Space Weather Follow On Ground Segment Product Generation and Distribution

SWFO Pre-CDR Peer Review: NCEI

National Environmental Satellite, Data, and Information Service

16 February 2022

The NCEI Team:
William Rowland, Laurel Rachmeler, Rob Redmon, Nazila Merati, Paul Loto'aniu, Brian Kress, Juan Rodriguez, Don Schmit, et al.

Outline

Section	Presenters	Approximate Presentation Time
Introductory Material	Laurel Rachmeler	5 min
Driving Requirements	William Rowland	5 min
SWPC-NCEI Interface (Review)	William Rowland	5 min
PG for Retrospective Users (Review)	William Rowland	5 min
Data Stewardship (including PD & Archive)	Nazila Merati	10 min
Calibration and Validation (Overview)	William Rowland	5 min
CCOR	Don Schmit	15 min
MAG	Paul Loto'aniu	10 min
STIS	Juan Rodriguez	10 min
SWIPS	Brian Kress	10 min
Discussion	General	10 min
NCEI Project Management Update (PMU)	Rob Redmon	20 min

Peer Review Expectations

The peer reviews will focus on specific parts of the design, especially those that are not well-defined from previous missions such as DSCOVR and GOES-R. The peer reviews will focus on the design prepared to implement the functions of the PGD element.

Topics covered by NCEI Peer Review include:

- Implementation of the SWPC-NCEI interface (NCEI portion)
- Data Stewardship
- Scientific (retrospective) processing code status
- Calibration and validation (Cal/Val)
- GPA and Retrospective ATBD considerations

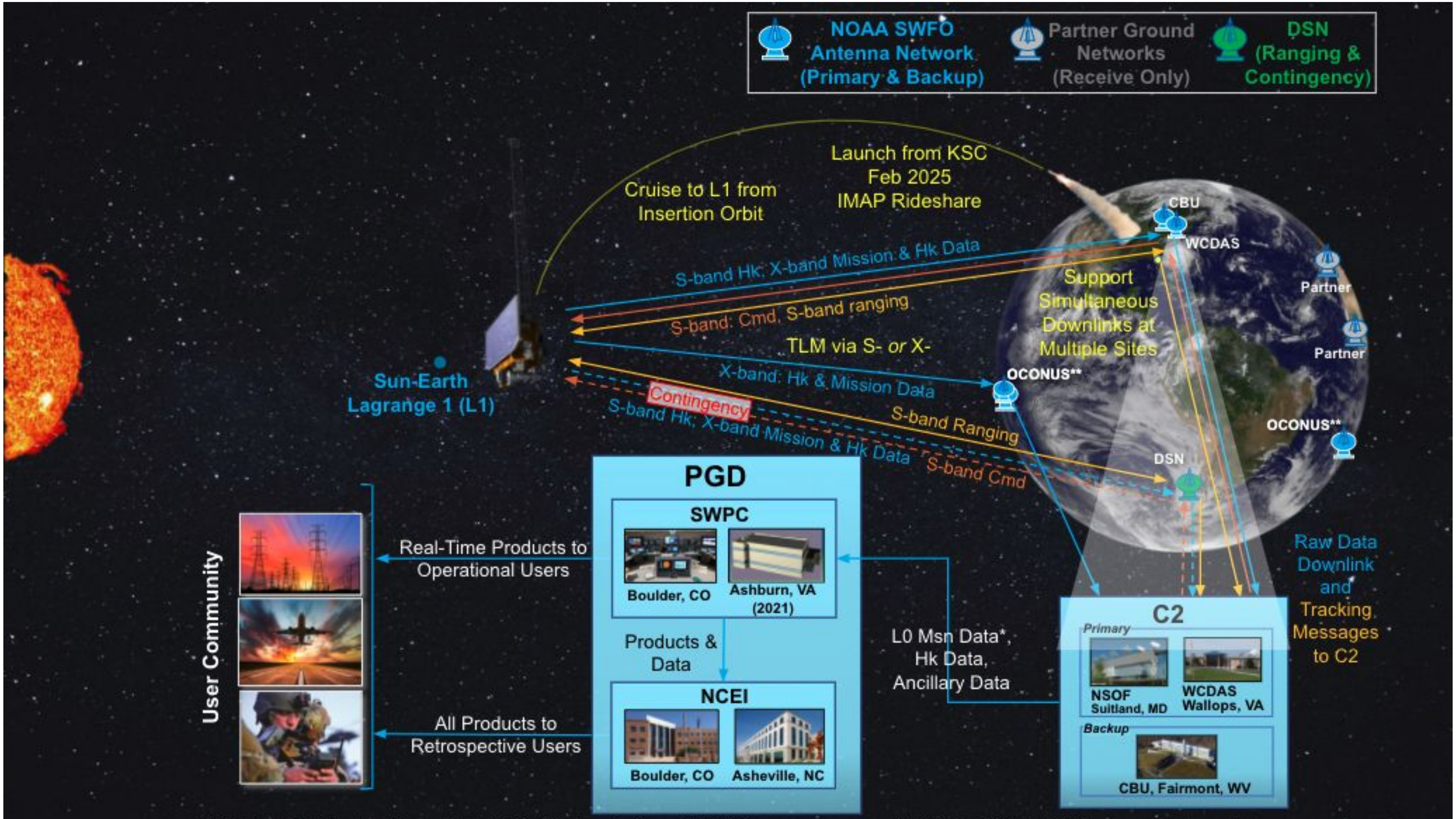
Rather than evaluating the design against specific criteria, the panels and other audience will provide feedback to the PGD team. This approach will not result in requests for action, but the review panel may issue advisories and issues/concerns. The panel will provide a 1-page (or longer) summary of their feedback and any advisories or concerns within one week of the last review.

PGD SRR slides

NCEI pre-PDR Peer Review Slides

PGD PDR Slides

Expectations taken from “2021.11.02pre-CDR peer review plan.docx”



*GOES-U CCOR-1 data provided to SWPC directly from GOES-R

** OCONUS SAN Stations are implemented as a service

Overview of NCEI's & SWPC's Roles
(copied from PDR deck #2, pg 50)

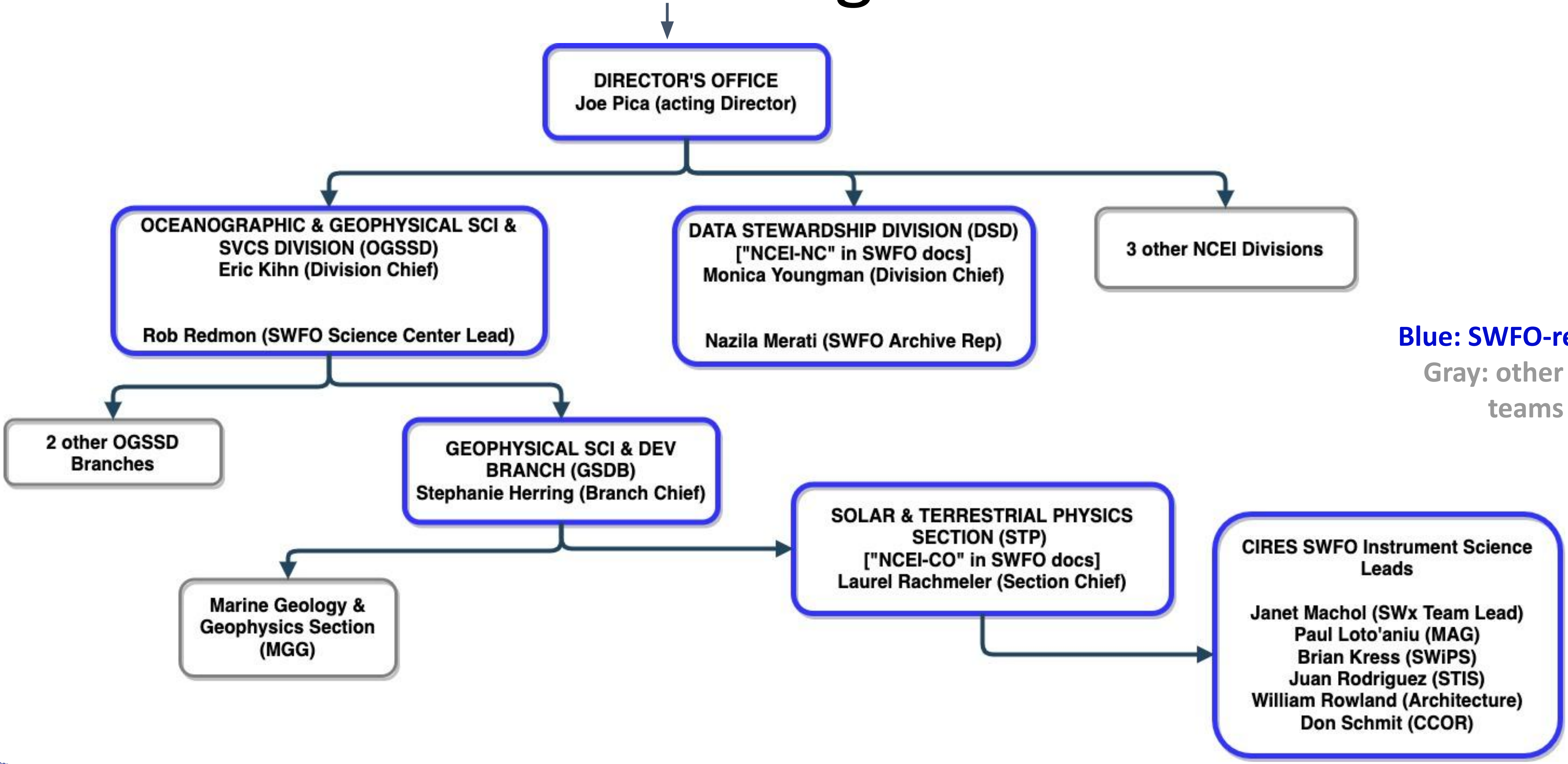
SWPC responsibilities include:

- Generate and distribute real-time products.
- Interface directly with the SWFO Command and Control (C2) system and GOES-R GS.
- Create 'day files' for all products, and make these files available to NCEI for archive.
- Lead the SWFO Algorithm Working Group (AWG). AWG is responsible for developing and implementing the real-time ATBDs and GPAs.
- Support the Calibration Working Group (CWG).

NCEI responsibilities include:

- Lead the SWFO CWG. CWG is responsible for planning, coordinating, and executing calibration and validation activities for SWFO's instruments and data products.
- Ingest and archive day files produced at SWPC.
- Generate improved (scientifically authoritative) retrospective products.
- Create the SWFO Science Center to provide enhanced stewardship and retrospective access to SWFO data.
    - This is used to serve both the operational products generated in real-time at SWPC and the scientifically authoritative data produced retrospectively at NCEI.

NCEI Org Chart



Blue: SWFO-relevant
Gray: other NCEI teams

Key SWFO CWG Assumptions[1]

1. Vendor is responsible for monitoring Flight/Instrument performance and creating the Flight LUTs (i.e flight tables) throughout the life of the mission.
2. The Vendor is always responsible for creating the flight LUT/commanding change file (i.e. instrument level change).
3. NCEI is responsible for generating and monitoring ground-processing calibration table updates.
4. Any CWG member (including NCEI) has the authority to recommend a flight or ground calibration table change be considered (e.g. Ground processing changes).
5. CWG approves any suggested changes to flight or ground LUTs.
6. Vendors tools required[2] for NCEI's Ground cal/val roles be developed and transitioned to NCEI in a manner usable within NCEI's IT infrastructure (i.e. not black box executables, nor complicated administrator level privileges).

[1]Note: This assumption list has been discussed with SWFO program. These are NCEI-proposed assumptions, the discussion is ongoing with both Program and vendors and the final list may be different than what is written above. This list is what NCEI used in its initial budget and schedule creation.
[2]Note: PGD has developed a "Calibration and Validation Tool Request" memo with Program and Flight, and is in the process of discussing with vendors..

GPA and Retrospective ATBD considerations

- Vendors are developing the GPA documents and codes for L2 products and below. NCEI is collaborating with both vendors and SWPC to:
  - plan the GPA schedules
  - evaluate the GPA deliveries
  - implement the GPA methods in retrospective reprocessing pipeline, to support cal/val and data stewardship
- ATBDs are written by SWPC for L3 data products.
  - NCEI will provide retrospective elements as part of those ATBD documents where needed, such as when a L3 product is calculated differently for operational vs retrospective products.
  - The ATBD work will occur in the latter half of calendar year 2022.

Driving Requirements

SWFO L4 Requirement Availability

Requirement Text:
L4-NCEI-2190, NCEI shall make 89% (not including planned maintenance) of Coronal White Light Intensity L0+ products available to the public within 3 days of SWPC making those products accessible to NCEI systems, as measured over a 365 day period.

Rationale:

1. SWFO RAD specifies 3 day latency, which is a more aggressive timeframe than DSCOVR's target.
2. DSCOVR latency was calculated differently - from the time the file became available on SWPC servers until fully archived at NGDC. SWFO latency also includes availability to users.
3. The SWFO RAD currently does not specify an availability for archive.
4. NCEI operates 8x5, not 24x7.
5. NCEI Software systems - 98% (.98) availability target within 3 days.
6. CLASS - 95% (.95) availability target. This does NOT include planned maintenance.
7. NCEI Infrastructure - Support contract has a 96% (.96) availability target.
8. **NCEI end to end system reliability** = .98*.95*.96 = **.89**

Verification Strategy: Analysis

SWFO L3 Requirement, NCEI Availability

Requirement Text:
The PGD Element shall have a minimum near-term retrospective data availability of 89% as measured over a 365-day period.

Requirement Text:
The near-term retrospective data availability is defined as the ratio of data made available to retrospective users in the near-term to the amount of data received from SWPC.The near-term timescale is 4 days, and is the sum of 1 day of SWPC processing time and 3 days for NCEI ingest processing (based on their 8x5 support), as allocated in the RAD. The availability is calculated over 365 days based on the retrospective data latency, 8x5 support, and NCEI evaluation practices. This near-term retrospective data availability value should not be confused with the fact that all data will reach the archive in the long term.

CM process has started for including this in official SWFO L3 requirements.

