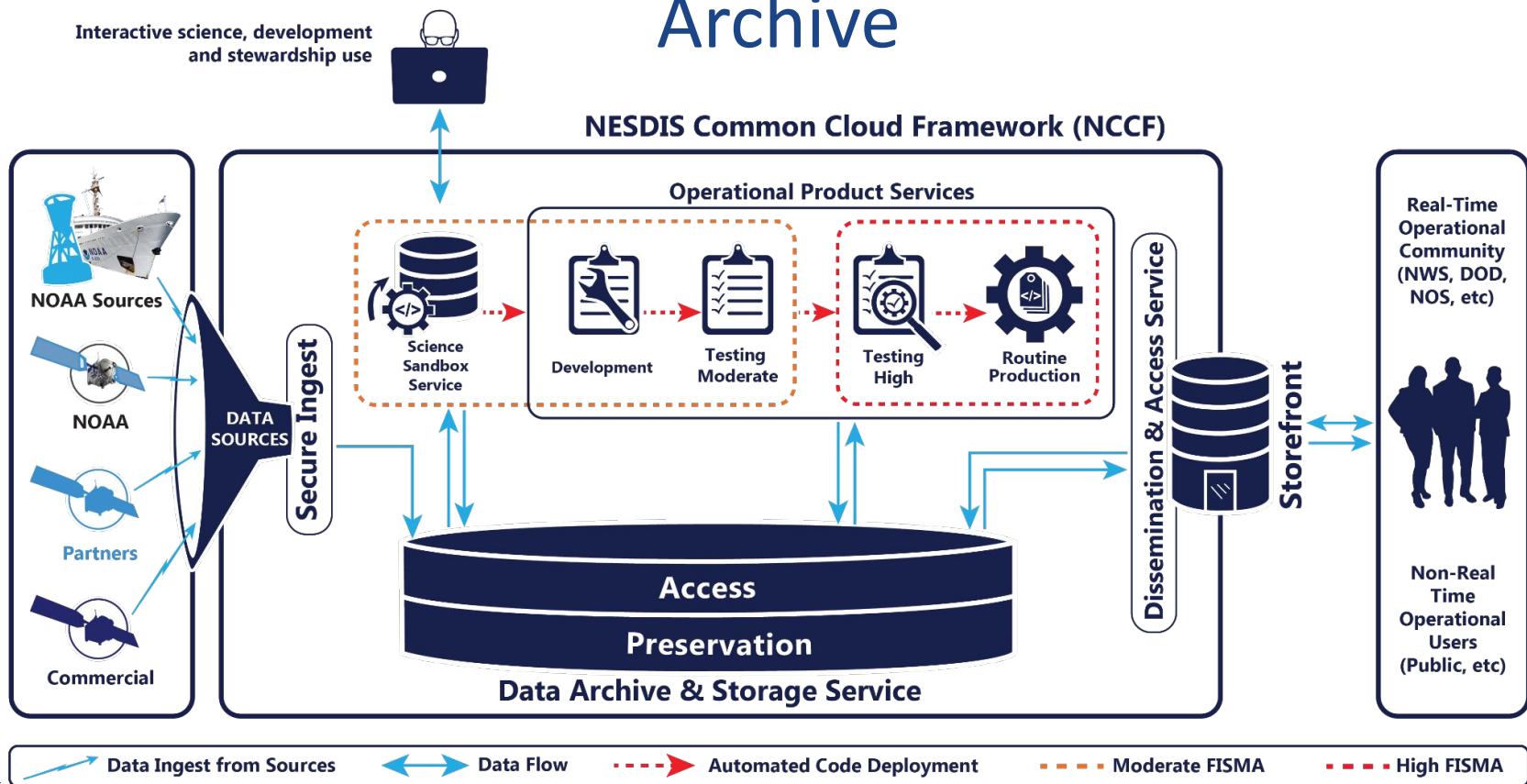
Scientifically Authoritative

Arriving at the most scientifically correct and analysis ready data is an iterative process, incorporating User feedback and emerging science.

