



**GODEEPP**  
Grid Operations,  
Decarbonization,  
Environmental and  
Energy Equity Platform  
@PNNL

# Characterizing the Impact of Heat Waves on the Electric Grid

**Casey Burleyson, Cameron  
Bracken, Kendall Mongird, Jennie  
Rice, and Nathalie Voisin**

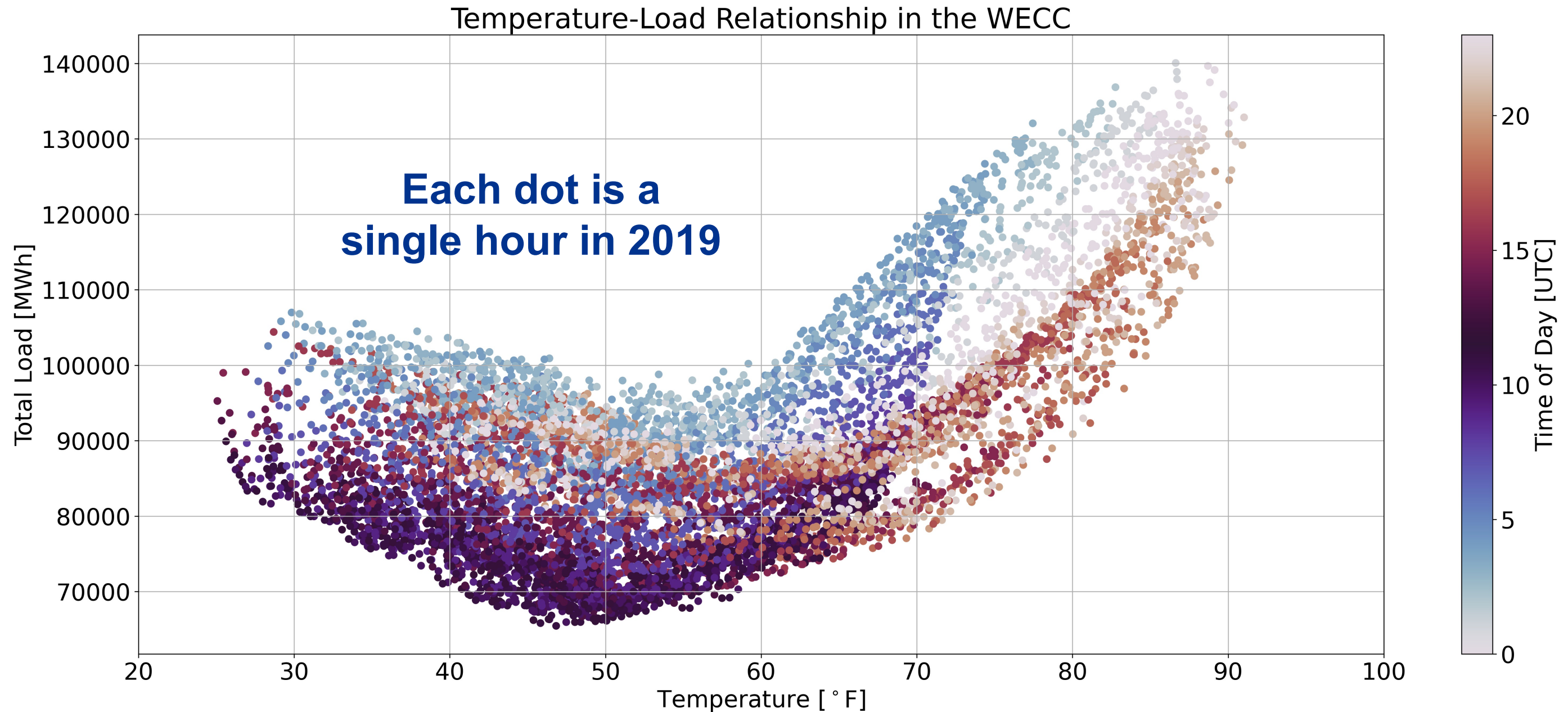


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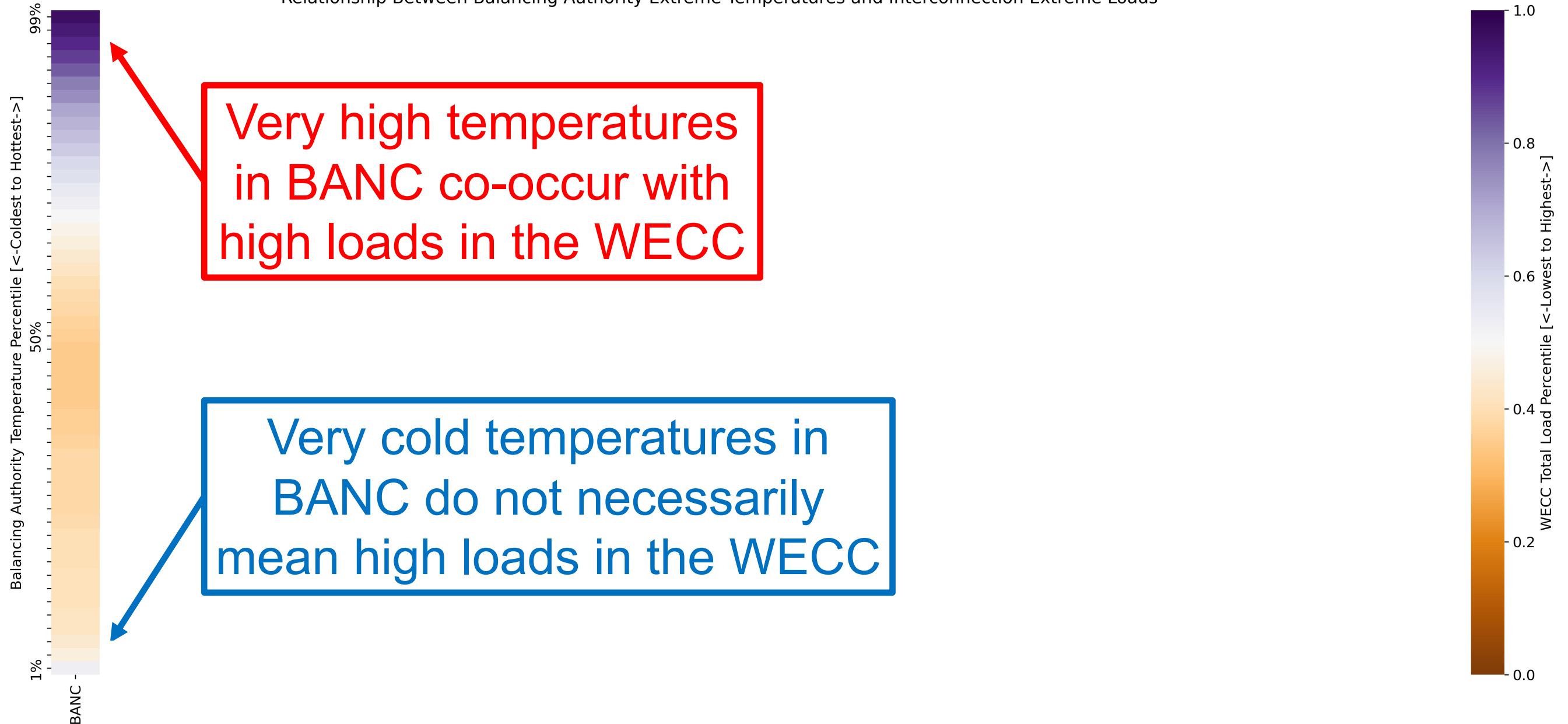