Selected CWG L4 Driving Requirements

Requirement #	Requirement Text	Rationale	Verification Method
L4-NCEI-1165	NCEI shall lead calibration and validation activities.	Overarching CWG requirement, with some specific activities covered under additional requirements	Inspection
L4-NCEI-160	NCEI shall refine and improve retrospective algorithms for the life of the mission.		Inspection
L4-NCEI-1250	NCEI shall retrospectively generate Level 1-3 products in support of CWG efforts.	NCEI will leverage these capabilities extensively throughout every phase of the mission.	Demonstration
L4-NCEI-10	NCEI shall submit documentation from NCEI-SWFO-CM-List(TBR) to PG-PD CM.	Examples: CVP, PS-PVR Provisional Briefings, Trend Analysis Plan, LUTs	Inspection
L4-NCEI-1170	NCEI shall lead creation of the Calibration and Validation Plan.		Inspection
L4-NCEI-1030	NCEI shall support SWFO CWG activities for at least 10 years after SWFO-L1 satellite launch.		Inspection

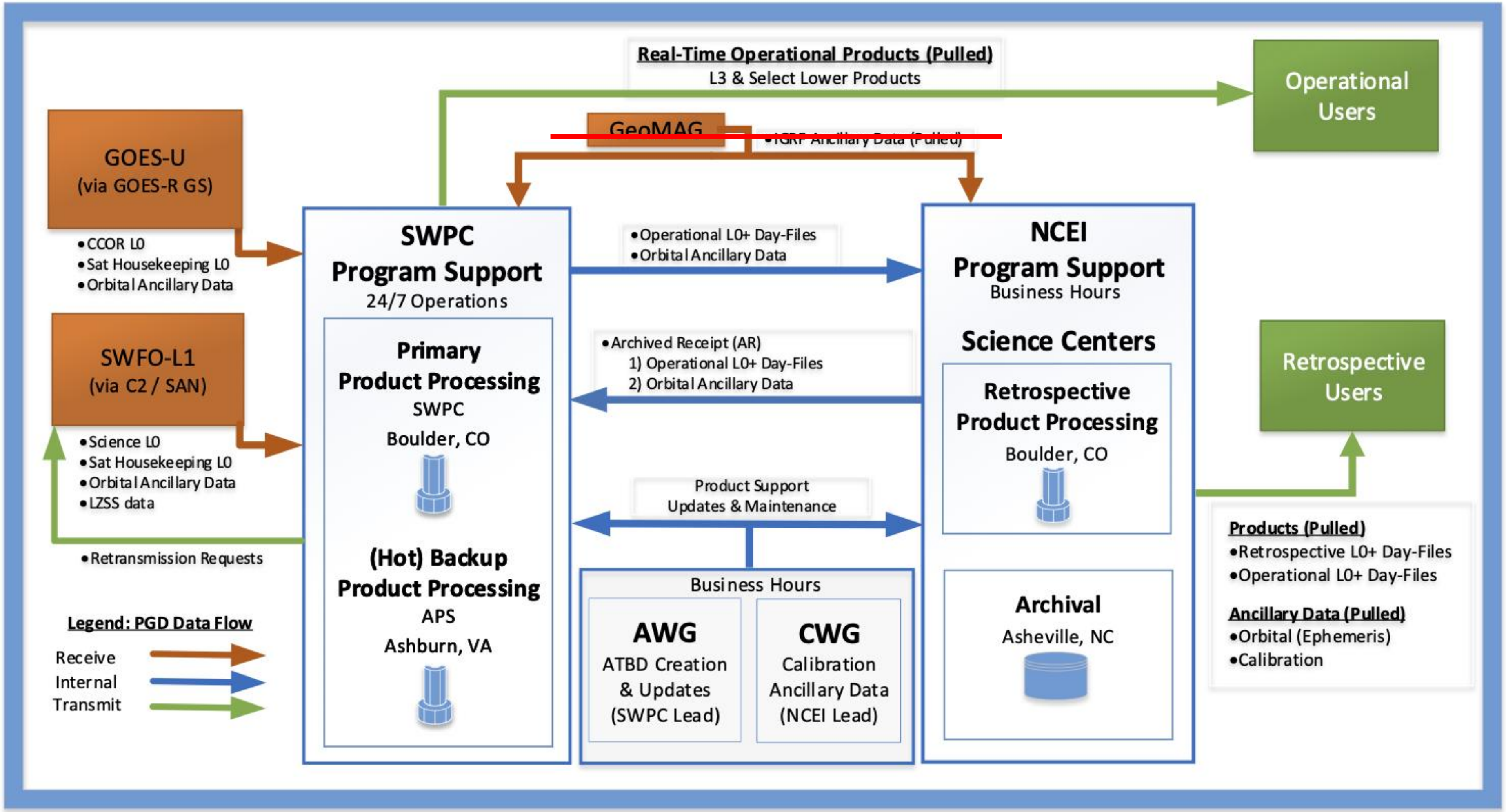
SWPC-NCEI interface

NCEI-SWPC interface

SWPC's interface is the same regardless of NCEI implementation for archive, storage, and retrieval. **This interface is identical to the heritage interface used for DSCOVR ingest and archive.**

1. **SWPC makes a data file available, together with a manifest.**
2. NCEI polls SWPC's server for new manifests
3. NCEI pulls new manifests, which contain filename and checksum.
4. NCEI pulls the corresponding data files, and validates using the checksum to confirm the data were not corrupted in transfer.
    a. Additional criteria (e.g. check validity of netCDF file) can be applied on a case by case basis.
5. NCEI archives valid data.
6. **NCEI provides a receipt back to SWPC, which includes checksum and filename for what NCEI archived.**
    a. **This permits SWPC to confirm that the file was not corrupted in transfer.**
    b. **SWPC can safely delete their copy of the file once the receipt is received.**
7. Within 24 hours of the file being archived, NCEI makes the file available through its public interfaces. The data will typically be archived within 48 hours of being made available from SWPC.

SWPC - NCEI interface



- *Representation of interface, Rev 5.15, included with current IRD submission (3.6.1)*
- *Note that IGRF should **not** be included in discussion of this interface. It is generated and made available to the public outside of the SWFO Program's support and purview.*

Archive interface considerations

This interface supports the planned cloud-based archive system, but can transition to using hardware on-premises at NCEI without requiring any changes to interfaces with SWPC or the SWFO Program.

PG for Retrospective Users

Retrospective Processing

- NCEI systems will rely on SPADES architecture and heritage
  - NCEI, SWPC, and instrument vendors use VLabs (Git) code repository (see SWPC Peer Review).
  - Shared repository permits teams to coordinate, and some teams (e.g. CCOR) plan to collaborate closely by using the same subroutines.
  - This minimizes redundant work and improves overall quality.
  - Direct benefit to mission life cal/val by providing an essential comparison.
    - Many of the cal/val issues identified for GOES-R cal/val were found in this way.
- Focus on Scientifically accurate and usable products
  - Metadata are human readable and follow space weather standards.
  - Reprocessing algorithms do not need to be optimized for low latency output. This permits decisions to improve quality by using additional data or subroutines that take longer to calculate.
  - Permits correction of issues that could not be performed in real-time, for example to apply a calibration correction identified 2 years into the mission to early-mission data.

SPADES-Science - SWFO Retrospective

Satellite Product Analysis & Distribution Enterprise System (SPADES)

NOAA Space Weather

Control Segment

1) Identify relevant files
2) Stage relevant files to EFS
3) Create Run Level Config (RLC) for relevant files
4) Spin up Fargate Workers for execution
5) Queue execution of RLCs in Fargate
6) Confirm execution, manage downstream algorithm dependencies
7) Ensure completed outputs are written to S3, then purged from EFS.

Schedule Workers

Status

Worker-nodes

Fargate

1) Pull tagged image from ECR
2) Execute algorithms based on RLCs received from Control Segment
3) Report success, failure, logs to Control Segment

Images (Code)

CI Pipeline[1]

Jenkins

AWS ECR

1) Receive Dev code changes
2) Automated validation
3) Create Image
4) Deploy to ECR

L0b-L3 Data RLCs, Logs

L1-L3 Data RLCs, Logs

L0b-L3 Data

SWFO Archive, Science Center

Reprocessed L1-L3

S3

Reprocessed L1-L3

EFS

EC2, Fargate, ECR, S3, and EFS are core services within AWS that our system uses.
Jenkins is an open source automation server, used for CI/CD.

[1]See "NCEI Scientific CI testing workflow" slide for more details

Retrospective Processing Status

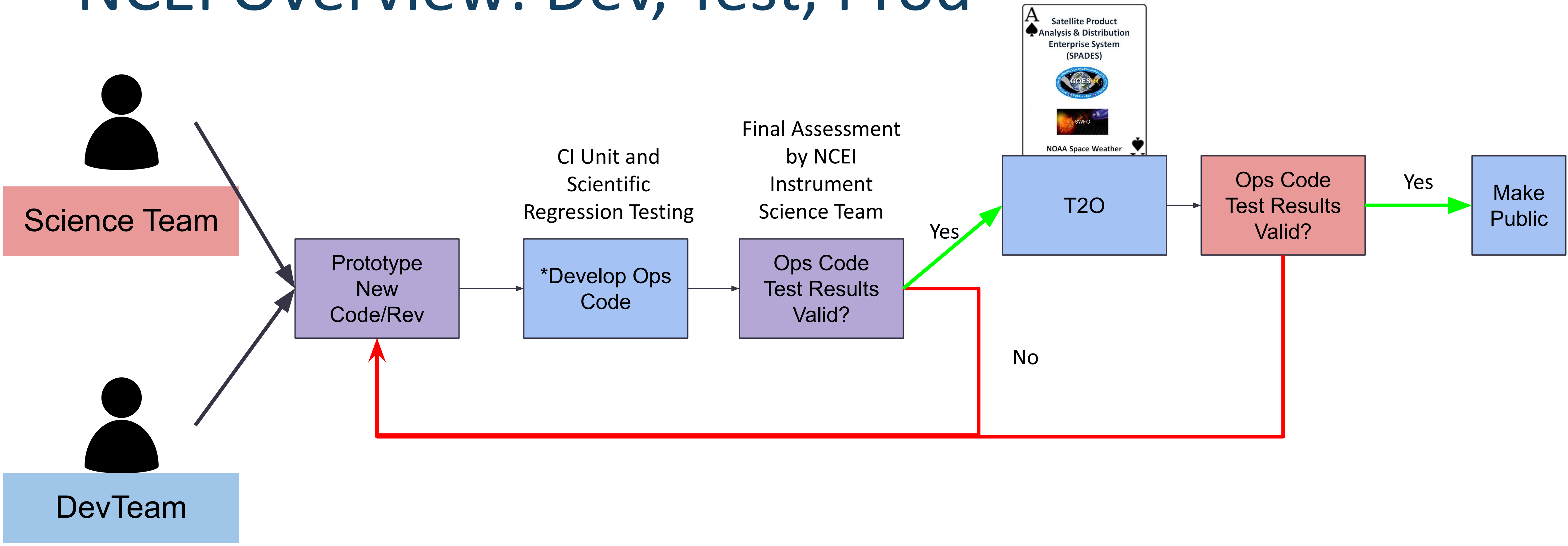
- Successfully performed processing in NCIS for all GOES-16 Space Weather Time Series data.
  - All L2+ products for the date range of January 1, 2017 through August 19, 2021.
- This took ~8 hours of wall-clock time. This can be further reduced by increasing the number of nodes available for processing.
  - Test utilized a maximum of 100 nodes.
- DSCOVR retrospective algorithms also function in SPADES framework.
- SWFO algorithms are being developed to function in the framework, so exercises like reprocessing GOES-R and DSCOVR data are the best tests we can perform for SWFO functionality.

NCEI software development

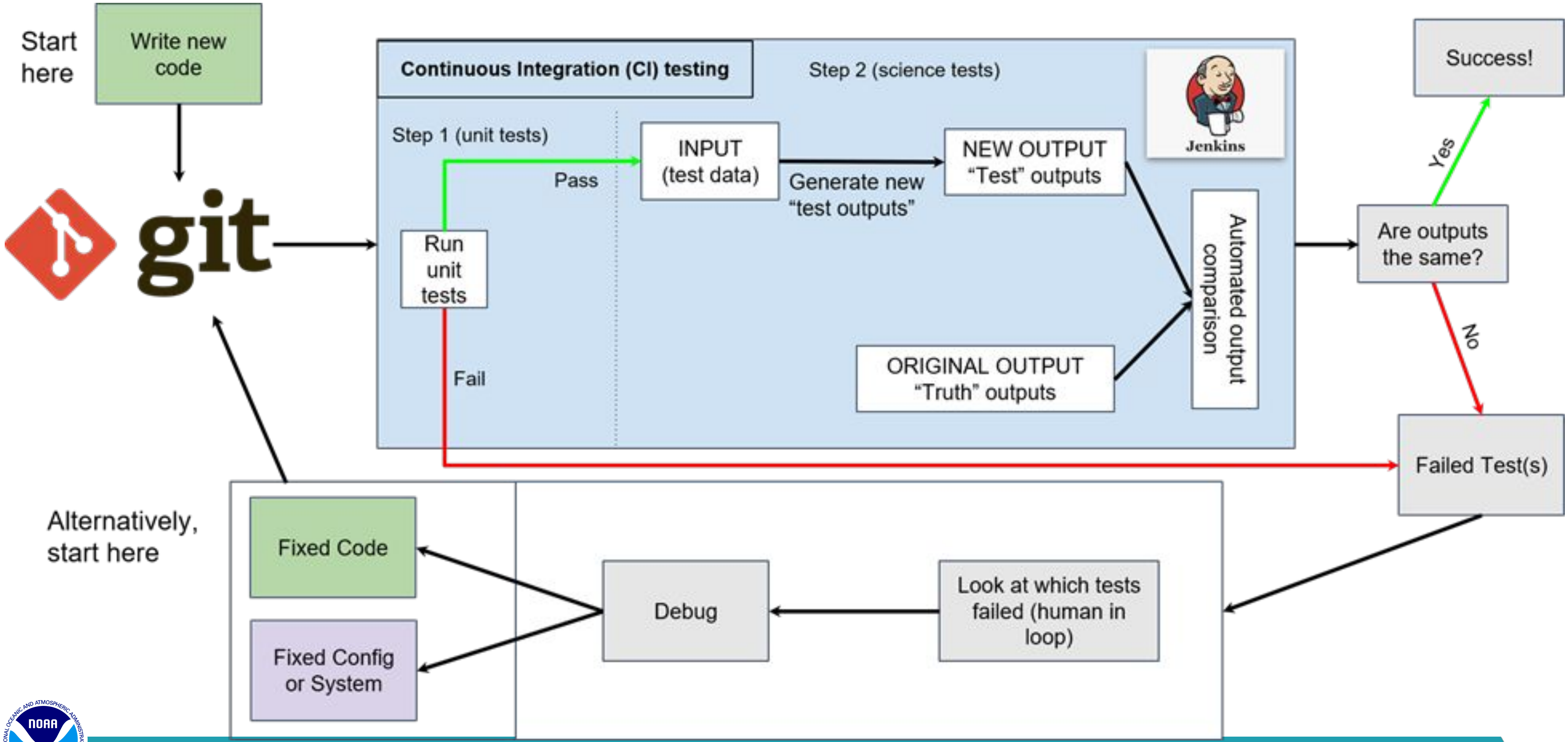
NCEI will create software to generate retrospective data in support of Cal/Val. Typically a number of issues and corrections to those issues are identified through the Cal/Val activities highlighted above. Algorithmic corrections are therefore frequently identified, prototyped, and tested as part of Cal/Val work.

The resulting algorithm changes are incorporated into NCEI's data stewardship algorithms. This permits us to efficiently leverage the Cal/Val work to provide improved retrospective data to the broader community as part of Data Stewardship activities.

