THE FEDERAL WEATHER ENTERPRISE

Fiscal Year 2020 Budget and Coordination Report

Interdepartmental Committee for Meteorological Services and Supporting Research
Working Group for the Budget and Coordination Report

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The Federal Weather Enterprise:
Fiscal Year 2020 Budget and Coordination Report

FEDERAL COORDINATOR FOR METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH

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Preface

This year's Budget and Coordination Report (BCR) continues a streamlined format for reporting the Federal Weather Enterprise's (FWE) coordination efforts and by-agency budget information related to meteorological services and supporting research.

Section 1 highlights the efforts of the interagency committees and working groups in addressing ongoing concerns and their progress in meeting the goals and objectives of the Strategic Plan for Weather Enterprise Coordination published in 2018. The Strategic Plan, along with information on the individual proceedings of the FCMSSR, committees, and working groups, can be found on OFCM's website.

Section 2 of this report provides brief summaries of agency enacted funding and budget requests. These summaries satisfy the requirements of Public Law 87-843, Section 304, which calls for an annual cross-agency look at resources applied to meteorological services and supporting research. Where applicable, these summaries include amplifying information describing priority needs related to the forecast process, as called for in the recently enacted Weather Research and Forecasting Innovation Act of 2017. Table 1 reflects the agencies' "top line" meteorological services and supporting research budget numbers: FY20 requests along with enacted funding for two previous fiscal years. Table 2 shows significant interagency transfers of funds for meteorological services.

This report has been compiled through the efforts of many agency budget experts and meteorology-related functional experts. These contributors were formally established as an OFCM working group last year: *the Working Group for the Budget and Coordination Report*. The agency/entity leads are listed in the inside cover of this year's report. We at OFCM will continue our efforts to release this report in the spring to enhance the report's utility. My sincere thanks to our agency partners for their efforts in helping us achieve this goal, for their participation in our coordination activities, and for their meticulous efforts in preparing this report.

Michael F. Bonadonna
Federal Coordinator for Meteorological Services
and Supporting Research

Purpose

This annual report is prepared for delivery to the Office of Management and Budget and the Congress to satisfy the requirements of PL 87-843 section 304, in which Congress directed that OMB prepare an annual horizontal budget for meteorological programs conducted by the Federal agencies. This report also satisfies Public Law 115-25, Title IV, Section 402(a)(2) - the Weather Research and Forecasting Innovation Act of 2017- by identifying and prioritizing top forecast needs for coordination against budget requests and program initiatives across federal offices and agencies.

The budgetary information in this report provides a 'horizontal' look at the meteorological funding requested in the current President's Budget Request and the funding enacted over the previous two fiscal years. The specifics of the budgetary narrative and tabular information requested from the agencies are outlined in an OMB-OFCM coordinated, input guidance document that is provided to the agencies as part of the annual data call.

This report consists of two main sections. Section 1 is a description of the Federal weather coordination structure and the ongoing collaborative efforts supporting the goals and objectives of the Strategic Plan for Federal Weather Enterprise (FWE) Coordination. Section 2 consists of meteorological services and/or supporting research funding requested by and assigned to the Federal Weather Enterprise and, where applicable, reflects the agencies' priorities related to the forecast process.

Section 1: Federal Coordination and Planning for Meteorological Services and Supporting Research

The mission of the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) is to foster the effective use of federal meteorological resources by encouraging and facilitating the systematic coordination of weather services and supporting research across the Federal Weather Enterprise.

The OFCM operates with policy guidance from the Federal Committee for Meteorological Services and Supporting Research (FCMSSR). The principal work in coordinating meteorological activities and in the preparation and maintenance of OFCM reports, plans, and other documents is accomplished by the OFCM staff with the advice and assistance of the Interdepartmental Committee for Meteorological Services and Supporting Research (ICMSSR) and 25 program councils, committees, working groups, and joint action groups. The individuals who serve on these coordination entities are federal agency representatives.

Statutory Basis for the Federal Coordination Process

In Section 304 of Public Law 87-843 (the Appropriations Act for State, Justice, Commerce, and Related Agencies) Congress directed that the Bureau of the Budget prepare an annual horizontal budget for all meteorological programs in the federal agencies. The Bureau of the Budget (now the Office of Management and Budget, OMB) issued a set of ground rules to be followed in the coordination process. The Bureau tasked the Department of Commerce (DOC) to establish the coordinating mechanism in concert with the other Federal agencies. It also reaffirmed the concept of having a central agency—the DOC—to be responsible for providing common meteorological facilities and services and clarified the responsibilities of other agencies for providing meteorological services specific to their mandated missions.

The implementation of these directives by DOC led to the creation of the OFCM and the appointment of the first Federal Coordinator for Meteorological Services and Supporting Research (the Federal Coordinator). The FCMSSR was established in 1964 to provide policy-level agency representation and guidance to the Federal Coordinator in addressing agency priorities, requirements, and issues related to meteorological services, operations, and supporting research.

The FCMSSR is comprised of representatives from the 15 federal agencies that engage in meteorological activities or supporting research, have a major need for meteorological services, or set policy and direction for such services and research. These 15 agencies are the Departments of Agriculture (USDA), Commerce (DOC), Defense (DOD), Energy (DOE), Homeland Security (DHS), Interior (DOI), State (DOS), and Transportation (DOT); the Environmental Protection Agency (EPA), National Aeronautics and Space Administration (NASA), National Science Foundation (NSF), National Transportation Safety Board (NTSB), Nuclear Regulatory Commission (NRC); OMB and the Office of Science and Technology Policy (OSTP). The Under Secretary of Commerce for Oceans and Atmosphere, who is also the Administrator of the National Oceanic and Atmospheric Administration (NOAA), serves as the FCMSSR Chairperson.

In addition to the original public law and directives which established the OFCM, the Weather Research and Forecasting Innovation Act of 2017 called for a new coordination structure under the President's Office of Science and Technology Policy and new coordination processes

encompassing federal weather enterprise offices and agencies. As of the writing of this report, this new structure is projected to be implemented in 2019.

Federal Meteorological Coordinating Infrastructure

The Federal Meteorological Coordinating infrastructure diagram (Figure 1) shows the current committees, working groups (WGs), and joint action groups (JAGs) through which OFCM carries out its mission. The FCMSSR is shown at the top of the diagram as the policy guidance advisor to its subordinate elements and the Federal Coordinator.

Program councils are executive bodies that coordinate the acquisition and management of cross-agency systems or important, broad initiatives. Working groups are intended to serve enduring coordination functions. Joint action groups are temporary elements established to address specific, short-term objectives.

The program councils, committees, working groups, and joint action groups operate at the executive, management, and subject matter expert levels to provide:

- A forum for reporting activities, challenges, and achievements;
- A mechanism for coordinating change and solving problems;
- A method for collecting, documenting, and consolidating agency requirements and inventories;
- A body for coordinating cross-agency system development;
- A vehicle for collaborating with other groups internal and external to the coordinating infrastructure; and
- A mechanism for preparing studies, agreements, standards, protocols, reports, and national plans.

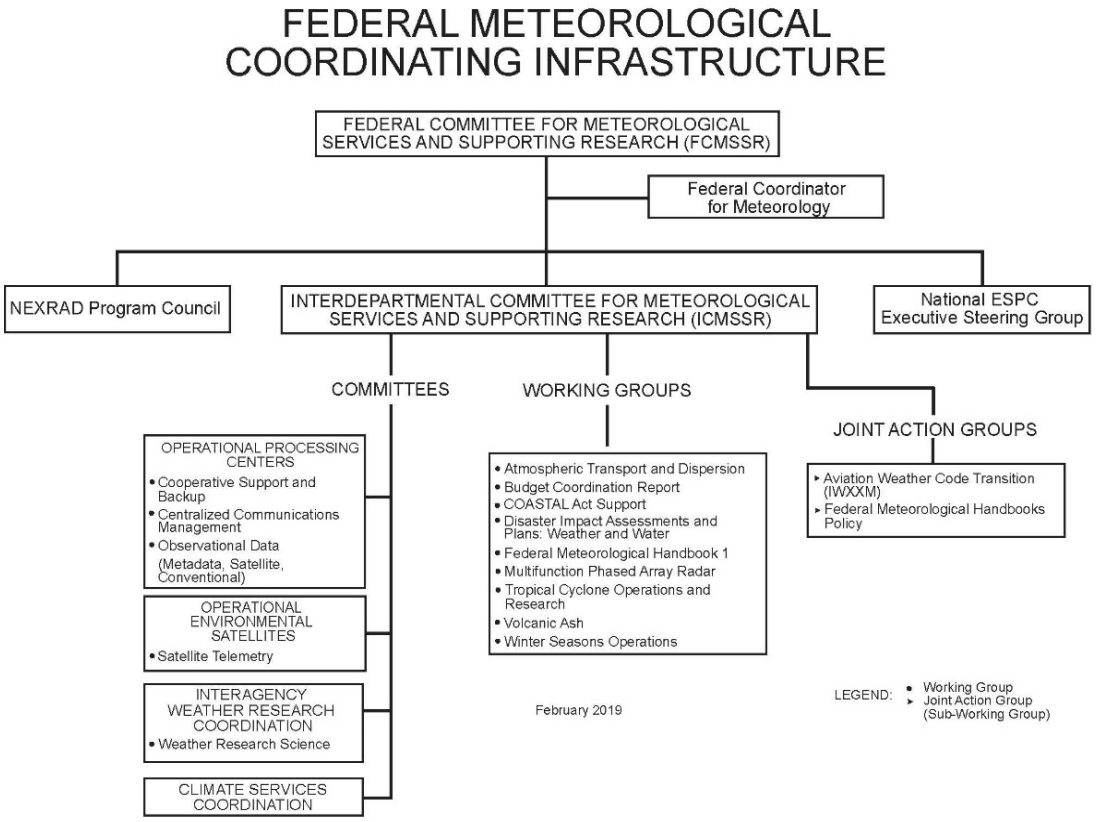

Figure 1: The Federal Coordinating Infrastructure.

Using these multiagency groups, OFCM pursues the following objectives as the means to achieve its mission:

- Coordinating the exchange of information, plans, and concerns among the FWE agencies to help the Nation achieve the most effective use of the $4.8 billion (FY19 enacted) collectively spent annually by the partner agencies.
- Coordinating federal agency efforts toward achieving strategic coordination goals and objectives, as outlined in the Strategic Plan for Federal Weather Enterprise Coordination
- Producing and maintaining foundational meteorological documents including Federal Meteorological Handbooks and National Plans.

Goals and Objectives of the Strategic Plan for Federal Weather Enterprise Coordination (FY2018-2022)

The Strategic Plan for Federal Weather Enterprise Coordination describes six coordination goal areas, each with several objectives that were determined by the FCMSSR to be areas readily benefited by interagency coordination. The goals and objectives are as follows:

1. Observing Capabilities

1.1: Enable interagency discussions of observation system acquisition at the capability planning stage.

1.2 Provide forums to discuss and promote development, deployment, and sustainment of common-use systems through formalized interagency processes.

1.3 Coordinate data formatting, processing, communication, management, and stewardship standards to optimize the exchange, timeliness, usability, and value of earth observations.

1.4 Coordinate the development of new observing technology and technology to extract information from observations.

2. Forecasting Processes

2.1 Strengthen interoperability among interagency forecasting centers in producing accurate, timely, and precise weather products, information, and services.

2.2 Ensure interagency utility (data types, precision, web services, etc.) of short-term to long-term forecasts.

2.3 Support agency efforts to plan and develop the cooperative use of processing resources to increase the Nation's computing power for enhancing data assimilation and modeling systems.

3. Decision support products, information, services

3.1 Coordinate interagency outreach efforts to identify weather and water-related information needs for decision making and risk management.

3.2 Improve the consistency of decision support and risk management products, information, and services across the FWE.

3.3 Cross feed processes and lessons learned between agencies to improve decision support tools.

4. Research

4.1 Exercise leadership in coordinating U.S. efforts in international weather research priorities including the current World Meteorological Organization Grand Challenges.

4.2 Foster interagency collaboration of research initiatives starting at the planning stage.

4.3 Support efforts among FWE participants to coordinate task definition and sponsorship of National Academies research initiatives.

4.4 Expand interagency use of data and information for research.

4.5 (new objective added in 2019) Develop coordination processes that facilitate operational feedback to the research community, and that accelerate the integration of promising research from federal, commercial and academic partners into operational improvements in observing, forecasting, warning and threat communication.

5. Workforce management

5.1 Coordinate Office of Personnel Management definitions and requirements for meteorology-related positions to ensure appropriate education and experience of the FWE workforce.

5.2 Coordinate opportunities to leverage outreach, including education efforts, recruiting, and diversity and inclusion initiatives.

5.3 Cross feed information on career path planning, training opportunities, diversity and inclusion, professional development, and retention programs.

