A Three-Dimensional Air Quality Measurement Model in an Opened High Traffic Street Canyon Using an Explicit Finite Difference Method

Hasakarn Thongzunhor, Nopparat Pochai

***Abstract*—The concentration of air pollutant is greatly affected by the urban design. The street-level air quality measurement is the most important factor of strategies on urban design. There has been relatively little attempt to include street-canyon air quality in the control of urban formation. In this research, a three-dimensional time-dependent air pollutant concentration measurement in several types of high traffic street canyons is proposed. A three-dimensional time-dependent air pollutant dispersion model with several kind of pollutant sources is considered. Various kinds of street canyon structure are also simulated. The Explicit finite difference techniques are used to visualize the considered model solution. The proposed numerical simulations provide positive agreeable results. The comparison of calculated results of different conditions promises useful information for street canyon designs. The climate change is affecting outdoor air quality. The major challenges and opportunities found during outdoor air pollution studies will be highlighted.**

***Index Terms*—Air pollution, street canyon, dispersion model, advection-diffusion equation, explicit method**

I. Introduction

EARTH is covered by layers of atmosphere which is 15 km thick. The atmosphere consists of nitrogen oxygen dust vapor and microorganism. The most important gas is oxygen. However, the layer that contains oxygen is only 5-6 km thick and with stable proportion of gas which are nitrogen 78.09 oxygen 20.94 carbon dioxide and inert gas 0.97. With this exact proportion of gas, it is fresh air. Whenever the proportion changes with too much increasing of dust gas smell mist smoke vapor ash and radioactivity, the stage of air is called "bad air" or "air pollution".

[16] studied the amount of air pollution in Krasnoyarsk (in Eastern Siberia) and utilized Markov's processes in USM to compute the spatial distribution of pollution levels away from roadways. [19] For the advection equation, they provide first and second order positive numerical approaches. They consider the direct discretization of the model problem and comment on its superiority to the so-called method of lines. They investigate the accuracy, stability and positivity properties of the direct discretization. In 2012 [20], the study analyzed the smoke dispersion model in a two-dimensional domain, taking into consideration 2- and 3-point sources as well as two barriers.

In 2013, [24] investigated and compared the performance of three alternative CFD numerical techniques, namely RANS, URANS, and LES, in order to assess their feasibility for predicting air flow and pollution dispersion in urban roadway canyons. The results showed that LES was observed to produce accurate more than RANS and URANS. [1] PM2.5 and NO2 values were determined inside and outside in 10 city center locations (store and workplaces) in Dublin, Ireland, in 2014. Outside values were determined at two points: the basement from outside structure and the inlet of the air vents.

[4] The current study conducts numerical research on pollution dispersion in roadway canyons with emission sources at the ground level. The roadway canyon model, which comprises of lengthy roadways that are laterally restricted by buildings, is commonly used to study pollutant dispersion concerns in metropolitan environments. [14]

The Semi-Empirical Urban Street (SEUS) model is introduced in this work. SEUS is a straightforward scientific principle that scales air pollution concentrations inside roadway canyons by using the emission rate, canyon width, dispersive velocity scale, and ambient concentration. [22] conducted a seasonal analysis in six typical roadway canyons in downtown Shanghai's residential area, which has been plagued by haze pollution despite having a significant number of green streets. Air flow and particulate matter dispersion outside of structures with varying window launching proportions were studied in 2015 using three-dimensional simulation studies to test the impact of road traffic on indoor environmental quality of air-conditioned buildings near a roadway canyon. [23] Studied the three-dimensional (3D) numerical simulations are performed using Large Eddy Simulation (LES). The FWBC produces more realistic results when compared to the frequently employed SWBC. [25] During a 12-month period, a gauge monitor was conducted to assess the hourly concentrations of PM2.5, PM10–2.5, and Black Carbon in a Hong Kong urban highway canyon. In 2016, [21], a 3D air-quality model including fluctuations from different perspectives are studied. In order to anticipate air pollution concentrations, fractional step approaches were applied. [7] to investigate the level of air pollution concentration in an urban roadway canyon, the spatial distribution of pollutant concentration level is modeled using a 2D advection-diffusion equation. The joint effects of building form and trees on air pollution concentrations in the Marylebone area was discussed in 2017 [2] (central London). The k-ε model is used to run computational fluid dynamics (CFD) simulations with Open FOAM. [10] Using the computation of a 3D air pollution

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model, they have investigated the air pollution in the tunnel underneath a sky train platform. This model took into account a variety of scenarios including wind ingress and obstructions. [17] To represent the dispersion of air pollution concentrations around an industrial zone, the atmospheric diffusion model was utilized. Controlling air pollution emissions beneath a point source was used to solve the problem. Air pollution control was found to be important for air quality management based on numerical experiments. On 2018, [11] used finite difference methods to investigate a numerical modeling of air pollution concentration in sky train platforms with airflow impediments on a busy road as solutions of the model. [12] The numerical model is utilized to calculate the amounts of air pollutants in this study. To approximate the simulated solutions, finite difference methods are used. In 2019, polluted air in cities has a strong effect on global public health [5]. Air pollution includes particulate matter are examples of air pollution (CO2). Urban vegetation can help to purify the air in densely populated places.

In this research, in a high traffic street canyon is focused an air quality measurement model. Numerical models of air pollutant concentration in urban roadway canyon with a junction and airflow obstacles on roadway canyon are considered. The solutions of Three-dimensional time-dependent advection-diffusion equation solutions are approximated by finite difference methods. In this research, the air pollution modeling depend on air pollution flows and wind direction are indicated. In the second section, the governing equation corresponding to the model is the three-dimensional time-dependent advection-diffusion equation including the practical initial and boundary conditions. The third section proposes their numerical methods. Finite difference techniques are introduced an explicit forward time, centered space (FTCS) scheme. In order to illustrate the performance of the model in section 4, the numerical experiments are also presented. Finally, the discussion and the conclusion are presented in section 5.

II. Governing Equation

The considered roadway canyon configuration is shown in Figure 1. That is, the roadway is surrounded on both sides by buildings, with the upper space also open. The bottom floor is the roadway floor. For both sides of the roadway are the section of buildings.

