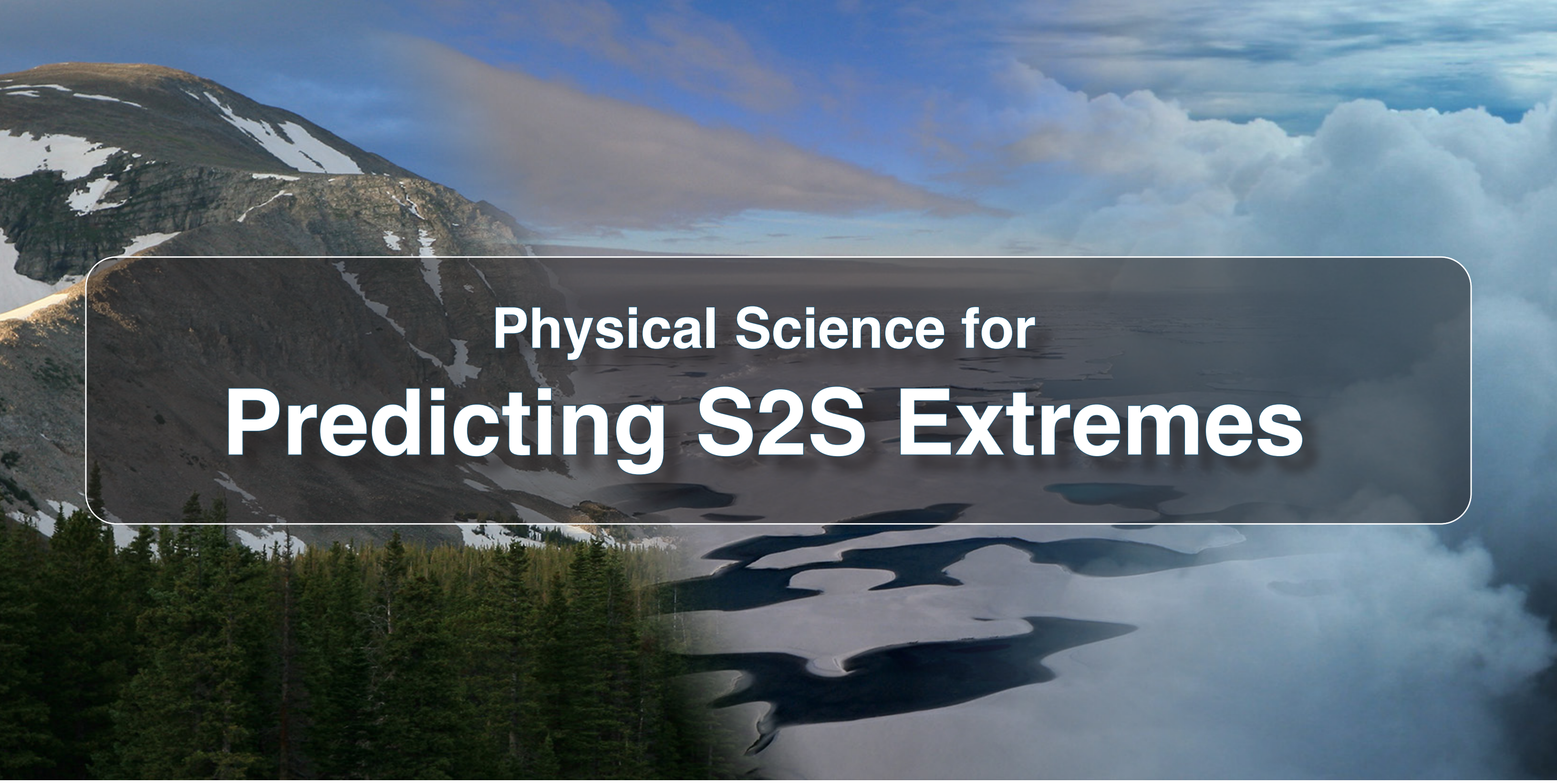


Physical Science for Predicting S2S Extremes

Given the impacts of serious risk to health, economic development, and food security, improved prediction of subseasonal-to-seasonal (S2S) extreme weather and climate is a high priority to help NOAA meet mission responsibilities to provide early warning and informed preparedness. Subseasonal-to-seasonal forecasting bridges the gap between the more-mature weather forecast and seasonal prediction. S2S has received much less attention than medium and seasonal prediction despite the considerable socioeconomic value that could be derived from such forecasts. The S2S time range is critical for proactive disaster mitigation efforts, since these effort often take several weeks to implement. S2S is considered a challenging forecast time range since the lead time is sufficiently long that much of the memory of the atmospheric initial conditions is lost, while too short for the variability of the ocean to have a strong influence.

Legislative Drivers

Title II, Section 201(h)(1) of United States Congress enacted PL115-25, with the short title, "Weather Research and Forecasting Innovation Act of 2017, "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."

