

## Background & Motivation

- Salt Lake Valley is known for wintertime persistent cold air pools (PCAPs), which inhibit vertical mixing and lead to higher pollutant levels.
- With **2034 Winter Olympics Games (WOG)** approaching, we aim to understand how PCAPs affect CO<sub>2</sub> enhancements ( $\Delta$ CO<sub>2</sub>), traffic, and their relationship.
- High CO<sub>2</sub> levels often correlate with other pollutant levels, so this knowledge can help identify air quality issues during large events.
- Assessing the 2002 WOG's effects on these variables could reveal how similar events in the future might influence local air quality and traffic.

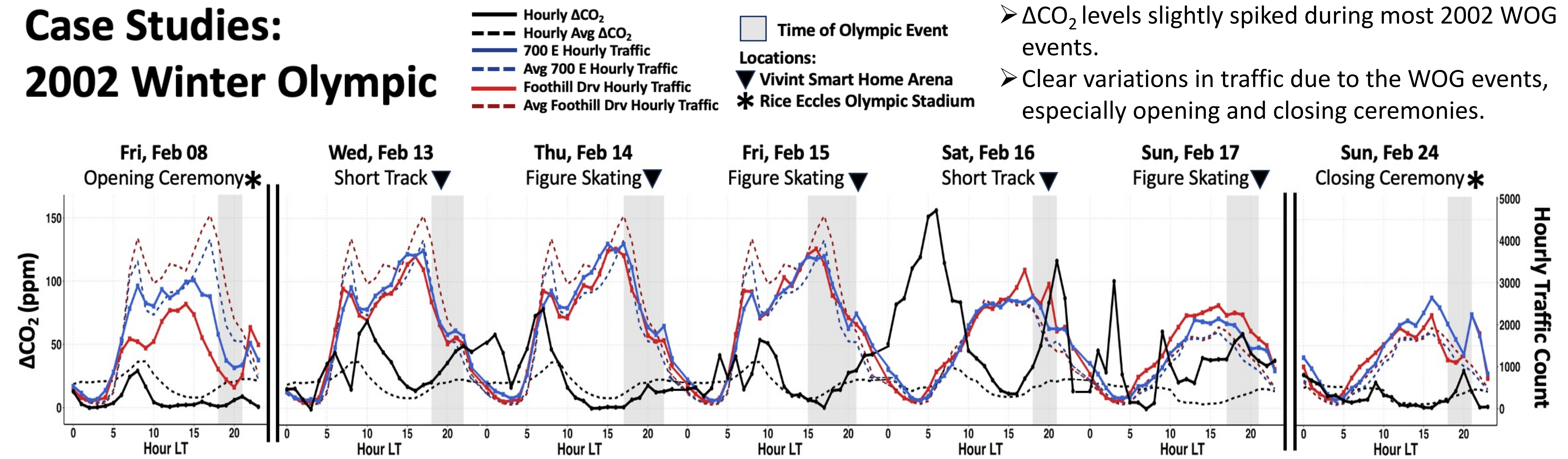
### Questions:

- What influence do PCAPs have on traffic &  $\Delta$ CO<sub>2</sub>?
- What are the diurnal cycles of traffic &  $\Delta$ CO<sub>2</sub>, and what is their relationship?
- How did the 2002 Winter Olympics influence traffic &  $\Delta$ CO<sub>2</sub>?

