Casey Burleyson

- Earth Scientist, Level 4
- 12.5 years with PNNL in the Atmospheric, Climate, and Earth Sciences (ACES) division in EBSD
- Research Interests
  - Weather impacts on power systems
    - IM3, GODEEEP, FORESIGHT, GDO, NTPS, NAERM, WPTO
  - Energy system planning
  - Open science
- Personal Interests
  - Shannon, Grant (7), and Reid (5)!
  - Baseball
  - Optimized wine and BBQ pairings
  - Non-fiction books (biographies, military history, and other things Shan considers boring)
  - Running

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Reliability EXplorer (REX)

Casey Burleyson, Alfred Wan, and Nathalie Voisin

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Motivation: NERC TPL-008-1

"The purpose of the TPL-008-1 standard is to establish transmission system planning performance requirements to develop a Bulk Power System (BPS) that will operate reliably during extreme heat and extreme cold temperature events."

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NERC Approves New Extreme Weather Planning Standard

R2. Each Planning Coordinator shall identify the zone(s) to which the Planning Coordinator belongs to under Attachment 1 and shall coordinate with all Planning Coordinators within each of its identified zone(s), to identify one common extreme heat benchmark temperature event and one common extreme cold benchmark temperature event for each of its identified zone(s) when completing the Extreme Temperature Assessment. The benchmark temperature events shall be obtained from the benchmark library maintained by the ERO or developed by the Planning Coordinators. Each benchmark temperature event identified by the Planning Coordinators shall: *[Violation Risk Factor: High] [Time Horizon: Long-term Planning]*

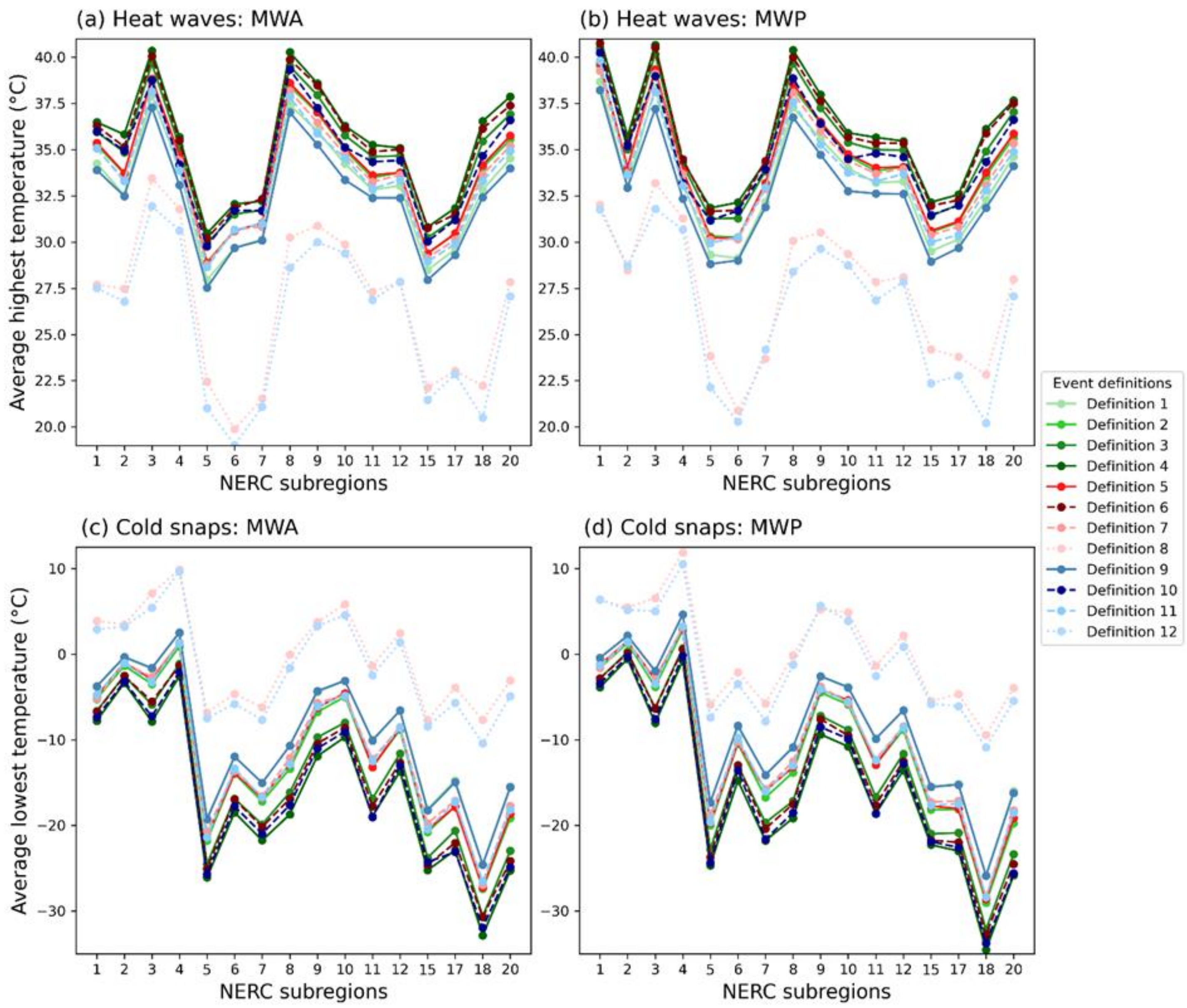
2.1. Consider no less than a 40-year period of temperature data ending no more than five years prior to the time the benchmark temperature events are selected; and

2.2. Represent one of the 20 most extreme temperature conditions based on the three-day rolling average of daily maximum (heat) or daily minimum (cold) temperature across the zone.

Wan, H., C. Burleyson, and N. Voisin, 2026: What technical choices matter to characterize thermal events in support of bulk power grid reiliaility studies? Accepted in *Earth's Future* – April 2026.

