

# **Space Weather Operations, Research, and Mitigation (SWORM) Subcommittee Update**

***Committee On Solar And  
Space Physics (CSSP)  
The National Academies of  
Sciences, Engineering, and  
Medicine***

***October 16-17, 2018  
Beckman Center, Irvine, CA***

***Michael Bonadonna (OFCM)  
Executive Secretary, SWORM Subcommittee***

# Overview

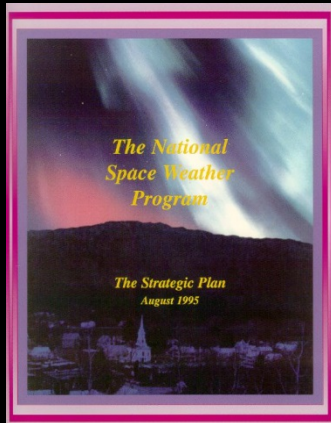


- **Background**
- **SWORM Current Status**
- **The Way Forward**

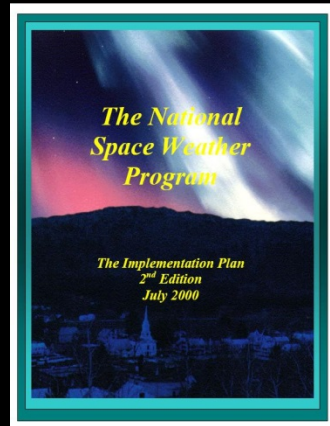


# National Space Weather Coordination

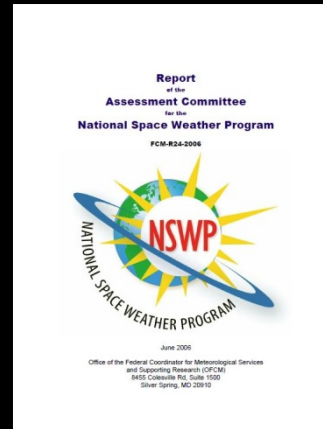
1995



2000



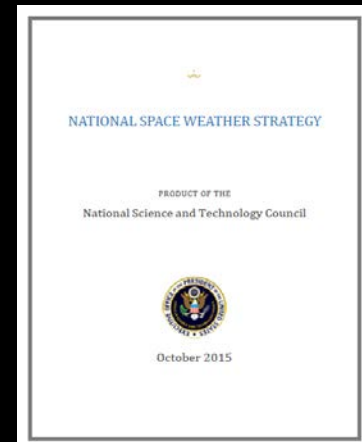
2006



2010



2015



NSTC National  
Space Weather  
Strategy & Action  
Plan

- 1995: National Space Weather Program Established
- 1999: NSWP Established the Community Coordinated Modeling Center
- 2003: Space Environment Center closure averted
- 2007: 1<sup>st</sup> Annual Space Weather Enterprise Forum
- 2007-2011: Produced 5 Impact Studies for OSTP
- 2015: National Space Weather Policy elevated to White House



DSCOVR launched in 2015

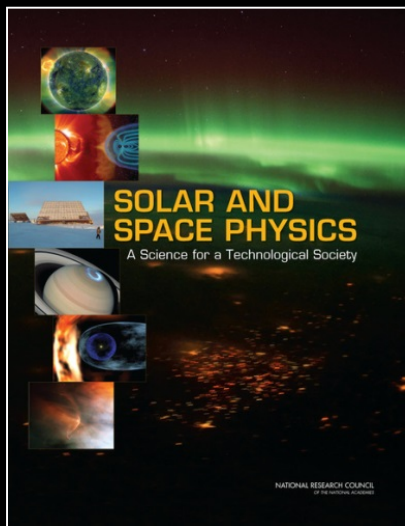
# Congressional Direction and National Research Council Recommendation

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## NASA Authorization Act of 2010 (Sec. 809)

ACTION REQUIRED.—The Director of OSTP shall:

- (1) improve the Nation's ability to prepare, avoid, mitigate, respond to, and recover from potentially devastating impacts of space weather events;
- (2) **coordinate the operational activities of the NSWP Council members**
- (3) submit a report to the appropriate committees of Congress that details the current and future data sources, both space- and ground-based, that are necessary for space weather forecasting  
(NSWP provided the SEGA reports through OSTP in response)



## National Research Council Decadal Survey 2013

“The survey committee recommends ... the **NSWP should be rechartered under the auspices of the NSTC** and should include the active participation of the OSTP and OMB.”

