BEHAVIOR OF ENVIRONMENTAL POLLUTANTS IN THE FIELD OF ELECTROMAGNETIC RADIATION: NUMERICAL CALCULATIONS

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Abstract

One of the familiar pollutants is the black cloud. The black cloud is a term written to describe the arrival of an enormous cloud of gas that enters the solar system and threatens to destroy most of the life on earth by blocking the sun's radiation, [7]. Close to the burning area, black clouds appear indicating strong absorption. While, further down wind they may look white, indicating weaker or no absorption. In previous study, it can be pointed out that the electromagnetic waves are an effective factor in the existence of the black cloud, [2]. The detection of the cloud was described using mathematical equations. In this paper, the effect of the ionosphere on the concentration of pollutants is investigated. Also, the behavior of the environmental pollutants in the occurrence of electric and magnetic fields is calculated and discussed.

1 Introduction:

Air is the ocean we breathe. Air supplies us with oxygen, which is essential for our bodies to live. Human activities can release substances into the air, some of which can cause problems for human, plants and animals [1].
The release of carbon dioxide occur and no absorption for it, because of elimination of vegetation. The biomass burning produces tiny smoke particles called aerosols. The aerosols can be either cooling or warming depending on how much solar radiation they absorb versus how much of it they scatter back to space. Fossil fuel burning in automobiles and power plants, also add aerosols to the atmosphere while polluting clouds. These aerosols are thought to absorb less solar radiation than those produced by biomass burning. But the exact amount of absorption from each type of aerosol is not yet known.
There are several main types of it and well-known effects of it, which are commonly discussed. These include smog, acid rain, the green house effect, and holes in the ozone layer. Each of these problems has serious implications for our health and well being, as well as, for the whole environment.
The green house effect, also referred to a global warming, is generally believed to come from the build up of carbon dioxide gas in the atmosphere. CO2 is produced where fuels are burned. Plant convert CO2 back to oxygen, but the release of CO2 from human activities is higher than the world plants can process. The situation is made worse since many of the earth's forests are being removed, and plant life is

being damaged by acid rain. The amount of CO2 in the air is continuing to increase. This build up acts like as blanket and traps heat close to the surface of earth. Two models are introduced in this study. The Gaussian Plume Model (GPM) and the Eddy Diffusion Model (EDM).

The GPM provides the primary method for calculating concentrations of non-reactive pollutants from an emitting source. This model has found widespread application in the design of stacks and environmental impact analysis, [3].

The EDM is to some extent similar to the GPM. The difference is in the formulation of the wind speed U. It can be represented by the eddy current and both the electric and magnetic .fields due to this current, [4].

2 Mathematical Treatments:

2.1 The Guassian Plume Model:

MATHEMATICA code used to calculate air pollution concentrations, [5]. The model assumes that a pollutant plume is carried downwind from its emission source by a mean wind. Also, the concentrations in the plume can be approximated by assuming that the highest concentrations occur on the horizontal and vertical midlines of the plume. This distribution about these midlines is characterized by Gaussian- or bell-shaped concentration profiles, [5].

If we consider a rectangular coordinate system with the x-axis oriented along wind velocity, U, the y-axis crosses wind, and the z-axis oriented vertically upward. Then conservation of mass for steady pollutant flow may be represented by an equation of the form, [3]:

$$u\frac{\partial C}{\partial x}=\frac{\partial}{\partial y}(k_y\frac{\partial C}{\partial y})+\frac{\partial}{\partial z}(k_z\frac{\partial C}{\partial z}) \qquad (1)$$

Where X.:is a mean pollutant concentration.

