

# **Summary Report of the Science Review of the NOAA Weather Program Office (WPO)**

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SUMMARY OF RECOMMENDATIONS

## OVERVIEW

The National Oceanic and Atmospheric Administration (NOAA) Office of Oceanic and Atmospheric Research (OAR) conducts program and laboratory science reviews every 5 years to evaluate the quality, relevance, and performance of research activities supported by its programs and conducted across its laboratories. The review of the Weather Program Office (WPO) was held virtually, January 24–27, 2023. OAR held two teleconferences for the panel in advance of the review, to discuss the review process and answer questions from panel members. To ensure that there was ample time for discussion during the review, several presentations were pre-recorded and posted on a designated website at least 2 weeks prior to the review week.

This review will be useful for planning, programming, and budgeting efforts, as well as alignment with external interests. Furthermore, it will help the WPO strategically plan for the future. In general, reviews are also intended to ensure OAR's research objectives are linked to NOAA's mission and priorities and connected to other relevant strategic plans, and that the research is responsive to congressional mandates, is of high quality as judged by preeminence criteria, and is carried out with a high level of performance.

This external review covers the programmatic activities and management of the WPO over the past 5 years (2017–2022). This is the WPO's first program office review. The programmatic themes/activity areas and related topics for the WPO review include:

Activity Area 1. Organizational Management

Activity Area 2. Weather Research Models, Observations and Forecasting

Tools Activity Area 3. Advancement and Transition of Weather Research

Activity Area 4. Effective Communication and Coordination of Weather Research

The reviewers independently prepared their written evaluations and provided them to the review panel chair, Dr. Robert O'Connor. He then put together a report that summarizes the individual evaluations and submitted it to OAR. O'Connor did not seek a consensus of the reviewers. OAR sent technical comments within 14 days of receiving the draft report and Dr. O'Connor submitted a final report no later than 30 days after that.

The Weather Program Office's (WPO) mission is cultivating, funding, and

transitioning collaborative weather research that results in accurate and actions weather information for all. WPO updated its strategic plan in late 2022, and developed a new vision statement and goals for the 2022-2026 timeframe. The new vision of the WPO is “Innovative Science Powering a Weather-Ready Nation.”

The report covered four cross-cutting activity areas:

### **Activity Area 1. Organizational Management**

For this activity area the panel evaluated WPO’s office management, including strategic plans and direction, budget execution, hiring practices, office restructure, and diversity, equity, inclusion, and accessibility (DEIA) initiatives.

WPO facilitates research, transitions research to operational products and applications, and seeks to improve how the public receives information to make weather-related decisions. Over the last 5 years, WPO has set a goal of organizational excellence to create an internal framework to meet stakeholder and partner needs while supporting NOAA’s mission. Over the last 5 years WPO grew substantially, guided by two strategic plans, spanning 2019–2021 and 2022–2026.

WPO’s growth necessitated thoughtful hiring practices to nurture a collaborative culture. The increase of office personnel has facilitated the need to restructure the organization of the office’s programs through the creation of divisions and teams. This approach allows WPO to support professional development for employees—from student interns to senior staff. WPO prioritizes diversity, equity, inclusion and accessibility as part of its strategic plan goals. WPO’s staff have received numerous awards for career achievements and DEIA accomplishments.

The Administrative Team helps WPO achieve its mission through budget management and execution, overseeing contracts, and logistics. Annual Operating Plan measures and milestones for the office reflect WPO’s immediate focus areas and benchmarks on the path to achieving WPO’s strategic goals.

Across all WPO programs, WPO staff work together to coordinate its annual funding opportunity. Publishing one annual WPO-wide competition reduces

individual program workload and streamlines the process for their principal investigators.

## **Activity Area 2. Weather Research Models, Observations and Forecasting Tools**

Under this activity area, WPO sought recommendations and evaluations of the Subseasonal to Seasonal (S2S), Earth Prediction Innovation Center (EPIC), and Observations programs. WPO maintains a critical role in weather observation coordination, advancing data assimilation, and model development. WPO recognizes that improvements in weather observing technologies need to occur concurrently with model improvements.

