Supplemental Information

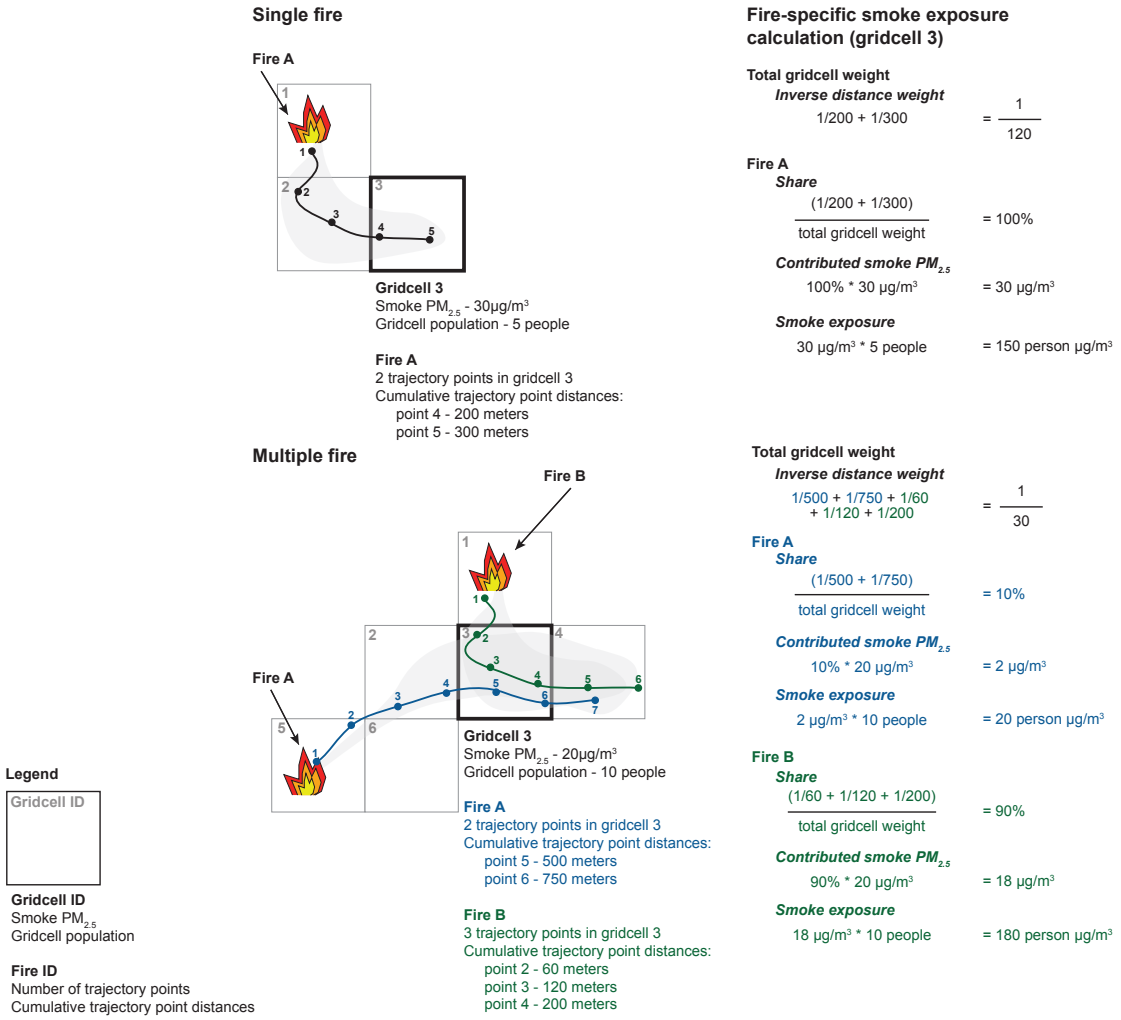

Figure S1: **Smoke exposure calculation.** Smoke exposure for a specific fire considers the smoke $PM_{2.5}$ contributed by a fire and the total population within affected gridcells. The calculation shown here for gridcell 3 in both the multiple and single fire case represents the smoke exposure for each fire in the gridcell. The smoke exposure for the fire as a whole aggregates the daily gridcell smoke exposure over the duration of the fire. The share of smoke $PM_{2.5}$ contributed by a specific fire is calculated as a function of the number of trajectory points and the cumulative distance of these trajectory points from the initial fire location.

