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Scientific Solution to Decelerate Climate Warming

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***Abstract*:- Historical climatic data clearly reveal that climate warming is an inevitable and natural process, not only due to human economic activities but also due to natural processes including the interactions among solar system, tectonic events, oceans and atmospheric constituents. In the absence of greenhouse gases including H_2O and CO_2, the planet would not have been habitable for many biological species including human beings. As an integral part of the natural creation, anthropogenic activities along with the solar and tectonic events would continue to cause gradual increase in climate warming and the biological species would continue to adapt to a continually changing climatic conditions. However, sudden increase in the planet's average temperature along with the extreme weather behaviors in the recent past is a point of concern which needs to be scientifically addressed. Many scientists including International Panel for Climate Change (IPCC) and global climatologists are continuing their scientific investigations to arrive at a workable solution. This article is humbly attempting to identify the possible causes of accelerated climate warming in the recent decades and offer a conceptual solution as an immediate remedy. It is well documented fact that the Solid Particulate Matters (SPM) in the troposphere have been gradually reducing in the last four decades and humidity levels have been significantly increasing during the same period. SPM of the right composition and size acts as cloud condensation nuclei (CCN) and adequate quantities of SPM are essential to facilitate a proper precipitation and formation of rain drops of adequate size ensuring the natural Hydrologic cycle which facilitates dissipation of atmospheric heat to the space. Presence of fine hydrophobic aerosol particulates from biomass and forest fire generate CNN of smaller cloud droplets necessitating super-saturation of water vapor and increasing the size and residence time of clouds in the troposphere which enhances greenhouse effect with positive feedback impeding the ambient heat dissipation process (malfunctioning of natural Hydrological cycle). The planet is therefore, experiencing extreme weather, unsteady precipitation, mal-distribution of water recirculation, cloud bursts, flood, draught, heat wave and snow-downpour. It is my Hypothesis that the deficit of the right SPM (hygroscopic natural salts and sulphates) and excess concentration aerosol (hydrophobic fine generated from bio-mass and forest fire), in the troposphere, for the past five decades, are the double jeopardy causes of accelerated climate warming and not due to gradual increase of CO_2 concentration. The immediate scientific solution lies in restoring hygroscopic (hydrophilic) SPM level in the troposphere to pre-1975 level through experimentally controlled effective and efficient injection of non-toxic fine particles of natural salts and sulphates without causing air pollution and without disturbing the solar system.**

Keywords: Aerosol, Atmospheric humidity, Atmospheric CO2 concentration, Cloud condensation nuclei, Chronology of atmospheric air quality, Curvature effect, Greenhouse gases, Global average temperature change, Hydrologic cycle, Positive feedback, Solid particular matter, Solvent effect

1. INTRODUCTION

The 26th Conference of the Parties (COP26) in Glasgow under United Nation Framework Convention on Climate Change (UNFCCC) was held from October 31 to November 15, 2021. It was projected to be the most important climate talks since 2015, when the Paris agreement was signed. All countries were supposed to have announced tough new targets for reducing emissions to keep the increase in the Earth's mean surface temperature to well below 2°C compared to preindustrial level before steam engine was invented. Such conventions and conferences are being held on global level since 1972-Stockholm conference, followed by Rio summit in 1992, Kyoto protocol 1997, Paris Agreement 2015 and recently the COP26 in 2021. However, even after more than 50 years of global efforts, no progress is achieved in identifying the main causes and reaching a technically feasible, socially, and ecologically acceptable and economically viable solution for climate warming. Every stakeholder is attempting to harvest the climate warming situation to his / her favor knowingly or unknowingly. In my view, attributing the climate warming solely to CO_2 is due to proximity error / biases / blind spots. In 1900, the people in London contrastingly and triumphantly declared that they eradicated the pollution caused by horse dung by inventing automobiles, after a century, the situation seemingly quite contrasting. If the global efforts are focused on reducing CO_2 to limit the climate warming, then the outcome even after another century would be no better the case of horse dung.

Unless we scientifically ascertain the real cause of the climate warming, it is impossible to resolve the climate warming issue. It is not yest scientifically established beyond doubt that CO_2 is the main culprit due to the complex interactions among solar system, atmospheric composition, tectonic events and oceans. It is further exacerbated by the limitations of scientific methods, human biases and blind spots. However, I am reasonably confident that CO_2 being a small constituent in the atmosphere has no potential to cause such an accelerated warming as the planet is experiencing it now.