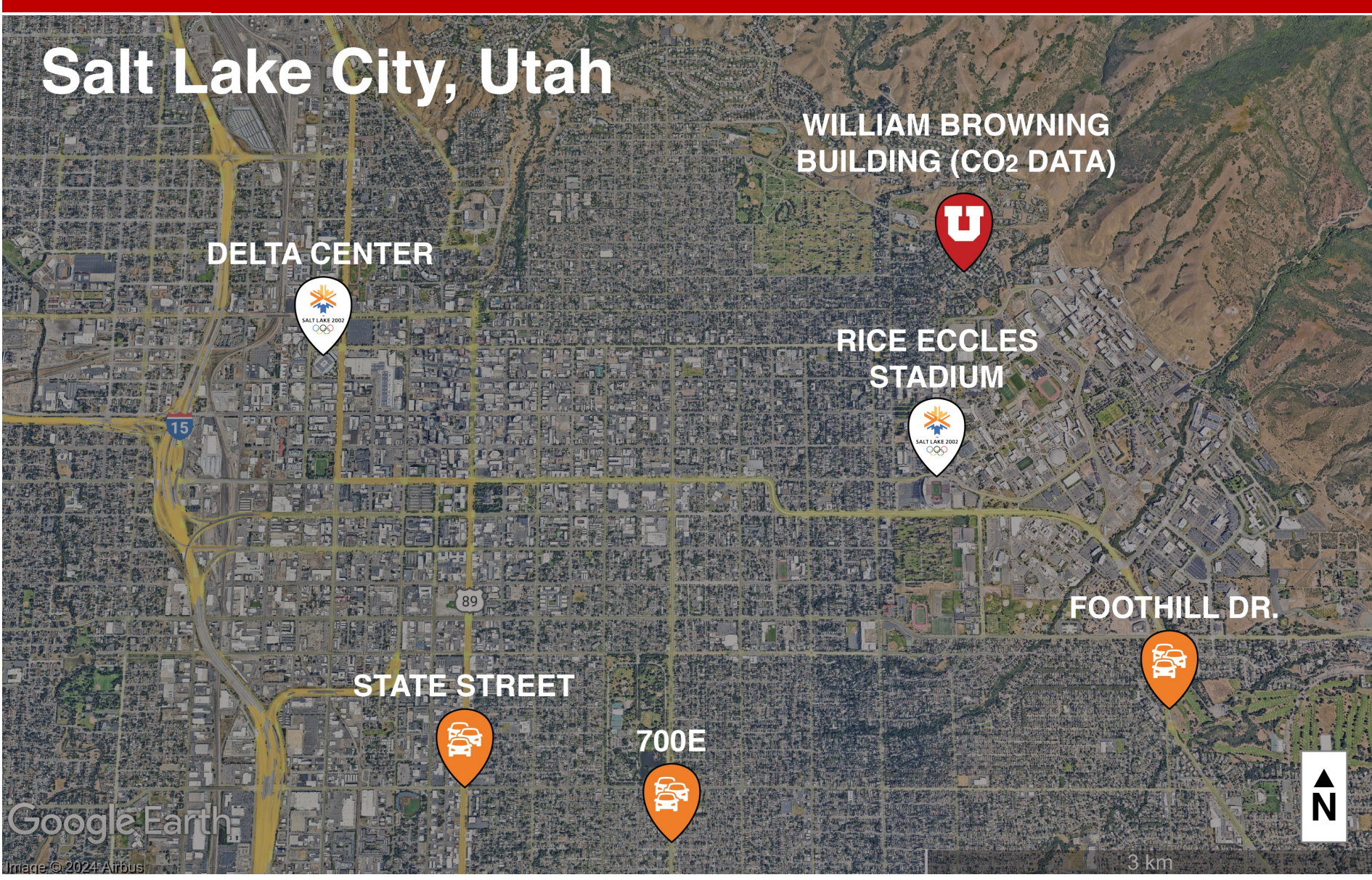
## Results: Key Takeaways

- $\Delta$ CO<sub>2</sub> levels slightly spiked during most 2002 WOG events.
- Clear variations in traffic due to the WOG events, especially opening and closing ceremonies.

## Case Studies: 2002 Winter Olympic



## Data & Methods



**Valley Heat Deficit (VHD):**  
Calculates the heat needed to achieve a dry adiabatic lapse rate in a specific atmospheric column (Bares et al., 2018).