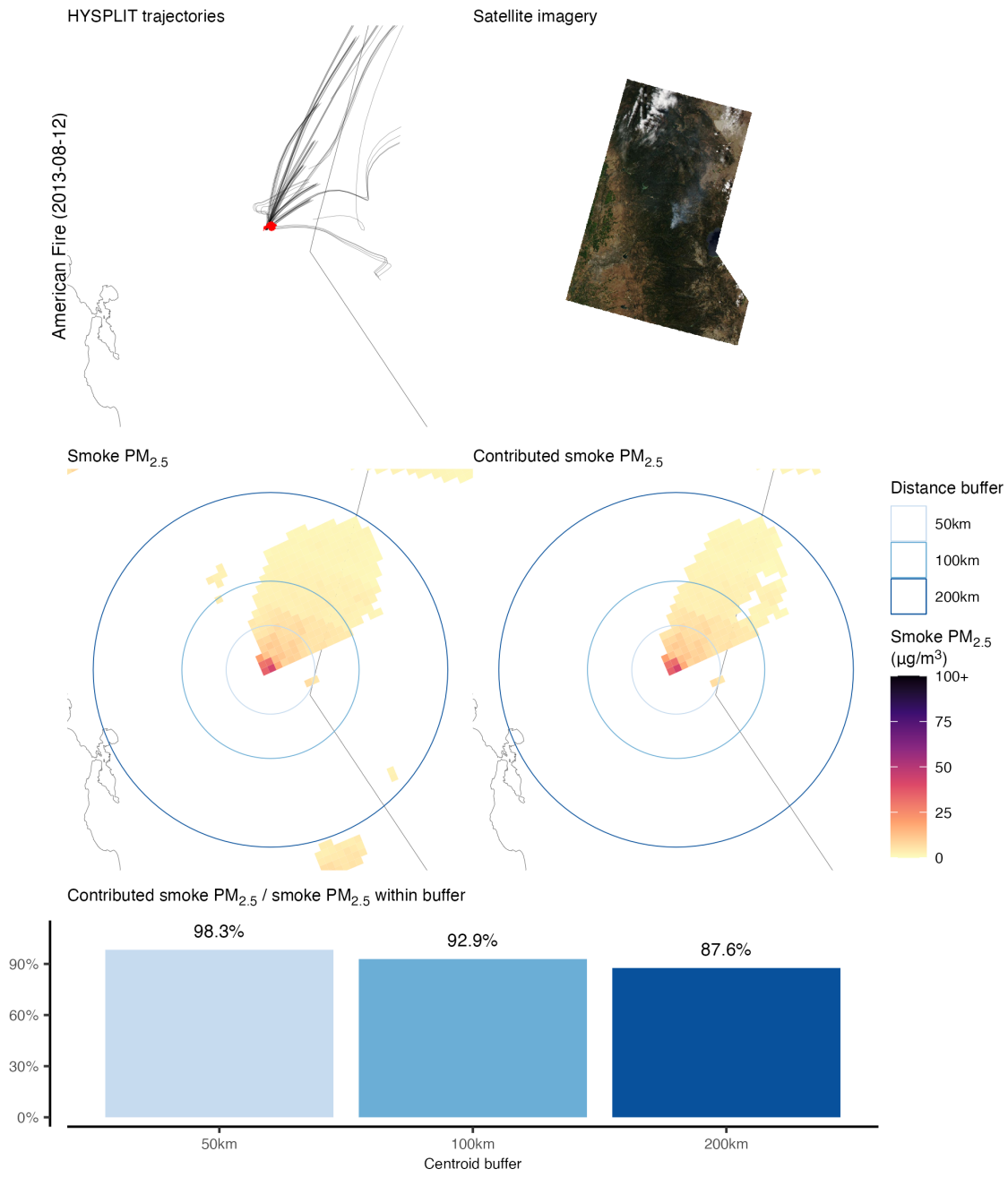

Figure S2: **American Fire contributed smoke $PM_{2.5}$ vs. raw smoke $PM_{2.5}$.** Trajectories, satellite imagery, and smoke $PM_{2.5}$ product all show the smoke generated by the American Fire. The successive concentric buffers around the centroid of the fire calculate the percent of total smoke $PM_{2.5}$ captured by the contributed smoke $PM_{2.5}$ method in this cropped area. The smoke $PM_{2.5}$ in this example appears to come mainly from the American fire with other small plumes noticeable in the 'Smoke $PM_{2.5}$' panel. Imagery was downloaded from NASA's Worldview application (https://worldview.earthdata.nasa.gov), part of NASA's Earth Observing System Data and Information System (EOSDIS).[40]

