Clean Air Vehicles vs. Air Pollution

A Data Analysis study

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Hypothesis

States that show higher adoption of Electric, Plug-In Hybrid, and Hybrid vehicles will show a measurable improvement in air pollution from roadway sources.

Data sets

Pollution data:

EPA National Emissions Inventory (NEI)

Years available:

2008, 2011, 2014, 2017, 2020

Clean Air Vehicle (CAV) adoption rates:

US Dept. of Energy Alternative Fuels Data Center (AFDC)

Years available:

2016 - 2021

2020 data & COVID

Pollution emissions in 2020 were very likely impacted by the COVID pandemic, and the ensuing stay-at-home orders. This limits the conclusions that can be drawn based on 2020's data.

NEI data is published every three years, with the next publication expected at the end of 2023. This data, were it available for the current analysis, would greatly increase the confidence of any conclusions.

Ten states with the highest and lowest % of CAV registrations selected for analysis.

CA, while showing the highest adoption, does not collect or report data in a way that is consistent with other states. CA was therefore excluded from the analysis.

High CAV % of Registrations*

State	2016	2017	2018	2019	2020	2021
California	4.0	4.4	4.8	5.3	5.6	6.4
Washington	2.7	3.0	3.4	3.8	4.2	4.9
Oregon	2.7	2.9	3.2	3.5	3.9	4.6
Hawaii	2.7	2.9	3.1	3.5	3.8	4.4
Vermont	2.2	2.4	2.6	2.8	3.1	3.8
Massachusetts	2.1	2.2	2.5	2.7	3.0	3.6
Maryland	2.1	2.2	2.4	2.6	2.9	3.5
Colorado	1.7	1.9	2.1	2.3	2.6	3.2
Nevada	1.6	1.8	2.0	2.2	2.4	3.0
Virginia	1.8	2.0	2.1	2.3	2.5	2.9
Arizona	1.8	1.9	2.1	2.2	2.5	3.0

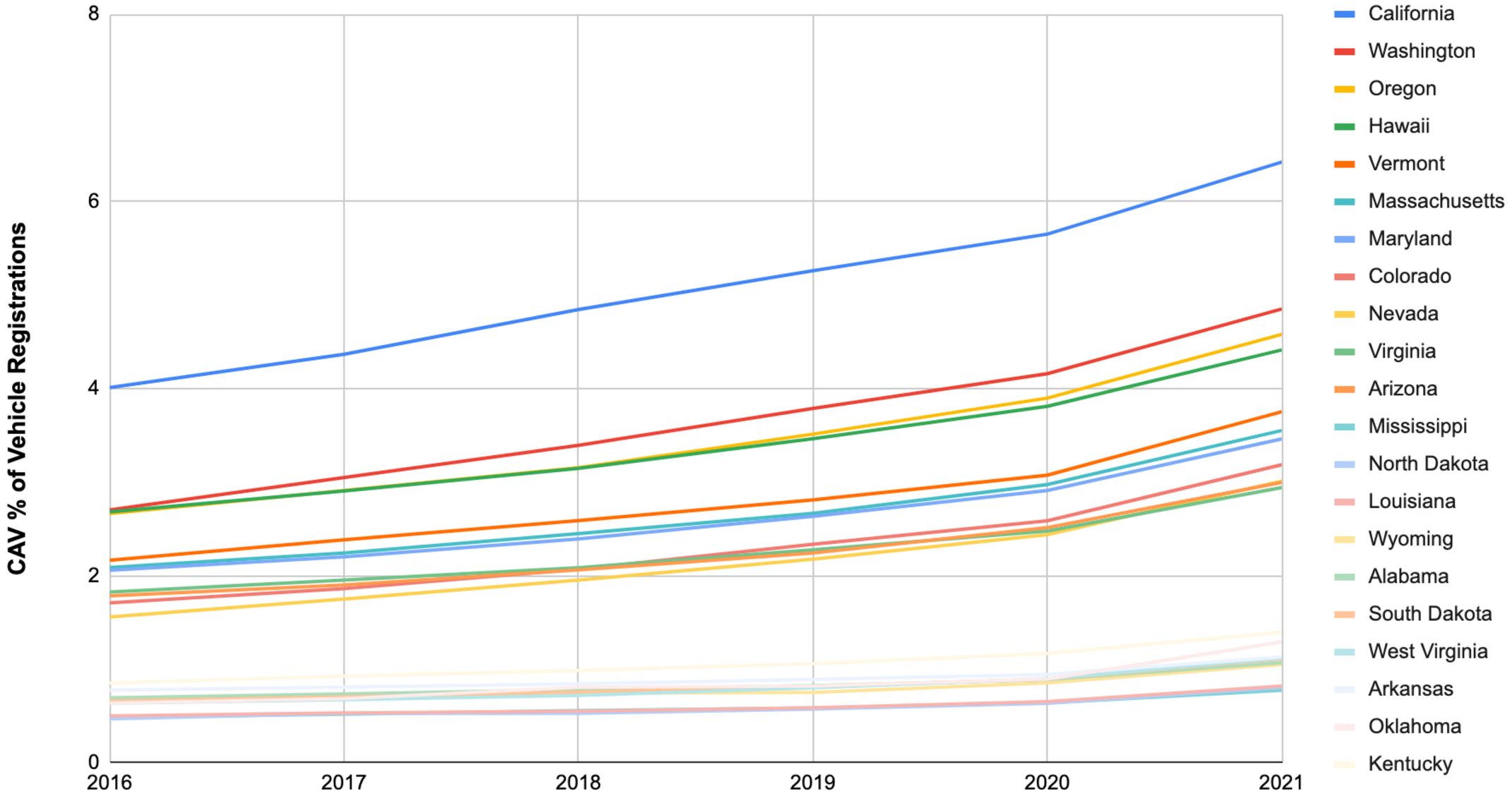
CA excluded from analysis

Low CAV % of Registrations

State	2016	2017	2018	2019	2020	2021
Mississippi	0.49	0.52	0.56	0.59	0.64	0.78
North Dakota	0.47	0.53	0.53	0.58	0.64	0.81
Louisiana	0.50	0.53	0.55	0.59	0.65	0.82
Wyoming	0.68	0.70	0.75	0.75	0.86	1.05
Alabama	0.70	0.74	0.78	0.82	0.89	1.07
South Dakota	0.66	0.71	0.76	0.82	0.89	1.11
West Virginia	0.64	0.68	0.72	0.80	0.90	1.12
Arkansas	0.78	0.81	0.84	0.89	0.94	1.13
Oklahoma	0.64	0.69	0.81	0.82	0.90	1.29
Kentucky	0.85	0.92	0.99	1.06	1.17	1.39

Clean Air Vehicle Adoption by State

Top and bottom 10 states



Pollutants

Four greenhouse gasses and nine health pollutants

Greenhouse Gasses

Carbon Dioxide
Carbon Monoxide
Methane
Nitrous Oxide

Health Pollutants

Chromium 6
Manganese
Mercury
Nickel
Nitrogen Oxides
Sulfur Dioxide
Volatile Organic Compounds

Particulate Matter (health)

Large: less than 10 microns (um)
Fine: less than 2.5 microns (um)

Health Impacts

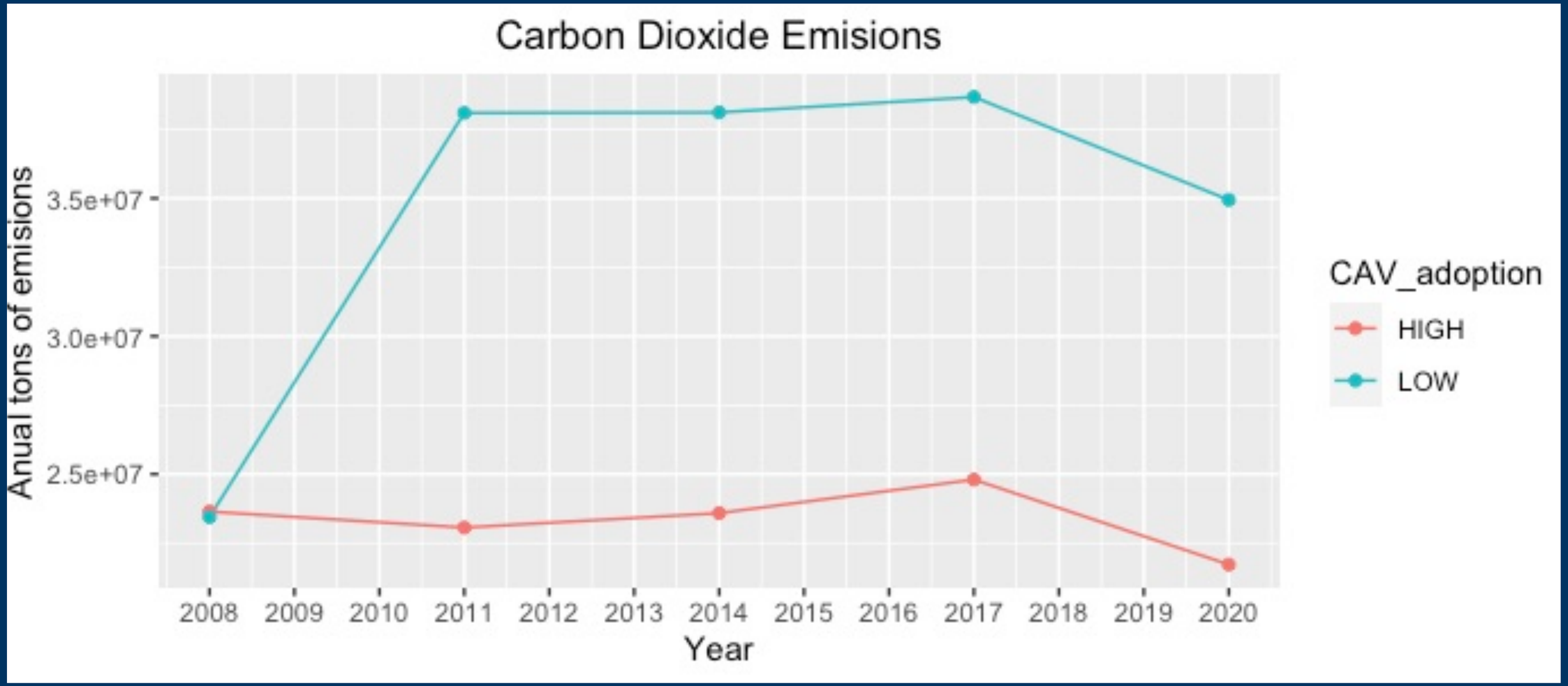
Several studies have shown a clear impact of roadway pollution on health. Resources can be found from the American Lung Association, among others.

