



# Spatiotemporal variations of on-road CO<sub>2</sub> emissions for Maricopa County, Arizona

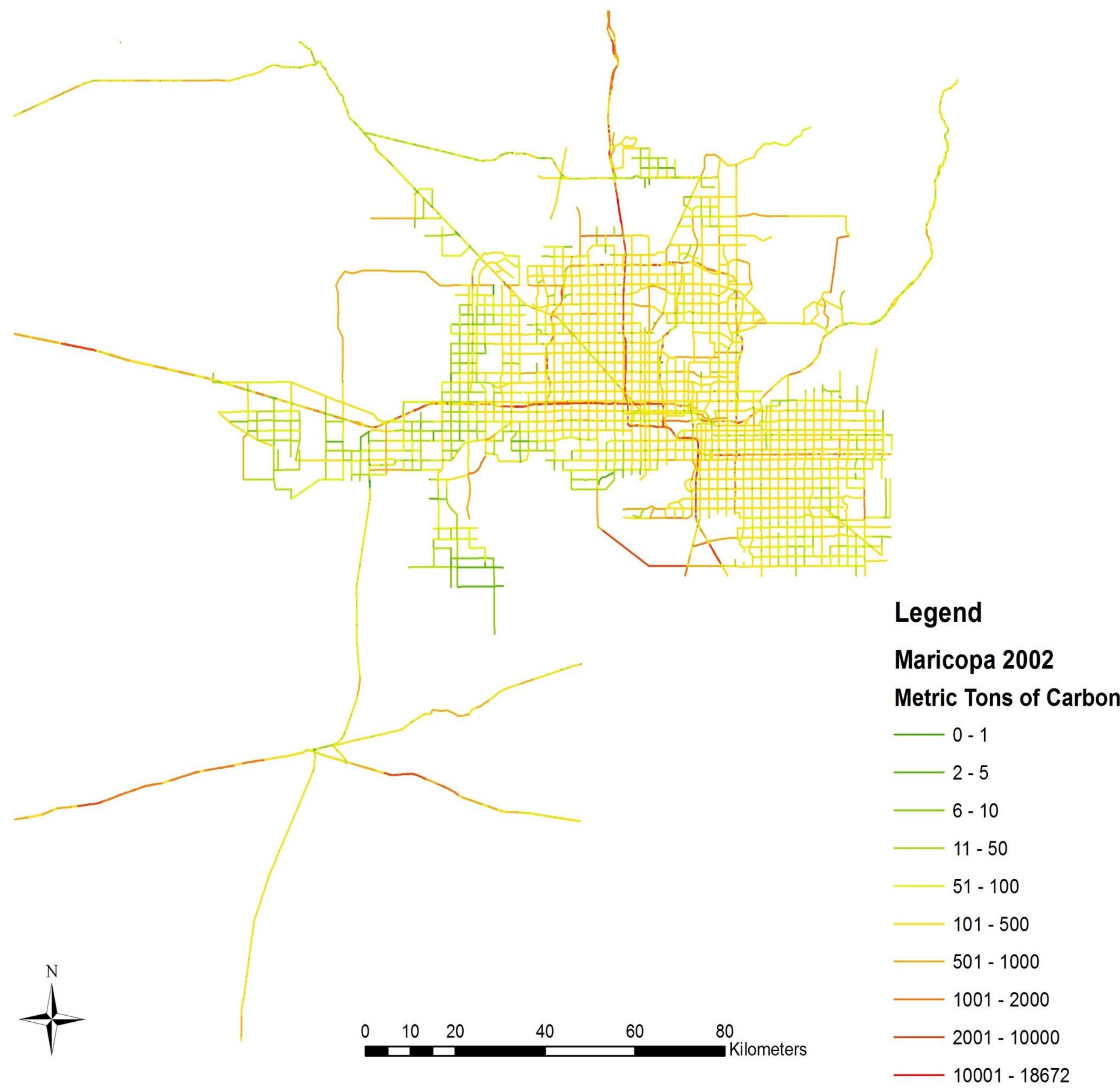
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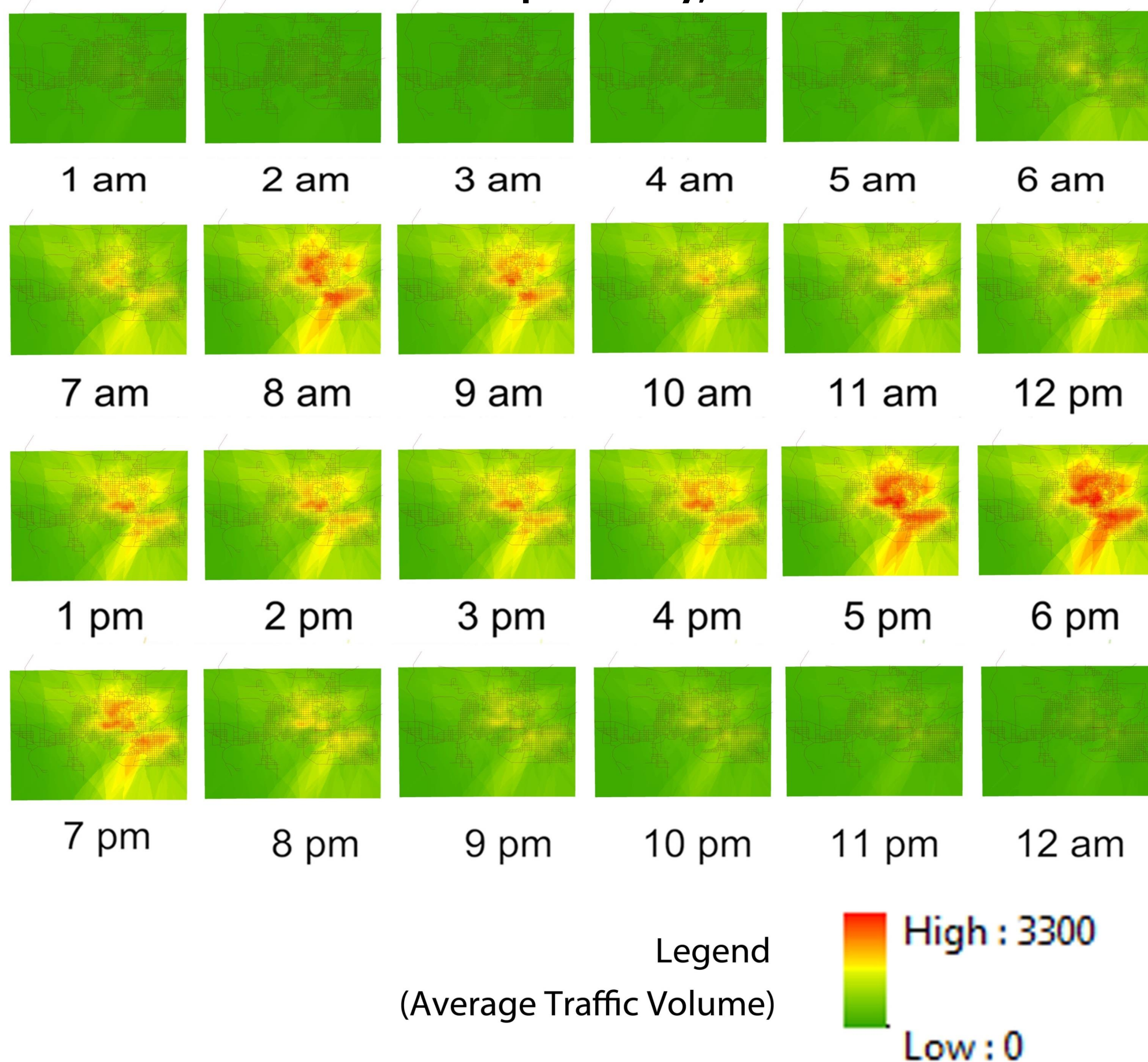


