*Supporting information for*

The Intersection of Total and Wildland Fire-Attributed PM2.5 Exposure Disparities in the United States

*R. Byron Riceab, Jason D. Sacksa, Kirk R. Bakerc, Stephen D. LeDuca, J. Jason Westb*

aCenter for Public Health and Environmental Assessment,Office of Research and Development, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, USA.

bDepartment of Environmental Sciences and Engineering, Gillings School of Global Public Health, University of North Carolina, Chapel Hill, North Carolina, USA

cCenter for Environmental Measurement and Modeling,Office of Research and Development, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, USA.

# List of Figures

[**Figure S1.** Percent of total contiguous US population weighted PM2.5concentrations attributable to wildland fire in 2007 to 2018. 6](#_Toc165977711)

[**Figure S2.** Maps of 2007 to 2018 CMAQ annual mean total PM2.5 concentrations. 7](#_Toc165977712)

[**Figure S3.** Maps of 2007 to 2018 CMAQ annual mean non-fire PM2.5 concentrations. 8](#_Toc165977713)

[**Figure S4.** Maps of 2007 to 2018 CMAQ annual mean wildland fire PM2.5 concentrations. 9](#_Toc165977714)

[**Figure S5.** Annual average total PM2.5 in Census tracts where both wildland fire PM2.5 and non-fire PM2.5 concentrations are in the top 50th percentile annually of Census tracts in 2007 to 2018. 10](#_Toc165977715)

[**Figure S6.** Count of people living in contiguous US Census tracts with annual means exceeding 9.6 μg/m3 PM2.5 (i.e., the overall 2007 to 2018 population weighted mean), considering total PM2.5 and PM2.5 from non-fire sources from 2007 to 2018. Light blue denotes people living in Census tracts that would not be above the 9.6 μg/m3 threshold if not for contributions from wildland fires. 12](#_Toc165977716)

[**Figure S7.** Annual average population-weighted PM2.5 concentrations in 2007 to 2018 by National Climate Assessment (NCA) region for total PM2.5 (CMAQ Total),non-fire PM2.5 (CMAQ No Fire), wildland fire-specific PM2.5 (CMAQ Fire), and wildfire PM2.5 estimated in Childs et al. (2022).30 (Childs Fire). 15](#_Toc165977717)

[**Figure S8.** Annual average population-weighted PM2.5 concentrations in 2007 to concentrations by urban-rural status identified using Rural-Urban Commuting Area primary codes (RUCA) for total PM2.5 (CMAQ Total),non-fire PM2.5 (CMAQ No Fire), wildland fire-specific PM2.5 (CMAQ Fire), and wildfire PM2.5 estimated in Childs et al. (2022).30 (Childs Fire). RUCA categories: urban core (RUCA code 1), suburban (RUCA code 2), micropolitan (RUCA codes 3, 4, 5, and 6), small town (RUCA codes 7, 8, and 9), and rural (RUCA code 10). 16](#_Toc165977718)

[**Figure S9.** Annual average population-weighted PM2.5 concentrations in 2007 to 2018 by language spoken at home for total PM2.5 (CMAQ Total),non-fire PM2.5 (CMAQ No Fire), wildland fire-specific PM2.5 (CMAQ Fire), and wildfire PM2.5 estimated in Childs et al. (2022).30 (Childs Fire). 17](#_Toc165977719)

[**Figure S10.** Annual average population-weighted PM2.5 concentrations in 2007 to 2018 by per-capita income quintile for total PM2.5 (CMAQ Total),non-fire PM2.5 (CMAQ No Fire), wildland fire-specific PM2.5 (CMAQ Fire), and wildfire PM2.5 estimated in Childs et al. (2022).30 (Childs Fire). Per-capita income quintiles: quintile 1: $150-$17,261, quintile 2: $17,261-$21,837, quintile 3: $21,837-$26,687, quintile 4: $26,687-$34,707, and quintile 5: $34,707-$293,610. 18](#_Toc165977720)

[**Figure S11.** Population weighted 98th percentile of contiguous United States daily average PM2.5 concentrations in 2007 to 2018. 19](#_Toc165977721)

[**Figure S12.** Annual population-weighted 98th percentile of 2007 to 2018 daily total CMAQ PM2.5 exposure by region, primary rural urban commuting area code (RUCA 1), race/ethnicity, language, and quintile of per-capita income. 20](#_Toc165977722)

[**Figure S13.** Relative burden of total (CMAQ Total), wildland fire (CMAQ Fire), non-fire (CMAQ No Fire) PM2.5 concentrations by Rural-Urban Commuting Area (RUCA) urbanicity classifications, race and ethnicity, language spoken at home, and per-capita income quintile in the midwest. Regional subgroup concentrations are compared to overall CONUS concentrations. 21](#_Toc165977723)

[**Figure S14.** Relative burden of total (CMAQ Total), wildland fire (CMAQ Fire), non-fire (CMAQ No Fire) PM2.5 concentrations by Rural-Urban Commuting Area (RUCA) urbanicity classifications, race and ethnicity, language spoken at home, and per-capita income quintile in the northeast. Regional subgroup concentrations are compared to overall CONUS concentrations. 22](#_Toc165977724)

[**Figure S15.** Relative burden of total (CMAQ Total), wildland fire (CMAQ Fire), non-fire (CMAQ No Fire) PM2.5 concentrations by Rural-Urban Commuting Area (RUCA) urbanicity classifications, race and ethnicity, language spoken at home, and per-capita income quintile in the northern great plains. Regional subgroup concentrations are compared to overall CONUS concentrations. 23](#_Toc165977725)

[**Figure S16.** Relative burden of total (CMAQ Total), wildland fire (CMAQ Fire), non-fire (CMAQ No Fire) PM2.5 concentrations by Rural-Urban Commuting Area (RUCA) urbanicity classifications, race and ethnicity, language spoken at home, and per-capita income quintile in the southern great plains. Regional subgroup concentrations are compared to overall CONUS concentrations. 24](#_Toc165977726)

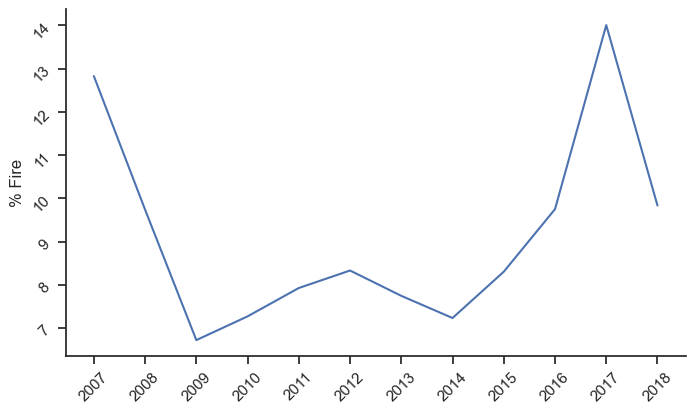
[**Figure S17.** Relative burden of total (CMAQ Total), wildland fire (CMAQ Fire), non-fire (CMAQ No Fire) PM2.5 concentrations by Rural-Urban Commuting Area (RUCA) urbanicity classifications, race and ethnicity, language spoken at home, and per-capita income quintile in the southwest. Regional subgroup concentrations are compared to overall CONUS concentrations. 26](#_Toc165977727)

[**Figure S18.** Relative burden of wildland fire (CMAQ Fire) compared to Childs wildfire PM2.530 (Childs Fire) concentrations by Rural-Urban Commuting Area (RUCA) urbanicity classifications, race and ethnicity, language spoken at home, and per-capita income quintile. 26](#_Toc165977728)

