SOCIAL & BEHAVIORAL SCIENCE RESEARCH TO OPERATIONS WORKSHOP

Workshop Report

Published July 2020

WEATHER PROGRAM OFFICE
National Oceanic and Atmospheric Research

TABLE OF CONTENTS

Executive Summary

Click on
Bolded words to find a definition
Appendix # to find appendix materials
URLs to go to supplementary materials

Inspired by the National Academies of Science (NAS) report on Integrating Social and Behavioral Sciences into the Weather Enterprise, the National Oceanic and Atmospheric Administration's (NOAA) Weather Program Office (WPO; formerly Office of Weather and Air Quality) hosted the first Social and Behavioral Science (SBS) Research to Operations (R2O) Workshop September 4th–6th, 2019, in Silver Spring, MD.

In winter 2019, the initial workshop agenda focused on types of transitions, how to develop a transition plan, and defining social science readiness levels. To ensure this initial agenda captured relevant topics, in the spring of 2019 WPO's Social Science Program met with stakeholders across NOAA's National Weather Service (NWS), including the Office of Science and Technology Integration; the Analyze, Forecast, and Support Office; the Office of Organizational Excellence; and the Performance and Evaluation Branch. These meetings highlighted that NWS organizational infrastructure largely supports the physical science transition process, and conversely, discovered a more urgent need for workshop discussion—the need to build an organizational infrastructure to support social science transitions.

With this discovery in mind, the workshop agenda evolved to address these broader challenges. For example, the Social Science Program found that NWS has performance metrics that guide their research and development (R&D) and 24/7 operational environment. In particular, NWS has data archives that assess new science against current practices, as well as staff resources that support the understanding and applicability of that science. There remains an expectation in current NOAA transition practices that social science transitions should follow a similar process. However, NOAA does not currently have the same organizational infrastructure to support an identical process for social science research—a finding that needs greater awareness. Thus, social science researchers are currently held to a standard they cannot meet and face a burden that research alone cannot overcome.

Another foundational issue the Social Science Program identified during these meetings surrounds how NOAA measures project "success." For example, when considering the transition of numerical weather modeling projects, NOAA is interested in how a research project improves current modeling capabilities. This measurement requires a comparison between current and new capabilities. In this simplified example, researchers create a new dataset and compare it to archived forecast datasets provided by NOAA. However, there is no equivalent archive for social science data. Without archived social science data—data that measures people's perceptions, feelings, or responses over time—new social science research projects have no point of comparison. Therefore, NOAA currently has no way of knowing whether they are improving upon capabilities that affect people.

To continue vetting this new perspective, the Social Science Program met with various stakeholders within NOAA and SBS researchers external to NOAA. Discovering these challenges with NWS, and hearing the equivalent desire from the research community to address these issues, represented a turning point in the final workshop agenda. The Social Science Program realized the previous workshop agenda, which focused on defining readiness levels and creating new **transition plan** templates, did not address the key challenge for social science transitions. Rather, *the core challenge is that NOAA needs to weave social science into its organizational infrastructure.* Specifically, NOAA needs an organizational infrastructure that supports social science transitions, such as collecting **longitudinal data** (i.e., data collected over time), data archives, and societal impact performance metrics that drive mission improvements. Until these organizational pieces are in place, measuring success of individual social science projects, as well as large scale change, will remain a challenge.

To start addressing these challenges, the workshop focused on nurturing an understanding of the unique roles, goals, and capacities of people and organizations comprising the social science and weather communities. Workshop presentations and activities helped build shared languages, terminologies, theories, concepts, and methodologies to enhance the social science research to operations (R2O) process. This workshop fostered opportunities to discuss and develop social science organizational infrastructure within NOAA by focusing on topics such as long term data collection, shaping research and development (R&D) policy and products, and transitioning knowledge.

Workshop participants represented a diverse group of individuals evenly divided between NOAA personnel and social science researchers (see Appendix One and Two). Approximately 100 participants registered prior to the workshop; however, additional participants registered the day of the workshop and participated remotely on Day 1. Overall, participants represented various NWS Headquarter offices and field staff, the NOAA Chief Economist's Office, and physical scientists from Oceanic and Atmospheric Research (OAR) Labs. Social science participants came from NOAA's Program Offices, Cooperative Institutes, Cooperative Science Centers, and universities and centers from around the country, including a number of NOAA funded principle investigators. These social scientists represented diverse disciplines including communication, human geography, sociology, economics, and more. The workshop initiated discussion between these different organizations and individuals comprising the social science R2O community, identified and worked towards achievable next steps, and helped nurture a strong social science R2O community.

Across the three days of the workshop, the following major takeaways emerged through presentations, panel discussions, interactive breakout sessions, and ongoing social media interaction:

- ➔ **Integrating Social and Behavioral Science (SBS) into NOAA requires expanding the definition of R2O.** The traditional definition of the word "operations" typically means anything that supports the 24/7 warning environment in NWS. To make a forecast, operational meteorologists need observations, models, and software tools. While social science research often has implications for the 24/7 warning environment, the applications and benefits of social science research reach beyond the warning environment and guide the people, processes, policies, and organizations surrounding the R2O process.

- ➔ **R2O policies need to reflect the importance of transferring knowledge, or more broadly, science.** Participants perceived an overemphasis on the transfer of technology in NOAA's R&D policies and transition practices. While some projects transfer technology, participants noted it is equally important to transfer the knowledge surrounding that technology. Specifically, the transfer of knowledge is imperative for informing user requirements, identifying forecaster training needs, and measuring outcomes, such as for Impact-Based Decision Support Services (IDSS). Knowledge transfer can also inform possible policy changes when the agency considers prioritizing or eliminating products or services. As emphasized by workshop panelists, understanding when there is enough knowledge to implement these changes requires careful thought, consideration, and iteration between the research and operational communities. To support all transition activities, especially social science transitions, R2O policies need to reflect the importance of knowledge and the practices to transfer it.

- **The R2O process could benefit from emphasizing the fluid and evolving nature of transition plan policies, process, and practice.** Workshop participants expressed a disconnect between how NOAA describes the R2O process and what researchers feel happens during the process. For researchers who write transition plans, they described the current process as complex, rigorous, and jarring. For those within NOAA who oversee the R2O process, they emphasized that both the researcher and NWS operator need to agree upon the end state, but the end state can evolve as the project progresses. However, social science research that works with end users may not have a clearly identified end state at the project onset; instead, the end state develops as more data about the end user is collected and more knowledge is uncovered.

- **There is a need to build an organizational infrastructure for social science R2O.** Workshop discussions revealed NOAA's organizational structure primarily supports the collection, management, and archival of physical science data. Without similar infrastructure for social science, NOAA cannot measure mission critical factors, such as performance metrics, impact, and change. This finding illuminates an opportunity to build infrastructure for social science data collection, management, and archives, which includes prioritizing collecting baseline and longitudinal data, encouraging data archival, and creating meta-data.

There are many tangible actions in this report, a critical next step is continuing the momentum this workshop fostered to develop necessary components of a robust SBS organizational infrastructure. When the major takeaways from this workshop are addressed, NOAA will able to measure SBS project success, its economic value, and the impact of large scale change. Although these efforts will take time to build, the enthusiasm from workshop participants indicated the community has the interest, fortitude, and passion to make these efforts happen. One participant remarked that past efforts required "screaming to headquarters" to garner attention for social science. What is required now, the participant said, "are whispers throughout the organization" - a sign social science is an integral part of our collective mission to save lives and protect property.

Efforts outlined in this report help provide the knowledge necessary to improve R2O processes in the short term, while incorporating social science into NOAA's organizational infrastructure as our long term goal.

1. Introduction

Based on the 2018 National Academies of Science (NAS) report on Integrating Social and Behavioral Sciences into the Weather Enterprise, the overall goal of the workshop was to nurture an understanding of the unique roles, goals, and capacities of people and organizations comprising the **social and behavioral science (SBS)** and weather communities by building shared languages, terminologies, theories, concepts, and methodologies to enhance the research to operations (R2O) process.

The NAS report was funded by NOAA's Weather Program Office (WPO; Formerly Office of Weather and Air Quality) in partnership with the National Weather Service (NWS) and the Federal Highway Administration. This report documented the history of integrating SBS in the weather community, such as early research on warnings, to more recent research that mines social media data with machine learning. More importantly, the NAS report lists challenges in transitioning SBS research that stem from "profound differences in the knowledge, roles, goals, and capacities of people who comprise the SBS and weather communities" (p. 73). Specifically, the report illustrates various communities (i.e., the physical and social, research and operations, and those communities internal and external to NOAA) do not speak the same language and have unique cultural differences. Turning these challenges into opportunities, this workshop aimed to identify ways to better integrate SBS research into operations and address the concerns outlined in the NAS report.

R2O is a multidimensional process that requires funding research, understanding operational challenges, and ultimately integrating research findings into NWS operations. Traditionally, NOAA's R2O process emphasized the transfer of technology into operations, as evident by the **Weather Research and Forecasting Innovation Act of 2017** and the **Joint Technology Transfer Initiative (JTTI)**. While technology is important, the people, policies, and missions that guide the operational process surrounding these technologies are equally important. Transitioning technology may include transitioning knowledge, such as transitioning a methodology to collect user requirements. As such, R2O comes in many forms and requires thoughtful care on how research findings can transition.

NOAA recognizes the uniqueness of each research and development (R&D) project, as documented in the NOAA Administrative Order (NAO) defining Policy on Research and Development Transitions and its corresponding handbook. For example, NOAA eliminated the word "technical" from "**readiness levels**" (i.e., a system to assess the transition maturity of research and development projects). The NAO states "much of what NOAA produces does not meet the definition of technology" (p. 5 of handbook). SBS research is also unique in that its findings may take the form of tangible to less tangible results. For example, SBS research results may be more tangible by informing a change to a product or service, an enhancement to an existing technology, or the development of a new software tool based on end user feedback. However, many SBS projects also make recommendations based on research findings, such as providing knowledge that improves risk communication. Both types of results and outcomes are critically important to integrating SBS research into NWS operations. Therefore, SBS R2O is a critical process to understand.

Recognizing the importance of transition types, the initial workshop agenda in winter 2019 focused on types of transitions, transition plan development, and defining readiness levels for social science. To ensure this initial agenda captured relevant topics, in the spring of 2019 WPO's Social Science Program met with stakeholders across NWS, including the Office of Science and Technology Integration; the Analyze, Forecast, and Support Office; the Office of Organizational Excellence; and the Performance and Evaluation Branch. These meetings highlighted that NWS organizational infrastructure largely supports the physical science transition process, and conversely, discovered a more urgent need for workshop discussion—the need to build an organizational infrastructure to support social science transitions.

For example, the Social Science Program found NWS has performance metrics that guide their research and development (R&D) and 24/7 operational environment. In particular, NWS has data archives that assess new science against current practices, as well as staff resources that support the understanding and applicability of that science. There remains an expectation in current NOAA transition practices that social science transitions should follow a similar process. However, NOAA does not currently have the same organizational infrastructure to support an identical process for social science research—a finding that needs greater awareness. Thus, social science researchers are currently held to a standard they cannot meet and face a burden that research alone cannot overcome.

Another foundational issue the Social Science Program identified during these meetings surrounds how NOAA measures project "success." For example, when transitioning numerical weather modeling projects, NOAA is interested in how a research project improves current modeling capabilities. This measurement requires a comparison between the current and new capabilities. In this simplified example, researchers create a new dataset and compare it to archived forecast datasets provided by NOAA. However, there is *no* equivalent archive for social science data. Without archived social science data (e.g., data that measures people's perceptions, feelings, or responses over time) new SBS research projects have no point of comparison. Therefore, *NOAA currently has no way of knowing whether they are improving upon current capabilities that affect people*.

To continue vetting this new perspective, the Social Science Program met with additional stakeholders within NOAA and with SBS researchers external to NOAA. Discovering these challenges within NWS, and hearing equivalent desire from the research community to address these issues, represented a turning point in what became the final workshop agenda. The Social Science Program realized the previous workshop agenda, which focused on defining readiness levels and creating new transition plan templates, did not address the key challenge for social science transitions. Rather, *the core challenge is that NOAA needs to weave social science into its organizational infrastructure.* Specifically, NOAA needs an organizational infrastructure that supports social science transitions, such as collecting longitudinal data (i.e., data collected over time), data archives, and societal impact performance metrics that drive mission improvements. Until these organizational pieces are in place, measuring success of individual social science projects, as well as large scale change, will remain a challenge.

These challenges, outlined both in the NAS report and during the planning process, became the foundation for the SBS R2O workshop. Turning challenges into opportunities, the workshop's overarching and session goals explored these topics in depth. The workshop design focused on starting the conversation and initiating achievable, tangible next steps surrounding organizational infrastructure needs, including collecting and archiving social science data, identifying terms that need defining, and most importantly, building a strong SBS R2O community.

2. Meeting Goals and Structure

The Social Science Research to Operations Workshop was held September 4th–6th, 2019 in Silver Spring, MD. A full copy of the agenda is found in Appendix Three.

Day 1 was a 3-hour event at the NOAA Auditorium. Panel presentations and discussions illustrated challenges surrounding the lack of mutual understanding in SBS integration within the **weather enterprise** (see NAS report). Presentations also laid the groundwork for the rest of the workshop by introducing key people, organizations, terminology, and methods to the R2O process.

Days 2 (full day) and 3 (half day) in the Silver Spring Civic Building explored the challenges of mutual understanding by examining and discussing multiple topics key to enhancing SBS R2O. Specifically, participants on Day 2 began to work towards a shared language by identifying terms that needed defining or resulted in confusion, as well as how these terms might systematically be measured. The second half of Day 2 concentrated on collecting, managing, and archiving SBS data in a way that helps measure the societal impacts of R2O progress. Topics included specific types of data needed to measure societal impacts, data infrastructure, and ethical considerations surrounding SBS data.

Day 3 focused on skills, methods, data, operational needs, and infrastructure needed to understand how and/or when we know enough to implement policies, change, and knowledge. The workshop concluded by identifying recommendations and goals for people and organizations to continue to work towards after the workshop concluded.

2.1 Feedback/Data Collection

The workshop used a variety of methods to collect feedback from both in-person and remote participants. This section describes how each method was used during the workshop and how the collected data informs this report.

2.1.1 Social Media

Participants were asked to answer questions and provide their thoughts via Twitter using the hashtag #sbsr2o. This allowed participants to share their own insights and engage with one another and their own Twitter networks on topics relevant to SBS R2O. These Tweets were incorporated into workshop notes that informed this report.