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## On-road CO<sub>2</sub> emissions in Maricopa County, 2002

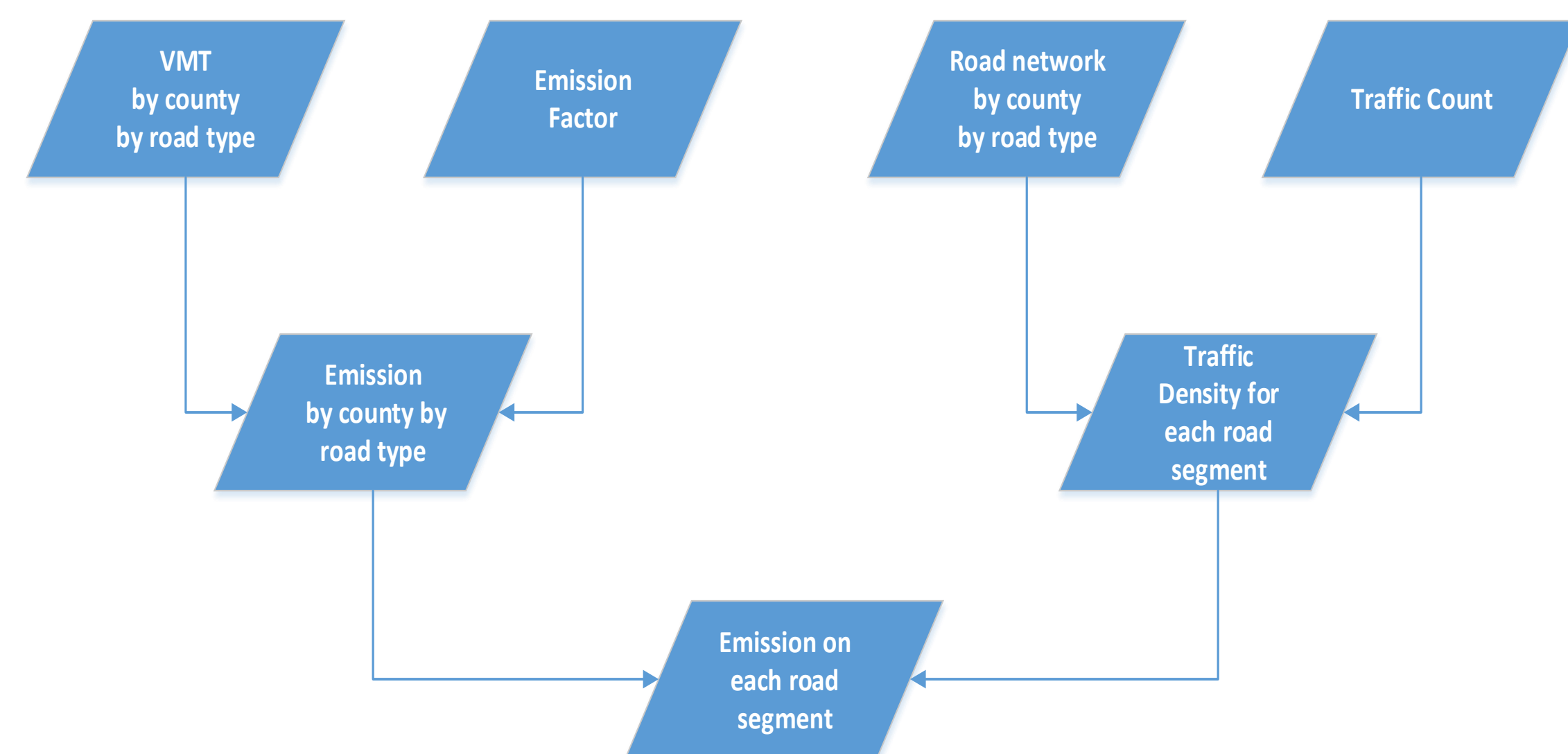


## Weekday Traffic data in the 24 hour cycle in Maricopa County, 2002



## INTRODUCTION

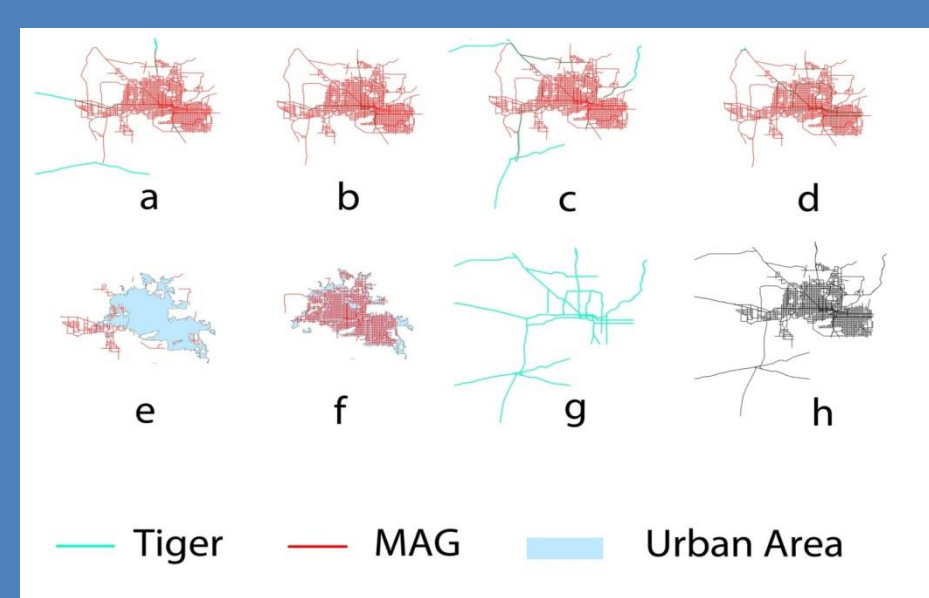
Quantification of the spatial and temporal characteristics of atmospheric CO<sub>2</sub> flux is a difficult yet essential component of carbon cycle research. The significance of fossil fuel carbon emissions in carbon budget/inversion studies stimulates the need for precise, complete and robust quantification of fossil fuel CO<sub>2</sub> emissions (Gurney, et. al., 2007). Previous research on urban greenhouse gas inventories mostly focused on trend analysis and emissions categorization instead of interactive geospatial analyses and data exploration. In order to utilize atmospheric CO<sub>2</sub> measurements in a complete carbon monitoring system, the emission data product must be constructed with explicit space and time details (Gurney, et. al., 2012).



## METHODS

### Spatial Allocation

The road atlas for Maricopa County was a combination of the local road network data provided by Maricopa Association of Governments (MAG), urban area definition by U.S. census and major roads based on Tiger geodatabase.



MAG provided 2007 Annual Average Daily Traffic (AADT) data for interstates and arterials in Maricopa County. The Vehicle Miles Traveled (VMT) for each road segment was calculated by multiplying the AADT with corresponding road segment length. The 2002 on-road emission for Maricopa County was calculated based on the National Mobile Inventory Model (NMIM), which utilizes VMT data from National County Database (NCD) and EPA emission factors. The emission was then allocated by road type and the VMT proportion on each road segment.