NCEI Overview: Dev, Test, Prod



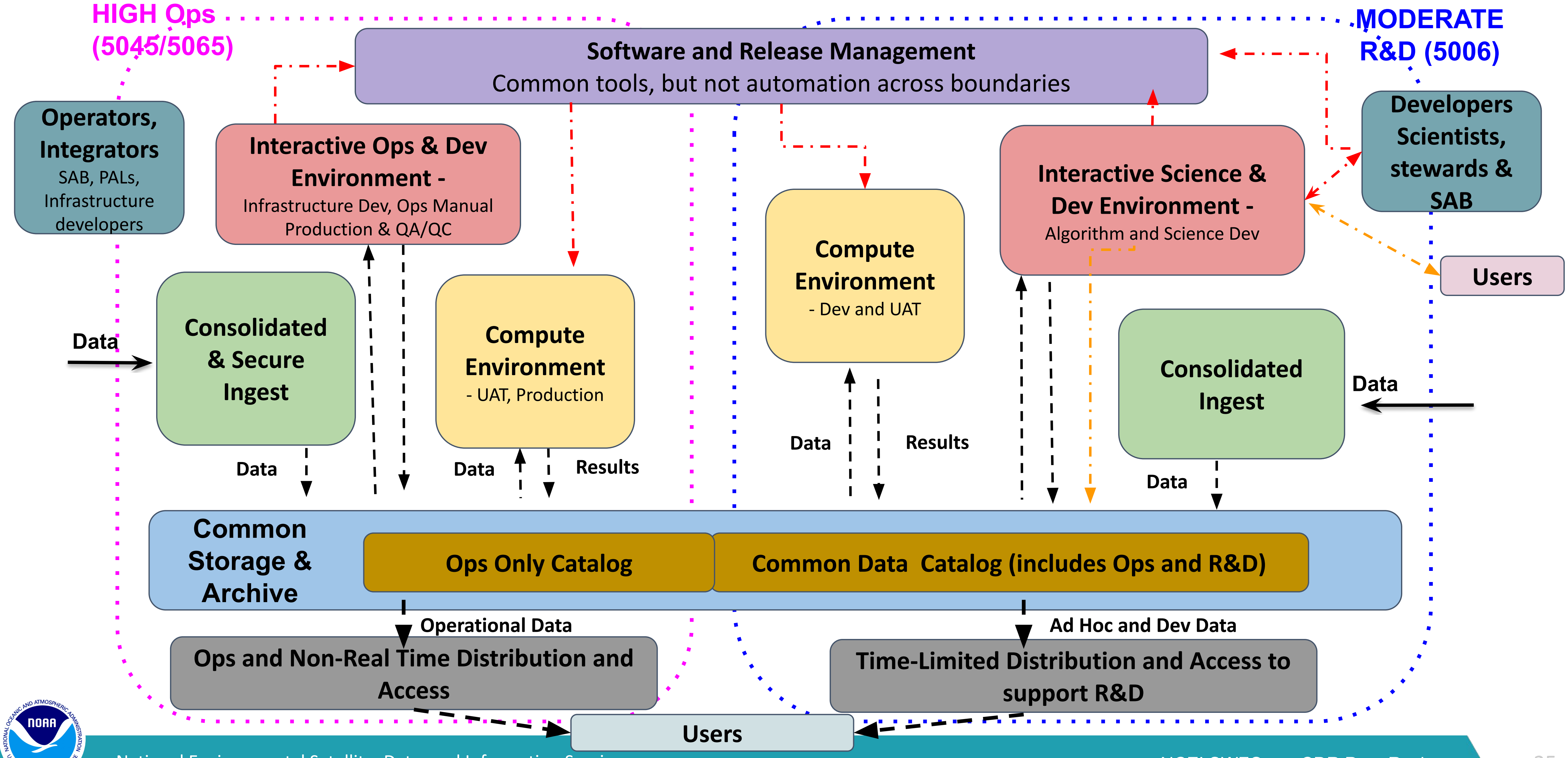
NCEI Scientific CI testing workflow



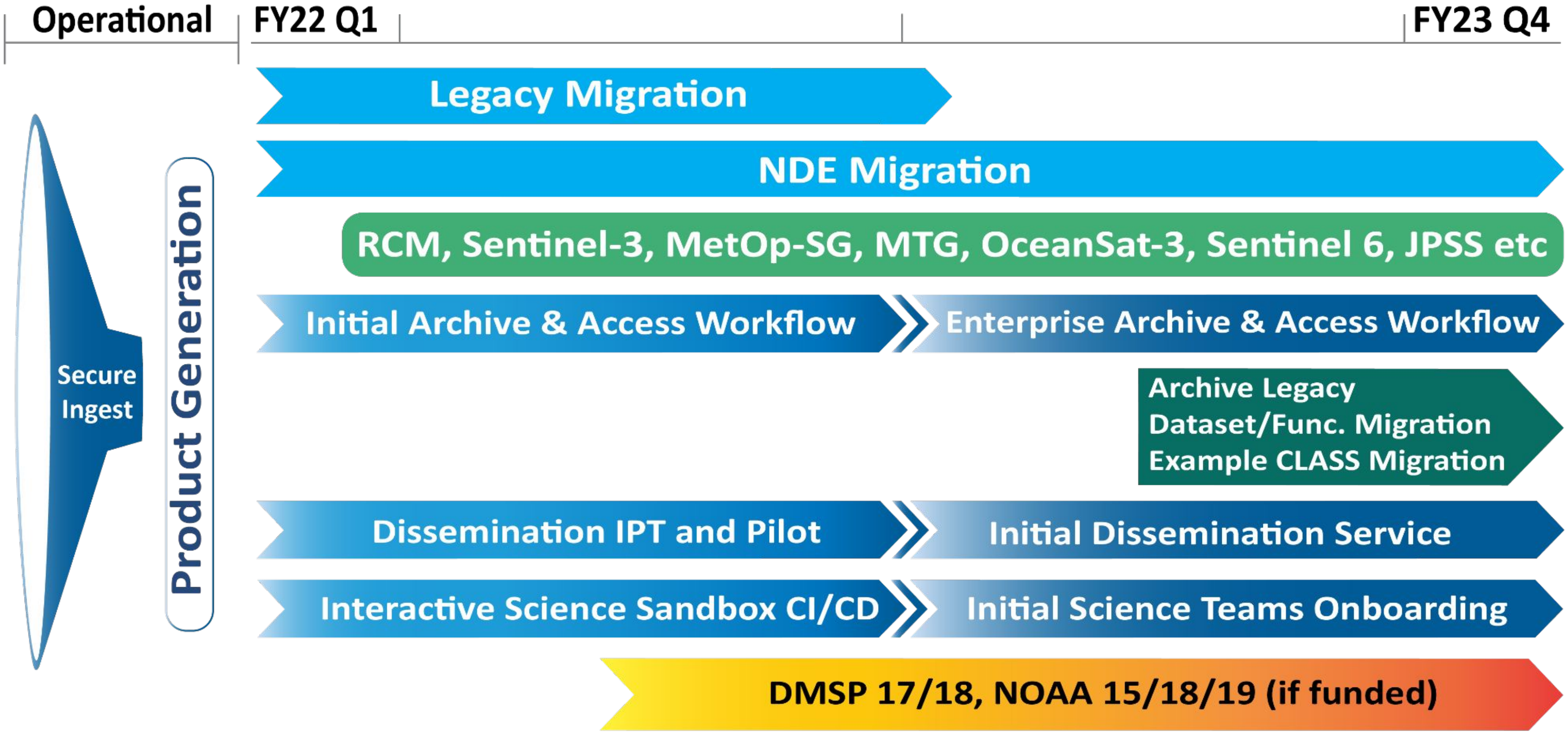
Data Stewardship

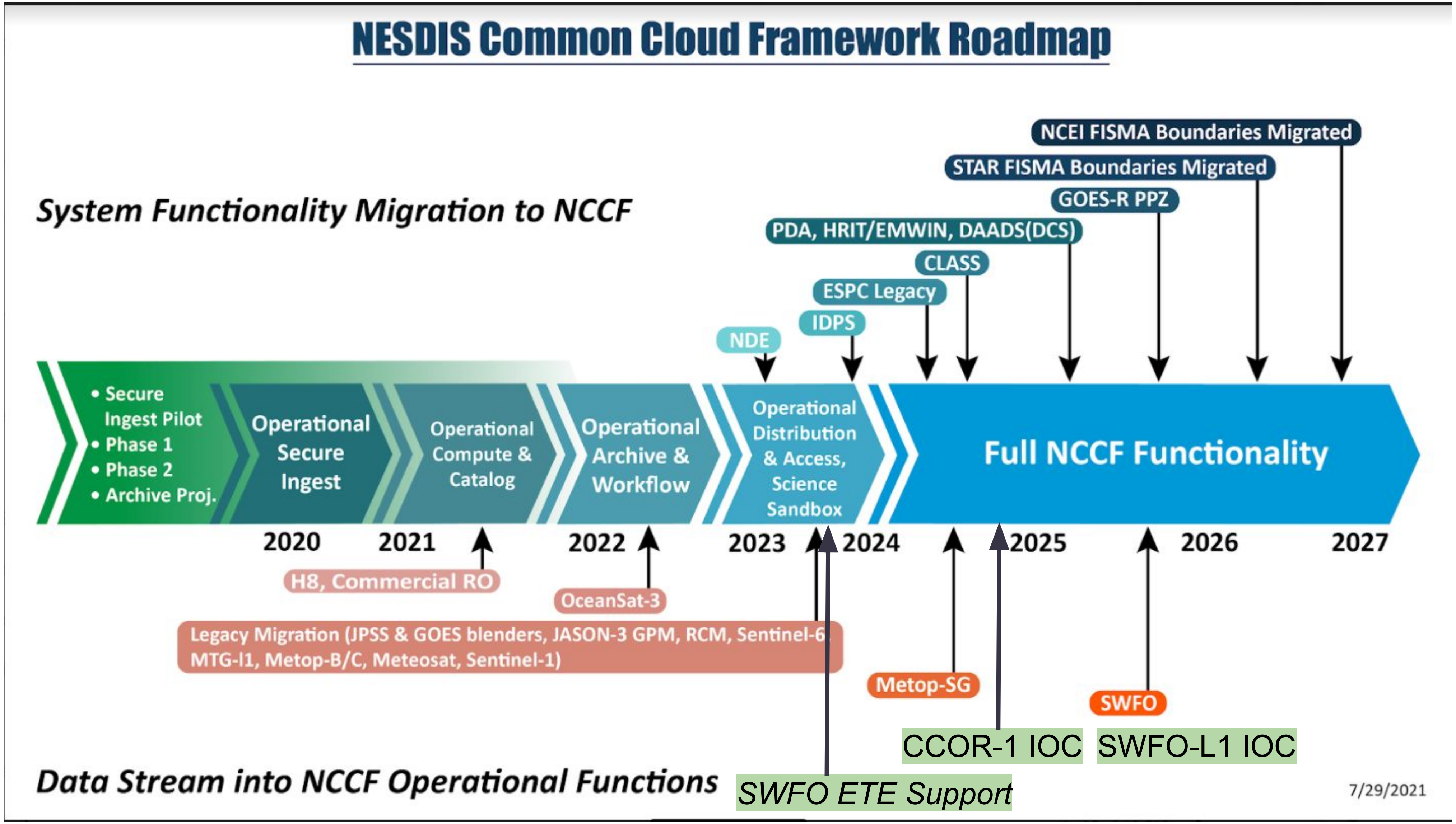
(including PD and Archive)

NCCF Architecture Vision

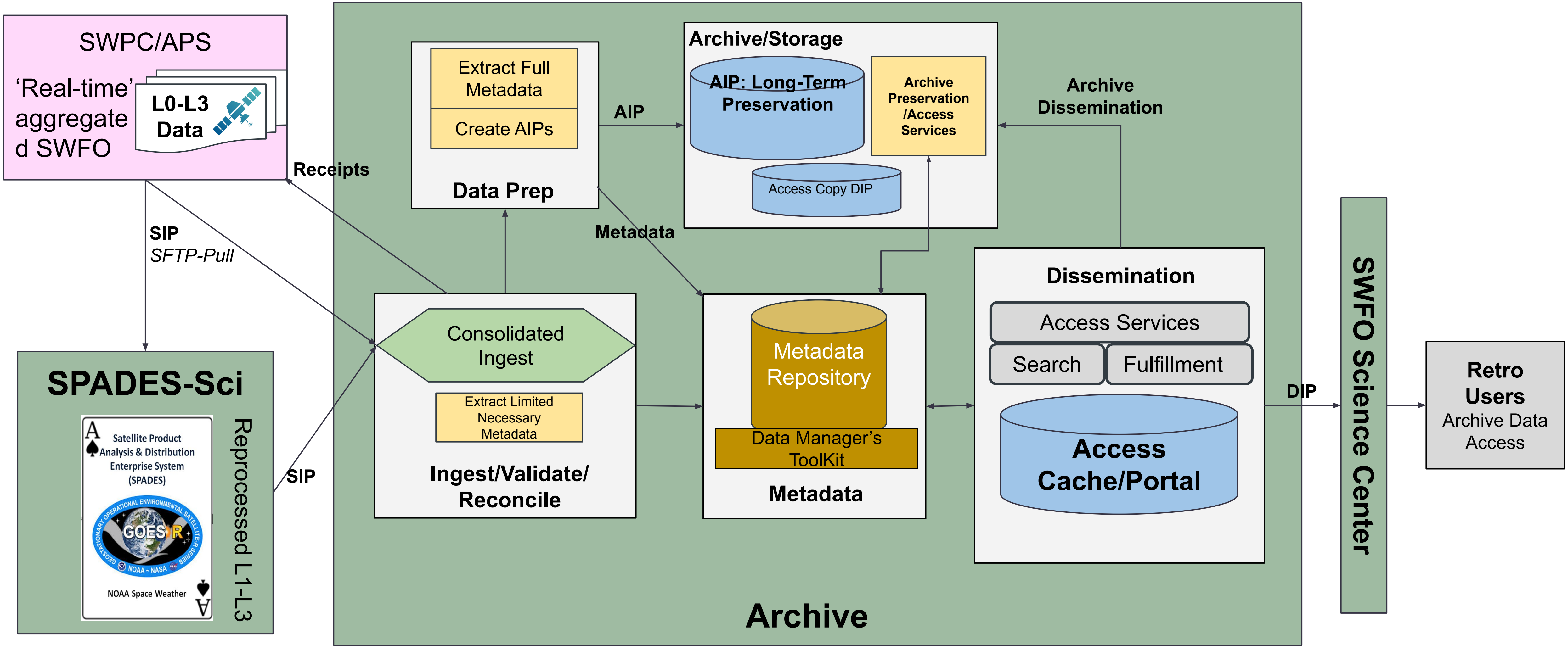


NCCF Near term Schedule




NESDIS Common Cloud Framework Roadmap
System Functionality Migration to NCCF
NCEI FISMA Boundaries Migrated
STAR FISMA Boundaries Migrated
GOES-R PPZ
PDA, HRIT/EMWIN, DAADS(DCS)
CLASS
ESPC Legacy
IDPS
NDE
• Secure Ingest Pilot
• Phase 1
• Phase 2
• Archive Proj.
Operational Secure Ingest
Operational Compute & Catalog
Operational Archive & Workflow
Operational Distribution & Access, Science Sandbox
Full NCCF Functionality
2020
2021
2022
2023
2024
2025
2026
2027
H8, Commercial RO
OceanSat-3
Legacy Migration (JPSS & GOES blenders, JASON-3 GPM, RCM, Sentinel-6 MTG-I1, Metop-B/C, Meteosat, Sentinel-1)
Metop-SG
SWFO
CCOR-1 IOC
SWFO-L1 IOC
SWFO ETE Support
Data Stream into NCCF Operational Functions
7/29/2021

