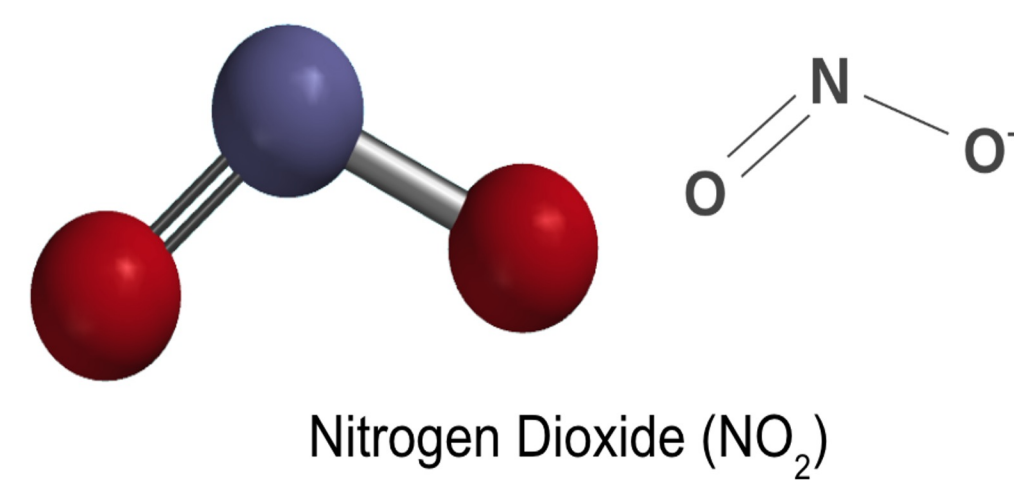


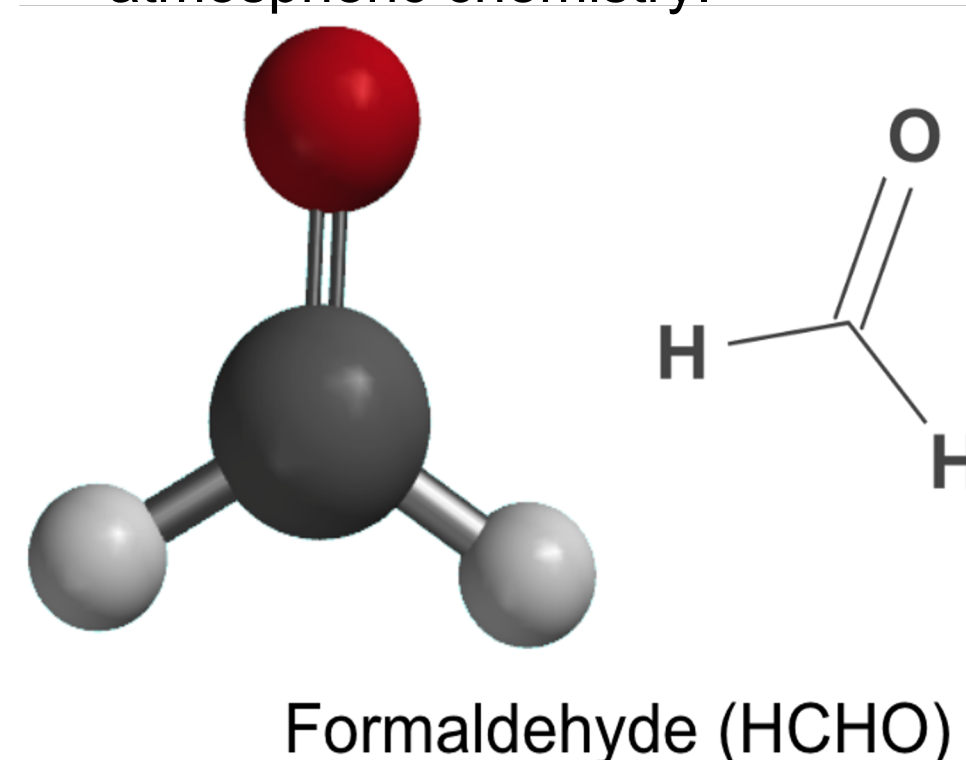
Remote Sensing Measurements of NO₂ and Formaldehyde with the NASA TEMPO Satellite in Industrial and Energy Generating Areas in Illinois

