

PV Performance Assessment of a very large portfolio using minimal data



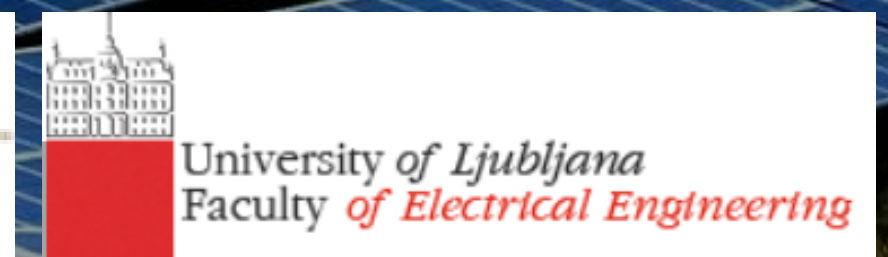
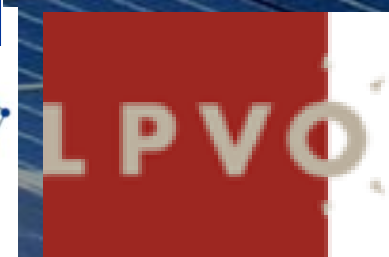
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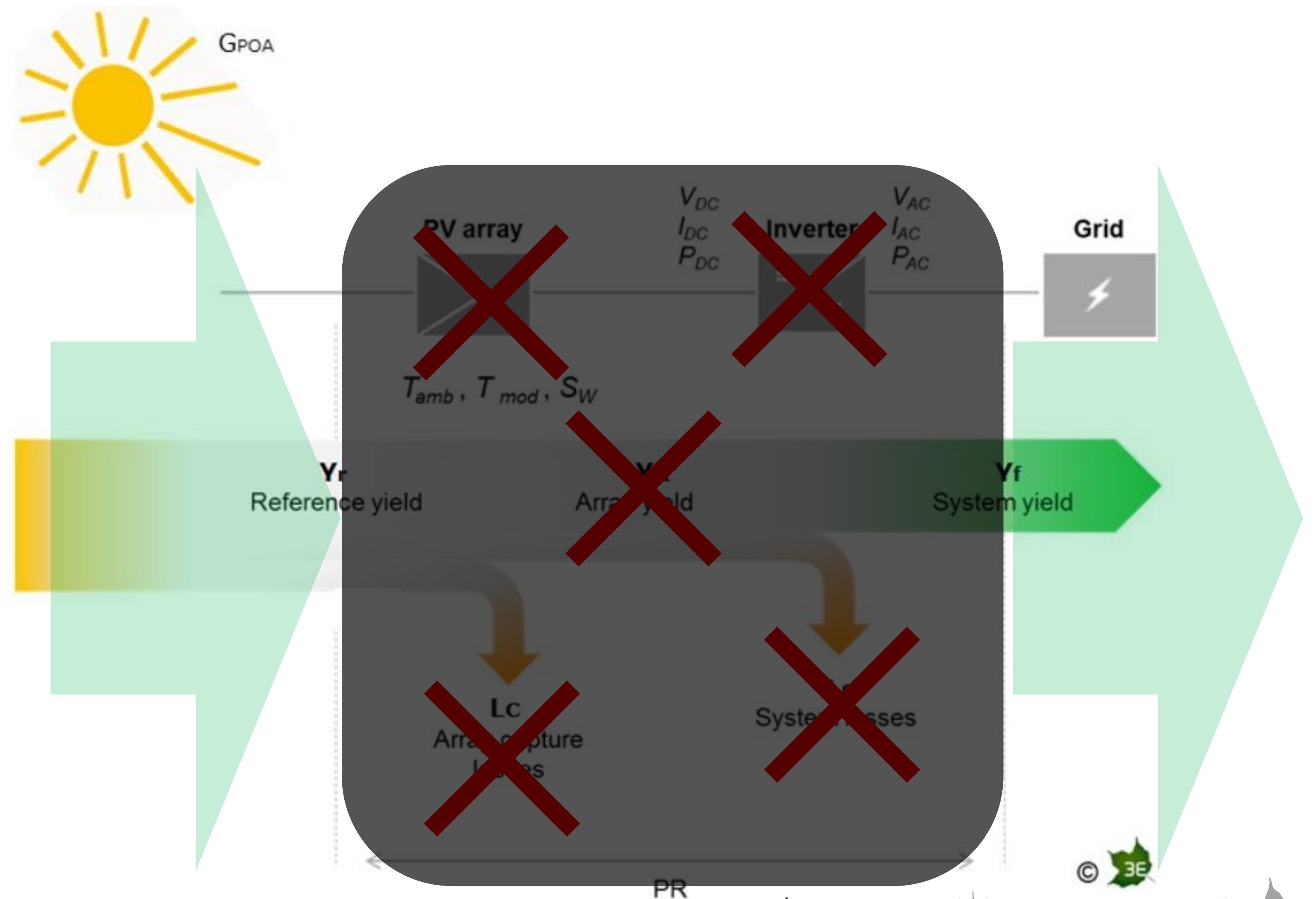
Content

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Introduction

Minimal data on PV systems

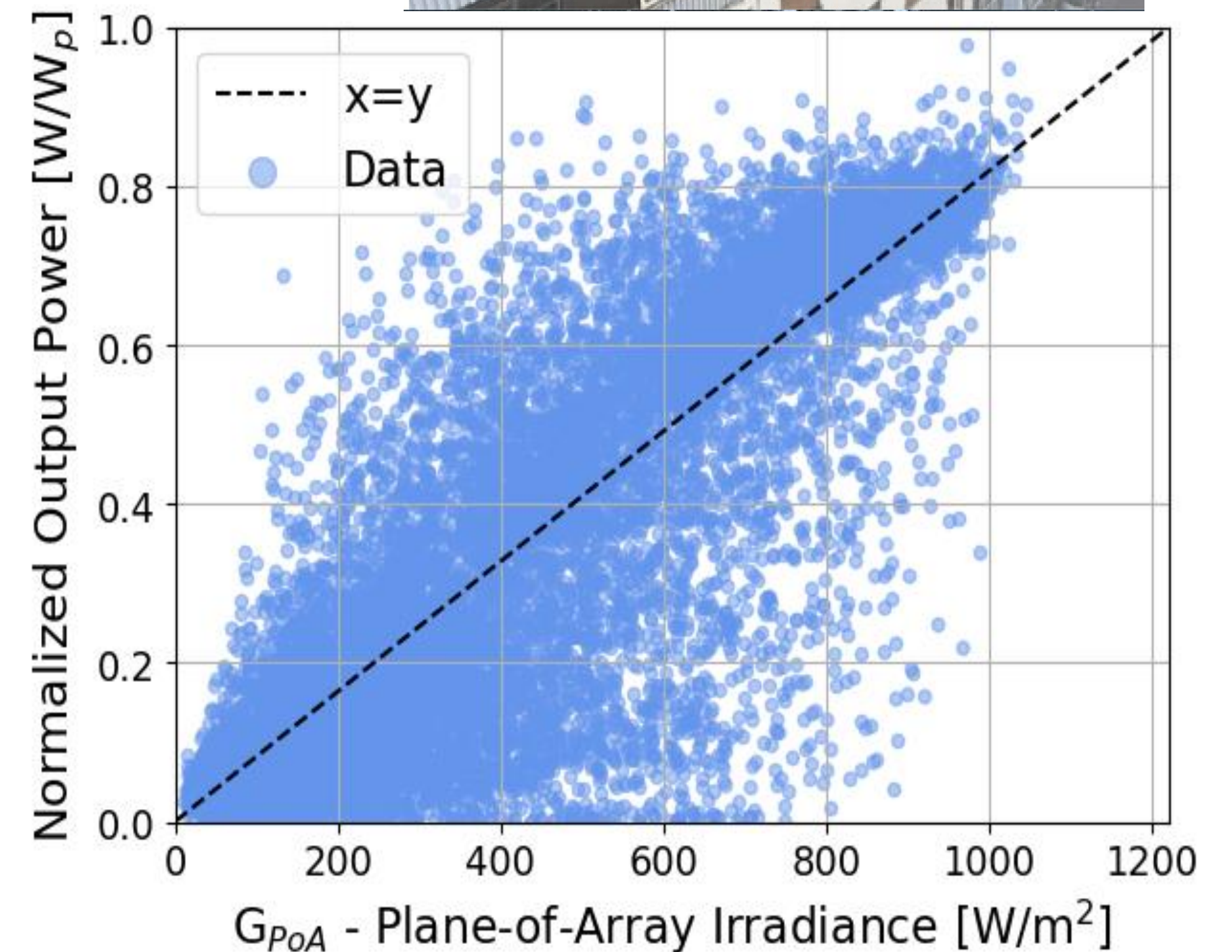
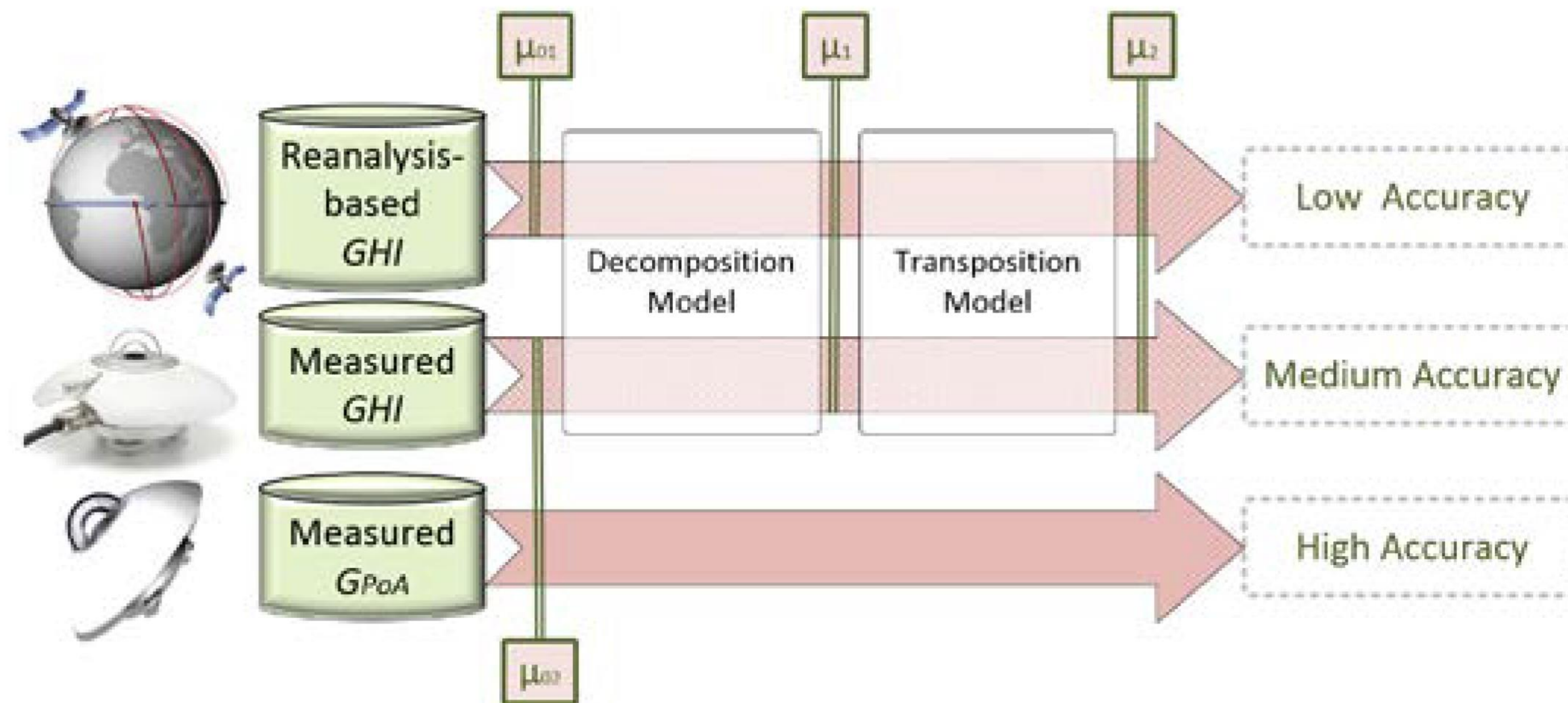
- The PV systems deployment is growing exponentially and in all climates
- Digitalization of PV systems is helping to improve the O&M activities
- However, still many PV systems count with limited monitoring data systems
 - Residential systems
 - Small-scale PV systems
- Often, only AC power data is available
 - Minimal data on PV systems
 - Grid point connection