2. IS CO_2 THE PROVEN CULPRIT OF CLIMATE WARMING & IS IT POSSIBLE TO REDUCE?

The 2007 Fourth Assessment report of the IPCC states that: Most of the observed increase in globally averaged temperatures since the mid-20th century is **very likely** due to the observed increase in anthropogenic greenhouse gas concentration. There are, however, uncertainties in predicting the climate of the future. At this point in time, it is unclear how water and land will ultimately affect rising levels of CO2. Currently, the oceans and the vegetation on land absorb about half of the CO2 emitted by human sources. As a result, both oceans and landmasses play a major role in the climate system, yet the exact effect they will have on

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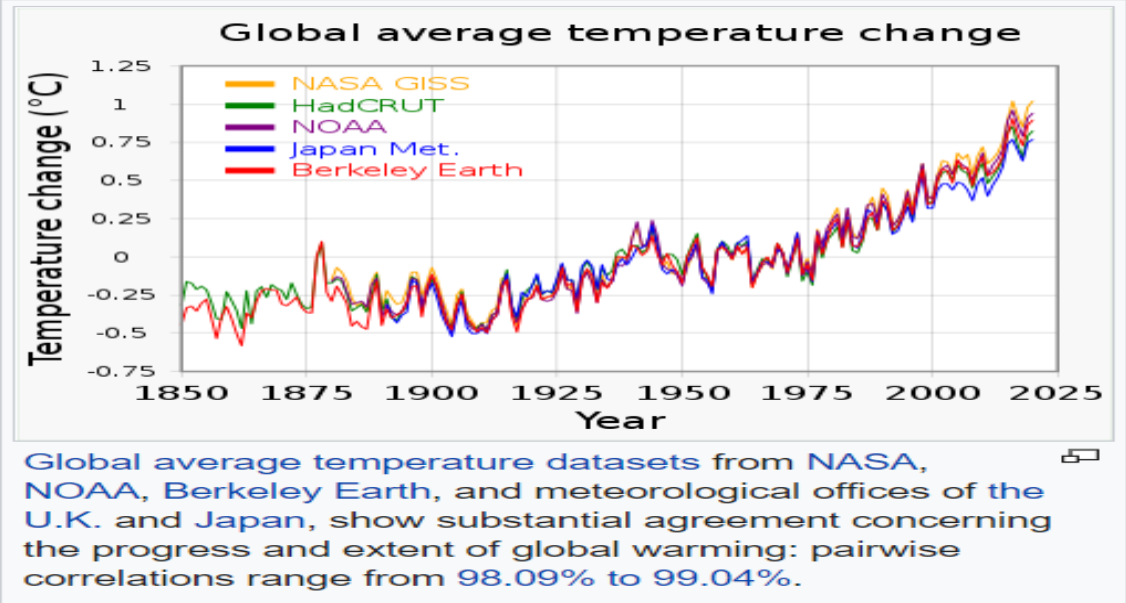
rising levels of CO2 and global warming is not totally clear[1]. Besides, it is not possible to reduce CO_2 emissions in the coming 10-20 years without decreasing the over-all global economic activities as the alternative energy sources are inadequate.
Further, the poverty of more than 750 million people in the world is worse than the CO_2 emission related pollution. Every country continues to exercise their sovereign rights in their economic development and military expansion and every citizen would like enjoy their freedom to choose his / her living style including extravagant entertainment, sports and space tourism which would only increase energy demand with consequential increase in CO_2 emissions. All the conferences and summits appear to be time buying exercises / pretentions for sake of doing something. It is therefore imperative for the scientific and engineering community to look for an alternative solution to limit the immediate climate warming rather than flutily discussing on how to reduce, who has to reduce how much / when to reduce CO_2 emission. I am therefore attempting to offer an immediate scientific solution with high level of confidence to mitigate the current accelerated climate warming problem.

3. PREVAILING CLIMATE CONDITIONS

There are abundant and variety of write-ups and reports openly available on the subject in question, hence without reproducing those published concepts such as Incoming Sunlight radiation, Heating Imbalances, Earth's Energy Budget, Surface Energy Budget, the Atmosphere's Energy Budget, The Natural Greenhouse Effect, Effect on Surface Temperature, Climate Forcing functions and Global Warming etc, I would like to highlight only the salient features related to Atmospheric Heat Engine performance impairment with its consequential effect on the Climate Warming and propose a practical solution.

3.1 Ambient Temperature:

It is evident from the following time versus climate temperature graph that global rate of increase of average temperature from 1975 is much higher than that of the previous years.



The above graph also reveals that the climate warming is an inevitable and natural process as the climate average temperature started increasing much before the industrialization. The very same greenhouse effect, created lots of sustainable biological species on the planet in the geological timeframe. As an integral part of natural creation, anthropogenic activities along with solar and tectonic events would continue to cause gradual increase in climate warming and the biological species would continue to adapt (some may go extinct) to a continually changing warmer climatic conditions. We can't preserve all the biological species forever and it is neither the Nature's intent. However, sudden increase in the planet's average temperature along with extreme weather conditions in the past five decades staring from 1975 is a point of concern which needs to be addressed scientifically. Many scientists including International Panel for Climate Change (IPCC) and global climatologists are continuing their scientific investigations to arrive at a workable solution. This article is humbly attempting to identify the possible cause and offer a conceptual and scientific solution to decelerate the planet's warming.

