# NOAA Commercial Data Program (CDP) Status

## For the National Academies Space Weather Roundtable

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National Environmental Satellite and Data Information Service

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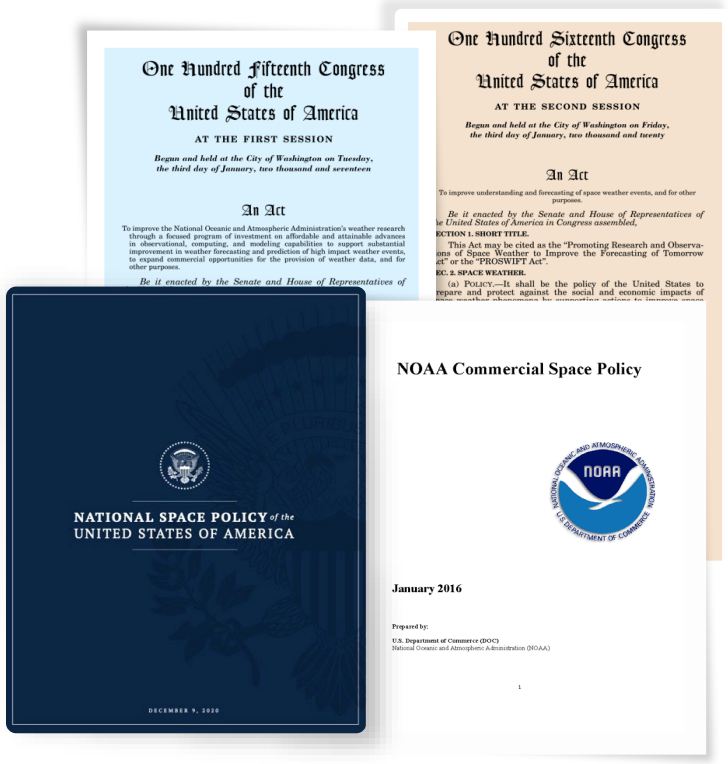
# NOAA Commercial Data Program Background

- In 2016, NOAA issued its *Commercial Space Policy*, which set a broad framework for use of commercial space-based data.
- After the launch of the COSMIC-1 global navigation satellite radio occultation system (GNSS-RO), several companies began plans to fly GNSS-RO sensors, with the first company collecting GNSS-RO from space in 2016.
- Also in 2016, NOAA/NESDIS initiated the **Commercial Weather Data Pilot (CWDP)** process to evaluate commercial satellite-based data, including GNSS-RO data, for use in weather models and other systems.
- At that time, the NOAA Satellite Observing System Architecture study recommended a government backbone of 5,000 radio occultations per day, augmented by commercial data purchases of up to 20,000 occultations per day.



# Commercial Data Authorization and Appropriation

## Weather Research and Forecasting Innovation Act of 2017 (Weather Act):

- Authorizes NOAA's space-based commercial weather pilot programs and data purchases
- For successful pilots, transition to operational use where appropriate, cost-effective and feasible
- Continue to meet international meteorological agreements
- Avoid unnecessary duplication between public and private data sources

## Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow (PROSWIFT) Act of 2020:

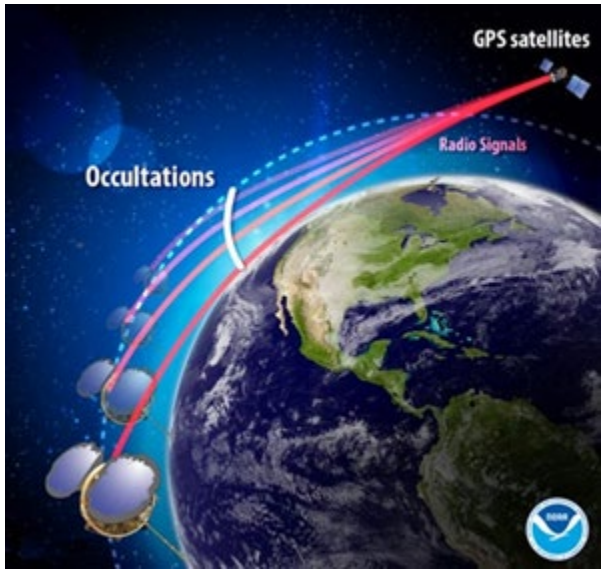
- Allows NOAA to establish a pilot program to enter into commercial space weather contracts to provide space weather data, and allows NOAA to evaluate the data for use in space weather research and forecasting models of NOAA, the Department of Defense, or both.