# Extreme Temperatures Drive Extreme Loads

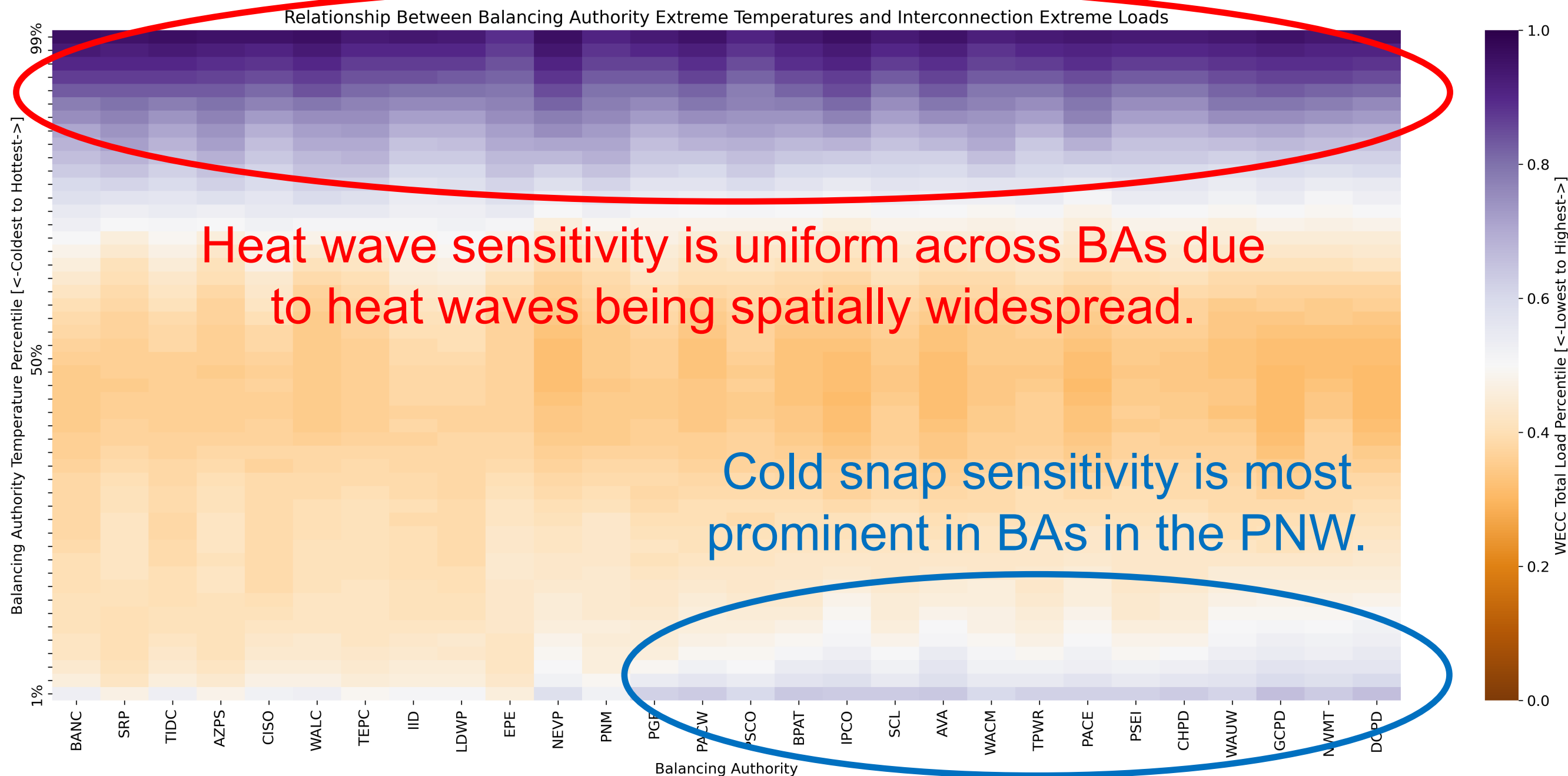


# Spatial Structure of Heat Wave Load Impacts

Relationship Between Balancing Authority Extreme Temperatures and Interconnection Extreme Loads



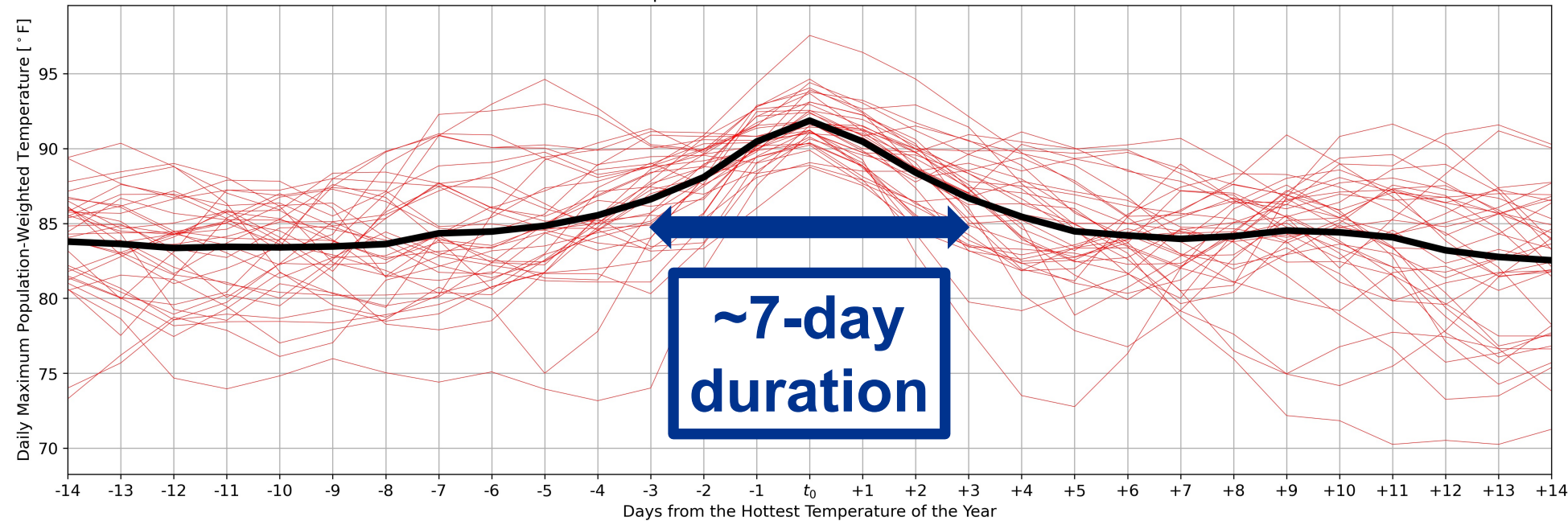
# Spatial Structure of Heat Wave Load Impacts