# National Space Weather Strategy

*A cohesive all-of-government strategy was necessary to ensure the federal government was positioned to mitigate, respond to and recover from a major space weather storm*

Nov 2014 – Space Weather Operations, Research, and Mitigation (SWORM) Task Force is established

Tasked to develop:

- National Space Weather Strategy (NSWS)
- Space Weather Action Plan



# Oct 2015 - National Space Weather Strategy and Action Plan Released



## NATIONAL SPACE WEATHER ACTION PLAN

PRODUCT OF THE  
National Science and Technology Council



October 2015

## NATIONAL SPACE WEATHER STRATEGY

PRODUCT OF THE  
National Science and Technology Council



October 2015





# Executive Order 13744 of October 13, 2016 – Coordinating Efforts to Prepare the Nation for Space Weather Events

The White House  
Office of the Press Secretary

For Immediate Release

October 13, 2016

## Executive Order -- Coordinating Efforts to Prepare the Nation for Space Weather Events

### EXECUTIVE ORDER

#### COORDINATING EFFORTS TO PREPARE THE NATION FOR SPACE WEATHER EVENTS

By the authority vested in me as President by the Constitution and the laws of the United States of America, and to prepare the Nation for space weather events, it is hereby ordered as follows:

Section 1. Policy. Space weather events, in the form of solar flares, solar energetic particles, and geomagnetic disturbances, occur regularly, some with measurable effects on critical infrastructure systems and technologies, such as the Global Positioning System (GPS), satellite operations and communication, aviation, and the electrical power grid. Extreme space weather events -- those that could significantly degrade critical infrastructure -- could disable large portions of the electrical power grid, resulting in cascading failures that would affect key services such as water supply, healthcare, and transportation. Space weather has the potential to simultaneously affect and disrupt health and safety across entire continents. Successfully preparing for space weather events is an all-of-nation endeavor that requires partnerships across governments, emergency managers, academia, the media, the insurance industry, non-profits, and the private sector.

It is the policy of the United States to prepare for space weather events to minimize the extent of economic loss and human hardship. The Federal Government must have (1) the capability to predict and detect a space



BRIEFING ROOM

ISSUES

THE ADMINISTRATION

PARTICIPATE

1600 PENN

HOME - BLOG

## Preparing the Nation for Space Weather: New Executive Order

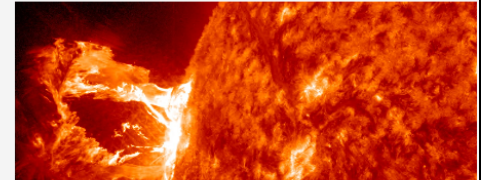
OCTOBER 13, 2016 AT 10:00 AM ET BY DR. TAMARA DICKINSON



Summary: The Administration takes significant step towards preparing critical infrastructure and technology for the risk of space weather.

Today, President Obama signed an [Executive Order](#) that seeks to coordinate efforts to prepare the Nation for space weather events. The Executive Order will help reduce economic loss, save lives, and enhance national security by ordering the creation of nationwide response and recovery plans and procedures that incorporate technologies that mitigate the effects of space-weather events. By this action, the Federal Government will lead by example and help motivate state and local governments to create communities that are more resilient to space weather.

The term "space weather" refers to the environment that arise from events on the sun including solar flares, solar energetic particles, and coronal mass ejections. Space weather events can significantly affect critical infrastructure, the economy, social wellbeing, and the environment.