The Subseasonal to Seasonal (S2S) Program supports projects to improve the utility of subseasonal to seasonal forecasts. Funded projects may assist progress in data assimilation, modeling within the United Forecast System (UFS) suite, or post-processing techniques to improve both scientific understanding and model fidelity of reproducing phenomena influencing the physical system, particularly for high-impact or extreme weather. S2S funds a range of projects from lower readiness level (RL) projects to higher RL projects that work with NOAA operational centers in the National Weather Service's Climate Testbed.

The primary goal of EPIC is to enable the world's most accurate and reliable operational numerical forecast model by partnering with the modeling community. EPIC strives to improve community access to the UFS, and hosts community engagement activities to gather requirements and facilitate the use of cloud and high-performance computing resources. This approach to earth system modeling aims to improve current weather prediction and develop models that adapt to future change.

The Observations Program advances observation systems that are mission-effective, integrated, adaptable, and affordable. A core function is to invest in innovative observing technologies extending from the surface through the troposphere, including planetary boundary layer, snowpack, soil moisture, hurricane, temperature, and precipitation extremes. The Observations Program also leads the project management of the Phased Array Radar (PAR) Program. This entails the cross-NOAA coordination and development of core documents (charter, requirements, risk register, executive briefings, congressional reports) and formal acquisition documents for risk reduction research and development

activities that are critical for NWS Analysis of Alternatives for future radars. In addition, WPO jointly administers the Verification of the Origin of Rotation Experiment (VORTEX-SE/USA) Program with the National Severe Storms Laboratory.

### **Activity Area 3. Advancement and Transition of Weather Research**

Under this activity area, WPO sought recommendations and evaluations on the Research to Operations/Applications (R2X), Testbeds, Joint Technology Transfer Initiative (JTII), Air Quality, and Forecasting a Continuum of Environmental Threats (FACETS) programs. WPO works to find, fund, and transition research for use by NWS and the broader weather enterprise.

The R2X Program coordinates research transitions in WPO, tracking research projects transitioning to operation, application, knowledge, and use by WPO's partners and stakeholders. WPO works with NWS and the Technology Partnerships Office (TPO) to standardize and manage transition plans for funded research.

The Testbeds Program coordinates projects and resources for the Hydrometeorological Testbed, Hurricane Ocean Testbed, and Hazardous Weather Testbed. Together, these workshop environments provide opportunities for operational and research communities to test forecast and tool improvements with forecasters to assess readiness for operations.

The Joint Technology Transfer Initiative (JTII) funds research with potential for impactful operational use, with the goal of transferring relevant science and technology to NWS. JTII collaborates with the Testbeds Program to test and demonstrate projects as they advance RLs in preparation for transfer to NWS.

The Air Quality Program—recently renamed the Atmospheric Composition Program—aims to advance air quality forecasts by coordinating and investing in air quality research and development. While WPO did not have a fire weather program as of this review, emerging fire weather activities are very much connected to this program.

Lastly, this activity area covers the FACETS Program which is a framework that extends across OAR labs and programs and with NWS to nurture research collaborations and assist in the collaborative research-to-operations (R2O) transition process. FACETS focuses on modernizing the creation, communication, and effective dissemination of a continuous flow of risk-based

and calibrated probabilistic hazard information to empower effective response to environmental threats.

#### **Activity Area 4. Effective Communication and Coordination of Weather Research**

WPO sought recommendations from the review panel regarding the office's Social Science Program, as well as its coordination and collaboration efforts. These include but are not limited to coordination of processes and activities to successfully transition research to operations and applications; communication and interpretation of policies that guide efforts; and collaborations with internal and external partnerships to NOAA, and across the weather enterprise.

WPO's Social Science Program (SSP) funds social, behavioral, and economic sciences projects with an aim to provide research-guided recommendations to the greater weather enterprise, and to incorporate user perspectives into physical science research. Partnerships with NWS, National Science Foundation (NSF), academia, and private industry enables results from SSP-funded research to enhance operational forecasts with actionable information for the public by understanding and addressing gaps between research and societal applications.