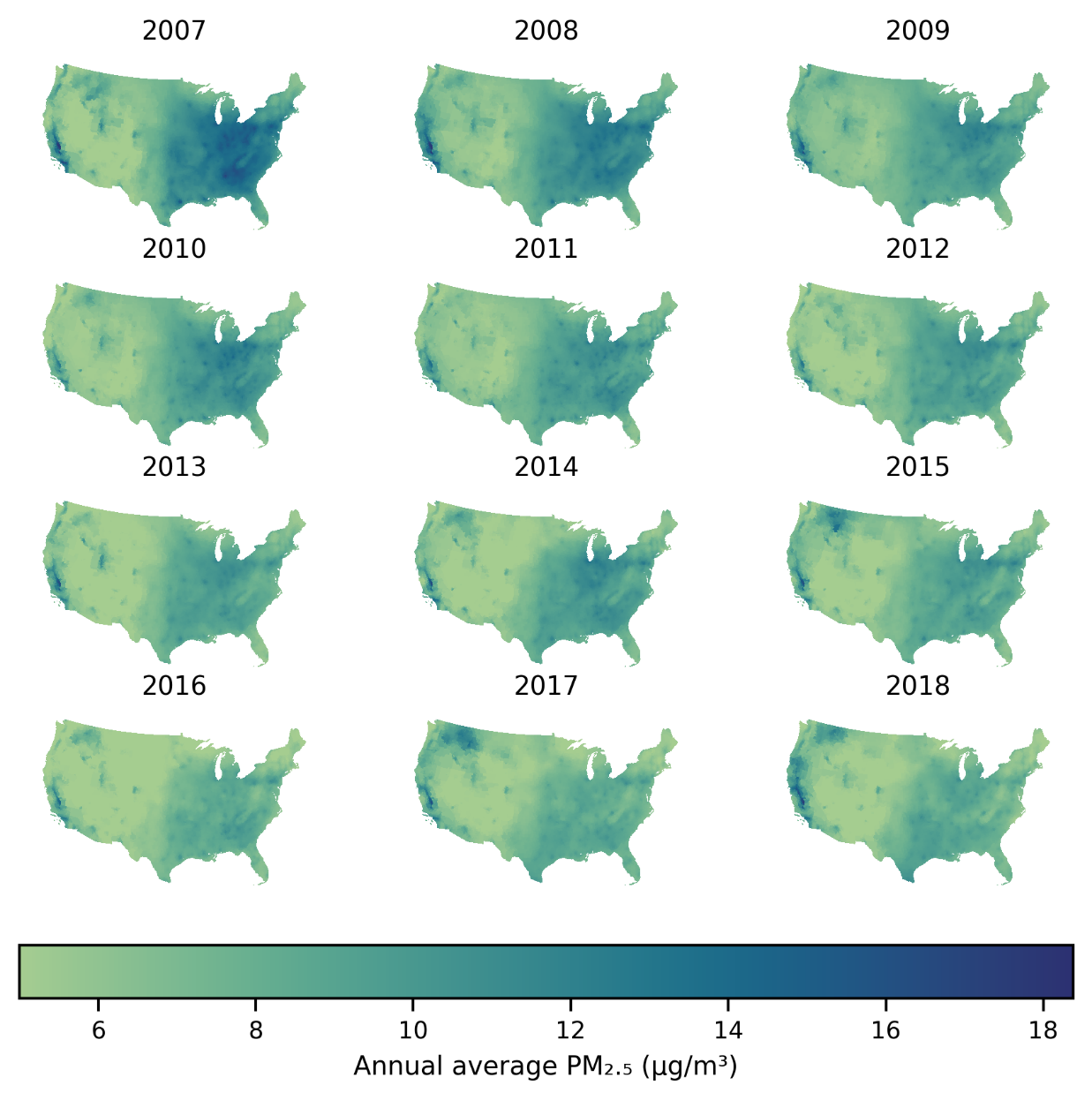
# List of Tables

[**Table S1.** Correlation (Pearson’s r) between census tract-level annual mean PM2.5 for each dataset included in this study, overall in 2007 to 2018. 10](#_Toc165962338)

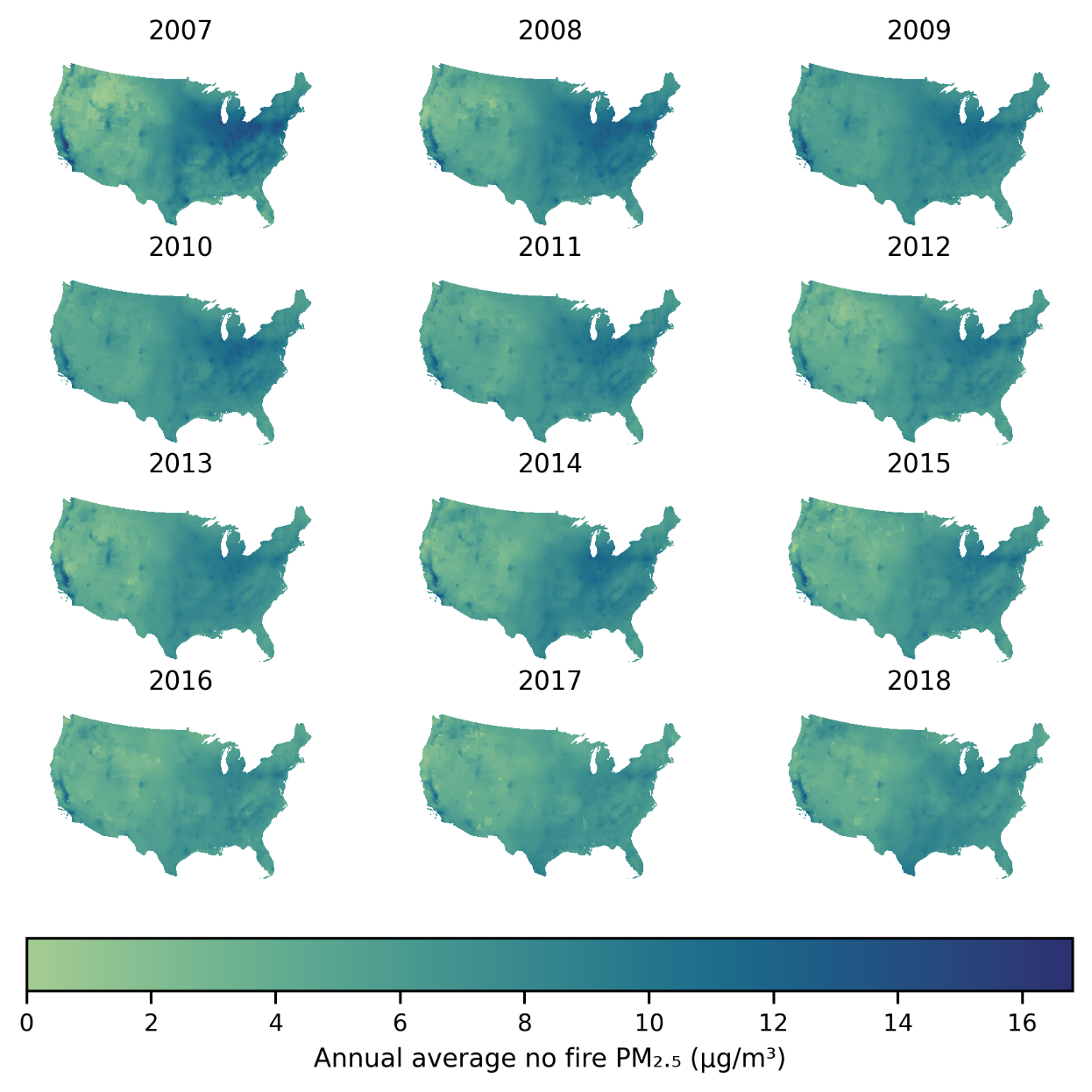
[**Table S2.** Population living in Census tracts with greater than the 2007 to 2018 population weighted mean no fire PM2.5 (8.7 µg/m³), fire PM2.5 (0.88 µg/m³), and both fire and no fire PM2.5 population weighted means by National Climate Assessment (NCA) regions, primary Rural Urban Commuting Area codes (RUCA), racial and ethnic groups, language spoken at home, and quintiles of per-capita income. 11](#_Toc165962339)



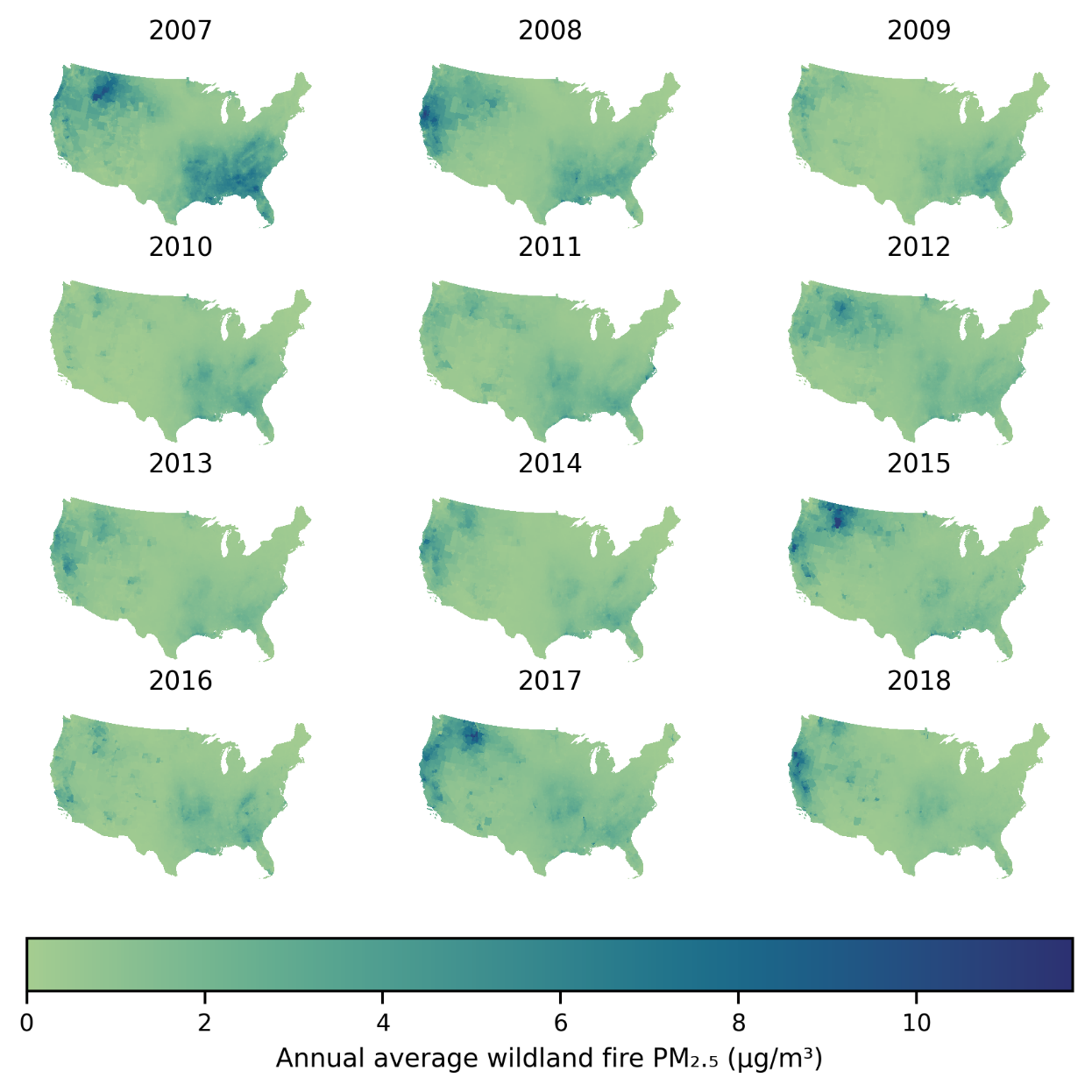
**Figure S1.** Percent of total contiguous US population weighted PM2.5concentrations attributable to wildland fire in 2007 to 2018.



