Aim:-

"Impact of weather variability on power demand"

Description:

I will use power usage data for Indian states and analyse the impact of weather variability (temperature and rainfall) on electricity consumption in these states. In particular, I will examine the impact of very hot and rainy days on power usage.

Data Sources

Electricity Data

Electricity Consumption and area of states are taken by Kaggle
https://www.kaggle.com/datasets/twinkle0705/state-wise-power-consumption-in-india

Electricity Consumption taking **per-day data state-wise** from 2017-04-01 to 2023-12-31
2466 rows × 31 columns Link

Electricity Consumption taking **hourly data state-wise** from 1 Jan 2017 to 30 April 2024
From NITI Aayog
https://iced.niti.gov.in/energy/electricity/distribution/national-level-consumption/load-curve
64248 rows × 33 columns 7 Years and 4 months Link

Population
State population data I'm taking from the **Census of India 2011**
https://censusindia.gov.in/census.website/data/data-visualizations/PopulationSearch_PCA_Indicators
AP (84580777) combined population was given in the Census of India 2011
Telangana 35,003,674 https://en.wikipedia.org/wiki/Demographics_of_Telangana
Andhra Pradesh 49,577,103 https://en.wikipedia.org/wiki/Andhra_Pradesh

Temperature and Rainfall

National Centers for Environmental Information https://www.ncei.noaa.gov/
https://www.ncei.noaa.gov/access/metadata/landing-page/bin/iso?id=gov.noaa.ncdc%3AC00861
https://www.ncei.noaa.gov/maps/daily/ **only per day(max_min_ave)** data is available
All stations haven't data of all time some are newly started and some are closed

NASA Prediction Of Worldwide Energy Resources (POWER) | Data Access Viewer (DAV)
https://power.larc.nasa.gov/data-access-viewer/ **hourly data of a coordinate is available**

India Meteorological Department gridded rainfall and temperature (minimum and maximum) data
https://imdlib.readthedocs.io/en/latest/Usage.html#reading-imd-datasets
capable of downloading gridded rainfall and temperature (minimum and maximum) data.
Data available **only per day** **rain / tmax / tmin** 1951-01-01 to 2023-12-31

Shapefile for Indian states and UT

https://github.com/AnujTiwari/India-State-and-Country-Shapefile-Updated-Jan-2020

Data Preprocessing

Cleaning and Structuring

Electricity Data

Download data in Microsoft Excel (.xlsx) from NITI Aayog and upload it to Google Drive and open it with Google Sheets after that

1. Cleen in Google Sheets and download data in CSV format
2. Download data in CSV format and clean by pandas and Dask

	State	Date	Hourly Demand Met (in MW)
0	Delhi - 2017	01-Jan 12am	1775.69
1	Delhi - 2017	01-Jan 1am	1565.98
2	Delhi - 2017	01-Jan 2am	1458.04
3	Delhi - 2017	01-Jan 3am	1413.88
4	Delhi - 2017	01-Jan 4am	1441.43
...	...	...	...
17519	Bihar - 2017	31-Dec 11pm	2933.49
17520	NaN	NaN	NaN
17521	Copyright © 2024, NITI Aayog	NaN	NaN
17522	https://iced.niti.gov.in	NaN	NaN
17523	The information on this platform is mainly tak...	NaN	NaN

17524 rows × 3 columns

Processed 8×33 Microsoft Excel (.xlsx) files and got one CSV(64248 rows × 33 columns)
Electricity conception per state hourly (megaunit) 64248 rows × 33 columns
Electricity conception per unit area state-wise hourly (unit per km^2) 64248 rows × 33 c
Electricity conception per person state-wise hourly (unit per person) 64248 rows × 33 c
Now Total of 64248 rows × 99 columns

