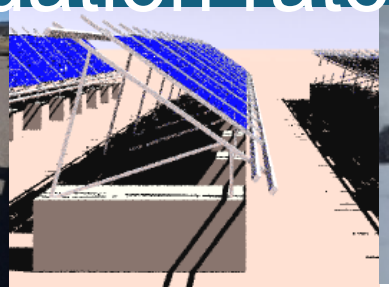
SAND2021-1096C

Geographic and technology factors in photovoltaic performance degradation rate estimations



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Photovoltaic degradation rate: problems and challenges

- **Unverified:** Real value of Rd is unknown

- **Irreproducible:** Rd is statistically estimated *but* different data pipelines and approaches yield different results

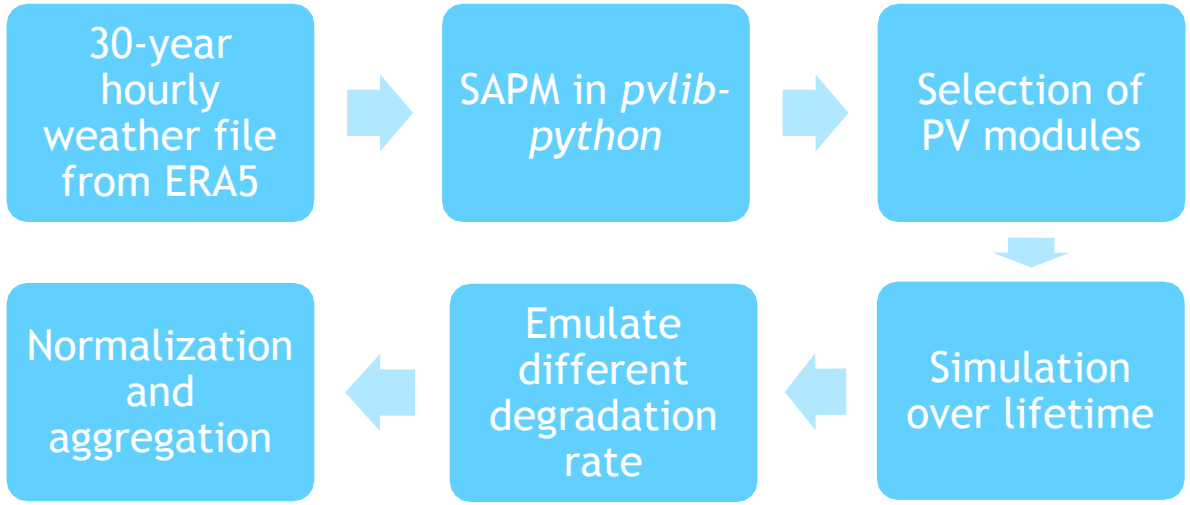
- **Some assumptions or steps are arbitrary:** Unknown requirements in respect to minimum length of dataset or the right way to handle the data in respect to filtering (missing data, outliers, inverter clipping), inference, aggregation, metric etc.

- **Can a universal solution exist?** Normalizations, aggregations, corrections and decomposition models are not perfect and still contain fluctuations depending on seasonality, which in turn, depends on location/climate and module type