6. Messaging priorities and needs

6.1 Coordinate input about FWE priorities to the Executive and Legislative branches, including communicating these priorities to federal agencies that are not FWE participants.

6.2 Coordinate messaging about FWE priorities to academia, professional and industry associations, non-federal governmental entities, and the general public.

Coordination Goal and Objective Activities

This section describes the Enterprise's activities in support of these goals. Groups that have taken actions applicable to the goals and objectives are listed, followed by bulleted descriptions of their actions. Since the strategic plan was published, redirecting focus on the objectives has been evolving. Therefore, not every area has been addressed, several groups have been omitted, and some goal activities are not represented. We expect these gaps will be filled over the life of the strategic plan. Additionally, we will leverage this infrastructure to meet the coordination goals of the Weather Research and Forecasting Innovation Act of 2017.

Detailed descriptions of the committees, working groups, and joint action groups, including records of their meetings, are available at the OFCM Groups web page.

Federal Committee for Meteorological Services and Supporting Research (FCMSSR)

- Conducted interagency negotiations to form consensus to revise the standard for the 1340 series qualifications for a U. S. government Meteorologist. Successful implementation will correct a long-standing, human resource impediment to diverse and inclusive hiring practices. (Objective 5.2)
- Reviewed NOAA's Next Generation Global Prediction System (NGGPS) Strategy as a possible framework for broader enterprise implementation. Examined various options for Exascale computing capabilities to support the national numerical weather prediction framework. (Objective 2.3)

NEXRAD Program Council

- Conducting a manpower review of the Radar Operations Center, jointly manned by NWS and U.S. Air Force. (Objective 5.1)

National Earth System Prediction Capability (ESPC), Executive Steering Group

- Integrated additional agencies into the development of 63 member multi-model (from multiple agencies) ensemble, forecasting out to 16 days; and is planning to extend to a 32 day forecast in the coming year. (Objective 2.3)
- Updating a joint roadmap describing an overarching investment strategy of earth system developmental and operational activities. (Objective 2.3)
- Working toward Common Model Architecture policies and standards, and towards producing a multi-model (from multiple agencies) ensemble for sub-seasonal to seasonal prediction. (Objective 2.3)
- Hosted Interagency High Performance Computing session to examine Exascale Computing Issues and needs. (Objective 4.2)
- Sponsoring extended range forecasting workshop to better coordinate agency resources at extended timescales from months to years. (Objective 4.2)
- Sponsoring interagency program managers summit and to determine areas of common interest and need and where the agencies can collaborate. (Objective 4.2)
- Drafted communications graphics materials for use in National ESPC agency materials. Objective 6.2)
- Drafted suite of strategy documents to assist in National ESPC priority messaging across agencies. (Objective 6.2)
- Initiated plans for an inter-governmental workshop on the “Building an Interannual to Decadal (2-30 year) Prediction/Projection Capability for Decision Support” in July. (Objective 6.2)

Interdepartmental Committee for Meteorological Services and Supporting Research (ICMSSR)

- Secured interagency agreement on the approach to addressing Section 402 of the Weather Research and Forecasting Innovation Act of 2017 that directs establishment of an Interagency Committee for the Advancement of Weather Services (ICAWS). (Objective 4.1)
- Developed a new objective for the Federal Weather Enterprise Strategic Plan to improve the Research-to-Operations / Operations-to-Research collaboration loop. (Objective 4.5)
- Initiated exploratory meetings to develop an approach for compiling the description of activities and requirements called for in Section 109 of the Weather Act of 2017 regarding the U.S. Weather Research Program. (Objective 4.1)
- Provided comments to the NWS regarding the Hazard Simplification project noting potential impacts to agency systems or operations that may result from changes to the current Watch, Warning, Advisory schema. (Objective 3.2)

Committee for Climate Services Coordination (C/CS)

- Finalized the Committee for Climate Services Coordination (C/CS) Terms of Reference to provide governance and structure to the committee. (Objective 2.2)

- Presented an update to the ICMSSR highlighting the committee's governance and future outlook with emphasis on supporting coordination of interagency climate products and information. (Objective 2.2)

Interagency Weather Research Coordination Committee (IWRCC)

- Coordinated to increase visibility of agencies priorities and projects, with specific focus on the WMO focus areas of High-Impact Weather, Polar Prediction, and Seasonal to Sub-seasonal forecasting. Members looked to National Academies research as cross reference research requirements for the future. (Objective 4.1)
- Coordinated With U.S. Permanent Representative to the WMO to formulate position papers on issues of interest to the U.S. agencies for WMO Executive Council meetings. (Objective 4.2)

Weather Research Science Working Group (SWG)

- IWRCC's SWG is composed of academic and other scientific community experts in focus areas such as High Impact Weather, Polar Prediction, and Seasonal forecasting. SWG conducted a survey of research topics across federal government and academia, looking for places of intersection. (Objective 4.2)

Committee for Operational Environmental Satellites (COES)

- Coordinating NOAA, USAF, and NASA efforts to obtain and evaluate commercial weather satellite data sources. (Objective 1.2)
- Initiated studies to examine the impact of Radio Frequency Interference (RFI) from rapidly expanding mobile telecommunication services on the satellite passive microwave sensors that provide the foundation of global weather and oceanographic observations. (Objective 1.2)
- Continuing to support the Government Accountability Office (GAO) R 10-799 recommendation 3. GOES-R program updates are annually briefed to the COES interagency partners. (Objective 1.1)
- Reviewed NASA's SmallSat and CubeSat programs seeking opportunities to leverage research capabilities for operational use and provide operational feedback to the research community. (Objective 1.4)

Satellite Telemetry Interagency Working Group (STIWG)

- Working to coordinate the use of OpenDCS software used by agencies to collect, validate, and disseminate data from Data Collection Platforms (DCP's); primarily via GOES DCS. (Objective 1.3)
- Pursuing opportunities to educate public about GOES DCS, spectrum allocation, growing number of GOES transmitting platforms, the consequences of interference to ground stations by terrestrial radio towers. (Objective 6.2)

Committee for Operational Processing Centers (COPC)

Working Group for Cooperative Support and Backup (WG/CSAB)

- Coordinated each Operational Processing Center's (OPC) GOES-17 data implementation strategy and the transition to GOES-West. (Objective 1.2)
- Monitored and coordinated actions leading to the removal of DOMSAT as a delivery vehicle for MSG to PDA delivery. (Objective 1.3)
- Monitored Air Force replacement for and Navy/NOAA members draft/develop replacement/s for the Data Acquisition, Processing, and Exchange (DAPE) Memorandum of Agreement (MOA) and the Environmental Satellite Data Annex (ESDA) to allow continued data exchange in a coordinated effort. (Objective 1.2)
- Monitored the transfer of funds across the OPC specific agencies for shared data services. (Objective 1.2)
- Coordinated the OPC's awareness and implementation of the Meteosat-11 decontamination exercise. (Objective 1.3)
- Coordinated new outage notification procedures among OPCs to ensure optimal situational awareness and allocation of recovery resources during operationally sensitive system down time events. (Objective 2.1)
- Coordinated mitigation actions among OPCs during a flood event along the Missouri and Platte Rivers threating 557 WW (AF) power sources and communications lines. (Objective 2.1)
- Documented COPC purpose, scope, responsibilities, procedures, and reports in a new COPC Terms of Reference to achieve actionable interagency coordination between member meteorological and oceanographic operational processing centers regarding cooperative data exchange and increased effectiveness of products and services for their customers. (Objective 1.2)
- Coordinated the delayed operational implementation of the Global Forecast System (GFS) - Finite Volume Cubed (FV3) among the OPCs. (Objective 1.2)

Working Group for Centralized Communications Management (WG/CCM)

- Developed a reoccurring semi-annual alternate COPC network path test procedure for the three DOD COPC circuits to evaluate whether the alternate path through Boulder is fully functional when needed. (Objective 2.1)
- Continued work with the fiber connection between the NOAA Satellite Operations Facility (NSOF) building and the National Maritime Intelligence Center (NMIC) building for moving forward with Mission Partner Gateway (MPG) implementation at the primary NOAA to DOD data exchange point. (Objective 2.1)
- Supporting and monitoring the DOD's Joint Information Environment-Joint Regional Security Stack (JIE-JRSS) implementation for potential latency impacts. (Objective 2.1)

Working Group for Observational Data (WG/OD)

- Continued interagency coordination of U.S. data management procedures for migrating from WMO migration from Traditional Alphanumeric Code (TAC) forms to BUFR formatted meteorological data. (Objective 1.3)

- Coordinated U.S. planned proposals to the WMO Inter-Programme Expert Team on Codes Maintenance (IPET-CM) for table-driven code forms, the Manual on Codes, and interoperability of metadata and data between WMO standards and formats. (Objective 1.4)
- Developed U.S. procedures for implementing the WMO Integrated Global Observing System and the Observing Systems Capability Analysis and Review tool (WIGOS and OSCAR/Surface), the future observing framework in support of weather, climate, water and relevant environment services - a WMO priority. (Objective 1.2, 1.3)
- Continued a coordinated effort to develop a U.S. systematic approach for assigning new U.S. WIGOS station identifiers, address data quality and data accessibility issues, and implement an OPC-collaborative observational data quality control process for metadata error discovery, reporting, tracking, and correction. (Objective 1.2, 1.3)
- Drafted preliminary U.S. procedures for implementing new WIGOS station IDs, alerted the operational processing center directors of the transition to these new IDs, and reached out to the public, private, and academia sectors by presenting this information at the 2019 American Meteorological Society Meeting. (Objective 1.2, 1.3)
- Drafted a preliminary “U.S. Federal Meteorological Data Management Practices” guide, primarily to define U.S. unique procedures for transitioning to the new WIGOS station ID schema and for establishing separate station metadata for stations with co-located surface and upper air observing sites. (Objective 1.2, 1.3)
- Organized and convened the National Operational Processing Centers 2nd Observational Data Workshop (Objective 1.3)
    - Clarified environmental data management roles and responsibilities
    - Addressed significant observational data challenges including data latency, observational gaps, and changes to data management requirements.
    - Published a workshop summary report, along with an online repository of workshop presentations
- Strengthened U.S. representation to the WMO by assigning WG/OD members to WMO Task Teams for WIGOS station ID development, Upper Air Data management, and WIGOS Data Quality Management. (Objective 1.2, 1.3)
- Assisted the National Science Foundation initiative to disseminate Antarctic Observations on the Global Telecommunications System. (Objective 1.2, 1.3)
- Established dropsonde data as a future need to be addressed by the Working Group/Air Reconnaissance Equipment and U.S. Air Force 53rd Weather Reconnaissance operations. (Objective 1.3)
- Coordinated testing of the Critical Infrastructure Protection satellite data services system that functions as a transparent backup for the most critical Earth System Prediction Capability data services. (Objective 1.3)
- Coordinated data access and preparation for Jason-2, Sentinel-3A, GOES-16 (R), and Meteosat-8 satellites. (Objective 1.3)
- Tracked and routinely satisfied Operational Processing Center requests for satellite data. (Objective 1.3)

Working Group for the Federal Weather Enterprise Budget and Coordination Report (WG/BCR)

- Finalized a formal charter and initiated this working group of BCR-reporting agencies for collaborative development of the annual report. (Objective 6.1, 6.2)
- Developed initial guidelines for identifying agencies' "top forecast needs", as called for in Public Law 115-25, Title IV, Section 402 (Objective 6.1, 6.2)

Working Group/Tropical Cyclone Operations and Research (WG/TCOR)

- Conducted the 2018 Tropical Cyclone Operations and Research Forum (TCORF) / Interdepartmental Hurricane Conference. Participants of the annual TCORF review the National Hurricane Operations Plan and the hurricane forecasting and warning program. (Objective 1.1, 1.2, 1.3, 2.1, 4.2)
- Reached agreement to modify aerial weather reconnaissance VORTEX message formatting leading to improvements to data transmission and utilization. (Objective 1.3)
- Reached agreement between the Air Force 53rd Weather Reconnaissance Squadron and NOAA Air Operations Center to add four (4) additional dropsondes at the turning points of the initial hurricane penetration pass. (Objective 1.3)

Working Group for Federal Meteorological Handbook Number 1 (WG/FMH-1)

- Examined and discussed weather observation guidelines for reporting changes in intensities for snow. The group met twice in 2018 and will continue to resolve this matter into 2019. (Objective 1.1,1.2, 1.3, 1.4, 3.1, 3.2, 3,3)

Joint Action Group for Aviation Weather Code Transition (JAG/AWCT)

- Coordinating federal agency efforts for transitioning aviation weather codes from the Traditional Alphanumeric Character (TAC) format to an extensible mark-up language (xml) based code generally referred to as the ICAO Meteorological Information Exchange Model **(IWXXM).** (Objective 1.3, 3.2)

