In [1]:
```
import datetime as dt
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import openpyxl as xl
```

In [2]:
```
grid_22_23 = pd.read_csv('table2ab 22-23.csv').drop('idx', axis=1)
grid_22_23['date'] = pd.to_datetime(grid_22_23['date'])
grid_22_23.set_index('date', inplace=True)
grid_22_23['value'] = pd.to_numeric(grid_22_23['value'], errors='coerce')

allmonth23 = grid_22_23.groupby('grid').resample('ME').mean().reset_index().sort_va
allmonth23 = allmonth23[['date','grid', 'value']].reset_index().drop('index', axis=

grid_24 = pd.read_csv('table2ab 2024 all.csv').drop('time', axis=1)
grid_24['date'] = pd.to_datetime(grid_24['date'])
grid_24.set_index('date', inplace=True)

allmonth24 = grid_24.groupby('grid').resample('ME').mean().reset_index().sort_value
allmonth24 = allmonth24[['date','grid', 'value']].reset_index().drop('index', axis=

table2ab = pd.concat([allmonth23, allmonth24]).dropna()
print(table2ab)
```

```
C:\Users\tseng\AppData\Local\Temp\ipykernel_1616\809579572.py:10: UserWarning: Could
not infer format, so each element will be parsed individually, falling back to `date
util`. To ensure parsing is consistent and as-expected, please specify a format.
  grid_24['date'] = pd.to_datetime(grid_24['date'])
           date grid      value
0    2022-01-31   C4   9.410000
1    2022-01-31   C5   8.420000
2    2022-01-31  D10  17.540000
3    2022-01-31  D11  21.730000
4    2022-01-31  D12  12.360000
...         ...  ...        ...
4565 2024-12-31  Y29   9.671357
4566 2024-12-31  Y30   8.599524
4567 2024-12-31  Y31   8.739270
4568 2024-12-31  Z30  10.650847
4569 2024-12-31  Z31   8.516347

[13603 rows x 3 columns]
```

In [3]:
```
from scipy.spatial import cKDTree

well_locs = pd.read_csv('well lat long.csv').dropna()
grid_locs = pd.read_csv('SCL GRID CENTER LAT LONG.csv')

grid_coords = grid_locs[['Lat', 'Long']].to_numpy()
tree = cKDTree(grid_coords)

well_coords = well_locs[['Latitude', 'Longitude']].to_numpy()
_, nearest_grid_idx = tree.query(well_coords)
```

```
well_locs['NearestGrid'] = grid_locs.iloc[nearest_grid_idx]['ID'].values

well_to_grid = well_locs[['Point ID', 'NearestGrid']]
print(well_to_grid)
```

```
     Point ID NearestGrid
3     AHW00001         N18
4     AHW00002         O18
5     AHW00003         N18
7     AHW00005         N18
8     AHW00006         O18
...        ...         ...
2372  TC03106A         N12
2373  TC03106B         N11
2374  TC03106C         M10
2375  TC03106D         M10
2376  TW002300         M18

[2165 rows x 2 columns]
```

In [4]:

```
# gas well data from file
arr = []
with open('data less col.csv') as f:
  lines = f.readlines()
  cols = lines[0].split(',')
  lines.pop(0)
  for line in lines:
    l = line.strip().split(',')
    l[1] = dt.datetime.strptime(l[1], "%m/%d/%Y %H:%M")
    arr.append(l)

cols[1] = 'datetime'
cols[-1] = 'Elevation'

df = pd.DataFrame(data=arr, columns=cols)

df['CH4'] = pd.to_numeric(df['CH4'], errors ='coerce')
df['CO2'] = pd.to_numeric(df['CO2'], errors ='coerce')
df['O2'] = pd.to_numeric(df['O2'], errors ='coerce')
df['Bal'] = pd.to_numeric(df['Bal'], errors ='coerce')
df['CO'] = pd.to_numeric(df['CO'], errors ='coerce')
df['Adj Temp'] = pd.to_numeric(df['Adj Temp'], errors ='coerce')
df['Adj Flow'] = pd.to_numeric(df['Adj Flow'], errors ='coerce')
df['Adj Static Press'] = pd.to_numeric(df['Adj Static Press'], errors ='coerce')
df['Baro'] = pd.to_numeric(df['Baro'], errors ='coerce')
df['Adj Diff Press'] = pd.to_numeric(df['Adj Diff Press'], errors ='coerce')
df['Adj Power'] = pd.to_numeric(df['Adj Power'], errors ='coerce')
df['System Press'] = pd.to_numeric(df['System Press'], errors ='coerce')
df['BTU'] = pd.to_numeric(df['BTU'], errors ='coerce')
df['H2S'] = pd.to_numeric(df['H2S'], errors ='coerce')
df['Ambient Temp'] = pd.to_numeric(df['Ambient Temp'], errors ='coerce')
df['Precip'] = pd.to_numeric(df['Precip'], errors ='coerce')
df['Latitude'] = pd.to_numeric(df['Latitude'], errors ='coerce')
df['Longitude'] = pd.to_numeric(df['Longitude'], errors ='coerce')
df['Elevation'] = pd.to_numeric(df['Elevation'], errors ='coerce')
df = df.fillna(0)
```

```
# df['date'] = pd.to_datetime(df['datetime'].dt.date)

df = df.drop(['Comments','Instr ID'], axis=1)
df.set_index('datetime', inplace=True)


df = df.groupby('Point ID').resample('ME').mean().sort_values(by=['datetime', 'Poin
df.rename(columns={'datetime':'date'}, inplace=True)

df = df.merge(well_to_grid, on='Point ID', how='left')
grid_avg = df.groupby(['date', 'NearestGrid'], as_index=False)[df.columns[2:-2]].me
grid_avg.rename({'NearestGrid': 'grid'}, axis=1, inplace=True)
```

In [5]:

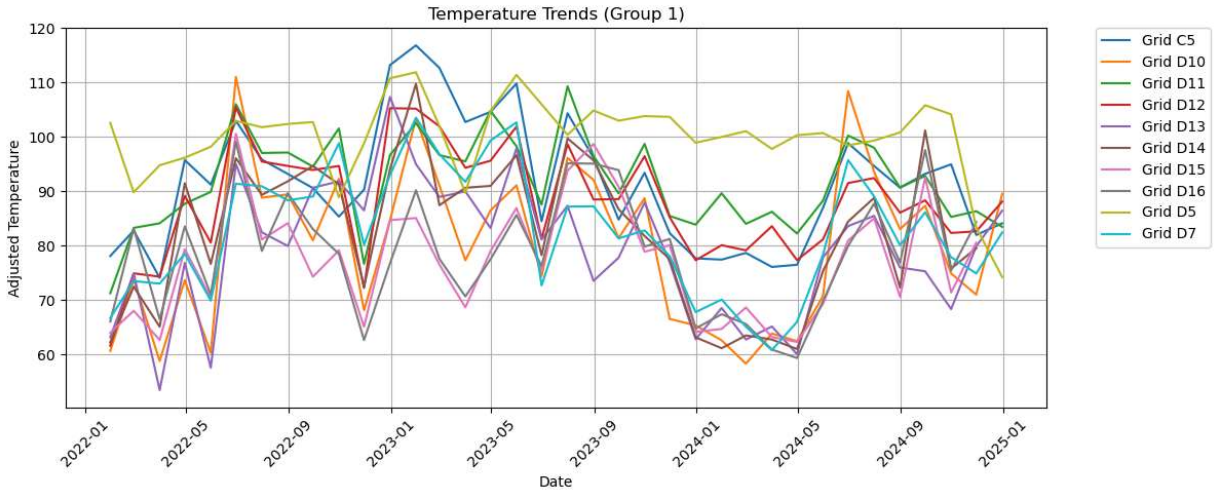
```
well_and_walk = grid_avg.merge(table2ab, left_on=['date', 'grid'], right_on=['date'
print(well_and_walk)
print(well_and_walk[well_and_walk.columns[2:]].corr()['value'])
```