Physical Sciences Laboratory Capabilities

» Observationally-based physical process understanding.

» Field observations of air-sea-ice-land interaction processes – surface fluxes, boundary-layer clouds, energy balance.

» Development of parameterizations – surface fluxes, mixing in cloudy boundary layers, cloud microphysics-radiative properties, stochastic parameterizations of model uncertainty.

» Ensemble-based data assimilation methods.

» Statistical post-processing using reforecasts.

» Using Linear Inverse Models, the Correlated-Additive and Multiplicative Noise model, and the Stochastically-Generated Skewed distribution to understand, diagnose, and predict changes in extremes, predictability, and model error.

» Developing reanalysis datasets for climate analysis and prediction.

» Diagnosing stratosphere-troposphere interactions in models.

» Developing high-quality, merged observational datasets for model validation and process studies.

» Coupled atmosphere/sea-ice/ocean forecasting in the Arctic.

» Diagnostic studies to explain and to assess the predictability of high-impact extreme weather, water and climate events.

Research Partnerships

NOAA NWS Climate Prediction Center

Collaborative research to advance the scientific knowledge and understanding needed to produce information products and predictions of climate variations and extremes on S2S timescales in support of effective management of climate risk and a climate-resilient society. Research explores the predictability of sub-seasonal to seasonal climate variability, the monitoring and nowcasting of weather, water and climate extremes, and the underlying causes of high-impact extreme events

NOAA NWS Environmental Modeling Center

Collaborative research and development to improve NOAA operational numerical weather, marine and climate predictions through advancements in data assimilation and modeling. Research develops, improves and prototypes data assimilation systems, and the representation of key physical processes in forecast models of the atmosphere, ocean and coupled climate system.

Subseasonal-to-Seasonal (S2S) Precipitation Coalition

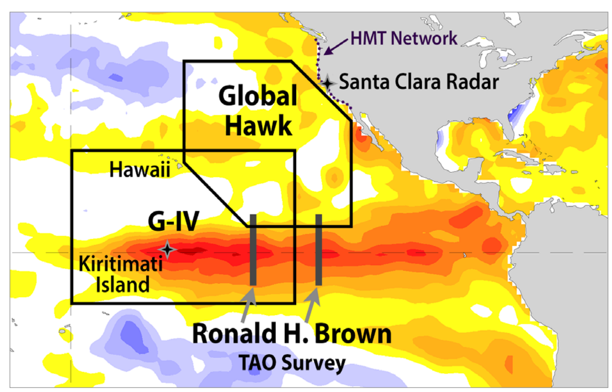
Collaborative partnership comprised of a broad-based, multi-state coalition of organizations and agencies committed to advancing federal support for enhanced precipitation prediction in the western United States. In recent years, the western states experienced several years of drought followed by a season of historic precipitation. In both extremes, improved forecasting will allow communities throughout the West to better prepare for wet and dry seasons alike. Effective water management in the West is enhanced by sound, scientifically-based decisions made weeks to months ahead of time, with key decisions hinging on expectations or predictions of precipitation, snow pack and general watershed conditions.

What's Next for PSL

- Determine skill baseline(s) of S2S predictions based on well-established metrics.
- Improve initialization of surface conditions, (e.g., land surface moisture, soil moisture, vegetation, sea-ice extent, sea-ice thickness, among others) for predicting meteorological and hydrological extremes on S2s timescales.
- Develop an S2S predictive capability for renewable energy forecasting through improved observation-based understanding and prediction of boundary layer processes.
- Diagnose the skill of a variety of high-impact extreme weather events that occurred during 1979-2018, and research methods to improve the S2S predictability of those cases.
- Develop research quality capability to provide ongoing S2S attribution and predictability assessments for Billion Dollar Disasters (https://www.ncei.noaa.gov/news/calculating-cost-weather-and-climate-disasters)
- Assess the importance of improved data analysis/assimilation/initialization versus forecast model development (e.g. physics, spatial resolution) in advancing S2S predictability.

PSL has developed and made available online a number of experimental research products. One example is an experimental sea-ice forecasting model, which is being used to understand the atmospheric, oceanic, and sea ice processes that impact formation. (Credit: NOAA)

Water releases from Oahe Dam, Pierre, SD during the Missouri River June 2011 flood. Improved S2S predictions are needed to inform water management risk-based decision making. (Credit: FEMA)



Observation-based process understanding research during the El Niño Rapid Response Field Campaign to advance S2S prediction. Schematic illustration of the locations of the NOAA G-IV and NASA Global Hawk flights, and NOAA Ship Ronald H. Brown survey track.

For more information, contact:

Dr. Robert Webb, Director
NOAA Physical Sciences Laboratory
Robert.S.Webb@noaa.gov

Visit us online at: psl.noaa.gov

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