ADVANCING COMMERCIAL WEATHER DATA: COLLABORATIVE EFFORTS TO IMPROVE FORECASTS, PART II

HEARING

BEFORE THE

SUBCOMMITTEE ON ENVIRONMENT

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED FOURTEENTH CONGRESS

FIRST SESSION

July 14, 2015

Serial No. 114–31

Printed for the use of the Committee on Science, Space, and Technology

Available via the World Wide Web: http://science.house.gov

U.S. GOVERNMENT PUBLISHING OFFICE
97–571PDF WASHINGTON : 2017

For sale by the Superintendent of Documents, U.S. Government Publishing Office
Internet: bookstore.gpo.gov Phone: toll free (866) 512–1800; DC area (202) 512–1800
Fax: (202) 512–2104 Mail: Stop IDCC, Washington, DC 20402–0001

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HON. LAMAR S. SMITH, Texas, *Chair*

FRANK D. LUCAS, Oklahoma
F. JAMES SENSENBRENNER, JR., Wisconsin
DANA ROHRABACHER, California
RANDY NEUGEBAUER, Texas
MICHAEL T. McCAUL, Texas
MO BROOKS, Alabama
RANDY HULTGREN, Illinois
BILL POSEY, Florida
THOMAS MASSIE, Kentucky
JIM BRIDENSTINE, Oklahoma
RANDY K. WEBER, Texas
BILL JOHNSON, Ohio
JOHN R. MOOLENAAR, Michigan
STEVE KNIGHT, California
BRIAN BABIN, Texas
BRUCE WESTERMAN, Arkansas
BARBARA COMSTOCK, Virginia
DAN NEWHOUSE, Washington
GARY PALMER, Alabama
BARRY LOUDERMILK, Georgia
RALPH LEE ABRAHAM, Louisiana
EDDIE BERNICE JOHNSON, Texas
ZOE LOFGREN, California
DANIEL LIPINSKI, Illinois
DONNA F. EDWARDS, Maryland
SUZANNE BONAMICI, Oregon
ERIC SWALWELL, California
ALAN GRAYSON, Florida
AMI BERA, California
ELIZABETH H. ESTY, Connecticut
MARC A. VEASEY, Texas
KATHERINE M. CLARK, Massachusetts
DON S. BEYER, JR., Virginia
ED PERLMUTTER, Colorado
PAUL TONKO, New York
MARK TAKANO, California
BILL FOSTER, Illinois

SUBCOMMITTEE ON ENVIRONMENT

HON. JIM BRIDENSTINE, Oklahoma, *Chair*

F. JAMES SENSENBRENNER, JR.
RANDY NEUGEBAUER, Texas
RANDY WEBER, Texas
JOHN MOOLENAAR, Michigan
BRIAN BABIN, Texas
BRUCE WESTERMAN, Arkansas
GARY PALMER, Alabama
RALPH LEE ABRAHAM, Louisiana
SUZANNE BONAMICI, Oregon
DONNA F. EDWARDS, Maryland
ALAN GRAYSON, Florida
AMI BERA, California
MARK TAKANO, California
BILL FOSTER, Illinois
EDDIE BERNICE JOHNSON, Texas

CONTENTS

July 14, 2015

ADVANCING COMMERCIAL WEATHER DATA: COLLABORATIVE EFFORTS TO IMPROVE FORECASTS, PART II

TUESDAY, JULY 14, 2015

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENVIRONMENT
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Committee met, pursuant to call, at 10:05 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Jim Bridenstine [Chairman of the Subcommittee] presiding.

LAMAR S. SMITH, Texas
CHAIRMAN

EDDIE BERNICE JOHNSON, Texas
RANKING MEMBER

Congress of the United States
House of Representatives

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
2321 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515-6301
(202) 225-6371
www.science.house.gov

Subcommittee on Environment

Advancing Commercial Weather Data:
Collaborative Efforts to Improve Forecasts, Part II

Tuesday, July 14, 2015
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Witnesses

The Honorable Manson Brown, Deputy Administrator, National Oceanic and Atmospheric Administration

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON ENVIRONMENT

HEARING CHARTER

Advancing Commercial Weather Data: Collaborative Efforts to Improve Forecasts Part II

Tuesday, July 14, 2015
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Purpose

The Environment Subcommittee will hold a hearing titled *Advancing Commercial Weather Data: Collaborative Efforts to Improve Forecasts Part II* on Tuesday, July 14, 2015, at 10:00 a.m. in room 2318 of the Rayburn House Office Building. The purpose of this hearing is to examine weather data policies and acquisition strategies of the National Oceanic and Atmospheric Administration (NOAA). Robust data streams from multiple observing systems are essential to maintaining up-to-date information to predict weather accurately and with timeliness, especially for extreme weather events like tornadoes and severe storm systems. Sources available for weather data include U.S. government-, international-, and commercially-owned and operated satellite-, aviation-, and surface-based observing systems. This hearing will examine NOAA's policies and partnerships for integrating these myriad data sources into weather predictions.

Witnesses

- **The Honorable Manson Brown**, Deputy Administrator, National Oceanic and Atmospheric Administration

Background

With a high potential for coverage gaps from NOAA's planned geostationary and polar orbiting satellite systems, it is critical to ensure continuous and robust streams of weather data to protect citizens, property, and safeguard the American economy. A report by the National Research Council in 2003 estimated that 80% of the data assimilated into numerical weather models comes from satellites.[1] This figure has not demonstrably changed since then. NOAA's

[1] National Research Council, "Fair Weather Report: Effective Partnership in Weather and Climate Services," 2003, available at: http://www.nap.edu/catalog/10610/fair-weather-effective-partnerships-in-weather-and-climate-services

Global Data Assimilation System also uses observations from various land-based sensors like radar or sound wave wind profilers, balloons, aircraft, and buoys to formulate the Global Forecast System model.[2] NOAA relies upon different technologies, observing systems, and partnerships for data that is constantly available for use in formulating forecasts and predicting weather events to protect lives and property.

Satellite Observing Systems

NOAA operates two main types of satellites that provide weather data. The geostationary satellite program, called Geostationary Operational Environmental Satellites (GOES), constantly monitors the Earth. The geostationary satellite fleet is comprised of three satellites: one satellite monitors the western United States (GOES-WEST), one satellite monitors the eastern United States (GOES-EAST), and one spare satellite sits in orbit to provide backup duties in the event of satellite failures. NOAA's next geostationary satellite is planned for launch in 2016.

The polar satellite program, called the Polar Operational Environmental Satellites, monitors the Earth from 500 miles above, traversing the globe 14 times daily between the north and south poles as the Earth spins.[3] The current polar orbiting fleet consists of three satellites operating in the afternoon orbit, NOAA-15, NOAA-18, and NOAA-19, all with various degrees of age and performance.[4] NOAA's next polar orbiting satellite is planned for launch in 2017.

International Satellite Agreements and Cooperation

In addition to U.S. government-owned satellites, NOAA has partnerships to ensure robust data streams. The European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) operates polar orbiting satellites that add coverage of the Earth in the mid-morning orbit.[5] These satellites comprise the Initial Joint Polar System Agreement (IJPS) between EUMETSAT and NOAA to share polar-orbiting satellite data.[6]

Likewise, there is historical context for geostationary satellite cooperation. EUMETSAT and NOAA now have formal collaboration to perform backup agreements in the event of a satellite failure. In 1985, Meteosat-2 (a European satellite) failed and was replaced by GOES-4

[2] National Oceanic and Atmospheric Administration, "Global Data Assimilation System," 2012, available at: https://www.ncdc.noaa.gov/data-access/model-data/model-datasets/global-data-assimilation-system-gdas
[3] National Oceanic and Atmospheric Administration, "Polar-orbiting Operational Environmental Satellites," 2014, available at: http://www.ospo.noaa.gov/Operations/POES/
[4] National Oceanic and Atmospheric Administration, "POES Operational Status," 2014, available at: http://www.ospo.noaa.gov/Operations/POES/status.html
[5] EUMETSAT, "Metop," 2015, available at: http://www.eumetsat.int/website/home/Satellites/CurrentSatellites/Metop/index.html
[6] Ibid.

to cover the operational gap over Europe.[7] In 1989, a NOAA satellite, GOES-6 failed and was aided by European satellite Meteosat-3 to cover the U.S. and Western Atlantic.[8]

NOAA also has relationships with other government organizations for weather data, including the Japan Meteorological Agency (JMA), Japan Aerospace Exploration Agency (JAXA), French Space Agency CNES), National Space Organization Taiwan (NSPO), Indian Space Research Organization (ISRO), Canadian Space Agency (CSA).[9]

Surface Observing Systems

NOAA also conducts observations and ingests datasets from surface-based observing systems. According to NOAA, "knowing the current state of the weather is just as important as the numerical computer models processing the data."[10]

NOAA operates land-based stations to collect data as part of its Automated Surface Observing System. Ground-based observing systems are located throughout the United States and collect data on various aspects of the atmosphere including ground temperature, humidity, precipitation, and wind speed.[11] NOAA also collects data from weather balloons with instruments called radiosondes that ascend through the atmosphere to collect data, which is then received by ground stations. The data from radiosondes are used for input into computer-based prediction models, local severe storm forecasts, and weather research.[12]

NOAA also acquires data on lightning through a partnership with Vaisala, a private sector company that uses ground based sensors to track lightning activity in the United States.[13] Of note, the raw data from this partnership is freely available throughout the U.S. government, and several derived products are openly available to all users.[14]

Aviation Observing Systems

NOAA also collects weather data from aviation-based observing systems. NOAA receives Aircraft Communications Addressing and Reporting System data (ACARS), as well as Aircraft Meteorological Data Relay (AMDAR). These systems provide data from commercial

---

[7] European Space Policy Institute, "EUMETSAT – NOAA Collaboration in Meteorology from Space," 2013, available at: http://www.espi.or.at/images/stories/dokumente/studies/ESPI_Report_46.pdf
[8] Ibid.
[9] National Oceanic and Atmospheric Administration, "Developing Partnerships," 2015, available at: http://www.nesdisia.noaa.gov/developingpartnerships.html
[10] National Oceanic and Atmospheric Administration, "Numerical Weather Prediction," 2015, available at: https://www.ncdc.noaa.gov/data-access/model-data/model-datasets/numerical-weather-prediction
[11] National Oceanic and Atmospheric Administration, "Land-Based Station Data," 2015, available at: https://www.ncdc.noaa.gov/data-access/land-based-station-data
[12] National Oceanic and Atmospheric Administration National Weather Service, "Radiosonde Observations," 2015, available at: http://www.ua.nws.noaa.gov/factsheet.htm
[13] National Oceanic and Atmospheric Administration, "Lightning Products and Services," 2015, available at: https://www.ncdc.noaa.gov/data-access/severe-weather/lightning-products-and-services
[14] Ibid.

aircraft during flight. According to NOAA, "the participating airlines retain a proprietary interest in their data and therefore set the rules regarding to whom and how it may be redistributed." [15] Both data from ACARS and AMDAR are assimilated into NOAA's National Center for Environmental Prediction models.[16]

Ocean Observing Systems

Ocean activities relating to weather at NOAA are conducted under the Integrated Ocean Observing System (IOOS), a partnership between federal, regional, private sector, and the academic community to track, predict, manage, and adapt to changes in marine environments.[17] The primary technologies deployed for ocean observing systems are oceanographic buoys, sensors, and coastal radars. The various data from these systems include air temperature, water temperature, wind direction and speed, and wave heights.[18]

Data Policy

With the multiple observing systems in use by NOAA to collect environmental data, an understanding of NOAA's data policies is crucial as the Agency evolves in the future to take advantage of more data sources and methods of collection. NOAA's Office of Technology, Planning, and Integration of Observation (TPIO) is responsible for "identifying and documenting all current and planned observation systems providing data to meet NOAA observational requirements and conducting analyses to aid in the development of an integrated observing system portfolio."[19] This office is also responsible for assessing NOAA's observation requirements for current, planned, and conceptual observational capabilities, as well as the prioritization of requirements.[20]

The Agency relies on multiple documents to outline its policy on sharing environmental data. NOAA advocates the use of full and open data policies that allow for the sharing of important environmental data.[21] NOAA provides data to the world and receives data in return. According to NOAA's partnership policy website, the agency adheres to the policies contained in the Paperwork Reduction Act, the Government Paperwork Elimination Act, and OMB

[15] National Oceanic and Atmospheric Administration National Weather Service, "ACARS/AMDAR Data," 2006, available at: http://www.nco.ncep.noaa.gov/sib/restricted_data/restricted_data_sib/acars+amdar/
[16] Ibid.
[17] National Oceanic and Atmospheric Administration National Ocean Service, "Integrated Ocean Observing System," 2014, available at: http://oceanservice.noaa.gov/programs/ioos.html
[18] NERACOOS, "About Ocean Observing Systems," 2014, available at: http://www.neracoos.org/about/ocean_observing
[19] National Oceanic and Atmospheric Administration Technology, Planning, and Integration for Observation, "NOAA Observing Systems," 2015, available at: https://www.nosc.noaa.gov/tpio/main/aboutosa.html
[20] Ibid.
[21] National Oceanic and Atmospheric Administration Satellite and Information Service, "Satellite and Data Policy," 2012, available at: http://www.nesdisia.noaa.gov/policy.html

Circular No.A-130.[22] The Agency is also guided by the National Space Policy of the United States of America, released in 2010.[23] In addition, the World Meteorological Organization's Resolution 40 established standards of sharing meteorological data openly, which is used by NOAA today.[24]

Additional Reading

- National Research Council. *Fair Weather: Effective Partnerships in Weather and Climate Services*. Washington, DC: The National Academies Press, 2003. Available at: http://www.nap.edu/catalog/10610/fair-weather-effective-partnerships-in-weather-and-climate-services
- National Research Council. Observing Weather and Climate from the Ground Up: A Nationwide Network of Networks. Washington, DC: The National Academies Press, 2009. Available at: http://dels.nas.edu/Report/Observing-Weather-Climate-from/12540
- Committee on Science, Space, and Technology. *To Observe and Protect: How NOAA Procures Data for Weather Forecasting.* Washington, DC. 2012. Available at: http://science.house.gov/hearing/subcommittee-energy-and-environment-hearing-how-noaa-procures-data-weather-forecasting

[22] National Oceanic and Atmospheric Administration, "Policy on Partnerships in the Provision of Environmental Information," 2015, available at: http://www.noaa.gov/partnershippolicy/
[23] White House, National Space Policy of the United States of America," 2010, available at: https://www.whitehouse.gov/sites/default/files/national_space_policy_6-28-10.pdf
[24] World Meteorological Organization, "Resolution 40," 2015, https://www.wmo.int/pages/about/Resolution40_en.html

Chairman BRIDENSTINE. The Subcommittee on Environment will come to order.