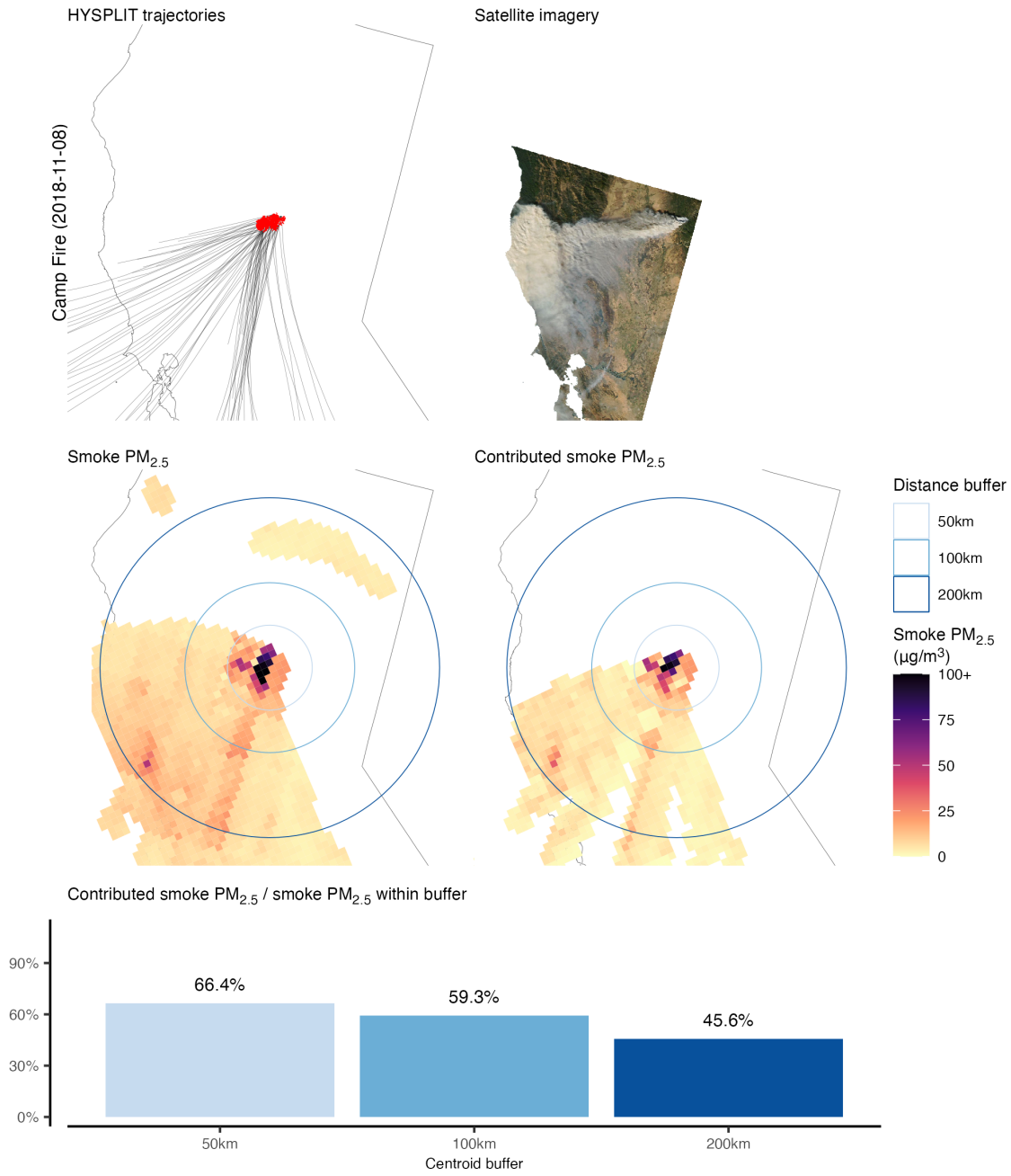

Figure S3: **Camp Fire contributed smoke $PM_{2.5}$ vs. raw smoke $PM_{2.5}$.** The ratio of contributed smoke $PM_{2.5}$ vs. smoke $PM_{2.5}$ is lower for the Camp Fire compared to the American Fire. Other smoke sources are likely producing smoke that is being considered in the total smoke $PM_{2.5}$ calculation. The contributed smoke $PM_{2.5}$ method does not associate these additional plumes to the Camp Fire. Imagery was downloaded from NASA's Worldview application (https://worldview.earthdata.nasa.gov), part of NASA's Earth Observing System Data and Information System (EOSDIS).[40]