## Enacted Appropriations:

| Fiscal Year | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|
| CWDP (Pilot) | $3M | $5M | $6M | $6M | $3M | $3M | $8M | $8M |
| Commercial Data Purchase | - | - | - | - | $5M | $9M | $9M | $19M |

# Commercial Data Program Data Purchasing Overview

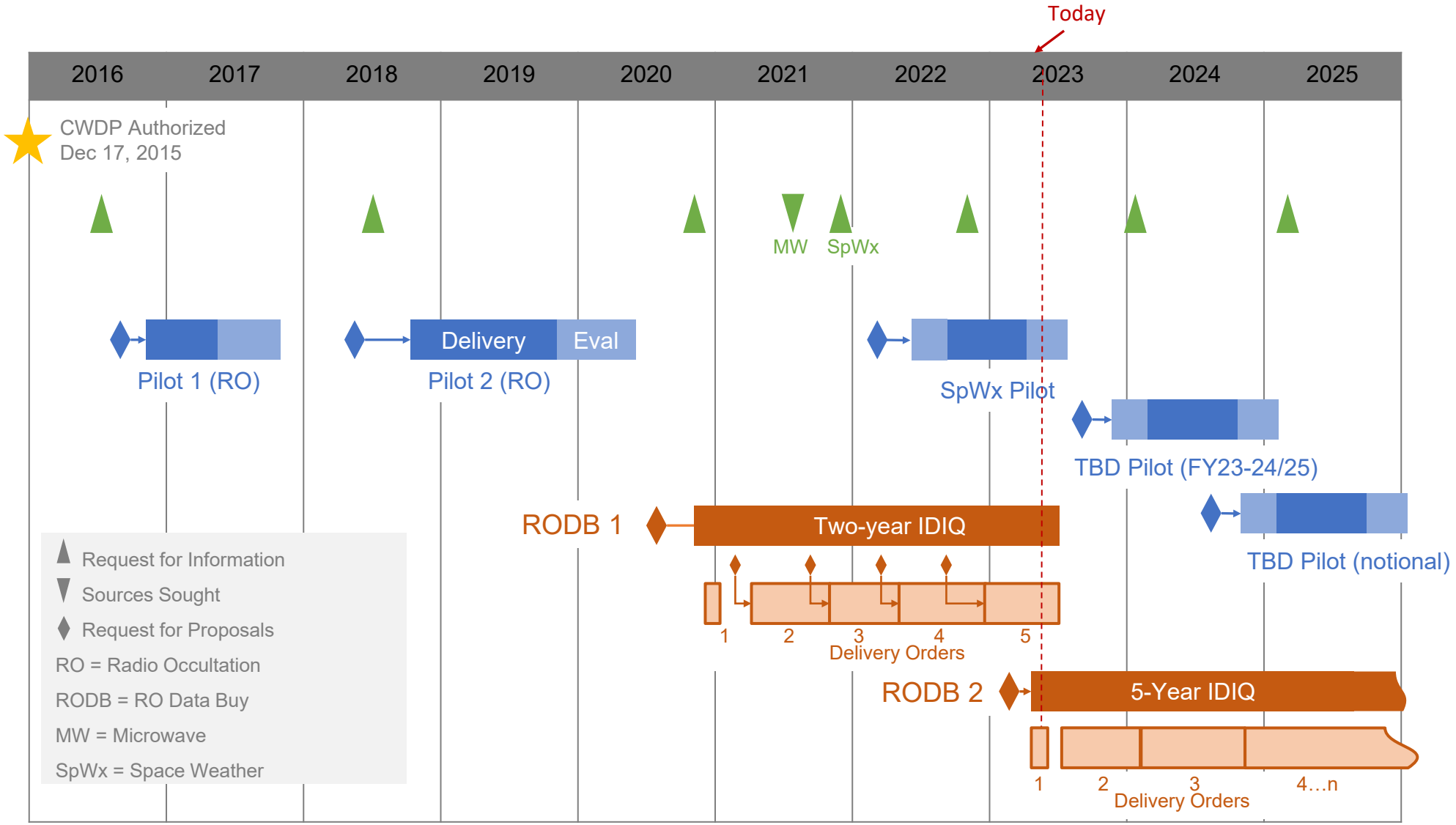
- In 2020, NOAA/NESDIS concluded the commercial sector was ready to provide operational RO data and initiated the **Commercial Data Program (CDP)** to manage the acquisition, ingestion, use, and dissemination of commercially sourced data, including RO.
  - Commercially-sourced operational GNSS RO data needed to meet NOAA's operational requirements into numerical weather prediction (NWP) models for neutral atmosphere and ionosphere data.
- In Nov 2020, NOAA/NESDIS awarded their 1st Commercial Data Buy (RODB-1) to Spire Global and GeoOptics for 2 years.
  - Operational assimilation of Commercial RO into NWP models began.
  - NOAA/NESDIS issued 5 delivery order contracts (DO-1 to DO-5) for the operational delivery of near-real-time RO profiles.




*GNSS-RO receivers observe distortion of GNSS signals as they transit the atmosphere*

- On Mar 27, 2023, NOAA/NESDIS awarded the 2nd Commercial Data Buy (RODB-2) to Spire Global and PlanetiQ for 5 years ; License: Unlimited distribution rights.
  - DO-1: 30 consecutive day "test" delivery concluded in May '23
    - Used To validate that the formats, latency, quality and coverage is sufficient for operational use.
  - DO-2: 6-month delivery with PlanetiQ begins Jul 19, '23 ; Deliver 3100 RO observations p/day