Units of NEI emissions data

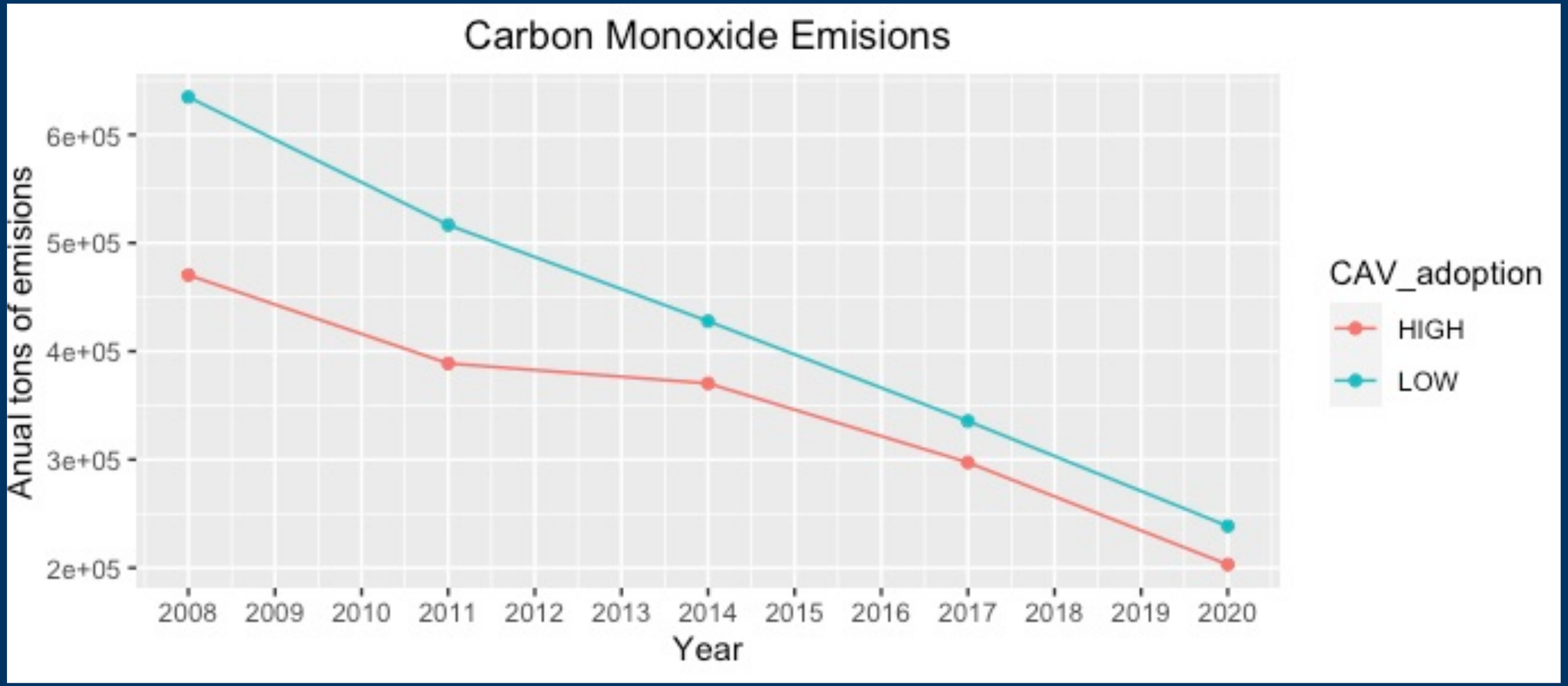
“NEI emissions values represent total annual emissions for the inventory reporting year. Criteria air pollutants and precursors (CAPs) are reported in short tons per year, and hazardous air pollutants (HAPs) are reported in lbs per year.”

In the following slides, county level data has been summed for each state, then plotted with a trend line. Averages are also plotted on separate slides. Individual states are not called out to preserve readability.

Greenhouse Gas pollution - averages



Greenhouse Gas pollution - averages



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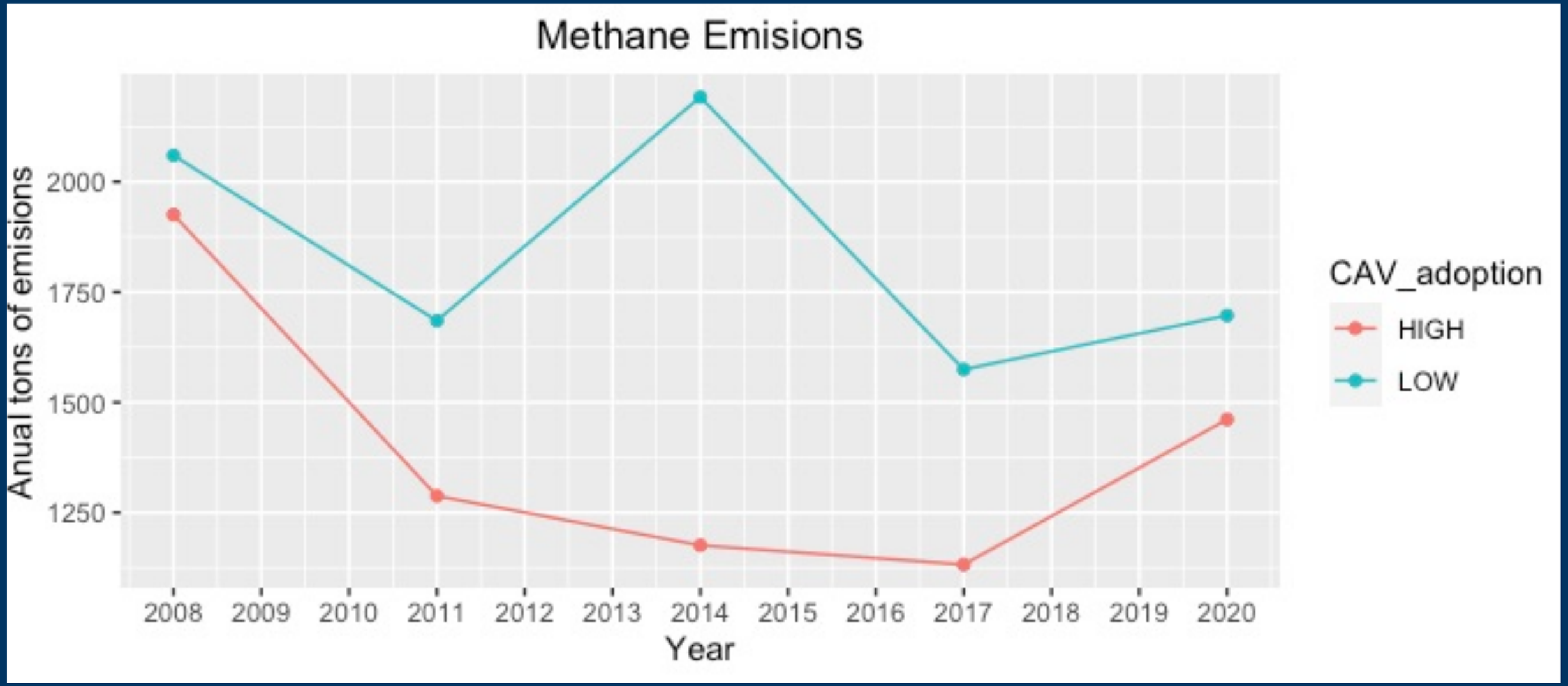

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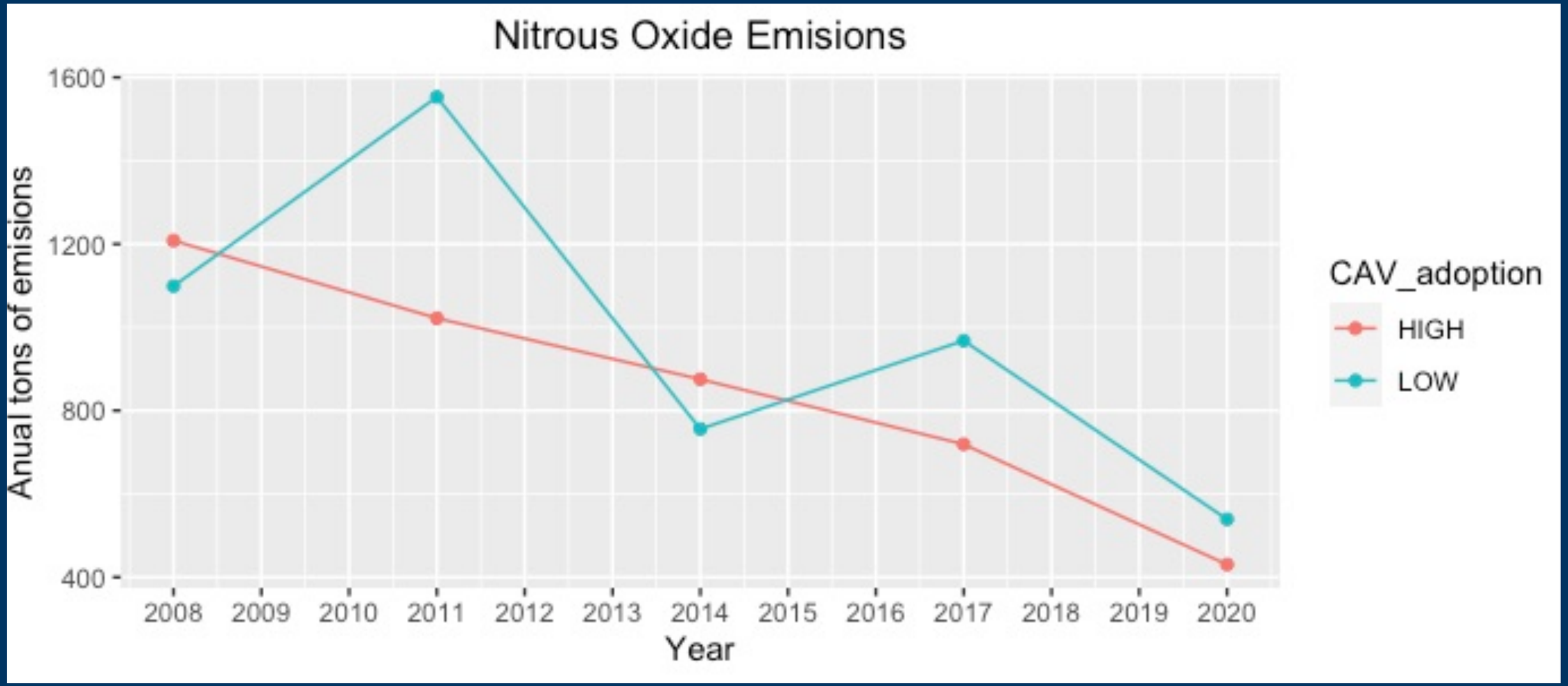
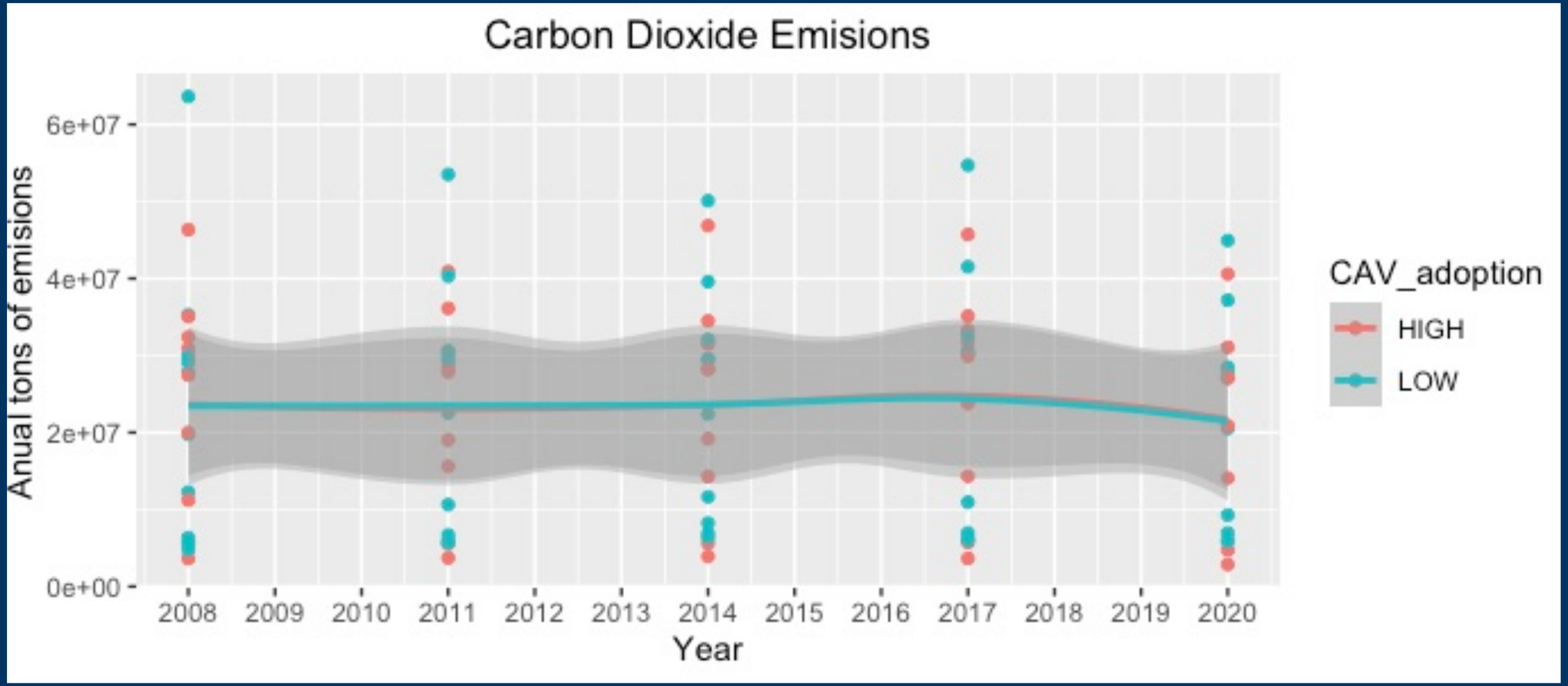


