

OKLAHOMA NSF EPSCoR S³OK RESEARCH

An overview of the S2S Focus Area Research Activities as part of the Oklahoma EPSCoR S3OK Project

Jeffrey Basara^{1,2}, Jason Furtado¹, Elinor Martin¹, Joseph Ripberger³, Yuting Zhou⁴, Jordan Christian¹, Benjamin Davis¹, Benjamin Fellman¹, Katherine Giannakopoulos¹, Taylor Grace¹, Ollie Millin¹, Henry Olayiwola¹, Bryony Puxley¹, and Alyssa Woodward¹

¹School of Meteorology, University of Oklahoma

²School of Civil Engineering and Environmental Science, University of Oklahoma

³Department of Political Science, University of Oklahoma

⁴Department of Geography, Oklahoma State University

OKLAHOMA
EPSCOR S³OK

Socially Sustainable Solutions for Water, Carbon, and Infrastructure Resilience in Oklahoma
NSF Award No. OIA-1946093



S³OK: MOTIVATION AND GOALS

THE GRAND RESEARCH CHALLENGE

Finding **broadly acceptable and sustainable solutions** to the intersecting (wicked) problems posed by:

- **Changing S2S weather patterns**
- **Terrestrial water and carbon dynamics**
- **Changing water quality/quantity; shifting landscape use**
- **Enhanced threats to infrastructure**

5-Year Project – Launched 1 July 2020

Multi-institutional project across Oklahoma

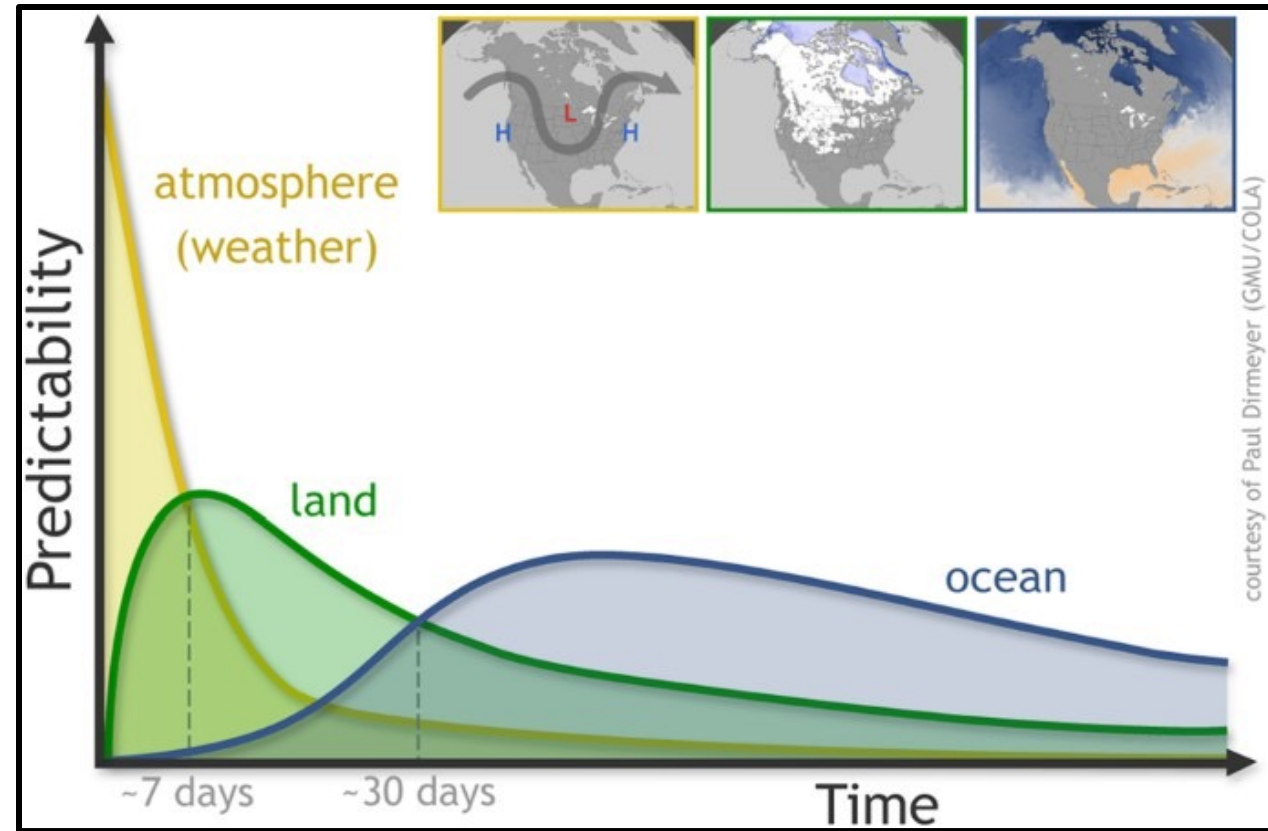
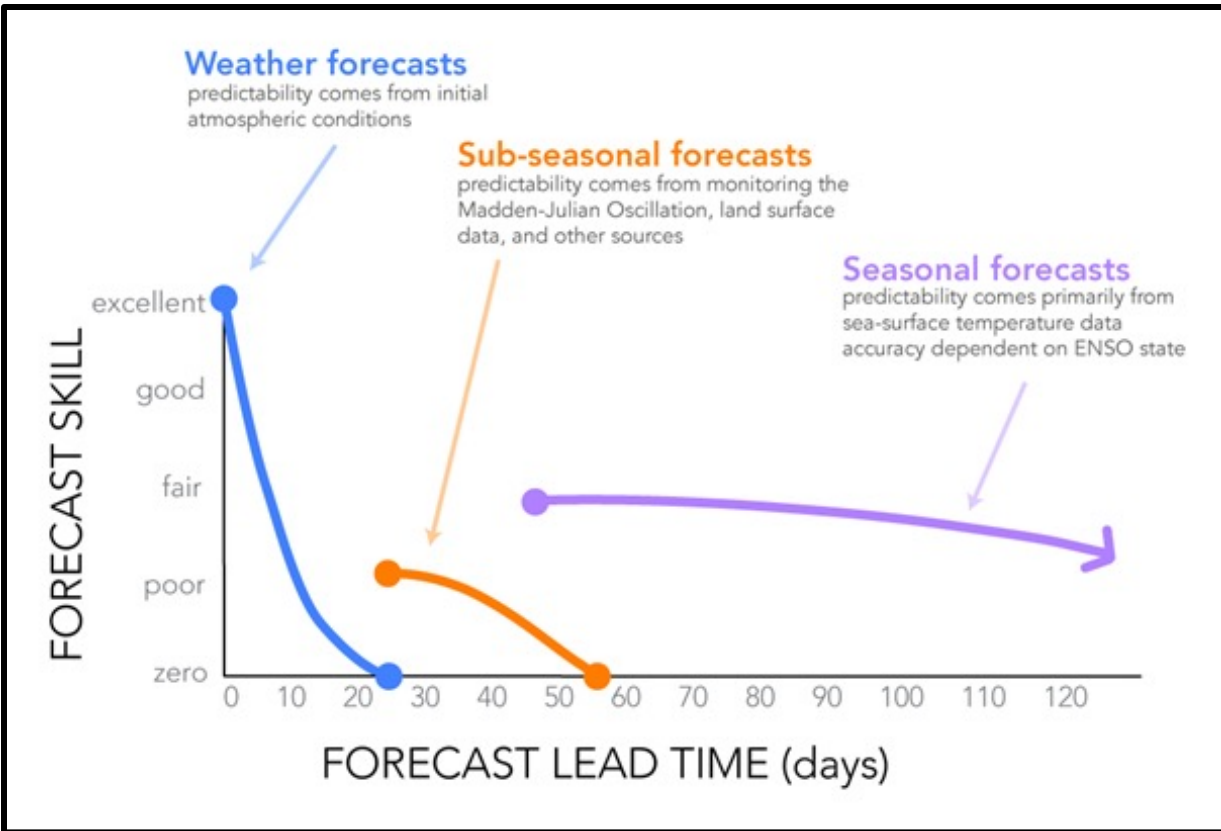
S³OK: MOTIVATION AND GOALS