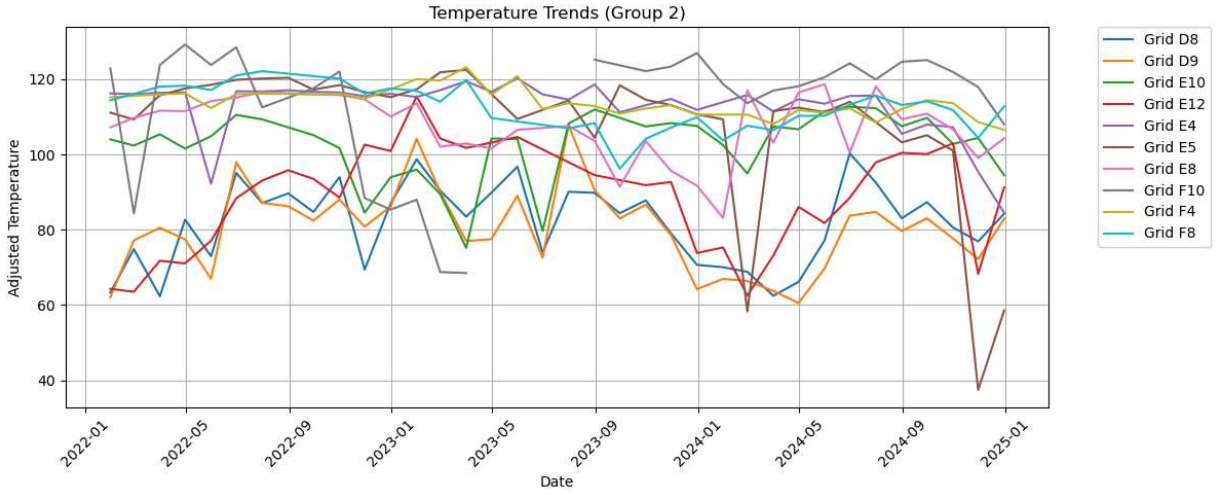
```
           date grid        CH4        CO2        O2        Bal   CO  \
0    2022-01-31   C5  57.666667  39.075000  1.758333   1.500000  0.0
1    2022-01-31  D10  32.200000  23.833333  8.700000  35.266667  0.0
2    2022-01-31  D11  52.975000  38.475000  2.200000   6.375000  0.0
3    2022-01-31  D12  54.225000  38.125000  1.675000   6.000000  0.0
4    2022-01-31  D13  35.700000  24.000000  8.700000  31.600000  0.0
...         ...  ...        ...        ...       ...        ...  ...
9447 2024-12-31  X30  39.650000  35.975000  0.000000  24.375000  0.0
9448 2024-12-31  Y28  21.550000  28.725000  0.475000  49.250000  0.0
9449 2024-12-31  Y30  48.250000  39.200000  0.300000  12.250000  0.0
9450 2024-12-31  Y31  38.450000  36.100000  0.050000  25.400000  0.0
9451 2024-12-31  Z31  17.050000  23.900000  2.025000  57.025000  0.0

       Adj Temp   Adj Flow  Adj Static Press  ...  Adj Diff Press  \
0     78.108333  63.908333        -46.526667  ...        1.446750
1     60.666667  16.200000         -0.296667  ...        0.281333
2     71.250000  29.425000         -3.117500  ...        0.558250
3     61.625000  26.050000        -28.807500  ...        0.193500
4     63.166667  11.766667        -23.986667  ...        0.053000
...         ...        ...               ...  ...             ...
9447  82.250000   9.650000         -9.465000  ...        0.121250
9448  72.350000  11.225000         -0.272500  ...        0.141000
9449  70.650000   3.700000        -55.230000  ...        0.022500
9450  89.150000  20.650000         -0.335000  ...        0.481500
9451  81.900000  17.225000         -0.260000  ...        0.335000

        Adj Power  System Press          BTU  H2S  Ambient Temp  Precip  \
0     2202.758333    -57.122500  220310629.0  0.0     66.166667     0.0
1      316.533333    -64.156667   31693816.0  0.0     66.666667     0.0
2      947.950000    -63.852500   94842059.4  0.0     67.500000     0.0
3      849.725000    -50.587500   84972934.2  0.0     67.500000     0.0
4      295.566667    -55.566667   29454867.2  0.0     66.666667     0.0
...           ...           ...          ...  ...           ...     ...
9447   205.750000    -55.650000   20572846.8  0.0     74.000000     0.0
9448   147.625000    -54.167500   14759362.2  0.0     74.000000     0.0
9449   112.700000    -55.230000   11377713.6  0.0     74.000000     0.0
9450   485.350000    -55.235000   48477633.6  0.0     74.000000     0.0
9451   177.775000    -53.275000   17778208.8  0.0     74.000000     0.0

       Latitude   Longitude      value
0     34.333770 -118.523790   8.420000
1     34.331448 -118.523244  17.540000
2     34.330290 -118.523084  21.730000
3     34.329800 -118.522996  12.360000
4     34.329311 -118.523006   6.770000
...         ...         ...        ...
9447  34.319778 -118.507012   4.027866
9448  34.320175 -118.506424  10.150789
9449  34.319875 -118.505997   8.599524
9450  34.319521 -118.505939   8.739270
9451  34.319666 -118.505246   8.516347

[9452 rows x 21 columns]
CH4                0.122732
CO2                0.076538
O2                 0.000554
```

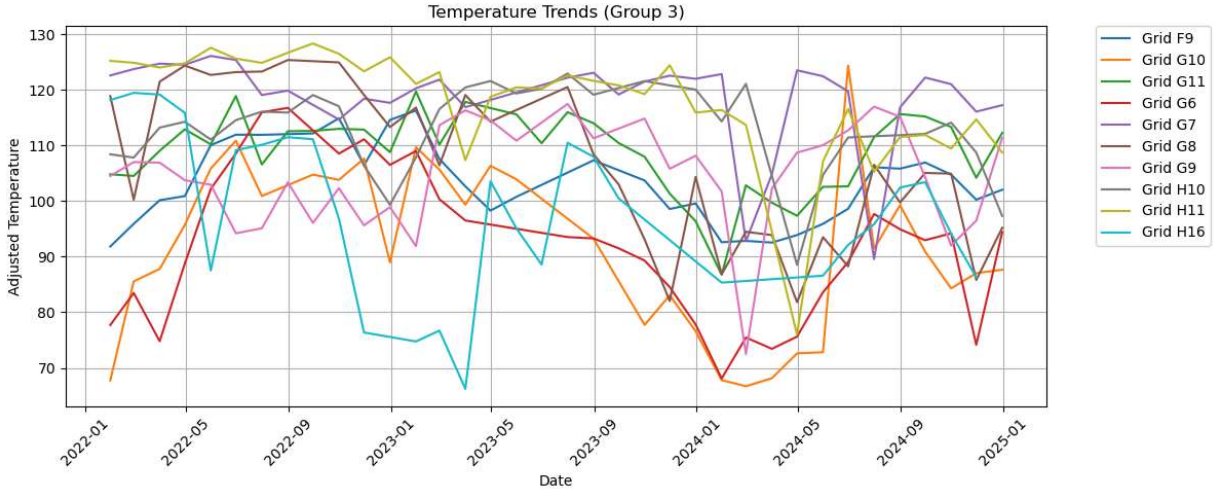
```
Bal                -0.128293
CO                  0.025504
Adj Temp           -0.019465
Adj Flow            0.076406
Adj Static Press   -0.117485
Baro               -0.029076
Adj Diff Press      0.128811
Adj Power           0.079959
System Press        0.242677
BTU                 0.079206
H2S                 0.012898
Ambient Temp        0.025372
Precip             -0.023144
Latitude            0.013588
Longitude          -0.013495
value               1.000000
Name: value, dtype: float64
```

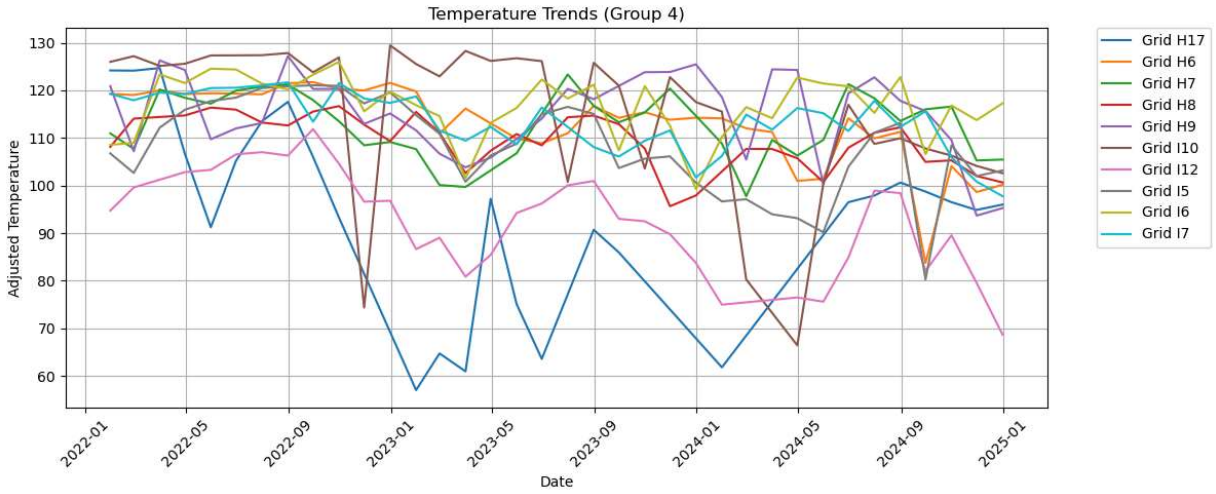
In [21]:

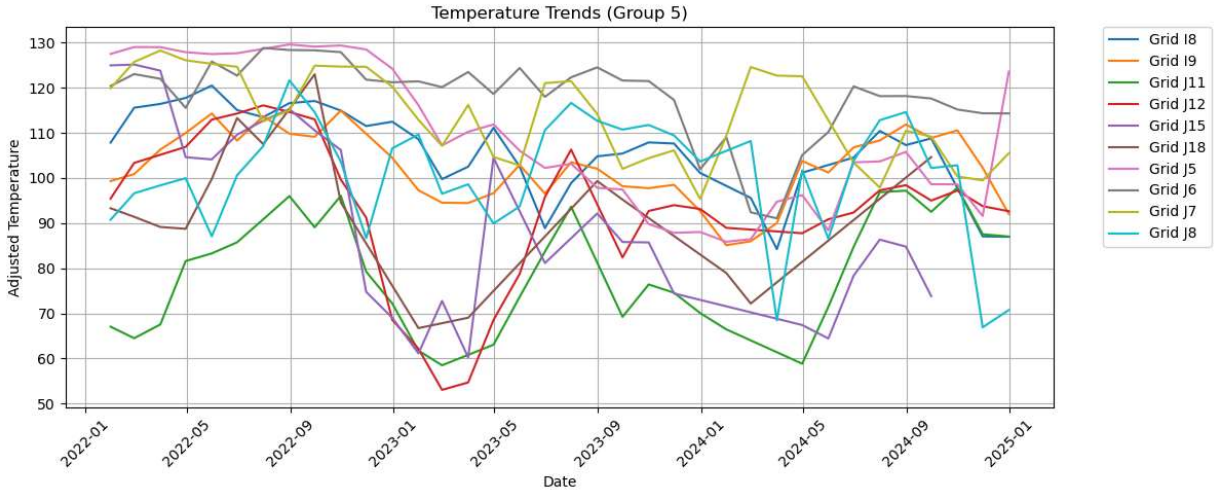
```python
import re

df = pd.DataFrame(well_and_walk)

df["date"] = pd.to_datetime(df["date"])

# Extract the letter component
unique_grids = df["grid"].unique()

# Split grids into groups of 5
grid_groups = [unique_grids[i:i+10] for i in range(0, len(unique_grids), 10)]

# Create separate plots for each group
for i, grid_list in enumerate(grid_groups):
    plt.figure(figsize=(12, 5))
    subset = df[df["grid"].isin(grid_list)]

    for grid_label, group in subset.groupby("grid"):
        plt.plot(group["date"], group["Adj Temp"], label=f"Grid {grid_label}")

    plt.xlabel("Date")
    plt.ylabel("Adjusted Temperature")
    plt.title(f"Temperature Trends (Group {i+1})")
    plt.legend(loc="upper left", bbox_to_anchor=(1.05, 1), borderaxespad=0.)
    plt.xticks(rotation=45)
    plt.grid(True)
    plt.tight_layout()
    plt.savefig(f"wellgrid/{i}.png")
    plt.show()
```