Burleyson, C., N. Voisin, O. Anderson, H. Wan, and C. Bracken, 2026: Characterizing diversity in heat wave and cold snap responses for assessing grid reliability. Submitted to *Applied Energy* – April 2026.

Impact of event definitions



"To identify heat waves and cold snaps, we used combinations of the two temperature spatial aggregation methods (MWA and MWP) and twelve event definitions taken from the peer-reviewed literature. Each of the twelve event definitions is paired with one of the two temperature spatial aggregation methods for detecting extreme weather events, resulting in a total of 24 combinations explored…Definitions 1-4 use daily mean temperature, 5-8 use daily maximum temperature, and 9-12 use daily minimum temperature. All definitions require events to last at least two days."

Wan, H., C. Burleyson, and N. Voisin, 2026: What technical choices matter to characterize thermal events in support of bulk power grid reliability studies? Accepted in *Earth's Future* – April 2026.

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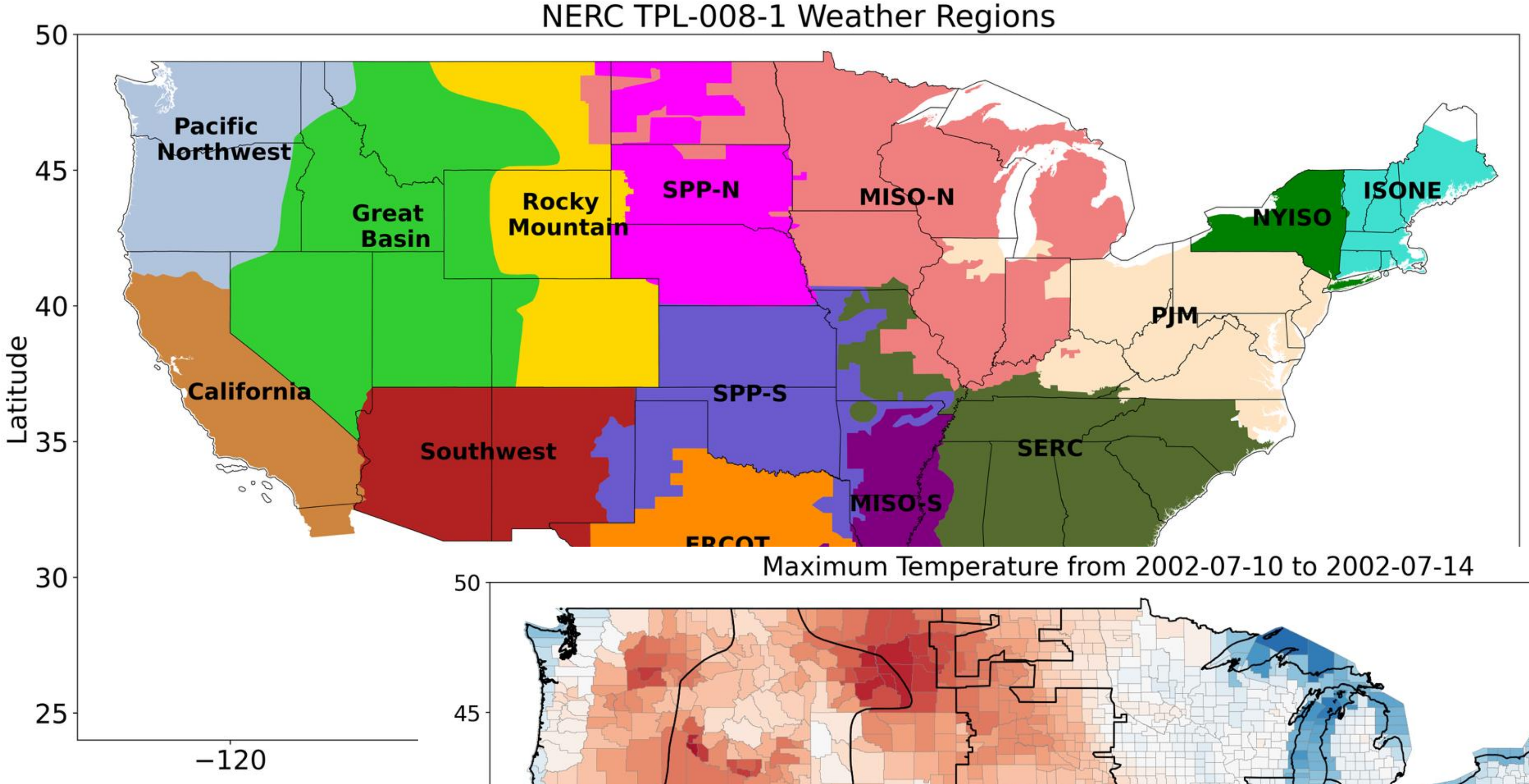
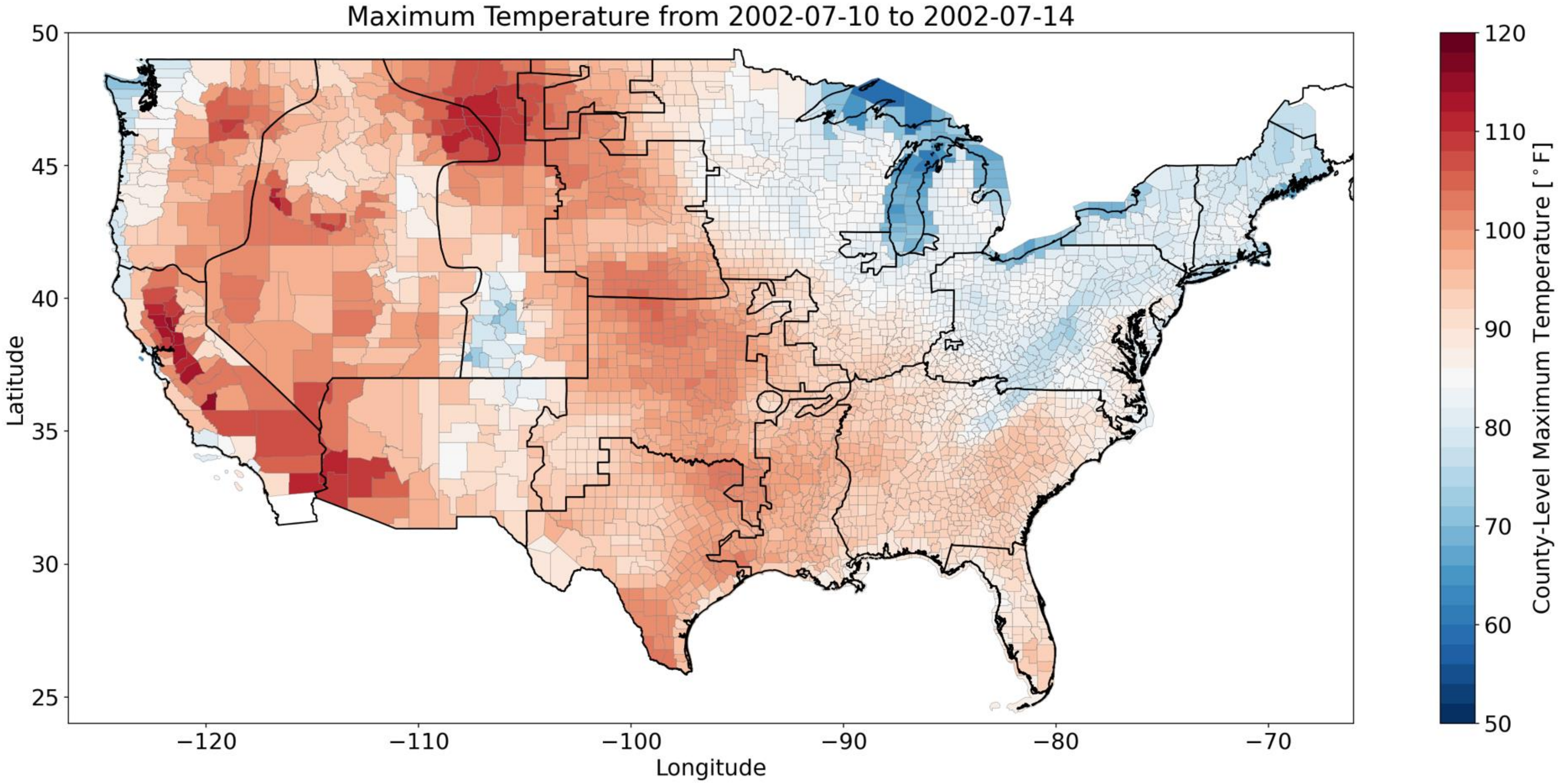
We used IM3's TGW historical meteorology dataset to look for heat waves and cold snaps