WHAT MAKES A PROBLEM WICKED?

- We have incomplete knowledge and/or competing understandings of the problem
- The problems are interconnected while stakeholders and institutions that seek to solve the problems are not
- The key stakeholders have varying perceptions, beliefs and interests
- The magnitude of expected economic costs of the problem and of potential solutions is large and unequally distributed

OKLAHOMA NSF EPSCoR RESEARCH

S2S: WHAT IS SUBSEASONAL TO SEASONAL (S2S)?



S2S is the “gap” between weather and climate.

RESEARCH FOCUS AREA 1: S2S

CHANGING SUBSEASONAL TO SEASONAL WEATHER PATTERNS

Goals and Objectives

Research Question: What key features and feedback processes (e.g., synoptic blocking, teleconnections, surface-atmosphere exchange, snowpack, etc.) drive S2S events in space and time?

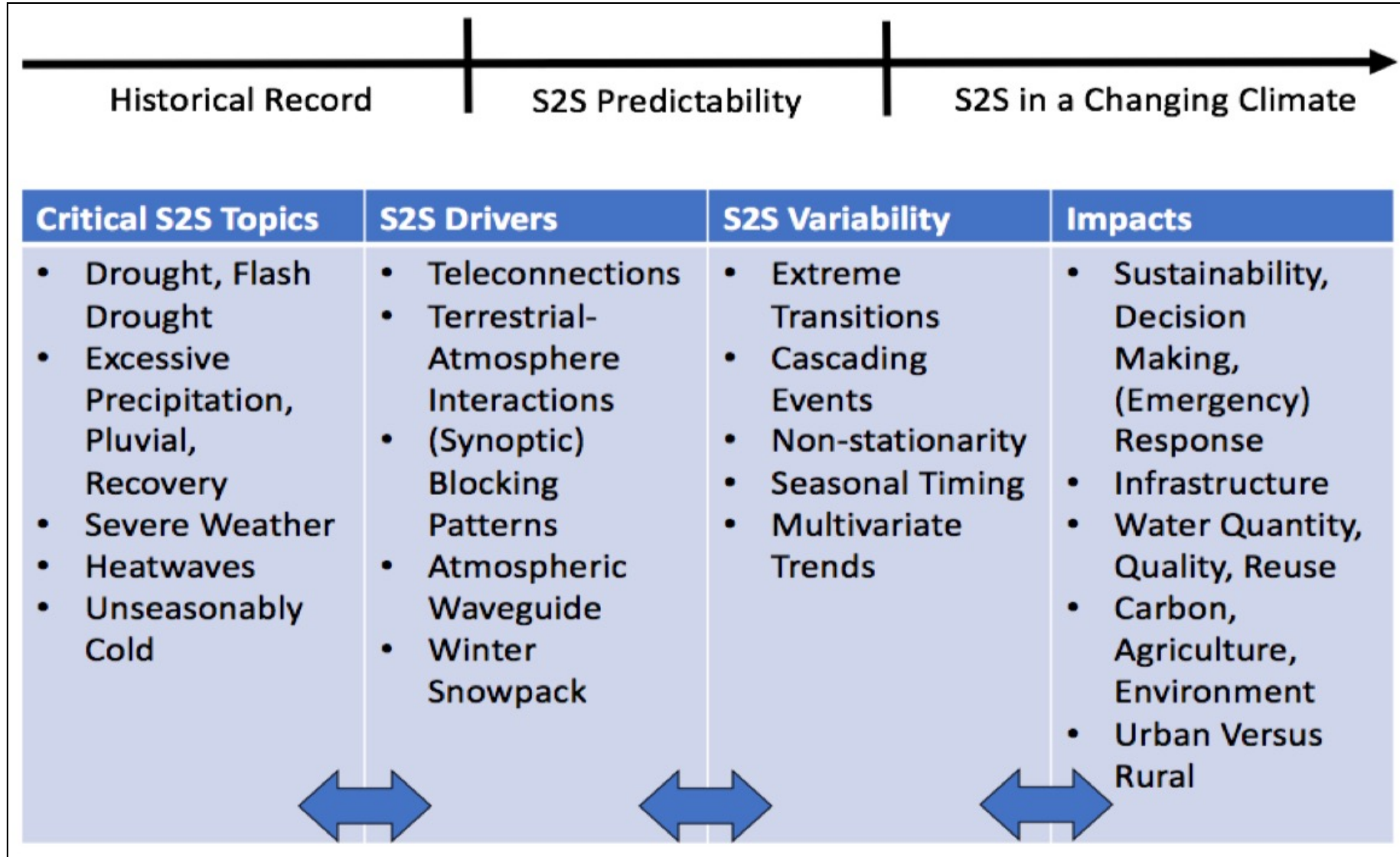
Research Question: How can we improve the predictability of critical S2S processes and events?

Research Question: What S2S thresholds and baselines are needed to improve or protect infrastructure, water (quality, quantify, reuse), carbon (e.g., agriculture), and overall societal needs?

- S2S Objective 1. Understand the basic processes driving changes in S2S patterns.