Working Group for the Space Weather Enterprise Forum (WG/SWEF)

- Planned and conducted the 2018 SWEF as a public meeting on Capitol Hill to provide congressional members and the public insights on the need for space weather services and supporting research to mitigate the impacts of space weather on vulnerable, essential technological infrastructure. (Objective 6.1, 6.2)
- Initiated planning for the 2019 SWEF to be conducted at the Department of Interior to focus attention on the threat of Geomagnetic Disturbance and their potentially devastating impacts to the national power grid. (Objective 3.1, 3.2)

Working Group for Disaster Impact Assessments and Plans: Weather and Water Data (WG/DIAP)

- Coordinated interagency wind, water, and radar data collection and damage assessments for landfalling hurricanes Lane, Florence, and Michael, for use in federal, private sector, and academic model development, post-storm investigations and research. (Objective 1.3, 3.2, 4.4)
- Initiated a litigation hold, requested by the Department of Justice, on data and information collected by this group in response to Hurricane Harvey. (Objective 1.3)

- Coordinated three Civil Air Patrol aerial assessments for the Alaska-Pacific River Forecast Center's Silver Jackets Project to determine glacier dammed lake flooding potential on the Kenai Peninsula, Alaska. (Objective 1.3, 3.2, 4.4)
- Coordinated two Civil Air Patrol support overflight assessments following tornado events, one in western through central Illinois and one in central North Carolina. (Objective 1.3, 3.2, 4.4)

Working Group for COASTAL Act Support (WG/CAS)

- Assisted NOAA to coordinate development of the Coastal Wind and Water Event Database to meet the requirements of the COASTAL Act. (Objective 1.3)
- Supported NOAA efforts to develop the Named Storm Event Model (NSEM) which will ingest a wide variety of observational data to produce inland flooding and inundation analyses for COASTAL Act cases. (Objective 1.4)
- Facilitated interagency coordination in support of the development of the Named Storm Event Model (NSEM) and examined required computer, data assimilation, and model architectures. (Objective 2.3)
- Facilitated open dialog between the federal agencies and academic partners in developing decision support tools required by the COASTAL Act. (Objective 3.3)
- Coordinating the acquisition of data via USGS storm tide gauges and Digital Hurricane Consortium mobile meteorological systems. (Objective 1.1)
- Coordinating weather and hydrological products, information and services needed to meet the requirement of the COASTAL Act. (Objective 2.1)

Working Group/Winter Season Operations (WG/WSO)

- Finalized agenda for the 2019 working group meeting to draft the National Winter Season Operation Plan for publication in the summer of 2019. (Objective 1.1, 1.2, 2.1, 3.1, 4.1, 4.2)

Working Group/Atmospheric Transport and Dispersion (WG/ATD)

- The WG/ATD held its annual interagency meeting at George Mason University. The conference included presentations from a number of agencies including NOAA/NWS, DOD, DOE, and NOAA/NESDIS. (Objective 1.2, 2.1, 2.3, 3.2, 3.3, 4.2, 4.5, 6.2)

Working Group/Air Reconnaissance Equipment (WG/ARE)

- This working group was initiated to project 1-10 year airborne research and reconnaissance equipment needs for aircraft flying operational and research missions into tropical and winter storms. This group will routinely brief the Interagency Coordinating Committee for Airborne Geoscience Research and Applications on its findings. (Objective 1.1,1.2, 1.3, 1.4, 3.1, 3.2, 3.3, 4.1, 4.2, 4.4)

Section 2: Agency Funding for Meteorological Services and Supporting Research: Resource Information and Agency Program Updates

The narratives and tables in this section summarize selected budgetary information for the Federal government for fiscal years (FY) 2018 through 2020. The funds shown are used to

provide meteorological services and associated supporting research, which includes research and development with service improvements as their direct objectives. Fiscal data are current as of the end of March 2019 and are subject to later changes. The data for FY 2020 are derived from the President's Budget Request for FY 2020. The data for FY 2018 and FY 2019 represent enacted (congressionally approved) funding amounts. The budget data are submitted by each agency or entity and prepared by the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) in compliance with Section 304 of Public Law 87-843, in which Congress directed that an annual horizontal budget, across Federal departments and agencies, be prepared for meteorological programs conducted by the Federal agencies. Where applicable, budget summaries identify and prioritize the agencies' top forecast needs for coordination across federal offices and agencies, as called for in Public Law 115-25, Title IV, Section 402(a)(2) - the Weather Research and Forecasting Innovation Act of 2017.

DEPARTMENT OF AGRICULTURE

The Department of Agriculture's (USDA) budget request for meteorological operations and supporting research for FY 2020 is $112.4 million, a 0.3% decrease from the FY 2019 funding level. The decline is largely due to a 6% decrease in the request for funding by the Agricultural Research Service (ARS).

- USDA has requested $91.6 million for research and development programs, about $0.4 million less than in 2019. This funding is supported through USDA's two major research agencies. The National Institute for Food and Agriculture (NIFA) provides grants that support weather and climate research initiatives, including drought and water quality issues facing our Nation's producers. ARS, USDA's principal in-house scientific research agency, conducts research on how to cope with annual variations of weather on crop and animal production, ecosystem services, and the environmental and economic sustainability of agricultural enterprises.
- The FY 2020 amount requested by USDA for meteorological operations is approximately $20.8 million, slightly below the funding level in FY 2019. Operational activities include specialized weather observing networks such as the SNOTEL (SNOw pack TELemetry) network operated by the Natural Resources Conservation Service (NRCS) Snow Survey and Water Supply Forecasting program (SSWSF) and the Remote Automated Weather Stations (RAWS) network managed by the Forest Service. The SNOTEL and RAWS networks provide cooperative data for NOAA's river forecast activities, irrigation water supply estimates, and Bureau of Land Management operations. The SSWSF program, managed by the NRCS National Water and Climate Center, provides western states and Alaska with information on future water supplies. The Forest Service uses meteorological data to inform wildfire management decision-making regarding preemptive resource deployment and suppression strategy. The meteorological staff of the Office of the Chief Economist's World Agricultural Outlook Board (OCE/WAOB) routinely collects global weather data and agricultural information to assess the impact of growing season weather conditions on crops and livestock production prospects, keeping USDA commodity analysts, the Chief Economist, and the Secretary of Agriculture and top staff well informed of weather impacts on crops and livestock worldwide. The Risk Management Agency (RMA) provides administration and oversight of programs authorized under the Federal Crop Insurance Act. RMA's Strategic Data Acquisition and Analyses (SDAA) unit works with Oregon State University's Parameter-Elevation Regressions on Independent Slopes Model (PRISM) Climate Group to develop and utilize spatial climate data sets to detect potential waste,

fraud and abuse in the Federal crop insurance program and to assist underwriting in developing crop suitability mapping.

In FY2020, USDA agencies will continue to work with the National Oceanic and Atmospheric Administration's National Weather Service (NOAA/NWS) to coordinate their need for forecasts and outlooks, while also continuing to provide data to the NOAA/NWS data stream. The Forest Service, as a partner in the National Interagency Fire Center (NIFC) with NOAA and numerous other Federal agencies, leverages data from its RAWS network in support of fire prediction activities critical to effective fire management. Forest Service relies on NOAA/NWS forecasts and outlooks for activities including decision making for prepositioning of supplies and ensuring the safety of firefighting crews. Similarly, NRCS coordinates release of its Water Supply Forecasts with the NOAA/NWS spring seasonal outlook, in addition to year-round sharing of data from its SNOTEL and RAWS networks with the River Forecast Centers, local Forecast Offices, and other NOAA agencies. Beginning in FY2019, USDA's Regional Climate Hubs, under the leadership of the Forest Service, OCE, and ARS, have been working with the NOAA/NWS Climate Prediction Service to help tailor sub-seasonal and seasonal outlooks to the agricultural community. The Hubs have effected methods of gleaning information relevant to agriculture from outlooks in anticipation of weather events potentially harmful to crops and livestock (freezes, heatwaves, flooding, etc.)

Reference: 2020 USDA Budget Congressional Justifications
USDA Budget Explanatory Notes for Committee on Appropriations
2020 President's Budget Office of the Chief Economist
https://www.obpa.usda.gov/06oce2020notes.pdf

Department Of Commerce / National Oceanic and Atmospheric Administration

National Weather Service

The National Weather Service (NWS) funding request for the FY 2020 President's Budget totals $1.1 billion. This is a 6.9% decrease from the FY 2019 enacted budget. NWS provides weather, water, and climate forecasts and warnings for the United States, its territories, adjacent waters, and ocean areas for the protection of life and property and the enhancement of the national economy, 24 hours every day. NWS is the sole, official and authoritative U.S. voice for issuing warnings during life-threatening weather situations. With this request, NOAA proposes to focus on the core weather mission with more efficient processes to provide forecasts and warnings. NWS will also continue to pursue the NWS Weather-Ready Nation goals including activities to sustain forecast accuracy and consistency, as well as provide Impact-based Decision Support Services to core partners.

In FY 2020, NWS will continue its Next Generation Weather Radar (NEXRAD) Service Life Extension Program (SLEP), continuing transmitter, pedestal, and shelter refurbishments to extend overall service life, and reduce the average time between failures. NWS will also continue the Automated Surface Observing System (ASOS) SLEP with production and installation of the upgraded Acquisition Control Unit (ACU) and Data Collection Package (DCP), in partnership with and including reimbursable funding from tri-agency partners, the Federal Aviation Administration (FAA) and the Department of Defense (DoD).

Significant requested increases in funding from the FY 2019 enacted level included below were derived based on complex decisions and may affect more than one program.

NOAA Ship Observation Data Buy. NOAA requests an increase of $2.2 million to initiate a

data buy contract for meteorological and oceanographic observations from ships. NOAA's most sparse in-situ measurements are on the oceans, so this initiative will fill a significant data gap used to support maritime commerce and warnings of extreme events (e.g. hurricanes, winter storms, etc.).

Support Impact-based Decision Support Services and IT Security. NOAA requests an increase of $4.9 million to support both Impact-based Decision Support Services (IDSS) and IT security. Specifically, NOAA will provide core IDSS training to improve professional competencies ranging from basic training in risk communications to specialized training for incident meteorologists. In addition, NOAA will purchase IT equipment for forecasters both in field offices and those deployed to emergency operations centers, dispatches to front line fire camps and to support post-storm damage surveys. This request directly supports the Administration's prerogative to improve cyber security of government systems.

Establish National Weather Service Pilots. NOAA requests an increase of $2.0 million to accelerate efforts in NWS model technology that is foundational to the Collaborative Forecast Process (CFP); specifically, the National Blend of Models (NBM). NWS will focus on the NBM as a primary science and technology tool that will enable the CFP by allowing forecasters the ability to have a scientifically valid common starting point for forecasts. A common starting point will improve national forecast consistency, and improve NWS customers' confidence in the forecast. Early testing of the NBM as a common starting point suggests that there may be efficiencies in the forecast process that could be used to improve IDSS to core partners.

References: NOAA FY2020 Congressional Justification
NWS Overview: page NWS-1
NOAA Ship Observation Data Buy: page NWS-28
Support Impact-based Decision Support Services and IT Security: page NWS-61
Establish National Weather Service Pilots: page NWS-96

National Environmental Satellite, Data, and Information Services

The National Environmental Satellite, Data, and Information Services (NESDIS) funding request for the FY 2020 President's Budget totals $1.5 billion. This is a 13% decrease from the FY 2019 Enacted. The FY 2020 request will support key initiatives committed to providing real-time operations and data services as well as continuing production of NOAA's flagship satellites to continue meeting NESDIS' primary mission essential functions without incurring gaps in coverage.

NESDIS is conducting a series of industry studies and performing critical analyses to develop a new generation of satellites to ensure that essential functions of weather forecasting are met. NOAA will continue building robust GOES-R and JPSS satellite series which will improve lead times for watches and warnings and will meet DOC's strategic goal to reduce impacts of extreme weather events. NESDIS will leverage its partnership with EUMETSAT to develop the infrastructure to ingest, process and distribute Metop-SG, a satellite that will orbit in a mid-morning orbit, to increase the accuracy of numerical weather prediction. NOAA is also developing SWFO-L1, a satellite to monitor and issue geomagnetic storm warnings. NESDIS is responsible for managing all aspects of remotely gathered environmental data, providing uninterrupted global coverage critical for generating short-and long-term weather forecasts to deliver observations for weather forecasting.

NESDIS encourages entrepreneurial and public service use of NESDIS data products and searches for innovative approaches for exploiting environmental data from satellites. NOAA's Commercial Weather Data Pilot (CWDP) facilitates such demonstration projects to expand its observational datasets. CWDP allows NOAA to purchase and evaluate environmental data to

meet NOAA's mission. NESDIS seeks environmental data and data products to become encompassed into NOAA meteorological models to add value and benefit weather forecasts.