**Persistent Cold Air Pool (PCAP):**  
A series of 3 or more twice-daily soundings each having VHD > 4.04 MJ m<sup>-2</sup> (Whiteman et al., 2014)

### Regression Analysis:

$$\Delta X[\text{ppb}] = X_{\text{Hourly Avg}} - X_{\text{Baseline}}$$

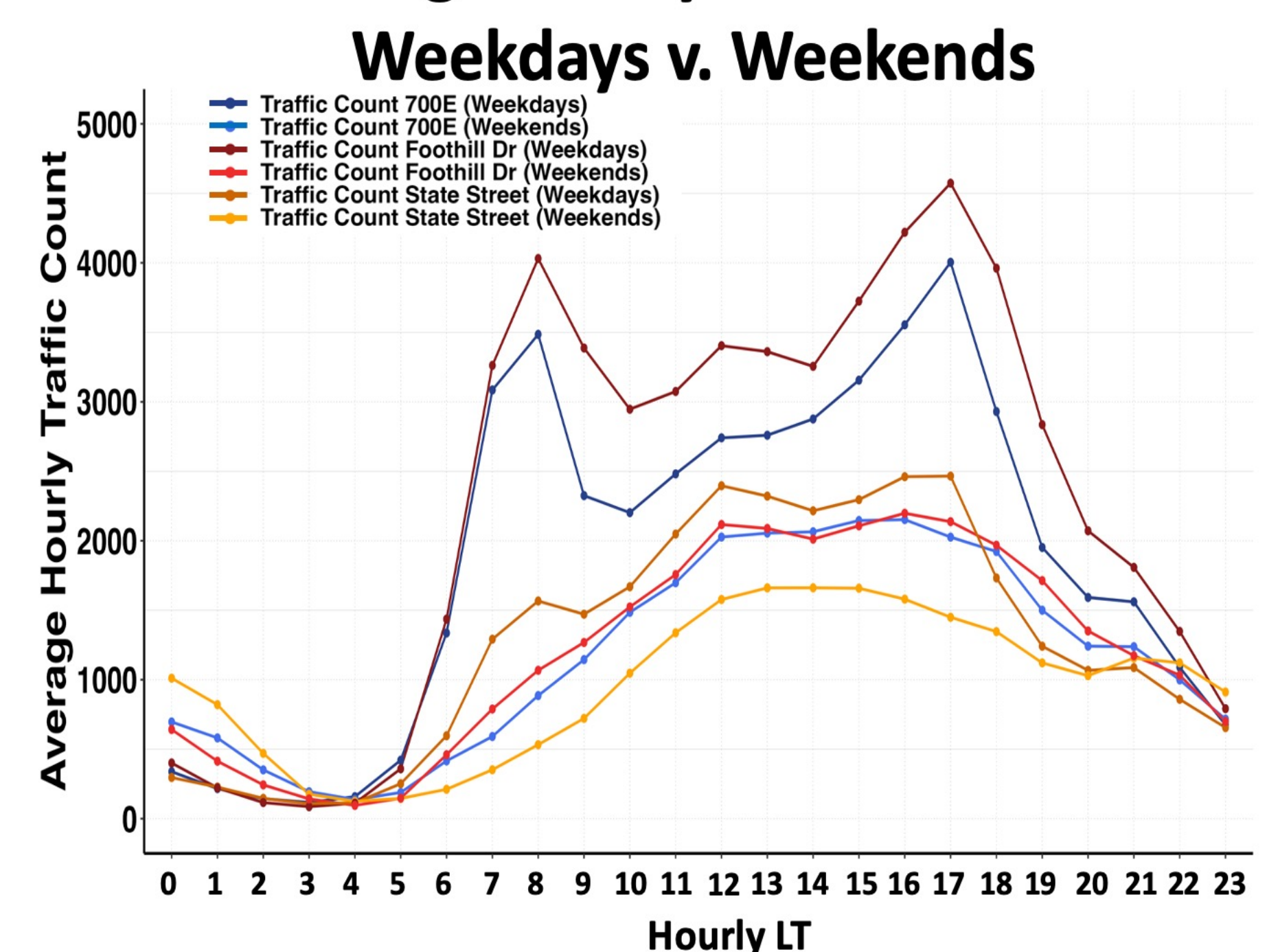
Baseline:  
Rolling 24-hr average of the 1st percentile of the Hourly Average