PV Performance Assessment

Different levels of irradiance data

- In cases, location and AC power output are available.
- This will allow retrieving climate reanalysis data (e.g., ERA5)
 - Low accuracy of irradiance data compared to ground measurements
- Possibilities to apply smart data filtering procedures

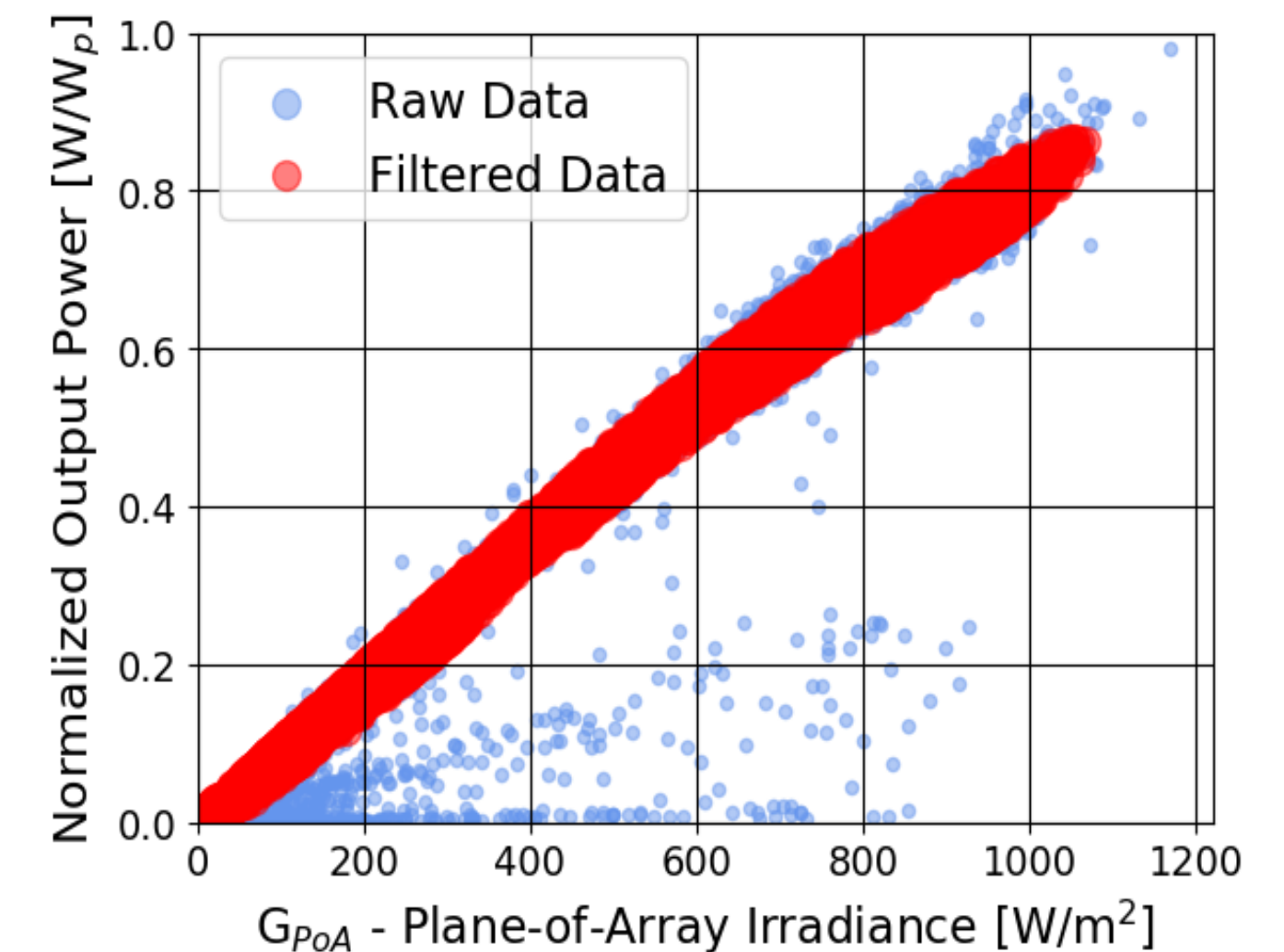
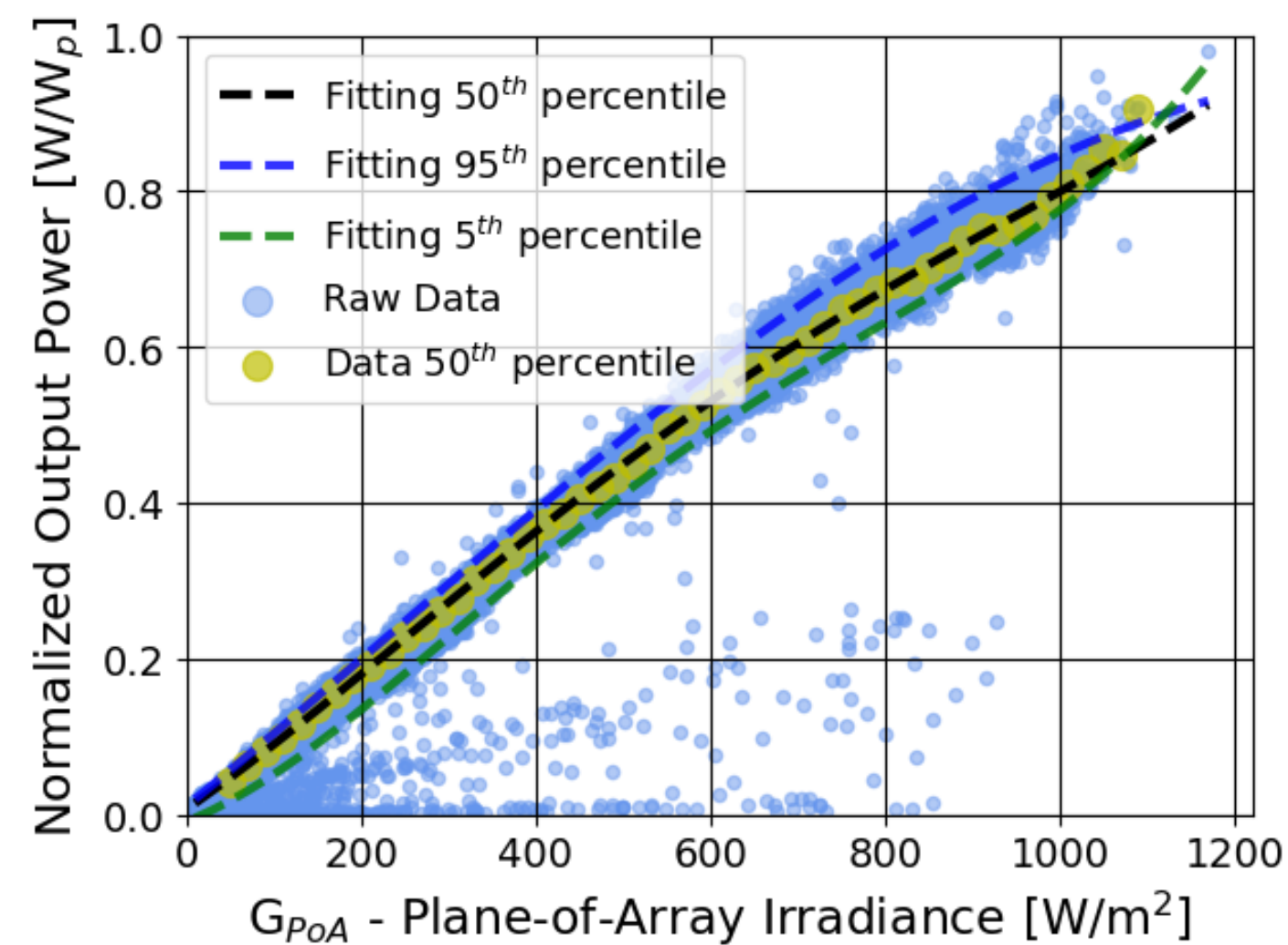
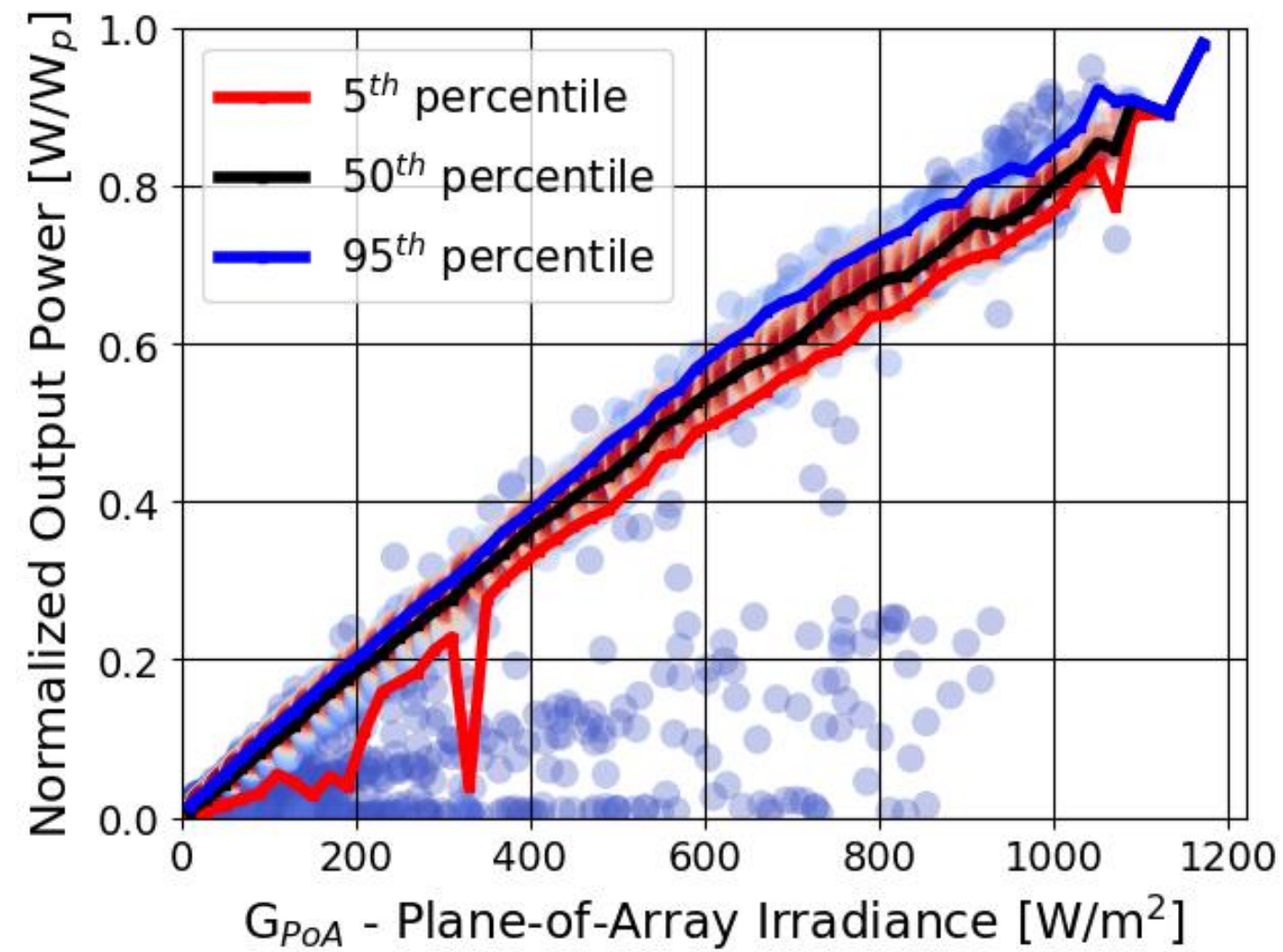
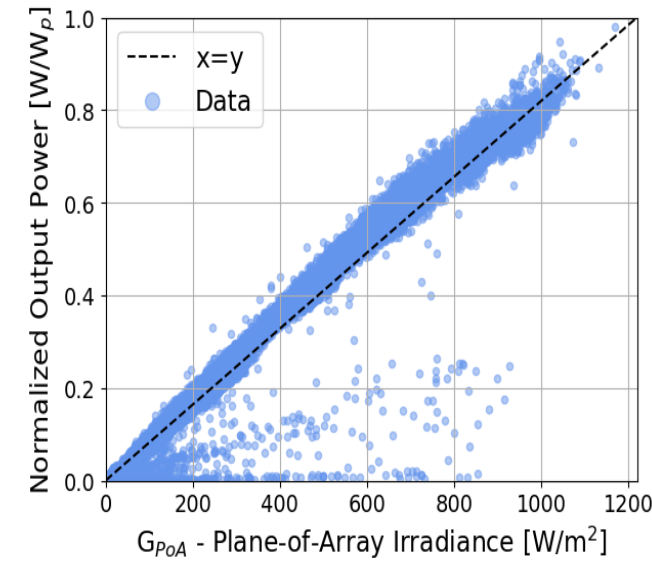