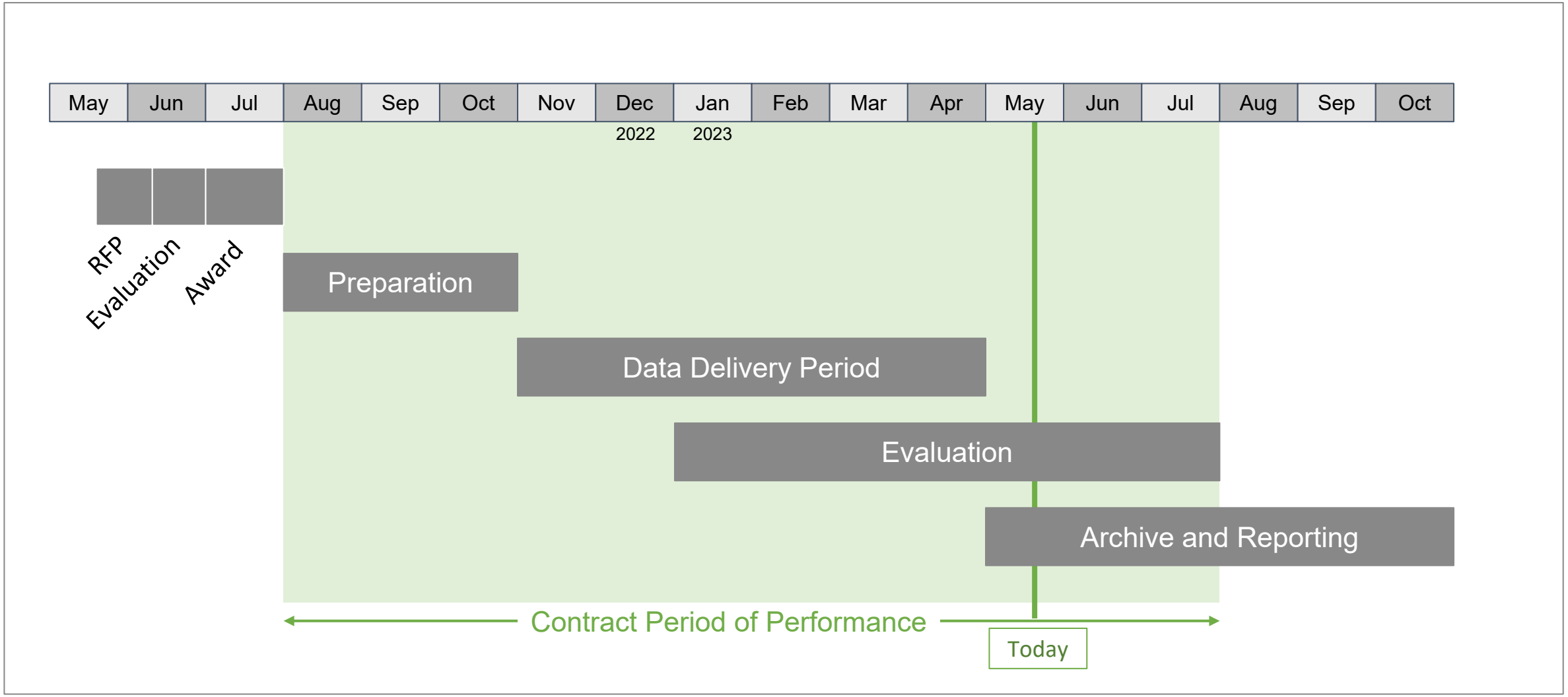
# Commercial Data Program Timeline



# Space Weather Data Pilot Status

- In July 2022, NOAA awarded contracts to three companies for the first **Space Weather Data Pilot**: Ionospheric measurements from GNSS RO sensors. This was in response to a market research analysis briefed to NESDIS AA and decision to issue an RFP for a pilot study.
  - Awards: GeoOptics Inc. (Pasadena, CA), PlanetiQ (Golden, CO) & Spire Global, Inc (San Francisco, CA).
    - Based on post-award developments, the effort with GeoOptics was bilaterally concluded prior to data delivery.
  - Distribution rights limited to U.S. Gov, Nat'l & WMO Met Centers, CGMS members for non-comm use only
- Measurement Objectives:
  - Total Electron Content (TEC)
    - Tracks must be at least 8 minutes in duration and span from 90 km (tangent point) to the maximum possible elevation angle for the transmitter /receiver geometry, which must occur at a positive elevation angle.
    - 1 Hz sampling rate (pseudo-range, carrier phase)
    - Measurement range:  0 to 2000 TECU
    - Maximum measurement uncertainty (Relative:  0.5 TECU RMS ; Absolute: 4 TECU RMS)
    - Can derive electron density profiles (EDPs)
  - Scintillation Indices
    - S4 (amplitude) computed on-orbit and provided for all tracks
    - For tracks where S4 > 0.3, high rate (50+ Hz) data from the entire observational altitude range to be provided.  To support phase analysis, data from a high-rate reference satellite is required for all such occultations.
    - Minimum carrier phase sampling rate: 50 Hz
    - S4 measurement range: 0.1 to 1.5 ; $\sigma\phi$ (phase) measurement range: 0.1 to 20 rad
    - Data from at least 25% of tracks with onboard S4 > 0.3
  - Maximum daily median latency 30 min for all data

