Improved CdTe PLR Estimates: Self-Shading and Spectral Mismatch

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PVRW

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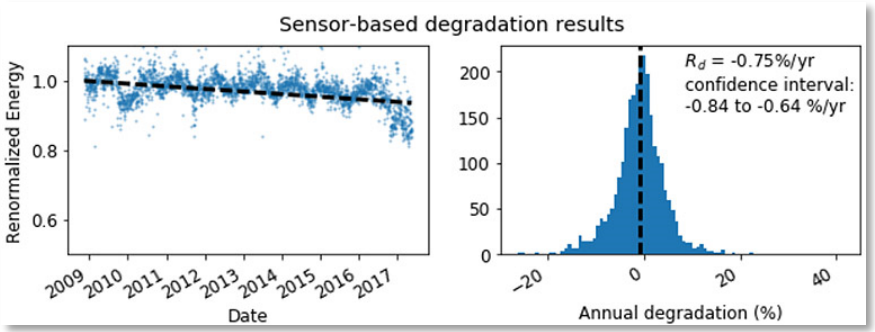
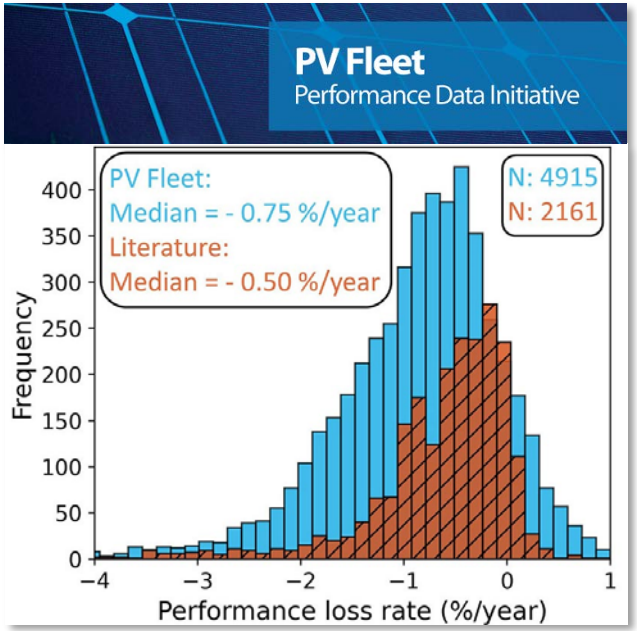
PV Fleets: Performance Loss Rates

RdTools

Normalize → Filter → Aggregate → Year-on-Year PLR estimate



× 5000 =



https://www.nrel.gov/pv/fleet-performance-data-initiative.html
https://rdtools.readthedocs.io

RdTools Normalization

$$\mathrm{PR} = \frac{P}{P_{\mathrm{STC,rated}} * \frac{G_{\mathrm{POA}}}{G_{\mathrm{ref}}} * \left(1 + \gamma * \left[T_{\mathrm{cell}} - T_{\mathrm{ref}}\right]\right)}$$

