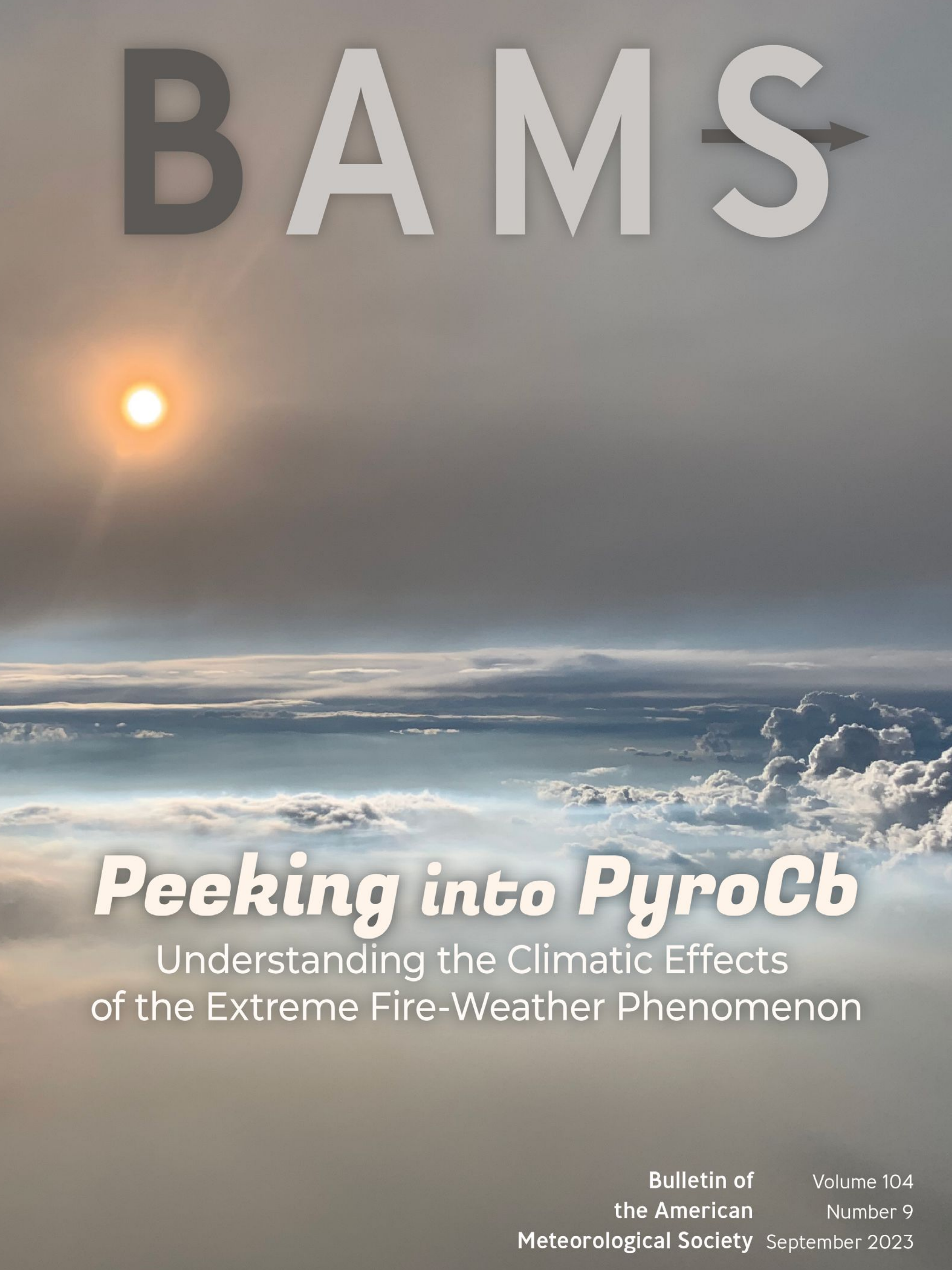

BAMS

Peeking into PyroCb

Understanding the Climatic Effects of the Extreme Fire-Weather Phenomenon

Bulletin of the American Meteorological Society

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PRECURSORS

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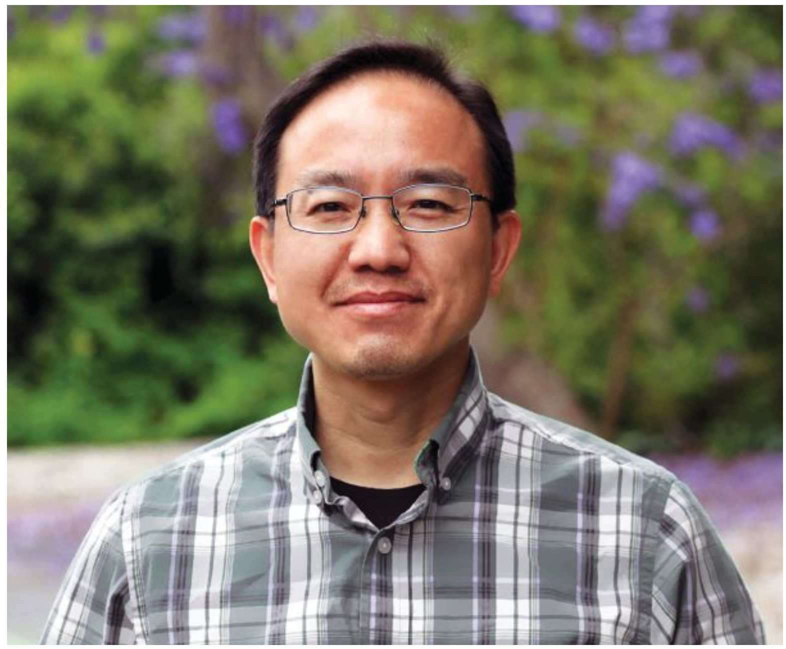

"I was born on an island on the east coast of China near Shanghai. On average, the island is struck by at least two strong tropical cyclones each year. During those days when the island was completely under the heavy rain and gusty winds brought by tropical cyclones, we had to stay at home to keep safe. The fishing boats that were operating near the island also had to return to the harbor to take shelter. For those special times, the local weather service would broadcast the forecast of the tropical cyclones' location, intensity, and movement through radio once an hour