Data-driven Impact Projections for Climate Risk Management

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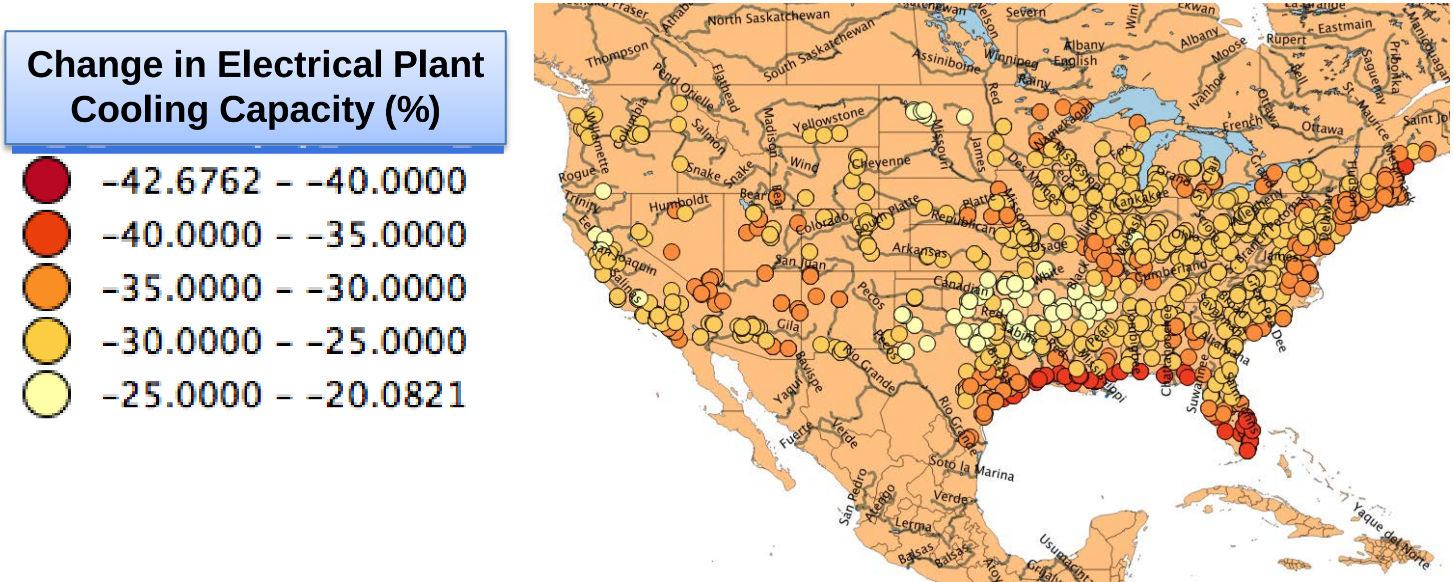
24 March 2016

Asset-specific Impacts for Climate Risk Management

- We estimate changes in:
  - Energy needs
  - Heat stress
  - Equipment downtime, performance, etc.
  - Health impacts
  - Electrical power plant cooling limits
- This list changes in breadth and level of detail depending on specific concerns of different industry sectors or government missions
- Risk approach informs resilience and adaption measures

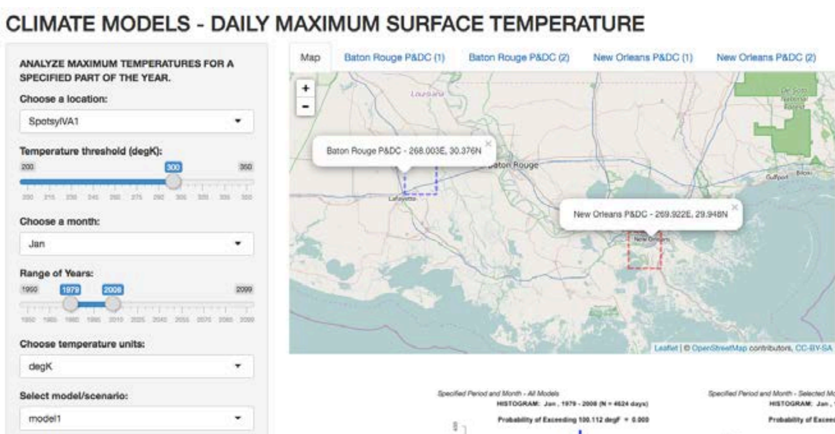
Applied Resilience Toolkit – Screening Level

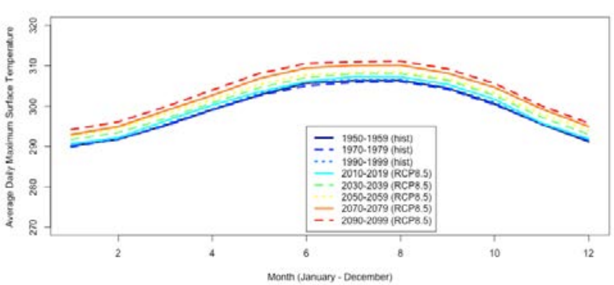
- Initial assessment of relative risk
- Identifies where to do detailed analysis
- Fast processing of thousands of locations using 27 indices from 31 models
- Calculates surrogates for specific risks (energy use, heat stress, etc.)
- GIS for rapid display of results and integration with other information (drainage basins, population distributions, storm surge data, etc.)

