

Pollution and Fatal Traffic Accidents in California from 1999-2019

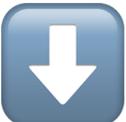
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Air pollution →  Crime

Air pollution →  Productivity

Air pollution →  Mortality

Air pollution →  Cognition

 Cognition →  Driving Ability

Air pollution →  Traffic Accidents

Air pollution →  Traffic Accidents

To what extent does air pollution
affect fatal car accidents in
California from 1999-2019?

Fatal traffic accidents cost
Californians \$5.83 billion in 2018.

● Air pollution

- Environmental Protection Agency (EPA)

● Fatal traffic accidents

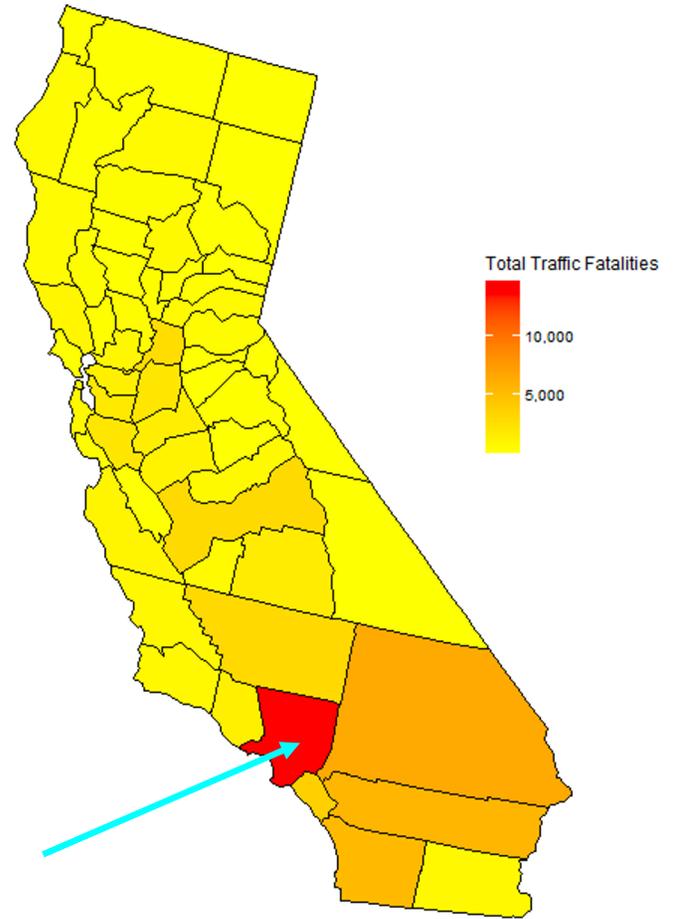
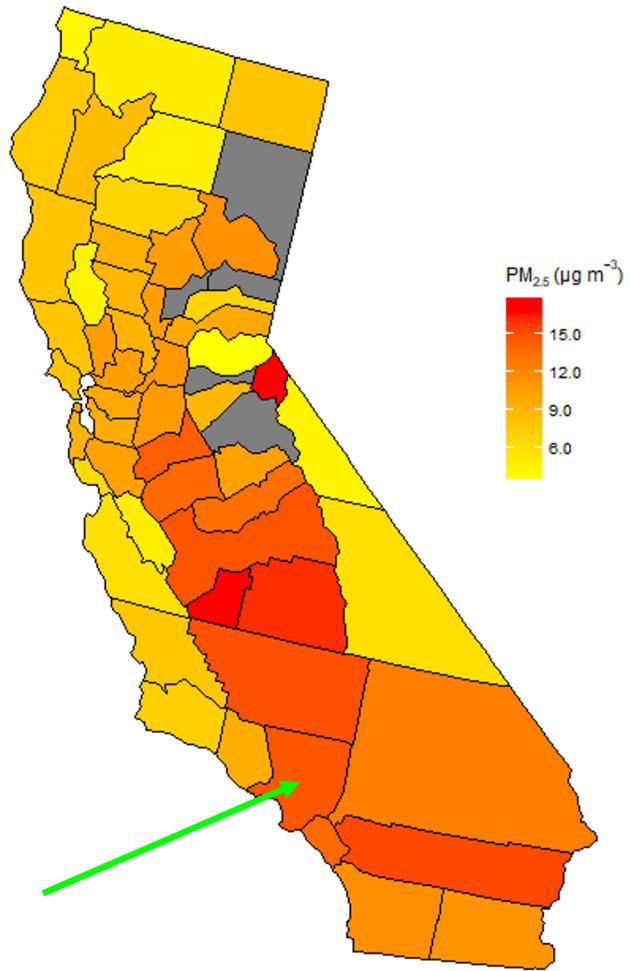
- National Highway Traffic and Safety Administration (NHTSA)