Framework for worldwide parametric analysis

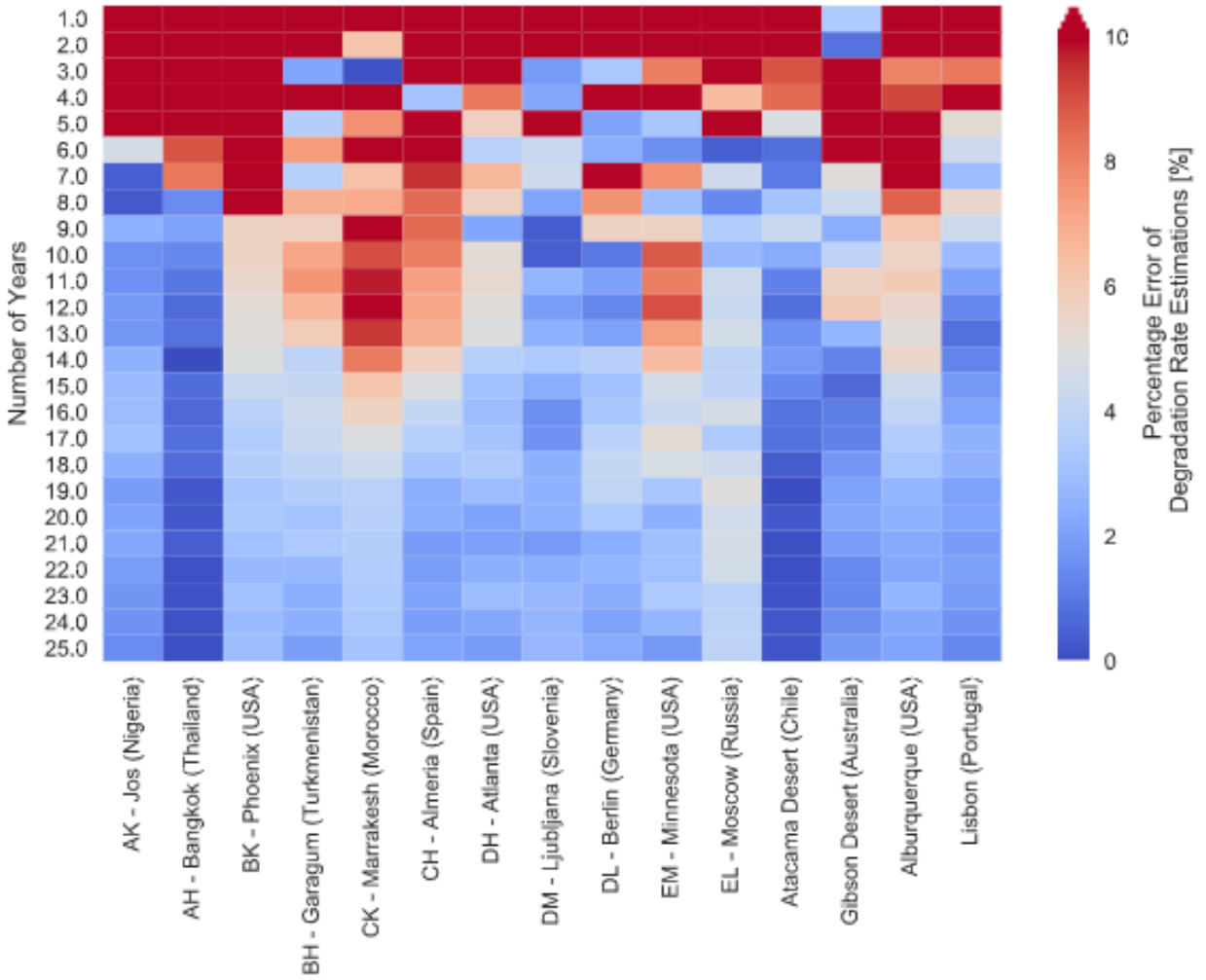
Real degradation rate value(s) is (are) unknown

