NOAA Space Weather Prediction Center Update

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National Oceanic and Atmospheric Administration

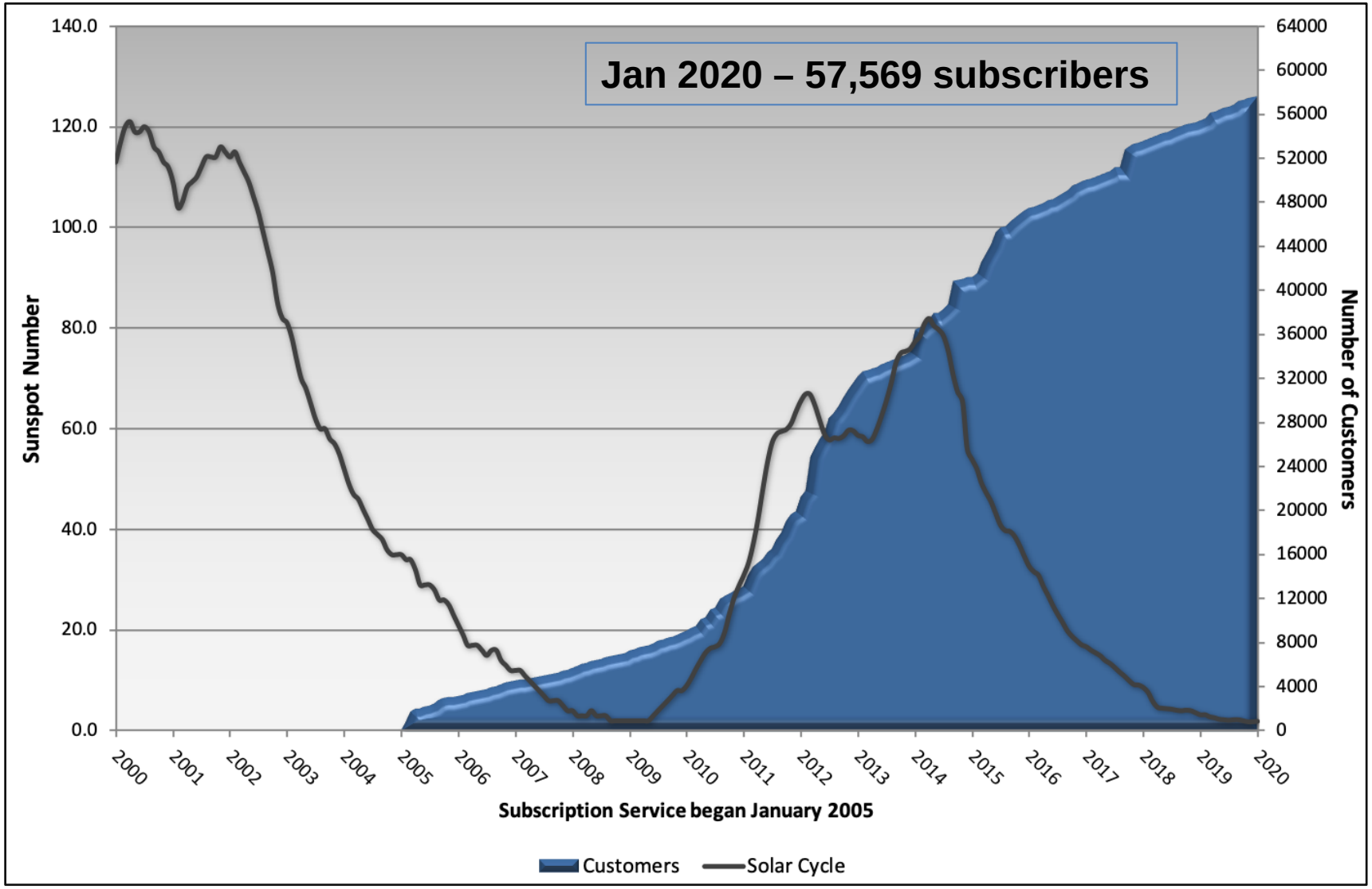
Acknowledgments: Biesecker, Hill, Murtagh, Singer

