

# Retrospective prediction of PM<sub>2.5</sub> concentrations based on the coexistent pollutants, and regional and temporal characteristics of the regression.

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## Introduction

Nationwide PM<sub>2.5</sub> monitoring began since 2010 in Japan, and we have not yet got enough PM<sub>2.5</sub> data for studies and measures. It should take long time to establish the relationship between PM<sub>2.5</sub> and its health effects. It may be possible to investigate the health effects of PM<sub>2.5</sub> retrospectively, if the past PM<sub>2.5</sub> concentration can be predicted by SPM (suspended particulate matter, long-time monitored in Japan). However, regional and temporal characteristics about PM<sub>2.5</sub> prediction has not been studied systematically.

The aim of this study is to predict past PM<sub>2.5</sub> concentrations by SPM, and/or other pollutants such as NO<sub>x</sub>, SO<sub>2</sub>, and O<sub>x</sub> at several cities and years,

in order to enable to investigate the health effects of PM<sub>2.5</sub> retrospectively.

## Methods



Twenty-four hour average of PM<sub>2.5</sub>, NO<sub>x</sub>, SO<sub>2</sub>, and O<sub>x</sub> concentrations from 2011 through 2014 measured at one monitoring site from each of Yokohama, Osaka, Nagoya and Saga cities, were used for this study. First, PM<sub>2.5</sub> concentration was regressed on SPM concentration(Single). Second, PM<sub>2.5</sub> concentration was simultaneously regressed on SPM, NO<sub>x</sub>, SO<sub>2</sub>, and O<sub>x</sub>, (Multi) and significant variables (pollutants) were selected by stepwise method. Statistical analysis was conducted by using EZR. For the city which showed the lower R<sup>2</sup>, the regression was performed by separating the annual data into monthly data to clarify the factors.

## Results and Discussion

Table 1. PM<sub>2.5</sub> mass concentration predicted by other pollutant(s)

city	year	Regression model	R <sup>2</sup>
Yokohama	2014	Single PM2.5= 2.50 +0.66*SPM	0.90
		Multi PM2.5= 0.63 +0.62*SPM +0.08*NOx +0.26*SO <sub>2</sub>	0.93
	2013	Single PM2.5= -3.42 +0.71*SPM	0.92
		Multi PM2.5= -4.56 +0.71*SPM +0.03*Ox +0.05*NOx -0.28*SO <sub>2</sub>	0.92
	2012	Single PM2.5= -2.53 +0.77*SPM	0.81
		Multi PM2.5= -4.72 +0.70*SPM +0.08*NOx -0.39*SO <sub>2</sub>	0.85
2011	Single PM2.5= -2.40 +0.73*SPM	0.73	
	Multi PM2.5= -2.81 +0.59*SPM +0.14*NOx	0.73	
Osaka	2014	Single PM2.5= 6.50 +0.52*SPM	0.46
		Multi PM2.5= 2.75 +0.31*SPM +0.08*Ox +0.10*NOx +2.16*SO <sub>2</sub>	0.48
	2013	Single PM2.5= 2.47 +0.77*SPM	0.74
		Multi PM2.5= -5.84 +0.67*SPM +0.08*Ox +0.31*NOx	0.88
	2012	Single PM2.5= 0.62 +0.89*SPM	0.87
		Multi PM2.5= -4.79 +0.75*SPM +0.10*Ox +0.20*NOx	0.91
2011	Single PM2.5= 10.04 +0.40*SPM	0.36	
	Multi PM2.5= -0.30 +0.30*SPM +0.14*Ox +0.33*NOx	0.52	
Nagoya	2014	Single PM2.5= 6.50 +0.52*SPM	0.77
		Multi PM2.5= -3.36 +0.64*SPM +0.08*Ox +0.14*NOx +0.99*SO <sub>2</sub>	0.81
	2013	Single PM2.5= 1.57 +0.71*SPM	0.73
		Multi PM2.5= -3.85 +0.60*SPM +0.09*Ox +0.25*NOx +1.41*SO <sub>2</sub>	0.81
	2012	Single PM2.5= 0.89 +0.74*SPM	0.68
		Multi PM2.5= -10.68 +0.60*SPM +0.24*Ox +0.43*NOx	0.86
2011	Single PM2.5= 4.49 +0.51*SPM	0.56	
	Multi PM2.5= -7.81 +0.44*SPM +0.21*Ox +0.40*NOx +1.23*SO <sub>2</sub>	0.78	
Saga	2014	Single PM2.5= 1.48 +0.64*SPM	0.64
		Multi PM2.5= -11.49 +0.56*SPM +0.27*Ox +0.51*NOx +0.64*SO <sub>2</sub>	0.75
	2013	Single PM2.5= -3.79 +0.89*SPM	0.87
		Multi PM2.5= -7.24 +0.84*SPM +0.09*Ox +0.10*NOx +0.59*SO <sub>2</sub>	0.89
	2012	Single PM2.5= -4.28 +0.81*SPM	0.93
		Multi PM2.5= -6.32 +0.78*SPM +0.03*Ox +0.14*NOx	0.94

### All Cities

Table1. describe the result of regression analysis and R<sup>2</sup>. PM<sub>2.5</sub> concentrations were well predicted by SPM at most cities and years. There were little difference of regression coefficients for SPM between single and multiple regressions and most of the coefficients for other pollutants were insignificant.