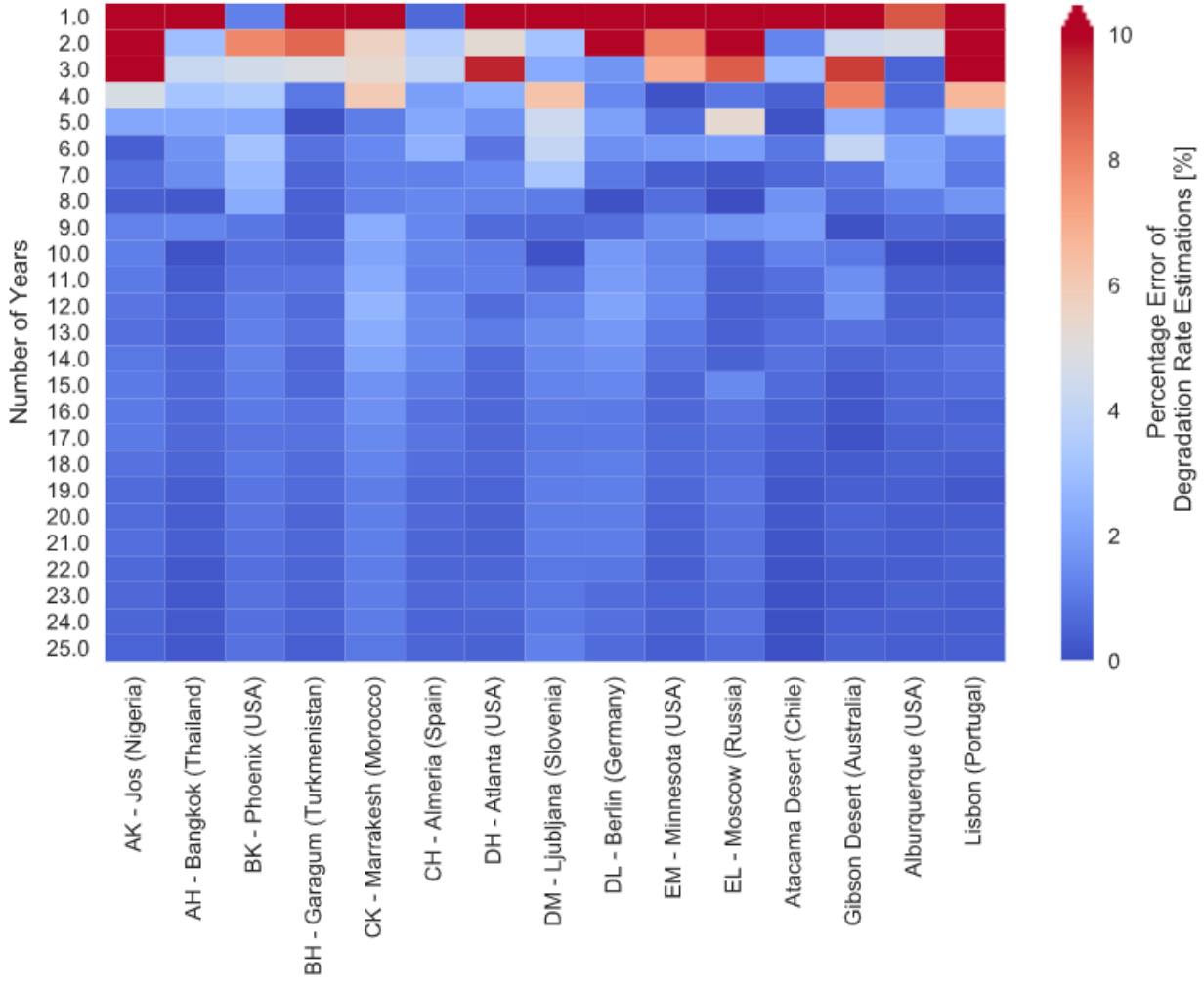
Synthetic datasets of known behavior were generated in order to perform the analysis