# Designing Stress Tests Based on Heat Wave Dynamics

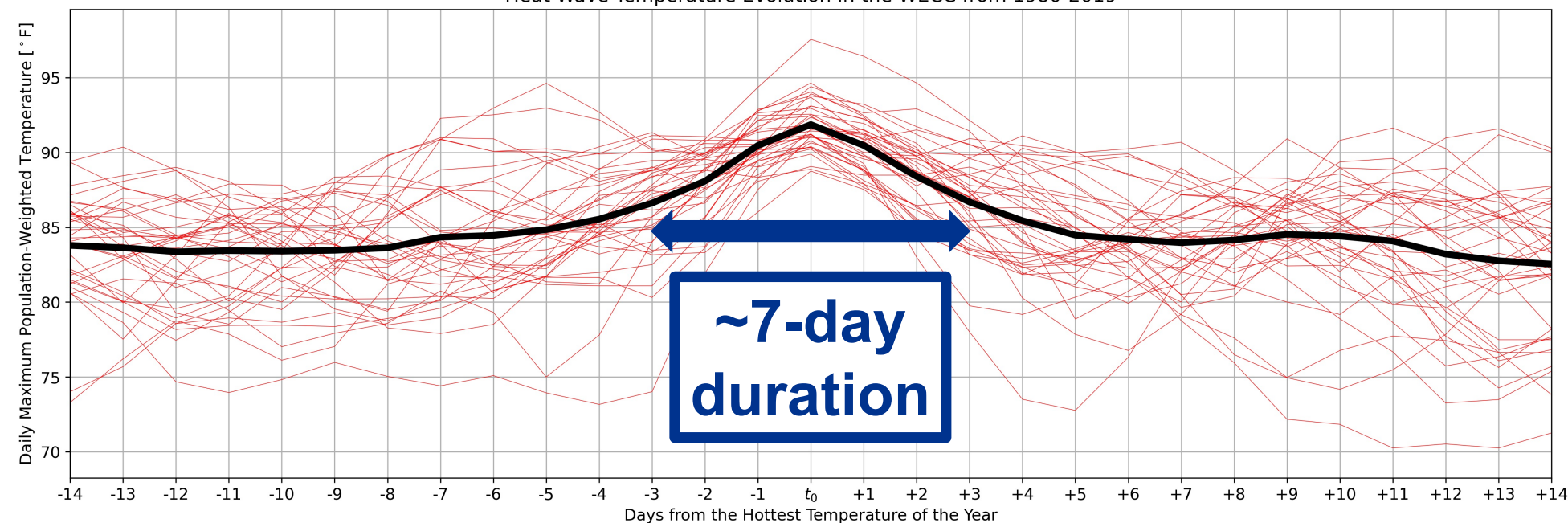
Heat Wave Temperature Evolution in the WECC from 1980-2019



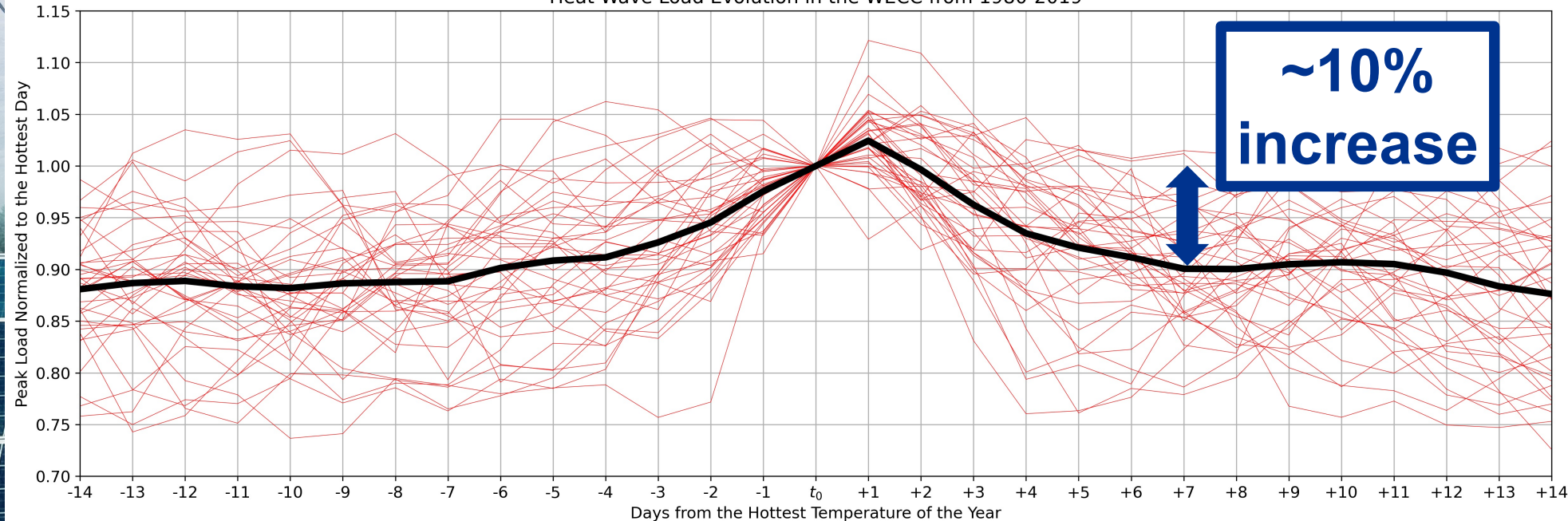
Typical heat waves last ~6-7 days and are, on average, symmetric about the maximum temperature day.