Source: Ascencio-Vásquez et al., Energies, 2020 ([link](#))

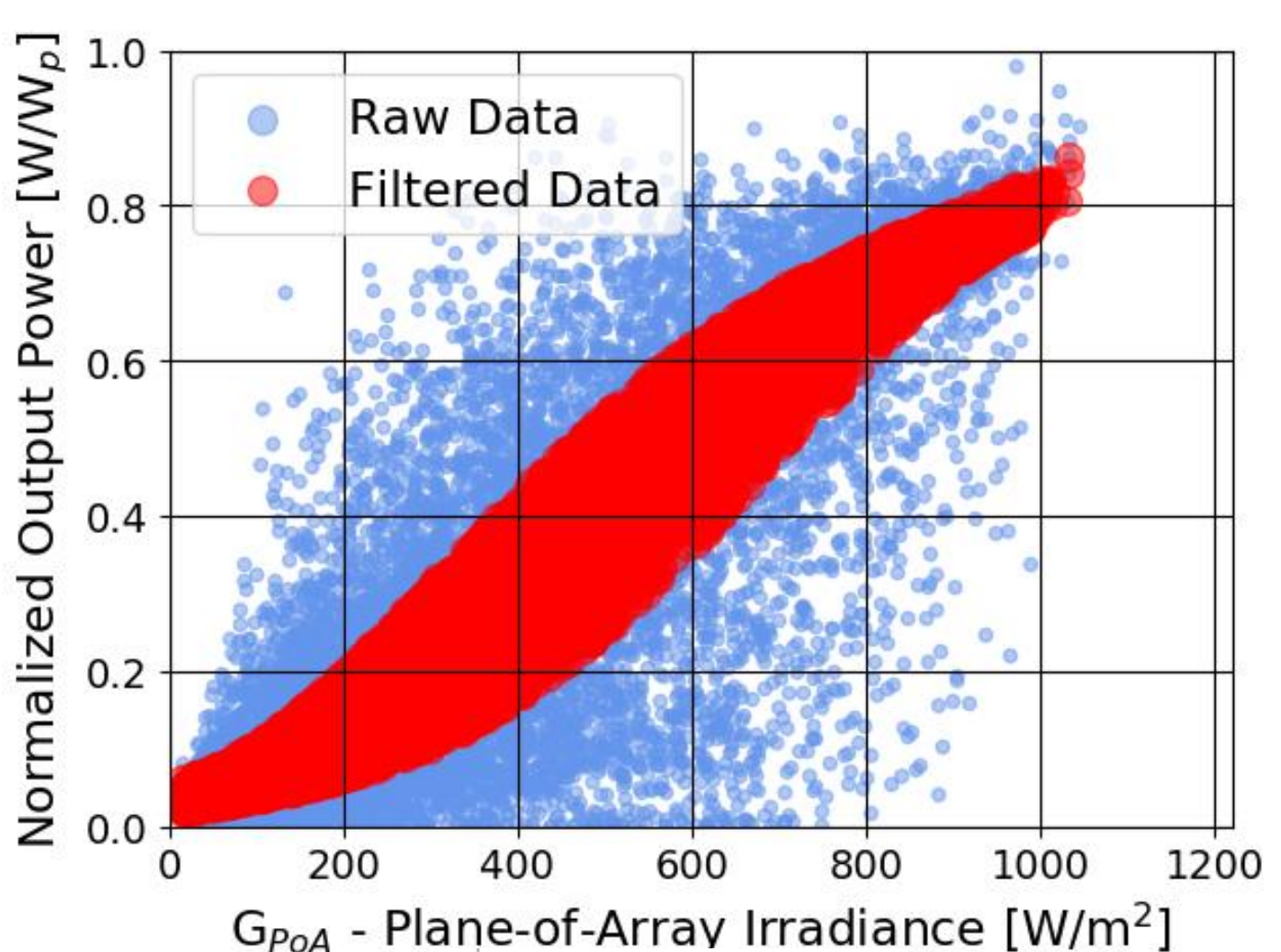
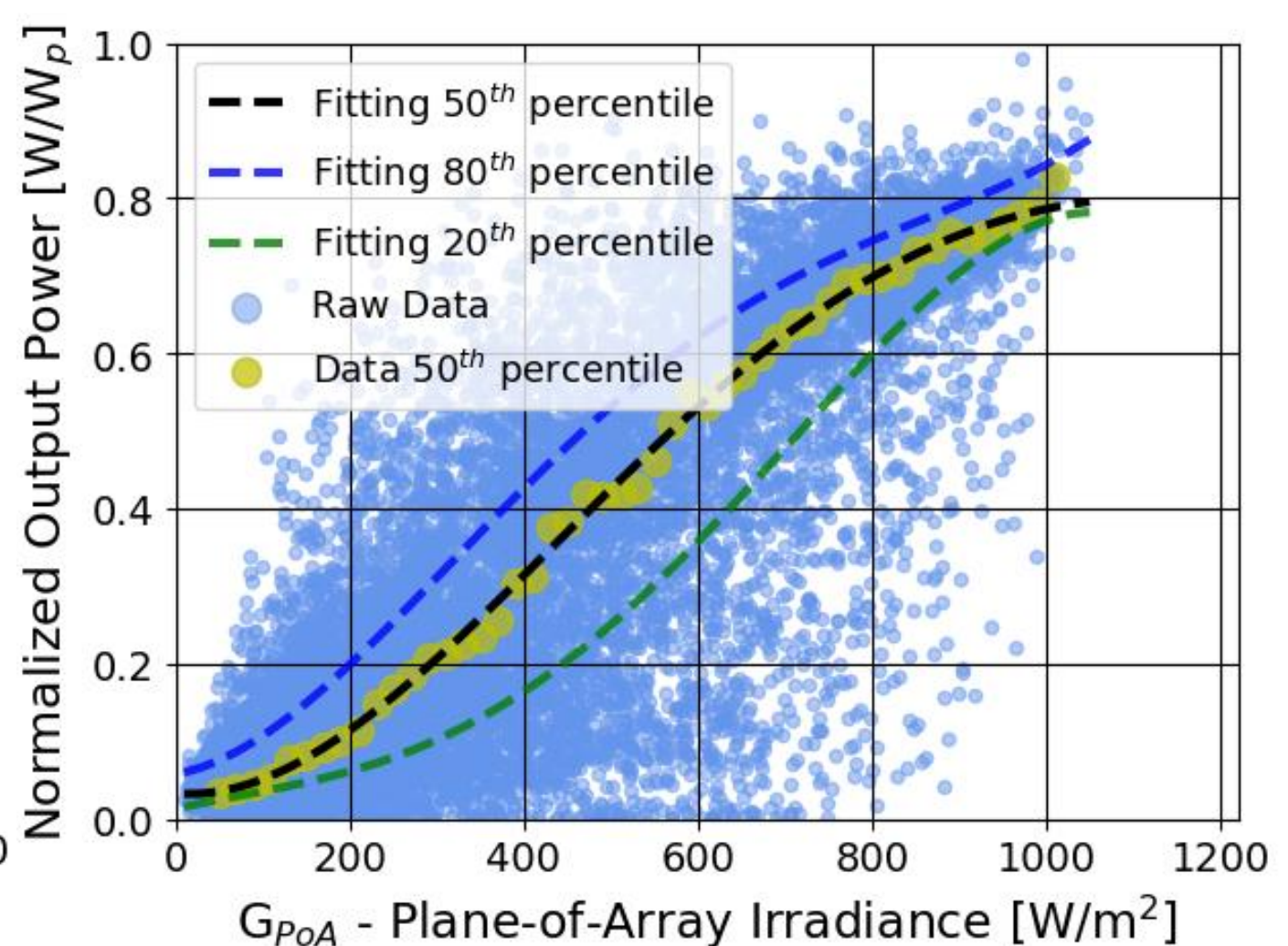
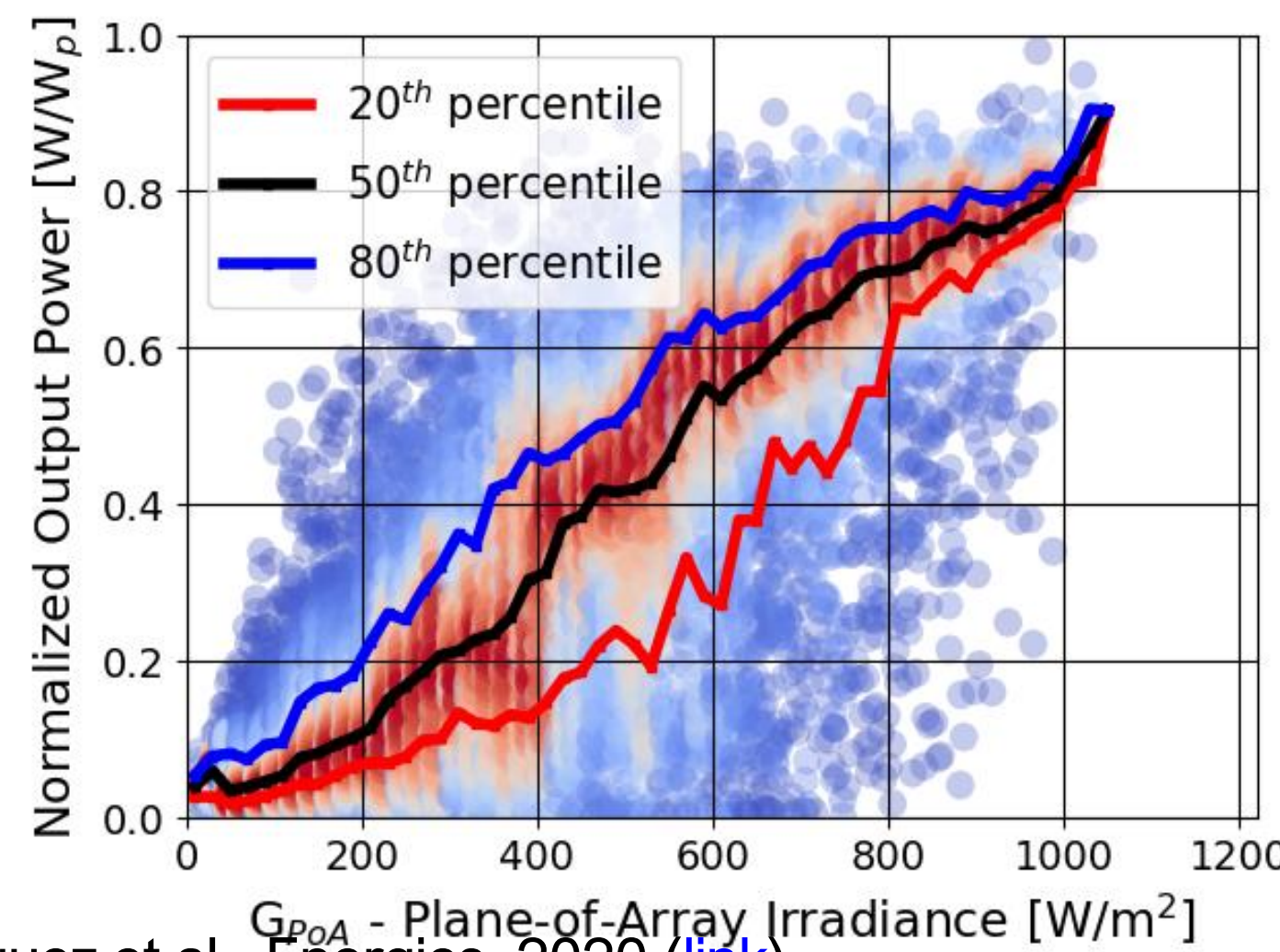
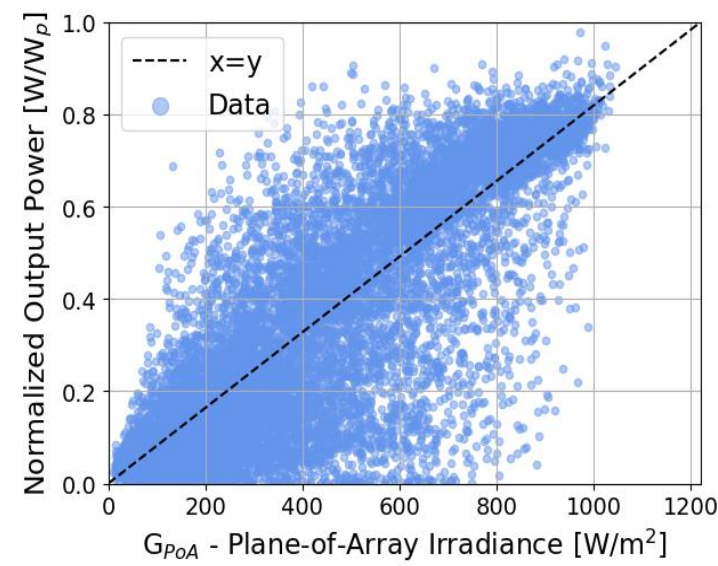
PV Performance Assessment

Filtering Algorithm (power versus irradiance)

High Accuracy



Low Accuracy



Source: Ascencio-Vásquez et al., Energies, 2020 ([link](#))

