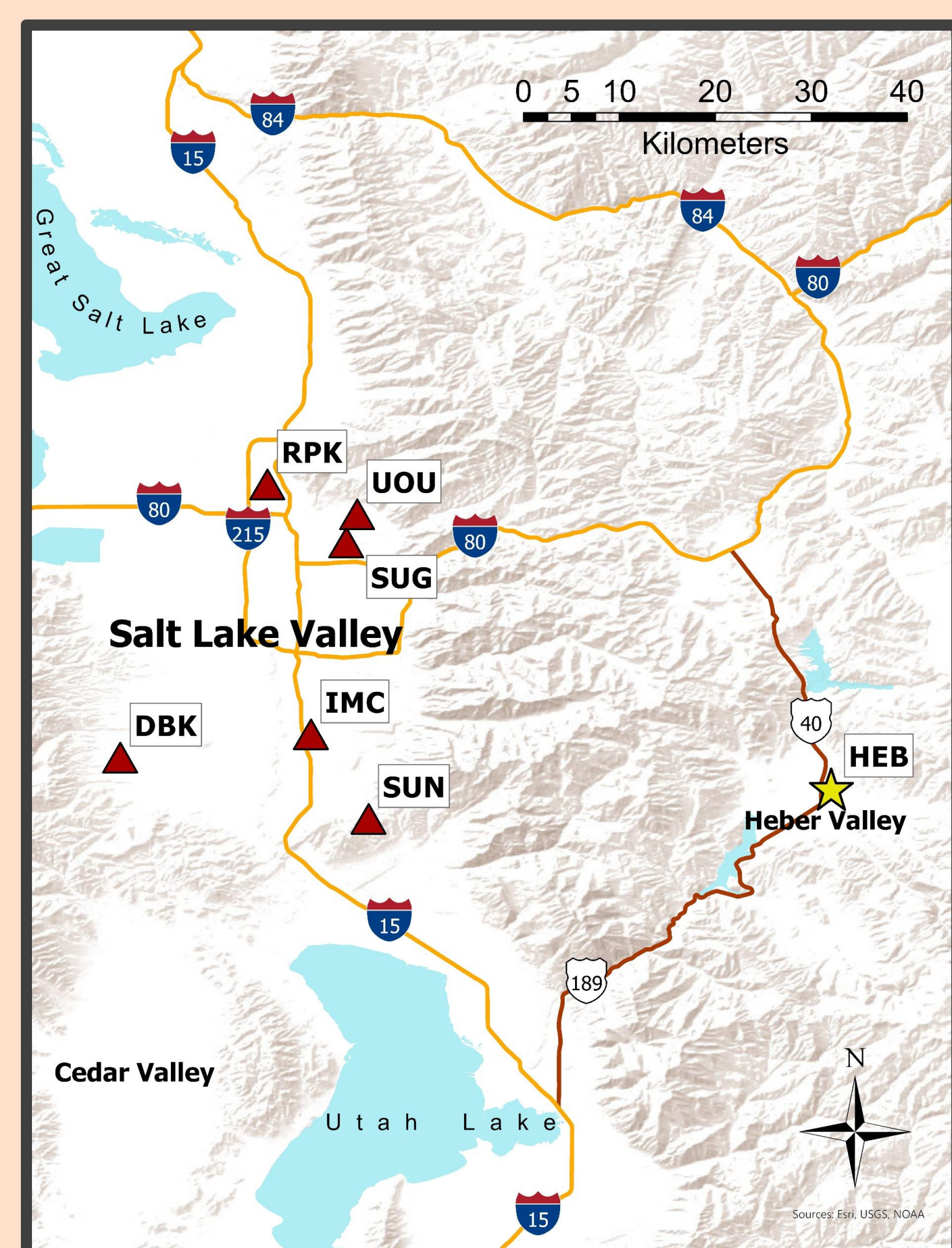


# Impacts of Population Growth on CO<sub>2</sub> Trends in the Montane-Urban Region of Heber Valley

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## 1. Motivation

Greenhouse gases (GHG), such as CO<sub>2</sub>, are primarily responsible for increases in global temperature. Since the industrial revolution, the human population has overwhelmingly been the cause of increased GHG emissions. As a result, cities are a significant source of GHGs to the atmosphere. In mountainous terrain, these emissions and other harmful particulates can become entrapped. This project asks the question: "Is population growth effecting CO<sub>2</sub> trends significantly?"