# Space Weather Operations, Research and Mitigation Subcommittee

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- The SWORM SC Provides policy guidance and management support to execute the National Space Weather Strategy and Action plan
  - Seven subordinate Working Groups
  - Working 107 NSWAP and Executive Order Actions
- The SWORM Subcommittee:
  - Chartered under the National Science and Technology Council (NSTC)
  - Moved to Committee for Homeland and National Security (CHNS)
  - Chaired by OSTP, NOAA, and DHS with members from 14 Departments / Agencies totaling over 70 participants (160+ including the Working groups)





# Overview



- Background
- **SWORM Current Status**
- The Way Forward

# Implementation of the National Space Weather Action Plan

## Six high-level goals

1. Establish Benchmarks for Space Weather Events
2. Enhance Response and Recovery Capabilities
3. Improve Protection and Mitigation Efforts
4. Improve Assessment, Modeling, and Prediction of Impacts on Critical Infrastructure
5. Improve Space Weather Services through Advancing Understanding and Forecasting
6. Increase International Cooperation

# Executive Order 13744 – Coordinating Efforts to Prepare the Nation for Space Weather Events

Orders the implementation of necessary, high-level activities that were not included in the Action Plan, including:

- Develop a plan to test and evaluate available devices that mitigate the effects of geomagnetic disturbances on the electrical power grid
- Identify mechanisms for sustaining and transitioning research to operations and operations to research, collaborating with industry

“To ensure accountability for and coordination of research, development, and implementation of activities identified in this order and in the Action Plan, the National Science and Technology Council shall establish a **Space Weather Operations, Research, and Mitigation Subcommittee** [SWORM]”



# Status

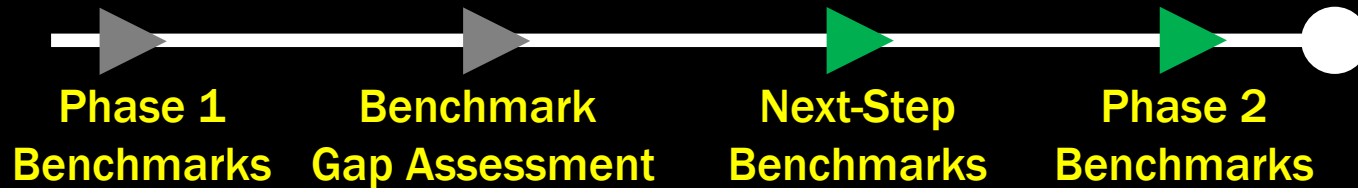
- ~60 of the 107 actions in the National Space Weather Action Plan (NSWAP) and EO are complete. Work continues on the remaining actions.
- A number of the resource-intensive activities have yet to be completed
  - Filling the gaps in research and modeling necessary to complete Phase 2 Benchmarks
  - Ensuring continuity of critical space-based observations (e.g., solar wind data at L1, coronagraph and other observations )
  - Creating a research-to-operations and operations-to-research capability
  - Developing impact modeling
- Successful progress towards enhancing preparedness will require multiple years of sustained national commitment of the resources to implement the developed plans and recommendations.

# Benchmarks (SWAP Goal 1)

Five benchmarks are under development by multi-agency working group teams:

- Induced geo-electric fields
  - Ionizing radiation
  - Ionospheric disturbances
  - Solar radio bursts
  - Upper atmospheric expansion
- 
- The Phase 1 Benchmarks were released in June 2018
  - Phase 2 next steps underway now
  - A goal in Phase 2 - Capitalize on the worldwide space weather expertise across industry, academia, and governments

# Extreme Space Weather Benchmark Development



Status: Completed

Activities that depend on benchmarks (e.g. 4.1.1) may initially use draft benchmark values provided in September for SWORM review (1.1.1, 1.2.1, 1.3.1, 1.4.1, 1.5.1)

Status: Completed

Identification of gaps in methods and available data to improve benchmarks (1.1.2, 1.2.2, 1.3.2, 1.4.2, 1.5.2)

Status: On Track

Community-driven process to inform development of Phase 2 benchmarks (improved identification of values and gaps)

Status: On Track

Refined and rigorous benchmarks developed after gaps are sufficiently addressed or significant new data and techniques available (1.1.3, 1.2.3, 1.3.3, 1.4.3, 1.5.3)



# CONOPS for Federal Department and Agencies

**EO Action 5(f)** DHS in coordination with relevant agencies, shall lead the development of a coordinated Federal operating concept and associated checklist to coordinate Federal assets and activities to respond to notification of, and protect against, impending space weather events.