Tyler Ranieri, Miecio Smith, and Joseph Kozminski

NO₂ & HCHO

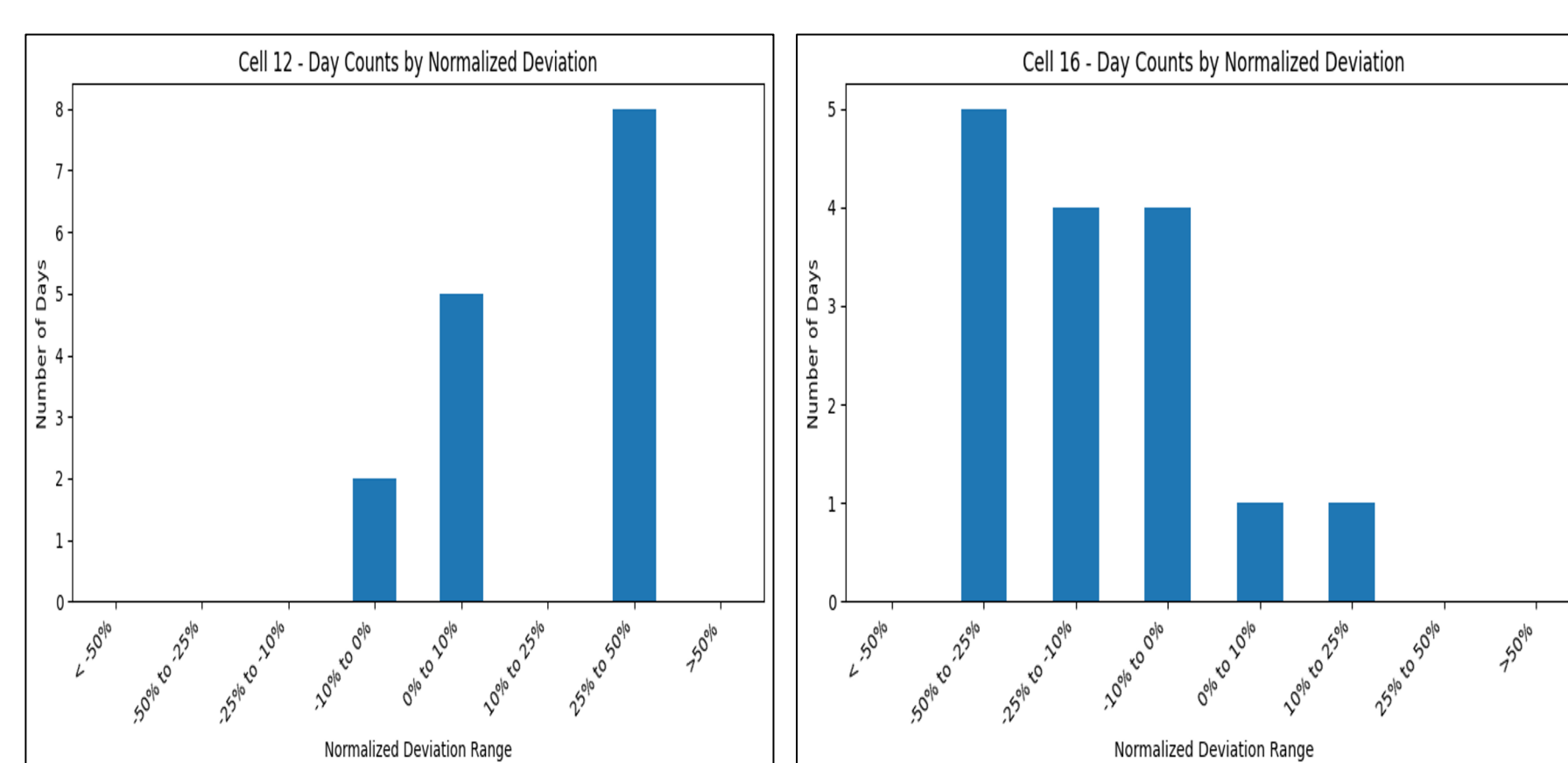
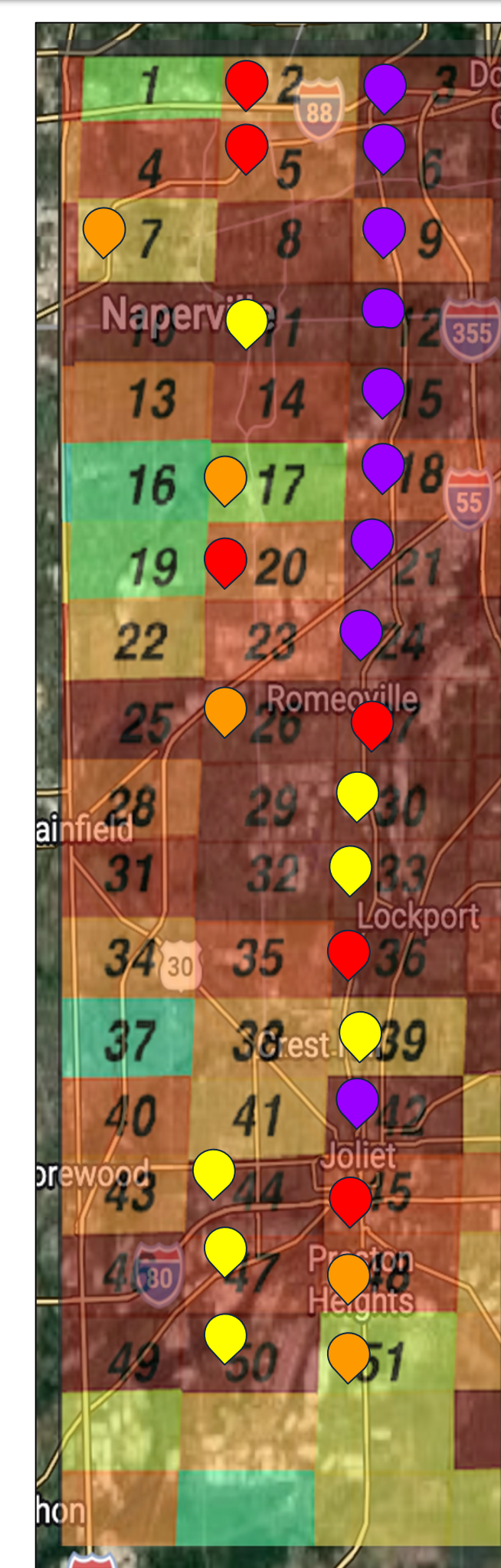
