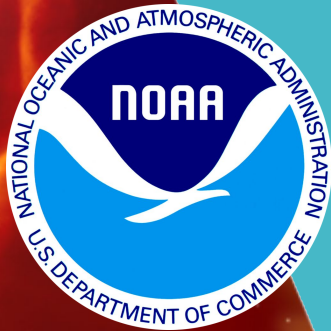Space Weather Workshop
The Meeting of Science, Research, Applications, Operations, and Users
April 17 – 21, 2023 • Boulder, CO

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 DSCOVR 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

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

F A I R

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

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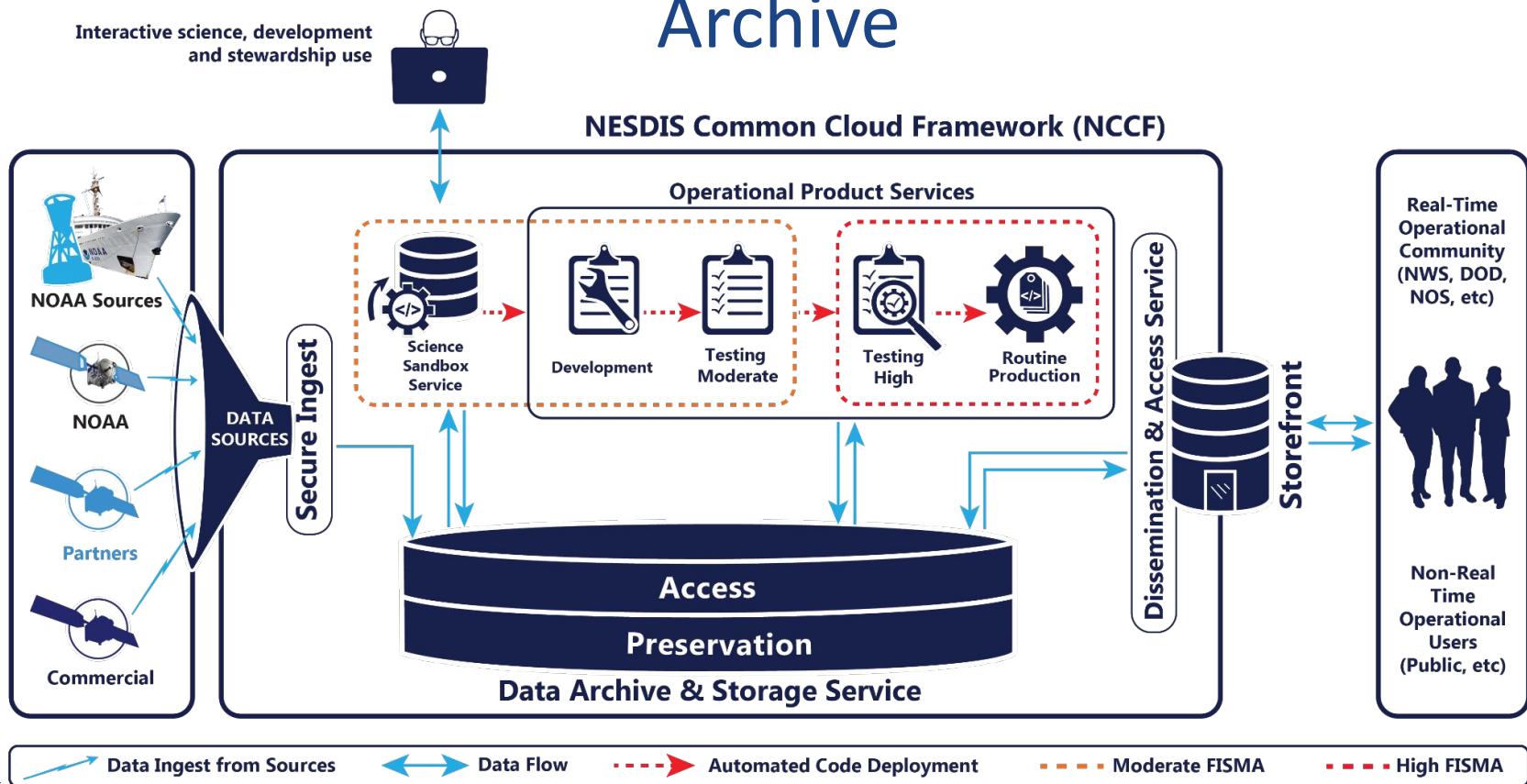The goal of **FAIR** is to optimise data reuse via comprehensive well-described metadata

