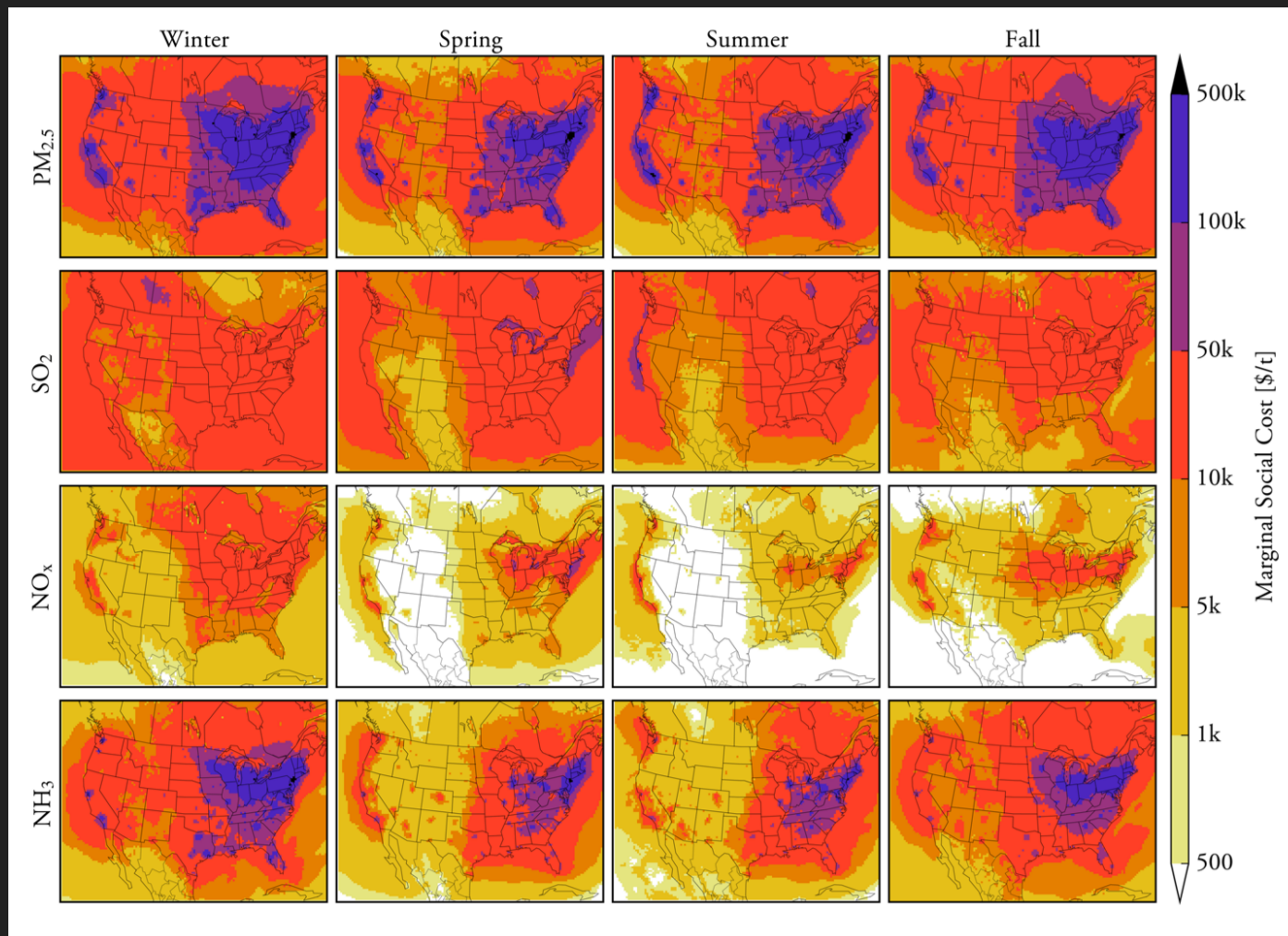


# Spatially explicit life cycle assessment for air pollution health impacts

Christopher Tessum, Jason Hill, Julian Marshall

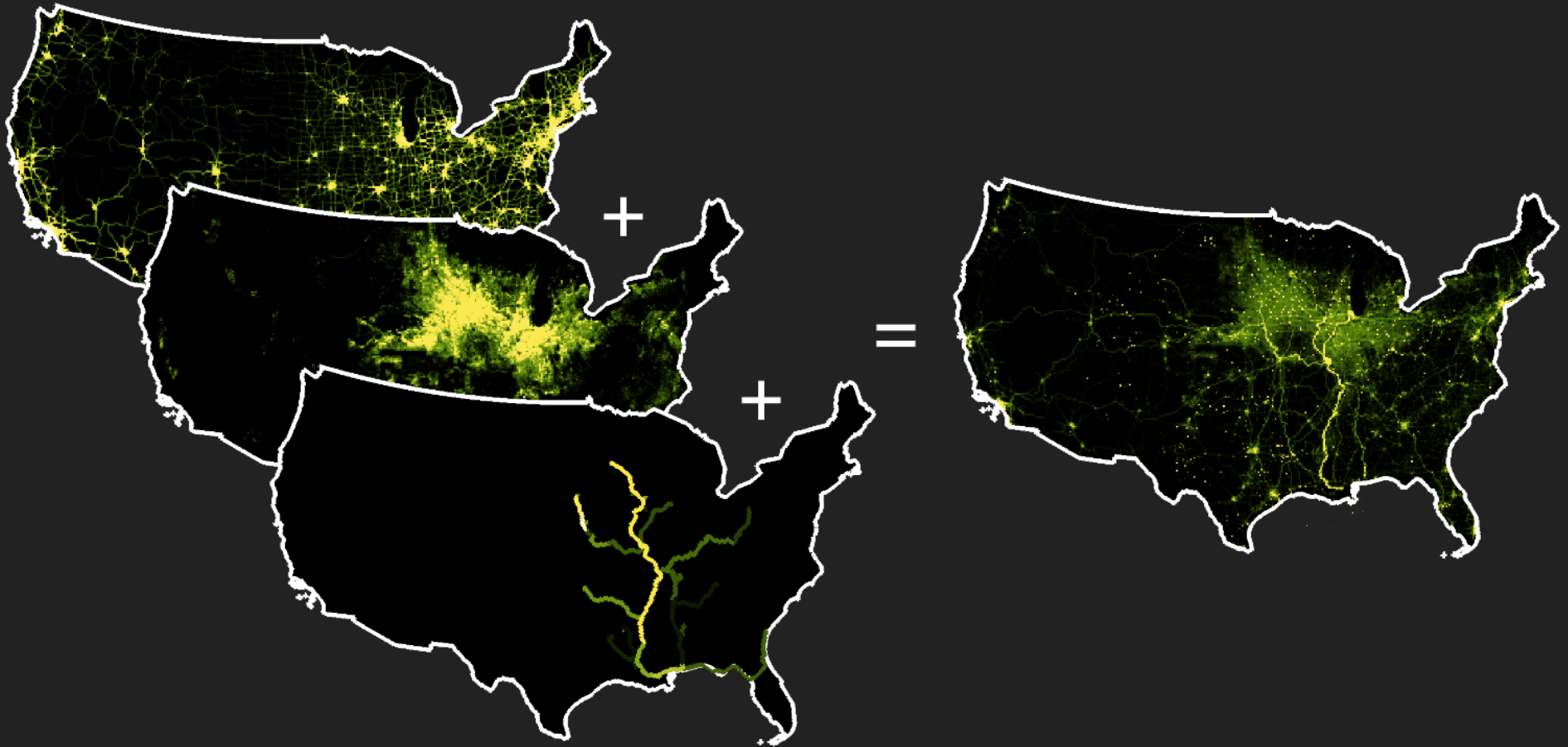
University of Washington; [ctessum@uw.edu](mailto:ctessum@uw.edu)



Marginal damages of emissions (\$ t<sup>-1</sup>) by emission location. The values represent the location where impacts originate rather than occur.