**June 2017: The National Security Council formed the Interagency Policy Committee/Domestic Resilience Group (NSC IPC/DRG) Space Weather policy coordinating subcommittee (sub-PCC)**

- The subcommittee is meeting regularly at the White House to work on completing this action
- Expected completion in late 2018

# Research to Operations

“Federal and non-Federal partners must ensure that research is effectively transitioned to operational forecasting centers” *National Space Weather Strategy - Oct 2015*

[Agencies] shall identify mechanisms for advancing space weather observations, models, and predictions, and for sustaining and transitioning appropriate capabilities from research to operations and operations to research, collaborating with industry and academia to the extent possible. *Executive Order 13744 - Oct 2016*

O2R2O Plan developed in 2017

Document will serve to inform Federal agency budgets

# SWEF 2018 Recap

- **When :** 25 July from 1200-1600
- **Where:** Library of Congress
- **Sponsor:** Representative Ed Perlmutter (D-CO)
  - Sponsor for H.R. 3086 “Space Weather Coordination Act”
- **Support:** NASA and Secure World Foundation
- **Theme:** “Advancing National Space Weather Research and Forecast Capabilities”
- **Panel Sessions:**
  - Understanding and managing risks and impacts associated with space weather
  - Implementation of activities across the space weather enterprise for the protection of critical infrastructure





# 2018 Space Weather as a Global Challenge Dialogue

Organized by the Embassy of Japan, the National Institute of Information and Communications Technology, the Japan Aerospace Exploration Agency, the Secure World Foundation, and the U.S. Department of State

Third such dialogue with the first taking place in 2016 at the U.S. Department of State and the second in 2017 at the Italian Embassy



The screenshot shows the U.S. Department of State website. The header features the U.S. Department of State seal and the text "U.S. DEPARTMENT OF STATE" and "DIPLOMACY IN ACTION". Below the header is a red navigation bar with links: SECRETARY OF STATE, ABOUT, WHAT WE DO, POLICY ISSUES, COUNTRIES & REGIONS, and PRESS. A search bar is located below the navigation bar. The main content area displays the title "Space Weather as a Global Challenge Dialogue" in a large, bold font. To the left of the title is a photograph of the U.S. Department of State building. To the right of the title is a paragraph of text: "Beginning in 2016, the Bureau of Oceans and International Environmental and Scientific Affairs (OES) and the Secure World Foundation have convened annual panel discussions on 'Space Weather as a Global Challenge.' The meetings provide an opportunity for other countries to learn more about the purpose and goals of the National Space Weather Strategy and accompanying Action Plan; ensure that policymakers in and leaders of partner nations recognize space weather as a global challenge; and facilitate the sustained, coordinated participation of partner nations in relevant international space weather initiatives." Social media sharing icons for Facebook, Twitter, Google+, and LinkedIn are visible to the right of the title.

U.S. DEPARTMENT OF STATE  
DIPLOMACY IN ACTION

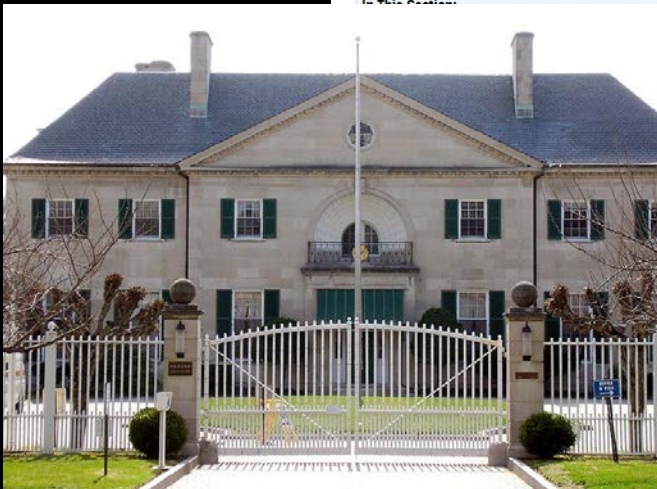
SECRETARY OF STATE ABOUT WHAT WE DO POLICY ISSUES COUNTRIES & REGIONS PRESS

Search Site...