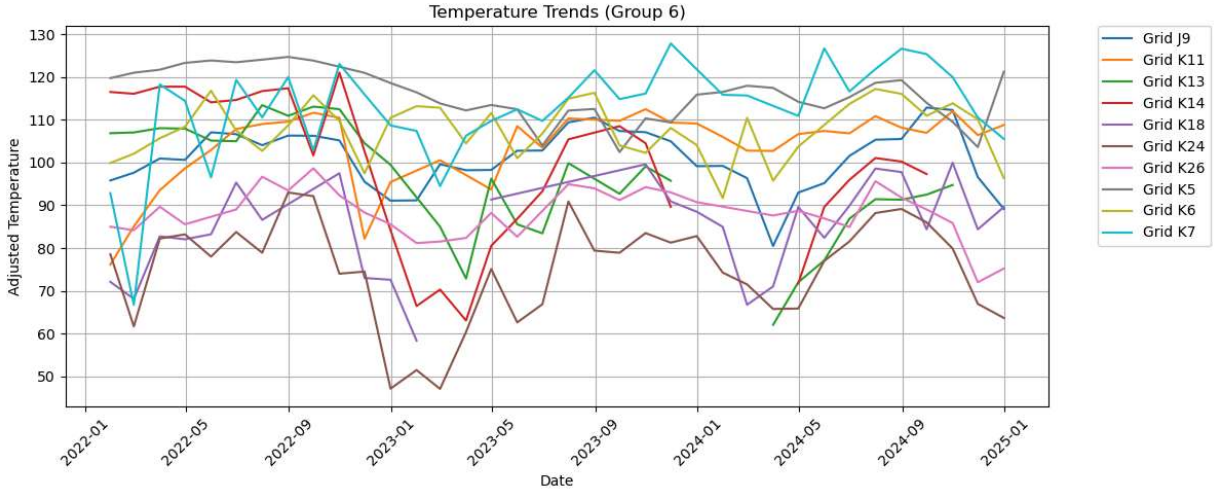

Temperature Trends (Group 1)
Adjusted Temperature
Date
Grid C5
Grid D10
Grid D11
Grid D12
Grid D13
Grid D14
Grid D15
Grid D16
Grid D5
Grid D7

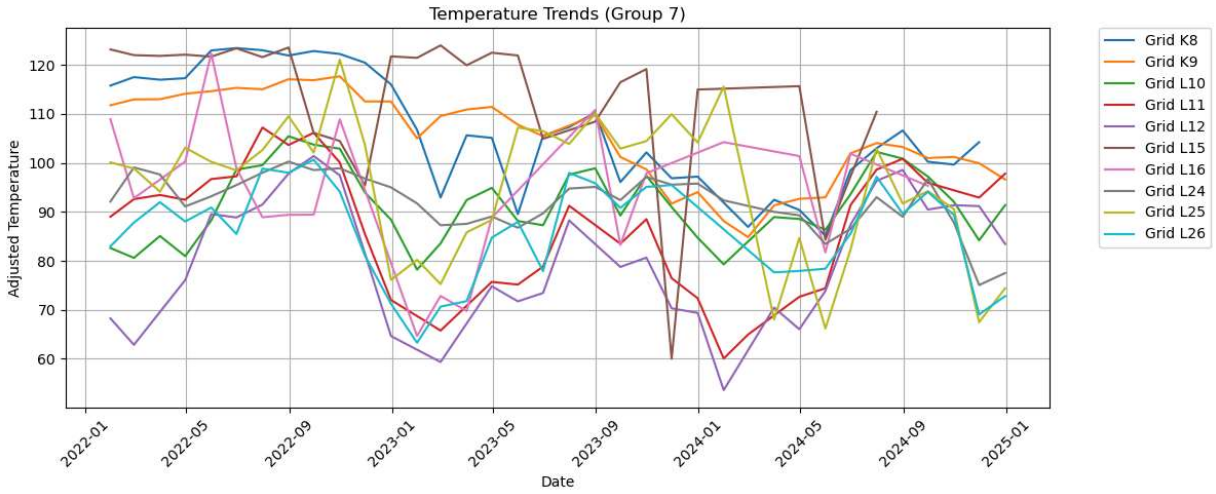

Temperature Trends (Group 2)
Adjusted Temperature
Date
Grid D8
Grid D9
Grid E10
Grid E12
Grid E4
Grid E5
Grid E8
Grid F10
Grid F4
Grid F8

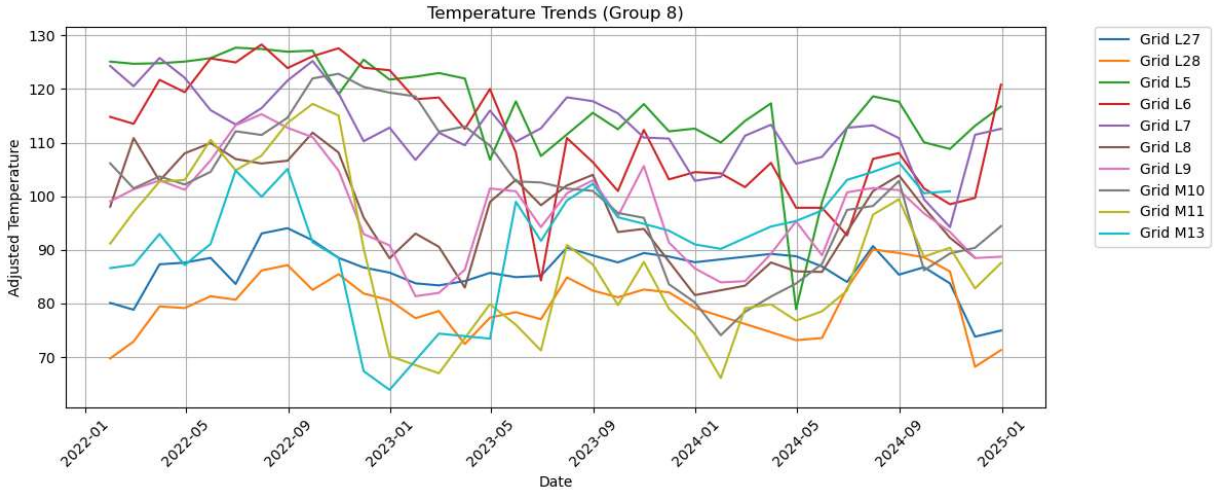

Temperature Trends (Group 3)
Adjusted Temperature
Date
Grid F9
Grid G10
Grid G11
Grid G6
Grid G7
Grid G8
Grid G9
Grid H10
Grid H11
Grid H16

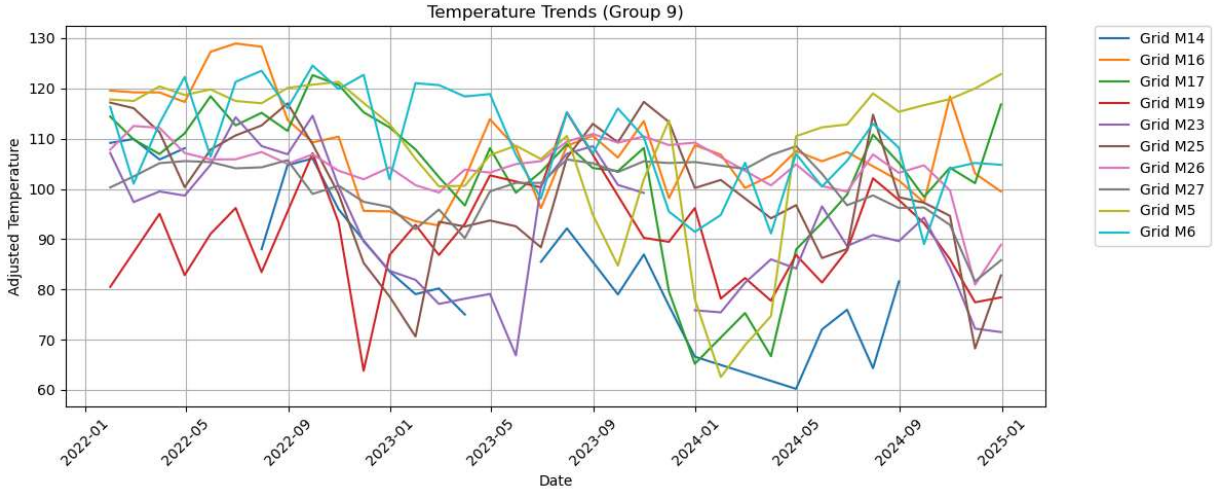

Temperature Trends (Group 4)
Adjusted Temperature
Date
Grid H17
Grid H6
Grid H7
Grid H8
Grid H9
Grid I10
Grid I12
Grid I5
Grid I6
Grid I7

