# Priorities for a New Decade: Weather, Water, and Climate

**A Policy Statement of the American Meteorological Society**

(Adopted by the AMS Council on Council 28 September 2020)

Weather, water, and climate (WWC) affect every community and every economic sector. Scientific observations and research in WWC help us meet basic human needs and create enormous opportunity for societal advancement. Near-term policy choices will help determine the nation's WWC capabilities and vulnerabilities for decades to come.

## Recommendations

To ensure economic and societal well-being over the next decade, AMS recommends that the nation:

- develop the next generation of WWC experts
- invest in research critical to innovation and advanced services
- invest in observations and computing infrastructure
- create services that harness scientific advances for societal benefit
- prepare informed WWC information users
- build strong partnerships throughout the WWC enterprise
- implement effective leadership and management

### Develop the Next Generation of WWC Experts

It is essential to foster a diverse and inclusive workforce where representatives of all members of our society feel welcome. To ensure this workforce is equipped to enable scientific and technological advances, apply science for the benefit of all people, and inform WWC decisions, investments must continue to: (i) educate and train students for careers in science, technology, engineering, and mathematics; and (ii) develop a new generation of WWC researchers. Environmental awareness and professional integrity are crucial values to instill in the next generation of WWC experts.

### Invest in Research Critical to Innovation and Advanced Services

To ensure continued leadership in understanding our complex and changing planet and application of this understanding for the benefit of society, increased investments are needed to support new discoveries, innovation, applications, and model development in the geosciences, engineering, and relevant social sciences.

### Invest in Observations and Computing Infrastructure

To ensure advances in scientific knowledge and more accurate and timely delivery of WWC products and support services at scales useful to decision-makers, and to preserve national security, targeted investments are required for:

- atmosphere–ocean–land–ice observational infrastructure
- techniques to translate the resulting large datasets into forms suitable for information services and prediction models
- leading-edge high-performance computers and software, including weather and climate models that incorporate the components of the Earth system in interactive fashion
- observation quality control, including enhanced diagnosis of observation error and improvements in automated observing systems

## Create Services that Harness Scientific Advances for Societal Benefit

To ensure society's most pressing needs are met and its capabilities are optimally utilized, mechanisms for engaging a variety of users and moving research into practical applications in a timely and effective fashion must be encouraged, developed, and implemented. In particular, open access to data and publications is an increasingly powerful tool for distributing the fruits of scientific labor as widely as possible.

## Prepare Informed WWC Information Users

To ensure we have informed users who can take full advantage of advanced WWC information and tools, education and communication programs must continue to focus on enhancing WWC skills and understanding by both decision-makers and society at large. These efforts should draw on insights from both physical and social science and should involve collaborations among scientists and decision-makers to maximize user feedback and the co-production of knowledge.

## Build Strong Partnerships Throughout the WWC Enterprise

Private companies, government officials, academic researchers, and the NGO community have always worked together to meet America's WWC challenges. As this task grows more consequential, urgent, and complex, a coordinated federal effort is needed to support, strengthen, and encourage strategic inter-sector partnerships, including efforts to increase the global suite of Earth observations, advance long-term stewardship of environmental data, and improve national and international community-level resilience to climate change and variability. Such partnerships must also be extended to related disciplines, including energy, transportation, health, and decision support.

## Implement Effective Leadership and Management

To ensure that WWC investments are made in the best interests of the nation, effective leadership and management approaches will be needed, including: (i) appointing highly capable, well-qualified, and diverse leadership to top WWC policy positions in the White House and federal agencies, and (ii) implementing management approaches that support integrated WWC research and services planning across federal agencies and Congress. These structures should proactively engage the academic and private sectors.

**The American Meteorological Society is a global community committed to advancing weather, water, and climate science and service.**

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## Background and Context

In order to prosper, the United States—its government, businesses, institutions, and people—relies on a wealth of physical resources. Food, water, and energy are essential, as is a life-supporting environment. Our future also rests on a bedrock expectation: that we are resilient enough to survive whatever the environment throws at us. Resilience includes having advance warning of weather hazards and safe shelter when needed. It also includes knowing what to expect and how we might respond as the byproducts of our technological success—carbon emissions—act to warm and transform our atmosphere, oceans, and biosphere.

