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# *Weather Modification* Techniques by Electric Field

**Arezu Jahanshir**

Department of Engineering Sciences and Physics, Buein Zahra Technical University, Qazvin, Iran

**Email address:**
jahanshir@bzte.ac.ir

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**Abstract:** Climate engineering program refers to large-scale manipulation of Earth's climate intended to counteract human-caused climate change, also describes a diverse of modern technologies for intentionally manipulating the global climate, in order to moderate or forestall the effects of climate change. As we know, climate engineering programs have the ability to generate precipitation, fog, and storms on earth or to modify space weather. Hence, the productions of artificial weather all are a part of an integrated set of environmental-military high technologies. Today's news show that discussions of climate engineering has grown considerably amongst scientists specially in engineering physics and environmental engineering groups who engaged in addressing climate change. In this article author tries to introduce readers with hi-tech climate engineering methods and equipment, which could be useful in managing climate change crisis, and could go one step further in attempting to reduce drought and flood seasons, decrease pollution and dust crisis in big cities, increase precipitation and rainfall in arid and semi-arid areas in the World.

**Keywords:** Climate Engineering, Engineering Physics, *Weather Modification*

## 1. Introduction

Hi-tech climate engineering programs or/and equipment in general are the deliberate modification of planets to suit human needs. Nevertheless, in this article we introduce with modern climate engineering programs and goals particularity in the Earth and climate changing issues in megapolis and industrial cities. In the not too distant past scientists attempted to find ways to adjust Earth's climate to counter the effects of climate change. Nowadays climate engineering programs let scientists find and complete modern achievements to manipulate the global climate in the local and nonlocal areas. On the other words, climate engineering can explain as a climate emergency programs that can be the fast-acting option to avoid a global catastrophe and local climate crisis. As we know greenhouse gases, dust and industrial smog emitted into the atmosphere directly affect on the human health and natural systems. In the last ten years, dust concentrations increase in the west, southwest, and southeast of Iran as atmospheric pollution concentration increase in big cities like Tehran, Esfahan etc., therefore, the risk of climate crisis are very high. The local pollution concentration data and the scientific evidence show that the climate crisis will rise in coming years if atmospheric dust and pollution concentrations continue to increase. Climate engineering, as a world leader in climate science can affect on the state of the engineering science sectors and their potential efficacy, which exactly guide the climate changing programs [1-5]. These research programs study various options for mitigating climate change in order to ensure that presented programs can help effectively minimize climate changing crisis and the local damages caused by global warming, dust, storms etc. Scientists in development countries are already engaged in initiate research programs on climate engineering high technologies and equipment funded by federal research grants. Some of these programs are: 1) Solar radiation management, 2) $CO_2$ emissions reduction, 2) Alternative energy sources, 4) $CO_2$ removal, 5) Hi-tech equipment that can affect on troposphere, 6) *Weather modification* by modern technology, 7) Creating Super storms, 8) Stratospheric Sunscreen. In this kind of circumstances, where is the Iranian position on the main road of climate engineering programs?! What is the local climate engineering program to reduce climate changing crisis?! How Persian scientists use modern technologies to solve these issues and local climate problems?! Unfortunately, most of us never hear some of these techniques and technologies. What is problem and where is climate engineering goals and why we are very far from it? When will

we know that?! Unluckily we will know when it's too late. In this case, the author tries to introduce audience with modern equipment and high technology that can be helpful to protect local climate in crisis and reduce crisis risk level in the Iranian territory.