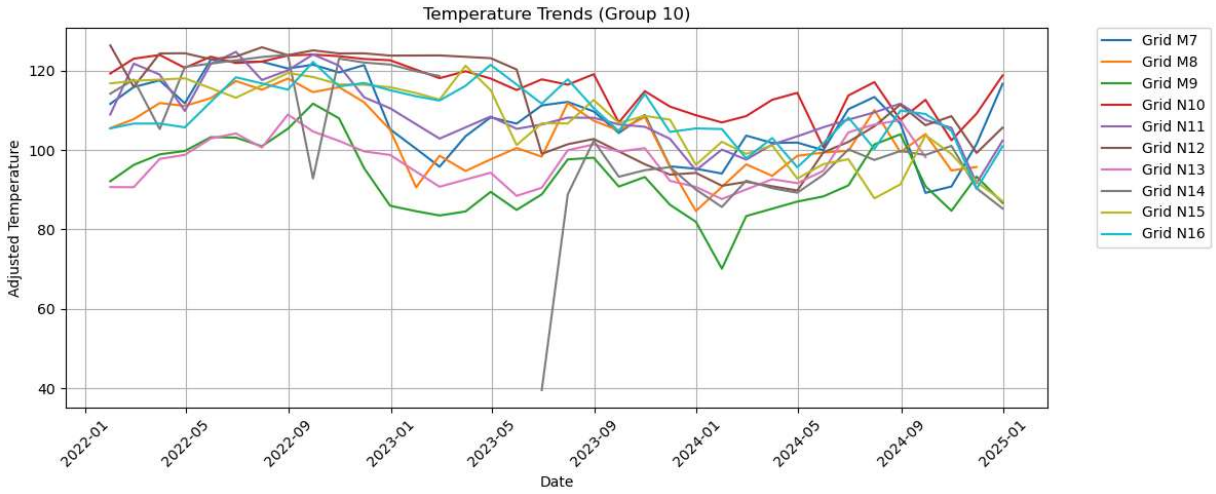

Temperature Trends (Group 5)
Adjusted Temperature
Date
Grid I8
Grid I9
Grid J11
Grid J12
Grid J15
Grid J18
Grid J5
Grid J6
Grid J7
Grid J8

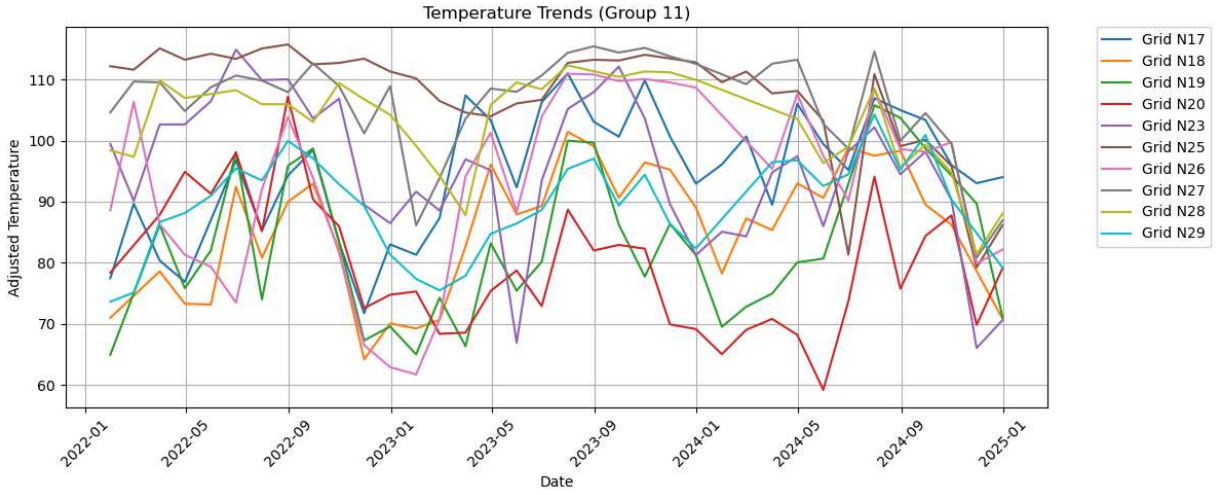

Temperature Trends (Group 6)
Adjusted Temperature
Date
Grid J9
Grid K11
Grid K13
Grid K14
Grid K18
Grid K24
Grid K26
Grid K5
Grid K6
Grid K7

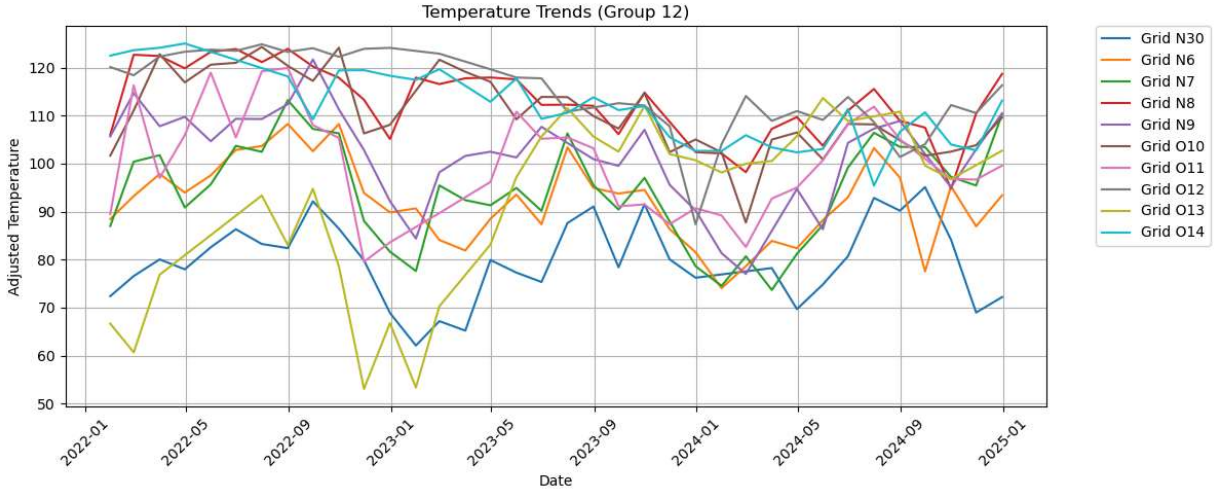

Temperature Trends (Group 7)
Adjusted Temperature
Date
Grid K8
Grid K9
Grid L10
Grid L11
Grid L12
Grid L15
Grid L16
Grid L24
Grid L25
Grid L26

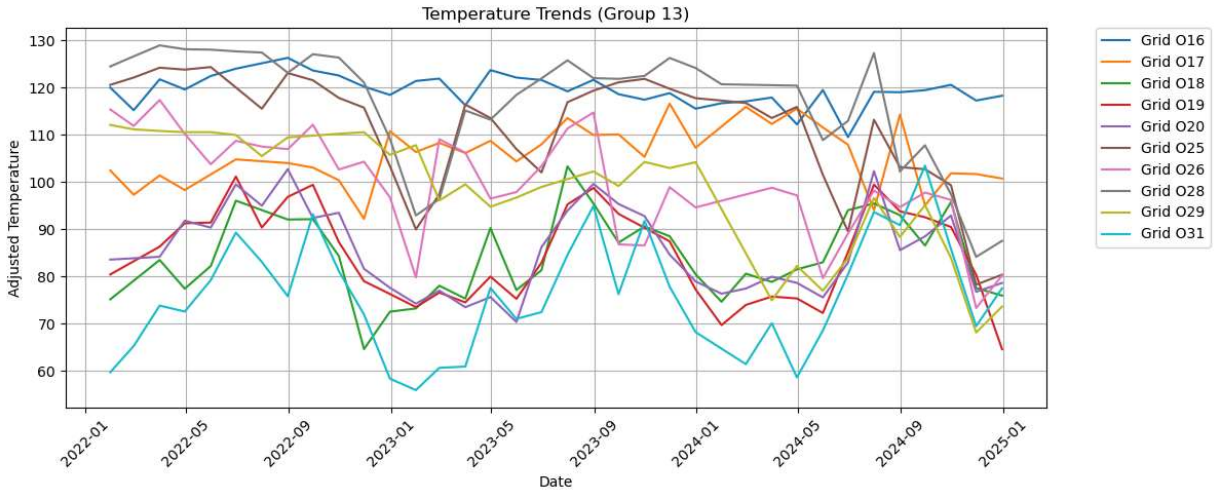

Temperature Trends (Group 8)
Adjusted Temperature
Date
Grid L27
Grid L28
Grid L5
Grid L6
Grid L7
Grid L8
Grid L9
Grid M10
Grid M11
Grid M13

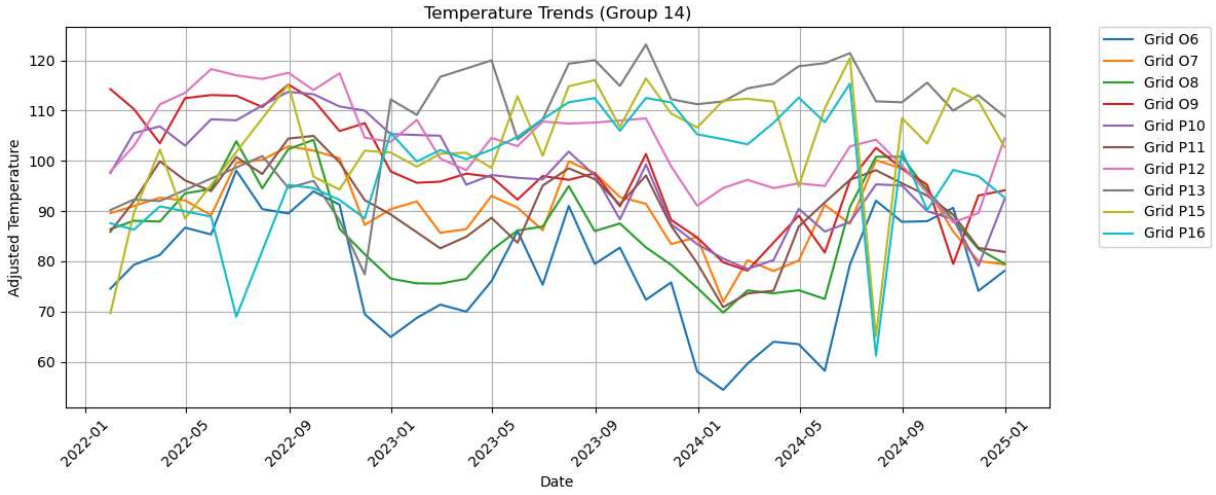

Temperature Trends (Group 9)
Adjusted Temperature
Date
Grid M14
Grid M16
Grid M17
Grid M19
Grid M23
Grid M25
Grid M26
Grid M27
Grid M5
Grid M6