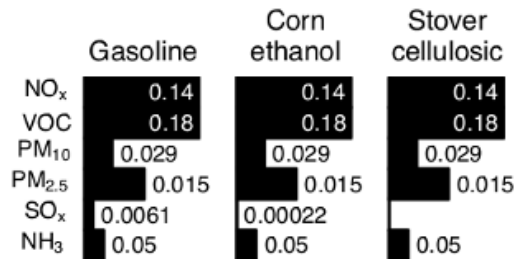
Heo J, Adams PJ, Gao HO (2016). *Environ Sci Technol*.

## LCA → Spatial LCA

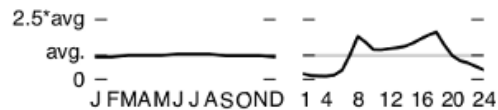


Tessum, C. W.; Marshall, J. D.; Hill, J. D. A spatially and temporally explicit life cycle inventory of air pollutants from gasoline and ethanol in the United States. *Environ. Sci. Technol.* 2012, 46 (20), 11408–11417 DOI: [10.1021/es3010514](https://doi.org/10.1021/es3010514).

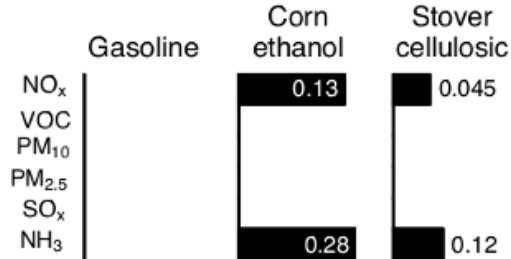
# Spatial LCA



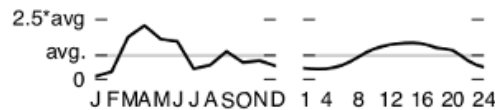
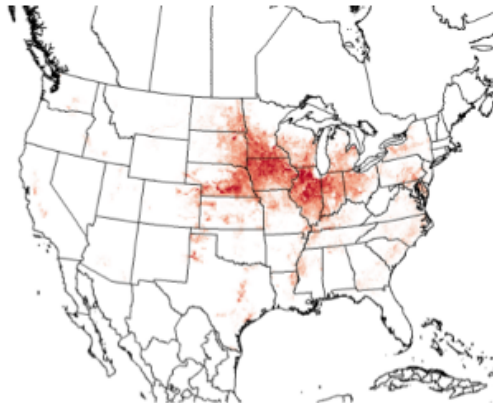
Emissions (g mile<sup>-1</sup>)



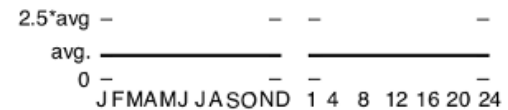
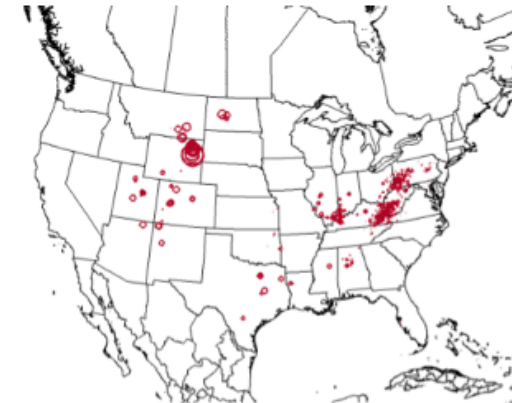
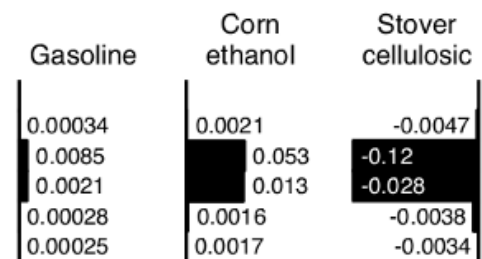
(a) Vehicle tailpipe