Committee on Solar and Space Physics - 1 Apr 2020

Customer growth – SWPC Product Subscription Service

Number of subscribers to SWPC services continues to rise – even during solar minimum

- **~150 new subscribers per month**
- **Adding in many sectors and industries**
  - **Major airlines**
  - **Drilling and oil exploration**
  - **Satellite companies**
  - **Power grid operators**
  - **Agriculture**
  - **Emergency Responders**
  - **Space exploration**

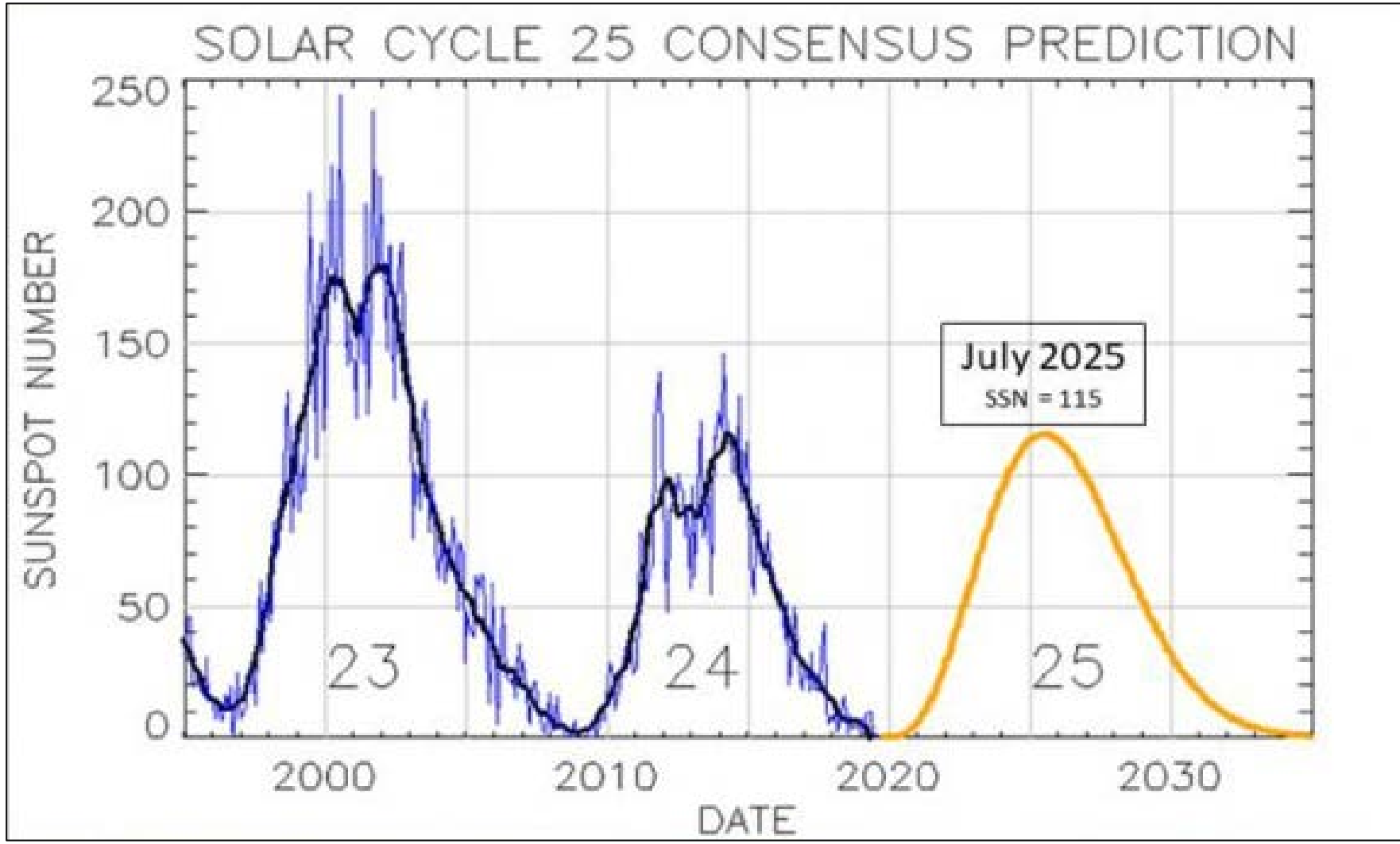


Solar Cycle 25 Forecast Update

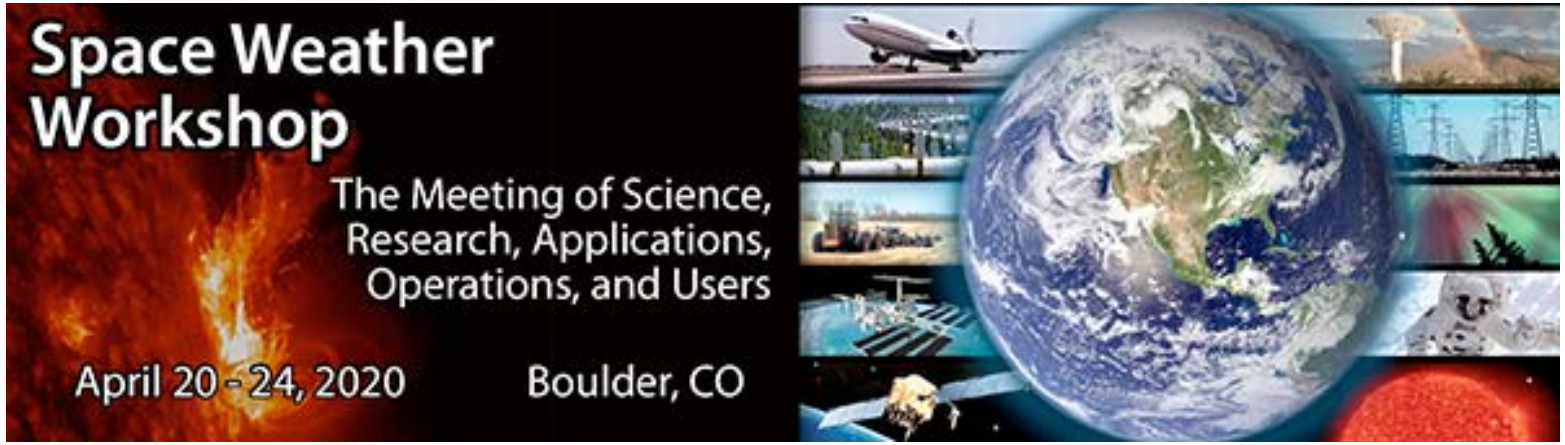
NASA funded-NOAA Led International Team

Solar Cycle 25 will have a peak Sunspot Number of 115 (± 10) in July 2025

