

Regional air quality impacts of intercity passenger trains in the United States



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Objective

Quantify the extent of **adverse health effects** attributable to **air pollution** from **intercity passenger trains** in the United States and the potential to mitigate such impacts by **upgrading or electrifying** the entire diesel locomotive fleet.

Background

- Unlike many industrialized nations with largely electrified rail networks, **rail service in the US is primarily operated by decades-old diesel locomotives.**
- **Adverse health impacts** from freight rail **air pollution** are well established, but the extent of impacts attributable to **Amtrak passenger trains** is not.
- Amtrak's fleet of **legacy locomotives** (Tier 0) is less efficient and faces more lenient emissions regulations than **modern locomotives** (Tier 4).

Comparing the impacts to other modes of transport

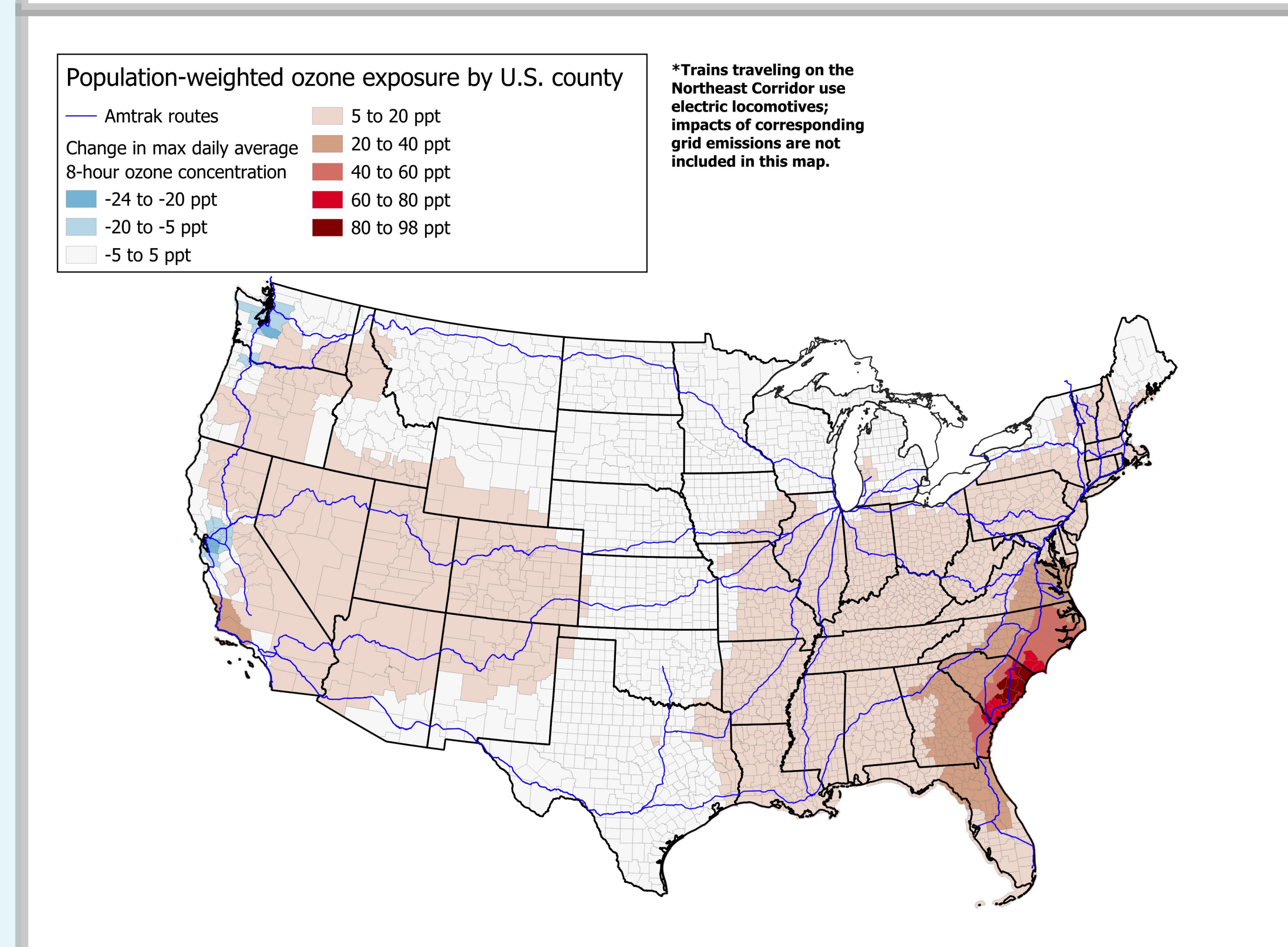
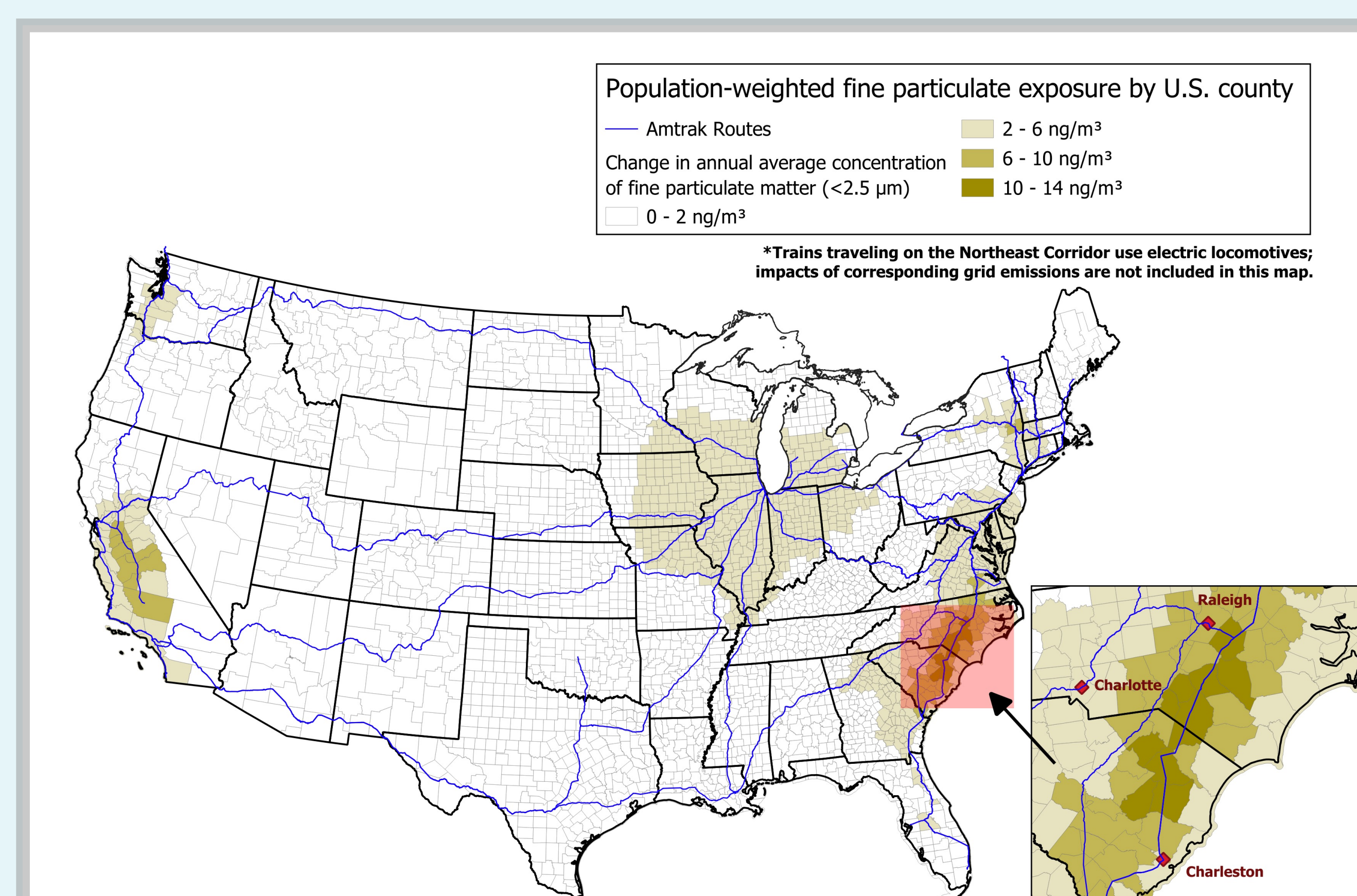
- In Greater Boston, **air pollution from road vehicles** causes 342 premature deaths each year (Soni *et al.* 2025).
- **Car accident fatalities** in the US (44,762) occur at a rate of roughly 1.9 per billion seat-km; air pollution from passenger trains results in 3.5 deaths per billion seat-km.
- **Air pollution from US freight trains** was responsible for 5,040 early deaths in 2005 (Caiazzo *et al.* 2013).
- That same year, **aviation air pollution** was responsible for 80 to 200 annual early deaths in the US (Dedoussi *et al.* 2020).