- S2S Objective 2. Improve models and predictions of basic S2S process and events.
- S2S Objective 3. Develop the data necessary for managing water, carbon and water cycles, and infrastructure in OK.
- S2S Objective 4. Create the S2S data repository and delivery system for the S3OK team, stakeholders, and future end users.

RESEARCH FOCUS AREA 1: S2S

CHANGING SUBSEASONAL TO SEASONAL WEATHER PATTERNS



RESEARCH FOCUS AREA 1: S2S
CHANGING SUBSEASONAL TO SEASONAL WEATHER PATTERNS

The S3OK S2S Team



Dr. Yuting Zhou
Department of Geography
Oklahoma State University



Dr. Jason Furtado – **FA Co-Lead**
School of Meteorology
University of Oklahoma



Dr. Jeffrey Basara – **FA Lead**
School of Meteorology
School of Civil Engineering and Environmental Science
University of Oklahoma



Dr. Elinor Martin
School of Meteorology
University of Oklahoma



Dr. Joseph Ripberger
Department of Political Science
University of Oklahoma

- **Postdoctoral Scientist – Dr. Jordan Christian**

- **7 (Current) Graduate Students**

RESEARCH FOCUS AREA 1: S2S

CHANGING SUBSEASONAL TO SEASONAL WEATHER PATTERNS

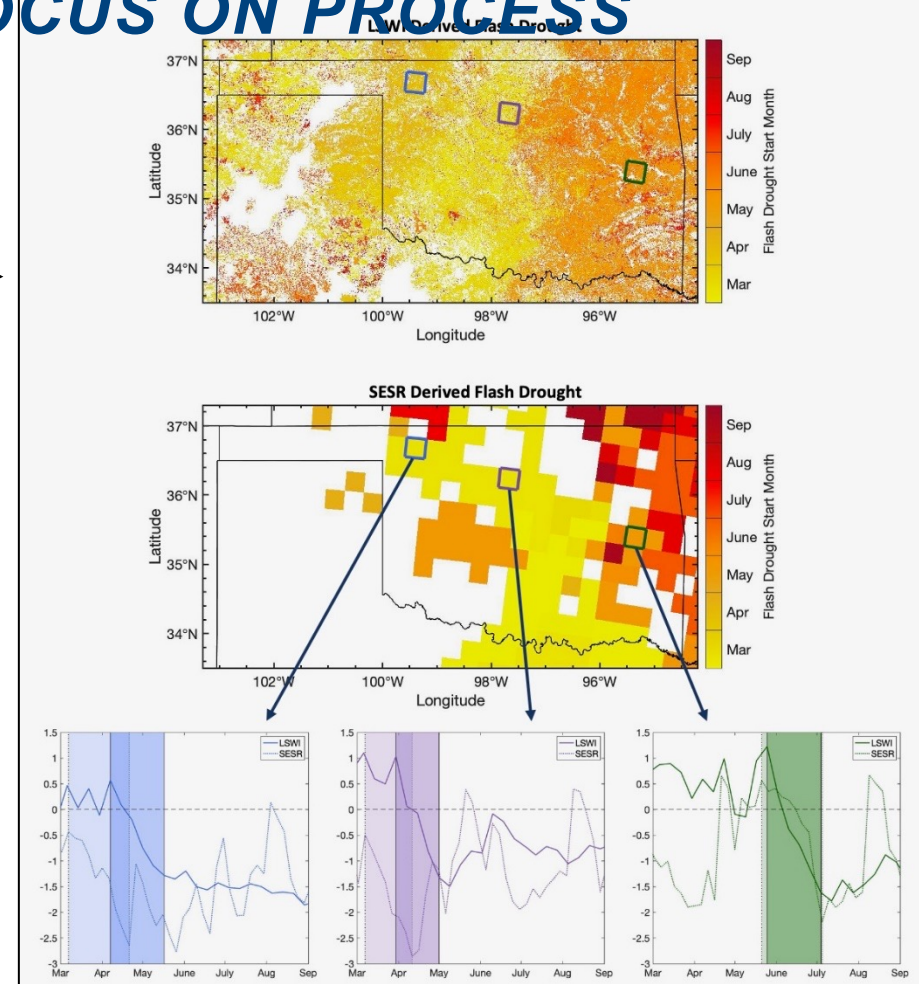
S2S : RESEARCH PROGRESS – FOCUS ON PROCESS