All of us are vulnerable to the impacts of weather extremes and climate change. Each person's risk will be influenced by where they live, socioeconomic status, family and community ties, societal structures, the presence or absence of racial discrimination, and many other factors. No matter who we are, we rely on environmental knowledge. Those who generate and use that knowledge are accountable to the nation and its people.

The United States benefits greatly from the world's largest assembly of specialists in weather, water, and climate (WWC), working in federal, state, and local government (the public sector), private firms, nongovernmental organizations (NGOs), and academia. Together, as a multifaceted enterprise, they supply Americans with crucial guidance on the behavior of the environment that shapes the lives of us all.

The decade of the 2020s will see new demands placed on the WWC enterprise—challenges that highlight the need to protect and enhance the nation's capabilities, economic strengths, resilience, and equity. Ironically, some of these challenges arise from technological progress itself. Among these challenges:

- new types of data from new platforms
- the intersection of climate change and societal change
- new sources of WWC information
- potential interference with WWC observing capabilities and operations

These examples point to two pressing needs:

- to have the WWC information required to avoid harmful consequences and enable new opportunities
- to use that information as effectively as possible

Policy makers at local, state, and federal levels will be hugely important in determining the extent to which these two needs are met.

WWC information must be as accurate, complete, accessible, and actionable as possible. The COVID-19 pandemic has brought home the enormous value of having timely, relevant information at hand when a crisis is looming. The nation must invest in the human and institutional foundation that undergirds WWC information so that the full spectrum of our people and communities have access to the best possible guidance on what to expect from our environment, when to expect it, and how they can respond to it. Increased diversity, equity, inclusion, and accessibility are paramount to accelerating the advancement of science and bringing the WWC workforce into alignment with the nation's population and its evolving needs. Economic and social prosperity belong to a society that understands and effectively responds to Earth's changing WWC conditions.

Environmental forecasts provide a range of value at different time scales. At each of these time frames, experts and stakeholders from a diverse range of regional, social, institutional, and disciplinary backgrounds must join forces to better understand what people and communities need to know to make the best use of advances in weather and climate guidance. The results could yield benefits across the spectrum of user needs and time frames, from minutes to decades and beyond.

With this context in mind, the AMS prepared the seven recommendations above for policies resulting in a strong WWC enterprise equipped to support services and research critical to societal health and resilience. Challenges to the implementation of these policies remain, and their implications on forecasts and other services vary according to the lead time. These considerations are highlighted below.

## Evolving challenges

- **New types of data from new platforms.** WWC data come from the public, private, and academic sectors, as well as from NGOs. Each component is critical to the WWC enterprise, as are the ways that the sectors collaborate and compete. This is particularly true given the rapidly increasing array of observational systems now being created and deployed. These data have the potential to strengthen the forecasts reaching Americans and to enhance our broader understanding of the atmosphere and oceans. By the year 2030, the national network of satellite-based sensors used in daily weather forecasting will be due for an upgrade, one that could potentially draw on the array of newly developed tools.

  However, there is no overarching policy to ensure that data from these new platforms are as consistent and reliable as possible, that forecasting systems can reap the maximum benefit from them, and that they will be available over the longer-term time frame needed to assess climate variability and change. Careful and continuous consideration of roles and responsibilities among the public, private, academic, and NGO communities will thus be critical as capabilities, interests, and needs evolve over the next decade and beyond.

- **The intersection of climate change and societal change.** Intensive observations and research over the past four decades have shown that people are causing climate to change and that human-caused climate change is dangerous and the consequences potentially dire. Global temperature hit record highs for three consecutive years in the 2010s. Further warming is expected in the 2020s and beyond, from greenhouse gases already added to the atmosphere and from additional emissions still to come. The latter will depend greatly on choices made by society over the next few years.

  Climate change is not only altering Earth's physical and biological systems but also affecting every societal and economic sector, from infrastructure to agriculture to energy supply and demand. As one example, intensified drought impacts can lead to large-scale migration across international borders, which in turn can fuel regional conflict and instability. Those who are marginalized tend to be most vulnerable to the manifold changes and crises triggered directly or indirectly by a changing climate.