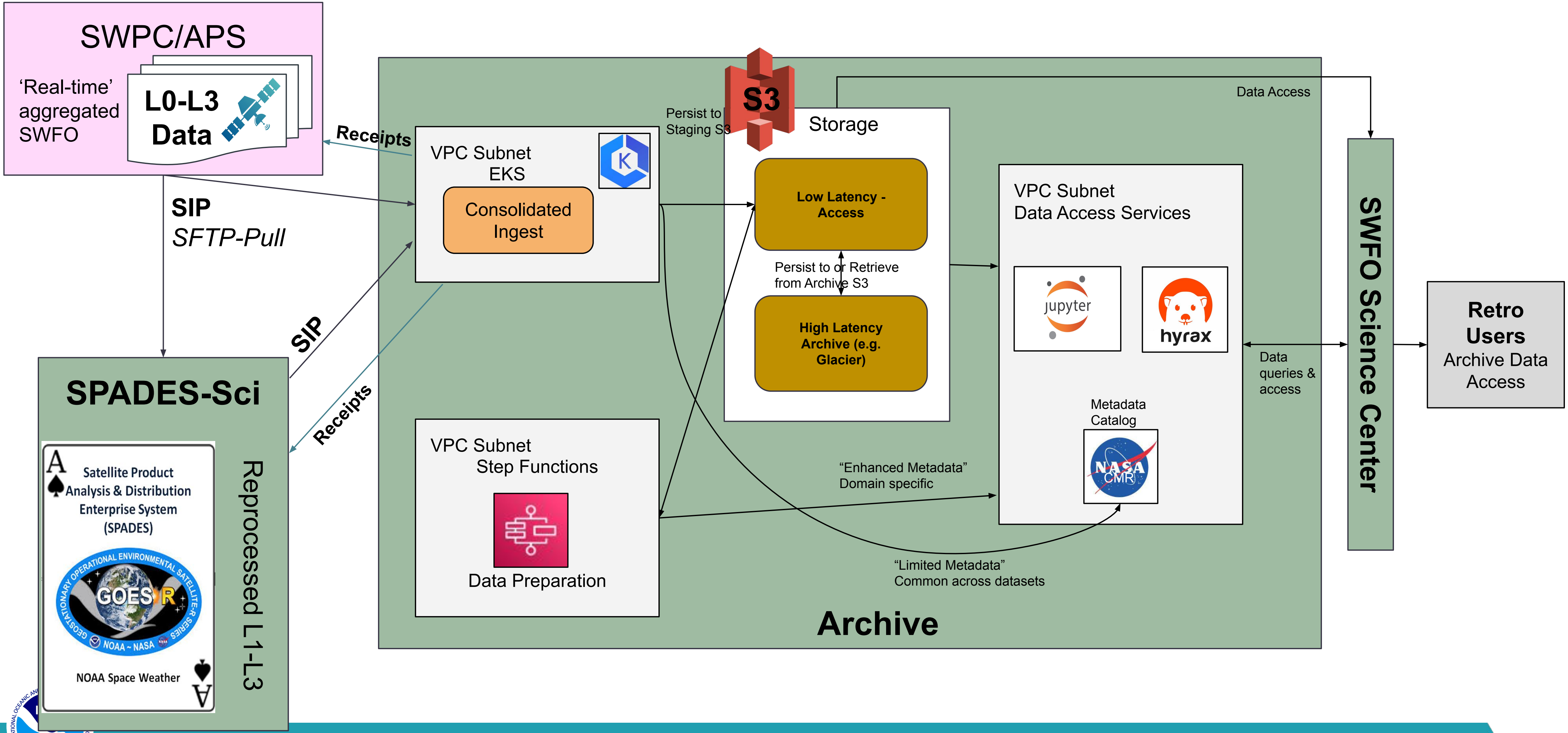
NCCF SWFO-focused Architecture



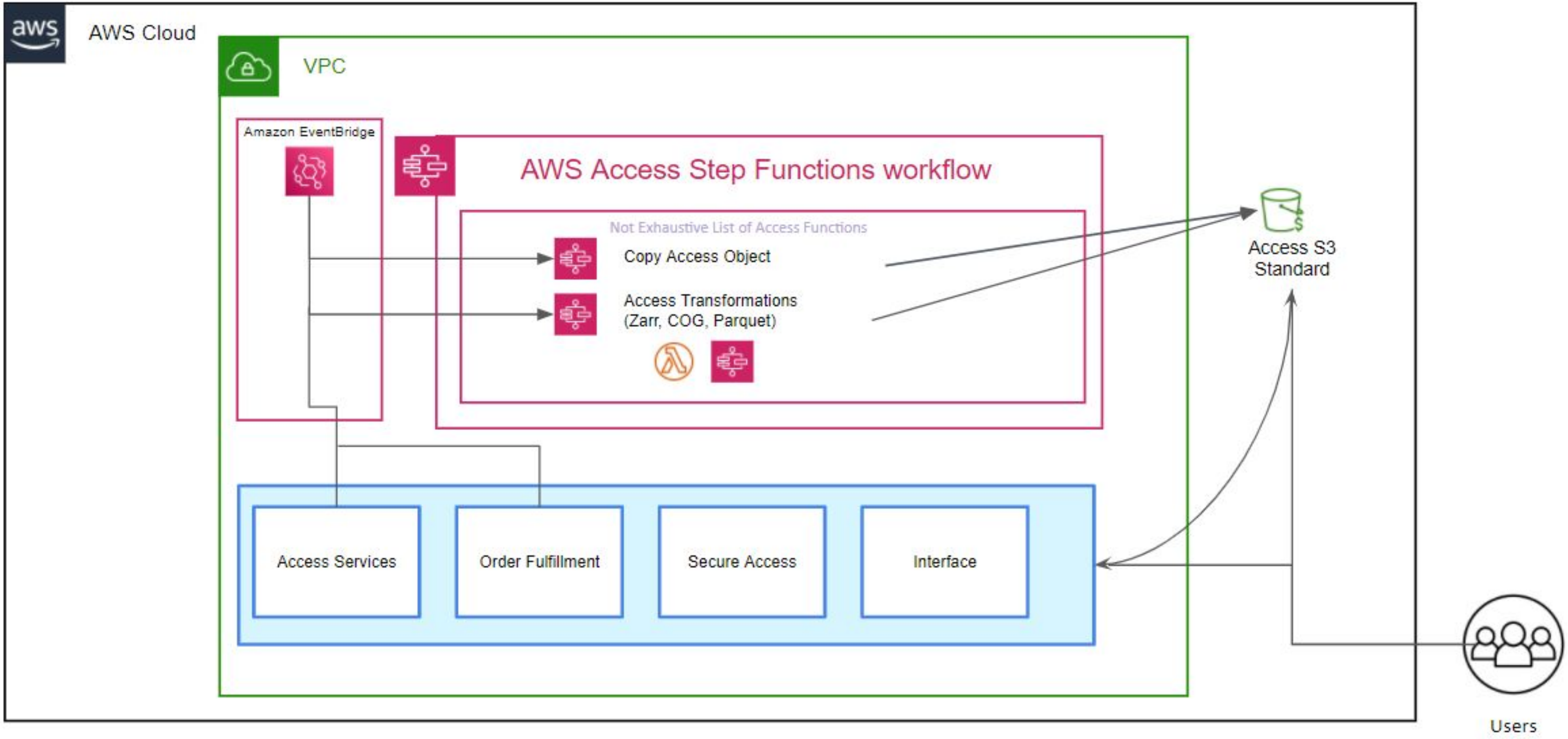
Stewardship Workflow Data Stewardship workflow is active throughout the entire lifecycle of the data archive Process.

From the OAIS Reference Model
SIP = *Submitter Information Package*
AIP = *Archival Information Package*
DIP = *Dissemination Information Package*

NCCF SWFO-Focused Technical Implementation

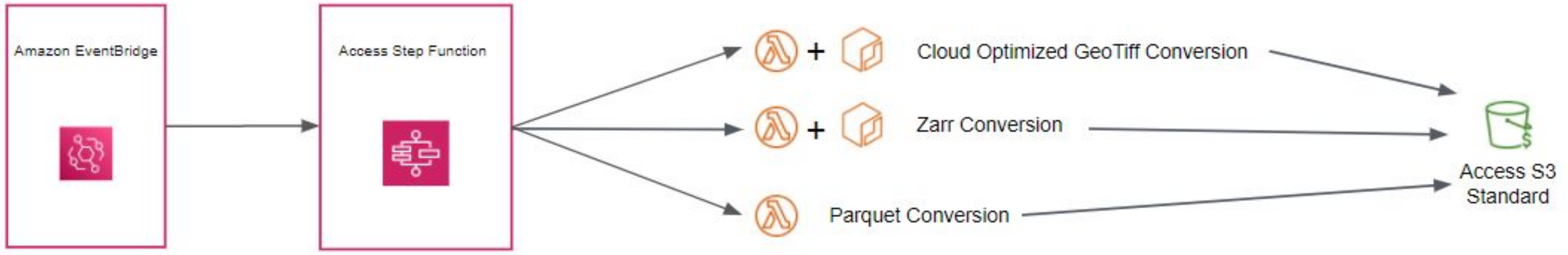


Data Access



aws
AWS Cloud
VPC
Amazon EventBridge
AWS Access Step Functions workflow
Not Exhaustive List of Access Functions
Copy Access Object
Access Transformations
(Zarr, COG, Parquet)
Access S3
Standard
Access Services
Order Fulfillment
Secure Access
Interface
Users

Data Access



Amazon EventBridge
Access Step Function
+
Cloud Optimized GeoTiff Conversion
+
Zarr Conversion
Parquet Conversion
Access S3
Standard

Highlight - Access Service

Dataset	S3	ZarrDAP	ERDDAP
Mag L1b	✅Download	✅Zarr agg, NC	✅Multiple EDDGrid aggs
XRSF L2	✅Download	✅Zarr agg	✅Single EDDGrid agg
SGPS L2	✅Download	✅Zarr agg	✅Multiple EDDGrid aggs
DSCOVR	✅Download	✅NC	❌Caching
SUVI L2	✅Download	❌FITS format	❌FITS format

As briefed for “NCAP PI-3 Sprint Demo 3”

Data Access
SWFO Science Center

- As previously discussed, Basic Access to SWFO data is TRL-9.
- Advanced Access (search, display, subsetting, etc)
  - Discussed in more detail on the next slide.
  - Data Access Branch (DAB) is beginning work to prototype the necessary advanced FITS access features this year. The access features for netCDF are already supported with existing tools.
  - Features are expected to be prototyped and tested in a production environment, e.g. TRL>6 using GOES-R FITS data, expected FY24.
  - Advanced access features are needed before 2025.

Advanced Access Features (FITS and netCDF)

- Data Searching using multiple metadata fields (e.g. time, wavelength, exposure time, etc) and ability to download a subset of the data, (i.e. one file every hour).
- Ability to download just the header/metadata instead of an entire file.
- Image, movie, and/or plot preview for search results
- Statistical tracking of number of users/amount of data downloaded/etc.
- Other features have been requested, the above features are the critical features for users.

Calibration & Validation

Product Maturity Levels*

Beta - The product is minimally validated based on product quick looks using the initial calibration parameters and may still contain significant errors. Product is made available to stakeholders to gain familiarity with data formats and parameters.

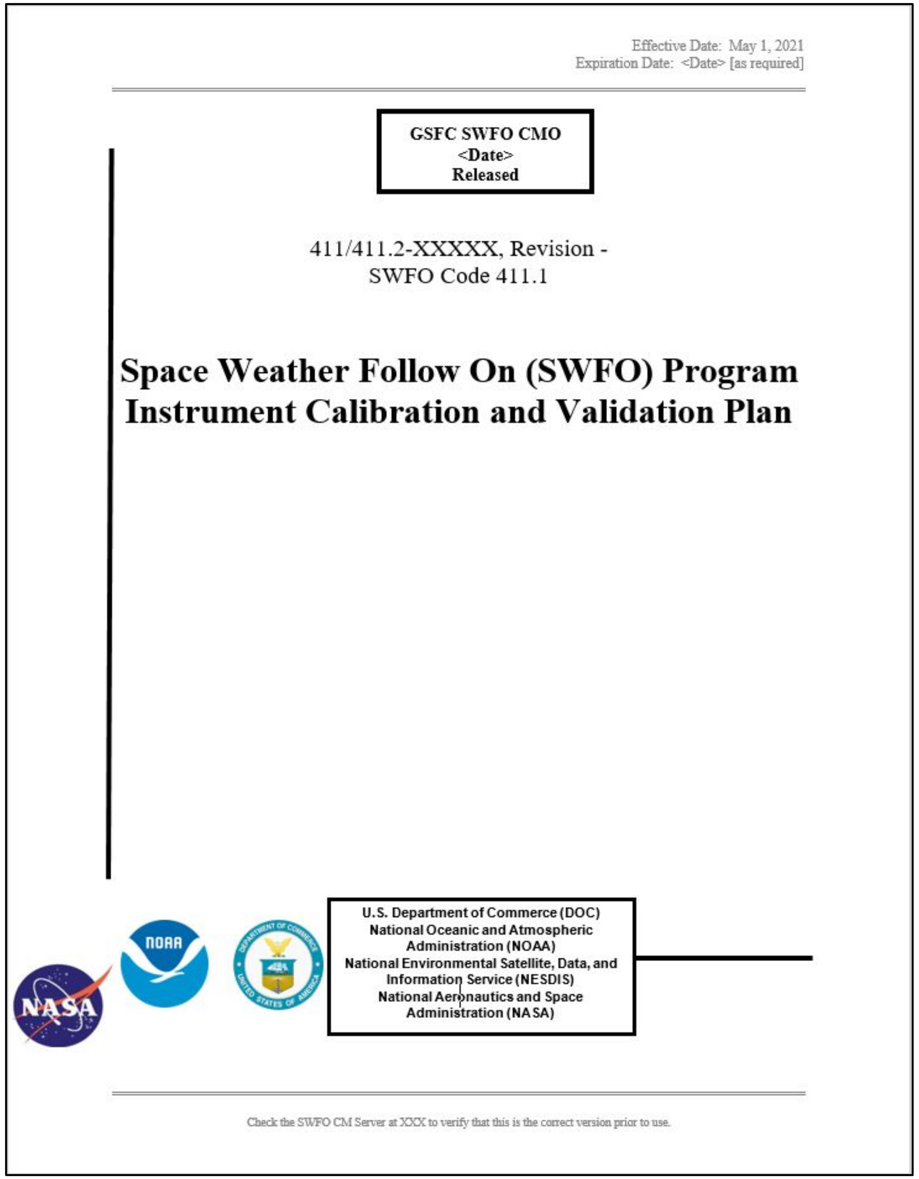
Provisional (aka IOC readiness) - Product performance has been quantified through a select number of independent measurements and periods. Validation has been documented for relevant requirements. Known issues have been communicated to operational users. Product is deemed ready for operational use. Products produced from this date forward are ready to be shared with the public, with documented caveats.

Full - Product is fully operational. Product performance has been demonstrated over a broad range of representative conditions, with comprehensive documentation of product performance, including known anomalies and their remediation. Remaining issues impacting operational product use have been documented and are accepted by operational stakeholders. Operational product performance continues to be tracked and maintained.