Emissions (g mile<sup>-1</sup>)

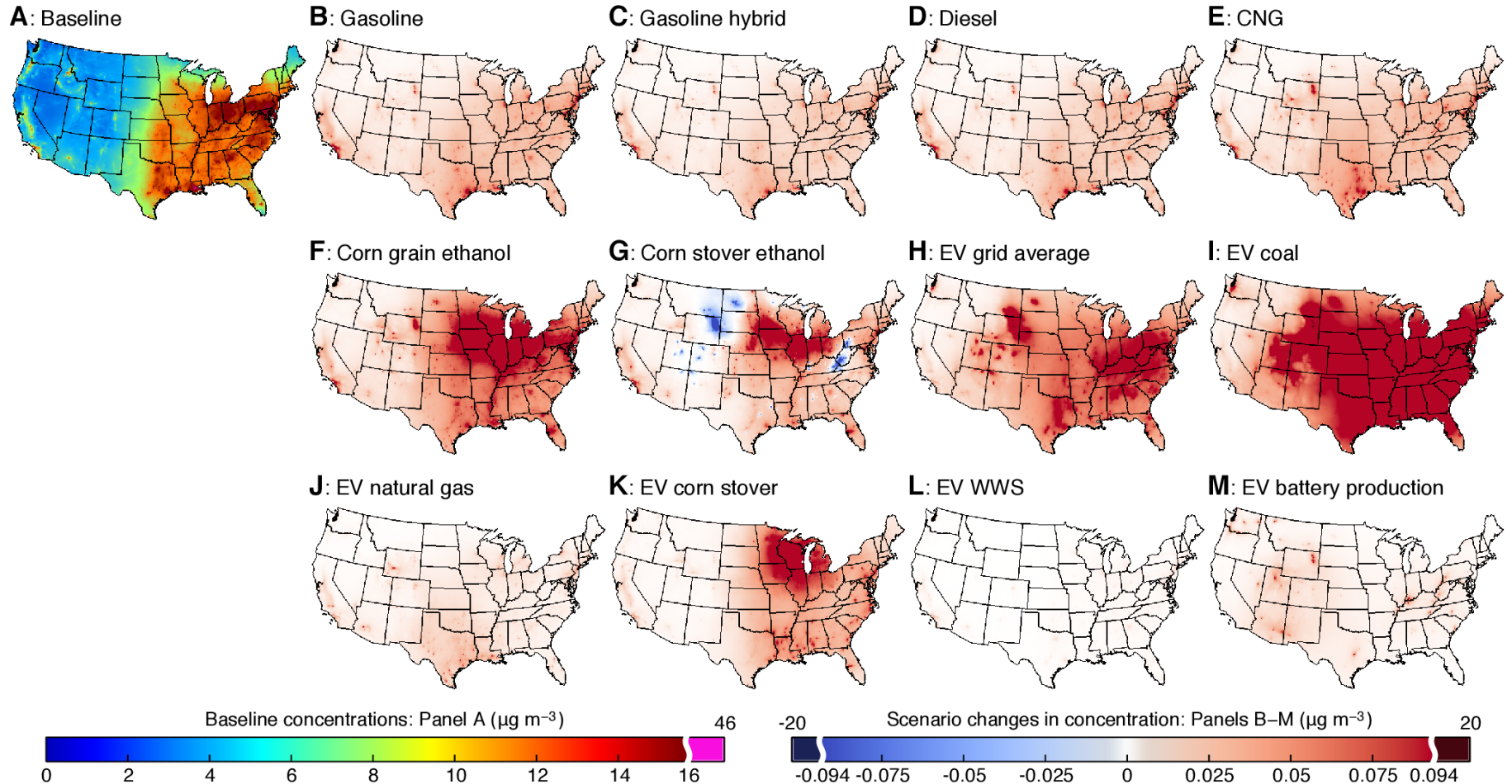


(b) Fertilizer nitrification



(c) Coal mining and cleaning non-combustion

# Annual average PM<sub>2.5</sub> concentrations



C. W. Tessum, J. D. Hill, J. D. Marshall, 2014. *Proc. Nat. Acad. Sci.* **111**(52), 18490–18495

## Problems

- Spatial information for each process is hard to find.
- Air quality modeling is difficult and expensive.