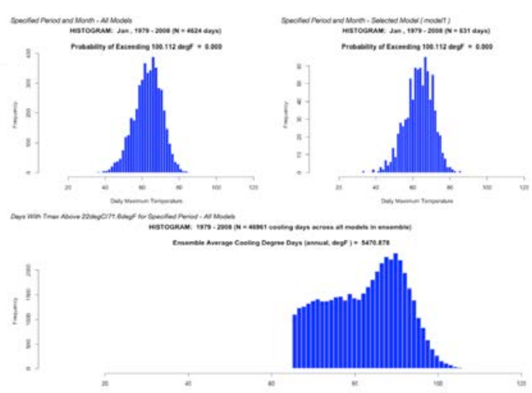


Applied Resilience Toolkit – Detailed Level

- Localized statistics for 1950-2100 anywhere on the globe.
- All CMIP5 models and variables
- Downscaled data from NEX-GDDP, NARCCAP, etc.





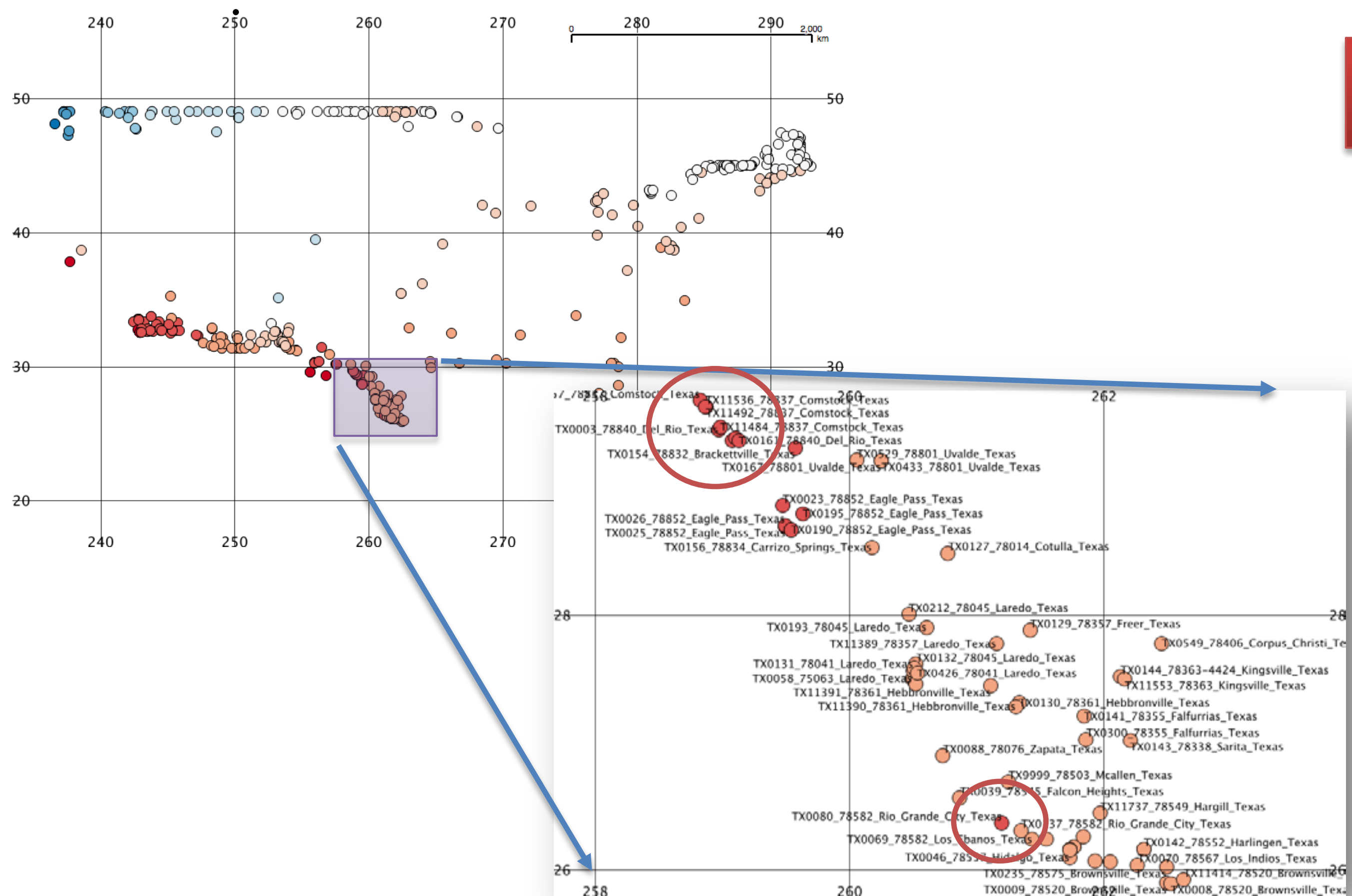


- Location-specific decadal averages for each month throughout year.
- Distributions for any month/year based on all models.
- Distributions for any period based on all models, or on selected model.

LMI Applied Resilience
Assessment. Understanding. Action.