The Supplemental Appropriations Program leads and coordinates projects supported by supplemental appropriations to improve severe weather forecasting and observational data assimilation, including research and development targeting forecast improvements related to heavy precipitation, hurricanes, floods, wildfires, and other hazards. This includes leading the execution of some project, coordinating for the Weather Research and Forecasting Act of 2017, and four supplemental appropriations. The supplemental appropriation supported by WPO include:

- The Improving Forecasting and Assimilation portfolio of the Bipartisan Budget Act of 2018 (Disaster Related Appropriation Supplemental)
- The Improving Forecasting of Hurricanes, Flood, and Wildfires portfolio of the Additional Supplemental Appropriations for Disaster Relief Act of 2019
- Disaster Relief Supplemental Act of 2022: Wildfires, Hurricanes, Extreme precipitation, and Floods.

External to NOAA, WPO participates in the Interagency Council on Advancing Meteorological Services (ICAMS), an interagency group that works to implement policy and practices across Federal agencies in support of meteorological services. WPO also works to improve partner engagements within NOAA (e.g., the NOAA Water Initiative Service Delivery Team; Weather Water and Climate Board, particularly the NOAA Modeling Board; the Weather Team; the Water Team) and with other Federal agencies (e.g., NSF, Federal Emergency Management Agency (FEMA), Federal Highway Administration (FHWA), Environmental Protection Agency (EPA), National Aeronautics and Space Administration (NASA) and the Centers for Disease Control and Prevention (CDC)).

To set the context, the panel sessions began with general overviews of NOAA, OAR, and WPO. In addition to the above open sessions, there were also closed stakeholder sessions that served as opportunities for reviewers to receive additional input about the program's science, products, and services from key stakeholders. To facilitate the discussion, some stakeholders completed questionnaires and the responses were provided to the panel ahead of the review. These closed sessions allowed further elaboration on the stakeholder responses and opportunity for discussion.

Each day, reviewers-only, closed sessions took place. In these sessions the review panel discussed information provided and identified additional information needed or issues to be clarified. These sessions also provided an opportunity to work on the individual evaluations and to prepare for the preliminary feedback to OAR and WPO leadership on the final day. The final day included a closed review panel discussion and a session for the review panel to report preliminary findings and recommendations to OAR and WPO leadership.



## **SUMMARY OF PROGRAM-WIDE FINDINGS AND RECOMMENDATIONS**

The panel members who provided an overall rating of the WPO scored the Office as Exceeds Expectations. This summary is consistent with the written assessments of all panel members. What accounts for the WPO not attaining an overall rating of Highest Performance is a disconnect between the size of the WPO staff and the enormity of its mission. The stakeholders who work with WPO personnel consistently praise the accomplishments of the team, often adding that outcomes would be even better if the Office were not understaffed.

Noteworthy throughout the evaluation is the consistency of conclusory evaluations that the work is high quality. There is not a single score of “Needs Improvement” on the quality, relevance, or performance criterion for any of the four activity areas. There are differences in how panel members perceive the success of WPO actions along different criteria for different activity areas. In no case, however, is there a perception that the WPO is failing to perform at a satisfactory standard.

This overall rating is a credit to the WPO staff and is remarkable considering WPO’s rapid growth and small size. Their leadership deserves credit for excellent hiring decisions and fostering a collective focus on shared goals.

The relevance of the WPO is indisputable. All WPO programs align well with NOAA’s mission as explained in the descriptions of the activity areas. WPO is a necessary and needed organization, particularly as convergent research comes to the forefront and societal impacts from weather and climate continue to rise.

The level of performance is consistently high. The tasks at hand are enormous, complex, and multidimensional. Combining social and physical sciences into convergence research frameworks to bring actionable societal solutions is a Herculean task. Overall, WPO is doing an outstanding job especially in terms of leadership and management given the available

resources. The outcomes from WPO products, technical improvements, and communications save lives and significantly boost the economy.

Noting the high quality, great relevance, and strong performance of the WPO does not bring about a conclusion that there are no areas of concern or where improvements would be beneficial.

One recommendation is that NOAA needs to nurture the WPO staff to avoid burnout and departures. There are concerns that staff members are spread too thin across multiple programs and asked to do too much. The WPO needs a larger professional staff to be able to respond adequately to the 42 objectives in the WPO strategic plan.

A related recommendation is that the WPO should optimize the value it provides NOAA and the Nation by establishing a small number of long-term “keystone projects” and focusing resources on those projects while decreasing resources invested in smaller projects. The keystone projects should be chosen in partnership with the National Weather Service (NWS) to address NWS’s highest priorities and to maximize value to the Nation. Also, keystone projects should have a complex mix of challenges that require WPO’s participation to catalyze necessary R&D advancements and transitioning them to applications. By setting priorities, the WPO can both nurture WPO staff and improve the utility of its performance.