Greenhouse Gas pollution - points



Trend-lines are identical but data spread too wide for conclusions

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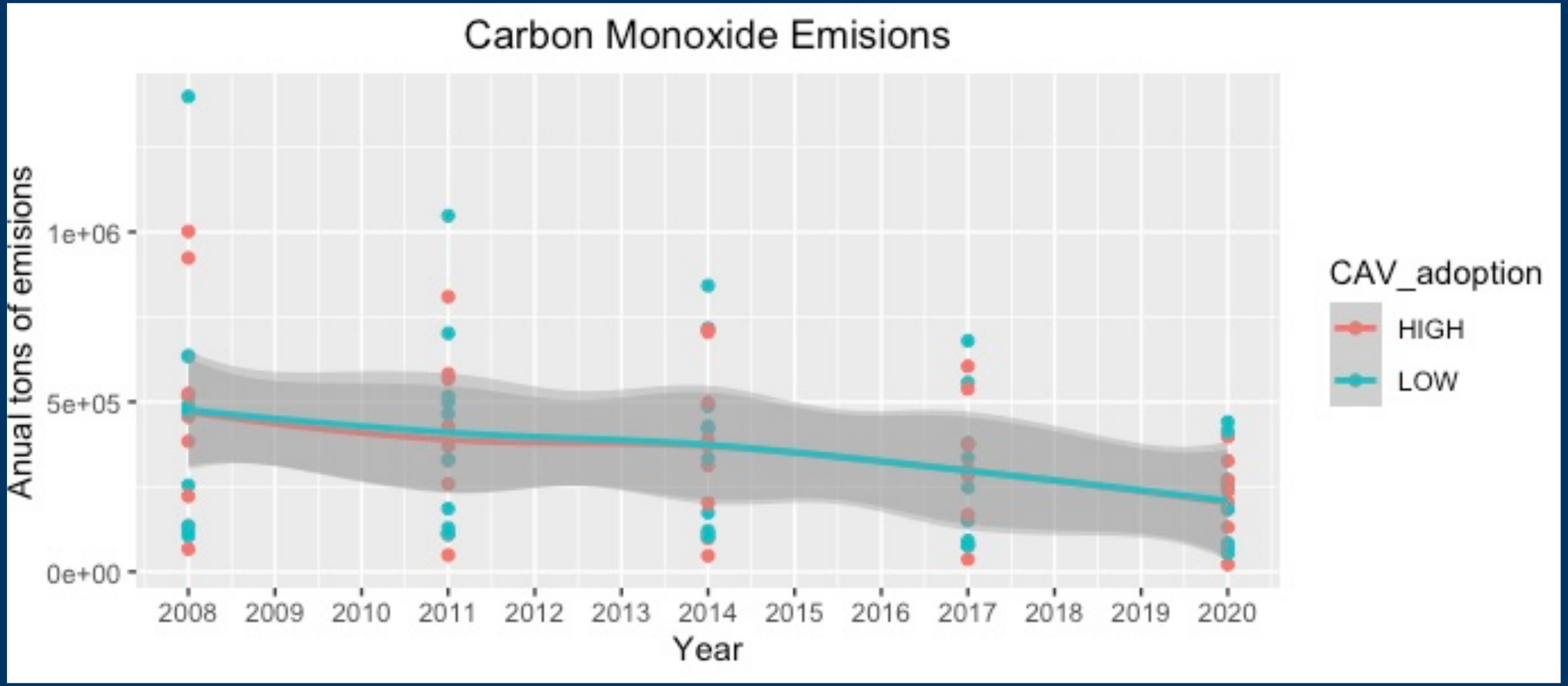

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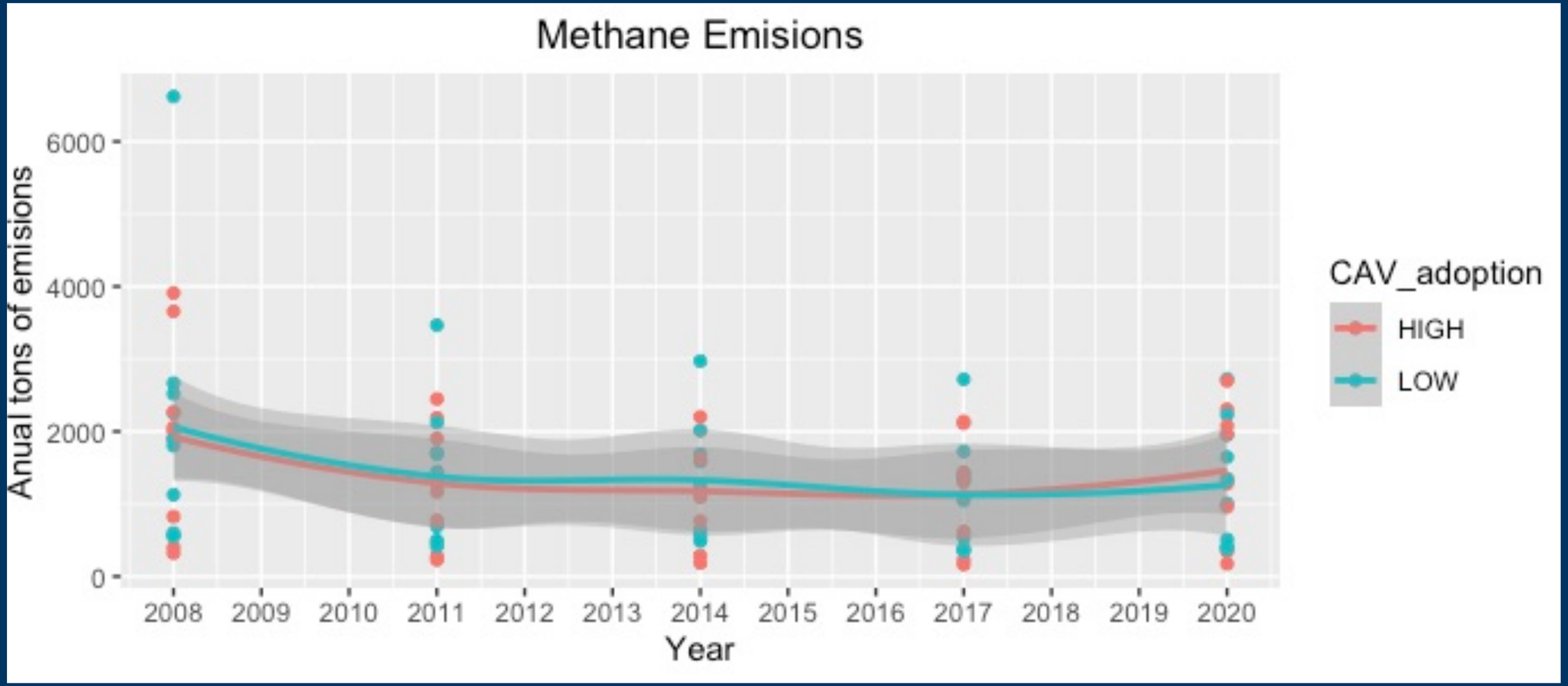
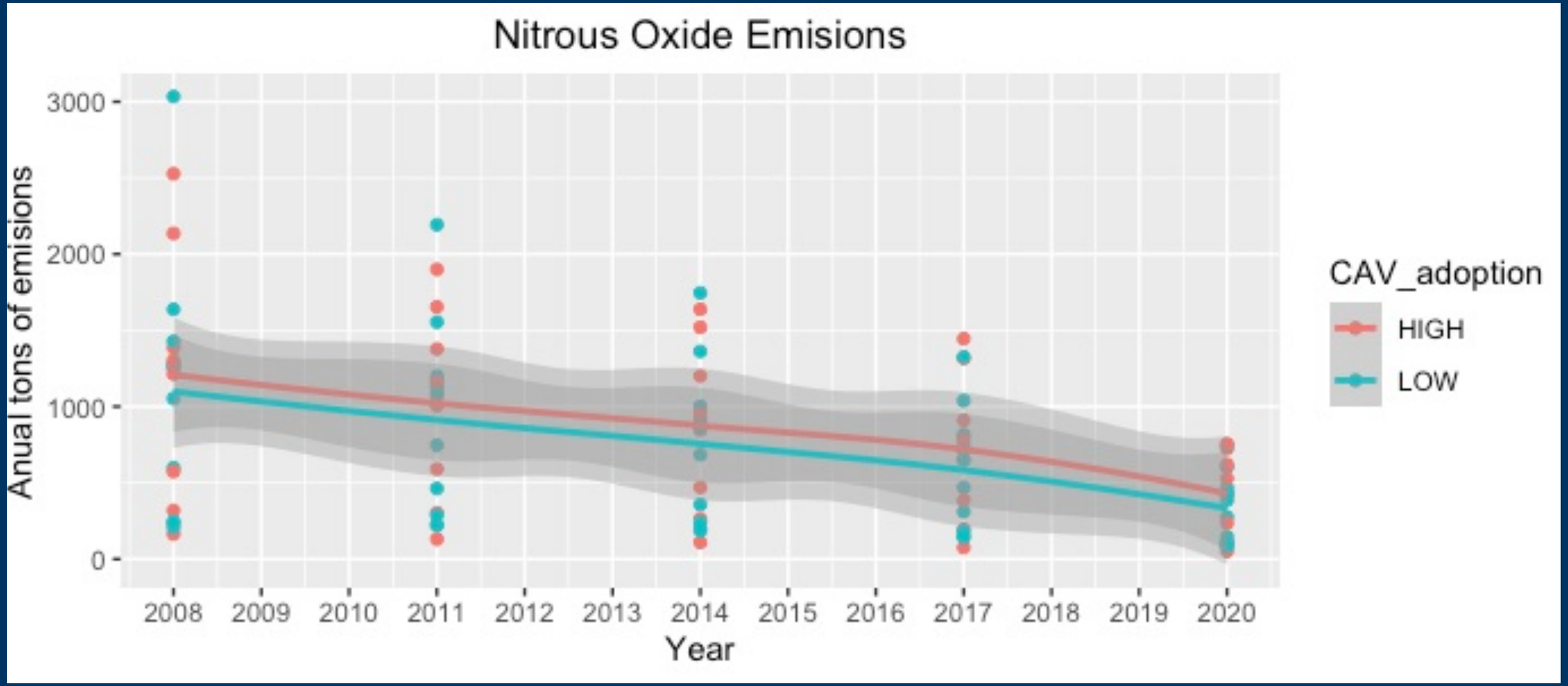


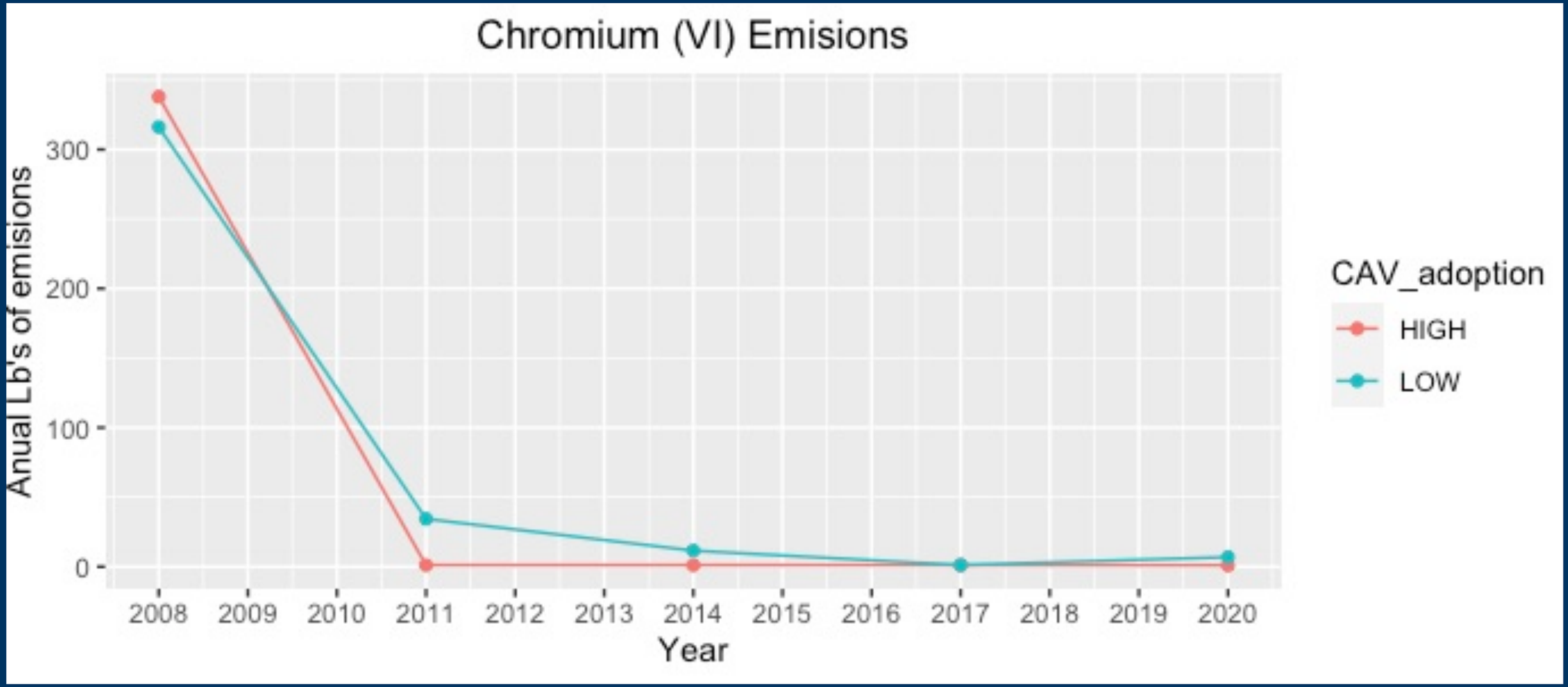
Trend-lines are nearly identical with data spread too wide for conclusions