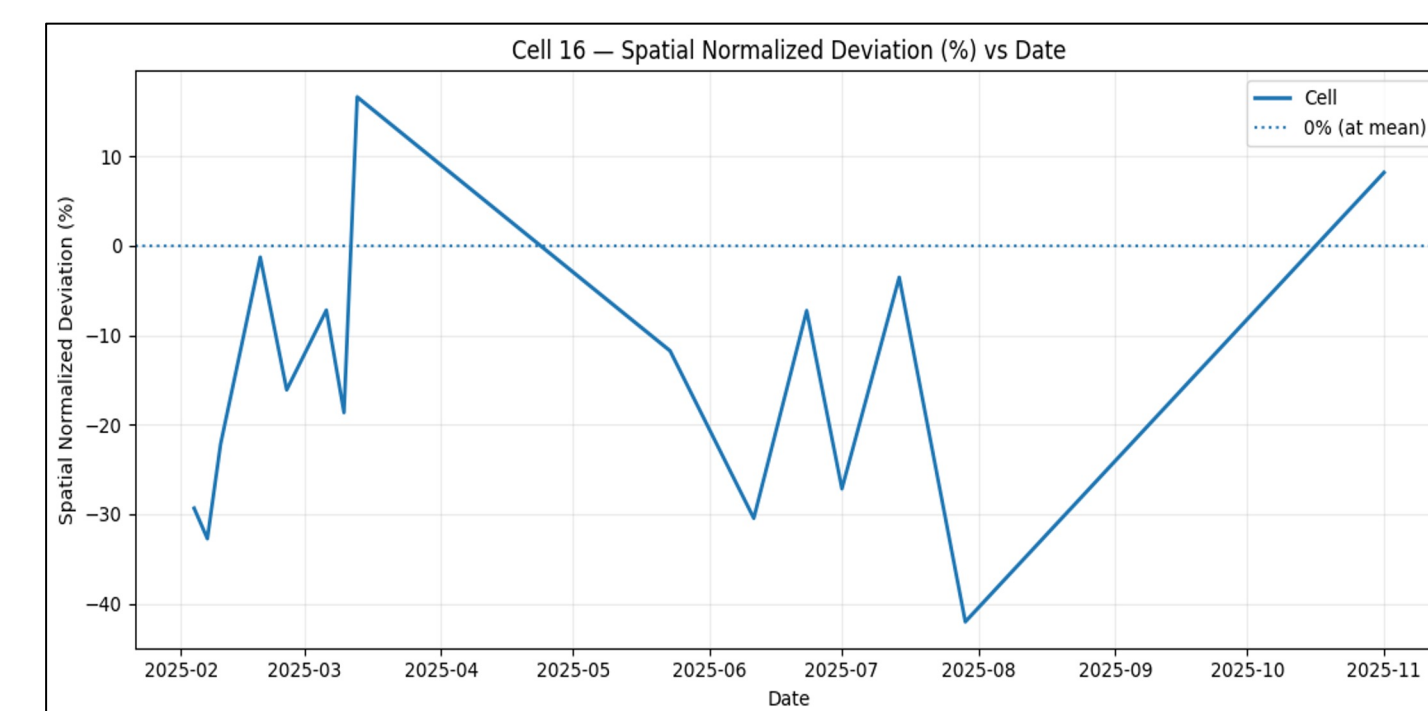
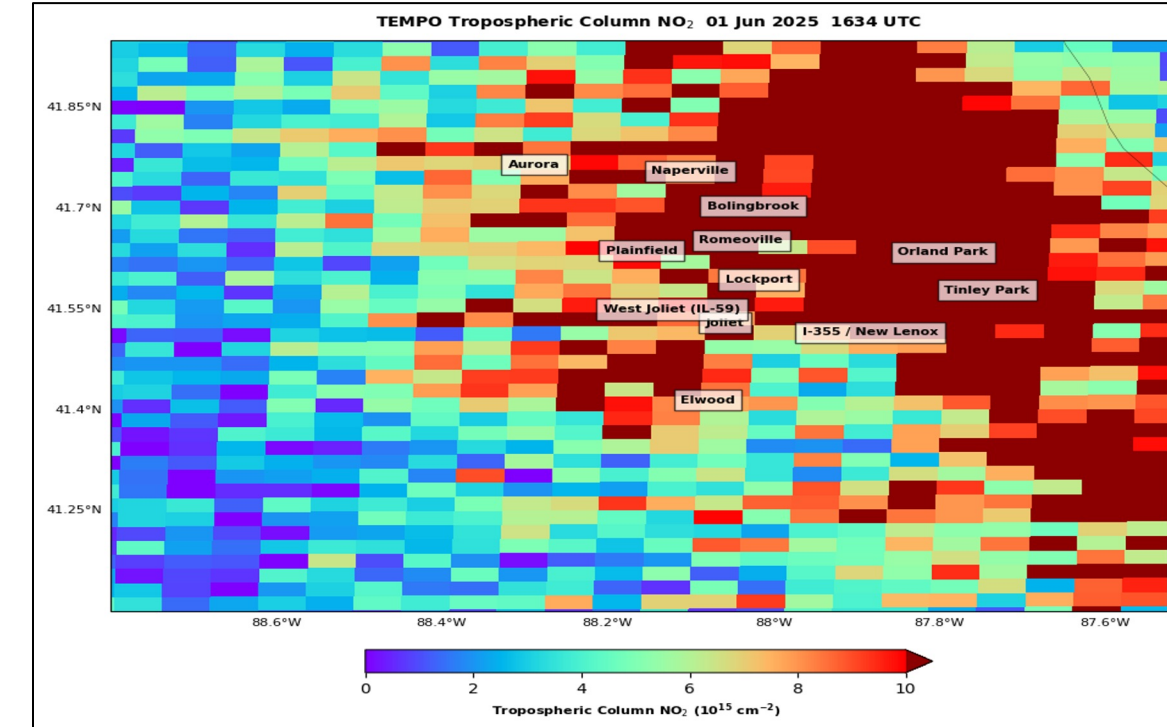
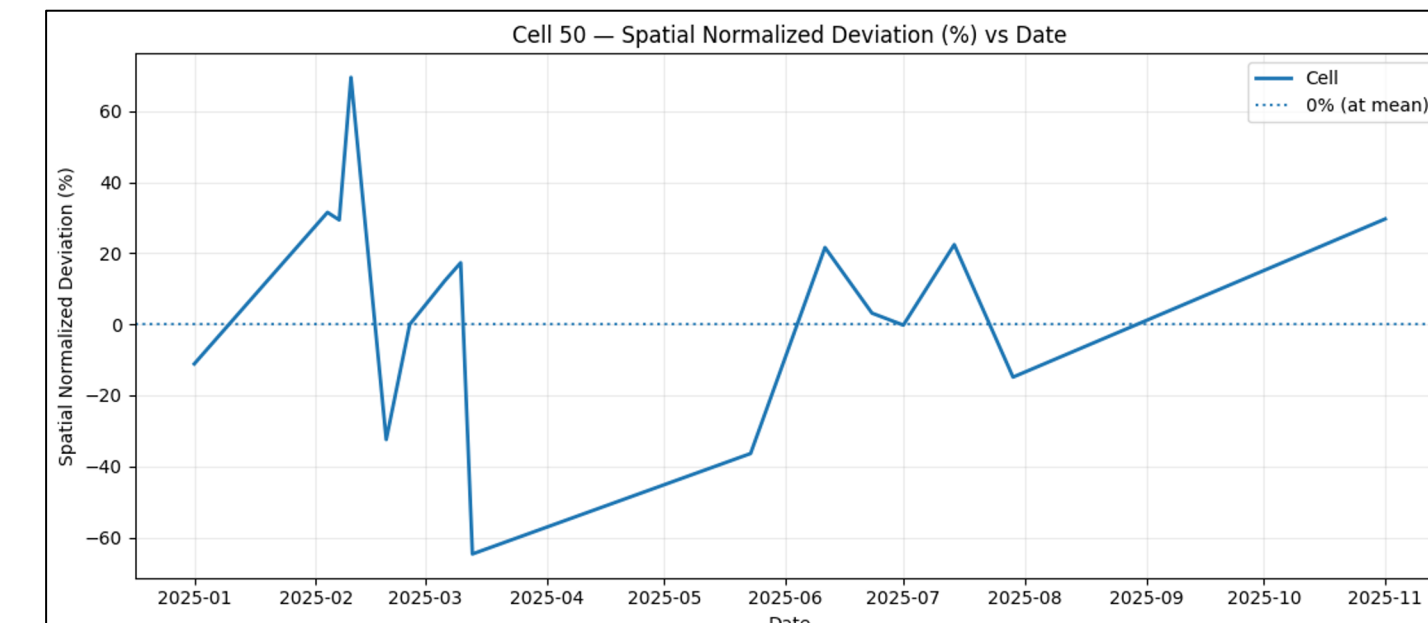