PV Performance Assessment

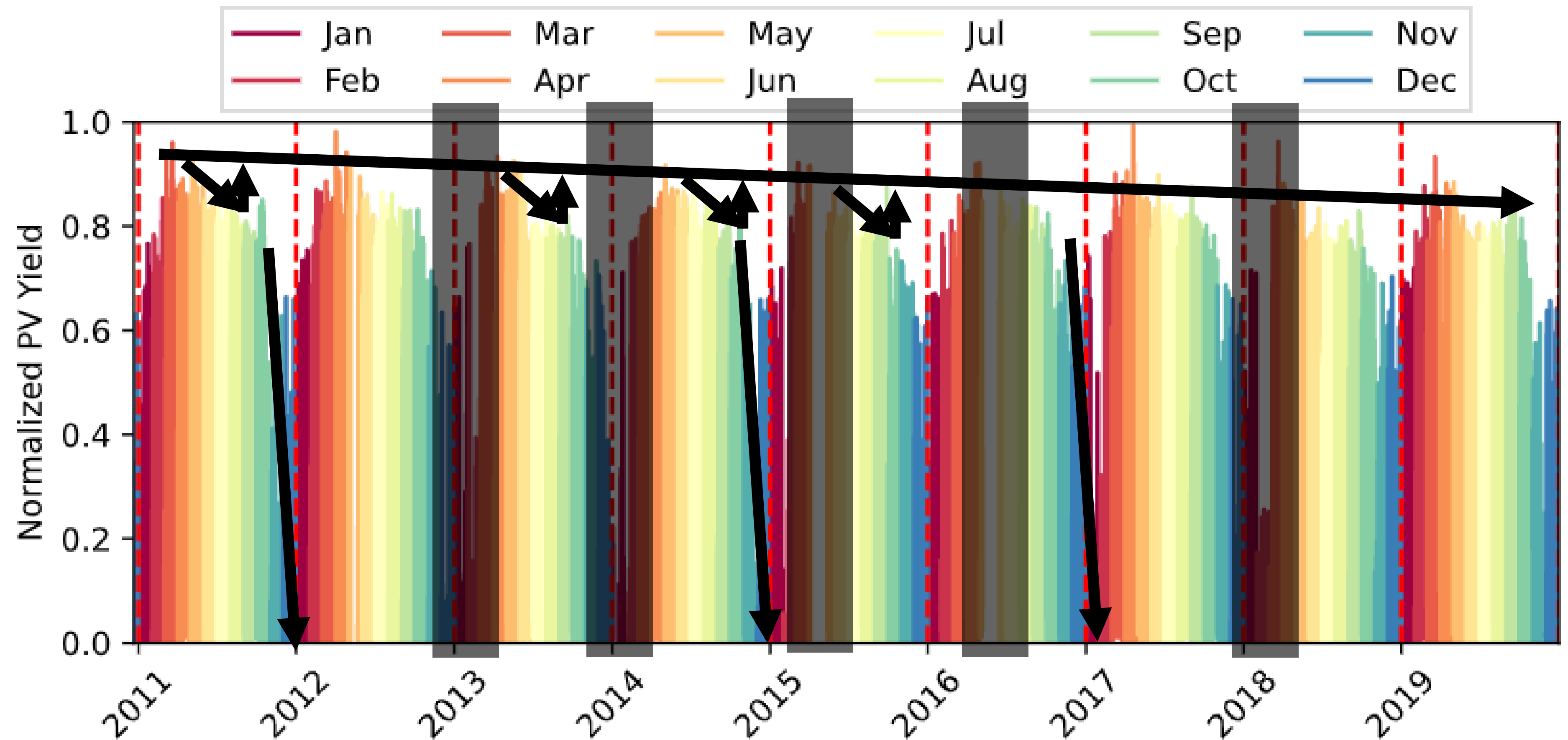
Common Data Operational and Data issues

- **Operational issues**

- String failures
- Degradation
- Soiling/Snow

- **Data issues**

- Gaps
- Outliers
- Communication issues
- Timeshifts



Source: Ascencio-Vásquez et al., publication under review, 2021

PV Performance Assessment

Typical Daily Profiles (1/3)

- **Seasonal patterns observed**

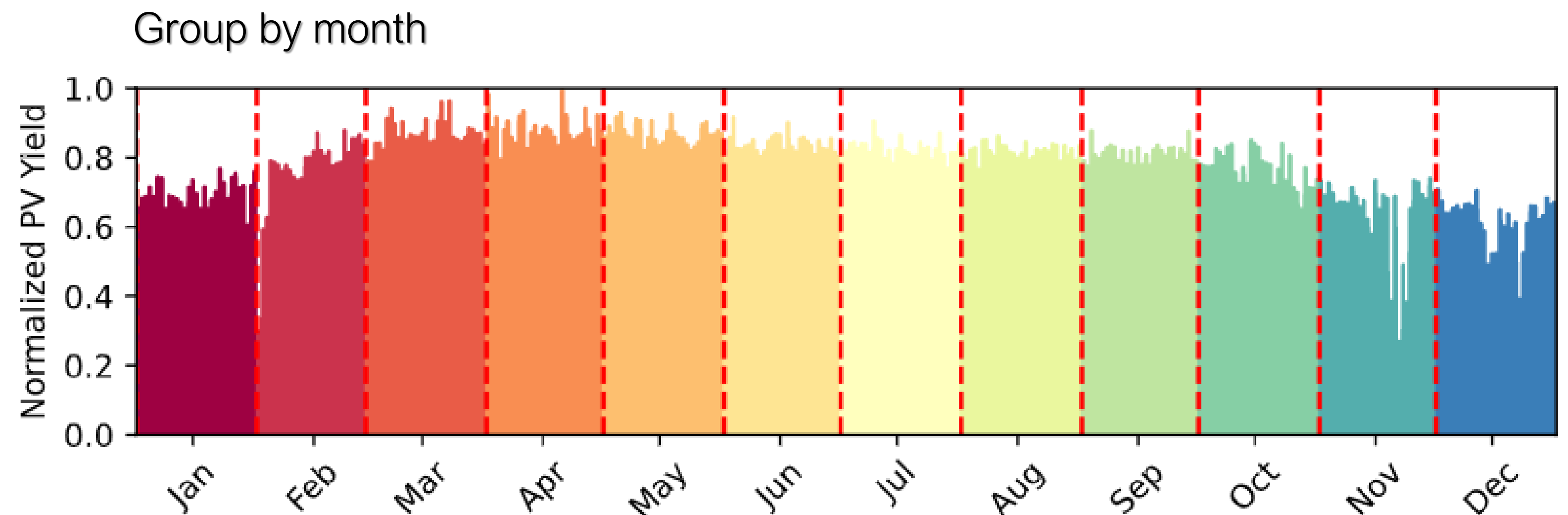
- Daily Pattern: sun motion over a day
- Annual Pattern: earth motion over a year

- **Expected**

- Highest PV power output possible
- At least one clear sky during the month

- **Typical Daily Profiles (TDP)**

- Find the optimal daily profile of the PV power output

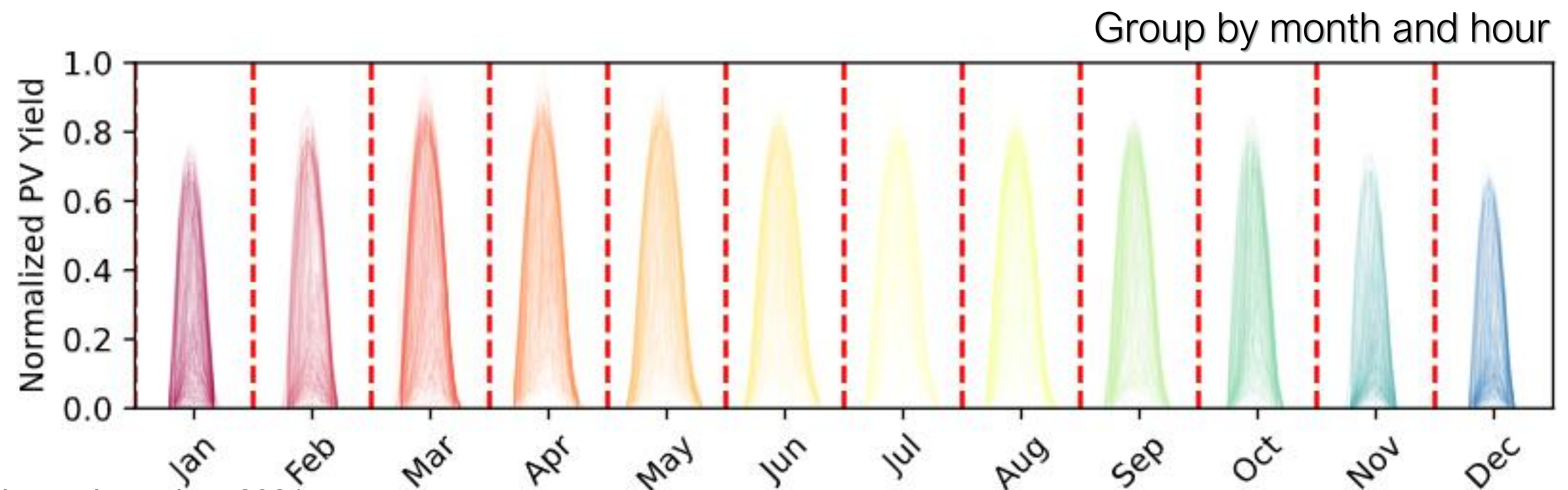


Source: Ascencio-Vásquez et al., publication under review, 2021

PV Performance Assessment

Typical Daily Profiles (2/3)

- **Overlap all the data within a month**
 - Creation of Average-TDP
 - Group all data per month and hour (example: all data month X from 2011 to 2020)
 - Creation of Year-to-Year TDP
 - Group data per month and hour (example: data month X for year 2019)

