Developing a Framework for Seamless Prediction of Sub-Seasonal to Seasonal Extreme Precipitation Events in the United States

Derek Rosendahl[1], Paulina Cwik[1], Elinor Martin[2], Jeffrey Basara[2], Harold Brooks[3], Jason Furtado[2], Cameron Homeyer[2], Heather Lazrus[4], Renee McPherson[1,5], Esther Mullens[1], Michael Richman[2], and Ashton Robinson-Cook[6]

[1]Dept. of Interior South Central Climate Science Center; [2] Univ. of Oklahoma, School of Meteorology; [3]National Severe Storms Laboratory; [4]National Center for Atmospheric Research; [5]Univ. of Oklahoma, Dept. of Geography & Envir. Sustainability; [6]Storm Prediction Center

1. Overview

Extreme precipitation events pose significant societal and economic risks to the U.S. with impacts across many sectors (e.g., water resource management, energy, infrastructure, transportation, public health, and agriculture). However, a forecasting skill gap exists on the sub-seasonal to seasonal (S2S; i.e., 14 to 90 days) timeframe that many decision makers use for planning, preparing, and resilience-building. This recently-funded, 5-year NSF PREEVENTS project assembles scientists and stakeholders to narrow the prediction gap of S2S extreme precipitation events. Our goal is to enhance the physical understanding of large-scale dynamics and forcing of S2S extreme precipitation events, improve our capability to predict these events, and increase communication between research and stakeholder communities with regard to extreme precipitation.

2. Defining an "Extreme Precipitation Event"

For this study, S2S extreme precipitation events will be defined as follows:

- Events with precipitation totals that exceed the 95th-percentile values for a given location and time period;
- Occurring over time periods of 14 days, 30 days, and 3 months; and
- With areal sizes of 10,000 to 200,000 km^2.

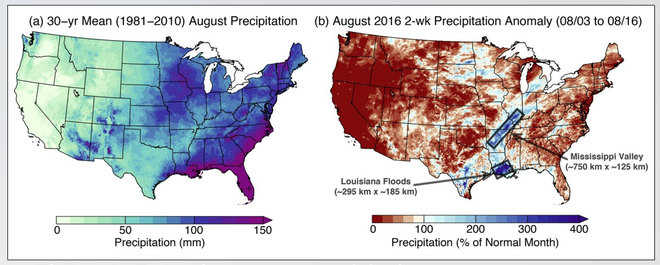

Figure 1: Example extreme precipitation event.

3. Research Questions

1. What are the synoptic patterns associated with, and characteristics of, S2S extreme precipitation events in the contiguous U.S.?
2. What role, if any, do large-scale modes of climate variability play in modulating these events?
3. How predictable are S2S extreme precipitation events?
4. How do we create an informative prediction of S2S extreme precipitation events for policymaking and planning?

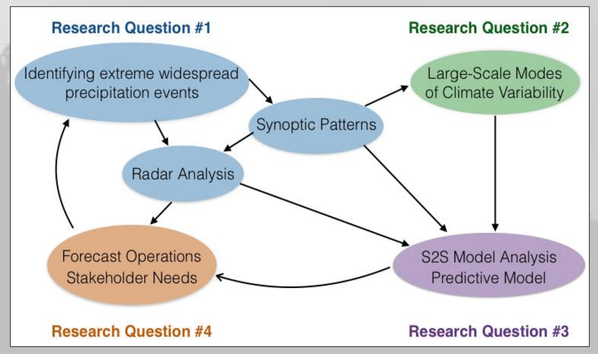

Figure 2: Relationship between research questions.

4. Research Activities

Our activities uniquely combine observations, reanalysis, and model output to examine fundamental processes of S2S extreme precipitation events across the U.S.

1. Develop an identification scheme for S2S extreme precipitation events.
2. Employ these statistical frameworks to analyze the characteristic patterns associated with S2S extreme precipitation events.
3. Analyze radar characteristics of S2S extreme precipitation events.
4. Quantify links between large-scale modes of climate variability and synoptic patterns associated with S2S extreme precipitation events.
5. Quantify the predictability of S2S extreme precipitation events in the North American Multi-Model Ensemble Phase-2 models.
6. Develop and test a statistical predictive model for S2S extreme precipitation events.
7. Apply best practices of co-production of knowledge to seek stakeholder input and guidance for our research.

Figure 3: Classifying characteristic synoptic patterns.