● Weather

- NASA's Goddard Earth Sciences Data and Information Services Center (GES DISC)
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Table 1: Summary Statistics

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
Surface Eastward Wind ($m s^{-1}$)	444,860	0.511	3.363	-14.875	-1.902	3.035	18.180
925 hPa Air Temp (K)	444,860	286.171	8.292	253.652	280.125	292.465	312.222
Surface Air Temp (K)	234,202	285.398	6.950	254.177	280.980	289.916	310.456
Traffic Fatalities	392,240	0.194	0.587	0.000	0.000	0.000	17.000
PM _{2.5}	256,996	10.480	9.740	-6.000	5.100	12.622	498.000
PM ₁₀	174,016	25.824	56.454	-17.500	12.472	31.000	10,020.000
SO ₂	110,308	2.514	3.885	-0.800	0.600	3.000	192.000
CO	215,125	0.605	0.499	-0.300	0.300	0.720	12.800
O ₃	369,628	0.041	0.015	0.000	0.031	0.050	0.125
Pb	15,126	0.047	0.208	0.000	0.004	0.024	14.360
NO ₂	255,524	22.626	13.197	-4.400	12.500	30.500	177.500
AQI	391,260	58.358	94.759	0.000	35.000	67.000	20,646.000
Inversion (K)	234,202	1.088	3.669	-5.839	-1.543	2.879	20.493
Cloud Coverage	444,860	0.369	0.319	0.000	0.050	0.642	0.998
Snowfall ($kg m^{-2} s^{-1}$)	444,860	0.00000	0.00002	0	0	0	0
Rainfall ($mm h^{-1}$)	414,816	1.583	6.887	0.000	0.000	0.137	232.740



Regression Analysis

- By county by day
 - $PM_{2.5}$ as independent variable
 - Fatal traffic accidents as dependent variable
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Table 3: OLS Regressions by County by Day

Dependent Variable:	Traffic Fatalities			
Model:	(1)	(2)	(3)	(4)
Variables				
(Intercept)	0.1706*** (0.0019)			
PM _{2.5}	0.0063*** (0.0001)	-2.74 × 10 ⁻⁵ (0.0001)	7.07 × 10 ⁻⁵ (0.0002)	-0.0003 (0.0008)
Surface Air Temperature (K)			0.0008 (0.0005)	0.0007 (0.0021)
Precipitation (mm h ⁻¹)			3.75 × 10 ⁻⁵ (0.0003)	-0.0003 (0.0009)
Snowfall (kg m ⁻² s ⁻¹)			-51.47 (92.12)	-648.5** (264.4)
Cloud Coverage			-0.0152* (0.0077)	-0.0159 (0.0176)
AQI				-0.0004 (0.0004)
SO ₂				0.0043 (0.0027)
CO				0.0284 (0.0308)
O ₃				2.965** (1.033)
NO ₂				0.0004 (0.0009)
<i>Fixed-effects</i>				
County	No	Yes	Yes	Yes
Date	No	Yes	Yes	Yes
<i>Fit statistics</i>				
Observations	256,996	256,996	131,645	40,297
R ²	0.00876	0.32886	0.33061	0.37467
Within R ²		1.34 × 10 ⁻⁷	4.14 × 10 ⁻⁵	0.00115

Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

Issue with OLS Regression

- Reverse causality

- Fatal traffic accidents may cause pollution



Instrumental Variables

- Sager (2019)
 - Air temperature inversions
 - Hot air above cold air, contrary to usual
 - Eastward Wind
 - Exclusion restriction
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Table 4: 2SLS First Stage by County by Day