Greenhouse Gas pollution - points



Trend-lines are parallel but data spread too wide for conclusions

Health Pollutants - Averages



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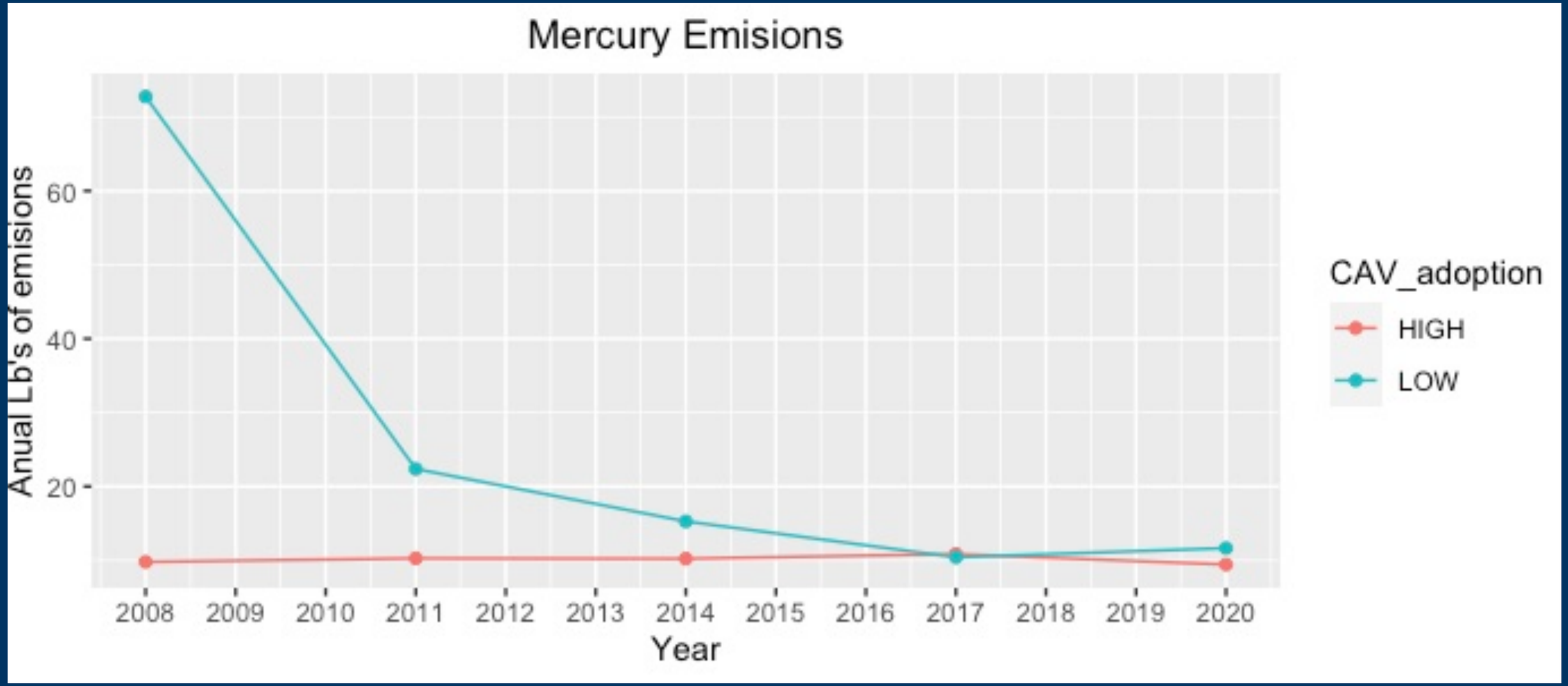

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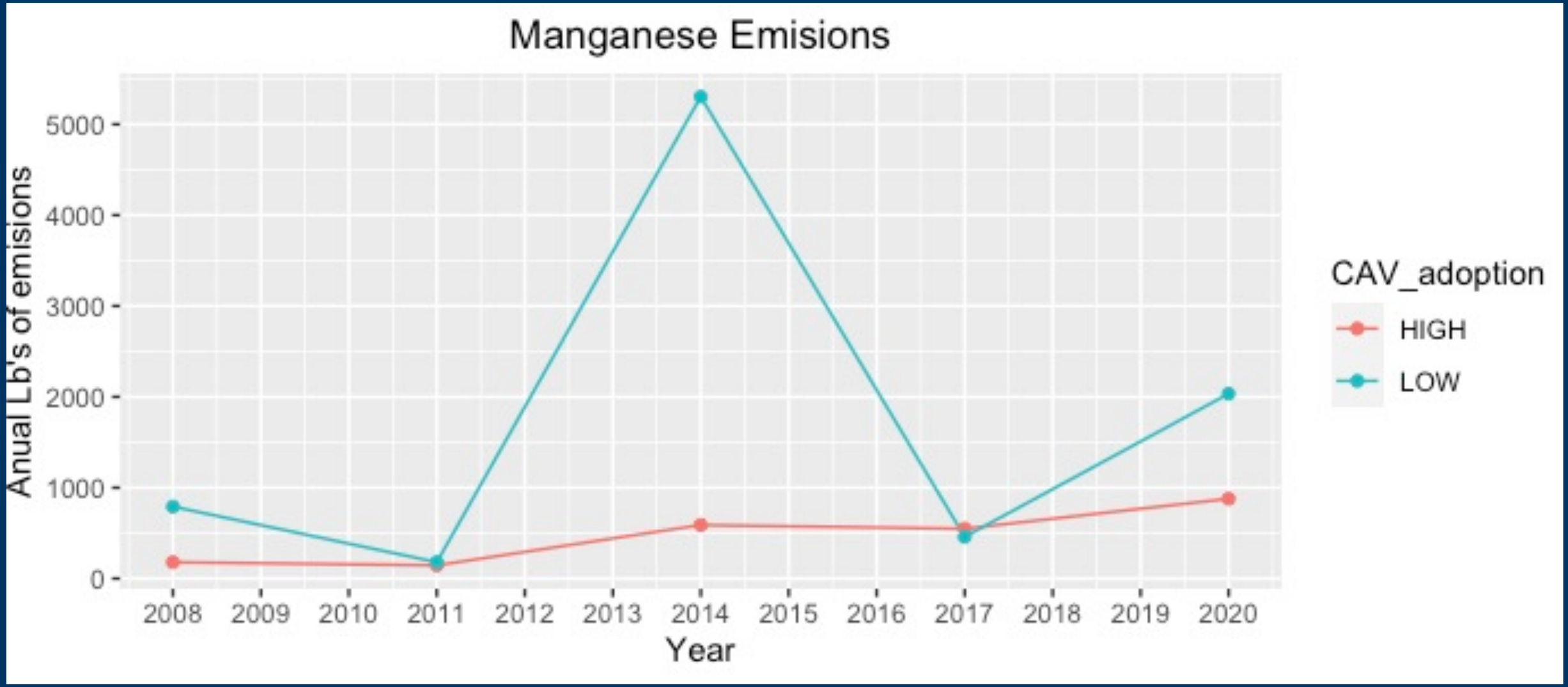

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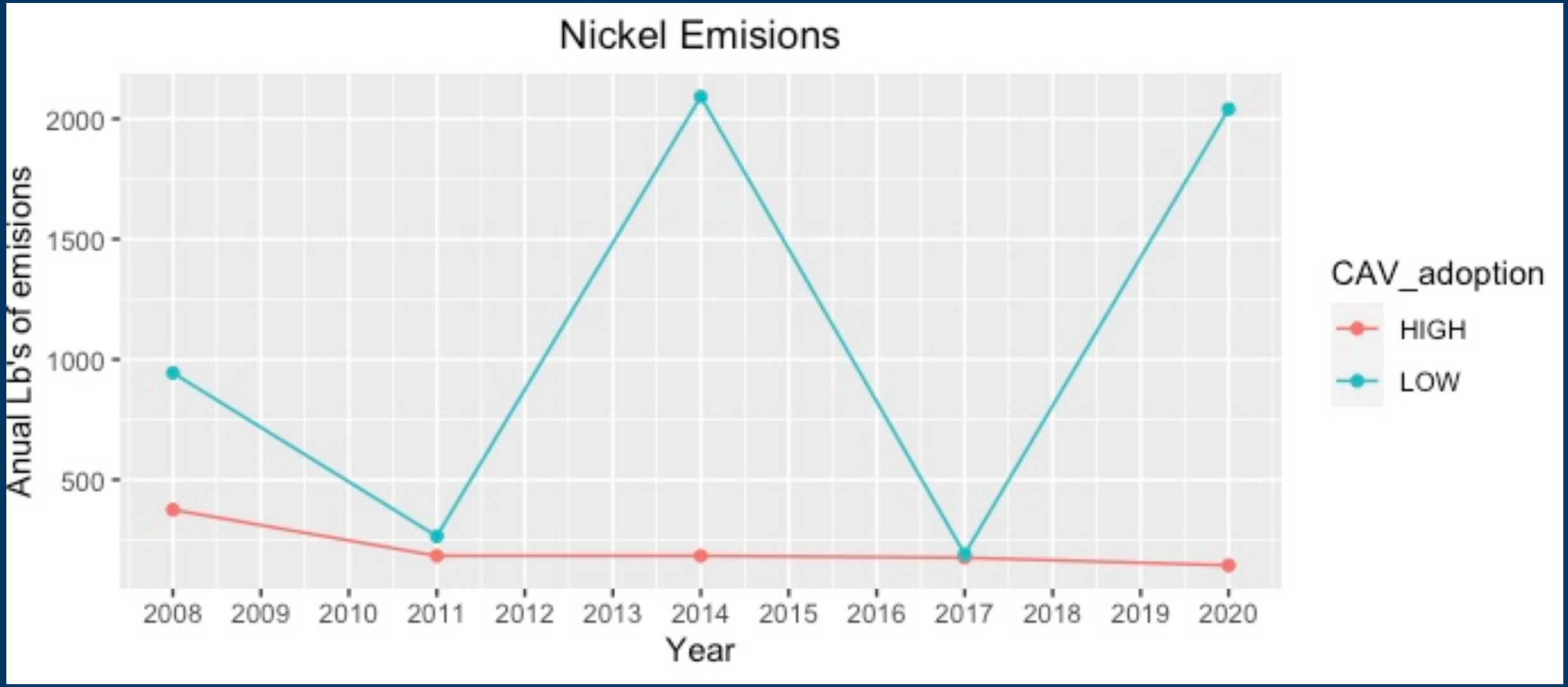