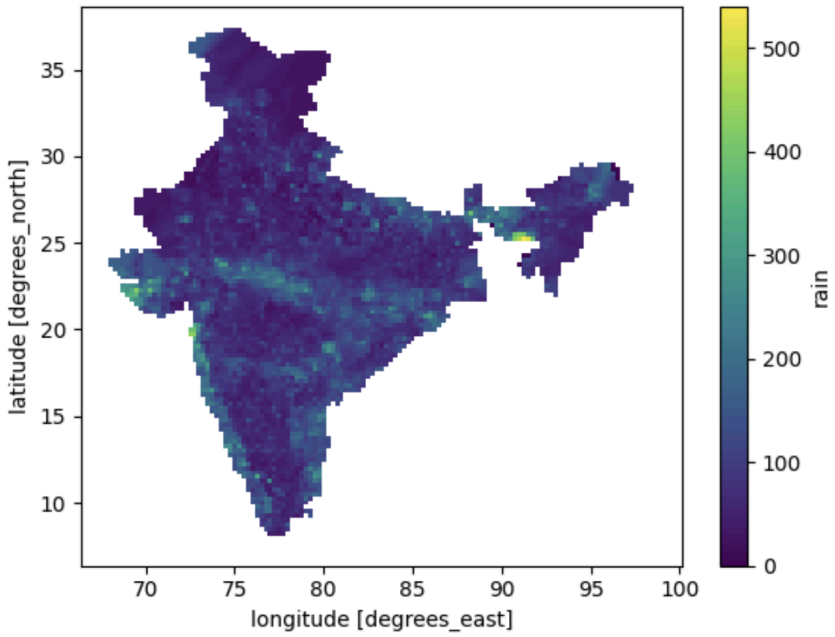
date	Andhra Pradesh	Arunachal Pradesh	Assam	Bihar	Chandigarh (UT)	Chhattisgarh	DNH (UT)	Delhi (UT)	Goa	Gujarat	...	Pondicherry (UT)/ Population	Punjab/ Population	Rajasthan/ Population	Po
2017-01-01 00:00:00	5336.69	95.00	801.33	2468.86	110.59	2574.13	898.02	1775.69	242.15	10132.63	...	178.468260	104.696847	117.612018	59
2017-01-01 01:00:00	5298.24	95.00	773.54	2401.92	99.58	2575.35	896.69	1565.98	233.27	10130.93	...	178.396141	99.464960	112.671278	56
2017-01-01 02:00:00	5193.17	95.00	739.62	2376.23	93.80	2529.59	888.63	1458.04	234.11	9829.56	...	175.070696	97.159542	110.295002	52
2017-01-01 03:00:00	5136.10	95.00	723.57	2276.16	94.26	2517.46	881.76	1413.88	229.89	9595.83	...	173.636347	97.570811	107.904284	52
2017-01-01 04:00:00	5533.07	95.00	725.32	2303.02	97.96	2520.96	885.62	1441.43	222.27	9482.91	...	172.394313	102.307084	100.582600	54
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
2024-04-30 19:00:00	8909.42	118.95	1742.18	5686.64	204.83	5922.05	1207.95	3937.19	597.46	18612.44	...	339.363742	242.661139	170.750648	148
2024-04-30 20:00:00	8881.86	118.95	1713.84	5646.58	193.22	5773.07	1172.28	3753.42	598.62	17867.36	...	328.033187	221.622214	171.266487	131
2024-04-30 21:00:00	9458.95	118.95	1614.30	5545.73	171.13	5680.85	1186.52	3543.18	591.86	17842.75	...	334.315475	207.125040	164.669546	118
2024-04-30 22:00:00	9723.71	118.95	1484.34	5332.01	155.08	5705.77	1192.69	3505.90	576.67	18283.14	...	338.898981	189.055837	164.622280	99
2024-04-30 23:00:00	9357.45	118.95	1363.26	4731.13	141.31	5868.19	1187.10	3381.62	559.99	18489.58	...	333.506150	162.867208	163.510803	84