3.2 Atmospheric humidity

The following time versus absolute humidity graph clearly reveals that the atmospheric moisture is significantly increasing with time due to greenhouse effect and positive feedback of the climate system.

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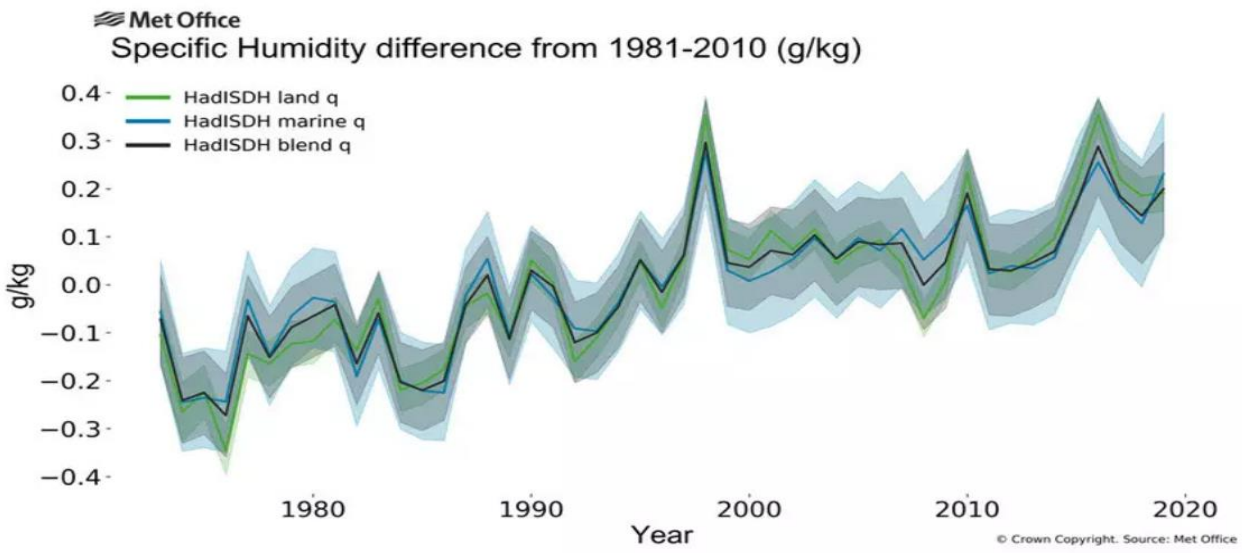


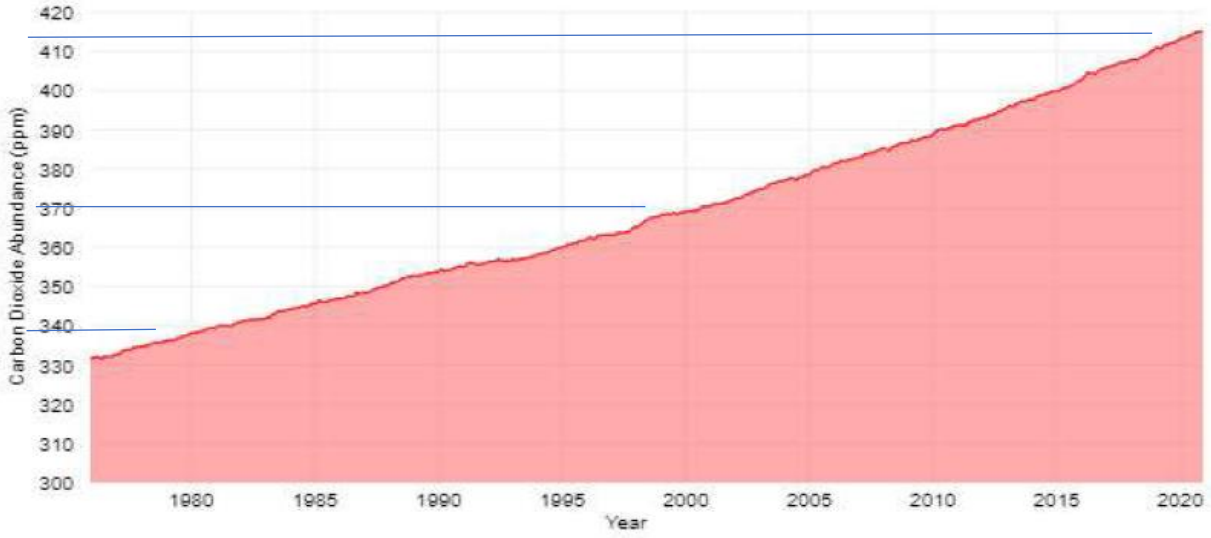
Global time series of annual average specific humidity for the land (green line), ocean (blue) and global average (dark blue), relative to 1981-2010.