**Based on GOES-R heritage, with minor modifications to address lessons learned. Preliminary proposed definition, to be formally defined for SWFO.*

Instrument Calibration and Validation Plan

- Modelled on heritage from GOES-R and DSCOVR.
- Program level description of all instrument and product calibration and validation activities impacting product quality.
- Provides an overview of what is necessary, also an early way to identify potential conflicts/issues.
- Currently in preliminary draft stage and working towards CDR update.


Effective Date: May 1, 2021
Expiration Date: <Date> [as required]

GSFC SWFO CMO
<Date>
Released

411/411.2-XXXXX, Revision -
SWFO Code 411.1

Space Weather Follow On (SWFO) Program
Instrument Calibration and Validation Plan

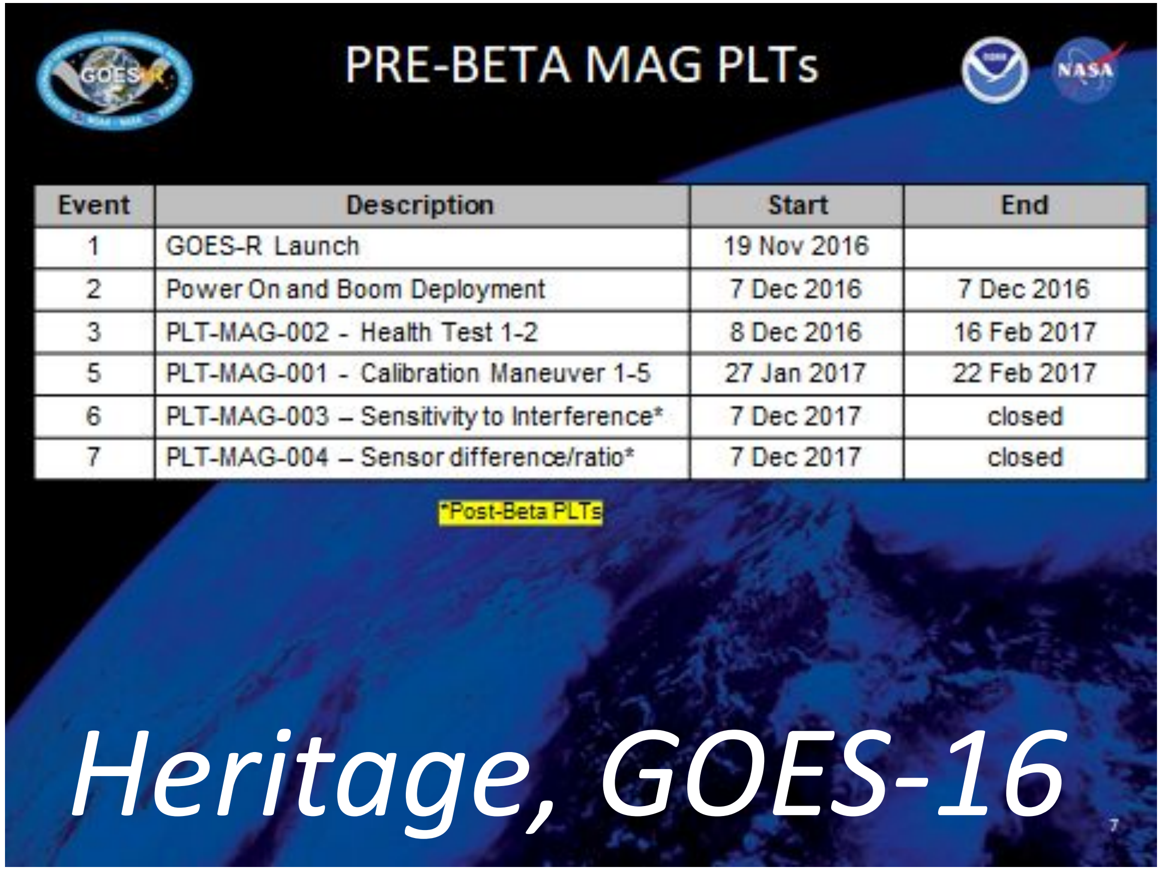
U.S. Department of Commerce (DOC)
National Oceanic and Atmospheric Administration (NOAA)
National Environmental Satellite, Data, and Information Service (NESDIS)
National Aeronautics and Space Administration (NASA)

Check the SWFO CM Server at XXX to verify that this is the correct version prior to use.

PLC definition and heritage examples

Post-Launch Commissioning (PLC) activities are short-term activities and comparisons necessary for basic engineering-level checkout of the instrument. They are typically performed prior to the instrument reaching Beta level maturity. They can permit identification of coarse product issues.

Instrument vendors will lead these activities. Any exceptions to this will be determined on a case by case basis.


PRE-BETA MAG PLTs

Event	Description	Start	End
1	GOES-R Launch	19 Nov 2016	
2	Power On and Boom Deployment	7 Dec 2016	7 Dec 2016
3	PLT-MAG-002 - Health Test 1-2	8 Dec 2016	16 Feb 2017
5	PLT-MAG-001 - Calibration Maneuver 1-5	27 Jan 2017	22 Feb 2017
6	PLT-MAG-003 – Sensitivity to Interference*	7 Dec 2017	closed
7	PLT-MAG-004 – Sensor difference/ratio*	7 Dec 2017	closed

*Post-Beta PLTs

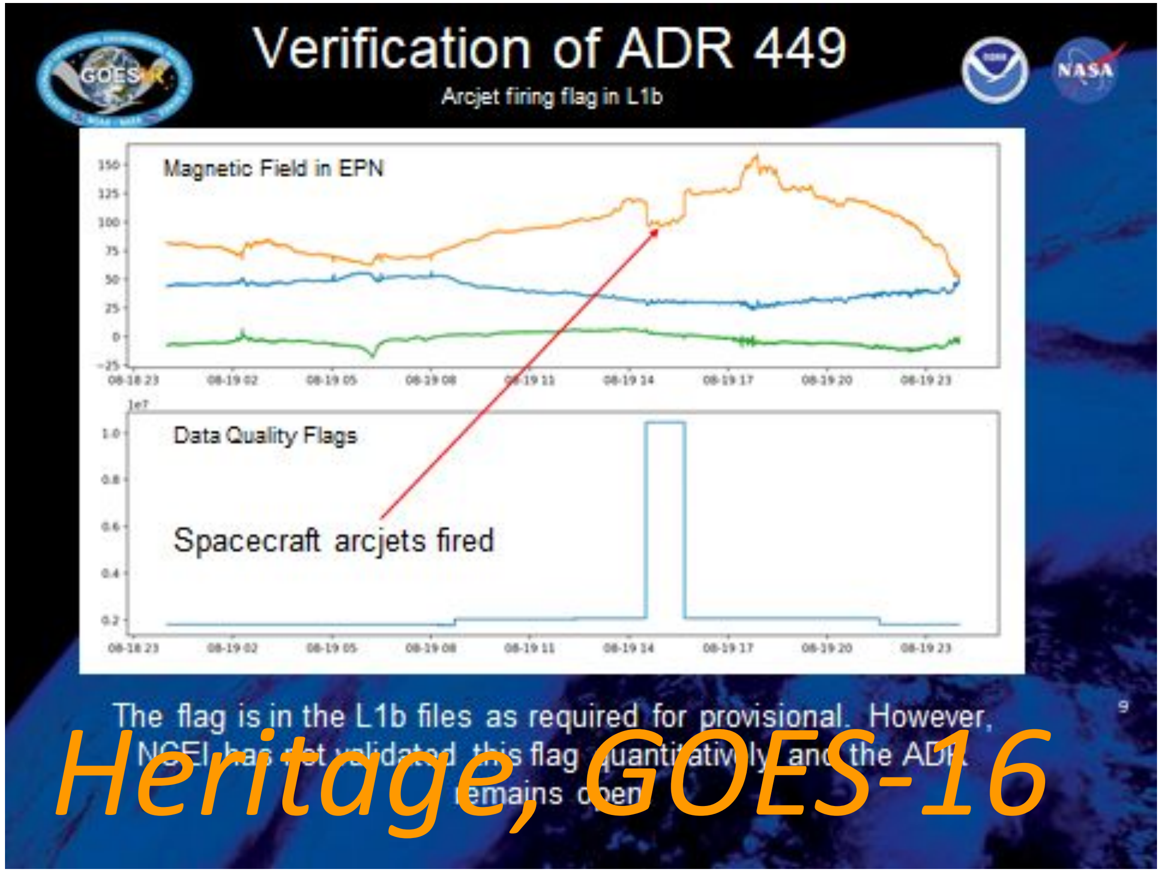
Heritage, GOES-16

From G16 MAG Provisional, as briefed by P. Loto'aniu, 2018

PLPT Example (G16 MAG, Provisional)

Post-Launch Product Tests (PLPT) are intended to thoroughly characterize product performance. These frequently involve extended on-orbit comparisons between various satellites or models. Several of these exercises typically must be completed as part of the assessments leading up to a product reaching Provisional maturity (IOC readiness).

NCEI performs and/or coordinates this type of detailed comparisons.



From G16 MAG Provisional, as briefed by P. Loto'aniu, 2018

SWFO-L1 PLC/PLPT Considerations

From SWFO CONOPS draft:

- Planned IOC is at or before 180 days.
- Cruise phase will last until approximately day 115.
- This leaves an estimated 65 days on station before IOC.
- MAG requires multiple calibration maneuvers during cruise and on station.
- "During the Cruise, Observatory attitude with respect to the sun will have to be continuously adjusted to account for instrument pointing constraints and X-band antenna orientation for data downlink." As a result, instruments will not in general be taking data continuously in cruise phase.
  - The effects of the reduced data collection restriction is being actively worked through instrument specific conversations with MOST/Vendors/CWG. An initial PLC/PLPT timeline has been produced, modifications and changes are expected.

CCOR

CCOR-2 PLC/PLPT Timeline

- CCOR-1 Vendor PLT Plan* delivered Sep 2021.
- MOST incorporate CCOR-1 PLT schedule into SWFO-L1 commissioning timeline. Modifications from CCOR-1 timeline are still forthcoming.
    - Off-pointing maneuvers, irregular telemetry, pointing stability, thermal stability
    - Detector effects can be calibrated in cruise if temps are consistent with station
    - Background/stray light calibration likely has to occur at station due to FOV/pointing/etc
- SWFO-L1 launch is 10 months after GOES-U. CCOR-1 (GOES-U) will be commissioned immediately before CCOR-2 (SWFO-L1). CCOR-2 test data will not start being transmitted for several weeks after launch.

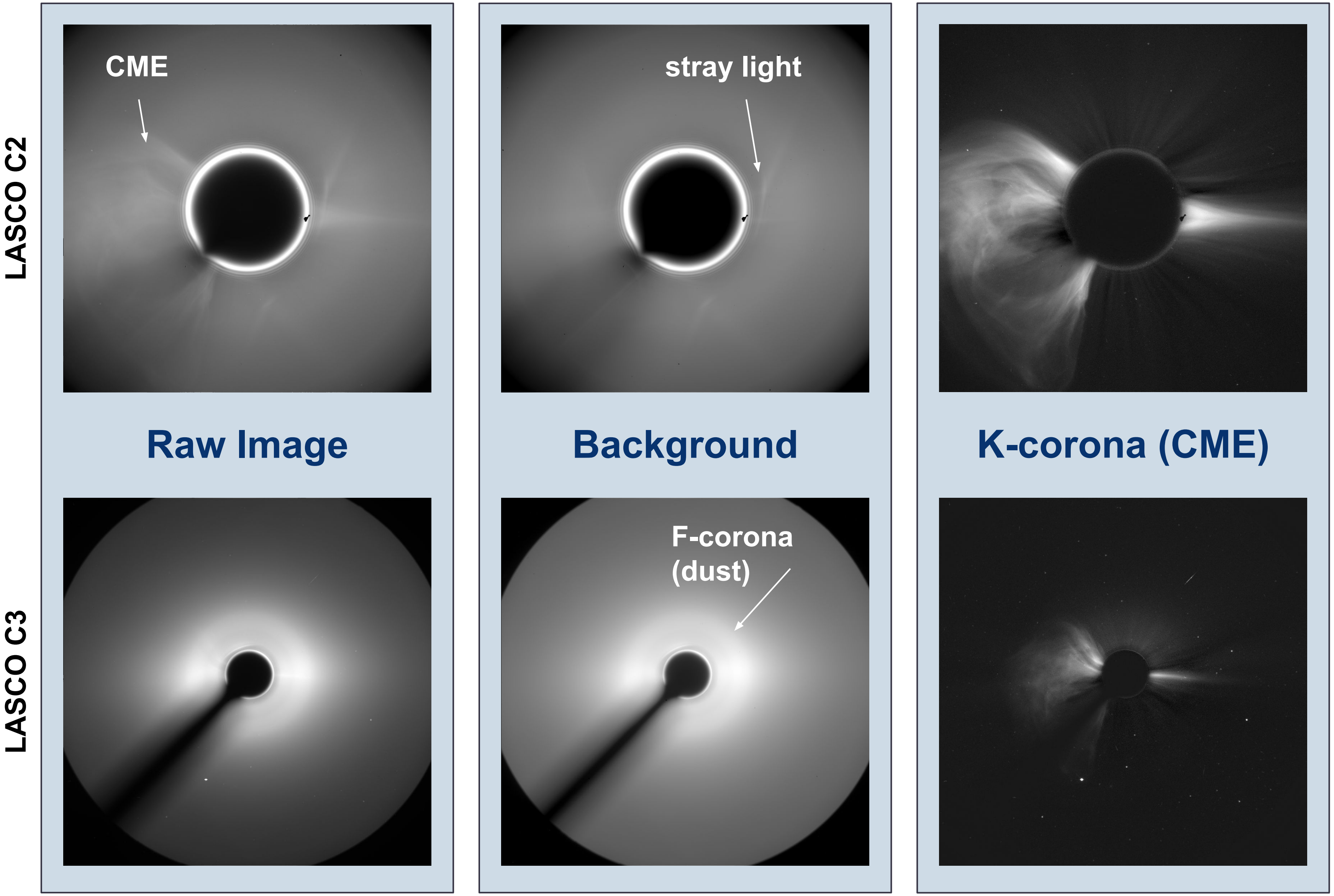
* see backup slides

CCOR PLC/PLPT Activities

SSD-PLN-CC037 Rev D2
modified from SSD-PLN-CC023 Rev -

Test	Description	Heritage
LED tests for detector performance	Periodic tests with LED on and door closed to generate **photon transfer curves** and determine pixel to pixel variations in **gain** (quantum efficiency), **offset**, **dynamic range** and **read noise**.	High: Camera detector, software, and electronics have heritage from Parker Solar Probe WISPR. (DOI)
APS Internal Performance Test	Special APS operating modes enable **characterization of the detector**. Opaque pixels allow direct measurement of dark current and column offset as well as read noise for those pixels. Sequencing of the source follower, reset and MIM driver transistor without activating TG allow measurement of offset and read noise of the pixels under various operating conditions.	
Spacecraft Off-Pointing Tests	Offpoints up to a solar radius in the four cardinal directions are used to determine the signal contribution due to **stray light**.	High: Calibration techniques and software have heritage from STEREO COR and SOHO LASCO (DOI)
Spacecraft Roll Tests	Rolling the spacecraft to 90, 180 and 270 degrees (5-10 min dwell each) about the solar vector enables the instrument **stray light** pattern to be determined.	
Synoptic Observations - Star Calibration	Star brightness can be compared to throughput calculations to refine **photometric calibration**. Stars will be used to adjust telescope **point source function** calibrations. Tracking a star along through the FOV will track **large scale responsivity** and **vignetting** variations within the instrument. Comparison of predicted and actual star positions allow **absolute pointing** and **optical image distortion** to be characterized.	