Risk: Increases in Energy Needs (Screening Level)

- Risk metric: Change in frost days plus tropical nights at 400 public-sector facilities
- For example, compare 2026-2045 to 2006-2025 for RCP 8.5 climate



Percent Change in Heating/Cooling Energy

- -20.39 – -20.00
- -20.00 – -15.00
- -15.00 – -10.00
- -10.00 – -5.00
- -5.00 – 0.00
- 0.00 – 5.00
- 5.00 – 10.00
- 10.00 – 15.00

Adaptation planning implications:
- Weight by energy use and source
- Prioritize infrastructure upgrades
- More detailed risk estimates needed

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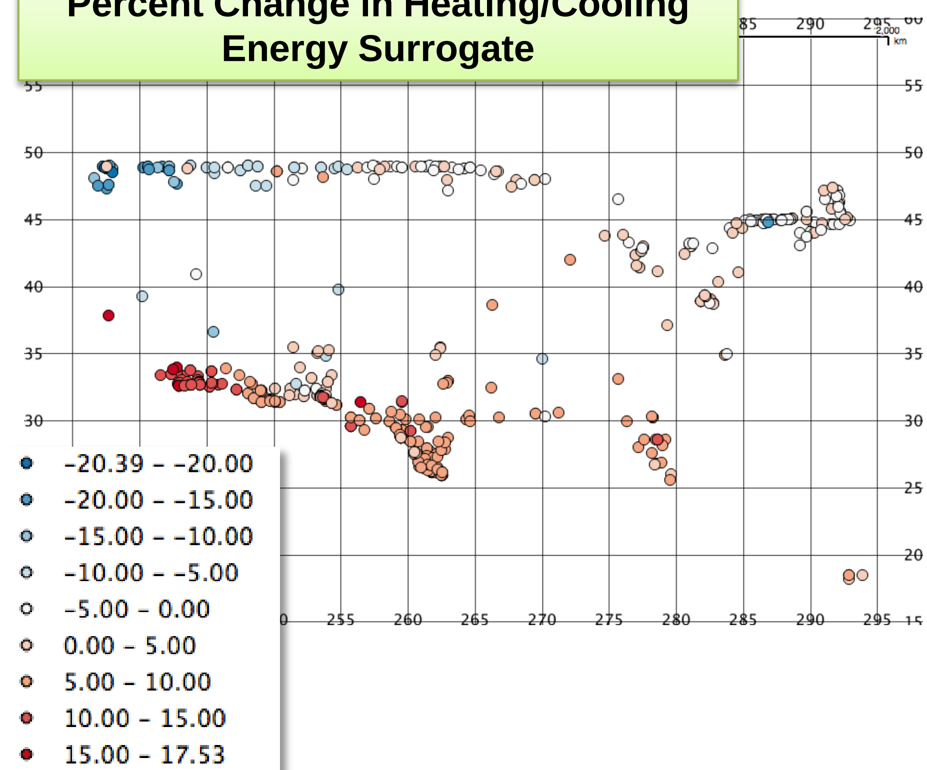
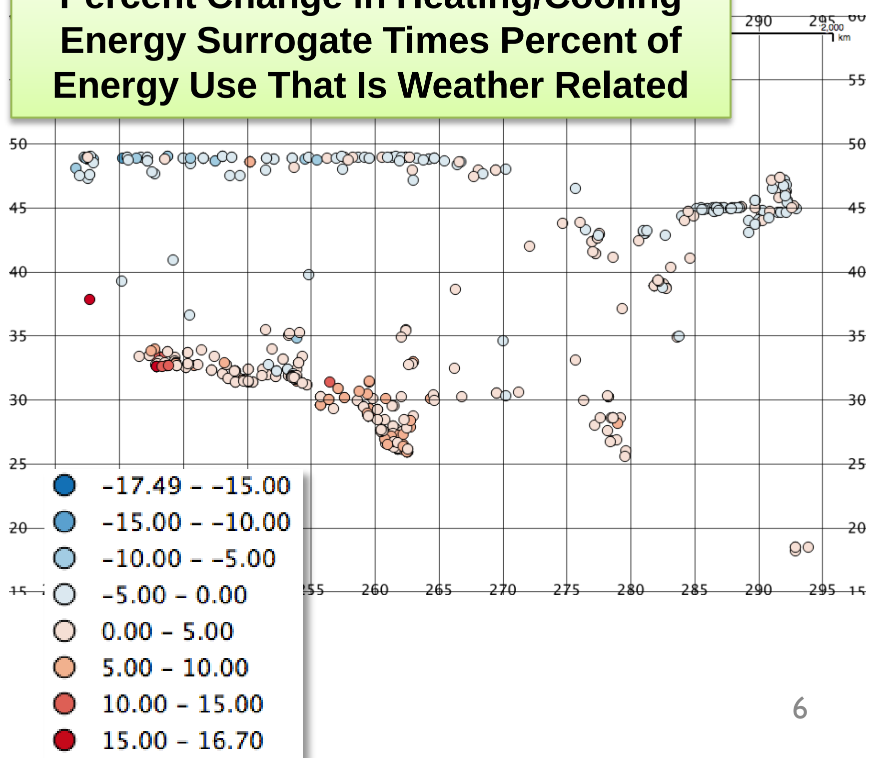
Energy Risk Refined Based on Energy Use Related to Weather (Screening Level)

- Utilized detailed energy billing records (100K records for 790 facilities)
- Heating/cooling energy-usage surrogate (frost days + tropical nights)
- Compare 2026-2045 to 2006-2025 for RCP 8.5 using 10 models