## FINDINGS AND RECOMMENDATIONS BY ACTIVITY AREA

Each panel member had the opportunity to rate each of the four activity areas in terms of quality, relevance, and performance. For each measure, most reviewers provided one of the following ratings:

- Highest Performance: WPO greatly exceeds the satisfactory level and is outstanding in almost all areas.
- Exceeds Expectations: WPO goes beyond the satisfactory level and is outstanding in many areas.
- Satisfactory: WPO meets expectations and the criteria for a satisfactory rating.
- Needs Improvement: In general, WPO does not reach expectations and does not meet the criteria for a satisfactory rating. The reviewer will identify specific problem areas that need to be addressed.

**Quality** is “a measure of the novelty, soundness, accuracy, and reproducibility of a specific body of research” (NOAA Administrative Order (NAO) 216-115). This refers to the merit of R&D that is funded by WPO and the resulting communication, outputs, and knowledge shared with the scientific community.

To obtain a satisfactory rating, WPO-funded research projects must add to the growing body of meteorological physical and social science research by contributing new knowledge, data, and technological advancements. WPO must expend its targeted percentage of funds for funding competitions and execute the peer review process on time. In addition, program staff need to participate in professional scientific societies and other external organizations, provide strategic leadership to the community, have a firm grasp on the direction of the science, and receive awards and/or recognition for leadership in their respective fields.

**Relevance** is the degree to which WPO funded research and development (R&D) is relevant to NOAA’s mission and of value to the Nation. Relevance is “a measure of how well a specific body of funded research supports NOAA’s mission and the needs of users and the broader society” (NAO 216-115). This primarily refers to the value of R&D to users beyond the scientific community. Relevance includes not only hypothetical value, but actual impact. It considers the question, “What would not have happened if you did not exist, and how

much would society have missed?” Examples of ways the impact of R&D can be realized include the application of scientific knowledge to policy decisions, the improvement of operational capabilities at NOAA’s service lines and other collaborating institutions, or licensing of inventions for commercial use.

To obtain a satisfactory rating, WPO’s program activities and funded projects need to demonstrate linkages to NOAA’s, OAR’s, and WPO’s mission and strategic plans, other key policy/guiding documents, and be of value to the Nation. Additionally, WPO needs to engage with stakeholders to develop research priorities collaboratively, and fund projects to meet operational needs.

**Performance** is “a measure of both effectiveness (the ability to achieve useful results) and efficiency (the ability to achieve quality, relevance, and effectiveness in timely fashion and with little waste)” (NAO-216-115). Performance refers to the effectiveness and efficiency with which program activities are organized, directed, funded, and executed. Assessing performance may include considerations of technical execution, finances, workforce, infrastructure, and leadership necessary to achieve WPO’s goals. This involves assessing the quality of management, including interaction with stakeholders, clear articulation of strategic direction, as well as the balance of the WPO’s portfolio across time frames and intended applications.

The evaluation of performance involves an evaluation of the overall effectiveness with which WPO plans and executes its research and development objectives to meet NOAA’s mission and priorities, and the needs of the Nation, given the resources provided. The evaluation looked at three sub-categories: a) Research Leadership and Planning, b) Efficiency and Effectiveness, c) Research Transition Management.

To obtain a satisfactory rating, WPO needs to document scientific objectives and strategies through strategic and implementation plans (e.g., Annual Operating Plan) and a process for evaluating and prioritizing activities. This includes meeting at least half of its performance measures and milestones in the Annual Operating Plan. The WPO director, deputy director, and program managers work across the office’s portfolio as a team, to achieve effectiveness and efficiency of administrative processes, operations, and research transitions. The following table presents the individual ratings of the six panel members who submitted ratings. Reviewers 1, 3, and 4 were willing to provide ratings for all four activity areas. Reviewers 2, 5, and 6 did not provide ratings for activity areas that they felt were outside their expertise.