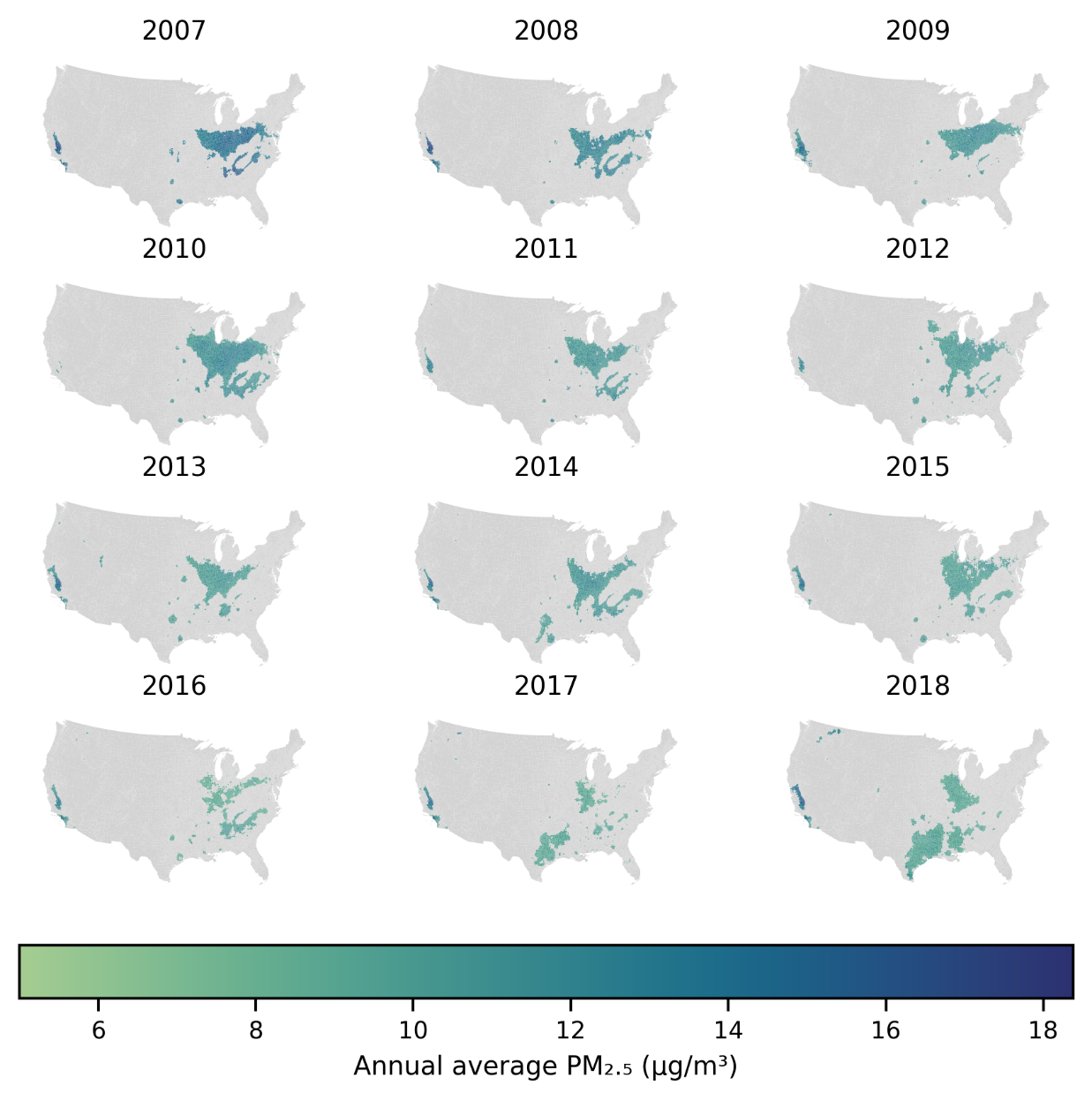
**Figure S2.** Maps of 2007 to 2018 CMAQ annual mean total PM2.5 concentrations.



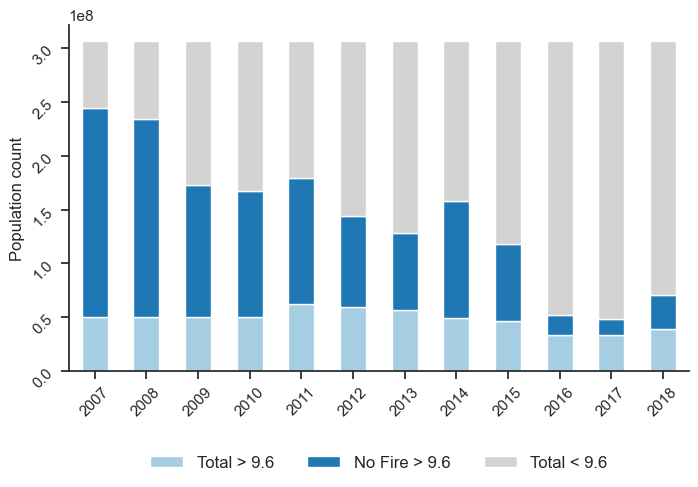
**Figure S3.** Maps of 2007 to 2018 CMAQ annual mean non-fire PM2.5 concentrations.



**Figure S4.** Maps of 2007 to 2018 CMAQ annual mean wildland fire PM2.5 concentrations.



**Figure S5.** Annual average total PM2.5 in Census tracts where both wildland fire PM2.5 and non-fire PM2.5 concentrations are in the top 50th percentile annually of Census tracts in 2007 to 2018.



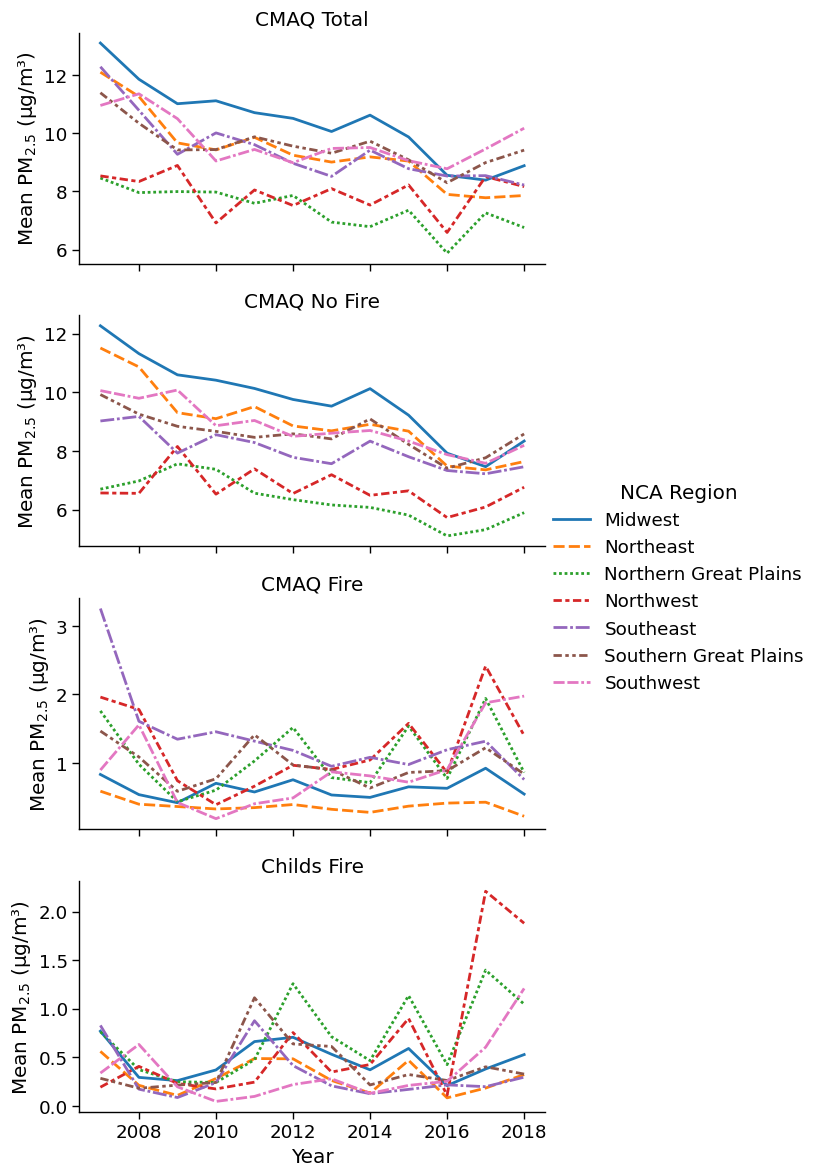
**Figure S6.** Count of people living in contiguous US Census tracts with annual means exceeding 9.6 μg/m3 PM2.5 (i.e., the overall 2007 to 2018 population weighted mean), considering total PM2.5 and PM2.5 from non-fire sources from 2007 to 2018. Light blue denotes people living in Census tracts that would not be above the 9.6 μg/m3 threshold if not for contributions from wildland fires.