Image: Met Office Climate Dashboard

It is well understood and generally accepted concept that about 75% of the Greenhouse effect is due to H_2O and 25% is due to CO_2 by virtue the respective concentrations in the atmosphere and their molecular (electronic) strctures. The abnormal atmospheric humidity increase is certainly due to high temperature and positive feedback of greenhouse gases which would be further elaborated in the following sections.

3.3 Atmospheric CO_2 concentration

The following CO2 concentration versus time graph clearly highlights the fact that the rate of increase of CO2 concentration in the atmosphere is 42 ppm from 1980 to 2000 and 44 ppm from 200 to 2020 which is in line with the global economic activities. However, there is no sudden increase in the CO_2 concentration like in the case of H_2O (humidity).



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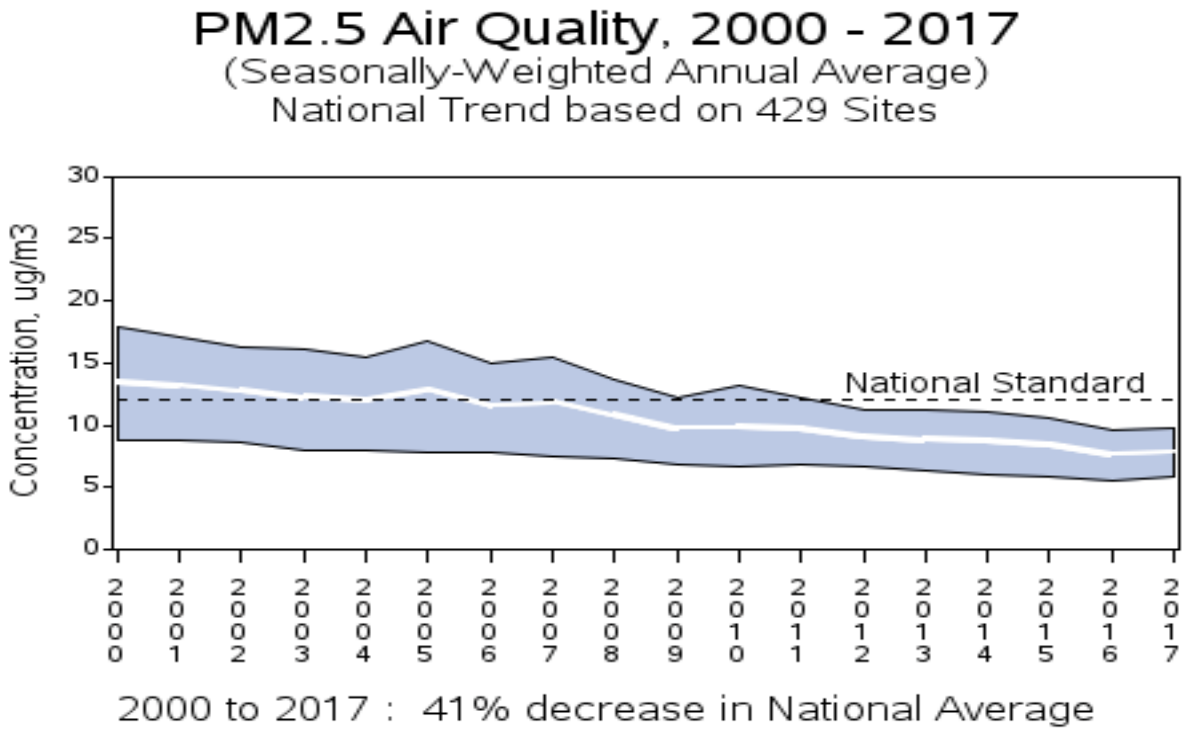
Basis: 1 Nm3 of air		
Description	**Value**	**UOM**
Density	1.3	Kg/M3
CO_2 in 2020	412	ppm
CO_2 in 1980	338	ppm
Increase in CO_2	74	ppm
Increase in CO_2	0.000074	Kg/Kg of air
Increase in humidity (H_2O) (1980-2020)	0.3	Kg/Kg of air
Increase in Mass Ratio of Moisture, H_2O / CO_2 (1980 to 2020)	4,054	
Window to block infrared for CO_2[1]	12-15	µm
Window to block infrared for H_2O[1]	1-10	µm
Mass comparison between H_2O and CO_2 in the atmosphere		

From this table it is evident that CO_2 has no potential to cause such an accelerated climate warming and it is therefore essential to ascertain the real cause of the accelerated climate warming. .