Theme	Criterion	Reviewers					
		1	2	3	4	5	6
<b>Overall Lab/Program</b>	Overall	EE				EE	EE
<b>Activity Area 1: Organizational Management</b>	Overall	EE	H	S	S	EE	EE
	Quality	EE	H	EE	S	EE	EE
	Relevance	H	H	EE	S	EE	H
	Performance	EE	H	EE	EE	EE	EE
<b>Activity Area 2: Weather Research Models, Observations and Forecasting Tools</b>	Overall	EE			EE	EE	
	Quality	EE		EE	EE	EE	
	Relevance	H		EE	EE	EE	
	Performance	EE		S	S	EE	
<b>Activity Area 3: Advancement and Transition of Weather Research</b>	Overall	H			S		
	Quality	EE		EE	S		
	Relevance	H		EE	S		
	Performance	H		EE	S		
<b>Activity Area 4: Effective Communication and Coordination of Weather Research</b>	Overall	EE	H		H		EE
	Quality	EE	H	H	H		H
	Relevance	H	H	H	H		H
	Performance	EE	H	EE	H		EE

H = Highest Performance; EE = Exceeds Expectations; S = Satisfactory; N = Needs Improvement

## **Organizational Management**

All six panel members felt qualified to evaluate the WPO in terms of Organization Management, the first Activity Area. One rated Organizational Management at the highest level, three as exceeding expectations, and two as satisfactory.

Of 117 projects WPO funded from fiscal year 2016 to 2019, 24 percent transitioned to operations or deployment. WPO promoted these transitions in a variety of ways. Another 29 percent of those projects were not intended for operational deployment. Many of those have resulted in publications. Many of the funded scholars are among the leaders in their fields. This is a strong record of quality. Bibliometric analysis of the Web of Science shared by WPO suggests that by at least one measure the quality of publications supported by WPO was near average.

Office management is a strength. WPO is a large, diverse program with strong leadership and dedicated staff. It was clear from our days together that the staff members are passionate about their work and go above and beyond expectations. Those outside of WPO spoke highly of the staff and quality of work. The strength of this office is its people. They seem more like a team than a collection of individuals, which is what all organizations aspire to be. This is especially impressive in the context of the WPO having five acting directors over a 2-year period.

The relevance of WPO is unquestionable. WPO is a cornerstone of OAR and NOAA. The Programs are foundational to the mission of NOAA and vary widely across topics and research methods. They include Air Quality and Fire Weather, Testbeds, Observations, Social Science, Joint Technology Transfer Initiative, Subseasonal to Seasonal Research, the Earth Prediction Innovation Center and activities tied to Supplemental Appropriations. The robust program of research to operations is effective in enhancing the relevance of the research activities.

The WPO as a whole is quite diverse, however, this diversity is centralized in many of the officer roles. Increasing diversity at the scientist level will require resource investment in earlier career stages to expand the pool of minority professionals trained in the fields of weather research. Possibilities include early-career summer training programs (perhaps modeled after the

Butler-Williams Scholars Program at the National Institute on Aging), faculty sabbaticals, programs for undergraduate/graduate fellows (perhaps modeled after the Bill Anderson Fund that is expanding the number of historically underrepresented professionals in the hazards and disasters field).

The performance of WPO as a managing entity is strong. Many stakeholders agree that the WPO is doing a good job in terms of promoting and enhancing weather and air quality research and communication with end users, decision makers, and the public in general. The WPO has exceeded all key metrics for FY22 (R&D Completed to RL8; Peer-Reviewed Publications; Projects with Transition Plan; Transitions to New R&D Phase).

## **Activity Area 2. Weather Research Models, Observations and Forecasting Tools**

The quality exceeds expectations for the most part, though the involvement of the WPO is often less widely known. Clear efforts have been made to showcase WPO online (e.g., the phenomenal program review website), but dissemination of this knowledge should expand (e.g., social media, conferences, sharing of recorded webinars that could be shown in the classroom).