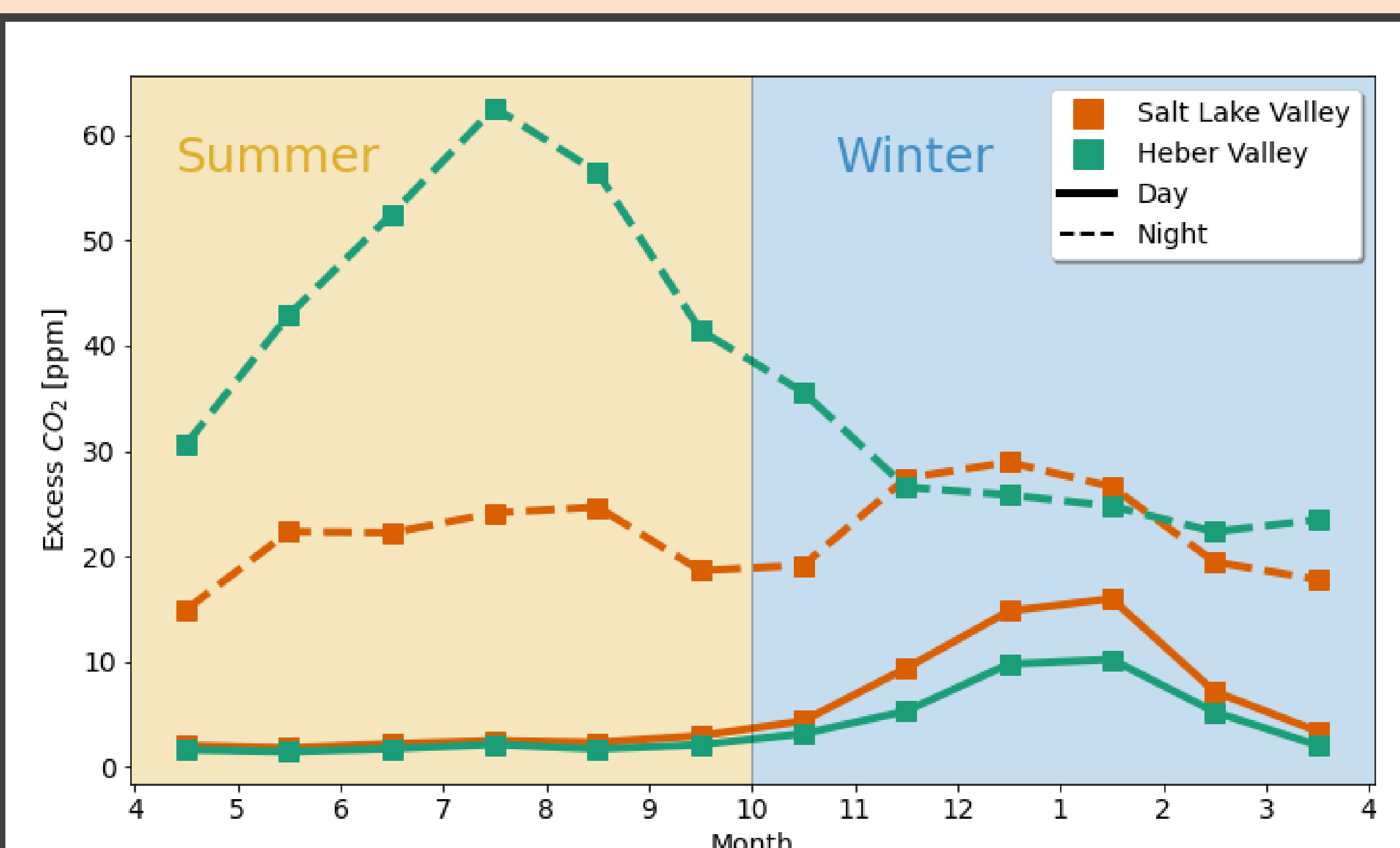


## 2. Contrasting Valleys

The planetary boundary layer (PBL) height acts to dilute or concentrate CO<sub>2</sub> concentrations within the lower troposphere. As a result of a deepening/diminishing PBL in the summer/winter, it is expected that CO<sub>2</sub> concentrations will decrease/increase. A similar PBL height fluctuation happens on a smaller diurnal scale with decreasing/increasing concentrations during the day/night.