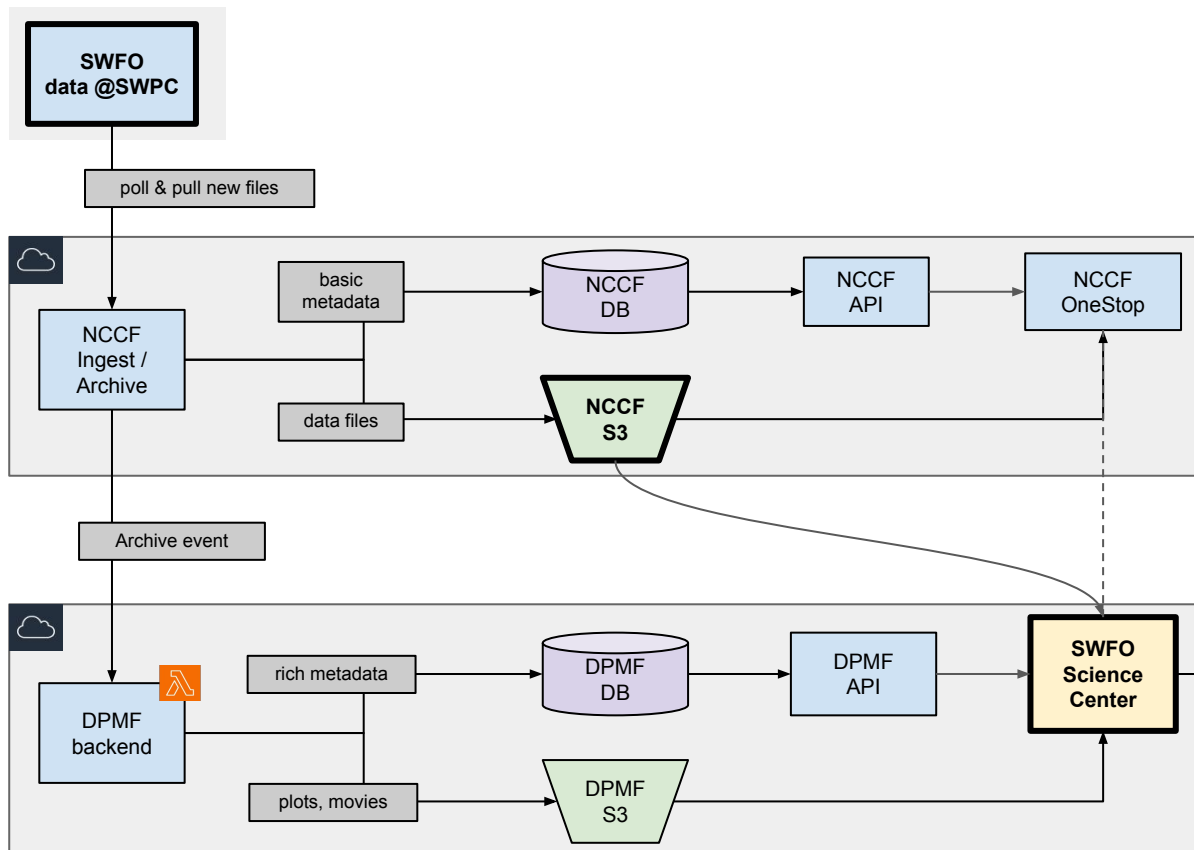
Motivation to take SWFO to the cloud

- NESDIS plans to retire on-prem systems in the near future and move data and science processing to the **NOAA Common Cloud Framework (NCCF)**. This effort cuts across various NESDIS and NOAA programs to use enterprise services to more efficiently and effectively manage common resources, **enhance data discovery, and enable innovative science**.
- The March 19, 2021 Memo from Dr. Volz codifies the decision to develop and migrate mission capability to the NCCF including product generation, dissemination, and archiving of all data using an enterprise approach.
- MetOp-SG (2024-2025) **is planned** to be the first program to leverage the NCCF to meet archival requirements and lay the groundwork for SWFO.

Archive



SWFO Science Center: Data Flow



This image shows the End to End Data workflow as it starts at SWPC and ends up in the SWFO science center. Each part of the process, shown in the grey boxes extracts information required for creation of metadata for data discovery specific to the needs of the system - for cataloging and data discovery using OneStop and a richer file level extraction through the use of DPMF to create richer search for expert users.

Standards and additional Collaborations

- Metadata
 - NCEI requires ISO 19115-2 collection-level metadata for all data.
 - In some cases (e.g. DSCOVR) our team has sometimes elected to create additional metadata for standards tailored to this community, such as [SPASE](#).
- SWFO Science Portal API
 - Provides a superset of the functionality of [Heliophysics API \(HAPI\)](#), by including a few additional items we need for our sites.
 - Therefore it is relatively straightforward to write a converter to permit a HAPI query to be answered via our API.
 - For DSCOVR this type of mapping program was created (thanks Bob Weigel)
 - This makes it possible to better support connections to VxOs and CDAWeb that are expected to be using HAPI.
- Our team has a strong collaboration with CDAWeb as well as various VxO stakeholders.



Focusing on CCOR-1

Compact Coronagraph-1 (CCOR-1) on GOES-U

White-light Coronagraph (450 -750 nm)

Launch: June 2024

Orbit: GEO (35,786 km)

CCOR-1 (built by NRL) → Coronal White Light Images

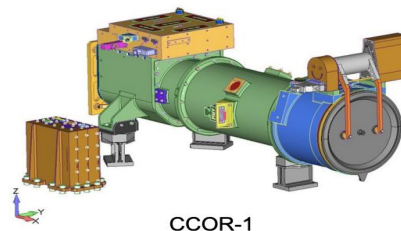
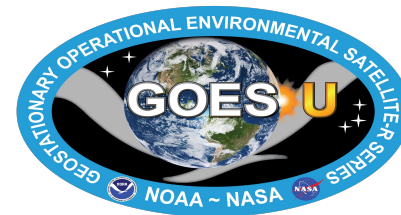
Observational extent: 3.7 - 17 Solar Radii

Spatial Resolution: 50 arcsec.