Without objection, the Chair is authorized to declare recess of the Subcommittee at any time.

Welcome to today's hearing titled "Advancing Commercial Weather Data: Collaborative Efforts to Improve Forecasts, Part II." I recognize myself for five minutes for an opening statement.

Today we are convening part two of a hearing we held in May on how the National Oceanic and Atmospheric Administration, NOAA, uses weather data to enhance their forecasting capability, and how and where they get that necessary data, and how these processes can be improved.

We have continually heard the word "robust" from multiple stakeholders when discussing the needs of our nation's satellite infrastructure, and I agree. But after hearing these perspectives, particularly from our hearing with NOAA in February, I believe the correct word for our current satellite architecture could be "fragile."

A gap in satellite data availability remains a very real threat. NOAA is taking the proper steps to mitigate this, but we still may be faced with an unprecedented gap in crucial weather data. We know that JPSS–1 has experienced delays and cost overruns, and we are now being told it is possible GOES–R will experience a slip from its planned March 2016 launch date. This underscores the need to augment our space-based observing systems by incorporating alternative modes of data collection. For instance, a competitive, commercial market for weather data could drive innovation, reduce costs, and increase the quantity and quality of data.

Through this Subcommittee's oversight, we learned that NOAA does in fact already purchase weather data from commercial entities, including lightning data, aircraft observations and synthetic aperture imagery for ice detection. Why not space-based weather data as well?

I have been encouraged by the forward-looking view of Stephen Volz, the head of NOAA NESDIS. He indicated that NOAA would be open to buying data from companies prepared to sell space-based weather data such as radio occultation and hyperspectral soundings. It was through our dialogue that we developed a concept for a pilot project to competitively select at least one provider of space-based data and test it against NOAA's proprietary data. With this pilot project, NOAA will be able to determine if the purchased data can be viably used in our numerical weather models. This pilot program was included in H.R. 1561, the Lucas-Bridenstine Weather Research and Forecasting Innovation Act of 2015, which passed the House of Representatives unanimously.

I am grateful to the Environment Subcommittee Ranking Member, the gentlelady from Oregon, Ms. Bonamici, for her bipartisan efforts. I am also now encouraged by the Senate's interest in weather legislation and look forward to incorporating their ideas into our bill.

I am pleased to have NOAA here today to continue the discussion of weather data and how a system that integrates multiple data sources will look in the future as NOAA evolves with the weather enterprise.

I hope we can have a productive conversation today to help inform Congress on the policies and laws in place that guide our data-sharing practices. It is my understanding that NOAA adheres to the principles of World Meteorological Organization's Resolution 40, which states that environmental weather data is publically shared internationally. While I agree with the intention of this policy, it could also possibly have negative effects on the very people NOAA is trying to help. It could prevent markets from forming, thwart innovation, reduce the quantity of data available, perpetuate the existing government monopoly, and cause costs to balloon. In short, this policy could work against our ability to predict timely and accurate weather events. If our policy requires a product to be given away free of charge, the only entity that will produce that product is the government.

In May, we learned that there are a few situations where NOAA applies a slightly different policy with success. NOAA contracts with some private entities, and the nature of those contracts prohibits NOAA from giving the data away for free.

Further, we learned that not everybody around the world follows this policy. For instance, the European Centre for Medium-Range Weather Forecasts does not make their model outputs available for free. Instead, nongovernment entities must purchase their forecasts.

This is not the case in the rest of the world, where NOAA's forecasts are available to all without charge. That leads me to believe that our international obligations are much more nuanced than the current interpretation. It seems that there may be room for NOAA's data policy to be set on a case-by-case basis rather than through a blanket policy.

I look forward to today's hearing and a meaningful discussion with today's witness.

[The prepared statement of Chairman Bridenstine follows:]

PREPARED STATEMENT OF SUBCOMMITTEE ON ENVIRONMENT
CHAIRMAN JIM BRIDENSTINE

Today we are convening part two of a hearing we held in May on how the National Oceanic and Atmospheric Administration, NOAA, uses weather data to enhance their forecasting capability, how and where they get that necessary data, and how these processes can be improved.

We have continually heard the word "robust" from multiple stakeholders when discussing the needs of our nation's satellite infrastructure, and I agree. But after hearing these perspectives, particularly from our hearing with NOAA in February, I believe the correct word for our current satellite architecture is "fragile."

A gap in satellite data availability remains a very real threat. NOAA is taking the proper steps to mitigate this, but we still may be faced with an unprecedented gap in crucial weather data. We know that JPSS-1 has experienced delays and cost overruns, and we are now being told it is possible GOES-R will experience a slip from its planned March 2016 launch date.

This underscores the need to augment our space-based observing systems by incorporating alternative modes of data collection. For instance, a competitive, commercial market for weather data could drive innovation, reduce costs and increase the quantity and quality of data.

Through this Subcommittee's oversight, we learned that NOAA does in fact already purchase weather data from commercial entities, including lightning data, aircraft observations and synthetic aperture imagery for ice detection. Why not space-based weather data as well?

I have been encouraged by the forward-looking view of Stephen Volz, the head of NOAA NESDIS. He indicated that NOAA would be open to buying data from com-

panies prepared to sell space-based weather data such as radio occultation and hyperspectral soundings. It was through our dialogue that we developed a concept for a pilot project to competitively select at least one provider of space-based data to test it against NOAA's proprietary data. With this pilot project, NOAA will be able to determine if the purchased data can be viably used in our numerical weather models.

This pilot program was included in H.R. 1561, the Lucas-Bridenstine Weather Research and Forecasting Innovation Act of 2015, which passed the House of Representatives unanimously. I am grateful to the Environment Subcommittee Ranking Member, the gentlelady from Oregon Ms. Bonamici, for her bipartisan efforts. I am also now encouraged by the Senate's interest in weather legislation and look forward to incorporating their ideas into our bill.

I am pleased to have NOAA here today to continue the discussion of weather data and how a system that integrates multiple data sources will look in the future as NOAA evolves with the weather enterprise.

I hope we can have a productive conversation today to help inform Congress on the policies and laws in place that guide our data sharing practices. It is my understanding that NOAA adheres to the principles of World Meteorological Organization's Resolution 40, which states that environmental weather data is publically shared internationally.

While I agree with the intention of this policy, it could also have negative effects on the very people NOAA is trying to help. It could prevent markets from forming, thwart innovation, reduce the quantity of data available, perpetuate the existing government monopoly and cause costs to balloon. In short, this policy could work against our ability to predict timely and accurate weather events. If our policy requires a product to be given away free of charge, only the government will produce the product.

In May, we learned that there are a few situations where NOAA applies a slightly different policy with success. NOAA contracts with some private entities and the nature of those contracts prohibits NOAA from giving the data away for free.

Further, we learned that not everybody around the world follows this policy. For instance, the European Centre for Medium-Range Weather Forecasts does not make their model outputs available for free. Instead, nongovernment entities must purchase their forecasts. This is not the case in the rest of the world, where NOAA's forecasts are available to all without charge.

That leads me to believe that our international obligations are much more nuanced than the current interpretation. It seems that there may be room for NOAA's data policy to be set on a case-by-case basis rather than through a blanket policy.

I look forward to today's hearing and a meaningful discussion with today's witness. I yield back and recognize the Ranking Member, Ms. Bonamici.

Chairman BRIDENSTINE. I yield back, and recognize the Ranking Member, Ms. Bonamici.

Ms. BONAMICI. Thank you very much, Mr. Chairman, and thank you for holding this hearing, and I appreciate the opportunity to work with you over the past several months and years on how we can improve weather forecasting, which I know is important to your constituents, my constituents, and frankly, everyone across the country and around the world.

So welcome to Admiral Brown. I'm glad you are here today to discuss NOAA's perspective on the issue of commercial weather data, and I look forward to discussing both the benefits and challenges associated with advancing the role of the commercial sector in providing this critical weather data to our national weather enterprise.

Several weeks ago, we had the opportunity to hear from representatives of the weather community. They described the positive relationship with NOAA and the relationship that NOAA has with numerous private entities in the acquisition of commercial weather data. They also described how this data is used to supplement global models and forecasts. Finally, they emphasized the importance of preserving full and open access to core data products that enable

the growth of the entire weather enterprise, both private and public.

Existing policies have for the most part allowed for unrestricted sharing of data and information with the research community, international partners, and commercial entities. This unrestricted access to weather data is the foundation of the current billion-dollar commercial weather industry, an industry that is the envy of the world. In fact, one of the witnesses stated that NOAA is the world's gold standard.

With this praise also came words of caution, caution to ensure that existing policies that maintain free and open access to essential weather data are not altered, policies that allow the scientific community and private sector to drive innovation and economic growth, and, most importantly, policies that ensure critical weather data remains reliable, and of the highest quality, so the lives and livelihoods of millions around the world are protected.

The current government-owned, commercially operated structure has served us well; however, even existing partnerships with private companies carry risks, things like delays in production, launch failures, and cost overruns. This is not to say the commercial sector is not ready to take on more responsibility in this area, but it does highlight the simple truth that space is difficult, and when it comes to providing critical observational data—the backbone of our numerical weather prediction—we must proceed with care and be certain of the path forward.

As we heard from the panel, a model where the government is solely a purchaser and not a provider of weather data presents a number of unique challenges and raises important questions that must be addressed to preserve the continued stability, credibility, and reliability of the nation's weather forecasting capabilities. These include: How would NOAA freely share the data it purchases from commercial sources? What effect do our international obligations have on policy considerations for the expanded use of commercial weather data? If NOAA maintains its policy of free and unrestricted use of data it purchases, will it be forced to purchase data at a premium, or serve as an anchor buyer, that will outweigh the anticipated cost savings? What data should NOAA purchase from the commercial sector and what, if any, data is so essential that the government should retain control? These are not simple questions with easy answers, but NOAA must consider these, and others, as they develop policies and practices for the continued purchase and use of commercial data.

We heard in our first hearing that although there are opportunities to advance our current model and thinking, there are also serious risks to consider. Congress must not rush to change a process that has worked well and provided such great benefits, without ensuring those successes can continue.

The entire weather enterprise, from NOAA to its industry partners and talented researchers, share the same goal of continually advancing our ability to accurately forecast the weather, save lives, and improve our economy in the process.

I look forward to hearing about the work NOAA is doing to identify ways to work more closely with industry to incorporate commercial weather data into its models, products, and services, and

continuing the discussion of how we can advance our robust weather industry.

Thank you again, Mr. Chairman, and again to our witness for being here this morning, and I yield back the balance of my time.

[The prepared statement of Ms. Bonamici follows:]

PREPARED STATEMENT OF SUBCOMMITTEE ON OVERSIGHT
MINORITY RANKING MEMBER SUZANNE BONAMICI

Thank you, Mr. Chairman, and welcome Vice Admiral Brown. I'm glad you are here today to discuss NOAA's perspective on the issue of commercial weather data, and I look forward to discussing both the benefits and challenges associated with advancing the role of the commercial sector in providing this critical weather data to our National weather enterprise.

Several weeks ago, we had the opportunity to hear from representatives of the weather community. They described the positive relationship NOAA has with numerous private entities in the acquisition of commercial weather data. They also described how this data is used to supplement global models and forecasts. Finally, they emphasized the importance of preserving full and open access to core data products that enable the growth of the entire weather enterprise—both private and public. Existing policies have—for the most part—allowed for unrestricted sharing of data and information with the research community, international partners, and commercial entities. This unrestricted access to weather data is the foundation of the current billion dollar commercial weather industry, an industry that is the envy of the world. In fact one of the witnesses stated that "NOAA is the world's gold standard."

With this praise also came words of caution. Caution to ensure existing policies that maintain free and open access to essential weather data are not altered. Policies that allow the scientific community and private sector to drive innovation and economic growth, and, most importantly, policies that ensure critical weather data remains reliable, and of highest quality, so the lives and livelihoods of millions around the world are protected.

The current government-owned, commercially-operated structure has served us well; however, even existing partnerships with private companies carry risks, things like delays in production, launch failures, and cost overruns. This is not to say the commercial sector is not ready to take on more responsibility in this area, but it does highlight the simple truth that "space is difficult," and when it comes to providing critical observational data—the backbone of our numerical weather prediction—we must proceed with care and be certain of the path forward.

As we heard from the panel, a model where the government is solely a purchaser and not a provider of weather data presents a number of unique challenges and raises important questions that must be addressed to preserve the continued stability, credibility, and reliability of the nation's weather forecasting capabilities. These include:

- How would NOAA freely share the data it purchases from commercial sources?
- What effect do our international obligations have on policy considerations for the expanded use of commercial weather data?
- If NOAA maintains its policy of free and unrestricted use of data it purchases, will it be forced to purchase data at a premium, or serve as an anchor buyer, that will outweigh the anticipated cost savings?
- What data should NOAA purchase from the commercial sector and what, if any, data is so essential that the government should retain control?

These are not simple questions with easy answers, but NOAA must consider these, and others, as they develop policies and practices for the continued purchase and use of commercial data.

We heard in our first hearing that although there are opportunities to advance our current model and thinking, there are also serious risks to consider. Congress must not rush to change a process that has worked so well, and provided such great benefits, without ensuring those successes can continue.

The entire weather enterprise, from NOAA to its industry partners and talented researchers, share the same goal of continually advancing our ability to accurately forecast the weather, save lives, and improve our economy in the process. I look forward to hearing about the work NOAA is doing to identify ways to work more closely with industry to incorporate commercial weather data into its models, products,

and services, and continuing the discussion of how we can advance our robust weather industry.

Thank you, Mr. Chairman, and again thank you to our witness for being here this morning. I yield back the balance of my time.

Chairman BRIDENSTINE. I thank the Ranking Member for her thoughtful comments.

Let me introduce our witness. Our witness today is the Honorable Manson Brown, Deputy Administrator of the National Oceanic and Atmospheric Administration, and Assistant Secretary of Commerce for Environmental Observation and Prediction.

Before joining NOAA, Mr. Brown served in the U.S. Coast Guard for 40 years—thank you for your service—where he rose to the rank of Vice Admiral. Mr. Brown received his master's degree in civil engineering from the University of Illinois at Champaign-Urbana and his master's degree in national resources strategy from the National Defense University.

In order to allow time for discussion, Vice Admiral Brown, please limit your testimony to five minutes. Your written statement will be made a part of the record.

We have the Chairman here. I hope you forgive me, Vice Admiral Brown, but I'd like to recognize the Chairman of the full Committee, Mr. Smith, for five minutes.

Chairman SMITH. Thank you, Mr. Chairman, and Admiral, thank you for letting me not so much cut into line but come in at the end of the line here before you begin your presentation, and normally, Mr. Chairman, this goes against all my instincts: Never keep an admiral waiting. But I'll be brief.