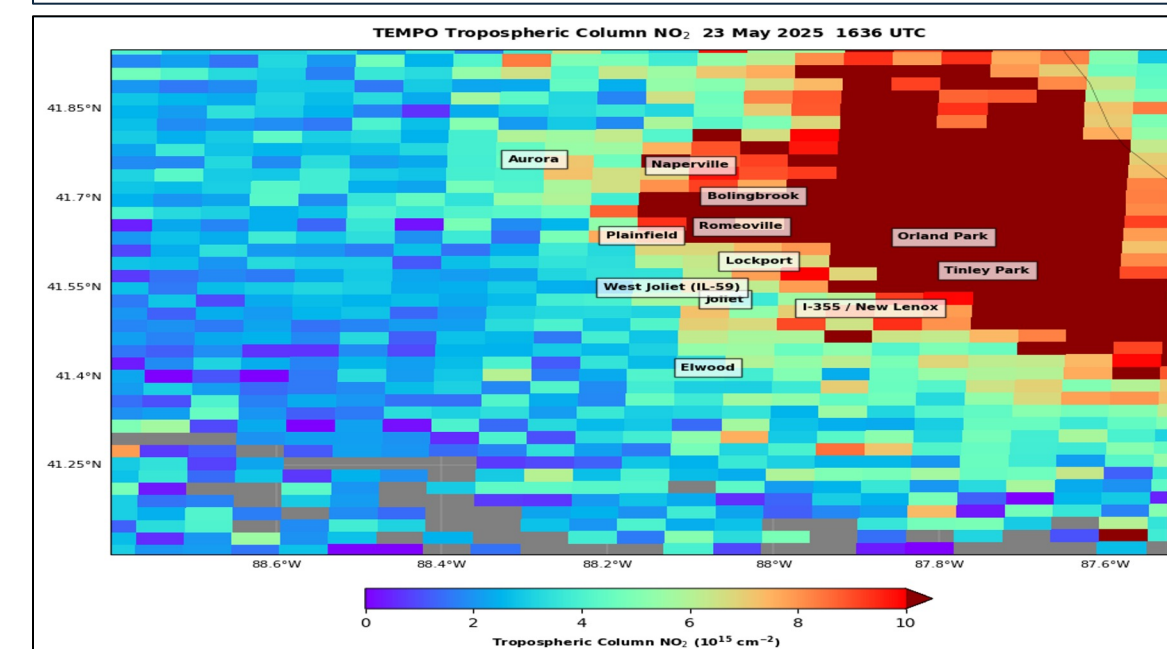
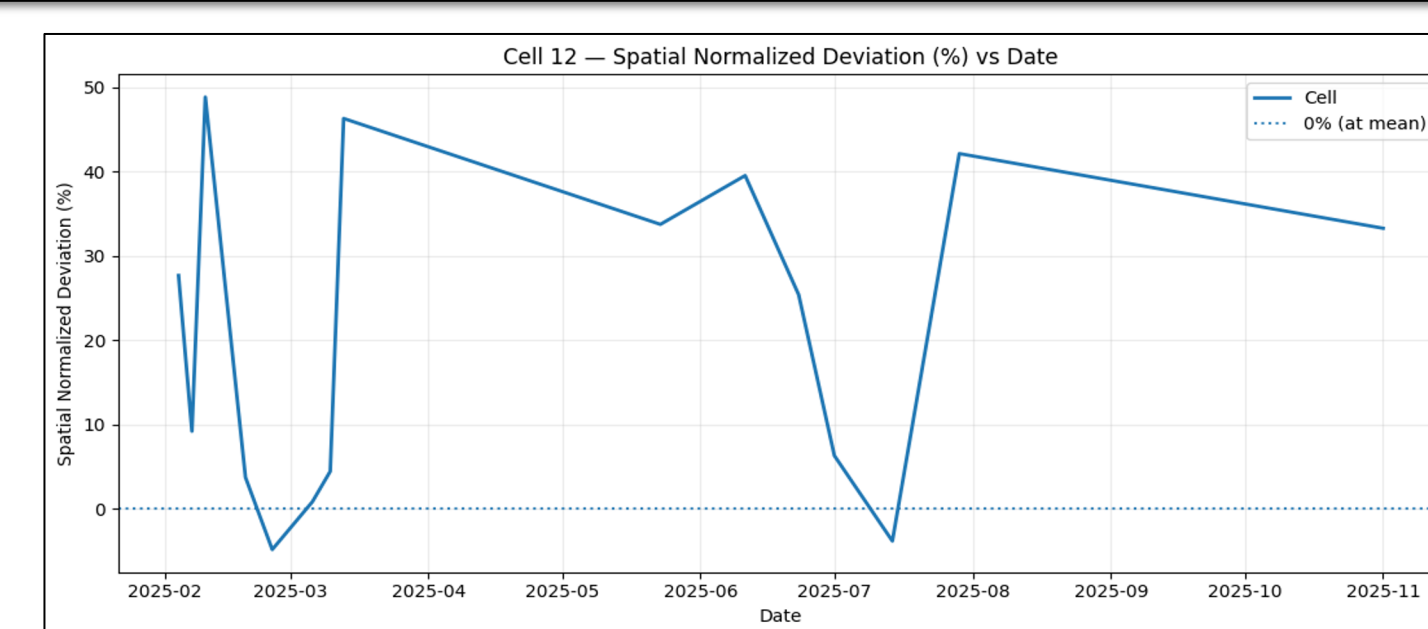
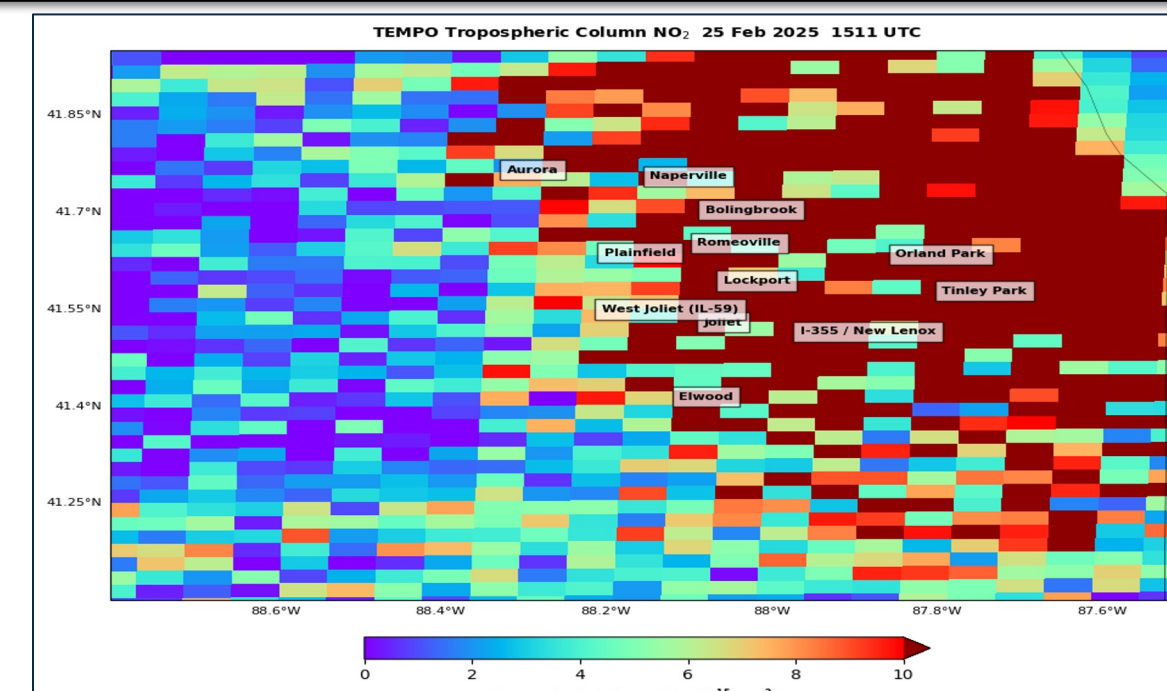