Latency: 15min | Intensity range: 10^{-11} to 10^{-8} B_{sun}

Image size: 2048x1920 pixels, or 7.8MB

Daily volume: 5 GB/day for operational products






Science Center Heritage



[Overview](#) [Visualize Data](#) [Download Data](#)

DSCOVR SPACE WEATHER DATA PORTAL

1. Space Weather Instruments
2. Data Descriptions
3. FAQ
4. Links
5. NCEI DSCOVR Team



The **Deep Space Climate Observatory (DSCOVR)** is the replacement satellite for NASA's [Advanced Composition Explorer \(ACE\) spacecraft](#) to continue monitoring **solar wind** near the **L1 point**. DSCOVR observations are critical to our space weather ready nation. These data support forecasts and research of phenomena that have the potential to **disrupt and damage** Earth-based infrastructure.

Here, data are archived, [distributed](#), and [visualized](#) for magnetometer and faraday cup measurements. For realtime data, see the [Space Weather Prediction Center \(SWPC\) real time solar wind page](#). For information and data from the other instruments onboard DSCOVR, EPIC and NISTAR, see NASA's [Atmospheric Science Data Center](#).

Space Weather Instruments

DSCOVR is carrying the following space weather monitoring instruments:

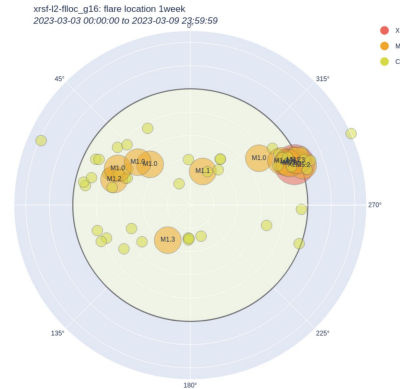
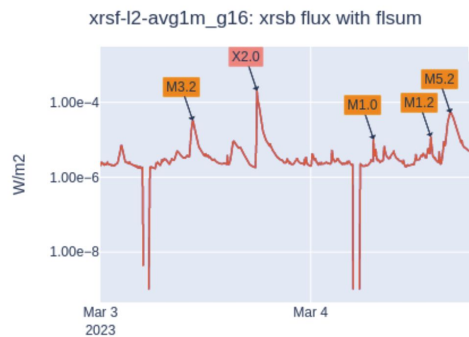
Nickname	Name	Purpose
MAG	Magnetometer	Measures solar wind magnetic field vector.
FC	Faraday Cup	Provide real-time measurement of solar wind proton density, speed, velocity, temperature, etc...



Loto'aniu, P. T. M., Romich, K., Rowland, W., Codrescu, S., Biesecker, D., Johnson, J., et al. (2022). Validation of the DSCOVR spacecraft mission space weather solar wind products. *Space Weather*, 20, e2022SW003085. <https://doi.org/10.1029/2022SW003085>

Data Processing Monitor Framework (DPMF)

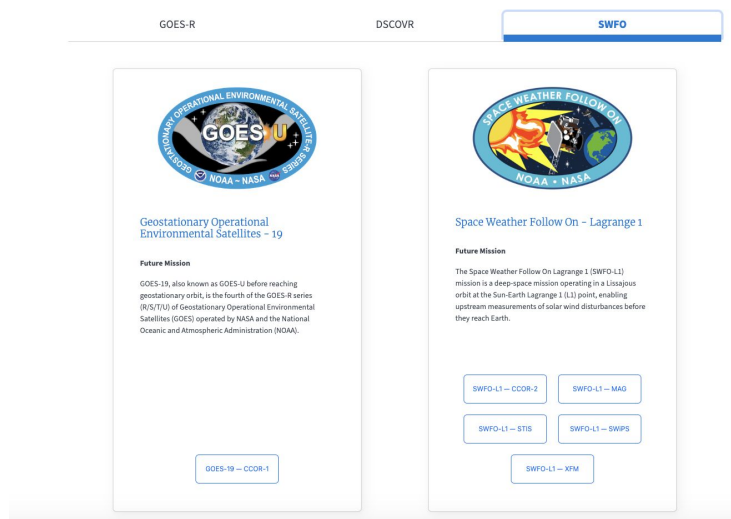
- Precursor for SWFO Science Center.
- Cloud-ready.
- Monitors all space weather data pipelines.
- Web dashboard with interactive plots, movies.
- API with rich metadata.
- In late stages of development.



Enhanced Data Access for the Space Weather Community: Space Weather POrTal (SPOT) UI