It is supposed that the domain under consideration exists by $\Omega = \{(x,y,z);\ 0 \le x \le L, 0 \le y \le W, 0 \le z \le H\}$, where W is the roadway canyon's width (m), L is its length (m), and H is its height (m).

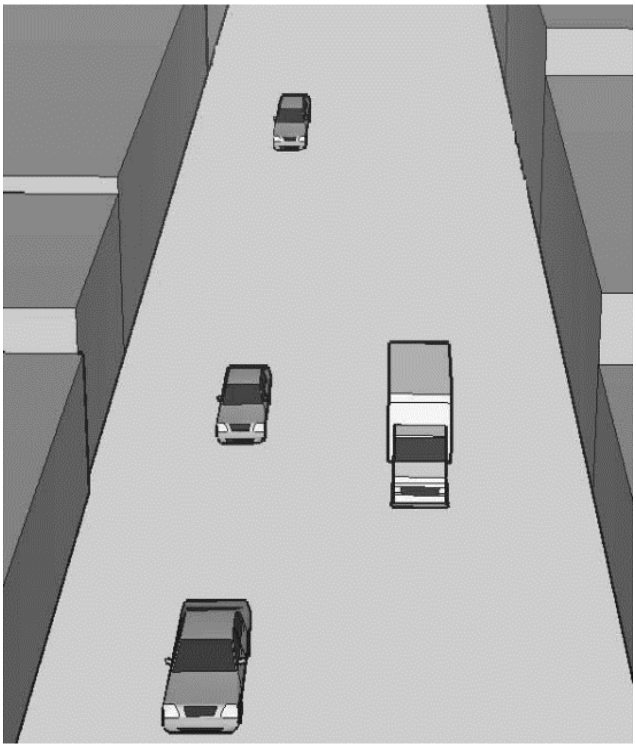

Fig. 1. A roadway canyon configuration.

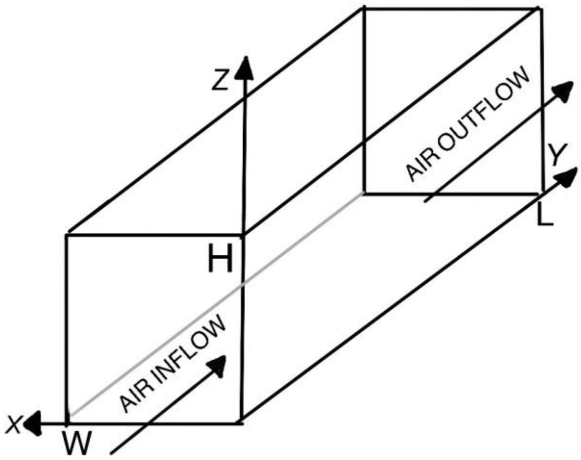

Fig. 2. The domain for roadway canyon (Case 1).

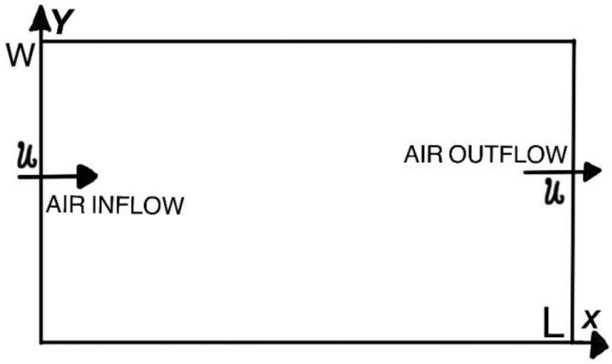

Fig. 3. The wind flow (Case 1).

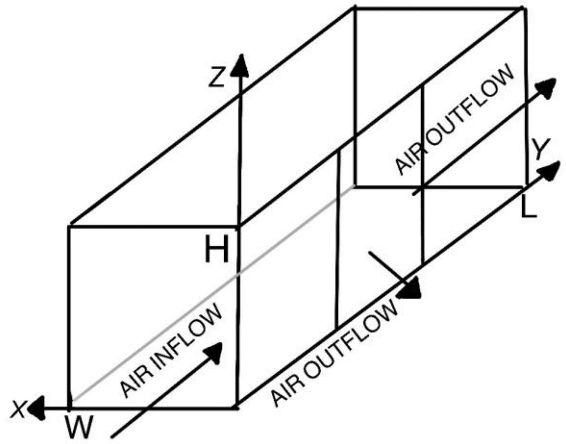

Fig. 4. The domain for roadway canyon (Case 2).

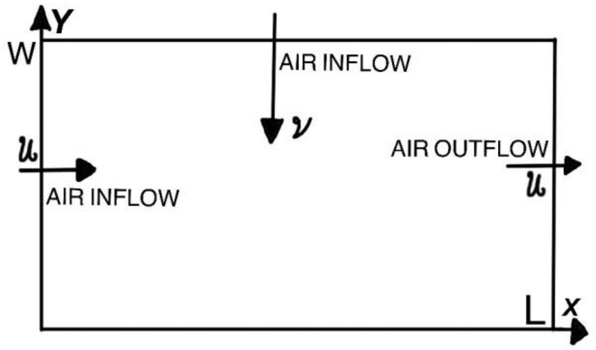

Fig. 5. The wind flow (Case 2).

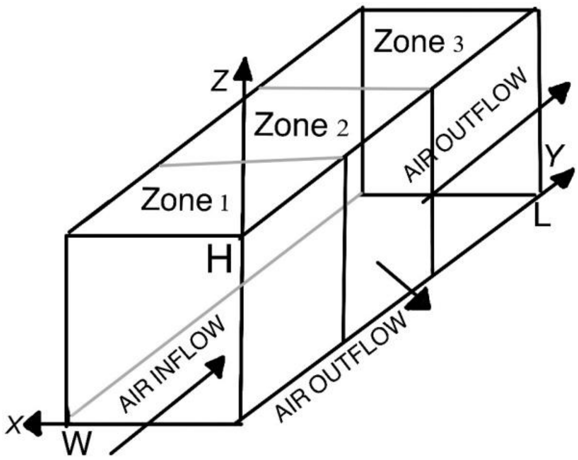

Fig. 6. The domain for roadway canyon (Case 3).