WPO is investing substantial efforts in simplifying NOAA's operational forecast suite by supporting the NOAA-wide effort to transition the current 21 forecast systems spanning many aspects of forecasting such as weather, hurricane, ocean, ice, waves, air quality and hydrology from regional to global scales to the Unified Forecast System (UFS) that consolidates different modeling aspects into eight components. Such investments will streamline efforts to develop, maintain, and support modeling systems that must continuously evolve and take advantage of new understanding, new modeling techniques and physics parameterizations, and new computational infrastructure. The WPO is to be commended for taking on this significant challenge in stride and strategically by coordinating modeling efforts within NOAA and leveraging community efforts through the Earth Prediction Innovation Center (EPIC). Besides internal NOAA efforts on UFS and EPIC, WPO is supporting high-quality research through the S2S program funding calls that emphasize projects which contribute to the development of and be integrated into UFS components/coupling, data assimilation, and postprocessing of model forecasts. Continued support of Multi-Model Ensembles (MMEs) is critical to take advantage of tools and infrastructure already established by the groups that contribute to MMEs and to expand the MME

database that has enabled important research to understand predictability and prediction skill at S2S timescales. While the WPO S2S program funding calls serve as a key mechanism to facilitate community contributions to UFS and S2S forecasting tools (i.e., R2O), coordination between WPO and CPO is critical to ensure that NOAA provides funding for the community to continue to advance understanding of S2S predictability. Traditionally, CPO supported research in S2S predictability, but as S2S prediction has become a key mission of WPO, the support for understanding S2S predictability may have fallen through the cracks, potentially leaving a gap in the NOAA funding portfolio to support the S2S science that underpins advancements in S2S prediction.

Regarding relevance, WPO priorities are well aligned with NOAA, NWS, and OAR priorities. WPO's activities on weather research models, observations and forecasting tools are highly relevant to WPO's goals to "integrate world class weather research into operational forecasts for the public, support new weather applications across the Weather Enterprise, and continually improve our understanding of weather phenomena." As noted above, by simplifying the existing diverse modeling systems within NOAA and EPIC, the development of the UFS provides a sustainable pathway for integrating world class weather research into operational forecasts. Increasingly, WPO is connecting its weather research and forecasting activities with stakeholders' needs. For example, WPO is coordinating a study, "Western States Hydrology," to investigate hydroclimatological changes in the major river basins of the Western United States over the next 30 years. This study will provide an important bridge to leverage NOAA modeling capabilities such as the UFS hydrologic component to address critical concerns of stakeholders in the western states, who have been facing challenges in managing both floods and droughts in an evolving climate. Already planned as a joint CPO-WPO activity, successful coordination to leverage capabilities from both program offices will be highly beneficial for addressing the modeling and prediction challenges related to hydrologic extremes at the nexus of weather and climate.

Regarding the assessment of the WPO's performance for models, observations, and forecasting tools, WPO is performing as expected at this point but with transformational potential. Given that certain programs are still in their infancy (e.g., EPIC), WPO is poised to exceed expectations in the near future, but there are significant challenges that must be overcome to achieve the vision of a strong, enterprise-wide community. The direction of community-based Earth system modeling that WPO is adopting has the potential to transform NOAA's modeling capabilities, which are the backbones of weather, S2S, air quality, and



fire weather forecasting and beyond. EPIC is serving as a major hub that ties modeling activities in all areas at all timescales. To date, substantial progress has already been made in the land surface model component (Noah-MP) and the land data assimilation system, representing state-of-the-art in modeling terrestrial processes and ingesting observations (snow depth) in constraining the land surface states and initializing forecasts. Community-based modeling has the advantage of casting a wider net for community inputs to improve the model and its use. The success of community-based modeling, however, hinges on many factors, including effective governance, community buy-in and ownership, shared objectives, well-defined scopes and measures of success, and clear communication and transparency. While much work lies ahead in developing UFS and its various applications, WPO has already been investing in the organization of the UFS and EPIC efforts, including the team and working group structure, the UFS governance, and EPIC workshops to entrain the community. Considering that the community models must meet the needs of the community besides the forecasting needs of NOAA (e.g., the Weather Research and Forecasting model is a good example of serving the needs of a large weather, air quality, and regional climate modeling community), future EPIC workshops may be used to cultivate two-way communications to develop common goals that meet the needs of NOAA as well as that of the larger community. Other significant challenges facing EPIC include high performance computing-related barriers for external partners and ensuring that EPIC's NOAA partners continue to see good returns on their investments in EPIC.

### **Activity Area 3. Advancement and Transition of Weather Research**

WPO facilitates high-quality weather research and research-to-operations efforts, with effectiveness clearly demonstrated during the review process.

Regarding relevance, WPO consistently targets research topics that matter and devotes considerable effort to the transition of those results into real-world products and applications.