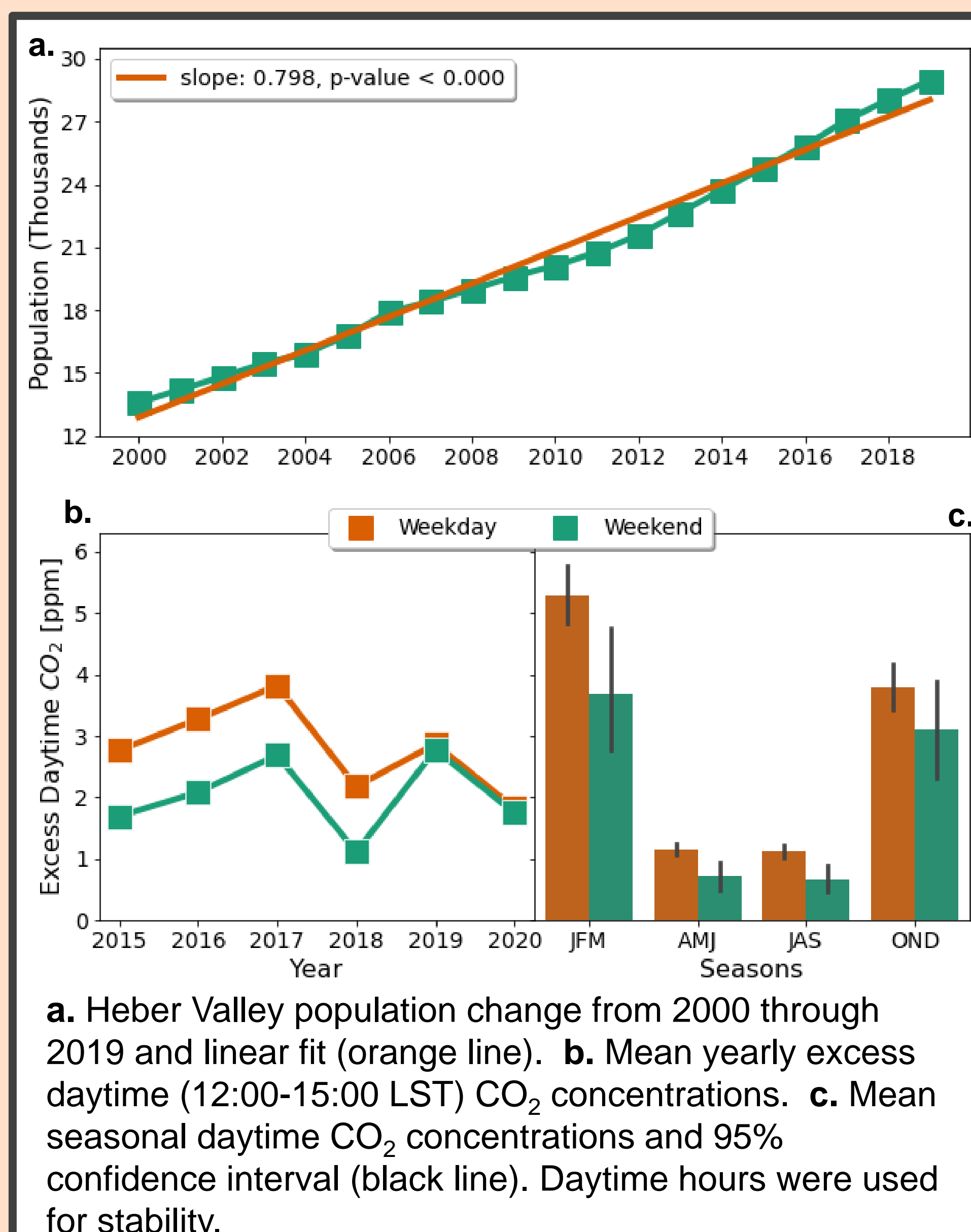
Differences between the Salt Lake Valley (SLV) and Heber Valley (HV) CO<sub>2</sub> concentrations as well as those of geophysical and socioeconomic nature include:

- Unexpected large nighttime concentrations in HV.
- The HV areal extent is approximately 10x that of HV.
- HV has a population of ~28,000; SLV has an aggregated population of over one million people.
- The main industry in HV is tourism, while SLV has no dominant industry.

