# Ozone Pollution: EDA, Cleaning & Analysis

Purpose: Clean and validate EPA ozone monitoring data, compute daily maximum 8-hour ozone concentrations, analyze trends across regions and time, examine weekday/weekend effects, and produce a geospatial heatmap of high ozone concentrations.

```
import pandas as pd
ozone = pd.read_csv('/content/ozone.csv')
ozone.head()
```

| | Date | Source | Site ID | POC | Daily Max 8-hour Ozone Concentration | Units | Daily AQI Value | Local Site Name | Daily Obs Count | Percent Complete | Method Code | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | /2024 | AQS | 60010007 | 1 | 0.031 | ppm | 29.0 | Livermore | 17 | 100.0 | 47.0 | 418 |
| **1** | 01/02/2024 | AQS | 60010007 | 1 | 0.037 | ppm | 34.0 | Livermore | 17 | 100.0 | 47.0 | 41 |
| **2** | /2024 | AQS | 60010007 | 1 | NaN | ppm | 30.0 | Livermore | 17 | 100.0 | 47.0 | 418 |
| **3** | January 04/2024 | AQS | 60010007 | 1 | 0.026 | ppm | 24.0 | Livermore | 17 | 100.0 | 47.0 | 418 |
| **4** | January 05/2024 | AQS | 60010007 | 1 | 0.027 | ppm | 25.0 | Livermore | 17 | 100.0 | 47.0 | 418 |

Next steps: Generate code with ozone New interactive sheet

```
ozone.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 29939 entries, 0 to 29938
Data columns (total 17 columns):
 #   Column                                Non-Null Count  Dtype  
---  ------                                --------------  -----  
 0   Date                                  29939 non-null  object 
 1   Source                                29939 non-null  object 
 2   Site ID                               29939 non-null  int64  
 3   POC                                   29939 non-null  int64  
 4   Daily Max 8-hour Ozone Concentration  28457 non-null  float64
 5   Units                                 29939 non-null  object 
 6   Daily AQI Value                       28469 non-null  float64
 7   Local Site Name                       29939 non-null  object 
 8   Daily Obs Count                        29939 non-null  int64
 9   Percent Complete                       29939 non-null  float64
 10  Method Code                            26406 non-null  float64
 11  CBSA Code                              27935 non-null  float64
 12  CBSA Name                              27935 non-null  object
 13  County FIPS Code                       29939 non-null  int64
 14  County                                 29939 non-null  object
 15  Site Latitude                          29938 non-null  float64
 16  Site Longitude                         29938 non-null  float64
dtypes: float64(7), int64(4), object(6)
memory usage: 3.9+ MB
```

```
# Count of missing values in each column
ozone.isna().sum()
```

| | 0 |
|---|---|
| **Date** | 0 |
| **Source** | 0 |
| **Site ID** | 0 |
| **POC** | 0 |
| **Daily Max 8-hour Ozone Concentration** | 1482 |
| **Units** | 0 |
| **Daily AQI Value** | 1470 |
| **Local Site Name** | 0 |
| **Daily Obs Count** | 0 |
| **Percent Complete** | 0 |
| **Method Code** | 3533 |
| **CBSA Code** | 2004 |
| **CBSA Name** | 2004 |
| **County FIPS Code** | 0 |
| **County** | 0 |
| **Site Latitude** | 1 |
| **Site Longitude** | 1 |

**dtype:** int64

```
import numpy as np
```

```
# Standardize column names
ozone.columns = ozone.columns.str.strip().str.lower().str.replace(' ', '_')
```

```
# Rename to consistent schema
ozone = ozone.rename(columns={
    'site_id': 'station_id',
    'local_site_name': 'site_name',
    'daily_max_8-hour_ozone_concentration': 'o3_ppb',
    'daily_aqi_value': 'aqi',
    'cbsa_name': 'region',
    'county': 'county',
    'site_latitude': 'latitude',
    'site_longitude': 'longitude'
})
```

```
ozone.head()
```

|   | date | source | station_id | poc | o3_ppb | units | aqi | site_name | daily_obs_count | percent_complete |
|---|---|---|---|---|---|---|---|---|---|---|
| **0** | /2024 | AQS | 60010007 | 1 | 0.031 | ppm | 29.0 | Livermore | 17 | 100.0 |
| **1** | 01/02/2024 | AQS | 60010007 | 1 | 0.037 | ppm | 34.0 | Livermore | 17 | 100.0 |
| **2** | /2024 | AQS | 60010007 | 1 | NaN | ppm | 30.0 | Livermore | 17 | 100.0 |
| **3** | January 04/2024 | AQS | 60010007 | 1 | 0.026 | ppm | 24.0 | Livermore | 17 | 100. |
| **4** | January 05/2024 | AQS | 60010007 | 1 | 0.027 | ppm | 25.0 | Livermore | 17 | 100.0 |