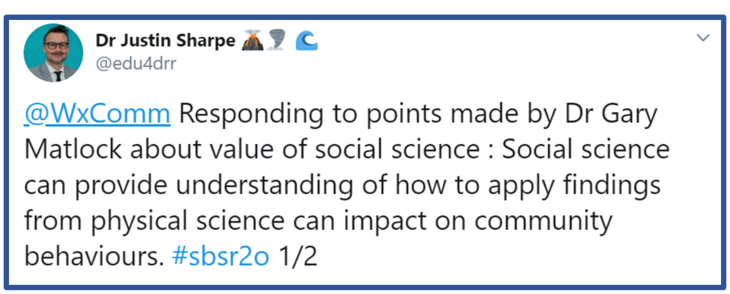


Figure 1: Example Tweet from workshop; Courtesy of Dr. Justin Sharpe

2.1.2 Slido

Slido was used to engage participants in real-time question and answer sessions, polling activities, and check-ins for remote and face-to-face participants. Slido provided analytics and feedback on event participation. A complete list of questions posed to the audience, poll results, and participant comments can be found here. Slido allows for anonymous feedback and for participants to "upvote" questions and comments they would like to address. Slido commentary enhanced the workshop notes.

Figure 2: Top Slido question from the workshop

2.1.3 Note-Takers

During the two breakout sessions, each of the eight breakout groups had an assigned, volunteer note-taker to capture group discussions. The notes from each group were analyzed for relevant themes and recommendations, which are discussed throughout this report. A separate note-taker was responsible for capturing the workshop holistically, including panel presentations, lightning talks, and breakout group report outs.

3. Meeting Summary - Day 1

Day 1 focused on a series of plenary and panel presentations, as well as group discussion and audience feedback that illustrated the challenges in integrating and transitioning SBS into operational contexts. Day 1 took place in the NOAA Auditorium and was broadcast through the OneNOAA webinar series. Bios for workshop panelists and speakers can be found in Appendix Four.

3.1 Historical Overview and Round Table Discussion on NOAA R2O Policies

Mary Erickson, Deputy Director, National Weather Service

Dr. Gina Eosco, Social Science Program Manager, Weather Program Office, Oceanic and Atmospheric Research

Dr. Gary Matlock, Deputy Assistant Administrator for Science, Oceanic and Atmospheric Research

Jennifer Sprague-Hilderbrand, Social Science Program Manager, National Weather Service

Dr. Gary Matlock and Mary Erickson provided background on the development, process, and purpose of research funding, as well as operations to research (O2R) and R2O integration from a NOAA perspective. Both Dr. Matlock and Erickson emphasized the importance of incorporating social science, noting that social science integration should not be an "afterthought," but rather encouraged at the very beginning of a project to increase its utility. Erickson also remarked that, "we at NOAA can better articulate our needs for social science." She encouraged all to explore the avenues and activities within NOAA Cooperative Institutes, Cooperative Science Centers, and NOAA Sea Grant programs to help NOAA better articulate social science needs and expand social science capacity. Erickson also noted that NOAA needs more mechanisms to capitalize on social science skills and talents outside of NOAA and that we must work together to build these mechanisms.

Challenges with transitions were also addressed. Dr. Matlock noted one challenge with social science transitions is "crosstalk." He stated that we are fond of our respective disciplines, but we all must have a degree of scientific humility and try to understand other disciplines. Dr. Matlock also emphasized that while transition plans are required for many of NOAA's funding calls, they are "living documents." In other words, transition plans are templates that help us focus on key outcomes by asking important questions and determining what matters most in the transition process. Here, there is no need for a separate transition plan for social science and physical science; ideally, transition plans represent all science, and as a template, are adaptable to each research project. However, some participants noted that current transition plan templates emphasize technology transfers. Instead, participants suggested broadening the language in transition plans and making them more inclusive to *all* transition types, including the transfer of knowledge.

While both Erickson and Dr. Matlock emphasized leveraging existing resources, Dr. Matlock strongly encouraged those within NOAA to take advantage of all social science-related training in order to develop a solid knowledge base for SBS integration. This includes asking questions within NOAA offices, having knowledge about social science projects, and utilizing all available training resources to help the integration process.

During this session, workshop participants noted it is the responsibility of both social and physical scientists to encourage integration of SBS within NWS activities. NOAA program managers and leaders, as well as the SBS community, should educate and familiarize themselves with integration initiatives. Transitioning social science findings requires the action of all involved, including the social science researcher(s), the corresponding NOAA funding program manager(s), NOAA leaders, and the team of operational partners.

3.2 What Guides NOAA Weather Funding: Policy, Priorities, and Process

This session gave a broad overview of how social science research is funded within NOAA.

Dr. Hendrik Tolman, Senior Advisor for Advanced Modeling Systems, Office of Science and Technology Integration, National Weather Service

Dr. Hendrik Tolman provided a historical perspective on social science integration within NWS operations. He began by noting that a significant milestone occurred about six years ago when NWS began to focus on *decision-support*, which examines the issues surrounding NWS **core partner** (e.g., emergency managers) decision contexts. The emphasis on decision contexts ultimately elevated social science research priorities within NWS. With this new focus in mind, he encouraged physical and social scientists to work together as a team internally to explore unique research applications, as well as externally to research operational challenges that are inherently interdisciplinary in nature. In order to encourage interdisciplinary teams, he explained that funding calls should focus on R2O broadly, rather than physical versus social science specifically.

Dr. Bill Lapenta, Acting Director, Weather Program Office, Oceanic and Atmospheric Research

Dr. Bill Lapenta emphasized NOAA's leadership in engagement and integration of two disparate and large fields of study and research: the *physical sciences* that study inanimate natural objects (e.g., physics, chemistry, astronomy, and related subjects) and the *social sciences* that are engaged in the process of describing, explaining, and predicting human behavior and institutional structures and how they interact with their environments (NOAA Science Advisory Board). For all researchers, he noted the importance of understanding the progression of research to operations via the NOAA R2O "funnel' (Figure 3), which moves from broader research and development to a narrowing operational system and implementation. Dr. Lapenta emphasized understanding where each respective funding call sits within this progression.

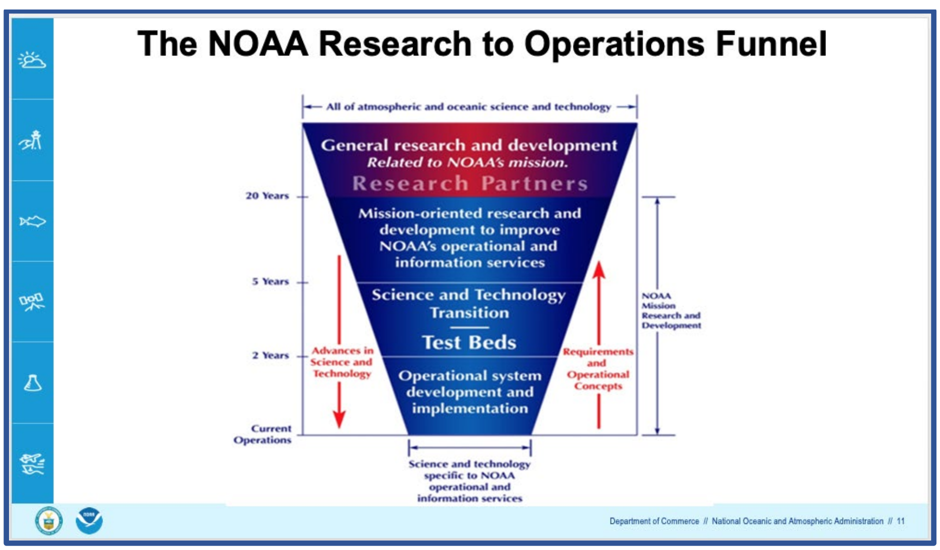


Figure 3: The NOAA R2O funnel from Dr. Lapenta's presentation

For example, the JTTI Program focuses on mature (i.e., readiness levels 4–8; Appendix Three) science and technology projects specific to NOAA operational environments and requires a clear and reasoned transition plan. Projects that are in more exploratory stages or address **basic research** are not suitable for JTTI funding. Given the R2O focus, Dr. Lapenta suggested starting at the bottom of the funnel to determine what operational target or challenge the research project will address. When NWS collaborators and researchers work together early as a team, this increases their collective success of navigating the transition process. Further, what a transition looks like requires an iterative process between the researcher and the potential beneficiary (e.g., NWS). To assist in this process, any NOAA-funded researcher and NWS point of contact, who are often assigned to the researcher by the funding program office, need to acquaint themselves with the [NOAA R&D policy](#).

Dr. Gina Eosco, Social Science Program Manager, Weather Program Office, Oceanic and Atmospheric Research

Jennifer Sprague-Hilderbrand, Social Science Program Manager, National Weather Service

Dr. Gina Eosco and Jennifer Sprague-Hilderbrand gave a joint presentation about social science R2O using the metaphor of "sibling rivalry," which illustrated the challenges associated with social science R2O and O2R. Specifically, they discussed how these challenges can lead to misunderstandings. Like siblings, those involved in R2O (e.g., physical scientists, social science researchers, operational meteorologists, NOAA Labs, and NOAA program managers) may have disagreements, but they are all part of the same family. Dr. Eosco and Sprague-Hilderbrand emphasized that overcoming misunderstandings requires leadership on all levels, which is also noted in the NAS report. In addition, all involved require persistence, patience, and empathy. This session introduced the panel discussions that followed, summarized in the next section.

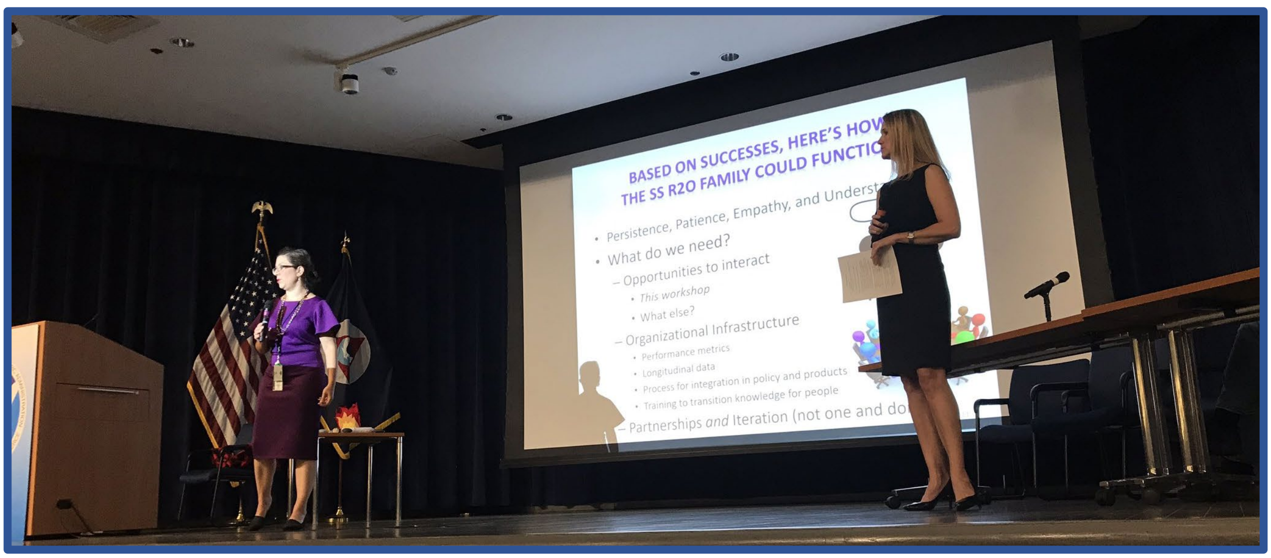


Image 1: Dr. Gina Eosco (left) and Jennifer Sprauge-Hilderbrand (right); Photo Courtesy of Ayesha Wilkinson

3.3 Panel Perspectives on the Meaning of R2O Transitions

Day 1 concluded with two panel discussions centered on examples of SBS research integration and the researcher experience in the transition process. The first panel was composed of NOAA leadership (Dr. Tolman, Dr. Lapenta, Dr. Eosco, and Sprague-Hilderbrand, Image 1). The second panel included a mix of external and NOAA internal researchers and NWS personnel, including:

Dr. Julie Demuth - Research Scientist, Mesoscale and Microscale Meteorology Laboratory, National Center for Atmospheric Research

Dr. Pam Heinselman - Chief, Forecast Research and Development Division, National Severe Storms Laboratory, Oceanic and Atmospheric Research

Dr. Dave Myrick - National Science and Operations Officer and Field Driven Research to Operations Team Lead, Office of Science and Technology Integration, National Weather Service

Castle Williams - Doctoral Candidate, Department of Geography, University of Georgia

General themes emerged across the two panels, which are explained below. Overall, there were distinctions made between technology transfer and knowledge transfer, as well as projects that involve both.

3.3.1 Transition Plans

Transition plans were discussed across the two panels. While NOAA has an official definition of a transition plan, the panelists described a transition plan as a document written iteratively between the researcher and their respective NWS point of contact. A transition plan includes the necessary steps to move research into operations, but does not guarantee an actual transition to operations will take place (primarily due to acquisition laws and details of distributed funding authorities within NOAA). Rather, a transition plan is a *guide* to a possible transition. For those who have never written a transition plan before, the process was described as complex, rigorous, and jarring.

NOAA leadership mentioned the importance of having a strong advocate within NOAA for a research project. Since communication and relationships are central to the R2O process, having a strong NWS collaborator on a project is important, especially if that collaborator or contact understands the operational and policy steps necessary to transition the research. However, one researcher noted it is often challenging to find the time and space to meet and discuss projects and/or transitions. If a funding call requires a transition plan, both the researcher and NWS collaborator must account for this iteration when planning the project, as well as prepare and budget for a possible transition. This iteration facilitates agreement on what the possible transferred research output is, such as a technology, knowledge, or a mixture of both.

While many understood the need for transition plan iteration, researchers expressed that the current transition plan template is constraining. Instead, they recommend having a “bank” of transition plans they could use to help create their own transition plan. Another researcher noted that having meta-information and/or examples of transition plans would be helpful to researchers, along with examples of potential “baton-passing” projects, (i.e., projects that spawned new and continuing research).

3.3.2 Readiness Levels

NOAA leaders acknowledged that the biggest problem associated with transition plans is a lack of understanding of readiness levels (RLs). In particular, there is a lack of agreement on the definitions of RL 8–9 (Appendix Five) or what is needed to be considered “ready for operations.” This lack of clarity about how RLs apply to social science research was noted as a stumbling block to its integration in operations.

Research panelists indicated that they believe RLs focus on technology transfers and therefore have less applicability for projects that focus on the transfer of knowledge. To these researchers, RLs appear very technical and linear (i.e., they feel they must go through each level), which makes assessing the RL for knowledge transfers difficult.