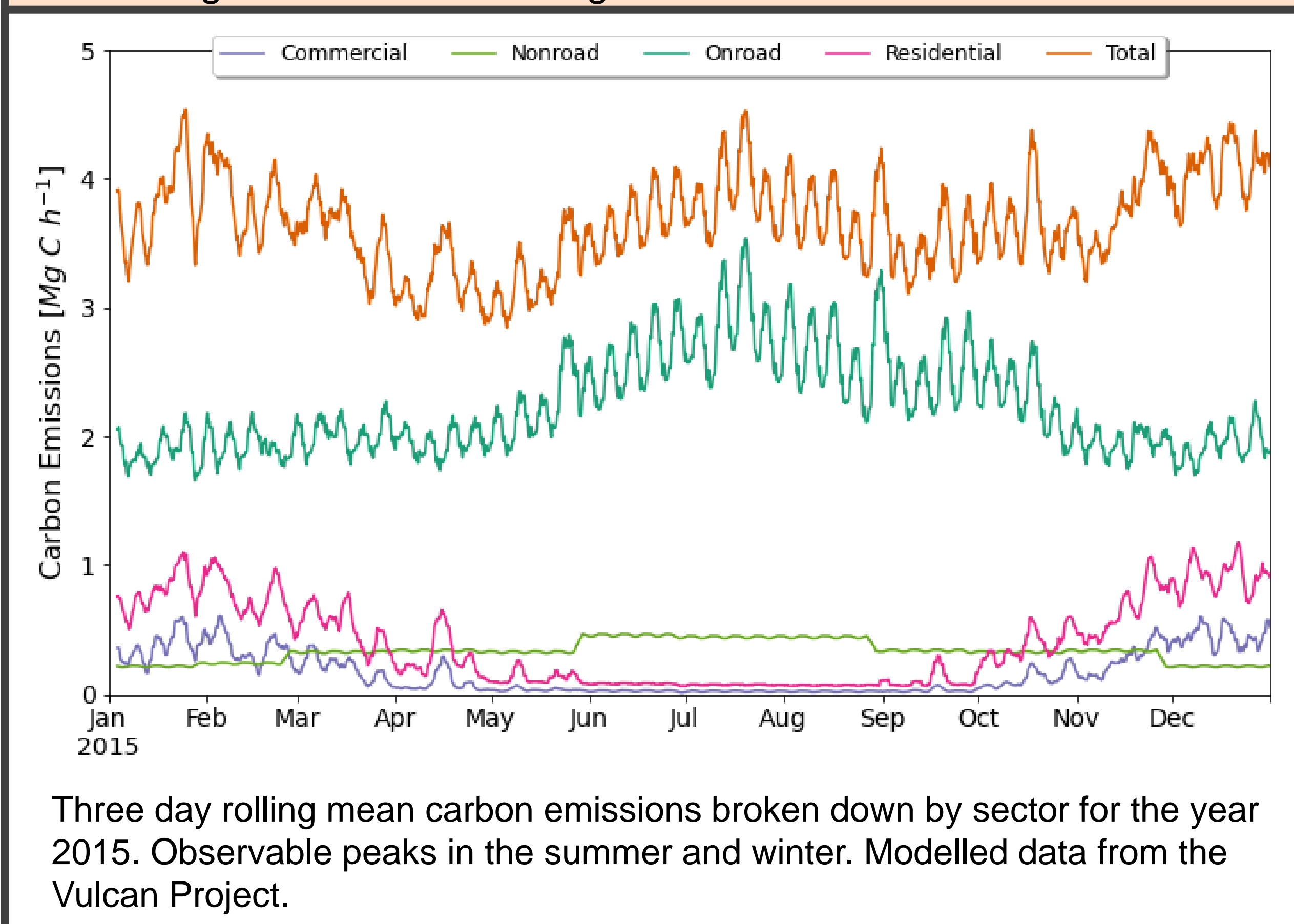


Mean monthly excess daytime (12-17) & nighttime (00-05) CO<sub>2</sub> concentrations at the single HV site (HEB) and the average of SLV sites (DBK, IMC, RPK, SUN, & UOU).