NCEI Space Weather Portal

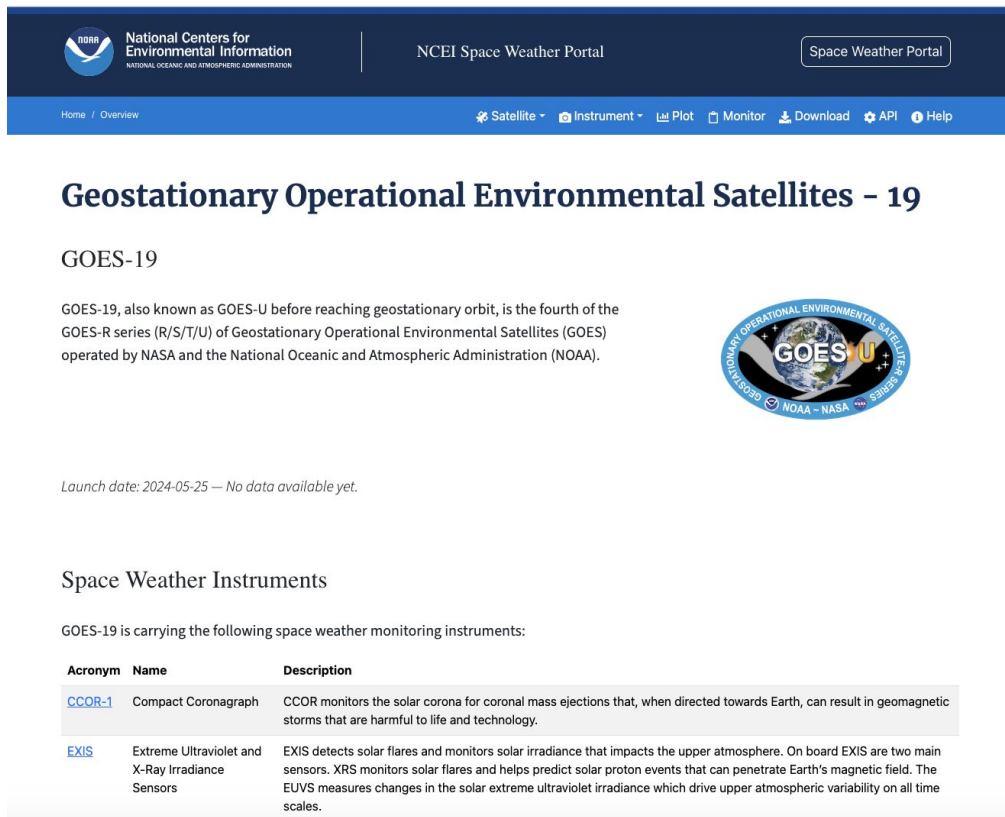


(NOTE: VPN req'd:
NOAA5006 AdminLAN
or NOAA5009 Mission)

SPOT UI Demo

SWFO Science Center Features


- Drives dynamic content of the SWFO Science Center GUI.
- Provides access to rich metadata for all data products.
- Users can use the API to do their own data analysis and plotting.



The screenshot shows the NCEI Space Weather Portal. The header includes the NOAA logo, "National Centers for Environmental Information", and "NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION". The main title is "NCEI Space Weather Portal". A navigation bar contains links for "Home / Overview", "Satellite", "Instrument", "Plot", "Monitor", "Download", "API", and "Help". The main content area is titled "Geostationary Operational Environmental Satellites - 19". Below this is the "GOES-19" section. It states: "GOES-19, also known as GOES-U before reaching geostationary orbit, is the fourth of the GOES-R series (R/S/T/U) of Geostationary Operational Environmental Satellites (GOES) operated by NASA and the National Oceanic and Atmospheric Administration (NOAA)." To the right is a circular logo for "GOES-U" with "NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION" and "NOAA - NASA" text. Below the text is the launch date: "Launch date: 2024-05-25 — No data available yet." The "Space Weather Instruments" section follows, stating "GOES-19 is carrying the following space weather monitoring instruments:". A table lists the instruments:

Acronym	Name	Description
CCOR-1	Compact Coronagraph	CCOR monitors the solar corona for coronal mass ejections that, when directed towards Earth, can result in geomagnetic storms that are harmful to life and technology.
EXIS	Extreme Ultraviolet and X-Ray Irradiance Sensors	EXIS detects solar flares and monitors solar irradiance that impacts the upper atmosphere. On board EXIS are two main sensors. XRS monitors solar flares and helps predict solar proton events that can penetrate Earth's magnetic field. The EUVS measures changes in the solar extreme ultraviolet irradiance which drive upper atmospheric variability on all time scales.

DPMF: Satellite Plot Summary page



Satellite: GOES-16
Instruments: EXIS MAG SEISS SUVI
(processed data: 2022-12-01 to present)

Date Range

Period: ☒ Days ☐ Weeks ☐ Months

Start (UTC):

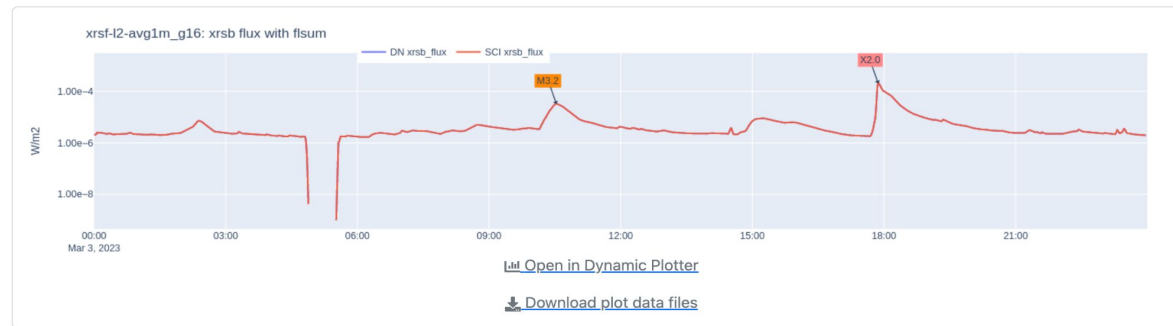
< 03/03/2023 >

Monitor Report ⓘ [Show Full Report](#)