- Nitrogen dioxide (NO₂) is a reactive gas and a major air pollutant.
- It is part of a group called NO_x (nitrogen oxides).
- Has a reddish-brown color and sharp, irritating odor.
- Plays a key role in atmospheric chemistry.



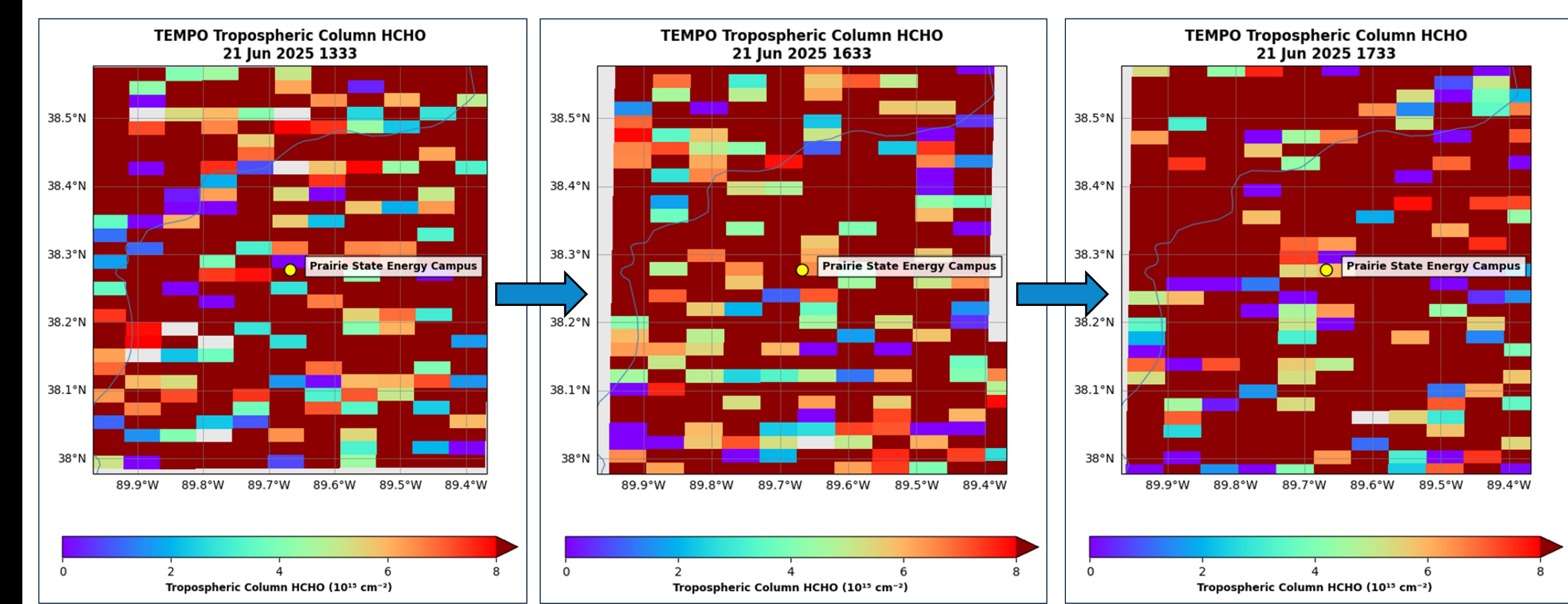
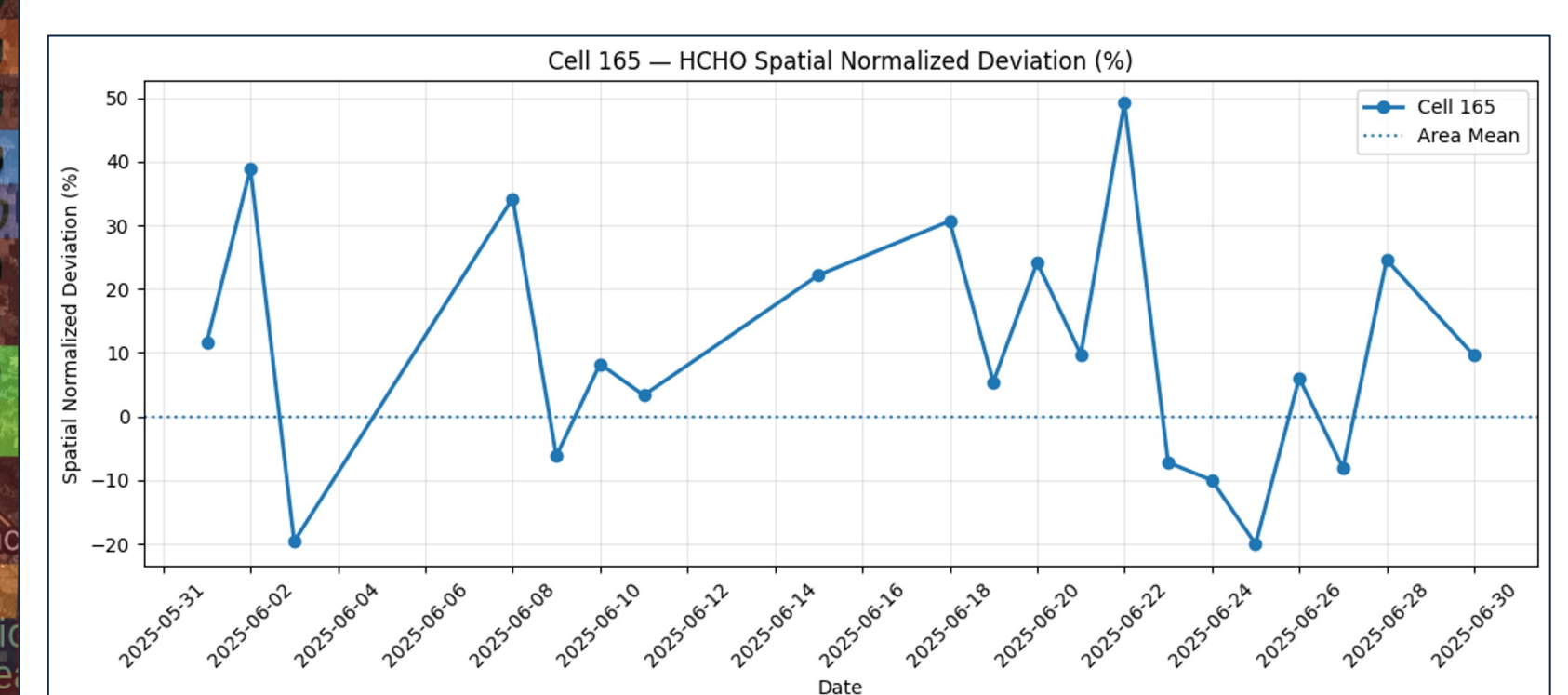
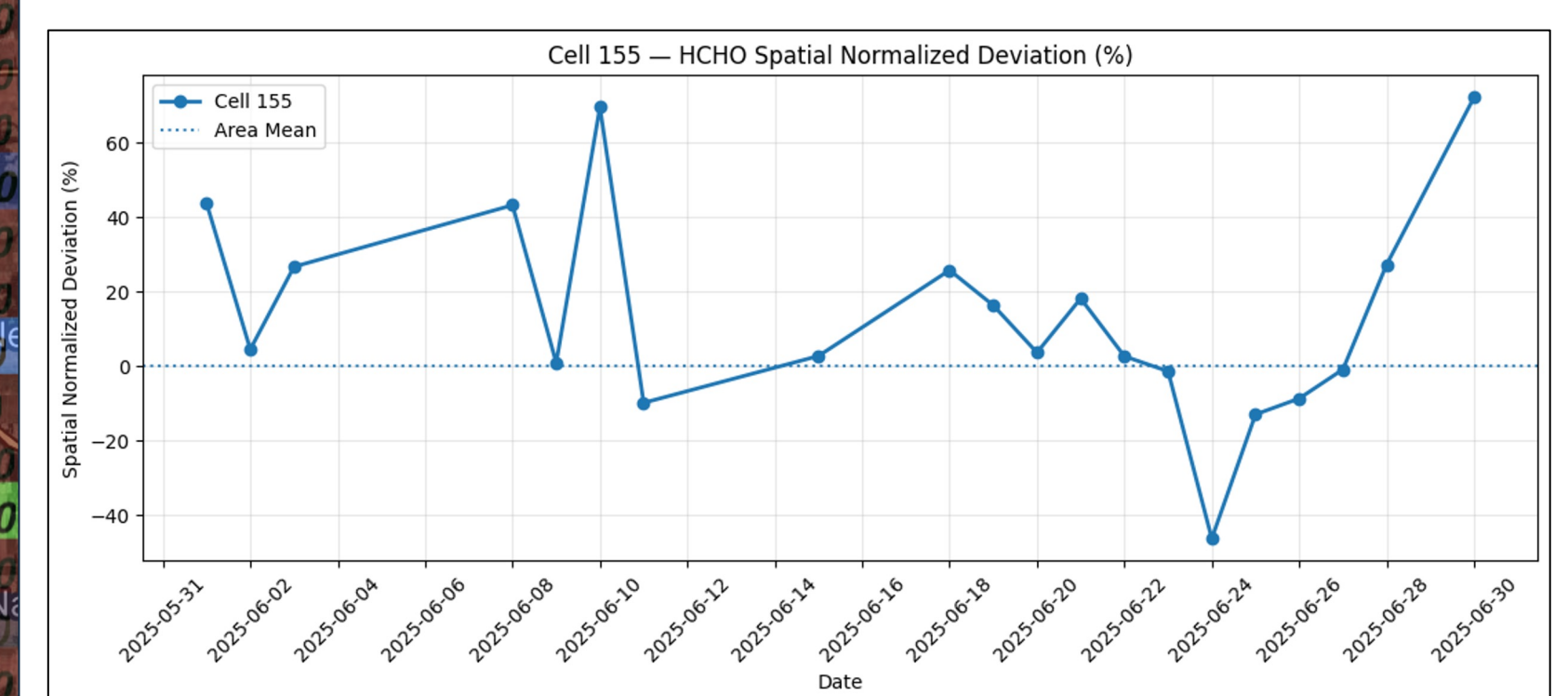