# Designing Stress Tests Based on Heat Wave Dynamics

Heat Wave Temperature Evolution in the WECC from 1980-2019



Heat Wave Load Evolution in the WECC from 1980-2019

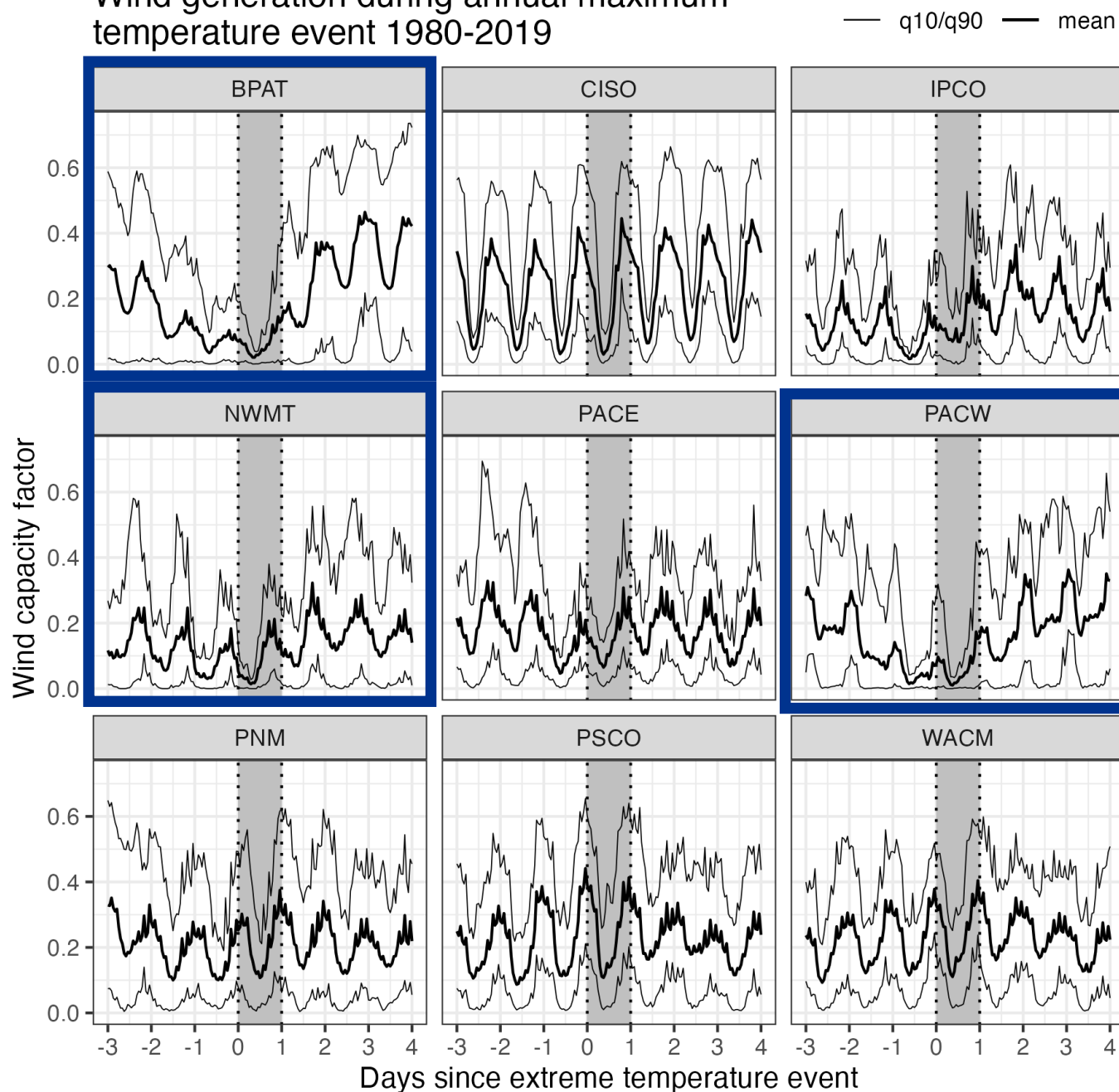


Heat waves increase peak loads by ~10% on average compared to the background peak loads.