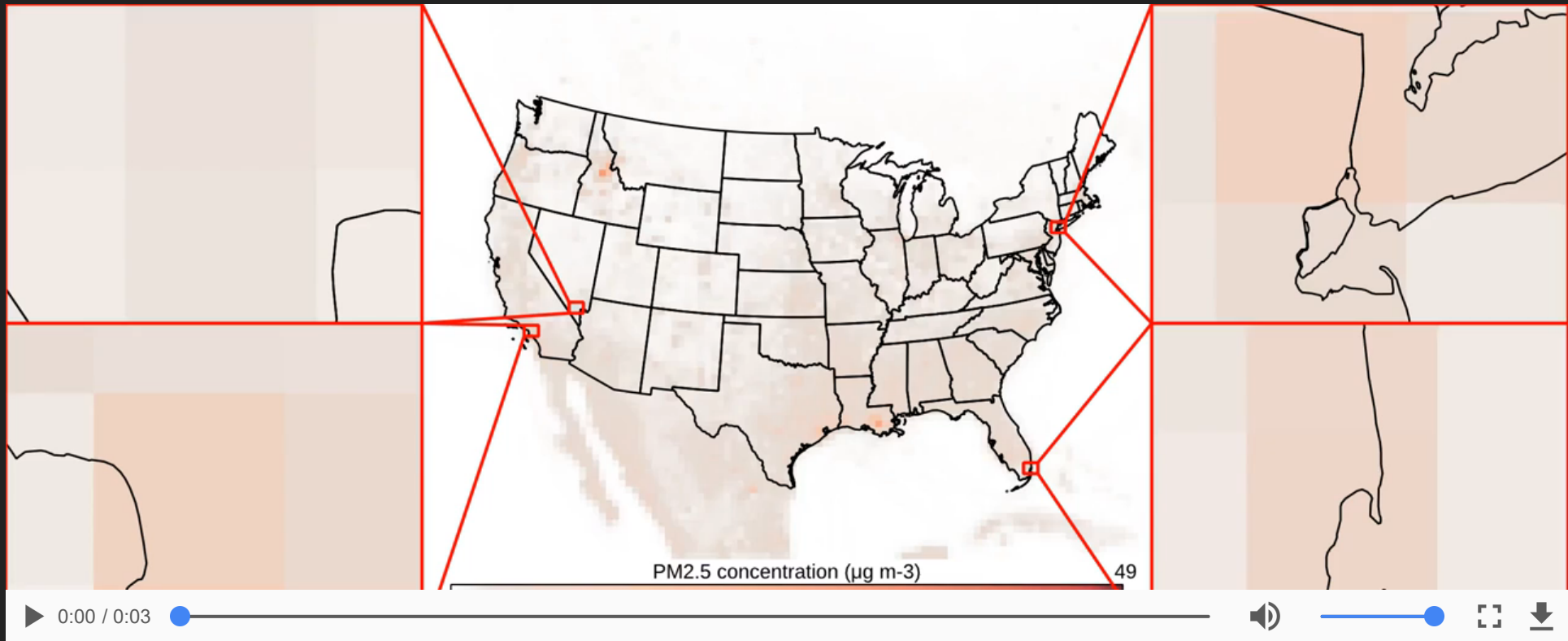
# Spatial life cycle assessment tools

## Air Emissions Processor (AEP)

- Similar to SMOKE, but (subjectively) easier to use
- <https://github.com/ctessum/aep>