+

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

[1]Adapted from NCEI publication Peng et al. (2018), https://datascience.codata.org/article/10.5334/dsj-2018-015/
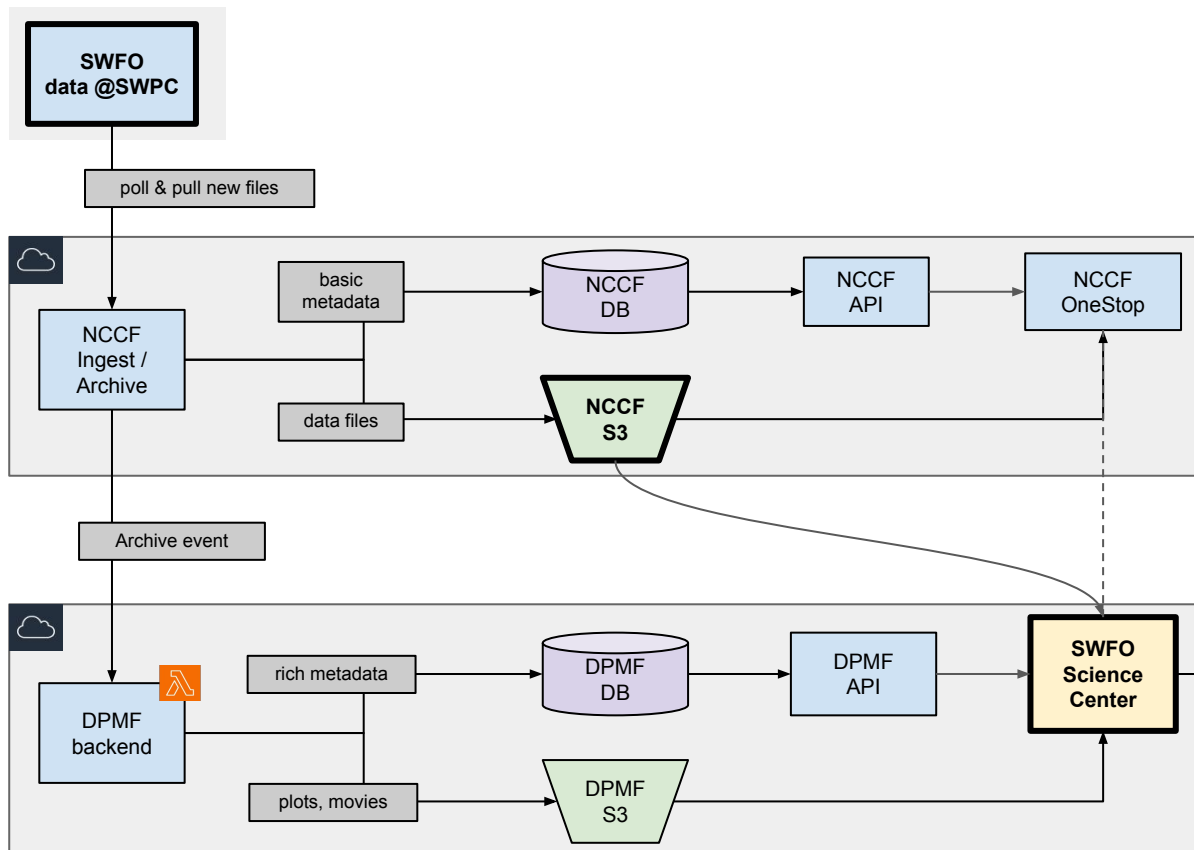
Motivation to take SWFO to the cloud

- 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

Interactive science, development and stewardship use

NESDIS Common Cloud Framework (NCCF)

Operational Product Services

- Science Sandbox Service
- Development
- Testing Moderate
- Testing High
- Routine Production

DATA SOURCES

- NOAA Sources
- NOAA
- Partners
- Commercial

Secure Ingest

Data Archive & Storage Service

- Access
- Preservation

Dissemination & Access Service

Storefront

Real-Time Operational Community (NWS, DOD, NOS, etc)

Non-Real Time Operational Users (Public, etc)

Legend:
- Data Ingest from Sources
- Data Flow
- Automated Code Deployment
- Moderate FISMA
- High FISMA