Next steps: Generate code with ozone New interactive sheet

```
# Parse date column
ozone['date'] = pd.to_datetime(ozone['date'], errors='coerce')
```

```
/tmp/ipython-input-2728457329.py:2: UserWarning: Could not infer format, so each element will be parsed
  ozone['date'] = pd.to_datetime(ozone['date'], errors='coerce')
```

```
# Drop rows with missing ozone values
ozone = ozone.dropna(subset=['o3_ppb'])
```

```
# Check all units are consistent
print(ozone['units'].value_counts())

if ozone['units'].nunique() > 1:
    print("Multiple units detected - conversion needed!")
else:
    print("All units are consistent")
```

```
units
ppm    28457
Name: count, dtype: int64
All units are consistent
```

```
# Remove duplicates
```

```
ozone = ozone.drop_duplicates(subset=['station_id', 'date'])
```

```
# Identify missing metadata
missing_region = ozone['region'].isna().sum()
missing_coords = ozone[['latitude','longitude']].isna().sum()

print("Missing region entries:", missing_region)
print("Missing coordinates:", missing_coords.sum())
```

```
Missing region entries: 1589
Missing coordinates: 0
```

```
# Quick summary
print(ozone.describe())
```

```
                                date    station_id           poc  \
count                          23745  2.374500e+04  23745.000000   
mean   2024-07-02 00:26:41.010738944  6.037171e+07      1.000547   
min              2024-01-01 00:00:00  6.001001e+07      1.000000   
25%              2024-04-02 00:00:00  6.019500e+07      1.000000   
50%              2024-07-03 00:00:00  6.037120e+07      1.000000   
75%              2024-10-01 00:00:00  6.059500e+07      1.000000   
max              2024-12-31 00:00:00  6.067001e+07      2.000000   
std                              NaN  2.000220e+05      0.023392   

             o3_ppb           aqi  daily_obs_count  percent_complete  \
count  23745.000000  22535.000000     23745.000000      23745.000000   
mean       0.044550     46.869536        26.908697         99.402106   
min        0.001000      1.000000         1.000000          6.000000   
25%        0.035000     31.000000        17.000000        100.000000   
50%        0.042000     39.000000        17.000000        100.000000   
75%        0.053000     49.000000        17.000000        100.000000   
max        0.114000    209.000000      1000.000000        100.000000   
std        0.014874     26.569345        94.562316          3.519204   

        method_code     cbsa_code  county_fips_code      latitude  \
count  20900.000000  22156.000000      23745.000000  23745.000000   
mean      96.243636  31389.267016         37.010107     36.326261   
min       47.000000  12540.000000          1.000000     32.676180   
25%       87.000000  23420.000000         19.000000     34.066590   
50%       87.000000  31080.000000         37.000000     36.634225   
75%       87.000000  40900.000000         59.000000     38.201850   
max      199.000000  46380.000000         67.000000     40.776780   
std       41.479428  10557.967471         19.958428      2.124220   

          longitude  
count  23745.000000  
mean    -119.526684  
min     -124.179490  
25%     -121.338353  
50%     -119.658339  
75%     -118.127200  
max     -114.602090  
std        2.083342  
```