Percent Change in Heating/Cooling Energy Surrogate

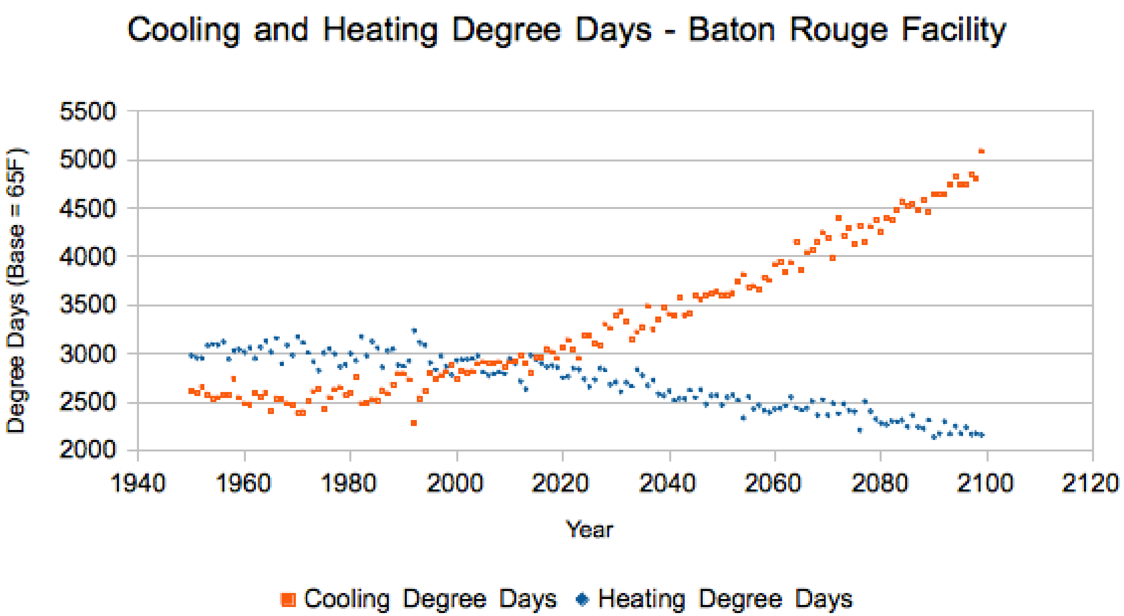


Percent Change in Heating/Cooling Energy Surrogate Times Percent of Energy Use That Is Weather Related



Risk: Increases in Energy Needs (Detailed Level)

- Risk metric: location-specific Cooling Degree Days (CDD) and Heating Degree Days (HDD) 1950-2100:



Approximate Changes in Degree Days:

	Cool	Heat	Cost
2025	+ 5%	- 5%	-
2045	+20%	-10%	+ $15000
2065	+40%	-15%	+ $38000
2085	+60%	-20%	+ $60000

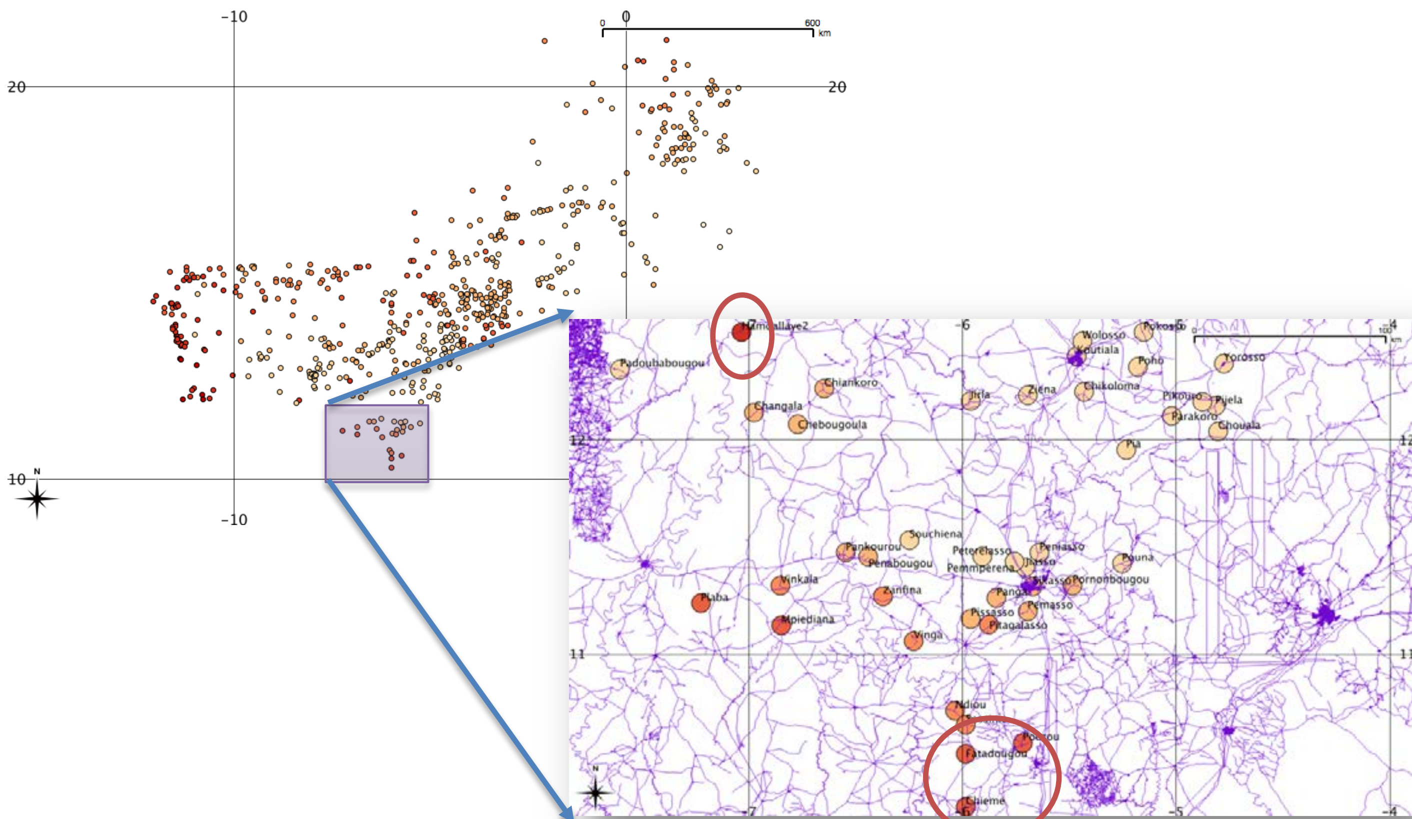
Adaptation planning implications:
- plan for higher energy needs;
- modify infrastructure

- Distribution of estimates for each year and each month give probabilities of exceeding decision-specific thresholds.