PLPT Example: background signal (CCOR)



The background (stray light + F-corona) is ~10-100x brighter than this CME.

Background subtraction is needed to isolate solar structures. PLPT tests will determine optimum settings for background calculations, and isolating coronal vs stray light background components, which is especially important for CCOR-1.

Earthshine in CCOR-1

- Background = F-corona + Stray Light.
- For SWFO-L1 the Background changes much more slowly (order of days) than the image cadence (15 min). SWPC tools use running difference images to find CMEs. Therefore for CCOR-2, a detector calibrated L1a image will satisfy KPP needs.
- Earthshine is a time dependent component of the Stray Light for CCOR-1.
  - Could have large effect on difference images when the Earth is in the FOV. L1a would satisfy CCOR-1 KPP when the Earth is not in the FOV.
  - L1b data would be needed when Earthshine changes rapidly and dominates the Background.
- NRL built and calibrated several low-Earth orbit coronagraphs (OSO-7 and Solwind) in the 1980’s, so they have heritage with Earthshine calculations, but has not been part of modern coronagraph calibration.
- NRL is conducting an optical analysis
- Discussions are ongoing with NRL on how to model/remove the time-dependent Background component in CCOR-1.

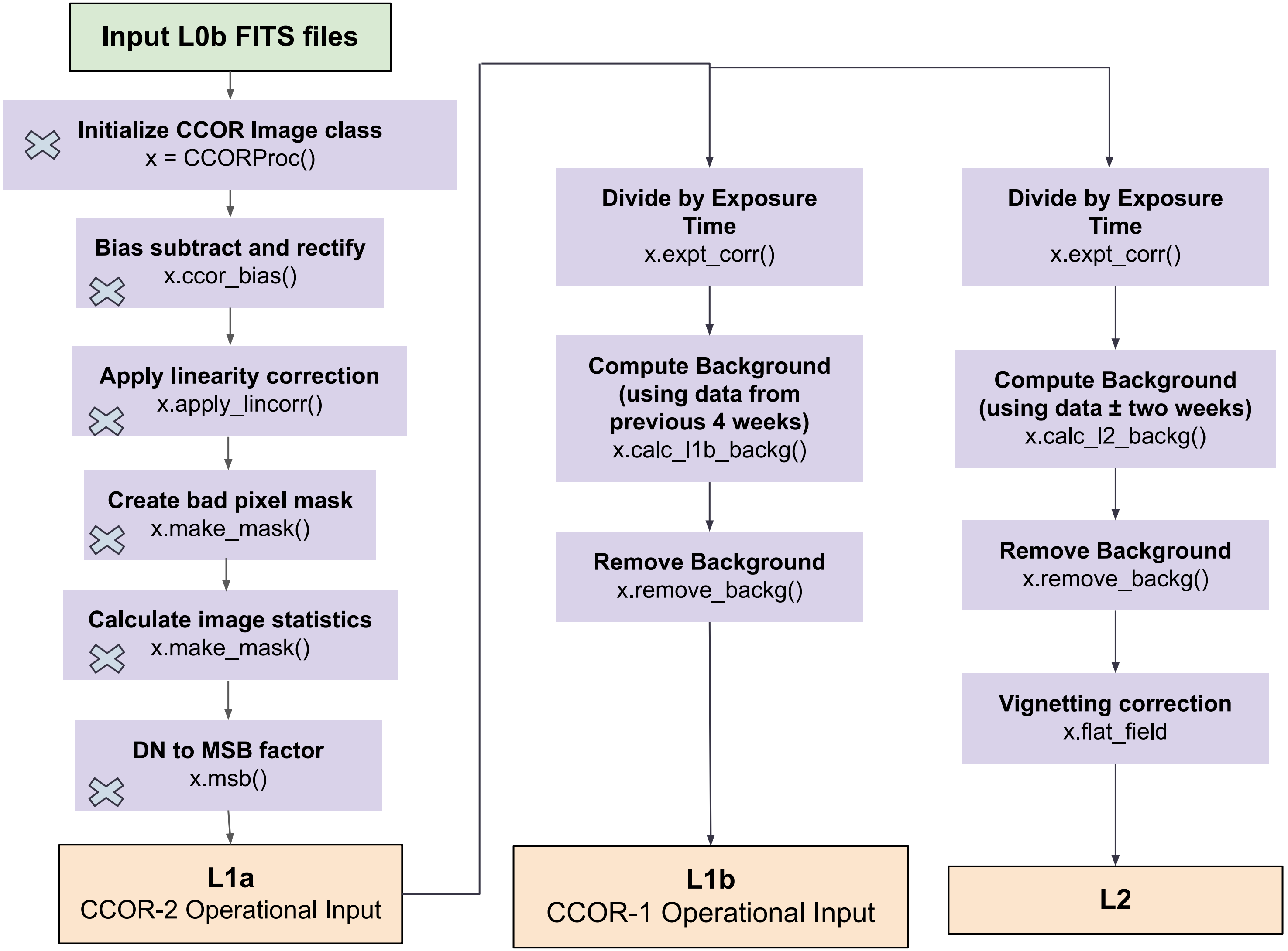
CCOR data levels (reference)

L0	L0b	L1a	L1b (ops)	L2	L3
CCSDS frames	Unpacked CCSDS frames with images rectified so solar north is 'up'	From L0b, image in DN, bias and defects removed, full resolution	From L1a, stray and scattered light removed. CCOR-1 only.	From L1a, full calibration with F-corona and stray light removed. In B_{sun} units.	From L1a, L1b, or L2. Spatially binned, rotated so solar north is in up.

NCEI Cal Code V0.5 delivery

CCOR L0b->L1a Retrospective Pipeline

- Based on NRL's IDL code
  - NCEI code in Python
  - Works within the SPADES architecture
  - Single pipeline for CCOR-1/2, controlled by SPADES config files.
  - Close collaboration with SWPC.
- Deliverable:
  - Prototype L0b->L1a code in the VLab repository (Sep 2022)
  - Prototype L1a->L1b and revisions to L1a (due May 2022)
  - Subroutines, order of operations, and required calibration data are identified. Not all methods will be fully populated.



=already in Retrospective VLab

Preliminary NCEI Pipeline Design (Python Class + Methods)

CCOR Retrospective Pipeline: Progress

- Architecture adapted from SUVI L0b→L1a reprocessing, leveraging the SPADES API
  - Delivered version will be closer to a direct and rough translation of NRL's IDL pipeline with identification of areas to be optimized for SPADES & Python.
- Difference from Operational Algorithm
  - Retrospective background subtraction will use ~1 month of data centered on the image date.
  - Operational pipeline uses ~1 month of data which ends on the image date.
- Challenges and further work
  - Identified and communicated underdeveloped areas of vendor IDL pipeline.
  - Cadence and method of background frame calculations for L2 products.
  - CCOR-1 stray light correction will likely need to be adjusted on-orbit.
- No risks are present

Calibration and Validation Tools

- CCOR CalVal tools include standard imager quantities (detector temperature, bias, gain, dead pixels) and include a substantial number of coronagraph-specific techniques and parameters
  - Stars are used to verify pointing knowledge, photometry, optical distortion
  - Vendor draws from a deep arsenal of heritage tool development
- CalVal tools are used for processing commissioning era data: updating straylight model using rolled and off-pointing data
- Allows separation of instrumental stray light from the F-corona
- Identified 16 software tools/algorithms (supported by vendor)
  - PlotTemp, PlotStars, GetStars, GetAttitudeFromStars, CheckDistortion, GetSunPosition, LEDImageAnalysis, PTC, OptimalBias, ComputeExptime, SeparateDiffractedSL, AnalyzeRoll, AnalyzeOffPoint, GetEarthMoonPosition, PlotSCPosition, ComputeFCorona

MAG

MAG PLC Activities

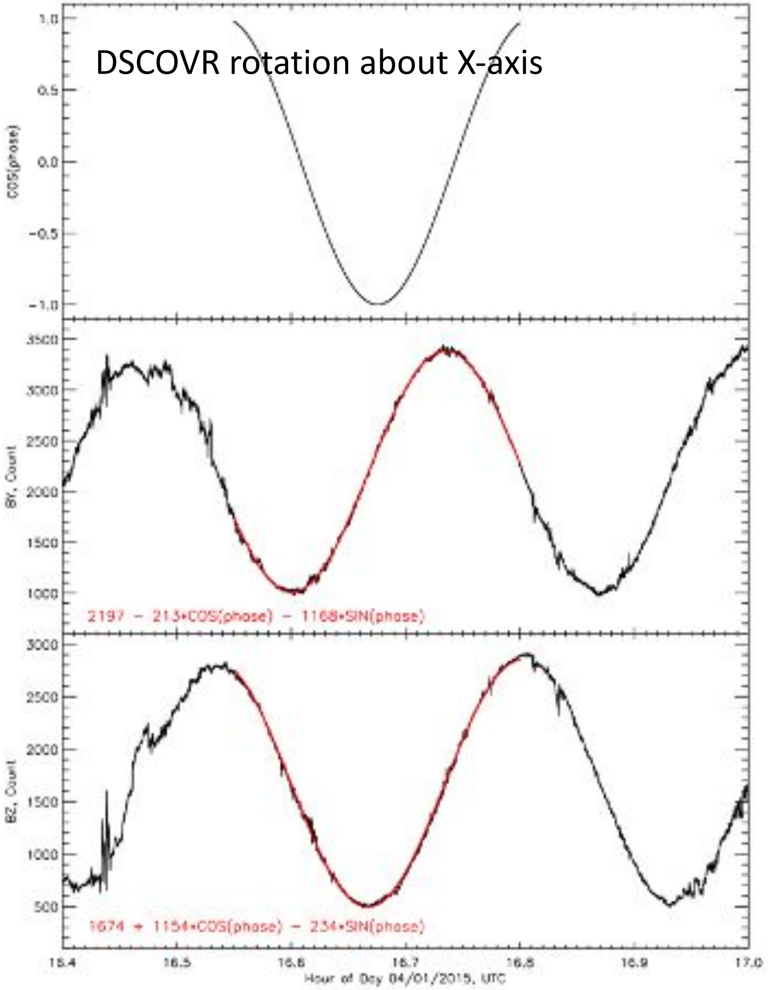
PLC Activity	Description	Estimated Data/Analysis Duration
In-flight Calibration	Determine DC offsets	2 weeks (after each calibration maneuver)
Inter-Sensor Difference Comparison	Determine S/C DC field, relative bias	2 weeks
Inter-Sensor Ratio Comparison	Validate relative instrument gains	2 weeks
MAG Sensitivity to Interference	Quantify magnetic field changes for all three axes of each magnetometer due to satellite time-varying and constant fields	Passive Test performed over duration of Observatory Activation; Analysis will take 2 months.
In-situ Noise Floor	Validate performance parameters (noise floor, relative phase, relative amplitude as a function of frequency)	1 month – need calibrated data (attempt)
Phase test	Detect potential changes in the sensor	5 days after test (thermal stability; 10 minutes/axis; pass/fail result – no actionable information)
Comprehensive/Limited -Performance	System checkout and verification on power-up	5 Days after turn-on

MAG PLPT Activities

PLPT Activity	Description	Estimated Data/Analysis Duration
Product level Inter-Sensor Comparisons	Validate that inboard and outboard data products are consistent with each other. Helps with relative accuracy.	2 weeks
Product level Noise	Determine product noise level	2 weeks
Product level Inter-Satellite Comparison	Determine product relative accuracy	6 weeks

MAG PLC Example (In-flight cal.)

Method 1. Spacecraft rotations

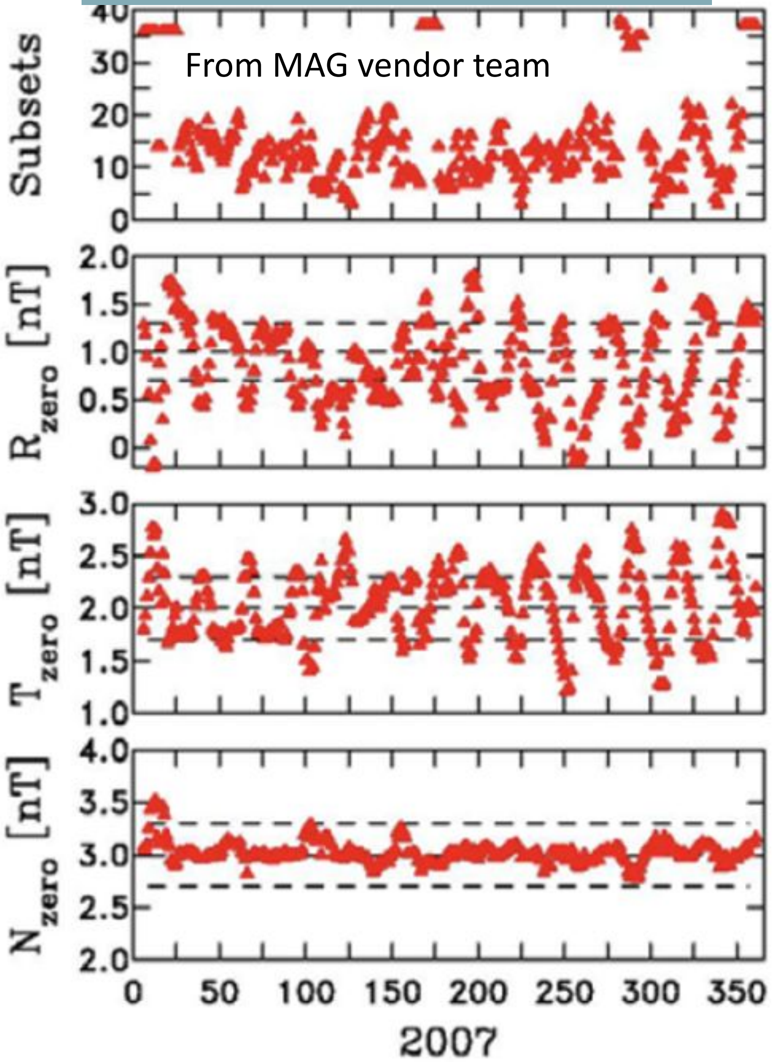


Using both occasional spacecraft rolls and the Alfvenicity techniques together yields the best solution (with an accuracy below 0.1 nT) [From A. Szabo on DSCOVR experience].

Recommendation is to follow similar calibration plan to DSCOVR of semi-regular monthly spacecraft rotations combined with Alfvenic method.

We are working on PLC schedules for maneuvers with program.

