# Influence of the $PM_{10}$ measurement techniques on the assessment of the short-term mortality impacts of $PM_{10}$

M. Pascal[1], M. Corso[1], V. Wagner[1], E. Chatignoux[2], C. Declercq[1]
1/ Institut de veille sanitraire (InVS) – 2/ Observatoire régional de la santé (ORS) Ile-de-France

## Background

In France, before 2007, particulate matter (PM) levels were measured with Tapered Element Oscillating Microbalance (TEOM). This technique requires a heating of the device up to a temperature above ambient levels, resulting in the evaporation of the water and of the semi-volatile components of the PM. It systematically under-estimates PM concentrations compared to the gravimetric reference method.

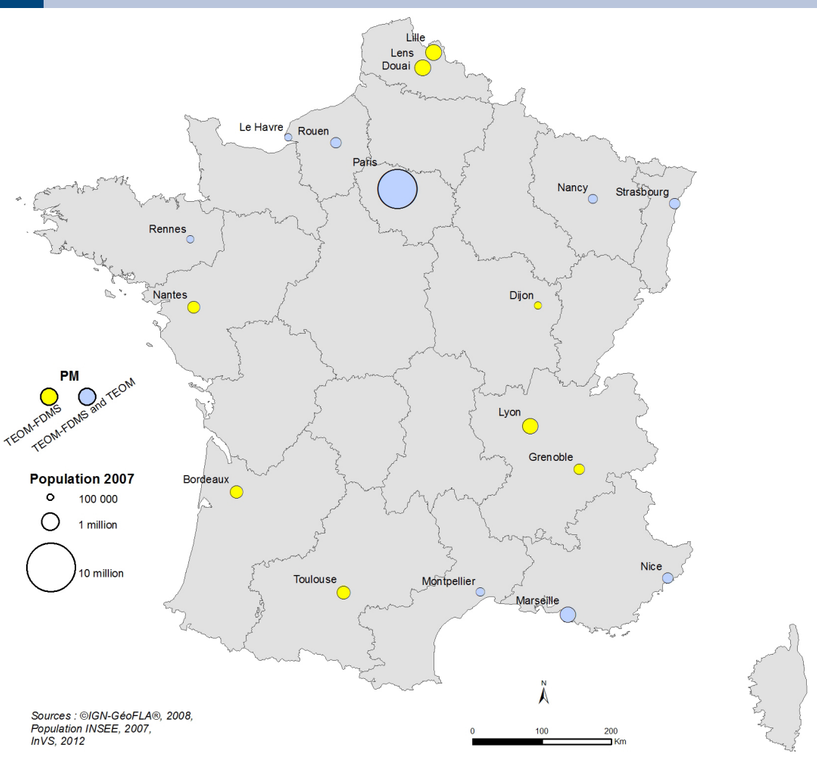
Since 2007, concentrations are measured with TEOMs equipped with a Filter Dynamics Measurement System (TEOM-FDMS), which corrects for the loss of semi-volatile compounds, and provide values consistent with the gravimetric method [1].

We investigate how this change in the measurement technique influences the estimates of the short-term impacts of $PM_{10}$ on mortality.

## Methods

The study was part of a larger study involving 17 French cities. The analysis was performed for the period 2007-2010 for the 9 cities where the TEOM and TEOM-FDMS $PM_{10}$ were recorded simultaneously. In the other cities, the TEOM values are no longer available (figure 1).

FIGURE 1 — Population and measurement techniques in the cities involved in the project




The association between daily background levels of $PM_{10}$ and daily non-accidental mortality was investigated in each city following APHEA-2 protocol [2] using a Poisson regression model controlling for possible confounders (temperatures, long-term and seasonal trends, day of the week, and bank holiday effects). The mean levels of $PM_{10}$ observed during the current and the previous day were introduced as a linear term. Mean temperatures at lag 0 and 1-7 were introduced as natural splines with 3 degrees of freedom.

The percent increase in the mortality rate was estimated for a 10 µg/m³ increase in $PM_{10}$ levels in each city for the whole year and by season (Winter: December-February, Spring: March-May, Summer: June-August, Autumn: September-November). City specific results were combined using random effect models.