*** Area of facility is 248,000 sqft. Average annual energy consumption is 6 kWh/sqft, so the annual energy use is about 1.5M kWh. At $0.10/kWh, the annual cost is $150,000.**

Risk: Increases in Heat Stress

- Risk metric: Heat impacts on persons based on hot days and hot nights (above historical 90th percentile values) at 600 cities and towns in Mali
- For example, compare 2026-2045 to 2006-2025 for RCP 8.5 climate scenario



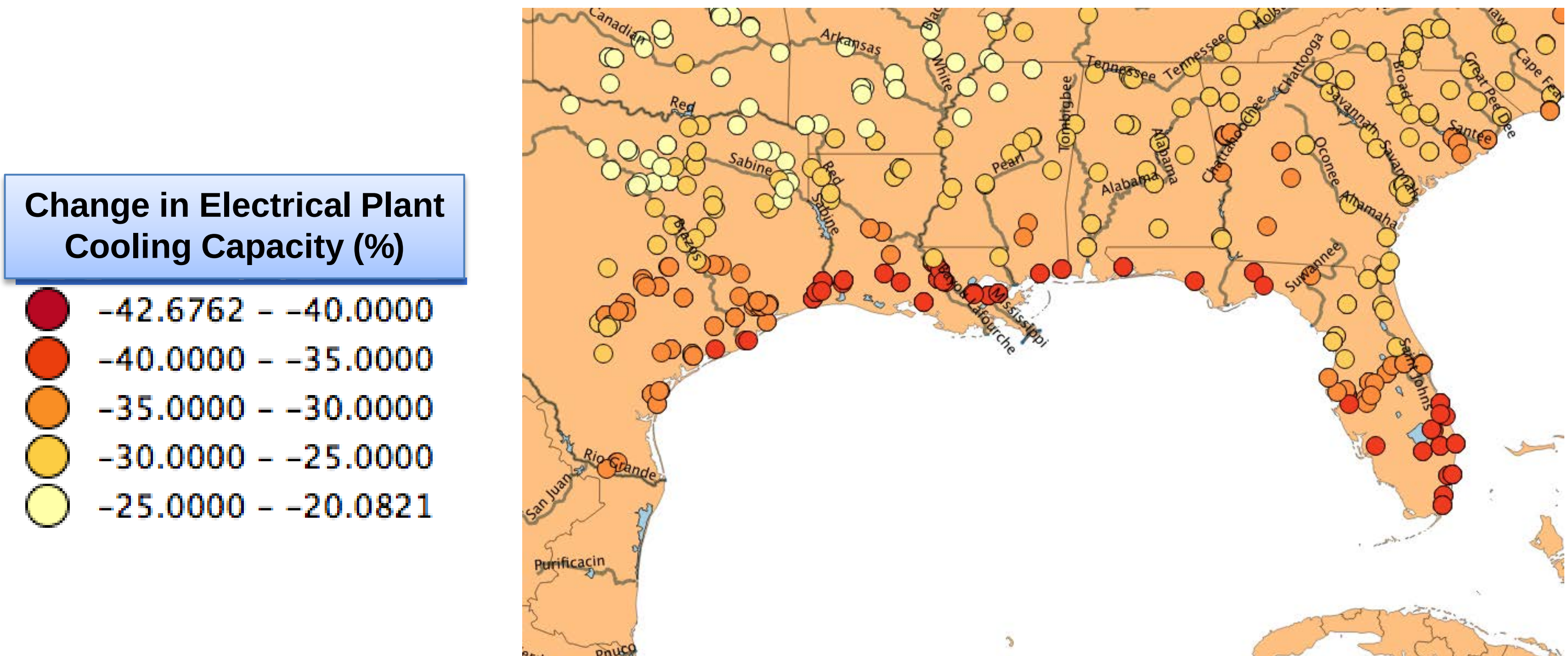
Percent Change in Hot Days and Nights

- 54.8 – 56.0
- 56.0 – 58.0
- 58.0 – 60.0
- 60.0 – 62.0
- 62.0 – 64.0
- 64.0 – 66.0
- 66.0 – 66.6

Adaptation planning implications:
- Local opportunities to mitigate?
- More detailed risk estimates needed