# 2. Method

### *2.1. Climate Engineering Research*

Climate engineering research and regional weather controlling program have existed on the fringes of academic debate in last five decade, it has seen a proliferation of scientific study methods and research programs to gauge the physical and environmental effects of climate engineering technologies. On the other hands, climate warming, increase in atmospheric greenhouse gases, pollution, dust, acidification of ocean, surface waters are practice, and global trends motivate climate engineering discussions. Therefore, interest in potential climate engineering options increase and necessitates a more complete research and understanding of the proposed actions. However, most relevant scientific research and publications on climate engineering subjects and themes presented only in the past few years. Scientific Studies have just begun to seek the potential environmental outcomes of climate engineering proposals. Most of these proposals include to reduce carbon dioxide concentration (greenhouse effect) from the atmosphere, cooling the Earth by increasing the reflection of sunlight, reducing soil erosion i.e. reducing dust storm and rainfall and precipitation in arid and semi-arid regions and also decreasing rainfall and precipitation in high rainfall areas [1, 2]. On the other words we can describe climate engineering programs are human attempts to modify their physical surroundings environment that have existed throughout time. Therefore, the main factors involved in climate engineering programs are the changes of the Earth's climate history that caused by our inattention and from our neglect of natural environment. In this, case scientific try to modify environment systems and control climate. They proposed too many methods and models for over 50 years in order to solve climate change issues and problems (high temperature problems, decrease sea ice, creating irrigation opportunities, increase dust and pollution concentration in the stratosphere, using sulphate aerosols to reduce incoming sunlight etc.). However, in the recent years modern technologies and new techniques let scientists extremely try to solve global and local climate problems by applying climate engineering programs and using high technology methods and modern equipment. All these proposed programs include in climate engineering achievements in developed countries. They want develop cheaper climate modification methods and conventional mitigation techniques such as air ionization method in troposphere, high frequency electromagnetic methods and high enough voltage laser light scattering technique that change climatic events during climate engineering activities [3, 4]. Looking on Persian climate change programs we can see that climate engineering research has until recently been absent from serious discussion in related scientific societies and governmental programs. We cannot see any scientific direct programs to the issue of climate issues like dust storm or air pollution problems in developing countries. Their government or scientists just involve in the low steps of finding methods that could be reduce the climate manmade problems. Unavailability in introducing with modern technologies and methods is the main reason for inability to identify climate engineering goals and achievements in reducing climate problems in developing countries. Therefore, the slow progress of recent climate engineering programs led to decreasing of using exclusive methods that focus on climate change that will generate efforts to prevent a damaging degree of modern technologies to accelerate the removal of dust, air pollution, and toxic gases from the air. Today's the field of climate engineering programs consists of atmospheric/ionospheric studies at a global or local scales based on high technologies, modern methods, and new equipment. When looking at another site to this topic and climate issues, we focus on the scientific potential for rapid climate change, temperature change, decreasing incoming solar radiation, etc. that associate with climate engineering programs. Climate engineering research shows that it could effectively stabilize weather that could create an optimal social, economic, regional and governmental strategies for solving the global or local climatic problems, which it can reduce the risks of hazardous climate change and natural atmospheric disasters. In this article, author highlights the relationship between climate engineering and climate modification programs by quantifying the good and/or bad risk of climate change where it use to stabilize temperatures, reduce greenhouse gas emissions and etc. Some of the modern technologies [6-7] such as carbon dioxide removal methods, solar radiation management, sunlight reflection methods and negative ion injection into the local area of the air that affect on the low tropospheric layers have a very little bad risk impact in climate changing process because they have minimum side effects on global atmospheric electricity balance.

### *2.2. Weather Modification Techniques*

Among of climate engineering terms the author presented the term "Peaceful *weather modification* techniques" refers to any technique for changing – through the deliberate manipulation of natural processes in the low layers of the troposphere. However, in the United Nations Convention, Geneva: 18 May 1977, the term "environmental modification techniques" refers to any technique for changing – through the deliberate manipulation of natural processes – the dynamics, composition or structure of the Earth, including its biota, lithosphere, hydrosphere and atmosphere, or of outer space. Therefore, using Peaceful *weather modification* techniques (PWMT), we can manipulate some special place of the troposphere inside each country, which can be useful for local environment for reducing and increase some of environmental problems [6, 7] like dust storm, precipitation, air pollution etc. PWMT can become a part of National