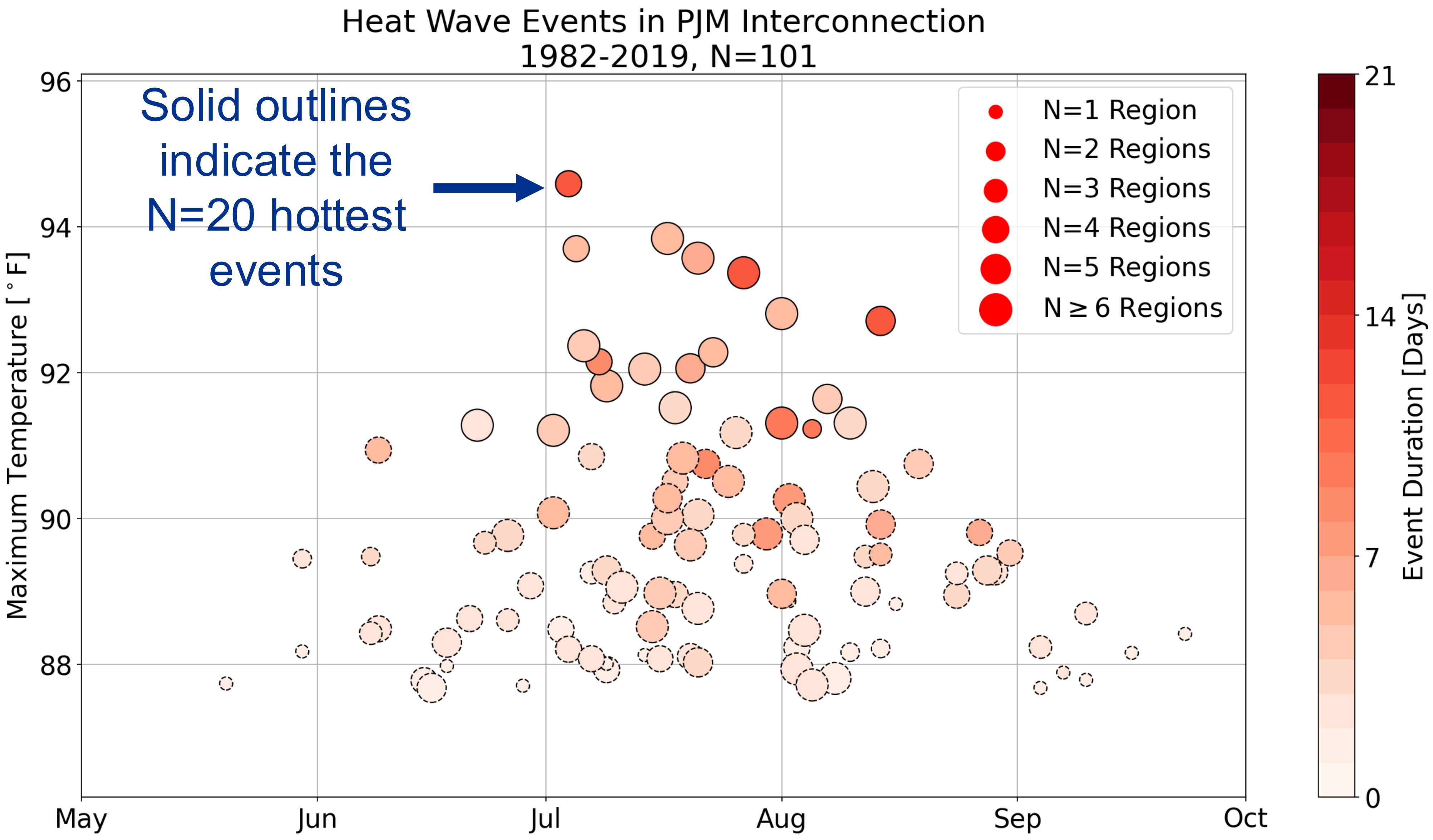




TGW Data

- Historic data reproduces observed sequence of past events (1980–2024)
- 1/8 deg (~12 km) resolution over the U.S.
- 25 hourly and 250+ three-hourly variables
- Output is first spatially-averaged by county then population-weighted to create annual 8760-hr meteorology time series each TPL-008-1 region
- Heat waves > 97.5% for daily max
- Cold snaps < 2.5% for daily min

We created a catalogue of heat wave and cold snap events for every region from 1982-2019



The thermal events in the catalogue have significant variability in severity, time of year, spatial extent, and duration.

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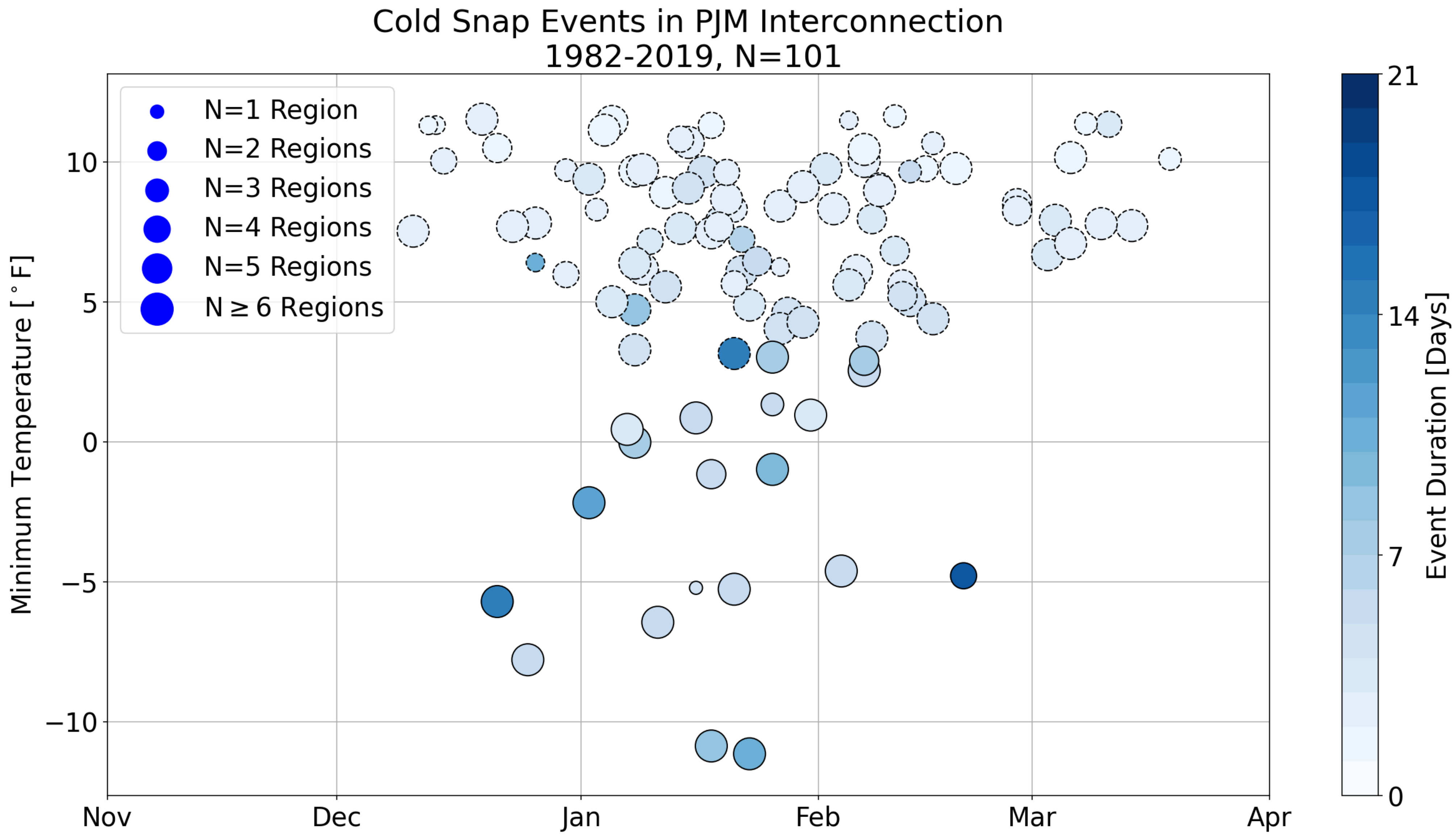

