

Quantifying Performance Differences Between Manufacturer-produced and Third Party-produced PAN Files

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Introduction - What Are PAN Files?

- Small text files used in performance modeling to represent the physical, electrical, and performance characteristics of a module.
- Generally produced either by a **manufacturer** or **third-party** lab, the latter of which is considered to be more bankable for projects.

The Problem with Manufacturer PAN Files

- Created from a manufacturer's internal, **unpublished** test data and PAN generation methods
- May or may not accurately represent module performance in the field

Goal: Simulate PAN file performance at various projects and quantify manufacturer PAN file performance relative to highly-bankable third-party PAN files

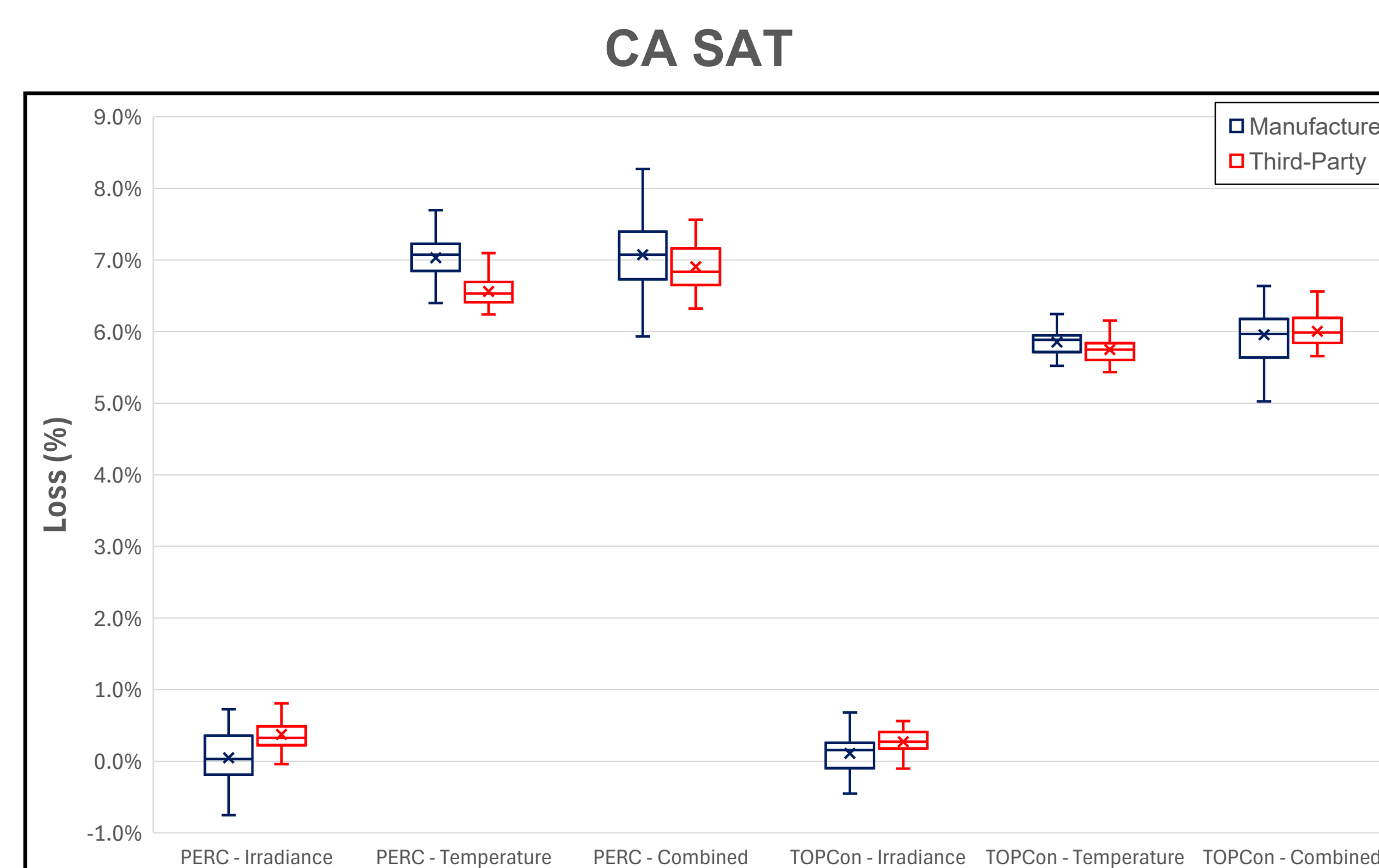
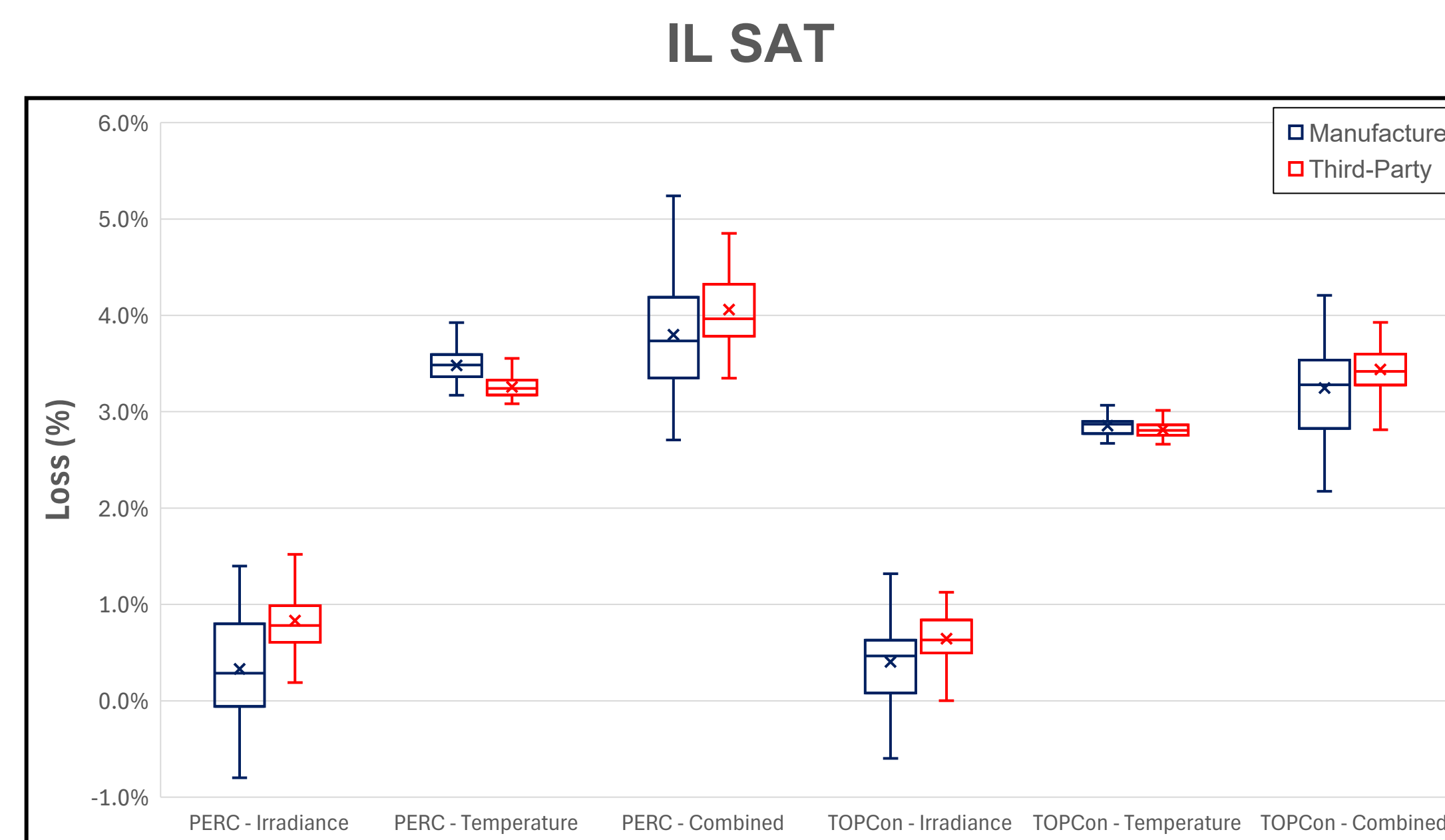
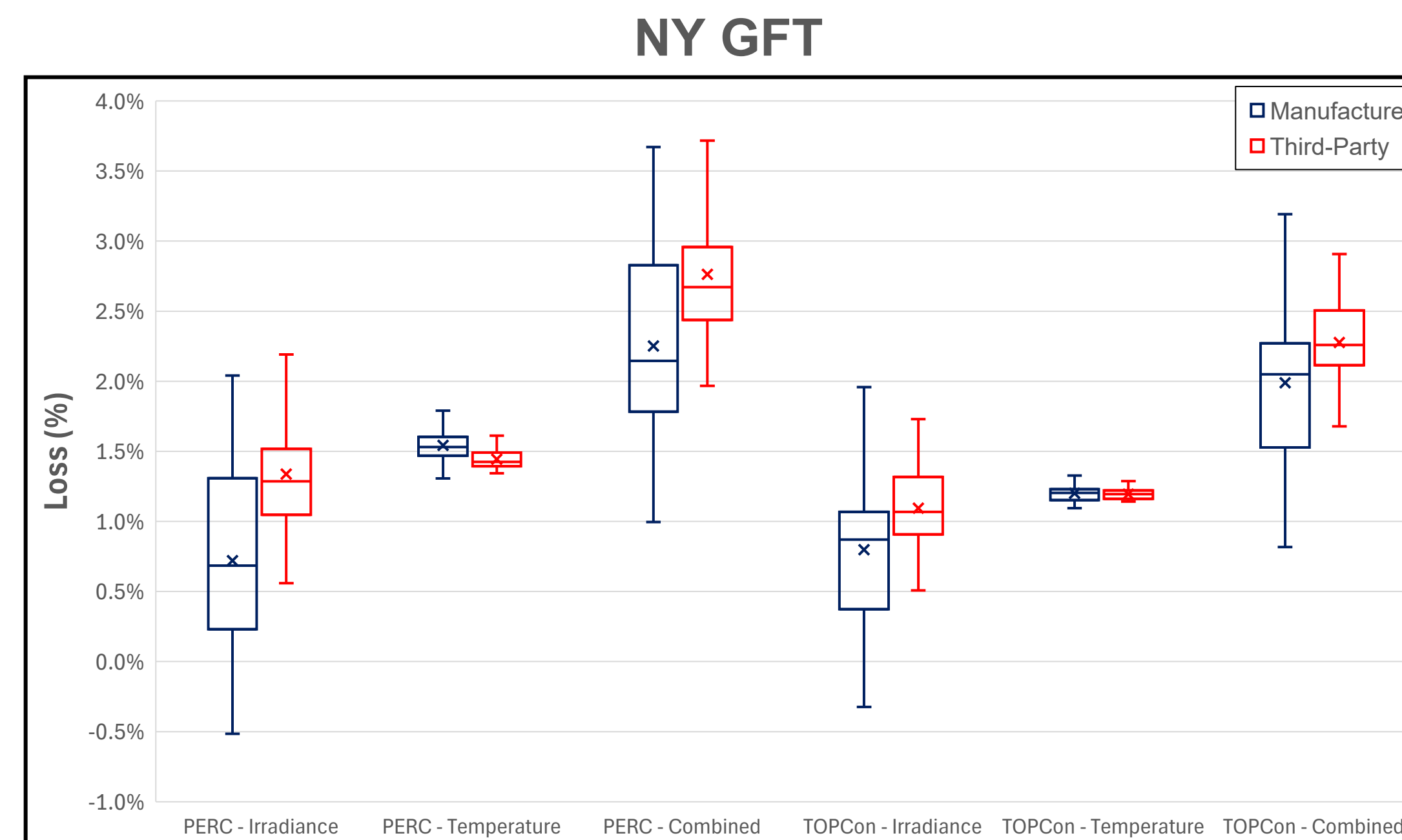
Methodology