# Space Weather Data Pilot Status



# Future Commercial Weather Data Pilot

- On an annual basis, CDP posts RFIs to pulse the commercial sector to determine whether any new capabilities have emerged in the past year.
- NOAA posted a General ***Request For Information*** **(RFI)** on September 15, 22; numerous responses were received on October 31, 22.
- NOAA solicited information on existing or planned commercial satellite environmental data and related capabilities that will be available in the FY23-30 time frame.
- Vendors were requested to submit Capability Statements to address which NESDIS Level Requirements (NLR) their commercially-provided data and related capabilities could augment NOAA in those capability areas. 14 vendors responded.
- CDP stood up a Capabilities Assessment Team (CAT) and assessed responses based on mission needs, mission impacts and vendor's on-orbit capabilities.
- CDP briefed the NESDIS AA in April 2023 with results and recommendations for the next pilot.
- CDP currently working RFP details ; RFP release expected Jun-Jul with award by Aug-Sep 2023.
- The CDP continues to pulse the commercial sector for emerging environmental data types that could help NOAA meet its observational needs.

# *Potential* Future Space Weather Pilots

## Energetic Particles

- Measure energetic charged particle data to improve magnetospheric modeling.
- Energetic particle data can be used for satellite anomaly attribution.
- Energetic charged particles can be assimilated into an existing research model and provide specification of the magnetosphere.

## Magnetic Field

- Magnetometers can be used to derive field aligned currents.
- Magnetometer data can be used by satellite anomaly groups.
- Global simultaneous magnetometer measurements are useful for space weather forecasting. They present the state of the magnetosphere pre- and post-event which reveals how impactful an event will be on the ground and improves understanding of how the magnetosphere responds to space weather.
- As constellations are replenished, clarifying capabilities and improving payload magnetometers can advance the science needed to get to a forecasting capability.

# Backup

# What's new in the RODB-2 IDIQ?

## Geographic/temporal sampling

- Added option to issue DOs to purchase data from specific geographic regions during specified periods,

## Space Weather Data Requirements

- Ionospheric measurements will be used to produce space weather products including total electron content and scintillation indices; ionospheric measurements can be purchased separately with specific requirements for space weather applications.
- Lower latency requirements (baseline is 140 min) can be specified in each DO, for tropospheric or ionospheric needs. TEC & Scintillation maximum daily median latency baseline is 30 min.

## Data sharing options

- Unlimited distribution rights (NOAA License option 1)

## On-ramping new vendors

- Contains a mechanism ***for on-ramping new vendors who were not awarded contracts in the initial IDIQ award.***
- **The need to on-ramp shall be evaluated annually** by the Commercial Data Program (CDP) Management to determine whether it is in the best interest of the Government to "reissue" an RFP.

## Non-duplicative data

- To avoid situations where NOAA and partner agencies purchase the same data with licenses to share the data, a stipulation to provide *unique* data in DOs was added. Methods are being developed now to ensure that data are unique before ingesting in NWP (e.g. deconflict from EUMETSAT's RO data).

# IDIQ-1 Contracts awarded to Spire & GeoOptics in Nov 2020. Contract ceiling (2-year POP): $23M

| Delivery Order | Vendor | Profiles per day | Duration (Months) | Period of Performance | Data Sharing | Notes |
|---|---|---|---|---|---|---|
| **1-Test** | Spire<br>GeoOptics | 500<br>500 | 1 | Dec '20 - Jan '21 | US Gov. | Test data; prep for operations |
| **2** | GeoOptics | 1300 | 6 | Mar '21 - Sep '21 | US Gov. | Operational use began May 2021 |
| **3** | Spire | 3000 | 6 | Sep '21 - Mar '22 | US Gov, WMO and CGMS Centers | Added Galileo GNSS occultations |
| **4** | GeoOptics<br>Spire | 500<br>5500 | 10 | Mar '22 - Jan '23 | US Gov, WMO and CGMS Centers | 10-month period began March 16, 2022 |
| **5** | Spire | 3300 | 6 | Jan '23 - Jul '23 | Unlimited distribution rights | Vendors were asked to provide 2 pricing options (1 & 3a) |