Researchers also noted that RLs are difficult to standardize because there are multiple meanings in both the physical and social sciences. Workshop participants from both the physical and social sciences disclosed there is not widespread understanding of RLs. To help address these gaps in understanding, efforts are currently underway within NOAA to organize a workshop focused specifically on RLs.

However, it was strongly recommended that everyone read the NOAA Administrative Order (NAO) that defines RLs. This policy defines the transition of R&D to "any operation, application, commercialization, or other use." For social science, RLs represent a way to measure research generalizability—or the extent to which research findings apply to a broader audience and possible applications. Dr. Eosco noted that the more generalizable a research project is, the higher the RL. For SBS, determining a project's RL is best accomplished with a NOAA contact who help researchers understand how their research will be used and applied.

3.3.3 Knowledge Transfer

A key theme that emerged from both panel discussions was the need to transfer knowledge. Researchers perceived an overemphasis on transferring technology and an under-emphasis on transferring science and/or *knowledge*. NOAA's R2O policies, including transition plans, ask for the current capability and the end state of the project. Some researchers believe the current language excludes knowledge transfers. While some funding calls emphasize technology, NOAA's policies acknowledge the importance of knowledge transfer. Whether the end result is technology and/or knowledge, NOAA needs a clear description of the project's end state by outlining what new knowledge or research output the project aims to produce. In addition, having an end state in mind helps determine the project's RL. However, SBS researchers pushed back by speculating that indicating an "end state" could introduce bias to the results. They explained that SBS research, and the knowledge it produces, evolves as data are collected and analyzed. One panelist remarked, "you have to find a [research] endpoint with funding; knowledge is cumulative." For those within NOAA who oversee the R2O process, they emphasized that both the researcher and the NWS point of contact need to agree upon the end state, which can include either technical outcomes, a research database, or previously unavailable scientific knowledge. However, end states can evolve as the project progresses.

Additionally, there was discussion surrounding the need to study knowledge transfer more holistically. One researcher noted their end goal is to develop concrete ways to transfer knowledge, rather than overemphasizing "getting into operations."

3.3.4 Working with End Users

Many workshop participants emphasized the cyclical nature of research projects that include stakeholder evaluation of forecasting products and services. For one physical science researcher, the most successful projects involved SBS from the beginning and continued to integrate stakeholder input throughout the process, which positively influenced the project outcome. However, as mentioned above, projects that work with end users may not have a concrete end state at the beginning of the project. Here, the research output becomes clearer as the project progresses and more knowledge is uncovered. Therefore, when working on a transition plan, the end state and RLs may not be known at a project's onset. This indicates transition plans need more agility for end user focused research. As one workshop participant stated, "innovation requires change."

In addition, projects that involve capturing end user feedback face operational constraints that are difficult to account for and build into the project's timeline at the beginning. The researcher and NWS operational collaborators, including the NWS point of contact, must iterate once the user feedback collection is complete. Not all end user ideas are operationally viable, and as such, require further iteration to determine an operational outcome responsive to end user needs. Both the research proposal and transition plan should account for such iteration.

3.3.5 Integration of SBS and Interdisciplinary Research

Questions emerged about how NOAA will ensure social science integration into the agency. Overall, NOAA views the integration of SBS into NOAA operations as critical to its mission and therefore would like to see greater SBS investment. This investment, however, may come in many forms, given a resource-constrained environment. NOAA stated that the most productive integration is when SBS and physical sciences are not placed in "stovepipes," but instead work side-by-side on interdisciplinary research, development, and transition efforts. Creating opportunities, such as workshops and R2O gatherings, helps the community build a shared language.

Generally, both the SBS research and NOAA panelists expressed that interdisciplinary funding is critical and advantageous. Interdisciplinary funding calls can support social science integration from the beginning. In addition, interdisciplinary projects helps everyone think creatively and collaboratively to shape research questions and increase research output utility. Researchers encouraged NOAA to define "interdisciplinary" and provide clarity and comprehensive language describing the agency's request. Since social science integration lags in the agency, explicitly stating the inclusion of social science in a funding call is helpful.

4. Meeting Summary - Day 2

4.1 Welcome and Recap

Dr. Eosco began Day 2 by providing an overview of Day 1. Participants shared the concern that NOAA perceives SBS as a monolithic field. In an effort to show the diverse disciplines and perspectives represented at the workshop, participants agreed to indicate which discipline (e.g., communication, anthropology, sociology) or perspective (e.g., researcher, forecaster, or policy-maker) they identify with, and where appropriate, what methodologies they use and the types of research questions they ask. Furthermore, participants emphasized it is not necessary to differentiate between social and physical science, but rather stressed the importance of interdisciplinary science—a point that was reiterated throughout Day 2.

4.2 Session 1 - Measuring Mission: Constructs, Metrics, and Policy: Lightning Talks on Key Concepts

Not speaking the same language is a challenge between SBS and the physical sciences, as well as between research and operations more broadly. To nurture a shared language, Session 1 began with a series of lightning talks—short, energetic, high level overviews—that introduced definitions, processes, and questions for the audience to consider during the following breakout session.

These lightning talks illustrated how NWS *operational definitions* are composed of certain SBS *constructs*. In social science research, constructs are terms that need clear, *shared definitions* so researchers know what variable(s) they need to measure. When constructs are measured consistently over time, NWS can determine its impact and change, as well as *success*. The lightning talks concluded with an overview of the NWS Strategic Plan to help ground these ideas in NWS applications.

Katie LaBelle Edwards - Impact-Based Decision Support Services (IDSS) Program Manager, National Weather Service

Katie LaBelle Edwards began with the operational definition of *Impact-Based Decision Support Services* (IDSS), stating, "IDSS is the provision of relevant information and interpretive services to enable core partner's decisions when weather, water, or climate has a direct impact on the provision of lives and livelihoods." Here, IDSS operations are flexible and adaptive to core partner needs. Edwards defined core partners as "both government and non-government entities directly involved in preparation, dissemination, and discussions involving weather, water, or climate-related National Weather Service information that support decision-making for routine or episodic high impact events." These entities, such as local, state, regional, and national emergency managers, have a unique need for increased interaction with NWS personnel in order to support the NWS mission.

Operational definitions are important for connecting operations to research. Specifically, understanding how NWS defines IDSS can help researchers contribute to its advancement. In the IDSS context, Edwards emphasized the need for research that helps NWS understand how to communicate scientific (and in the future, probabilistic) information to support core partner decision making.

Dr. Joe Trainor - Associate Professor and Director of the Disaster Science and Management Program in the School of Public Policy and Administration, Core Faculty Member of the Disaster Research Center, University of Delaware

Dr. Joe Trainor provided a high level overview of measurable *constructs* within SBS research and discussed why they are important to the R2O process. Constructs in social science research are terms or ideas that describe something, such as "effective IDSS." In the R2O space, these terms need a shared definition so researchers know what variable(s) they need to measure. For example, operational definitions, such as *effective decision support*, can be broken down into multiple measurable constructs (e.g., timely communication, trust in source, understandable graphics). Having shared definitions allows the R2O community to support the goal of consistent measurement and allows an organization to track its progress, which illustrates why having shared research constructs for operational terminology is of high value.

However, having shared definitions does not mean all disciplines will measure a construct the same way. Dr. Trainor explained various disciplines (e.g., psychology, geography, economics, communication, sociology, and physical sciences) have different theoretical and methodological approaches that affect what we should measure and how we should measure it. These disciplines utilize different tools, problems, theories, and methods; therefore, we can measure certain constructs in more than one way. This multi-dimensionality in SBS research is similar to a numerical weather ensemble—each model run contributes to our greater understanding of the atmosphere. Likewise, unique SBS methods and disciplines contribute to a greater understanding of a construct. How NOAA approaches this topic will affect outcomes related to its mission and vision, organizational structures, programs, culture, and capabilities.

Dr. Joe Ripberger - Assistant Professor of Political Science and Deputy Director for Research at the Center for Risk and Crisis Management, University of Oklahoma

Dr. Joe Ripberger discussed the Severe Weather and Society Survey (WxSurvey), which measures constructs that are key to many severe weather operational definitions and efforts, such as reception, comprehension, and responsiveness to forecasts and warnings. These constructs are measured consistently over a period of time—what social scientists refer to as longitudinal data.

The WxSurvey is distributed annually and the project team is beginning their fourth year of data collection. This type of data collection helps establish baselines, track progress, and determine where change is or is not occurring. For example, as NWS adapts and develops new policies, products, and communication practices (e.g., the Hazard Simplification Project), having longitudinal measurement of these concepts across the country, both before and after these policies, products, and communication changes are implemented, allows NWS to evaluate its impact. Therefore, longitudinal studies and their associated data are essential to measure improvements that inform operational decision-making.

To make the WxSurvey more accessible, Dr. Ripberger introduced the Severe Weather Dashboard, an interactive display of the longitudinal data by NWS County Warning Area.

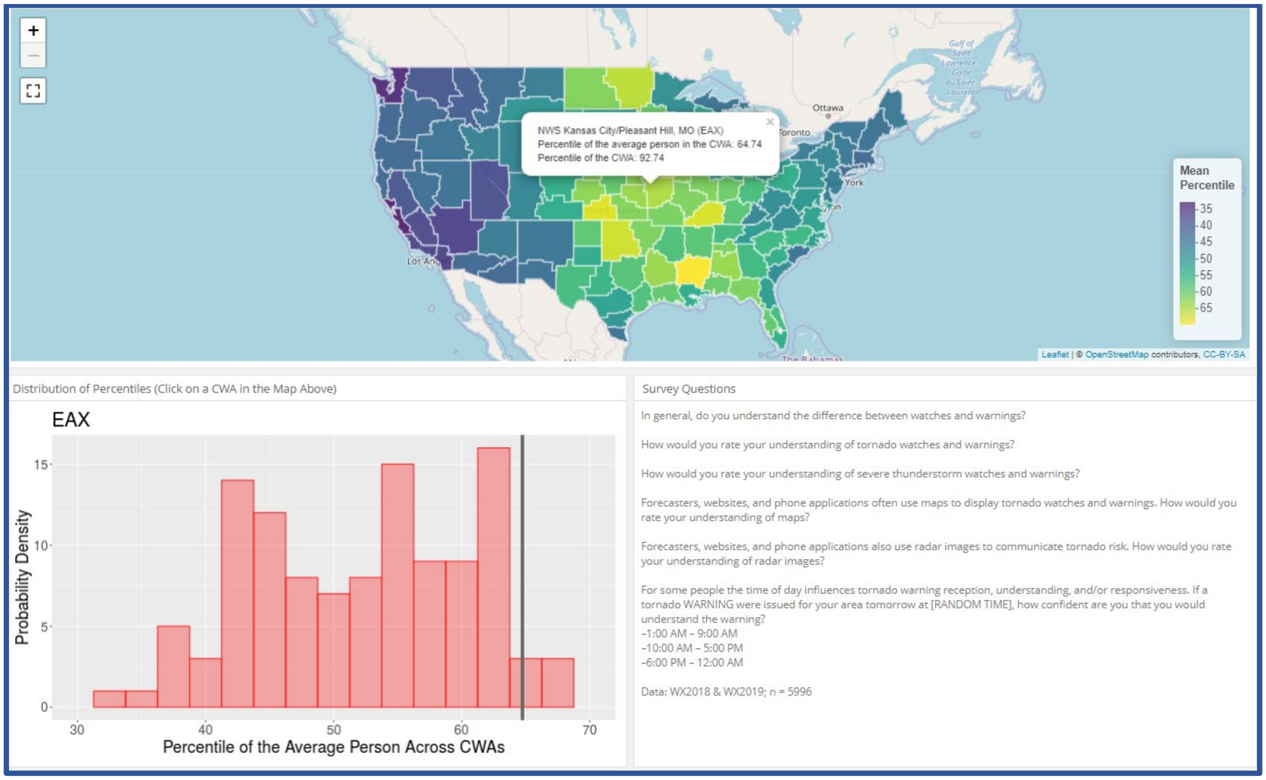


Figure 4: Tornado warning comprehension results for Kansas City/Pleasant Hill, MO County Warning Area

Figure 4 is an example of how the variable tornado warning comprehension is viewed on the dashboard. Dr. Ripberger explained that in order to measure the construct of comprehension thoroughly, three variables need to be measured: the gist, timing, and geographic scope of the warning.

- → The gist of the information (watch vs. warning) - approximately 80% of US adults know the difference between a watch and warning.
- → The timing of the information (warning lead time) - only 25% of US adults know they have less than 30 minutes to take protective action following a warning
- → The geographic scope of the information (warning area) - only 30% of US adults know tornado warnings are about the size of small cities.

Dr. Hendrik Tolman, Senior Advisor for Advanced Modeling Systems, Office of Science and Technology Integration, National Weather Service

Dr. Hendrik Tolman explained how the NWS Office of Science and Technology Integration (OSTI) defines and measures physical science research project success. Here, comparing a new project to past archived weather data helps measure important metrics, such as model improvements. Archived data and subsequent comparison helps NOAA evaluate and determine the operational viability of research. However, since there is no baseline or archive of longitudinal SBS data, similar policy expectations for SBS research projects (i.e., determining their level of "success") is currently unattainable. A lack of baseline and longitudinal data not only prevents measuring the success of large endeavors and policies, but also impedes measuring the success of individual projects. Here, successful projects can help inform operational decisions.

Dr. Tolman also encouraged the SBS community to pave its own R2O path. For example, SBS does not need to follow the exact R2O process as numerical weather modeling. Instead, he suggested SBS build a path side-by-side with researchers and operators. He also stressed that there are other ways to think about R2O, or R2X, where "X" refers to application more broadly. He suggested that SBS may create tools for researchers and/or encourage new ways of thinking both inside and outside of the 24/7 operational environment.

Dr. John Ten Hoeve - Deputy Director, Office of Organizational Excellence, National Weather Service

Dr. John Ten Hoeve concluded the lightning talks by providing an overview of the NWS Strategic Plan, which helped ground the questions posed throughout the remainder of the workshop to NWS applications.

Dr. Ten Hoeve opened by discussing how NWS initially viewed SBS integration, which emphasized SBS as a means to simplify the communication of information and improve the understanding and utility of its forecasts and warnings. While this perspective is a component of integration, Dr. Ten Hoeve stated that this view limits the broader utility of SBS. He then provided an overview of potential social science integration within the NWS Strategic Plan objectives, including:

- What is the human element behind a collaborative forecast process? (Objective 3.5)
- What makes a forecaster trust new technologies? (Objective 2.7)
- How do we measure the societal outcomes associated with Weather-Ready Nation? (Objective 3.12)
- How do we effectively communicate longer lead-time forecasts? (Objective 1.7)
- Finally, how can the NWS better manage the cultural change required to evolve the NWS operating model, such as organizational structures, roles, processes, and staffing to align resources with shifting user demands and enhance the quality, quantity and consistency of IDSS at every level?