In many parts of the nation, emerging climate trends are compounding societal stresses. For example, persistent weather patterns atop rising mean sea level sent water above high tide in 2019 for more than 2000 hours in the Miami area, where real estate is already being affected by concerns about long-term sea level rise. In Texas, record downpours produced by Hurricane Harvey in 2017 were consistent with global trends toward intensified rainfall extremes, and the catastrophic floods that resulted were exacerbated by sprawl in the Houston area. In California—where development has increasingly pushed into fire-prone forests and where dry periods are increasingly accompanied by record heat—a string of wildfires in 2017–18 took an unprecedented toll in life and property. Millions of Californians were affected by utility power cuts intended to reduce risk during fire-prone weather. Predicting and responding to such multipronged threats will require new forms of collaboration and data sharing across sectors and disciplines.

Another task for the research community will be to ensure that efforts to address climate change work to reduce rather than to exacerbate social inequities. For example, if not thoughtfully designed, a cap-and-trade program that reduces total emissions across a state or region may allow the remaining pollution to become even more concentrated in marginalized communities. With increased awareness, physical and social scientists can work with affected populations to repair or avert disproportionate harms they may suffer, whether from climate change itself or from efforts to address it.

- **New sources of WWC information**. The proliferation of smartphones and social media gives Americans virtually nonstop access to information, and it lays the groundwork for weather warnings to be much more specific in time and location. However, new forms of media can also make it more difficult for consumers to assess the source and/or accuracy of weather information. This gap may lead to public vulnerability at times when deadly weather threatens or when major decisions loom.

- **Potential interference with WWC observing capabilities and operations**. Weather, water, and climate operations rely on the radio frequency spectrum to observe the Earth system (e.g., with satellites, weather radars, and wind profilers) and to transmit crucial information. The radio frequency spectrum is a limited resource, and competition for it is intense and growing, particularly with the opportunity to expand 5G access. This competition puts WWC-related uses of the radio spectrum at risk. It will be extremely important for decision-makers to understand and account for meteorological uses of the radio spectrum before reallocation decisions are made.

## How policy affects WWC services on different time scales

Predictions across the traditional weather-forecast window of about one day to two weeks remain tremendously important to a variety of users. These forecasts can be improved and leveraged further in a variety of ways—for instance, incorporating multiday rainfall forecasts more completely into flood outlooks and water resource management.

Forecasts at other time scales offer their own benefits and challenges. Three illustrative examples are shown below. This is not a complete list; other examples could be created for each time scale, from minutes to decades and beyond.

- **One to three hours**. Our national investment in research and observations has paved the way for severe weather guidance to extend beyond traditional 30- to 60-minute warnings into the 1- to 3-hour time frame. Such guidance could lead to major benefits in preparation and safety. It also raises new questions. How will people respond if they expect to have more than an hour to take action ahead of a possible tornado or a flash flood? How can the probabilities and uncertainties inherent in such guidance best be conveyed? How can schools, workplaces, and other institutions act to support public safety measures in these extended time frames?

- **Weeks to months**. Specific local weather forecasts cannot be issued with accuracy beyond about 10 to 14 days. However, many other types of outlooks have demonstrated accuracy over periods of weeks to months (subseasonal to seasonal periods) when they are presented in terms of probabilities or likelihoods. For example, some periods of increased regional tornado risk may be predictable more than three weeks in advance. The progression of the Madden–Julian oscillation can signal enhanced probabilities of hurricane development weeks ahead of time. The development of El Niño and La Niña events can provide months of advance notice on which parts of the nation are most likely to experience winters that are wetter, drier, warmer, or colder than usual. Utilities, agriculture, and other economic sectors already save money based on such seasonal outlooks. How can the science underlying these outlooks be improved, and how can the resulting probabilities—which are often complex in nature—be presented in terms that are even more useful to the public and other stakeholders, allowing for even greater economic and safety benefits? For example, how can forecast confidence be incorporated and communicated so that users know whether a given situation is likely to produce a more-skillful or less-skillful forecast?

- **Five to ten years.** Billions of dollars of infrastructure must be deployed across the nation over the coming decade and beyond to ensure safe water supplies, protect communities from flooding, and meet many other goals. WWC guidance is critical to developing infrastructure that will fit the needs of today, tomorrow, the next decade, and decades to come, in a changing climate. What aspects of climate change are likely to emerge most quickly in the 2020s, and how will these intersect with societal change? How can research best support the tools that are needed to understand and respond to these changes?

*[This statement is considered in force until September 2025 unless superseded by a new statement issued by the AMS Council before this date.]*