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Retrospective prediction of $PM_{2.5}$ concentrations based on the coexistent pollutants, and regional and temporal characteristics of the regression.

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Introduction

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

The aim of this study is to predict past $PM_{2.5}$ concentrations by SPM, and/or other pollutants such as NO_X, SO_2, and O_X at several cities and years,

in order to enable to investigate the health effects of $PM_{2.5}$ retrospectively.

Methods

Twenty-four hour average of $PM_{2.5}$, NO_X, SO_2, and O_x 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, $PM_{2.5}$ concentration was regressed on SPM concentration(Single). Second, $PM_{2.5}$ concentration was simultaneously regressed on SPM, NO_X, SO_2, and O_X, (Multi) and significant variables (pollutants) were selected by stepwise method. Statistical analysis was conducted by using EZR. For the city which showed the lower R2, the regression was performed by separating the annual data into monthly data to clatify the factors.

Results and Discussion

Table 1. $PM_{2.5}$ mass concentration predicted by other pollutant(s)

city	year		Regression model						R^2
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_2	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_2	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_2	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_2	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_2	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_2	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_2	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_2	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_2	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^2. $PM_{2.5}$ 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 urbam city)

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

Saga (wastern 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^2 was lower in Osaka and Nagoya. than the others
- Predicted $PM_{2.5}$ 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.

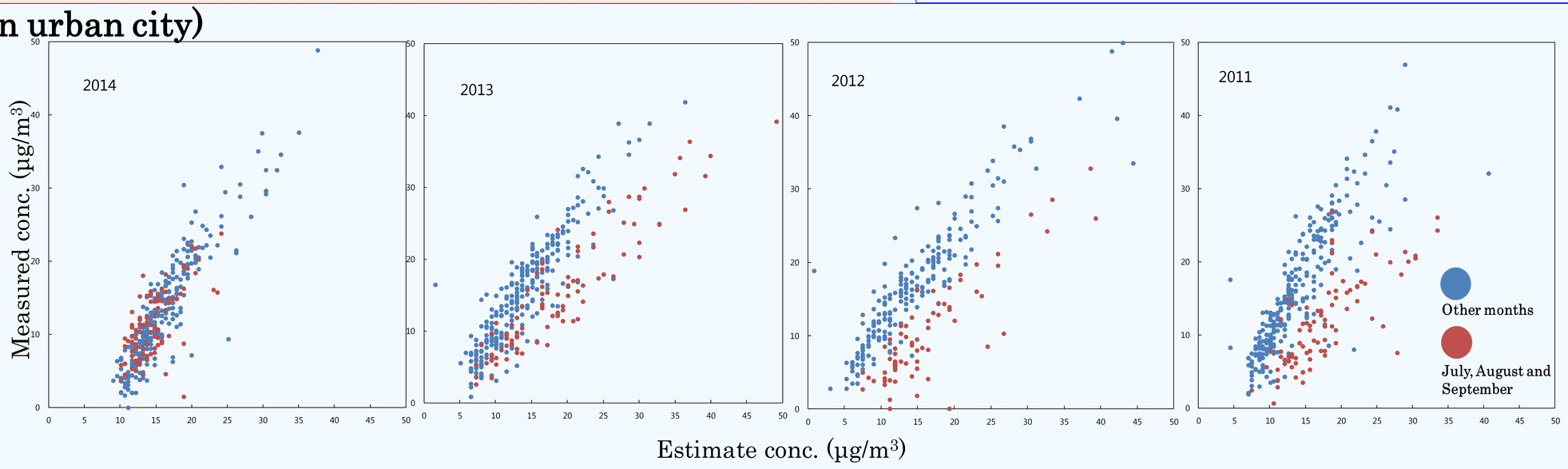

Figure.1 Relationship between estimated and measured concentration of $PM_{2.5}$ in Nagoya.

Conclusion

It is possible to predict PM2.5 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^2 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^2s were high in this such areas, it is considered to be a possible to estimate the past of $PM_{2.5}$ concentration. On the other hand, in area there was no consistent trend in the coefficients of SPM and R^2, the factors other than SPM have to be considered contribute to $PM_{2.5}$ concentration.

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