Solar Cycle 24/25 minimum will occur in April 2020 (± six months)



Space Weather Workshop – 2020-Cancelled
Look forward to next year: April 19-23 2021



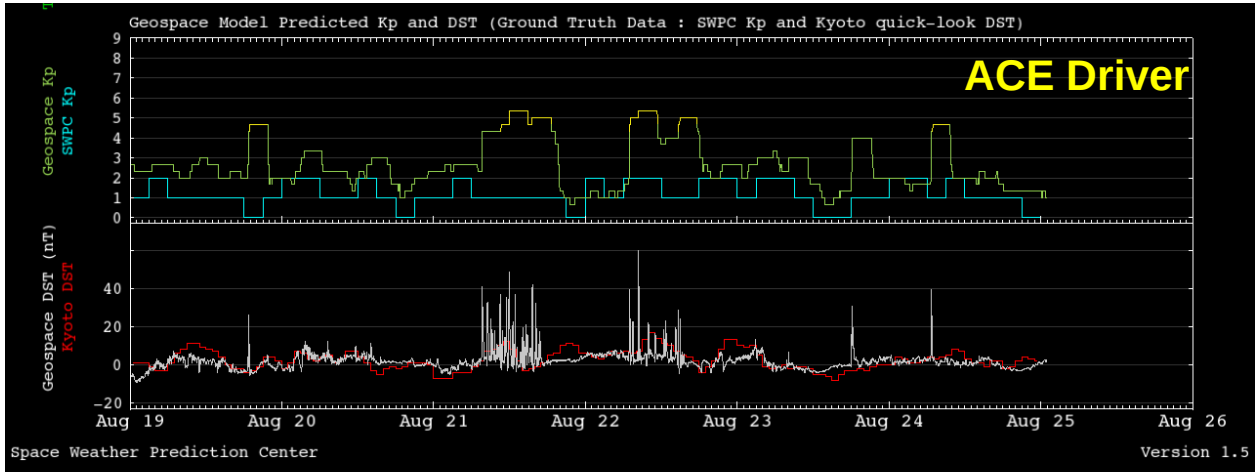
- UCAR organized (+Steering Committee)
- Co-sponsored NOAA, NASA, NSF
- Brings together: researchers, space weather service providers, and users of space weather services
- Last year over 360 attendees; 91 oral; 96 poster, >20 students; 20 nations
- 2020 program was 95 % complete including greater diversity, enhanced student program, exciting new research results, operational impacts…
- Topics included: Satellite Anomalies, R2O2R, Power Grids, Aviation, new Observations and Models, Human Exploration, and more