### Correlation Analysis:

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}}$$

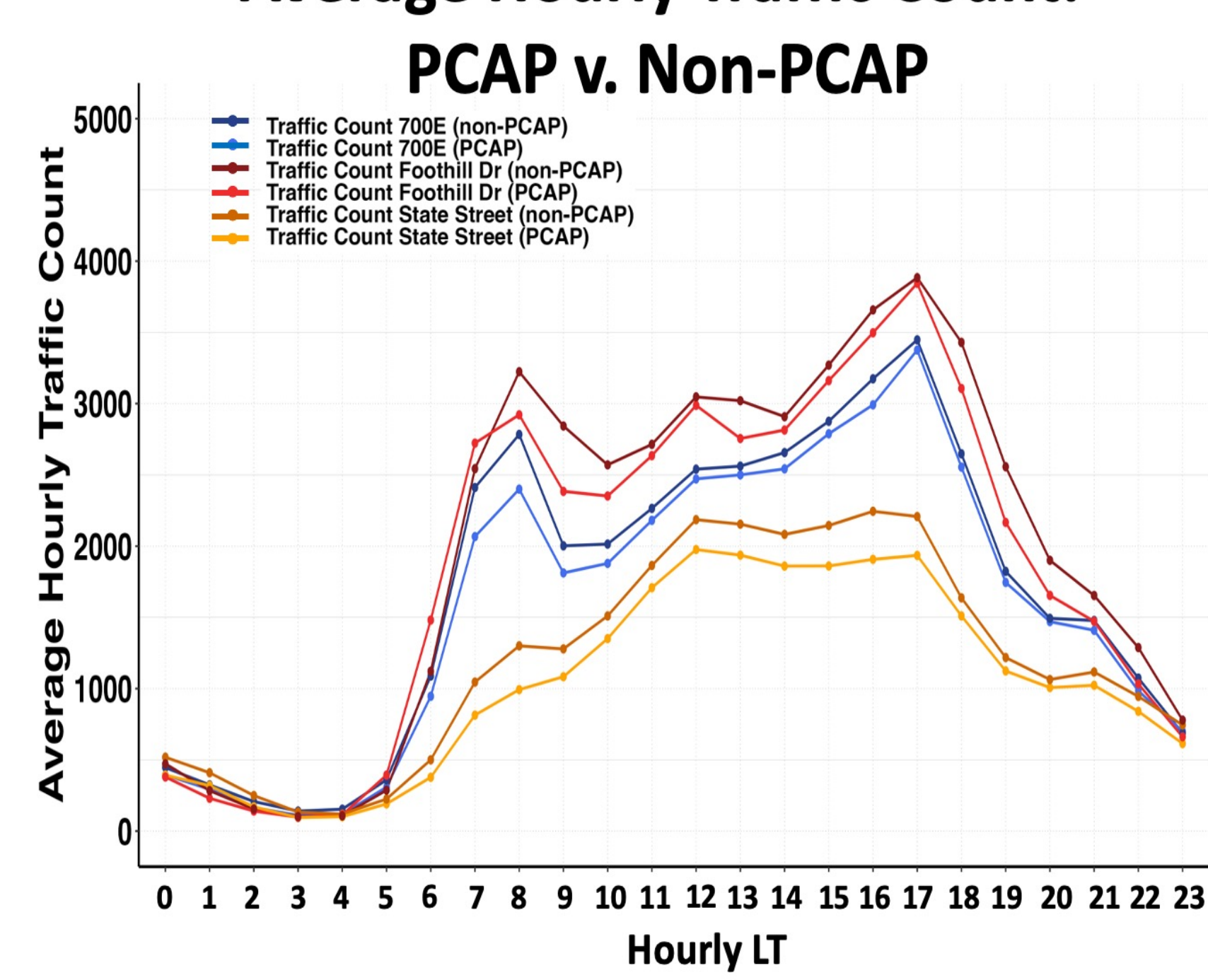
Pearson correlation was used to measure the linear relationship between daily traffic data and average daily  $\Delta$ CO<sub>2</sub> levels.