### Yokohama (Eastern urban city)

- The regression coefficient of each year was almost the same(nearly 0.7) .
- All R<sup>2</sup>s were high (>0.7)
- It was possible past PM2.5 concentration prediction

Saga (western rural city) • The regression coefficients in fiscal year 2013 and 2012 were almost the same (0.81,0.89). But the coefficient in fiscal year 2014 was lower than those in 2013 and 2012. There might be some errors of the prediction.

- Although there was some error it was possible past PM2.5 concentration prediction

### Osaka and Nagoya (Western urban city)

- The coefficients varied among years and the each R<sup>2</sup> was lower in Osaka and Nagoya. than the others
- Predicted PM<sub>2.5</sub> concentrations on July, August and September in Nagoya were higher than the observed values. (Figure.1) A similar trend was seen in Osaka in fiscal year 2014 and 2011.

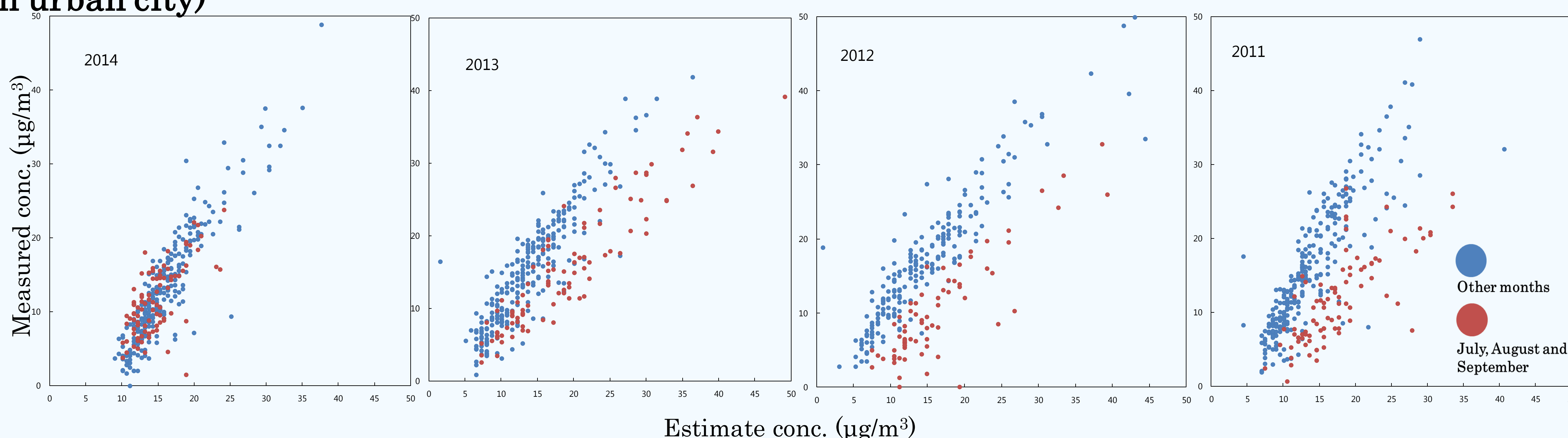


Figure.1 Relationship between estimated and measured concentration of PM<sub>2.5</sub> in Nagoya.

## Conclusion

It is possible to predict PM<sub>2.5</sub> concentration in the past in Yokohama and Saga. It is difficult to predict the concentration in Osaka and Nagoya. of Trends of the regression coefficients and R<sup>2</sup> was different by region. The reason why the trend was different was not known at this study. By comparing the partial regression coefficient, in some areas it was found a tendency that the contribution of SPM is about the same in each year. If R<sup>2</sup>s were high in this such areas, it is considered to be a possible to estimate the past of PM<sub>2.5</sub> concentration. On the other hand, in area there was no consistent trend in the coefficients of SPM and R<sup>2</sup>, the factors other than SPM have to be considered contribute to PM<sub>2.5</sub> concentration.

## Acknowledgement

This work was supported by JSPS KAKENHI Grand Number JP26340046.

## COI

We have no financial relationships to disclose.