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

CCOR-1
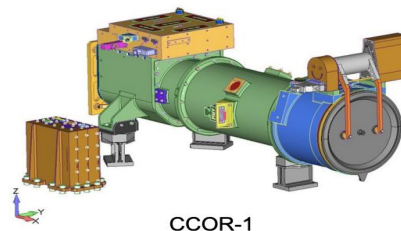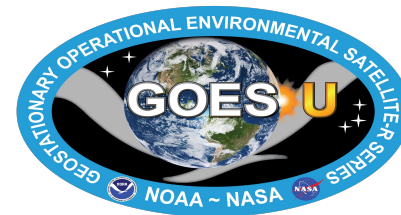
Science Center Heritage

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 **P**rocessing **M**onitor **F**ramework (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.
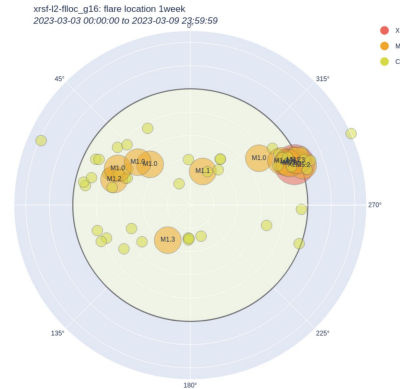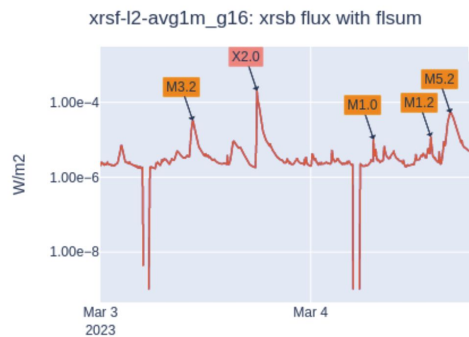
Enhanced Data Access for the Space Weather Community: Space Weather POrTal (SPOT) UI
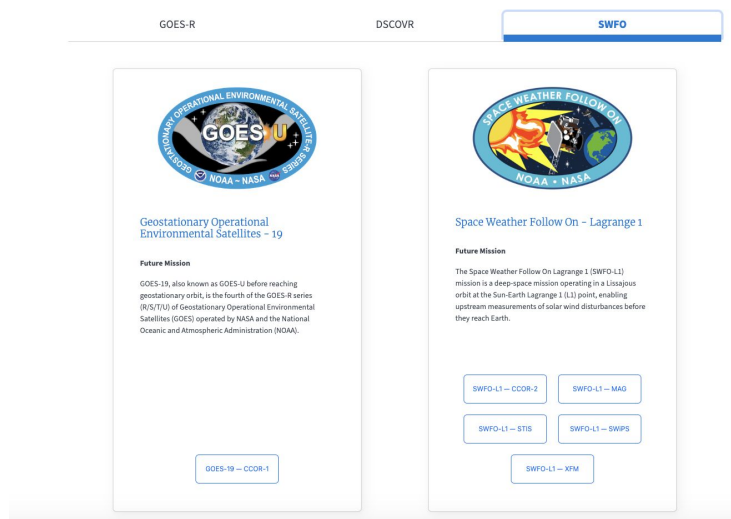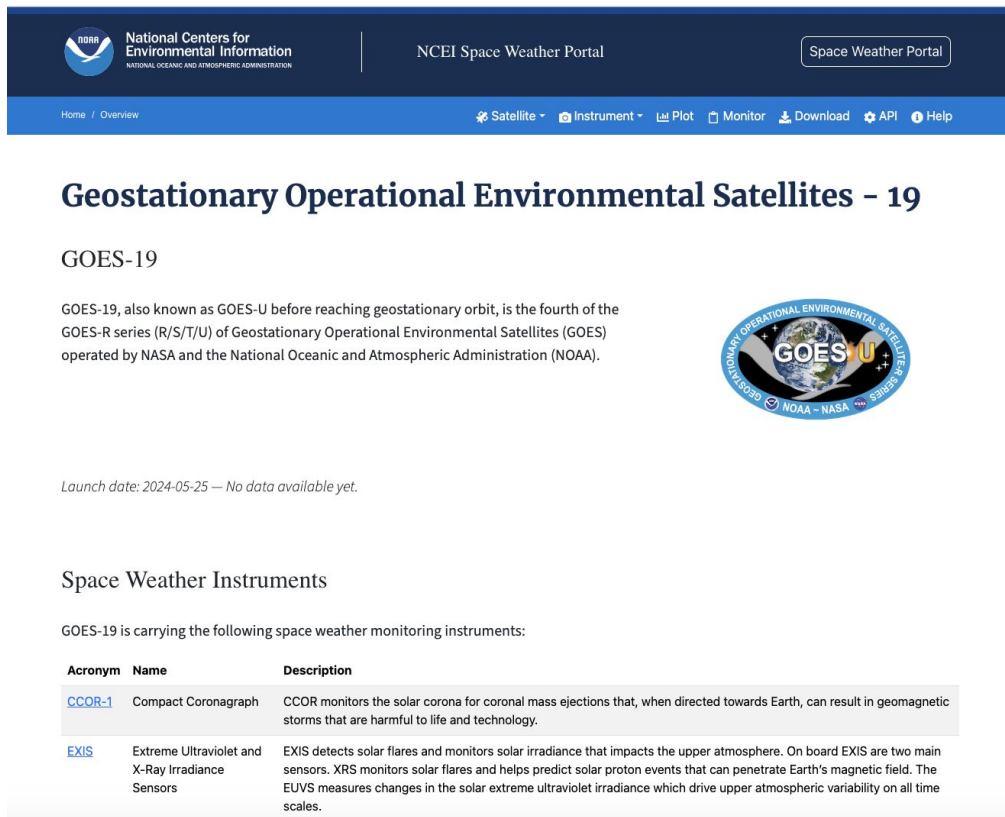
[SPOT UI Demo](#)