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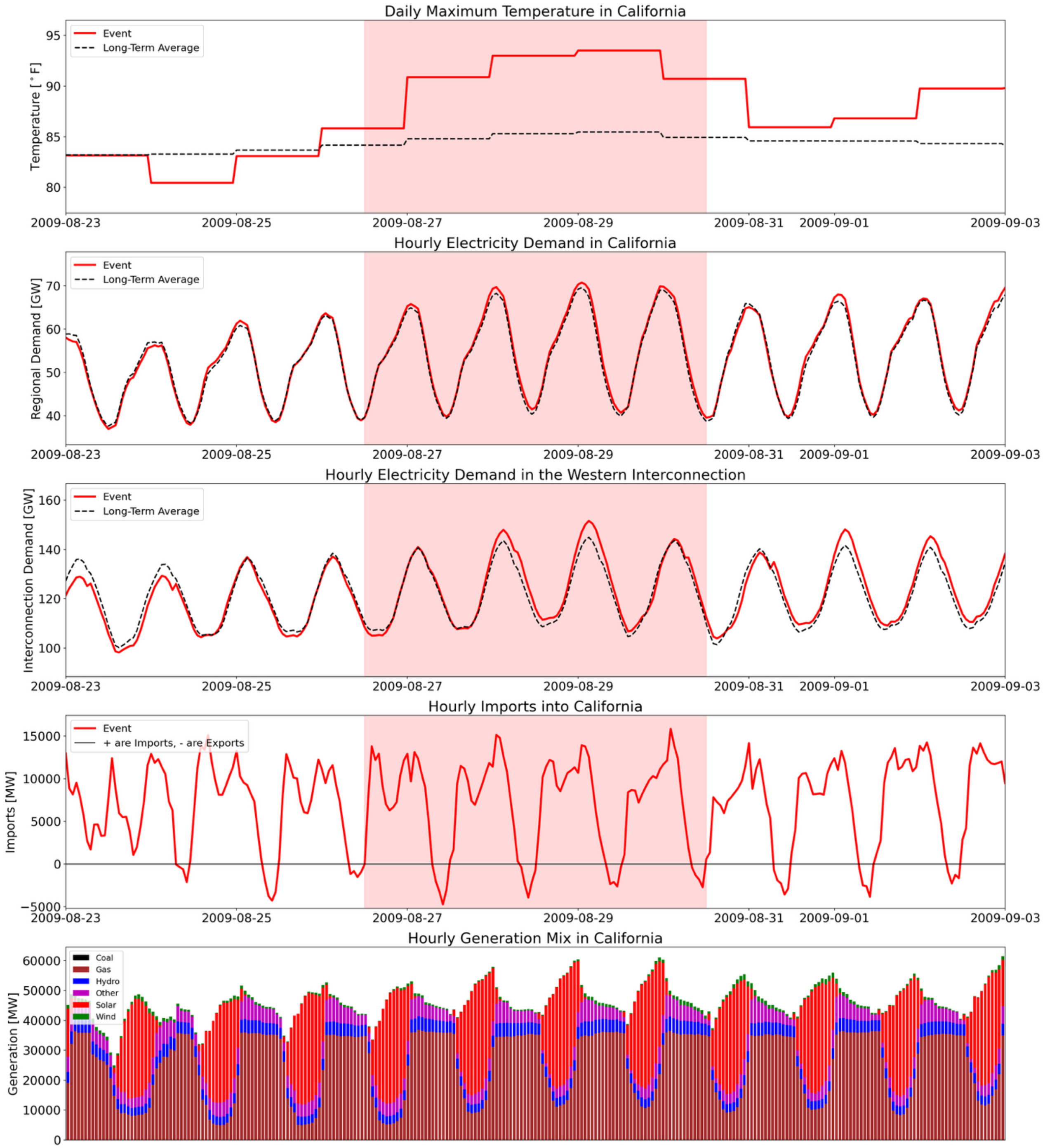
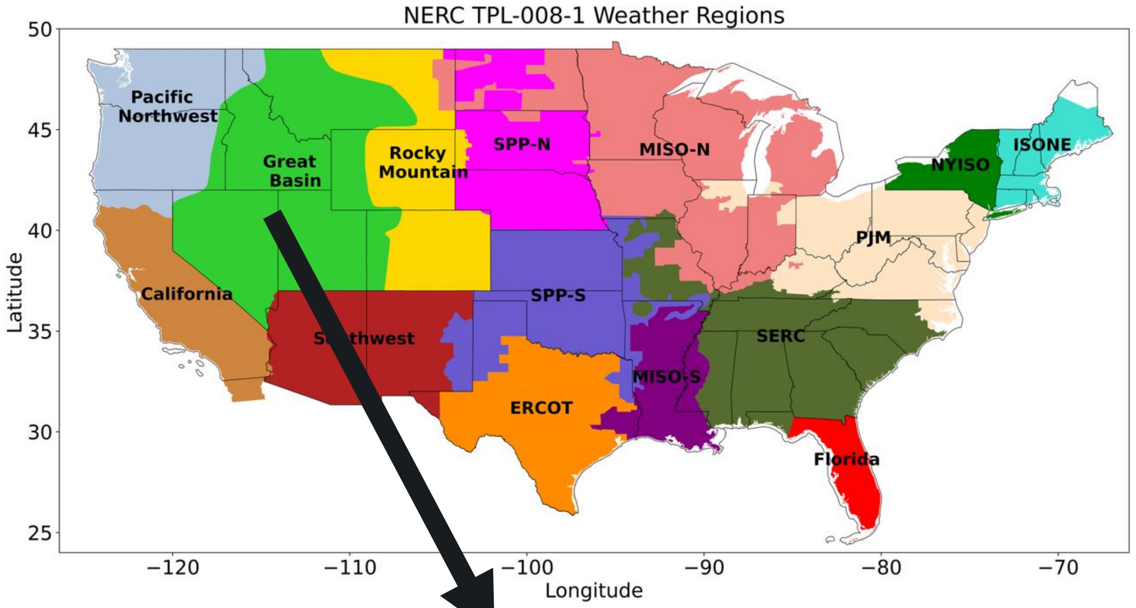
We simulated all 38 historical weather years to understand how the events impacted the grid