Home > Under Secretary for Economic Growth, Energy, and the Environment > Bureau of Oceans and International Environmental and Scientific Affairs  
> Space and Advanced Technology > Space Weather

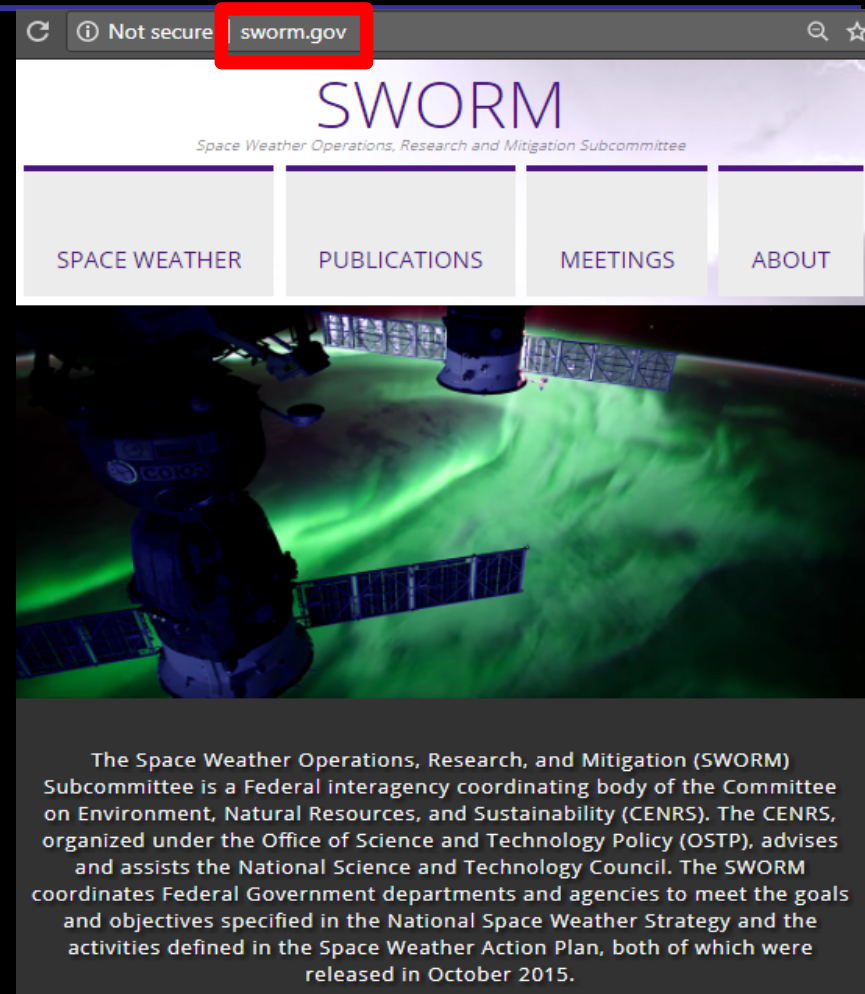
## Space Weather as a Global Challenge Dialogue

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# Public Access to SWORM Documents

- SWORM.gov launched Sep 2017
- Provides public access to Federal activities supporting the SWORM Subcommittee as well as other activities and events relevant to the national space weather enterprise
- Expected to evolve as community needs emerge



# Overview



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- **The Way Forward**



# National Space Weather Strategy - Update

April 2018 – White House announces update to National Space Weather Strategy

Update seeks to:

- Enhance national preparedness to space weather events
- Promote American leadership in space weather research, technology, and innovation
- Improve the safety and viability of human and robotic space activities
- Enhance private sector engagement across these endeavors
- Address EMP