or more. I was impressed by the overall accuracy of the forecasts and felt it would be very cool to be a meteorologist. So I majored in meteorology, later obtaining a master's degree at Shanghai Typhoon Institute, before pursuing a Ph.D. in tropical meteorology in the United States."

— Xianan Jiang, University of California, Los Angeles, and California Institute of Technology

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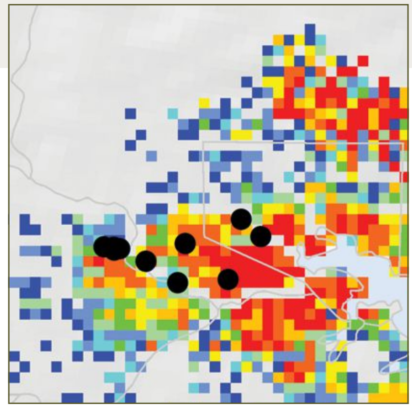
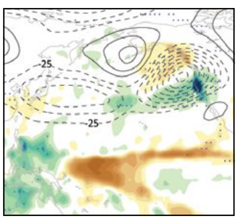
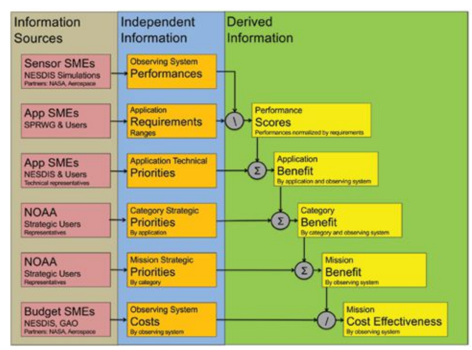
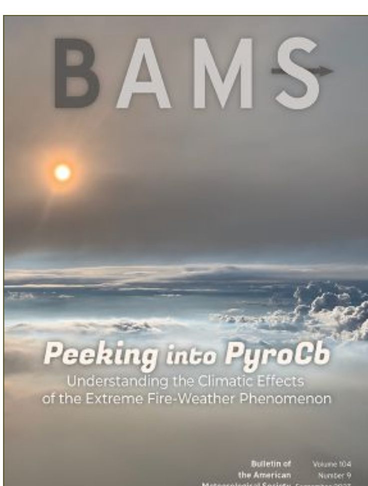


FEATURES







ON THE COVER: NASA's DC-8 flying laboratory glimpses the setting sun from within the smoke-filled pyroCb anvil of the Williams Flats fire in Washington State on 8 August 2019. A growing, interdisciplinary community is currently working to understand the role of these distinctive storms in a warming climate.