One of the best known and widely used dispersion models is the Gaussian Plume Model (ITIM) which based on the solution of equation(1). The concentration distribution from a single release is given as, [6]

$$C(x,y,z,h)=\frac{Q}{2\pi\sigma_y\sigma_z U}e^{\frac{y^2}{2\sigma_y^2}}[e^{-\frac{(z-h)^2}{2\sigma_z^2}}+e^{-\frac{(z+h)^2}{2\sigma_z^2}}] \qquad (2)$$

Where:

X = concentration of the substance at location ξ; ψ; ζ in ≠γ =μ³

Θ = rate that the substance is released into atmosphere (in ≠γ = second)

ξ = number of meters downwind from release point at which X is measured

ψ = number of meters cross wind from release point at which X is measured

ζ = number of meters above ground at which X is measured

Y = wind speed in meters / second

η = height above ground in meters at which the substance was released

—$_{\psi}$ (ξ)= standard deviation of the distribution of the substance in the Crosswind (y) direction, as a function of x

—$_{\zeta}$(ξ)= standard deviation of the distribution of the substance in the Vertical (z)

The ground level concentration below the mid-lines center of the plume is obtained by setting $\psi = \zeta = 0$ in equation (2) than we have

$$C(x,0,0,h) = \frac{Q}{\pi\sigma_y\sigma_z U} e^{-\frac{h^2}{2\sigma_y^2}} \tag{3}$$

The two coefficient —$_{\psi}$ and —$_{\zeta}$ are functions of download distance ξ and atmospheric stability and they are expressed as:

—$_{\psi}$ =465:11628ξ tan($\propto$); $\propto$ =0:017453(χ -δ ln(ξ)); —$_{\zeta}$ =$\alpha\xi^{\beta}$

The coefficients α, β, χ and δ depend on the atmospheric stability case, as shown in the table, [6]

Therefore, equation(3) will be

$$C(x,0,0,h) = \frac{Q}{\pi U a c x^{(b+d)}} e^{-\frac{h^2}{2a^2x^2b}} \tag{4}$$

The maximum concentration occurs at the region when $\frac{\partial C}{\partial x} = 0$

	Stability	x	a	b	c	d
A	Very unstable	$.1 \le x \le 3.11$	$122.8 \le a \le 453.85$	$.94470 \le b \le 2.1166$	24.167	2.5334
B	Unstable	$.2 \le x \le 4$	$90.763 \le a \le 109.3$	$.98332 \le b \le 1.0971$	18.333	1.8096
C	Slightly unstable	.All	61.141	0.91465	12.5	1.0857
D	Neutral	$.3 \le x \le 30.0$	$34.459 \le a \le 44.053$	$.86974 \le b \le 0.51179$	8.333	0.7238
E	Slightly stable	$.1 \le x \le 40.0$	$24.26 \le a \le 47.618$	$.8366 \le b \le 0.29592$	6.25	0.54287
F	Stable	$.2 \le x \le 60.0$	$15.202 \le a \le 34.219$	$.81558 \le b \le 0.21716$	4.1667	0.36191

2.2 The Eddy Diffusion Model(EDM) ([3], [4])

Consider the following Electro hydrodynamic equation, from Lorentz force equations (8)and (9), we have:

$$\overline{F} = q(\overline{E} + v \times \overline{B})$$

Then, we can get:

$$\overline{J} = \sigma(\overline{E} + \overline{U}\ \overline{H}) \qquad (5)$$

From Maxwell's equations, we get:

$$\overline{J} = \overline{\nabla} \times (\overline{\mu}\ \overline{H}) \qquad (6)$$

Where

$\overline{H}$: is a magnetic field

$$\overline{H} = H_x\,\overline{i} + H_y\,\overline{j} + H_z\,\overline{k}$$

$\overline{J}$: is the eddy current density

$$\overline{J} = J_x\,\overline{i} + J_y\,\overline{j} + J_z\,\overline{k}$$

≠: is a magnetic permeability

—: is a conductivity coefficient

□:is the velocity of the medium, which can be considered as the velocity of the wind.