NOAA's Deep Space Climate Observatory (DSCOVR) satellite operational again

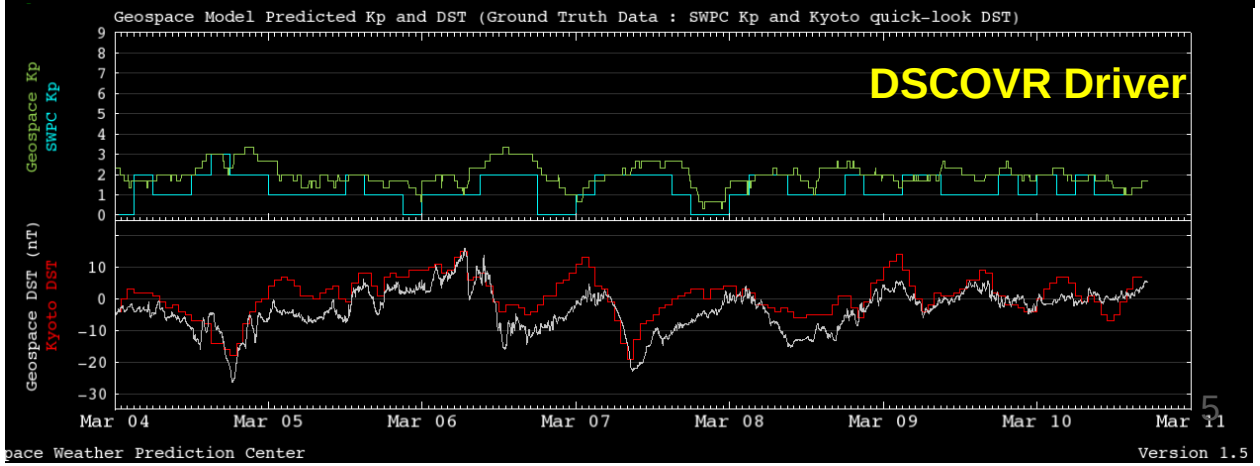
2 March 2020: DSCOVR had been offline for ~nine months due to a technical glitch, is fully operational again

SWPC Models Depend on High-Quality Solar Wind Data

- NASA ACE data served SWPC operations well; now backup for DSCOVR
- Real-time ACE data can be noisy when solar wind density is low - DSCOVR data have less noise
- Geospace, and other operational models driven by solar wind, are sensitive to data quality

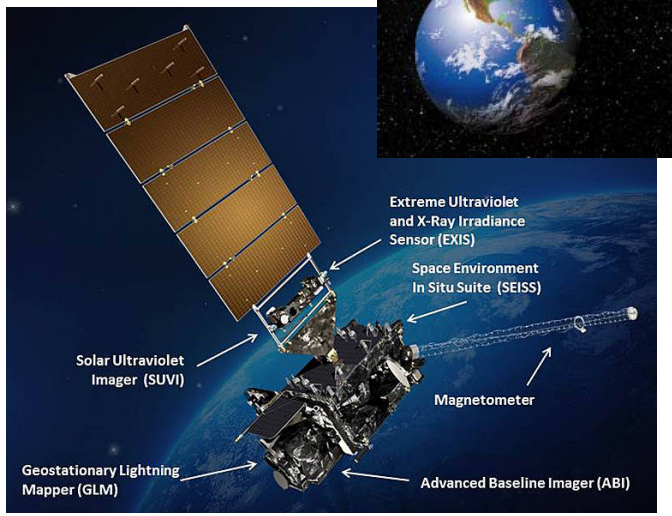


Geospace Model Predictions (7-day plot) compared to Obs
Top panels: Kp model (varying colors) vs Kp SWPC (blue)
Bottom panels: Dst model (white) vs Dst Kyoto (red)