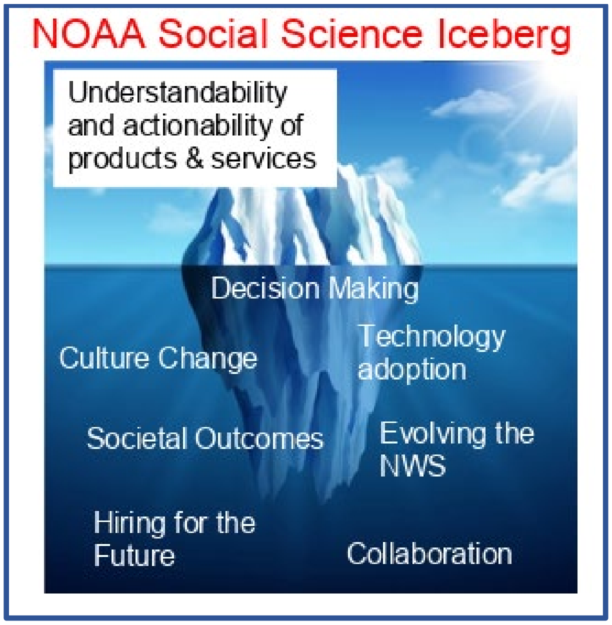


Figure 5: Incorporating SBS into the NWS from Dr. Ten Hoeve's Presentation

Figure 5 represents a few ideas for how social science can help NWS achieve its strategic objectives beyond improved weather communication. Dr. Ten Hoeve encouraged SBS researchers to propose how they can connect the dots between research results and NWS operations and strategic objectives. Working together will help the NWS innovate how they think about SBS integration.

4.2.1 Summary

Dr. Eosco summarized the session as the following:

- Edwards provided an overview of how the NWS defines *IDSS*, which showed multiple ways to interpret, and therefore research, its applications.
- Dr. Trainor gave an overview of what a *construct* is—a term or phase that needs a shared definition for measurement—and emphasized the value of diverse measurement and theoretical perspectives.
- Dr. Ripberger showed an example of *measuring a construct*, which exemplified Dr. Trainor's point about diverse methods. Dr. Ripberger also introduced the value of baseline and longitudinal data *(*i.e., data collected over time) to track mission, metrics, and progress.
- Dr. Tolman articulated the importance of archived data for *measuring project success* and expressed that there is an opportunity to build the infrastructure for social science data collection, management, and archival. He also encouraged broadening our view of what R2O means for SBS.
- Lastly, Dr. Ten Hoeve walked us through the NWS Strategic Plan and highlighted unique applications for SBS integration.

One of Dr. Eosco's main takeaways is *the social science community has an opportunity to expand the definition of R2O*. While NWS 24/7 operations are critical, social science has additional applications that can support things like NWS organizational infrastructure, cultural environment, staffing roles, and training. The NWS lightning talks encouraged workshop participants to innovate and create a new path.

4.3 Breakout 1- Defining Terms, Measuring Terms, Measuring Success

To begin working towards a shared vocabulary, Breakout Session 1 sought to broadly identify and discuss what terms need defining, how they might be measured, and how we can build mutual understanding in order to help the SBS R2O process.

4.3.1 Breakout Session Process

Participants were asked to self-select into groups that had approximately equal numbers of researchers and NOAA personnel. A note-taker was assigned to each table to capture the unique contributions of each respective discussion. After discussing the breakout questions (Appendix Six for the complete list of questions), participants selected a group speaker who presented their group's findings to the larger audience. In total, there were 8 breakout groups.

Image 2: Breakout groups during breakout group #1; Photo courtesy of Dr. Gina Eosco

While there were many terms discussed among the groups, the terms presented below received attention by more than one breakout group. To create this list, terms or phases identified by one group were cross checked with one another, until all groups were checked. Then, notes were combined from each breakout group for each respective term. This process created a holistic picture describing how participants viewed the term or phrase.

4.3.2 Breakout Session Results

From creating a Word Cloud (Figure 6) that illustrates the challenges of language, to re-posing the breakout questions themselves, participants provided valuable feedback and revealed how much our respective professional languages differ.

Figure 6: Word cloud created by a breakout group

Participants also expressed a strong enthusiasm for ongoing opportunities for SBS and operational forecast personnel to have face-to-face gatherings and other technology-based forms of interaction so that we may all learn from one another.

During the discussion and report-outs, participants generally agreed the following terms need defining and/or there was disagreement over its definition. These terms range from the abstract (e.g., value, knowledge) to more organizationally focused (e.g., requirements, readiness levels).

Define Value

Questions arose about how to define the *value* of social science research and how *value* is demonstrated or measured. For example,

- → What does it mean for a forecast or a piece of information to have *value*? For example, does it lead to someone making a decision or a "better" decision?
- → In what "segment" or entity does something hold value? Is there such thing as community value, societal value, or forecaster value?

Participants indicated that sometimes physical scientists have trouble understanding how social science work benefits them, and therefore cannot articulate the overarching value of using social science. Participants encouraged each other to explore ways we, as a whole, can better articulate and communicate the ways SBS benefits NWS, including meet-and-greets with NWS offices, internal/external seminars, and conference presentations.

Define Knowledge

Emerging from multiple breakout groups, *knowledge* became a major discussion topic. Knowledge is hard to define since it comes in many different forms (e.g., experiential, scientific, conceptual, structured, and local), is not static, and is always evolving. Related to the discussion of *value* (see above), a key theme emerged from this conversation about the *value of knowledge*, as well as the responsibility of researchers to make knowledge accessible, timely, and up-to-date. Specific questions surrounding this term encompassed:

- ➔ What counts as knowledge?
- ➔ Is knowledge synonymous with science?
- ➔ Is there a distinction between operational and research knowledge? For example, in the R2O framework does knowledge need to become more tangible, such as providing research guided recommendations for practitioners?
- ➔ If knowledge is the research output, how does the NWS or researcher track its use?

Define Response

Stemming from its use in the NWS Strategic Plan (see "effective preparedness and response," p. 7, and "improved forecasts will drive better response," p. 9), workshop participants highlighted the need to define the word *response***.** This discussion centered on how NWS views the term in light of forecast watches, warnings, and predictions. While response is usually synonymous with action, one participant said "it shouldn't be." A more SBS interpretation of the term is whether or not the recipient understands and/or receives the information. In the NWS Strategic Plan, responsiveness may also refer to the agency (see "match workforce to workload across the organization to enable rapid response…" p. 19) and core partners. Participants noted that *response* is another construct that needs more discussion and clarity, as diverging definitions may lead to inconsistent measurement of this concept.

Define Success

What constitutes *success* between the physical sciences and in SBS research is variable, goal-dependent, and in some cases, performance metric-dependent. Participants proposed defining *success* by determining if operations has a greater and more widespread understanding of the importance and value of SBS knowledge. This understanding can be accomplished through developing tools and services that provide integrated data and knowledge about the users (e.g., core partners, public) of NWS information.

There was additional discussion on what successful research output looks like. Specifically, some participants felt a perceived bias toward *knowledge* as a project outcome. In this discussion, some participants believed that *knowledge* as a research output is viewed as basic science (i.e., RL 1). In some cases, this may lead the researcher to not apply for certain funding calls that require more mature research and higher RLs, such as JTTI. However, transferring *knowledge* allows the researcher to provide many ideas for the receiving unit to consider. In addition, participants perceive an emphasis on concrete language in transition plans, which can limit the value of transferring *knowledge*. Overall, there was a desire to hear that knowledge transfer *is* a successful project output.

Define the Users, Customers, and Stakeholders

Three breakout groups indicated that there is often confusion about whom NWS references as their *user*. Specifically, groups stated that terms like *users*, *customers*, and *stakeholders* need further clarity, as well as what engagement looks like with these individuals. This lack of understanding led one participant to wonder, "If we do not know the user, are we measuring things, challenges, or problems that matter?" Participants emphasized not having a shared definition and conflating these terms can lead to inconsistent measurement.

Define Requirements

There was general confusion among participants related to what a *requirement* is. During the discussion, requirements were defined as a milestone, a need, or a minimum standard to meet, which prompted one participant to ask, "…which one is it?" At the workshop, requirements were framed as, "…someone in the field has a need, and then it goes up through the chain, and theoretically it could get to a solution," but they also admitted that the definition is not clear within NWS. Generally, participants stated they would like more transparency surrounding requirements and if NWS indicated their needs, researchers could better address their challenges.

Other Terms

There was also discussion associated with specialized terminologies and forecast-related language, such as *confidence* and *uncertainty*, which are critical to fostering understanding of NOAA's goals for a Weather-Ready Nation and for providing decision-support. In addition, there were exchanges about key terms related to the R2O process; for example, what do we mean when we say we want to *transition* research to *operations*? What constitutes a *transition* and what exactly are we transitioning to? Likewise, *operations* is composed of diverse organizations and people, and we all must agree on what facet of operations we are referring to. There was also confusion surrounding more organizational terms, such as *readiness levels*, which were also discussed on Day 1.

4.4 Session 2 - Measuring Mission: Exploring the Need for Collecting, Managing, and Archiving Social and Behavioral Science Data

Session 2 explored ways to collect, manage, and archive SBS data in a way that allows people and organizations to measure societal impacts and R2O progress. Lightning talk presentations offered overviews of the speaker's areas of expertise and approaches regarding various kinds of relevant data.

Some questions that were addressed include:

- ➔ How does SBS data collection and management compare to the physical science?
- ➔ What are challenges associated with the lack of longitudinal data?
- ➔ What data or opportunities exist to create societal impact metrics now and in the future?

Dr. Vankita Brown - Social Scientist, Office of the Chief Operating Officer, National Weather Service

Michael Scotten - Chief, Performance and Evaluation Branch, National Weather Service

Michael Scotten introduced the NWS Performance and Evaluation Branch that is responsible for tracking the accuracy of NWS forecasts and warnings. These activities primarily relate to physical data collection and archival (e.g., verification scores and forecast and warning accuracy). His presentation provided insights on NWS capacity to collect and house data as it relates to data needed for the Government Performance and Results Act (GPRA). At this time, GPRA does not have any mandated societal impact performance metrics.

While there are no mandated metrics, Dr. Vankita Brown spoke about efforts surrounding social science data collection in NWS, including a pilot survey used to determine the impact of core IDSS constructs, such as trust, consistency, and accessibility (see Edwards overview on IDSS on p. 20). The Evaluation program also maintains other types of social science data, including a Customer Satisfaction Index based on survey data collected quarterly. The program is also in charge of conducting national and regional service assessments over the five primary regions of service for NWS. Service assessments represent an example of social science integration in the agency, since social science methodologies inform process, as well as a social science data collection opportunity.

Dr. Lou Nadeau - Vice President, Eastern Research Group

Dr. Lou Nadeau discussed a project Eastern Research Group completed for the NWS Weather-Ready Nation program that explored ways to measure the NWS's societal impact metrics. He provided insights on the successes and challenges in using current NWS data for these purposes. For this project, they employed a variety of **instruments**, including a website pop-up survey, a quick response survey effort, and the NWS Storm Data database. Each of these efforts had various pros and cons associated with them:

- ➔ Website Pop-up Survey - *Pros*: The survey leveraged readily available data, provided a large dataset to access, and collected data directly from the source (e.g., the sample of interest). *Cons*: The data was not dedicated for this specific purpose, which limits what the data can provide for metrics, and required **Office of Management and Budget (OMB) approval** (i.e., a Federal review process similar to a university's **Institutional Review Board (IRB)**). While important, OMB approval can slow down data collection efforts and is needed over time.
- ➔ Quick Response Survey - *Pros*: This method collected data from the source, has OMB approval, and is collected directly after an event within 1–2 days. *Cons*: This data needs OMB approval

over time and survey responses are event-dependent. This means the data cannot provide trends over time to support metrics.

- NWS Storm Data Database - *Pros*: No OMB approval is required, it leveraged currently available data and is expected to remain available in the future, is a type of longitudinal data (i.e., data collected over time), and is based on sound theory. *Con*: This particular type of data needs continual updating.

One of Dr. Nadeau's calls to action was to leverage existing data. He also emphasized the need to consider long-term collection (i.e., longitudinal data) in respective agency and research efforts. There are pros and cons of different data collection efforts, including the timeframe in which data is collected and its sampling strategy. Lastly, he described that OMB provides constraints to government data collection. Having instruments that are already OMB approved is valuable and should be leveraged wherever possible.

Brenda Phillips - Co-Director, Center for Collaborative Adaptive Sensing of the Atmosphere (CASA), University of Massachusetts Amherst.

Brenda Phillips' presentation focused on a particular data collection effort that exemplifies unique ways to collect social data. She began by describing the CASA Alerts App, which is both a research tool (collecting physical, technical, and social scientific data in real-time) and a weather warning app for users. The app can provide customized alerts using their customer-specific data combined with the CASA radar network. Through this app, Philips explained that the CASA team co-creates information through their public-private partnership. In particular, she outlined how the CASA Alerts App enables research and data collection on user perceptions and response to weather information, which they can use to integrate back into the app's messaging system.

Using the CASA alerts app as an example, Philips posed multiple questions and prompted the audience to think differently when it comes to collecting social data. Specifically,

- How can the social science community combine social science data with other types of data, such as from the physical sciences, transportation data, etc.?
- How do we observe people along the receipt-perception-behavior-response-outcome continuum, and at what level of granularity?
- What new and novel data can be collected?
- What new technologies and software exist to facilitate data collection?

Dr. Lori Peek - Director of the Natural Hazards Center and Professor in the Department of Sociology, University of Colorado Boulder

Dr. Lori Peek's presentation focused on opportunities for identifying and coordinating social science researchers and interdisciplinary research teams before, during, and after disasters (i.e., Social Science Extreme Events Research, or SSEER), as well as ways to enable data sharing and publishing, which include the use of **digital object identifiers (DOIs)** and repositories. She also discussed specific challenges and concerns with sharing social science data related to privacy (e.g., having identifying information in the data), data management plans (which are required for most grants), and IRB policies.

Dr. Peek reminded everyone of a prior remark made at the workshop that, "there is no central SBS database," and reported the National Science Foundation (NSF) funded a collaborative project to address this issue. Housed at the University of Texas, DesignSafe-CI (cyberinfrastructure) is an online resource for managing, archiving, and publishing hazards and disaster data. She strongly encouraged everyone to publish social science research data and its associated instruments to DesignSafe-CI: "If you don't have a sense of the landscape, it's hard to change the landscape." In other words, without access to data and the associated instrument, the community cannot advance our collective knowledge as quickly as desired. Rather than replicating work that helps strengthen our collective knowledge and understanding, the community is duplicating efforts due to limited access to data and instruments. For this reason, Dr. Peek emphasized the importance and value of publishing data and its associated instrument(s).

