Written Testimony of the
WESTERN STATES WATER COUNCIL

Submitted to the
Senate Appropriations Committee
Subcommittee on Commerce, Justice, Science, and Related Agencies

Regarding NOAA/NWS U.S. Weather Research Program Appropriations
June 21, 2021

On behalf of the Western States Water Council (WSWC), a government entity advising the governors of eighteen states, we wish to express our strong support for a $15 million increase in the U.S. Weather Research Program line item within the National Oceanic and Atmospheric Administration's (NOAA) Fiscal Year 2022 appropriation for the National Weather Service (NWS), Office of Oceanic and Atmospheric Research (OAR) account.

The Weather Research and Forecasting Innovation Act of 2017 (Public Law 115-25), reauthorized in 2019 along with the National Integrated Drought Information System (NIDIS), directed NOAA to "collect and utilize information in order to make usable, reliable, and timely foundational forecasts of subseasonal and seasonal [S2S] temperature and precipitation." The statute further required submission of a report to Congress that described "specific plans and goals for the continued development of the subseasonal and seasonal forecasts" and "an identification of research, monitoring, observing, and forecasting requirements" needed to meet the statutory goals.

In 2020, the NWS submitted to Congress the report, *Subseasonal and Seasonal Forecasting Innovation: Plans for the Twenty-First Century*. The report outlines current uses of NOAA S2S products and services, and how NOAA plans to improve the usability and transference of data, information, and forecasts. Developed with input from federal, regional, state, tribal, and local government agencies, research institutions, and the private sector, the report outlines innovations needed to achieve two goals for improving products and services: (1) improving the skill of foundational tools in order to improve the skill of the official S2S forecasts; and (2) enhancing the value of S2S products for stakeholders.

The report recommended a number of pilot projects, including one for improving forecasts of winter precipitation (which provides the snowpack sustaining water supplies in mountain areas) in the West, and one for spring/summer precipitation forecasts for agricultural water supply in the Plains States. Another was recommended for Artic sea ice and one for tropical cyclones.

The WSWC urges the Subcommittee to provide resources to start the western pilot project to improve S2S precipitation forecasting to support water management. In fiscal year 2021 NOAA's Weather Research Program line item was budgeted at $26.5 million. The fiscal year 2022 President's Budget request is $26.7M. A $15 million investment in S2S pilot projects would be on par with NOAA's successful Hurricane Forecast Improvement Project (HFIP).

Much of the West is currently experiencing unprecedented drought conditions. Currently, nearly all of our 18 member states are suffering from severe to exceptional drought, with half

afflicted by the latter, the driest condition represented on the U.S. Drought Monitor scale (www.drought.gov). Agricultural interests are hit hardest as crops, feed, and forage deteriorate and rise in cost, threatening farmers, ranchers, and dairies. In some cases, producers are culling herds. Municipal water shortages are also possible, particularly for rural communities. Dry, hot, and windy weather combined with dried out vegetation has wildfires on the rise.

The scientific insights, data, and tools that the S2S pilot projects promise would help agricultural, rural, and urban water and land managers make better decisions. Better forecasts will provide private and public decisionmakers with longer lead times than are currently feasible to implement mitigation policies and programs. This would help to protect surface and ground-water supplies and provide greater certainty to farmers and ranchers who must make important crop, livestock, and conservation decisions now without reliable extended precipitation forecasts.

Current skill in S2S precipitation forecasting is not adequate to support water management decision-making, and a priority need to be placed on improving S2S forecasting capabilities. Water is the life-blood of the West, which experiences far greater variability in annual precipitation than does the eastern half of the country. Managing water in the West is about managing for the extremes of droughts and floods, and the need to store water when available to manage it during drier times for cities, farms, energy, and the environment. Better longer-term precipitation forecasts are a necessary tool for more efficient water resource management. Will this summer (or next winter) be wet or dry? This is a critical question asked every year by state, local, federal, and tribal water managers, as well as by cities, farmers, and hydroelectric powerplant operators.

Although the skill of conventional short-term weather forecasts (which go out as far as two weeks) has improved over the past several decades, the same cannot be said for the critical longer-term forecasts important for water management. These longer S2S forecasts span time periods of several weeks out to one or two years. The NWS's Climate Prediction Center (CPC) has minimal skill when producing available S2S forecasts.

As documented by NOAA's National Centers for Environmental Information, disasters at both wet and dry extremes of the hydrologic cycle are responsible for billions of dollars in losses. With better S2S forecasts, water managers can better prepare for and respond to drought and flooding, reducing loss of lives and property, as well as economic and environmental losses. Similarly, decision makers in agriculture, fisheries, hydroelectric power generation, and emergency management sectors share a common interest in more skillful and useful forecasts.

Lead time is critical in making water management decisions. Longer lead times are especially useful in planning and managing for the extremes of droughts and floods. Skillful S2S forecasts would inform and allow for more efficient operation of dams and reservoirs, balancing competing objectives of flood control and water storage. Absent good predictive capability, weeks ahead, reservoir operators must manage risk as conservatively as possible to ensure that space will be available to hold winter-spring runoff and manage floods. Better forecasts would allow operators to store more water for use during drought, while still providing flood protection – the equivalent of developing new water supplies at minimal cost. There are opportunities for improving S2S forecasting, but historically there has been a S2S research investment gap between conventional numerical weather modeling and century-scale climate modeling. Significant

scientific progress has been achieved at the weather and century-scale ends of this spectrum, thanks to ongoing federal investments, but much remains to be done at the S2S scale.