# Intervention Model for Air Pollution (InMAP)



<http://inmap.spatialmodel.com>

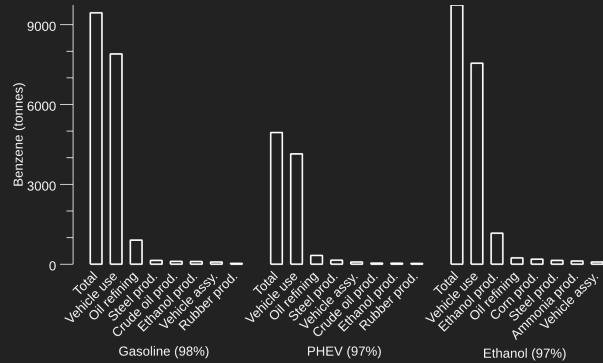
## Life Cycle Inventory models

- GREET: <https://greet.es.anl.gov/>
- BEA IO tables + NEI:  
[https://www.bea.gov/industry/io\\_annual.htm](https://www.bea.gov/industry/io_annual.htm)

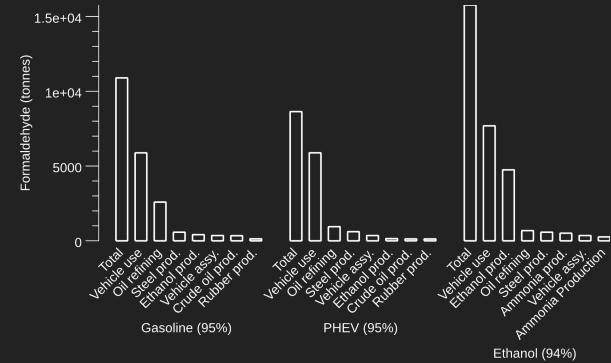
# Applications

# Speciated life cycle emissions from transportation

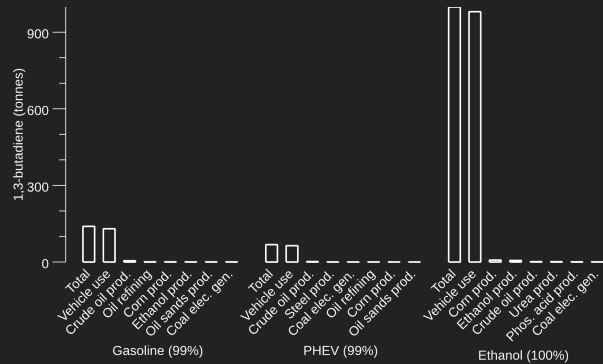
## Benzene



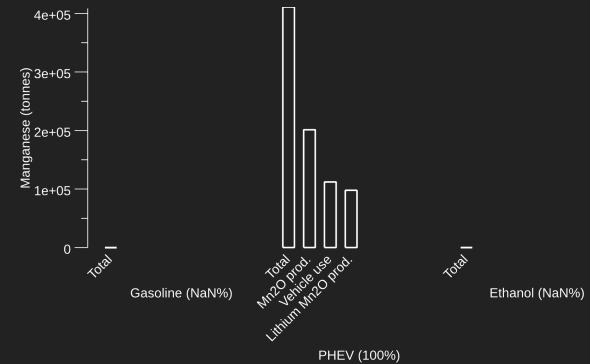
## Formaldehyde



## 1,3-Butadiene

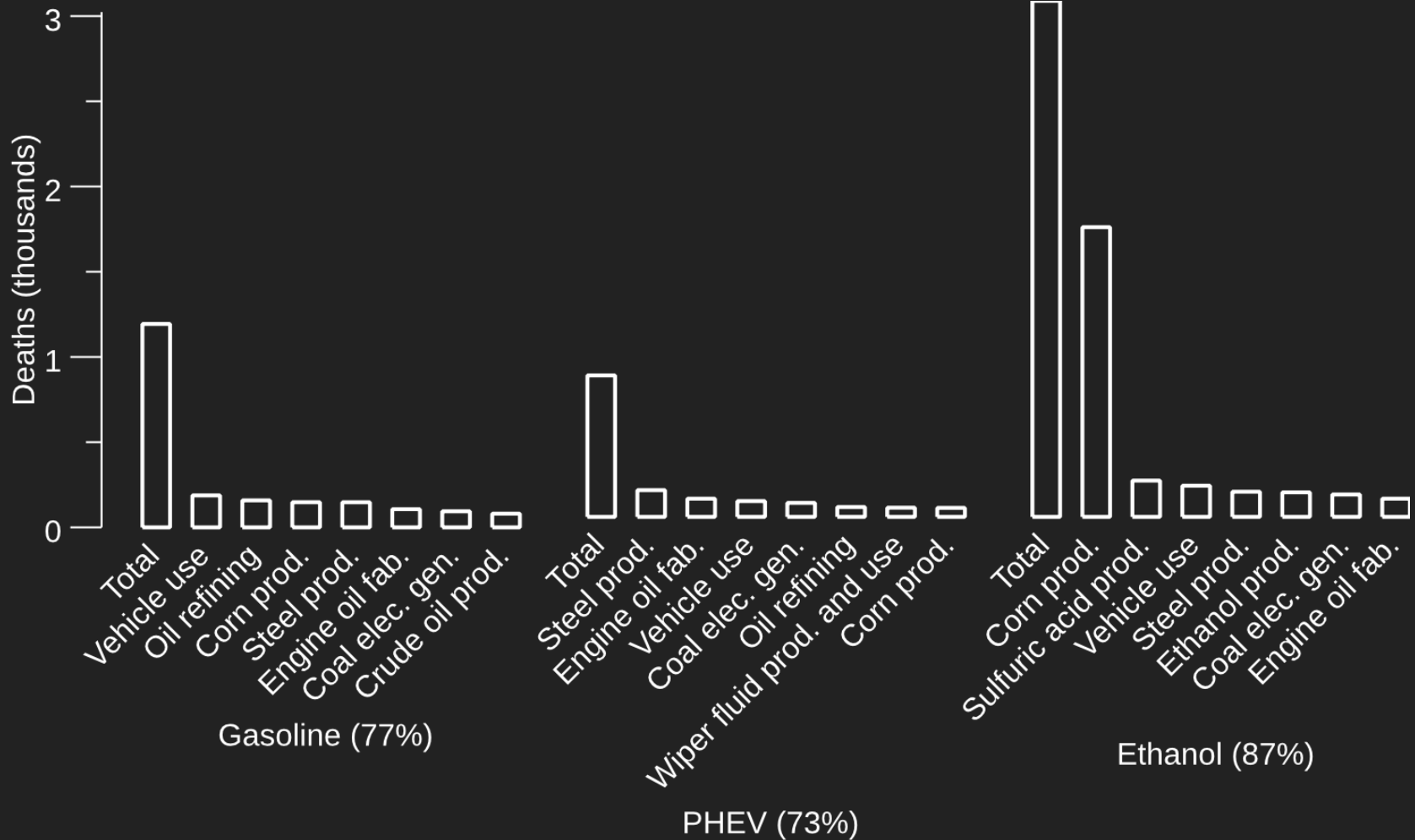


## Manganese



Basis: 10% increase in total VMT using only the specified vehicle type

# Transportation health impacts



The health impacts from traveling 10% of year-2020 light-duty vehicle miles in different vehicle types. Percentages represent the fraction of total impacts shown on each chart.

## Health impacts of corn production

Social cost of producing a bushel of corn in each county. Colors show total damages attributed to corn production in each county, not the locations where damages occur.

## Health impacts of economic activity

Relationships between a) overall, b) personal consumption, and c) demographic-specific personal consumption demand for goods and services and the production of air pollution health impacts in 2003 and 2014.

# Thank you



ctessum@uw.edu

- InMAP:  
<http://inmap.spatialmodel.com>
- AEP: <https://github.com/ctessum/aep>

This presentation was developed under Assistance Agreement No. RD83587301 awarded by the U.S. Environmental Protection Agency. It has not been formally reviewed by EPA. The views expressed in this document are solely those of authors and do not necessarily reflect those of the Agency. EPA does not endorse any products or commercial services mentioned in this publication.