And I do thank our witness for being here today to discuss a crucial issue that is important to all of us and also to my constituents.

Severe weather routinely affects large portions of the United States. This year we already have seen the devastating effects of tornados across our country, especially in Texas and Oklahoma. My home State of Texas also has seen record-breaking flooding that caused widespread damage and loss of many lives in my district. These events are stark reminders that we depend heavily on the accuracy and timeliness of our weather forecasts. Unfortunately, our expertise has slipped in severe-weather forecasting.

Also of concern is that the large satellite programs we rely on for our forecast data are at risk of not meeting crucial schedule commitments. Delayed satellite launches would dramatically reduce our ability to predict weather and issue accurate and timely forecasts. We must do everything we can to save lives and protect property from severe weather events.

This past May, the House of Representatives passed a bill that I cosponsored, H.R. 1561, "The Weather Research and Forecasting Innovation Act of 2015." This bill greatly improves our severe-weather forecasting capabilities, and I thank the gentleman from Oklahoma, our Chairman, Mr. Bridenstine, for his involvement with this bill, and Ranking Member Bonamici for her cosponsoring this legislation as well.

This bill prioritizes weather research at the National Oceanic and Atmospheric Administration's research agency. It prompts NOAA to actively acquire new commercial data and seek private-sector weather solutions through a commercial weather data pilot

project. It also increases forecast warning lead times for tornados and hurricanes, and it creates a joint technology transfer fund in NOAA's Office of Oceanic and Atmospheric Research to help put technologies developed through NOAA's weather research into operation.

In this year's Commerce, Justice, and Science Appropriations bill, the House also approved my amendment to fully fund these crucial weather-related research activities at NOAA. The enhanced prediction of severe weather events is of great importance in protecting the public from injury and loss of property. It is something that Texans, and people in any community recently affected by severe weather, can appreciate.

It is time for us to bring our weather forecasting systems into the 21st century. Mr. Chairman, I look forward to our discussion today about how we can continue to support and enhance our weather prediction capabilities, and I'll yield back.

[The prepared statement of Chairman Smith follows:]

PREPARED STATEMENT OF COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
CHAIRMAN LAMAR S. SMITH

Good Morning and I thank our witness for being here today to discuss a crucial issue that is important to all of us and also to my constituents. Severe weather routinely affects large portions of the United States. This year we already have seen the devastating effects of tornados across our country, especially in Texas and Oklahoma. My home state of Texas also has seen record breaking flooding that caused widespread damage and loss of life in my district.

These events are stark reminders that we depend heavily on the accuracy and timeliness of our weather forecasts. Unfortunately, our expertise has slipped in severe weather forecasting. Also of concern is that the large satellite programs we rely on for our forecast data are at risk of not meeting crucial schedule commitments.

Delayed satellite launches would dramatically reduce our ability to predict weather and issue accurate and timely forecasts. We must do everything we can to save lives and protect property from severe weather events.

This past May, the House of Representatives passed a bill that I co-sponsored, H.R. 1561, "The Weather Research and Forecasting Innovation Act of 2015." This bill greatly improves our severe weather forecasting capabilities. I thank the gentleman from Oklahoma, Mr. Bridenstine, for his involvement with this bill, and Ranking Member Bonamici for co-sponsoring this legislation.

This bill prioritizes weather research at the National Oceanic and Atmospheric Administration's (NOAA's) research agency. It prompts NOAA to actively acquire new commercial data and seek private sector weather solutions through a commercial weather data pilot project. It also increases forecast warning lead times for tornadoes and hurricanes. And it creates a joint technology transfer fund in NOAA's Office of Oceanic and Atmospheric Research to help put technologies developed through NOAA's weather research into operation.

In this year's Commerce, Justice, and Science Appropriations bill, the House also approved my amendment to fully fund these crucial weather-related research activities at NOAA. The enhanced prediction of severe weather events is of great importance in protecting the public from injury and loss of property.

It is something that Texans, and people in any community recently affected by severe weather, can appreciate. It is time for us to bring our weather forecasting systems into the 21st century. I look forward to our discussion today about how we can continue to support and enhance our weather prediction capabilities.

Chairman BRIDENSTINE. I'd like to thank the Chairman for his leadership on these very important issues and his guidance on this Committee.

Admiral Brown, you are now recognized for five minutes for an opening statement.

**TESTIMONY OF HON. MANSON BROWN,
DEPUTY ADMINISTRATOR,
NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION**

Hon. BROWN. Thank you, Chairman.

Before I deliver my oral statement, I'd like to give you a brief summary of an operational update that I received this morning on the widespread flooding and severe weather which has impacted the upper Midwest, Mississippi River Valley, and continues to affect the Ohio River Valley and the Central Appalachians.

Heavy rainfall has led to devastating flash flooding, especially in Kentucky, where one fatality has been reported and others are missing. Conditions warranted the issuance of a special flash-flood emergency yesterday. Water rescues continue this morning across Kentucky, Virginia, and West Virginia.

In addition to the flooding, there were 500 preliminary reports of damaging winds extending from the Midwest to the Central Appalachians yesterday. Obviously, with this ongoing event, it's appropriate that we keep those impacted by this severe weather in our thoughts and prayers today.

With that, Mr. Chairman, thank you, Chairman Smith, Chairman Bridenstine, Ranking Member Bonamici, Members of the Committee, it's a pleasure to be with you today.

Today, insight and foresight about the state of our planet is factored into individual and collective decisions to an extraordinary degree from planning our individual day to providing for the national defense. NOAA's mission is to leverage our ability to understand and predict changes in the Earth's environment. We provide environmental intelligence that delivers timely, actionable, and reliable information to protect citizens, businesses and communities. Our observing systems are the final foundation for all we do.

The weather forecasting system in particular must have an assured and uninterrupted flow of high-quality data from these systems. An accurate forecast 3 or more days in advance can only be made when the entire globe has been measured by both satellites and in situ sensors. Since no single entity, no government, no university, no private company, no scientist has the capacity to do this on their own, a global system of systems that seeks to maximize free and open sharing of data has developed.

To give you a sense of how important these cooperative arrangements are, NOAA provides only three of the eight primary satellites that feed data into the global forecasting system. We share United States data freely and openly so that we can receive data freely and openly from our international partners. This regime is codified in treaty commitments under the World Meteorological Organization's Resolution 40, which sets up free and unrestricted data sharing amongst participating nations. Resolution 40 requires participating nations to share essential data without restriction. These basic data and products are the ones that support the protection of life and property and the wellbeing of all nations.

The benefit of full, free and open for the United States is that by volume, we receive about three times as much environmental data for our forecasting models as we provide. NOAA does pur-

chase a variety of environmental data using competitive procurements, but we do not distribute on a full, free and open basis. Because this data is only used for local and regional forecasts, this practice is consistent with our WMO commitments.

I would add that over 75 percent of NOAA's satellite budget goes out as competitive contracts to the private space and technology industry to build instruments, launch satellites, and manage ground and data systems. This is over 85 percent of the GOES–R and JPSS programs. That number is over 85 percent.

In addition, NOAA's environmental data and model output fuels a vibrant and growing private weather enterprise that refines and tailors our information down to individual citizens and national sectors such as energy and agriculture. According to the University Corporation for Atmospheric Research, the private sector is estimated to generate billions of dollars of annual revenue, employing thousands of people, and providing a rich array of analytical products and tailored services to everyone from commodity traders to TV weathercasters. The health of this industry is underwritten by this convention of full, free and open.

NOAA recognizes the dynamics of a changing space environment driven by such things as an increasing demand for more precise environmental intelligence, changing technology, that this aggregation of satellite systems, affordability issues and changing business models. We're mindful that space is expected to become more congested, contested, and competitive.

As a science-based services agency, we maintain a keen focus on public safety. For our satellite systems, our desire is to preserve an unblinking stream of high-quality scientific data that can be assured over the long term. Our current satellite programs will help us to do that in a way that minimizes gaps and achieves a level of robustness for this critical national infrastructure.

NOAA has and will continue to explore industry's ability to contribute to these goals in a way that minimizes risk, maximizes assuredness, and upholds the convention of full, free and open. In doing so, we seek to uphold the successful model which delivers tremendous return on investment for the United States, improves our forecasts and the safety of our citizens, and supports both a thriving private weather industry and the economy as a whole.

Thank you again for the opportunity to testify. I welcome your questions.

[The prepared statement of Hon. Brown follows:]

WRITTEN STATEMENT BY
MANSON K. BROWN
ASSISTANT SECRETARY OF COMMERCE FOR ENVIRONMENTAL OBSERVATION AND PREDICTION
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

HEARING TITLED
COMMERCIAL WEATHER DATA: COLLABORATIVE EFFORTS TO IMPROVE FORECASTS, PART 2

BEFORE THE
SUBCOMMITTEE ON ENVIRONMENT
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

July 14, 2015

Chairman Bridenstine, Ranking Member Bonamici, and Members of the Subcommittee, I am Vice Admiral Manson Brown, Assistant Secretary of Commerce for Environmental Observation and Prediction and Deputy Administrator for the National Oceanic and Atmospheric Administration (NOAA). Thank you for the opportunity to testify before you today on this important topic.

The Societal Challenge

Few environmental phenomena affect our economy, ecosystems, and livelihoods more than weather and climate. Severe weather and climatic extremes pose risks to human health, safety, and property. Understanding and responding to weather, both routine and extreme, influences the patterns of everyday lifer:

- Every morning, we seek weather updates to give us an idea of the conditions at the city block or neighborhood level, either on our favorite television or radio station, on the internet, or with a simple click of our thumbs on our smartphone Apps.
- Citizens and businesses in the Midwest and southern states prepare for and respond to the spring severe weather season. Some wonder - why can't we have one hour advance warning of a tornado versus 15 minutes?
- Residents across the U.S. Gulf and Atlantic coasts, and the Caribbean spend the summer with one eye on their activities and the other on the latest tropical weather development off the west coast of Africa.

- Millions of residents on the West Coast and Southwest who are living in a perpetual state of severe drought, increasingly demand to know when the crippling drought might break.
- U.S. businesses investing here in the U.S. and overseas want to know if their capital is being placed at unnecessary risk from weather events
- Our military relies on accurate and timeline weather information for situational awareness to achieve mission success and to protect the lives of our service men and women when defending U.S. national security at home and overseas.

The weather-related needs and expectations of Americans worldwide are of central concern to NOAA's operational and research scientists. The challenge to deliver these products and services that we constantly strive to improve is dependent on four major capabilities:

- Quality, quantity, relevance, and timeliness of data (satellite and *in situ*)
- Computing capacity (operational and research)
- Data assimilation and numerical model prediction
- Forecaster knowledge, skill, and ability

This testimony will focus on two key points that need to be considered carefully as potential commercial supplier models are evaluated: the value of the U.S. "free & open" data policy and current global data sharing arrangements, and the need for pre-purchase demonstration of data quality, sufficiency and reliability.

World Meteorological Organization (WMO) Resolution 40 and Data to Support the National Weather Enterprise

NOAA's role of providing the Nation's weather forecasts through the National Weather Service (NWS) has developed through 100 years of performing this service. Over the years, our ability to deliver the weather forecast has evolved to meet the growing need for more local and precise forecasts. Our weather research, aided by data from radars, aircraft, radiosondes, oceanic buoys, and satellites and modeled on our high performance computers, has shown us the complex links in the ocean-atmospheric interaction and the atmospheric "rivers" that drive our one to seven day weather forecast. One only needs to look at the El Niño Southern Oscillation (ENSO) phenomenon and its known impacts on the water cycle and hurricane behavior to understand the need for large scale and global datasets to inform our decision-making.

Long before WMO resolution 40, the notion that free and open access to data across international borders was important to economic and commercial development. Radiosondes were launched worldwide in the 1940s and 1950s to improve global weather prediction. They are still critical sources of data today. The WMO, the first organization within the newly formed United Nations, ensured free and open access to the data worldwide. These data were critical to building global commercial airline routes and dramatically expanding the commercial airline business.

The free and open sharing of radiosonde data through continued throughout the Cold War as the United Stated and the Soviet Union continued to make their observational data available to one another. Radiosonde data sharing occurred from Cuba even during the Cuban Missile Crisis. WMO resolution 40 was developed in the spirit of free and open access, improving the global economy through the commercial sector's use of the data, which they could not afford on their own.

Weather patterns over Asia and the Pacific form the basis of the weather for much of Alaska and the West Coast of the United States; similarly, Europe monitors the weather over the United States since our weather will be theirs within 5 days. Simultaneously, Asia watches the European weather as a precursor of what is coming, and the circle closes with the United States monitoring Asia's weather trends. Additionally, weather off the west coast of Africa could potentially spawn hurricanes in the Atlantic basin. All of these data are vital to U.S. global security and commercial interests, both within our borders and for our citizens and companies abroad.

Our ability to monitor these global weather and environmental phenomena that affect the United States is based on our ability to access data when we need it, in a format that we can use, and with the necessary assurances that we can trust it for input into our numerical weather prediction models. These data come from a variety of sources including other nations' weather stations, surface weather radars, ocean buoys, and government and commercial satellites. These data are transmitted in near-real-time to the United States for use in our short-term weather forecasting and as input to our longer-term numerical weather prediction models. The more data we receive, the better our predictions become. These data are a prime example of data that is covered by WMO Resolution 40 and the direct benefits to the U.S. taxpayer from this type of exchange. That is why the free and open exchange of data globally has been the U.S. position in many bilateral and multilateral fora.

There has been a lot of discussion about the role WMO Resolution 40 plays in NOAA's views toward commercial weather data. WMO Resolution 40 does not apply only to NOAA; it applies to the United States as a whole, and supports our U.S. data policy and principles.

While there is space to apply national data policies and principles, when interpreting what is allowable or required under WMO Resolution 40, not open to interpretation or debate are the data sets we are obligated to share under Annex 1. WMO Resolution 40 stipulates that Member countries shall provide, on a free and unrestricted basis, essential data and products which are necessary for the provision of services in support of protection of life and property and the well-being of all nations, particularly those basic data and products, as, at a minimum, described in Annex 1. Annex 1 has eight subsections that detail the types of data deemed essential and that must be free and unrestricted. Subsection eight specifically addresses satellite data and products

and calls for "those data and products from operational meteorological satellites that are agreed between WMO and satellite operators. (These should include data and products necessary for operations regarding severe weather warnings and tropical cyclone warnings)." Data not covered in Annex 1 is considered additional data and each country determines the data rights and access terms associated with additional data sets. This "additional data" categorization affords the National Weather Service the ability to enter into a licensing agreement for lightning data. This distinction is important because it may be assumed that the United States has flexibility to choose which data sets to restrict and which ones to not restrict, and that is not the case.