- Evaluate PAN performance at various projects
 - Iteratively solve PVsyst single-diode and steady-state thermal models to convergence
 - Determine annual **irradiance** loss, **temperature** loss, and **combined** irradiance and temperature loss from STC
 - Group comparisons by cell technology (i.e., PERC and TOPCon)
- PAN file selection
 - Manufacturer and third-party PAN files selected from Anza internal database
 - Filtered to represent one module per product line
- Project selection
 - Represent typical DG- and utility-scale projects in the US
 - Varied annual insolation and average ambient temperatures

	PERC	TOPCon	Total
Manufacturer	97	79	176
Third-Party	40	39	79

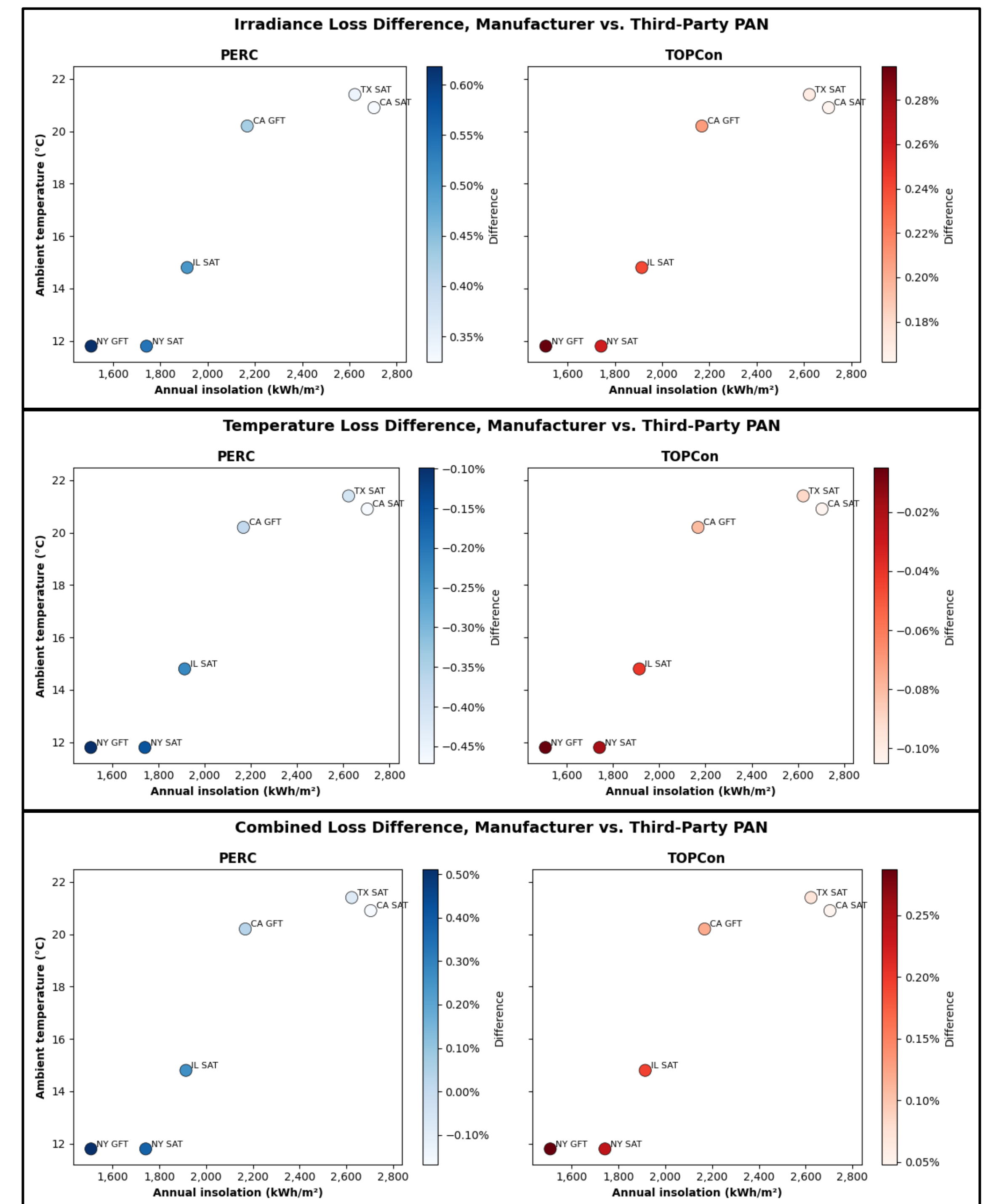
Project	US State	Fixed Tilt or Tracker	Insolation Characterization	Ambient Temperature Characterization
NY GFT	New York	Fixed Tilt	Low	Low
CA GFT	California	Fixed Tilt	Medium	High
IL SAT	Illinois	Tracker	Medium	Medium
TX SAT	Texas	Tracker	High	High
NY SAT	New York	Tracker	Low	Low
CA SAT	California	Tracker	High	High

Box-and-Whisker Performance Distributions



Multivariable Scatter Plots

Note: Positive values correspond to manufacturer PAN file overperformance relative to third-party



Observations and Conclusions

1. The irradiance loss and combined loss spreads for manufacturer PAN files are generally larger than those for third-party PAN files, indicating that some outlier PAN files may not represent the actual field performance of modules
2. The temperature loss spread for manufacturer PAN files is remarkably similar to that for third-party PAN files and overall lower than its spread for irradiance losses, indicating that manufacturers are more consistent in modeling thermal behavior
3. On average, manufacturer PAN files **underpredict irradiance loss** by as much as **0.6%** for PERC and **0.3%** for TOPCon modules, with the difference lessening as annual insolation increases
4. On average, manufacturer PAN files **underpredict combined loss** by as much as **0.5%** for PERC and **0.3%** for TOPCon modules, with the difference lessening as annual insolation and ambient temperature increase