64248 rows × 99 columns

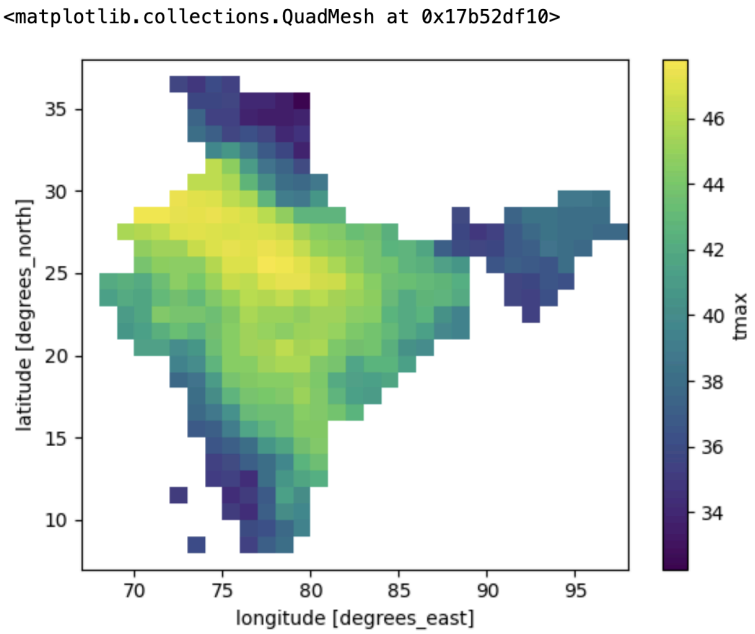
Temperature and Rainfall Data

Download data in gridded(rainfall and temperature) from the I**ndia Meteorological Department**