Method 2. Alfven waves



MAG prototype code

- Vendor provided update to CDRL 64 on 11/15/2021
- Vendor upload L1b and L2 code to NOAA Git (Vlabs).
- NCEI to use these vendor code for developing prototypes.
- Where possible, NCEI will leverage their DSCOVR and GOES-R Magnetometer codes.
  - NCEI developing SWFO MAG calibration maneuver codes based on GOES-R codes and will be testing codes using DSCOVR data
- Architecture
  - Leveraging SPADES API in development.
- Challenges
  - Waiting on in-flight Alfvenic method calibration code from vendor.
  - Currently coordinating with vendor, MOST and SWFO Program concerning MAG in-flight calibration maneuver profile or schedule.

Identified MAG Tools

G/R Item #	Category / Req	Item	Giver	Receiver	Due Date	Notes
1	Software	Modified Davis-Smith method code and documentation to manually extract MAG offsets	UNH	NCEI	end of 2022	
2	Software	Algorithms to convert housekeeping data to engineering/science units for display	UNH	NCEI	2023	

STIS

STIS PLC/PLPT Activities

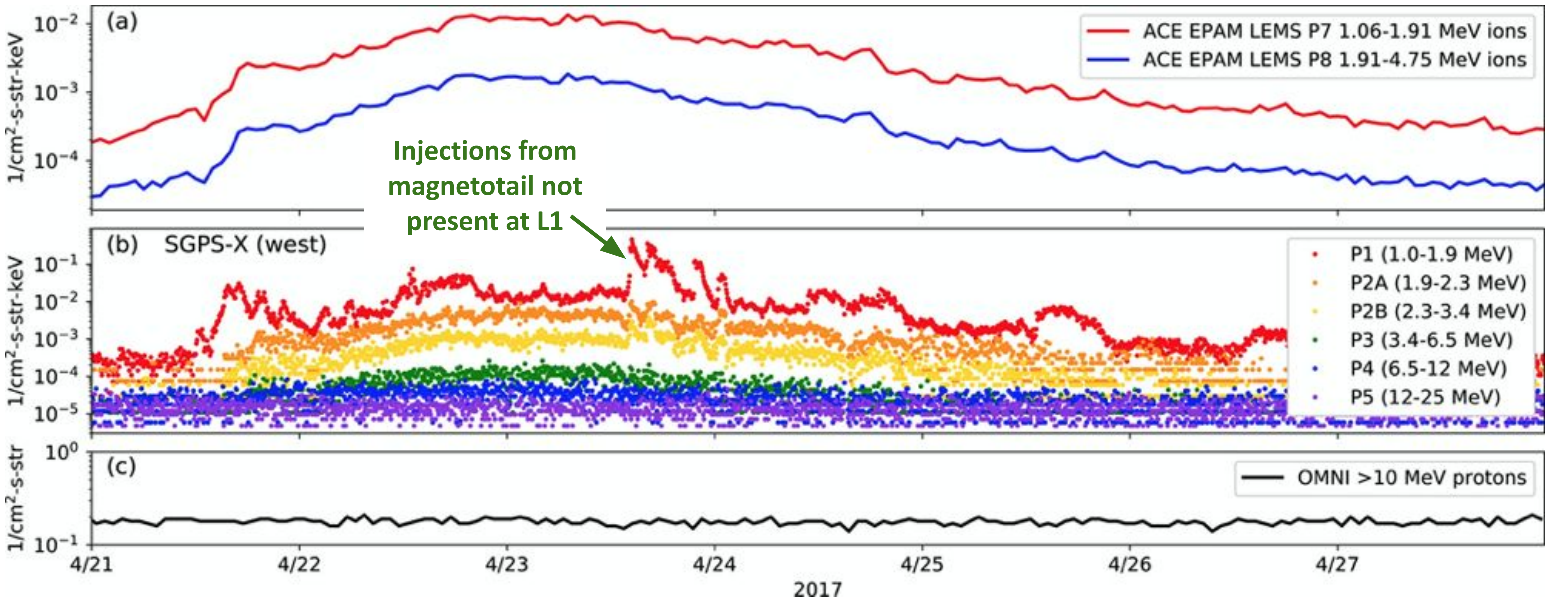
Activity	Description	Dependencies	Estimated Data Duration
STIS-PLC-001: Initial Turn-on of Detector Bias Voltages	Perform initial turn-on of electron and ion voltages and optimize bias levels on solid state telescopes	Instrument powered on	TBD
STIS-PLC-002: Initial In Flight Calibration (IFC)	Command initial IFC and verify IFC commands, IFC table, IFC table upload and IFC update commands	PLC-001 completed	TBD
STIS-PLC-003: Initial IFC Verification and Analysis	Verify that STIS electronics are functioning properly and begin the on-orbit IFC trend process; Upload new IFC table if initial IFC results indicate it is needed	PLC-002 completed	TBD
STIS-PLC-004: On-orbit Calibration	Begin checkout of fluxes at high energies, beyond those available in ground calibrations, via comparison to THEMIS and ACE		TBD
STIS-PLC-005: On-orbit Calibration Optimization	Adjust low energy noise threshold on each detector to be above the noise floor		TBD
PLPT-001: Backgrounds Trending	Characterize backgrounds and determine sources of backgrounds	PLCs 001-005	Several Months
PLPT-002: Evaluation of Out-of-band Contamination	Look for evidence of OOB contamination in measurements and compare with known/likely sources. Quantify contribution from OOB contamination.	PLCs 001-005	Solar Particle Event (electrons and protons)
PLPT-001: Cross Instrument Comparisons	Comparisons with measurements from similar instruments on other spacecraft (e.g. ACE/EPAM)	PLCs 001-005	Solar Particle Event (electrons and protons)

PLCs are as listed in CDR-maturity STIS CDRL 064 (Calibration Program Plan, 25 Oct 2021). No substantial updates relative to prior plan.

STIS PLPT Example: Cross-Instrument Comparison

- Goal is to quantify differences with similar measurements from other spacecraft (e.g. ACE)
- Important for establishing continuity with legacy NOAA instruments/measurements
- May indicate violation of accuracy requirements, but does not necessarily verify accuracy requirements are met
- Complicated by differing energy-angle coverage and spacecraft locations – Perform apples-to-apples comparisons where possible

Comparison between ACE EPAM and GOES-16 SGPS at upper end of STIS proton energy range



April 21–27, 2017 corotating interaction region (CIR) proton event observations, including 1-h level 2 fluxes from the ACE Low Energy Magnetic Spectrometer (LEMS) P7 (1.06–1.91 MeV) and P8 (1.91–4.75 MeV) ion channels (a), 5-min averaged fluxes from SGPS−X (west viewing) P1–P5 channels (b), and hourly OMNI 10 MeV 1AU proton flux (c). The CIR-associated proton enhancement appears at energies up to 6.5–12 MeV in the SGPS data, and there is no enhancement seen in the SGPS P5 (12–25 MeV) or OMNI 10 MeV proton fluxes (ACE data from R. Gold at JHU/APL and OMNI data from J. H. King, N. Papitashvili, ADNET, NASA GSFC; both via CDAWeb at https://cdaweb.gsfc.nasa.gov/index.html/).

From Kress et al., 'Observations from NOAA's Newest Solar Proton Sensor', *Space Weather*, *19*, 2021, 10.1029/2021SW002750

STIS data levels clarified

- L1a: count rates, not corrected for dead time (UCB)
- L1b: fluxes at native temporal and spectral resolution (UCB)
  - Analogous to MAVEN/SEP L2 science product
  - Corrected for dead time
- L2: fluxes at ACE/EPAM temporal and spectral resolution (UCB)
  - Provides IOC for SWPC
  - Permits direct comparison with ACE/EPAM during cal/val
- L3: products not yet defined (NOAA)

Retrospective processing may be required to flag and correct L1b & L2 ion fluxes for contamination by high-energy protons outside of STIS required range (during energetic SEP events such as 28 Oct 2021)

Retrospective processing will be required to flag and correct L1b & L2 electron fluxes for contamination (electron fluxes are not required by STIS contract)

STIS GPA code (L0b to L2)

- UCB GPA doc (CDRL 66)
  - Three revs (2021-02-03, 2021-10-25, 2021-11-24)
- UCB GPA IDL code (via SPEDAS)
  - Three G/R drops (Sept 2021 (L1a), ~~Jan~~ Feb? 2022 (L1b), March 2022 (L2))
- NCEI developing prototype based on UCB GPA doc and IDL code
  - First version of L1a Python code is complete
  - L1b code has been started but is on hold until UCB L1b IDL G/R
- Architecture
  - NCEI retrospective processing code is leveraging SPADES API in development.
- Challenges
  - Incomplete GPA description in CDRL 66
  - Incomplete functionality in IDL code
  - Lack of concrete definition of event histogram maps and response matrices
  - Such challenges are expected before an instrument is calibrated & delivered

Cal/Val: Identified STIS CWG G/R Items (1 of 2)

G/R #	Category / Req	Item	Giver	Receiver	Due Date	Notes
1	Data Set, Software and Documentation	Complete GEANT runs and software to read them, and instrument response matrices (protons, electrons, alphas, x-rays) for launch configuration	UCB	NCEI	6/1/2022 (updates at STIS PSR, after commissioning). Documentation can be provided after STIS PSR	Software should be essentially platform-independent (i.e., IDL or Python source code, not an executable). Admin privileges should not be required to install and run the software. GEANT output files OK in native format. UCB provided IDL 'swfo_stis_inst_response.pro' via SPEDAS nightly update on 2/2/22. Creates response matrices for protons and electrons from Geant runs. Not commented. Documentation: Description of corresponding logic & energy levels, commented code Training needed: minimal, limited to some Q&A
2	Software Package and Documentation	Algorithm and/or algorithm description document (TBD) describing how to obtain full, energy and species dependent, response functions for operational channels from GEANT results.	UCB	NCEI	6 months after STIS PSR	CDR RFA #2. Software should be essentially platform-independent (i.e., IDL or Python source code, not an executable). Admin privileges should not be required to install and run the software. Documentation: substantial Training needed: minimal, limited to some Q&A

Cal/Val: Identified STIS CWG G/R Items (2 of 2)

G/R #	Category / Req	Item	Giver	Receiver	Due Date	Notes
3	Data Set and Documentation	File containing calibration coefficients and instrument parameters used by L1a and L1b codes from command set and laboratory calibrations	UCB	NCEI, SWPC	STIS PSR	File format is TBD, should include metadata / variable attributes (e.g., units). Goal is that UCB IDL code and NOAA Python code would use same file. Data include but are not limited to: dead time, geometric factors, histogram indices corresponding to L1b energy windows, energy window midpoints and widths, dead layer energy loss, electron contamination removal factors. Documentation: metadata / variable attributes in file, including descriptive ‘long name’ containing provenance, etc. Training needed: minimal, limited to some Q&A
4	Software Package and Documentation	Code for analyzing on-orbit Limited Performance Tests / In-Flight Calibrations	UCB	NCEI	6 months before launch	**Required for post-launch trending.** Software should be essentially platform-independent (i.e., IDL or Python source code, not an executable). Admin privileges should not be required to install and run the software. Documentation: substantial Training needed: probably need a ~1 hr tutorial to go through the nature of the tests and the software Note: UCB STIS limited performance test (LPT) is similar in function to a GOES SEISS in-flight calibration (IFC)

- Prior to analysis tool #4 being available, v0 of STIS long-term trending tool will focus on HSK data that can be read from raw HSK packets
  - Will need sample packets from ground test to develop v0 tool

SWIPS

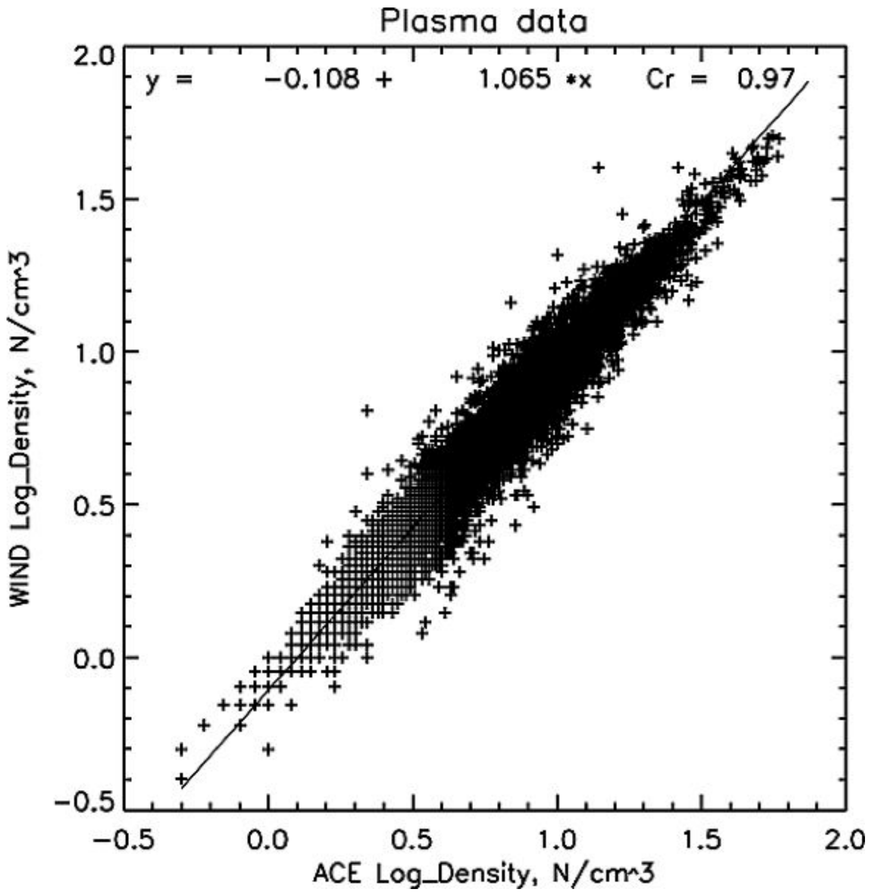
SWiPS PLC/PLPT Activities

Activity	Description	Dependencies	Estimated Data Duration
PLC: Initial Low-Voltage Functional Test Procedure	Initial power on, memory tests, exercising LV modes (interactive)	Instrument powered on	1 day
PLC: SWiPS High-Voltage Functional Test Procedure	Power on and testing of HV, includes HVENG and HVSCI mode testing, initial ramp-up of HV, testing select tables, ramp down of HV	Activity 1 and >30d passive outgassing in LVENG completed	1-2 days
PLC: Full Science Checkout	Exercising of all tables with HV enabled, includes execution of in-flight calibration script	Activity 2 completed	1-2 days
PLC: Thruster Operation Test (under development)	Verity SWiPS can operate near and/or during thruster firings	TBD	TBD
PLPT: Evaluation of Out-of-band Contamination	Look for evidence of OOB contamination in measurements and compare with known/likely sources. Quantify contribution from OOB contamination.	Activities 1-4	Solar Particle Event (electrons and protons)
PLPT: Cross Instrument Comparisons	Comparisons with measurements from similar instruments on other spacecraft (e.g. ACE-SWEPAM)	Activities 1-4	TBD, including periods of elevated n, v, and T moments

* From SWiPS Cal/Val plan, also in SWFO Cal/Val Plan Draft, subject to change

Solar Wind Cross Instrument Comparison PLPT Example

- Goal is to quantify systematic and random differences with similar measurements from other spacecraft (e.g. ACE)
- Important for establishing continuity with legacy NOAA instruments/measurements
- May indicate violation of accuracy requirements, but does not necessarily verify accuracy requirements are met
- Complicated by differing energy-angle coverage and spacecraft locations – Perform apples-to-apples comparisons where possible



Scatterplot of Wind-SWE vs. concurrent ACE-SWEPAM log density (10,235 points from 1998 to 2001) from King and Papitashvili [2005]. Best fit linear regression equation is shown at the top of the plot. Quantity Cr is the correlation coefficient.