### Average Hourly Traffic Count: Weekdays v. Weekends



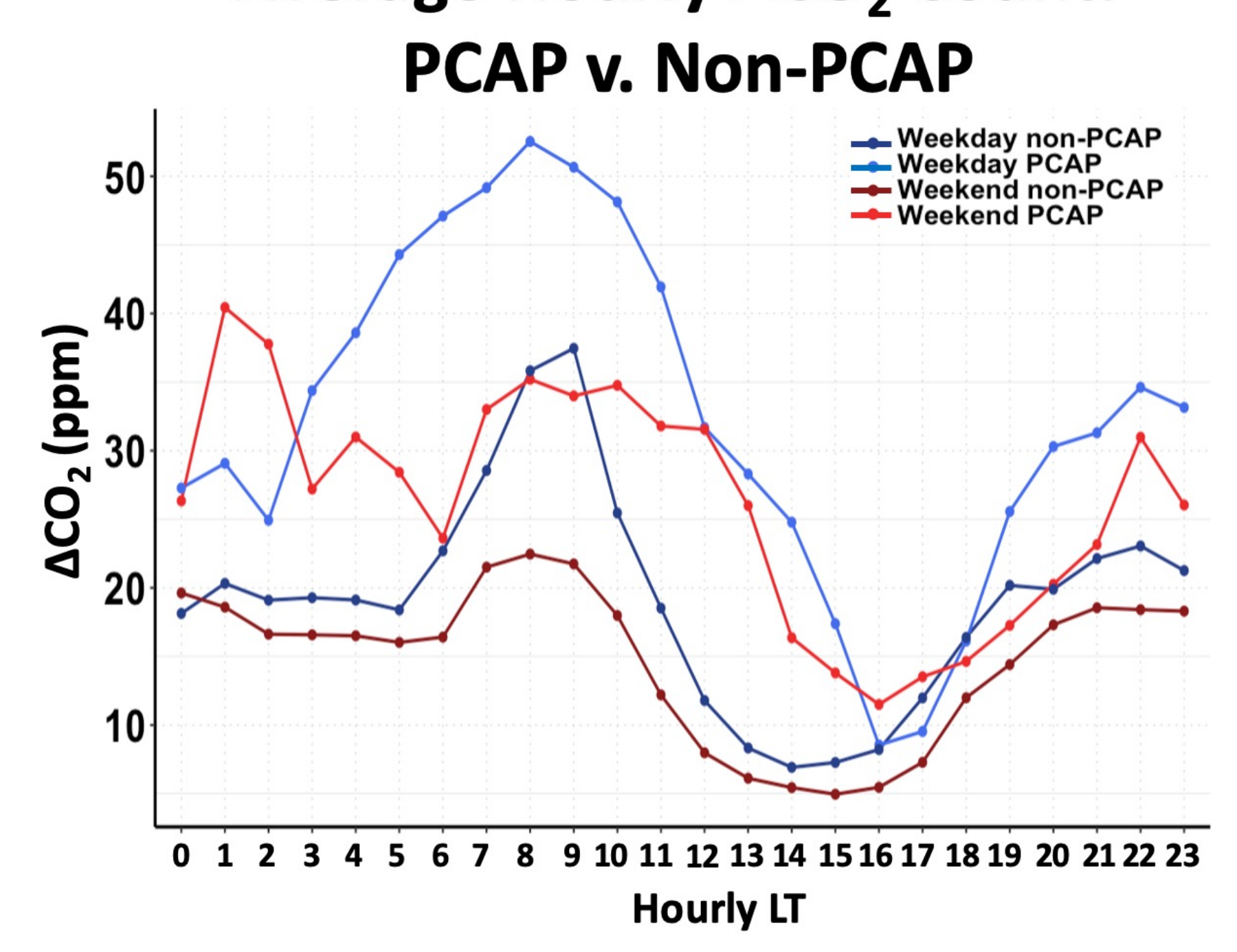
- Weekdays experience more traffic than weekends. Rush hour traffic only occurs on weekdays.