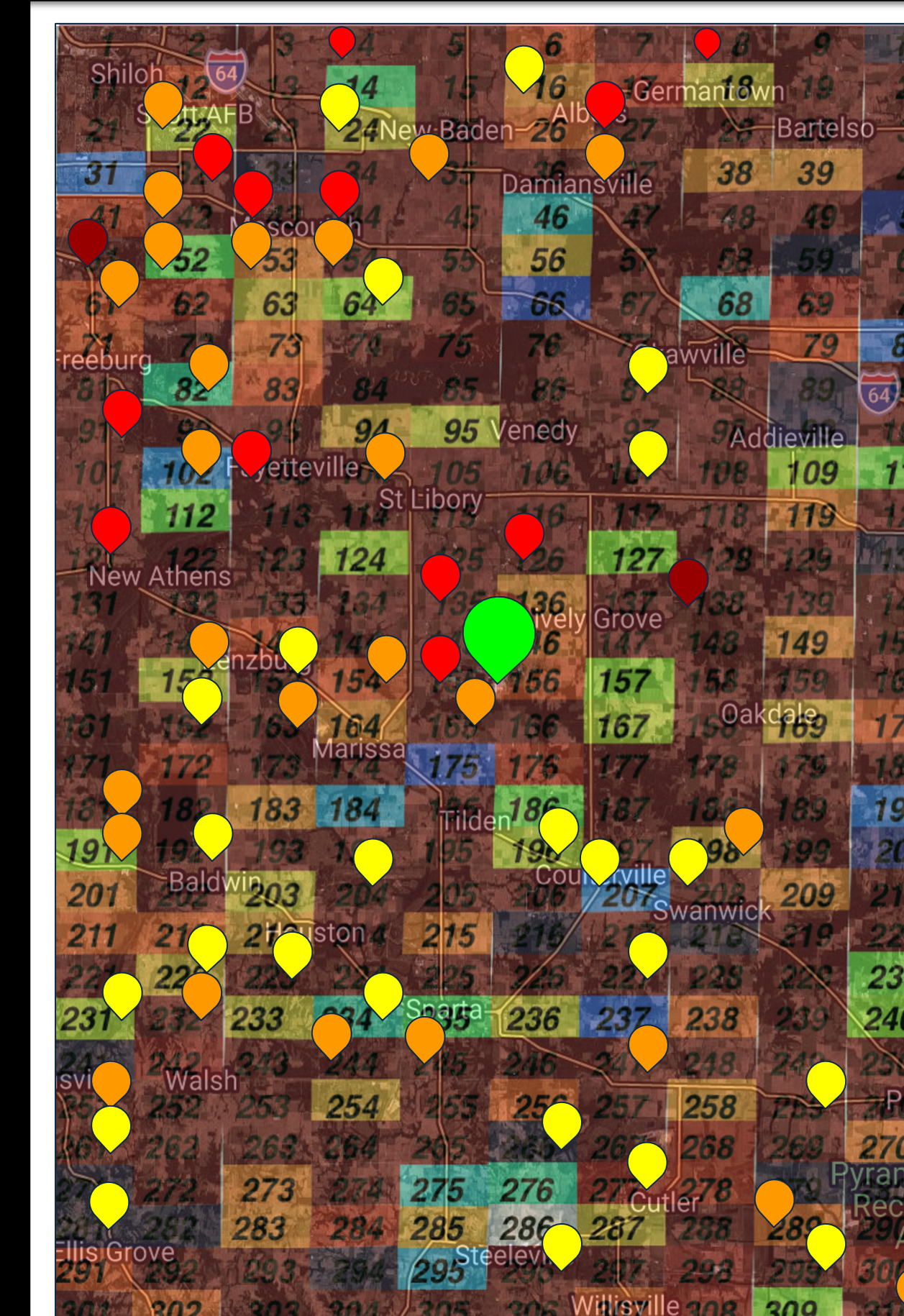
- Formaldehyde (HCHO) is a Volatile Organic Compound (VOC).
- It is a byproduct of combustion, industrial processes and textile manufacturing.
- Colorless, flammable gas with a strong odor.
- Prolong exposure can lead to adverse health effects such as cardiovascular and lung diseases.