Broadband Irradiance

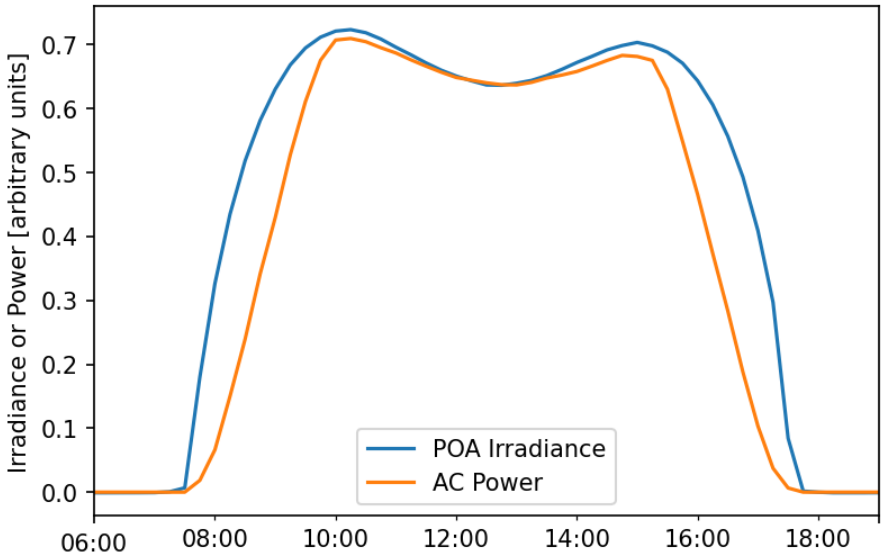
Cell Temperature Adjustment

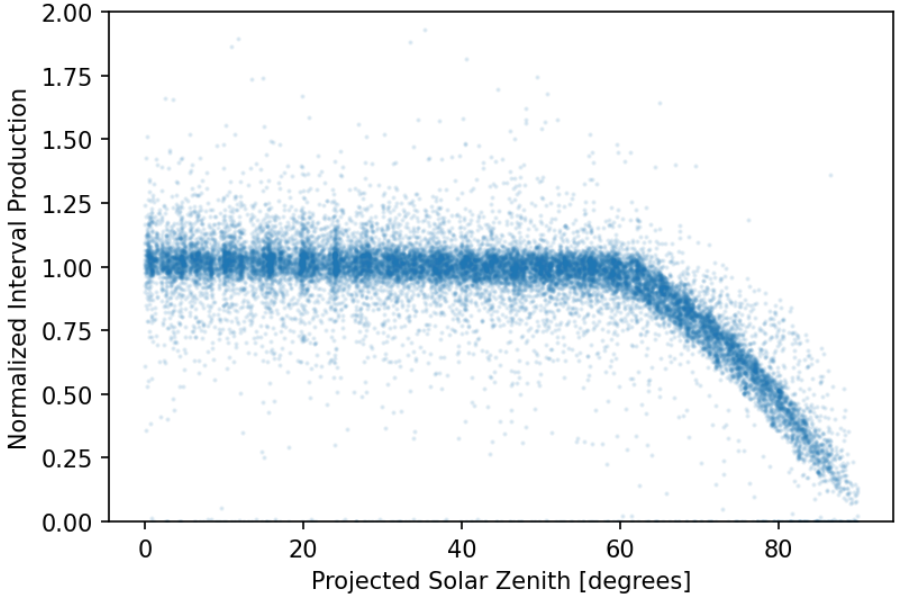
What about:

1. CdTe tracking systems intentionally self-shade (no backtracking)
2. CdTe is more spectrally sensitive than c-Si

D. Jordan et al. “Robust PV Degradation Methodology and Application”, JPV 2017

Self-Shading

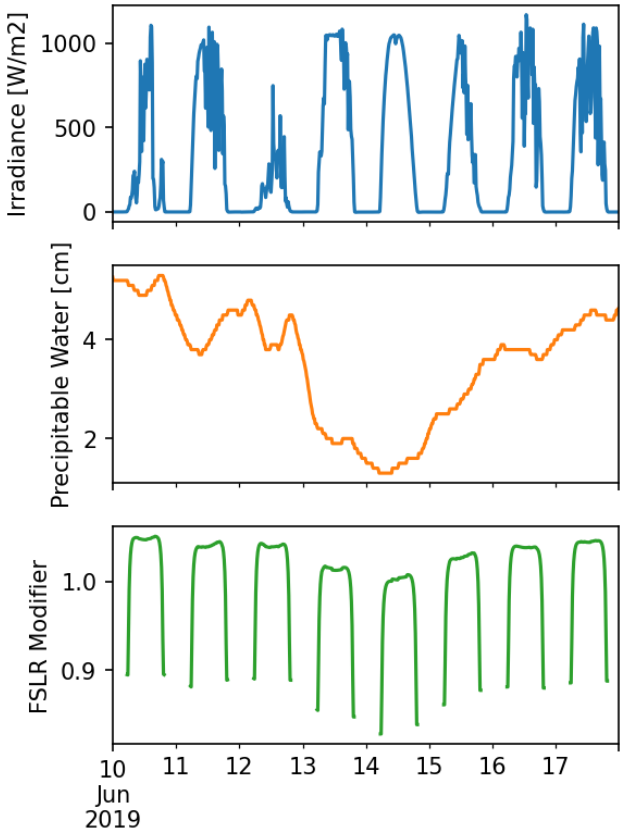


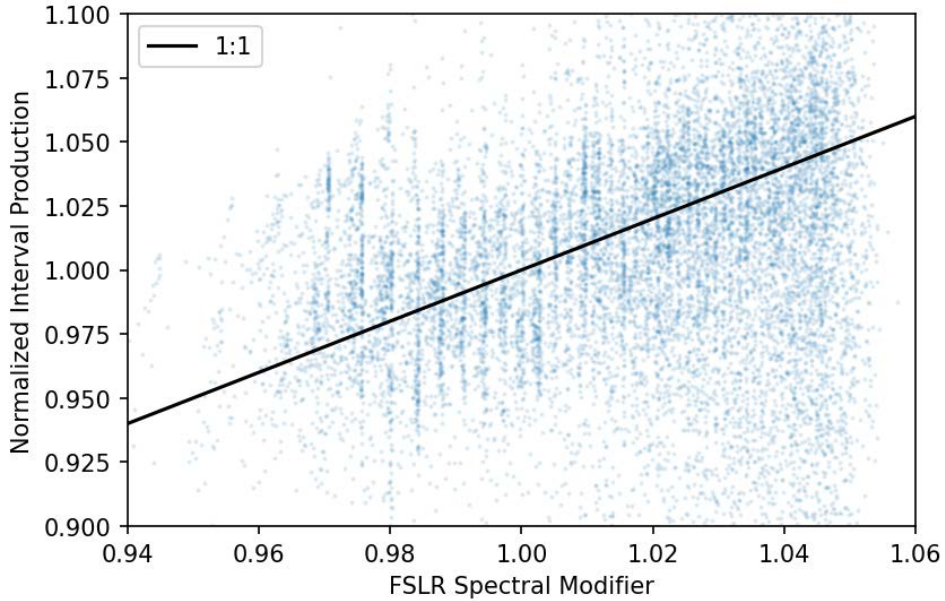


Linear derate for beam reduction, where diffuse fraction is…

- From PSM3
- From GTI-DIRINT (decompose POA into DNI, DHI components)
- 20% always (“simple”)