## 3. Human Influence

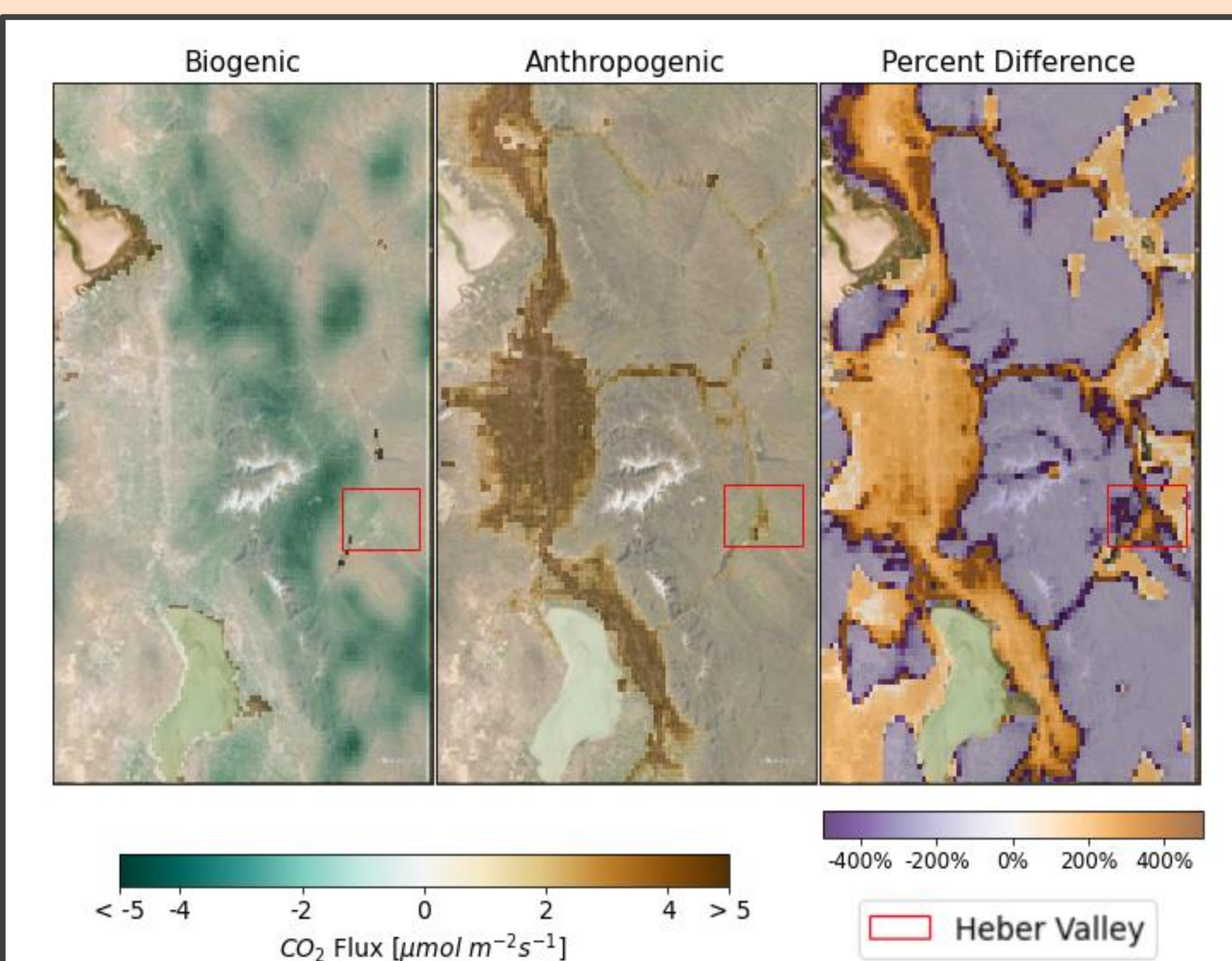


- Heber Valley has experienced a doubling of its population in the past two decades.
- Human influence is observable in the CO<sub>2</sub> concentration signal. Peaks in the summer and winter are, in part, due to summer tourism and winter heating of buildings.
- Weekday/weekend patterns are also distinguishable with decreased concentrations during the weekend. 2020 saw a convergence between the signals.