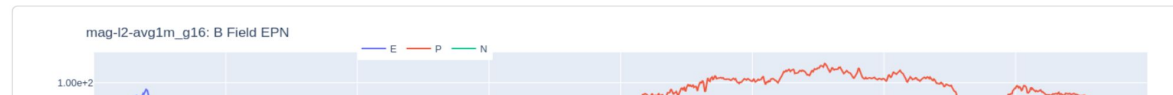
Start Date: 2023-03-03, End Date: 2023-03-03
Satellite: GOES-16

L0-ops(g) ✓ L1b-ops(g) 1 L1b-ops ✓ L1b-sci ✓
L2-ops 7 L2-sci ✓

xrsf_l2_avg1m_g16_xrsb_flux_fsum

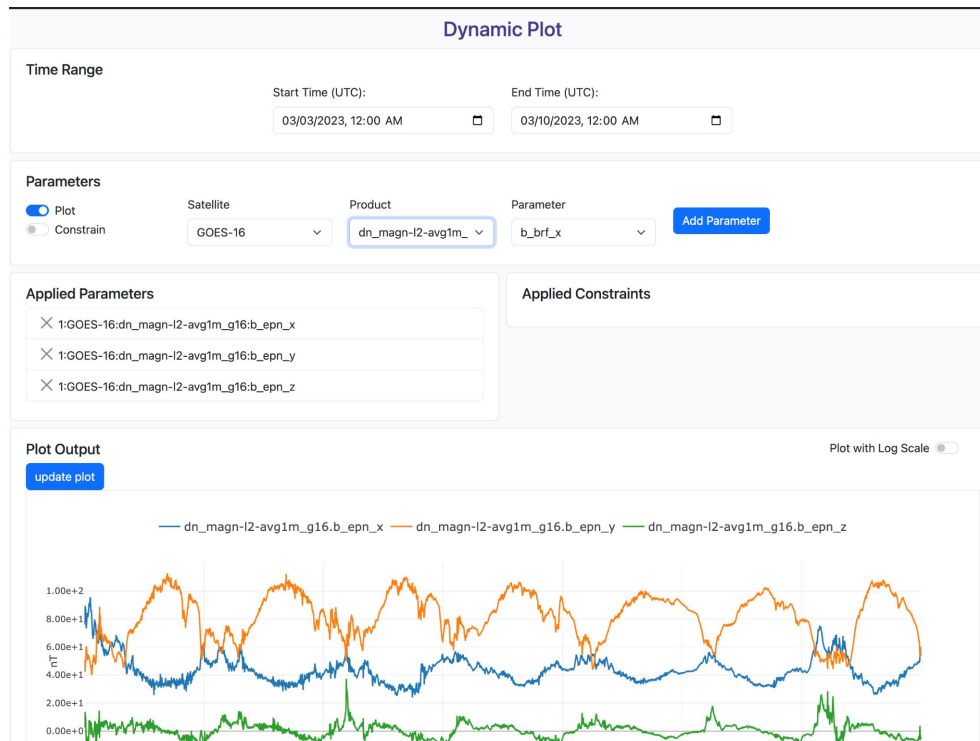


mag-l2_avg1m_g16_bepn





DPMF: Dynamic Plot page



DPMF: Monitor page

SPOT

Satellites

Instruments

Plot

Monitor

Download

Help

Monitor: GOES-16

Date Range

Start (UTC):

02/01/2023

End (UTC):

02/14/2023

Instrument Status: Satellite: GOES-16, Instrument:

Format: ☐ table ☒ heatmap

Key

<0%

<10%

<20%

<30%

<40%

<50%

<60%

<70%

<80%

<90%

<100%

Missing Files

Product / Dates	01	02	03	04	05	06	07	08	09	10	11	12	13	14
OR_EXIS-L0_G16	5	0	1	0	0	0	0	0	0	0	0	0	0	0
ops_exis-l1b-sfeu_g16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ops_exis-l1b-sfxr_g16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OR_EXIS-L1b-SFEU_G16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OR_EXIS-L1b-SFXR_G16	0	0	1	0	0	0	0	0	0	0	0	0	0	0
sci_exis-l1b-sfeu_g16	0	0	0	0	1	1	0	0	0	0	0	0	0	0
sci_exis-l1b-sfxr_g16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
dn_euvs-l2-avg1d_g16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
dn_euvs-l2-avg1m_g16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
dn_xrsf-l2-avg1m_g16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
dn_xrsf-l2-avg1d_g16	0	0	0	0	0	0	0	0	0	0	0	0	0	0

https://ncis-sw-x-dpmf-internal.nesdis-hq.noaa.gov:8443/monitor

DPMF: Download page

SPOT

Download Data

Time Range

Start Time (UTC):

03/03/2023, 12:00 AM

End Time (UTC):

03/06/2023, 12:00 AM

Filters

Satellite:

GOES-16

Instrument:

none

List

☐ dn_euvs-l2-avg1d_g16

☒ dn_euvs-l2-avg1m_g16

☒ dn_xrsf-l2-avg1m_g16

☐ dn_xrsf-l2-bkd1d_g16

☐ dn_xrsf-l2-fldet_g16

☐ dn_xrsf-l2-filloc_g16

Files results

Search

Total files found: 6

Download Options ⓘ

File links

2023-03-03

[dn_euvs-l2-avg1m_g16_d20230303_v1-0-3.nc](#)

[dn_xrsf-l2-avg1m_g16_d20230303_v2-1-0.nc](#)

2023-03-04

[dn_euvs-l2-avg1m_g16_d20230304_v1-0-3.nc](#)

[dn_xrsf-l2-avg1m_g16_d20230304_v2-1-0.nc](#)

2023-03-05

[dn_euvs-l2-avg1m_g16_d20230305_v1-0-3.nc](#)

[dn_xrsf-l2-avg1m_g16_d20230305_v2-1-0.nc](#)

Batch download

Collection Links

SWFO API response examples

/files API route

```
#https://ncis-swx-dpmf-internal.nesdis-hq.noaa.gov:10000/files?start_time=
2023-06-10T00:00:00&end_time=2023-06-11T00:00:00&prod=sci_xrsf-l2-avglm_g1
6

{

  "id": "sci_xrsf-l2-avglm_g16_d20230610_v2-2-0.nc",

  "satellite": "GOES-16",

  "instrument": "EXIS",

  "product": "sci_xrsf-l2-avglm_g16",

  "size_bytes": 3141746,

  "time_coverage_start": "2023-06-10T00:00:00.000Z",

  "time_coverage_end": "2023-06-11T00:00:00.000Z",

  "file_link": "https://data.ngdc.noaa.gov/platforms/solar-space-observing-satellites/goes/goes16/l2/data/xrsf-l2-avglm\_science/2023/06/sci\_xrsf-l2-avglm\_g16\_d20230610\_v2-2-0.nc",
```

/values API route

```
#https://ncis-swx-dpmf-internal.nesdis-hq.noaa.gov:10000/values
?start_time=2023-06-10T00:00:00&end_time=2023-06-11T00:00:00&pa
rameters=GOES-16:dn_xrsf-l2-avglm_g16:xrsa_flux&format=json

{

  "data": {

    "dn_xrsf-l2-avglm_g16.xrsa_flux": [

      2.1307e-8,

      1.98066e-8,

      1.71907e-8,

      1.68023e-8,

      1.48922e-8,

      1.50094e-8,

      1.37775e-8,

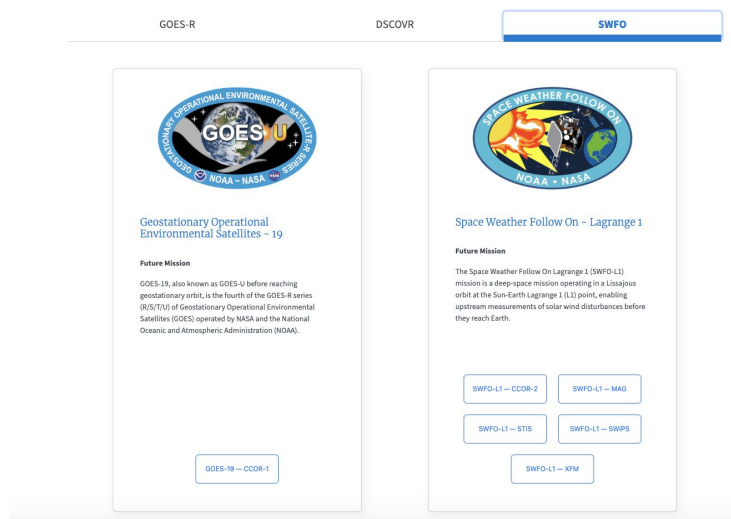
      1.333e-8,

      ...
```

Enhanced Data Access for the Space Weather Community: Space Weather POrTal (SPOT) UI



NCEI Space Weather Portal



(NOTE: VPN req'd:
NOAA5006 AdminLAN
or NOAA5009 Mission)

SPOT UI Demo



Plans for future work

- SWFO moving to new FISMA domain - UAT>>>Production
- User Business Logic enhancements - data manager self service
- Common Metadata Repository Integration (CMR)
- Other Space Weather projects leveraging work in NCCF - SpWx Next/CADAT

Acknowledgements

For the wisdom, program and technological knowledge, support and visioning to get SWFO into NCCF

STP team - Ale Pacini, Laurel Rachmeler

Rob Redmon, Josh Riley, William Rowland and Andrew Wilson

DSD - Jeff Arnfield, Rich Baldwin, Ryan Berkheimer, Ken Casey, Jeremy Hall, Dave Neufeld, Nancy Ritchey, Brandon Shelton and Chad Whitney