3.4 Chronology of Atmospheric Air quality

The following chronological air quality data taken from the United States, Environmental Protection Agency portal, for Particulate Matter $PM_{2.5}$ describes fine diameters that are generally 2.5 micrometers clearly indicates that the SPM level in the atmosphere has been gradually decreasing with time which needs to be correlated with the increase in atmospheric air humidity, the life time, size and quality of clouds followed by precipitation and rain formations. The size, quality of clouds and their **lifetime (residence time)** in the troposphere have a strong impact on climate warming with the positive feedback.



4. IRREGULAR HYDROLOGIC CYCLE

From the atmospheric humidity and SPM graphs presented above clearly indicate that SPM level in the troposphere has been gradually decreasing whereas, the humidity level has been drastically increasing which circumstantially proves the fact that there is an inverse correlation between SPM concentration and humidity in the troposphere. It is well experienced globally that the extreme weather conditions such as heat waves, drier droughts, bigger storm surges, cloud bursts, floods and greater snowfalls have started post 1980. It is a clear symptom of a damage to the natural Hydrologic cycle leading to malfunctioning ambient heat engine (heat dissipation process) which is the main cause of accelerated rate of climate warming in the recent past five decades.

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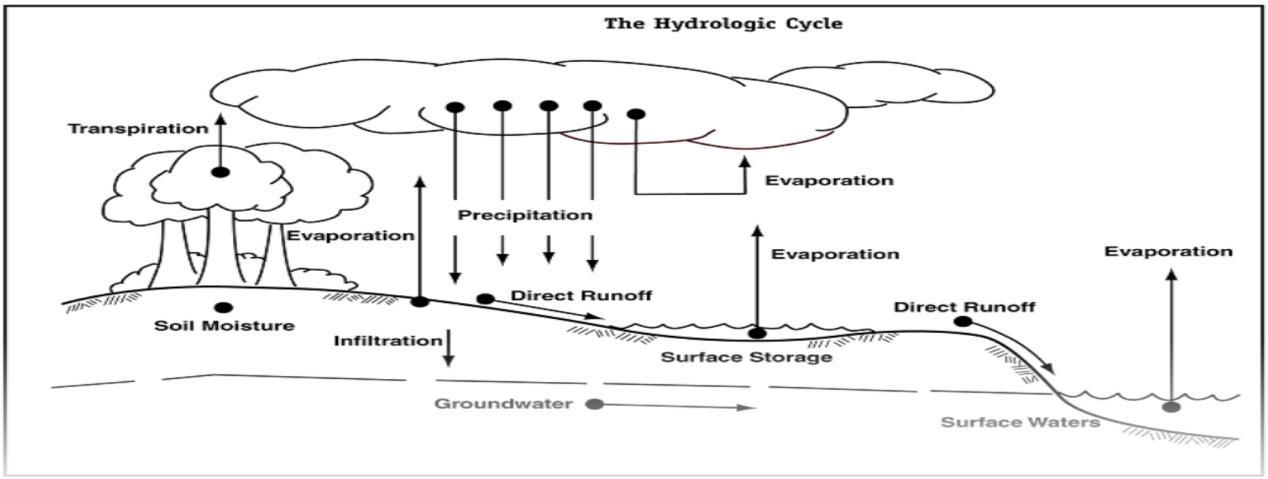
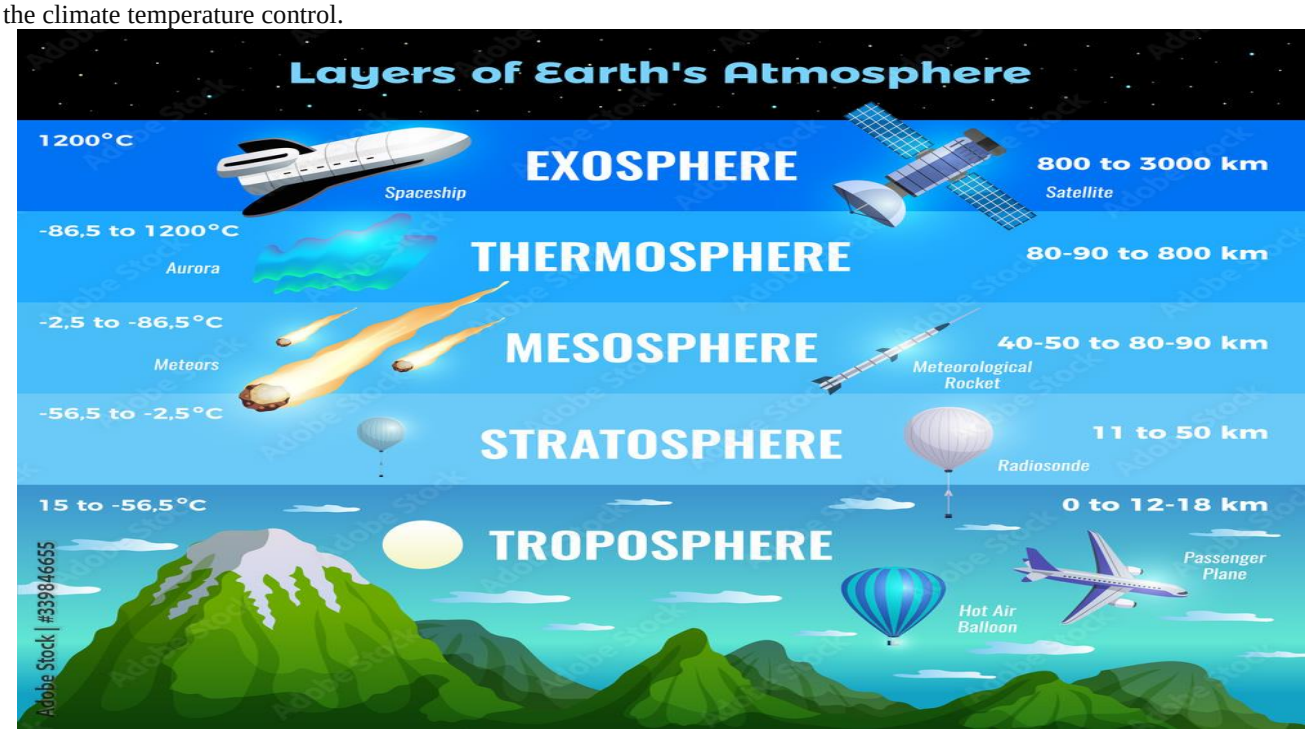