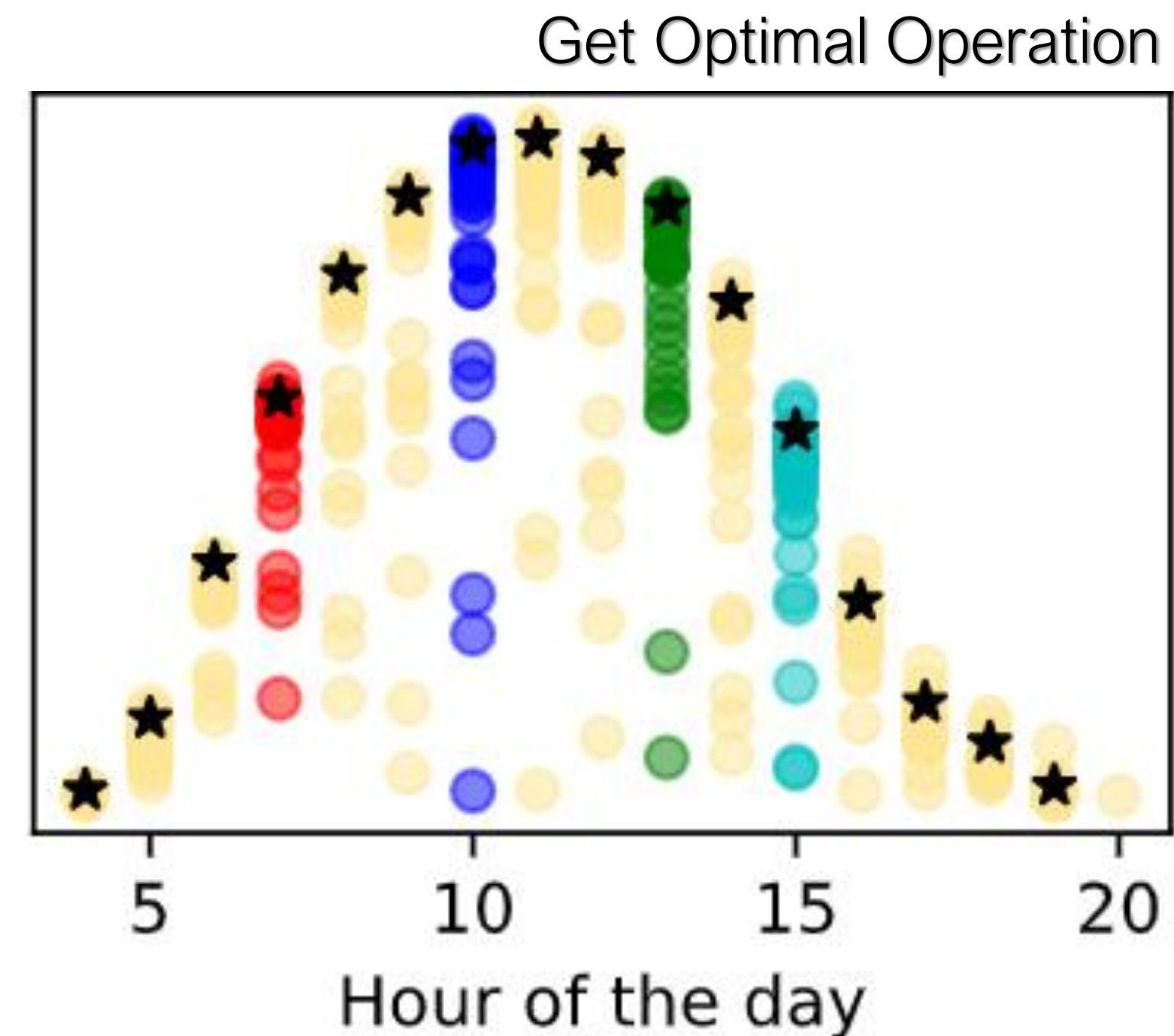
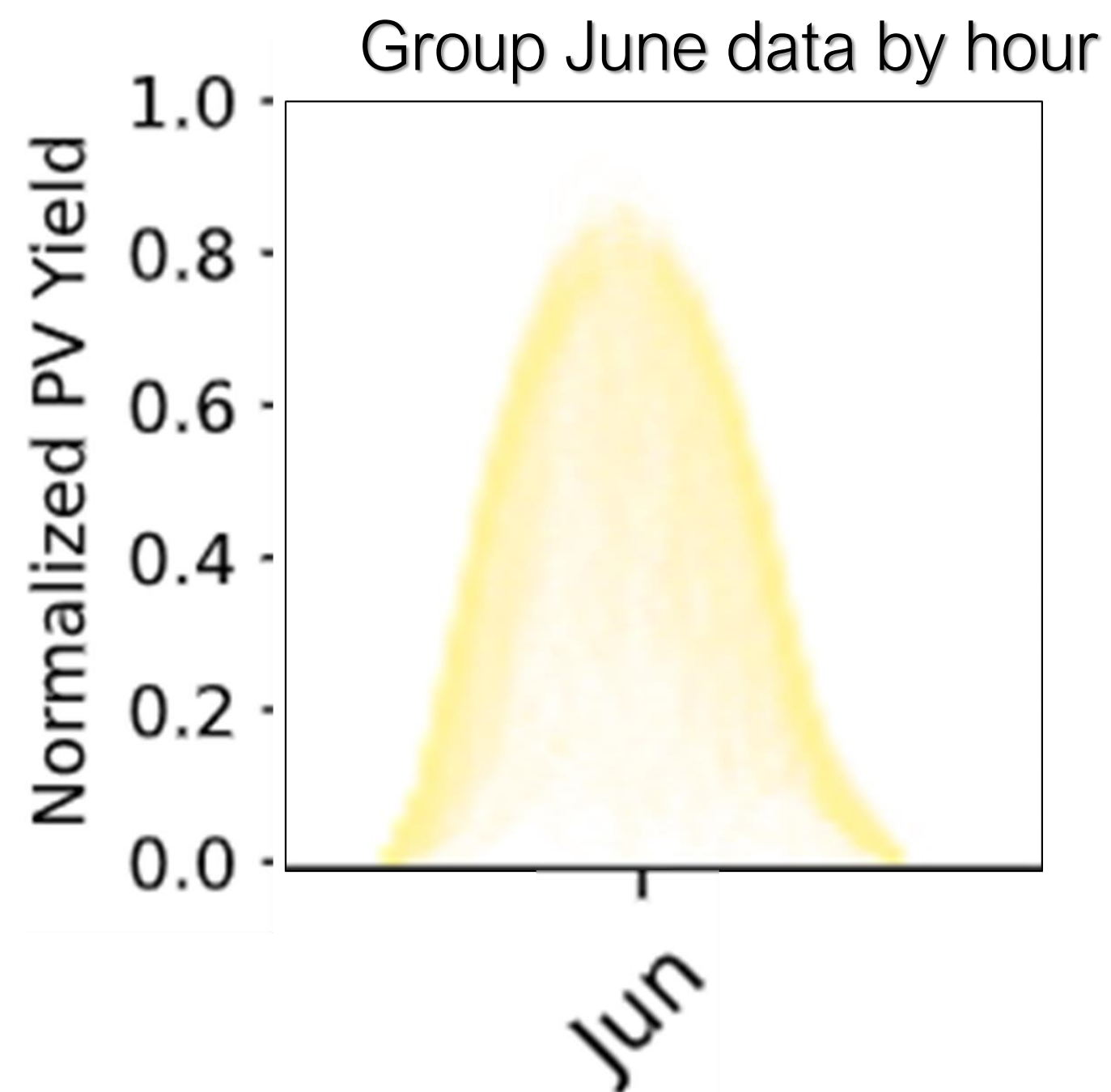


Source: Ascencio-Vásquez et al., publication under review, 2021

PV Performance Assessment

Typical Daily Profiles (3/3)

- Select a mathematical operation to extract the desired PV power output
 - Percentile 90th or above to extract the operation under clear sky conditions
- Observed consistency of PV production (per hour) over time