Spectral Correction



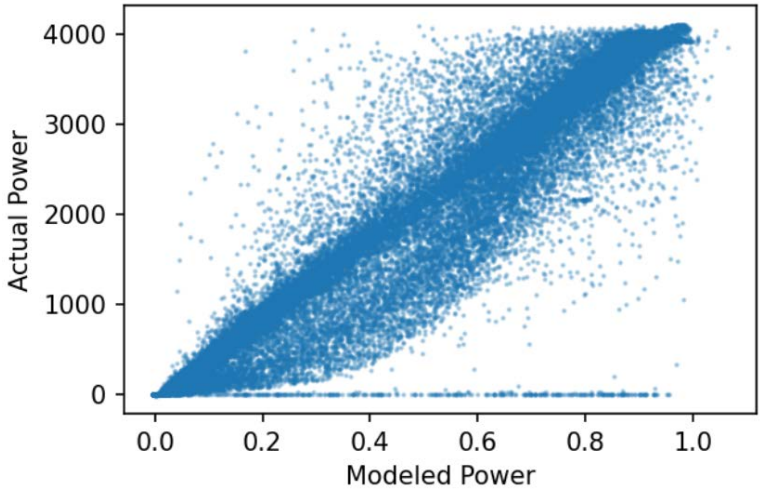


FSLR: airmass, precipitable water

SAPM: airmass only

Model Improvement

Modeled Power:
Irradiance, Temperature

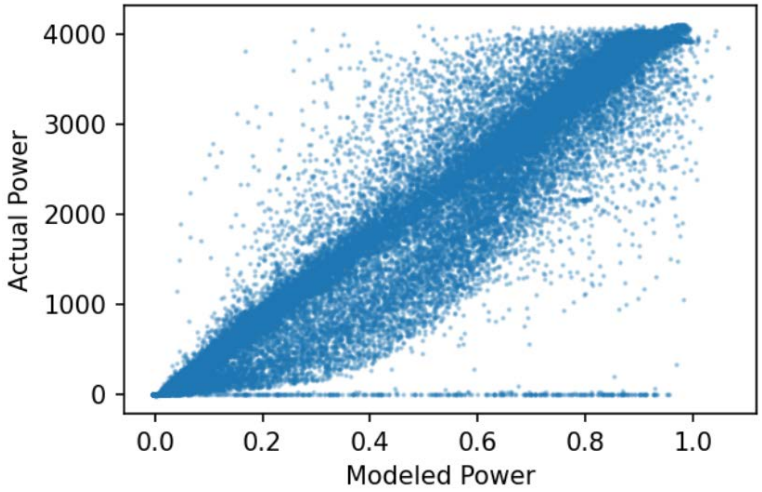


POWERED BY pvlib

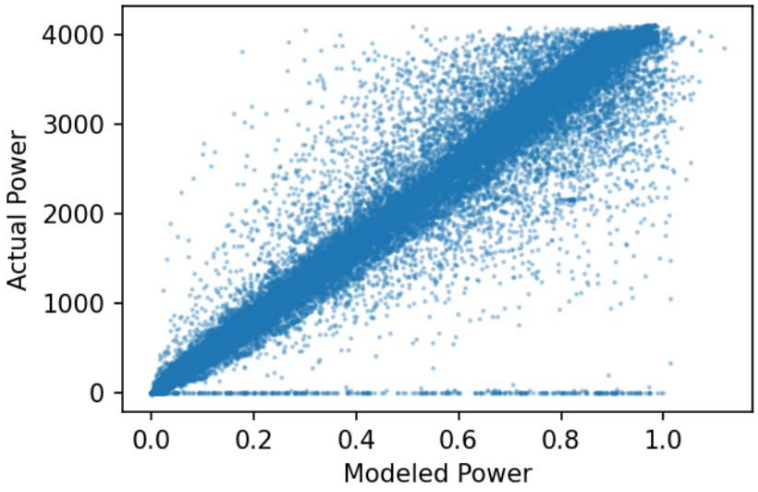
https://pvlib-python.readthedocs.io

Model Improvement

Modeled Power:
Irradiance, Temperature



Modeled Power:
Irradiance, Temperature, Self-Shading, Spectrum



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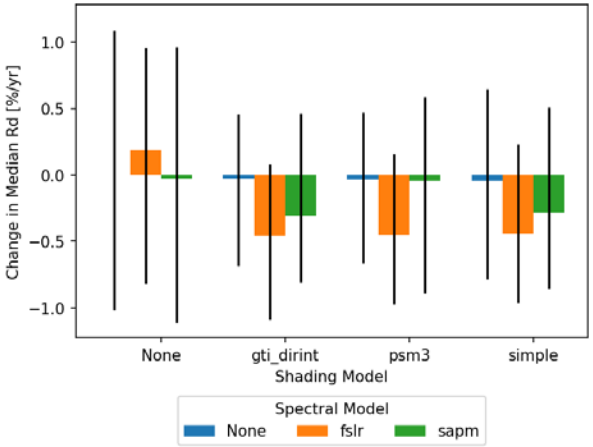
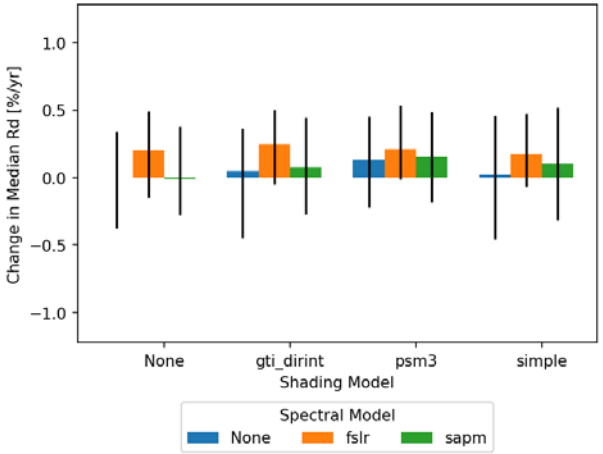
Results

System 1
Southeast US, Humid



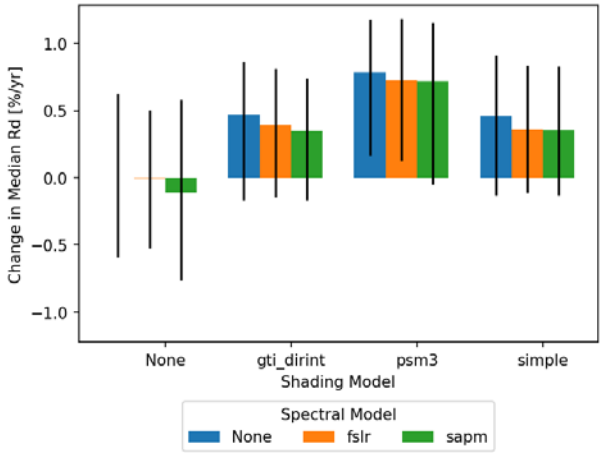
46% reduction in CI width

System 2
South-central US, Semi-Arid



40% reduction in CI width

System 3
Southwest US, Arid



32% reduction in CI width

Conclusions

Spectral Correction

FSLR often (but not always) gives tighter confidence intervals than no correction

Toss-up for whether SAPM widens or tightens the CI

Self-Shading

Including a shading model tends to tighten the CI, but it's not obvious that one shading model is better than another for all systems

Heavy soiling makes all results suspect

Standard caveat: we don’t know what the right answer is

Thank You

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