NO₂ Study on Southern Chicagoland Suburbs

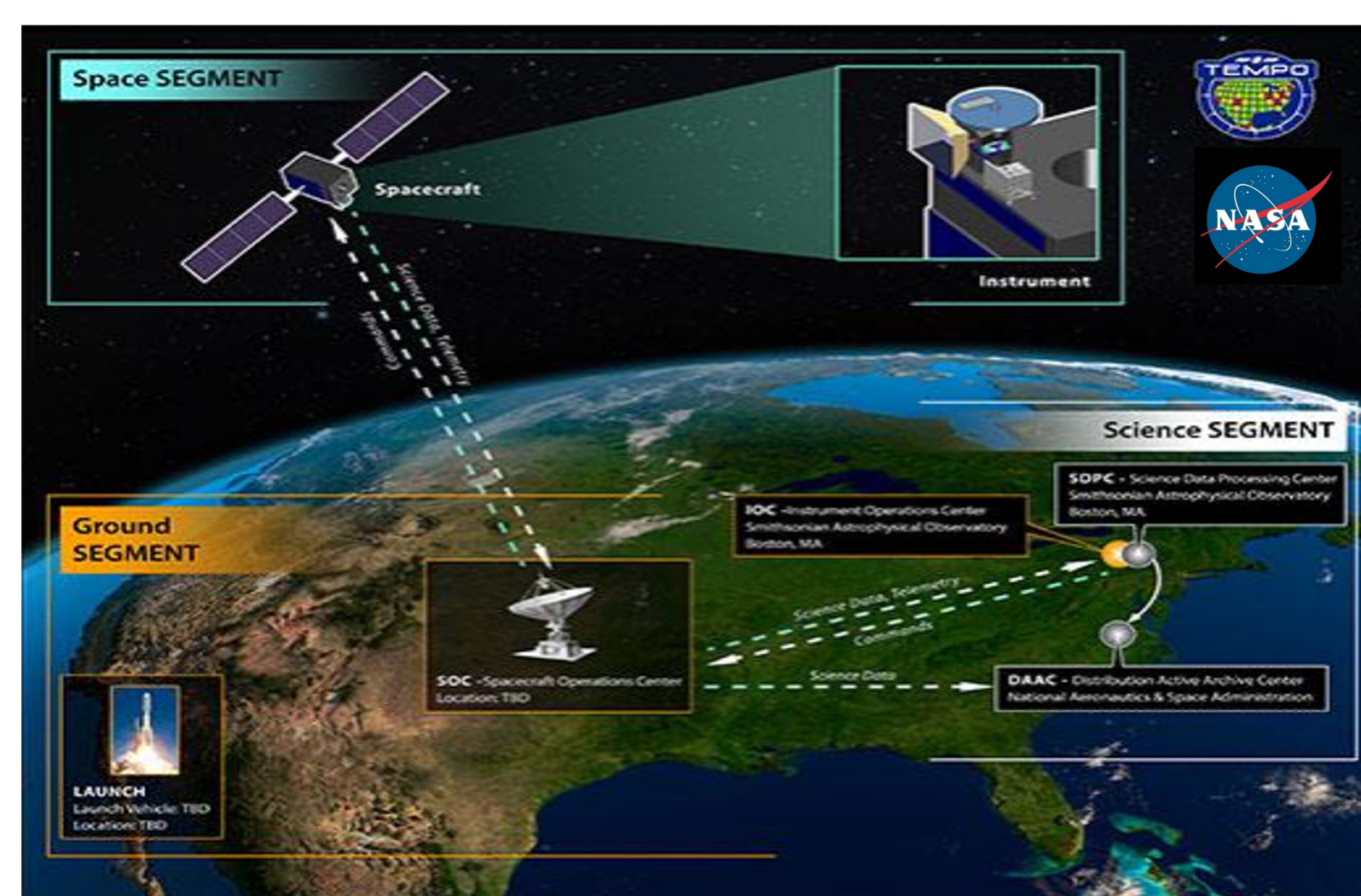


- Daily NO₂ variability was quantified using normalized deviation (%), and histograms show the number of days within defined deviation ranges for each spatial cell
- Most observations fall within $\pm 10\%$, indicating generally stable atmospheric conditions, while larger deviations represent less frequent but significant changes
- Values outside $\pm 50\%$ were excluded to avoid distortion from extreme or noise-driven fluctuations and to ensure consistent comparison across all cells