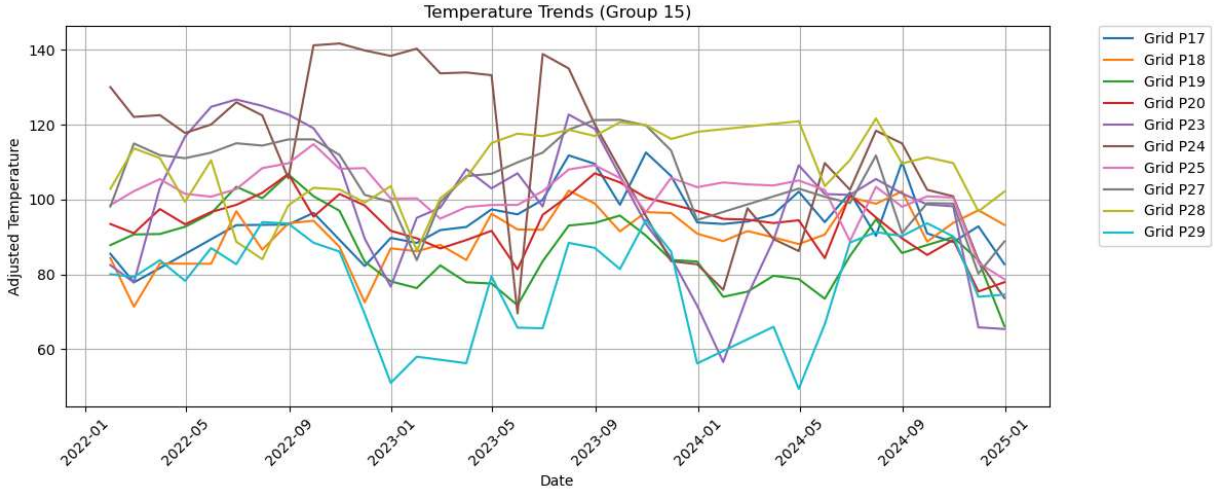

Temperature Trends (Group 10)
Adjusted Temperature
Date
Grid M7
Grid M8
Grid M9
Grid N10
Grid N11
Grid N12
Grid N13
Grid N14
Grid N15
Grid N16

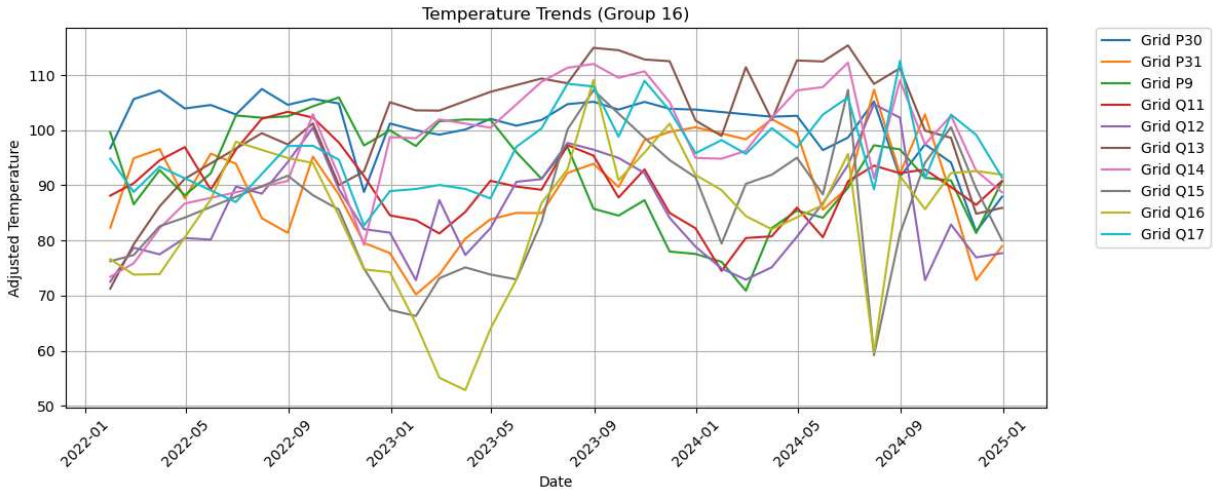

Temperature Trends (Group 11)
Adjusted Temperature
Date
Grid N17
Grid N18
Grid N19
Grid N20
Grid N23
Grid N25
Grid N26
Grid N27
Grid N28
Grid N29

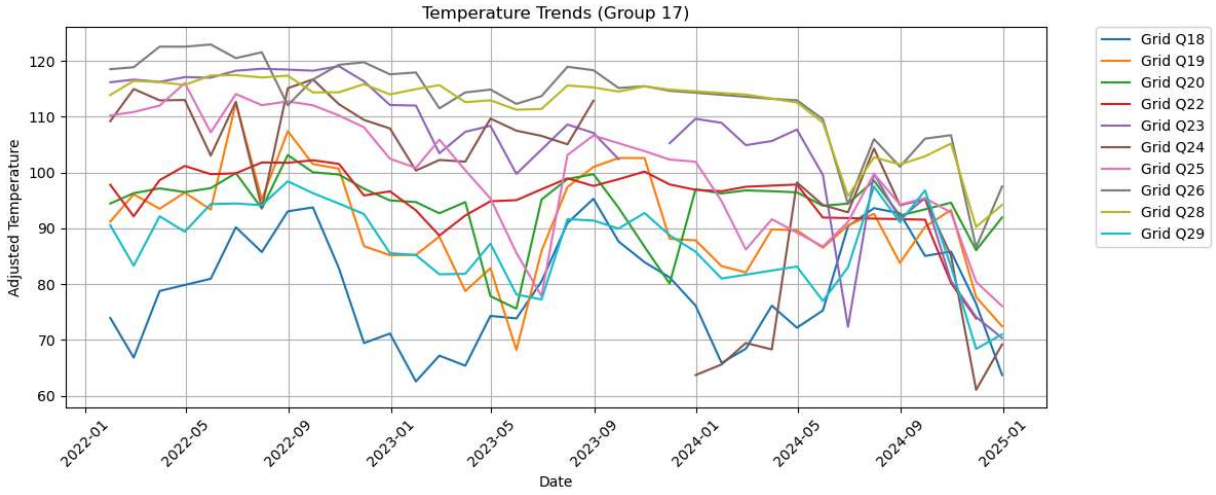

Temperature Trends (Group 12)
Adjusted Temperature
Date
Grid N30
Grid N6
Grid N7
Grid N8
Grid N9
Grid O10
Grid O11
Grid O12
Grid O13
Grid O14

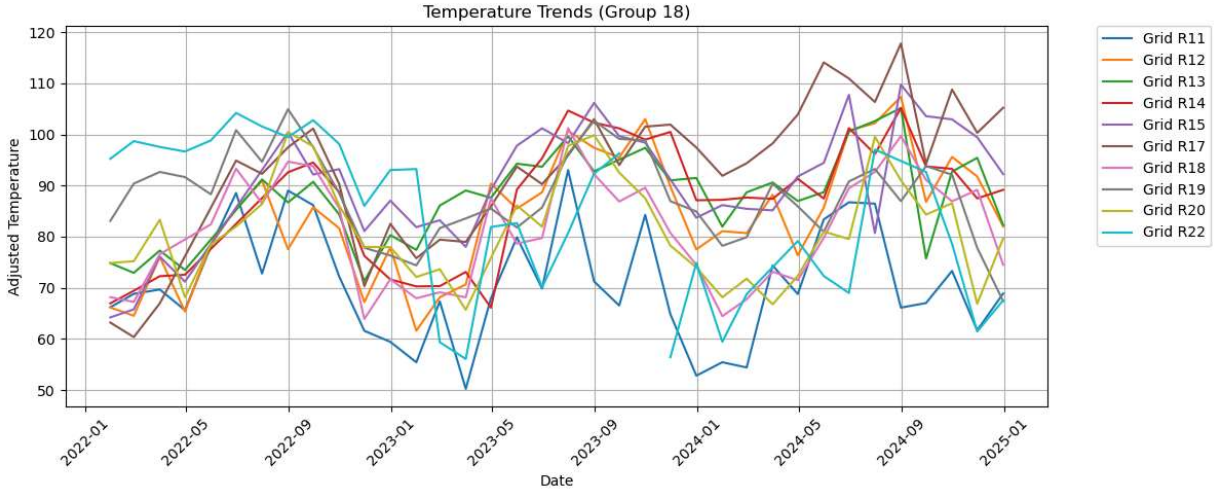

Temperature Trends (Group 13)
Adjusted Temperature
Date
Grid O16
Grid O17
Grid O18
Grid O19
Grid O20
Grid O25
Grid O26
Grid O28
Grid O29
Grid O31