<matplotlib.collections.QuadMesh at 0x1500bdf10>

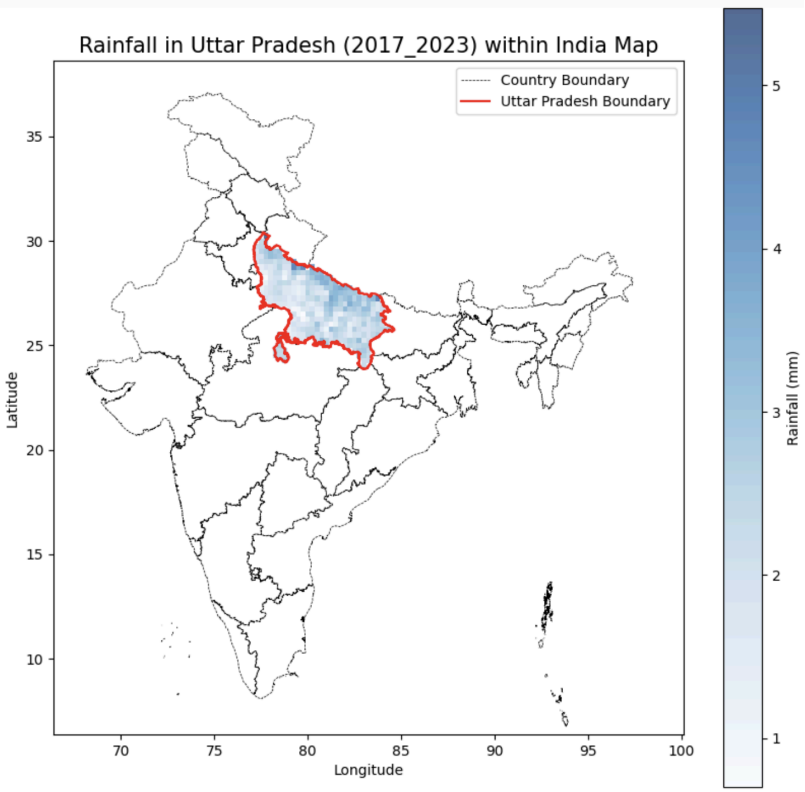


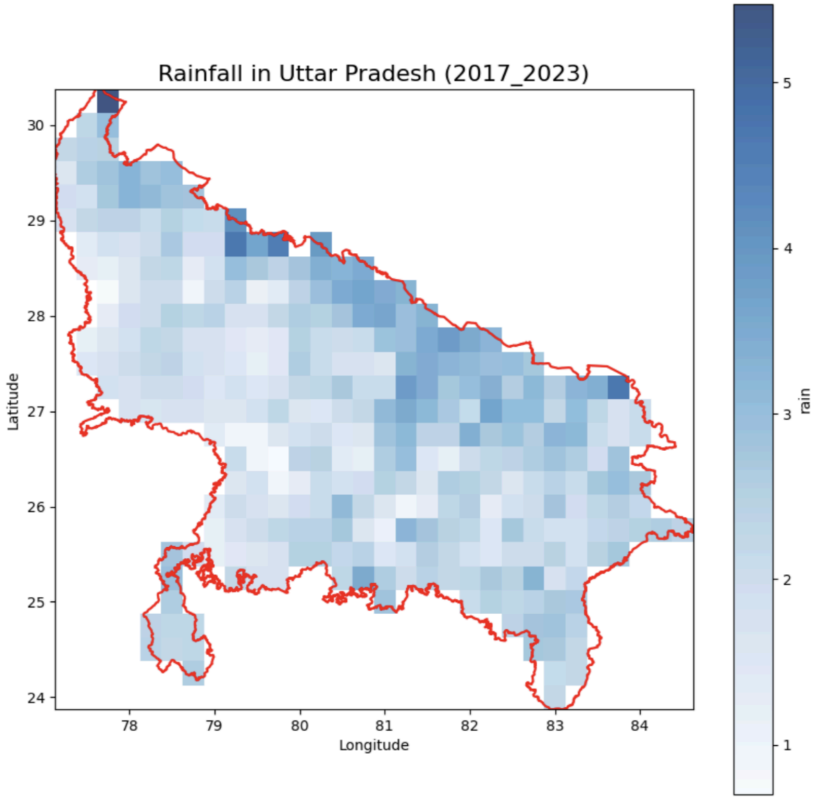
<matplotlib.collections.QuadMesh at 0x17b52df10>



- Can collect CSV of any grid
- After that I take a state boundary (Taken UP State boundary)
- Take all the gridded data inside that Boundary

The maps are of the daily average mean of rain of that Grid





- I took an average of all grids on that day and got Data in CSV format The Daily average rainfall in Uttar Pradesh (2017 to 2023)

- Similarly I did for Temperature (tmax, tmin)

Python Libraries used

Primary Libraries

Pandas For data manipulation and analysis
Numpy For numerical operations on arrays
Matplotlib For plotting scatter plots.
Seaborn Provides a more aesthetic interface for creating scatter plots
Geopandas For handling geospatial data such as boundaries of regions or states.
numpy and Used for clipping and masking data within specific geographical boundaries
pandas
Xarray For working with multi-dimensional arrays, especially when handling time-series data like rainfall and temperature grids.
Rioxarray Used for clipping data to specific geometries like state boundaries (e.g., Uttar Pradesh)

Supporting Libraries

Datetime For handling date and time-related operations.
Shapely For geometry operations, often used internally by geopandas.
Cartopy For creating maps
Scipy For additional numerical operations or statistical analysis

Analysis

Finally, I chose data from **IMD**(daily temperature & rainfall) and **NITI Aayog**(Electricity Consumption)

