SAND2021-7027C

Sandia National Laboratories

Exceptional service in the national interest

Quantifying Wildfire-Induced Impacts to Photovoltaic Energy Production in the Western United States

Samuel D. Gilletly, Nicole D. Jackson and Andrea Staid

Photovoltaics Specialist Conference (PVSC) 2021

June 20-25

SAND NUMBER

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc. for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

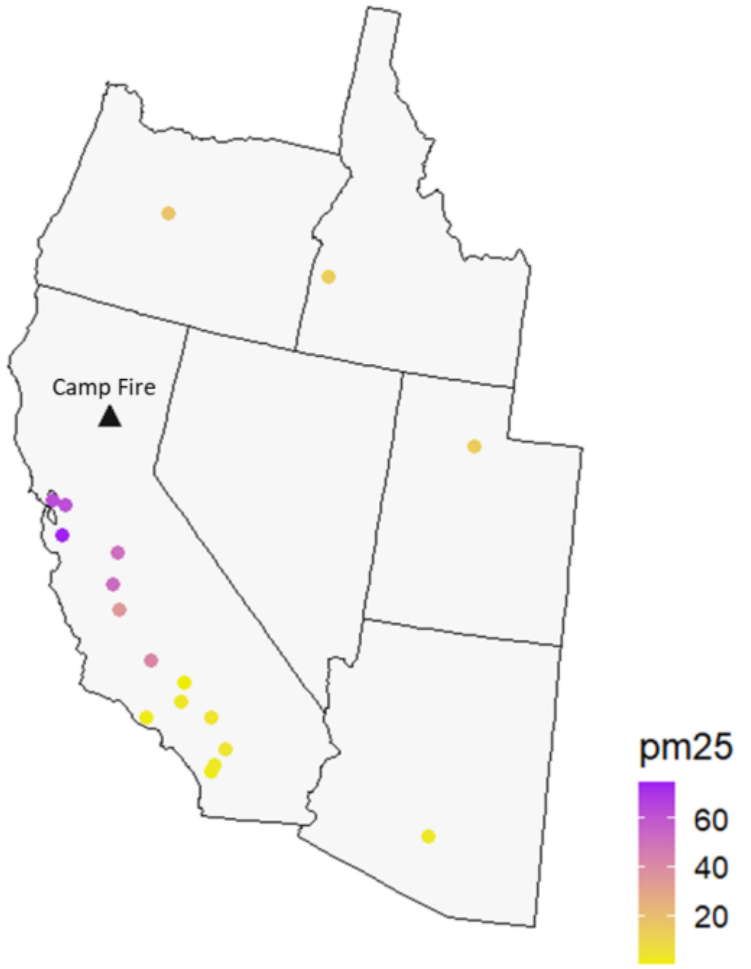
U.S. DEPARTMENT OF ENERGY

NNSA

Motivation

- There is an increasing number of wildfires[1] and solar PV deployment in the western United States[2].
- Wildfire smoke (PM2.5 particles) has been shown to decrease solar energy production by reducing irradiance[2].
- **Project goal**: Quantify the impact of smoke using historical PV production data, PM2.5 and weather data during 2018 fire season.

Camp Fire Smoke



[1] https://ww2.arb.ca.gov/wildfires-climate-change
[2] https://www.eia.gov/todayinenergy/detail.php?id=45336#:~:text=Smoke%20from%20California%20wildfires%20decreases%20sola Source%3A%20U.S.%20Energy&text=This%20matter%20reduces%20the%20amount,about%20the%20size%20of%20Connecticut.