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

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.

DPMF: Satellite Plot Summary page

DPMF: Instrument Summary Plot page

DPMF: Dynamic Plot page

DPMF: Monitor page

DPMF: Download page

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-avg1m_g1
6


{

        "id": sci_xrsf-l2-avg1m_g16_d20230610_v2-2-0.nc",

        "satellite": "GOES-16",

        "instrument": "EXIS",

        "product": "sci_xrsf-l2-avg1m_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-obs
erving-satellites/goes/goes16/l2/data/xrsf-l2-avg1m_science/2023/06/sci_xr
sf-l2-avg1m_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-avg1m_g16:xrsa_flux&format=json


{

  "data": {

    "dn_xrsf-l2-avg1m_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
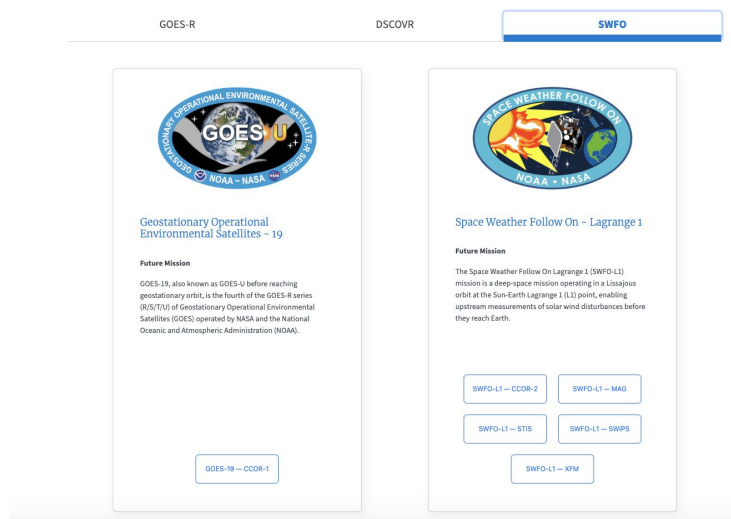
[SPOT UI Demo](#)