NOAA is proposing to restructure NESDIS's budget to prepare for a new operating paradigm that increases use of partner and commercial sources of Earth observation data. This will allow NOAA to continue to be a world leader in space-based observations and expand commercial space activity. This proposed restructure will leverage new public and private sector science and technical innovation, allow NESDIS to be agile and responsive to users' needs and expectations, reduce and mitigate risks and to be cost effective, while also promoting and protecting the Nation's security, environment, economy, and quality of life.

Significant requested increases and decreases in funding over the FY 2019 Enacted Budget include:

GOES-R. NESDIS requests a planned decrease of $104.3 million for a total of $304.1 million in the Geostationary Operational Environmental Satellites – R (GOES-R) Series program following the successful launch of the GOES-17 satellite on March 1, 2018. The remaining funding will continue satellite engineering development, production, and integration for the GOES-R Series program. The GOES program, which has provided essential observational data since 1975, supports the National Weather Service (NWS) in forecasting, tracking, and monitoring severe storms.

Polar Weather Satellites. NESDIS requests a planned decrease of $103 million for a total of $755 million for the Polar Weather Satellites (PWS). The FY 2020 funds will be used to continue the build of the JPSS-2 instruments and spacecraft, continue JPSS-2 satellite level integration and testing, and continue the development of the spacecraft and ATMS, CrIS, VIIRS, and OMPS instruments for JPSS-3 and JPSS-4. NOAA will continue the maintenance and sustainment of the ground system supporting the Suomi National Polar-orbiting Partnership (Suomi NPP) and NOAA 20- (formerly JPSS-1) satellites, and continue development of the ground system support for JPSS-2. NOAA will continue to work to improve its constellation strategy for PWS continuity while seeking cost efficiencies, managing system technical risks and leveraging partnerships

Space Weather Follow On. NESDIS requests $25.6 million, a decrease of $1.4 million, to ensure the continuity of coronal mass ejection (CME) and solar wind measurements currently provided by the NASA/European Space Agency (ESA)'s Solar and Heliospheric Observatory (SOHO) and from NOAA's Deep Space Climate Observatory (DSCOVR) respectively. Both sets of data are required to forecast space weather and provide accurate warnings.

Joint Venture Partnership. NESDIS requests $2.2 million to initiate Joint Venture Partnership activities with NASA, other agencies, and the commercial sector. The National Academies' 2017 Earth Science and Applications from the Space Decadal Survey recommended that NOAA and NASA develop a cost effective and joint framework for identifying and executing activities that advance NOAA's observation capabilities; the Decadal Survey also recommended that NOAA provide funding to support its share of the collaboration. The reauthorization of the Weather Research and Forecasting Innovation Act of 2017 requests NOAA to analyze data sources that can lower the cost of observations or provide value-adding technological advancements to improve weather forecasting. Additionally, community feedback on implementation of recommendations from the NOAA Satellite Observing System Architecture Study indicated the need for funded engagement with industry early on in program and project development to best leverage industry's investments and ability to innovate.

Geostationary and Extended Orbits (GEO-XO). NESDIS requests $10 million to conduct a series of industry studies, analyses, and potential flight demonstrations to optimize ways to

meet NOAA's future requirements from geostationary and extended orbits, informed by results of NOAA's Satellite Observing System Architecture (NSOSA) study. Additionally, this increase follows the guidance on Next Generation Satellite Architecture provided under the Satellite Architecture Planning section of Public Law 115-25 to plan for future data sources and satellite architectures, based on NSOSA findings, that lower costs, disaggregate satellite systems where appropriate, include new, value adding technological advancements, and improve weather forecasting and predictions.

Commercial Data Purchase. NESDIS requests $5 million to initiate purchasing commercial Global Navigation Satellite System (GNSS) Radio Occultation (RO) data for operational use. It will also support continued development of the infrastructure and capability to securely import, transfer, process, and store external data from commercial partners for operational use. GNSS RO has the potential to be a cost-effective means of increasing the volume of quality global atmospheric soundings. It provides temperature, water vapor, and pressure profiles, necessary for accurate weather forecasts.

References: NOAA FY 2020 Congressional Justification
Overview: page NESDIS-1
GOES-R Series: page NESDIS-62
PWS: page NESDIS-68
SWFO: page NESDIS-84
Joint Venture Partnership: page NESDIS-95
GEO-XO: page NESDIS-99
Commercial Data Purchase: page NESDIS-103

Office of Oceanic and Atmospheric Research

The Office of Oceanic and Atmospheric Research (OAR) request for funding related to meteorological supporting research in the FY 2020 President's Budget totals $184.5 million. This is a 6.0% decrease from the FY 2019 Enacted budget. OAR will continue to provide the nation with critical environmental information to support informed decision-making and promote healthy, productive, and resilient ecosystems, communities, and economies. OAR will continue research focused on improving our understanding and forecasting capabilities for atmospheric events that endanger lives and property and research focused on establishing a greater understanding of, and ability to predict, climate variability and change, and to enhance society's ability to plan and respond. OAR also will conduct innovative research for the development of the next generation of products and services.

Climate Labs and Cooperative Institutes. NOAA requests an increase of $ 12.9 million for a total of $73.9 million to support research activities that will help to gain a comprehensive understanding of the physical, chemical, and dynamical processes that shape our climate. NOAA will continue to support the world-class climate science that takes place at NOAA, but will eliminate arctic research and remaining Climate Competitive Research funding which was originally reduced in the FY2018 President's Budget. This will result in the closing of the Climate Program Office (CPO) as it currently exists. NOAA will reduce competitive research grants to Cooperative Institutes, universities, NOAA research laboratories, and other partners. NOAA's extramural grant competitions fund research in all 50 states and support nine Cooperative Institutes (CI) focused on climate research.

With the remaining climate funding, OAR will preserve priority activities including 1) Earth System Research within the OAR laboratories; 2) Long-term observations and climate records; 3) Research and development associated with Seasonal to Sub-seasonal (S2S) atmospheric research; and 4) legislatively mandated work on the National Climate Assessment

Weather and Air Chemistry Research (W&ACR). This sub-activity includes Laboratories and Cooperative Institutes (CIs) and Weather and Air Chemistry Research Programs. NOAA requests a decrease of $24.6 million for a total of $110.7 million. Within this level of funding NOAA would increase priority weather research contained within the US Weather Research Program by $2.9 million, which leads to near-term, affordable, and attainable advances in weather forecasting and computer and modeling capabilities to deliver substantial improvements in weather forecasting. Within this amount, NOAA proposes to bolster the Earth Prediction Innovation Center (EPIC) to accelerate community-developed scientific and technological enhancements into operational applications for numerical weather prediction (NWP). This virtual center will serve as the core research-to-operations-to-research (R2O2R) center for building and maintaining a community modeling framework to link world class scientists and software engineers in academia, the private sector and partner agencies with the research, development, and operational activities inside the agency. The following labs, programs and activities are proposed for reduction or termination:

- Air Resources Laboratory
- Unmanned Aircraft Systems Program
- Vortex SE
- Infrasonic Research
- Airborne Phased Array Radar
- Joint Technology Transfer

References: NOAA FY2020 Congressional Justification
OAR Overview: page OAR-1
Climate Research: page OAR-13
Weather Research: page OAR-38

National Ocean Service

The National Ocean Service (NOS) request for funding related to meteorological services in the FY 2020 President's Budget totals $34.0 million. This represents a 3% reduction compared to FY2019 enacted funding. These funds allow for continued operation of the National Water Level Observation Network (NWLON), the Physical Oceanographic Real-Time System (PORTS®) program, the data quality control program known as the Continuous Operational Real-time Monitoring System (CORMS), and the Ocean Systems Test and Evaluation Program (OSTEP), which is a development program for bringing new sensor technology into operations. Both the NWLON and PORTS® programs include subsets of operational water level stations with meteorological sensors installed for various partners and users, including the NWS. NOS will continue to provide meteorological observations that are critical to navigation activities and the safety of life and property.

Though traditionally oceanographic observing systems, NWLON and PORTS® technology allows multiple other sensors to be added, including meteorological sensors such as wind speed/direction/gusts, air temperature, relative humidity and barometric pressure. These meteorological observations provide important data for improving and verifying marine weather forecasts and warnings. Additionally, NOS has fourteen PORTS® stations with operational visibility sensors located in Mobile Bay, AL, San Francisco Bay, CA, Narragansett, RI, Northern Chesapeake Bay, Tampa Bay FL and Jacksonville, FL. NOS has upgraded and enhanced the majority of its NWLON stations with new meteorological sensors. This increase in meteorological observations has led to a 10% increase in the probability of detection of marine weather events and a ten minute increase in lead times for marine warnings, according to actual verification data for special marine warnings.

Navigation data users require a complete picture of their operating environment, which includes local meteorological data, to make safe and cost-effective decisions. Leveraging existing observing infrastructure is a cost-effective alternative to establishing new platforms to collect these data. The additional meteorological data improves the accuracy of NWS forecasts for storm surge, marine wind speed, and marine wave heights, used by both marine navigation and coastal communities when extreme weather events occur. The real-time data can be used by emergency responders to make sound decisions based upon the most up to date and accurate information. For example, when coastal areas are flooding, emergency responders must know which evacuation routes are still viable and other related information that most accurately reflects the current state of the physical environment. WFO Mobile call PORTS the backbone of the Coastal Flood Program.

References: NOAA FY2020 Congressional Justification
NOS Overview: page NOS – 1
Navigation Services: pages NOS – 6-8
Ocean and Coastal Observations (NWLON, NCOP, Modeling, PORTS): pages NOS – 9-11

Office of Marine and Aviation Operations

The FY 2020 President's Budget requests $36.1 million for the Office of Marine and Aviation Operations (OMAO) in funding to support meteorological operations and research activities ($32.5M for Aviation, $3.6M for Marine O&M). This is a 3% reduction from the FY 2019 enacted. OMAO supports meteorological operations and research activities through collection of related data from the aircraft and ship fleet. The fleet supports NOAA's science, service, and stewardship mission. The fleet operates throughout the United States and around the world; on and over open oceans, mountains, coastal wetlands, and the Arctic. NOAA's fleet fulfills multiple missions in support of NOAA's programs providing capable, mission-ready platforms and professional crews that survey snowpack levels for flood prediction, improve hurricane prediction models, assess air quality, survey coastal erosion, investigate oil spills and conduct oceanographic research and weather forecasts. In FY 2020, OMAO will continue to support meteorological observations through its Aircraft Operations PPA and Marine Operations and Maintenance PPA. OMAO's airplane and ships also help local decision makers respond to real-time meteorological events, including hurricane reconnaissance and research.

References: NOAA FY2020 Congressional Justification
OMAO Overview: page OMAO-1
Marine Operations and Maintenance: page OMAO-7
Aviation Operations and Aircraft Services: page OMAO-17

DEPARTMENT OF DEFENSE

U.S. Air Force

The U.S. Air Force request for meteorological program support FY 2020 is $143 million. Air Force resources for meteorological support fall into three categories: general operations and maintenance, procurement, and research, development, test & evaluation. This is a 15.3% decrease from FY19 enacted funding. This does not include all meteorological activities conducted within the Air Force.

Operations

Operational resources are dedicated to providing timely, accurate, resilient and relevant environmental information, to include space and terrestrial weather, for global battlespace

situational awareness for U.S. Air Force/U.S. Army forces and platforms supporting the 2018 National Defense Strategy objectives.

Research and Development

In order to align with the 2018 National Defense Strategy lines of effort, the U.S. Air Force continues investing in modernized environmental data collection, analysis, prediction, dissemination and tailoring capabilities to include commercial technologies that enhance system efficiency, ensure cybersecurity and promote interoperability. The USAF plans to invest in the following capability areas:

Weather Data Analysis and Dissemination. Weather Data Analysis and Dissemination provides command and control and mission planning integration; centralized, cybersecure weather web service capability; large-scale data ingest, processing, and warfighter product generation and visualization; agile software development and deployment; global, regional, and mission execution forecasts; specific, mission-tailored weather data on demand; and weapon system interoperability through machine to machine interfaces. Research, development, test and evaluation activities will enhance the capability to ingest, process, store, access, and disseminate meteorological data via upgrades to the web services architecture to expand the Open Geospatial Consortium services, implementation of modular open system architecture, upgrades to large-scale data processing, migration to continuous delivery/continuous integration methods for software development and deployment, and transition to a cloud computing environment.

Weather Forecasting. Weather Forecasting provides advanced scientific numerical weather prediction capabilities for automated, high resolution forecast products for mission planning, rehearsal, and execution with an emphasis on clouds, theater scale weather, aerosol/chemical constituents, and space environment characterization. Weather Forecasting includes programs for Numerical Weather Modeling, Weather Services - Live, Virtual, Constructive, and Space Weather Analysis and Forecast System. Research, development, test and evaluation activities will develop software for exploitation of dynamic aerosols, new meteorological satellite data sources, explicit numerical weather prediction cloud forecasting, and exploitation of space weather data. Additional research, development, test and evaluation activities include optimization of software for cloud migration and transition of the machine-learning Global Synthetic Weather Radar capability to operations.