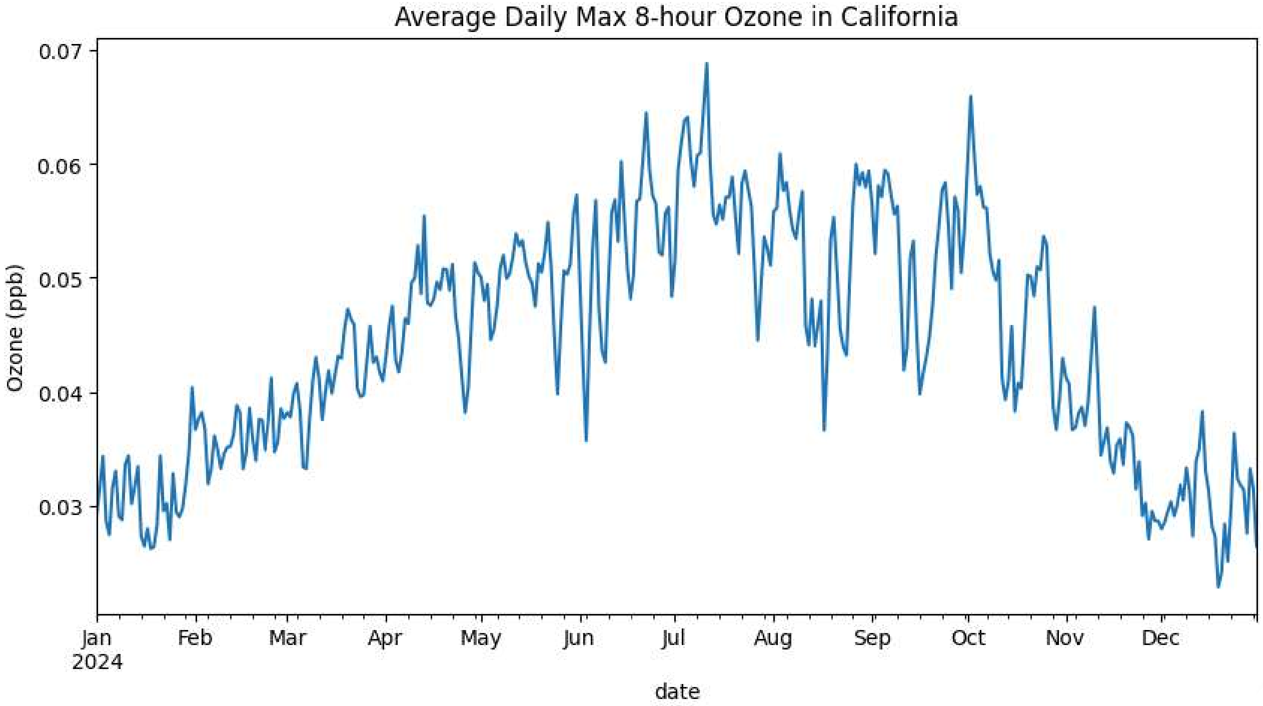
## Key Analysis

Exploratory analysis and spatial/temporal insights:

1. Trend over time and regions

```
import matplotlib.pyplot as plt

ozone.groupby('date')['o3_ppb'].mean().plot(figsize=(10,5), title='Average Daily Max 8-hour Ozone in Cal
plt.ylabel('Ozone (ppb)')
plt.show()
```



2. Regions with consistently high ozone

```
region_stats = (
    ozone.groupby('region')['o3_ppb']
    .agg(['mean', 'median', 'max', 'count'])
    .sort_values('mean', ascending=False)
)
print(region_stats.head(10))
```

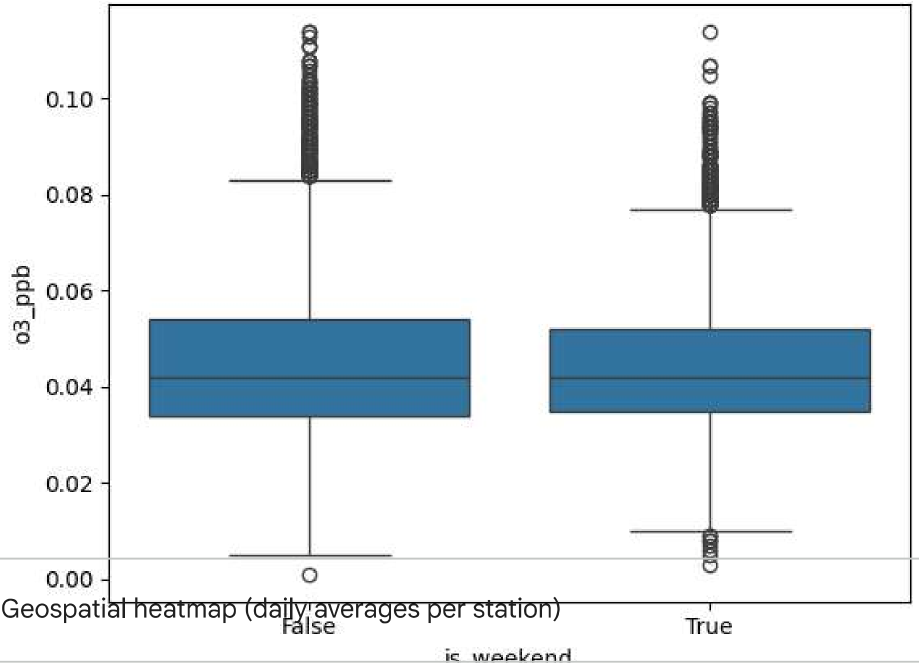
```
                                          mean  median    max  count
region
Riverside-San Bernardino-Ontario, CA  0.052377   0.049  0.113   3133
El Centro, CA                         0.049987   0.050  0.114    985
Bakersfield, CA                       0.049072   0.047  0.096   2212
Los Angeles-Long Beach-Anaheim, CA    0.047479   0.044  0.114   3934
Merced, CA                            0.046677   0.045  0.084    285
Fresno, CA                            0.045716   0.044  0.093   1978
Hanford-Corcoran, CA                  0.045367   0.045  0.088    267
Madera, CA                            0.045188   0.044  0.082    581
Bishop, CA                            0.044873   0.044  0.076    797
Truckee-Grass Valley, CA              0.043021   0.041  0.072    288
```