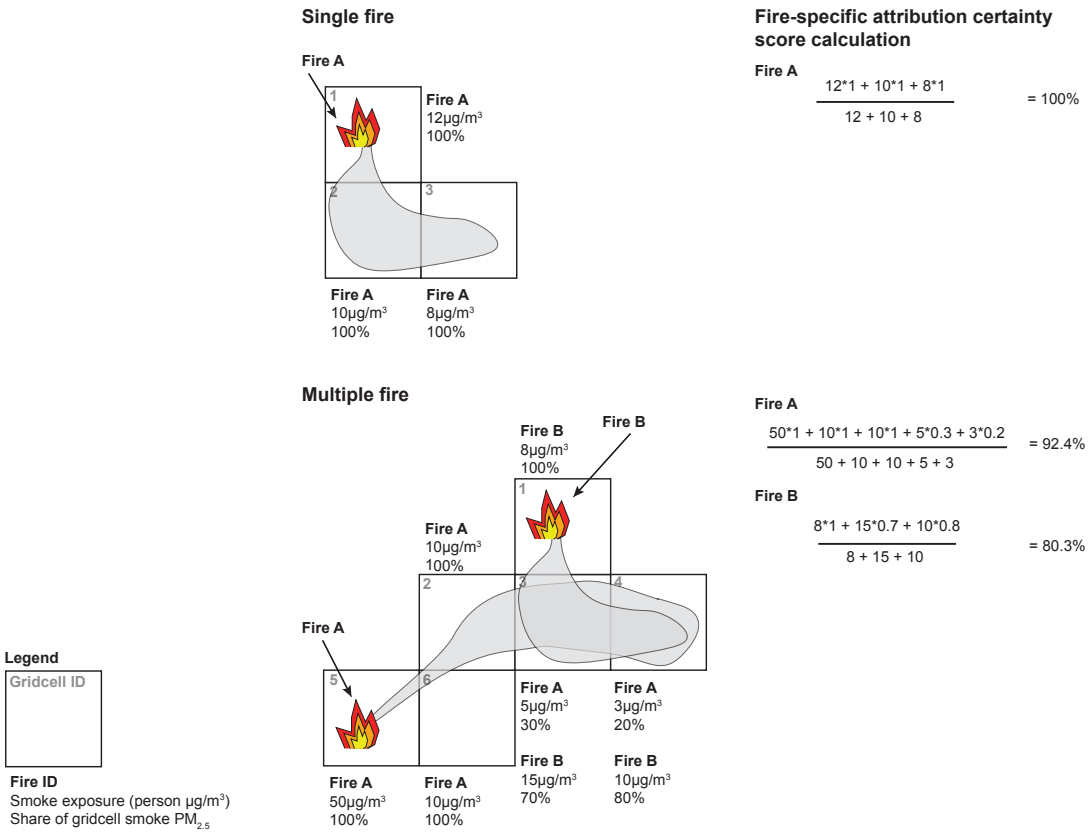

Figure S4: **Attribution certainty score calculation.** The attribution certainty score is a fire-specific estimate of the percent of a given fire's smoke exposure that is not coincident with smoke from other fires. Specifically, the measure takes into account the number of trajectory points contributed by a fire, the distance of trajectory points from the source fire, and the smoke $PM_{2.5}$ exposure of the fire. A fire with an attribution certainty score of one is a fire whose smoke never overlapped smoke from any other fire. When smoke from multiple fires overlaps, there is less certainty about fire-specific smoke attribution, and the attribution certainty score is lower.