Legacy Tier 0 diesel locomotives emit more pollution than the modern Tier 4

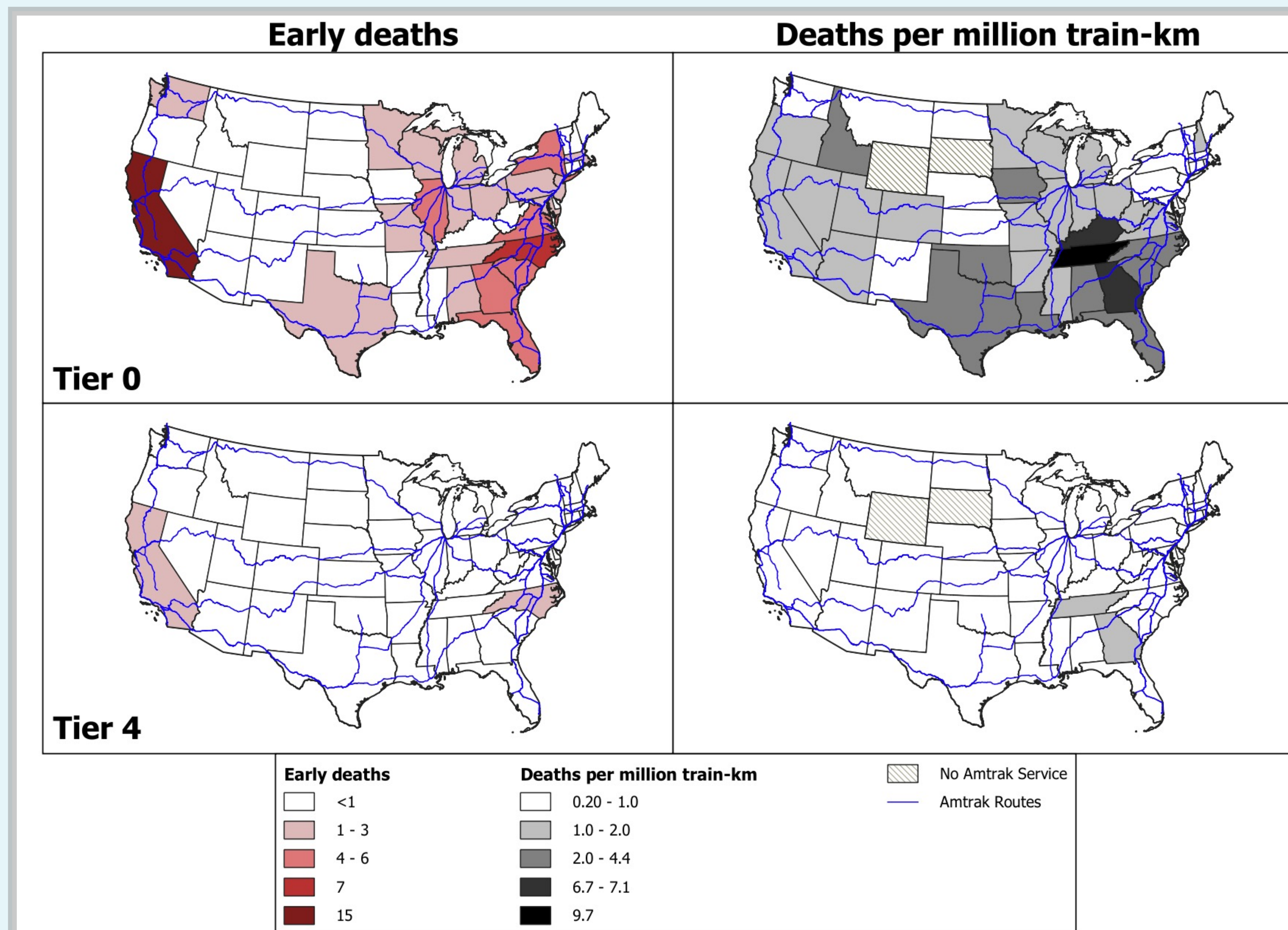
Standard	Nitrogen Oxides	Particulate Matter	Hydrocarbons	Carbon Monoxide
Tier 0	10.7	0.30	1.3	6.7
Tier 4	1.7	0.04	0.2	2.0

*Pollutant emission standards are in grams per kW-hr

Emissions from Amtrak locomotives increase exposure to PM_{2.5} and O₃



Exposure to pollution from Amtrak diesel locomotives is responsible for 106 early deaths each year



Maps of early deaths and deaths per million train-kilometers attributable to Amtrak diesel locomotive emissions each year. The top and bottom rows correspond to the legacy Tier 0 and a potential modern Tier 4 diesel fleet.

Conclusions

- We attribute **85 to 138 premature mortalities** to air pollution from Amtrak trains (diesel and electric) in a simulated year, 80% of which occur in the US.
- Half of Amtrak trips and trains use the electrified Northeast Corridor, yet only 2.7% of estimated early deaths are from such activity.
- Appalachian states such as **Tennessee, Kentucky, and Georgia are disproportionately affected** relative to their share of Amtrak activity.
- **Modernizing** the diesel locomotive fleet **reduces air pollution impacts by 78.7%** and diesel fuel usage by 29.3%.
- **Electrifying** the entire Amtrak network **reduces air pollution impacts by 92.5%**.