Performance: The review panel applauds the investment in assessment to ensure transition procedures are useful and relevant without adding hurdles to the process. Expanded partnerships could further improve performance while limiting time/effort burden on WPO staff. While transition plans can provide benefits, their creation can also entail significant challenges. For instance, each transition plan may require significant effort from NWS staff even though the

project may have a limited opportunity to reach operations.

Grantees who do not have pre-existing connections with NOAA and NWS may find it challenging to create a strong transition plan—even if the grantees have outstanding qualifications and projects—which can discourage participation in funding opportunities from a broader and more diverse set of external teams. This problem is exacerbated by OAR’s policy of *requiring* transition plans for projects that seek to progress beyond Research Level 4 (successful evaluation in an experimental environment), compared to NOAA’s policy which *recommends* transition plans for such projects. WPO’s social science team has applied a human-centered approach for developing transition plans that includes greater WPO involvement in the planning process. The human-centered approach, which includes facilitating key conversations, has shown significant promise in improving the process, especially for grantees who do not have pre-existing connections with NOAA and NWS. But the WPO does not have sufficient resources to provide that level of engagement in the development of every transition plan it must request. The WPO might consider “office hour” sessions similar to those hosted by some NSF program officers to facilitate conversations with potential PIs about what RL level means and where their project ideas fit along the RL scale. These conversations might help PIs understand where their research fits in a NOAA sense vs. NSF, as RL 1-2 projects may be a better fit at NSF.

#### **Activity Area 4. Effective Communication and Coordination of Weather Research**

The Communication and Coordination Activity Area received the highest ratings of the four activity areas. There are more scores of “highest performance” than “exceeds expectations” for the quality management, relevance, and performance criteria.

Regarding quality, as one reviewer summarized, “Phenomenal team with unified goals and passion for their work.” This Activity Area includes the Supplemental Appropriations Program, the Social Science Program and the Policy, Communications and Partnerships Program. These programs are highly functional and well exceeded expectations. The Supplemental Appropriations Program coordinates \$170 million in scientific investments across four portfolios, including 76 projects. This end-to-end coordination is managed by only four staff. They have also identified a way to creatively communicate

budget summaries, partner organizations, and research results and progress by using ArcGIS StoryMaps. The Social Science Program has squeezed every penny of value from the money allocated to them. Their impact across NOAA, as well as its reputation outside of the agency, is felt far and wide. The Program's accomplishments have been impressive since their creation in FY20. A Policies and Partnerships Program is needed in order to reach a broader audience and widen outreach. This office will be key in demonstrating the contributions of the WPO to NOAA and the Nation.

The relevance of the work in communications and coordination is clearly at a high level. The WPO's work is essential to advance NOAA's goals. The social science and supplemental appropriations teams have demonstrated the ability to make excellent accomplishments under challenging circumstances. The Social Science Program was able to accomplish so much with only \$3.2 million allocated in FY22. Supplemental funding provided a significant boost to Social Science and Service Delivery but again, there is a need for higher levels of dedicated funding. There are not sufficient staff to address all significant needs related to supplemental appropriations. The portfolio analysis and evaluation areas are less developed compared to the other two areas (social science data and research, and research to applications).

## Summary of Recommendations

Review panel members have developed the following recommendations that would help WPO build on its successes and enhance the office's ability to achieve its mission. The order is not intended to be a prioritization.

1. Expand the pool of professionals trained in weather-research fields by considering efforts such as early-career summer training programs (perhaps modeled after the Butler-Williams Scholars Program at the National Institute on Aging), faculty sabbaticals, programs for undergraduate/graduate fellows (perhaps modeled after the Bill Anderson Fund that is expanding the number of historically underrepresented professionals in the hazards and disasters field).
2. In response to concerns about the ability of PIs not previously funded by NOAA to be successful without “insider information” (e.g., partnering with existing/past NOAA-funded PIs or NOAA CIs), design and implement virtual workshops and webinars targeted to non-R1 and minority serving institutions (MSIs), and then publicize those recorded materials, released around the time of the NOFO announcement.
3. Invite MSIs to participate in UFS user workshops and have an MSI host a UFS workshop.
4. Develop an active presence on social media to communicate with the public.
5. Prioritize tasks including identifying a small number of keystone focus areas as the WPO lacks the resources to do everything it is being asked to do.
6. Establish a suitably funded hurricane program, as reliance on supplemental funding is inefficient and inadequate to address needs.
7. Expand the social-science research focus beyond communicating forecasts, in order to better incorporate the impact and recovery stages of major extreme events, as there is a need to demonstrate the long-term impact that exposure to these events can have on social and economic life for communities.
8. Hire more professionals to address the imbalance between the current staffing level and the increasing demands on the WPO.
9. Build the capacity of the Social Science Program to be able to respond to demands and opportunities as there are only two Social Sciences Specialists compared to fourteen General Physical Scientists.
10. Nurture WPO staff by ensuring that the work environment and the