**Table S1.** Correlation (Pearson’s r) between census tract-level annual mean PM2.5 for each dataset included in this study, overall in 2007 to 2018.

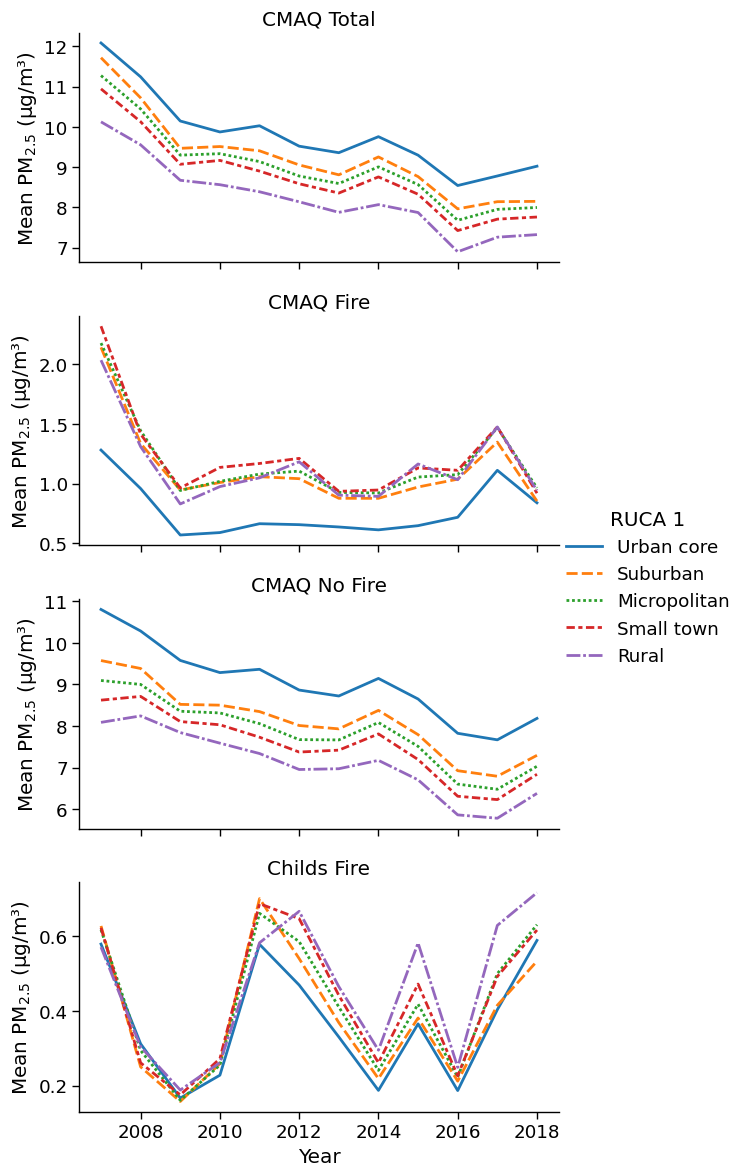
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Total PM2.5 | No Fire PM2.5 | Fire PM2.5 | Childs Fire PM2.5 |
| Total PM2.5 | 1.00 |  |  |  |
| No Fire PM2.5 | 0.92 | 1.00 |  |  |
| Fire PM2.5 | 0.20 | -0.19 | 1.00 |  |
| Childs Fire PM2.5 | 0.14 | -0.01 | 0.49 | 1.00 |

**Table S2.** Population living in Census tracts with greater than the 2007 to 2018 population weighted mean no fire PM2.5 (8.7 µg/m³), fire PM2.5 (0.88 µg/m³), and both fire and no fire PM2.5 population weighted means by National Climate Assessment (NCA) regions, primary Rural Urban Commuting Area codes (RUCA), racial and ethnic groups, language spoken at home, and quintiles of per-capita income.

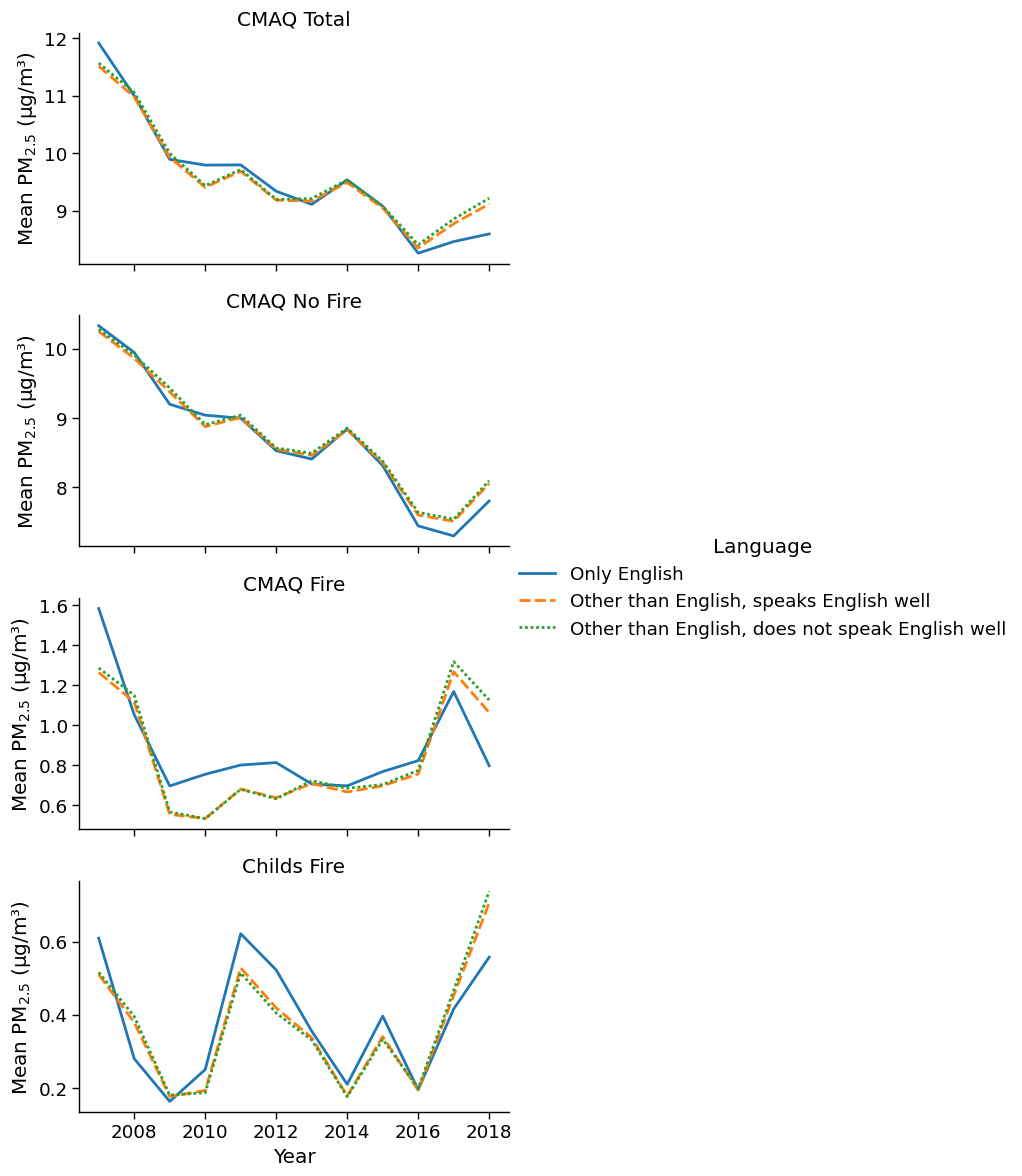
|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | Overall | High No Fire PM2.5 | High Fire PM2.5 | High Both |
| Overall population count | | 306,675,006 | 153,110,004 | 121,820,264 | 44,871,863 |
| NCA Region (%) | Midwest | 19.8 | 32.2 | 6.7 | 10.7 |
| Northeast | 21.0 | 23.9 | 1.2 | 1.5 |
| Northern Great Plains | 1.6 | 0.2 | 1.4 | 0.0 |
| Northwest | 4.0 | 0.0 | 5.9 | 0.0 |
| Southeast | 25.0 | 16.3 | 51.7 | 48.7 |
| Southern Great Plains | 10.4 | 9.9 | 14.2 | 16.9 |
| Southwest | 18.3 | 17.5 | 18.9 | 22.3 |
| RUCA (%) | Rural | 3.2 | 0.8 | 4.0 | 1.0 |
| Small town | 4.3 | 1.8 | 6.5 | 2.8 |
| Micropolitan | 9.8 | 5.2 | 14.3 | 6.9 |
| Suburban | 9.7 | 6.4 | 13.6 | 8.1 |
| Urban core | 73.1 | 85.7 | 61.6 | 81.2 |
| Race and ethnicity (%) | White | 63.9 | 58.8 | 65.6 | 58.9 |
| Black | 12.3 | 14.8 | 14.3 | 16.5 |
| Hispanic | 16.4 | 18.0 | 13.2 | 17.1 |
| Asian | 4.5 | 5.9 | 3.8 | 5.0 |
| Native American | 0.7 | 0.3 | 0.9 | 0.4 |
| Language spoken at home (%) | Only English | 73.5 | 72.7 | 73.3 | 70.1 |
| Other than English, speaks English well | 10.5 | 10.4 | 9.3 | 9.5 |
| Other than English, does not speak English well | 8.0 | 8.0 | 7.5 | 7.5 |
| Per-capita income quintile (%) | 1 (lowest) | 20.0 | 20.6 | 23.1 | 24.0 |
| 2 | 19.5 | 18.9 | 23.3 | 22.6 |
| 3 | 19.6 | 19.2 | 18.8 | 17.7 |
| 4 | 19.8 | 20.0 | 16.7 | 17.2 |
| 5 (highest) | 20.2 | 20.4 | 17.2 | 18.0 |