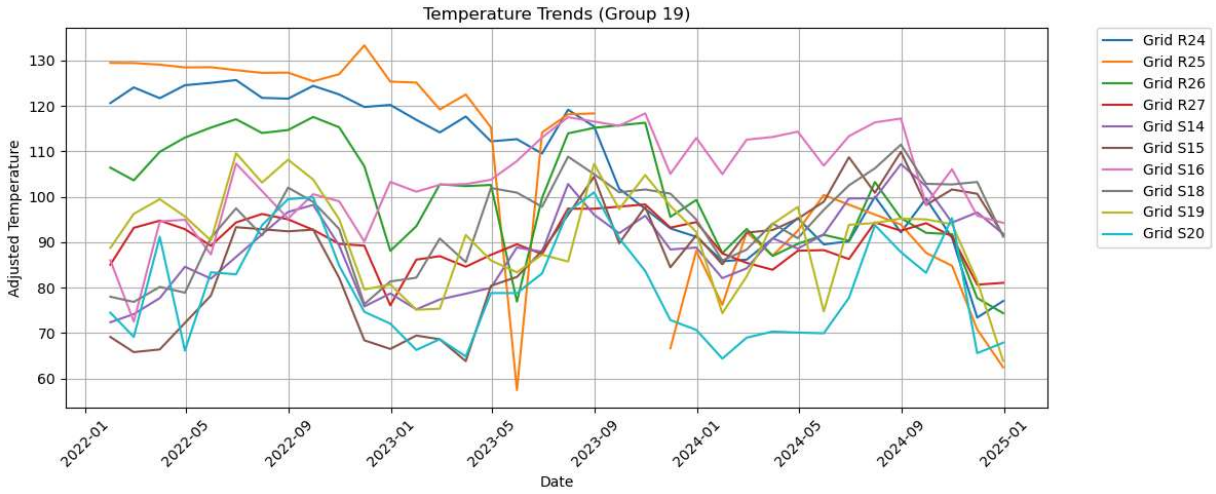

Temperature Trends (Group 14)
Adjusted Temperature
Date
Grid O6
Grid O7
Grid O8
Grid O9
Grid P10
Grid P11
Grid P12
Grid P13
Grid P15
Grid P16

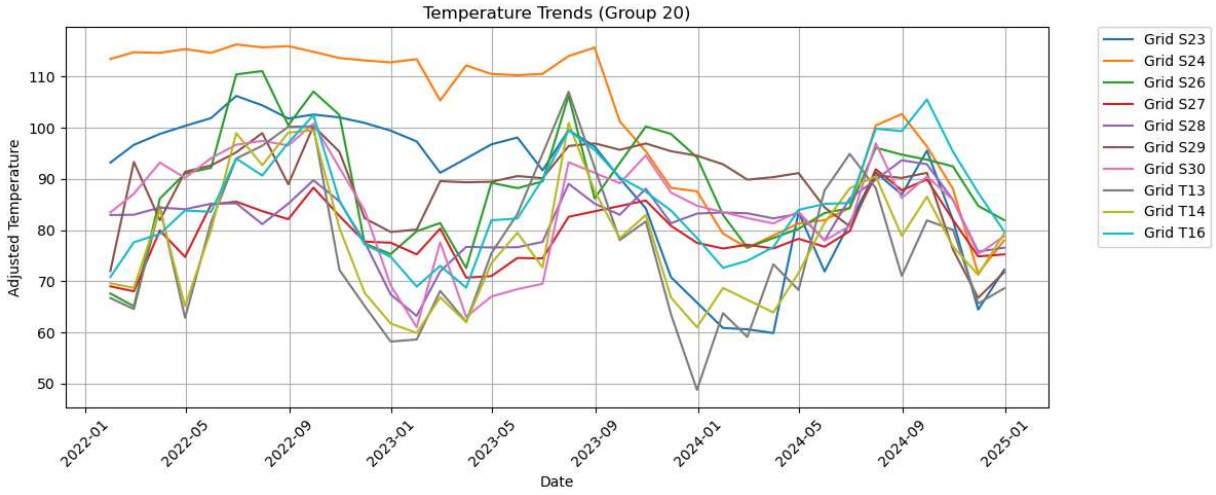

Temperature Trends (Group 15)
Adjusted Temperature
Date
Grid P17
Grid P18
Grid P19
Grid P20
Grid P23
Grid P24
Grid P25
Grid P27
Grid P28
Grid P29

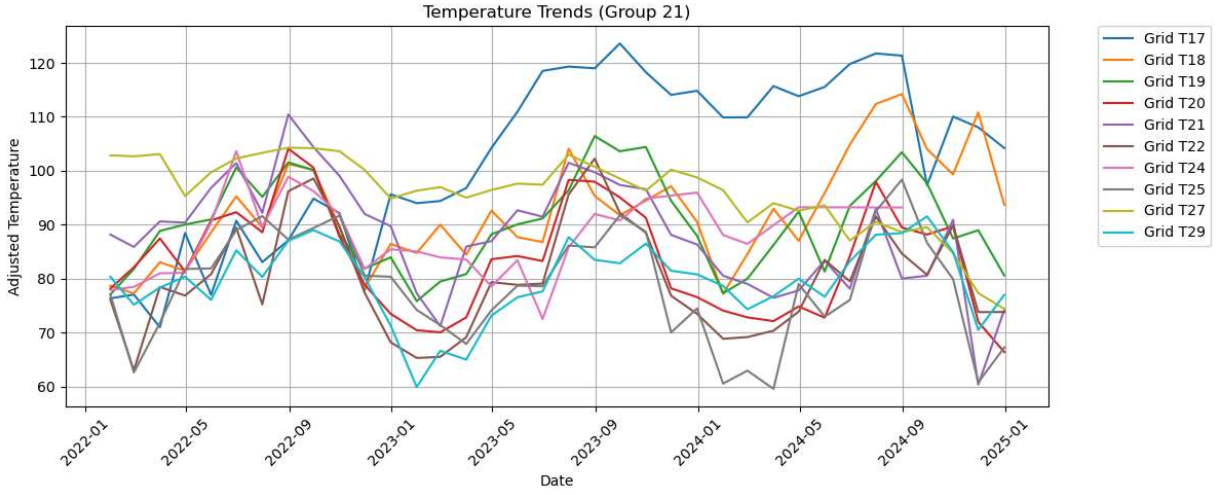

Temperature Trends (Group 16)
Adjusted Temperature
Date
Grid P30
Grid P31
Grid P9
Grid Q11
Grid Q12
Grid Q13
Grid Q14
Grid Q15
Grid Q16
Grid Q17

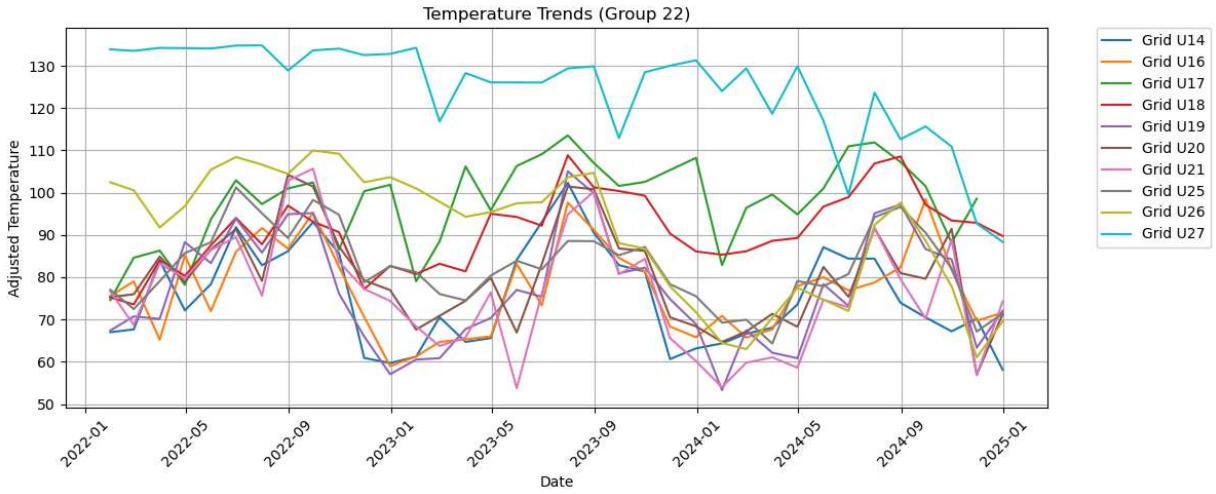

Temperature Trends (Group 17)
Adjusted Temperature
Date
Grid Q18
Grid Q19
Grid Q20
Grid Q22
Grid Q23
Grid Q24
Grid Q25
Grid Q26
Grid Q28
Grid Q29

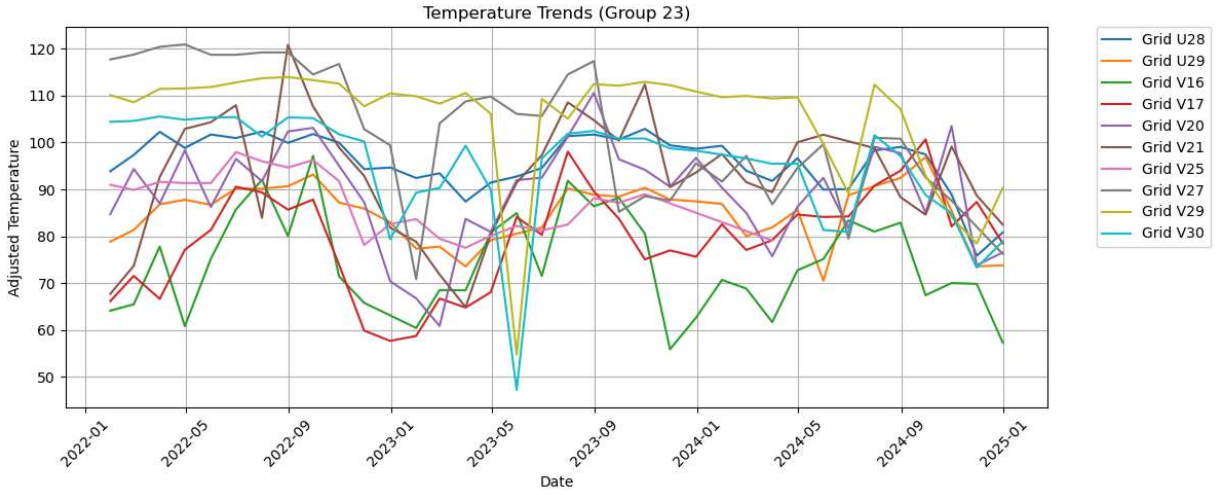

Temperature Trends (Group 18)
Adjusted Temperature
Date
Grid R11
Grid R12
Grid R13
Grid R14
Grid R15
Grid R17
Grid R18
Grid R19
Grid R20
Grid R22