$\overline{E}$: is the electric field

If we consider that the wind is the only effective factor so, the velocity will be the medium be the velocity of wind, then:

$$\overline{U} = U\, i$$

Then equation(5) can be written as

$$J_x = \sigma E_x \tag{7}$$

$$J_y = \sigma (E_y - U H_z) \tag{8}$$

$$J_z = \sigma (E_z - U H_y) \tag{9}$$

From equations(8) and (9)

$$U = \frac{\frac{J}{\sigma} + E_y}{H_z} \tag{10}$$

The Eddy diffusion Model can be written as:

$$C(x, y, z, h) = \frac{Q}{2\pi\sigma_y\sigma_z \frac{\frac{J}{\sigma} + E_y}{H_z}} e^{-\frac{y^2}{2\sigma_y^2}} [e^{-\frac{(z-h)^2}{2\sigma_z^2}} + e^{-\frac{(z+h)^2}{2\sigma_z^2}}] \tag{11}$$

Equation(11) and (2) are similar, in equation(11) the velocity is taken from equation(10) as function of currant, electric field and magnetic field.

3 Numerical Calculations and Results:

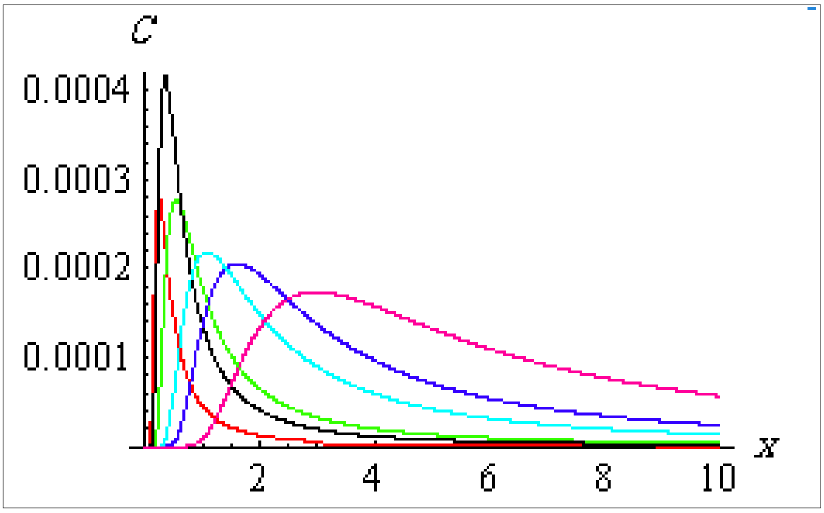
Form the above equations, MATHEMATICA software is applied for the numerical calculations.

Firstly, the relation between the pollutant concentrations as function of the distance, at constant applied magnetic field is calculated. Different weather instability classes, as given in the table, are taken into consideration. Figure(1), gives the six weather instabilities, for the pollutant concentration as function of the distance from 0 to 10 kilometers. It is clear that the instability is an effective factor for the described shapes.

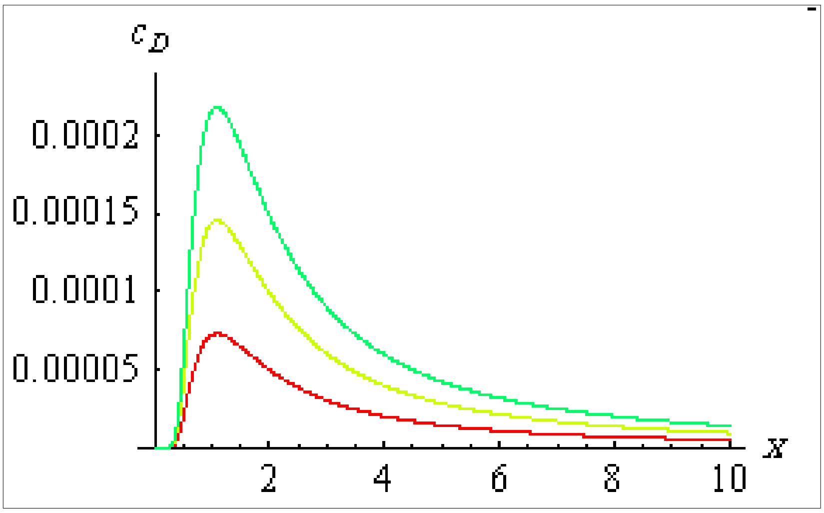
1- Secondly, the same calculation were performed for different magnetic fields, as function of the distance and for the case stability D. Figure (2) gives rise to the effect of the magnetic field and how it is observable and effective. Also, from the same calculation, the relation between the pollutant concentration and the magnetic is displayed. It gives linear relation as presented in figure(3).