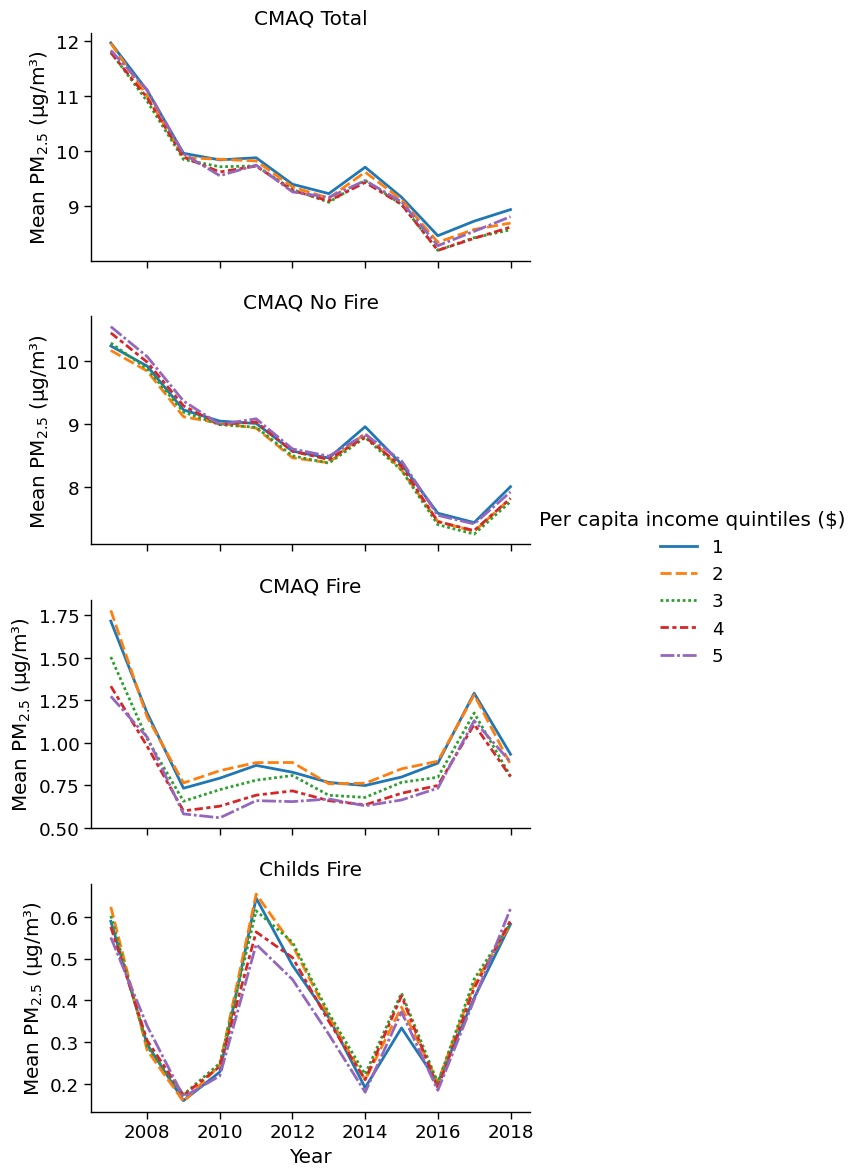
**Figure S7.** Annual average population-weighted PM2.5 concentrations in 2007 to 2018 by National Climate Assessment (NCA) region for total PM2.5 (CMAQ Total),non-fire PM2.5 (CMAQ No Fire), wildland fire-specific PM2.5 (CMAQ Fire), and wildfire PM2.5 estimated in Childs et al. (2022).33 (Childs Fire).



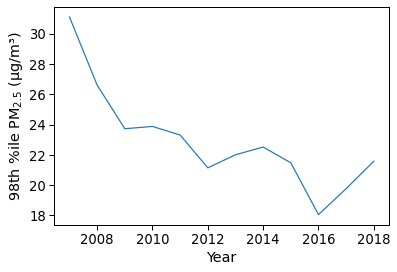
**Figure S8.** Annual average population-weighted PM2.5 concentrations in 2007 to concentrations by urban-rural status identified using Rural-Urban Commuting Area primary codes (RUCA) for total PM2.5 (CMAQ Total),non-fire PM2.5 (CMAQ No Fire), wildland fire-specific PM2.5 (CMAQ Fire), and wildfire PM2.5 estimated in Childs et al. (2022).33 (Childs Fire). RUCA categories: urban core (RUCA code 1), suburban (RUCA code 2), micropolitan (RUCA codes 3, 4, 5, and 6), small town (RUCA codes 7, 8, and 9), and rural (RUCA code 10).



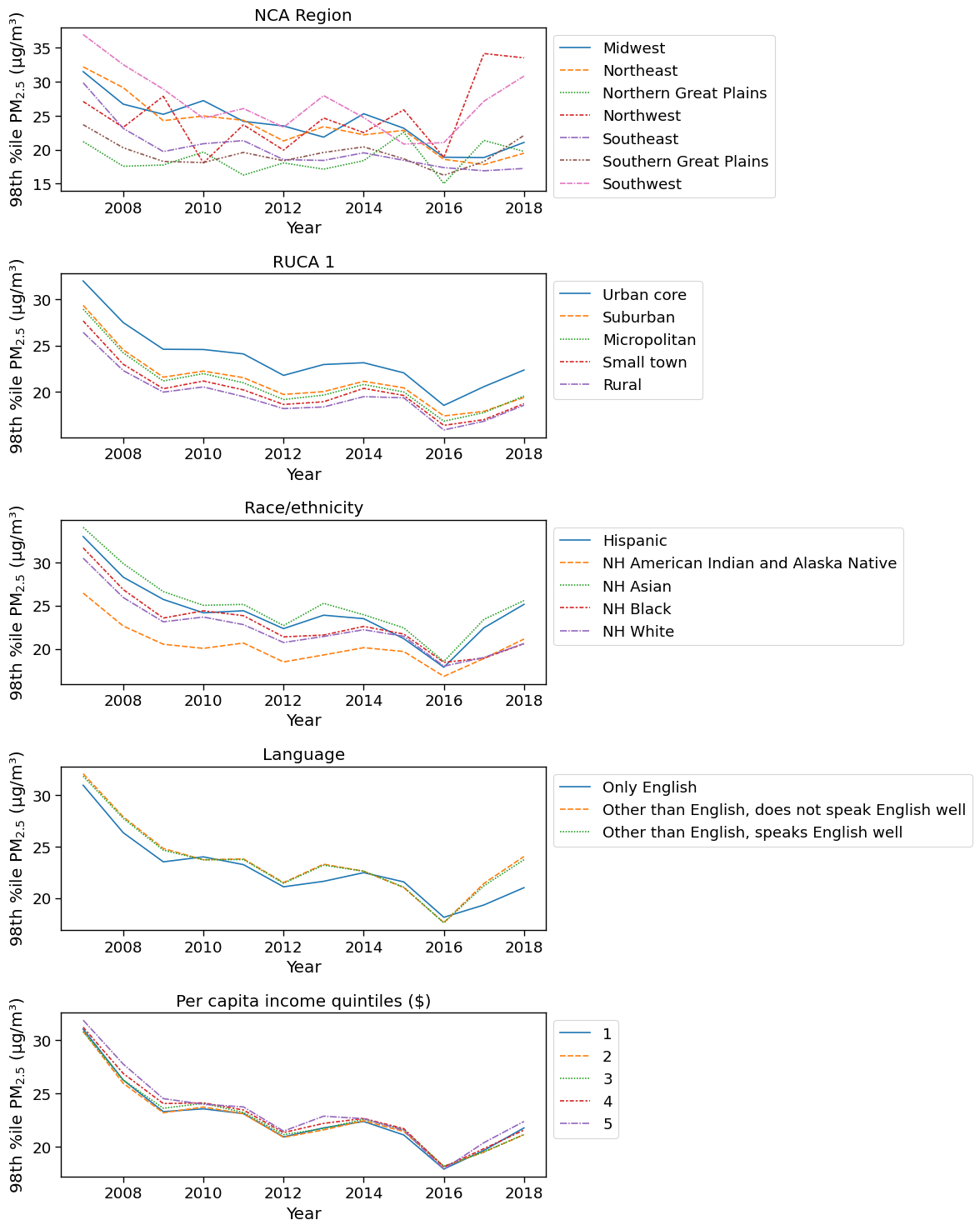
**Figure S9.** Annual average population-weighted PM2.5 concentrations in 2007 to 2018 by language spoken at home for total PM2.5 (CMAQ Total),non-fire PM2.5 (CMAQ No Fire), wildland fire-specific PM2.5 (CMAQ Fire), and wildfire PM2.5 estimated in Childs et al. (2022).33 (Childs Fire).