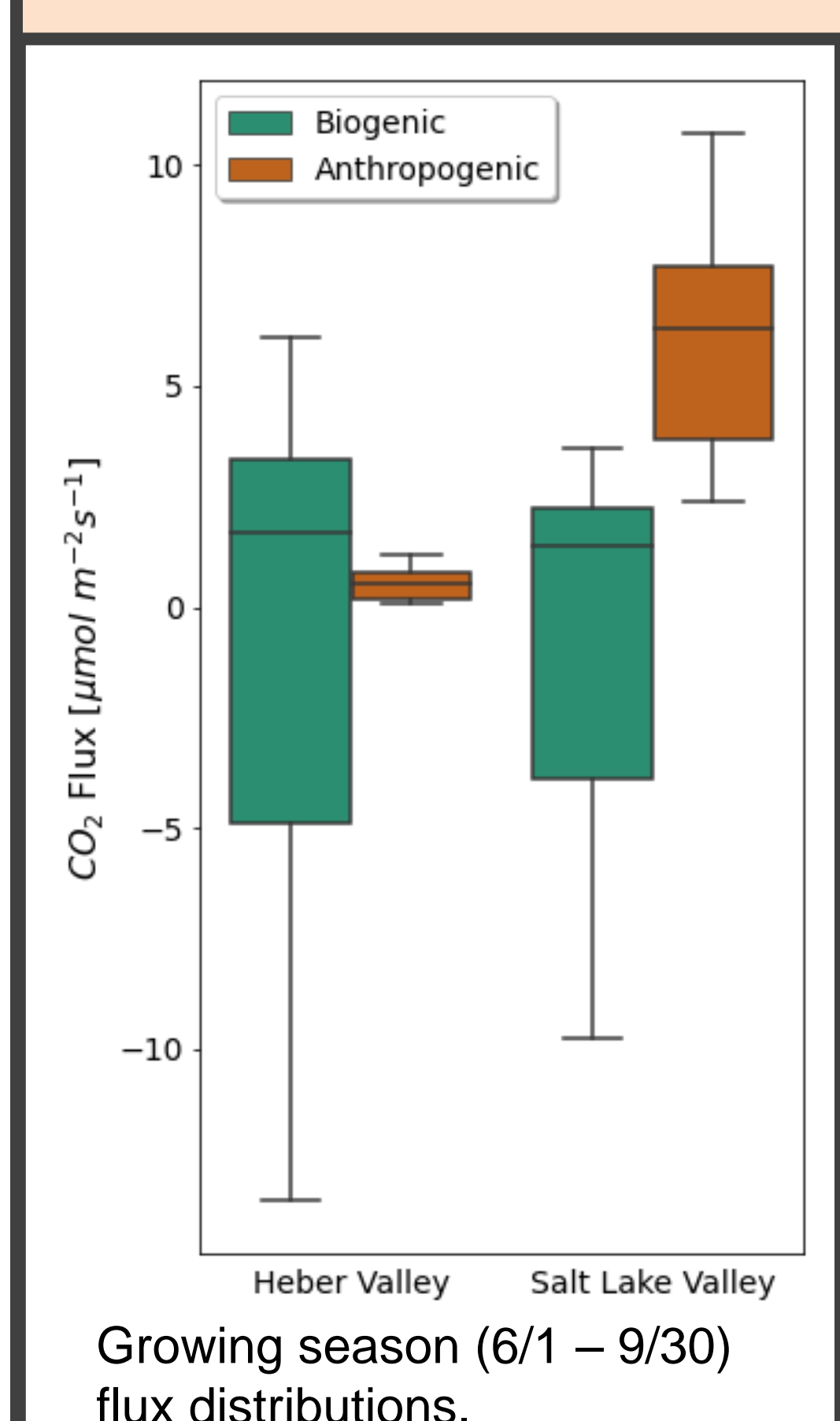
Three day rolling mean carbon emissions broken down by sector for the year 2015. Observable peaks in the summer and winter. Modelled data from the Vulcan Project.