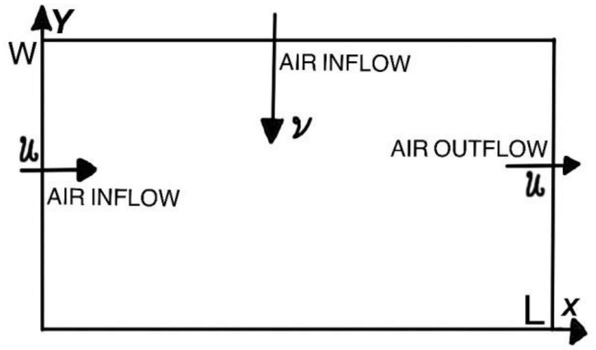

Fig. 7. The wind flow (Case 3).

An advection-diffusion equation can be used to characterize the pollutant concentration in the air:

$$\frac{\partial C}{\partial t} + V \cdot \nabla C = \nabla \cdot \left(\overline{K} \otimes \nabla C \right) + R(x,y,z,t) \qquad (1)$$

where $C = C(x,y,z,t)$ is the concentration of air pollution at a given place in usual coordinates over time t, (kg/m^3). The wind velocity field represents the vector V (m/sec); $\overline{K}$ is the eddy-diffusivity or diffusive vector (m^2/sec). $\nabla = \frac{\partial}{\partial x}\vec{i} + \frac{\partial}{\partial y}\vec{j} + \frac{\partial}{\partial z}\vec{k},$ $\otimes$ is matrix multiplication, and $R(x,y,z,t)$ denotes the inputs and drains of pollutants in the atmosphere (sec^{-1}).

The governing equation becomes if the flow velocity and pollutant diffusive coefficient are both constant,

$$\begin{aligned} &\frac{\partial C}{\partial t} + u\frac{\partial C}{\partial x} + v\frac{\partial C}{\partial y} + w\frac{\partial C}{\partial z} \\ &= k_x \frac{\partial^2 C}{\partial x^2} + k_y \frac{\partial^2 C}{\partial y^2} + k_z \frac{\partial^2 C}{\partial z^2} + R(x,y,z,t) \end{aligned} \qquad (2)$$

where u, v and w are the constant flow velocity (m/sec) in x-,y-, and z-directions, respectively, k_x, k_y, and k_z are the diffusive coefficient (m^2/sec) in x-,y-, and z-directions, respectively.

As shown in Fig. 2-7, the wind inflow is assumed by horizontally isotropic and that the dispersion is horizontally isotropic. As a result, we can write the equation in (2) as

$$\frac{\partial C}{\partial t} + u\frac{\partial C}{\partial x} + v\frac{\partial C}{\partial y} = k_h \frac{\partial^2 C}{\partial x^2} + k_h \frac{\partial^2 C}{\partial y^2} + k_v \frac{\partial^2 C}{\partial z^2} + R(x,y,z,t) \quad (3)$$

where k_h is a diffusive coefficient in the horizontal direction (m^2/sec), and k_v is a constant diffusive in the z -direction (vertical) (m^2/sec) with the appropriate initial and boundary conditions.

We consider the components of the canyon in Fig. 8. The potential pollutant concentration in the air may be stated as follows: $C(x,y,z,0) = f(x,y,z)$ for all $(x,y,z) \in \Omega$. The boundary conditions are as follows:

Entrance gate: $C(0,y,z,t) = c_0,$

Ground: $\frac{\partial C}{\partial z}(x,y,0,t) = c_1,$

Top side wall: $\frac{\partial C}{\partial z}(x,y,H,t) = c_2,$

Exit gate: $\frac{\partial C}{\partial x}(L,y,z,t) = c_3,$

Left side wall: $\frac{\partial C}{\partial y}(x,W,z,t) = c_4,$

Right side wall: $\frac{\partial C}{\partial y}(x,0,z,t) = c_5,$

Right side wall gap: $C(x,0,z,t) = c_6, F \le x \le G$

where c_0 and c_6 are the air pollutant concentration inflow x- and y-direction, respectively, $c_1, c_2, c_3, c_4,$ and c_5 are rate of change of air pollutant concentration in each roadway canyon boundaries.

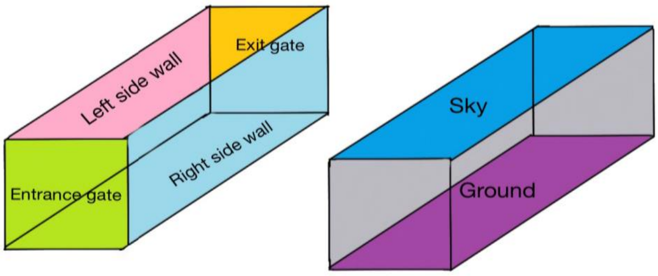

Fig. 8. Components of the canyon.

III. Numerical Techniques

The time-dependent 3D advection-diffusion equation is approximated numerically using finite difference techniques. The solution domain is defined by a grid spacing of: $x_i = i\Delta x, i = 0,1,2,\ldots,M$; $y_j = j\Delta y, j = 0,1,2,\ldots,N$; $z_k = k\Delta z, k = 0,1,2,\ldots,P$; $t_n = n\Delta t, n = 0,1,2,\ldots,Q$; parallel to the space and time coordinate axes, respectively. The approximated solution of the air pollutant concentration $C^n_{i,j,k}$ to $C(i\Delta x, j\Delta y, k\Delta z, n\Delta t)$ are determined at the location where these lines cross, namely, $(i\Delta x, j\Delta y, k\Delta z, n\Delta t)$ which is denoted by the (i,j,k,n) grid point. The constant spatial and temporal grid-spacing are $\Delta x = \frac{L}{M}, \Delta y = \frac{W}{N}, \Delta z = \frac{H}{P}, \Delta t = \frac{T}{Q}$, respectively.