Risk: Decreases in Electricity Plant Cooling Capacity

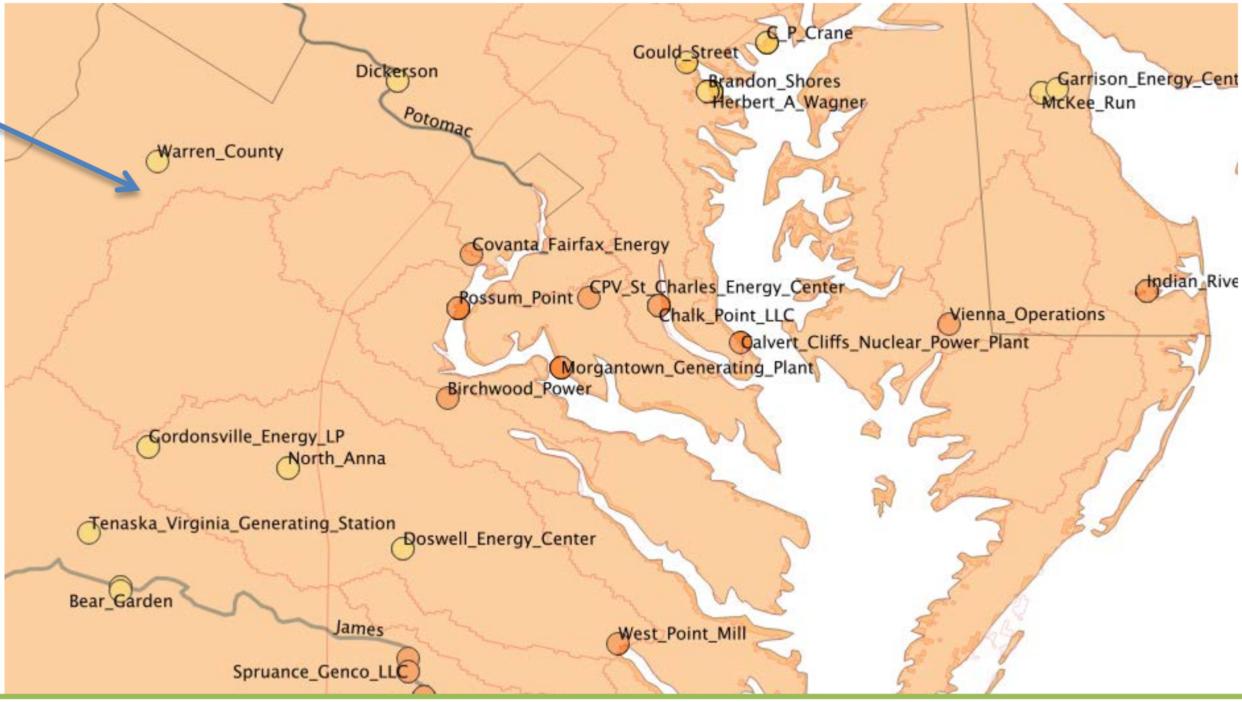
- Plant data: location, cooling type, water source/sink, flow rates, etc.
- Screening results using surrogate for decreases in cooling capacity (total precipitation divided by high-temperature days, prcptot/tx90p)
- Compare 2026-2045 to 2006-2025 for RCP8.5 scenario.



Risk: Decreases in Electricity Plant Cooling Capacity (Cont'd)

- Drainage basins* merged with plant data to prepare for more detailed analysis.
- Screening results as on previous slide.