Although WMO Resolution 40 has not been changed, it is reviewed before each WMO Congress, which meets every four years. During one of the reviews, it was determined that Resolution 40 did not effectively address hydrological data and resulted in WMO Congress passing WMO Resolution 25, Exchange of Hydrological Data and Products.

Further, WMO Resolutions 40 and 25 do not solely drive the U.S. data principles and policies, but rather reinforce and support our belief that government data, sourced with tax payer dollars, is a public good and has more benefit to the overall weather enterprise when it is unrestricted. This applies internationally too. As we exchange more data from around the globe, our models, products and ultimately the forecasts out of the National Weather Service's local forecast offices improve. There is reciprocity in the global sharing of WMO Resolution 40 essential data. On a whole, the rate of exchange is nearly 3 to 1, in that NOAA's receives three times more meteorological data than it provides to the international community. There are also benefits domestically as certain sectors of the private weather industry in the United States benefit from our data policies. Companies are able to obtain our data and products, add value or innovate off these data to provide additional services to the public and/or key sectors of the U.S. economy, such as the transportation, agricultural, and energy sectors. With international commerce and business interests abroad, U.S. civilians and businesses use weather and environmental information on all continents. Similarly, for our national defense, NOAA provides access to its data and information products and services to all Department of Defense services and the U.S. Coast Guard as they implement their global missions.

There is also global exchange of numerical weather prediction model output. The popular press falsely pits the "European" and the "U.S." models against each other. Although exchange of model output is not governed by WMO Resolution 40, it is crucial to maintaining and enhancing our forecasting capabilities. Research and operations have demonstrated that model ensembles - a combination of different model runs - increase forecast accuracy and reliability. The sharing of model outputs provides a much larger set of ensembles, leading to better overall forecasts, especially for extreme events.

NOAA's ability to monitor global weather and environmental trends hinges on access to relevant, high-quality, and timely data.

NOAA as the Environmental Intelligence Agency
With all these streams of data and model outputs, where does NOAA fit into the picture?

NOAA is America's Environmental Intelligence agency. This means we provide timely, actionable, reliable, science-based information and products that citizens, communities, and businesses need to stay safe and operate efficiently. The cornerstone of this work is perhaps NOAA's most distinctive role among all Federal agencies, and that is the capability for practical weather prediction. As discussed above, NOAA's ability to deliver Environmental Intelligence starts with keeping the pulse of the planet, especially the atmosphere and the ocean, and this is the central capability where space-based assets come into play.

Environmental Intelligence provides us with life-saving situational awareness, and equally powerful insight and perspective about the conditions of the environment around us. Environmental Intelligence provides us with foresight, the ability to look ahead, anticipate future conditions, and assess alternative courses of action we might take to make our society more resilient and better prepared.

Finally, Environmental Intelligence provides citizens pressing their smartphone apps, or listening for weather updates on their favorite television or radio station, the appropriate information in the right context for them to make intelligent decisions about their daily lives, including protection from extreme weather. Americans do not care if the information came from a U.S. or international government or commercial satellite, or whether the model output was U.S. or European. They simply expect that NOAA will perform the necessary analyses and provide them with actionable information for their use.

Looming Challenges
Earth is warming and this will lead to more extreme weather and water events, and more intense extremes. The planet's population continues to grow. By 2040, today's 7 billion Earth inhabitants will become 9 billion – an increase of 28 percent. Because of population growth, increased standards of living, and economic development, resource margins will be stretched even thinner, putting greater strain on water, food, energy, and ecosystems. The water-food-energy nexus, which includes the interplay with and impact on the world's natural ecosystems, is already critical and will become more so in 2040. All of these factors lead to greater societal vulnerability in the locations where humans increasingly concentrate, be it larger U.S. towns and cities in the South Central "Tornado Alley," in arid locations that rely on water sources hundreds of miles away, along major rivers that flood with increased frequency, or within 50 miles of the coast (where over 80 percent of our population now lives).

As NOAA provides the Environmental Intelligence needed to navigate ever changing weather patterns, we must also plan for the weather support that will be needed in the future. These data,

which are regulated in over 20 different statues, policies and regulations,[1] are critical for federal, state, local, and tribal planners as they assess the best ways to build resiliency at the societal and community levels today and well into the future.

As NOAA works with its federal, state, local, and tribal customers and users to prepare for the future, protecting and enhancing access to data is foundational.

The Changing Paradigm

An accurate forecast three or more days in advance can be made only when the entire globe has been measured by both satellites and *in situ* sensors. Since no single entity - no government, no university, no private company, no entrepreneur or scientist - has the wherewithal to do this on their own, a global system of systems that seeks to maximize free and open sharing of data has developed. This highly successful model dates back to the earliest, pre-satellite days of weather forecasting. Today, there are many other sources of data.

In the 1960s when the first NOAA and Department of Defense operational weather satellites were launched, the government was the only entity with the resources and know-how to build these machines. Today, the U.S. Government is no longer the sole provider of Earth Observation satellite data. NOAA relies on other national space and meteorological agencies to supplement our data needs. Simultaneously, international space agencies have developed competence in development of Earth Observation missions that have proved extremely useful to support U.S. data needs. The satellite data we get from other governments improves the amount and accuracy of our satellite data by about 2X at their expense – a tremendous value made possible by our free-and-open stance and WMO commitments. Based on our assessments, no commercial entity, either domestic or foreign, can replace U.S. or foreign government satellite systems.

Over the years, the aerospace industry has evolved and grown. The 2010 National Space Policy supports a strong aerospace sector. NOAA depends on a strong private aerospace sector to develop its satellites. Over 80 percent of NOAA's appropriations for satellite services goes to the U.S. aerospace industry to help us build, launch, and operate these satellites. NOAA also purchases regional data from commercial companies that improve the reliability of our U.S. forecasts (e.g. Mesonet, lightning data).

In recent years, emerging elements of the aerospace industry have begun to invest private capital to build, launch, and operate satellites with the intent of selling data to private sector users and to the U.S. Government, and to NOAA in particular to support its weather mission.

---

[1] A comprehensive list of all laws, statutes, policies, and NWS directives guiding NOAA's use of weather related data is available in Appendix I.

NOAA welcomes this new role from the aerospace sector. In fact, NOAA spends at least $20 million in appropriated dollars annually to purchase commercially-provided satellite, lightning, airborne, and *in situ* data. NOAA anticipates purchasing more data over the coming years as the aerospace industry matures and develops new and additional data streams, and as NOAA has a chance to evaluate how these commercial sources of data can meet its operational requirements.

Before incorporating any data set, public or commercial, into our models, we must ensure that data is accurate, reliable, and can be validated. Though meeting data quality specifications cannot be our sole criterion: its impact on the highly valuable international data sharing regime must also be taken into account.

In this arrangement, the foundational environmental measurements are made available freely/without restriction to governments to use for the protection of life and property; to innovators or researchers with clever new products, and to entrepreneurs with promising new business models. Much of the economic value of the data comes from derived products generated by the private sector - analytical and tailored services - rather than from fees for the data.

The full U.S. weather enterprise is vivid proof of the tremendous tangible economic benefits this approach produces for our country. NOAA provides the output of weather models as well as the underlying data to the public that fuels these enterprises. According to the University Corporation for Atmospheric Research, the private sector is estimated to generate billions of dollars of annual revenue, employing thousands of people and providing a rich array of analytical products and tailored services to everyone from commodity traders to TV weathercasters. Examples abound of instances where the commercial weather sector has a role in this national weather enterprise and has monetized that role, from Google and its Earth Engine, to the Climate Corporation, which was sold to Monsanto for $1 billion, from the Weather Channel sale to NBC, to the sale of ocean data companies including GEBCO (General Bathymetric Chart of the Oceans).

NOAA's view, consistent with the 2010 National Space Policy, is that policies should facilitate the full, open and timely access to government environmental datasets on which the global enterprise and the global good depend. NOAA supports, and uses, private data purchase models in cases where the data improve our U.S. forecasts, and where lack of sharing does not undermine the forecasts of U.S. and other global partners. As noted earlier, data shared by our global partners gives us insight into weather that could be affecting the United States in a few hours, days, or weeks, and powers a vibrant private sector enterprise.

In order for NOAA to continue to provide increasingly relevant products and services to meet its mission, it requires full and open access to observational data - regardless of whether that data is

commercially-sourced or obtained from government developed systems - for local, regional, and global applications.

Conclusion

We live in a time when insight and foresight about the state of our planet is factored into individual and collective decisions to an extraordinary degree. These are decisions made at levels from head of household to head of state and have tremendous consequence for lives and livelihoods and the greater global good.

The space age made this possible. Satellites allow us monitor our global commons in near-real time on scales never before imagined. The ability to, in effect, take a snapshot of the planet has catalyzed the radical transformation in observations that we have witnessed over the past three decades.

And yet every day, across the entire globe, we also see evidence of needs for the right information, at the right scales, to reach the right people at the right time, to enable communities to make wiser decisions for their future and the future of the planet. There is much more work to do to develop new space sensors, new system architectures, denser *in situ* sampling, and further Earth system and computational research.

At NOAA, we are excited about the future. We think there is a very strong value proposition for being in the environmental intelligence service and we are eager to tackle these challenges. As the world changes, new business models may emerge. NOAA is changing to meet these challenges. While we also are assessing how the commercial sector may assist us in meeting those challenges, it is essential we obtain high assurances and validations before any policy changes on reliance on the source of data are enacted. We remain committed to keeping the proven U.S. and international data partnerships in place while the commercial sector demonstrates and validates its ability to meet our data requirements. Foremost is ensuring our mission protecting lives and property, securing critical infrastructure, and supporting a growing and thriving economy.

Thank you again for the opportunity to testify before you today. I am happy to answer any questions you may have.

Appendix I: A comprehensive list of all laws, statutes, policies, and NWS directives guiding NOAA's use of weather related data.

Statutes

Weather Service Organic Act, 15 U.S.C. § 313
Sets out the weather and meteorological reporting and forecasting responsibilities assigned to the Secretary of Commerce, including monitoring and recording climatic conditions.

Note to Weather Service Organic Act, 15 U.S.C. § 313 *note*
Public Law No. 101-595 (1990) - Authorizes NOAA to purchase Atmospheric Wind Data
Public Law No. 99-198 (1985) - Authorizes NOAA to provide agricultural and silvicultural weather services to Federal, state, and private efforts.

Space Weather Authority, 15 U.S.C. § 1532
Provides authority to: conduct research on all telecommunications sciences, including wave propagation and reception and conditions; prepare and issue predictions of electromagnetic wave propagation conditions and warnings of disturbances; conduct research and analysis in the general field of telecommunications sciences in support of other Federal agencies; investigate nonionizing electromagnetic radiation and its uses; and compile, evaluate, and disseminate general scientific and technical data.

User Fee Authority for the National Environmental Satellite, Data, and Information Service, 15 U.S.C. § 1534
Provides authority to assess fees, based on fair market value, for access to environmental data and information and products collected and/or archived by NOAA.

National Climate Program Act. 15 U.S.C. § 2901 *et seq.*
Authorizes a National Climate Program with responsibilities that include data collection, monitoring, analysis, assessment, and dissemination.

Global Change Research Act, 15 U.S.C. § 2931 *et seq.*
Provides authority for the development and coordination of a comprehensive and integrated United States research program to assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change.

Flood Control/River Forecasting Authority, 33 U.S.C. § 706

Authorizes agency expenditures in support of flood control, rivers and harbors, and related purposes, as well as for the establishment, operations, and maintenance by the NWS of the Hydroclimatic Network of precipitation stations to provide information on precipitation, flood forecasts, and flood warnings.

Tsunami Warning and Education Act, 33 U.S.C. § 3201 *et seq.*
This Act requires NOAA to operate a Tsunami Forecasting and Warning Program that is charged with providing tsunami detection, forecasting, and adequate warnings.

Meteorological Services to Support Aviation, 49 U.S.C. § 44720
This Act requires the Secretary of Commerce to provide meteorological services for aviation in coordination with the Federal Aviation Administration.

Regulations

Modernization of the National Weather Service, 15 C.F.R. Part 946

Menu of Services, 15 C.F.R. 946.4
The basic weather services provided by the National Weather Service are: surface observations; upper air observations; radar observations; public forecasts, statements, and warnings; aviation forecasts, statements, and warnings; marine forecasts, statements, and warnings; hydrologic forecasts and warnings; fire weather forecasts and warnings; agricultural forecasts and advisories; NOAA Weather Radio Broadcasts; climatological services; emergency management support; and special products and service programs.

Policies

NOAA Policy on Partnerships in the Provision of Environmental Information, http://www.noaa.gov/partnershippolicy/

OMB Circular A-130, Management of Federal Information Resources, http://www.nws.noaa.gov/im/omblink.htm. .

WMO Resolution 40, WMO Policy and Practice for the Exchange of Meteorological and Related Data and Products Including Guidelines on Relationships in Commercial Meteorological Activities
http://www.wmo.int/pages/about/Resolution40_en.html

WMO Resolution 25 (Cg-XIII), Exchange of hydrological data and products
http://www.wmo.int/pages/about/Resolution25_en.html

NWS Directives

NWS Policy Directive 1-10, Managing the Provision of Environmental Information
http://www.nws.noaa.gov/directives/sym/pd00110curr.pdf

NWS Policy Directive 10-17, Dissemination
http://www.nws.noaa.gov/directives/sym/pd01017curr.pdf

NWS Instruction 10-1710, NOAA Weather Radio (NWR) Dissemination
http://www.nws.noaa.gov/directives/sym/pd01017010curr.pdf

NWS Instruction 10-1711, NOAA Weather Radio All Hazards (NWR) Systems Management
http://www.nws.noaa.gov/directives/sym/pd01017011curr.pdf

NWS Policy Directive 10-18, Service Outreach
http://www.nws.noaa.gov/directives/sym/pd01018curr.pdf

NWS Procedural Directive 10-1806, NWS Support for Special Events
http://www.nws.noaa.gov/directives/sym/pd01018006curr.pdf

NOAA Leadership

Manson K. Brown, P.E.

Manson K. Brown, Assistant Secretary of Commerce for Environmental Observation and Prediction and Deputy Administrator for NOAA.

Manson K. Brown was sworn in as the Assistant Secretary of Commerce for Environmental Observation and Prediction on March 18, 2015. He strategically drives Administration policy, programming, and investments for all NOAA observing systems, including in situ instruments and satellites, and the process of converting observations to predictions for environmental threats related to weather, climate, water, oceans, and space weather. He serves as NOAA Deputy Administrator and Chair of NOAA's Observing Systems Council.