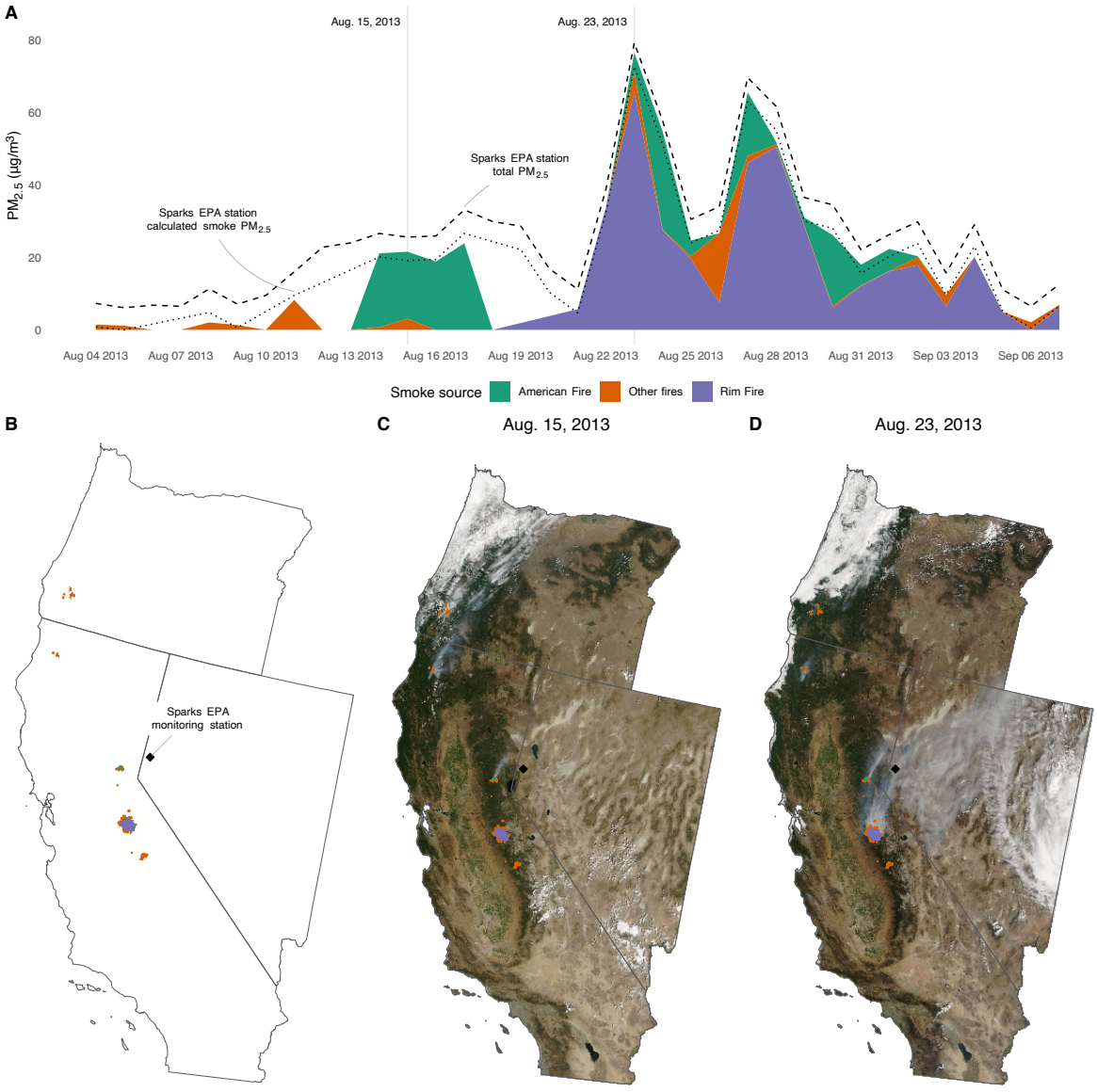

Figure S5: **Fire-specific contributions to Sparks EPA monitoring station readings. A.** Time-series readings from the Sparks EPA air pollution monitoring station show close alignment between the estimated contributed smoke $PM_{2.5}$ from source fires, the 'calculated smoke $PM_{2.5}$', and the total $PM_{2.5}$ estimated at the monitoring station. The 'calculated smoke $PM_{2.5}$' was used in the training process of the smoke $PM_{2.5}$ product in ref.[6] and is estimated at the EPA station by subtracting the month-specific 3-year non-smoke day median from the total $PM_{2.5}$ readings. The sum of the contributed smoke $PM_{2.5}$ aligns closely with the 'calculated smoke $PM_{2.5}$' because the machine learning model was trained to predict this value. We direct interest readers to ref.[6] for more information. **B-D.** Satellite imagery on specific days marked by the dotted vertical lines in panel A. Imagery was downloaded from NASA's Worldview application (https://worldview.earthdata.nasa.gov), part of NASA's Earth Observing System Data and Information System (EOSDIS).[40]