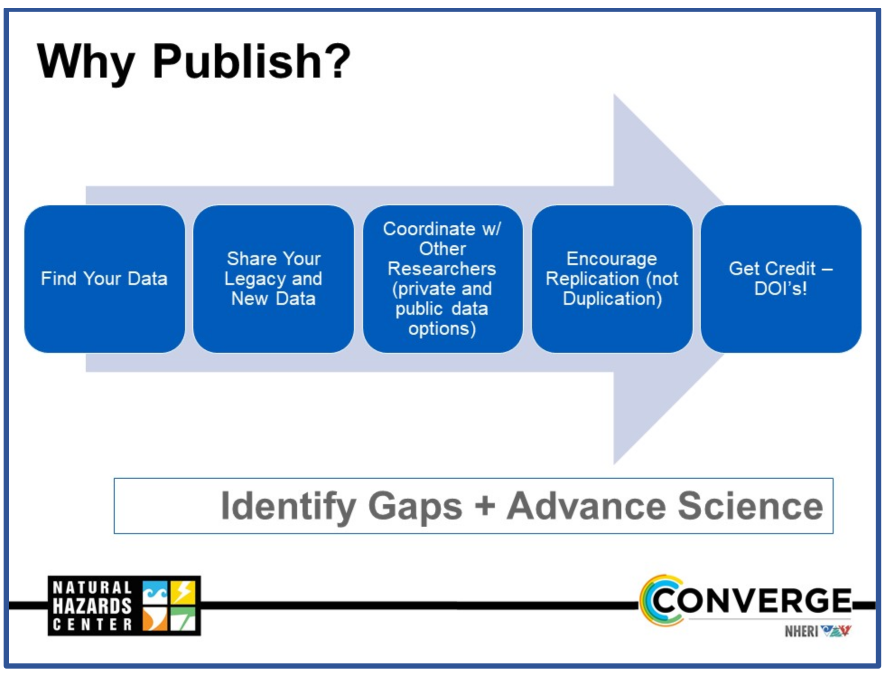


Figure 7: Slide from Dr. Peek's presentation about why we should publish data

4.4.1 Summary

Dr. Eosco summarized the session as follows:

- Scotten and Dr. Brown provided insights on NWS capacity to collect and house data related to performance metrics. Currently, there are no formal NWS societal impact performance metrics. However, they are evaluating their development.
- Dr. Nadeau illustrated a case study on societal impact performance metrics that emphasized the value of leveraging existing data and investing in longitudinal datasets.

- → Philips walked us through how new technologies can collect and monitor social science data, especially combined with atmospheric data, such as radar.
- → Dr. Peek articulated the need for publishing datasets and their associated methodological instruments in a way that allows for replicating findings, sharing research knowledge, and creating a database for broader use.

The panelists provided many opportunities and tangible suggestions to formalize social science data archival. Taken together, the possibility of data and instrument archival and interest in creating NWS societal impact performance metrics suggests the social science community is moving toward integrating social science into NOAA's organizational infrastructure.

4.5 Breakout 2 - Measuring Mission: Exploring the Need for Collecting, Managing, and Archiving Social and Behavioral Science Data

4.5.1 Breakout Group Process

For the second breakout session, participants self-selected into groups based on their interest in either data collection, data management, or data archival. The objective was to broadly identify what data is needed, if there is pre-existing data, and what incremental steps can be taken to collect, manage, and archive it (see Appendix Seven for detailed breakout group questions and directions).

Notes from the groups for each topic were combined to determine predominant and relevant themes related to data collection, management, and archival.

4.5.2 Outcomes

Data Collection Breakout Group

Participants exploring data collection issues were asked to discuss what data are needed to measure the NWS mission (Figure 8), how these concepts could be measured, and how NOAA could leverage existing data to help aid in this endeavor.

OAR Mission	**NWS Mission**
Conduct research to understand and predict the Earth system, develop technology to improve NOAA science, service, and stewardship, and transition the results so they are useful to society	Provide weather, water, and climate data, forecasts and warnings for the protection of life and property and enhancement of the national economy

Figure 8: The NWS and OAR Mission Statements

The groups suggested that it is imperative to:

- Understand, and therefore measure, what people do with weather information.
- Collect data about appropriate and/or inappropriate responses by the communication recipient.
- Understand how NOAA affects outcomes beyond mortality, including quality of life, loss of income, economic impact, patterns of change, and health impacts.
- Determine not just *what* to measure, but determine *at what point in time* (i.e., before, during, or after an event) we should measure a construct.

Baseline and Longitudinal Data

Participants expressed that NOAA needs to measure constructs over time (i.e., longitudinally). Regardless of what is being measured, longitudinal data collection is connected to questions of value, improvements, and change. These questions require baseline data collected across different communities. Therefore, to determine value, if things "work," or if improvements are made (which collectively are key to NWS and OAR missions), baseline *and* longitudinal data needs to be collected from a variety of people, communities, and users.

Leverage Existing Data

In addition, the groups discussed ways to leverage existing NWS data (e.g., NWS Customer Satisfaction Survey, NWS Quick Response Survey, and NWS Chat). One data source discussed by multiple groups was NWS Service Assessment reports. Some participants wondered if having publicly accessible service assessment data—such as survey results or interview transcripts—could lead to NWS partnerships with academia and the private sector. Other suggestions included overlaying NWS social media data with radar data. As Philips noted in her presentation, this blend of physical and social data provides a unique perspective.

Create incentives to further explore existing datasets

Participants noted the agency must look beyond internal data to leverage data collected by others, either through OAR-funded research grants, interagency collaborations, or academic partnerships. Publically available archived data, such as the DesignSafe-CI database (as discussed by Dr. Peek), is another avenue to find pre-existing data.

While there is value in collecting new data, some participants noted that there is more to learn from existing external data sets. Accordingly, some suggested providing funding incentives to explore pre-existing data sets. Researchers expressed that they (or others) have large amounts of quality data, but "tons of research questions die in data sets." In other words, while researchers intend to go back to re-analyze a dataset, there is often little incentive to do so. Researchers either do not have enough funded time on grants to analyze all the data has to offer, or they are already engaged in their next research endeavor. They also noted NSF, for example, requires novel and innovative questions, which does not prioritize re-analyzing existing data. Since datasets are often expensive to collect, participants suggested funding agencies provide incentives to re-analyze existing data. One participant noted the cost-saving benefits of analyzing pre-existing data by stating, "you'd be able to get so much….without the cost associated with collection."

Data collection as an intellectual act

In discussing these topics, researchers noted the amount of energy required to collect data. As one participant noted, "I think that the intellectual energy that goes into creating a data set is more significant than people give credit." Often, a great deal of theory, thought, and iteration must be dedicated to the creation of an instrument. As such, participants encouraged each other to use DOIs in order to get academic credit on the data set, either through DesignSafe-CI or other mechanisms. Not only does using a DOI give the author credit, it also gives others a way to use the data and associated instrument. DOIs for instruments and data could further provide a measure of research value by tracking who uses or cites the data.

Data Management Breakout Group

Once data is collected, participants raised several questions and voiced concerns related to ownership and publicly sharing data.

Data Ownership and Currency

While researchers acknowledge publicly funded data collection is required to become publicly accessible through the Public Access to Research Results (PARR) memorandum, researchers felt they lose the right to publish their results first, and therefore lose their "currency." In other words, if their data are publicly accessible, some researchers feel they are giving away their ability to analyze and publish using the data first. To counter this, participants suggested a period of time where researchers are given proprietary rights to data sets they collect (i.e., a "data embargo"). This period would allow researchers to work with, analyze, and publish using the data set before the data becomes publicly accessible.

Data Archival Breakout Group

Participants indicated that having a central place to archive SBS data would be useful. However, there was confusion about whether NOAA has a central place to archive SBS data, and if so, if data would be in a useful format. For example, questions emerged surrounding whether the National Center for Environmental Information (NCEI) archives social science data and the requirements for submitting social science data to such an archive. If an internal SBS data archival capacity does not exist, many indicated that an internal or external database would be useful to establish. Participants pointed to the broader value of having an SBS database, as it allows the weather community to conduct exploratory analyses, replication studies, and meta-analyses that help innovate, create, and explore more creative directions in SBS research.

Some participants speculated as to why there is not a centralized system. For example, some wondered if there are legal constraints to sharing data? Or perhaps it is too difficult to meet data requirements? Or, ultimately, is there a lack of resources? Many noted the instrument used to collect data should also be published and archived, since understanding how data was collected influences potential analysis. In addition, being able to see an instrument shows how terms and variables were defined. For example, *risk perception* has many different definitions and can therefore be measured in different ways. Accordingly, being able to see an instrument can lead to a more consistent measurement of terms and concepts.

Some participants noted that encouraging archival of data will need an accompanying culture change. Here, those who have data will need to feel comfortable publishing their data and instruments, which entails a shift in thinking about the openness of data (see *Data Management* section above).

Since many did not know if a centralized SBS database exists, participants emphasized the value of prior relationships with the "data gatekeeper," explaining that data accessibility is more about relationships, partnerships, and who you know. Trusted relationships lead to knowledge about who has data and securing permission to use it. Without those relationships, one participant noted, "…who has the keys to the gate or knows about the hurdles that are needed to jump over?"

Workshop participants also discussed the idea of having accessible meta-data, which would allow more researchers to see who has different types of data.

Ethics

In addition, the ethical dimension of data publishing and archival were discussed. For qualitative research, ensuring data are properly de-identified prior to publication warrants special care and consideration. Privacy protocols, such as those stipulated by IRB and the OMB (pg. 30), may dictate or hinder sharing data collection practices and results.

5. Meeting Summary - Day 3

Day 3 began with a discussion panel on research generalizability and operational viability, or "*when do you know that you know enough?*" This panel was intended to combine research methods and data with operational needs, costs, and infrastructure to assess how and when we know enough to implement the research output and/or recommendations.

The panel was followed by a *Lessons Learned* discussion, which identified recommendations that will enhance the R2O process.

5.1 Session 3 - "When do you know that you know enough?" A Discussion Panel about Research Generalizability and Operational Viability

Dr. Julie Demuth - Research Scientist, Mesoscale and Microscale Meteorology Laboratory, National Center for Atmospheric Research

Dr. Julie Demuth provided context for her own experiences related to the question "*When do you know you know enough*"? Here, she gave examples of the types of methods and analyses she has conducted, including both quantitative (e.g., surveys, quasi-experiments) and qualitative (e.g., interviews, focus groups) approaches. She discussed that different social science approaches and methodologies provide different types of validity (Figure 9) and generalizability, which affects when a person or group feels they know enough to implement SBS knowledge. She discussed the importance of evaluating the validity and sampling of the research project, and also emphasized thinking critically if knowledge transfers to another person, context, or community. She concluded by quoting Michael Quinn Patton (2015): *"Methods do not ensure rigor. A research design does not ensure rigor. Analytical techniques and procedures do not ensure rigor. Rigor resides in, depends on, and is manifest in rigorous thinking—about everything."* She stressed that there is no singular way to determine if we know enough, but constant evaluation and strategic thinking can contribute to increased confidence in research findings.

Validity = approximate truth of an inference; credibility of findings

External validity: do the findings generalize?

- To other people? (Does a study of people affected by Irma generalize from people in Florida to people in Puerto Rico?)
- To other situations? (Does a study of residents affected by Florence—a hurricane that weakened and caused tremendous flooding—generalize to Michael—a TC that rapidly intensified to Cat 5?)
- To other events? (Does a study of how people perceive risks from tornadoes generalize to how they perceive risks from hurricanes? Or flash floods?)

Construct validity: do our measures generalize?

- Does my item that measures one's perceived likelihood of a tornado occurring represent risk perception?
    - For all risk targets (individual vs. community vs. other)?
    - For all risk contexts (a general/abstract tornado threat vs. specific/concrete threat)?

Figure 9: Excerpt from Dr. Demuth's presentation about different types of validity

Dr. Scott Miles - Director, Impact360 Alliance, University of Washington

Dr. Scott Miles' answer to "*When do we know enough?*" is that "we know enough right now, so let's get going." When policy makers or other scientists ask what to expect from any given circumstance, the answers are multidimensional, contextual, and subjective. This means it is often difficult to synthesize multiple methodologies and approaches. He introduced the user-experience design terms *viable*, *feasible*, and *desirable*, and suggested applying these terms when moving from a problem to a solution space. He suggests we ask if the research result and output are desirable, feasible, and viable at *all* stages of the research process. Therefore, R2O transitions can happen at any time, not just at the end.

Elliot Jacks - Chief, Forecast Services Division, National Weather Service

Elliot Jacks provided an operational perspective to the question of "*when do we know enough*"? He began by noting that Field Offices, the National Centers for Environmental Prediction (NCEP), and regional offices are the primary drivers of requirements—or an expression of a need for something. While requirements can constrain research, research can also inform requirements. Specifically, research input can be infused into the NWS requirements process through NWS Service Program teams. He noted that there are opportunities for researchers to enter into the requirements process by proposing requirements to their operational collaborator. Then he showed how the Hazard Simplification Project, an evaluation of the watch, warning, and advisory program, used social science methods to identify problems and user needs that inform operational recommendations pursued by NWS.

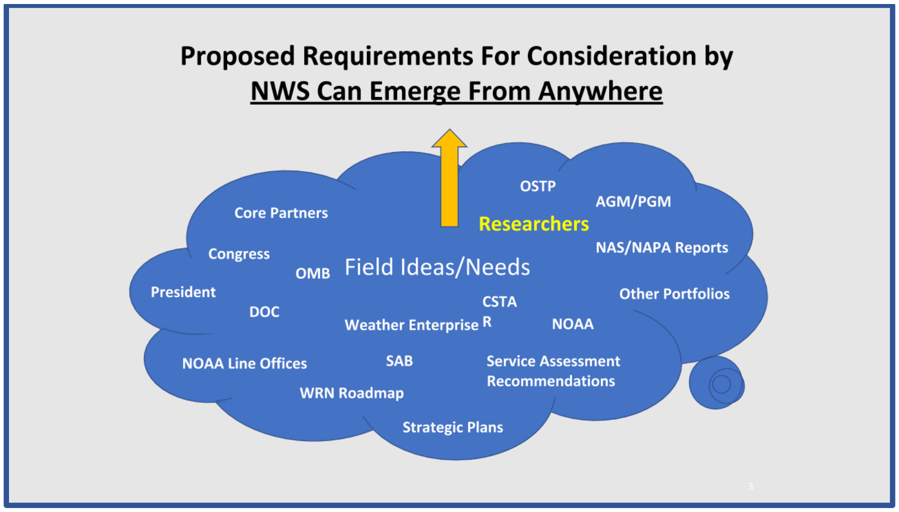


Figure 10: Factors informing the requirements process (from Jacks presentation)

Dr. Hendrik Tolman, Senior Advisor for Advanced Modeling Systems, Office of Science and Technology Integration, National Weather Service

Dr. Hendrik Tolman spoke about how NWS approaches the viability of a proposed operational change. He utilized the example of how NWS makes modeling decisions, which is primarily an internal process. However, the agency is moving toward a community-based Unified Forecast System. At the same time, IDSS (pg. 20) is also a top priority in NWS, which is changing how the agency addresses viability and transferability.