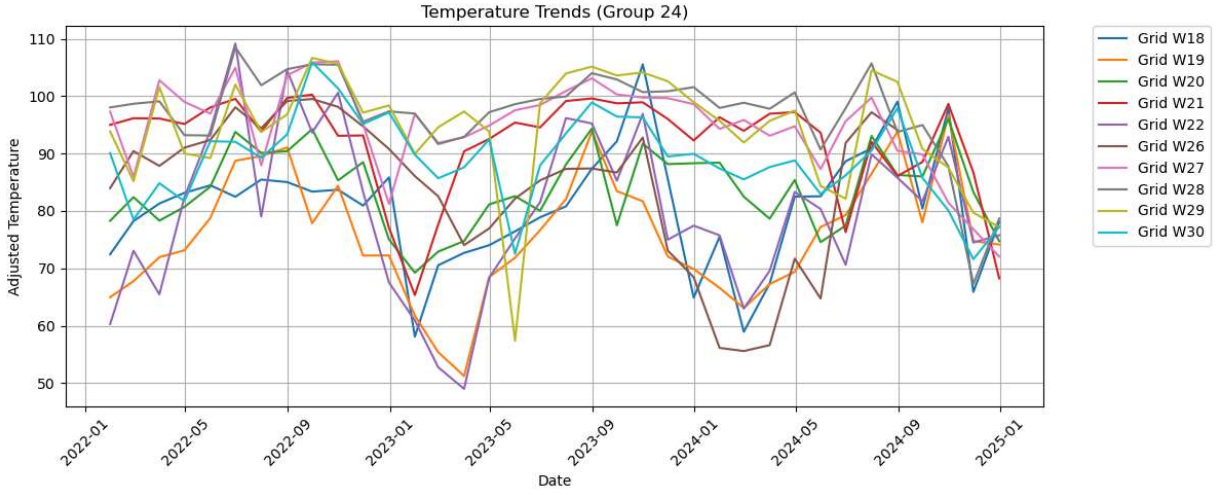

Temperature Trends (Group 19)
Adjusted Temperature
Date
Grid R24
Grid R25
Grid R26
Grid R27
Grid S14
Grid S15
Grid S16
Grid S18
Grid S19
Grid S20

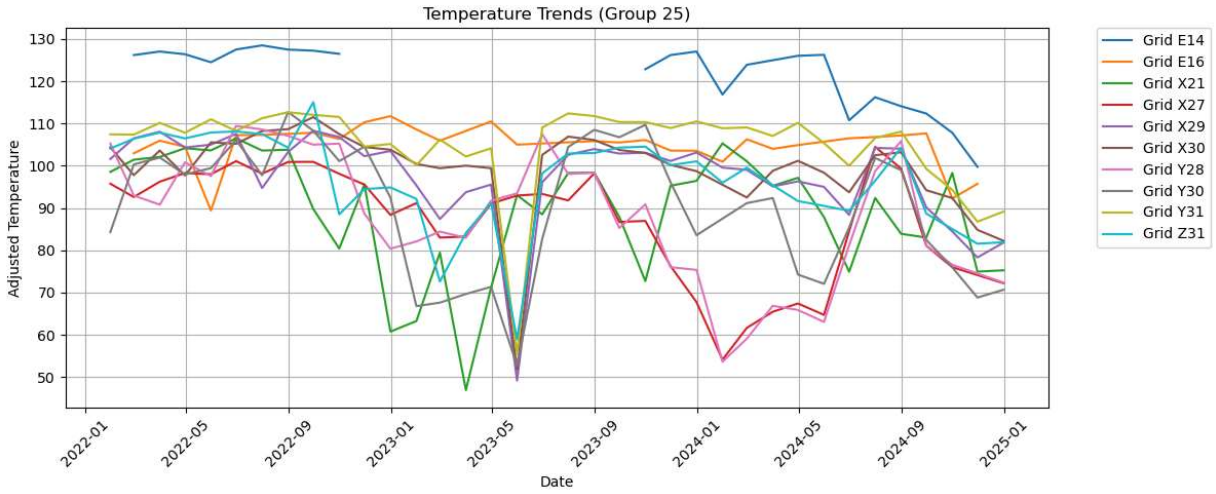

Temperature Trends (Group 20)
Adjusted Temperature
Date
Grid S23
Grid S24
Grid S26
Grid S27
Grid S28
Grid S29
Grid S30
Grid T13
Grid T14
Grid T16

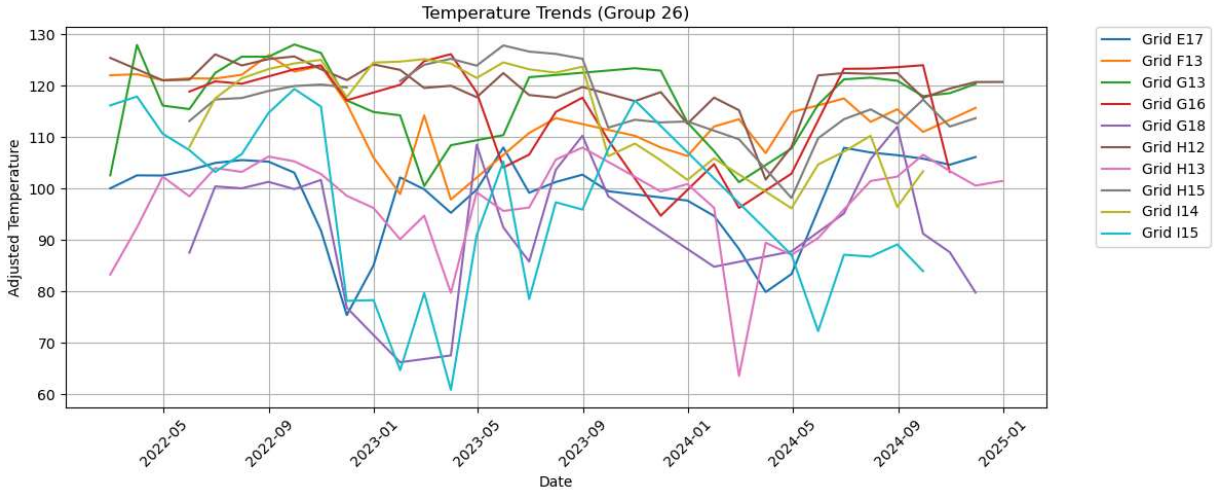

Temperature Trends (Group 21)
Adjusted Temperature
Date
Grid T17
Grid T18
Grid T19
Grid T20
Grid T21
Grid T22
Grid T24
Grid T25
Grid T27
Grid T29

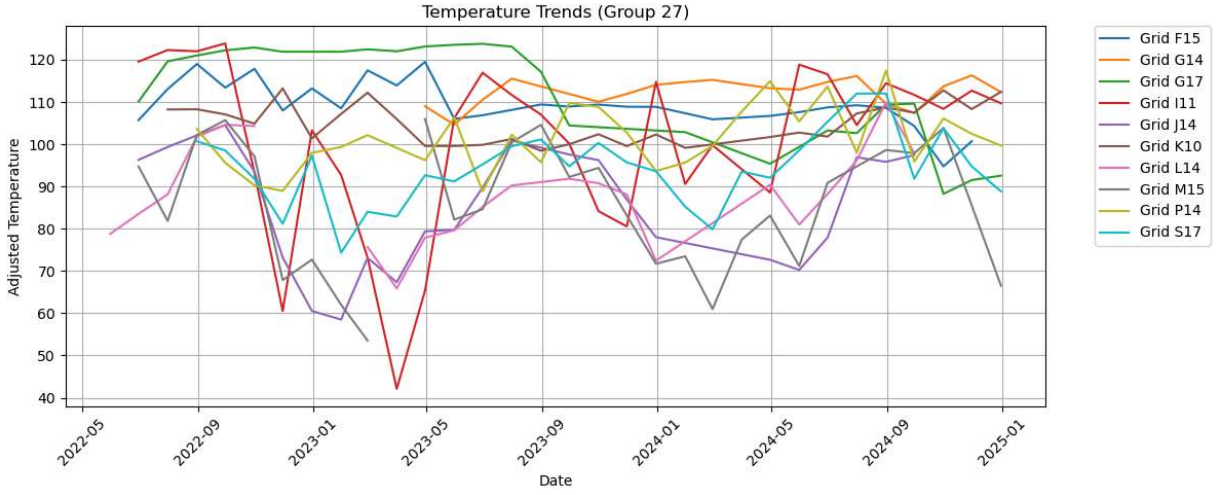

Temperature Trends (Group 22)
Adjusted Temperature
Date
Grid U14
Grid U16
Grid U17
Grid U18
Grid U19
Grid U20
Grid U21
Grid U25
Grid U26
Grid U27