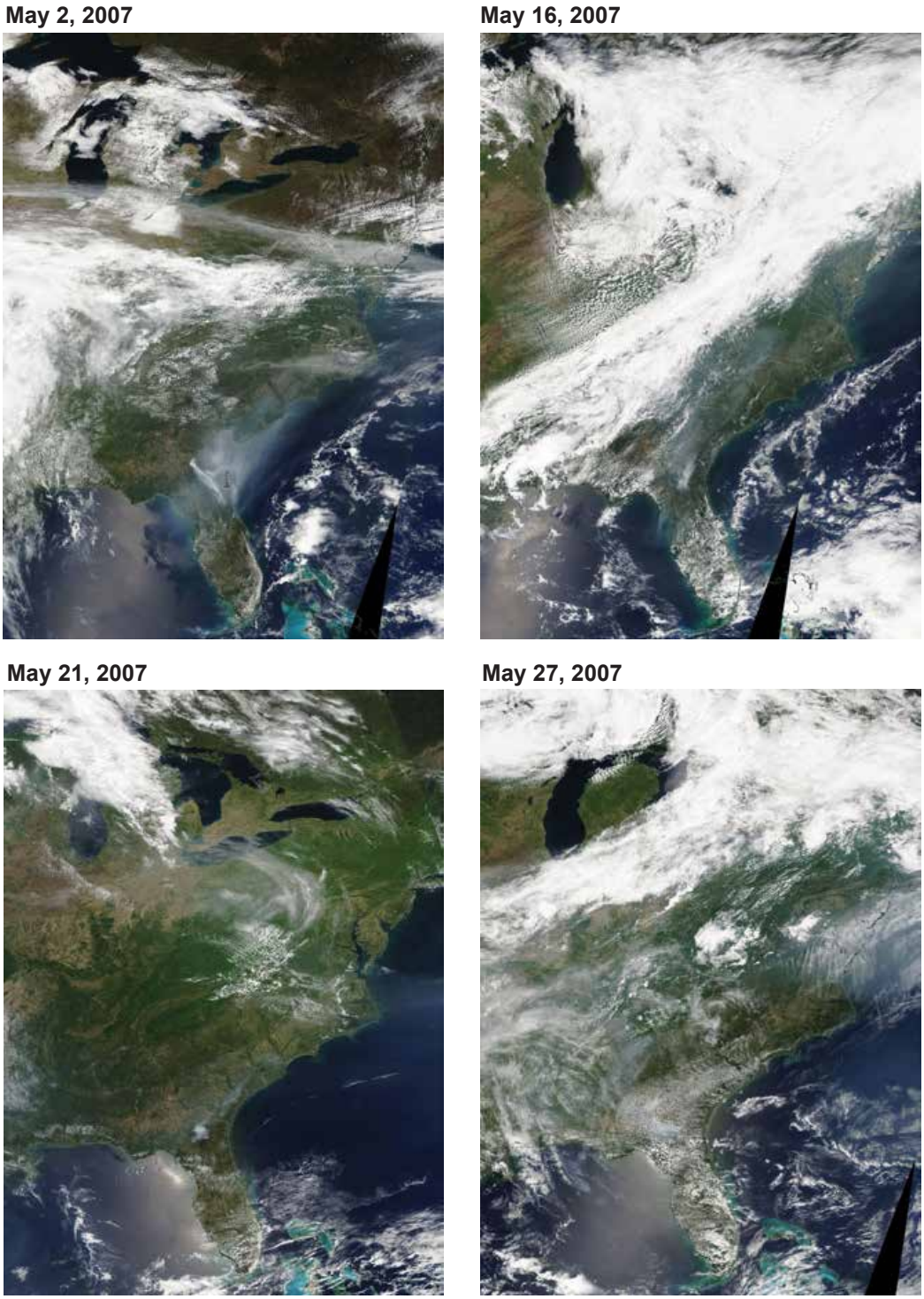

Figure S6: **Bugaboo fire satellite imagery.** The Bugaboo/ Georgia Complex fire burned from April - June 2007 and resulted from several different fires combining together. The smoke $PM_{2.5}$ generated by the fire traveled along much of the Eastern seaboard. The images are from 4 separate days showing the dispersion of smoke. Clouds are also visible in the imagery but are white compared to the gray smoke. Imagery was downloaded from NASA's Worldview application (https://worldview.earthdata.nasa.gov), part of NASA's Earth Observing System Data and Information System (EOSDIS).[40]

Figure S7: **State-to-state source receptor matrix.** A large proportion of smoke $PM_{2.5}$ affects within state communities although West coast states such as California also contribute a large amount of smoke $PM_{2.5}$ to other states.

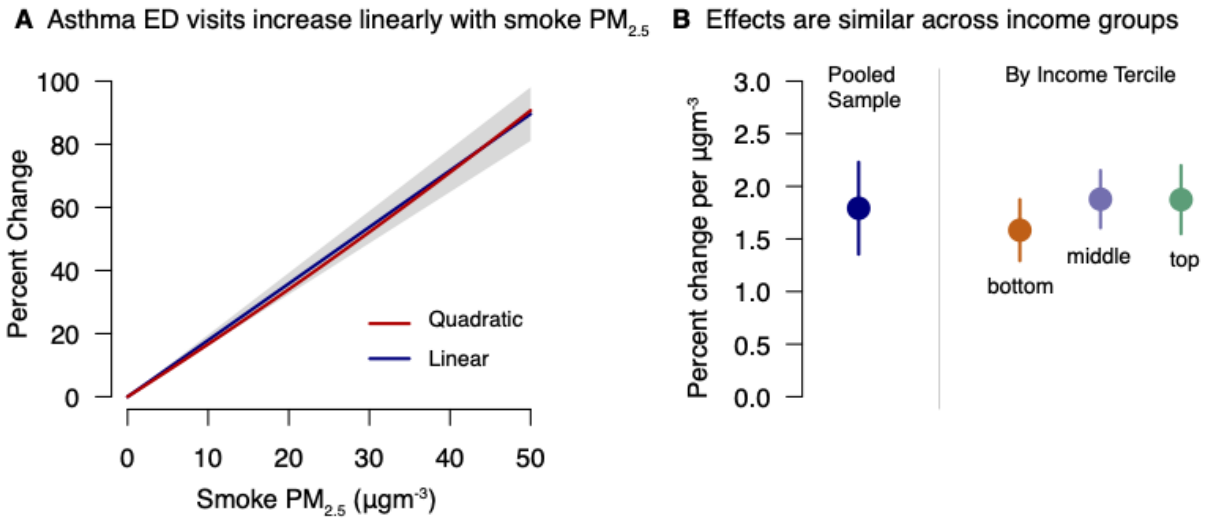

Figure S8: **Asthma emergency department visit response to wildfire smoke.** The rate of ED visits for asthma in the 7 days following wildfire smoke increases linearly with wildfire smoke $PM_{2.5}$ concentration and effects are similar across income subgroups.