Drainage basins outlined in red

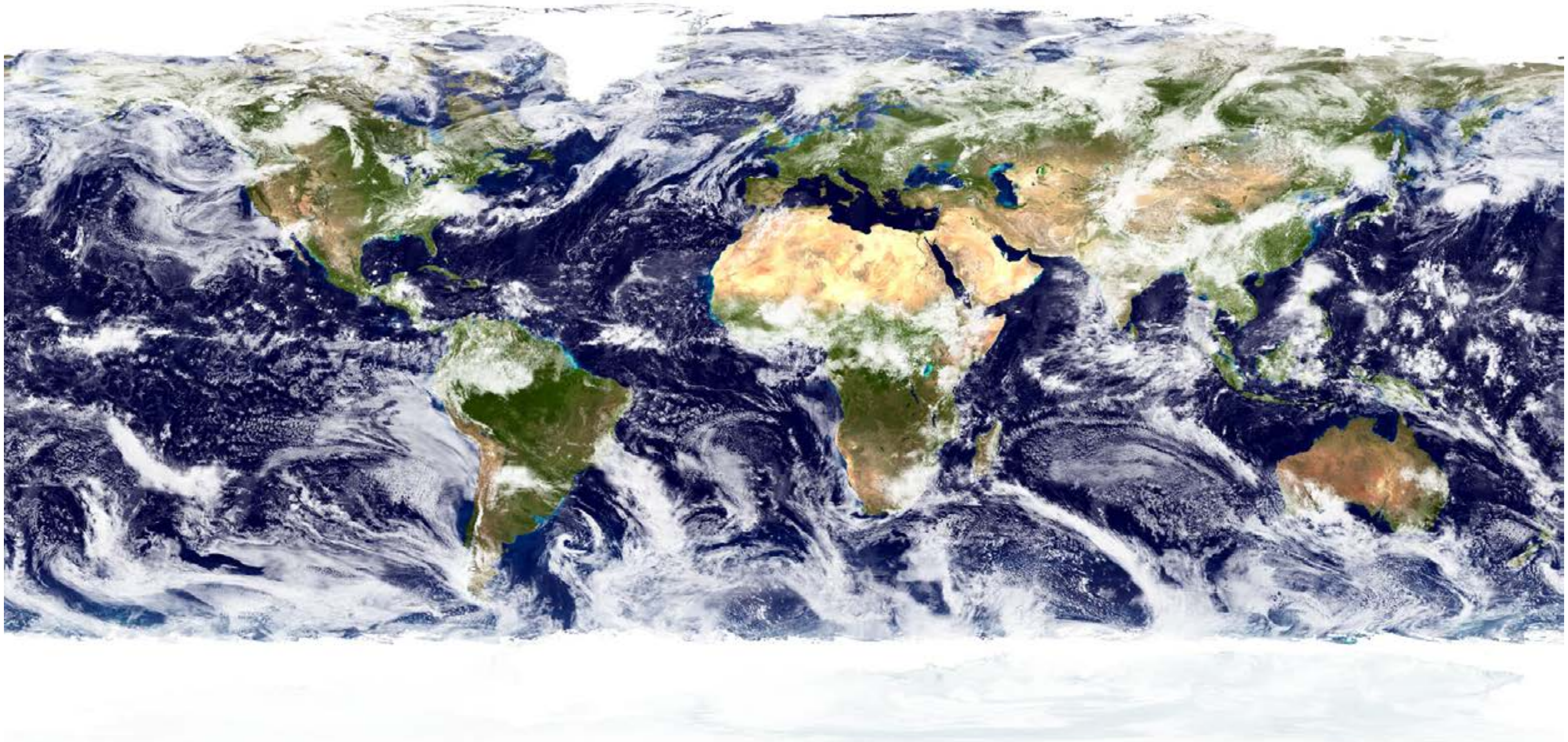


* Basin data from Global Drainage Basin Database, Yuji Masutomi, Yusuke Inui, Kiyoshi Takahashi and Yuzuru Matsuoka, "Development of highly accurate global polygonal drainage basin data", Hydrological Processes, 23, 572-584, DOI: 10.1002/hyp.7186, 2009.

Value of the Approach

- Interpret climate data within specific end-user context
- Improves allocation of adaptation resources:
  - Decision-specific risk metrics with probabilities
  - Localized and time-specific
  - World-wide coverage
- Bridges gap between latest climate-projection data and needs of planners for risk-based decision-making on asset-level resilience investments

Questions?



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Backup Slides

Effective Adaptation Planning Must Be Driven by Detailed Climate Data

- Adaptation resources will always be limited
- Need to prioritize allocation according to best available data
- We bridge the gap between general changes in climate and specific risks to local assets

Changes in Climate Variables → **Impacts on Specific, Localized Assets** → **Sector-specific Adaptation Planning**

Changes in Climate Variables
- Temperature
- Humidity
- Sea level
- Extreme events

Impacts on Specific, Localized Assets
- People
- Infrastructure
- Energy needs
- Supply chain

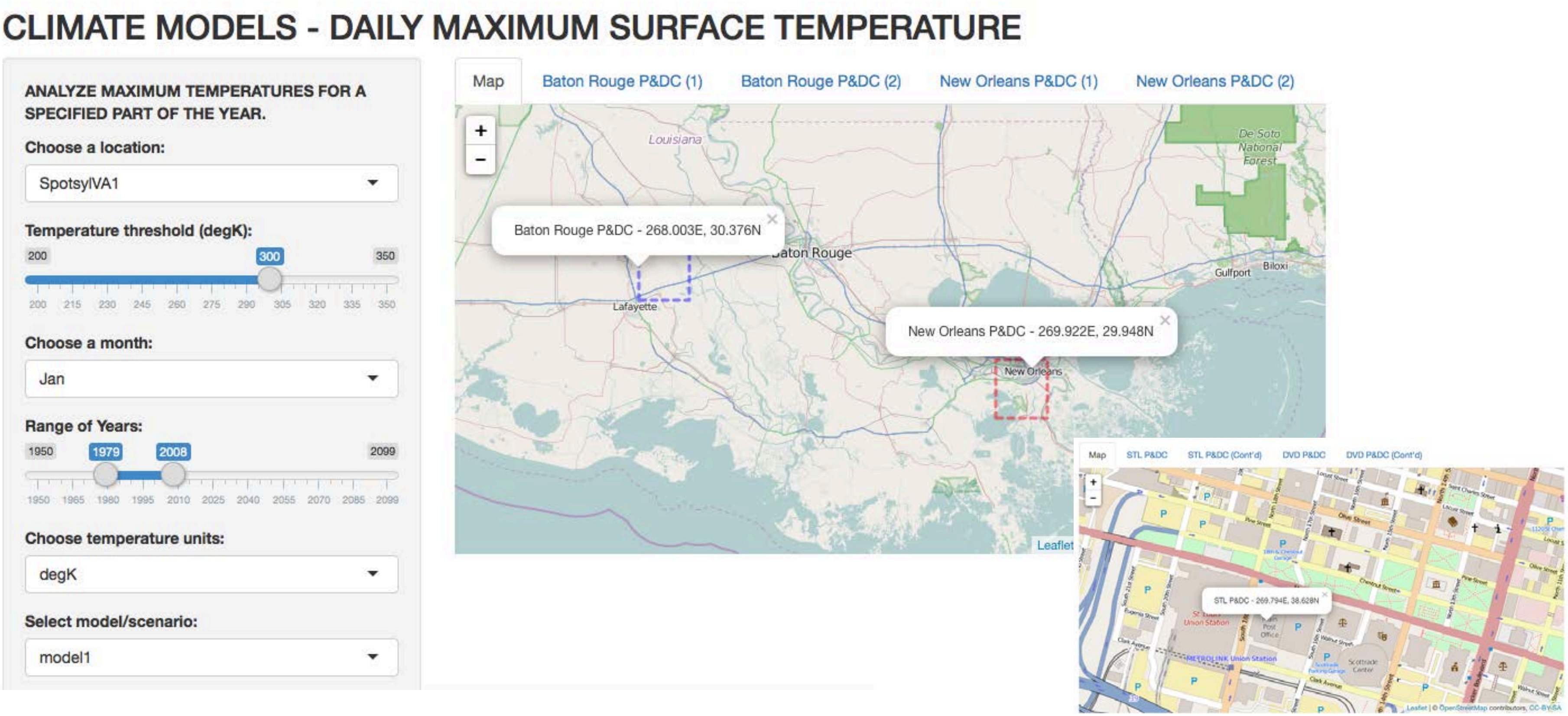
Sector-specific Adaptation Planning
- Capital planning
- Aid/assistance planning
- Infrastructure design
- Supply chain design