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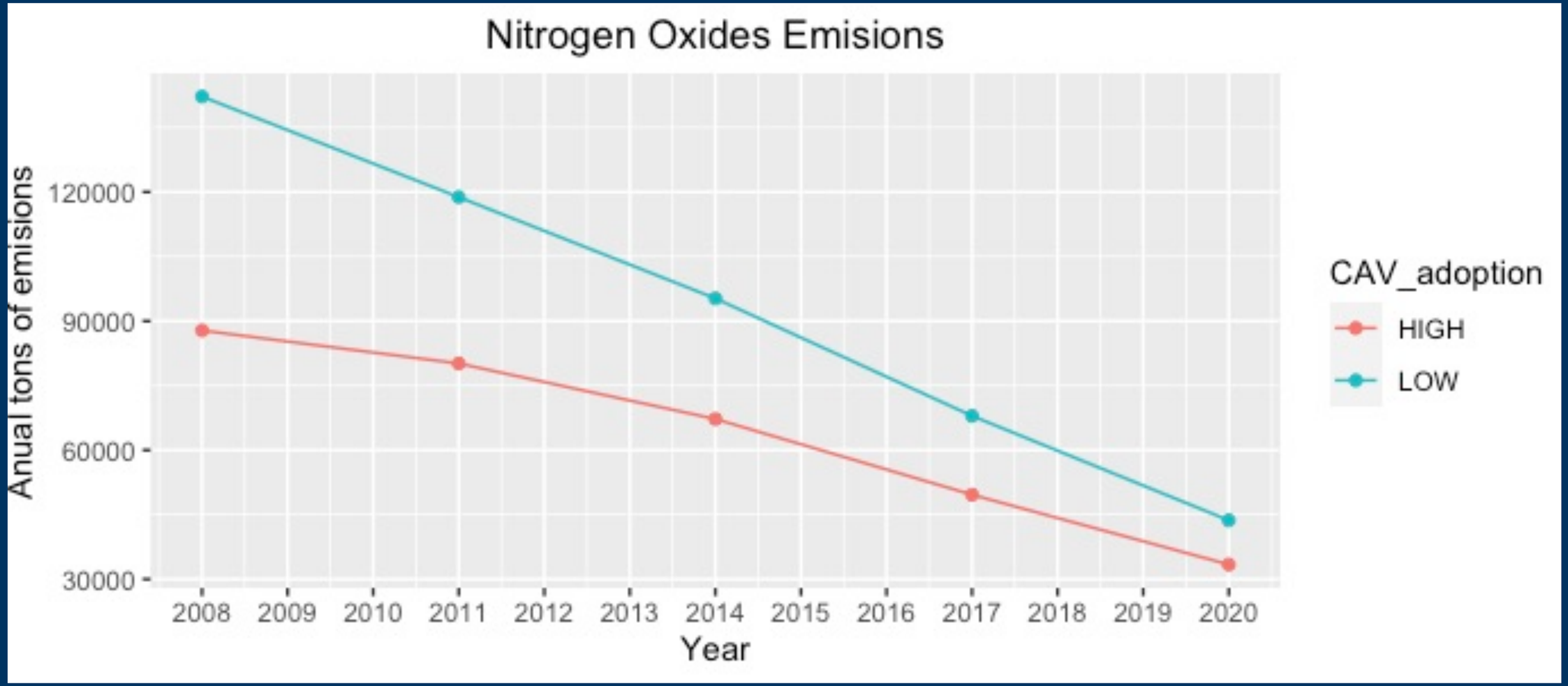

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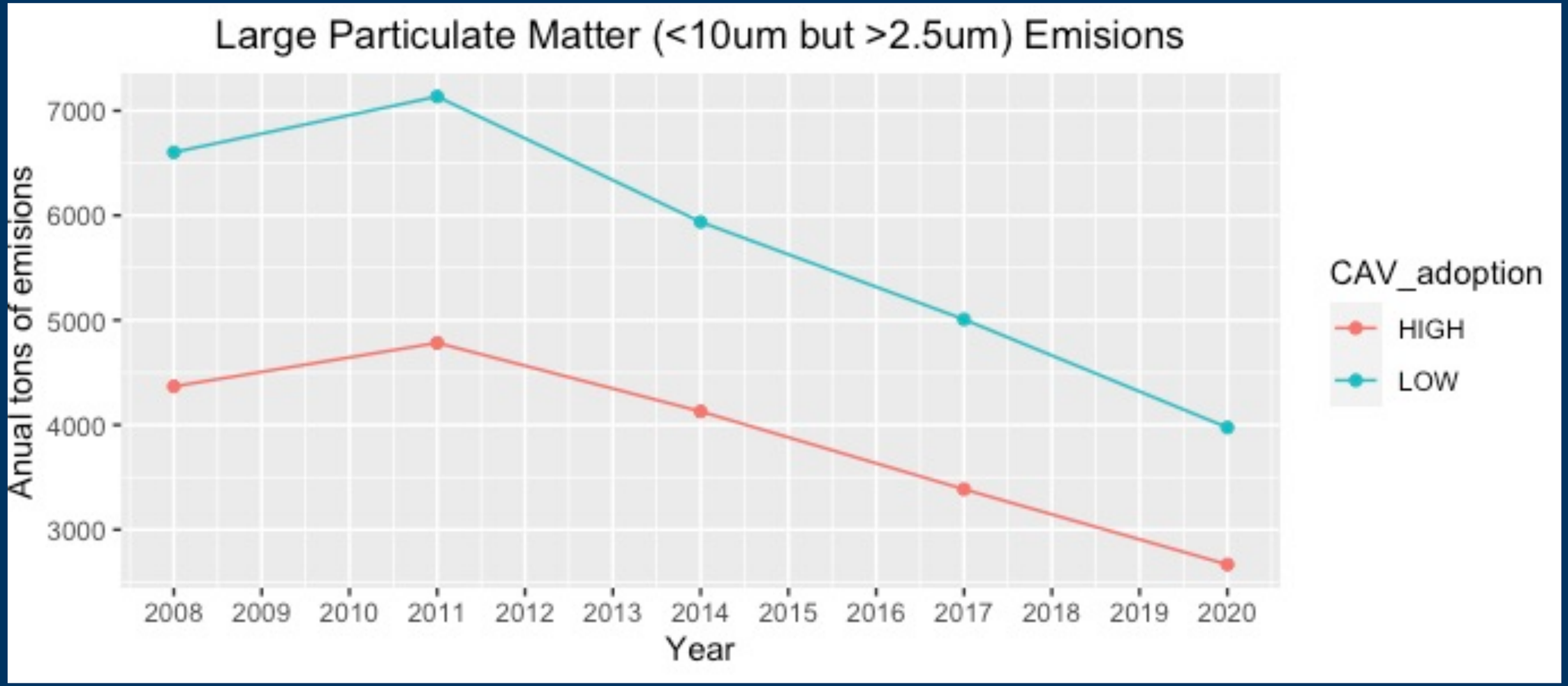

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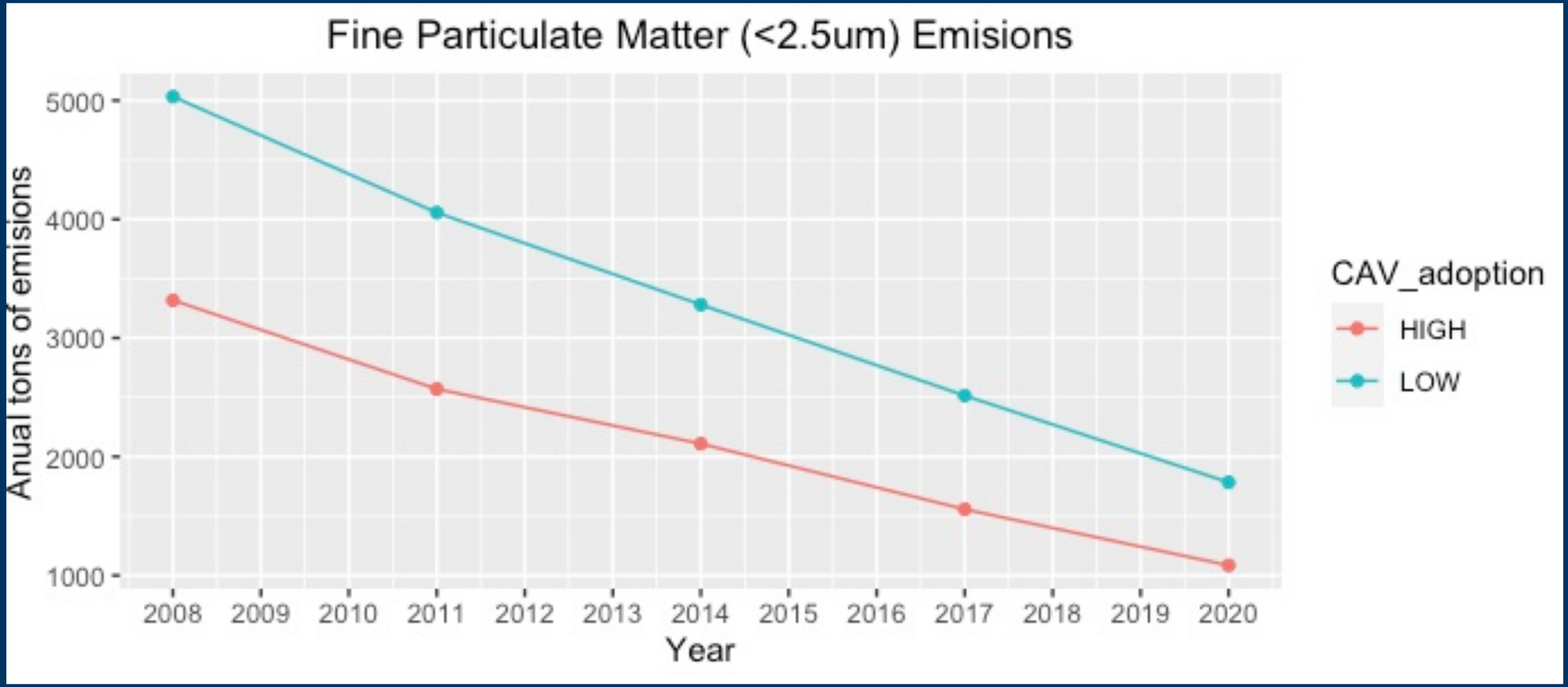

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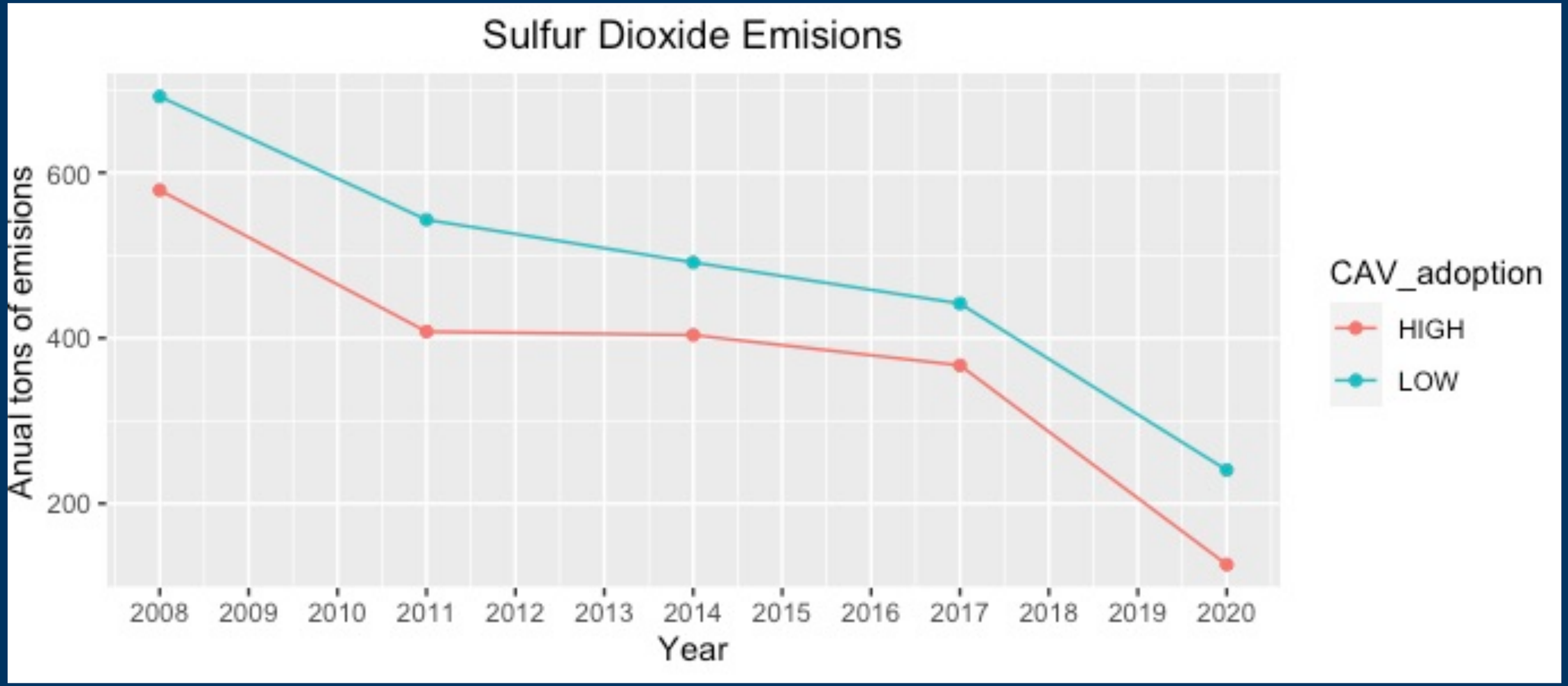