References: U.S. Air Force FY2020. Congressional Justification
OPERATION AND MAINTENANCE, AIR FORCE VOLUME II
Multiple Pages (Weather Systems), Depot maintenance
Other Procurement, Air Force - Vol 1
Line # 21, Pg 143, (Weather Observation Forecast)
Research, Development, Test & Evaluation, Air Force Vol−III Part 2, Vol 3b
Line # 243 Pg 197 (Weather Service)
Research, Development, Test & Evaluation, Air Force Vol−III Part 2, Vol 2
Line # 36 Pg 87 (Air Force Weather Services Research)

U.S. Army

The U.S. Army (USA) submitted a $19 million request for FY 2020 for meteorological operations, research, and development, a decrease of 11.6% compared to FY 2019 enacted funding. The decrease is primarily due to a 33.5% reduction in funding for training and new equipment for Army Test and Evaluation Command (ATEC) meteorological support.

Operations

The U.S. Army funds meteorological support for developmental and operational tests and evaluations at ranges across CONUS, Alaska and Panama to provide essential information to acquisition decision makers and commanders. The Army also funds systems which provide highly accurate meteorological data for long range missile systems, ballistic missile defense systems, and government and commercial space mission tests as well as for operational employment of Field Artillery weapon systems. In its civil operational activities, the U.S. Army Corps of Engineers (COE) funds an extensive network of land-based gages collecting hydrologic and meteorological data used in support of COE major water projects, flood control, navigation, hydroelectric power, irrigation, water supply, and water quality. Within the Army's Training and Doctrine Command, funds are provided to conduct meteorological education and training at several Centers of Excellence. The ATEC utilizes their funds for indirect meteorological support costs not billable to ATEC subordinate command research, development, engineering and test and evaluation customers and additionally to replace and upgrade meteorological instrumentation and support systems. The $3.3 million decrease in ATEC's FY20 budget is attributable to a $2M/year reduction pursuant to the Equipping Program Evaluation Group Deep Dive/Night Court decisions by the Secretary of the Army and Chief of Staff of the Army during POM 20-24.

Research and Development

The U.S. Army funds laboratories to conduct basic and applied research in atmospheric science and technology with a focus on atmospheric sensing, modeling, and dynamics. The Army also provides funding to conduct research, development, and engineering services to solve the challenging problems in military engineering, geospatial sciences, water resources, and environmental sciences.

References: Army Justification Book of Other Procurement
Army Communications and Electronics Equipment, Budget Activity 2; p154, p455, p507.
Operation and Maintenance - Volume I, Operation and Maintenance, Army Justification Of Estimates, Operation and Maintenance, Army Budget Activity 01: Operating Forces Activity Group 13: Land Forces Readiness Support Detail by Subactivity Group 131: Base Operations Support, p237.
Army Justification Book of Research, Development, Test & Evaluation Army RDT&E – Volume I, Budget Activity 1; p78, p79, p114.
Army Justification Book of Research, Development, Test & Evaluation Army RDT&E – Volume I, Budget Activity 2; p277, p293, p611
Army Justification Book of Research, Development, Test & Evaluation Army RDT&E – Volume I, Budget Activity 3; p558

U.S. Navy

The U.S. Navy FY 2020 budget request for meteorological programs is $123.5 million, made up of $94.1 million for operations and $29.4 million to support enabling research. This represents a 3.7% decrease from FY19 enacted funding. The Chief of Naval Operations, through the Oceanographer of the Navy, sponsors the Naval Oceanography Program (NOP) consisting of operational Navy Meteorology and Oceanography (METOC) services and related research and development. Navy Headquarters, Navy Information Forces and the Commander, Naval Meteorology and Oceanography Command work together to field new capabilities. Funding for significant systems and capabilities include the following:

Earth Systems Prediction Capability (ESPC) The FY20 request of $10.7 million reflects a $2.8 million increase from the FY19 enacted funding. The Navy's Earth System Prediction Capability (ESPC) program will provide a more accurate, longer range, global ocean, atmosphere, and sea ice forecast system of global coupled ensemble technologies for lead

times of 1-10 days as well as a new capability for accurate forecasts from the Tropics to the Arctic at tactical, operational, and strategic lead times. It will develop a Navy interface to NOAA's products for seasonal to multi-annual lead times for deliberate planning through integrating atmosphere, ocean, ice, land and near-space forecast models into a seamless prediction system.

Naval Integrated Tactical Environmental System – Next (NITES-Next) The FY20 request of $12.2 million reflects a $1.1 million increase from the FY19 enacted funding. These systems ingest, store, process, distribute, and display conditions of the physical environment needed to optimize employment and performance of naval warfare systems. These capabilities make the warfighter and planner more aware of the operational impacts of the meteorological and oceanographic factors within the air and ocean environments. Changes in FY20 funding for NITES-Next continues the re-phasing of the program plan of FY19 to better align with the Program Manager's fielding schedule.

Surface-Based Sensing The FY20 request of $11.8 million includes both shipboard and land-based weather radar. The Surface-Based Sensing request is an increase of $3.2 million from the FY19 enacted funding. The land-based Automated Surface Observing Systems (ASOS) was procured as a partnership bulk-buy with the National Oceanic and Atmospheric Administration, National Weather Service enabling lower cost per unit, as well as aligning baseline configuration for contract maintenance. The shipboard program pulls Doppler information from the air search radar and converts the data into weather information, providing Sailors the ability to organically obtain local area weather and environmental measurements and provide near real-time weather information without adversely affecting tactical operations.

References: NAVY METOC FY 2020 Congressional Justification RDT&E:
RDT&E Air/Ocean Equipment Engineering PE 0604218N appears in DON2020 BA:05 Exhibit R-2A.
RDT&E Air/Ocean Tactical Applications PE 0603207N appears in DON2020 BA:04 Exhibit R-2A.
OPN Navy Meteorological and Ocean Sensors-Space PE 0305111N appears in DON2020 Exhibit P-40.

Department of Homeland Security

Federal Emergency Management Agency

The FY 2020 requested funding for FEMA's meteorological operations and supporting research programs is $1.94 million, no change from the FY 2019 Enacted Budget. The majority of this funding, $1.2 million, supports National Hurricane Program HURREVAC operations and maintenance of decision support tools used by federal, state, local, and tribal governments, along with technology modernization.

FEMAs Response Directorate administers the National Hurricane Program (NHP), which provides technical assistance supporting deliberate hurricane response/evacuation planning and operational decision making during an event. Under an Interagency Agreement between FEMA and the National Weather Service's National Hurricane Center (NWS/NHC), the NHC develops and applies its SLOSH (Sea, Lake, and Overland Surges from Hurricanes) storm surge model to provide planning and operational products to support storm surge risk analysis. Development of these products includes model runs and simulations, as well as inundation mapping. The operational products are used to support state and local evacuation decisions and are used at all levels of government to prepare for the potential impacts and required response. The planning products are used as the basis for the hazard analysis and evacuation zone development work done as part of the Hurricane Evacuation Studies (HESs) process. Planning products are also used to assess the potential storm surge risk for an approaching hurricane prior to the availability of the operational products.

As part of the NHP, FEMA also develops, operates, maintains and distributes the HURREVAC decision-support software tool. HURREVAC combines real-time NHC forecast data with evacuation clearance times from the HESs to guide emergency managers as to when decisions on hurricane evacuations would need to be made to ensure evacuation is completed before the arrival of hazardous conditions. The software is also widely used as a situational awareness and briefing tool and as a common operating platform to view official NHC hurricane forecast and risk information. Currently the NHP is working with NHC and other program partners on the development of the next generation platform for emergency manager hurricane decision support, which will aim to increase accessibility and capability.

FEMA's Recovery Directorate provides the necessary funding for NOAA's National Centers for Environmental Information (NCEI) to improve, maintain, and update its Snow Climatology Database (SCDB) and allows for more stations to participate in climatological and near-real time snowfall datasets and comparisons. These activities are necessary to support FEMA's emergency and major disaster declaration process and assistance to state, local, and tribal governments related to snow events.

References: DHS Congressional Budget Justification FY 2020
FEMA FY19 Operating Expenses

U.S. Coast Guard

All of the U.S. Coast Guard's (USCG) funding for meteorological programs is for operations support. For FY 2020, the requested funding level is an estimated $30.4 million, a slight (0.3%) increase from the FY 2019 enacted estimate. The Coast Guard does not have a specific program and budget for meteorology—all meteorological activities are accomplished as part of general operations. The USCG does not track meteorological costs at an organizational level, so the funding level is an estimate. The Coast Guard's activities include the collection and dissemination of meteorological and iceberg warning information for the benefit of the marine community. The Coast Guard also collects coastal and marine observations from its shore stations and cutters and transmits these observations daily to the Navy's Fleet Numerical Meteorology and Oceanography Center and NOAA's National Weather Service. These observations are used by both the Navy and NOAA in generating weather forecasts.

The Coast Guard also disseminates a variety of weather forecast products and warnings to the marine community via radio transmissions. Coast Guard shore stations often serve as sites for NWS automated coastal weather stations, and the National Data Buoy Center provides logistics support in deploying and maintaining NOAA offshore weather buoys from Coast Guard cutters. The International Ice Patrol conducts iceberg surveillance operations and provides warnings to mariners on the presence of icebergs in the North Atlantic shipping lanes. Coast Guard efforts in meteorological operations and services have not changed significantly during recent years.

References: DHS Congressional Budget Justification FY 2020
Attachment 9, U.S. Coast Guard

Department of the Interior

Bureau of Land Management

The Bureau of Land Management (BLM) requested funding for meteorological activities for FY 2020 is $4.5 million, which is a 1.5% decrease from enacted funding in FY 2019. The BLM funds two principal programs related to meteorological services and supporting research —the

soil, water, and air (SWA) program and the fire weather activities of the Office of Fire and Aviation (OFA).

References: BLM FY2020 Budget Justification
SWA Overview: page VI-29
References: DOI Wildland Fire Management FY2020 Budget Justification
Preparedness Program, predictive services: page 16

Bureau of Ocean Energy Management

The Bureau of Ocean Energy Management (BOEM) requests an estimated $3.23 million to continue ongoing air quality studies, to initiate new studies, to establish a wind resource database and to understand the power potential within a wind energy area in FY 2020, an estimated 280% increase from FY2019 funding levels that totaled $847 K. These studies are environmental and technical studies to inform the safe management and development of U.S. Outer Continental Shelf energy and mineral resources in an environmentally and economically responsible way. Any funding that goes towards the federal weather enterprise is usually in the form of supporting research for marine air quality modeling and monitoring; and meteorological-oceanographic resource assessment and characterization.

References: BOEM FY2020 Budget Justifications
Pages: 17, 72, 92, 96

National Park Service

The National Park Service (NPS) budget request for meteorological operations and research for FY 2020 is an approximate $2.7 million, approximately a 4% reduction in this area from FY 2019 enacted funding. The NPS expends about $700 K on atmospheric research with a focus on measurements of all forms of atmospheric reactive nitrogen and on aerosol science. The goal of this research is to identify the sources of air pollution that are affecting park ecosystems and visibility and to quantify their impacts. The NPS also expends approximately $2.0 million in routine air quality, visibility, and meteorological monitoring networks.

References: DOI National Park Service FY2020 Budget Justification
Note: The NPS budget request and enacted funding is not this granular - Natural Resource Management is the lowest level in the authorized budget. The allocations estimated here are based on internal assessment of needs and are not explicitly indicated by Congress. The FY 2019 estimate is based on the overall reduction for Natural Resource Management in the President's budget request.

U.S. Geological Survey

The U.S. Geological Survey (USGS) requested funding for FY 2020 is an estimated $31.5 million, no change from the FY 2019 enacted. This reflects funding requirements for the Water Mission Area and the Geomagnetism Program.

Hydrometeorological Data Collection and Distribution and Post-wildfire debris flow warning operations. The FY2019 request for this mission area is an estimated $29.6 million. The USGS Water Mission Area (WMA) collects streamflow, precipitation, water quality, ground-water level, and other water resources and climatological data as part of a national network and for a number of projects concerning rainfall-runoff, water quality, and hydrologic processes. A number of federal, state, and local agencies contribute to the costs of collection and distribution of these data.

USGS water related programs and associated budget line items were reorganized in 2015 and 2016 and the hydrometeorological related research was reorganized correspondingly.

Beginning in 2018 the WMA area was reorganized to focus more directly on water- and water-quality modeling and integration and reframing of USGS research products. Among other goals, a principal objective was to better support and complement the NOAA NWS National Water Model and, ultimately, to provide the hydrologic expertise needed to enable development of groundwater and water-quality predictions and forecasts in association with that model.