NOAA Geostationary Operational Environmental Satellite (GOES) – Update from Operations

- GOES -13 transferred to AF; GOES-14, and GOES-15 retired
- At SWPC: GOES -16 in operations, GOES -17 begins late 2020
  - GOES -13, -14, and -15 (Boeing)
    - Began with GOES-13 launch 5/24/06
    - GOES-13 decommissioned by NOAA 2018
    - GOES -14 storage 3/4/20; GOES-15 storage 3/9/20
  - GOES-R Series: GOES -16, -17, T, and U (Lockheed M)
    - Began with GOES-16 launch 11/19/2016

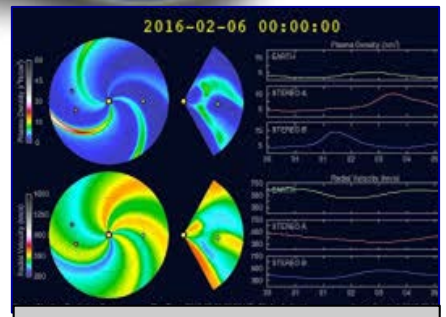


New GOES –R Series comes with <u>new capabilities</u> including:

- **high-resolution Solar Ultraviolet Imager, expanded energy range for energetic particles, and a <u>coronagraph</u> planned for GOES–U**

More from Elsayed Talaat next

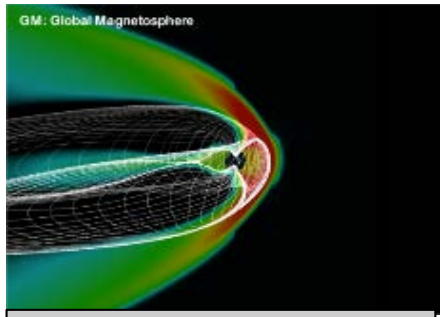
Operational Space Weather Modeling at NOAA – A Sun-to-Earth Continuum



GMU/AFRL WSA/Enlil

Predict and understand the structure of the solar wind as it propagates from the Sun to Earth

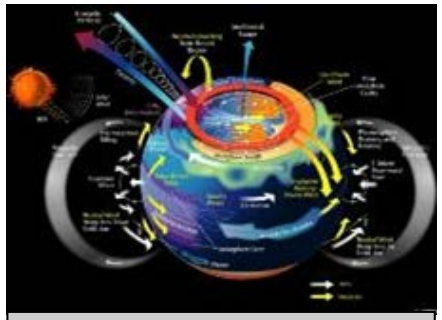
Operational 2011
Upgraded 2019



U. Michigan Geospace

Predict and understand the geomagnetic response to changes in solar wind; provide regional predictions of geomagnetic storms

Operational
Sept 2016



NOAA/CIRES WAM-IPE

Predict and understand details in the mesosphere, exosphere, and ionosphere, to understand links between the lower and upper atmosphere

Operational 2021

NOAA/USGS E-field

Characterize and predict the regional electric field and the associated currents that impact electric power grids

Operational
Sept 2019

A modeling framework that captures critical domains of the Sun-Earth system, beginning at the Sun and ending at the Earth's surface..

Supporting a space weather watch/warning paradigm similar to terrestrial weather...