A native of Washington, DC, he is the son of public servants. At the age of 17, he entered military service as a cadet at the U.S. Coast Guard Academy. His journey with the Coast Guard spanned 40 years, propelling him to the rank of Vice Admiral. He commanded operations at every level, culminating as Commander of Pacific Area in San Francisco where he oversaw all Coast Guard operational activities throughout the Pacific Rim. Building on his technical competence as a registered professional civil engineer, his last assignment on active duty was as Deputy Commandant for Mission Support in Washington, DC, where he oversaw all aspects of human resources, engineering, information technology, acquisition, and logistics support for Coast Guard operations and people throughout the globe.

His other Coast Guard assignments ranged from duty as an engineering officer aboard the icebreaker Glacier during Arctic and Antarctic deployments to working as a Military Assistant to the U.S. Secretary of Transportation (DOT). After the terrorist attacks of September 11, 2001, the Honorable Norman Y. Mineta temporarily assigned him as DOT's Deputy Chief of Staff for six months. In 2004, he was asked to fill a key leadership gap in Iraq as the Senior Advisor for Transportation for the Coalition Provisional Authority where he oversaw restoration of Iraq's transportation systems, including major ports.

He holds Master of Science degrees in Civil Engineering from the University of Illinois at Champaign-Urbana and in National Resources Strategy from the National Defense University.

He received many awards and honors during his career. His top military decoration is the Coast Guard Distinguished Service Medal. In 1994, he became the first recipient of the Coast Guard Captain John G. Witherspoon Award for Inspirational Leadership. In 2012, he was honored with the Golden Torch Award by the National Society for Black Engineers. In 2014, he was honored by the National Association for the Advancement of Colored People with the Meritorious Service Award, an honor annually bestowed to a service member in a policy-making position for the highest achievement in military equal opportunity.

Married for 33 years, he and his wife, Herminia, are proud parents of three adult sons. He is an avid road cyclist and enjoys completing century rides.

Chairman BRIDENSTINE. Thank you, Admiral, for your testimony. Members are reminded that the Committee rules limit questioning to five minutes. The Chair recognizes himself for five minutes.

Admiral, we did a bipartisan weather bill here in the House of Representatives not too long ago, and it included a pilot project for NOAA to enter into a contract with at least one private-sector company to test weather data, to test it against, you know—can it be validated and be usable for the data assimilation systems, the numerical weather models. I just wanted to find out, are you supportive of that effort?

Hon. BROWN. I am supportive of that effort consistent with available resources, Chairman. As Dr. Volz testified in February, we do want to learn forward with our industry partners, and we think radio occultation is a good technology to do that with.

Chairman BRIDENSTINE. That's great. Does NOAA have any plans at this time to enter into such a contract to start testing that kind of data?

Hon. BROWN. Right now, we do have plans to do that. There are several elements to that. The caveat that I mentioned before was consistent with available resources. Obviously we need budget support to do a technology demonstration.

The second thing is, I anticipate later this year NOAA will release our commercial satellite data policy, which will really signal to the industry our interest. As a follow-on to the release of that policy, I expect that Dr. Volz will release what we're calling his NESDIS procedures, which define the data standards that industry will have to meet principally and what the architectural requirements of the systems will be.

Chairman BRIDENSTINE. Do you have a data for when that might occur, just out of curiosity?

Hon. BROWN. I don't have a specific date, Chairman. These products are still in clearance.

Chairman BRIDENSTINE. But you would anticipate it would be this year?

Hon. BROWN. I am driving towards this year. Very aggressively.

Chairman BRIDENSTINE. Okay. Thank you for that.

At part one of our hearing in May, I asked former UCAR President Dr. Bogdan how difficult it would be to make data specifications, as you just mentioned, data specifications for GPS radio occultation available to the public. He answered, "I don't see any difficulty from our perspective in making that information available."

We have a growing commercial sector that is eager to help provide data. They are looking to NOAA for answers on how they can help, and of course, you've indicated that you're looking at providing those specifications, making those available to the public, you know, as you mentioned, very aggressively before the end of the year. Is that correct? Or your goal would be.

Hon. BROWN. The goal is before the end of the year. And just one caveat to that, Chairman. As part of Dr. Volz and his team development of the draft procedures, he actually had a session with industry during the NOAA satellite conference in April and talked through the essential elements, if you will, of what those data standards would be and what that architecture is, and so he is folding the feedback from that discussion into those procedures.

Chairman BRIDENSTINE. That's great to hear.

Now, was that just kind of like an informative, informal briefing or were there negotiations taking place as far as what it would cost and what they need to invest and that kind of thing?

Hon. BROWN. This was really a public session. It was not the government and contractors, if you will, of the negotiating setting. This was really a framing of the environment, if you will, specifically with regards to the architecture that industry will have to plug into during some of this technology demonstration.

Chairman BRIDENSTINE. So as far as the technology demonstration and of course, you know, using potentially commercial capabilities to argument our numerical weather modeling, there's the testing, validation, there's all that effort. Is there a point in time when you would foresee the ability for NOAA to purchase commercial data as those validations have been met?

Hon. BROWN. Not at this point, Chairman, because radio occultation specifically is listed as one of those technologies on WMO Resolution 40s essential list. What we'd like to do, as I mentioned before, is to learn forward. Let's see if we can get the technology and the architecture and the feeds right, and then there's this whole separate discussion about the business arrangements, if you will.

Chairman BRIDENSTINE. When you say it's on the essentials list, what is that? What does that mean? What does that entail?

Hon. BROWN. The World Meteorological Organization's Resolution 40 has two types of data. They have what's called essential data and they have what they call additional data. Essential data is data that is used by all of the global met partners to feed global forecasts, and this is a determination that's made collaborative between scientists and operators, and it is codified under Resolution 40 as what they call Annex 1.

Chairman BRIDENSTINE. Is commercial aviation data also included in that, the essential data?

Hon. BROWN. It is not, and I'm—I really need to defer to some of the experts. I can get you a detailed briefing——

Chairman BRIDENSTINE. Okay.

Hon. BROWN. —on the specifics of what are essential and nonessential. Let me answer it this way. We do buy aviation data for instrumentation that's on our aircraft during takeoffs and landings, but that is data that does not inform the global forecasting models. That informs local and regional models, and that is the distinction that WMO makes.

Chairman BRIDENSTINE. And just so you're aware, we had testimony before this Committee in February with a panel of experts including Dr. Volz was on that panel, and the testimony came back to us that that commercial data does feed the global initial conditions for creating the numerical weather models or for feeding numerical weather models. So just—there might be a contradiction here. We probably should look into finding out what the——

Hon. BROWN. We'll work through your staff——

Chairman BRIDENSTINE. Okay.

Hon. BROWN. —to reconcile the difference.

Chairman BRIDENSTINE. Okay. Thank you for that. I'm out of time.

I recognize the Ranking Member, Ms. Bonamici, for five minutes.

Ms. BONAMICI. Thank you, Chair Bridenstine.

First, I want to follow up on the conversation that you were having with Chairman Bridenstine, Admiral Brown. You talked about the conference in April to—and my understanding, that that was in large part to inform the agency about developing a process for assessing commercial solutions. There's a statement that Dr. Volz made at the start that it was a public discussion between NOAA NESDIS and the emerging commercial field about the possibilities for more active engagement for providing future measurement capabilities.

So can you talk a little bit about the stakeholder engagement at that conference and at that—through that conversation and any additional steps that NOAA is taking to hear from stakeholders about the expanded use of the commercial weather data?

Hon. BROWN. Ranking Member, NESDIS holds an annual satellite conference. I actually was a kickoff speaker for this year's production. There were about, as I recall, 600 participants. We get scientists, we get industry technologists. We have a lot of our staff. We get folks from the international community. It is really a great opportunity for us to discuss and debate the state of NOAA satellite technology and data assimilation.

I really don't want to mischaracterize what occurred at that session because I wasn't there, and I would accept at face value Dr. Volz's characterization. The way that he described it to me, it really was just an opportunity for a conversation between NOAA and the industry.

Ms. BONAMICI. Thank you, and I want to get a few more questions in. I'm sorry.

You talked about the release of the commercial data policy later this year. Thank you for making that a priority. How have stakeholders been involved in that—the crafting of that policy and the development? Have you had conversations with the private sector, with other stakeholders?

Hon. BROWN. This is really a NOAA policy. We did discuss and debate these things with our advisory committee, the Industry Trade Advisory Council, if you will. We have not specifically shared the elements of that policy with them because we're on the cutting edge of policy development. I think our judgment is, let's get the policy out there. Let's treat it as a bit of a living policy, and based upon the response and the feedback that we get, the things like the next satellite conference, we will consider adjustments to the policy.

Ms. BONAMICI. Terrific. Thank you.

And as I mentioned in our—at our hearing in May, the current model where NOAA maintains and operates a suite of observing satellites but then purchases supplemental ad hoc data to enhance the forecasting products has worked well, and as NOAA continues to explore opportunities to expand its procurement of commercial data, we do run the risk of ceding critical observational capabilities to the private sector. So in your opinion, are there essential observational capabilities that should always be operated by the government?

Hon. BROWN. Ranking Member, NOAA is in the public safety business at the end of the day. We're responsible to the citizens of

this great nation, businesses, the communities for providing environmental intelligence. I mentioned the term "unblinking stream of high-quality data." We have to be relentless in our pursuit of that. I think through the GOES project, through JPSS, we are bringing robustness and minimizing gaps to the critical observations that are most important to feeding the global forecasting system. I would like to keep that our focus.

I think as we consider the future of commercialization in space, we just have to be very thoughtful about the impacts to those essential elements.

Ms. BONAMICI. Thank you, and as we look at possible scenarios, if there were ever a system where the United States exclusively purchases weather data from private companies, what would be the implications for these international obligations which you mentioned under the WMO Resolution 40 to share data freely and openly? What—how would that be managed?

Hon. BROWN. As I've researched this issue and discussed it with my experts, you know, we're focused on the data. We're really talking about the transaction. Can I conceive hypothetically of a way for a government, a nation-state, to purchase commercial data on a basis so that they get the intellectual property rights and instantly transmit it full, free and open to all of their partners? Yes. The problem with that is, as I understand it on the industry side, there's no business model that supports that. So that's sort of where we get stuck.

Ms. BONAMICI. Thank you very much, and my time is expired. I yield back. Thank you, Mr. Chairman.

Chairman BRIDENSTINE. I'd like to thank the gentlelady.

The gentleman from Alabama is recognized for five minutes.

Mr. PALMER. Thank you, Mr. Chairman, and thank you, Vice Admiral Brown, for testifying.

I'd like to ask you to clarify something. Is NOAA legally bound by the World Meteorological Organization Resolution 40?

Hon. BROWN. Congressman, it's not legal in the sense of it's a U.S. statute. The World Meteorological Organization commitment is a treaty commitment, and we actually signed a treaty back in 1949. Resolution 40 was created much later and is an extension of that treaty commitment.

I think of it more as an international contract, if you will, and as I said before, the benefit for us is for every one byte of data we put into the system, we get three bytes out.

Mr. PALMER. If it's a treaty, it's not a cooperative agreement. Did the United States ratify that?

Hon. BROWN. It was ratified.

Mr. PALMER. It was ratified? The WMO Resolution 40 details the types of data deemed essential as well what data is agreed on for sharing freely. How often is the WMO 40 updated to reflect current weather enterprise and landscape?

Hon. BROWN. Congressman, as I mentioned, WMO is sort of a recent construct, and to my understanding, there have not been really any hard updates to it. What the scientists have found is that it actually needed to be expanded. WMO Resolution 40 spoke only to atmospheric services. They also needed to think about sort of the hydrology of the planet, the effect of water, tidal surges, flooding.

So they actually spun off Resolution 40 and created something called Resolution 25 to talk about that. But the strict answer to your question, it has been a static document since it was created.

Mr. PALMER. And how long ago was that?

Hon. BROWN. I don't specifically recall. I think it was—I'm recalling from a briefing somewhere in the 1990s but I'll ask my staff to check.

Mr. PALMER. Well, if it's a treaty and this is a modification for that, was that brought before Congress? Do you know?

Hon. BROWN. I don't believe it was.

Mr. PALMER. Yet are we obligated to abide by anything out of the Resolution 40?

Hon. BROWN. Well, under WMO, and I'm familiar with IMO, we ratified the broader agreement. There are a whole bunch of subcommittees and instrumentalities that are created under that. I don't know the specific rules about how those amendments affect the whole.

Mr. PALMER. Okay, but you said we ratified the broader agreement, and you said that was 1949?

Hon. BROWN. We ratified it in 1949. The United States became an official signatory in 1949.

Mr. PALMER. Should it be updated if it's been in place for such a long time?

Hon. BROWN. Well, I think Resolution 40 is under the purview of those scientists and operators that I talked about, and I think we rely on their expert judgment to determine when it's appropriate to update.

I will point out, Congressman, that the United States is a leader within the WMO. Certainly, our influence carries some weight, but that really is a matter for our U.S. representative to the WMO and more broadly the State Department.

Mr. PALMER. Okay. Let me ask you another question. There's a 2012 report from the Department of Justice that noted that NOAA employs nearly 150 armed federal agents. Is this really necessary to have armed agents working for NOAA?

Hon. BROWN. I am not familiar with that specific report, so I'd like to give that to you on background.

Mr. PALMER. Are you aware that you have armed agent?

Hon. BROWN. I am aware that we have armed agents. If I could just leverage my background as a former Coast Guard officer, I have done joint operations with enforcement officials from the fishery service, and our job is to protect American fisheries. That's a dangerous environment. I would not be surprised if——

Mr. PALMER. Does NOAA have a role in that, though? I mean, that doesn't make sense. We've got ample law enforcement agencies to provide the kind of protection you're talking about, I mean, unless there's some threat from missing a forecast, and I would think that would be more of a local thing, but I don't understand why NOAA needs armed agents.

Hon. BROWN. I would just say generically, Congressman, again, I don't know the specifics of this particular issue, but I will just tell you, people use the tools of what we used to call the use-of-force continuum based upon the threat environment. My recent knowl-

edge from Coast Guard experience is that the threat of environment probably dictates the need for armed officers.

Mr. PALMER. I would like for you to provide the Committee a more detailed explanation for why NOAA needs armed agents if I may ask for that?

Hon. BROWN. We'll be pleased to do that, sir.

Mr. PALMER. Mr. Chairman, my time is expired. I yield back.

Chairman BRIDENSTINE. The gentleman yields back.

The gentleman from Illinois, Mr. Foster, is recognized for five minutes.

Mr. FOSTER. Thank you, Mr. Vice Admiral. Let's see. First a big-picture question. How do you balance data acquisition and data analysis from a budgetary point of view? You know, is there a possibility that there be a much larger bang for the buck putting money into supercomputers versus more satellites?

Hon. BROWN. Congressman, you said data analysis and data acquisition?

Mr. FOSTER. And data acquisition, you know, satellites versus supercomputers.