How LMI Determines Asset-specific Impacts

- **Integrate enormous amounts of climate data** from observations and models to get good statistics.
- Develop statistics for **specific asset locations and time periods**.
- **Use the uncertainty in these statistics systematically** in our risk-management decisions.
- Link the statistics to **real-world measures of employee and infrastructure risk**, tailored to client management processes

LMI Toolkit Integrates Climate-model Data

- Projected climate statistics for specific locations
- Based on all available climate-model outputs (CMIP5)



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LMI Toolkit Derives Local Statistics

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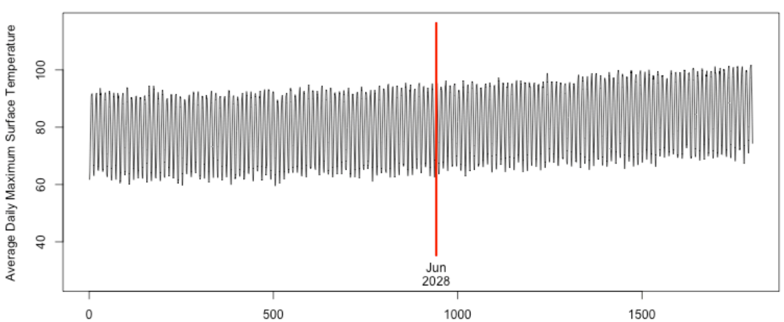

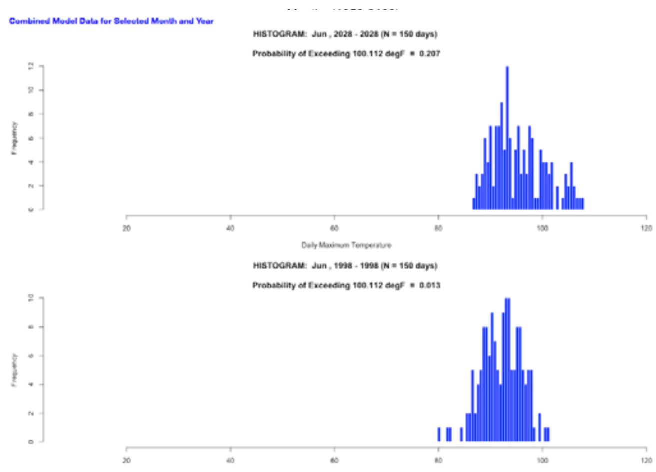

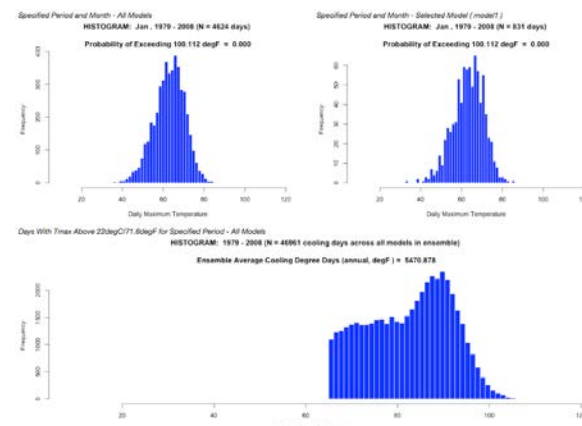

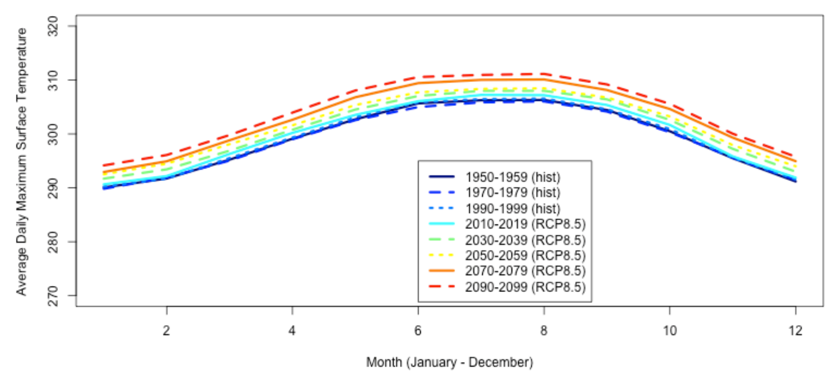

Extremes Indices Overview

TN10p	Cold nights
TX10p	Cold days
TN90p	Warm nights
TX90p	Warm days
WSDI	Warm spell duration
CSDI	Cold spell duration
TXx	Max TX
TXn	Min TX
TNx	Max TN
TNn	Min TN
FD	Frost days
ID	Ice days
SU	Summer days
TR	Tropical nights

GSL	Growing season length
DTR	Diurnal temperature range
RX1day	Max 1-day precipitation
RX5day	Max 5-day precipitation
SDII	Simple daily intensity
R1m	Number of wet days
R10mm	Heavy precipitation days
R20mm	Very heavy precipitation days
CDD	Consecutive dry days
CWD	Consecutive wet days
R95p	Very wet days
R99p	Extremely wet days
PRCPTOT	Total wet-day precipitation

See Sillmann, J., V. V. Kharin, F. W. Zwiers, X. Zhang, and D. Bronaugh, 2013a: Climate extremes indices in the CMIP5 multi-model ensemble. Part 1: Model evaluation in the present climate. *J. Geophys. Res.*, doi:10.1002/jgrd.50203. Also see Part 2: Future projections. *J. Geophys. Res.*, doi:10.1002/jgrd.50188.