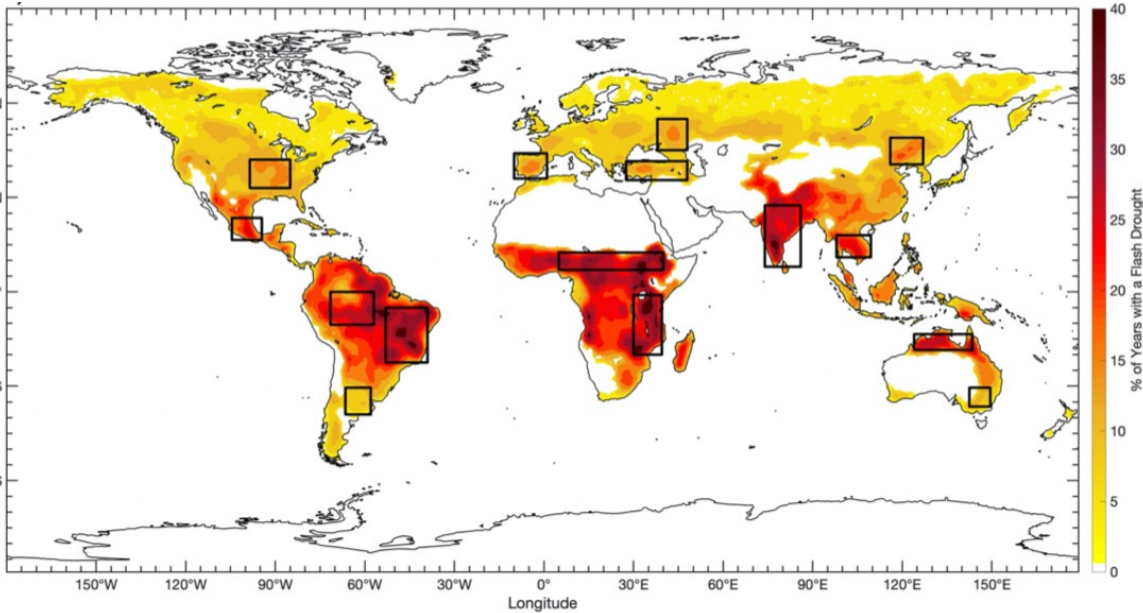
Flash Drought Dynamics

Dr. Jordan Christian
 Postdoctoral Scientist
 School of Meteorology
 University of Oklahoma

High Resolution
 Flash Drought from
 Satellite/Vegetation
 Observations →



← Global
 Climatology
 of Flash
 Drought



Christian, J., Basara, J. B., Hunt, E., Otkin, J., Furtado, J., Xiao, X. and R. Randall, 2021: Global Distribution, Trends, and Drivers of Flash Drought Occurrence. *Nature Comms.*, **12**, 6330 (2021). <https://doi.org/10.1038/s41467-021-26692-z>.

Christian J. I., J. B. Basara, L.E.L. Lowman, X. Xiao, D. Mesheske, and Y. Zhou, 2022: Flash Drought Identification from Satellite-Based Land Surface Water Index. *Remote Sensing Applications: Society and Environment*, **26**, 100770.