Comparisons and consistency between the FY 2018, FY 2019, and FY 2020 are difficult for several reasons. The President's 2019 request called for steep reductions in USGS Water programs, most of which were restored by Congress. In addition, in the 2020 budget request, three USGS water program line items are being combined into two program elements: the Water Observing Systems Program (WOSP) and the Water Resources Availability Program (WRAP). The previous Groundwater and Streamflow Information Program (GWSIP) and the monitoring network components of the previous National Water-Quality Program (NWQP) are being absorbed in to the new WOSP. The remainder of the assessments and research and development aspects of the NWQP are being absorbed into the new WRAP. (The third, remaining Water program, the National Water Resources Institute Program continues unchanged.)

- WOSP items that support hydrometeorological research include the USGS Federal Priority Streamgage (FPS) and groundwater networks and the National Atmospheric Deposition Program (NADP). The WOSP FY19 request included $24.7M for FSP. Congress added a total of $8.5 M for a Next Generation Observing System (NGWOS) pilot effort to more fully instrument select mid-scale watersheds to capture all elements of the water cycle and many associated water-quality data such as water temperature, conductivity, sediment and nutrient concentrations and loads. Of this 8.5M, $3.4M was used to install and operate and maintain new instrumentation in the Delaware River Basin in FY2019. In 2019-20, the USGS plans to build out that pilot network for the Delaware River Basin and move into a basin in the Western US. Given the broad linkage between USGS Water programs and meteorological research and operations, the relevant program elements include FSP, NADP, and NGWOS and is reported here as $29.6 million.
- The relevant WRAP request focuses on evapotranspiration and irrigation and implementation of groundwater components for the NWS NWM and remains an estimated $500 K.

Geomagnetism Program. The FY 2020 budget request for the USGS Geomagnetism Program is $1.88 million, providing funding unchanged from the Consolidated Appropriations Act, 2019 funding level. The 2020 budget request supports a continued focus on operating magnetic observatories and providing real-time geomagnetic data needed for issuing warnings and forecasts of geomagnetic storms. In 2020, the USGS will build on previously completed preliminary models of the induced electric field in the crust due to geomagnetic storms. This work is part of a National Science and Technology Council working group for coordinating Space Weather Operations Research and Mitigation (SWORM) across multiple Federal agencies. These results will help power-grid companies improve the resilience of their systems to magnetic storms, as required by the Federal Energy Regulatory Commission. Power grid operators will use these results to design mitigation strategies for geomagnetic storms, and the space weather alerting agencies will use the resulting electric field model to issue improved forecasts and nowcasts for space weather alerts.

References: FY 2020 Department of Interior Budget Justifications – U.S. Geological Survey
pages 75-87 Water Programs
pages 70-71 Geomagnetism Program

Department of Transportation

Federal Aviation Administration (FAA)

For FY 2020, the FAA is requesting a total of $279 million for Aviation Weather related Operations Support, Facilities and Equipment, and Research and Development costs, an approximate 2% decrease from FY 2019 actual funding received. The changes are comprised of:

- An increase in requested funding for Operations Support (OPS): from $230 million of actual funding received in FY 2019 to a requested $237 million in FY 2020, in line with Agency needs and priorities.
- A decrease in requested funding for Facilities and Equipment (F&E): from $39 million of actual funding received in FY 2019 to a requested $35 million in FY 2020, in line with Agency needs and priorities.
- A decrease in requested funding for Research and Development (RE&D): from $15 million actual funding received in FY 2019 to a requested $6 million in FY 2020, in line with Agency needs and priorities.

The funding will support the Aviation Weather programs for the Next Generation (NextGen) National Air Transportation System. The fund will support enhancements, including the dissemination of weather products and decision-making information.

For FY 2020, we will continue to research and make progress in the weather area to support NextGen weather requirements. Research projects may include integration of weather products into the air traffic decision-making, weather sensor improvement, weather needs in the flight deck, and refresh of the weather infrastructure.

United States (U.S.) Code Title 49 Section 44720 (49 U.S.C. 44720) designates the FAA as the Meteorological Authority for domestic and international aviation weather services of the U.S. In this capacity, the FAA provides requirements for the administration of aviation weather services to the National Weather Service (NWS). The FAA is responsible for ensuring compliance with these services and with maintaining International Civil Aviation Organization (ICAO) Standards and Recommended Practices as specified in Annex 3-Meteorological Service for International Air Navigation.

References: The weather Operations Support numbers source is the documentation from the Operations Review Board (ORB) process within ATO.
Page 61(172) - Facilities and Equipment; Detailed Justification for 2A14 - NextGen Weather Processors (NWP)
Page 102(172) - Facilities and Equipment; Detailed Justification for 2C01 - Aviation Surface Observation System (ASOS/ASWON)
Research, Engineering & Development; Detailed Justification for A11.j - Weather Programs

Federal Highway Administration

The current transportation authorization, the Fixing America's Surface Transportation (FAST) Act, allocates funds for Research, Technology and Education. This authorization includes core Highway Research and Development as well as Intelligent Transportation Systems (ITS). Of this, for FY 2020, the Road Weather Management Program (RWMP) was budgeted at $1.5 million, which equals the FY 2019 budget. All of RWMP's funding is for applied research, with an increased emphasis on knowledge and technology transfer to assist operating agencies in the deployment of the research products. RWMP research activities involve the development, testing and evaluation of analysis tools and decision support systems that integrate high-

resolution road weather and connected vehicle data to enable transportation system owners and operators to make more effective and efficient management decisions. Such decisions save lives, time and money for both the operating agencies and the traveling public. Work will continue to evaluate the challenges and opportunities of automated vehicles operating under adverse weather conditions.

Reference: FHWA FY 2020 Budget Estimates
Section IV Research, Development and Education
Page IV-3 Highway Research and Development Program
Page IV-9 Intelligent Transportation Systems

Environmental Protection Agency

The anticipated funding level in FY 2020 for directed meteorological research is approximately $2.1 million, a 66% decrease from FY 2019 funding. All of the Environmental Protection Agency's (EPA) funding of meteorological and air quality programs is for supporting basic and applied research.

Continued but reduced attention is being paid to the effects of airborne toxins, ozone, and fine particulate matter on human health, and the impact of air pollution on human health and sensitive ecosystems. To promote excellence in environmental science and engineering, the EPA historically has supported a national research grants program for investigator-initiated research. The funding for grants (with reliance on quality science and peer review) and for graduate fellowships (to support the education and careers of future scientists) has provided for a more balanced, long-term capital investment in improved environmental research and development. The funding for the grants program is anticipated to decline significantly in FY2020.

The EPA continues its development and evaluation of air quality models for air pollutants on all temporal and spatial scales as mandated by the Clean Air Act as amended in 1990. Research at reduced levels compared to previous years will focus on urban-to-hemispheric scales, and multimedia models, which will be used to guide development air pollution control policies, human and ecosystem exposure assessments, and air quality forecasts. Emphasis will be placed on meteorological research into global-to-regional-to-urban-local formation and intercontinental transport of air contaminants in support of the revisions to the National Ambient Air Quality Standards and ecosystem protection strategies. Some increased efficiency of computation and interpretation of model results are being made possible by means of supercomputing and scientific visualization techniques.

Reference: FY2020 EPA Budget in Brief
Pages 58: Research – Air and Energy
Note: Based on historical records (pre-FY17), a proportion of the Air and Energy research program budget is estimated to apply to meteorological services and supporting research. Year-to-year changes in these budget values reflect annual variations in the total AE budget.

National Aeronautics and Space Administration

The National Aeronautics and Space Administration's (NASA) estimated FY20 funding related to meteorological services and supporting research is $351 million, a decrease of approximately 19 percent from the enacted FY19 funding of $432M. This reduction largely reflects the progress of NASA's contribution to the European Space Agency's Solar Orbiter Collaboration (SOC) mission as it moves into spacecraft testing and preparation for an anticipated launch in FY20. The budget figures reported are based on relevant missions and programs in the Earth Science Division and the Heliophysics Division within the Science Mission Directorate (SMD),

as well as Human Exploration and Operations Mission Directorate (HEOMD). The Earth Science Division (ESD) reported budget includes an estimate of weather observations and research, as well as other closely-related program activities. Research and satellite mission budgets are calculated based on their estimated overall contributions to the weather focusing activities reported, noting that the objective of ESD's program is to advance Earth System science. This report also includes Heliophysics Division research assets and programs that contribute significantly to the advancement of space weather knowledge and to the transfer of that knowledge into space weather prediction systems. The HEOMD reported budget includes an estimate of terrestrial and space weather operations and research activities. Only missions and programs relevant to meteorological operations and research are included as part of this report, with select missions and programs highlighted below.

- Earth Science Research: NASA projects a budget of $53 million in FY20 for Earth Science Research relevant to meteorological supporting research, representing no change from the FY19 enacted amount of $53 million. Earth Science Research addresses complex, interdisciplinary Earth science problems in pursuit of a comprehensive understanding of the Earth's interconnected systems. This strategy involves six interdisciplinary and interrelated science focus areas, one of which is specifically dedicated to weather research. The projected FY20 budget will provide continued investment in weather related Research and Analysis (R&A) projects, including competed atmospheric dynamics investigations, as well as the Global Modeling and Assimilation Office (GMAO), Short-term weather Prediction Research and Transition (SPoRT) center, and the NASA-NOAA-DoD Joint Center for Satellite Data Assimilations (JCSDA) and its supporting data system for weather-related missions and projects. The GMAO is responsible for building the state-of-science Earth system modeling and data assimilation system for fundamental research in atmospheric science, disastrous weather phenomena including hurricanes and floods, and techniques to utilize satellite observation in the models through the data assimilation process. The SPoRT center is responsible for transitioning NASA developed satellite algorithms and data products into operational weather forecast environments, especially the National Weather Service. The JCSDA is a multi-agency effort building the nation's infrastructure of satellite data assimilation for the purpose of weather forecasting.
- Earth Science Flight Missions: The projected FY20 budget relevant to meteorological supporting research is $165 million, a decrease from $189 million in FY19. Earth Science Flight Missions include those that are operational and those under development, covering a broad range of multi-disciplinary science investigations aimed at understanding the Earth system and its response to natural and human-induced forces and changes. Global Precipitation Measurement (GPM), Suomi National Polar-orbiting Partnership (Suomi-NPP), Aqua, Surface Water and Ocean Topography (SWOT), the Deep Space Climate Observatory (DSCOVR), and the European Space Agency's (ESA) Sentinel-6 are the missions most relevant to the Federal Weather Enterprise, as well as investments in Earth Systematic Missions research. A combined projected FY20 budget of $45 million will constitute the weather relevant portion supporting the continuing operation of GPM, Aqua, Suomi-NPP, and DSCOVR for producing long-term data records and supporting weather research. GPM provides next-generation observations of rain and snow worldwide every three hours, advancing our understanding of Earth's water and energy cycles, improving the forecasting of extreme rain events that cause natural disasters, and extends current capabilities of using satellite precipitation information. The Aqua spacecraft carries six state-of-the-art instruments to observe the Earth's oceans, atmosphere, land, ice and snow cover, and vegetation, providing high measurement accuracy, spatial detail, and temporal frequency. Aqua and Suomi-NPP bridge the Earth Observing System weather-relevant measurements to NOAA's JPSS series of operational satellites. DSCOVR maintains the

nation's real-time solar wind monitoring capabilities, which are critical to the accuracy and lead time of NOAA's space weather alerts and forecasts.

For missions under development in FY19, the SWOT mission completed the development of the Global Positioning System-Payload (GPSP) instrument and began integration and testing of the nadir payload module. A projected SWOT budget relevant to meteorological supporting research is $66 million in FY20, a decrease of $22 million from FY19. SWOT is planned to complete the System Integration Review (SIR), the development of the Ka-band Radar Interferometer (KaRIn) instrument, the nadir payload module integration and testing, and the integrated payload module integration and testing. SWOT will make the first global survey of Earth's surface water, observe the fine details of the ocean's surface topography, and measure how water bodies change over time. The Sentinel-6 project completed the development and testing of the Sentinel-6 NASA instrument payload in FY19. A projected Sentinel-6 budget relevant to weather research needs in FY20 is $13 million, a decrease of $1 million from FY19. Sentinel-6A is planned to complete the Operational Readiness Review (ORR) and begin preparations for launch in FY20. The Sentinel-6 mission will provide continuity of ocean topography measurements. Consistent with the 2017 Earth Science Decadal Survey (DS), a budget of $4 million is requested in FY20 for DS Missions that are relevant to weather research to continue four designated observable (DO) studies. The DS recommended a set of space-based observation capabilities that included all currently planned Earth Science missions, and additional observation capabilities including but not limited to the following designated observable scientific areas: Aerosols, Clouds, Convection, and Precipitation. The Earth Science Flight Missions projected FY20 budget also includes $15 million for the weather-relevant portion of missions and instruments in the Earth System Science Pathfinder (ESSP) program. ESSP provides frequent, competitively-selected Earth science research opportunities, including space missions and remote sensing instruments for space-based missions of opportunity or extended duration airborne science missions. Two missions of most relevance to weather research are the Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats (TROPICS) and Cyclone Global Navigation Satellite System (CYGNSS). TROPICS, in final design and fabrication (Phase C), will provide rapid-refresh microwave measurement over the tropics to observe the thermodynamics and precipitation structure of tropical cyclones over much of the system’s lifecycle, while CYGNSS, currently in operation, has the mission objective to measure ocean surface winds throughout the life cycle of tropical storms and hurricanes to facilitate better weather forecasting. A projected FY20 budget of $2 million is planned for TROPICS to complete its final system integration activities, and $3 million is planned for CYGNSS for continuous operations. The Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS), an Earth Venture Suborbital-3 airborne mission, is also included in the FY20 budget and will continue the precipitation science research missions.