A cloud is an aerosol consisting of a visible mass of minute liquid droplets, frozen crystals, or other particles suspended in the atmosphere of a planetary body. Precipitation is a product of the condensation of atmospheric water vapor that falls under the gravitational pull from clouds. The main forms of precipitation include drizzling, rain, sleet, snow, ice pellets, graupel and hail. However, the fog and mist forming colloids, in which water vapor does not condense sufficiently to precipitate. Cloud droplets form onto pre-existing aerosol particles / natural solid particulate matter (SPM), known as cloud condensation nuclei (CCN). Droplets condensing around current hydrophobic aerosols of fine particulates in the atmosphere produce more numerous drops than those form around the aerosol particles of natural salts and larger SPM. Smaller cloud droplets exhibit a greater curvature, which causes a more rapid rate of evaporation from its surface. As a result of this curvature effect process, smaller droplets require an even greater vapor pressure (higher super-saturation) to keep them from evaporating away. The smaller the droplets, the greater its curvature, and the higher the supersaturation needed to keep the droplet in equilibrium which is a symptom of precipitation inhibition.

Clouds with fog and mist forming colloids do enhance the atmospheric greenhouse effect. Tiny liquid cloud droplets are good absorbers of infrared radiation but poor absorbers of visible solar radiation. Clouds even absorb the infrared wavelengths between 8 and 11 μm, which are otherwise "passed up" by water vapor and CO2. Thus, they enhance the atmospheric greenhouse effect by closing the atmospheric window. In other words, larger SPM facilitate a smooth and regular precipitation whereas smaller ones inhibit precipitation making water vapor and clouds of larger size over-stay in the atmosphere causing higher greenhouse effect leading to climate warming and extreme weather conditions through positive feedback.

The following picture containing the layers of Earth's atmosphere, clearly indicates the position of clouds which play a vital role in the climate temperature control.



In order to ensure a smooth precipitation, adequate cloud condensation nuclei (CNN) in the form relatively larger (1-2 μ) solid particulate matters (SPM) are required at the pre-1975 level. The current hydrophobic fine aerosol is causing cloud condensation nuclei with smaller droplet size and increase in cloud droplet number which is suppressing a regular precipitation and rain

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formation. The increase in the water vapor, cloud size and lifetime in the troposphere is leading to higher greenhouse effect causing accelerated climate warming. As the ambient temperature and moisture content have positive feedback resulted in to an accelerated increase in ambient temperatures and humidity. As clouds can't remain in the troposphere forever, excessive increase in moisture, clouds grow abnormal in size and quantity of moisture with smaller drop size leading to unsteady precipitation including but not limited to impairment of nature water recirculation / mal-distribution of rains, cloud bursts, flood, draught, heat wave and snow-downpour etc.