RESEARCH FOCUS AREA 1: S2S

CHANGING SUBSEASONAL TO SEASONAL WEATHER PATTERNS

S2S : RESEARCH PROGRESS – FOCUS ON PROCESS



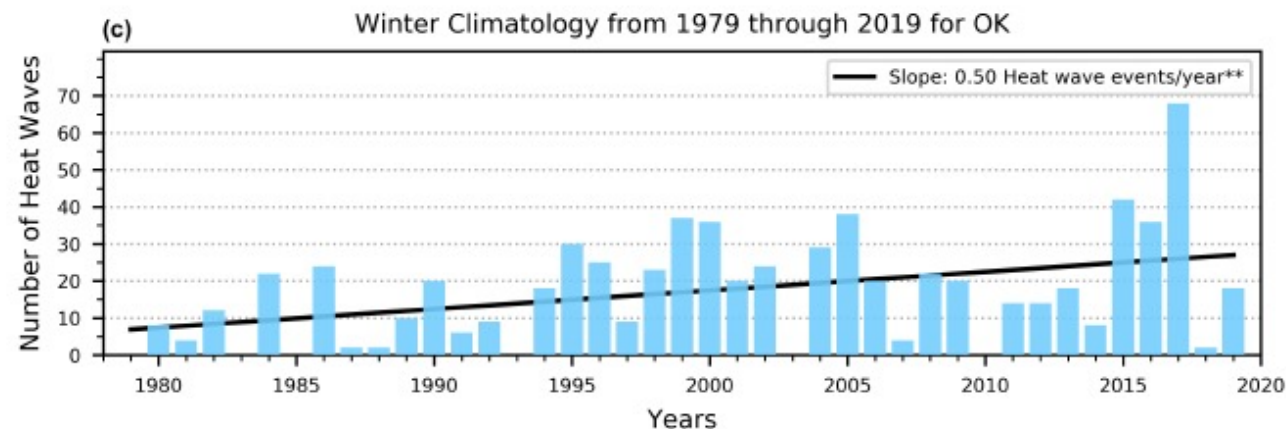
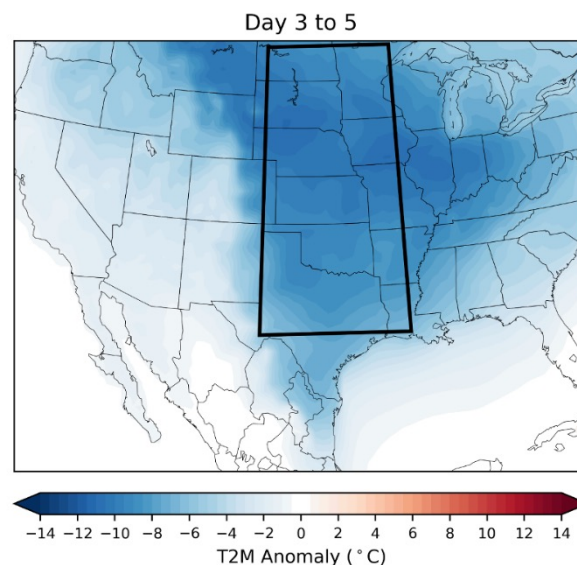
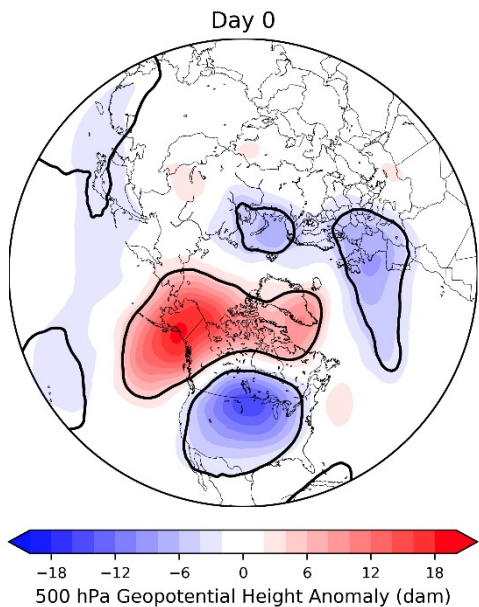
Drivers and Predictability of Cold Snaps in the Great Plains

Ollie Millin
 Graduate Research Assistant
 School of Meteorology
 University of Oklahoma



(All Season) Heat Waves in the Southern Great Plains

Taylor Grace
 Graduate Research Assistant
 School of Meteorology
 University of Oklahoma



RESEARCH FOCUS AREA 1: S2S

CHANGING SUBSEASONAL TO SEASONAL WEATHER PATTERNS

S2S : RESEARCH PROGRESS – FOCUS ON PROCESS



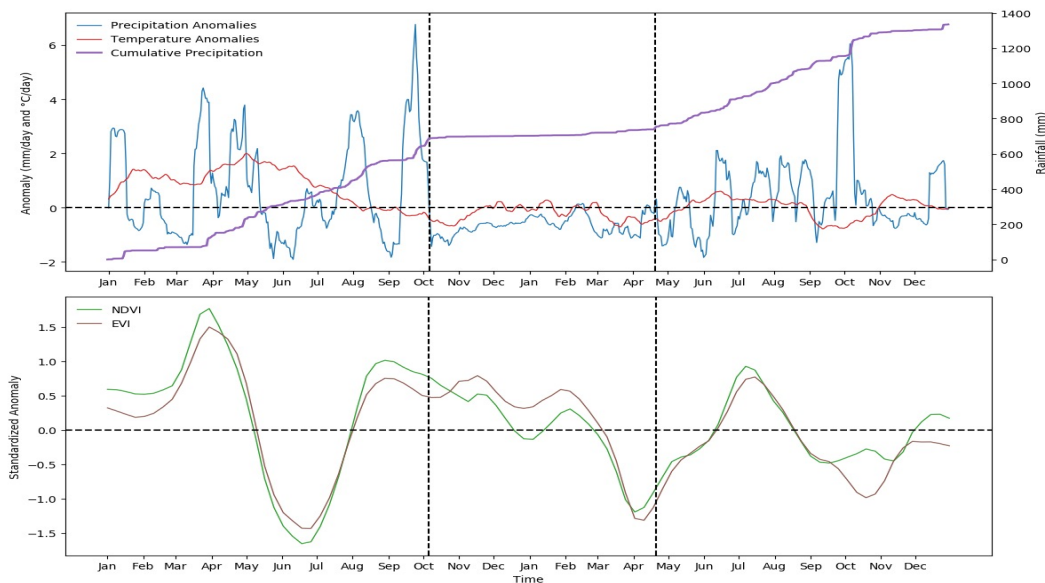
S2S Precipitation Transitions: Drought to Pluvial – Pluvial to Drought