A forward in time and central in space (FTCS) approach will be used in this research. As a result, the finite difference equation to (3) becomes the following finite difference equation:

$$C \approx C^n_{i,j,k}, \tag{4}$$

$$\frac{\partial C}{\partial t} \approx \frac{C^{n+1}_{i,j,k} - C^n_{i,j,k}}{\Delta t} \tag{5}$$

$$\frac{\partial C}{\partial x} \approx \frac{C^n_{i+1,j,k} - C^n_{i-1,j,k}}{2\Delta x} \tag{6}$$

$$\frac{\partial C}{\partial y} \approx \frac{C^n_{i,j+1,k} - C^n_{i,j-1,k}}{2\Delta y} \tag{7}$$

$$\frac{\partial^2 C}{\partial x^2} \approx \frac{C^n_{i+1,j,k} - 2C^n_{i,j,k} + C^n_{i-1,j,k}}{(\Delta x)^2} \tag{8}$$

$$\frac{\partial^2 C}{\partial y^2} \approx \frac{C^n_{i,j+1,k} - 2C^n_{i,j,k} + C^n_{i,j-1,k}}{(\Delta y)^2} \tag{9}$$

$$\frac{\partial^2 C}{\partial z^2} \approx \frac{C^n_{i,j,k+1} - 2C^n_{i,j,k} + C^n_{i,j,k-1}}{(\Delta z)^2} \tag{10}$$

$$R \approx R^n_{i,j,k} \tag{11}$$

Substituting Eqs. (4-11) into Eq. (3), we can obtain an explicit form of finite difference equation as follows,

$$\begin{aligned}&\frac{C^{n+1}_{i,j,k} - C^n_{i,j,k}}{\Delta t} + u\left(\frac{C^n_{i+1,j,k} - C^n_{i-1,j,k}}{2\Delta x}\right) + v\left(\frac{C^n_{i,j+1,k} - C^n_{i,j-1,k}}{2\Delta y}\right)\\ &= D_h\left(\frac{C^n_{i+1,j,k} - 2C^n_{i,j,k} + C^n_{i-1,j,k}}{(\Delta x)^2}\right) + D_h\left(\frac{C^n_{i,j+1,k} - 2C^n_{i,j,k} + C^n_{i,j-1,k}}{(\Delta y)^2}\right)\\ &+ D_v\left(\frac{C^n_{i,j,k+1} - 2C^n_{i,j,k} + C^n_{i,j,k-1}}{(\Delta z)^2}\right) + R^n_{i,j,k}\end{aligned} \tag{12}$$

Rearrangement and simplification of Eq. (12), we get the explicit form,

$$\begin{aligned}C^{n+1}_{i,j,k} &= (s_x + r_x)C^n_{i-1,j,k} + (s_y + r_y)C^n_{i,j-1,k}\\ &+ (s_z)C^n_{i,j,k-1} + (1 - 2s_x - 2s_y - 2s_z)C^n_{i,j,k}\\ &+ (s_x - r_x)C^n_{i+1,j,k} + (s_y - r_y)C^n_{i,j+1,k} + (s_z)C^n_{i,j,k+1}\end{aligned} \tag{13}$$

in which $s_x = \frac{D_h \Delta t}{(\Delta x)^2}, s_y = \frac{D_h \Delta t}{(\Delta y)^2}, s_z = \frac{D_v \Delta t}{(\Delta z)^2}, r_x = \frac{u\Delta t}{2\Delta x}, r_y = \frac{v\Delta t}{2\Delta y}$.

IV. Boundaries Solution Approximation

The ground: $\frac{\partial C}{\partial z}(x,y,0,t) = c_1$, or $\frac{\partial C^n_{i,j,0}}{\partial z} = c_1$,

Using forward difference scheme

$$\frac{C^n_{i,j,k+1} - C^n_{i,j,k}}{\Delta z} = c_1,$$

$$k = 0; \quad \frac{C^n_{i,j,1} - C^n_{i,j,0}}{\Delta z} = c_1,$$

$$\text{So,} \quad C^n_{i,j,0} = C^n_{i,j,1} - c_1(\Delta z). \tag{14}$$

The top side wall: $\frac{\partial C}{\partial z}(x,y,H,t) = c_2$, or $\frac{\partial C^n_{i,j,P}}{\partial z} = c_2$,

Using backward difference scheme

$$\frac{C^n_{i,j,k} - C^n_{i,j,k-1}}{\Delta z} = c_2,$$

$$k = P; \quad \frac{C^n_{i,j,P} - C^n_{i,j,P-1}}{\Delta z} = c_2,$$

$$\text{So,} \quad C^n_{i,j,P} = C^n_{i,j,P-1} + c_2(\Delta z). \tag{15}$$

The exit gate: $\frac{\partial C}{\partial x}(L,y,z,t) = c_3$, or $\frac{\partial C^n_{M,j,k}}{\partial x} = c_3$,

Using forward difference scheme

$$\frac{C^n_{i+1,j,k} - C^n_{i,j,k}}{\Delta x} = c_3,$$

$$i = M-1; \quad \frac{C^n_{M,j,k} - C^n_{M-1,j,k}}{\Delta x} = c_3,$$

$$\text{So,} \quad C^n_{M,j,k} = C^n_{M-1,j,k} + c_3(\Delta x). \tag{16}$$

The left side wall: $\frac{\partial C}{\partial y}(x,W,z,t) = c_4$, or $\frac{\partial C^n_{i,N,k}}{\partial y} = c_4$,

Using backward difference scheme

$$\frac{C^n_{i,j,k} - C^n_{i,j-1,k}}{\Delta y} = c_4,$$

$$j = N; \quad \frac{C^n_{i,N,k} - C^n_{i,N-1,k}}{\Delta y} = c_4,$$

$$\text{So,} \quad C^n_{i,N,k} = C^n_{i,N-1,k} + c_4(\Delta y). \tag{17}$$

The right-side wall: $\frac{\partial C}{\partial y}(x,0,z,t) = c_5$, or $\frac{\partial C^n_{i,0,k}}{\partial y} = c_5$,

Using forward difference scheme

$$\frac{C^n_{i,j+1,k} - C^n_{i,j,k}}{\Delta y} = c_5,$$

$$j = 0; \quad \frac{C^n_{i,1,k} - C^n_{i,0,k}}{\Delta y} = c_5,$$

$$\text{So,} \quad C^n_{i,0,k} = C^n_{i,1,k} - c_5(\Delta y). \tag{18}$$

Respectively. In x- ,y- and z- directions are obtained in the same way.