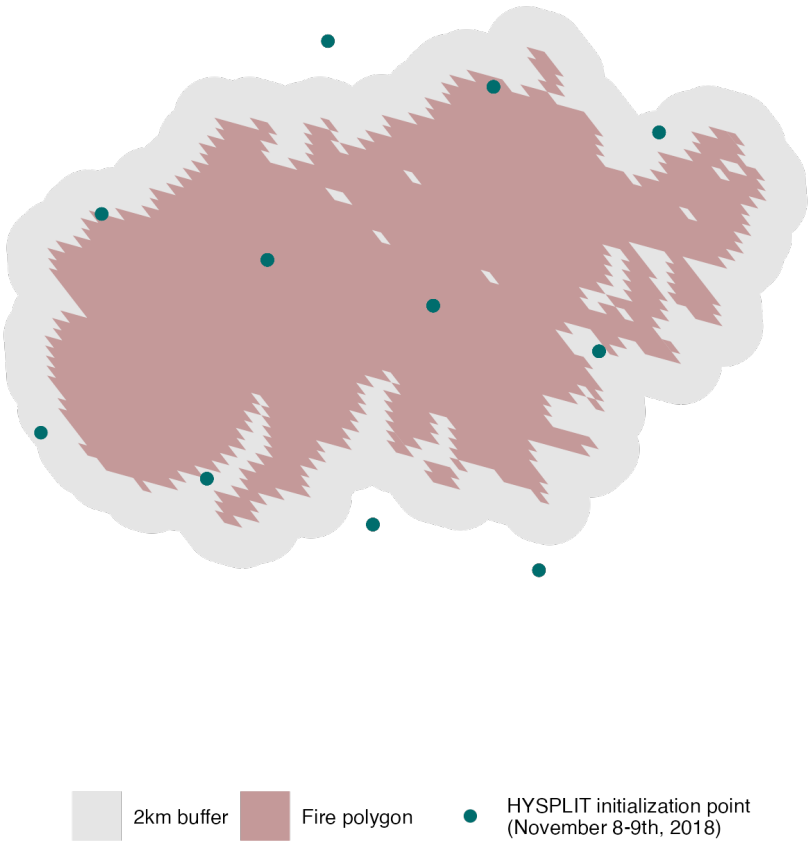

Figure S9: **Camp Fire fire polygon, buffered polygon, and HYSPLIT initialization points.** Smoke producing fire points on November 8-9th show large amounts of overlap with the Camp Fire location, but several HYSPLIT initialization points fall outside of the fire polygon. The rectangular grid of HYSPLIT initialization points suggests that the points were identified by satellite thermal sensors, which may have limited spatial resolution and cause points to fall outside the 2km buffer around fire polygons.

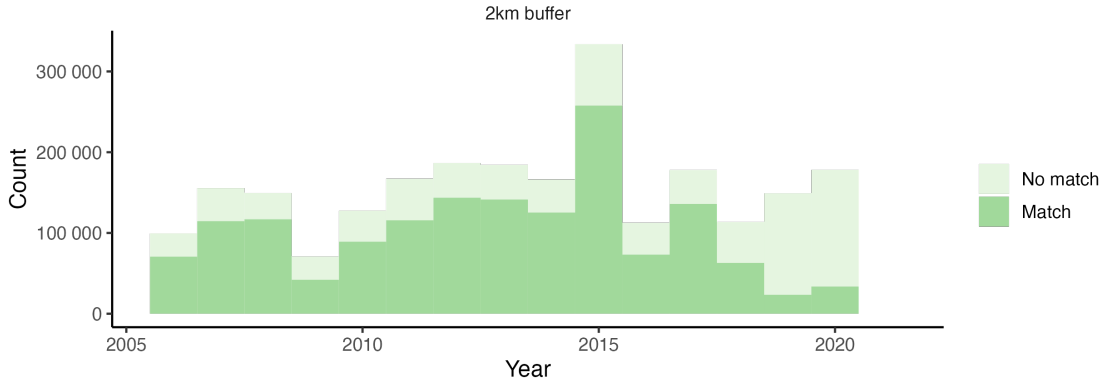

Figure S10: **Yearly distribution of matched vs. unmatched HYSPLIT initialization points.** The trajectories used to distribute smoke $PM_{2.5}$ were generated from analyst identified smoke generating fire points (Method). Over time, different satellite sensors were used to identify fire hotspots with higher resolution satellites introduced around 2016 potentially leading to a greater number of detected thermal anomalies.