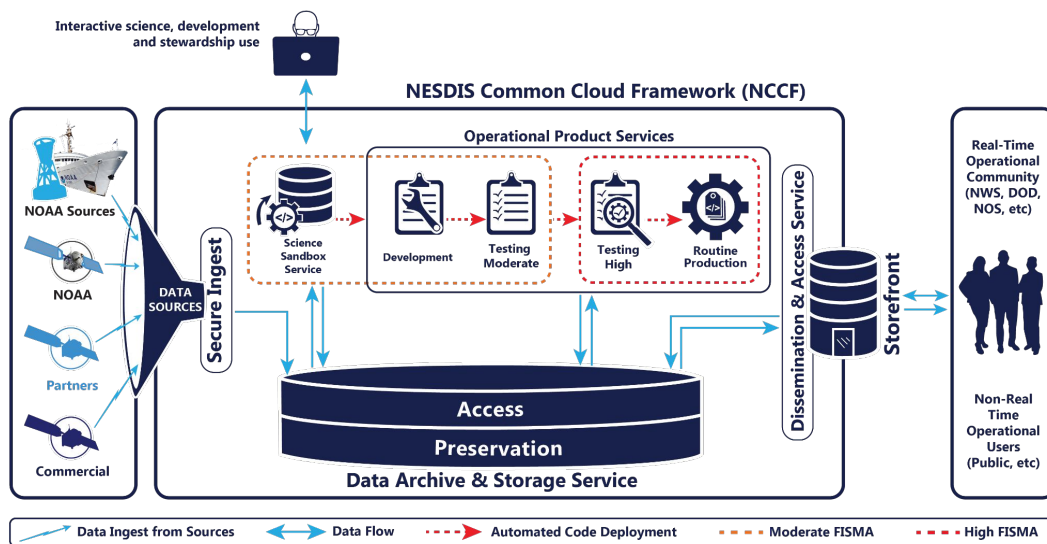
NCCF - Rafat Khair, Pura Perez and David Whittington

Backups

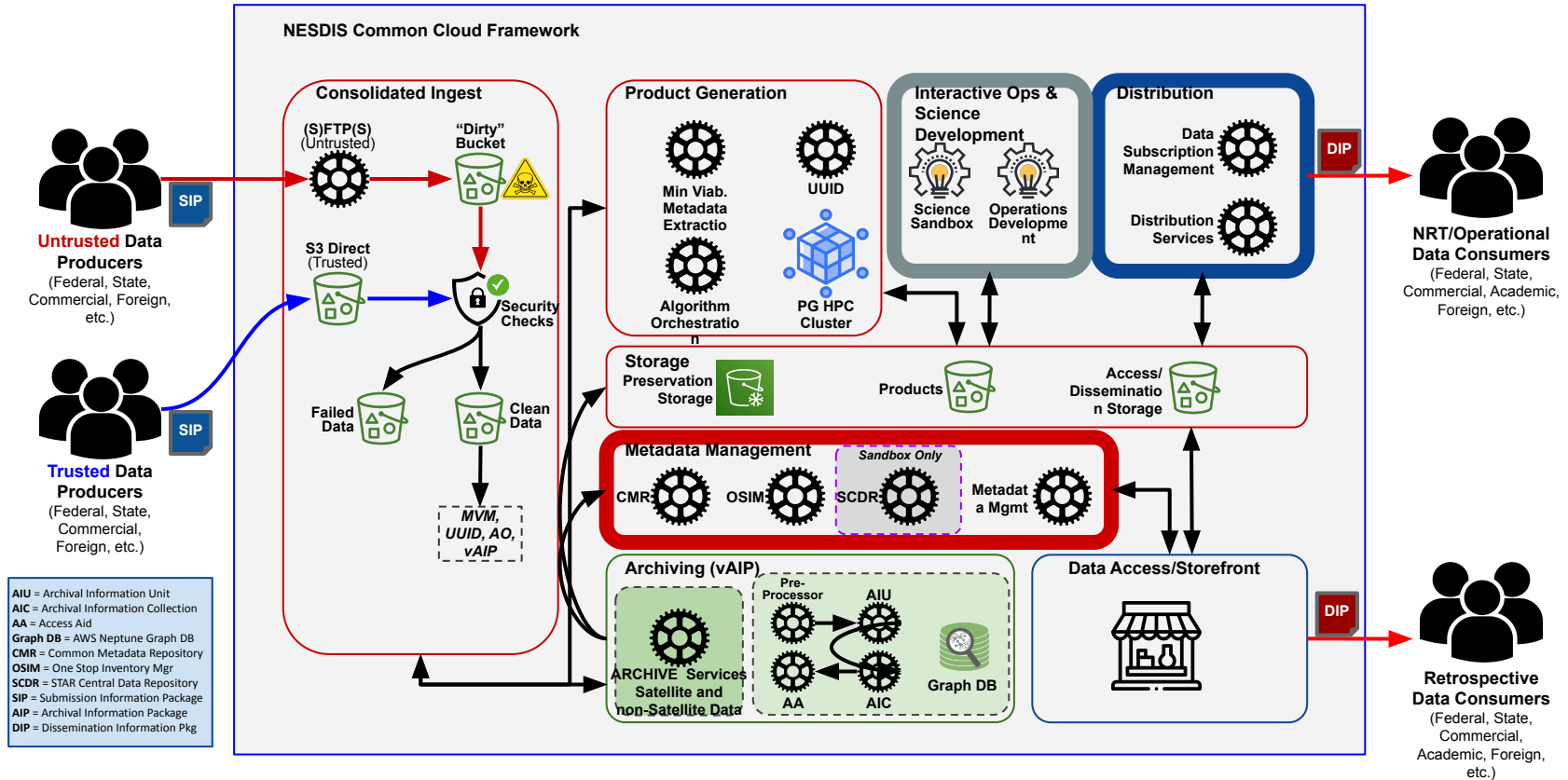
A Data-Centric Enterprise Cloud Vision for NESDIS

