

Supplementary material File 1

Equations used to integrate spatial and temporal dimensions into PM10 exposure estimates

Equation (1)

Aim: to predict the ratio of the PM10 exposure between the different lines and line 7 (the most exhaustively monitored in the 2019 WP2 campaign) for locomotive operators

$$[PM_{10}]_{\text{gravimetric, line X, 2019}} = [PM_{10}]_{\text{gravimetric, line 7, 2019 WP2}} * \frac{[PM_{10}]_{\text{line X, 2016 Locomotive Operators}}}{[PM_{10}]_{\text{line 7, 2016 Locomotive Operators}}}$$

Equation (2)

Aim: to predict the ratio of the PM10 exposure between the different geographic sectors of security guards and the geographic sector monitored in the 2019 WP2 campaign

$$[PM_{10}]_{\text{gravimetric, sector X, 2019}} = [PM_{10}]_{\text{gravimetric, sector Paris, 2019 WP2}} * \frac{[PM_{10}]_{\text{sector X, 2017 Security Guards}}}{[PM_{10}]_{\text{sector Paris, 2017 Security Guards}}}$$

Equation (3)

Aim: to predict the ratio of the PM10 exposure between the different sectors and the sector North of the line 7 for station agents

$$[PM_{10}]_{\text{gravimetric, sector X, 2019}} = (p_{US}) * [PM_{10}]_{\text{gravimetric, underground sector X, 2019 WP2}} + (1 - p_{US}) * [PM_{10}]_{\text{gravimetric, aerial sector X, 2019 AirParif}}$$

Where p_{US} : proportion of underground stations within the sector of assignment X; $(1 - p_{US})$: proportion of aerial stations within the sector of assignment X.

Equation (4)

Aim: to integrate the temporal dimension in the PM10 exposure prediction for locomotive operators.

$$\begin{aligned} & [PM_{10}]_{\text{gravimetric, line X, year Y}} \\ &= [PM_{10}]_{\text{gravimetric, line X, 2019}} * \left(\frac{[PM_{10}]_{\text{Squales, year Y}}}{[PM_{10}]_{\text{Squales, 2019}}} * p_{US} + \frac{[PM_{10}]_{\text{AirParif, year Y}}}{[PM_{10}]_{\text{AirParif, 2019}}} * (1 - p_{US}) \right) \\ &= [PM_{10}]_{\text{gravimetric, line X, 2019}} * (e^{a_{\text{Squales}} (\text{year Y} - 2019)} * p_{US} + e^{a_{\text{AirParif}} (\text{year Y} - 2019)} * (1 - p_{US})) \end{aligned}$$

Where: p_{US} : proportion of underground stations within the line of assignment X (metro line or RER line); $(1 - p_{US})$: proportion of aerial stations within the line of assignment X; a_{Squales} : the Squales campaign temporal slope on a log-scale; a_{AirParif} : the AirParif campaign temporal slope on a log-scale

Equation (5)

Aim: to integrate the temporal dimension in the PM10 exposure prediction for security guards.

$$\begin{aligned}
 & [PM_{10}]_{\text{gravimetric, sector X, year Y}} \\
 &= [PM_{10}]_{\text{gravimetric, sector X, 2019}} \\
 & * \left(\frac{[PM_{10}]_{\text{Squales RER, year Y}}}{[PM_{10}]_{\text{Squales RER, 2019}}} * p_{T_{\text{underground RER}}} + \frac{[PM_{10}]_{\text{Squales metro, year Y}}}{[PM_{10}]_{\text{Squales metro, 2019}}} * p_{T_{\text{underground metro}}} + \frac{[PM_{10}]_{\text{AirParif, year Y}}}{[PM_{10}]_{\text{AirParif, 2019}}} * p_{T_{\text{outdoor}}} \right) \\
 &= [PM_{10}]_{\text{gravimetric, sector X, year Y}} \\
 & * (e^{a_{\text{Squales RER}}(\text{year Y} - 2019)} * p_{T_{\text{underground RER}}} + e^{a_{\text{Squales metro}}(\text{year Y} - 2019)} * p_{T_{\text{underground metro}}} + e^{a_{\text{AirParif}}(\text{year Y} - 2019)} * p_{T_{\text{outdoor}}})
 \end{aligned}$$

where pT: proportion of time spent while on duty in one of the three types of surrounding environments (the underground RER; the underground metro and the outdoor); aSquales: the Squales campaign temporal slope on a log- scale; aAirParif: the AirParif campaign temporal slope on a log-scale.

Equation (6)

Aim: to integrate the temporal dimension in the PM10 exposure prediction for station agents.

$$\begin{aligned}
 & [PM_{10}]_{\text{gravimetric, sector X, year Y}} \\
 &= [PM_{10}]_{\text{gravimetric, sector X, 2019}} * \left(\frac{[PM_{10}]_{\text{Squales, year Y}}}{[PM_{10}]_{\text{Squales, 2019}}} * p_{US} + \frac{[PM_{10}]_{\text{AirParif, year Y}}}{[PM_{10}]_{\text{AirParif, 2019}}} * (1 - p_{US}) \right) \\
 &= [PM_{10}]_{\text{gravimetric, sector X, 2019}} * (e^{a_{\text{Squales}}(\text{year Y} - 2019)} * p_{US} + e^{a_{\text{AirParif}}(\text{year Y} - 2019)} * (1 - p_{US}))
 \end{aligned}$$

Where pUS : proportion of underground stations within the line of assignment X (metro line or RER line); (1- pUS): proportion of aerial stations within the line of assignment X; aSquales: the Squales campaign temporal slope on a log-scale (i.e., metroSquales as the temporal slope for metro Squales and RERSquales as the temporal slope for 'RER Squales'); aAirParif: the AirParif campaign temporal slope on a log-scale.