HCHO Study on Prairie State Power Plant

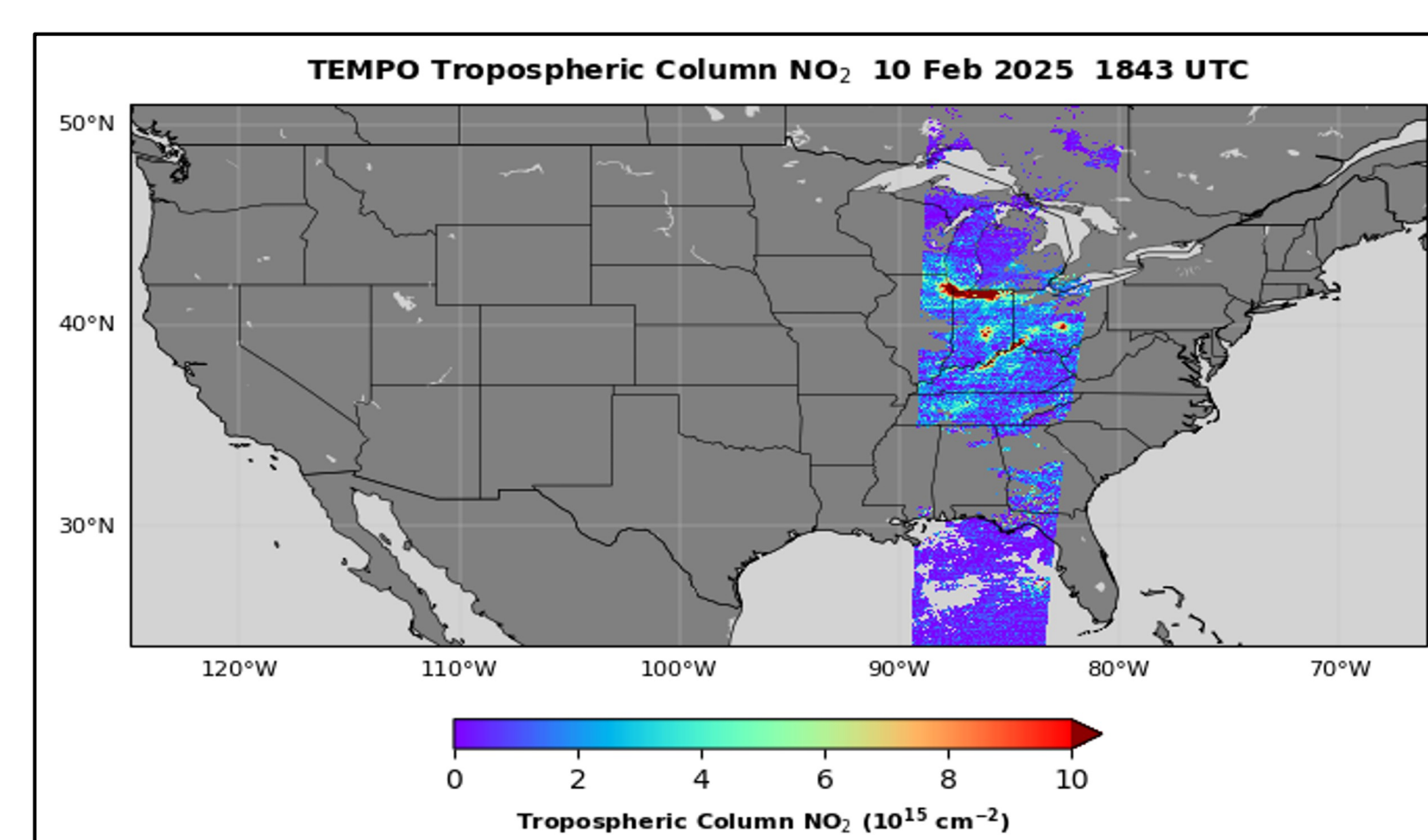


TEMPO



- TEMPO uses UV-Visible spectroscopy to measure atmospheric gases
- It observes sunlight reflected off Earth's surface and atmosphere
- Gases (like NO₂) absorb specific wavelengths of light
- TEMPO detects these absorption features → identifies gases and their amounts
- Retrieval algorithms convert this into column concentrations (molecules/cm²)

- **Resolution:** "TEMPO measures air pollution in small grid cells about 2 × 4 km in size, allowing us to see detailed differences across cities and even near major roads."
- **Slicing (time):** "TEMPO scans North America once every hour, creating 'slices' of data that show how pollution changes throughout the day like a time-lapse."



Google Colab Python Analysis

```
data_path = Path('/content/data_files')
maps_path = Path('/content/map_plots')

data_path.mkdir(parents=True, exist_ok=True)
maps_path.mkdir(parents=True, exist_ok=True)

auth = earthaccess.login(strategy='interactive')

short_name = 'TEMPO_HCHO_L2'
observation_start = '2025-06-23 12:00:00' # 'YYYY-MM-DD HH:MM:SS'
observation_end = '2025-06-23 18:00:00' # 'YYYY-MM-DD HH:MM:SS'

results = earthaccess.search_data(short_name=short_name,
                                  temporal=(observation_start, observation_end))

if results:
    print(granule for granule in results)
    print(granule.data_links.access_external) for granule in results]
    earthaccess.download(results, local_path=data_path)
else:
    print("No data found for the specified date range.")

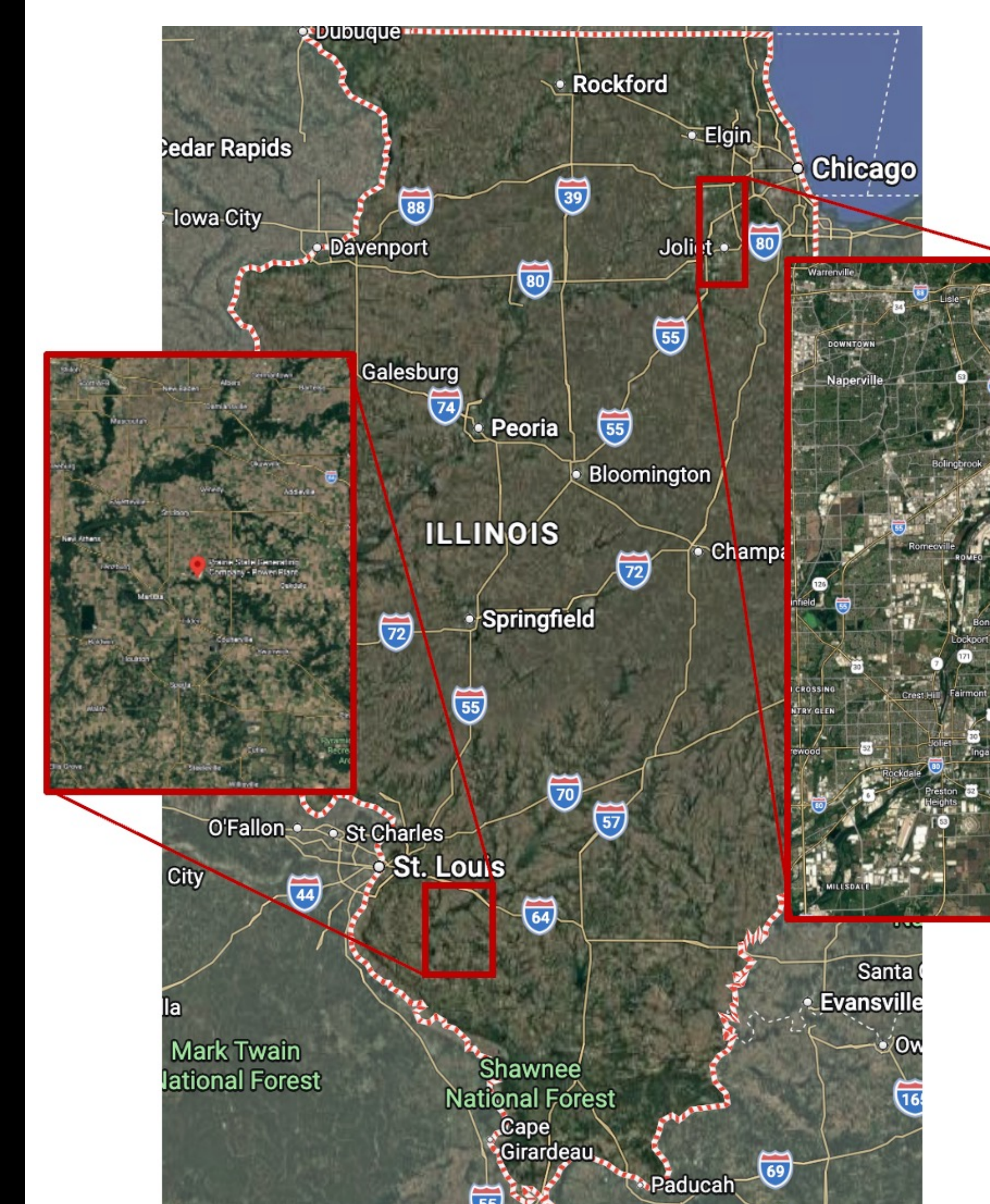
url = 'https://www.star.nesdis.noaa.gov/pub/smc/akbuff/ACX_STM_TEMPO_Training/tempo_aod_ah_20230818.zip'
response = requests.get(url)

with open(data_path / 'tempo_aod_ah_20230818.zip', 'wb') as file:
    file.write(response.content)

file_name = '/content/data_files/TEMPO_HCHO_L2_V03_20250621T120000Z_S001001.nc'
file_id = data_path / file_name
```

- Data is collected directly from NASA Earthdata website.
- Xarray analysis is done on the raw files retrieved from the TEMPO satellite.
- The 3D data is transposed onto 2D maps, with the information stored in Google Colab.
- Every map consist of data with per hour intervals during the daytime.

Study Locations



Conclusion

- NO₂ developments were confirmed in warehouse and traffic zones with the NASA TEMPO through geospatial analysis.
- The emergence of a trend in HCHO developments surrounding the Prairie State Energy Campus was confirmed.

References & Abstract