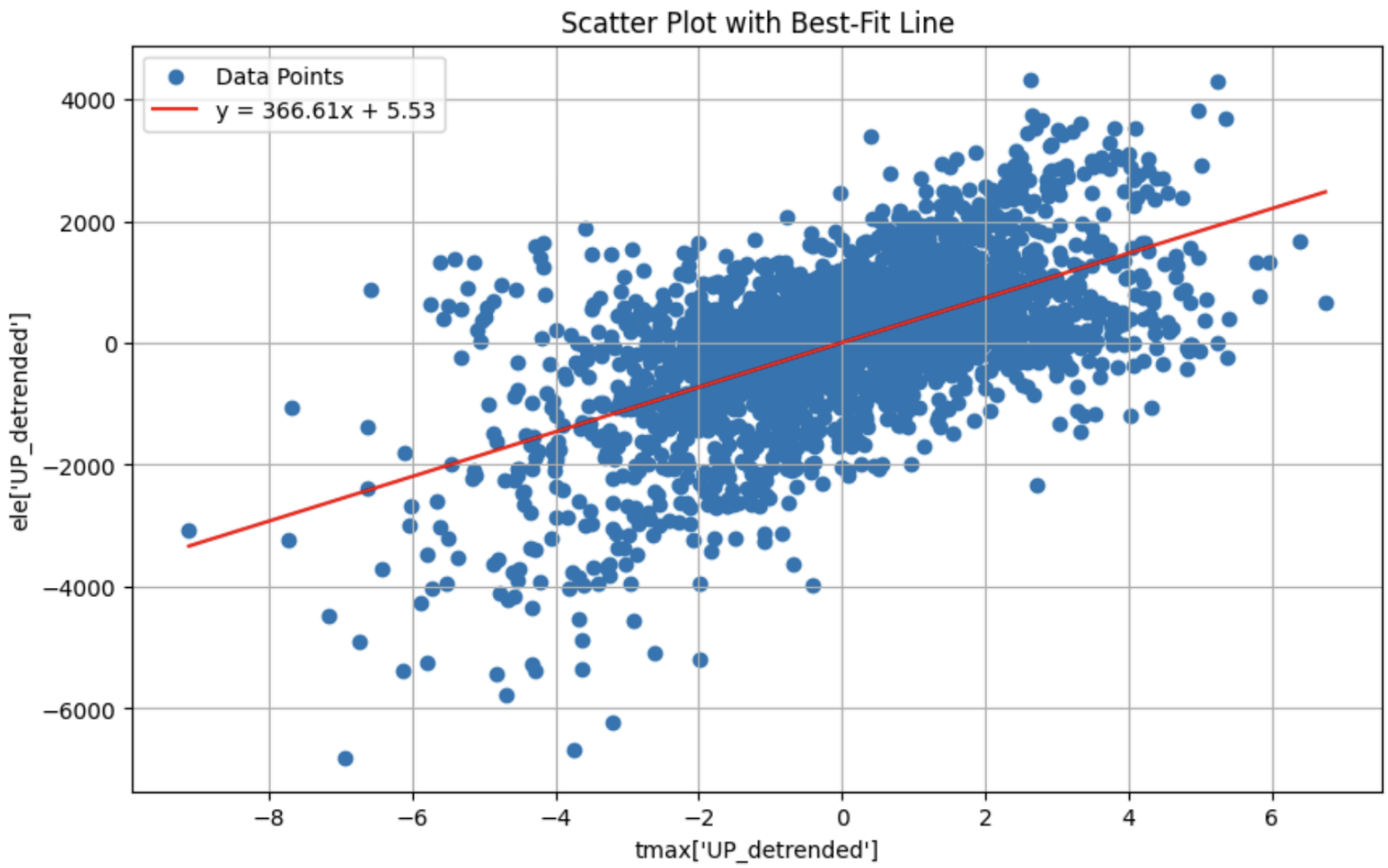
IMD data was in grad form, I masked the UP boundary and took all the grids inside that boundary. After that, I average all the grids of UP and convert them into CSV, Which will be the daily temperature and rainfall of UP.