# Notable Suppression of Wind Generation During Heat Waves

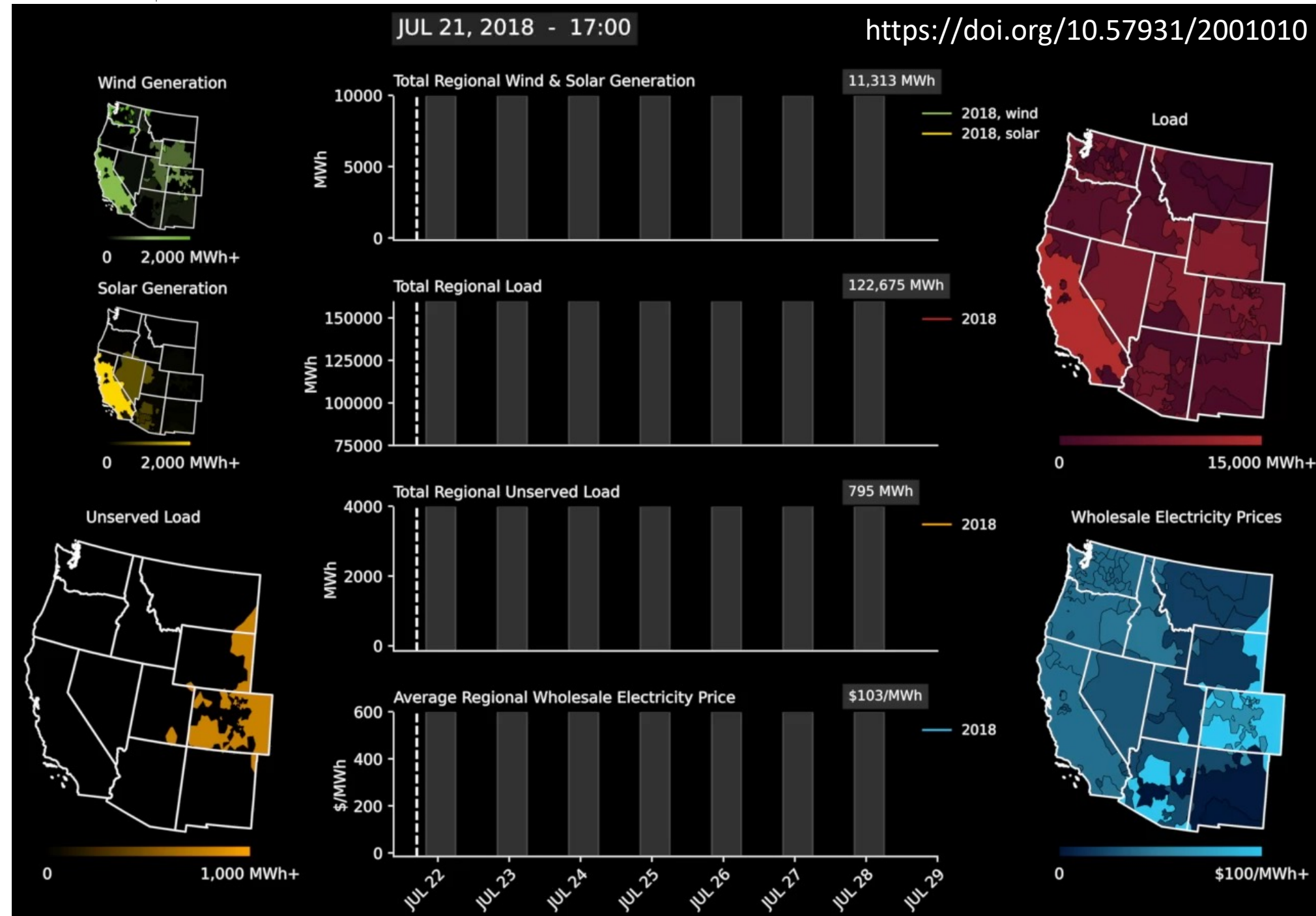
Wind generation during annual maximum temperature event 1980-2019



BAs in the Pacific Northwest (e.g., BPAT, PACW, and NWMT) show notable suppression of wind generation during heat waves.