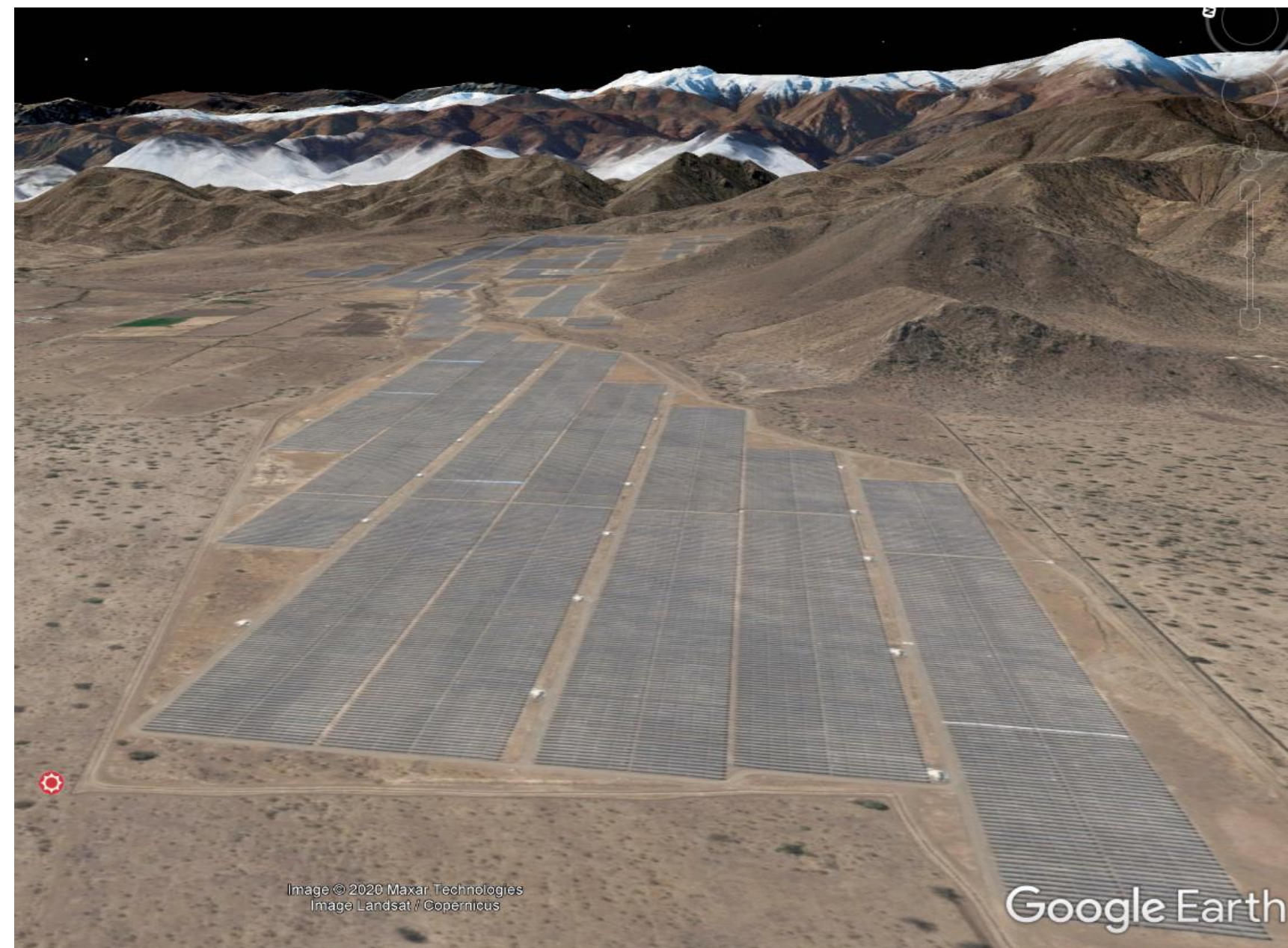


Source: Ascencio-Vásquez et al., publication under review, 2021

Application of the TDP on real PV power plants

One PV system

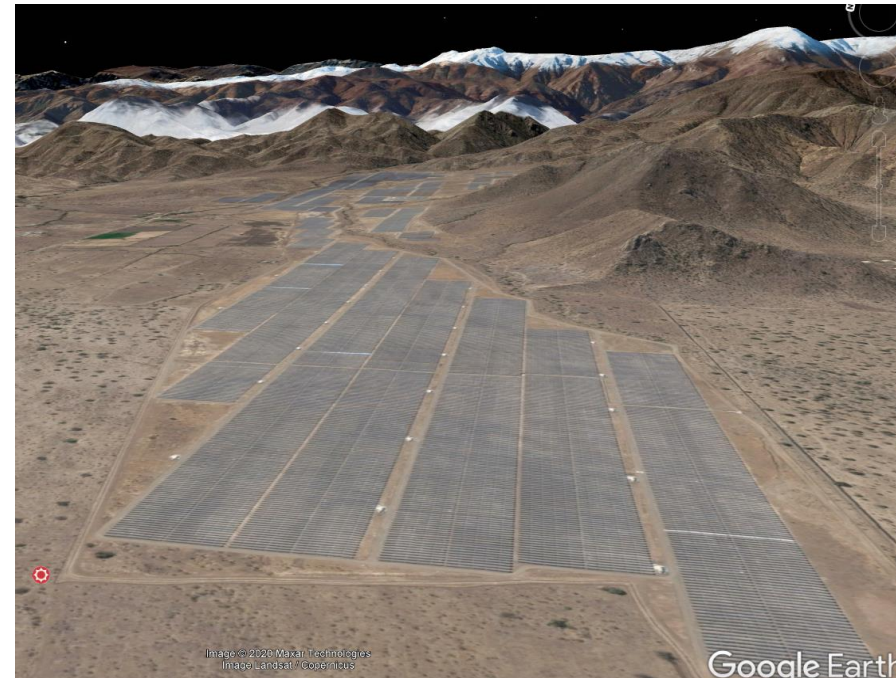
- **Location: Atacama, Chile**
- **Rated power: 103 MW**
- **Data Availability: only AC data (extracted from local TSO website)**



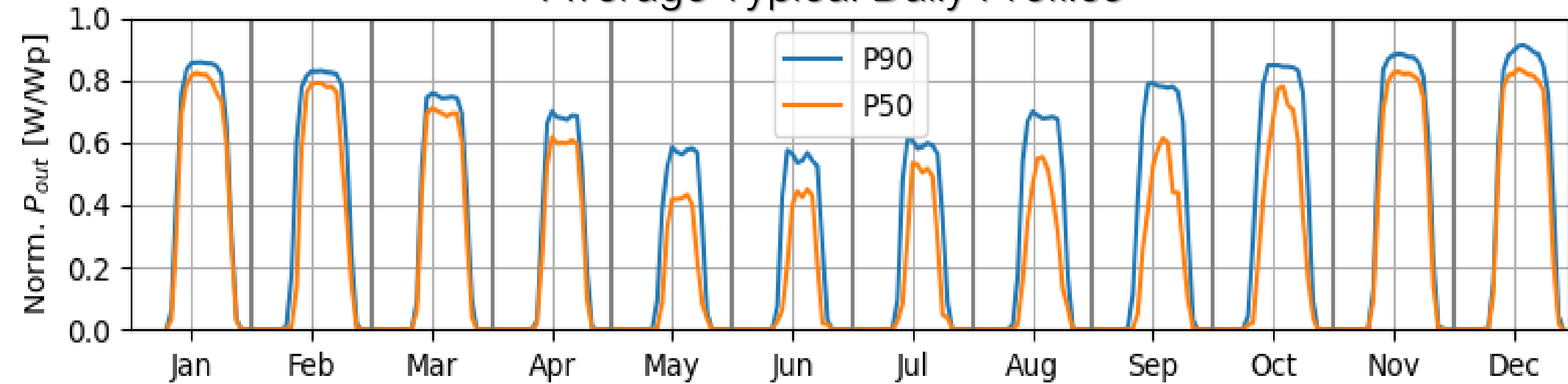