See page 685.

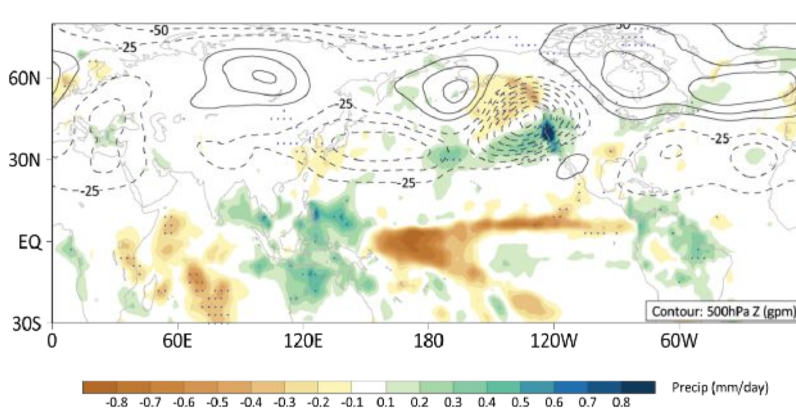
Not Looking So California

Winter Season Outlooks There Using Only ENSO May Be Unreliable

Key messages from "Why Seasonal Prediction of California Winter Precipitation Is Challenging," by **Xianan Jiang** (University of California, Los Angeles, and California Institute of Technology), **Duane E. Waliser, Peter B. Gibson, Gang Chen,** and **Weina Guan**. Published online in *BAMS*, December 2022. For the full, citable article, see https://doi.org/10.1175/BAMS-D-21-0252.1.

California (CA) experienced extreme droughts during the water years of 2020–22, which led to the declaration of a statewide drought emergency in 2021. Since the bulk of CA precipitation is received during the winter season from November to March, a reliable forecast of winter precipitation several months ahead is critical to guide state water managers in decision-making on water conservation and restriction policies. Despite the urgent need to support drought preparedness, our main seasonal prediction systems at NOAA and other prediction centers show rather limited skill in predicting historical fluctuations of CA precipitation. While most of these prediction approaches heavily rely on the anomalous sea surface temperature over the tropical Pacific and its induced circulation patterns [e.g., the El Niño–Southern Oscillation (ENSO)], historical records suggest that ENSO only explains about 30% of the year-to-year variability of CA winter precipitation. This became the primary motivation of this study—a critical question we wanted to address: What are the key processes beyond the influences of ENSO that tend to limit predictive skill of CA precipitation?

Since the wet and dry spells over CA during the winter season are closely linked to moisture transport by circulation patterns off the U.S. West Coast, we managed to separate the total year-to-year variability of CA winter precipitation and associated circulation patterns into ENSO-related and non-ENSO-related components. The results are surprising: ENSO only plays a minor role for total CA precipitation; instead, a majority of CA precipitation tends to be independent from ENSO and closely associated with a short-Rossby wave pattern over the extratropical North Pacific. After we examined historical winter predictions issued in October from three state-of-the-art model systems, it was even more surprising



Large-scale precipitation and circulation patterns associated with the year-to-year variability of California winter precipitation beyond the influences of El Niño. This circulation pattern needs to be accurately predicted for skillful seasonal prediction of California precipitation, but it remains poorly represented in present-day climate prediction models.

to find that all three models have almost no capability to predict the ENSO-independent circulation patterns associated with CA precipitation, although they generally show good skill for ENSO. This explains the models' overall limited skill in predicting CA precipitation. In other words, our results suggest that skillful prediction of the ENSO-independent circulation patterns is essential for a breakthrough in seasonal prediction skill of CA precipitation. Despite its importance for CA precipitation, the key drivers of the ENSO-independent circulation patterns remain poorly understood. We also do not know whether the poor prediction of the ENSO-independent circulation patterns by climate models is due to the chaotic nature of mid- to high-latitude atmospheric processes, or due to model inability in representing remote influences from tropical convection, Arctic sea ice, and/or the stratospheric polar vortex, etc. If the latter is the case, it could represent a promising direction to achieve a breakthrough in seasonal prediction of CA precipitation through improved process understanding and modeling capability.