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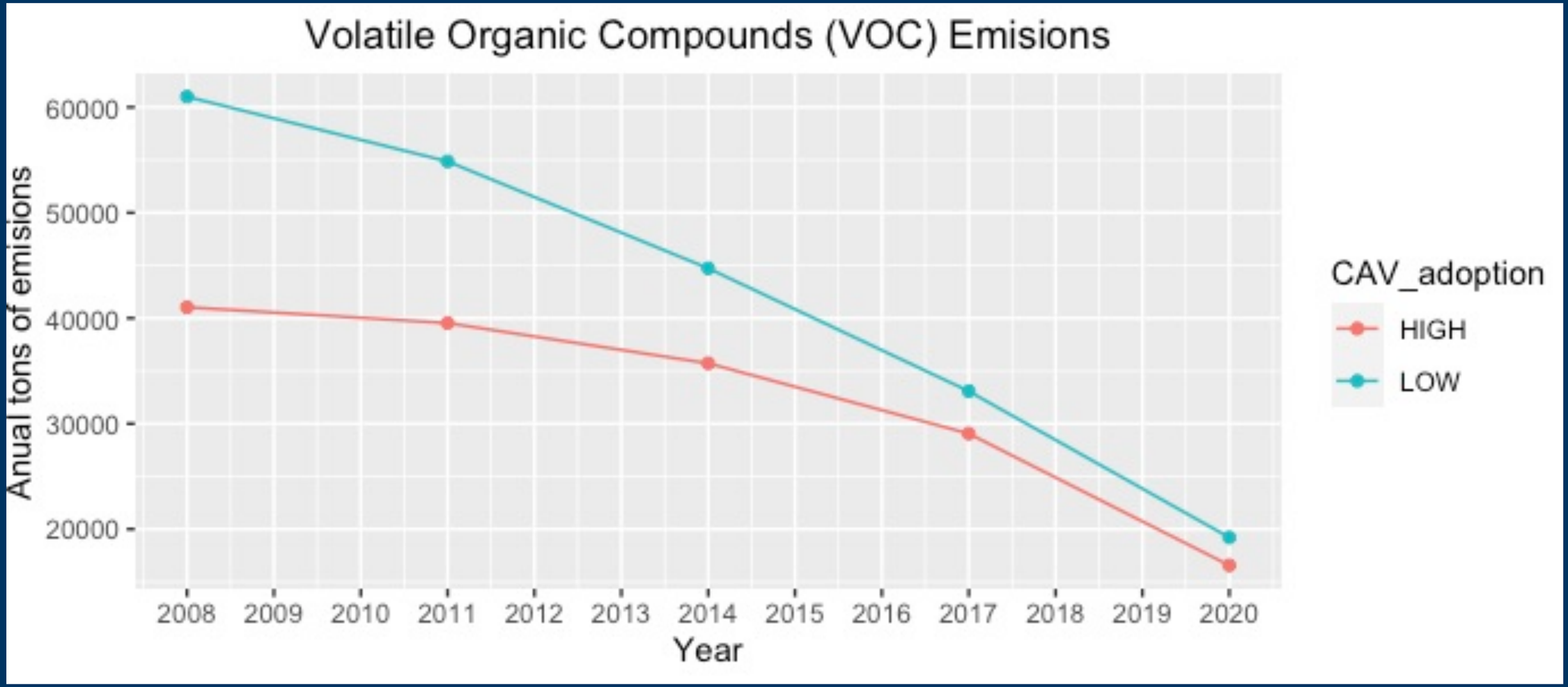

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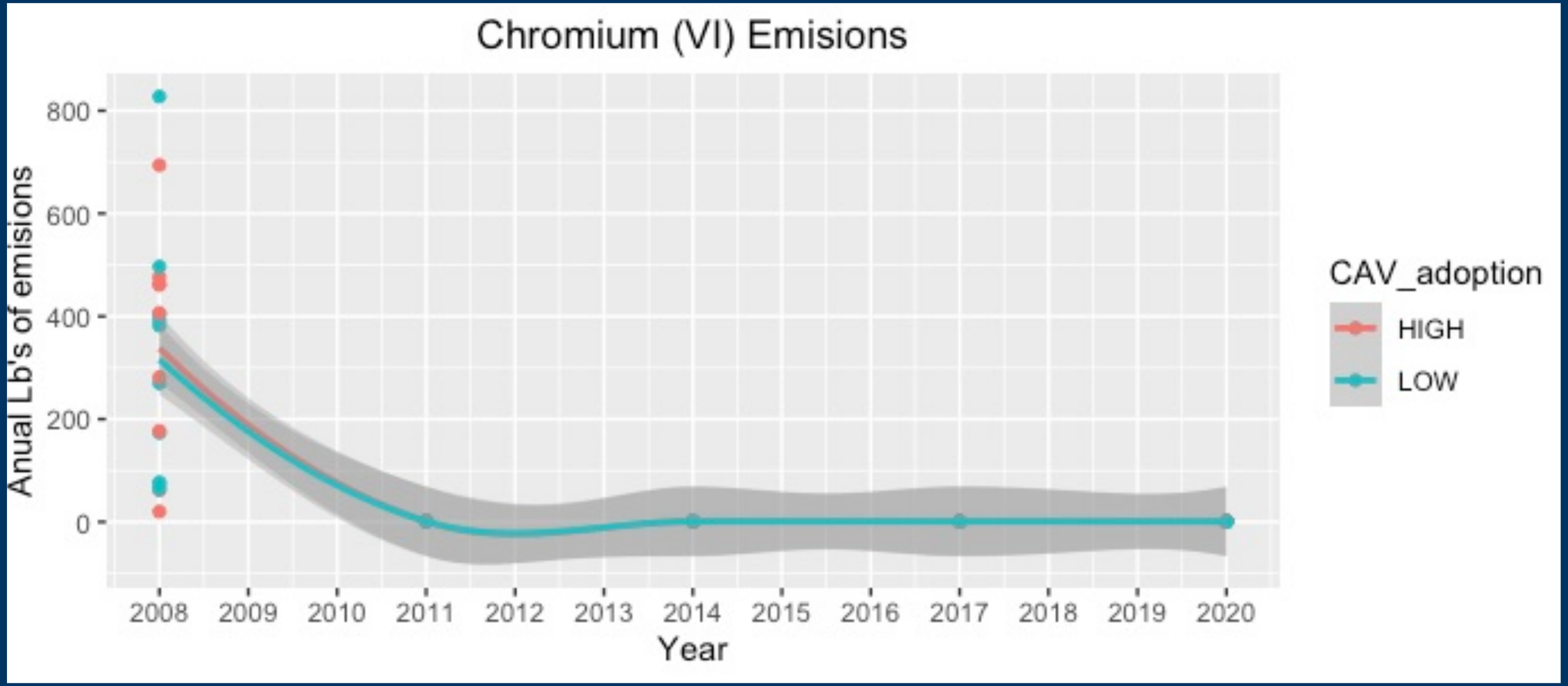
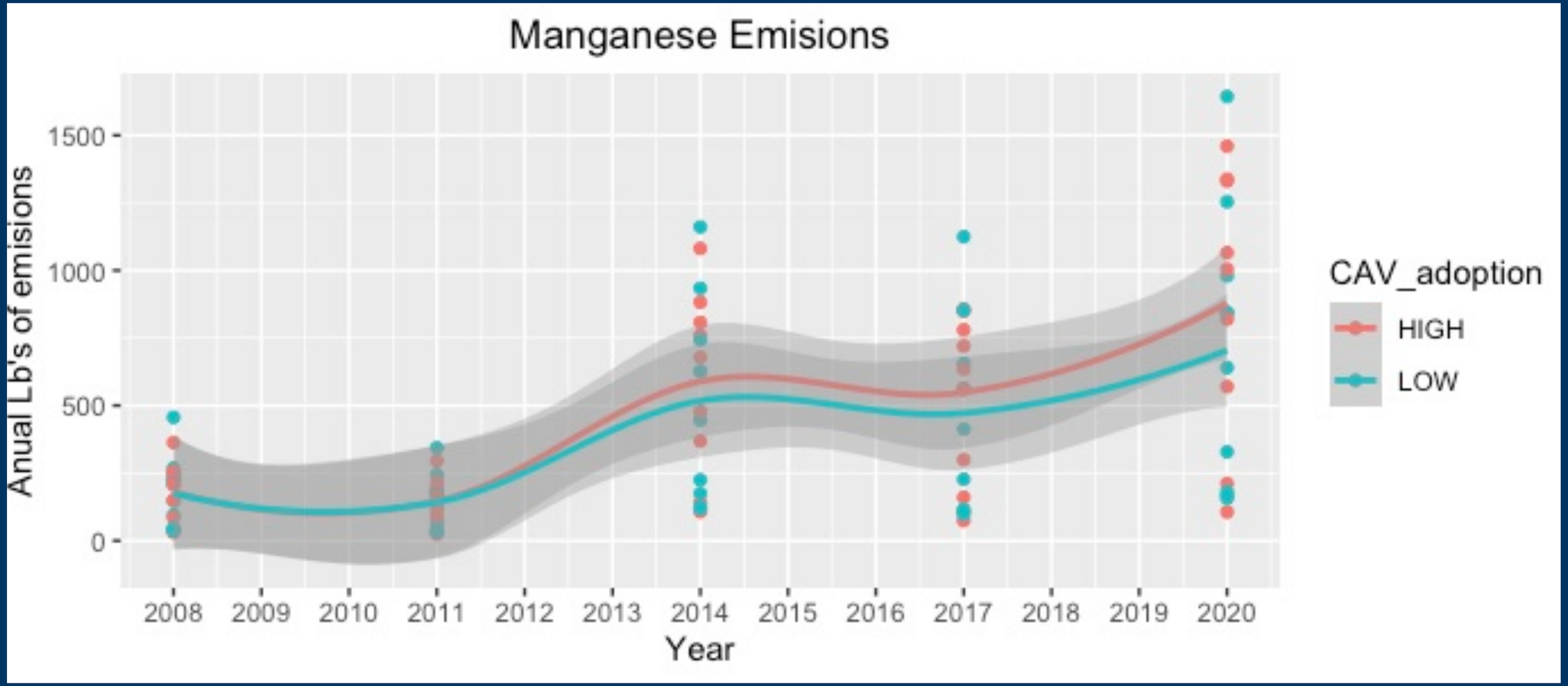