Hon. BROWN. NESDIS is principally in the role of data acquisition, you know, they—principally from the satellite systems. I assume that's what we're taking about. They're responsible for managing the procurements and managing the systems that bring that data into the rest of the organization for analytical and modeling purposes.

On the data analysis side, it's a bit of a shared responsibility, and Congressman, I'm giving you the generic sort of executive view on this.

NESDIS makes sure that it's high-quality data according to the requirements that were set by, say, the National Weather Service. That data is ported over through our systems into the National Weather Service, and then they start doing a series of validation and anomaly detection as they prepare to ingest that data into their models. So it's a bit of a shared responsibility.

Mr. FOSTER. And let's see. Having to—whenever you're making a make-versus-buying decision, you need to come up with an in-house estimate to compare the contract price with, and so do you have plans in place for making that comparison and the tools to do the in-house part of that comparison?

Hon. BROWN. I want to just step back a bit, and I'm assuming we're talking about commercial satellite data.

Mr. FOSTER. Yes.

Hon. BROWN. We're not there yet, Congressman. I think we want to learn forward. We want to test the ability of a commercial vendor to provide radio occultation data, and once we get to that step, I think it's time for us to think through the rest of it.

Mr. FOSTER. Okay. So——

Hon. BROWN. And do we have that capability resident within NOAA? We do, but I would just say in terms of the satellite business, NOAA is not a market maker. We leverage heavily our relationships with both NASA and the United States Air Force, and so we would probably partner with those folks to take a look at this as a system to come up with our best judgment.

Mr. FOSTER. Okay, because, you know, there have been a number of retrospective looks at privatization efforts looking at do they actually save money with, I think it's fair to say, a rather mixed set of results. So you may want to look carefully at those, particularly in cases where the privatization has not saved us much money as anticipated, understand that there are lessons to be learned and advanced as you look down this road.

Can you say a little bit about, does any of this potentially affect archiving of the data? Does that remain a unique federal or shared international role here?

Hon. BROWN. Archiving is important because it is the context that we use for modeling. It is the context we use for simulation exercises. It is the context that scientists use to push the boundaries of atmospheric sciences, and also to push the boundaries of the capability of future instruments. So we had spent a lot of capital to archive. I think a disaggregation of essential satellite systems would potentially compromise our ability to do that.

Mr. FOSTER. Thank you, and I yield back.

Chairman BRIDENSTINE. The gentleman yields back.

I'd like to recognize the gentleman from Arkansas, Mr. Westerman, for five minutes.

Mr. WESTERMAN. Thank you, Mr. Chairman.

Vice Admiral Brown, could you discuss NOAA's public-private partnerships with surface-based aviation and space-based data providers in the context of proprietary data—we've talked about that a little bit here already—and the current licensing construct that exists for them?

Hon. BROWN. Yes, sir. Just in general terms, we buy about five different categories of data that are on the additional list for Resolution 40. We buy aircraft data that I referred to before. We buy lightning data that helps us really look at the regional and local impacts of severe weather. We buy ocean color that helps us with things like harmful algal blooms and we buy a couple of other things. But they're all—they're all within upholding our commitment to the WMO and Resolution 40, and we do buy it on a proprietary basis and generally do not redistribute it according to the contracts that we sign.

Mr. WESTERMAN. So you don't share all the data?

Hon. BROWN. We don't necessarily share all the data.

Mr. WESTERMAN. What policies and procedures does NOAA have in place to facilitate the acquisition and application of commercial data to improve operational weather forecasting?

Hon. BROWN. Well, I talked about the process of NESDIS building satellites and building the essential data stream into the weather service and others. We've got other programs that are managed by the National Weather Service to assimilate other data sets. If you will recall recently, the First Lady put a rain gauge in the Rose Garden of the White House. Someone at the White House enters that information into a database that's a national database. The National Weather Service uses that information to reconcile what the forecasts are telling us, and it really reflects actual conditions on the ground.

Mr. WESTERMAN. And you talked about lightning data. Do you believe the longstanding partnership for lightning data has sig-

naled long-term interest in the technology and helped increase the technology advancement?

Hon. BROWN. I would defer that question to our subject-matter experts. I'll just tell you that they have conveyed to me that lightning data is very useful in developing our insight about severe weather and its impacts.

Mr. WESTERMAN. So in general, do you think that government interests can signal the market to increase technological advancements and create new markets?

Hon. BROWN. In general, I do, and that's one of the reasons why we want to learn forward with this radio occultation tech demonstration.

Mr. WESTERMAN. So does NOAA negotiate with private-sector companies it enters into agreements with in regards to the sharing of data?

Hon. BROWN. We do, and we try to be as beholding to full, free and open as we can because it is international custom, and because it obviously leverages the innovation of the scientific and academic community.

Mr. WESTERMAN. And do you believe the current private-sector partnerships can be used as a model for future weather-observing systems?

Hon. BROWN. I don't know if I'm ready to translate what we do for those data sets on the additional list to the essential list. I'm more interested in sort of proof—positively proving the technology and the ability of industry to provide that data stream, and then as I said before, I think we should learn forward from there without compromising all of the benefits that we get from full, free and open.

Mr. WESTERMAN. And for decades, the United States has used hosted payloads for a variety of U.S. government missions. Does NOAA intend to utilize hosted payloads for its missions?

Hon. BROWN. Yes. We're in consultation with the U.S. Air Force to be part of their hosted payload system.

Mr. WESTERMAN. Would this reduce the increasing cost of government-owned, -built, -operated, and -launched satellites?

Hon. BROWN. Congressman, we hope it does. Hosted payloads is supposed to be more affordable over time. I'm at the point in my learning where I'm still learning about how that actually happens. Often it's the launch costs that dictate the overall affordability of these satellite programs.

Mr. WESTERMAN. Thank you, Vice Admiral, and Mr. Chair, I yield back.

Chairman BRIDENSTINE. The gentleman yields back.

The gentleman from Colorado, Mr. Perlmutter, is recognized for five minutes.

Mr. PERLMUTTER. Thanks, Mr. Chair, and Admiral, thank you for being here and your testimony today.

I've had an opportunity to kind have been through a number of these hearings and meetings concerning our weather data, how we acquire it, how we analyze it, similar to what Mr. Foster was asking you, and as I was reading WMO 40 and listening to your testimony, there's sort of five principles, you know, again, looking at it at the executive level for me, you know. Does it protect life, does

it protect property? So the public safety component that you mentioned right at the outset, does it advance science, okay? For me, that's a key principle here. Does it honor international agreements? Because we have—you have contracts out there, some with business, some with other countries, whatever it is, and how you thread this needle has to honor those agreements. And then finally, does it deliver the biggest bang for the buck for the taxpayer.

So as you look at commercializing and buying commercial information, which then goes to your public safety and your advancing science reasons to be, you've got to think about that biggest bang for the buck, and you are absolutely right when you said, you know, business, their objective is to generally—you know, there may be some altruistic piece to it—generally, to get profit for the shareholders.

You, on the other hand, most public safety and most advancement to sciences that you can for the taxpayer, and they're different kinds of things but generally—so my question to you is, I see this as a contract matter, and I see sort of the two words in WMO 40, and you mentioned them, essential and additional, and how we construe and interpret those words. So can you tell us, because you are buying commercial information which respects the intellectual property of the business in some instances but in most instances, and I like that too, is that there's a free exchange of information. So if you could just comment on sort of the contractual side of this thing?

Hon. BROWN. Yes, sir. Thank you, Congressman, for the question, and I like your five principles. I may actually shamelessly steal those.

Mr. PERLMUTTER. You're more than welcome to take them.

Hon. BROWN. You know, and I think underlying this whole discussion about contract mechanisms is, the question is, what is data. What is essential environmental data? Is it intellectual property or is it a public good? And that's really the heart of the discussion that we're having within NOAA. We think it's a public good. Is there a potential for some sort of a hybrid in the future that upholds public good, upholds full, free and open yet leverages businesses' ability to provide data and preserving its intellectual property rights so that they can sell it many times? I don't know. I don't know.

Mr. PERLMUTTER. Let me jump in there. So—but I guess what I would suggest to you is that you guys investigate this thing clearly, because I do think the ability to leverage businesses, you know, it's whether you're the owner or the lessor of something, okay, and they're leasing to you or licensing to you, but that leverage with new ideas or a new secret sauce, new intellectual property can lead you to do a better job protecting life, do a better job protecting property, and see, that's the balancing act, and I know you're doing it. Just listening to your testimony, I feel more comfortable about what you—how you all are approaching this, but I guess sitting up here on this policy panel, I think that you really do need to continue to investigate and utilize the business sector where you can to leverage the first three—protecting life, protecting property, advancing science—and you've got to do that with your lawyers in honoring all the agreements you've already entered into.

So if you want to respond to that?

Hon. BROWN. Yes, sir. As we go through this very thoughtful discussion, you asked the question, what's really at stake. In my mind, there's three important things that potentially are at stake. The first one is that three to one return on investment for the data that we leverage. The second one is if there is a compromised flow of that data, we are going to weaken our ability to provide forecasting warning data to our citizens. And the third, and this is very unique for countries throughout the world, this country has built this multibillion-dollar enterprise we call private weather. I think this Committee has correspondence from some of the leaders from those folks that say really they are leveraged off of full, free and open, and so we also have to be thoughtful abut that third piece of it.

Mr. PERLMUTTER. Thank you. I yield back.

Chairman BRIDENSTINE. The gentleman yields back.

The gentleman from Louisiana, Mr. Abraham, is recognized for five minutes.

Mr. ABRAHAM. Thank you, Mr. Chairman.

Admiral Brown, thank you for being here. As a guy that still flies for the Coast Guard in an auxiliary role now, we have a little bit of a common bond, so good to see you, sir.

Why is NOAA waiting to release standard and specific specifications of data to the public? And I'll give you—if NOAA has used GPS radio occultation data for years, shouldn't that information already be available and ready to share?

Hon. BROWN. Yes, sir. There's two components to that question. We are currently ingesting cosmic data, radio occultation data, and making that available full, free and open, and so we will continue to do that.

The second part of your question was, sir?

Mr. ABRAHAM. Well, shouldn't the information be readily available already——

Hon. BROWN. Yeah, and that's——

Mr. ABRAHAM. —using the GPS occultation?

Hon. BROWN. Well, you can provide data to users all over the globe without having them understand what the requirements for that data were, what are the standards that we use to harvest and process and disseminate that data. That's very much—and I'm an engineer—a technical specification, and that's what we're intending to release pursuant to the release of our NOAA commercial satellite data policy are the NESDIS procedures that articulate what those data standards are for all to see.

Mr. ABRAHAM. And that's going to be when?

Hon. BROWN. I'm hoping it is later this year. We're working aggressively to release both of those documents.

Mr. ABRAHAM. I'm from Louisiana, and as you're aware, we've had some horrific flooding in Louisiana, Oklahoma, that water from Oklahoma coming down the Red River, and I think the National Weather Service changed the crest of the river predictions seven times in 13 days, and it really threw chaos into not only our private-sector homes but in the public sector, our sheriffs being able to react and do what they needed to do on a timely basis.

What is the National Weather Service and NOAA doing with the Corps to help prevent something like that in the future?

Hon. BROWN. Yes, sir. I just met with General Bostick three Fridays ago. We were discussing these very issues. Let me put this in a broader context. We are in the midst of what we are calling evolving the National Weather Service, and a lot of the things that we're doing were harvested from two Congressionally mandated reports, one from the National Academy of Sciences and one from the National Academy of Public Administrators, and one of those reports used the bumper sticker "Second to None." That is our vision for this evolution. As part of evolving the Weather Service, Senator Shelby just recently joined Secretary Pritzker down at Alabama to cut the ribbon on the National Water Center. That Water Center will bring more precision to the way that we analyze water threats to our nation.

Mr. ABRAHAM. Do you think that'll improve the hydrological——

Hon. BROWN. Dramatically, sir. We are working on plans internal to NOAA to take our current technology, which gives us a basin-level forecast, and neck it all the way down to street-level forecast.

Mr. ABRAHAM. Thank you, Mr. Chairman. I yield back.

Chairman BRIDENSTINE. I thank the gentleman.

We'll enter into round two since we've still got some Members here that might have some questions.

I'd like to hit on a key point. We had maybe a discrepancy here earlier between the testimony received before this Committee in February about commercial aircraft data and then of course testimony today, and here's one thing that I'd like—the premise that we got from your written testimony, Annex 1 of Resolution 40, WMO 40, has eight subsections that detail the types of data being essential and that must be free and unrestricted. Subsection 8 specifically addresses satellite data products and calls for "those data and products from operational meteorological satellites that agree between WMO and satellite operators. These should include data and products necessary for operations regarding severe-weather warnings and tropical cyclone warnings." So that's section 8 which I think is clear. I think that can be interpreted in different ways.

Here's the point, though. Annex 1 of subsection 3—earlier you were talking about what data is essential. Annex 1 of subsection 3 specifically identifies aircraft data as a designated data set that is deemed essential and that must be "free and unrestricted." And yet at the same time, the NOAA policy—on your Web site, there's a list of data—you know, data sets that are not free and unrestricted, you know, and aircraft data, ACAR's data and our data, that data is delayed for 48 hours, and the purpose for that is because the contracts that you've entered into with Panasonic and I think Rockwell Collins as well, they want to make sure that their data is protected because if that data is not protected, if it's immediately given to the world for free, then they lose their market, and if they lose their market, then there would be no data, and I think that's the point that I'd like to make is that this data policy is critically important for actually creating the markets that drive the innovation that we see from whether it's Panasonic or Rockwell Collins that drive the competition, the ability to get more data to feed

these global condition, initial condition models that ultimately help us better predict weather. For example, you know, my goal in Oklahoma is to be able to predict tornados more timely and accurately.

And there's one thought I'd like to just impart, Admiral, and you know, I'm not going to pretend like I've got, you know, some words of wisdom for a 40-year admiral from the United States Coast Guard, but when I came in Sunday night to come to Congress, I was hungry. It was 9:30 at night. I'm hungry, and I decided I wanted to get a cheeseburger. Well, at 9:30 at night, I was able to get a cheeseburger. Now, if that cheeseburger being food, if food was to be declared, you know, a global public good and therefore necessary to be given away for free, that cheeseburger would not have been available to me. That cheeseburger was available because, as Mr. Perlmutter correctly identified in his comments, the shareholders of that firm—it was McDonald's—the shareholders of that firm, they're interested in making a profit, and because there is a profit motive, there was that global public good that was able to give me nutrition at night.

Now, I'm now claiming necessarily that McDonald's is the best nutrition, but you get my point, that you've got to have the market in order to get the products that are necessary for that global public good. My concern is, we need to make sure that if there is a global public good, that that good gets produced, and if we don't have a market, then that good never gets produced. So while it may be global and public, if it doesn't exist, it can't be utilized, you know, to the advantage of people who are seeking that data.