According to the American Meteorological Society, the skill of five- to six-day NWS temperature forecasts in 2012 is equivalent to that of three- to four-day forecasts in 1992. Also, substantial federal support from 1990 onwards for the U.S. Global Change Research Program resulted in major progress in developing increasingly complex climate models. However, similar progress and investment have not occurred at the S2S time scale so important for western water management. Improving S2S precipitation forecasting is a scientifically challenging subject that will require a commitment of dedicated, sustained funding. There is no silver bullet for S2S forecasting improvement, but the necessary ingredients for making progress include investment in all aspects of the subject (human resources, high-performance computing, observing systems, and transition of research innovations to operations). Well-defined metrics and timelines for evaluating success, with a strong project management focused on outcomes, are needed.

Regional pilot projects in areas where NOAA's current predictive skill is minimal are key to accelerating advancement of forecasting skill. Pilots provide opportunities to test tools such as statistical models or hybrid statistical-dynamical tools that can enhance information provided by NOAA's dynamical models.

The international Colorado River Basin has experienced prolonged drought conditions, for over 20 years, resulting in declining reservoir elevations in Lake Mead and Lake Powell. Water agencies in the seven Colorado River Basin states have been taking unprecedented steps to manage the risk of shortage, including executing historic drought contingency plans with the Department of the Interior in 2019. Drought risk management programs in the contingency plans cost money and/or water. Skillful seasonal precipitation forecasts would help support decisions to balance costs against risks of shortage.

In 2015 NOAA released its first-ever service assessment for drought, for the California drought which had then completed its third year. NOAA assessments evaluate its performance after significant hydrometeorological, oceanographic, or geologic events. The assessments are triggered by factors such as major economic impacts to a large area or population, or extensive national public interest impacts. Assessments evaluate the effectiveness of products and services made available to stakeholders, to help NOAA continuously improve the services it provides. The drought assessment's top finding given the input received from numerous stakeholders emphasized the need for an improved seasonal prediction capability focused on cool-season mountain precipitation, both in California and in the Colorado River Basin. "A majority of the stakeholders interviewed for this assessment noted one of the best services NOAA could provide is improved seasonal predictions with increased confidence and better interpretation."

NOAA's CPC seasonal precipitation products are national in scale and are not designed to provide regional forecast information – information which is most relevant to decision makers. For instance, state and federal officials managing California's water supply have a major unmet need for skillful predictions targeted at cool-season snowpack for the Sierra Nevada Mountains.

Improving the skill of S2S precipitation forecasting to make it usable for water resources management is scientifically challenging. In 2016, the National Academy of Sciences released a report on a national research agenda for improving S2S forecasting. The report provided a vision for S2S forecasts that could be as widely used in the next decade as conventional weather forecasts are today. It identified key strategies and made 16 specific recommendations for a research agenda. It noted, "More skillful and useful S2S forecasts – developed through sustained engagement with users and advances in basic knowledge and technological capabilities – could radically improve the basis for decision making on S2S timescales. There are also emerging science and technical capabilities that make rapid advances in S2S forecasts more likely than envisioned even 5 years ago."

Preliminary experimental work being performed by NOAA's Earth Systems Research Laboratory (ESRL) under a contract with the California Department of Water Resources developed a preliminary statistical model for S2S precipitation using sea surface temperatures and sea level pressure. This work demonstrates a potential opportunity for improving S2S forecasting precipitation through NOAA investment in statistical modeling.

NOAA outlooks now rely heavily on the El Niño-Southern Oscillation (ENSO) as a source of predictability. NOAA's early winter forecast in 2014 called for a weak to moderate El Niño with above-normal precipitation for California. ENSO conditions were neutral and California had one of its driest years on record. In 2015, NOAA correctly predicted the onset of very strong El Niño conditions, but the expectation of a wet Southern California and dry Pacific Northwest was met with continued drought in Southern California and flooding in the Pacific Northwest, illustrating how much work remains to be done to improve seasonal forecasting.

NOAA's National Centers for Environmental Information (NCEI) tracks U.S. Billion-Dollar Weather and Climate Disasters (https://www.ncdc.noaa.gov/billions). The 2012 drought was the most extensive drought to affect the U.S. since the 1930s, with moderate to extreme drought conditions affecting more than half the country. Estimated losses totaled $34.8 billion. Drought in the West and Plains States in 2013 caused an estimated $11.7 billion in losses. In 2014 California suffered its worst drought of record, and together with other states, losses were estimated at $4.4 billion. The western drought of 2015 cost $5 billion and in 2016 a Southeast and Northeast drought cost $3.8 billion. Similarly, drought costs across the Nation have been estimated at $2.7 billion in 2017, $3.1 billion in 2018, and $4.5 billion in 2020. These numbers don't include related wildfire losses, or losses due to floods. This year the West is experiencing another drought, the costs of which will be significant.

Better S2S forecasts would help inform decision-making and help mitigate such losses. This $15 million request for a pilot project to accelerate research and improve S2S predictive capabilities is a small investment, compared to the potential savings nationwide.