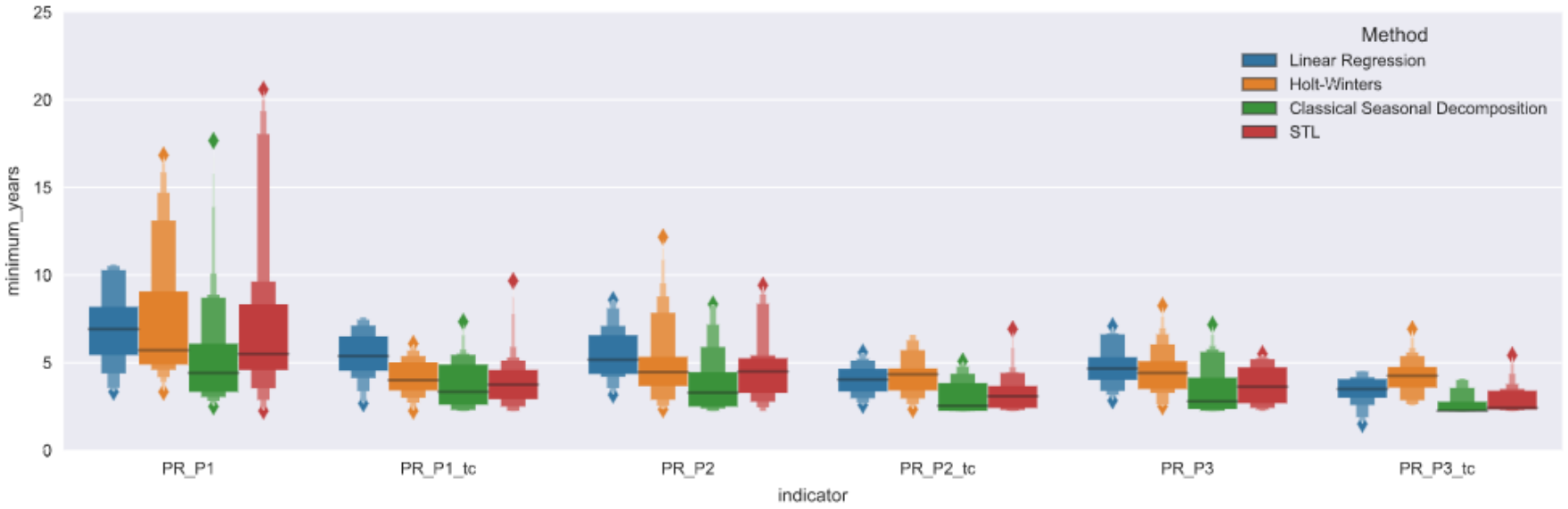
Target: to match the synthetic with “estimated” degradation rate within 2% relative (**arbitrary**)

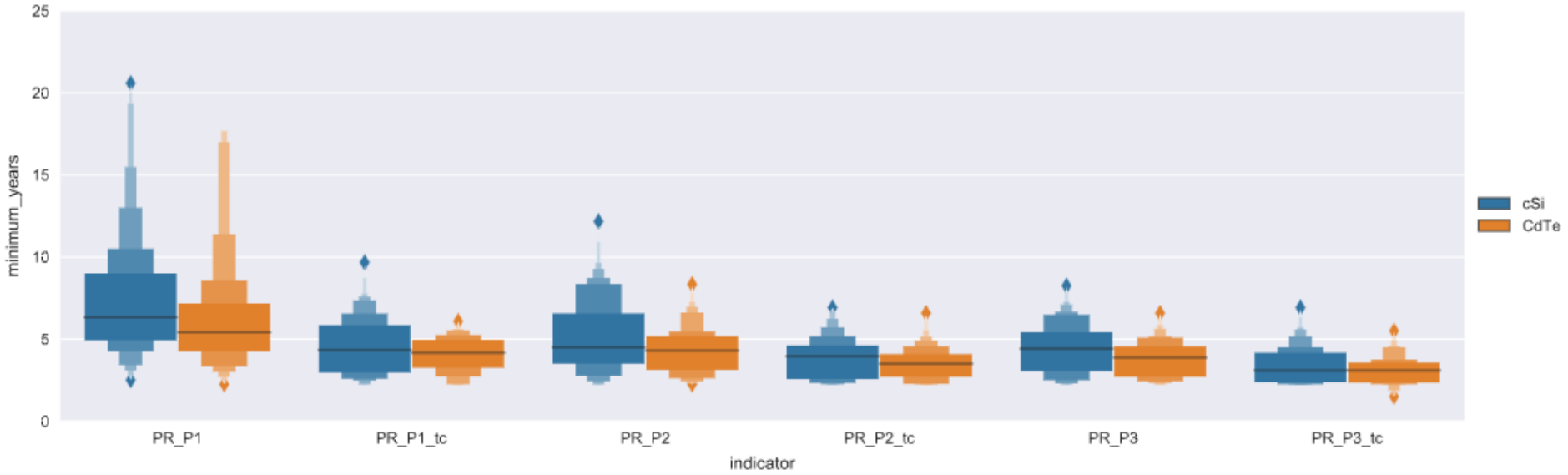
Linear regression (LR) with ordinary least squares (OLS)
Case Study: -1%/year, Monthly PR and PR