demands on their time are manageable so that overworked staff do not burn out or find employment elsewhere. Use annual surveys to assess needs.

11. Provide professional development opportunities by asking WPO staff to give seminars about EPIC and UFS initiatives at universities (MSIs, R1, and non-R1), and AMS and AGU conferences.
12. Create an external advisory board to participate in regular reviews—such as the quarterly program review—and provide perspective on WPO activities (e.g., a “Strategic Advisory Board” akin to the NOAA Science Advisory Board), and to serve as resources when discussing future directions such as how to conduct outreach to expand diversity of PIs on submitted proposals or facilitate new/expanded partnerships that promote WPO-funded findings.
13. Form an oversight group/committee to monitor timeliness of EPIC updates and community contributions as well as their quality, as UFS is a highly ambitious system and it remains unclear how the open source/open science component will be implemented.
14. Enhance coordination with CPO on UFS-related activities and support of S2S research to cover both foundational research on understanding S2S predictability and R2O research on improving S2S predictions.
15. Consider creating/expanding partnerships with entities such as UCAR or Unidata to identify collaborations, skill-building opportunities, and data sharing potential (e.g., coding examples, hosting data at the UCAR Research Data Archive).
16. To better utilize capabilities in the private sector, expand collaboration with OAR’s Technology Partnership Office, including exploring opportunities to use the Small Business Innovation and Research Program to address WPO priorities (e.g., new observing systems); and, as appropriate, work with other offices in NOAA to consider intellectual property approaches (e.g., data licenses) that support NOAA needs and provide incentives for private sector engagement.
17. Encourage the EPIC team to work with its operational modeling partners to improve the cost-benefit ratio of collaboration with WPO (e.g., more focus on operational deliverables, reducing management burden, ensuring strategic priorities are shared) and expand its efforts to build a vibrant community around UFS by establishing an ongoing external advisory committee or a workgroup under an existing advisory committee to obtain input on priorities, policies, and governance approaches. Specific actions should include seeking input from social science experts on how to build and maintain a strong modeling community; adopting appropriate best

practices from other community modeling efforts (including for earth system, ocean, and atmospheric composition models); cultivating two-way communication between NOAA and the broader community to develop common, mutually beneficial goals; providing a useful example that demonstrates the value of UFS for modelers; considering ways to provide at least 3 years of support for graduate students to ensure sufficient time for them to learn UFS and make significant contributions; engaging OAR to work with other NOAA offices to think “outside of the box” and reduce high performance computing-related barriers for external EPIC partners; and ensuring that data management approaches addresses needs of the community.

18. For OAR to improve the return on investment for transition plans while still building strong partnerships, rescind the rigid rules that require projects to create transition plans and instead trust the judgment of the transition experts in WPO to effectively implement NOAA’s policy on transition plans and to require plans or components of planning (e.g., discussions between grantees and NWS) where they will be beneficial.
19. Coordinate with additional groups and expand coordination with existing partners (e.g., ICAMS committees on observational systems and research and innovation; key National Air Quality Forecast Capability stakeholders including state and local air quality forecasters, the U.S. Environmental Protection Agency, and the U.S. Forest Service; and OAR programs that have shared interests, including ocean observations and unmanned systems) to inform WPO priorities.
20. Develop a coherent and consistent strategy for OAR to task the WPO, CPO, etc., to provide a balanced and manageable portfolio of programs.
21. Fund adequately and assign management responsibility to the WPO for the Joint Effort for Data assimilation Integration (JEDI) activity under the Joint Center for Satellite Data Assimilation.