The screenshot shows the Federal Register website. At the top, the Federal Register logo and the text 'The Daily Journal of the United States Government' are visible. Below this, a blue banner reads 'Notice'. The main title of the notice is 'Developing an Update to the National Space Weather Strategy'. Below the title, it says 'A Notice by the Commerce Department on 04/20/2018'. The notice is categorized as a 'PUBLISHED DOCUMENT'. On the left side, there is a sidebar with icons for various actions like commenting, sharing, and printing. The main content area is divided into sections: 'AGENCY:', 'ACTION:', and 'SUMMARY:'. The 'AGENCY:' section lists the National Weather Service, National Oceanic and Atmospheric Administration, and the U.S. Department of Commerce. The 'ACTION:' section states it is a 'Notice of request for information.' The 'SUMMARY:' section provides a detailed overview of the request for information, mentioning the National Science and Technology Council (NSTC), the National Weather Service (NWS), and the goals of the update, which include enhancing national preparedness, promoting American leadership, and improving private sector engagement. On the right side, there is a 'DOCUMENT DETAILS' box containing information such as the printed version (PDF), publication date (04/20/2018), agency (Department of Commerce), dates (responses due by May 16, 2018), document type (Notice), document citation (83 FR 17526), page count (17526-17527 (2 pages)), and document number (2018-08336).

**FEDERAL REGISTER**  
The Daily Journal of the United States Government

**Notice**

**Developing an Update to the National Space Weather Strategy**

A Notice by the [Commerce Department](#) on 04/20/2018

**PUBLISHED DOCUMENT**

**AGENCY:**  
National Weather Service, National Oceanic and Atmospheric Administration,  
U.S. Department of Commerce.

**ACTION:**  
Notice of request for information.

**SUMMARY:**  
On behalf of the National Science and Technology Council (NSTC), Committee on Homeland and National Security, the National Weather Service (NWS) requests input from all interested parties on the development of an update to the National Space Weather Strategy (Strategy). Through this Request for Information (RFI), NWS seeks input from the public on ways to improve government coordination and on long-term guidance for Federal programs and activities to enhance national preparedness to space weather events, including geomagnetic disturbance (a natural source of electromagnetic pulse); promote American leadership in space weather research, technology, and innovation; and improve the safety and viability of human and robotic space activities. This RFI also seeks input on ways to enhance private sector engagement across these endeavors. The public input provided in response to this RFI will inform the

**DOCUMENT DETAILS**

**Printed version:**  
[PDF](#)

**Publication Date:**  
04/20/2018

**Agency:**  
[Department of Commerce](#)

**Dates:**  
Responses are due by May 16, 2018.

**Document Type:**  
Notice

**Document Citation:**  
83 FR 17526

**Page:**  
17526-17527 (2 pages)

**Document Number:**  
2018-08336

**DOCUMENT DETAILS**

# Update to the National Space Weather Strategy

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- Continue successful interagency approach executed through the SWORM Subcommittee
- Develop a policy for space weather preparedness that aligns to this Administration's priorities
- Advance a national space weather strategy that bolsters America's leadership in space and enhances national security
- Align ongoing and future activities to further enhance the preparedness of the Nation to space weather events

# Alignment with Administration Priorities

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- Enhance the Nation's resilience to natural disasters and the threat of EMP
- Reduce Government reporting burden and enhance Government efficiency
- Improve the safety and longevity of human and robotic space activities
- Facilitate access to data and identify novel and non-traditional private sector data sets
- Enhance private sector's contributions to space weather preparedness and the viability of commercial space endeavors
- Strengthen the U.S. military
- Promote leadership in research, technology, and innovation

# Recent Executive and Legislative Policies

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## Executive

- **2017 National Security Strategy**
  - Promotes American resilience
  - Seeks to build culture of preparedness
  - Calls to address threat from electromagnetic attacks
  - Prioritize U.S. leadership in research, technology, invention, and innovation
- **Space Policy Directive-1**
  - Amends 2010 National Space Policy
  - Identifies human space exploration as a priority
- **FY2019 President's Budget Request**
  - Continues to support space weather-related R&D

## Legislation

- **FY2017 National Defense Authorization Act**
  - Calls for DHS to develop strategy to protect against threats of EMP, both natural and adversarial
- **FY2018 NDAA**
  - Re-establishes the EMP Commission
  - Identifies space weather as a hazard to military operations in defense of the U.S.
  - Authorizes the Secretary of Defense to ensure timely provision of operational space weather products
- **Consolidated Appropriations Act, 2018**
  - Funded several space weather programs
  - Directed DOE and FEMA to take actions to address space weather
- **Space Weather Research and Forecasting Act**
  - S.141 Passed by the Senate in May 2017
  - H.R. 3086 House continues to review