Dr. Tolman said the challenge is the agency applies the "modeling approach" of operational viability to IDSS. He said "a lot of our people in the organization, the physical scientists, they still think like scientists. We need to make sure that before we do it at all [make any changes], we need to teach them why we are doing things the way we are with SBS...we need to change the culture of the scientists."

He emphasized that the path for SBS transitions may look different than modeling transitions. He also recognized NWS does not know "when they know enough." Improvements are generally driven by what can be done from a physical science point of view. However, for the NWS mission it has become increasingly important now to look at the impact on the public and how NWS can prioritize physical science research. Dr. Tolman said ultimately SBS integration represents a culture change for NWS scientists, which is why this workshop is extremely valuable for advancing that effort.

5.2 Session 4 - Lessons Learned

The meeting concluded by soliciting a brief response from each participant articulating one action or recommendation they will pursue to integrate SBS with the physical sciences. Participants indicated their collective energies will carry forward the effective integration of SBS with physical sciences practices, processes, and operations across NWS and NOAA as a whole.

Recommendations included:

Continue community interactions by leveraging existing platforms:

There were repeated calls to leverage existing mechanisms that connect people (including forecasters), programs, and NOAA line offices to social scientists and vice versa. Suggestions included:

- An American Meteorological Society (AMS) town hall sponsored by the Weather-Ready Nation Symposium;
- A social science-focused Research Operations Nexus (RON) informal event at the AMS Annual Conference to exchange ideas;
- Informal meetups at SBS professional societies, such as the Society for Risk Analysis, emergency management, and hazards conferences.

While it is important for both sides to continue to talk and interact, one participant noted that we must also *listen* to one another and remain open to each other's perspectives.

Create new, creative mechanisms for interaction

While conferences and meetings are a reliable annual forum, questions emerged as to how we can engage more frequently. Dr. Eosco noted there is an open invitation for SBS researchers to present at NOAA in Silver Spring, MD. Advance notice helps organize webinars or other forums for exchanging ideas, interaction, and collaboration. In the past, these "meet and greets" at NOAA have influenced the direction of research projects and broadened their possible transition applications. Another workshop suggestion was to initiate a virtual discussion forum to stay connected.

Embed ourselves in each other's processes

Participants emphasized they need more opportunities to create things together. One participant noted we do not spend a lot of time either virtually or physically working together on outcomes. Another participant noted that when multiple people work on a problem individually, it can break down communication. They suggested working more closely and collaboratively across disciplines.

Participants also said it is important to put structures in place to identify important interdisciplinary spaces, places, and opportunities. Here, participants encouraged each other to embed themselves in each other's processes. For example, it was proposed that SBS researchers shadow forecasters *and* forecasters shadow SBS researchers. Observing each other's work and experiments, like in NOAA testbeds, creates an understanding of each other's respective processes and purpose.

Empower through training

One participant wondered if NOAA has the capacity to provide SBS-related training to forecasters to demonstrate how SBS benefits operational processes. Another participant replied that NWS has a training budget that could be utilized for this purpose. For example, the University Corporation for Atmospheric Research (UCAR) COMET modules are commonly used for training in NWS and could be a mechanism to integrate social science training. Participants also noted some SBS training already exists within the agency, but needs further marketing.

Highlight and market social science "successes"

Participants also suggested NOAA ought to highlight how social science altered an outcome or product in the agency. Increasing awareness of the impact of SBS helps others see potential applications. Suggestions included presenting through NOAA webinar channels and/or collecting stories and archiving them on NWS Virtual Laboratory and in the NOAA Research and Development Database.

Integrate SBS into Funding Calls

Several participants suggested NOAA grants should include SBS scientific priorities, when appropriate. While prior NOAA funding calls (e.g., WPO's JTTI and Testbed programs) included SBS scientific priorities, NOAA funding call should incorporate clear SBS language that makes it apparent to SBS researchers that a particular funding call is applicable to their work. Clear funding calls help communicate NOAA's commitment to integrating social science. Participants said this action would allow SBS researchers to see their connection to NOAA and allows social scientists to take part in the process.

Build NOAA's internal social science capacity

Several participants articulated a need to create SBS federal positions throughout NOAA. However, having a small number of social scientists could lead to feelings of isolation, which indicates a need for leadership and strategy to ensure a productive environment for SBS hires. Participants also discussed integrating SBS into NOAA strategic plans, performance metrics, and reports.

6. Conclusion and Next Steps

This workshop focused on starting the conversation and initiating achievable, tangible next steps surrounding organizational infrastructure needs. These needs include collecting and archiving social science data, identifying terms requiring definitions, and understanding ways to nurture a strong SBS R2O community. Understanding transitions and necessary training for *all* individuals involved across the dynamic spectrum of R2O and O2R is critical for fostering better communication, mutual understanding, and trusted relationships. As Dr. Tolman described, SBS integration represents a culture change for NWS scientists, which is why this workshop was extremely important in maximizing the value of SBS research and its applications within the weather community.

The workshop highlighted many nuances to SBS R2O, including redefining the phrase *R2O* itself. This workshop highlighted that the traditional definition of *operations* indicates anything that supports the NWS 24/7 warning environment. To make a forecast, operational meteorologists need observations, models, and software tools. While social science research findings may apply to the 24/7 warning environment, the implications and benefits of SBS research can reach far beyond this context.

Redefining R2O requires highlighting the importance of transferring *knowledge*—or as some described, transferring science. The workshop discussion illustrated potential knowledge transfer applications, such as informing user requirements, identifying forecaster training needs, and measuring IDSS outcomes. Transferring knowledge can also inform policy changes as NOAA considers prioritizing or eliminating products or services. As emphasized by workshop panelists, understanding you have enough knowledge requires careful thought, consideration, and iteration between research and operational communities.

Workshop participants and readers of this report have an opportunity to transition knowledge by learning from and implementing the findings in this workshop report. Overall, improving SBS R2O, and R2O more broadly, depends on the transfer of knowledge. Workshop participants from all disciplines and organizations described a disconnect between how NOAA describes the R2O process and how researchers feel during the transition process. Workshop discussions illustrated that the R2O process could be improved by emphasizing the *agile* and *evolving* nature of the transition plan policies and practice. While participants described the current transition process as complex, rigorous, and jarring, the hope is that in the not-too-distant future participants will describe the process as straightforward, productive, and meaningful. This will only happen if we transfer knowledge and take actions to build on it.

There are many tangible actions in this report, but a critical next step is to develop the necessary components of a robust SBS organizational infrastructure. Currently, NOAA's organizational structure primarily supports physical science data collection, management, and archival. As such, current mechanisms that measure research project success and performance metrics are not possible for social science research. This finding illuminates an opportunity to build the infrastructure needed for social science data collection, management, and archival. This process includes prioritizing the collection of baseline and longitudinal data, encouraging SBS data archival, and creating meta-data.

When we collectively address the major takeaways outlined in this report, measuring the success of individual projects, as well as larger scale change and economic valuation, will become possible. Although these efforts will take time to build, the enthusiasm from workshop participants indicated the SBS R2O community has the interest, fortitude, and passion to make these efforts happen. One participant remarked that past efforts required "screaming to headquarters" to garner attention for social science. What is required now, the participant said, "are whispers throughout the organization"—a sign that social science is an integral part of our collective mission to save lives and protect property.

The efforts outlined in this report provide the knowledge necessary to improve R2O processes in the short term, while incorporating social science into NOAA's organizational infrastructure as our long term goal.

Acknowledgements

Thank you to our volunteer note-takers: Castle Williams (University of Georgia), Dr. Denna Geppi (Consultant), Jinan Allen (University of Oklahoma), Makenzie Krocak (University of Oklahoma), John Opatz (WPO), Matt Mahalik (WPO), Jordan Dale (WPO), and Dr. Segayle Thompson (WPO).

Thank you to our report reviewers: Dr. Julie Demuth (NCAR), Dr. Hendrik Tolman (NWS), Dr. Chris Lauer (NOAA), Castle Williams (University of Georgia), Jennifer Sprague-Hilderbrand (NWS), Alison Agather (WPO), Chantel Bivins (WPO), Dr. Hernan Garcia (WPO), and Dr. Kandis Boyd (WPO).

Thank you to our communications, registration, logistics, and report writing support: Chantel Bivins (WPO), Christina Bargas (CPAESS), and Eileen McIlvain (CPAESS).

Thank you to our special meeting planners and contributors: Tamara Battle (WPO), Ayesha Wilkinson (Howard University), and Castle Williams (University of Georgia).

Thank you to our lead workshop organizers who executed the analysis of the workshop materials and drafted this workshop report: Michele (Micki) Olson and Dr. Gina Eosco.

Finally, a big thank you to those who engaged in conversations with us and helped shape our topics and discussion. You helped create a workshop that we believe will nurture the SBS R2O process.

Remembering Dr. William “Bill” Lapenta

Dr. William “Bill” Lapenta’s participation and presentation during the workshop, and his work in general, illustrated his dedication, vision, and enthusiasm for tackling challenges related to R2O. He emphasized the importance of building relationships and remembering “*people, products, and policy”* when discussing transitions. The Social Science Program is deeply saddened by his unexpected passing and will continue to work towards the vision outlined in this report in his memory.

Starting in July 2019, Lapenta was the Acting Director of NOAA’s Weather Program Office (WPO; formerly the Office of Weather and Air Quality), where he oversaw NOAA’s world-class weather and air quality research and helped accelerate its transition to NOAA’s National Weather Service (NWS) to benefit the American public. Prior to joining WPO, Lapenta was the Director of the NWS National Centers for Environmental Prediction (NCEP), delivering national and global weather, water, climate, and space weather guidance, forecasts, warnings, and analyses to help save lives and protect property. Lapenta received his Ph.D. in meteorology from Pennsylvania State University in 1990, and a Bachelor of Science Degree in meteorology with a minor in mathematics from the State University of New York at Oneonta in 1983. A native of Nyack, New York, Bill resided in Northern Virginia. He and his wife, Cathy (also a meteorologist) have two adult children.

NWS internships and AMS scholarships are offered in honor of Bill. Please visit his Memorial Page for updates.

Image 3: Dr. Lapenta presenting “What Guides NOAA Weather Funding” - Day One of Workshop (Sept. 4th, 2019); Photo Courtesy of Paul Chakalian

Appendix

Appendix One: List of Registered Participants

Return to text

Last name:	First name:	Organization/Affiliation:
Abshire	Kate	NOAA/NWS
Adams	Terri	Howard University
Allan	Jinan	University of Oklahoma
Atwell Seate	Anita	University of Maryland
Ba	Mamoudou	NOAA/NWS/STI/MDL
Badder	Andrea	NOAA/OAR
Bargas	Christina	UCAR/CPAESS
Battle	Tamara	NOAA/OAR/WPO
Berg	Robbie	NOAA/NWS/NHC
Berry	Kodi	NOAA/OAR/NSSL
Boyd	Kandis	NOAA/OAR/WPO
Brinson	Ayeisha	NOAA
Brooke	Liu	University of Maryland
Brown	Vankita	NOAA/NWS
Carman	Jessie	NOAA/OAR/WPO
Chakalian	Paul	NOAA/OAR/CIMMS/NSSL
Chantel	Bivins	NOAA/OAR/WPO
Conran	Joseph	NOAA/NESDIS/TPIO
Dale	Jordan	NOAA/OAR/WPO
David	Myrick	NOAA/NWS/OSTI
Devin	Gill	Cooperative Institute for Great Lakes Research
Digiantonio	Gina	NOAA/OAR
Edwards	Katie	NOAA/NWS/AFS
Eosco	Gina	NOAA/OAR/WPO
Friedman	Jack	University of Oklahoma
Garcia	Hernan	NOAA/NCEI
Geppi	Denna	Consultant

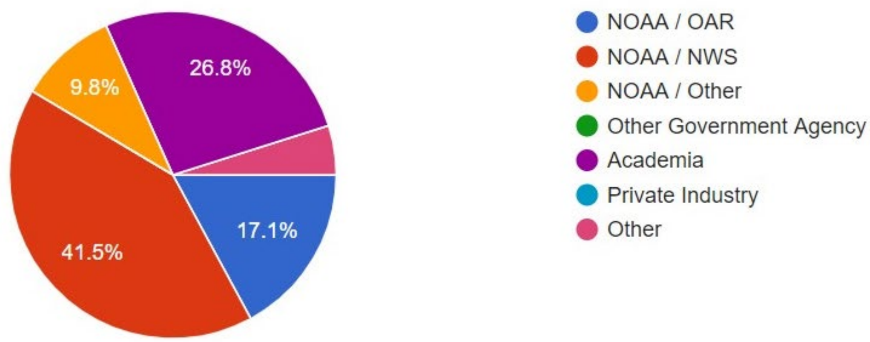
Gerard	Alan	NOAA/OAR/NSSL
Ghirardelli	Judy	NOAA/NWS/MDL
Gilbert	Kathryn	NOAA/NWS/NCEP
Goldberg	Mitch	NESDIS/JPPS
Gonzalez	Tatiana	NOAA/NWS
Grasso	Monica	NOAA
Grundstein	Andrew	University of Georgia
Heinselman	Pam	NOAA/OAR/NSSL
Henderson	Jennifer	Cooperative Institute for Research in Environmental Sciences (CIRES)
Hilderbrand	Douglas	NWS Weather-Ready Nation
Hoffman	Philip	NOAA/OAR
Jacks	Eli	NOAA/NWS/AFS
Jones	Hollis	NOAA/OAR/Sea Grant
Julie	Demuth	NCAR/MMM
Karstens	Chris	NOAA/NWS/SPC
Khanbilvardi	Reza	NOAA Center for Earth System Sciences and Remote Sensing Technologies
Krocak	Makenzie	University of Oklahoma
Kurkowski	Nicole	NOAA/NWS/OSTI
Lapenta	Bill	NOAA/OAR/WPO
Lauer	Chris	NOAA/PRSSO
Lee	Larissa	NOAA
Leticia	Williams	NOAA Center for Atmospheric Sciences and Meteorology (NCAS-M)
Lim	Jungkyu Rhys	University of Maryland
Mackell	Stacy	NOAA/NWS/STI
Marks	Frank	NOAA/AOML/Hurricane Research Division
Matthew	Mahalik	NOAA/OAR/WPO
McIlvain	Eileen	UCAR/CPAESS