The Office of Common Services (OCS) is developing the NESDIS Common Cloud Framework (NCCF), which provides a new concept of operations - to **consolidate its operational workloads around centralized data, enable innovative science, and enhance data discovery**

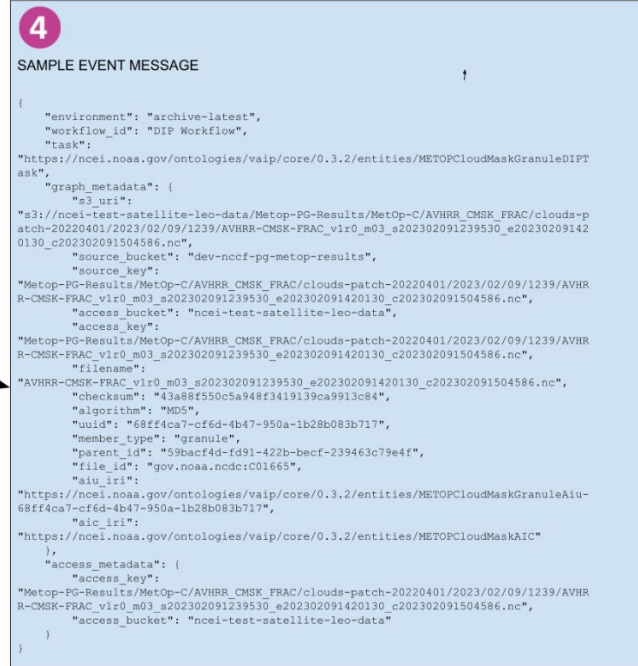
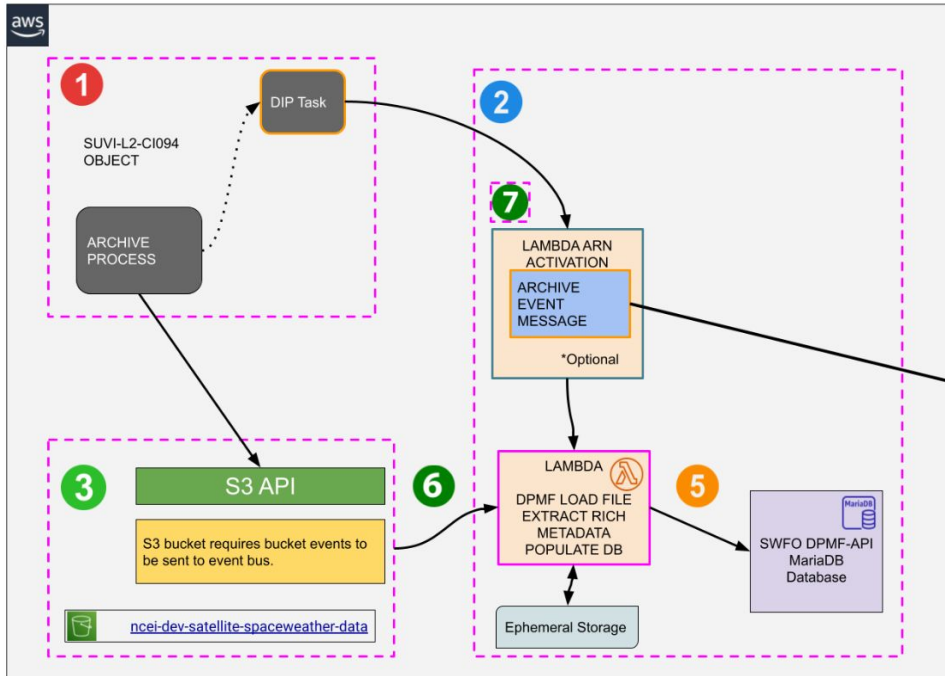
- Consolidate and improve access to archived NOAA data holdings
- Improved system performance through automation and cloud redundancy
- Faster research to operations transition for code updates
- Innovative science potential with AI/ML tools and centralized data
- Increased traceability of cost and data use



NCCF Architecture



SWFO Backend Rich Metadata Load



1. The archive process that is responsible for archiving the data.
2. The SWFO DPMF BACKEND that opens the file and extracts rich metadata and stores in the SWFO DPMF-API Maria database
3. Storage layer for storing objects in AWS s3 buckets
4. Sample Event Message sent from Archive Process to Lambda Trigger to start process DPMF-BACKEND process
5. Write access to SWFO DPMF-API Maria Database. Extracted Metadata controlled by DPMF-BACKEND code
6. Read Only Access to Access Bucket
7. Optional Trigger for Lambda to be activated by Queue or Event Bridge Rule. Should be activated directly by DIP task in current example. Event Message will remain the same.