

## **Supplementary Material**

### **Enhancing fire emissions inventories for acute health effects studies: integrating high spatial and temporal resolution data**

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## Supplementary Material S1

### Combined FEI Steps

- Download and import data from WFEIS for two products: MTBS (fire total emissions) and MODIS (daily emissions).
  - This information is downloaded from the WFEIS website. Use Firefox/Chrome and use the smallest possible spatial domain to get results (i.e., select the boundary instead of trying to download the whole year for the whole US).
  - This method still does not work sometimes, so using wget with a custom WFEIS URL is better.
- Assign a fire ID to each unique fire in the WFEIS-MTBS data.
  - Because each fire in the MTBS dataset is already one row, assign a row number starting at one. These fire IDs are positive.
- Extract the latitude/longitude centroid and burned area for each unique fire.
  - WFEIS-MTBS data provides the total burned area of the fire and the center point of each burned area polygon.
- Using the fire centroid and burned area, search the WFEIS-MODIS dataset to assign the same fire ID to each unique fire.
  - Use WFEIS-MTBS fire burned area to create a circular search radius. Because fires are not a perfect circle, this radius determined from the burned area was multiplied by 1.5 to capture the most points from each fire while minimizing overwriting points that have burned multiple times. For every MODIS point within the circular boundary of the MTBS area, the MTBS fire ID was assigned to the MODIS point.

- Because not every MODIS point was assigned a fire ID using this method, the remaining points were assigned a negative fire ID to differentiate from the fire IDs assigned based on MTBS data. These points were subset by states and then grouped into fires by day since the data was already organized by location. If a row (representing a fire pixel) occurred within three days of the previous row, they were assigned to the same fire. This likely breaks one fire into several smaller fires due to cloud cover issues, but because fire IDs are used to determine fuel type, this doesn't impact our results.
- Spatially average WFEIS-MODIS data using the fire ID and assign a spatially weighted fire centroid (latitude/longitude) for each day.
  - The weighted centroid ensures that points with more emissions are weighted more heavily.
  - To ensure that there was only one point per fire per day, rows with the same fire ID on the same day were aggregated. Latitude and longitude were averaged using a weighted average based on PM<sub>2.5</sub> emissions for each cell (i.e., higher emissions have more influence). Because we are averaging each fire daily, this is a relatively small area, we do not need to account for the shape of the earth.
- Assign values to missing days in the fire progression due to cloud cover or other remote sensing issues.
  - For fires with non-consecutive days, the PM<sub>2.5</sub> emissions, heat, and burned area for the missing days are estimated using a linear relationship between the two nearest points. If more than one day is missing, the first day is estimated using the linear relationship, and the next point is estimated using the previous point. The

location of each point is the average between the two locations used to determine the line.

- Fires with more than seven days missing between points were broken into two different fires.
- For fires from MTBS that were not assigned a daily progression from MODIS points (i.e., small fires), the total fire PM<sub>2.5</sub> emissions, heat, and burned area were divided evenly between each day of the fire.
  - Fire length was determined using a linear correlation equation between burned area and fire length from the fires assigned daily progressions from MODIS. This equation was determined using the burned area and fire length of the MTBS fires. Fire burned area was linearly correlated with fire length, and then this correlation equation was used to determine the fire length of the MTBS fires without daily progression, based on the burned area of the fire. The fire length was then used to provide a daily fire progression by dividing the total fire burned area, heat, and PM<sub>2.5</sub> emissions by the fire length in days.
  - All fires from MTBS that did not have a daily progression from MODIS were under 100 km<sup>2</sup>, so the linear regression excluded all fires larger than this.
  - The latitude and longitude of each daily fire point were left as the centroid of the MTBS perimeter.
- For each fire, extract the temporal profile (daily emissions rate) of the fire emissions from WFEIS-MODIS (i.e., percent of total fire emissions on each day of the fire).

- The total PM<sub>2.5</sub> emissions for each fire ID were summed to give the total fire emissions amount. Then, the total emissions per fire per day were summed, and this was turned into a percentage.
- Apply the daily allocation of the fire emissions rates and locations from WFEIS-MODIS to the WFEIS-MTBS fire emissions estimates to get a daily emissions progression.
  - For fire IDs from MTBS data (positive fire IDs), the daily percentage of total fire emissions that day was multiplied by the total fire emissions from the WFEIS MTBS data. For MODIS fire IDs (negative), the daily progression was left as the sum of emissions contributions from each row with the same date and fire ID.