Merchant	Shakila	NOAA Center for Earth System Sciences and Remote Sensing Technologies
Merdjanoff	Alexis	New York University
Miles	Scott	Impact360 Alliance
Morris	Sherrie	NOAA/NWS/STI-M
Mozumder	Pallab	Florida International University
Nadeau	Lou	Eastern Research Group
Nietfeld	Daniel	NOAA/OAR/ESRL/GSD
O'Connor	Robert	National Science Foundation
Olson	Michele	NOAA/OAR/WPO
Paltz	Emily	University at Albany, SUNY
Peek	Lori	University of Colorado Boulder
Philips	Brenda	University of Massachusetts Amherst
Pryor	William	NOAA/NWS/OSTI
Rakesh	Bhavana	NOAA/NWS/OSTI
Ray	Andrea	NOAA/OAR/ESRL/PSD
Ripberger	Joe	University of Oklahoma Center for Risk and Crisis Management
Rodden	Ann	Independent
Rudack	David	NWS/OSTI/MDL/SMB
Sanders	Shayda	Howard University
Schattel	John	NOAA/NWS/OSTI/MDL
Schneider	Russell	NOAA/NWS
Scotten	Michael	NOAA/NWS
Segayle	Thompson	NOAA/OAR/WPO
Sharan	Majumdar	University of Miami
Shivers-Williams	Cassandra	NOAA/OAR/CIMMS/NSSL
Sindic-Rancic	Gordana	NWS/OSTI/MDL
Sizer	Tania	UCAR/CPAESS
Smith	Stephan	NWS/OSTI/MDL
Snowden	Derrick	NOAA/NOS/Integrated Ocean Observing System
Sprague-Hilderbrand	Jennifer	NOAA/NWS
Susan	Joslyn	University of Washington

Sutton	Jeannette	University of Kentucky
Ten Hoeve	John	NOAA/NWS/OOE
Thomas	Wendy Marie	NOAA/NWS/AFS
Tolman	Hendrik	NOAA/NWS/OSTI
Trainor	Joe	University of Delaware, Biden School, Disaster Research Center
Upadhayay	Sikchya	NOAA/NWS/OSTI
Vincent	Mark	NOAA/OAR/WPO
Vitols	Lisa	Environment and Climate Change Canada
Walker	A. Camden	Weather & Capital Weather Gang
Were	Valerie	NOAA Center for Earth System Sciences and Remote Sensing Technologies
Wilkinson	Ayesha	NOAA Center for Atmospheric Sciences and Meteorology (NCAS-M)
Williams	Castle	University of Georgia
Xin	Lingyan	NOAA/NWS/MDL/DSB
Xue	Yan	NOAA/NWS/OSTI

Appendix Two: Affiliation of Participants

Return to text



Appendix Three: Workshop Agenda

Return to Introduction, Section 3

Workshop goal: To nurture an understanding of the unique roles, goals, and capacities of people and organizations comprising the SBS and weather communities by building shared languages, terminologies, theories, concepts and methodologies to enhance the research to operations process.

Day 1 ☁ September 4, 2019 ☁ NOAA Auditorium

2:00 pm **Welcome and Opening Remarks**
Dr. Gina Eosco, *Social Science Program Manager, Weather Program Office*

2:05 pm - Fireside Chat 🔥: A Historical Overview and Round Table Discussion on NOAA R2O Policies
Dr. Gary Matlock, *Deputy Assistant Administrator for Science, Oceanic and Atmospheric Research*
Mary Erickson, *Deputy Director, National Weather Service*

3:00 pm - What Guides NOAA Weather Funding: Policy, Priorities, and Process
Dr. Hendrik Tolman, *Senior Advisor for Advanced Modeling Systems, National Weather Service, Office of Science and Technology Integration*
Dr. Bill Lapenta, *Acting Director, Weather Program Office*
Dr. Gina Eosco and Jennifer Sprague-Hilderbrand, Social Science Program Managers, *Weather Program Office and National Weather Service, respectively.*

3:45 pm - Panel Perspectives on the Meaning of R2O Transitions
Dr. Julie Demuth, *National Center for Atmospheric Research*
Castle Williams, *University of Georgia*
Robbie Berg, *National Weather Service National Hurricane Center*
Dr. Dave Myrick, *National Weather Service Office of Science and Technology Integration*
Dr. Pam Heinselman, *National Severe Storms Laboratory*

5:00 pm **Kickoff Concludes**

Day 2 ☁ September 5, 2019 ☁ Silver Spring Civic Building's Great Hall

8:00 am **Registration Opens**

8:30 am **Welcome & Day 1 Recap**
Dr. Gina Eosco and Micki Olson, *Weather Program Office Social Science Team*

9:00 am **Session 1: Measuring Mission: Constructs, Metrics, and Policy, Oh My! Lightning Talks on Key Concepts**
Goal: Introducing people, organizations, terminology, and methods to enhance the research to operations process.

Katie LaBelle Edwards, *National Weather Service, Analyze, Forecast, and Support Office*
Dr. Joe Trainor, *University of Delaware*
Dr. Joe Ripberger, *University of Oklahoma*
Dr. Hendrik Tolman, *National Weather Service, Office of Science and Technology Integration*
Dr. John Ten Hoeve, *National Weather Service, Office of Organizational Excellence*

10:00 am **Break & Networking**

10:15 am **Breakout #1**

11:15 am **Report out**

12:15 pm **Lunch** (check the guide for local restaurants)

1:30 pm **Reconvene and Introduction to Session 2**

1:40 pm **Session 2: Measuring Mission: Exploring the Need for Collecting, Managing, and Archiving Social and Behavioral Science Data**
Goal: Introducing ways to collect, manage, and archive social and behavioral science data to allow people and organizations to measure the societal impact of our research to operations progress.

Dr. Vankita Brown & Michael Scotten, *National Weather Service*
Dr. Lou Nadeau, *Eastern Research Group*
Dr. Brenda Philips, *University of Massachusetts Amherst*
Dr. Lori Peek, *Natural Hazards Center*

2:30 pm **Break & Networking**

2:45 pm **Breakout Session #2**

3:45 pm **Report out**

4:45 pm **Wrap up**

5:00 pm **Networking Happy Hour at All Set Restaurant & Bar**

Day 3 ☁ September 6, 2019 ☁ Silver Spring Civic Building's Great Hall

8:30 am **Welcome & Day 2 Recap**

9:00 am **"When do you know that you know enough?" A Discussion Panel about Research Generalizability and Operational Viability**
Goal: Building skills to combine research methods and data with operational needs, costs, and infrastructure to assess how and when we know enough to implement.

Dr. Scott Miles, *Impact360 Alliance*
Dr. Julie Demuth, *National Center for Atmospheric Research*
Eli Jacks, *National Weather Service, Analyze, Forecast, and Support Office*
Dr. Hendrik Tolman, *National Weather Service, Office of Science and Technology Integration*

10:00 am **Break**

10:15 am **Lessons Learned**
Goal: To identify recommendations for roles or goals for people and organizations to continue to build shared languages, terminologies, theories, concepts and methodologies to enhance the research to operations process.

12:15 pm **Closing Remarks and Evaluation**

12:30 pm **Workshop concludes**

Appendix Four: Speaker Bios

Return to text

Wednesday, September 4, 2019

Dr. Gary Matlock is the Deputy Assistant Administrator for Science for Oceanic and Atmospheric Research (OAR). He is responsible for guiding and evaluating NOAA's research and development portfolio. Throughout his career, Gary has successfully led an effort to base fisheries management decisions on scientific information. He has and continues to publish in the national and international scientific literature on the biological, ecological, social, and economic aspects of fisheries science and management.

Mary C. Erickson is the Deputy Director of the National Weather Service (NWS). Her primary responsibilities include leading the agency's major change initiatives, ensuring accurate and timely service delivery to key stakeholders, supporting management-labor relations, and building important relationships with America's Weather Industry. Previously, as the Director of the National Centers for Coastal Ocean Science, Mary ensured the timely and effective transition of ecosystem science solutions from research and development to operations and applications.

Dr. William "Bill" Lapenta is the Acting Director of the Weather Program Office (WPO; formerly the Office of Weather and Air Quality), a dynamic program within NOAA's Oceanic and Atmospheric Research that supports world-class weather and air quality research, accelerating its transition to the National Weather Service (NWS) to benefit the American public. Bill comes to NOAA Research from NWS, where he served as the Director of the National Centers for Environmental Prediction (NCEP), delivering national and global weather, water, climate and space weather guidance, forecasts, warnings and analyses to help save lives and protect property.

Dr. Hendrik L. Tolman is the Senior Advisor for Advanced Modeling Systems for the National Weather Service (NWS) in the Office of Science and Technology Integration (STI), leading the development and implementation of NWS scientific strategies and capabilities for advanced modeling systems. He also provides guidance and advice on the scientific basis for operational weather, water and climate models, products and services in NWS and NOAA, and reviews all phases of scientific work in the NWS, leading to improved operational models. Prior to this position, Hendrik served as Director of the Environmental Modeling Center (EMC), one of nine centers that make up NOAA's National Centers for Environmental Prediction (NCEP).

Jennifer Sprague-Hilderbrand currently works at National Weather Service (NWS) Headquarters as the Social Science Portfolio Manager. In her role, Jen oversees social, behavioral and economic (SBE) science projects across the agency as well as coordinates SBE efforts across NOAA and with external partners. Prior to this role, Jen served as the Senior Advisor to the National Weather Service Director and Acting Chief of Staff for the National Ocean Service. Jen also served as Policy Advisor in the Strategic Planning and Policy Office at NWS, working closely on public private partnership issues, including the NOAA Science Advisory Board's Environmental Information Services Working Group and Weather-Ready Nation activities. Jen began her career at NOAA in 2005 serving as Policy Advisor for the NOAA Administrator. Jen is actively involved with the AMS, serving as co-chair of the WRN Symposium, leading of the WRN Scouting Event held every year at the Annual Conference, and serves on several committees; Forecast Improvement Group and the Committee on Effective Communication of Weather and Water.

Castle Williams is currently a Ph.D. Candidate in the Department of Geography at the University of Georgia. His research interests lie at the intersection of risk communication, societal impacts, and meteorology, and is currently examining how meteorologists communicate weather information and hazards to members of the public. Castle's dissertation examines the importance of consistent messaging and/or visual design when communicating weather-related risk, uncertainty, and probabilistic information to members of the public. Castle holds an M.S. degree in Geography, and B.S. degrees in Atmospheric Sciences, Geography, and Psychology from the University of Georgia.

Dr. Julie Demuth is a Research Scientist at the National Center for Atmospheric Research (NCAR) in the Mesoscale and Microscale Meteorology (MMM) Lab with the Weather Risks and Decisions in Society (WRaDS) research group. She has been working for nearly 15 years on integrating social science research with the meteorological research and practitioner communities. With a hybrid background in atmospheric science and communication, Julie conducts research on hazardous weather risk communication, risk perceptions, and responses; working with both experts (i.e., weather forecasters) and members of the public. Her work centers on understanding how forecast information, in conjunction with other factors, influence what people think and feel, and how they respond.

Dr. David Myrick is the National Science and Operations Officer (SOO) and the Office of Science and Technology Integration (STI) Field Driven Research to Operations (R2O) Team Lead. The team is responsible for coordination and management of NWS field-driven innovation and research to operations transition programs. Prior to this appointment, he served as a Lead Physical Scientist and Verification Team Lead at the Meteorological Development Laboratory. David holds a B.S. degree in Atmospheric Science from Cornell University, and M.S. and Ph.D. degrees in Meteorology from the University of Utah.

Dr. Pam Heinselman is Chief of the Forecast Research and Development Division, and Manager of the Warn-on-Forecast (WoF) Program at the National Severe Storms Laboratory (NSSL). She also serves as an affiliate Associate Professor at the University of Oklahoma School of Meteorology. Her work involves supervising a diverse, multi-generational and multi-disciplinary division of scientific and technical personnel that accomplish research focused on data assimilation, convection-allowing and convection–resolving ensemble modeling systems, and the post-processing, visualization, verification, and evaluation of probabilistic forecast guidance. Pam manages the Division's and WoF Program's strategic plans, milestones, and budgets. Her responsibilities include building relationships and partnerships with internal and external collaborators, universities, NOAA line offices, and other government agencies in order to achieve NSSL's short-to-long-term research goals and vision.

Thursday, September 5, 2019

Katie LaBelle Edwards is a Meteorologist at the National Weather Service (NWS) Headquarters in Silver Spring, MD, and is currently serving as the Impact-Based Decision Support Services (IDSS) Program Manager. She is responsible for managing national IDSS policy, training development, and the national Deployment-Ready Program, and also works occasional weather shifts for the NWS National Operations Center. Prior to her current position, Katie served as the Executive Officer in the NWS Communications Office, where she led communications efforts for large scale projects such as the NWS Headquarters Reorganization and the Operations and Workforce Analysis (OWA) project, later assumed leadership of the OWA project to its completion in 2016.

Dr. Joe Trainor is an Associate Professor in the School of Public Policy and Administration at the University of Delaware, and a Core Faculty Member of the Disaster Research Center, where he conducts research, provides consultation, teaches, and mentors students. Currently, Joe conducts multi-disciplinary, mixed methods, qualitative, and quantitative research focused on various dimensions of disasters and crises through "basic" science, applied research, and rapid reconnaissance post-disaster fieldwork studies. His recent projects include warnings, risk perception, and protective action decision making for short-fuse hazards, post-hurricane housing decisions; household insurance and mitigation decision; and multi-organizational response.

Dr. Joe Ripberger is an Assistant Professor of Political Science, and the Deputy Director for Research at the Center for Risk and Crisis Management at the University of Oklahoma. Prior to his appointment in the Department of Political Science, Joe was a Postdoctoral Research Associate and Research Scientist at the Cooperative Institute for Mesoscale Meteorological Studies (CIMMS), where he worked with the National Severe Storms Laboratory (NSSL) and National Weather Service on severe weather policy. He holds a Ph.D. in Political Science from the University of Oklahoma, and is currently working on risk and public policy with an emphasis on weather, climate, and water policy.

Dr. John Ten Hoeve is the Deputy Director of the Office of Organizational Excellence at NOAA's National Weather Service (NWS), which leads the development of NWS strategies, manages partnerships with the Weather, Water, and Climate Enterprise, and enables NWS to become a more agile and effective organization by improving organizational processes and culture. John holds a B.S. degree in Meteorology from Penn State and M.S. and Ph.D degrees from Stanford University in Civil and Environmental Engineering, and has authored over a dozen peer-reviewed publications on topics ranging from aerosol-cloud-climate interactions to renewable and nuclear energy.