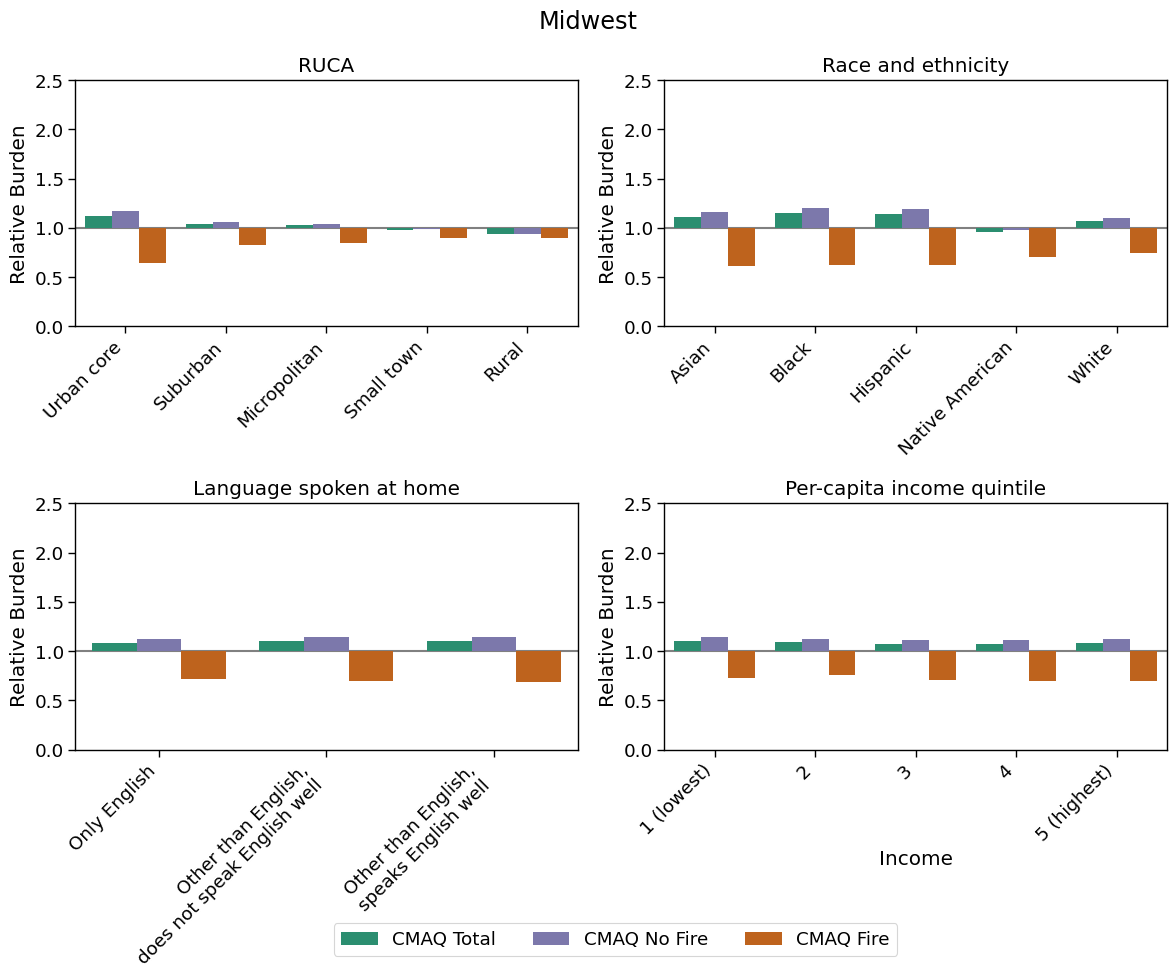
**Figure S10.** Annual average population-weighted PM2.5 concentrations in 2007 to 2018 by per-capita income quintile for total PM2.5 (CMAQ Total),non-fire PM2.5 (CMAQ No Fire), wildland fire-specific PM2.5 (CMAQ Fire), and wildfire PM2.5 estimated in Childs et al. (2022).33 (Childs Fire). Per-capita income quintiles: quintile 1: $150-$17,261, quintile 2: $17,261-$21,837, quintile 3: $21,837-$26,687, quintile 4: $26,687-$34,707, and quintile 5: $34,707-$293,610.

****

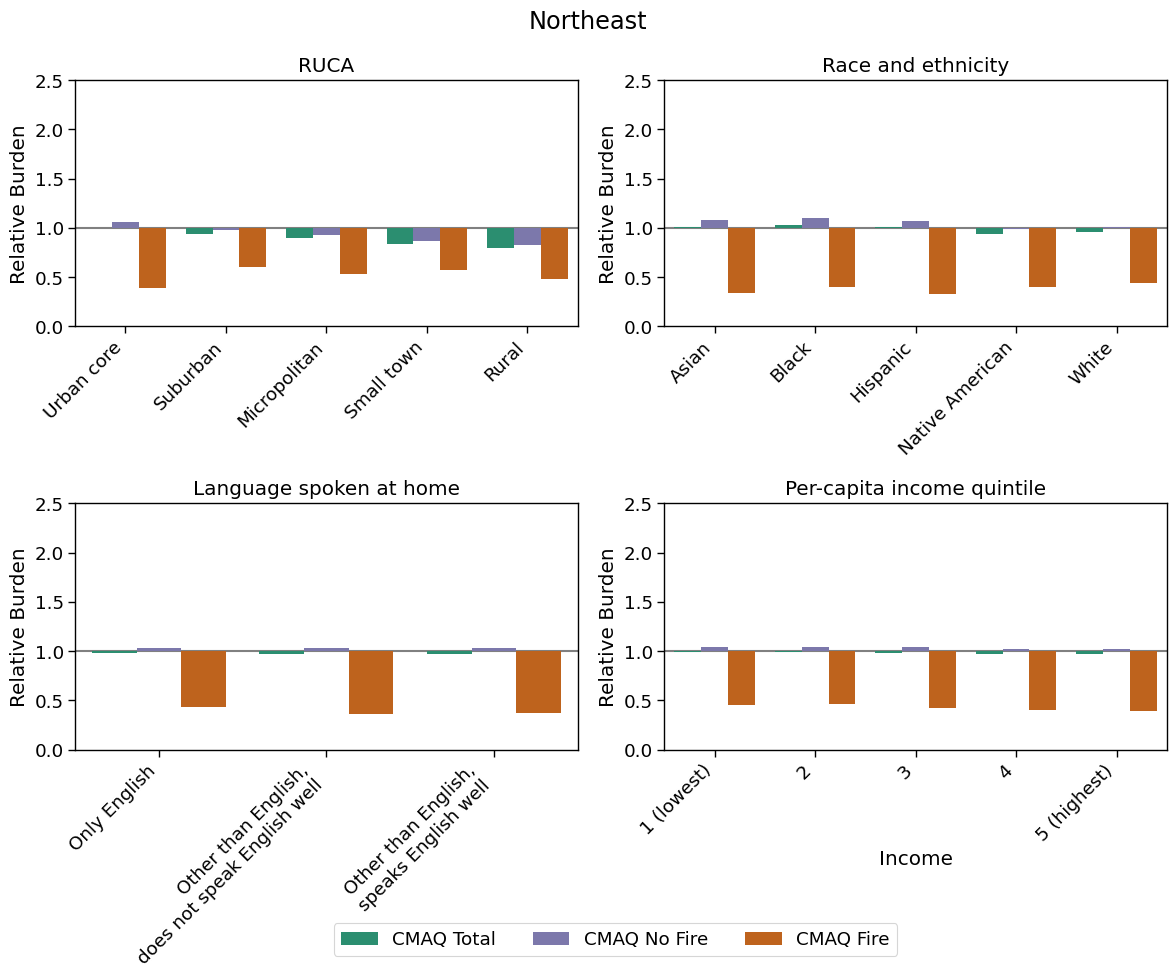
**Figure S11.** Population weighted 98th percentile of contiguous United States daily average PM2.5 concentrations in 2007 to 2018.