Credit: OSTP

# Space Weather Legislation

## S.141 - Space Weather Research and Forecasting Act

- 2 May 2017 – Passed in Senate unanimously



### Press Releases

[Home](#) / [Newsroom](#) / [Press Releases](#)

May 02 2017

### Senate Unanimously Approves Bill to Improve Space Weather Prediction

**Peters-Gardner-Booker-Wicker-Klobuchar Bill Helps Address Economic Impact of Solar Flares on Technology**





# 24 July 2018: The House Science Committee recommended new text

The House Science Committee substituted the text of S.141 with a new bill. Among the differences in the amended bill are provisions that give responsibilities for space weather coordination to the National Space Council, which had not yet been reestablished when the Senate passed S.141 last year



# The Space Weather Enterprise

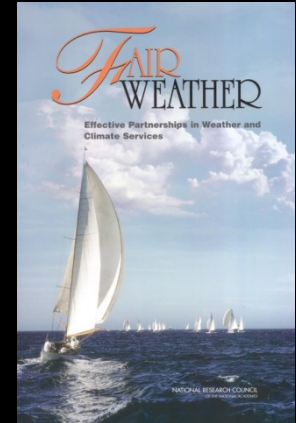
Products and Services

**Maximizing Value**

Analogy:  
**“Weather  
Enterprise”**

Government

- **Public Safety**
- Economic Health
- National Defense
- **Regulation**



Academia

- Science
- **Research**

Commercial


- Services
- **Efficiency**
- Competition
- **Robust Economy**
- Communication



# National Space Council

**Space Policy Directive-3:** “Department of Commerce should be the new civil agency interface for space traffic management (STM) and space situational awareness (SSA)”

- Space Weather situational awareness is critical when assessing the natural environment occupied by the increasing government and commercial space activity, which will soon include space tourism
- Space weather services contribute to the following goals of STM:
  - Mitigate the effect of orbital debris on space activities  
*(actionable collision avoidance warnings require space weather information)*
  - Encourage and facilitate U.S. commercial leadership in S&T, SSA, and STM
  - Provide U.S. Government-supported basic SSA data and basic STM services to the public
  - Improve SSA data interoperability and enable greater SSA data sharing



“We are increasingly dependent on advanced technology. The potential for disruption to society, including the possible destruction of critical infrastructure by space weather events, is alarming. While we have made strides toward better modeling and prediction of solar phenomena as well as accurately forecasting space weather, there is still significant room for improvement.”

House Committee on Science, Space, & Technology  
Lamar Smith (R-Texas)  
26 April 2018