- **Heliophysics Space Weather:** The projected FY20 budget is $129 million, a change from $187 million enacted in FY19. The FY19 enacted budget represents a change from the FY19 requested budget largely due to the launch of Parker Solar Probe on August 12, 2018, and thus, reallocation of Mission Directorate Unallocated Future Expenses. NASA supports space weather research through the Heliophysics Division. One of the Division’s objectives is to understand the Sun and its interactions with the Earth and the solar system, including space weather. As part of this, the Living with a Star (LWS) Parker Solar Probe mission will trace the flow of energy to help scientists better understand the heating of the solar corona, the Sun’s outer atmosphere, and explore what accelerates the solar wind, by flying through the solar corona in the region where these processes happen. The FY19 budget of $20 million supported the mission’s first perihelion, or closest approach to the Sun, and return of

science data. A budget of $21 million is requested for Parker Solar Probe in FY20. The LWS mission, Solar Orbiter, is a collaborative mission with ESA. The mission, including instruments and launch service contributed by NASA, will perform a close-up study of our Sun and inner heliosphere using a combination of in-situ and remote-sensing instruments. In FY19, $62 million is dedicated to launch service costs and U.S. instrument activities during spacecraft testing and preparations for launch. A projected budget of $4 million in FY20 will support continued preparations for the anticipated February 2020 launch and subsequent data collection. A projected FY20 budget of $8 million will support mission operations for the Van Allen Probes mission as it continues its investigation of the Earth's radiation belts. FY20 also includes a projected budget of $30 million in support of the Administration's multi-agency Space Weather Strategy and Action Plan. The Heliophysics Division recently established the Space Weather Science and Applications (SWxSA) program, expanding the role of NASA in space weather science under a single budget element. The program is consistent with the recommendations of the 2013 Heliophysics Decadal Survey. It competes ideas and products, leverages existing agency capabilities, collaborates with other agencies, and partners with user communities to facilitate the effective transition of science knowledge to operational environments. A budget of $16 million in FY20 is requested for the SWxSA program. Heliophysics also includes investment in research within the LWS program that addresses science that impacts life and society. Other programs within the Heliophysics Division that supports space weather include the Community Coordinated Modeling Center, which supports space weather modeling efforts, instrument and technology development activities, and missions such as Solar Terrestrial Relations Observatory (STEREO), Advanced Composition Explorer (ACE), Solar and Heliospheric Observatory (SOHO), and the recently launched Global-scale Observations of the Limb and Disk (GOLD) mission.

- **Human Exploration and Operations Mission Directorate (HEOMD)** Terrestrial and Space Weather: The projected FY20 budget for Terrestrial and Space Weather is $4 million, an increase from $3 million enacted in FY19. The FY19 enacted budget represents a $1 million increase from the FY19 requested budget due to the addition of research for space weather forecasting. HEOMD measures and forecasts atmospheric and space weather events that impact all operational phases (e.g., design, test, ground operations, launch, landing and recovery) of NASA's manned space flight and Expendable Launch Vehicle (ELV) programs, as well as crew radiation exposure at all phases of space flight (i.e., extra- and intra-vehicular activity). Additionally, HEOMD maintains the required weather infrastructure; develops and implements weather support requirements; develops and evaluates launch and landing constraints; and improves operational and launch availability through the development, evaluation, and transition of weather technology into operations.

References: NASA FY2020 Full Budget Request (Congressional Justification):
Earth Science Research: pages ES-2, 9
Earth Science Flight Missions: pages ES-15, 17, 36, 53-55, 58, 62, 67, 68
Heliophysics Space Weather: pages HELIO-1, 13, 16, 22, 24-25, 32, 46, 50

Nuclear Regulatory Commission

The Nuclear Regulatory Commission's (NRC's) request for meteorological activities in the FY 2020 President's budget request totals $628K. This is a 22% decrease from the FY 2019 enacted funding. This funding supports NRC's total planned expenditures for meteorological operations and supporting research and included the following areas:

- **Research on Application of Point Precipitation Frequency Estimates to Watershed-Scale Flood Modeling.** The objective of this project is to develop guidance on the

application of NOAA point precipitation estimates to watersheds (i.e. conversion of point estimates to areal estimates).

  - **Radiation Protection Dispersion Computer Codes Analysis & Maintenance.** Resources are used to maintain and develop the NRC's Radiation Protection and Dose Assessment computer codes, including RASCAL, ARCON, and HABIT. These codes support the Agency's safety and environmental reviews for nuclear power plant siting, design, construction, and operation.
  - **Accident Consequence Computer Code Analysis and Maintenance.** The MACCS atmospheric transport and dispersion model uses a Gaussian plume segment model for probabilistic consequence assessment due to its flexibility, computational efficiency, and modest data needs. In FY19, NRC is completing the integration of NOAA's HYSPLIT model into MACCS as an alternate atmospheric transport and dispersion model for consequence analysis. The MACCS-HYSPLIT integrated model offers both puff and particle dispersion models which accept a wide variety of high quality publicly available meteorological data and provide graphical capabilities. NRC is conducting an external peer review of the MACCS-HYSPLIT integration to verify that it is a state-of-practice model adequate for its intended purposes. These models are used to support regulatory applications involving health effects, environmental analyses, and activities with the ICMSSR and FCMSSR.

- **Meteorology, Availability of NOAA Databases for NRC Guidance.** NRC staff is undertaking a major effort to update and modernize the Standard Review Plan (SRP) to improve the agency's agility in reviewing future applications for new reactor technologies, streamline the reviews, and incorporate lessons learned from past reviews. For example, meteorology data resources currently cited in the NRC's Interim Staff Guidance document DC/COL-ISG-007 and in the SRP Sections 2.3.1, "Regional Climatology," and 2.3.2, "Local Meteorology", are typically used by applicants to identify or estimate meteorological parameters applicable to a specific nuclear power plant design or to characterize a specific site and/or region where a given design might be deployed. Collaborative work between NRC staff and NOAA staff will focus on updating and further developing climatology and meteorology datasets that will be used in NRC licensing actions. NRC staff expects to update references in other meteorology related sections of the SRP.
- **Meteorology, New and Operating Nuclear Power Plant Licensing Applications.** NRC staff reviews meteorological portions of license applications for new nuclear power plants. This work relates to Regional Climatology, Local Meteorology, the On-site Meteorological Measurements Program, and Short and Long Term Atmospheric Dispersion calculations. This work is expected to continue through 2020 for both the siting of new reactors, and in determining design-basis conditions for new reactor designs. NRC staff also reviews applications for License Amendment Requests (LARs) from current NRC license holders. These applications aim to modify the current licensing basis for a specific plant, and may be related to issues such as the source term, the ultimate heat sink, wind speed, precipitation, or other meteorologically related topics. LAR reviews are expected to continue through FY2020.

References: USNRC FY 2020 Congressional Budget Justification
Operating Reactors/Major Activities: page 13
New Reactors/Major Activities: page 31

Department of Energy

The Department of Energy (DOE) requested funding for meteorological activities in FY 2020 is an estimated $118.67 million a 54.6% decrease from enacted funding in FY 2019. DOE conducts meteorological services and supporting research and related activities within several DOE entities: the Office of Science/Biological and Environmental Research (BER), the National Nuclear Security Administration (NNSA) for emergency operations and in the Office of Energy Efficiency and Renewable Energy (EERE) for the Wind Forecasting Improvement Project in Complex Terrain (WFIP 2).

References: DOE FY2020 Budget Justification
Volume 1: National Nuclear Security Administration
Volume 3 Part 2: Energy Efficiency and Renewable Energy
Volume 4: Science

Office of Science / Biological and Environmental Research (BER)

The Office Science/BER/Climate and Environmental Sciences Division (CESD) FY 2020 request for funding for basic research is $116.6 million, a 54.9% decrease from the FY 2019 enacted funding. The Office of Science's CESD supports basic research involving atmospheric and ecological sciences as well as research on integrative earth system modeling. The goal of the Climate and Environmental Sciences Division is to enhance the predictive, systems-level understanding of the Earth system, including improved process-level understanding of the atmospheric, ecological, hydrological, cryospheric, and human components as well as interdependencies among the components. CESD does not provide climate services to federal, state, or local agencies nor does it conduct research for the purpose of improved weather forecast operations or climate services.

National Nuclear Security Administration (NNSA)

Office of Emergency Operations. The DOE/NNSA request for funding related to coordinating and supporting operational meteorological programs at Defense Nuclear Facilities (DNF) in the FY 2020 President's budget request is $350 K, no change compared to FY 2019 enacted funding (there will be at least two site visits by DMCC due to previous postponements). Requested FY 2020 funds would allow NNSA to continue funding the DOE Meteorological Coordinating Council (DMCC) activities, provide meteorological expertise, and support Consequence Assessment Modeling tools in support of the NNSA Emergency Management and Response Enterprise.

Office of Energy Efficiency and Renewable Energy (EERE)

Wind Energy Technologies Office/Wind Forecasting Improvement Project in Complex Terrain (WFIP 2). The DOE/EERE request for funding related to meteorological supporting research for FY2020 is $1.7 million, a 30% decrease from FY2019 enacted funding. Requested FY2020 funds would allow DOE-EERE to continue to fund the analysis from the Wind Forecasting Improvement Project in Complex Terrain (WFIP 2) that completed in FY18. Funding also supports developing a plan for conducting an offshore field observational study in later years that builds on the advances of WFIP2 and addresses the unique offshore environment including coastal and marine atmospheric boundary layer process data, wave-atmosphere interactions, and factors that control wind speeds within the marine boundary layer, including cloud cover, land-ocean coupling that drives coastal meteorology. Funding will also continue support for an initiative targeting wind energy specific forecasting. Using the Weather Research

and Forecasting (WRF) model as a starting point, the Energy Research and Forecasting (ERF) simulation framework will provide high-fidelity weather and environment-dependent energy inflow and boundary condition information to the microscale wind plant simulator (Nalu), within DOE's advanced HPC environments.

Department of State

In the FY 2020 President's budget request, the Department of State (DOS) requests $19.25 million. Of this request, $12.85M is requested to fund U.S. assessed contributions to the World Meteorological Organization through the Contributions to International Organization account In addition $6.4M is requested for the UN Framework Convention on Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change (IPCC), including for related research programs such as the Global Climate Observing System and/or the Group on Earth Observations, in which the United States protects U.S. interests and advances a level playing field. The United States supports a balanced approach to economic growth, energy security, and environmental protection and highlights private sector innovation and deployment of technologies that reduce emissions, strengthen resilience, and foster sustainable land use. As of this writing, FY 2019 funding information is not available regarding potential contributions to UNFCCC, IPCC, GCGOS and/or GEO and WMO.

References: FY2020 Congressional Budget Justification for Foreign Operations
(Appendix 2) State Bureau of Oceans and International Environmental and Scientific Affairs (OES)
Note: as of 5/9/2019 Appendix 2 had not yet been released
WMO Funding Reference:
https://www.state.gov/documents/organization/291298.pdf
page 322

Smithsonian Institution

Global Volcanism Program (GVP). The Smithsonian Institution requested funding for meteorology-related activities in FY 2020 is $15 K to support the Natural History Museum, Global Volcanism Program. This funding level is comparable to FY2019 levels. The GVP collects, catalogs, and disseminates information on over 1,500 volcanoes active in the last 10,000 years, using a small staff working regular business hours Monday to Friday in the Natural History Museum in Washington, D.C.

National Science Foundation

The National Science Foundation (NSF) request for funding related to meteorological supporting research in the FY 2020 President's budget request is $118 million, a 9.0% decrease from FY 2019 enacted funding levels. Requested FY 2020 funds will allow NSF to continue to fund research related to basic meteorology, climate, and space weather. NSF proposal requests are community-driven, which allows funding to move to emerging areas of interest. In addition, the funding will ensure that facilities, both observational and computational, are made available for community use. NSF awards grants to single investigators or small collaborative groups working on specific topics, as well as larger interdisciplinary groups and the National Center for Atmospheric Research.