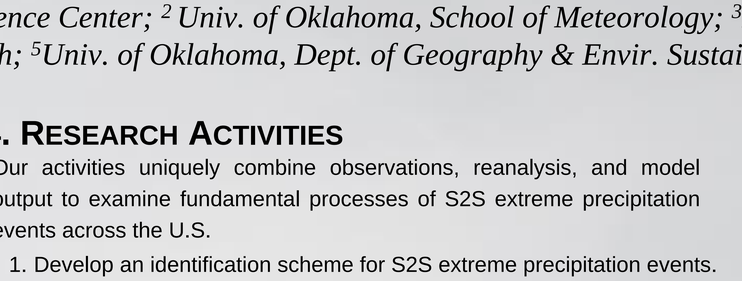

Figure 4: Radar-based evaluation of the physical and dynamical characteristics of precipitating systems.

5. Key Data Sets

We will use a variety of existing observation-based datasets and model output:

- Observations and Reanalysis Products
  - Precipitation (e.g., PRISM; Livneh; Daymet; CRUv3.23)
  - SSTs (e.g., HadISST; NOAA Extended Reconstruction SST V4)
  - Radar reflectivity (NEXRAD WSR-88D network)
  - Atmospheric variables (e.g., CFSR, ERA-Interim, JRA-55, MERRA-2, NOAA 20th Century Reanalysis V2)
- North American Multi-Model Ensemble Phase 2 (NMME-2)
  - Operational S2S forecasting system of coupled climate models with multiple ensemble members
- Coupled Model Intercomparison Project Phase 5 (CMIP5)
  - Fully coupled and atmosphere-only (AMIP) historical simulations

6. Stakeholder Workshops & Testbed Activity

Co-production of knowledge is the practice of two-way interactions between researchers and end users, leading to relevant and actionable results. We will co-produce sample products and tools in partnership with NOAA, the USGS South Central Climate Science Center, and three user communities: water resource managers, tribal environmental professionals, and emergency managers through a series of planned activities.

- A Research Priorities Workshop will occur in Year 1 to *prioritize* the types of S2S extreme precipitation events that will be studied.
- A Product Definition Workshop will be held in Year 3 to clarify how our research activities and results can best be translated into operational or educational products.
- A Testbed Activity will occur in Year 5 to bring researchers, partners, and users side-by-side to evaluate the research results and transform them into tangible outcomes, products, and tools.

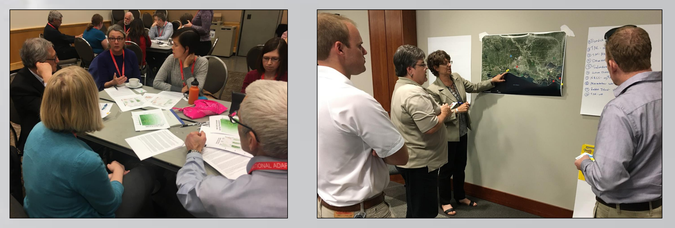

Figure 5: Stakeholder engagement throughout the project will provide guidance to researchers from multiple decision makers.

7. Summary

This project's aim is to enhance scientific understanding of S2S extreme precipitation events, improve their prediction, and increase communication between research and stakeholder communities with regard to such events.

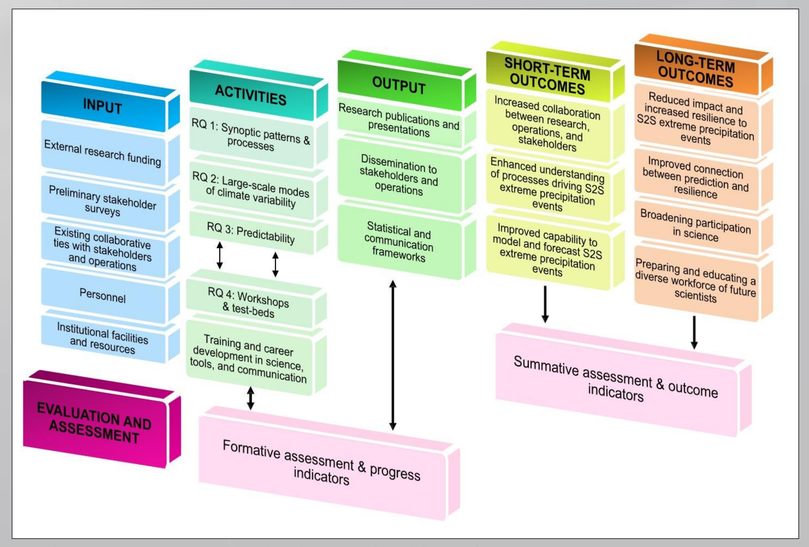

Figure 6: Summary logic diagram for this project.

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