*Thank You!*

Slide credits to: OSTP, NOAA-SWPC, USAF A3W, ACSWA



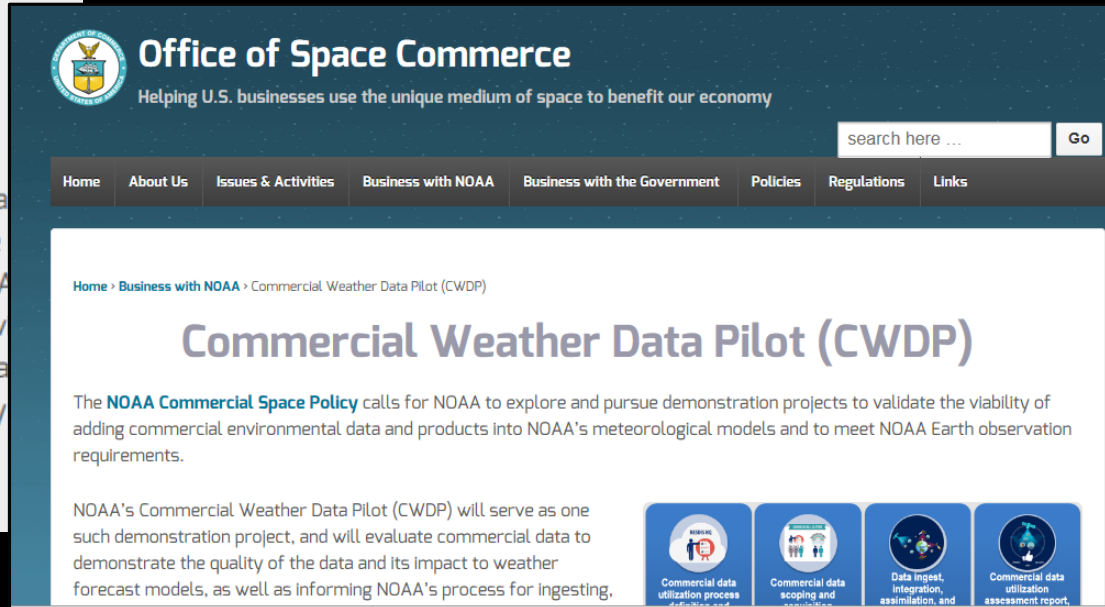


**Action 5.3.7** DOC (Commerce) and DOD (Defense) will enable and sustain the acquisition and delivery of satellite-based GNSS radio occultation data with sufficient geographical coverage, data-rate, and latency to satisfy operational ionospheric-forecasting requirements.

## 2016 Contract Awards

On September 15, 2016, NOAA awarded contracts to GeoOptics, Inc., and Spire Global, Inc., as part of the Commercial Weather Data Pilot.

GeoOptics and Spire Global will each provide space-based GNSS radio occultation data to NOAA for the purpose of demonstrating data quality and potential value to NOAA weather forecasts and warnings. This approach is a win-win solution. Both NOAA and the commercial firms will gain from the trial run of the NOAA evaluation process, a necessary step to considering sustained operational use of new commercial weather data.



The screenshot shows the NOAA Office of Space Commerce website. The header features the NOAA logo and the text "Office of Space Commerce" with the tagline "Helping U.S. businesses use the unique medium of space to benefit our economy". A search bar is located on the right. Below the header is a navigation menu with links: Home, About Us, Issues & Activities, Business with NOAA, Business with the Government, Policies, Regulations, and Links. The main content area has a breadcrumb trail: Home > Business with NOAA > Commercial Weather Data Pilot (CWDP). The title "Commercial Weather Data Pilot (CWDP)" is prominently displayed. Below the title, a paragraph states: "The NOAA Commercial Space Policy calls for NOAA to explore and pursue demonstration projects to validate the viability of adding commercial environmental data and products into NOAA's meteorological models and to meet NOAA Earth observation requirements." Further down, another paragraph explains: "NOAA's Commercial Weather Data Pilot (CWDP) will serve as one such demonstration project, and will evaluate commercial data to demonstrate the quality of the data and its impact to weather forecast models, as well as informing NOAA's process for ingesting." At the bottom, there are four circular icons representing different stages of the process: "Commercial data utilization process", "Commercial data scoping and evaluation", "Data ingest, integration, assimilation, and", and "Commercial data utilization assessment report".

**Office of Space Commerce**  
Helping U.S. businesses use the unique medium of space to benefit our economy

search here ... **Go**

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[Home](#) > [Business with NOAA](#) > Commercial Weather Data Pilot (CWDP)

## Commercial Weather Data Pilot (CWDP)

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NOAA's Commercial Weather Data Pilot (CWDP) will serve as one such demonstration project, and will evaluate commercial data to demonstrate the quality of the data and its impact to weather forecast models, as well as informing NOAA's process for ingesting.

**Commercial data utilization process**  
**Commercial data scoping and evaluation**  
**Data ingest, integration, assimilation, and**  
**Commercial data utilization assessment report**

**EO Action 5(e)** The DOD and DOC shall make historical data from the GPS constellation and other U.S. Government satellites publicly available to enhance model validation and improvements in space weather forecasting and situational awareness.

**23 satellites: More than 141 satellite-years of data!**

- **GPS/MEO Data now available at NOAA/NCEI**
- **LANL(DOE)/GEO particle data to follow soon**