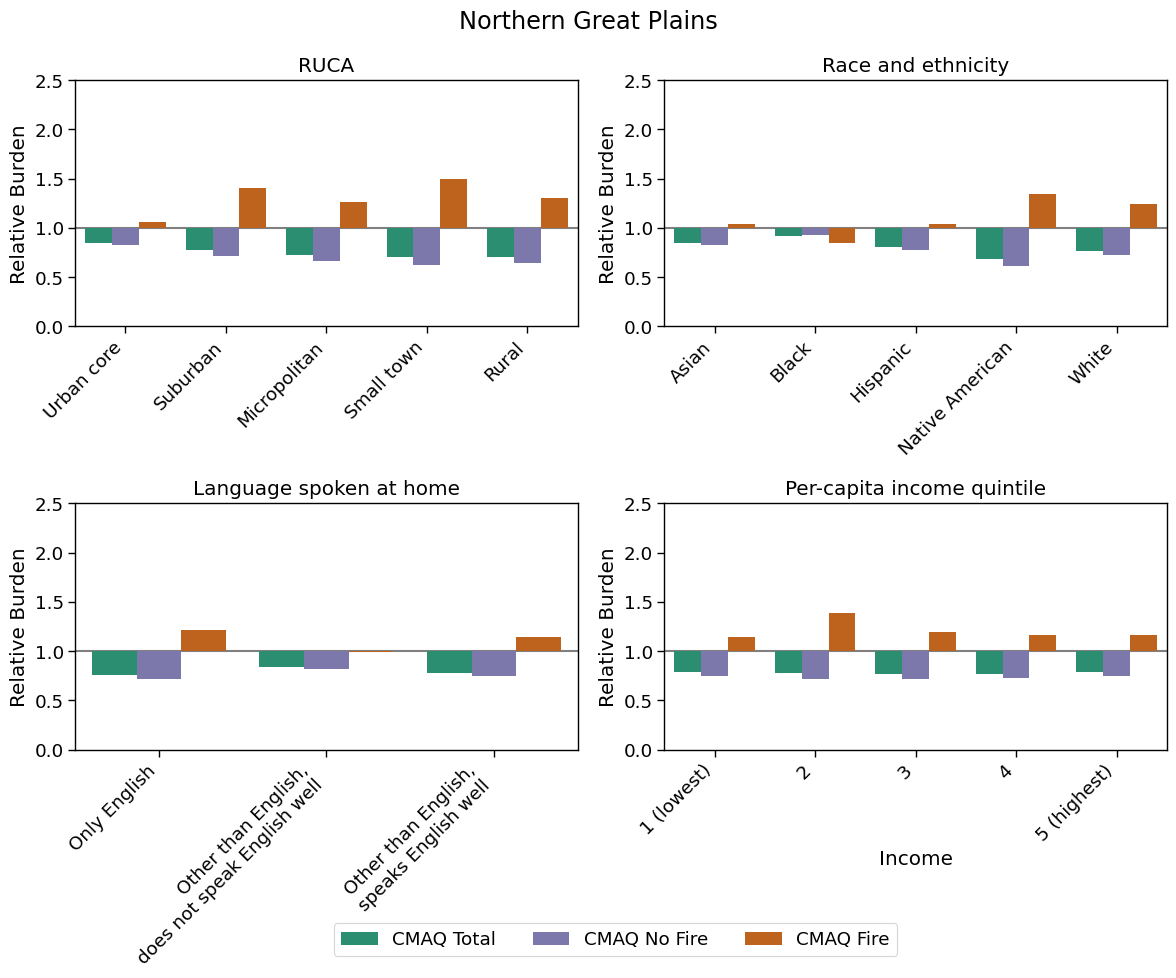
**Figure S12.** Annual population-weighted 98th percentile of 2007 to 2018 daily total CMAQ PM2.5 exposure by region, primary rural urban commuting area code (RUCA 1), race/ethnicity, language, and quintile of per-capita income.



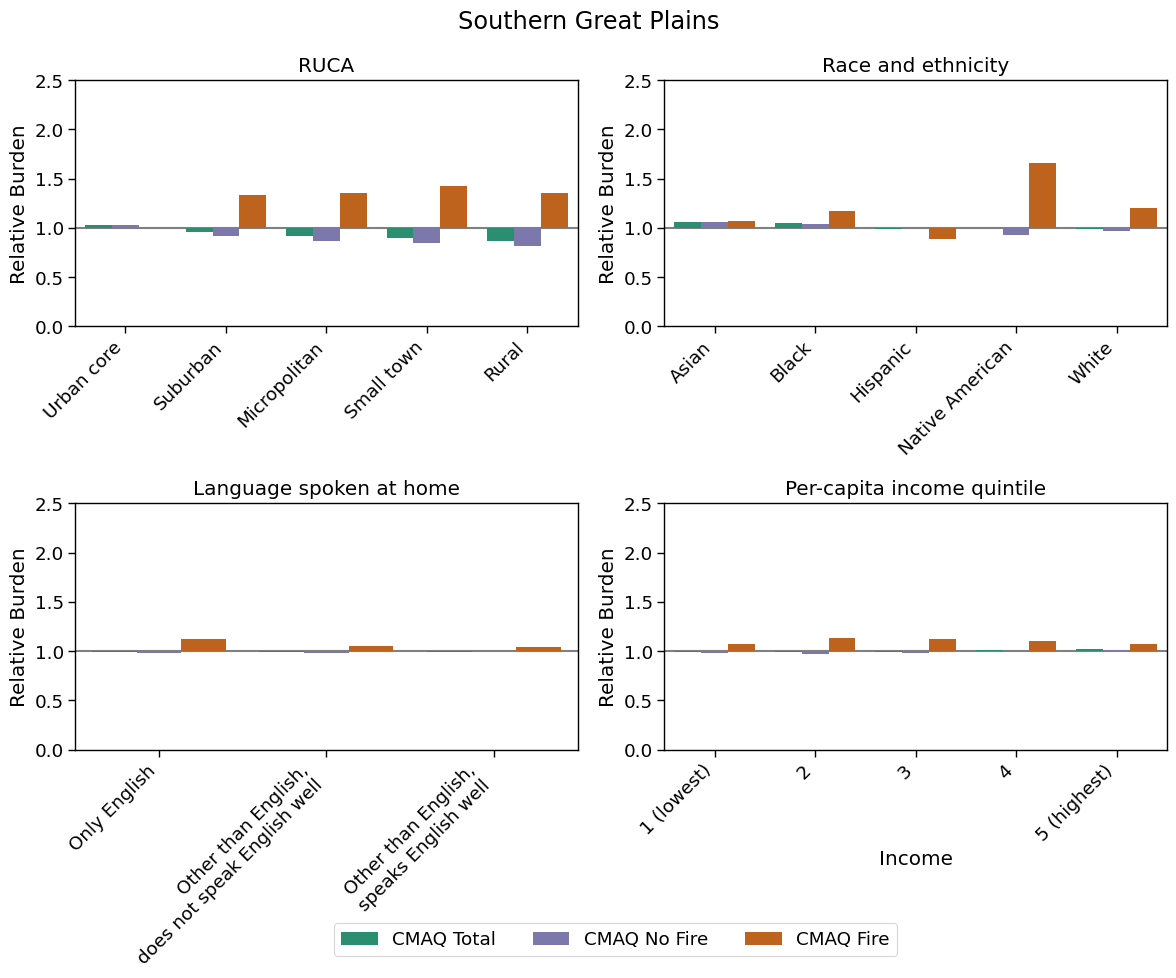
**Figure S13.** Relative burden of total (CMAQ Total), wildland fire (CMAQ Fire), non-fire (CMAQ No Fire) PM2.5 concentrations by Rural-Urban Commuting Area (RUCA) urbanicity classifications, race and ethnicity, language spoken at home, and per-capita income quintile in the midwest. Regional subgroup concentrations are compared to overall CONUS concentrations.