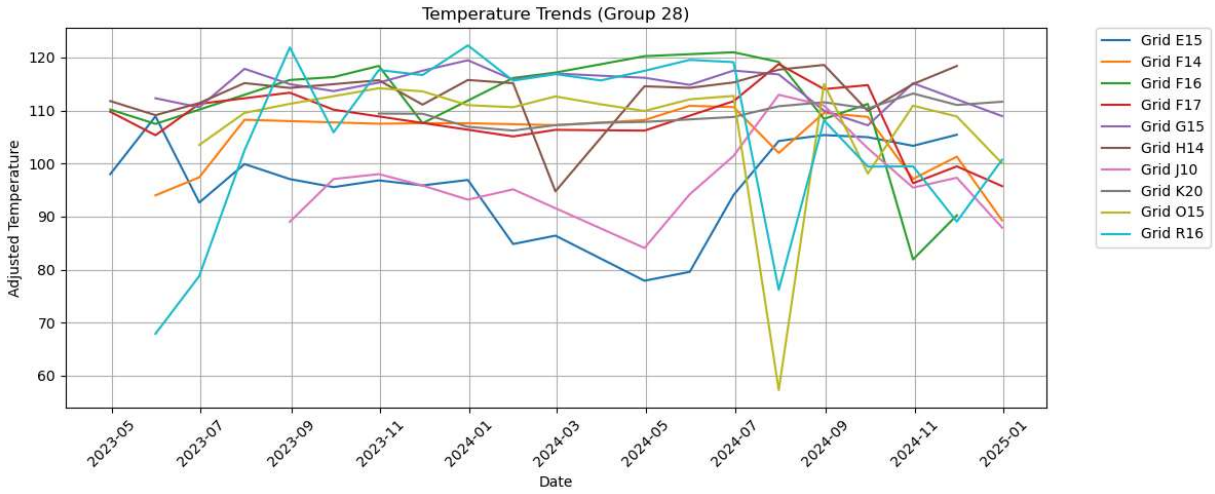

Temperature Trends (Group 23)
Adjusted Temperature
Date
Grid U28
Grid U29
Grid V16
Grid V17
Grid V20
Grid V21
Grid V25
Grid V27
Grid V29
Grid V30

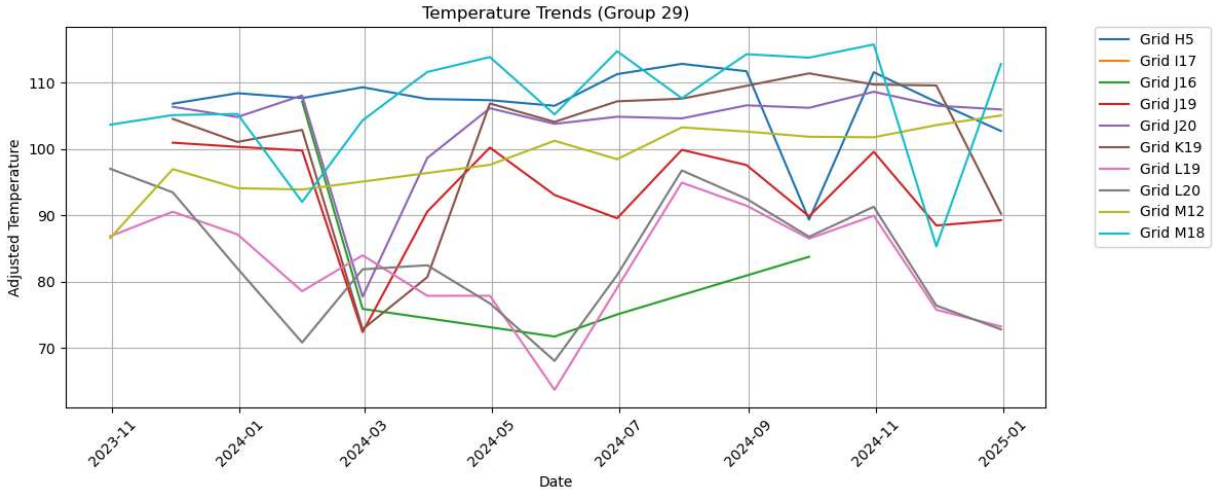

Temperature Trends (Group 24)
Adjusted Temperature
Date
Grid W18
Grid W19
Grid W20
Grid W21
Grid W22
Grid W26
Grid W27
Grid W28
Grid W29
Grid W30

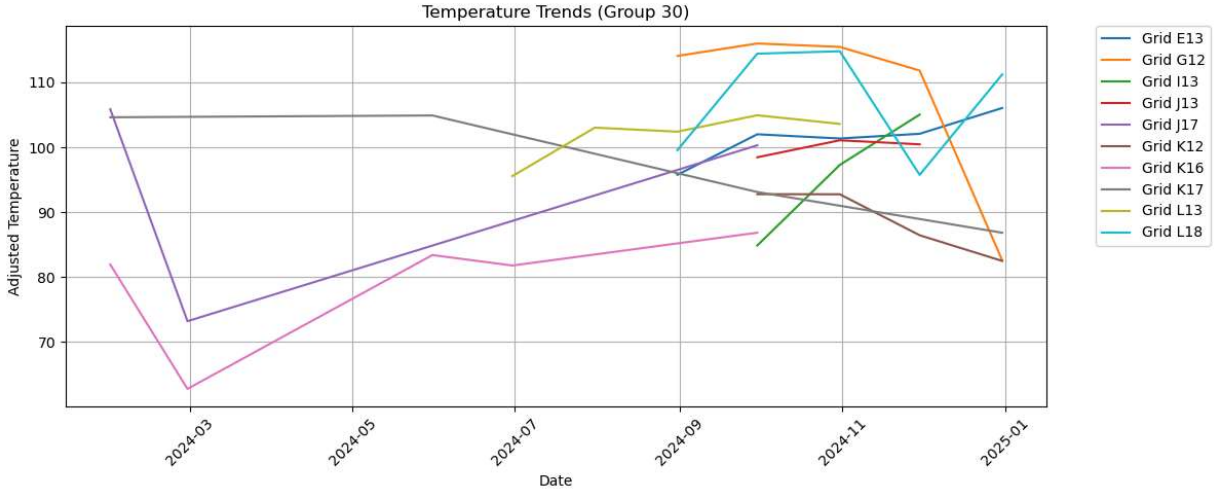

Temperature Trends (Group 25)
Adjusted Temperature
Date
Grid E14
Grid E16
Grid X21
Grid X27
Grid X29
Grid X30
Grid Y28
Grid Y30
Grid Y31
Grid Z31

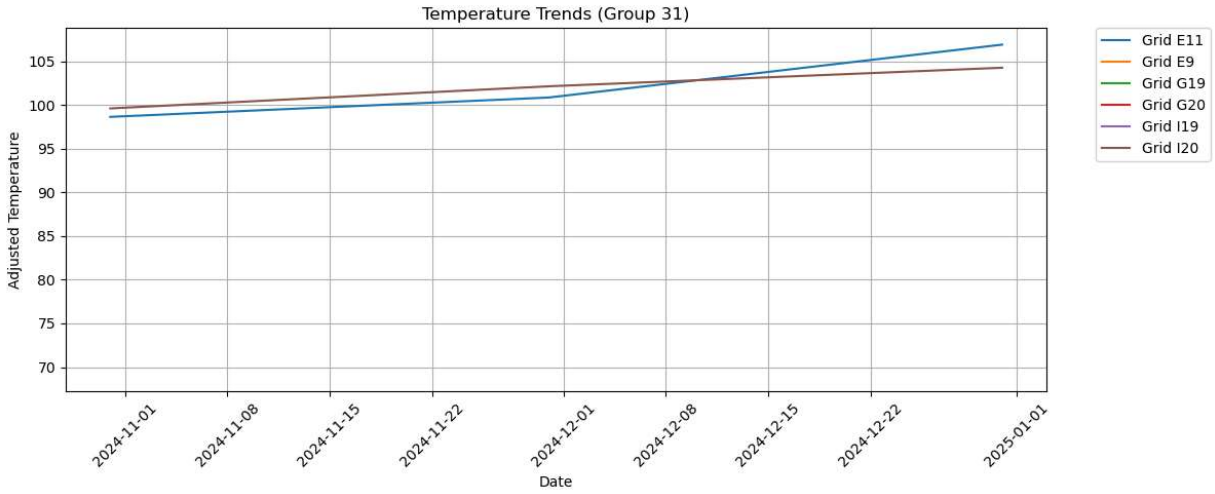

Temperature Trends (Group 26)
Adjusted Temperature
Date
Grid E17
Grid F13
Grid G13
Grid G16
Grid G18
Grid H12
Grid H13
Grid H15
Grid I14
Grid I15


Temperature Trends (Group 27)
Adjusted Temperature
Date
Grid F15
Grid G14
Grid G17
Grid I11
Grid J14
Grid K10
Grid L14
Grid M15
Grid P14
Grid S17


Temperature Trends (Group 28)
Adjusted Temperature
Date
Grid E15
Grid F14
Grid F16
Grid F17
Grid G15
Grid H14
Grid J10
Grid K20
Grid O15
Grid R16


Temperature Trends (Group 29)
Adjusted Temperature
Date
Grid H5
Grid I17
Grid J16
Grid J19
Grid J20
Grid K19
Grid L19
Grid L20
Grid M12
Grid M18


Temperature Trends (Group 30)
Adjusted Temperature
Date
Grid E13
Grid G12
Grid I13
Grid J13
Grid J17
Grid K12
Grid K16
Grid K17
Grid L13
Grid L18


Temperature Trends (Group 31)
Adjusted Temperature
105
100
95
90
85
80
75
70
2024-11-01
2024-11-08
2024-11-15
2024-11-22
2024-12-01
2024-12-08
2024-12-15
2024-12-22
2025-01-01
Date
Grid E11
Grid E9
Grid G19
Grid G20
Grid I19
Grid I20