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

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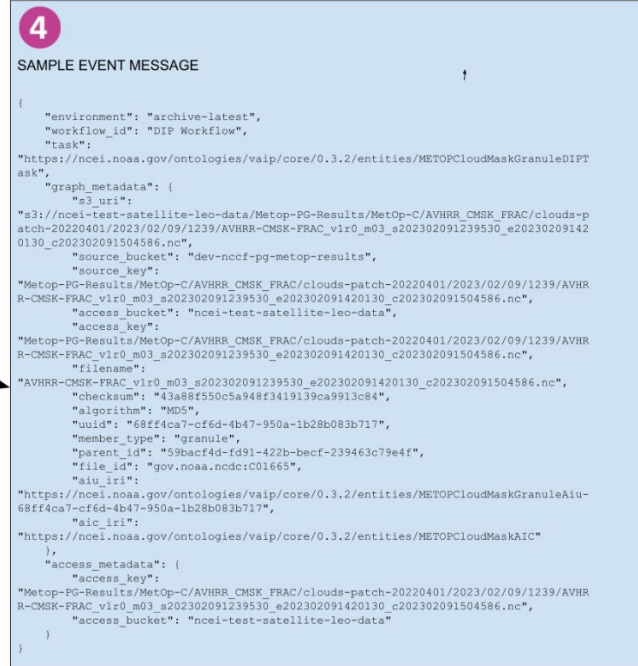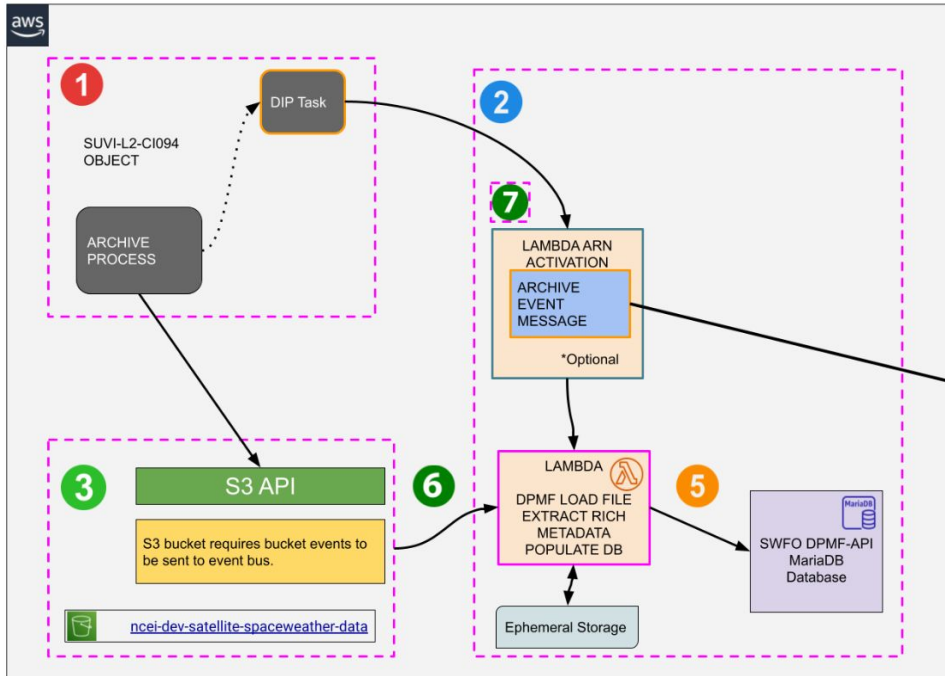
- Consolidate and improve access to archived NOAA data holdings
- Improved system performance through automation and cloud redundancy
- Faster research to operations transition for code updates