## 4. Carbon Sources



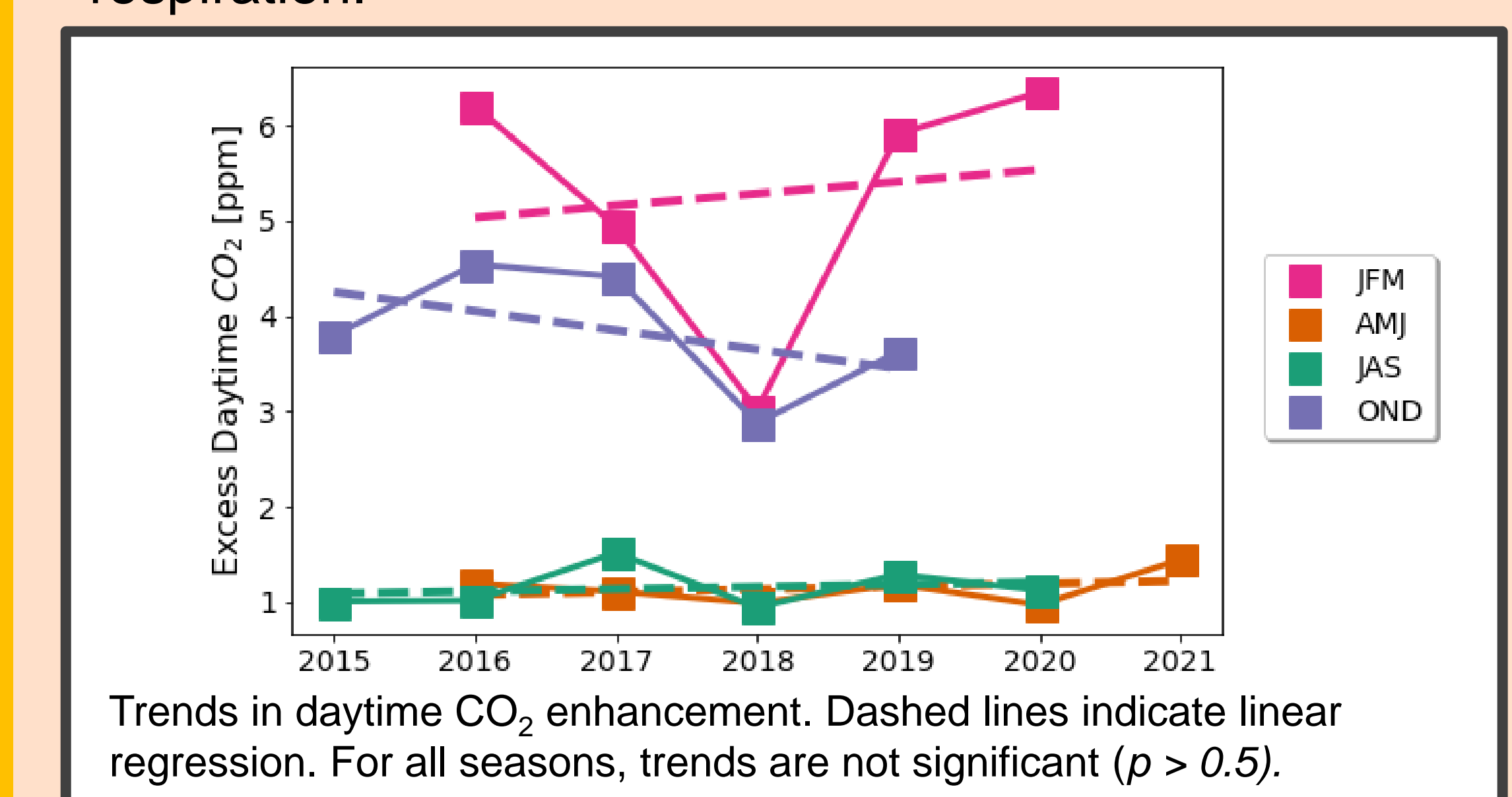
Modelled biogenic and anthropogenic fluxes from the Solar-Induced Fluorescence for Modeling Urban biogenic Fluxes (Wu et al., 2021) and Vulcan v3.0 Emissions (Gurney et al, 2019) datasets. Period shown is June 1<sup>st</sup> – September 30<sup>th</sup> from 2017 and 2015 for the left and middle map, respectively.

Compared to Salt Lake Valley, Heber Valley is characterized by fewer anthropogenic sources and a closer proximity to biogenic sources. The distribution plot below demonstrates that Heber Valley CO<sub>2</sub> concentrations are dominated by the biosphere and experiences fluxes in both directions, providing insight into the cause of the summer nighttime concentrations.