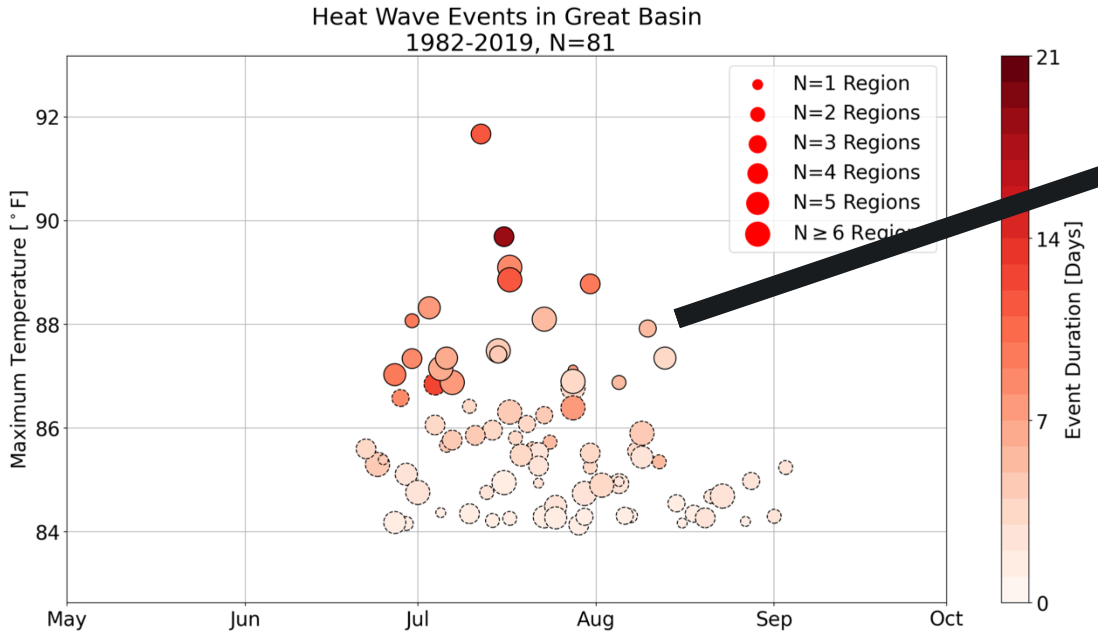


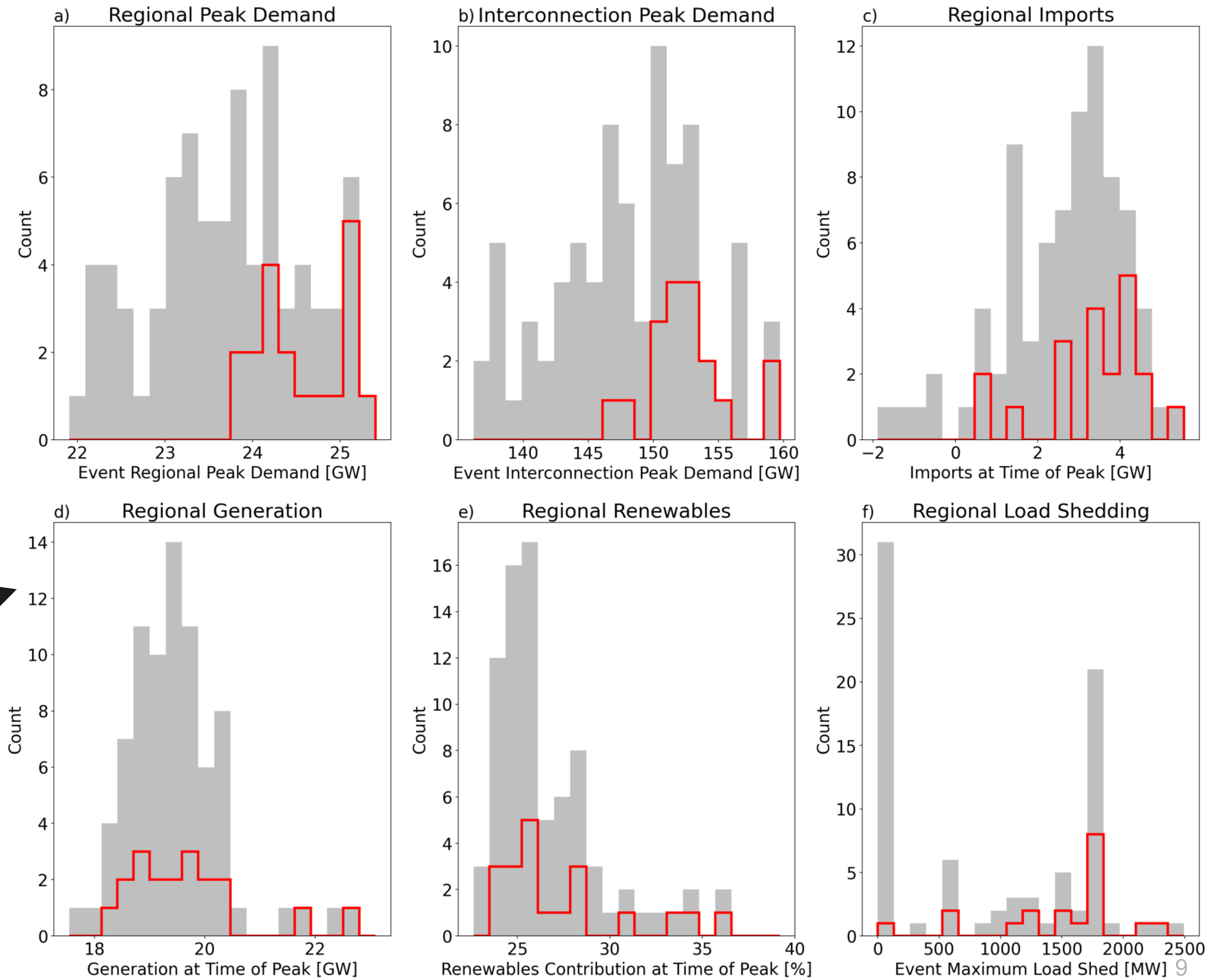
PCM Simulations

- Hourly meteorology was converted into coincident hourly load, wind, solar, and hydropower potential
- We projected all variables onto the WECC 2032 ADS system to reflect how the event might impact a future version of the grid
- Hourly simulations were conducted using GridView to measure the grid’s response to the events