As droplets become larger, the effect of curvature lessens; for a droplet whose diameter is greater than 20 μm, the curvature effect is so small that the droplet behaves as if its surface were flat. Just as relative humidity less than that required for equilibrium permit a water droplet to evaporate and shrink, those greater than the equilibrium value allow the droplet to grow by condensation. When *cloud condensation nuclei* are *hygroscopic (*affinity for water vapor), condensation may begin on such particles when the relative humidity is well below 100 percent. When condensation begins on hygroscopic salt particles, for example, they dissolve, forming a solution. Since the salt ions in solution bind closely with water molecules, it is more difficult for the water molecules to evaporate. This condition reduces the equilibrium vapor pressure, an effect known as the **solute effect[1].** Due to the solute effect, once an impurity (such as a salt particle) replaces a water molecule in the lattice structure of the droplet, the equilibrium vapor pressure surrounding the droplet is lowered. As a result of the solute effect, a droplet containing salt can be in equilibrium with its environment when the atmospheric relative humidity is much lower than 100 percent. Should the relative humidity of the air increase, water vapor molecules would attach themselves to the droplet at a faster rate than they would leave, and the droplet would grow larger in size.

Since the smaller nuclei are more affected by the curvature effect, only the larger nuclei are able to become cloud droplets. The cloud composed of many small droplets too small to fall as rain and these minute droplets require only slight upward air currents to keep them suspended. Those droplets that do fall descend slowly and evaporate in the drier air beneath the cloud. It is evident, then, that most clouds cannot produce precipitation. The condensation process by itself is entirely too slow to produce rain. However, observations show that clouds can develop and begin to produce rain in less than an hour. Since it takes about 1 million average size (20 μ) cloud droplets to make an average size (2000μ) raindrop, the condensation process with larger hygroscopic SPM by which cloud droplets grow large and heavy enough to fall as precipitation.

There is a strong interdependence between the size and nature of SPM and quality of precipitation affecting the health of the Hydrological cycle.

5. RADIATIVE FORCING COMPONENTS

The following picture taken from the referenced literature, containing Radiative forcing components of both positive and negative forcing components. H_2O in the troposphere is also very strong greenhouse component but it is not indicated in the following picture as it is assumed that H_2O is a natural component which is not under anthropogenic control. However, anthropogenic decisions and with consequent actions do generate atmospheric positive forcing components as explained in the previous section. Aerosols irrespective of sources is indicated as negative forcing component, but in my opinion, hydrophobic fine aerosols from bio-mass and forest fire create generate clouds with fine droplets which cause positive forcing components. However, the aerosol of hygroscopic particles of natural salts (NaCl) and sulphates (gypsum) have potential to generate clouds with proper precipitation with a healthy hydrological cycle which would automatically reduce the climate warming rate.

The natural salts and sulphates are part of the plant formation, which are not expected to cause any harmful effect on the biosphere as those particles circulate with hydrologic cycle. The concentration of these non-toxic natural particles at pre-1975 level is expected to repair the natural heat engine performance by restoring a healthy Hydrologic cycle.

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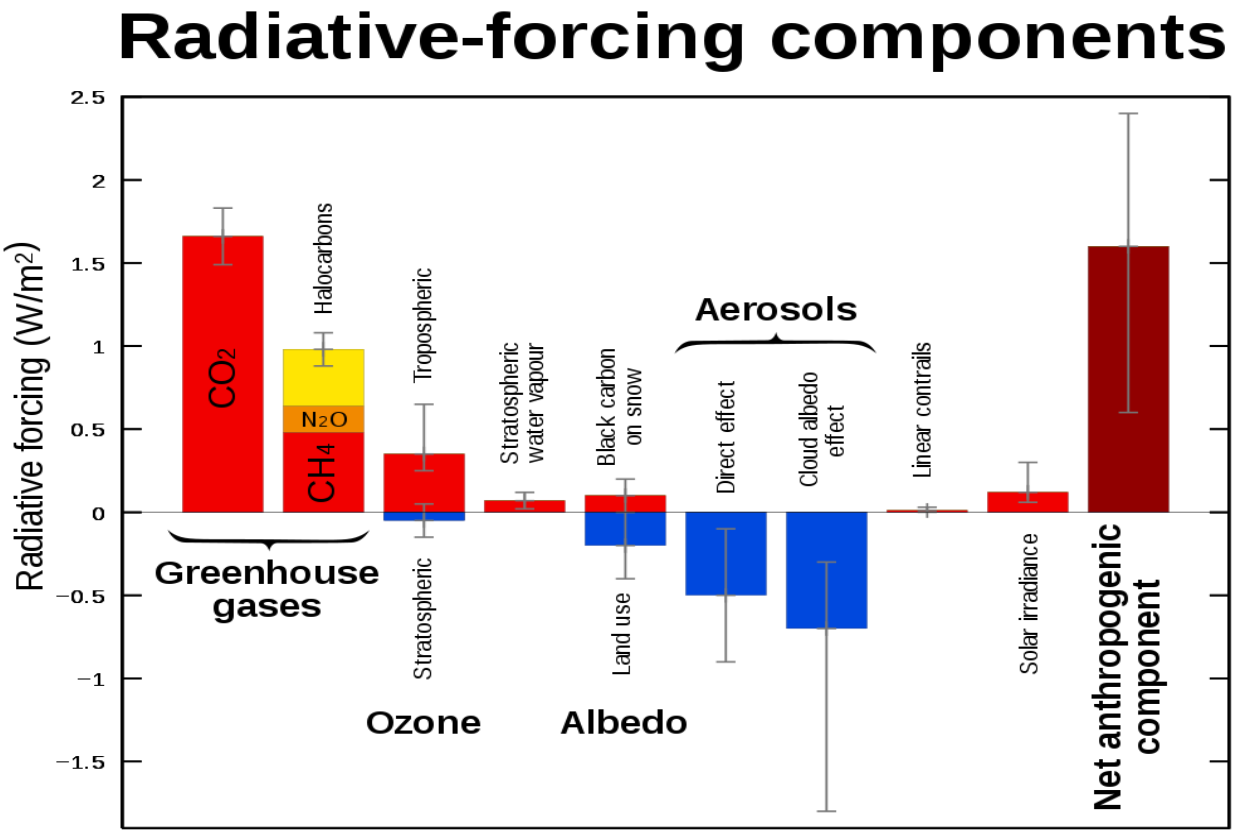