[King, J. H., and Papitashvili, N. E. (2005), Solar wind spatial scales in and comparisons of hourly Wind and ACE plasma and magnetic field data, J. Geophys. Res., 110, A02104, doi:10.1029/2004JA010649].

SWiPS Algorithm Status (1 of 2)

Schedule and Status Table

Item	Giver	Receiver	Due Date
SWiPS Data Level Definition	SWPC	SWRI	Delivered
SWiPS GPA Documentation Draft	SWRI	SWPC	Delivered
SWiPS GPA Documentation & Software Interim-Delivery for L0-L1a	SWRI	SWPC	Delivered July 2021
SWiPS GPA Update (L1b & L2 updates)	SWRI	SWPC	Delivered Dec 2021
Location of the spacecraft (trajectory and orbit) and pointing	SWPC/ NOAA	SWRI	*In progress – received preliminary inputs*
SWIPS GPA Test & Validation Plan Update	SWRI	SWPC	Delivered Jan 2022
SWiPS GPA 2022 Interim-Delivery	SWRI	SWPC	4/29/2022
SWiPS GPA Final	SWRI	SWPC	Aug-22

1/27/2022 SWiPS Critical Design Review - 11. Ground Processing 14

SWiPS Algorithm Status (2 of 2)

L0 and L1a - Complete

Retrospective L0 and L1a algorithms were developed and have been tested and incorporated into SPADES Framework. Results are consistent with the vendor's Python code delivery.

L1b and L2 - In-work

Science L1b and L2 prototype code was received in December. This was received in IDL, rather than the Python code that was expected. Development staff and science team are experienced with IDL->Python conversion.

Identified SWiPS Tools

G/R Item #	Category / Req	Item	Giver	Receiver	Due Date	Notes
4	GPA/Instrument Parameter Tables	• swips_cal_inst_param_v0.csv; • swips_theta_dfl_settings_<LUT id>_v0.csv • swips_geofact_anXX_<LUT id> _<protons/alphas>.csv; • Science Lookup Table (active, on-orbit, instrument configuration table) • Engineering Parameter Table (final format TBD) • Any additional parameters needed by GPA but not currently included in science processing tables (e.g., anode_bgnd_scale_factor, pgs. 28 and 31 of 26093-GPA-01 Rev 2).	SwRI	NCEI	SWiPS PSR	*Will need well established procedure for delivering updates to NCEI and SWPC.*
5&6	IFC Analysis Codes and Documentation	In-flight calibration analysis codes, documentation describing analysis and interpretation of results (e.g., recommended MCP Voltage or GPA gain parameter adjustment). Software should be essentially platform-independent (i.e., IDL or Python source code, not an executable). Admin privileges should not be required to install and run the software.	SwRI	NCEI	Mar 30, 2023 (Instrument delivery + 3 months)	CWG request; Will be needed for long-term trending and cal/val .

Identified SWiPS Tools

G/R Item #	Category / Req	Item	Giver	Receiver	Due Date	Notes
TBA	Ground calibration and simulation data	**Additional data requested for retrospective processing:** ● Energy-Angle Response (EAR) functions ● theta and phi response curves ● Beam calibration data ● MCP gain test data	SwRI	NCEI	Mar 30, 2023 (Instrument delivery + 3 months)	Needed for Cal/Val and analysis for retrospective processing.

To be discussed: Does SWRI recommend anything else for maintenance of ground processing and trending?

NCEI Deliverables - Progress

(See PMU section at the end of the deck)

Conclusion

Summary

- NCEI has met all committed milestones.
- We have presented a clear picture of the current architectural and implementation plans for potential archive implementations.
- CWG and AWG activities are ongoing and providing a path for critical information necessary for successful product generation.
- Code development is in progress.
- NCEI has successfully identified gaps present in the existing algorithm deliverables, which will help in the Program’s efforts to have viable operational code for E2E testing.

PMU - Feb 2022

Link to PMU slide folder

https://drive.google.com/drive/folders/1DboQ0SxB2f7ayabWU5wlRzQPNX-OQPpw

Back ups

Acronym List

ACE	Advanced Composition Explorer
AIP	Archive Information Package
APS	Alternate Processing Site
AR	Archival Receipt
API	Application Programming Interface
ARD	Archive Recommendation Document
ASM	Attached Sync Marker
ATBD	Algorithm Theoretical Basis Document
AWG	Algorithm Working Group
C2	Command and Control
CBL	[SPADES] Configurable Business Logic
CCB	Change Control Board
CCOR-1	[GOES-U] Compact Coronagraph
CCOR-2	[SWFO-L1] Compact Coronagraph
CCSDS	Consultative Committee for Space Data Systems
CDR	Critical Design Review
CIRES	Cooperative Institute for Research in Environmental Sciences
CME	Coronal Mass Ejection
COG	Cloud Optimized Geotiff
COTS	Commercial-Off-The-Shelf
CI	Content Information, Common Ingest, Consolidated Ingest, Cooperative Institute, Continuous Integration
CWG	Calibration Working Group
DB	Database
DIP	Dissemination Information Package
DMZ	Demilitarized Zone
DSCOVR	Deep Space Climate Observatory
EC2	[AWS] Elastic Cloud Computing
ECR	[AWS] Elastic Container Registry
ECS	[AWS] Elastic Container Service
EFS	[AWS] Elastic File Service
EKS	[AWS] Elastic Kubernetes Service
ETE	End-To-End Test
FITS	Flexible Image Transport System
FISMA	Federal Information Security Modernization Act
FTE	Full-Time Equivalent
G16/G17	GOES-16/GOES-17
GB	Gigabyte
GPA	Ground Processing Algorithm
GS	Ground System
GSE	Geocentric Solar Ecliptic
GSFC	Goddard Space Flight Center
GSM	Geocentric Solar Magnetospheric
I&T	Integration and Test
IDE	Integrated Development Environment
IDL	Interactive Data Language
IGRF	International Geomagnetic Reference Field
IPDU	Internet Protocol Data Unit
IRD	Interface Requirements Document
IT	Information Technology
JSON	JavaScript Object Notation
L0	Level 0 (zero)
L0b	Level 0b
L1	Lagrange Point 1 Level 1
L1a	Level 1a
L1b	Level 1b
L2	Level 2
L3	Level 3
LEO-T	Low-Earth Orbiter-Terminal
LZSS	Level Zero Storage Space
MAG	[SWFO-L1] Magnetometer
MD5	Message-Digest 5
NASA	National Aeronautics and Space Administration
NCEI	National Centers for Environmental Information
NCIS	NESDIS Cloud Infrastructure Sandbox
NCCF	NESDIS Common Cloud Framework
NCS	National Critical System
NDE	NPOESS Data Exploitation
NRT	Near-Real-Time
NOAA	National Oceanic and Atmospheric Administration
OS	Operating System
O2R2O	Operations to Research / Research to Operations
PAL	Product Area Lead
PD	Product Distribution
PDR	Preliminary Design Review
PG	Product Generation
PLC	Post Launch Commissioning
PLPT	Post Launch Product Test
PLT	Post Launch Test
QL	Quick Look
RFC	Request For Change
RLC	[SPADES] Run-Level Configuration
RSW	Real-Time Solar Wind
S3	[AWS] Simple Storage Service
SAB	Science Advisory Board
SAN	Satellite Antenna Network
S/C	Spacecraft
SDR	System Design Review
SFTP	Secure File Transfer Protocol
SIP	Submission Information Package
SLOC	Source Lines Of Code
SPADES	Satellite Product Analysis & Distribution Enterprise System
SRR	System Requirements Review
STIS	[SWFO-L1] Supra Thermal Ion Sensor
SWFO	Space Weather Follow On
SWiPS	[SWFO-L1] Solar Wind Plasma Sensor
SWPC	Space Weather Prediction Center
SWX	Space Weather (also SWx)
TCP/IP	Transport Control Protocol/Internet Protocol
UAT	User Acceptance Test
UPS	Uninterruptible Power System
UTC	Universal Time Coordinated
VLab	Virtual Lab
VM	Virtual Machine
VPC	Virtual Private Cloud

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/

NCEI's Scientific Data Stewardship

- Scientific Stewardship of SWFO data is a primary PGD function implemented at NCEI
- NCEI will:
  - Acquire, create, archive, document and disseminate science-quality data
    - Science-quality data refer to the best available data;
  - Support typical formats: FITS for images and NetCDF for all other data.
  - Develop and manage the SWFO Science Center
  - Ensure retrospective capability (O2R2O) which is critical for both cal/val and generating scientifically improved products and Climate Data Records (CDRs) (e.g. smooth calibration parameters)
  - Develop Archive Recommendation Package (ARP - SIGNED)
  - Lead and process the official Request to Archive (RTA) which is a collaboration between PGD and NCEI
  - Develop & manage the submission agreement (SA), which is a formal agreement document that includes details of archive pathways, data locations, permissions, file formats and names, access methods, etc.
  - Serve Ops and Science products to all retrospective NOAA stakeholders which include the US and international User community. US stakeholders include NOAA, NASA, DoD, Academia.
- *NCEI conducts its work during business hours 9-5, M-F, on a non-operational basis.*

Science Center

- *The SWFO Science Center provides the entire space science community with scientifically authoritative data services for solar remote sensing and solar wind in situ products.*

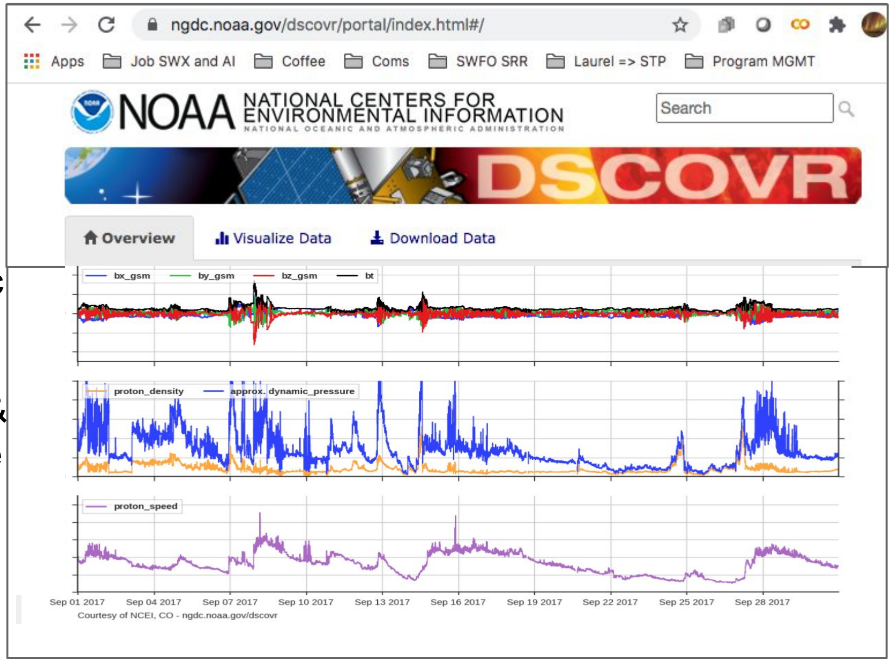
- Foundational
  - NCEI Tiers of Stewardship
    - o Defined in speaker notes
  - User Community Needs
  - Advancing SWX Research
  - Accelerating O2R2O Pipeline
  - Heritage: NCEI GOES-R and DSCOVR, ACE Science Center
- Future:
  - Cloud accessible pending outcome of Archive implementation options evaluation.
  - AI and Analysis Ready Data

Heritage: NCEI's DSCOVR Data Services Portal
GOES-R science portal heritage in Backup Slides

Magnetic Field

Density & Pressure

Velocity



https://www.ngdc.noaa.gov/dscovr/

Archive Documentation

Archive Recommendation Document

This is new since GOES-R and is prepared by NCEI and required by the NCEI-Data Stewardship Division. This high level document contains information about what will be archived, when, and why. The draft will be submitted at PDR for consideration. By PGD CDR it is typically signed by the NCEI Director and a high-level SWFO Program representative. No change to document is expected for archive implementation. Status: SIGNED.

Submission Agreement

This is heritage (e.g. GOES-R, DSCOVR) and is required by the NCEI-Data Stewardship Division. This is a formal agreement document that includes details of archive pathways, data locations, permissions, file formats and names, access methods, etc. This document must be finalized before data starts flowing, it is drafted by NCEI after the PGD CDR. (Minor changes between archive implementations expected.)

<CONTROL ID>

Archive Recommendation Package (ARP)
for the
Space Weather Follow On (SWFO) Program /
SWFO-L1 and GOES-U CCOR
Data Products and Supporting Information

Draft July 2021

National Oceanic and Atmospheric Administration

CCOR-1 (GOES-U) PLT/PLPT Preliminary Timeline*

*modified from SSD-PLT-CC0XX Rev. Draft

Unclear which tests can be done during cruise for CCOR-2.

SWFO-L1 cruise ends ~115 days; ~65 days on station until IOC

Delta from Launch [Days]	Test Duration [Days]	CCOR activities (ideal timeline, this does not yet include coordination with spacecraft timeline/CONOPS)
21	15	Turn on CCOR-1. The door remains closed. Perform functional test, based on TVAC procedure. PTC, flat field, synoptic mode with LEDs on.
36	15	Door is cracked 1mm for outgassing. Synoptic mode with LEDs off (1 day). PTC, flat field, synoptic mode with LEDs on.
51	1	Open CCOR-1 door. First light.
52	5	Synoptic mode, LED off. Wait for temperatures to stabilize.
57	5	Optimization of exposure time
62	15	15 days of synoptic mode at optimal exposure time, to allow stars to fully transit the CCOR FOV.
77	1	Off-pointing
78	1	Spacecraft roll
79	10	Earth shine (not relevant to CCOR-2)
89	5	Eclipse mode (not relevant to CCOR-2)
94	15	Synoptic mode, with longer exposures
109	71	Synoptic mode (should be primarily conducted at station for SWFO-L1)
180	X	Continued analysis of data taken during PLT/PLPT for operational useability.

S&MA Software Product Assessment

- NASA-STD-8739.8A – Software Safety and Software Assurance Standard
  - Ability to perform assessment of all artifacts will be conducted as a by-product of successfully gating through the programmatic milestone reviews
  - Has reached general agreement with the NCEI Team on process, procedure, and responsibility for performing product audits

- NPR-7150.2C - NASA Software Engineering Requirements for Projects
  - 7150.2C Class-C Compliance Matrix has been performed for both SWPC & NCEI
  - NCEI has been classified as 7150.2C Class-C 'Non-Safety Critical'
  - NCEI systems are FISMA Moderate
    - Satisfied under the NIST 800-53 Security Program- Cybersecurity
  - NCEI will not be subjected to NASA Independent Verification and Validation (IV&V) and therefore SWEs pertaining to IV&V will not be applicable