### Average Hourly Traffic Count: PCAP v. Non-PCAP



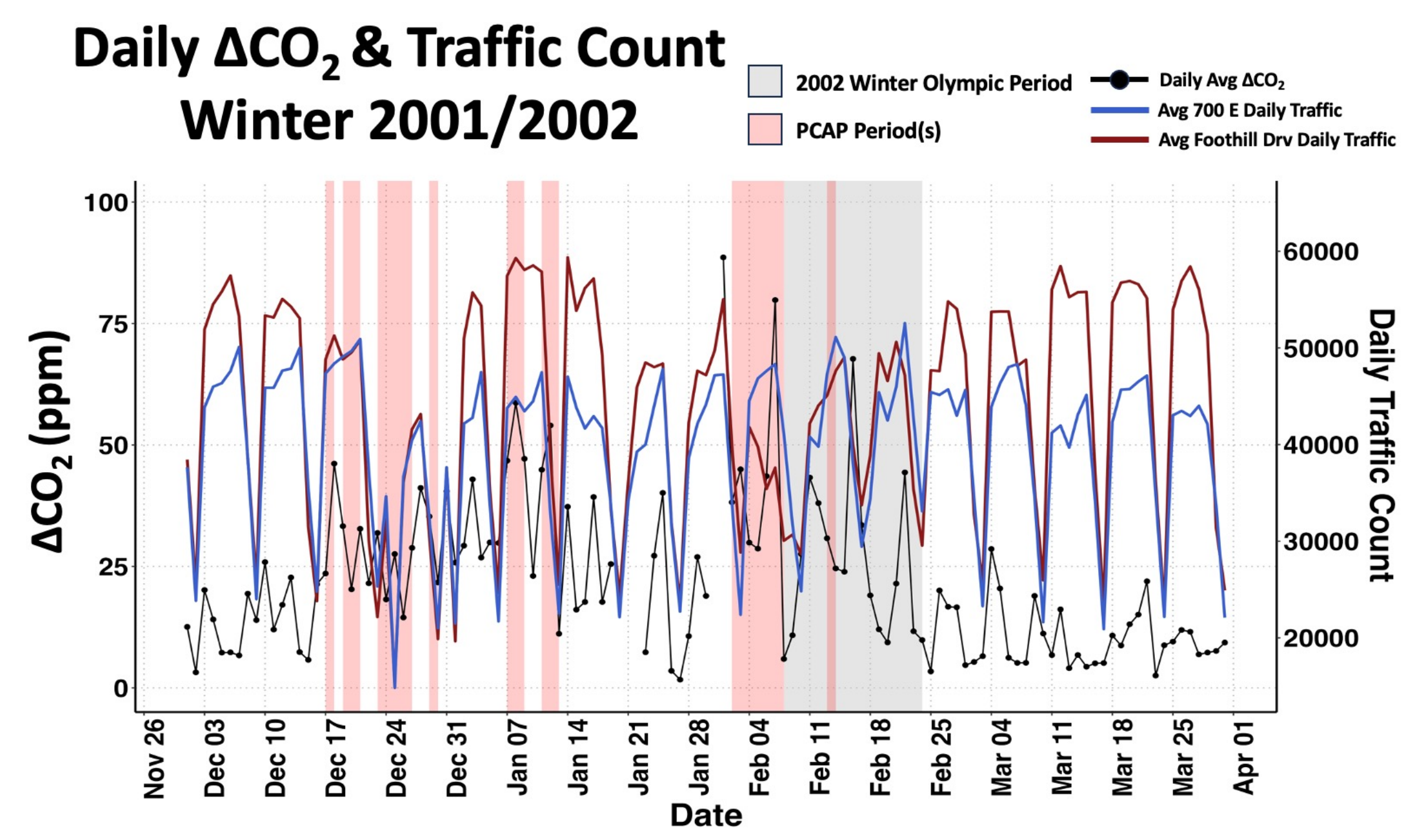
- PCAP days appear to have slightly less traffic than non-PCAP days on all three locations.