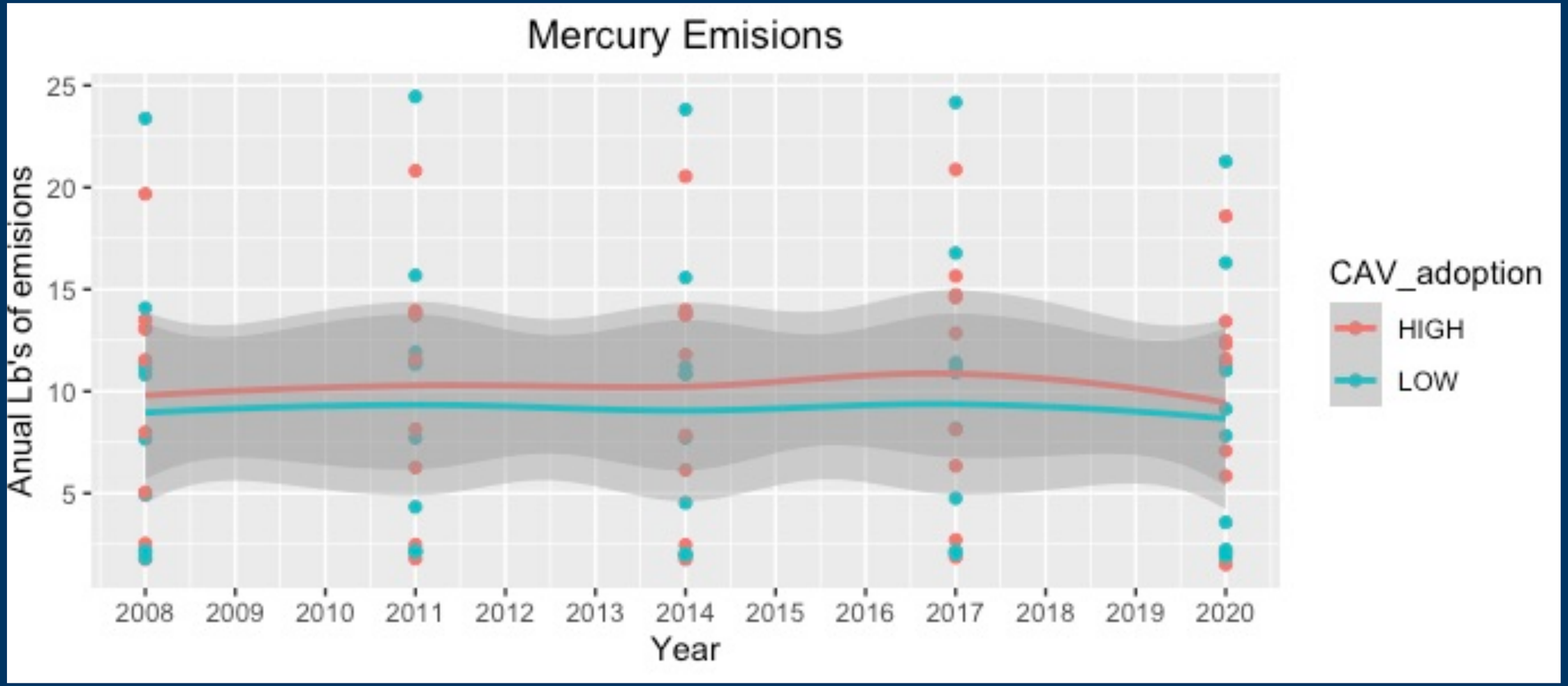
Trend-lines are identical and data past 2008 very tightly spaced

Health Pollutants



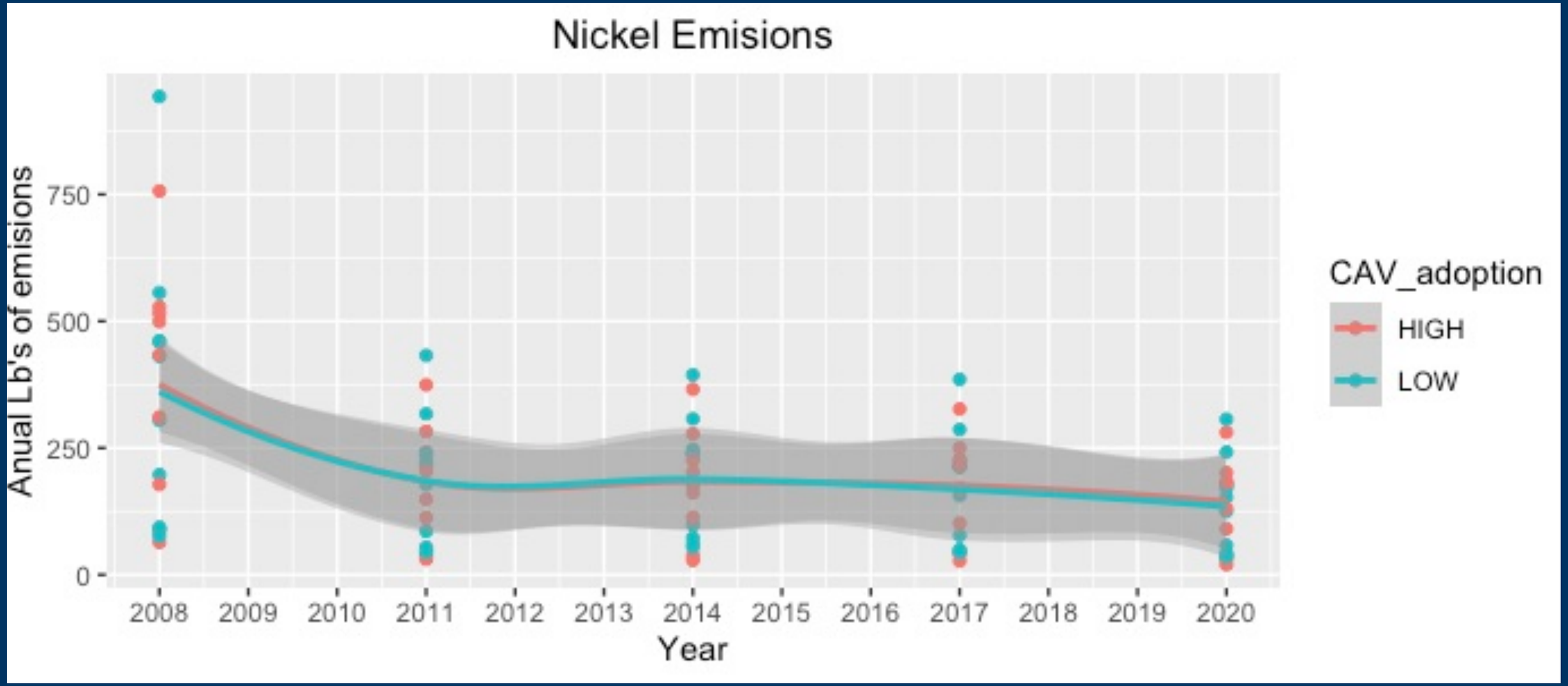
Trends slightly counter to expectations
data spread too wide for conclusions
Progressively worse over time

Health Pollutants



Trend-lines parallel with counter-intuitive positioning
data spread too wide for conclusions

Health Pollutants



Trend-lines are identical

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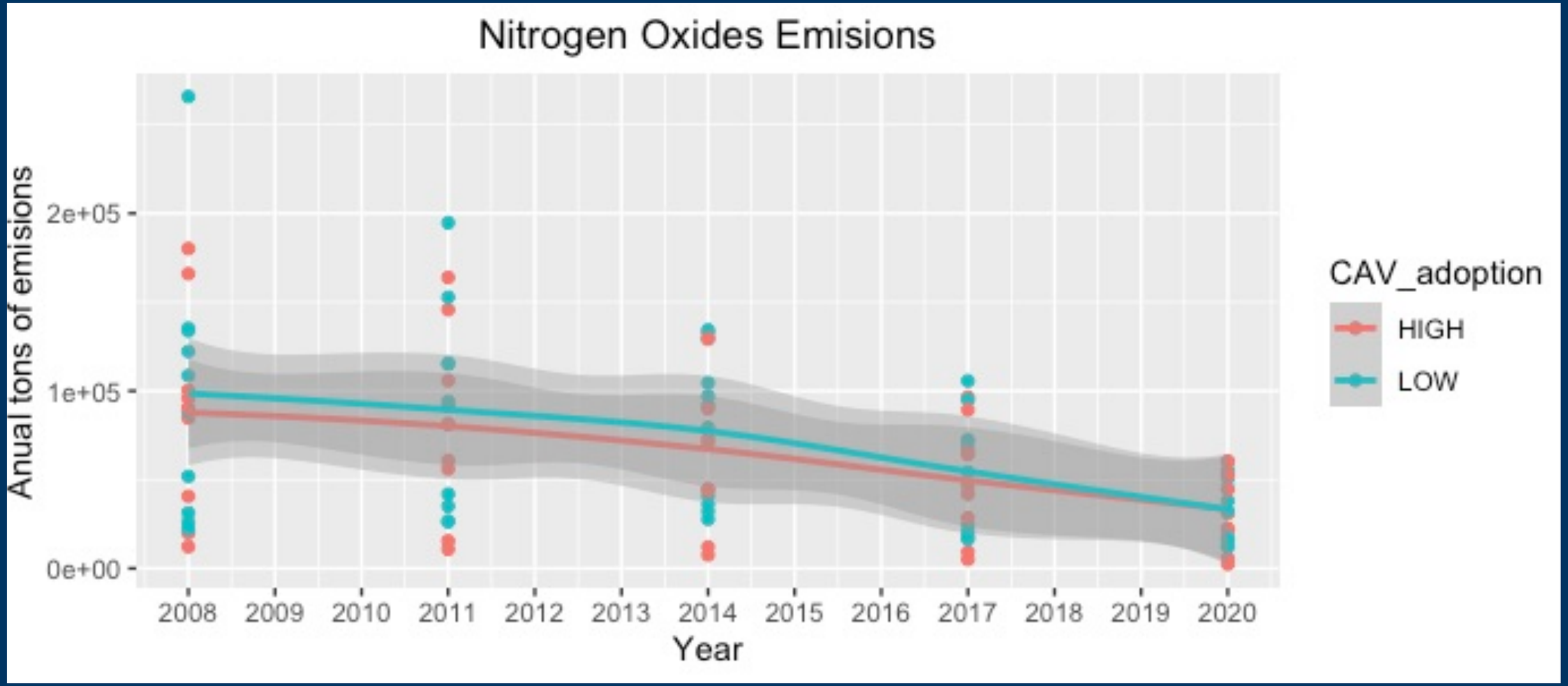

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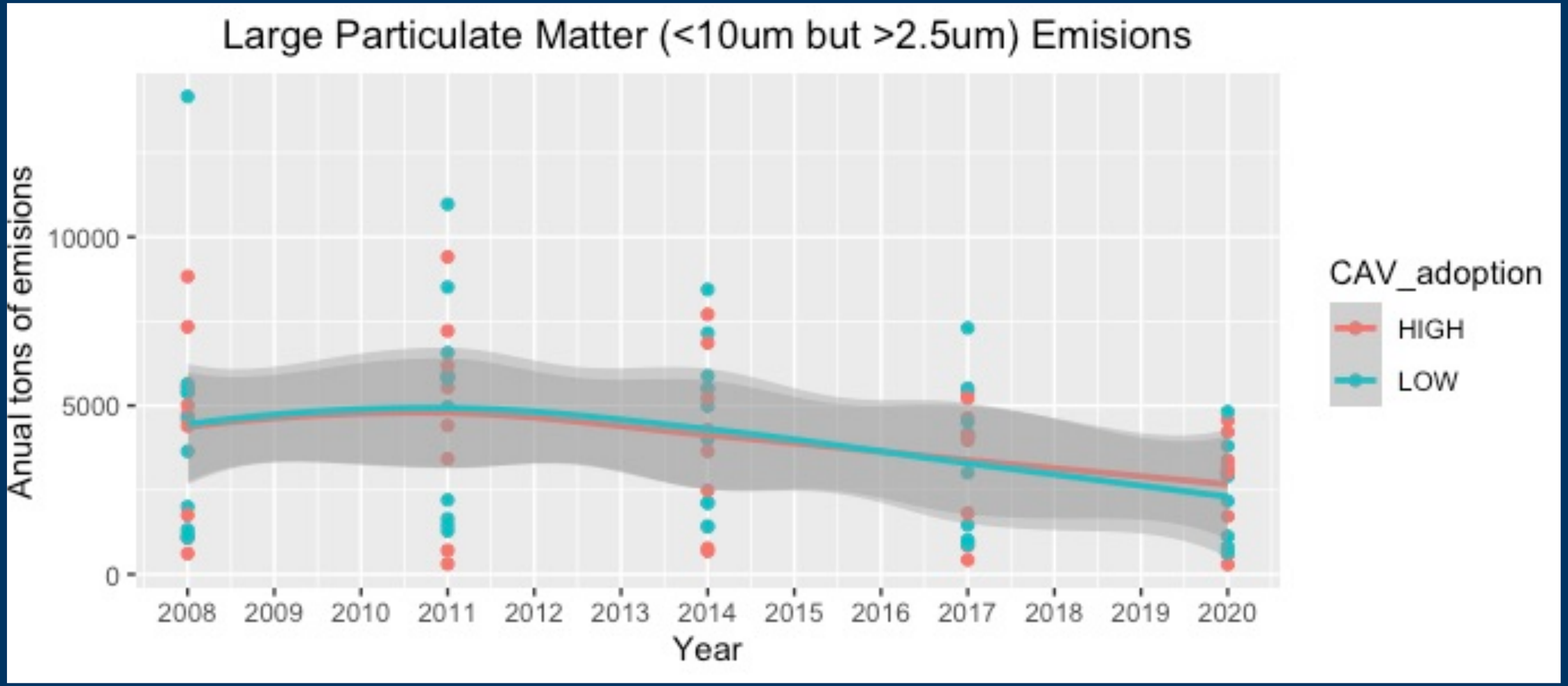