Bryony Puxley
Graduate Research Assistant
School of Meteorology
University of Oklahoma



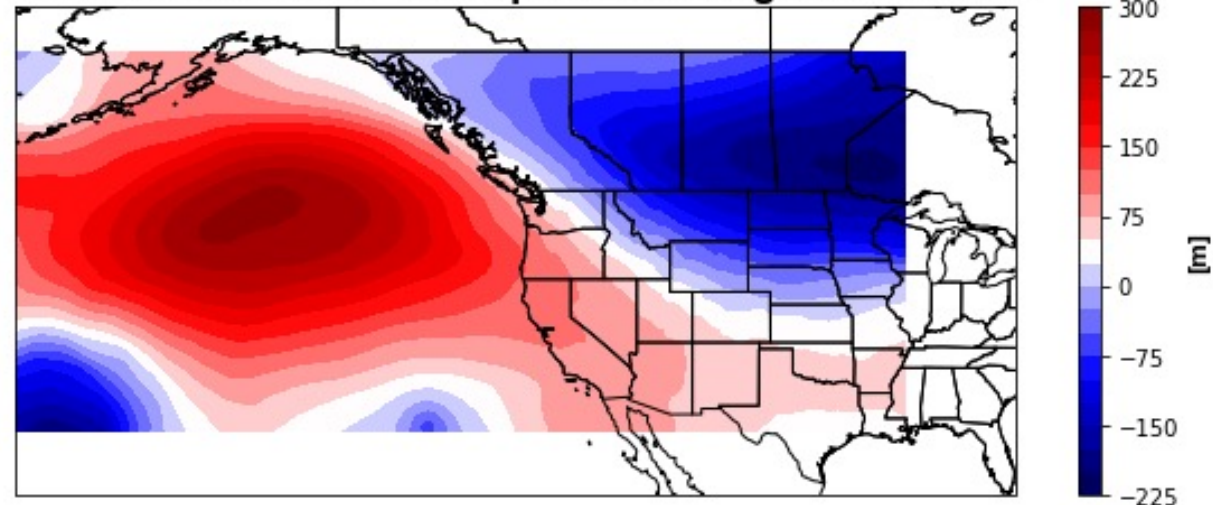
The October 2020 Ice Storm

Alyssa Woodward (*Graduated*)
Graduate Research Assistant
School of Meteorology
University of Oklahoma



Key Results: Location/timing of precipitation whiplashes (especially Fall transitions) and links to wildfires.

October 2020 500 hPa Geopotential Height Anomalies

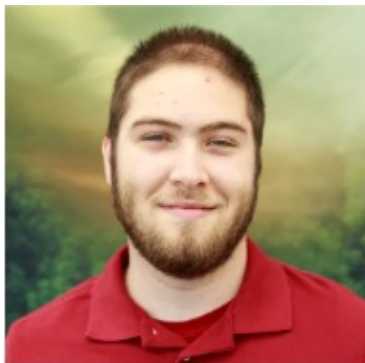


Key Results: Earliest ice storm on record, major impacts across sectors, links to large-scale dynamical processes.

RESEARCH FOCUS AREA 1: S2S

CHANGING SUBSEASONAL TO SEASONAL WEATHER PATTERNS

S2S : RESEARCH PROGRESS – FOCUS ON PROCESS



Wet Bulb Globe Temperature Heat Stress and Heatwave Events

Ben Davis
Graduate Research Assistant
School of Meteorology
University of Oklahoma



Abrupt Flash Drought Events And Associated Impacts to Agriculture

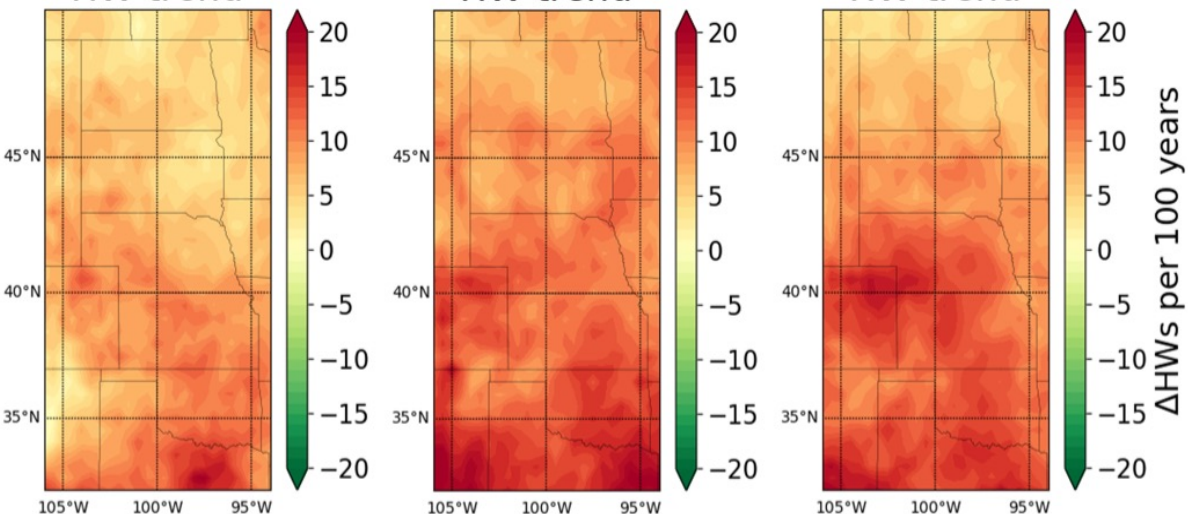
Ben Fellman
Graduate Research Assistant
School of Meteorology
University of Oklahoma