projects in order to help environment in all countries based on specific issues and needs. In developing or non-developed countries, it can solve water shortage crisis, dust crisis and one may get too many other useful achievements from PWMT. One of the PWMT is Local Air Ionization, this method based on high voltage electric field that we know as dark-silent corona discharge technique [7, 8]. In electricity, a corona discharge is an electrical discharge brought on by the ionization of a fluid surrounding a conductor that is electrically charged. Spontaneous corona discharges occur naturally in high-voltage systems unless care is taken to limit the electric field strength. The corona will occur when the strength (potential gradient) of the electric field around a conductor is high enough to form a conductive region, but not high enough to cause electrical breakdown, noise or arcing to nearby objects. The ionized air of a corona is chemically active. In air, this generates gases such as ozone and nitrogen oxide, and in turn nitric oxide, and thus nitric acid if water vapor is present, but controlled corona discharges used in a variety of local climate engineering programs, filtration, printing, and other processes. *Weather modification* technique that occurs by high corona discharge is a process by which a current flow from electrodes with a high potential (90-120 kV) into the local troposphere, by ionizing the air and it creates a region of plasma (ions) around the electrodes. The ions generated eventually pass charge to nearby areas of lower potential, or recombine to form neutral air molecules [8]. Air near the electrode ionized, while regions more distant do not. When the air near the point becomes conductive, it has the effect of increasing the apparent size of the conductor. Since the new conductive region is less sharp, the ionization may not extend past this local region. Outside this region of ionization and conductivity, the charged particles slowly find their way to an oppositely charged (dust or air molecules) object and are neutralized. Corona discharge usually forms at highly curved regions on electrodes, such as sharp corners, projecting points, or small diameter wires. In the peaceful *weather modification* equipment, corona discharge occurs by using small diameter wires and it may be positive or negative. This is determined by the polarity of the voltage on the highly curved electrode and whether conditions and local and specific configuration of corona discharge sites. If the curved electrode is positive with respect to the flat electrode, it has positive corona discharge, if it is negative; it has a negative corona discharge. As we know, the physics of positive and negative coronas are strikingly different. This asymmetry is a result of the great difference in mass between electrons and positively charged particles, with only the electron having the ability to undergo a significant degree of ionizing collision at normal air temperatures and pressures. An important reason for production Ozone is the production corona discharge processes in air. A negative corona generates much more ozone than the corresponding positive corona. However, the good result of *weather modification* in the local areas and good achievement of this technique are very important, ozone concentration compares to air pollution and dust concentration is very small, and we can neglect ozone concentration around the electrodes. An important reason for considering corona is the production of ozone around conductors undergoing corona processes in air. A negative corona generates much more ozone than the corresponding positive corona. In other words, corona discharge is the similar to lightning reason during thunderstorm. Lightning is a sudden electrostatic discharge between charged regions of an air, cloud, intra-cloud or between a cloud and the ground.

### *2.3. Dynamics Emission in Corona Discharge*

This section is a brief mention of physics topics and dynamic equations of particle emission in the electric field during discharge. In compressible fluid electrodynamics, the mathematical model governs the motion and the dynamics of particles in the field ionization, which generates by electrical discharge with a very high potential difference. One can be written a non-linear Navier- Stokes equation and charge continuity equation as follows [8-10]:

$$\rho\left(\frac{\partial \vec{v}}{\partial t}+\vec{v}\cdot\vec{\nabla}\vec{v}\right)=\vec{\nabla}T-\vec{\nabla}P+\vec{F}_{f}+\vec{F}_{ext} \tag{1}$$

And

$$\frac{\partial \rho}{\partial t}+\vec{\nabla}\cdot\vec{J}=\sigma \tag{2}$$

In these equations, the air flow velocity formed by charged particles depends on the pressure (P), temperature (T), fluid force ( $\vec{F}_f$ ), charge density ($\rho$), time (t), electric current density (J), rate of produced electric charge per unit volume per unit time ($\sigma$) and kinetic viscosity ( $\upsilon$). Combining above equations (Navier- Stokes equation and continuity equation), which have an essential role in calculating the Laplacian, the following simple equation is obtained

$$\rho\left(\vec{v}\cdot\vec{\nabla}\right)\vec{v}=\frac{1}{\rho}(\vec{F}-\vec{\nabla}P)+\upsilon\Delta\vec{v}$$
$$\vec{\nabla}\cdot\vec{v}=\vec{\nabla}\cdot\vec{J}=0 \tag{3}$$