- Innovative science potential with AI/ML tools and centralized data
- Increased traceability of cost and data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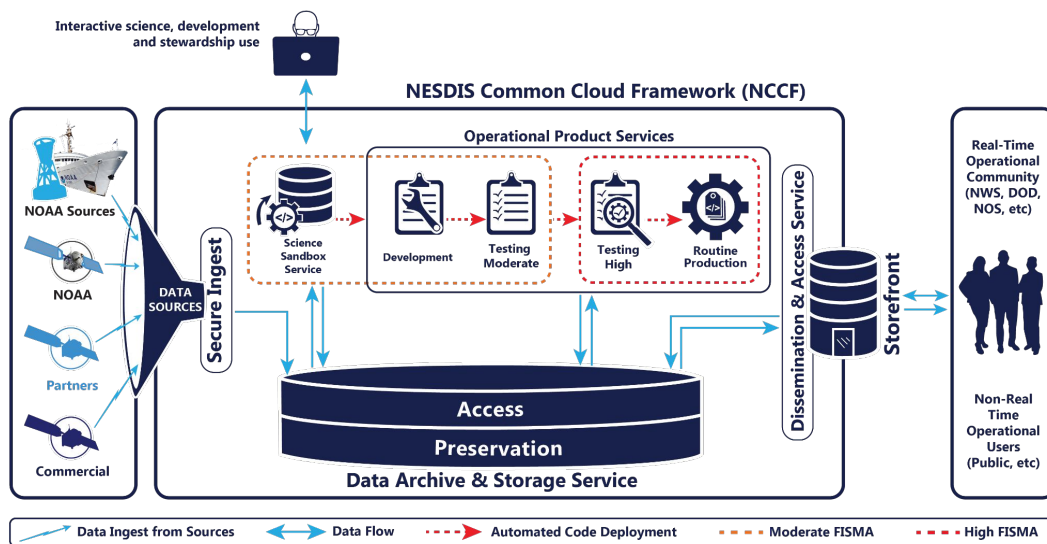
NCCF Architecture
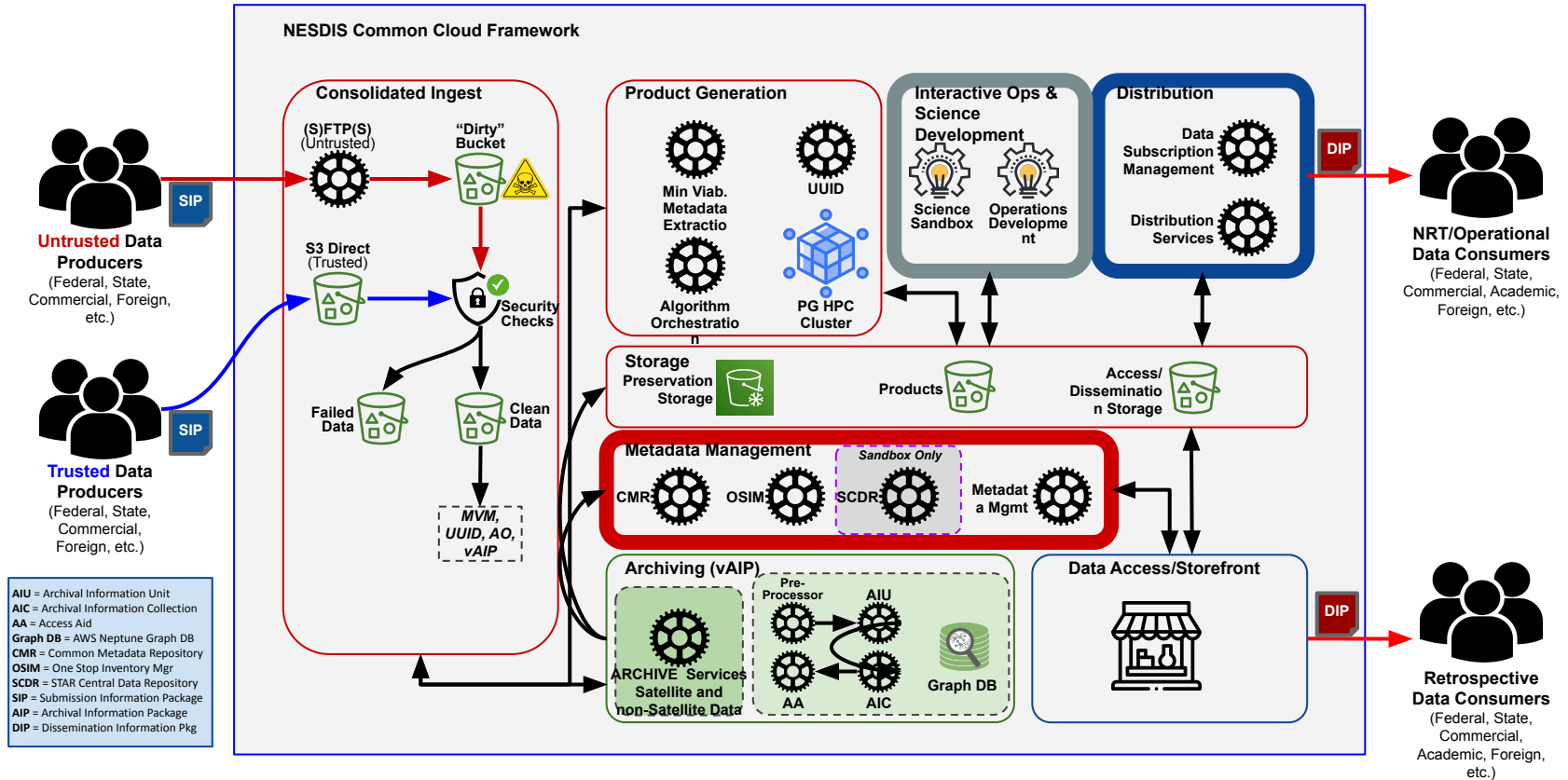
SWFO Backend Rich Metadata Load

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.