We created an integrated panel of weather and PV production data

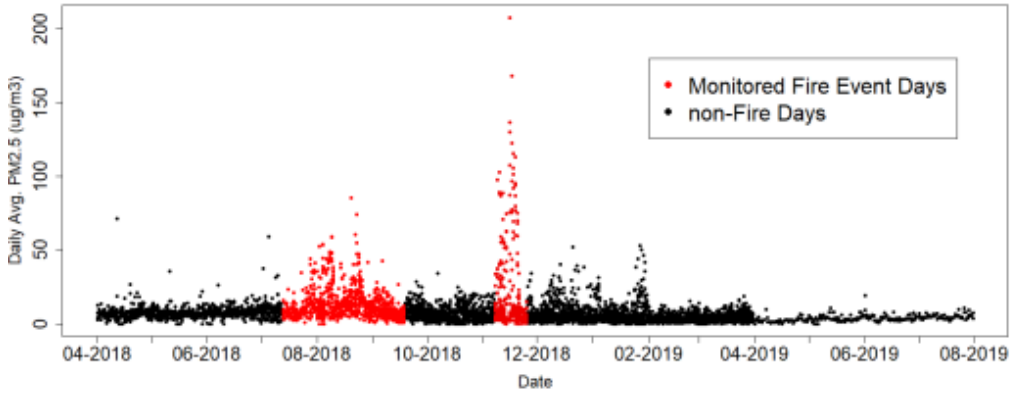
Publicly available weather data

- PM2.5 particle data from U.S.EPA
- Satellite weather data from NASA POWER project

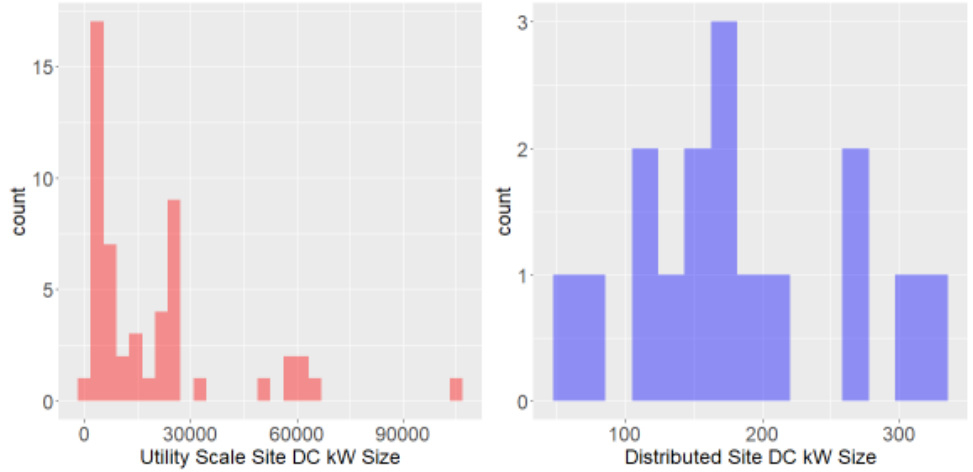
Sandia's PVROM database

- 20,000 production days for 68 sites
- Site selection criteria
  - Located in the Western U.S.
  - Proximity to PM2.5 monitoring stations
  - Data availability during 2018 wildfire seasons
  - Limited errors during production hours

PM2.5 Measurements



PV Site DC kW Sizes



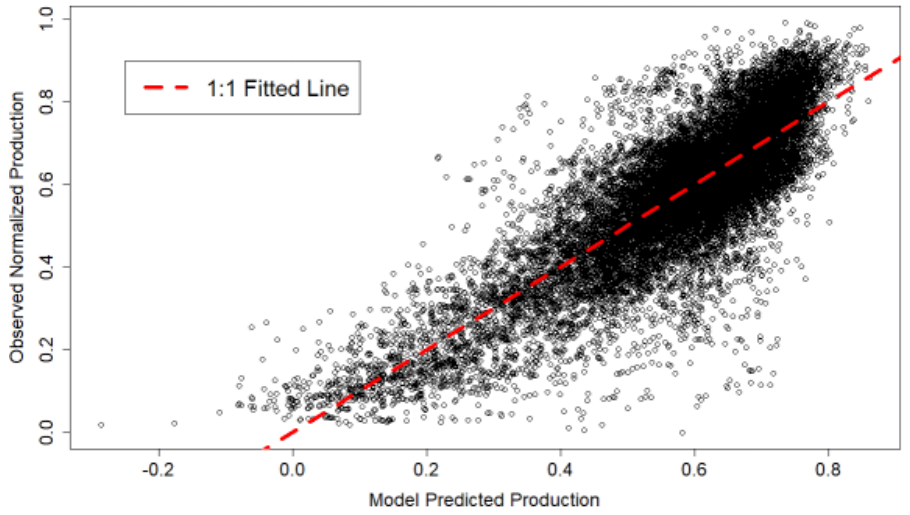
Linear regressions are used to quantify the relationship between PM2.5 particle counts and PV production

- Key variables of significance:
  - PM2.5
  - Insolation/clear sky index
  - Precipitation
  - Wind speed
- No variables interacted with PM2.5
- Model performance
  - R^2: 0.6732 and an
  - RMSE: 0.099