It is worth noting that after we published this study in September 2022, NOAA issued the seasonal overlook for the 2022/2023 winter with warm and dry conditions predicted over the southwest United States, including CA, largely based on the La Niña pattern at that time. However, the 2022/2023 winter turned out to be one of the wettest in CA history. This prediction failure reminds us of a very similar situation when predicting CA precipitation during the 2016/2017 winter, confirming the main message from this study that prediction of CA precipitation purely based on ENSO could be unreliable. It is our hope that this study will motivate community efforts to focus on circulation patterns beyond ENSO influences for improved seasonal prediction of CA precipitation.

METADATA

BAMS: What would you like readers to learn from this article?

Xianan Jiang (University of California, Los Angeles, and California Institute of Technology): *The main message we wanted to deliver in this study is that while the El Niño–Southern Oscillation (ENSO)—the leading variability mode of tropical sea surface temperature and its induced circulation patterns—has been widely used as a primary predictor for California precipitation, it only plays a relatively minor role in contributing to the total winter precipitation over California based on historical records. To achieve a breakthrough in seasonal prediction of California precipitation, we need to focus on circulation patterns beyond the influences of ENSO.*

BAMS: How did you become interested in the topic of this article?

XJ: *As a resident of the Los Angeles area, I have experienced the extremely dry conditions in Southern California. In particular, through the participation of a partnership project on subseasonal-to-seasonal prediction of California precipitation, which involved the California Department of Water Resources, the Jet Propulsion Laboratory, UCLA, and other academic institutions, I keenly felt the urgent need for a reliable forecast of California precipitation to aid state water managers coping with the prolonged droughts. After realizing the limited seasonal prediction skill for California precipitation in current prediction systems, and that most prediction systems heavily rely on the ENSO pattern, I felt the need to explore processes associated with California precipitation beyond the ENSO influences to better understand why prediction of California precipitation is so challenging.*

BAMS: What surprised you the most about the work you document in this article?

XJ: *Although it has been indicated in several previous studies, I was still a bit surprised that ENSO, which has been widely used as the primary predictor for California precipitation, only plays a minor role in the year-to-year variability of California precipitation. What particularly surprised me was to find that our most recent generation of numerical models have almost no capability for predicting the ENSO-independent circulation patterns that are crucial in regulating California precipitation.*

BAMS: What was the biggest challenge you encountered while doing this work?

XJ: *The most challenging part of this study is understanding the origins of the ENSO-independent circulation patterns associated with California precipitation, and why these circulation patterns are poorly predicted in climate models. Addressing these questions will be critical for a breakthrough in predicting California precipitation. One of the main purposes of this study is to call for coordinated community efforts toward improved understanding of the mechanisms and predictability of the ENSO-independent circulation patterns associated with California precipitation.*

"I will conduct in-depth analyses to better understand the key processes controlling circulation patterns associated with California precipitation beyond the ENSO influences. These processes can provide critical insights into the precursor signals for prediction of California precipitation. Meanwhile, by closely working with colleagues at modeling centers, I will explore how California precipitation and associated circulation patterns can be predicted in our new-generation global high-resolution models, given their improved capability in representing both tropical and polar processes, as well as interactions between the troposphere and stratosphere."

—Xianan Jiang, University of California, Los Angeles, and California Institute of Technology

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"The AMS AI Committee will continue to welcome new practitioners to our conferences, encourage broader use in the environmental sciences, and continue education activities so that novices can learn to get the best from their attempts at using AI while demonstrating rigor in their applications of the techniques."

—Sue Ellen Haupt, National Center for Atmospheric Research

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Sue Ellen Haupt (second from left) and some of her *BAMS* article coauthors at the 2020 AMS Annual Meeting in Boston: (left to right) Vladimir Krasnopolsky, Philippe Tissot, Amy McGovern, John Williams, and David John Gagne.