6. SCIENTIFIC SOLUTION

It is my Hypothesis that the deficit of the right SPM (hygroscopic natural salts and sulphates) and excess concentration aerosol (hydrophobic fine generated from bio-mass and forest fire), in the troposphere, for the past five decades, are the double jeopardy causes of accelerated climate warming and not due to gradual increase of CO_2 concentration. As this is a testable Hypothesis conceived based on the empirical evidences as explained in the previous sections need to be experimentally calibrated by injecting fine particulates of non-toxic natural salts and sulphates (gypsum) in to the troposphere. The locations, particulate size, composition, quantities and method of injection need to be ascertained through basic calculations, simulations and experimental calibration with an active participation of global experts, scientists and engineers.

The injection of non-toxic natural particles is to restore the SPM level to pre-1975 level or till a healthy Hydrological cycle is restored. Such an injection is not expected cause air pollution and also not disturb the solar system as the injected particles are in limited quantities and of natural origin. The specified fine particulates injected in to the troposphere will not come in contact with human breathable atmospheric air and precipitated rain water will scrub the SPM and return SPM to the sea and land without causing any associated health issues.

It is expected that, with the proposed mitigation, the rate of climate warming would reach to the level at which the biological specifies can naturally adapt without any natural disaster like the ones of extreme weathers the planet is experiencing. With the manageable climate warming rate through a healthy and natural hydrologic cycle, the excess CO_2 recirculation through a healthy hydrologic cycle and well distributed cloud precipitation / rain would automatically limit the CO_2 concentration in the troposphere. It does not mean that alternative climate warming mitigation actions should not be taken and renewable energy resources need not be developed. The global efforts should be continued to stop deforestation, maximize reforestation through scientific plantation, balance the energy mix on a continual basis without creating energy crisis and without starving energy resources to the developing countries through un-balanced and infeasible legal machinery and economic instruments.

The best long-term solution is to prevent deforestation and start mass plantation on the global level. Making the planet carbon neutral is against the natural process. Having electrical vehicle may only create additional ecological pressure due to increased mining without helping to reduce CO_2 emission. Hydrogen generation needs more energy than it can generate. Nuclear energy could be a feasible and viable solution provided the safety norms are enhanced and the people accept it as a manageable risk. Elimination of poverty, extravagancy and military expansions need to be implemented simultaneously to reduce the global energy demand and CO_2 emissions. Allowing the powerful politicians and corporations to server their vested interests in the name of climate warming would only make the world more asymmetric and unstable.

It is only a beginning of conceiving a Hypothesis and experimental execution is a long-drawn marathon process with the participation of Global political, corporate and institutional leaders, scientists and engineers. It is my intuition and heuristics that restoration of a healthy Hydrologic cycle would automatically limit the global warming limit of 1.5 ^{o}C over the pre-industrial revolution timeline.

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7. REFERENCES:

[1] I do not claim originality for all the material mentioned in this article, in fact I have picked up from various openly available resources. The following is the partial list of references and I apologize if I have missed to list any of the original authors of the information this article contains.
[2] Nasa: Earth Observatory Rebecca Lindsey January 14, 2009, Overview Incoming Sunlight Heating Imbalances Earth's Energy Budget Surface Energy Budget, The Atmosphere's Energy Budget Climate Forcings and Global Warming
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