

# Extreme weather events and the impact on PV time series data

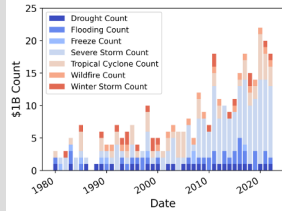
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## 1 Introduction

Frequency & impact of extreme weather events has been increasing

Count of US\$ 1 billion extreme weather events in the USA



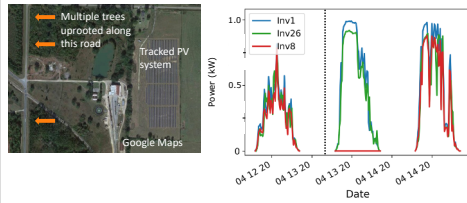
NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2023).

Some case studies have been published but still know very little about the impact from a high-level view

4

## Example

Tracked system

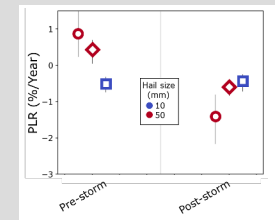


1 inverter out of 26 impacted for 1 day

7

## Long-term Impact - Hail

Hail impact on performance loss rate (PLR)



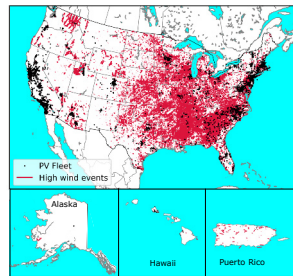
Needed 2 years of data before & after impact

2 hail systems with high PLR after storm were impacted by hail above current IEC 61215 threshold  
1 system with the same PLR after storm was impacted by hail below current IEC 61215 threshold

Supports the development of better hail resistance testing

## 2 Method

Compare NOAA database on extreme weather with PV Fleet timeseries

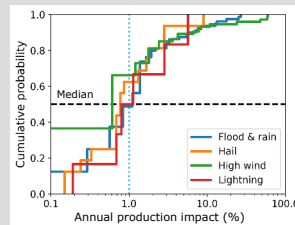


Determine events that came within 10 km of an existing PV system

5

## Short-term Impact

Cumulative distribution function (CDF) of lost annual production (%)



At median lost production is around 1% of annual production

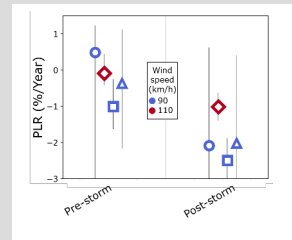
Long tail for flooding & high wind events (up to 60% lost production)

Statistically extreme weather leads to ca. 1% lost production  
High risk manifested in long tail.

8

## Long-term Impact - Wind

Wind impact on performance loss rate (PLR)



Needed 2 years of data before & after impact

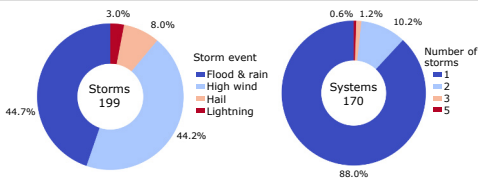
High wind → statistically significant higher PLR after storm

3

## Extreme Weather Pareto

Pareto of weather events

Multiple storms impacting the same system

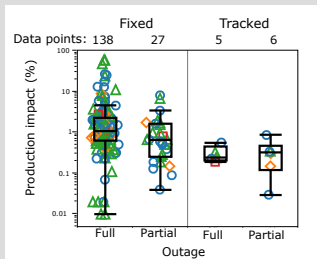


1 system was impacted by 5 severe weather events!

Flooding & high wind events are the most common storm types  
Most systems were impacted by a single extreme weather event

6

## Trackers vs Fixed Tilt



Did not have a lot of systems with trackers impacted

Fixed system tend to show more full outages  
Tracked systems: see more partial outages (like example)

9

## Conclusion



Quantified impact of extreme weather events of PV systems from fleet perspective

Short-term impact (outages) lead to ca. 1% of annual lost production, at the median.

Installation quality can influence impact



Distributions have a long tail that can lead to substantial annual losses (60%)

Systems impacted by hail exceeding current IEC 61215 showed higher Performance loss after storm → need better hail testing (already in development)

All systems impacted by "storm" to "violent storm" on Beaufort wind scale showed higher PLR after storm.



We have only begun to quantify the impact.

These numbers may change, as PV deployment increases, extreme weather events become more common.

The evaluation may be different on different continents.