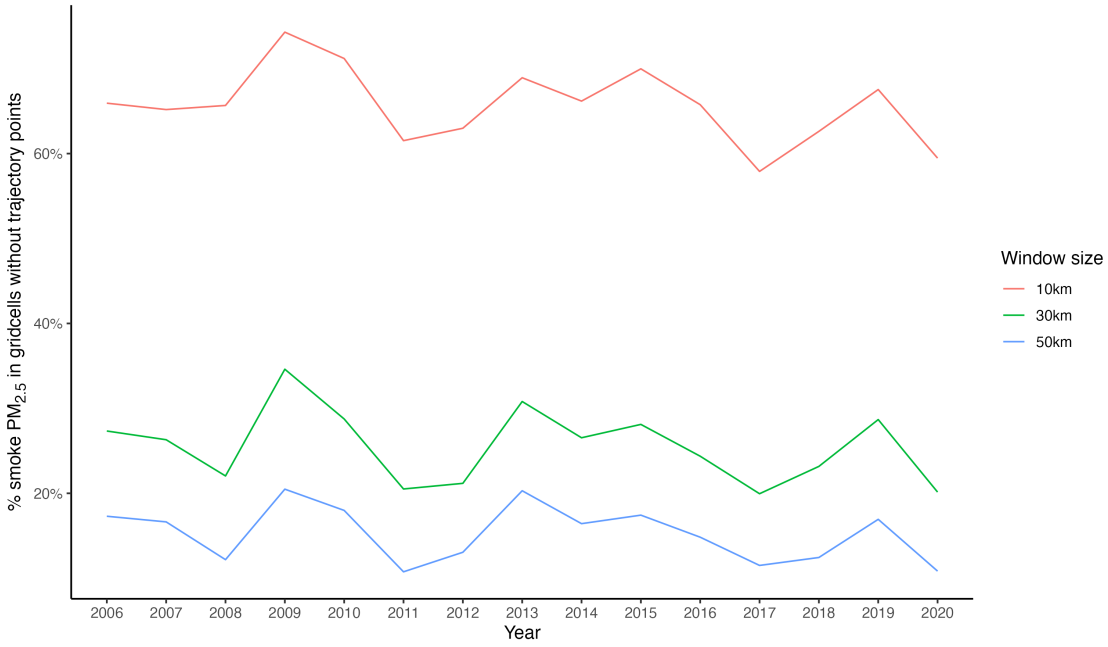

Figure S11: **Comparison of different window sizes to aggregate trajectory points.** The window sizes compare the amount of smoke $PM_{2.5}$ that remains after aggregating neighboring gridcells that may also be affected by smoke. The 10km window does not aggregate neighboring gridcells and only links smoke $PM_{2.5}$ based on the gridcells that intersected with trajectory points. This approach results in the largest amount of unaccounted for smoke $PM_{2.5}$ because smoke is likely to disperse over space away from the path of an average air parcel. Increasing the window size of aggregated neighbors reduces the amount of unaccounted for smoke $PM_{2.5}$.

Table S1: Top 20 fires ranked by population smoke exposure

	Fire name	Year	State	Isolation score	Days elapsed	Population smokePM (billion person μg/m^3)	Excess asthma ED visits (95% CI)	Average smokePM (μg/m^3)
1	Bugaboo Fire	2007	GA & FL	0.89	54	8.21	1407 (1295, 1518)	13.20
2	August Complex Fire	2020	CA	0.52	71	4.98	853 (785, 921)	5.85
3	Dolan Fire	2020	CA	0.58	42	3.25	557 (513, 602)	4.41
4	Bobcat Fire	2020	CA	0.50	29	3.05	522 (480, 563)	4.54
5	Camp Fire	2018	CA	0.61	17	2.68	460 (423, 496)	13.45
6	Creek Fire	2020	CA	0.43	45	2.45	419 (386, 453)	5.22
7	Ranch Fire (Mendocino Complex)	2018	CA	0.72	51	2.36	404 (372, 436)	5.23
8	Santiam Fire	2020	OR	0.28	49	2.14	366 (337, 395)	4.85
9	Claremont Fire (North Complex)	2020	CA	0.49	57	2.07	355 (327, 383)	4.36
10	SCU Lightning Complex Fire	2020	CA	0.57	28	1.97	337 (310, 364)	5.12
11	Castle Fire (SQF Complex)	2020	CA	0.43	57	1.89	325 (299, 350)	4.08
12	Holiday Farm Fire	2020	OR	0.36	18	1.58	270 (248, 291)	6.63
13	Wallow Fire	2011	AZ	0.82	32	1.51	259 (238, 280)	4.27
14	Hennesey Fire	2020	CA	0.50	25	1.31	224 (206, 242)	4.26
15	Basin Complex Fire	2008	CA	0.73	49	1.28	219 (202, 236)	1.62
16	Archie Creek Fire	2020	OR	0.32	19	1.21	207 (190, 223)	4.50
17	Riverside Fire	2020	OR	0.27	18	1.18	202 (186, 218)	4.87
18	El Dorado Fire	2020	CA	0.43	26	1.10	188 (173, 203)	3.40
19	Glass Fire	2020	CA	0.54	15	1.08	184 (170, 199)	3.80
20	Klondike Fire	2018	OR	0.57	77	1.06	182 (168, 197)	3.08