Source: Ascencio-Vásquez et al., publication under review, 2021

Application of the TDP on real PV power plants

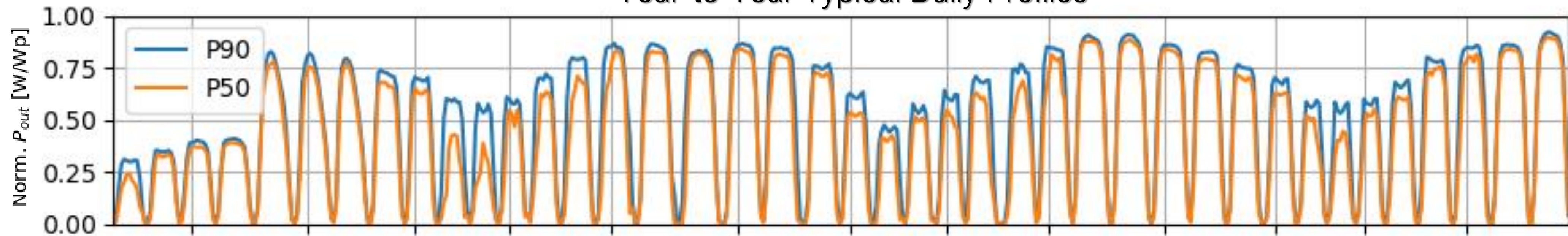
One PV system



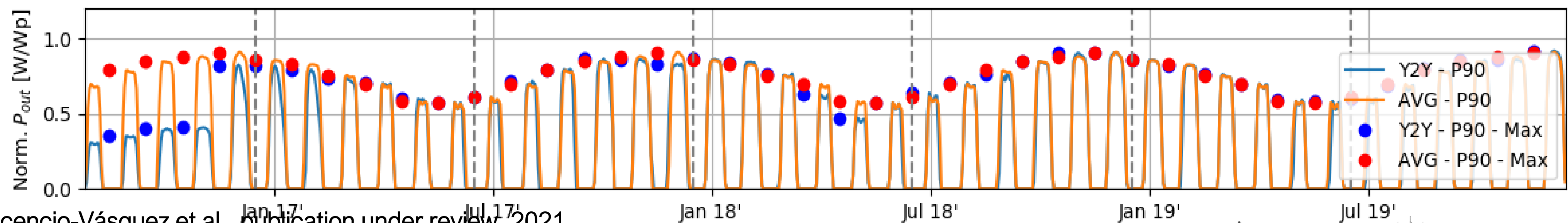
Average Typical Daily Profiles



Year-to-Year Typical Daily Profiles



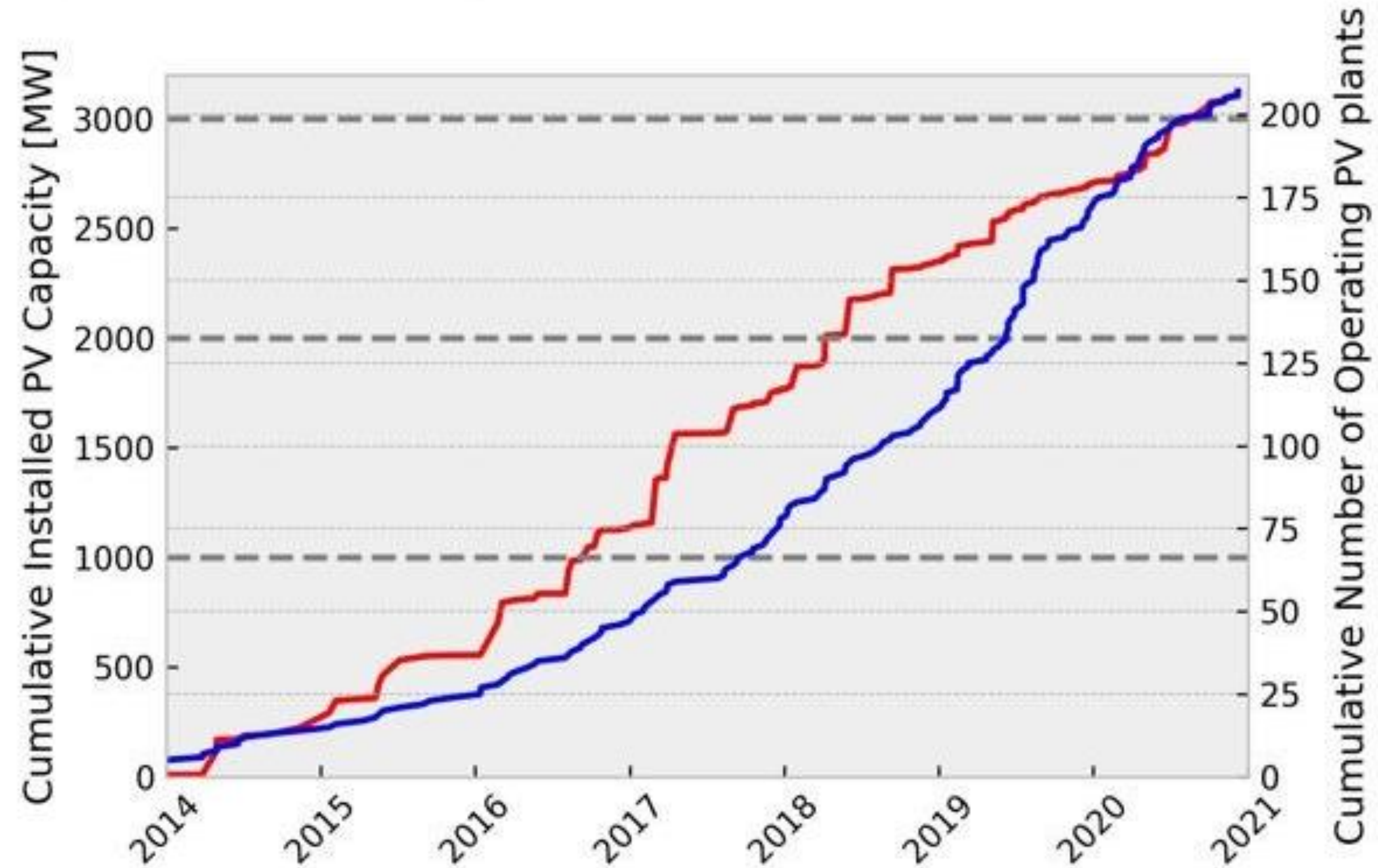
Combination AVG and Y2Y Typical Daily Profiles