## Results

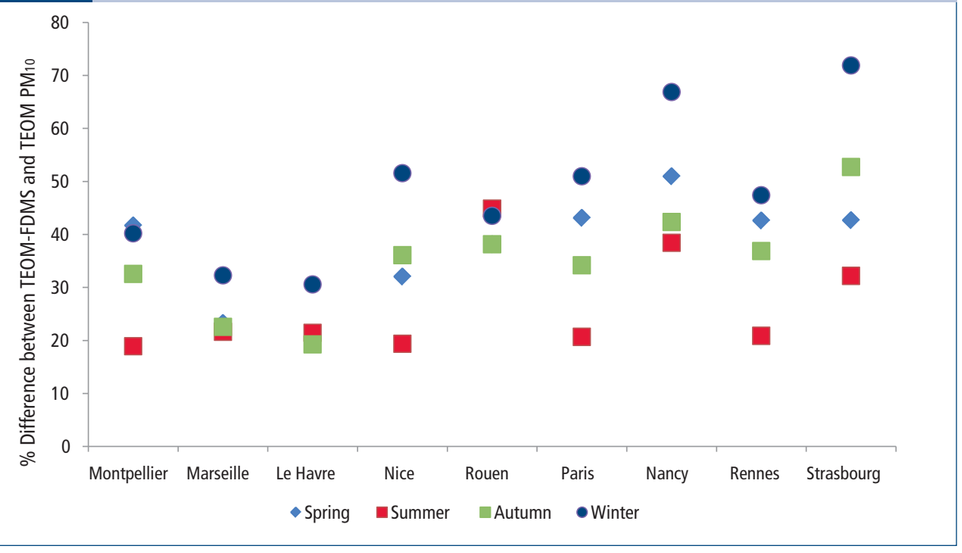
The daily mean number of deaths ranged from 104 in Paris to 4 in Rennes (table 1).

On average TEOM-FDMS $PM_{10}$ concentrations were 20 to 50% larger than TEOM concentrations (table 1). Even during summer, when less heating is required and the loss of volatile compounds is reduced TEOM-FDMS concentrations were at least 20% larger than TEOM concentrations. Differences were up to 70% larger during winter for all cities except Rouen (figure 2).

TABLE 1 — Characteristics of the cities

| City | Population | Mean Non-accidental daily mortality | Mean Daily $PM_{10}$ TEOM (µg/m³) | Mean Daily $PM_{10}$ (TEOM-FDMS) (µg/m³) |
|---|---|---|---|---|
| Paris | 6 542 671 | 104 | 19.6 | 27 |
| Marseille | 969 434 | 22 | 25.5 | 31.8 |
| Rouen | 447 098 | 10 | 18.8 | 25.9 |
| Nice | 441 924 | 12 | 20.7 | 29.2 |
| Strasbourg | 440 704 | 8 | 17 | 25.6 |
| Nancy | 331 521 | 7 | 17.6 | 23.9 |
| Montpellier | 320 760 | 6 | 18.9 | 23.2 |
| Le Havre | 242 587 | 6 | 18.4 | 24.6 |
| Rennes | 239 412 | 4 | 14.6 | 21.9 |

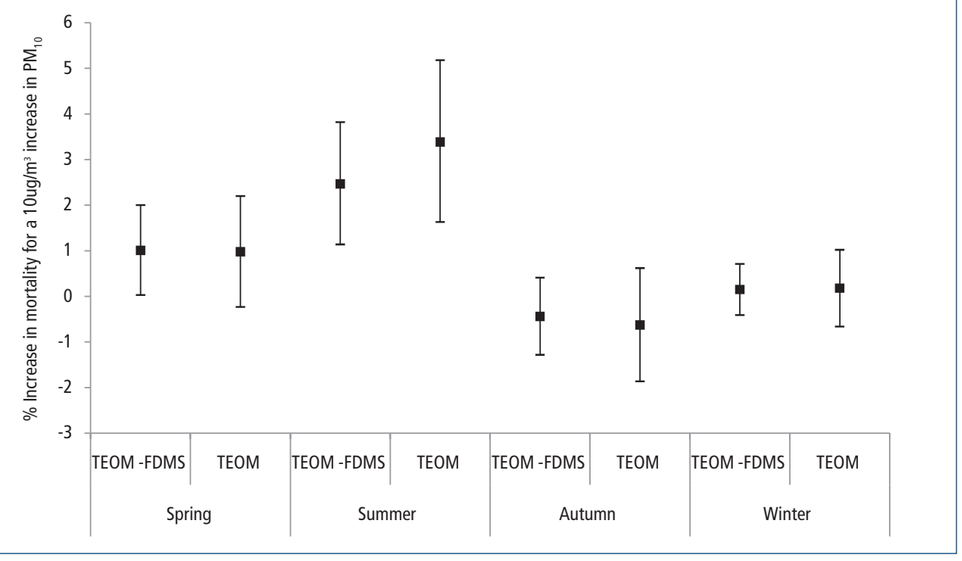
FIGURE 2 — Differences between TEOM-FDMS and TEOM concentrations by seasons