V. Numerical Experiments

Three simulations of released air pollutant phenomena are presented in this section using the finite difference method (5). The air pollutant concentration is discharged from the entry gate in all simulations. The starting state is presumed by since there is no possibility for air pollution, $f(x,y,z,0)=0$.

The simulation of roadway canyon configuration is separated into three situations in this experiment:

-- Case 1, assuming the pollution concentration in the air is discharged from the entrance gate. The wind flow is only blowing in x-direction. Figure 2 shows the roadway canyon under consideration. Figure 3 shows the wind flow direction field.

-- Case 2, assuming the air pollution concentration is released from both the entry and right-side gates. The wind blows in both directions. Figure 4 shows the roadway canyon under consideration. Figure 5 shows the wind direction field.

-- Case 3, assume that the air pollutant concentrations are intakes from both the entry and right-side gates. The wind blows in both x and y directions. We separated the source into three sections. Figure 6 shows the roadway canyon under consideration. Figure 7 shows the wind direction field.

For three cases, we consider the length, width, and height of the roadway canyon are 200, 15 and 15 meters, respectively. Then, the problem domain is

We assume that $c_0=c_6=0.1, c_1=c_2=c_3=c_4=c_5=0$, $F=65$ and $G=130$. When we investigate the scenario model illustrated in Figure. 5, we can see that $0\le x<65, 65\le x<130$, and $130<x\le 200$ are Zones 1-3, respectively. For the grid $\Delta x=\Delta y=\Delta z=0.005, \Delta t=0.0001$ sec and for the time, $T=0.5$

Simulation A (Case of normal roadway canyon with averaged pollutant source). The roadway canyon with buildings lined up constantly on both sides is considered in this scenario. The wind will blow in x-direction. There are 3 cases are considered such as R is the inputs $(R>0)$, which is 0.001 sec^{-1}, R is assumed by no inputs or outputs $(R=0)$ and R is the drain $(R<0)$, which is -0.001 sec^{-1}. The results of Simulation 1 are shown in Fig. 9-12.

Simulation B (Case of opened roadway canyon with averaged pollutant source). In this scenario, roadway canyons are investigated that are not always by structures on both sides, providing for some gaps in the canyon walls. The wind is flowing in both directions. There are 3 cases are considered such as R is the inputs $(R>0)$, which is 0.001 sec^{-1}, R is assumed by no inputs or outputs $(R=0)$ and R is the drain $(R<0)$, which is -0.001 sec^{-1}. The results of Simulation 2 are shown in Fig. 13-19.

Simulation C (Case of mobile air pollutant source inside an opened roadway canyon). In this scenario, we analyze roadway canyons that are not always surrounded by structures on both sides continually, providing for some gaps on the canyon walls and smooth air flow along a roadway canyon, and we split R into three zones. Consequently, R_1, R_2, and R_3 are sources of zone1, zone2, and zone3, respectively. The wind is flowing in both directions. Three cases will be considered. First, R in zone 1 is the small and progressively increases, which are $R_1=0.001$, $R_2=0.005$, and $R_3=0.01$, sec^{-1}. Next, R in zone 1 is the biggest and progressively diminishes, which are $R_1=0.01, R_2=0.005$, and $R_3=0.001$, sec^{-1}. Finally, R is the function of input or drain, that are $\frac{0.01}{5}\left|\sin(xyt)\right|$ sec^{-1}. The outcomes of Simulation 3 are presented in Fig. 20-26.

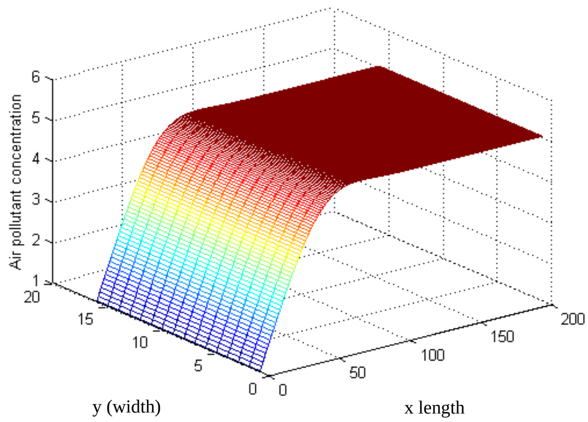

Fig. 9. Surface plot of air pollutant concentration for R = 0.001 sec^{-1} of Simulation A at time 5000s.

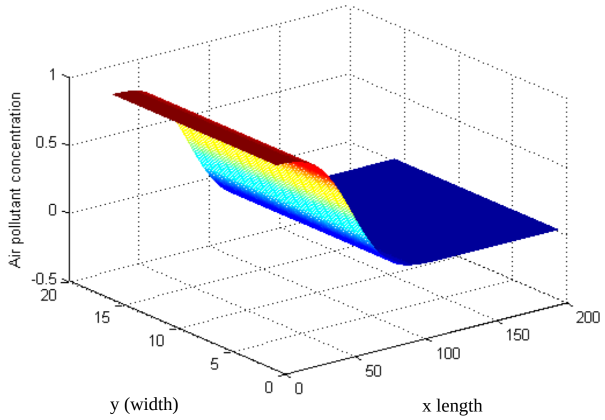

Fig. 10. Surface plot of air pollutant concentration for R = 0 sec^{-1} of Simulation A at time 5000s.