### Temporal Allocation

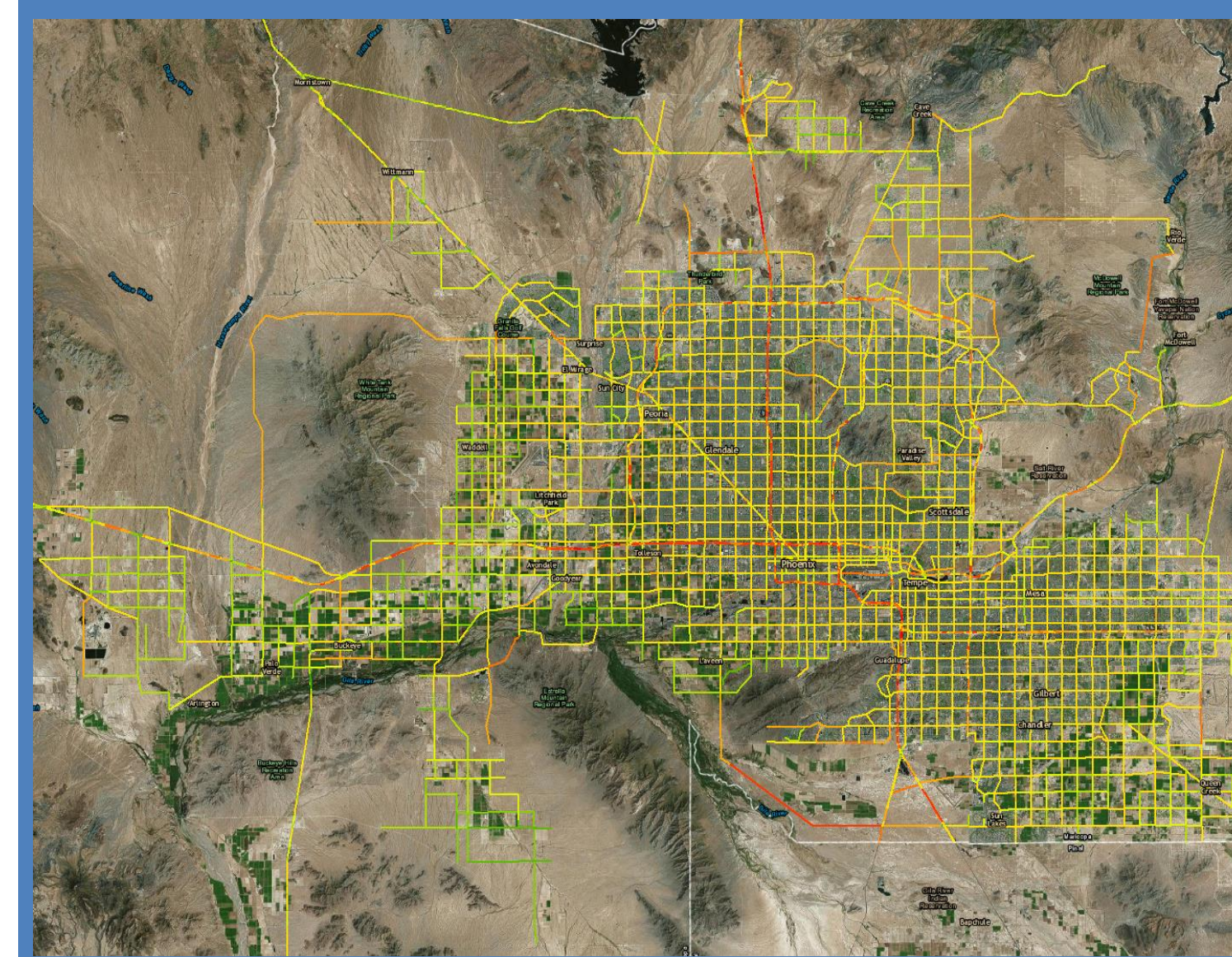
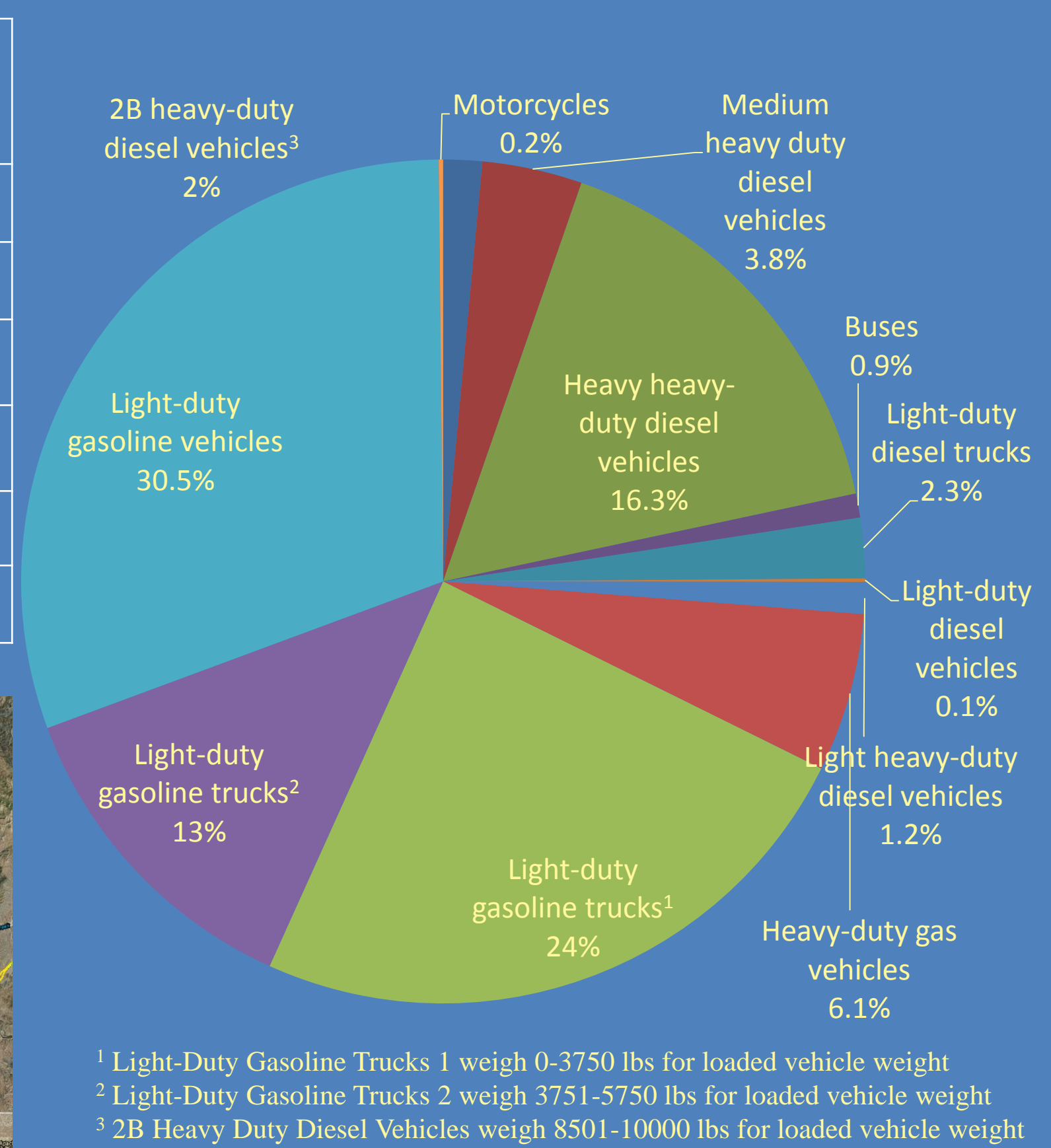
MAG provided 15-minute interval traffic count data on the above-mentioned road segments. Each segment was collected for 24 hours. Combining with the weekly, monthly and seasonal traffic scaling factors (also provided by MAG), the temporal profile for 8760 hours of a typical year was constructed. The annual CO<sub>2</sub> emissions were distributed according to each hourly fraction of traffic counts. For segments that are outside the scope of MAG data, the temporal profile was constructed based on the Federal Highway Administration's (FHWA) permanent automatic traffic recorder (ATR) network data. Due to the fact that ATR stations are unevenly distributed in space, we created Thiessen polygons such that each road segment was linked to the nearest neighboring ATR station. The hourly profile for each individual station was then combined to create a "climatology" of CO<sub>2</sub> emissions in time on each road segment.