## IDIQ-2 (RODB-2) Contracts awarded to Spire & PlanetiQ in Mar 2023. Contract ceiling (5-year POP): $59.31M

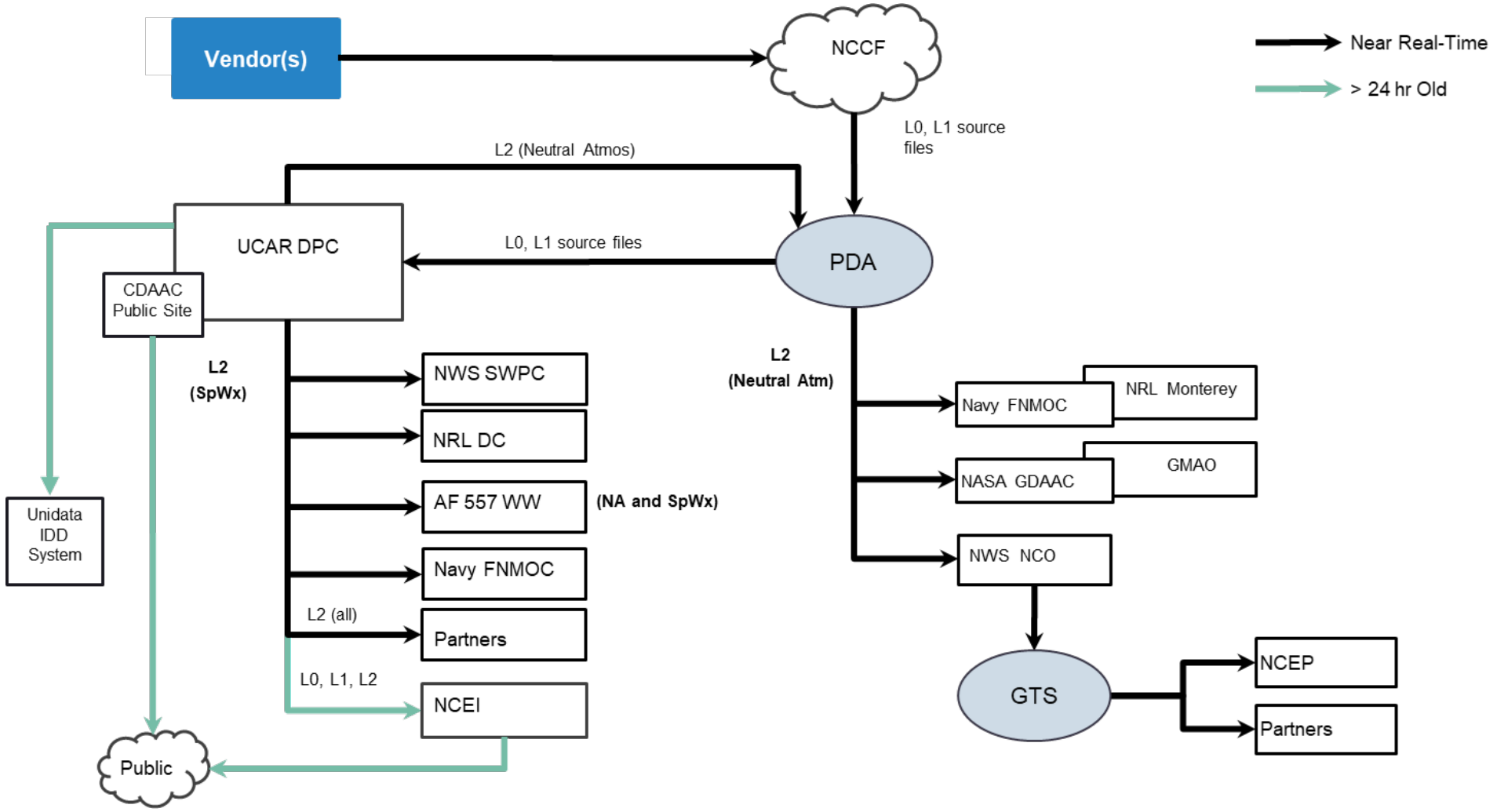
| Delivery Order | Vendor | Profiles per day | Duration (Months) | Period of Performance | Data Sharing | Notes |
|---|---|---|---|---|---|---|
| **1-Test** | Spire<br>PlanetiQ | 500<br>500 | 1 | Apr ‘23 - May ‘23 | Unlimited distribution rights | Test data; prep for operations |
| **2** | PlanetiQ | 3100 | 6 | Jul ‘23 - Jan ‘24 | Unlimited distribution rights | Coordination and evaluation of DO-1T data is on-going with UCAR, NWS (SWPC, EMC, NCO) to prepare for operational assimilation into NWP on day #1! |
| **3** | TBD | TBD | TBD | TBD | TBD | |
| **4** | TBD | TBD | TBD | TBD | TBD | |
| **DO-n** | TBD | TBD | TBD | TBD | TBD | |