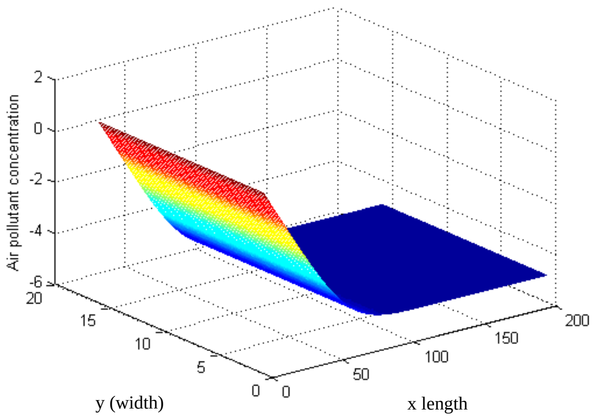

Fig. 11. Surface plot of air pollutant concentration for R = -0.001 sec^{-1} of Simulation A at time 5000s.

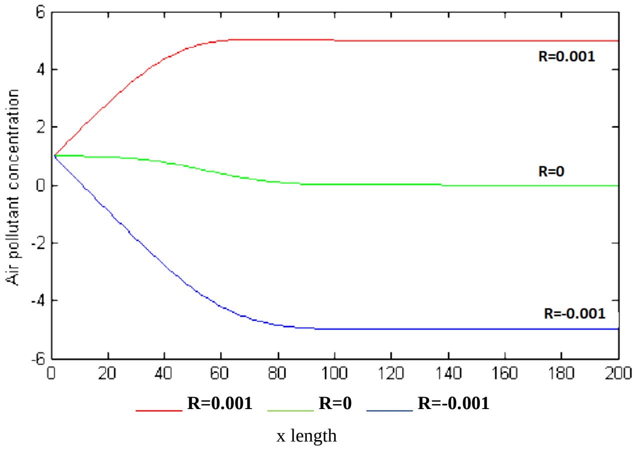

Fig. 12. Compare the air pollutant concentration for R = 0.001, R = 0 and R = -0.001 sec^{-1} of Simulation A at time 5000s.

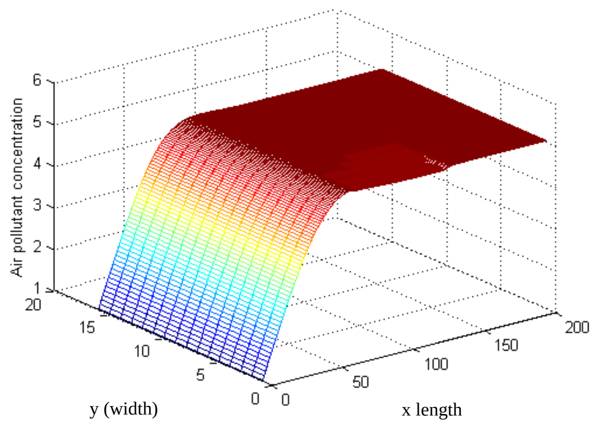

Fig. 13. Surface plot of air pollutant concentration for R = 0.001 sec^{-1} of Simulation B at time 5000s.

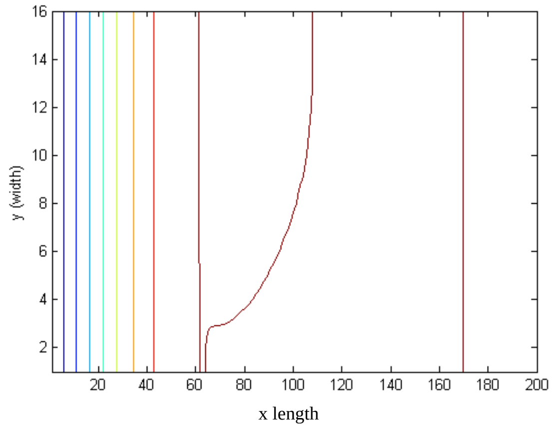

Fig. 14. Contour plot of air pollutant concentration for R = 0.001 sec^{-1} of Simulation B at time 5000s.

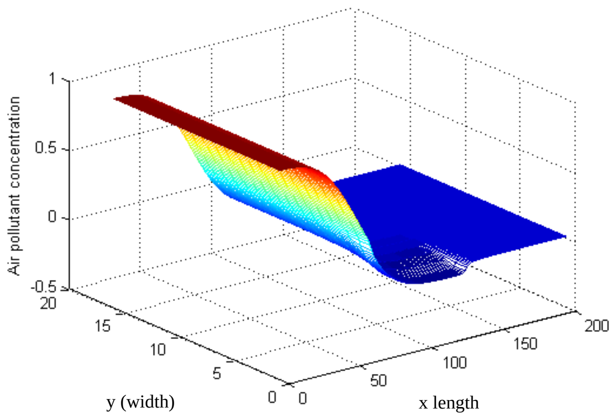

Fig. 15. Surface plot of air pollutant concentration for R = 0 sec^{-1} of Simulation B at time 5000s.

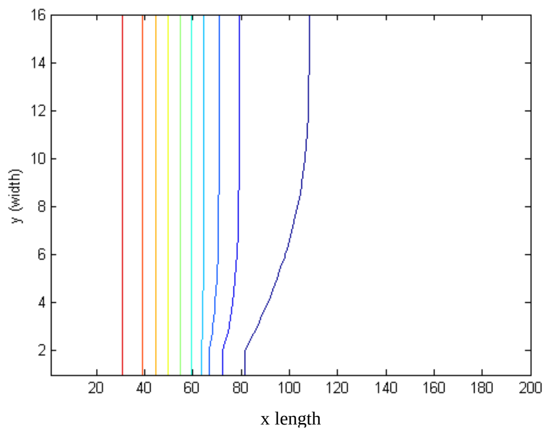

Fig. 16. Contour plot of air pollutant concentration for R = 0 sec^{-1} of Simulation B at time 5000s.