Maximum HW trend

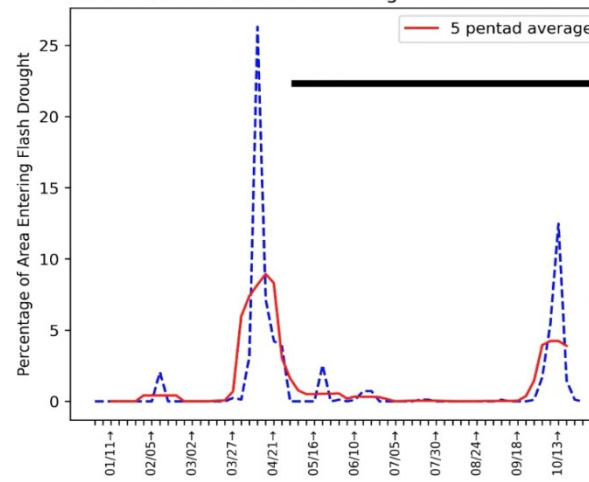
Minimum HW trend

Mean HW trend

Δ HWs per 100 years

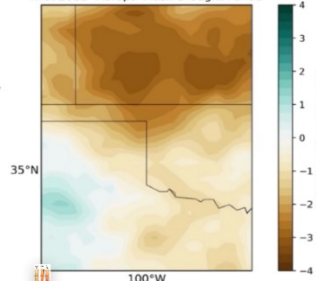


Southern Great Plains Flash Drought Start Date for 2012

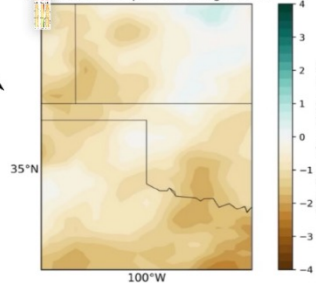


2012 featured 2 abrupt flash drought events, covering different areas with varying intensities.

First 2012 "Abrupt" Flash Drought Period



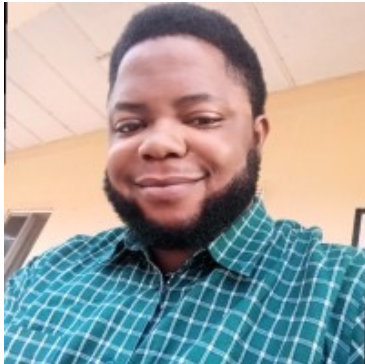
Second 2012 "Abrupt" Flash Drought Period



RESEARCH FOCUS AREA 1: S2S

CHANGING SUBSEASONAL TO SEASONAL WEATHER PATTERNS

S2S : RESEARCH PROGRESS – FOCUS ON PROCESS



Compound and Cascading Events

Henry Olayiwola
Graduate Research Assistant
School of Meteorology
University of Oklahoma



Temperature Whiplash Events

Katherine Giannakopoulos
Graduate Research Assistant
School of Meteorology
University of Oklahoma

Coming Soon ...

RESEARCH FOCUS AREA 1: S2S

CHANGING SUBSEASONAL TO SEASONAL WEATHER PATTERNS

Impacts of the Research

- **Example** - Flash drought research has improved methods to identify and monitor occurrence from local (i.e., in Oklahoma) to global. Was published in a high impact journal (Nature Communications), was featured as a Nature Highlight, has received significant media coverage, and has directly impacts research collaborations with other S3OK teams (TWCD, SI, SD, V-MWQ)
- **Example** – Cold air outbreak research has advanced scientific understanding across the weather/S2S/climate research but also tangible impacts across infrastructure and socio-economic impacts. Jason Furtado presented at the Society for Risk Analysis Annual Meeting in December 2021.

The image shows a screenshot of a research article page from Nature Communications. The article title is "A Meteorological Evaluation of the February 2021 North American Cold Wave". The authors listed are Jason Furtado, Oliver Millin, and Jeffrey Basara. The article is part of a symposium titled "W57 - Symposium: Exploring the Complexity of Extreme Weather Events: Risk Perceptions, Communication, State Capacity, and Societal Response During the February 2021 Cold Weather Event". Other authors listed for the symposium include Andrew Fox, Jeff Basara, Kuhika Gupta, Joseph Ripberger, Muralee Muraleetharan, and Warigia Bowman. The page also features a sidebar with navigation options like "HOME" and "Will", and a "Flash drought" section with a "Like" button.

A Meteorological Evaluation of the February 2021 North American Cold Wave

Co-Authors: Jason Furtado, Oliver Millin, Jeffrey Basara Rationale: For about two weeks in February 2021, widespread r...

Jason Furtado
School of Meteorology, University of Oklahoma
Associate Professor

1:00 PM - 1:15 PM CST (Wed, Dec 8)

APPLIED RISK MANAGEMENT | RISK COMMUNICA... | RISK ASSESSMENT | DEVELOPMENT

CLIMATE ADAPTATION (PREPAREDNESS)

SYMPOSIUM

W57 - Symposium: Exploring the Complexity of Extreme Weather Events: Risk Perceptions, Communication, State Capacity, and Societal Response During the February 2021 Cold Weather Event

Co-Authors: Andrew Fox, Jeff Basara, Kuhika Gupta, Joseph Ripberger, Muralee Muraleetharan, Warigia Bowman Rationale: T...