Heat waves and cold snaps create diverse stress responses on the grid

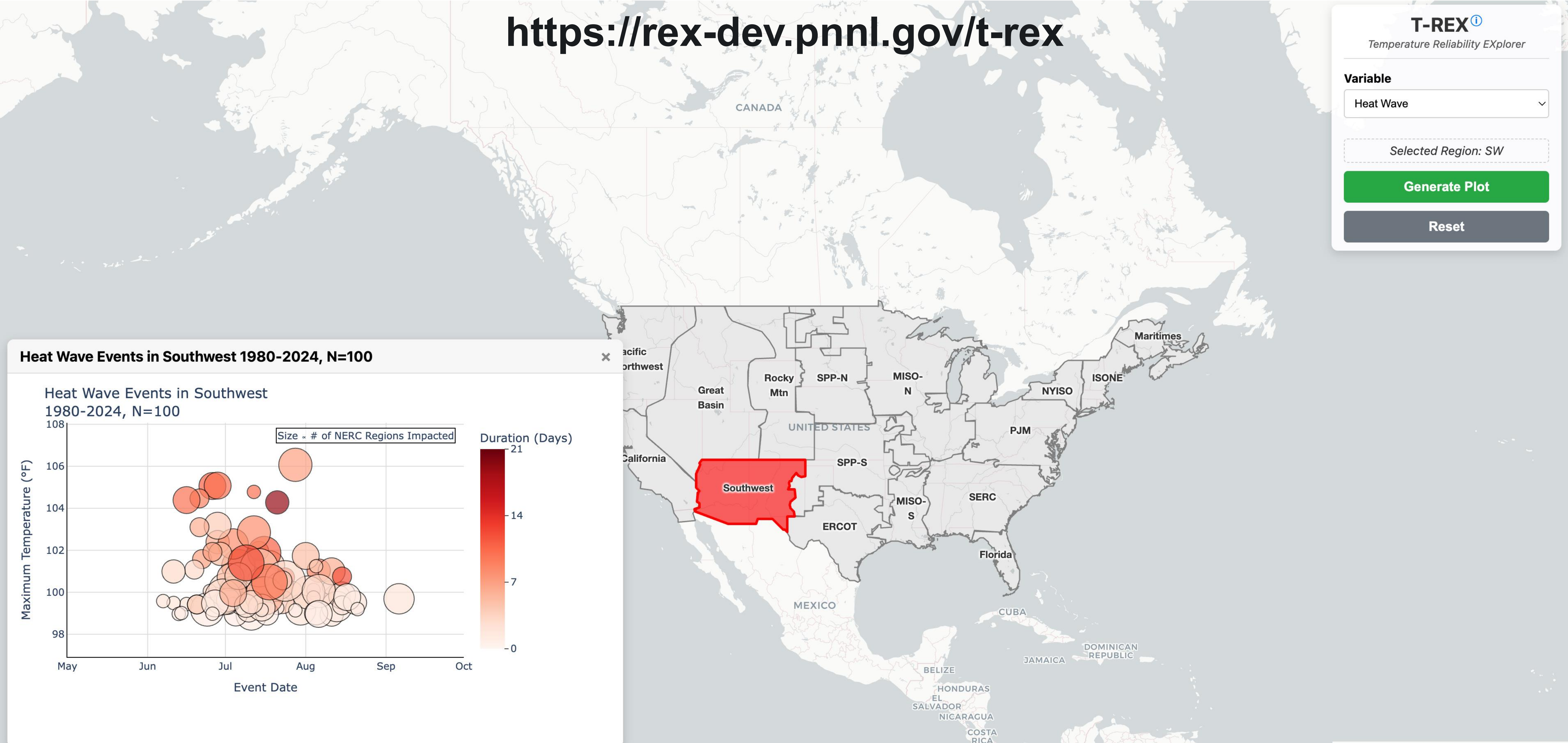






The Reliability EXplorer (REX) allows users to explore how events impacted their system

https://rex-dev.pnnl.gov/t-rex



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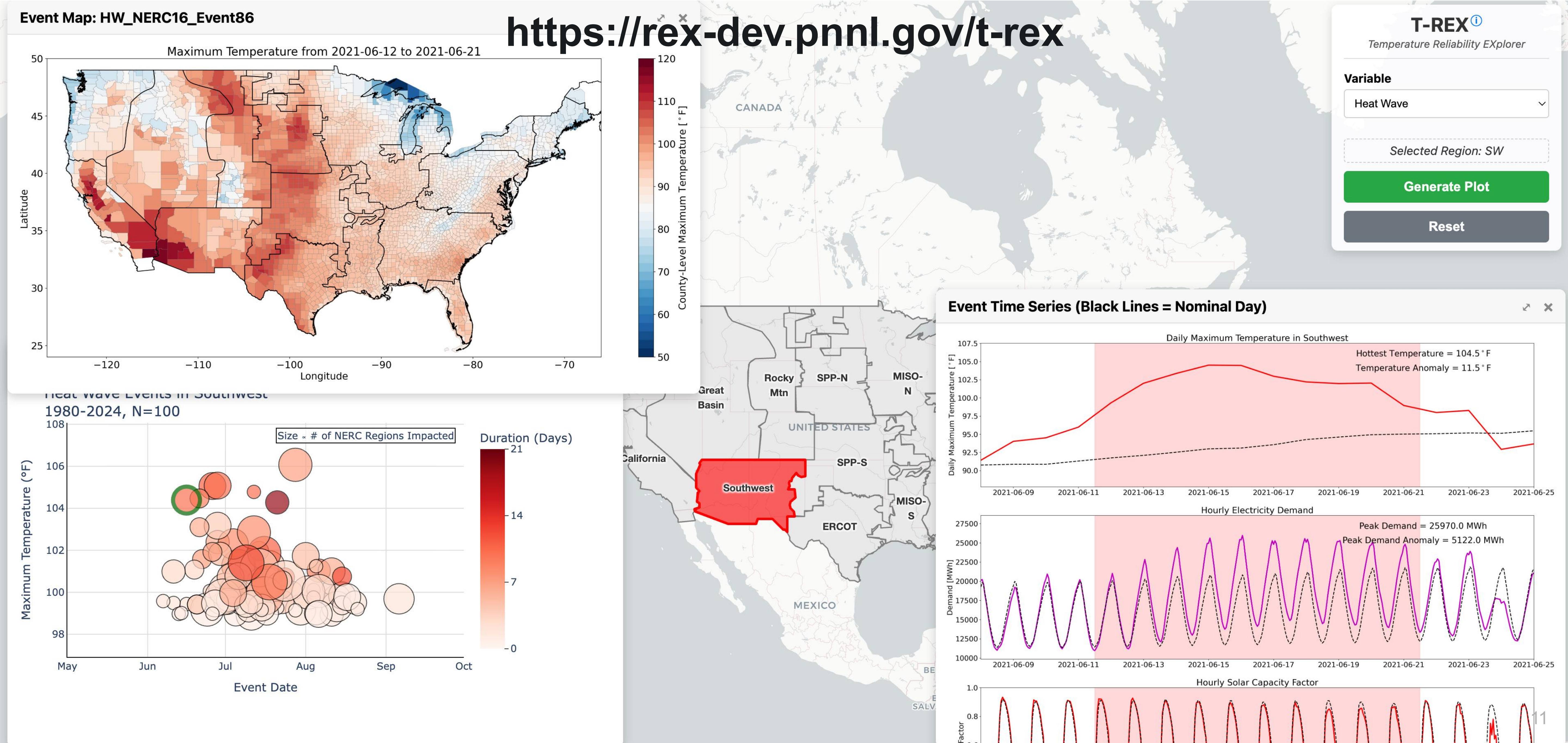