New Space Weather Services for Global Aviation

U.N. International Civil Aviation Organization (ICAO) called for the establishment of space weather information services for global aviation

- Services began November 7, 2019

- Three centers selected for the provision of services:
  - SWPC - United States
  - PECASUS – A Pan-European Consortium including Finland (Lead), Belgium, UK, Poland, Germany, Netherlands, Italy, Austria, and Cyprus
  - ACFJ – Consortium of Australia, Canada, France, and Japan

- New products in development now to address space weather impacts on communications, navigation, and health (radiation exposure)

Space Policy Directive-3 (SPD-3): National Space Traffic Management (STM)

"Timely and actionable Space Situational Awareness data and STM services are essential to space activities" (*SPD-3 Jun 2018*)

NASA ROSES-20 Amendment 8 (Mar 2020): Space Weather Science Application Operations-to-Research

- **Satellite Drag:** Improve the specification and forecast of neutral density in the thermosphere as it pertains to satellite drag and orbital operations.

The National Academy of Public Administration (NAPA) has contracted with NOAA to conduct an assessment of the Office of Space Commerce

- NAPA will conduct an assessment of which department or agency, and entity within that department or agency, is best suited for responsibility for space traffic management

National Policy Initiatives – 2019 White House Strategy and Action Plan: Enhance the Nation's resilience to space weather

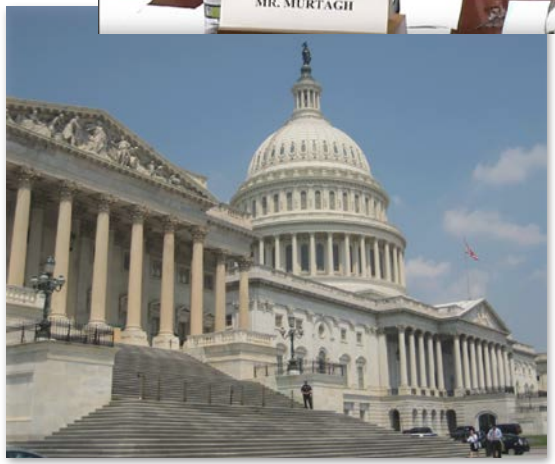
- Enhancing the protection of national security, homeland security, and commercial assets and operations against the effects of space weather
- Developing and disseminating accurate and timely space weather characterization and forecasts
- Establishing plans and procedures for responding to and recovering from space weather events.

The underpinning science and observations will help drive advances in modeling capability and improve the quality of space-weather products and services.

National Policy Initiatives – Congressional action: New space weather bills introduced

Senate bill 881 – *"Space Weather Research and Forecasting Act"*

Bipartisan legislation passed the Senate Commerce Committee in Apr 2019; placed on Senate Legislative Calendar in Dec 2019 awaiting Senate floor action in 2020



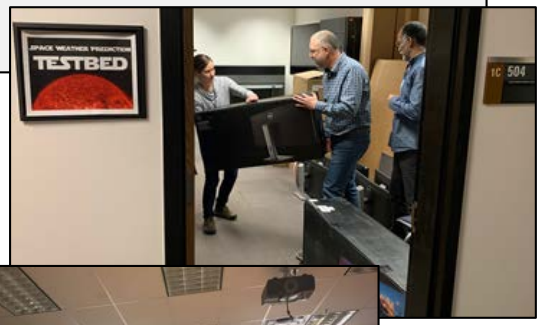
House bill 5260 – "*Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow Act*"

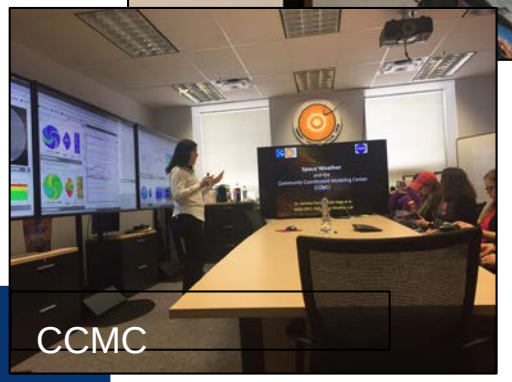
House companion to S. 881 – bipartisan support

Introduced in Nov 2019 - approved by the House Committee on Science, Space and Technology on 9 Jan 2020

Research-to-Operations-to-Research (R2O2R)

National Space Weather Strategy and Action Plan 2.7: Identify mechanisms for sustaining and transitioning models and observational capabilities from research to operations that will include academic, private sector, and international partnerships.