## 5. Preliminary conclusions

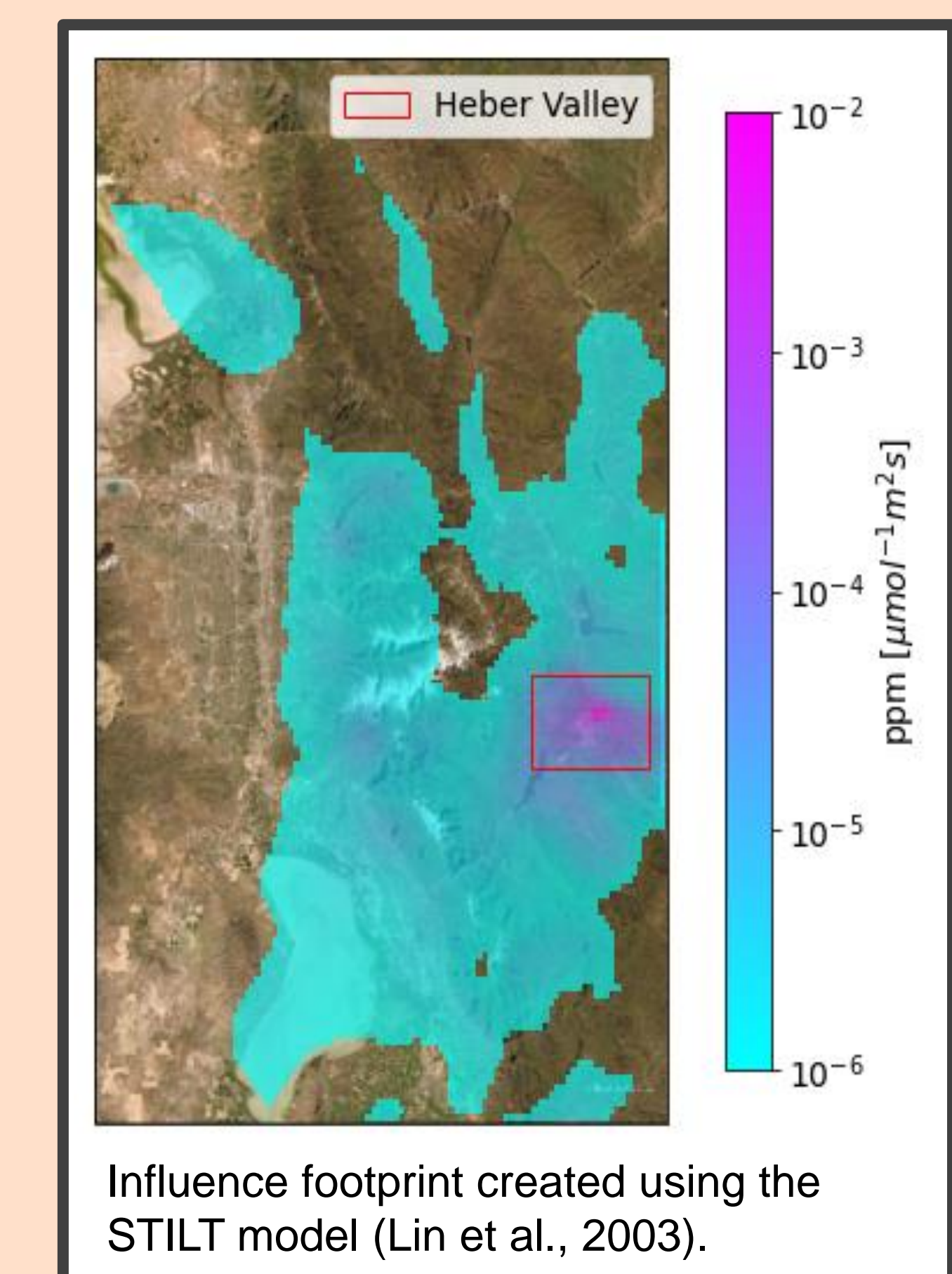
Despite a doubling in population in Heber Valley, there are no significant trends in CO<sub>2</sub> enhancement since the installation of the sensor in late 2015. Though human influences are observable in the data, the relative dominance by biogenic sources acts to obscure any significant long-term trends caused by climate change. While Salt Lake Valley is largely influenced by anthropogenic sources, Heber Valley's proximity to the biosphere is likely the cause of increased summer nighttime concentrations due to nighttime ecosystem respiration.



## 6. Future work?

Future work includes verifying CO<sub>2</sub> concentration changes using the STILT influence footprint as well as identifying specific the land cover types that exert the greatest influence. Additional questions include:

- Are there local influences that effect the carbon baseline?
- At what point does CO<sub>2</sub> scale with population size?
- What effect does upstream topography have on concentrations?
- What influence do the local water bodies exert?



## Acknowledgements



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