Regression Model Parameter Estimates

Parameter	Estimate	Std. Error	t value	P value
Intercept	0.06593	0.007286	9.049	<2e-16
PM2.5	-0.001888	0.0000967	-19.519	<2e-16
Insolation Clearness Index	0.8614	0.006556	131.398	<2e-16
Precipitation	-0.003005	0.0002434	-12.346	<2e-16
Wind Speed 10 Meters	0.1025	0.002596	39.645	<2e-16
Wind Speed 50 Meters	-0.07101	0.001938	-36.645	<2e-16

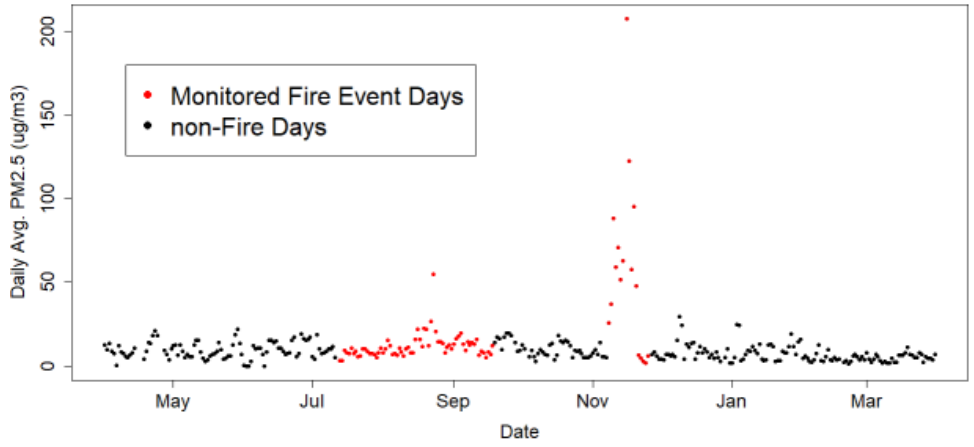
Regression Model Predicted vs Observed Production



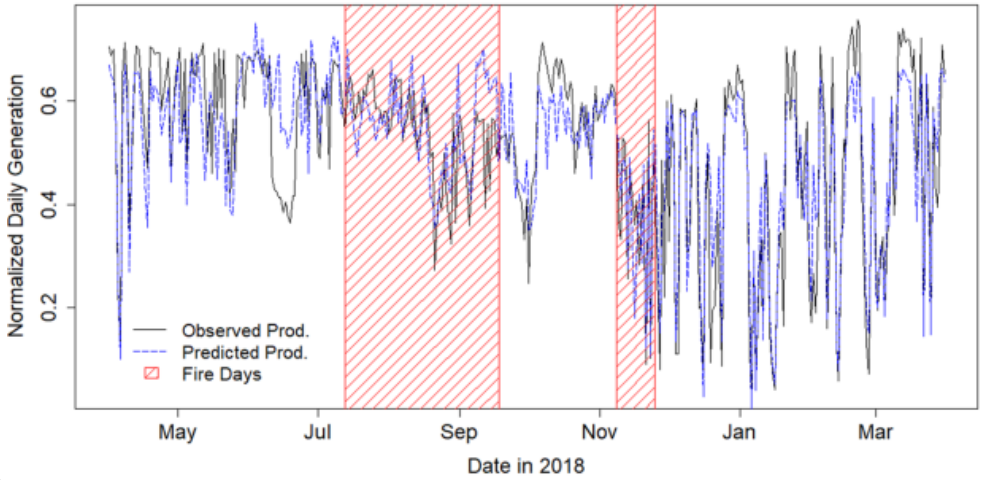
In conclusion, we have developed a PV energy production model that incorporates impacts from wildfire-related PM2.5

- The PM2.5 variable had a model parameter estimate of -0.00189, this corresponds to a 9-37% reduction in PV production on smokey days when PM2.5 measurements reach 50-200 µg/m3
- Our model can be used to predict expected energy losses during wildfire events due to smoke for both long and short term planning and decision making
- Work is ongoing to further refine the regression model and data, primarily based on explaining some of the currently unexplained variability in the production data

Single Site PM2.5 Measurements



Single Site Predicted vs Observed Production



sgillet@sandia.gov