Identify an effective R2O2R process for space weather:

- Partnerships with Gov. Agencies, Academia, Private Sector, International
- Includes Community Coordinated Modeling Center (CCMC) at NASA GSFC in R2O partnership, priorities, and process
- New Space Weather Capabilities Research-to-Operations (R2O)
  - Evaluate, Prototype, Transition
- Operations-to-Research (O2R)
  - Improves existing operational capabilities
  - Informs future capabilities
  - Establishes research priorities

Capabilities

- Products
- Models
- Observations
- Applications
- Techniques

Space Weather: Recent R2O2R History

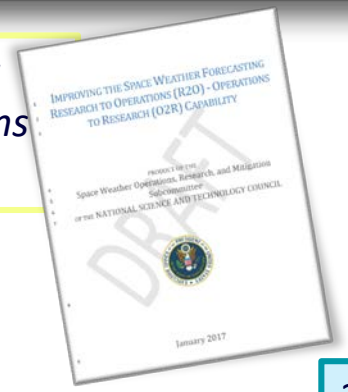
1st of several activities at EOP to address gaps in R2O2R

Space Weather Operations to Research (O2R) Workshop

Oct 2015

Oct 2016

Draft document "*Improving the Space Weather Forecasting Research to Operations – Operations to Research Capability*"



Tri-Agency MOU
NASA, NOAA, NSF

Jan 2018

Mar 2019

2020 – Working with White House and across Federal agencies to develop a R2O2R Framework

Jul 2014

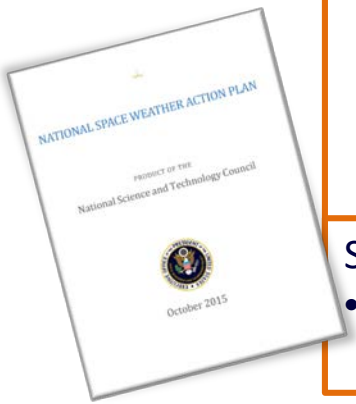
Aug 2016

Jan 2017

Nov 2018

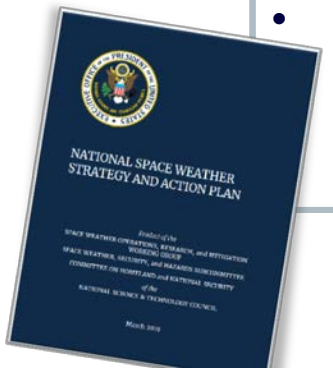
EO 13744 – *Coordinating Efforts to Prepare the Nation for Space Weather Events* (R2O2R)

First Coordinated Interagency Space Weather Applied Research Funding opportunity



SWAP 5.6.1 and 5.6.2 focused on R2O2R

- Improvement, testing, and maintenance of operational forecast models



Action 2.7 in the 2019 NSW-SAP

- Identify mechanisms for sustaining and transitioning models and observational capabilities from research to operations

R2O2R Challenges

- Tsunami of O2R ROSES Grant and other research with no feasible path to formal validation, demonstration, and transition to NOAA Operations
  - $10Ms investment in R&D (e.g., DHS, DOE, DOI, and DOD) per NSW-SAP
  - Lack of commensurate investment in R2O
    - No Catchers Mitt; The “Valley of Death”
- NOAA constrained resources only support continuous improvement of currently operational models
  - Currently incapable of accepting new capabilities for transition to operations
- Lack of R2O Infrastructure, Standards, and Processes

NOAA Testbeds and Proving Grounds

https://www.testbeds.noaa.gov/

NOAA's testbeds and proving grounds facilitate the orderly transition of research capabilities to operational implementation

- Developmental testing
- Researchers and operational scientists/experts
- Government Agencies, Academia, Private Sector, International Partners