Dependent Variable:	PM _{2.5}			
Model:	(6)	(7)	(8)	(9)
<i>Variables</i>				
(Intercept)	10.53*** (0.0281)			
Surface Eastward Wind ($m s^{-1}$)	-0.4402*** (0.0080)	-0.2015*** (0.0157)	-0.1214*** (0.0157)	-0.0213 (0.0174)
Inversion (K)	0.2802*** (0.0070)	0.1272*** (0.0164)	0.3969*** (0.0208)	0.1993*** (0.0203)
Surface Air Temperature (K)			0.3952*** (0.0189)	-0.0829*** (0.0266)
Precipitation ($mm h^{-1}$)			-0.0371*** (0.0054)	-0.0147*** (0.0056)
Snowfall ($kg m^{-2} s^{-1}$)			9,054.1*** (1,358.0)	-14,197.6*** (1,882.5)
Cloud Coverage			0.1166 (0.3118)	0.1854 (0.3070)
AQI				0.1663*** (0.0067)
SO ₂				-0.0528*** (0.0163)
CO				2.841*** (0.3043)
O ₃				-231.6*** (9.570)
NO ₂				0.0631*** (0.0079)
<i>Fixed-effects</i>				
Date	No	Yes	Yes	Yes
County	No	Yes	Yes	Yes
<i>Fit statistics</i>				
Observations	135,469	135,469	131,645	40,297
R ²	0.02821	0.44855	0.44807	0.71913
Within R ²		0.00375	0.01581	0.42955

Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

F-test on Eastward Wind and Inversion

138.245, confirming that the instruments significantly affect $PM_{2.5}$

Table 5: 2SLS Second Stage by County by Day

Dependent Variable:	Traffic Fatalities			
Model:	(10)	(11)	(12)	(13)
<i>Variables</i>				
(Intercept)	0.2688*** (0.0116)			
PM _{2.5}	-0.0032*** (0.0011)	-0.0017 (0.0028)	0.0004 (0.0023)	0.0063 (0.0090)
Surface Air Temperature (K)			0.0008 (0.0007)	0.0021 (0.0029)
Precipitation ($mm\ h^{-1}$)			5.14×10^{-5} (0.0003)	-0.0002 (0.0009)
Snowfall ($kg\ m^{-2}\ s^{-1}$)			-54.23 (92.65)	-561.6** (259.9)
Cloud Coverage			-0.0150** (0.0070)	-0.0151 (0.0176)
AQI				-0.0016 (0.0015)
SO ₂				0.0046 (0.0028)
CO				0.0094 (0.0432)
O ₃				4.520* (2.533)
NO ₂				-2.43×10^{-5} (0.0009)
<i>Fixed-effects</i>				
County	No	Yes	Yes	Yes
Date	No	Yes	Yes	Yes
<i>Fit statistics</i>				
Observations	135,469	135,469	131,645	40,297
R ²	-0.01154	0.33172	0.33060	0.37372
Within R ²		-0.00065	2.5×10^{-5}	-0.00037

Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

Potential Biases

- Omitted variable bias: traffic volume
 - Sager finds that $PM_{2.5}$ does not affect volume
 - Omitted data points
 - By county by week analysis
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F-test on Eastward Wind and Inversion Weekly Analysis

132.092, confirming that the
instruments significantly affect $PM_{2.5}$

Table 6: 2SLS Second Stage by County by Week

Dependent Variable:	Traffic Fatalities			
Model:	(14)	(15)	(16)	(17)
<i>Variables</i>				
(Intercept)	2.173*** (0.1122)			
PM _{2.5}	-0.0811*** (0.0114)	0.0096** (0.0047)	0.0043 (0.0060)	0.0018 (0.0420)
Surface Air Temperature (K)			0.0104*** (0.0030)	0.0145* (0.0077)
Precipitation ($mm\ h^{-1}$)			0.0013 (0.0014)	0.0093 (0.0054)
Snowfall ($kg\ m^{-2}\ s^{-1}$)			1,951.9*** (638.3)	-3,132.0 (2,082.3)
Cloud Coverage			-0.1081** (0.0486)	-0.0966 (0.1251)
AQI				-0.0033 (0.0095)
SO ₂				0.0314** (0.0140)
CO				0.0786 (0.2017)
O ₃				8.765 (13.26)
NO ₂				0.0125** (0.0045)
<i>Fixed-effects</i>				
County	No	Yes	Yes	Yes
Week	No	Yes	Yes	Yes
Year	No	Yes	Yes	Yes
<i>Fit statistics</i>				
Observations	53,155	53,155	50,034	13,902
R ²	-0.16191	0.72407	0.72665	0.74406
Within R ²		-0.00243	0.00030	0.00460
<i>Signif. Codes: ***: 0.01, **: 0.05, *: 0.1</i>				

Discussion and Conclusion

- “To what extent does air pollution affect fatal car accidents in California from 1999-2019?”
 - Raises questions
 - Further research
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