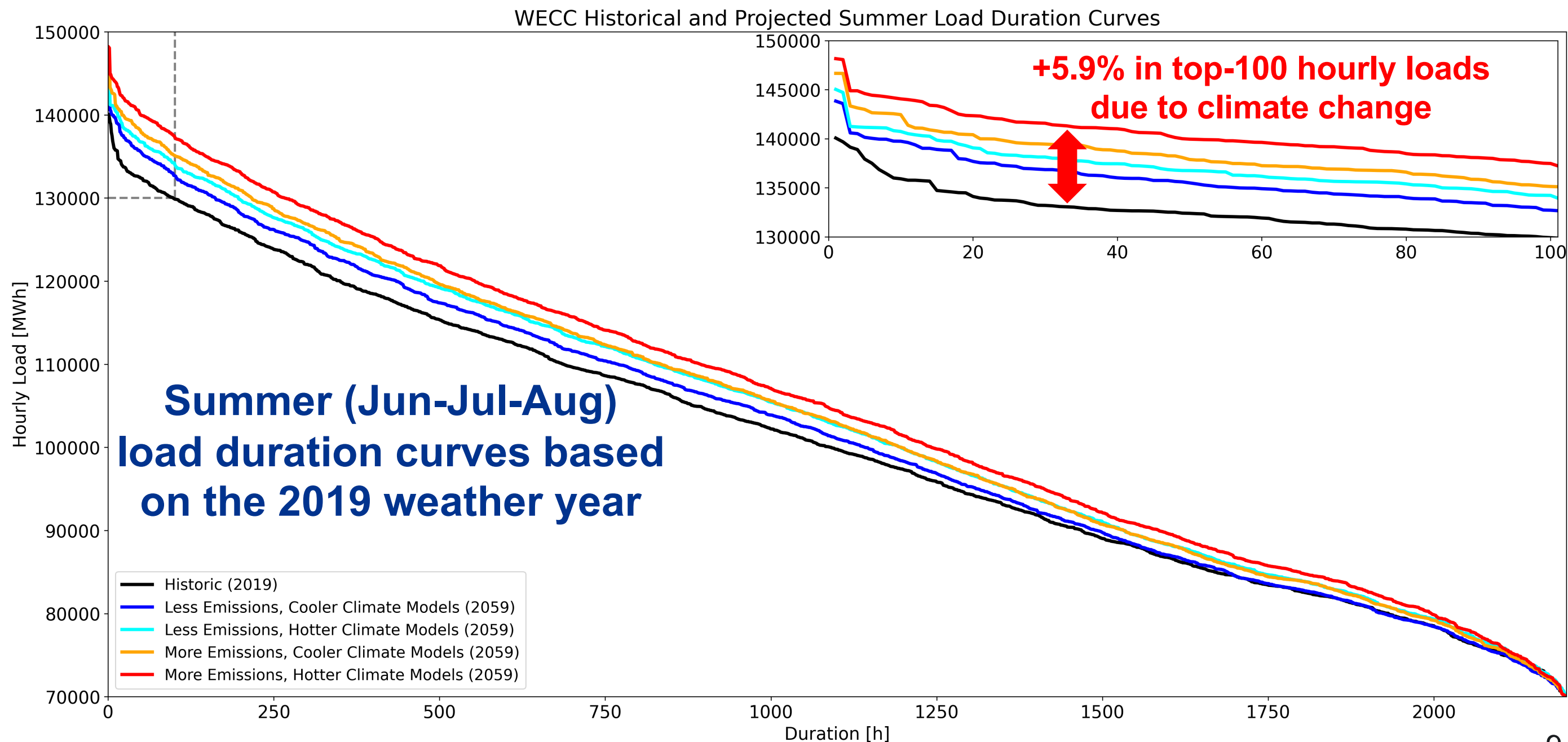


# Exploring Historical Heat Wave Grid Stress

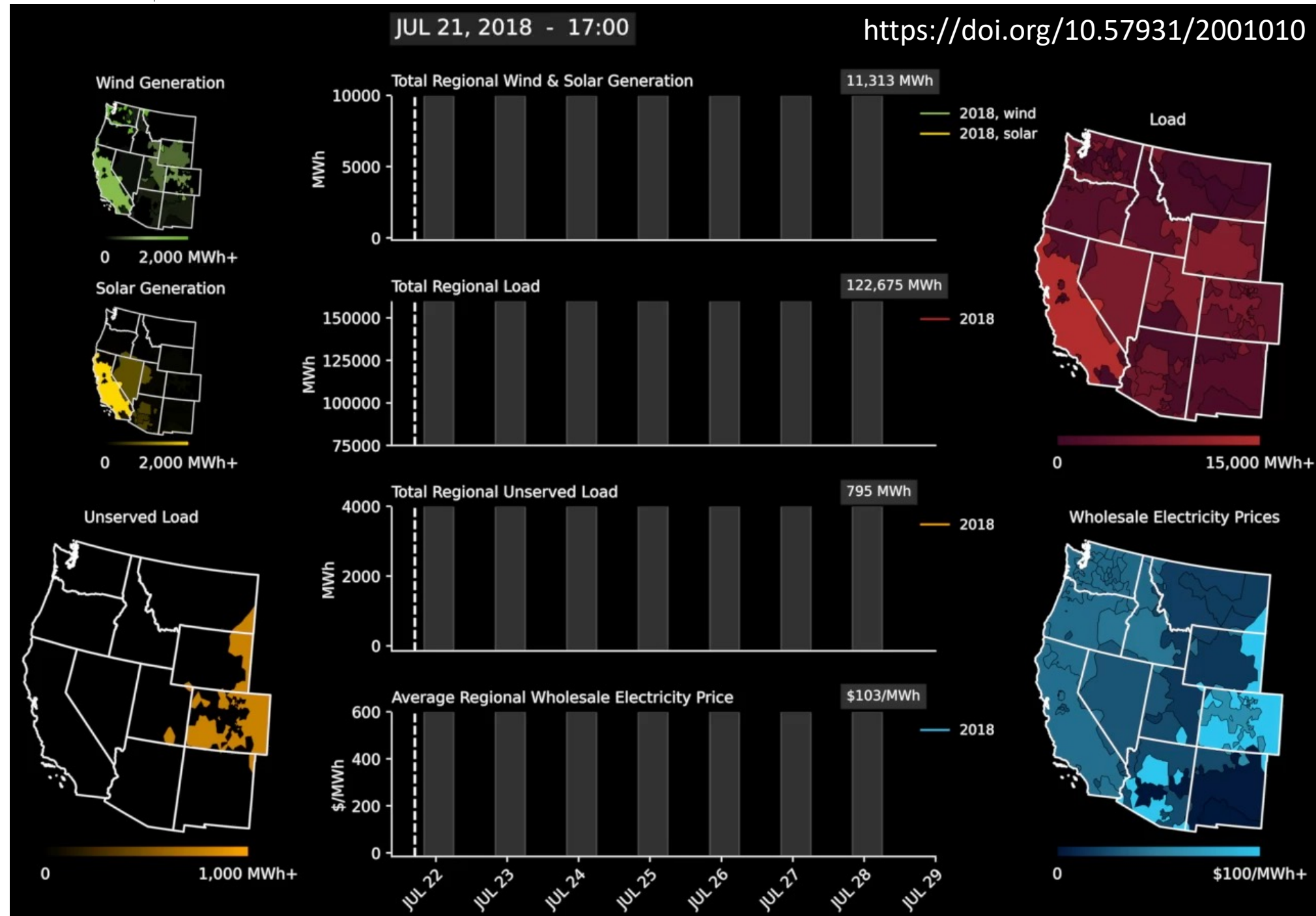




# What About Future Heat Waves?



# Exploring Future Heat Wave Grid Stress





Open-source, vetted datasets are available in multiple formats in support of targeted questions by industry.

Choose a Scenario Comparison

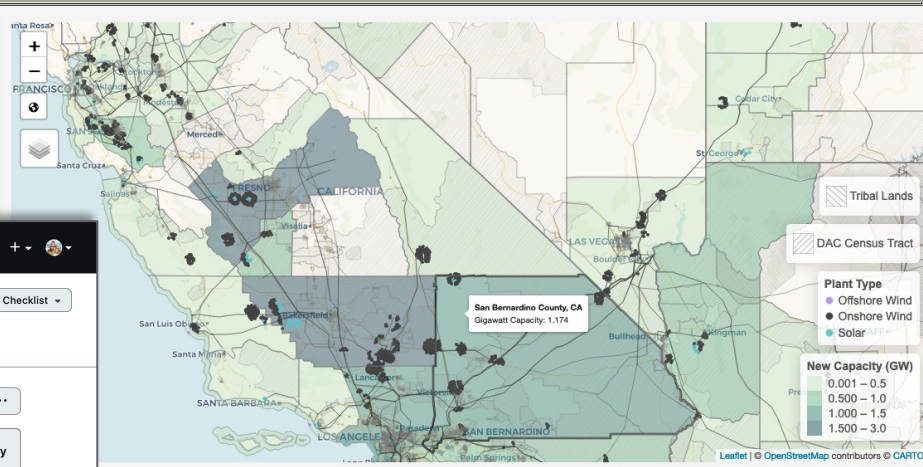
Compare 2035 Clean Grid scenario to 2020 conditions

Choose Aggregation Scale for Map

County

Choose U.S. State(s)

Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico



San Bernardino County, CA  
Gigawatt Capacity: 1,174

Plant Type  
Offshore Wind  
Onshore Wind  
Solar

New Capacity (GW)  
0.001 - 0.5  
0.500 - 1.0  
1.000 - 1.5  
1.500 - 3.0

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update\_grid\_view\_database.py GridView Database

Legend dataset interface

I data provided from gcamextractor, the substation energy