Research to Operations to Research Process

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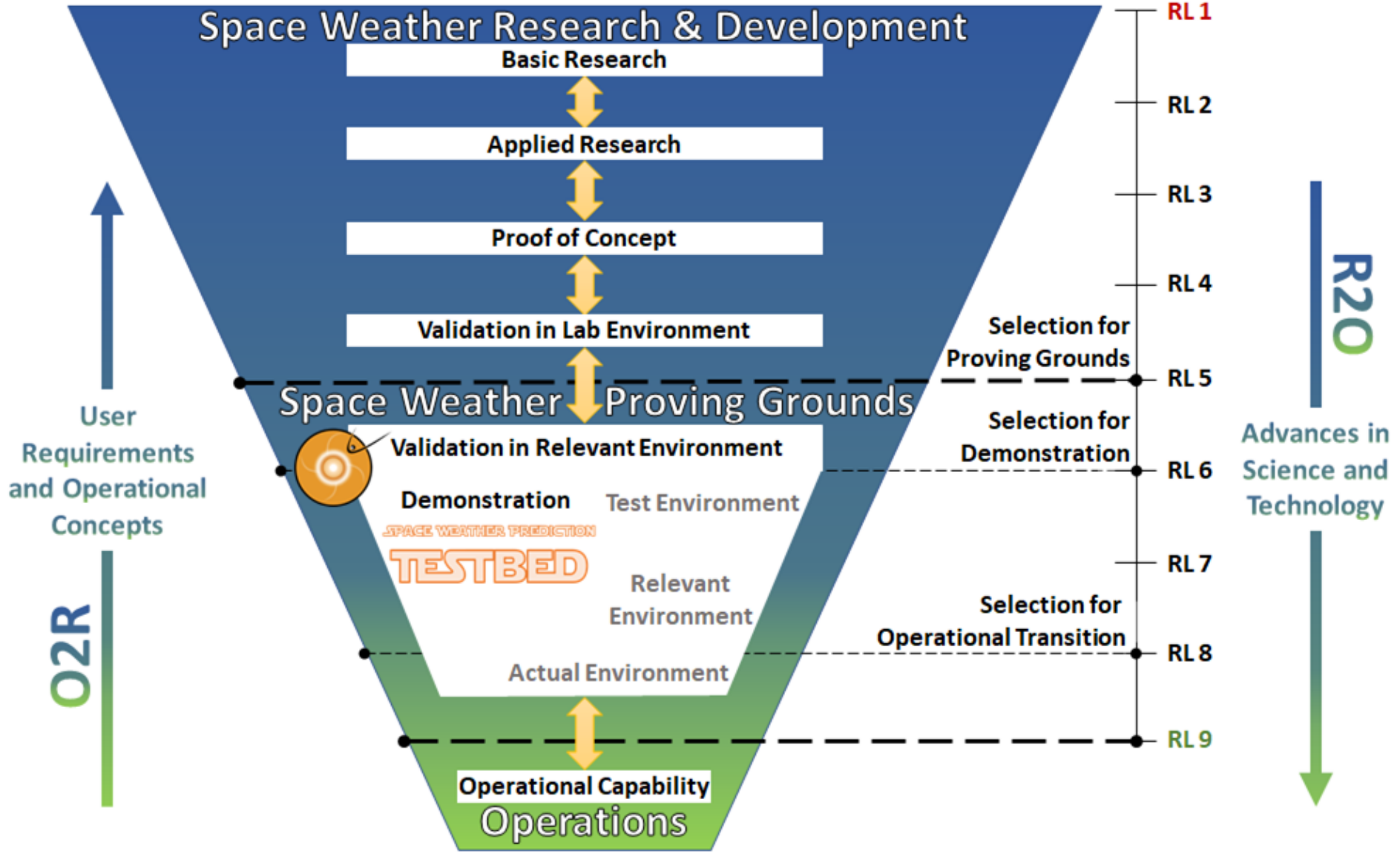

Space Weather Prediction Testbed (SWPT)

- New and improved capability evaluation / operational prototyping
- Includes a new physical facility at SWPC
- Core set of professionals highly experienced in R2O
- Researchers, developers, forecasters, and customers
  - Government Agencies, Academia, Private Sector, Int'l Partners
- Conduct collaborative exercises and experiments under quasi-operational conditions

Conclusion

"The Secretary of Commerce will ensure the continuous improvement of operational space weather services, utilizing partnerships, as appropriate, with the research community, including academia and the private sector, and relevant agencies to develop, validate, test, and transition space weather models from research to operations and from operations to research"

Executive Order 13744 - *Coordinating Efforts to Prepare the Nation for Space Weather Events*