In the electric discharge and the beginning of ion avalanche, the voltage ( $U$ ) should be at a certain level. To obtain its numerical value, field potential difference equation placed into the charge continuity equation (2) and we will obtain [4, 5, 10, 11]:

$$\vec{\nabla}\rho\cdot(\vec{\nabla}U)=\frac{\rho^{2}}{\varepsilon} \tag{4}$$

Moreover, the electric field intensity E(r) and electric charge density ρ (r) in the ionization zone from equation (4) and Poisson's state equation are obtained and read

$$\frac{1}{r}\frac{d(rE)}{dr}=\frac{\rho(r)}{\varepsilon_{0}} \tag{5}$$

The impact of the ionization process on the dust has a

close relationship to the quantity of electric charge (Q). The numerical value of the electric charge in the inter-electrode space is calculated using the following equation through the integration of charge density function in the discharge electrode level to its distance from $l$ as. The obtained numerical value of this integration indirectly dependent on the field force $F_1$ and $F_2$:

$$Q = \int_{r_0}^{1} 2\pi r\rho(r)dr = 2\pi\varepsilon_0 \int_{r_0}^{1} d(rE) = 2\pi\varepsilon_0 (r_0 E_w - lE_c) \quad (6)$$

The initial potential difference in the proposed structure of this paper established more than 10kV. Selecting the electrodes with a radius of $r_0 = 5.10^{-6} m$ which locate at the distance of $d = 0.01m$ from each other. Distribution of force $F_1$ at the level of discharge electrodes and $F_2$ at the level of the collector electrodes always must be as $F_1 > F_2$ ($F_1$ and $F_2$ are the Coulomb (electrostatic) force between discharge electrodes). This shows the downward trend of force distribution through distancing from discharger electrodes and states that the maximum rate of ionization occurs in the same area. Thus, the electric charge density decreases at certain distances from discharge electrodes compared to outside the ionization zone as the distance increases. For the effectiveness on the lower layers of the atmosphere on a small local zone, it is necessary that the potential difference between electrodes significantly increased in order to compensate the loss of ionized particles volume at a distance away from the electrodes. High potential difference is equivalent to more power in ionization and higher source power in ion production. This is the main aim for affecting the cloud and water molecule. For this reason, as the ion production increases, the deposition and gravitational settling power of water droplets increases, and the troposphere states become more active to give precipitation. Therefore, the expansion and optimization of the structure and process of electric discharge in modern technology, provide the possibility of creating climate change. The ionization equipment design and application of new technologies, along with the mass production of ions and ionization process management make changes to the interaction and mechanisms of particles in the troposphere, which have a significant impact on increasing cloud masses and centralizing them in the arid and semi-arid tested zone in experimental conditions.

# 3. Conclusions

Taking advantage of PWMT in order to promote the *weather modification* and change some of the local climate problems can be an appropriate way to solve dust and air pollution issues, water shortage crisis etc. Climate and environmental crisis (dust and air pollution) is one of the fundamental social problems for a country's population. Therefore, expansion of the local weather, underground public places metropolis such as subways, long tunnels in the city, underpasses pedestrians, increasing closed silos and many industrial centers as well as the increasing complexity of processes affecting the air pollution in large cities, will increase the need for healthy air conditioning systems in the cities and in the human community centers. The use and application of modern technologies in the increase of healthy and low-risk air conditioning equipment is necessary today. For this reason, using achievements and integration of new technologies in air purification structure will improve the health of the public closed centers air and we can achieve the goals of protecting the health, safety, and welfare of population effectively. Therefore, in this paper, we suggest the necessity of using PWMT in Iran as a main scientific strategy to improve the situation in order to reduce unhealthy air pollutants, or in some cases having more breathing air for health care and industrial facilities.

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