3. Weekday vs weekend comparison

```
ozone['weekday'] = ozone['date'].dt.day_name()
ozone['is_weekend'] = ozone['weekday'].isin(['Saturday','Sunday'])

import seaborn as sns
sns.boxplot(x='is_weekend', y='o3_ppb', data=ozone)
```

```
<Axes: xlabel='is_weekend', ylabel='o3_ppb'>
```



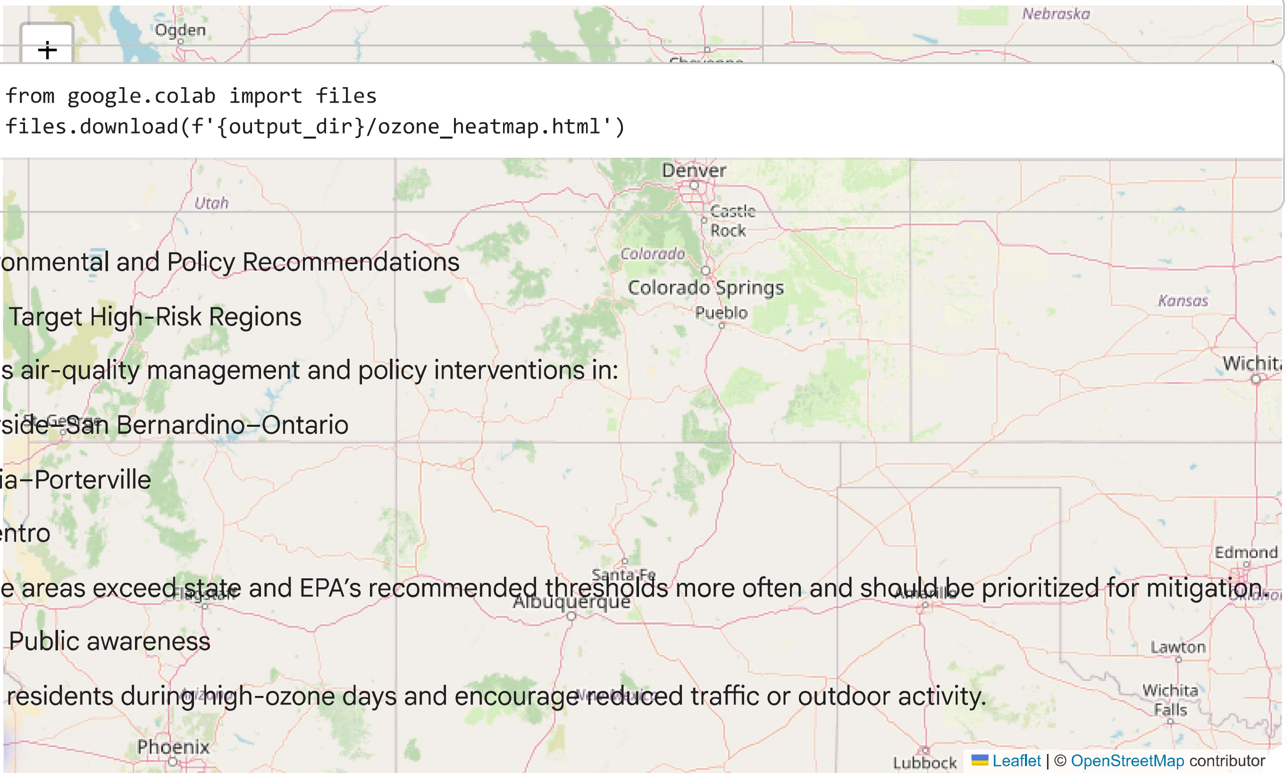
4. Geospatial heatmap (daily averages per station)

```
import os
import folium
from folium.plugins import HeatMap

station_summary = ozone.groupby(['station_id', 'latitude', 'longitude'])['o3_ppb'].mean().reset_index()

m = folium.Map(location=[station_summary['latitude'].mean(), station_summary['longitude'].mean()], zoom_
HeatMap(station_summary[['latitude', 'longitude', 'o3_ppb']].values, radius=10).add_to(m)

#Ensure the output directory exist before saving
output_dir = 'outputs'
os.makedirs(output_dir, exist_ok=True)
m.save(f'{output_dir}/ozone_heatmap.html')
m
```



```
from google.colab import files
files.download(f'{output_dir}/ozone_heatmap.html')
```

Environmental and Policy Recommendations

1. Target High-Risk Regions

Focus air-quality management and policy interventions in:

Riverside–San Bernardino–Ontario

Visalia–Porterville

El Centro

These areas exceed state and EPA’s recommended thresholds more often and should be prioritized for mitigation.

2. Public awareness

Alert residents during high-ozone days and encourage reduced traffic or outdoor activity.