# RODB-2 DO-2 Data Flow Diagram

**Data Sharing License:**

Unlimited distribution rights

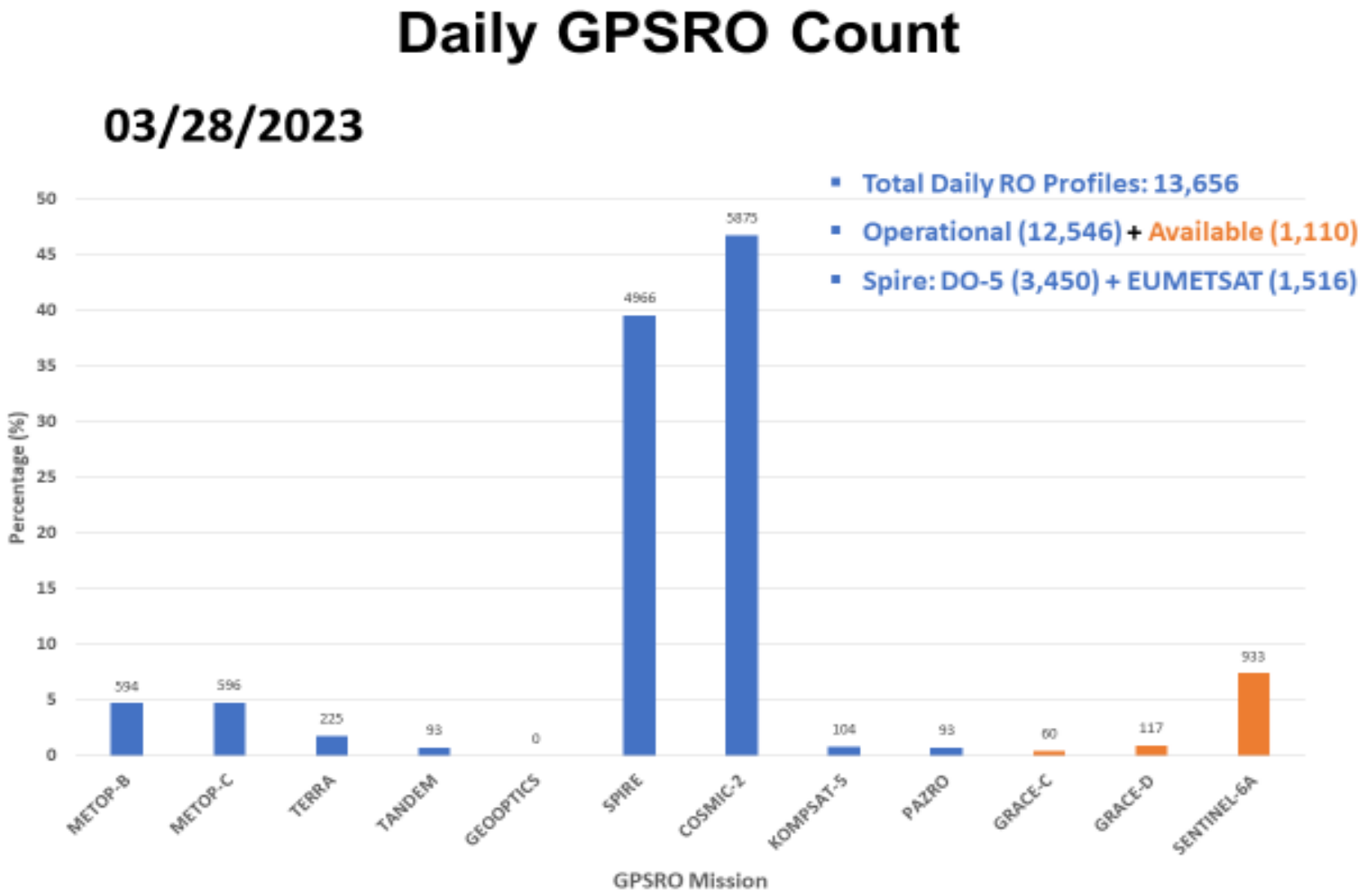
**L0, L1, L2:** Level 0, Level 1, Level 2 data
**NCCF**: NESDIS Common Cloud Framework
**NCEI:** National Center for Environmental Information
**NWS:** National Weather Service
**OSGS:** NESDIS Office of Satellite Ground Services
**OSPO:** NESDIS Office of Satellite and Product Operations
**PDA**: Product Distribution and Access system
**SWPC:** Space Weather Prediction Center
**UCAR:** University Center for Atmospheric Research