Warigia M. Bowman
University of Tulsa College of Law
Associate Professor

Andrew S. Fox
University of Oklahoma
Research Scientist

Jason Furtado
School of Meteorology, University of Oklahoma
Associate Professor

Kuhika Gupta
University of Oklahoma

Paul Moses, PhD
University of Oklahoma
Assistant Professor

Muralee Muraleetharan
School of Civil Engineering & Environmental Science, University of Oklahoma
Professor

Joseph Ripberger
University of Oklahoma

RESEARCH FOCUS AREA 1: S2S

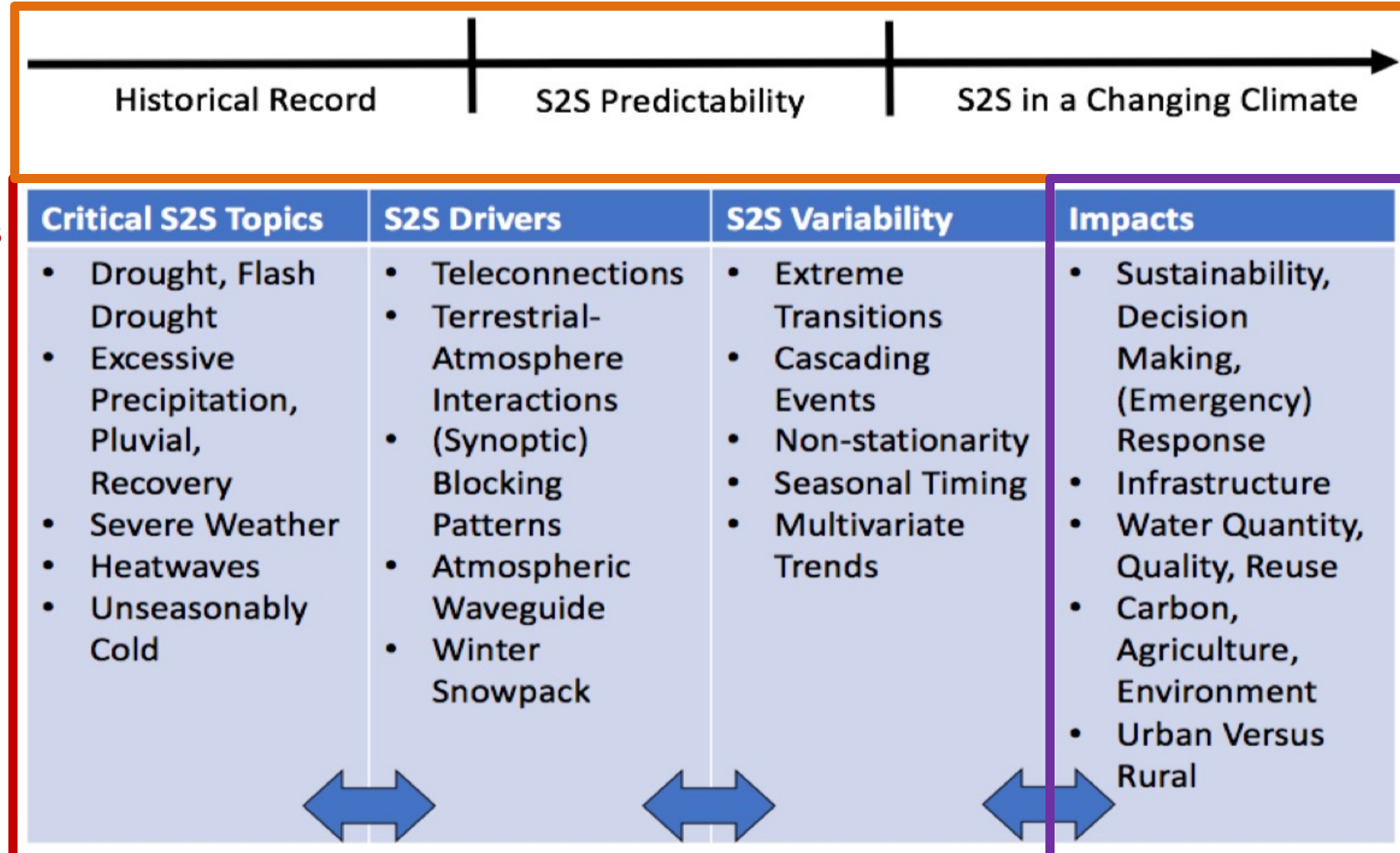
CHANGING SUBSEASONAL TO SEASONAL WEATHER PATTERNS

Progress to Date

- Understanding Processes
- Predictability/Change
- Impacts
- Extreme Events

Focus Timelines

1. Years 1-4
2. Years 2-5
3. Years 2-5
4. Years 1-5



RESEARCH FOCUS AREA 1: S2S

CHANGING SUBSEASONAL TO SEASONAL WEATHER PATTERNS

Future Plans

- Transition from **Process Understanding** to **Predictability and Change** – especially in Years 2-3.
- Address Process and Predictability under the full S3OK umbrella (e.g., flash drought, whiplash events → wildfires, heatwaves, etc.)
- Analysis of Extreme Events and Impacts with S3OK teams (i.e., 2020 Ice Storm – [SI](#) , 2021 Deep Freeze - [SD](#), 2021 Flash Drought - [TCWD](#), etc.).
- Structured engagement with S3OK teams via focused/collaborative projects (e.g., the Little River Watershed Study).
- Continued development of the S3OK event database – significant opportunities for collaboration.