- NSF will fund research on processes related to physical and mesoscale meteorology at a projected level of $54.5 million in FY 2020. This level of funding will allow NSF to support basic research on observational systems, analysis techniques and understanding of phenomena that will help to improve weather forecasts and public safety. Recent major

investments include the study of the initiation and upscale growth of convection into organized systems and the impact of small changes in temperature and humidity on the development of tornadoes.

- NSF will fund basic climate research, modeling, and process studies at a projected level of $46.1 million in FY 2020. NSF invests in the Community Earth System Model (CESM), a fully-coupled global climate model that provides state-of-the-art simulations of the Earth's past, present, and future climate states. NSF also funds the supporting infrastructure for climate studies by making computing resources required to perform data-intensive simulations available for community use. As a basic science funding agency, NSF does not directly provide climate services to federal, state, and local agencies, but through its funding of basic science research, NSF contributes to the fundamental understanding of the climate system which is required for the provision of climate services.
- NSF will fund supporting research on Space Weather at a projected level of $17.0 million in FY 2020. NSF supports the National Space Weather Strategy and National Space Weather Action Plan in pursuing the program's objective to perform the research and technology transfer needed to improve the specification and forecasts of space weather events that can cause disruption and failure of space-borne and ground-based technological systems and that can endanger human health. Space weather relevant research efforts include the development of large-scale space weather forecast models, construction and operation of advanced ground-based instruments and networks for the observation of space weather parameters, and the development and demonstration of innovative and creative small space weather satellites.
- NSF has initiated funding for new priorities related to the 10 Big Ideas. It is anticipated that supporting research for meteorological processes will have connections to the Navigating the New Arctic (NNA), Harnessing the Data Revolution (HDR), and Mid-scale Research Infrastructure Big Ideas. Across NSF, $135 million is set aside for these activities in FY 2020. Funding from these sources is not guaranteed for meteorological research and will depend on the outcome of the peer review process.

References: NSF FY2020 Budget Request to Congress

Budget Tables

Table 1. Meteorological Services and Supporting Research by agency -- funding levels (not actual spending) for three consecutive fiscal years:

- Enacted Budget for Fiscal Years 2018 and 2019
- President's Budget Request for Fiscal Year 2020

Table 2. Funds transferred (or planned) during FY2019 for meteorological services and supporting research activities:

- Only transfers near or exceeding a $1 million dollar threshold are included

TABLE 1: Meteorological Services and Supporting Research* (.00M)

AGENCY	FY18	FY19	FY20
USDA	112.70	112.68	112.39
DOC/NOAA (Subtot)	3541.77	3129.64	2809.18
NWS	1114.02	1162.60	1081.87
NESDIS	2187.45	1698.54	1472.71
OAR	172.60	196.30	184.50
NOS	32.00	35.00	34.00
OMAO	35.70	37.20	36.10
DOD (Subtot)	300.50	318.90	285.80
Air Force	139.90	169.10	143.30
Navy	139.10	128.30	123.50
Army	21.50	21.50	19.00
DHS (Subtot)	32.13	32.24	32.34
FEMA	1.93	1.94	1.94
USCG	30.20	30.30	30.40
DOI (Subtot)	39.51	39.71	41.92
BLM	4.66	4.56	4.49
BOEM	1.76	0.85	3.23
NPS	3.09	2.80	2.70
USGS	30.00	31.50	31.50
DOT (Subtot)	275.50	285.90	280.47
FAA	274.00	284.40	278.97
FHWA	1.50	1.50	1.50
EPA	6.22	6.22	2.12
NASA	630.61	432.00	351.00
NRC	1.11	0.81	0.63
DOE (Subtot)	240.96	261.31	118.67
Science/BER	239.00	258.50	116.60
NNSA	0.40	0.35	0.35
EERE	1.56	2.46	1.72
DOS	17.08	**	19.25
Smithsonian	0.02	0.02	0.02
NSF	134.10	129.61	117.55
TOTAL	5332.21	4749.04	4171.34

*FY18 and FY19 amounts reflect Congressionally appropriated funds.
FY20 amounts reflect funding requested in the President's FY20 budget submission to Congress

** Unavailable

TABLE 2: Interagency Fund Transfers for Meteorological Operations and Supporting Research

FY2019 Fund Transfers (estimated or planned - near or exceeding $1M)

Transferred			
From:	**To:**	**(.00 M)**	**Purpose:**
DOC/NOAA			
NESDIS	NASA	768.20	Continue work on GOES-R series spacecraft, instruments, and launch vehicle. Build, integration and testing of JPSS-2, -3 and -4 instruments and spacecraft. GOES-NOP, POES/MetOp on-orbit support. Develop a Space Weather Follow On satellite mission to rideshare with the NASA Interstellar Mapping and Acceleration Probe to Lagrange point 1. Begin integration activities for a compact coronograph on the GOES-U satellite mission in support of the Space Weather Follow On program.
NESDIS	DOD/USAF	22.50	Continue support from Lincoln Labs for GOES-R technical and satellite support for satellite development programs. USAF Hosted Payload Solution support for CDARS.
NESDIS	DOD/NRL	7.30	Continue development of the compact coronograph in support of the Space Weather Follow On program.
NESDIS	NTIA	2.70	Satellite Ground Services assistance with acquisition of a Radio Frequency Interference Monitoring System.
NESDIS	GSA	11.40	Satellite Ground Services assistance with acquisition of Engineering and Technical Support.
DOD			
Air Force	NWS/NOAA/NESDIS	3.12	DAPE, DOMSAT, DREN, JPSS, MDCRS
Air Force	DOE/ORNL	12.55	Oak Ridge National Lab High Performance Computing and Partnership
Air Force	NWS/NOAA	2.15	NEXRAD Service Life Extension Program/Spares
Air Force	NWS/NOAA	4.12	NEXRAD (Precision Measurement Equip/Depot Purchased Equip Maintenance)
Air Force	NASA Goddard Space Ctr	1.50	Land Information System (3600)
Army	NCAR	4.89	4DWX Model Support
Army	DOI/USGS	2.30	Hydro-meteorological collection
Navy	NASA	2.30	Stennis Space Center operations
Navy	NOAA	1.00	Satellite Data and Analysis
DOT			
FAA Weather	DOC/NOAA/NWS	19.00	IAA-Center Weather Service Unit
FAA Weather	DOC/NOAA/NWS	14.00	IAA-ASOS/ALDARS

Appendix A: Federal Coordination and Planning Crosscut Matrix

Strategic Plan Objectives

Groups	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2	4.3	4.4	4.5	5.1	5.2	5.3	6.1	6.2
FCMSSR							X										X			
NEXRAD PC																X				
ESPC ESG							X					X								X
ICMSSR									X		X				X					
C/CS						X														
IWRCC											X	X								
SWG												X								
COES	X	X		X																
STIWG			X																	X
WG/CSAB		X	X		X															
WG/CCM					X															
WG/OD		X	X	X																
WG/BCR																			X	X
WG/TCOR	X	X	X		X							X								
JAG/FMH1	X	X	X	X				X	X	X										
JAG/AWCT			X						X											
WG/SWEF								X	X										X	X
WG/DIAP			X						X					X						
WG/CAS	X		X	X	X		X			X										
WG/WSO	X	X			X			X			X	X								
WG/ATD	X	X	X	X					X	X		X			X					X
WG/ARE	X	X	X	X				X	X	X	X	X		X						

Appendix B: OFCM Activities

2018 Activities Review

January

*American Meteorological Society Annual Meeting

February

Interdepartmental Committee for Meteorological Services and Supporting Research

March

Space Weather Operations, Research and Mitigation Committee
Tropical Cyclone Operations and Research Forum/72nd IHC
Committee for Operational Environmental Satellites

April

Space Weather Operations, Research and Mitigation Committee
Federal Committee for Meteorological Services and Supporting Research
*Space Weather Workshop
*AMS Washington Forum

May

Committee for Operational Processing Centers
Observational Data Workshop
Interdepartmental Committee for Meteorological Services and Supporting Research

June

GMU Atmospheric Transport and Dispersion Conference Special Session on Federal Agency Activities
*Interagency Coordinating Committee for Airborne Geosciences Research and Applications (ICCAGRA)
Committee for Operational Environmental Satellites

July

*Friends and Partners in Aviation Weather
Space Weather Operations, Research and Mitigation Committee
Space Weather Enterprise Forum

August

10th International Conference on Urban Climate/14th Symposium on the Urban Environment
Interagency Weather Research Coordination Committee
Interdepartmental Committee for Meteorological Services and Supporting Research

September

Committee for Operational Environmental Satellites
Interdepartmental Committee for Meteorological Services and Supporting Research

October

Federal Committee for Meteorological Services and Supporting Research

Interagency Weather Research Coordination Committee
Committee for Operational Processing Centers

November

*Conference on Space Environment Applications, Systems, and Operations for National Security
*NOAA Hurricane Conference

December

Committee for Operational Environmental Satellites
*American Geophysical Union Annual Meeting
Committee for Operational Processing Centers
Interagency Weather Research Coordination Committee

Asterisks indicate meetings not sponsored by OFCM.

FY 2018 OFCM Publications

The publications listed in table 3 were added to OFCM's website during FY 2018.

Table 3: FY18 OFCM Publications

OFCM PUBLICATION	DATE	NUMBER
The Federal Weather Enterprise: Fiscal Year 2018 Budget and Coordination Report	April 2018	FCM-R36-2017
National Hurricane Operations Plan 2018 Build 17.X Dual Pol WSR-88D Tropical Cyclone Operations Plan 17.X "QUICK CHECK" List 2018 Build 18 Dual Pol WSR-88D Tropical Cyclone Operations Plan 18 "QUICK CHECK" List	May 2018	FCM-P12-2018
2018 Tropical Cyclone Operations and Research Forum/72nd Interdepartmental Hurricane Conference Summary Report	March 2018	n/a
Summary report of the Special Session, 21st Annual George Mason University (GMU) Atmospheric Transport and Dispersion Modeling Conference	July 2018	n/a
Summary report of the Space Weather Enterprise Forum	August 2018	n/a

Appendix C: OFCM External Involvement

American Meteorological Society (AMS)

The OFCM participates in and supports AMS activities; serving on several committees, groups, and teams. Beginning in 2019, the OFCM initiated and chaired a session at the AMS Annual meeting to present highlights of OFCM interagency group activities of interest across the Federal Weather Enterprise.

Interagency Coordinating Committee for Airborne Geosciences Research and Applications (ICCAGRA)

The ICCAGRA was formed in the late 1990s to improve cooperation, foster awareness, and facilitate communication among the partner agencies within the U.S. government. Membership consists of most of the Federal agencies participating in the FWE. These agencies oversee numerous and varied manned and unmanned aircraft dedicated to geosciences research. ICCAGRA recently has been involved in overseeing standardization of instrument interfaces and data formats within the United States to improve access across the different agencies. OFCM participates as a member of ICCAGRA and has raised its profile by facilitating an overview presentation to ICMSSR.

Acting on a recommendation from the OFCM-Tropical Cyclone Operations and Research Forum, the working group Air Recon Equipment (WG-ARE) was initiated to focus on equipment needs for tropical reconnaissance aircraft. The group consists of both operational forecasters and researchers. The group met for the first time in November 2018 and developed a ten-year plan for tropical and winter season reconnaissance equipment needs. The ICCAGRA will be briefed of the group's findings in May 2019.

National Academies of Sciences, Engineering, and Medicine (NAS)

The OFCM continues its mutually beneficial interactions with the National Academies of Sciences Engineering, and Medicine (the National Academies). The Federal Coordinator participates in the National Academies' Board on Atmospheric Sciences and Climate (BASC) strategic planning workshops and attends regularly scheduled BASC meetings.

In addition, the OFCM provided program updates to the National Academies' Space Science Board (SSB) and its Committee on Space and Solar Physics (CSSP).

The NAS and its members address all Goals of the Strategic Plan for FWE Coordination.

Office of Science and Technology Policy (OSTP)

OFCM provides Executive Secretary support for the Space Weather Operations, Readiness, and Mitigation (SWORM) Working Group and all three of its Sub Working Groups. OFCM was a primary author of the National Space Weather Strategy and Action Plan (NSW-SAP). By pursuing interagency activity through the SWORM activity, OFCM supports the NSW-SAP Objectives and those of the Strategic Plan for FWE Coordination.

OFCM also participated in the US Group for Earth Observations (USGEO) managed through OSTP. USGEO activities support the National Plan for Civil Earth Observations and Goals 1, 3, 4, and 6 of the Strategic Plan FWE Coordination.