I've heard you reference the three to one, you know, we get three times as much as we give, and I don't doubt that your numbers are correct on that, but I would attest is that if we maybe change, nuance the data policy for satellites, what we have actually done for commercial aircraft data and maybe provide a 48-hour delay, that while it could still be three to one with what the United States provides compared to what we receive, or we provide the one and we receive the three, that whole pie would be much bigger than it is now, in other words, because we would leverage commercial, we'd have more data, better data, cost-competitive data, innovation that we don't currently receive, which means the pie gets bigger, which provides better ability of NOAA to save lives, to save property, which I think is the goal of everybody here.

The other thing that's important is, you know, I've read articles recently indicating that there are—when you think about the numerical weather modeling, there are as many as, you know, seven or eight companies that do numerical weather modeling, and if NOAA is—or the National Weather Service is one, then we could cost-share with all of this commercial data that might be available. NOAA could be one purchaser of the data. In essence, you'd be spreading the cost for the purchase of that data among eight different entities that are all interested in feeding their numerical weather models.

So I guess my point in this—and I'm out of time so I'm going to not ask you a question but just leave you with the idea that there could be a nuanced position where when you look at aircraft data from commercial aircraft feeding the global initial conditions that ultimately help us predict weather, maybe considering a nuanced

position for satellite data, GPS radio occultation, hyperspectral sounding, these kinds of things that the commercial sector is ready, willing and able to do just as Panasonic and Rockwell Collins, not to mention all of the airlines are ready, willing and able to do, something to think about because the goal here is more data, better data, and of course, improved capability to detect and predict extreme weather events.

And I'll give you ten seconds if it's okay with the Ranking Member.

Hon. BROWN. Thanks, Chairman. We'll take that on board for consideration as we learn forward.

Chairman BRIDENSTINE. Thank you, and I turn it over to the Ranking Member, Ms. Bonamici, for five minutes.

Ms. BONAMICI. Thank you, Mr. Chairman, and I just want to point out that you have just mentioned feeding, pie and cheeseburgers, so I think somebody needs to bring the Chairman some lunch.

So thank you very much, Vice Admiral Brown, for your thoughtful testimony and your commitment to NOAA's mission. I just want to make, first of all, a point that at our last hearing, Dr. Bill Gale cautioned us as we move forward, that we really need to be careful to not break what's working well, and he talked about a principle known as no degradation of services, and with NOAA's commitment and our commitment to high-quality services, I just hope that we can add that to the list, whether it be to Mr. Perlmutter's list of five or just to make sure that we keep that in mind going forward.

I also wanted to follow up on the discussion about the WMO Resolution 40 and suggest that we have further conversations about this in the Subcommittee and the Committee. There's been suggestions, well, is this a treaty, is it a contract, is it a law, but when we're looking at an international agreement, I think we can all agree it's an agreement with a number of member of countries. There are significant ramifications of violating that type of international agreement. So we really need to have a follow-up discussion about that and look forward to talking with you about that going forward.

And I also wanted to, you know, talk about in regard to the WMO resolution, the importance of continued international engagement by NOAA, even outside the WMO. That's really critical. I was—I have been constantly impressed in this Subcommittee and this discussion as well as in space issues that oftentimes these issues defy other global conflicts and the importance of international engagement is so critical that we set aside other differences and continue that international collaboration.

I also wanted to follow up on, we've been talking a lot about satellites. I wanted to just mention and ask about the IOOS. As someone who represents a coastal community, the Integrated Ocean Observing System is really critical. So if we can come back down to Earth for a few minutes and talk about the importance of the buoys and the sensors and the coastal radars, and are there analogous conversations going on with the private sector? Because I know that that is sort of a partnership between federal, regional

and the private sector, so if you could address that important issue? Thank you.

Hon. BROWN. Ranking Member, with regards to IOOS, I just addressed the capital—the Congressional Oceans Caucus, Senate Oceans Caucus, on this issue. It's 11 regional associations sort of fusing intergovernmental, academia, private sector. I think it works well. It's clearly a disaggregated form of observing, and all of that is batched up and fed into databases that help NOAA make predictions about various things. A lot of it is port centric. For instance, we had the head of the Marine Exchange for the Port of LALB come talk to us about the power of the fusion of all of those observing systems and the collaboration to talk about the conditions within the port and the approaches to the port.

Your broader question is about relative health of the observing systems in situ versus satellite. It's something that's a part of my portfolio. I chair something called the NOAA Observing Systems Council. Our job within that council is to attend to the health. A lot of that is a function of the budget obviously. Those in situ measurements are also critical, particularly for some of the other things that we do in NOAA, and it's the fusion of all of these things from the depths of the ocean to the surface of the sun that give us the insight that we need to protect America.

Ms. BONAMICI. Thank you very much.

One more question. Can you talk a little bit about some of the possible innovations—you know, we hear about—you mentioned the collecting rainwater at the White House, but apps on phones—I mean, are there other areas where we could be going to really capitalize on the innovative culture and society that we have to help strengthen all the data that NOAA has, and what are some of the potentials?

Hon. BROWN. I talked about the rainwater gauge in the White House. That's a part of the Community Collaborative Rain, Hail and Snow Network, and it's called CoCoRaHS. CoCoRaHS is now the largest provider of daily precipitation observations in the United States, and yesterday there were more than 8,000 observations that were reported, and as I said before, we ingest that data because it gives us real time what's happening on the ground, and we can use it to reconcile our forecasts and our models.

The second one is what I'll call—I think it's a great innovation. It's called the mPING app. The NOAA National Severe Storms Laboratory is collecting public weather reports through a free app available for smartphones and mobile devices, and mPING starts—stands for Meteorological Phenomena Identification Near the Ground, and obviously our sensors don't necessarily go all the way to the ground. So this also provides supplemental observations for us to get smarter and deeper in our insight about what's happening.

Ms. BONAMICI. Terrific, and I see my time has long expired. I yield back. Thank you, Mr. Chairman.

Chairman BRIDENSTINE. The gentlelady yields back.

The gentleman from Colorado, Mr. Perlmutter, is recognized for five minutes.

Mr. PERLMUTTER. I have a couple of those apps, and they're really cool, so I congratulate you on that.

The Chairman used the word "augment" in his opening and in his initial questions to you, and I guess where I'm coming from is, I want to see us continue to build out and I would hope accelerate our JPSS and our GOES–R and to eliminate whatever gaps or chasms might exist. I see the private sector as helping you refine this bulk of information that you gather, and so, you know, I think it's going to take a little bit of everything to really, you know, just almost have instantaneous information that helps them deal with tornados, helps us deal with fires and floods in Colorado, those kinds of things.

So today I was very pleased with the step forward I think we've taken in the Middle East with the Iranian peace agreement and we'll see how that transpires, but we had China and Russia and the European community—France, Germany—and Iran obviously. In connection with—you said we were a leader on the WMO. I mean, how many countries are involved, and do you think as a leader in kind of organizing this weather community we would have influence on maybe reshaping WMO a little bit?

Hon. BROWN. Congressman, there are 191 members that are signatories to the WMO. That includes all of the major countries of the world. Obviously, weather is a concern for every nation for its citizens. We are a leader. We're admired, we're respected. Our Deputy Administrator for the National Weather Service, Laura Furgione, is our U.S. representative to the WMO. She just came back a month or so ago from two weeks in Geneva where diplomats were discussing and debating these things. You know, as a world leader, we have to be careful about how we express our influence, and as I thought about this, if from a scientific basis we legitimately want to recommend a change, I think we should do that, but it has to be scientifically sound because that list on Resolution 40, Annex 1, is managed by scientists and operators, and through the process of the WMO, we have empowered those folks to have the insight necessary to make those judgments. Is there something that we could do to influence that list? Yes. I just hope it would be for the right reasons.

Mr. PERLMUTTER. Well, and I think it will be. I mean, the Chairman and the Ranking Member and I have had a chance to meet with a lot of—a number of scientists who are also, you know, starting their businesses or have developed businesses, and they want to—they have a new algorithm or they have a new approach to something, and I guess I'm not afraid of taking advantage of their—what they believe are steps forward, and I don't want NOAA to be nervous about that either, and I don't think you are, but I agree with you. It's not just for profit's sake that I'm looking for this to happen. This is really coming back to those first two things are the public safety aspect of your job. You know, I don't want anybody getting—you know, I want to minimize the number of people who get flooded and, you know, their car goes boom right into the South Platte River. You know, we had a bunch of that about a month ago. We had a number of people die in floods, you know, in Colorado a month ago. You know, forget about what happened in 2013.

Hon. BROWN. So I agree with the Chairman's comments in general about nuancing the system. I think we're smart enough, creative enough, innovative enough to do that.

The other thing I would say on a broad term, if you take a look at the state of weather over the last 40 years, very dramatic scientific and technological advances. I think it's going to be that future wave that drives conditions for satellites in the future.

There's one additional caveat that I mentioned in my verbal statement that I'm mindful of. I went and joined many of our colleagues from DoD, NASA, National Geospatial Agency in Denver recently at the Space Symposium, and what the folks on the national security side are painting for the future of space is something that's congested, contested and competitive. Nation-states need to be very concerned about their critical infrastructure that's up there including those that feed our weather systems, and I just think we need to be thoughtful about that as we move into the future too.

Mr. PERLMUTTER. Thank you, Admiral. I yield back.

Chairman BRIDENSTINE. The gentleman yields back, and I agree with you, congested, contested, competitive, and here's what else I will tell you. We deal with this on the Armed Services Committee. There are ways to deal with it. Disaggregating is one. Taking advantage of commercial would be a very quick way to disaggregate and distribute those sensors and the distribution of weather data, and of course, we've done that in the Department of Defense. We've done that with communications. We've done it with imagery, and of course, the commercial applications from GPS are quite robust as well. So I agree with all that.

Regarding Mr. Perlmutter's comments on WMO 40, I think there is a way where the way we interpret WMO 40 may be different than a lot of the international partners that we have, and if we could maybe come more in line with where they are and at the same time when you mentioned this section 8 or—what is it—Annex 1, section 8, and then of course Annex 1, section 3, which provides information about commercial aircraft data, that maybe the way we interpret it might be different without having to go to our 91 international partners that are signatories to the WMO 40. So just another thought.

Unless anybody has any more questions, I think this will be the end of our hearing.

I want to just say thank you, Admiral, for being here, and thank the Members for their questions. I love the way these kinds of things go where they're bipartisan. We're all trying to figure out how do we get the best data, the most data to feed our numerical weather models and provide a little more safety for our citizens.

The record will remain open for two weeks for additional comments and written questions from the Members if you have more questions.

This hearing is adjourned.

[Whereupon, at 11:16 a.m., the Subcommittee was adjourned.]

Appendix I

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by The Hon. Manson Brown

U.S. HOUSE OF REPRESENTATIVES COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
Subcommittee on Environment

Hearing Questions for the Record: The Honorable Jim Bridenstine (R-OK)

Advancing Commercial Weather Data: Collaborative Efforts to Improve Forecasts Part II

The Honorable Manson Brown

1. Please list for the record all data currently produced by NOAA that falls under WMO 40 Annex 1's characterization of essential.

While the question appears to be directed at observational data, WMO Resolution 40 covers data from the forecast models as well. The answer below reflects both observational data and model data covered by WMO Resolution 40.

The United States (U.S.) provides surface synoptic observation reports from 278 Regional Basic Synoptic Network (RBSN) stations and upper air soundings from 92 of these stations. This includes sites across all 50 states, Puerto Rico, Guam, and the Pacific island territories.

The U.S. operates and provides surface CLIMAT code reports from 119 Regional Basic Climatological Network (RBCN) stations and upper air soundings from 15 of these sites. CLIMAT is a report specifically coded to represent climate variables as defined by the WMO. The sites are within the 50 states, Puerto Rico, Guam, and the Pacific island territories. These sites are a subset of the RBSN sites listed above which provide the additional observation types.

The United States operates and provides surface observations from 60 Antarctic Observing Network (AntON) stations, and 2 upper air soundings. Note these sites do not overlap the RBSN and RBCN sites listed above. Also many of these sites are maintained by research institutions, only operated during part of the year, and provide data as available. The data are primarily surface observations however there are some sites that also provide upper air soundings.

NOAA provides surface observations from 309 NOAA owned and operated buoys, including Deep-ocean Assessment and Reporting of Tsunamis (DART) stations, as well as the Tropical Atmosphere Ocean (TAO) observing network in the central equatorial Pacific Ocean.

There are 890 ships that are actively reporting data via the Voluntary Observing Ships program. These observations are provided when the ships are at sea. They are collected by various systems, including radio and satellite.

Data collected by NOAA and Air Force aircraft while conducting reconnaissance for tropical cyclones and winter weather are made available immediately under WMO Resolution 40.