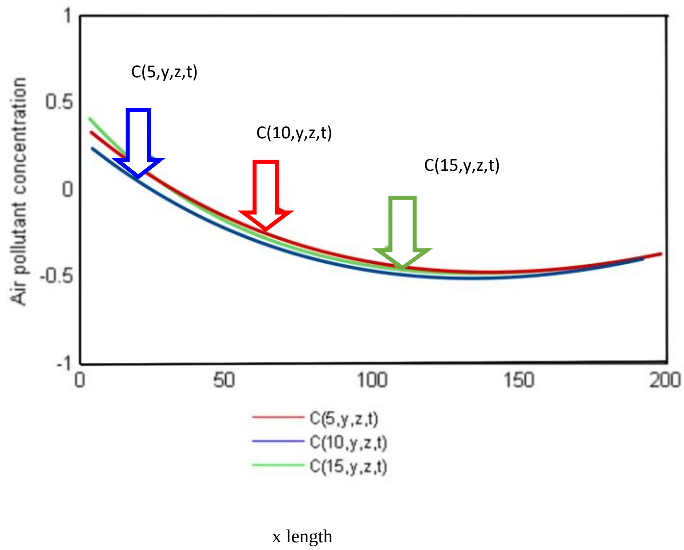

Fig. 17. Compare the air pollutant concentration for R = 0 sec^{-1} of Simulation B at time 5000s.

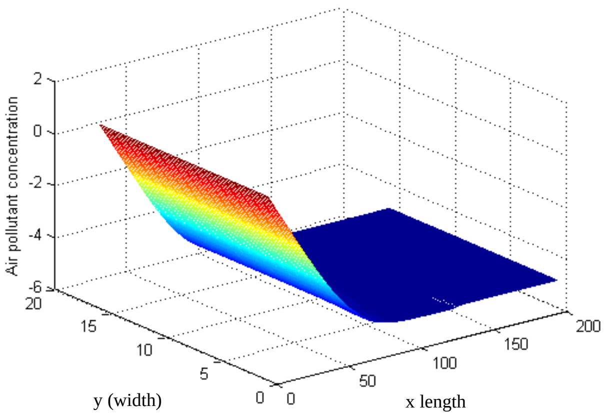

Fig. 18. Surface plot of air pollutant concentration for R = -0.001 sec^{-1} of Simulation B at time 5000s.

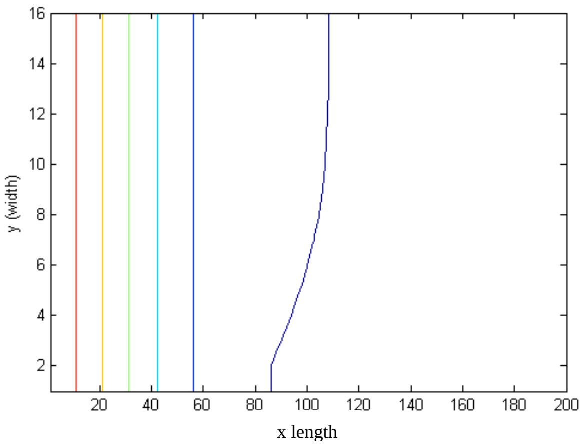

Fig. 19. Contour plot of air pollutant concentration for R = -0.001 sec^{-1} of Simulation B at time 5000s.

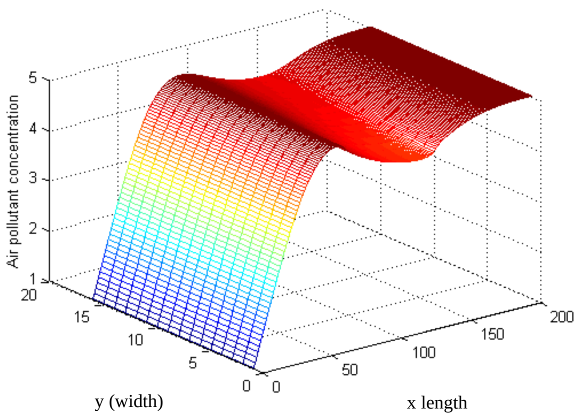

Fig. 20. Contour plot of air pollutant concentration for R = 0.001, R = 0.005 and R = 0.01 sec^{-1} of Simulation C at time 5000s.

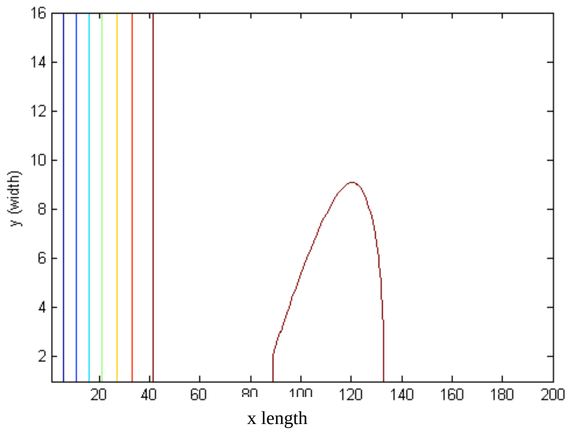

Fig. 21. Contour plot of air pollutant concentration for R = 0.001, R = 0.005 and R = 0.01 sec^{-1} of Simulation C at time 5000s.

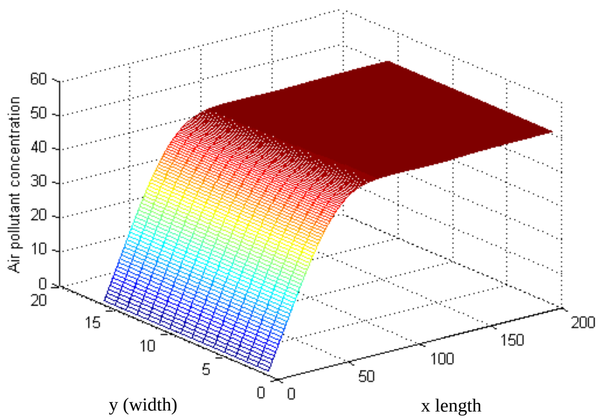

Fig. 22. Surface plot of air pollutant concentration for R = 0.01, R = 0.005 and R = 0.001 sec^{-1} of Simulation C at time 5000s.