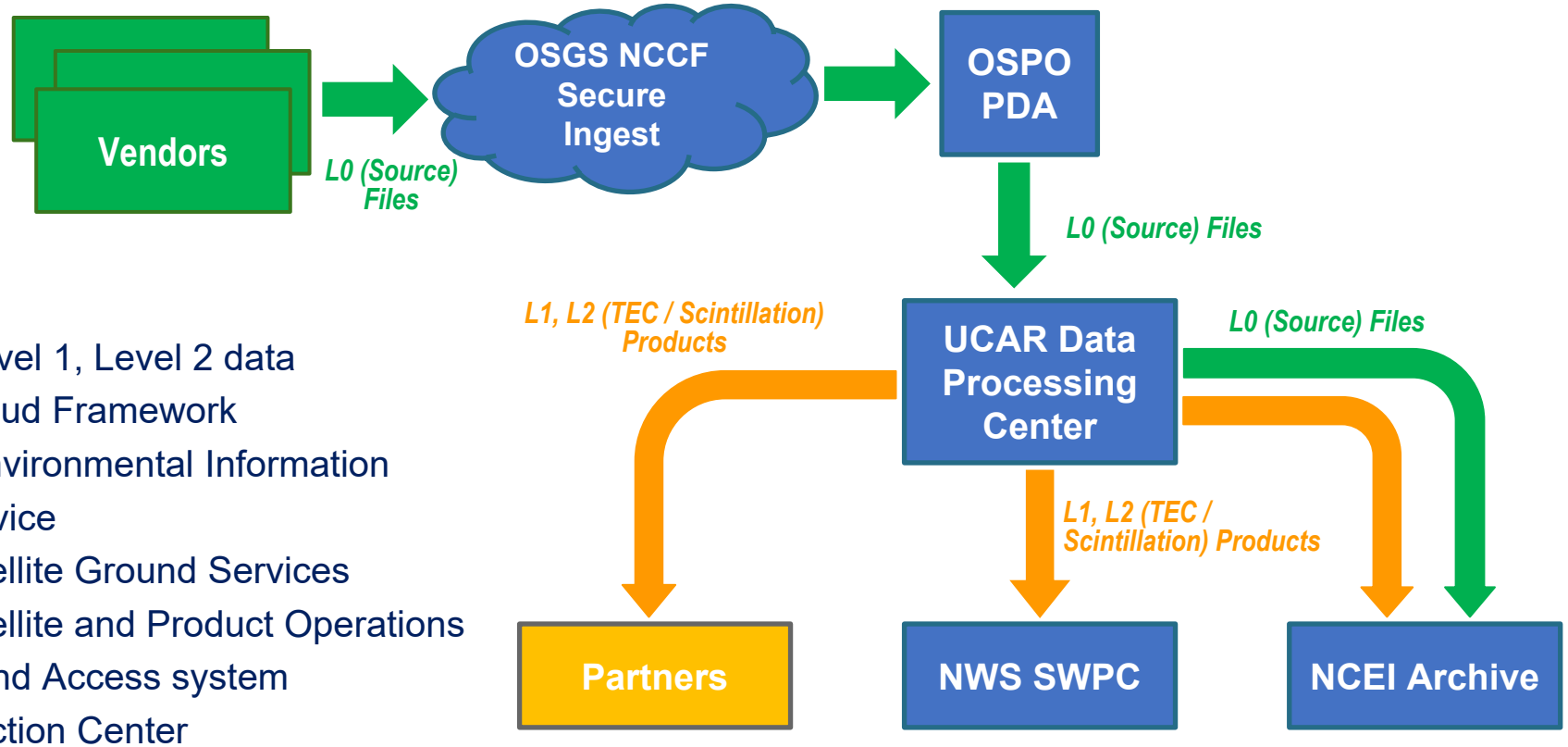
# RO Data Operationally Assimilated by NOAA *as of (3/28/2023)*

| Mission | Daily Occs. | % of Total Operational |
|---|---|---|
| COSMIC-2 | 5,875 | 47% |
| SPIRE | 4,966 | 40% |
| METOP-B | 594 | 5% |
| METOP-C | 596 | 5% |
| TERRA | 225 | 1.8% |
| KOMPSAT-5 | 104 | 0.8% |
| TANDEM | 93 | 0.7% |
| PAZRO | 93 | 0.7% |
| GEOOPTICS | 0 | 0% |
| Total Operational March 28, 2023 | 12,546 | 100% |
| GRACE-C | 60 | 0.5% of Total Daily |
| GRACE-D | 117 | 0.9% of Total Daily |
| SENTINEL-6A | 933 | 7% of Total Daily |
| Total Daily March 28, 2023 | 13,656 | |

# RO Data Operationally Assimilated by NOAA *as of (3/28/2023)*



# Space Weather Pilot Data Flow




L0, L1, L2: Level 0, Level 1, Level 2 data
NCCF: NESDIS Common Cloud Framework
NCEI: National Center for Environmental Information
NWS: National Weather Service
OSGS: NESDIS Office of Satellite Ground Services
OSPO: NESDIS Office of Satellite and Product Operations
PDA: Product Distribution and Access system
SWPC: Space Weather Prediction Center
UCAR: University Center for Atmospheric Research

# CWDP Process:

**Market Research**

- Pulse community: Issue *Request for Information* or *Sources Sought* Notice to identify potential data types of interest
- Evaluate responses against NOAA goals, requirements, resources, and schedules

**Pilot Planning**

- Organize team and allocate resources
- Develop requirements, engaging user community and experts
- Release draft “Statement of Work”
- Issue solicitation (“Request for Proposals”)
- Evaluate proposals
- Award contracts as appropriate

**Pilot Execution**

- Plan for data ingest, processing, dissemination and archive
- Conduct data delivery period
- Evaluate data quality and impact
- Report results to leadership and community at large
- Recommend data type for operational purchase when appropriate

# Scope: NOAA Commercial Data Sharing

NOAA's data sharing practices are driven by USG laws, policies, and international agreements:

- The NOAA Commercial Space Policy states **NOAA will negotiate the least restrictive terms possible, while evaluating data sharing on a case-by-case basis**
- The Weather Act directs NOAA to adhere to existing international agreements in use of commercial data
- **World Meteorological Organization Resolution 40 sets the standard of full and open data sharing for global meteorological data (WMO currently updating Res 40 to address commercial data considerations)**

As other USG agencies and EUMETSAT begin commercial data purchases, interagency and international coordination on the sharing of commercial data purchased by each will be critical

- Agreement to share data purchased is the first step (requires paying higher price per observation, but allows collective buying and sharing)
- Need coordination to ensure partners buy different data, to maximize the impact on the global system

CGMS WG II recommendations regarding RO data have further been defined:

- Plenary WGII R49 WG II recommends that Agencies when pursuing data clearly define all aspects of the data, e.g., orbits and coverage, in order to optimize the benefits of the data
- Plenary WGII R49 WG II recommends that **Agencies consider data buy with an option for redistributing data to global NWP centers.**