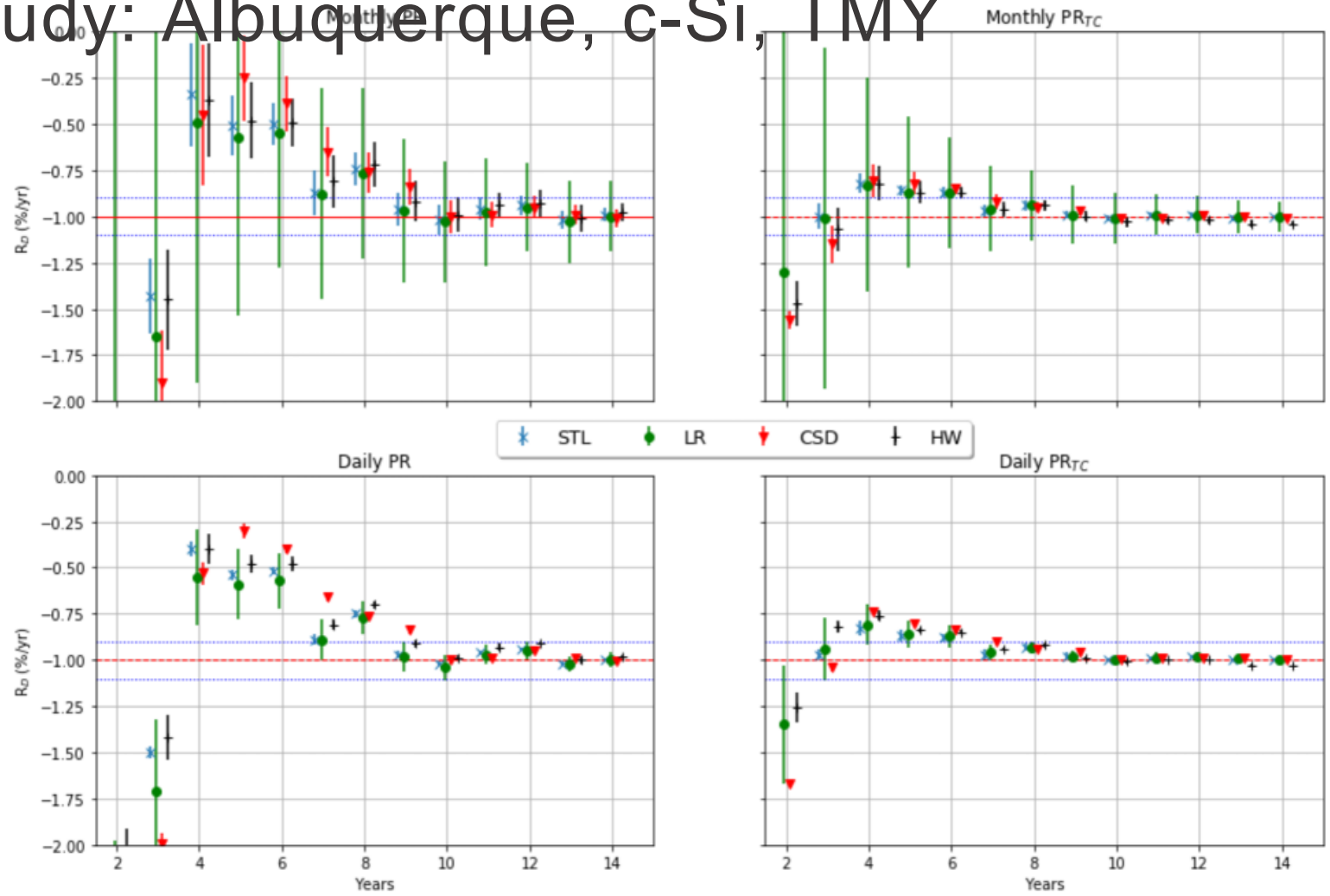


Boxenplots: Monthly data, 2% threshold, all locations

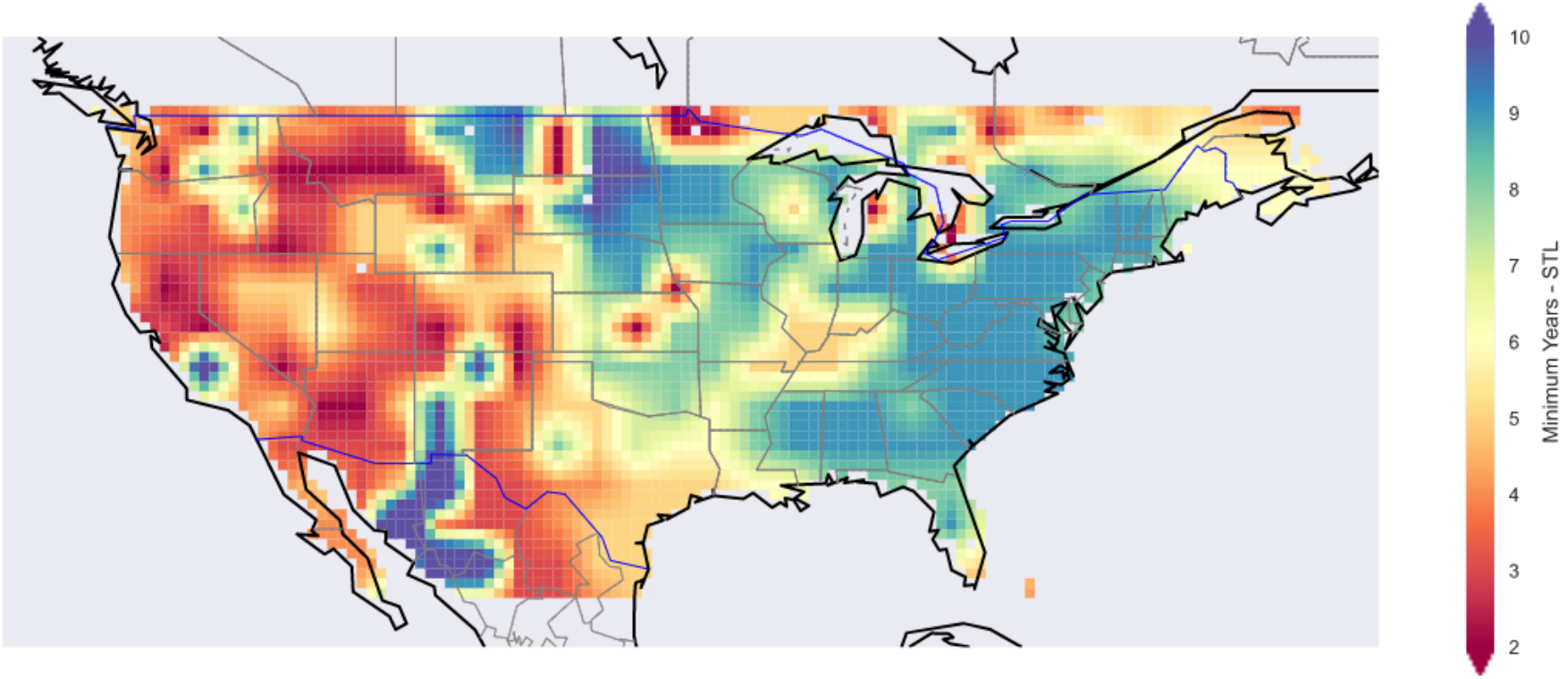




Confidence intervals, aggregation, temperature correction
Case Study: Albuquerque, c-Si, TMY



Investigations over large geographical regions



Spatial Grid : 2°x2° Latitude, Longitude

Minimum years will depend on the selected threshold value and method, but also the weather conditions (irradiance, temperature, etc) and seasonal index.

Bilinear interpolation to smoothen results

Conclusions

- True hypothesis: Climate/location and PV technology indeed affect the R_D accuracy

- Faster convergence in degradation rate estimation is achieved when:
  - Using temperature correction and finer aggregation
  - Degradation rates are larger (e.g. -1%/year Vs -3%/year)
  - PV technology exhibits low seasonal performance (e.g. thin-films Vs crystalline silicon)

- Confidence interval is as important as the degradation rate estimations

- Confidence intervals are reduced with temperature correction and finer aggregation

Thank you for your attention!

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