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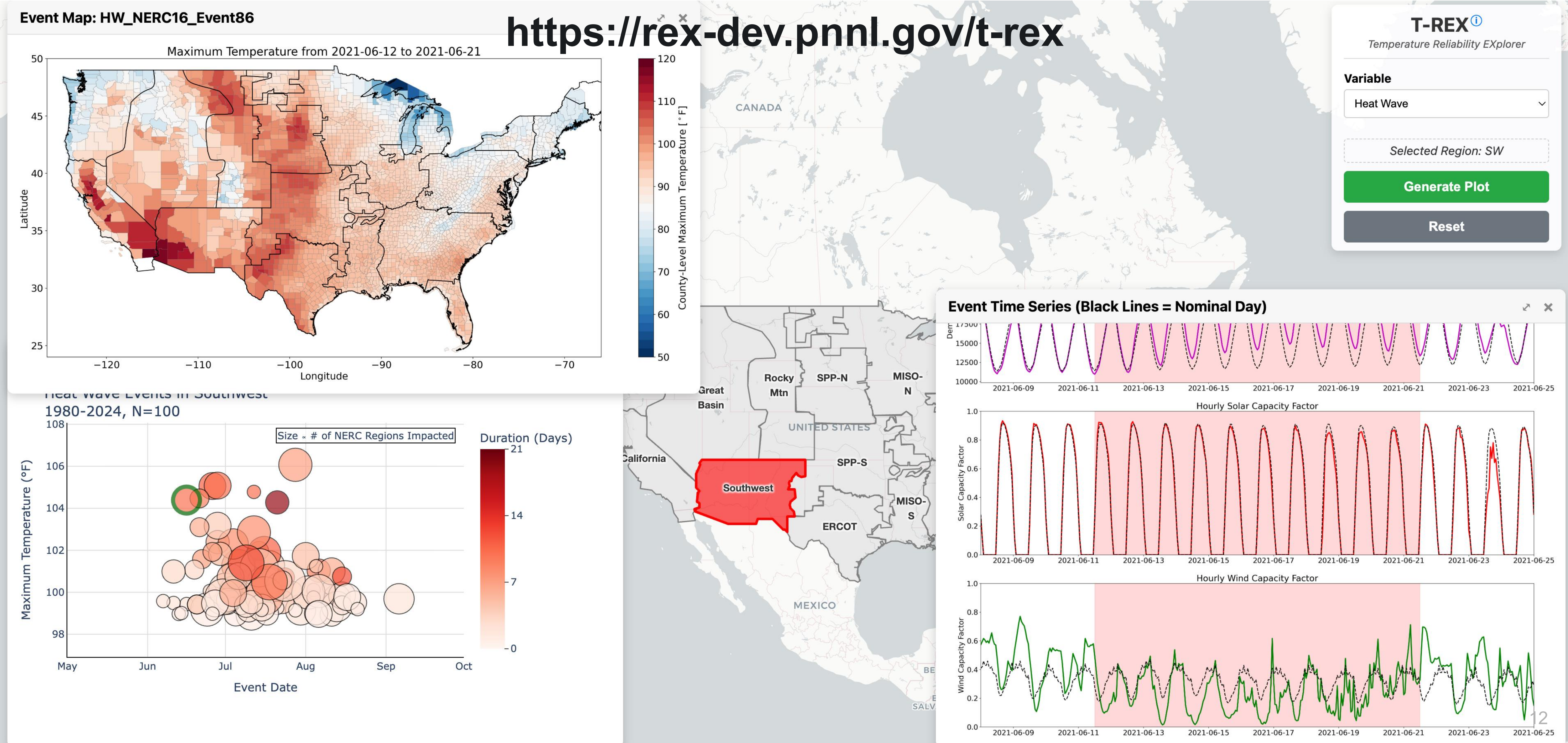

Potentially useful insights

- Basic to applied is a loop not an arrow. We can learn things by propagating knowledge in both directions. This is our superpower.
- Weather is complex. The grid is complex. The most extreme temperature events may not be the events that impose the most stress on the system.
- Your tools are more flexible than you think. If you expand your network, you might find new, impactful ways to apply them.

"I don't care about what anything was designed to do, I care about what it can do."