# Data Sharing License Options: IDIQ-2

| | |
|---|---|
| Option 1 | Unlimited distribution rights |
| Option 2 | Distribution to U.S. Government agencies, National Meteorological Centers (NMC), WMO Met Centers, CGMS members, non profit organizations, Academic entities for non-commercial use with no further distribution |
| Option 2a | Option 2 plus unlimited distribution after 24 hours |
| Option 3 | Distribution to U.S. Government agencies, National Meteorological Centers (NMC), WMO Met Centers, and CGMS members for non-commercial use with no further distribution |
| Option 3a | Option 3 plus unlimited distribution after 24 hours |
| ~~Option 4~~ | ~~Distribution to U.S. Government agencies for non-commercial use and no further distribution (except to contractors for use on agency behalf)~~ |
| ~~Option 4a~~ | ~~Option 4 plus unlimited distribution after 24 hours~~ |
| ~~Option 5~~ | ~~No distribution outside NOAA (except for contractors and grantees for use on NOAA's behalf)~~ |
| ~~Option 5a~~ | ~~Option 5 for first 24 hours plus unlimited distribution after 24 hours~~ |

# RO Commercial Data Product Users

- **US Govt users:**
  - Receiving products that UCAR processes:
    - NWS SWPC
    - NWS NCO (EMC)
    - NESDIS STAR
    - Navy FNMOC / NRL-MRY
    - USAF 557th Weather Wing
    - NASA GSFC DAAC / GMAO
    - NRL-DC
- **International Partner users:**
  - PDA is preferred distribution means for an existing PDA user
  - NWSTG (GTS) point-to-point distribution is the alternate path
- **Researchers:**
  - Have delayed access (24-hours) through NCEI and the CDAAC data portal

# Partner Agencies Currently Receiving Data

| Country / Region | Agency | Membership | Access Options Available |
|---|---|---|---|
| Australia | Bureau of Meteorology (BOM) | WMO | GTS & PDA |
| Canada | Environment & Climate Change Canada (ECCC) Canadian Meteorological Center (CMC) | WMO | GTS & PDA |
| China | China Meteorological Administration (CMA) | WMO & CGMS | GTS & PDA |
| Europe | European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) | CGMS | GTS & PDA |
| France | Centre National d'Etudes Spatiales (CNES) | CGMS | Via EUMETSAT |
| Hong Kong | Hong Kong Observatory (Weather Forecasting Office) | WMO | GTS |
| India | Indian Meteorological Department National Centre for Medium Range Weather Forecasting (NCMRWF) | WMO | GTS & PDA |
| India | Indian Space Research Agency (ISRO) | CGMS | GTS & PDA |
| Japan | Japan Meteorological Agency (JMA) | WMO | GTS & PDA |
| Korea | Korea Meteorological Administration (KMA) | WMO & CGMS | GTS & PDA |
| New Zealand | Meteorological Service of New Zealand (MetService) | WMO | GTS |

# Commercial Data Purchase Core Team:

CDP Funded PI's/SME's

| Org. | Name | Role |
|---|---|---|
| OSAAP | Office of Systems Architecture and Advanced Planning | Program management |
| NWS/NCEP | National Weather Service | Requirements, NWP operational assimilation, Analysis and Evaluation (*Primary user*) |
| SWPC | Space Weather Prediction Center | Requirements, Ionospheric (RO) Product Assimilation, Analysis and Evaluation |
| NCEP | National Centers for Environmental Prediction | Requirements, Operational assimilation of commercially sourced radio occultation data product |
| OAR/AOML | Atlantic Oceanographic and Meteorological Laboratory (AOML) | RO data evaluation and data quality and impact assessment studies |
| STAR | Center for Satellite Applications and Research | RO data evaluation and data quality and impact assessment studies |
| UCAR | University Center for Atmospheric Research | Requirements, Processing, Evaluation |
| NCCF | NOAA Common Cloud Framework | Data ingest and internal dissemination |
| NCEI | National Center for Environmental Information | Data archive and external dissemination |
| AGO | Acquisition and Grants Office | Contracting |
| IIAD | International/Interagency Affairs Division | International communications |

# Space Weather (SpWx) Pilot Core Team Roles:

CDP Funded PI's/SME's

| Org. | Name | Role |
|---|---|---|
| OSAAP | Office of Systems Architecture and Advanced Planning | Program management |
| SWPC | Space Weather Prediction Center | Requirements, Evaluation (*Primary user*) |
| UCAR | University Center for Atmospheric Research | Requirements, Processing, Evaluation |
| NCCF | NOAA Common Cloud Framework | Data ingest and internal dissemination |
| NCEI | National Center for Environmental Information | Data archive and external dissemination |
| SWO/OPPA | Space Weather Observations office / Office of Projects, Planning, & Analysis | Space weather expertise, Interagency coordination |
| AGO | Acquisition and Grants Office | Contracting |
| IIAD | International/Interagency Affairs Division | International communications |
| U of CO; Aerospace | External Data Evaluation Team | Data Evaluation Analysis and Reporting |
| U of Taiwan, EUMETSAT | External Data Evaluation Team | Data Evaluation Analysis and Reporting |