3- For various curves of the pollutant concentration, concerning the steady weather, case F, were calculated. The area under the curves for different values of the magnetic field and with distance varying from 0 to 60 kilometers was evaluated. This is shown graphically in figure(4). It is noticed that the relation is linear, and the polluted area increases as the increase of the magnetic field.

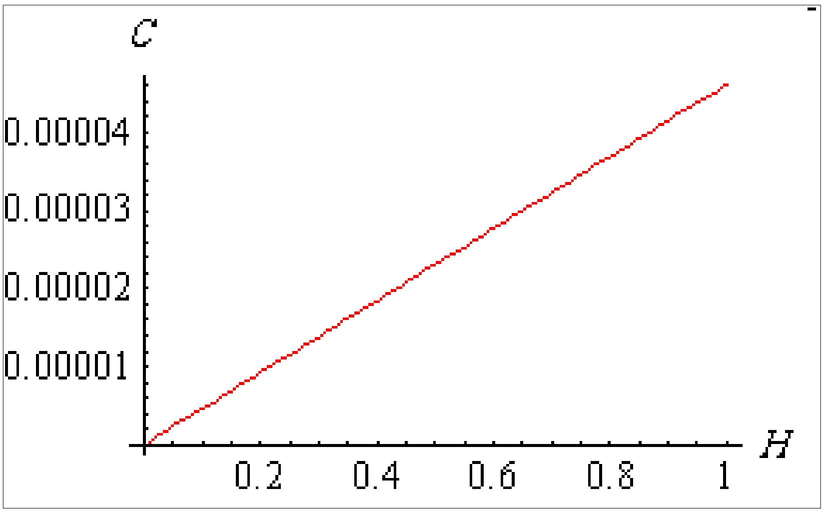
4- So, it can be concluded that the electromagnetic fields is an observable factor that increases the pollutants in our environment.



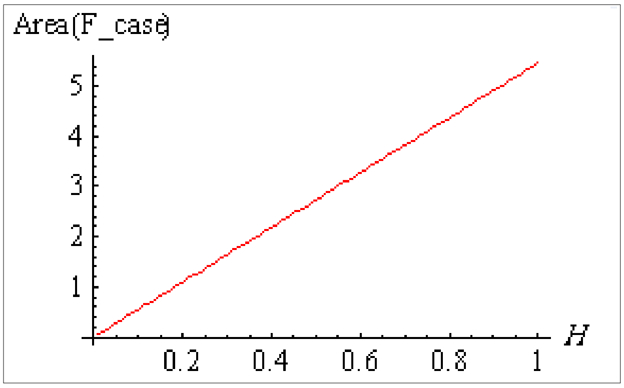
5- **Figure 1**: Effect of atmospheric stability on pollutant concentration, for the six stability cases, the maximum concentration occurs at very unstable state, case A, and the minimum concentration occurs at stable state, case F



6- **Figure 2**: The relation between the Pollutant Concentration C and the downwind distance x at three different values of magnetic field H (H=0.3 with green color, H=0.2 with orange color and H=0.1 with red color) for stability class D



7- **Figure 3**: The relation between the Pollutant Concentration C and the magnetic field H



8- **Figure 4**: The relation between the area under the curve of Pollutant Concentration C and the magnetic field H

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