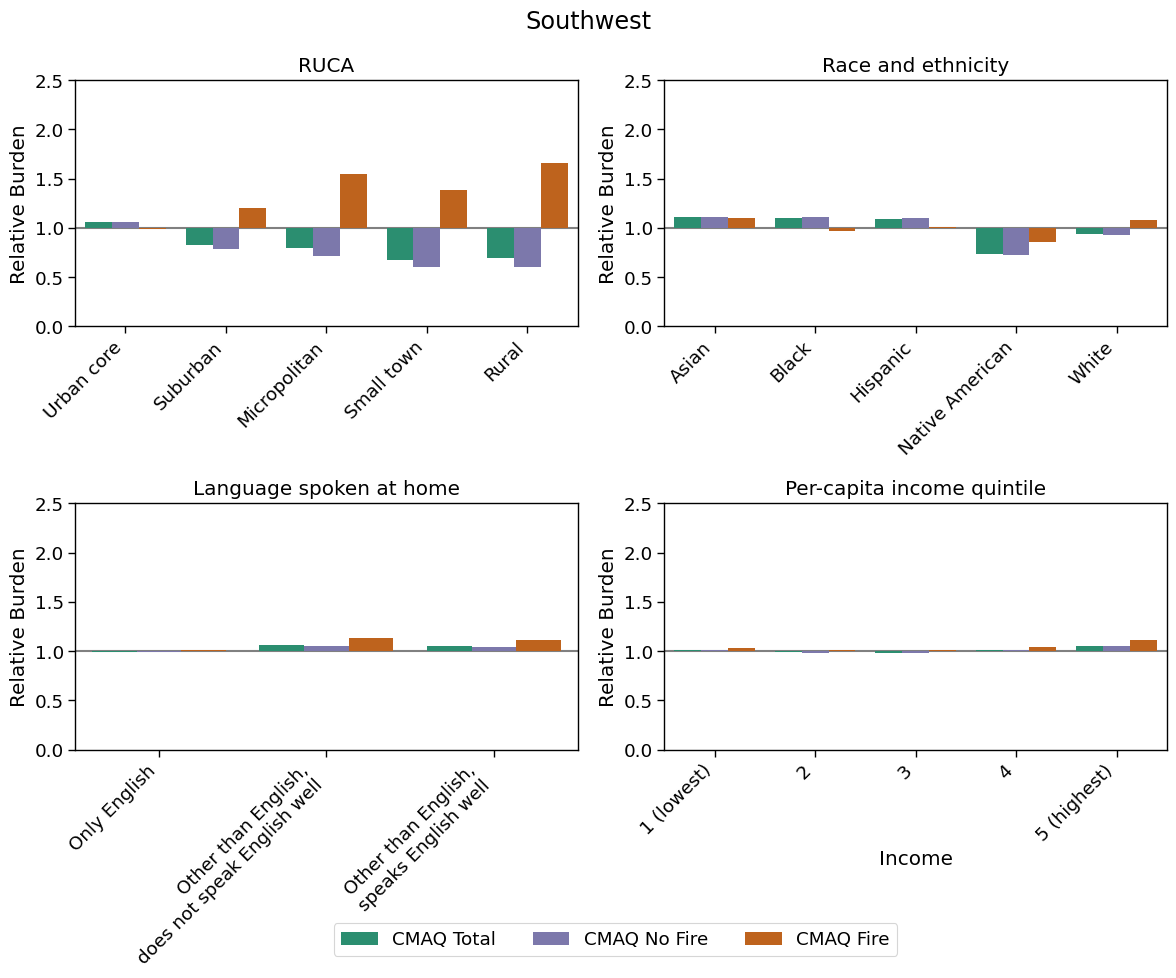
**Figure S14.** Relative burden of total (CMAQ Total), wildland fire (CMAQ Fire), non-fire (CMAQ No Fire) PM2.5 concentrations by Rural-Urban Commuting Area (RUCA) urbanicity classifications, race and ethnicity, language spoken at home, and per-capita income quintile in the northeast. Regional subgroup concentrations are compared to overall CONUS concentrations.



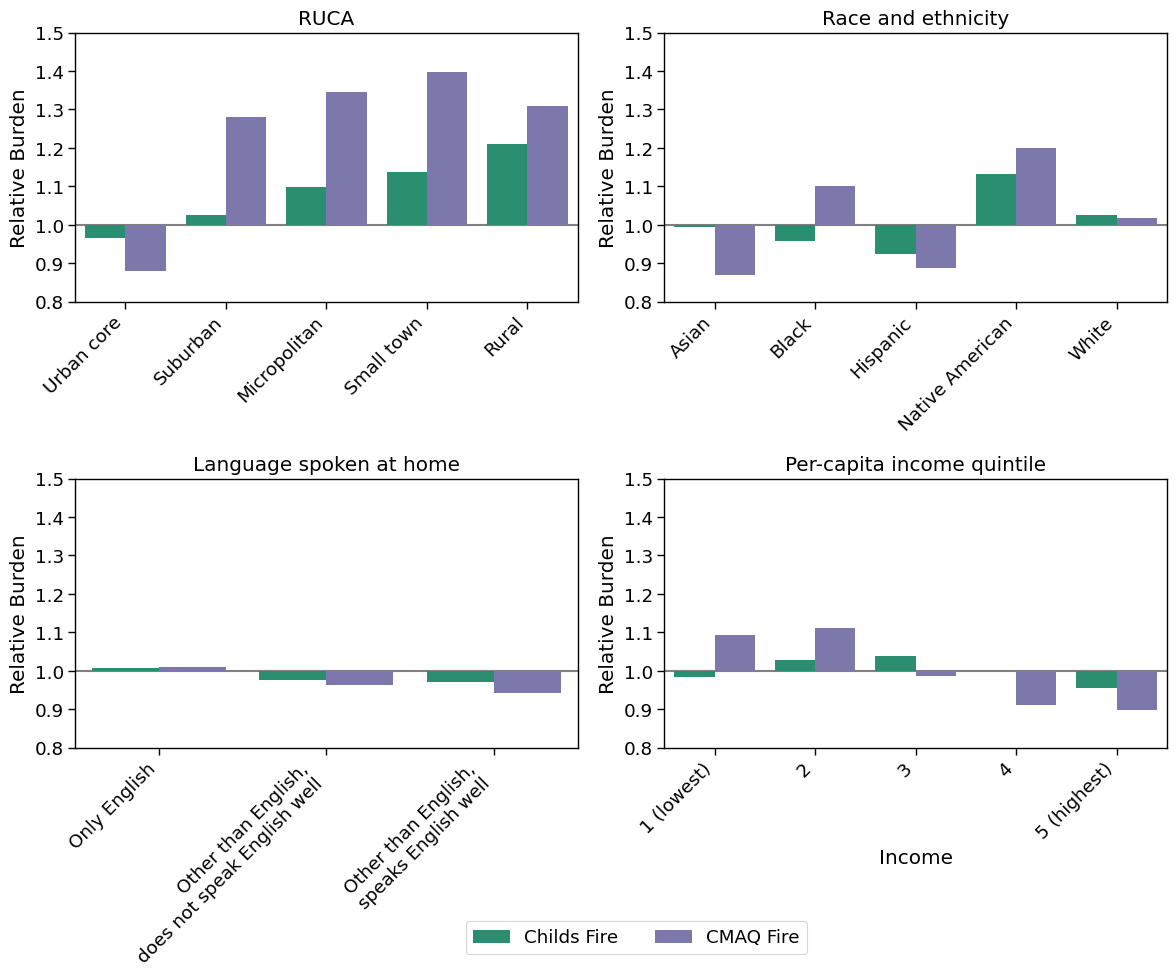
**Figure S15.** Relative burden of total (CMAQ Total), wildland fire (CMAQ Fire), non-fire (CMAQ No Fire) PM2.5 concentrations by Rural-Urban Commuting Area (RUCA) urbanicity classifications, race and ethnicity, language spoken at home, and per-capita income quintile in the northern great plains. Regional subgroup concentrations are compared to overall CONUS concentrations.



**Figure S16.** Relative burden of total (CMAQ Total), wildland fire (CMAQ Fire), non-fire (CMAQ No Fire) PM2.5 concentrations by Rural-Urban Commuting Area (RUCA) urbanicity classifications, race and ethnicity, language spoken at home, and per-capita income quintile in the southern great plains. Regional subgroup concentrations are compared to overall CONUS concentrations.



**Figure S17.** Relative burden of total (CMAQ Total), wildland fire (CMAQ Fire), non-fire (CMAQ No Fire) PM2.5 concentrations by Rural-Urban Commuting Area (RUCA) urbanicity classifications, race and ethnicity, language spoken at home, and per-capita income quintile in the southwest. Regional subgroup concentrations are compared to overall CONUS concentrations.



**Figure S18.** Relative burden of wildland fire (CMAQ Fire) compared to Childs wildfire PM2.533 (Childs Fire) concentrations by Rural-Urban Commuting Area (RUCA) urbanicity classifications, race and ethnicity, language spoken at home, and per-capita income quintile.[[1]](#footnote-1)

1. Per-capita income quintiles: quintile 1: $150-$17,261, quintile 2: $17,261-$21,837, quintile 3: $21,837-$26,687, quintile 4: $26,687-$34,707, and quintile 5: $34,707-$293,610. RUCA categories: urban core (RUCA code 1), suburban (RUCA code 2), micropolitan (RUCA codes 3, 4, 5, and 6), small town (RUCA codes 7, 8, and 9), and rural (RUCA code 10). [↑](#footnote-ref-1)