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operating and maintenance costs, offshore wind, and

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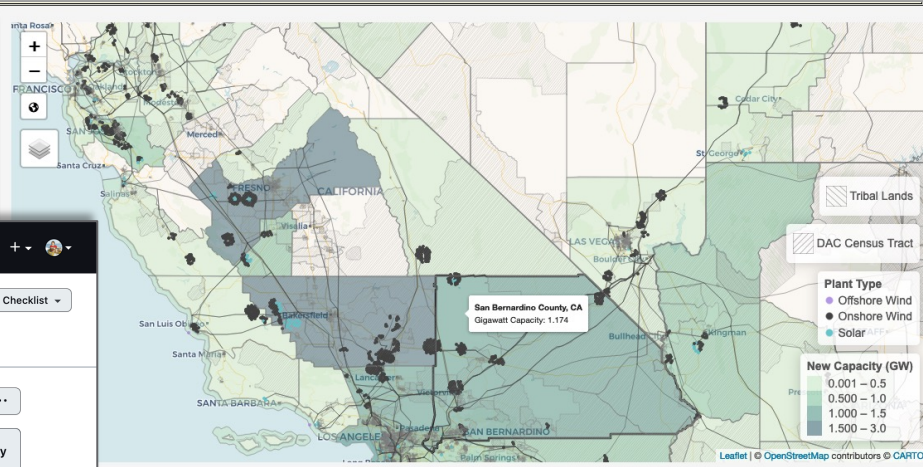
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# Key Messages and Results

- We are translating scientific understanding into actionable power-system relevant data and insights for use in long-term planning.
- Innovations:
  - Spatially- and temporally-coincident load, wind, and solar data.
  - Capture consistent and realistic impacts on electricity supply and demand for use in stress testing projected infrastructure.
- We use customizable open-source data and models for projecting heat waves into the future including for different realizations of the grid.
- Results:
  - WECC-wide peak loads increase by ~10% during heat waves. Wind energy potential tends to be suppressed in the PNW.
  - WECC summer peak loads could increase by 2-6% in the next 40 years due to climate change.