Forecasts, Guidance, and Numerical Weather Prediction products covered under WMO Resolution 40:

For middle latitudes and subtropical areas, the following products derived from deterministic and ensemble numerical weather prediction (NWP) systems and services in real time:

(a) Surface and upper-air analyses;

(b) Prognoses one to three days in advance for:

(i) Surface and upper-air prognoses of pressure (geopotential), temperature, humidity and wind;

(ii) Diagnostic interpretation of numerical weather prediction (NWP) products to give:

a. Areal distribution of cloudiness (location of clouds);

b. Precipitation location, occurrence, amount and type;

c. Sequences at specific locations (time diagrams), at the surface and aloft, of temperature, pressure, wind, humidity, etc.;

d. Vorticity advection, temperature/thickness advection, vertical motion, stability indices, moisture distribution;

e. Jet-stream location and tropopause/layer of maximum wind;

f. Numerical products providing sea-state or storm-surge forecasts;

(c) Prognoses four to 10 days in advance, for:

(i) Surface and upper-air prognoses of pressure (geopotential), temperature, humidity and wind;

(ii) Outlooks of temperature, precipitation, humidity and wind;

(d) Extended- and long-range forecasts of averaged weather parameters, sea-surface temperature, temperature extremes and precipitation;

(e) Interpretation of numerical products using relations derived by statistical or statistical/dynamical methods to produce maps /spot forecasts of probability of precipitation or precipitation type, maximum and minimum temperature, probability of thunderstorm occurrence, etc.;

(f) Sea-state and storm-surge forecasts using models driven by winds from global NWP;

(g) Environmental quality monitoring and prediction products;

For tropical areas the following products from deterministic and ensemble NWP systems and services in real time:

(a) Surface and upper-air analyses;

(b) Prognoses one to three days in advance for:
    (i) Surface and upper-air prognoses, particularly of wind and humidity;
    (ii) Diagnostic interpretation of NWP products to give:
        a. Areal distribution of cloudiness;
        b. Precipitation location/occurrence/amounts;
        c. Time sequence of weather parameters at specific locations;
        d. Vorticity, divergence, velocity potential, vertical motion, stability indices, moisture distribution;
        e. Jet stream and layer of maximum wind locations;
        f. Numerical products providing sea-state or storm-surge forecasts;
    (iii) NWP-nested models or diagnostic interpretation of fine-mesh global models to give:
        a. Tropical storm positions and tracks;
        b. Tropical depression and easterly wave positions and movement;
(c) Prognoses four to 10 days in advance:
    (i) Surface and upper-air prognoses, particularly of wind and humidity;
    (ii) Outlooks of precipitation, wind, cloudiness and wet and dry periods;
    (iii) Life cycle of tropical storms;
(d) Extended- and long-range forecasts of averaged weather parameters, sea-surface temperature, temperature range and precipitation;
(e) Interpretation of numerical products, using relations derived by statistical/dynamical methods to produce maps/spot forecasts of probability of cloudiness, temperature range, precipitation, thunderstorm occurrence, tropical cyclone tracks and intensities, etc.;
(f) Environmental quality monitoring and prediction products;
(g) Sea-state and storm-surge forecasts using models driven by winds from global NWP;

Satellite:
NOAA considers all data from its operational geostationary and polar-orbiting satellites essential and shares pursuant to U.S. data policy and WMO Resolution 40, Annex 1 subsections *(7) Severe weather warnings and advisories for the protection of life and property targeted upon end-users; (8) Those data and products from operational meteorological satellites that are agreed between WMO and satellite operators. (These should include data and products necessary for operations regarding severe weather warnings and tropical cyclone warnings).*

NOAA fully and openly provides data from its operational satellites, GOES-East and GOES-West, and from the Suomi NPP satellite. NOAA also provides access to usable data from its secondary polar-orbiting satellites, NOAA-15, NOAA-18, and NOAA-19. NOAA also shares satellite altimetry data products from the Jason-1 and Jason-2 satellites. The DSCOVR satellite is in the final stages of completing post-launch check and NOAA will make the space weather data from this satellite fully and openly available.

Once launched and operational, data from NOAA's GOES-R Series, JPSS Series, Polar Follow On, Jason-3, and DSCOVR satellites will be fully and openly available. Data from the joint United States-Tawian COSMIC-2 constellation will also be fully and openly shared.

2. Please list for the record all data currently procured by NOAA that falls under WMO 40 Annex 1's characterization of essential.

NOAA interprets "procured" in this instance to mean purchased. The only data NOAA purchases that are classified as "essential" under WMO Resolution 40, Annex 1, are aircraft observations. These observations are purchased by NOAA and shared with WMO member nations immediately. For public safety and security reasons associated with the aircraft, the data are available to the public after a 48 hour delay. Data collected by NOAA and Air Force aircraft while conducting reconnaissance for tropical cyclones and winter weather are made available immediately and covered under WMO Resolution 40.

Aircraft observations are provided by airline operators. There are 8 U.S operators with approximately 2300 aircraft equipped to provide observations. They provide approximately 555,000 observations per day. These airline operators are Southwest, FedEx, Alaska Airlines, United/Continental, UPS, American Airlines, Delta/Northwest, and Air Wisconsin.

3. What has NOAA learned from NASA's work with the private sector for space launch, satellite imagery and unmanned transportation services?

NOAA has monitored and learned from NASA's work with the private sector, but at the same time recognizes that unique mission requirements must inform NOAA's approach to the acquisition of commercial weather data. In particular, NOAA's operational responsibility to protect lives and property must be kept central in any commercial activity with the private sector. This operational mission requires an uninterrupted stream of quality observations leading to a reliable stream of services. NOAA seeks to minimize risk of a lapse in capability, which would need to be evaluated in order to fund a commercial entity seeking to provide that capability in the future. NOAA must deliver services 24 hours a day, 7 days a week, so any implementation of a new system would need to operate in parallel with existing systems until reliability of the system is proven.

In the area of satellite imagery, NOAA continues to evaluate multiple models of U.S. government procurement of commercial data, including NASA's experience with SeaWiFS, to inform its procurement approaches and applicable authorities that could be used for purchasing satellite data. NOAA's National Environmental Satellite, Data, and Information Service is continuing to develop a process that will inform mechanisms to acquire commercial satellite data.

In the area of space launch, NOAA has relied on U.S. Air Force and NASA certifications of SpaceX launch vehicles for the DSCOVR, Jason-3, and COSMIC-2 missions. NASA's pathfinding work for commercial sector transportation services has resulted in opportunities for the government to leverage new contractual mechanisms that provide greater flexibility and offer possibilities for reduced cost and increased competition in the launch services market.

4. Can you provide this Committee with the analysis that NOAA used to determine that the United States obtains a 3 to 1 return on data received versus data given away?

A tremendous amount of data is freely transmitted between nations. These data include conventional observations - radiosondes (upper air soundings), surface observations, ocean observations, aircraft observations, radar observations, satellite observations, and a large amount of forecast and warning data and information. Much of these data pass through the WMO Information System and are received by NOAA through the hub it operates as part of the WMO Global Telecommunication System (GTS). Our review indicates NOAA provides 5.4 gigabytes per day. We receive 15.9 gigabytes per day of data from the rest of the world, about 3 times the amount of data we provide.

Many nations fly satellites and the data from these satellites are openly exchanged. The U.S. operates two operational geostationary satellites and two operational polar orbiting satellites. We access six other geostationary satellites from EUMETSAT, Korea, and Japan. NOAA also uses data from other polar-orbiting satellites operated by EUMETSAT, Japan, and Taiwan.

With respect to data directly used in our models, about 95 % of the data assimilated into U.S. models are satellite data. Of the satellite data, approximately 80 % are received from international sources, and 20% are from U.S. satellites (POES, GOES, DMSP). Of those satellite data, after quality control and assessment, approximately 70 % of the satellite data assimilated in the NWS Global Forecast System are from international sources, and about 30 % from U.S. satellites.

The different ways of measuring the use of data by NOAA, yields an average ratio of a 3 to 1 return on data received versus provided.

5. When will NOAA publish the standards and guidelines established for radio occultation from its involvement in the COSMIC program?

The NESDIS Commercial Process will address the data quality and characteristics to be used when considering any external data stream, including data from commercial sources. NOAA

released its NOAA Commercial Policy on September 1 for public comment and will release the NESDIS Commercial Space Process later this year.

6a. What is NOAA doing to work with other agencies and the international community to protect spectrum for GPS radio occultation measurements?

Establishing new regulatory protections for GPS radio occultation could require limiting the power levels in the spectra adjacent to the RNSS band to that produced by its traditional users such as the Mobile Satellite Service (MSS). While such limits are not currently under formal consideration within the domestic or international regulatory activity, NOAA is working closely with NTIA and other federal agencies to ensure any domestic and international proposals for use of frequencies adjacent to the GPS bands do not impact important atmospheric and space weather applications, like GPS radio occultation.

NOAA has begun discussions with other federal agencies to begin the process of recognizing radio occultation to provide the needed protections in light of the increasing importance of GPS RO measurements to the nation. While this could ultimately grant certain protections against interference from other radio services, it is a lengthy process and must not risk constraining the evolution of future GPS capabilities. New applications of radio occultation are also being developed for the future implementation. NOAA will continue to work with regulators to preserve our scientists ability to exploit the full potential of this observing capability, enhancing atmospheric and space weather prediction for the safety of life and property.

6b. Do you believe the FCC understands the importance of such measurements to improving weather predictions?

NOAA participated in a GPS spectrum usage workshop, hosted by the FCC, attended by NTIA and industry to help the regulators better understand the various applications of GPS, including radio occultation, and their importance. While this workshop and other activities have sought to increase understanding of the importance of GPS radio occultation, questions related to FCC's understanding and views can only be addressed by the FCC.

U.S. HOUSE OF REPRESENTATIVES COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
Subcommittee on Environment

Hearing Questions for the Record: The Honorable Mo Brooks (R-AL)

Advancing Commercial Weather Data: Collaborative Efforts to Improve Forecasts Part II

The Honorable Manson Brown

1. Is NOAA considering a public-private arrangement for air quality modeling?

NOAA is working with other U.S. federal agencies, international partners, state and local agencies, academia, and private sector to improve air quality modeling. As an example of an arrangement with the private sector, NOAA established a Cooperative Research and Development Agreement (CRADA) with AURAIA, Inc. to engage in joint development of technologies and techniques to predict at a higher spatial and temporal resolution when and where air quality will be more (or less) healthy to help individuals take action to avoid exposure to polluted outdoor air.

2. How is NOAA leveraging the existing capabilities in the private sector for use to improve their forecast operations and warning process?

There are 4 major ways NOAA uses existing capabilities in the private sector; purchasing commercially available observations, cooperative research and development agreements (CRADAs), leveraging private sector capabilities to maintain NWS observing network (e.g., maintain/service buoys - as well as purchasing hardware from the private sector), and through the Small Business Innovation Research (SBIR) program.

1) NWS leverages private sector observing capability by purchasing or using commercially available critical observations to enhance NWS warning/forecast services:

- **Lightning data:** NWS competitively contracts for lightning data. The current vendors provide NWS with real-time lightning data that are used for a variety of meteorological purposes including severe weather warnings, potential wildfire detection, aviation forecasts, and tropical storm/hurricane intensity changes.
- **Aircraft-based data:** NWS has several aircraft-based observational programs currently in various stages of operation. These projects obtain real-time, commercial aircraft-based meteorological data used for numerical weather prediction (NWP) and operational

weather forecasting. The current contractor works with commercial airlines to leverage the avionics on board commercial airliners to provide meteorological data during aircraft ascents, descents, and en-route using the Meteorological Data Collection and Reporting System (MDCRS). In some cases, at the expense of the NWS, the airlines install and maintain specialized water-vapor-sensing equipment to measure atmospheric humidity. These data provide critical information used in the NWS operational aviation forecast and warning program as well as integrated into NWS operational forecast models.

- **Surface observations:** NWS pays for surface observations as a part of the competitively bid National Mesonet program. The National Mesonet program obtains real-time, surface observation data that is used for a variety of meteorological purposes including short-term forecasts. These mesonet data include conventional surface observations as well as mobile sensors on trucks.
- **Ship observations:** Privately owned and operated ships provide valuable observations while ships are out at sea. These observations are used by forecasters and as input into NOAA weather forecast models.
- **Dissemination:** NWS uses private sector weather companies, the media ,and cell phone operators (through the Wireless Emergency Alerts – WEA) to help disseminate NWS forecasts and warnings.

2) NOAA collaborates with the private sector through CRADAs to test new technologies and make product improvements. An example is GPS-Met, which is a ground-based remote sensing capability that utilizes GPS signal delay to measure total column water vapor. GPS-Met is currently operated by NOAA Labs, and under a CRADA with Trimble Navigation and Earth Networks, they are working to transfer existing GPS-Met tools, techniques and/or capabilities. The CRADA will assist in refining and improving the functionality of GPS-Met which is used in NWP and NWS forecast office operations. NWS plans to enter into a commercial data buy to obtain this data.

3) NWS leverages private sector capabilities to maintain NWS observing networks. For example, NWS has marine services contracts with commercial vessel operators to provide ship time to deploy and maintain many of the far-offshore weather buoys and tsunami detection buoys. The National Data Buoy Center charters over 300 ship days each year to provide buoy maintenance. Also, weather observations are made and transmitted to the NWS by commercial vessels at sea as part of the Voluntary Observing Ship program. These buoy and ship observations are critical inputs for NWS marine forecast and warning products.

4) NWS uses the SBIR program to enable small companies to develop new technology to meet Weather Ready Nation challenges and be commercially viable for the United States over the next 4-5 years. Two examples of this work with the private sector are developing new, eye-safe

LIDAR devices for measuring moisture in a vertical profile of the atmosphere from the ground up; and developing new methods to improve solar flare forecasting.

3. How much of the NOAA budget is spent on efforts that duplicate already existing private-sector services (e.g., web pages, weather apps)?

NOAA and the emergency management community recognize that no one, single dissemination method will reach all people all the time in our effort to protect lives and property. Every dissemination method is vulnerable to failure, so reliance on any one system operated by NOAA and/or our partners could result in critical warnings and information not reaching the public. To ensure critical information is received by those in harm's way, and to provide environmental intelligence for the enhancement of the national economy, NOAA employs multiple dissemination methods and systems, including the Internet, NOAA Weather Radio All-Hazards, and satellite distribution. These systems feed into conventional radio and television broadcasts, the nation's Emergency Alert System, and Wireless Emergency Alerts (via cell phones), allowing warning information to reach the widest audience possible.

NOAA is always exploring additional ways to more efficiently and effectively disseminate critical information in support of its mission, especially as communication technologies evolve. However, it is long-standing NOAA policy to not expend funds or undertake efforts that duplicate already-existing private sector services. Conversely, NOAA actively supports having the private sector duplicate, repackage and create value-added products and services derived from NOAA's baseline data and core services. More recently, NOAA has partnered with the private sector to make its vast volumes of environmental data more widely available to the public with the express purpose of facilitating increased value-added private sector development of new and innovative products and services.

Appendix II

Additional Material for the Record

PREPARED STATEMENT OF COMMITTEE RANKING MEMBER
EDDIE BERNICE JOHSNON

Thank you, Mr. Chairman. I'd also like to welcome and thank Vice Admiral Brown for appearing before us today.

This hearing is a necessary follow up to a productive hearing we had in May with members of the weather community. I am pleased that we will be able to continue the discussion with NOAA today.

Data gathered by NOAA satellites feed global weather models that are critical to protect lives and property through accurate and timely weather forecasts and warnings. Americans have always appreciated the value of timely and accurate weather forecasts. Now, at a time when climate change impacts are being felt by more and more people, the importance of NOAA's weather satellites cannot be overstated.

What we learned from our hearing in May was simple: with respect to new sources of commercial data, four things must remain intact: We must continue to meet our international obligations; we must preserve the ideal of free and open access to weather data; we must ensure the data are useful and needed; and we must ensure that data purchased from commercial entities do not degrade our ability to make accurate forecasts. These are important to ensuring we have an approach that provides long-term benefits to this country and the world.

As I said before, observing the Earth and its changes is a truly global enterprise and we all benefit from deep and long-lasting international engagement and data sharing. Anything that has the potential to harm such arrangements must be dealt with from the beginning.

To that end, I am pleased to learn that NOAA is taking a thoughtful approach to expanding their use of commercial weather data, mindful of the risks and open to its benefits. I look forward to discussing this approach more today, and to be certain, in the coming months and years.

Thank you and I yield back the balance of my time.