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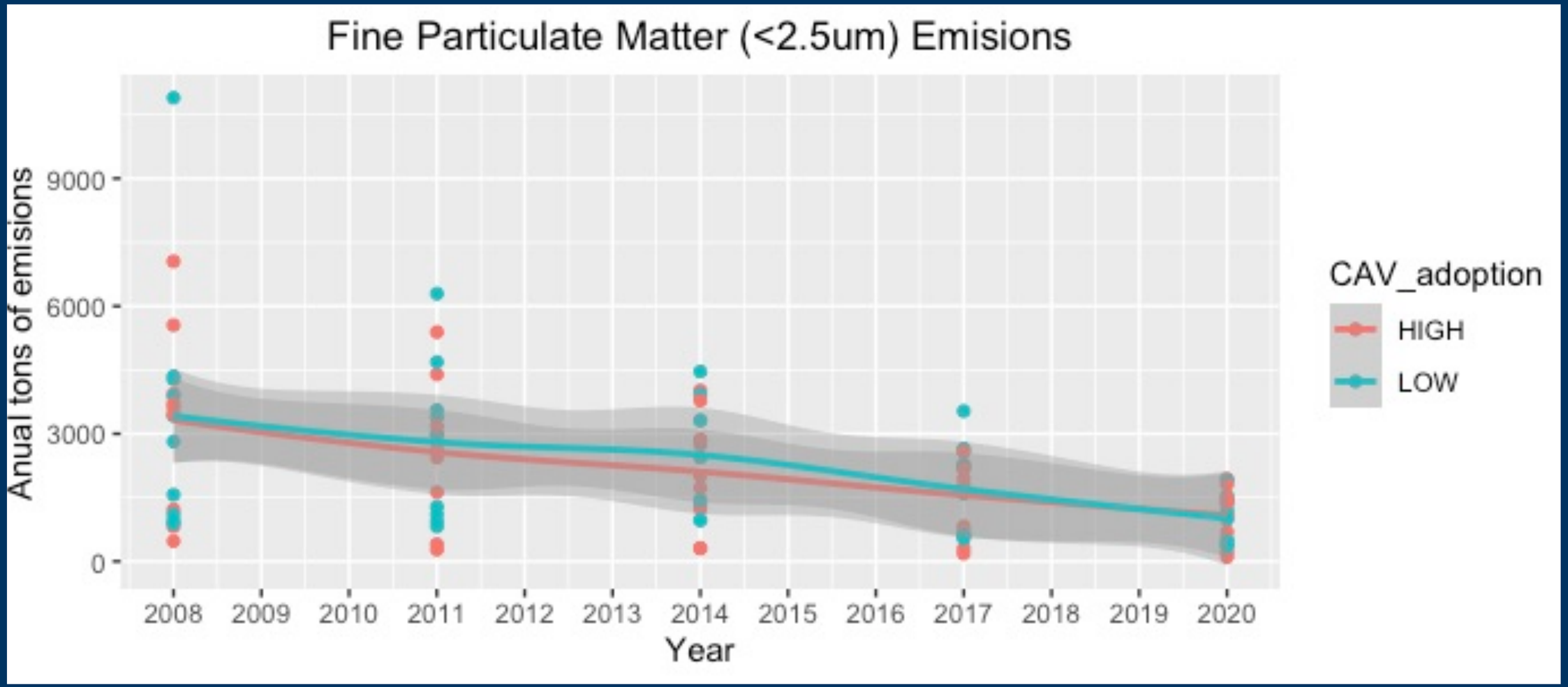

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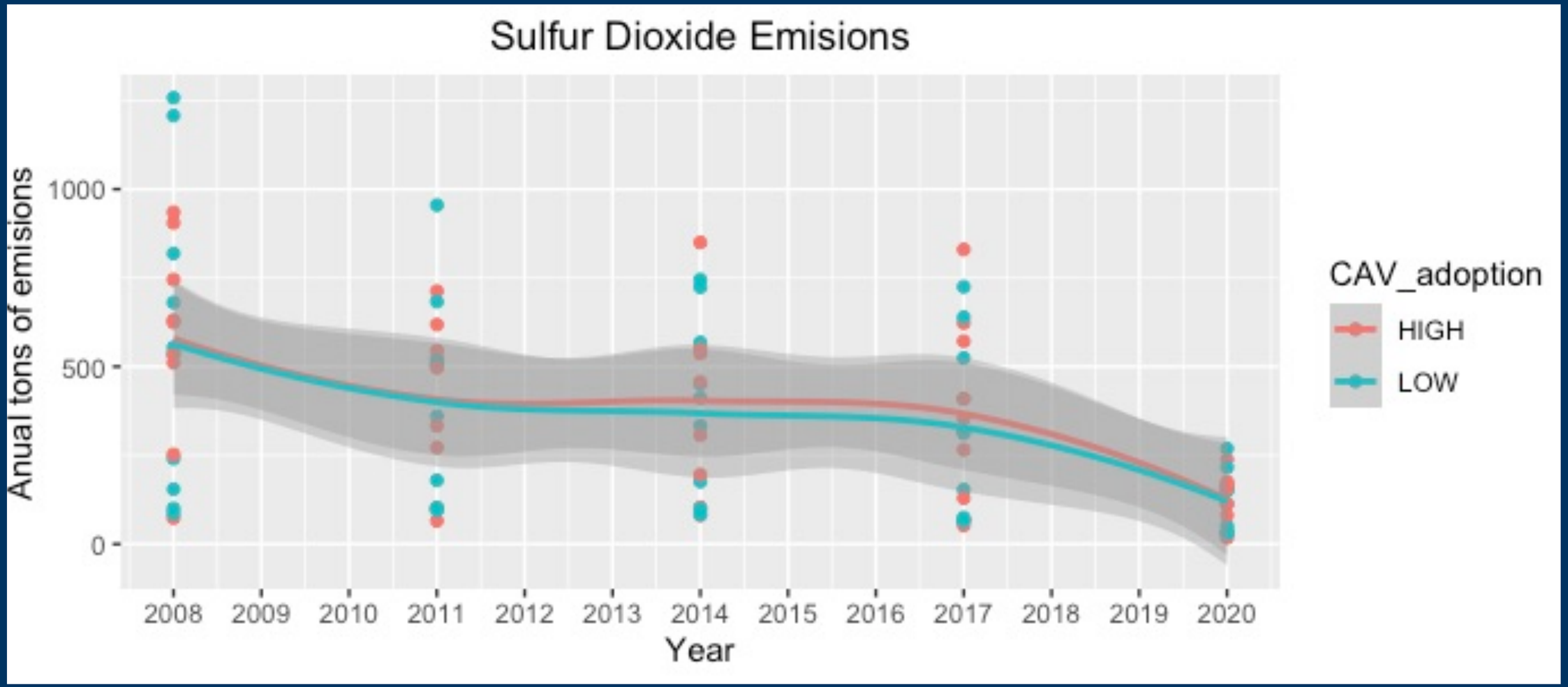

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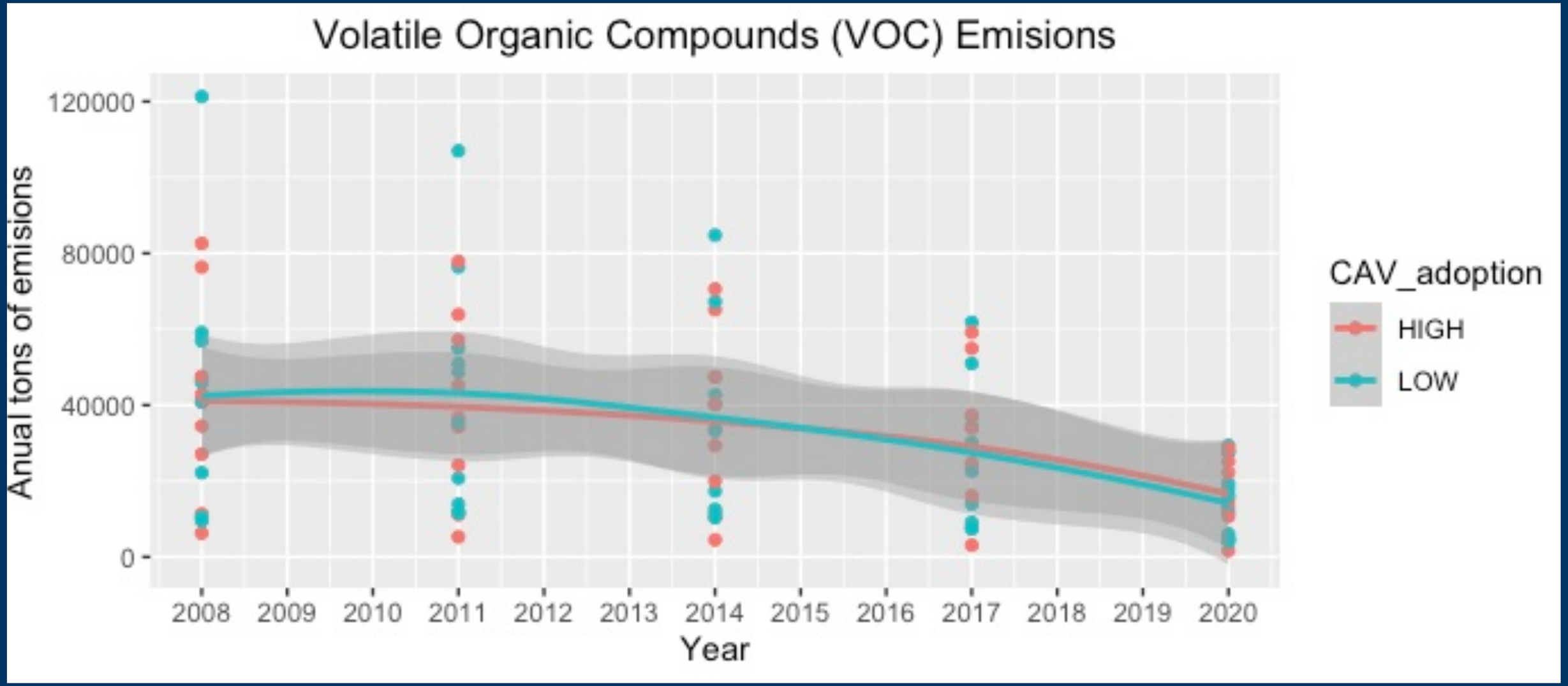

Trend-lines are identical

Conclusions

With only 4% adoption of CAV's by 2020, there was not yet enough of a reduction in roadside pollution to be noticeable when comparing states with high vs. low adoption of Electric, Plug-in Hybrid, and Hybrid vehicles.

On the bright side, most pollutants analyzed here showed improvements, primarily in early years. Due to the similarity in most of the data across states, it is likely due to nationwide changes as opposed to those of individual states. One speculation is federal laws affecting the American fleet over time. Another, the natural phasing out of older vehicles with lower gas mileage.

The Future

2021 showed increase in clean air vehicle registrations, in both sets of states discussed. While information on 2022 and 2023 are not yet available, indications from other sources show increased sales of EV's, PHEV's, and Hybrids.

California, the most populous state in the union, recently announced the phasing out of gasoline cars by 2035. Other states are considering similar legislation. Even more states are incentivizing zero emission vehicles.

The 2023 NEI data set will be very interesting to review when it is available. Perhaps we will then be able to see the beginning of a separation in data for states that have more low and zero emission vehicles.

Sources

U.S. EPA National Emissions Inventory (NEI)

U.S. Dept. of Energy Alternative Fuels Data Center

American Lung Association

CA Phasing out Gasoline Cars - CNN
Other States following CA’s lead - Bloomberg