## RESULTS

### On-road CO<sub>2</sub> emissions by road type in Maricopa County, 2002

Road Type	CO <sub>2</sub> emissions (MtC/yr)	CO <sub>2</sub> emissions (%)	Length (km)	Length (%)	CO <sub>2</sub> emissions linear density (tC/km)
Rural Primary Roads	0.25	6.1%	138.5	7.6%	1784.1
Urban Primary Roads	2.26	56.1%	70.9	3.9%	31841.1
Rural Secondary Roads	0.16	4.1%	167.8	9.2%	979.5
Urban Secondary Roads	0.91	22.7%	166.9	9.1%	5473.5
Rural Local Roads	0.04	1.1%	242.9	13.2%	172.5
Urban Local Roads	0.40	9.9%	1047.4	57.0%	384.1

### On-road CO<sub>2</sub> emissions by vehicle type in Maricopa County, 2002



## DISCUSSIONS

- ❖ Majority of on-road CO<sub>2</sub> emissions in Maricopa County are from interstates I-10 and I-17. State Route 51, 60 and State Highway Loop 101, 202 consist the secondary biggest emissions.
- ❖ Urban road segments inside Loop 101 and 202 generally have higher emissions compared to road segments in suburban/rural area in west Maricopa.
- ❖ The temporal distribution showed that the peak hour of CO<sub>2</sub> emission is from 8am to 9am in the morning and 5pm to 6pm in the afternoon, primarily focused in Phoenix, Scottsdale, Mesa and Chandler, which is consistent with 2007 MAG report on freeway congestion.
- ❖ Future study may focus on the spatial allocation of on-road CO<sub>2</sub> emission by vehicle types, which may provide decision and modeling support for mitigation policies related to fuel price change.

## REFERENCES

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- Gurney, K.R., Razlivanov, I., Song, Y. Zhou, Y., Benes, B., Abdul-Massih, M. (2012) Quantification of fossil fuel CO<sub>2</sub> at the building/street scale for a large US city, *Environmental Science and Technology*, 46 (21), pp 12194- 12202
- Maricopa Association of Governments, 2007 Freeway Bottleneck Map in MAG Region

## ACKNOWLEDGEMENTS

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