For the whole year, the mortality increased by 0.37% [CI 95% -0.01:0.75] for an increase of 10 µg/m³ of TEOM-FDMS $PM_{10}$. It was of 0.51% [-0.07:1.09] when using TEOM $PM_{10}$.

By season, estimates obtained withTEOM-FDMS or TEOM $PM_{10}$ data were also similar. The highest effect was observed for summer, with a +2.47 % [1.14:3.83] increase in mortality with TEOM-FDMS *vs* a 3.39% increase [1.63:5.18] using TEOM $PM_{10}$.

FIGURE 3 — % increase in mortality for a 10 µg/m³ in $PM_{10}$ for TEOM or TEOM-FDMS measurements




## Discussion

Large differences were observed between $PM_{10}$ concentrations obtained with TEOM or TEOM-FDMS, reflecting the weight of the semi-volatile compounds of PM.

Yet, the concentration-response functions were comparable, suggesting that the semi-volatile part of $PM_{10}$ has a health impact similar to the non-volatile part.

Concentration-response functions found with the TEOM or TEOM-FDMS $PM_{10}$ were consistent with those observed in a previous French multi-cities study (2000-2006), and with those obtained for a larger set of cities for the same period (table 2). They were also consistent with the estimates reported by Aphena for Europe [3].

TABLE 2

| | % increase in mortality for a 10 µg/m³ in $PM_1$ |
|---|---|
| $PM_{10}$ 2000-2006<br>9 cities (not the same cities)<br>TEOM | 0.2<br>[-0.5 ; 0.9] |
| $PM_{10}$ 2007-2010<br>9 cities<br>TEOM | 0.51<br>[-0.01; 1.09] |
| $PM_{10}$ 2007-2010<br>9 cities<br>TEOM-FDMS | 0.37<br>[-0.01; 0.75] |
| $PM_{10}$ 2007-2010<br>17 cities<br>TEOM-FDMS | 0.30<br>[-0.01; 0.60] |

### Acknowledgments
We wish to give our special thanks to the air quality monitoring networks who supported this work with their data and expertise.

### References
[1] Hauck H, Berner A, Gomiscek B, Stopper S, Puxbaum H, Kundi M, *et al.* On the equivalence of gravimetric PM data with TEOM and beta-attenuation measurements. Journal of Aerosol Science 2004;35(9):1135-1149.
[2] Touloumi G, Samoli E, Pipikou M, Le Tertre A, Atkinson R, Katsouyanni K. Seasonal confounding in air pollution and health time-series studies: effect on air pollution effect estimates. Stat Med 2006;25(24):4164-4178.
[3] Samoli E, Peng R, Ramsay T, Pipikou M, Touloumi G, Dominici F, *et al.* Acute effects of ambient particulate matter on mortality in Europe and North America: results from the APHENA study. Environ Health Perspect 2008;116(11):1480-6.

August 2013, International Society of Environmental Epidemiology (ISEE) - Basel, Switzerland

FRENCH INSTITUTE FOR PUBLIC HEALTH SURVEILLANCE

Contact : Mathilde Pascal (m.pascal@invs.sante.fr) - French Institute for Public Health Surveillance - Environmental Health Department - 12, rue du Val d'Osne 94415 Saint-Maurice Cedex - Tél. : +33 (0)1 41 79 68 87 - Fax : +33 (0)1 41 79 67 68