### Average Hourly ΔCO<sub>2</sub> Count: PCAP v. Non-PCAP



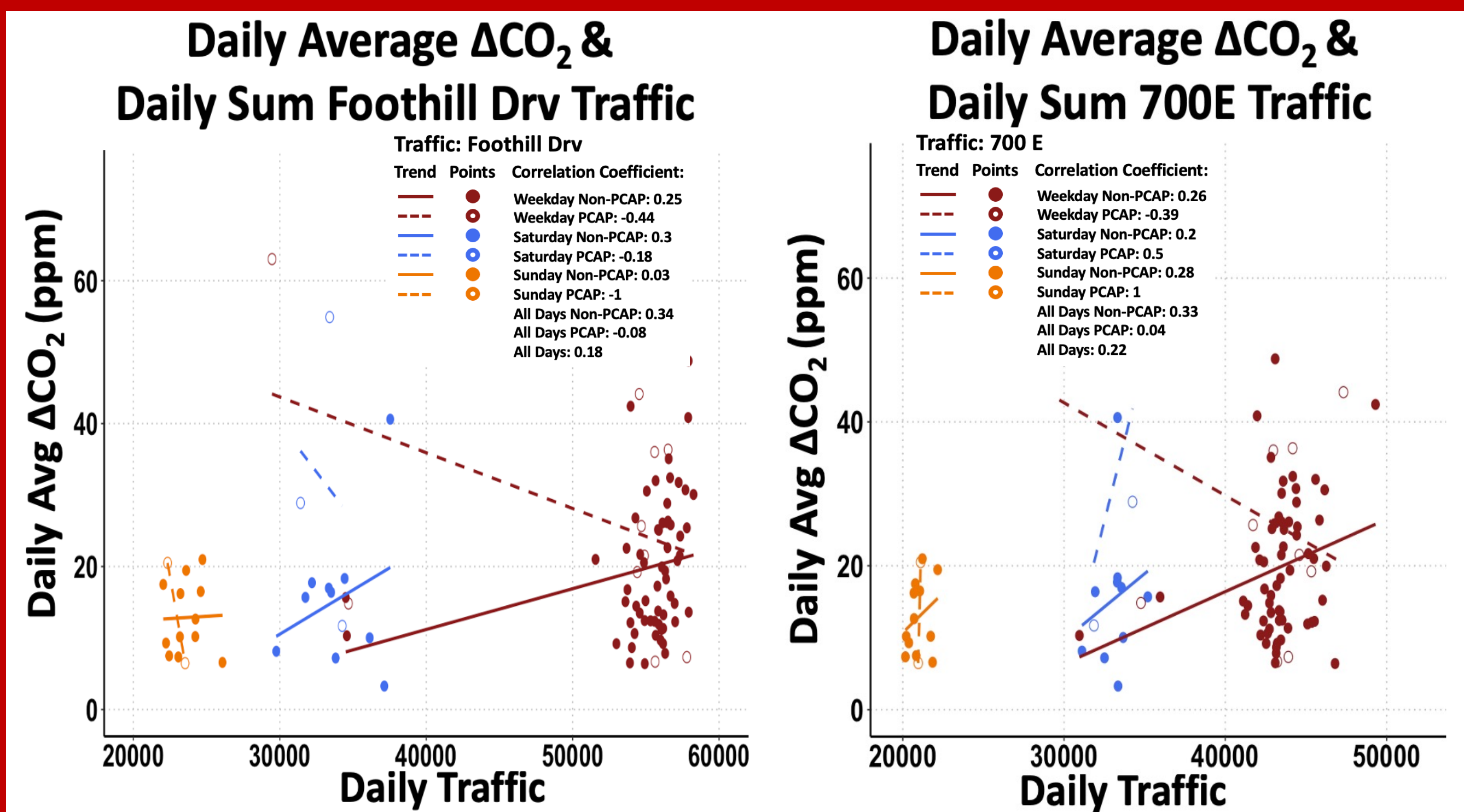
- PCAP days: Afternoon dip in  $\Delta$ CO<sub>2</sub> levels occurs later in the afternoon as it takes more vertical mixing to break the capping inversion.

## Results: Broad Picture



- PCAP days generally had higher  $\Delta$ CO<sub>2</sub> levels during winter 2001/2002.
- Significant drop in traffic on Foothill Drive during the 2002 Winter Olympics.

## Results: Correlations



- Traffic &  $\Delta$ CO<sub>2</sub> levels are slightly correlated on non-PCAP days.

## Conclusions & Future Work

- PCAP days have higher  $\Delta$ CO<sub>2</sub> levels and less traffic.
- WOG impacted overall traffic &  $\Delta$ CO<sub>2</sub> levels on Foothill Drive, and on specific event days.
- $\Delta$ CO<sub>2</sub> levels measured at the University of Utah show a slightly stronger correlation with traffic on 700E than on Foothill Drive, because downtown is located upwind of the University.
- Future Work: Verify the results by conducting statistical analyses, including t-tests and calculations of standard deviation.

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