Dr. Lori Peek is the Director of the Natural Hazards Center, and Professor in the Department of Sociology at the University of Colorado Boulder. Lori has conducted field investigations in the aftermath of the 9/11 terrorist attacks, Hurricane Katrina, the BP Oil Spill, the Christchurch earthquakes, the Joplin tornado, Superstorm Sandy, and Hurricane Matthew. She is currently leading a National Science Foundation (NSF)-funded project to establish two initiatives for the hazards and disaster research community: the Social Science Extreme Events Reconnaissance (SSEER) and Interdisciplinary Science and Engineering Extreme Events Reconnaissance (ISEEER) platform and network. Lori is also co-leading an NSF effort on interdisciplinary disaster research methods, and is a member of the social science team for the National Institute of Standards and Technology Center of Excellence for Risk Based Community Resilience Planning.

Dr. Lou Nadeau is the Vice President of the Eastern Research Group (ERG), and is an expert in Econometrics, Statistical Analysis, Survey Design, and Process Analysis. Since joining the organization in 1996, Lou worked to develop and currently manages ERG's program evaluation and performance measurement practice, focusing on evaluating the impacts of federal programs (including developing performance metrics) and valuing ecosystem services. Multiple government agencies including NOAA, the Food and Drug Administration (FDA), and U.S. Environmental Protection Agency (EPA) have utilized his services to identify program impact areas, improve program effectiveness, and provide a data-based foundation for enhanced management decision-making.

Brenda Philips is currently co-Director of the Center for Collaborative Adaptive Sensing of the Atmosphere (CASA), at the University of Massachusetts Amherst. Her research focuses on high spatio-temporal resolution severe weather warning systems as a socio-technical process, and is motivated by her interest in bridging the human and environmental dimensions of warning systems. Brenda's work also focuses on developing platforms such as the CASA Dallas Fort Worth Living Lab, a socio-technical warning system where research can be developed, evaluated, and transitioned into practice in live environments. Other topics that her work covers include public response to "everyday" severe weather, urban flash flood warning, practitioner researcher collaborations, and personalized warnings. Brenda holds a Master's in Public and Private Management from Yale University, and is pursuing a doctoral degree in Economics at the University of Massachusetts.

Dr. Vankita Brown is a Research Social Scientist at the National Weather Service (NWS) in the Operations Division of the Chief Operating Officer. She leads the societal impacts component on National Service Assessment Teams, evaluating the decision-making and behavior of partners and stakeholders after significant weather events. Vankita provides social science consult in the development and enhancement of products and services, and facilitates social science training for NWS staff. She also currently leads the Measuring Impacts Decision Support Services (IDSS) Impacts Team that is responsible for developing internal and external performance measures for IDSS. Vankita holds a Ph.D. in Mass Communication from Howard University, and is a Fellow at the University of Alabama's Center for Advanced Public Safety (CAPS).

Michael Scotten is currently the Performance and Evaluation Branch Chief of the National Weather Service (NWS), which includes overseeing Government Performance and Results Act (GPRA) metrics, verification data, service assessments, customer satisfaction, and the StormData program. Throughout his 20-year career in NWS, Michael has successfully delivered Impact-Based Decision Support Services during numerous weather events, including the May 20, 2013 EF5 Moore/Oklahoma City tornado and Hurricane Katrina. Additionally, he has been instrumental in collaborating on several projects and hazardous weather testbeds to successfully transfer research into operations. Michael holds a B.S. degree in Meteorology from Penn State University, and B.S. degree in Computer Science from American Sentinel University.

Friday, September 6, 2019

Dr. Scott Miles is a Research Scientist in the Department of Human Centered Design and Engineering at the University of Washington, and an expert on disaster risk reduction, community resilience, and lifeline infrastructure. He is also the Director of Impact360 Alliance and a private consultant, with extensive experience working with federal, state, and local agencies to improve their mitigation and recovery planning efforts. Scott possesses a unique set of skills and expertise across the fields of Human Geography, Civil Engineering, Geomorphology, Geographic Information Systems, and Human-Centered Design.

Elliot "Eli" Jacks is Chief of the National Weather Service (NWS) Forecast Services Division at NOAA Headquarters. In this role, he leads requirements development and oversees policy for 11 National Service Programs, and serves as the Lead for the World Meteorological Organization's "IMPACT" Expert Team which recommends best practices to advance the Impact-Based Forecast and Warning Services concept to both developed and developing countries across the globe. Eli is also the Lead of the NWS "Hazard Simplification Project," the goal of which is to clarify and simplify the organization's messaging system for expected weather and water-based hazards.

Appendix Five: Description of Readiness Levels (RLs)

Return to text

An Overview of RLs 1–9

(NAO 216-105B)

RL 1: Basic research, experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view. Basic research can be oriented or directed towards some broad fields of general interest, with the explicit goal of a range of future applications (OECD, 2015).

RL 2: Applied research, original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim or objective. Applied research is undertaken either to determine possible uses for the findings of basic research, or to determine new methods or ways of achieving specific and predetermined objectives (OECD, 2015).

RL 3: Proof-of-concept for system, process, product, service, or tool; this can be considered an early phase of experimental development; feasibility studies may be included.

RL 4: Successful evaluation of system, subsystem, process, product, service, or tool in a laboratory or other experimental environment; this can be considered an intermediate phase of development.

RL 5: Successful evaluation of system, subsystem process, product, service, or tool in relevant environment through testing and prototyping; this can be considered the final stage of development before demonstration begins.

RL 6: Demonstration of a prototype system, subsystem, process, product, service, or tool in relevant or test environment (potential demonstrated).

RL 7: Prototype system, process, product, service or tool demonstrated in an operational or other relevant environment (functionality demonstrated in near-real world environment; subsystem components fully integrated into system).

RL 8: Finalized system, process, product, service or tool tested, and shown to operate or function as expected within user's environment; user training and documentation completed; operator or user approval given.

RL 9: System, process, product, service or tool deployed and used routinely.

Appendix Six: Breakout 1 Questions and Directions

Return to text

Breakout #1: Constructs, Metrics, and Policy

Objective: To broadly identify terms that need defining, and how we can systematically measure them.

Possible Outcomes may include:
- A list of terms or phrases that need further defining
- Recommendations on how to increase transparency of definitions to build mutual understanding
- Recommendations to further refine methodological approaches to measure these terms and related project success (identify the people or organizations you believe can help)

Directions:
- Short, brief introductions for group members
- Assign a group presenter to work with the note-taker to summarize the *main* points for the plenary
- Jot down any notes you would like to present to the group
- Feel free to use any materials provided!

Question 1: To build mutual understanding between researchers and operations, what terms or phrases do you feel need defining? If you need ideas, please consider consulting the NWS Strategic Plan for terms.

Suggested Format (~15 minutes):
- Silently brainstorm before sharing with the group (if you need ideas, use the NWS Strategic Plan)
- Share your terms with your group and consider the following:
    - Does a definition exist for the term? If yes, please document the definition.
    - Do you all agree upon the definition? Why or why not?
    - What 3 terms do you feel we should prioritize for systematic measuring?
    - What can we do to increase transparency of how operations defines the term?

Question 2: How do SBS researchers and operations measure these terms, respectively?

Suggested Format (~20 minutes):
- Silently brainstorm before sharing with the group
- Share your measurement thoughts with your group and consider the following:
    - How does the operational community measure the term (i.e., policy, metrics, AOP, etc.)?
    - How does the research community measure this term? What are the pros and cons to developing a shared community approach to measuring this term or phrase (such as standard scales?)
    - How can WPO, NWS, and others help facilitate this?

Question 3: Now that you've discussed ways to measure data at the community level, now discuss the project level. How should we measure if an individual research project succeeds? (e.g., operational viability? Tie it to an organizational performance metric?)

Suggested Format (~15 minutes):

- Silently brainstorm before sharing with the group
- Discuss your proposed measures of success
- What project measures of success are possible now vs. in the future?

Appendix Seven: Breakout 2 Questions and Directions

Return to text

Breakout #2: Archiving, Collecting, and Managing Social and Behavioral Science Data

Objective: To broadly identify what data we need, and what incremental steps we can take to collect, manage, and archive it.

Possible Outcomes may include:
- A list of data needed
- Recommendations for how to collect data
- Recommendations for increasing transparency on who has data, making data more accessible,

Directions:
- Short, brief introductions for group members
- Assign a group presenter to work with the note-taker to summarize the *main* points for the plenary
- Address the questions for your topic (see below)
- Jot down any notes you would like to present
- Feel free to use any materials provided!

Collecting Data: Tables 1, 2, and 3
- What is the most important societal impact goal of our mission to measure? (Think performance metrics)
- What type of data do we need to measure this goal?
  - What 2–3 types of data should we prioritize collecting to reach this goal or what creative ways could we collect this data?
  - Who should collect this data?
- Are there ways to leverage existing NWS data to assist in measuring this goal?
  - Is it accessible?
  - What tools, such as machine learning, could we use to make NWS data more useful (e.g., NWS chat data)?
- What new technologies exist or could exist to collect data to measure this goal?
  - What unique ways can we combine and collect social and physical science data together?
  - What does the transition process look like for data and/or the technology used to collect it?

Managing Data: Tables 4, 5, and 6
- What social data currently exists?
  - How do you know what data exists?
  - What do you need to know to identify existing data resources?
- How do we increase transparency about the meta-data, i.e., who owns the data and what type of data they collected?
  - Are there different needs for qualitative vs quantitative data? Please explain.
- What are some ways we can ensure that we're not oversampling the same population (i.e., the same NWS office, emergency managers, members of the public, etc.)

Archiving: Tables 7, 8, and 9

- While law dictates that the public have access to digital data (https://www.ngdc.noaa.gov/parr.html), what ethical issues do we need to consider when making social data public?
- In addition to storing data at NCEI, what tools, mechanisms, or other ways are there to share data or meta-data (i.e. have the ability to identify who owns the data; identifying what kind of data exists, etc.)?
- What potential opportunities exist if social science data archives were accessible? For example, meta-analysis, economic valuation, performance metrics, etc.?

Appendix Eight: Definitions of Terms

Click on bolded word to return to text

Basic Research

"Experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view. Basic research can be oriented or directed towards some broad fields of general interest, with the explicit goal of a range of future applications." NAO 216-105B

Core Partners

"Government and non-government entities which are directly involved in the preparation, dissemination and discussions involving weather, water, or climate related National Weather Service information, that supports decision making for routine or episodic, high impact events." National Weather Service (NWS) Service Description Document (SDD) Impact-Based Decision Support Services for NWS Core Partners, April 2018

Digital Object Identifier (DOI)

"A string of numbers, letters and symbols used to permanently identify an article or document and link to it on the web." (University of Illinois at Chicago)

Institutional Review Board (IRB)

"An IRB is a committee within a university or other organization receiving federal funds to conduct research that reviews research proposals. The IRB reviews the proposals before a project is submitted to a funding agency to determine if the research project follows the ethical principles and federal regulations for the protection of human subjects. The IRB has the authority to approve, disapprove or require modifications of these projects." American Psychological Association

Instrument

A research instrument is the way in which data is obtained and measured. Research instruments can include, surveys, scales, questionnaires, and interview questions. Columbia University

Joint Technology Transfer Initiative (JTTI)

A WPO program designed "to accelerate the transition of matured weather research to NWS operations. The mission of the JTTI is to ensure continuous, cost effective development and transition of the latest scientific and technological advances into NWS operations." JTTI Information Sheet

Longitudinal Data

While different disciplines define longitudinal data differently, a broad definition would include data that is collected "for more than one time period [and] possibly, but not necessarily, involving the collection of data at different time periods" (Lewis-Beck, Bryman, & Liao, 2003, p. 567). Longitudinal data can be quantitative and/or qualitative, and is used to analyze changes over time (Lavrakas, 2008).

Office of Management and Budget Approval

"The Paperwork Reduction Act (PRA) of 1995 gives the Office of Management and Budget (OMB) authority over the collection of certain information by Federal agencies. OMB must clear an information collection if the agency conducts or sponsors the collection of information from 10 or more members of the public, regardless of whether the collection is mandatory, voluntary, or required to obtain or retain a benefit. The ICR approval process can vary depending on the complexities of the collection." Paperwork Reduction Act (PRA) Guide.

Readiness Levels (RLs)

"A systematic project metric/measurement system that supports assessments of the maturity of R&D projects from research to operation, application, commercial product or service, or other use and allows the consistent comparison of maturity between different types of R&D projects." NAO 216-105B

Social and Behavioral Science (SBS)

"The process of describing, explaining and predicting human behavior and institutional structures in interaction with their environments." NOAA Science Advisory Board, 2009

Transition Plan

"A document that represents an agreement between clearly identified researchers and potential recipients, organizations, or other users of the product resulting from the transition of an R&D output." NAO 216-105B

Weather Enterprise

"Individuals and organizations from public, private, and academic sectors that contribute to the research, development, and production of weather forecast products, and primary consumers of these weather forecast products." H.R.353 — 115th Congress (2017–2018)

Weather Research and Forecasting Innovation Act of 2017

A law designed "to improve the National Oceanic and Atmospheric Administration's weather research through a focused program of investment on affordable and attainable advances in observational, computing, and modeling capabilities to support substantial improvement in weather forecasting and prediction of high impact weather events, to expand commercial opportunities for the provision of weather data, and for other purposes." H.R.353 — 115th Congress (2017–2018)

Appendix Nine: Abbreviations

AMS	**American Meteorological Society**
CASA	**Center for Collaborative Adaptive Sensing of the Atmosphere**
DOI	**Digital Object Identifier**
GPRA	**Government Performance and Results Act**
JTTI	**Joint Technology Transfer Initiative**
IDSS	**Impact-Based Decision Support Services**
IRB	**Institutional Review Board**
NAS	**National Academy of Sciences**
NCAR	**National Center for Atmospheric Research**
NCEI	**National Center for Environmental Information**
NCEP	**National Centers for Environmental Prediction**
NOAA	**National Oceanic and Atmospheric Administration**
NSF	**National Science Foundation**
NWS	**National Weather Service**
O2R	**Operations to Research**
OAR	**Oceanic and Atmospheric Research/"NOAA Research"**

OMB	**Office of Management and Budget**
OSTI	**Office of Scientific and Technical Information**
PARR	**Public Access to Research Results**
R&D	**Research and Development**
R2O	**Research to Operations**
RLs	**Readiness Levels**
RON	**Research Operations Nexus**
SBS	**Social and Behavioral Science**
UCAR	**University Corporation for Atmospheric Research**
WPO	**Weather Program Office**