electricity 2017-01-01 00:00:00 to 2024-04-30 23:00:00

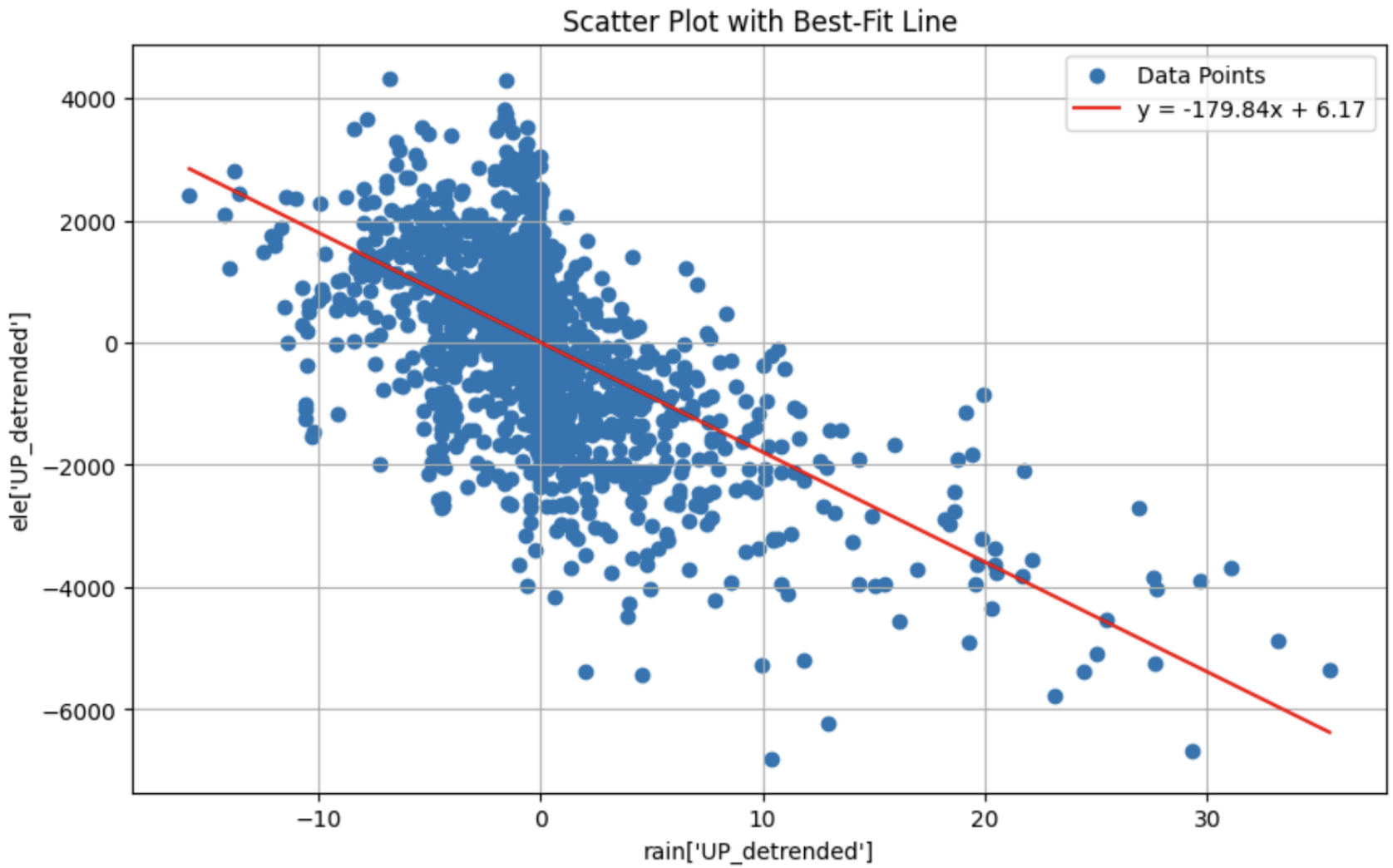
rain/tmax/tmin 1951-01-01 to 2023-12-31

so I sliced DateTime 2017-01-01 to 2023-12-31 for analysis
electricity (per hour) while rain/tmax/tmin (per day)

All about the graph below
Computed a 15-day rolling mean for both temperature, rainfall and electricity consumption.
subtract this running mean from the original data to obtain anomalies (the running mean subtraction will remove seasonal effects)
Scatter plot between anomalies of temperature vs. electricity and rainfall vs. electricity




```
Equation of the best-fit line: y = 366.61x + 5.53
```




```
Equation of the best-fit line: y = -179.84x + 6.17
```