Source: Ascencio-Vásquez et al., publication under review, 2021

Application of the TDP on real PV power plants PV fleet in Chile

- At least 4 main climates of the [KGPV](#) climate classification
- The highest solar irradiance in the World
- The 1st ranked country for investment in renewables (Climatescope)



Source: Ascencio-Vásquez et al., publication under review, 2021



Application of the TDP on real PV power plants

PV fleet in Chile

- **Initial Operational Phases**

- 15 PV Systems

- **Curtailment**

- 12 PV Systems

- **Large Performance Losses**

- 29 PV Systems

- **Inverter Clipping**

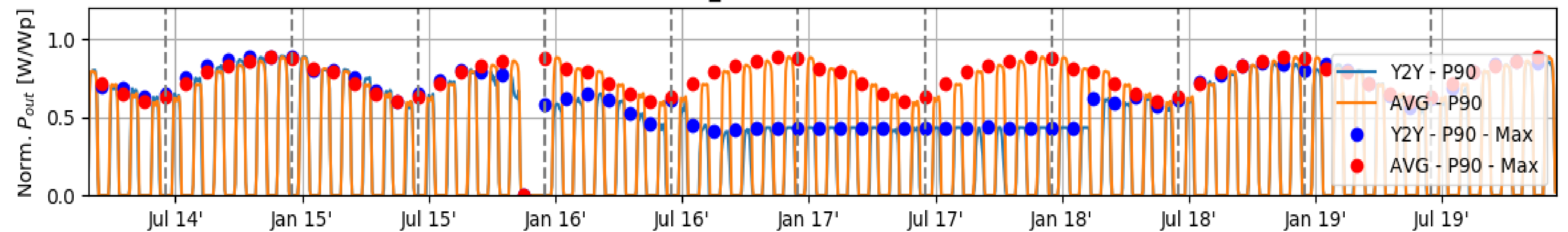
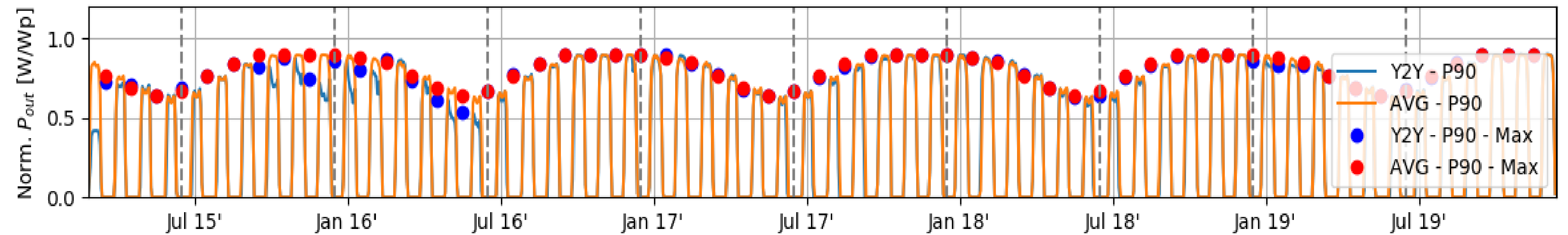
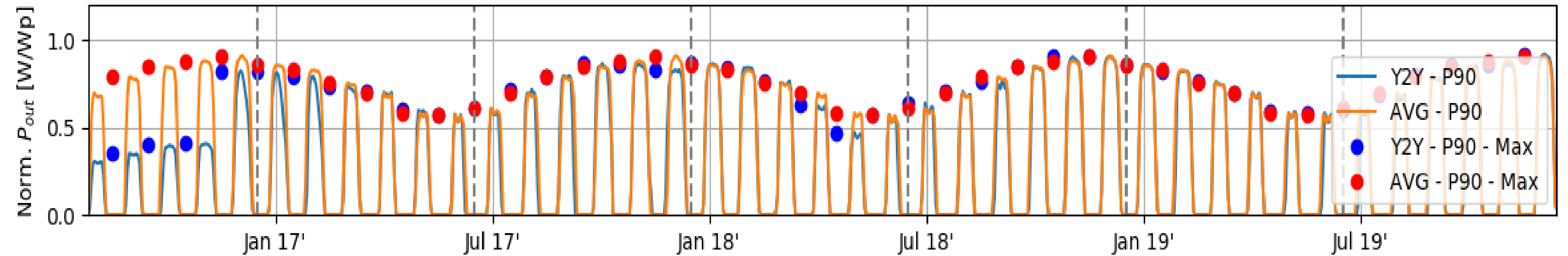
- 93 PV Systems

- **Missing data**

- 42 PV Systems

- **No useful data**

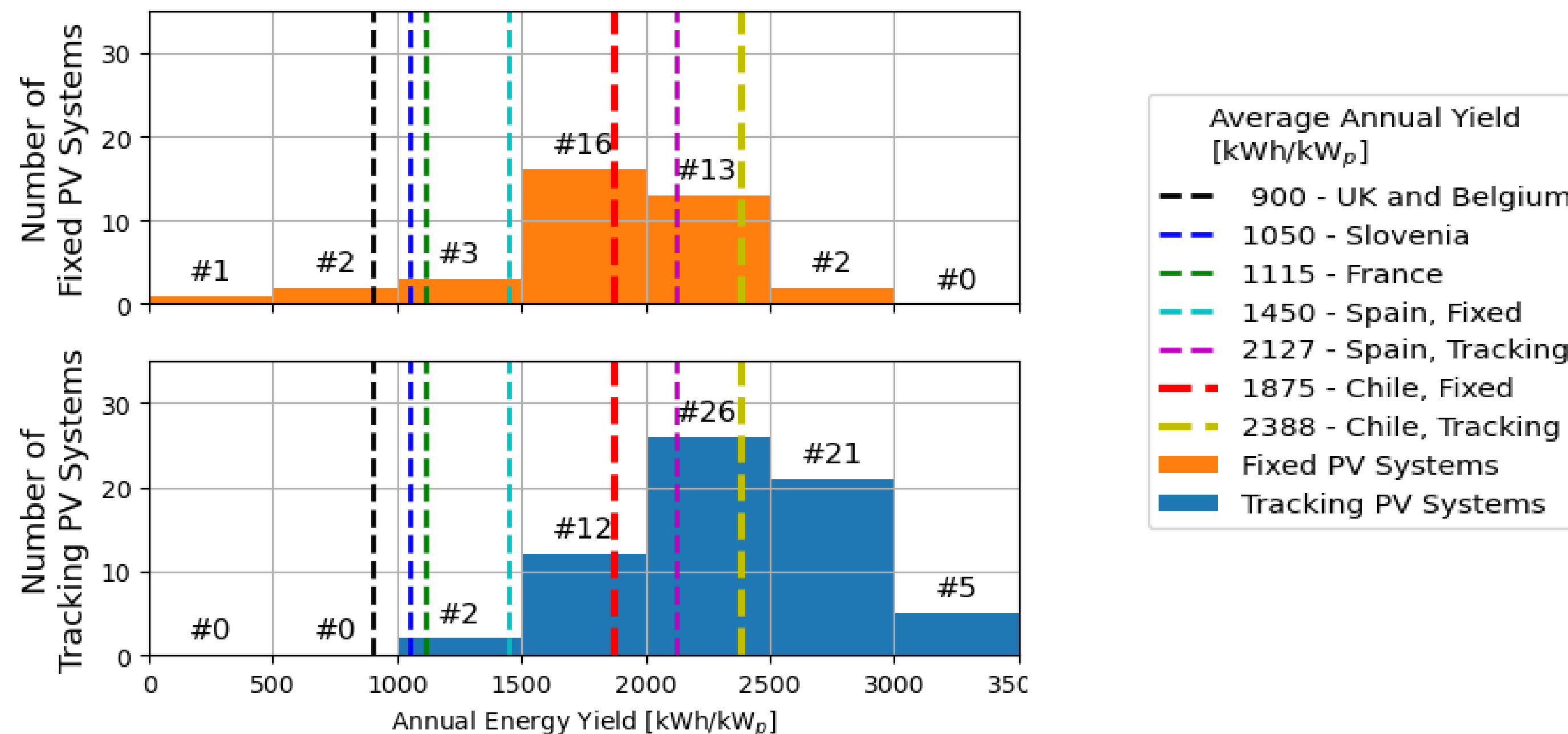
- 8 PV systems



Source: Ascencio-Vásquez et al., publication under review, 2021

Application of the TDP on real PV power plants PV fleet in Chile

- Tracking systems predominate in the country
- UCF can get up to 38% in annual basis
- Annual Energy Yield gets up to 3500 kWh/kWp in best cases



Source: Ascencio-Vásquez et al., publication under review, 2021

Conclusion and Further Work

- **Smart, fast and straightforward mathematical algorithms can help to filter PV operational data and assess the performance and losses**
- **The use of irradiance data (even low accuracy data) can be used to improve the filtering of PV operational data**
- **A new algorithm called Typical Daily Profiles (TDP) can support the PV performance assessment with minimal data**
 - Cases with only PV power output data
- **The TDP has been successfully applied the “one” and “many” PV systems**
- **The PV performance assessment of the whole PV fleet in Chile can be efficiently executed**
- **Further work will include the extraction of Performance Loss Rates (PLR) using TDP in Chile and in countries where TSOs provide free-of-charge with power plants' operational data (e.g., Australia).**

Thank you!

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