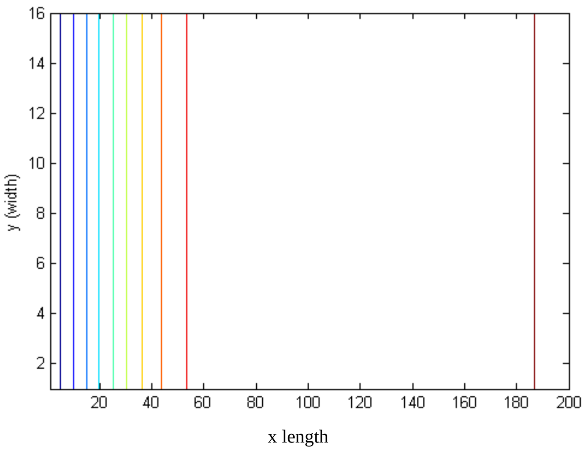

Fig. 23. Contour plot of air pollutant concentration for R = 0.01, R = 0.005 and R = 0.001 sec^{-1} of Simulation C at time 5000s.

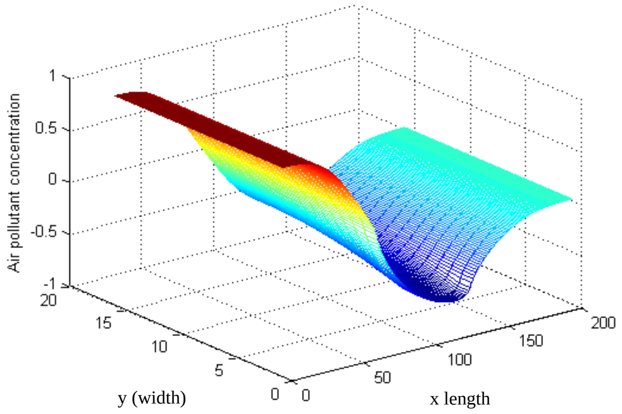

Fig. 24. Surface plot of air pollutant concentration for $R = (0.01/5)|\sin(xyt)|\ \mathrm{sec}^{-1}$ of Simulation C at time 5000s.

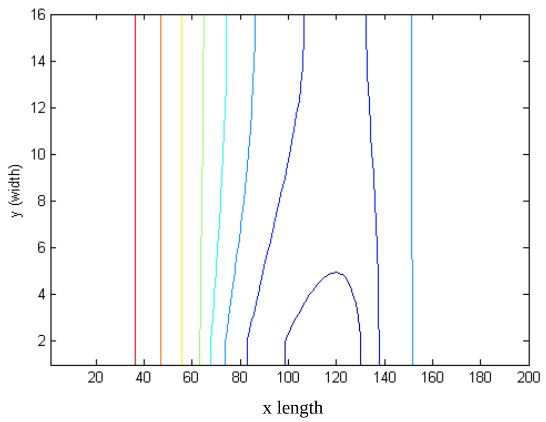

Fig. 25. Contour plot of air pollutant concentration for $R = (0.01/5)|\sin(xyt)|\ \mathrm{sec}^{-1}$ of Simulation C at time 5000s.

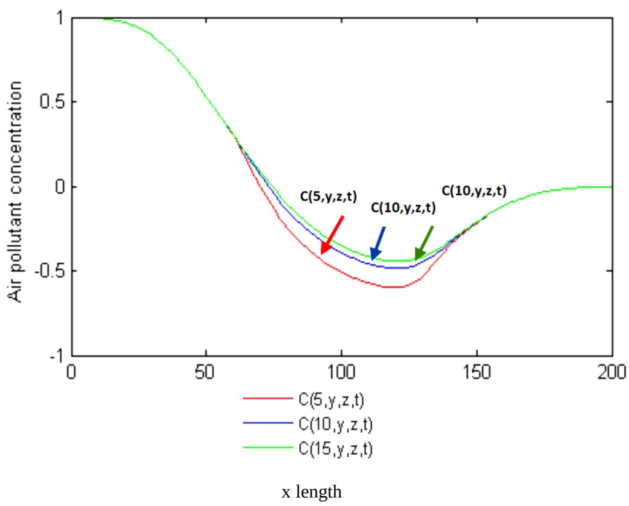

Fig. 26. Compare the air pollutant concentration for $R = (0.01/5)|\sin(xyt)|\ \mathrm{sec}^{-1}$ of Simulation C at time 5000s.

VI. Discussion

The air pollutant concentrations were determined using a suggested finite difference technique. We proposed three simulations for estimate the air pollutant concentration as follows; Simulation A: Fig. 9-11 show the air pollutant concentration level where $R = 0.001$ (source), $R = 0$, $R = -0.001$ (sink), respectively. In each example, where R is the constant, Fig. 12 compares the air pollutant concentration level. The result of this simulation shows that the air pollutant in roadway canyon is high because it only emits pollution at the entrance gate. Simulation B: Fig. 13-19 show the air pollutant concentration level where $R = 0.001$ (source), $R = 0$, $R = -0.001$ (sink), respectively. As the result, the air pollution gradually decreases because the pollution will be absorbed at the wall gap at the right side. Simulation C: Fig. 20-21 show the air pollutant concentration level where R in zone 1 is small and progressively increases. Fig. 22-23 show the air pollutant concentration level where R in zone 1 is strongest in zone 1 and then drops. Figures 24-26 depict the level of air pollution concentration, where R is a function of input or drain.

VII. Conclusion

The proposed model may be used to simulate the concentration of air pollutants in a roadway canyon under a variety of high-traffic situations. The model is governed by a three-dimensional in space and one-dimensional in time of advection-diffusion equation in a roadway canyon is solved by using forward time center space finite difference techniques while a forward in space method and back in space method to their opened roadway canyon boundaries. The simulation show that the pollution problem will be arise by internal sources from the released vehicle air pollutant. However, we have added gaps on the right walls in the valley roads. As a result, the concentration of air pollution is reduced, especially the gap on the right wall of the column has a lower concentration than the inside of the column. The lower of air pollution comes from the columns. Furthermore, we suppose that the sources are emitted from the entry gate and the right-side wall gap, and that there exists wind input in both directions. As a result, the concentration of air pollution is lowered, particularly at the gap on the canyon's right wall, which has a lower concentration than the canyon's interior. More research is required to gain a more complete understanding of how changes in air pollution will affect resident’s health.

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