The influences of human activity On climate

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Abstracts: *Human activity how influenced global surface temperature by changing the radioactive balance governing the earth on various timescales and at varying spatial scales. The most profound and well-known anthropogenic influence in the elevation of concentration of greenhouse gases in the atmosphere. Humans also influence climate by changing the concentrations of aerosols and ozone modifying the land cover of earth surface.*

As it was discussed in [1] greenhouse gases warmed up the earth surface by increasing the net down word longwave radiation reaching the surface. The relationship between atmospheric concentration of greenhouse gases and the associated positive radioactive forcing of the surface is different for each gas. A complicated relationship enlists between the greenhouse gas and the relative amount of longwave radiation that each can absorb. What follows it is a discussion of the radioactive behavior of each major greenhouse gas.

1. Water vapor is the most potent of the greenhouse gases in the earth's atmosphere but its behavior is fundamentally different from that of other greenhouse gases. The primary role of water vapor is not as a direct against radioactive forcing but rather as a climate feedback that is a response within the climate system influences the systems that continued activity .

2. This distinction arises from the fact that amount of water vapor in the atmosphere cannot, in general, be directly modified by human behavior but instead it in set by air temperatures. The larger water surface, the greater evaporation rates of the water from the surface. As a result, increased evaporation leads to greater concentration of water vapor in the lower atmosphere capable of absorbing longwave radiation and emitting it downward. Carbon dioxide Of the greenhouse gases, carbon dioxide (CO_2) is the most significant natural source of atmospheric CO_2 including out gassing from volcanos, earthquakes, the combustion and the natural decay of organic matter respirations by aerobic (oxygen-using) organisms. These sources are balanced, an average, by causes called "sinks", that tend to remove CO_2 from the atmosphere. The role ofvegetation issignificat, as it takes up CO_2 during the process of photosynthesis.

A number of oceanic processes also act as carbon sinks. One such process called the "solubility pump" involves the decent of surface seawater containing dissolved CO_2. Another process, the "biological pump", involves the uptake of dissolved CO_2 by marine vegetation and phytoplankton (small free floating photosynthetic organisms) living in the upper ocean or by other marine organism that use $C0_2$ to build skeletons and other structures made of calcium carbonate ($CaCO_3$) as these organisms expire and fall to the ocean floor, the carbon they contain is transported downward and eventually buried at depth. A long-term balance between these natural sources and sinks leads to the background or natural level of CO_2 in the atmosphere. In contrast human activities increase atmospheric CO_2 primarily through the burning of fossil fuels, principally oil and coal and secondarily, natural gas usage in transportation. Reacting and the generation of electrical power and through the production of cement. Other anthropogenic sources include the burning of forest tends the clearing of land. Anthropogenic emissions currently account for the annual release of about 7 gigatons of carbon into the atmosphere Anthropogenic emissions are equal to approximately 3 percent of the total emissions of $C0_2$ by the natural sources and this amplified carbon load from human activites far exceeds the offsetting capacity of natural sinks. CO2 consequently accumulated in the atmosphere at an average rate of 1.4ppm per year between 1959 and 2006 and roughly 2.0ppm per year between 2006 and 2018. Over all this rate of accumulation has been linear. However certain current sinks, such as the oceans, could become sources in the future, this may lead to a situation in which concentration of atmospheric CO_2 build at an exponential rate. That is its rate of increase also growing. The natural background level of carbon monoxide varies in timescales of millions of years because of slow changes in outgassing through volcanic activity. For example, roughly 100 million years ago during the cretaceous period (145million to 66million years ago), CO_2 concentrations appear to have been several times higher than they are today over past 700000 years, CO_2 concentrations have varied over a far smaller range in association with the same earth orbital effects linked to the coming and going of the Pleistocene ice age, by the early 21st century CO_2 levels had reached 384pmm, which is approximately 37 percent above the natural background level of roughly 280pm that existed in the beginning of the industrial revolution Radioactive forcing caused by carbon dioxide varies in an approximately fashion with the concentration of that gas in the atmosphere. The logarithmic relationship occurs as the result as a saturation on effects where in it become increasingly difficult, as the CO_2 concentrations increases for additional CO_2 molecules to further influence the “infrared window” the logarithmic relationship predicts that the surface warming potential will wise by roughly the same amount for each doubling of CO_2 concentration as current rates of fossil fuels use, a doubling of CO_2 concentrations would represent an increase of roughly 4 watts per square meter of radioactive forcing. Given typical estimated of “climate sensitivity” in the absence of any offsetting. Factors this energy increased lead to warming of 2 to 5c over preindustrial times/ the total radioactive forcing by anthropogenic CO2 emissions since the beginning of the industrial age its approximately 1,66 watts per square meter.

3.Methane

Methane (CH_4) is the second most important greenhouse gas, CH_4 is more potent than CO_2 because the radioactive forcing produced per molecule is greater. In addition to the infrared windows is less saturated in the range of wave lengths of radiation absorbed by CH_4, so more molecules may fill in the region. However, CH_4 exists in far lower concentrations by volume in the atmosphere are generally measured in parts per billion (ppb) rather than ppm CH_4 also has a considerably shorter residence time in the atmosphere than CO_2. Natural sources of methane include tropical and northern wetlands, methane oxidizing bacteria, volcanoes and methane hydrates trapped along the continental shelves of the oceans and polar permafrost. The primary natural sink methane is the atmosphere itself as methane reacts rapidly with the hydroxide radical (OH) within (H_2O) when CH_4 reaches the stratosphere it is destroyed, another natural sink is soil, where methane is oxidized by bacteria. As with CO_2, human activity is increasing the CH_4 concentration faster than it can be offset by natural means. Anthropogenic sources currently account for approximately 70 percent of total annual emissions leading to substantial increases in concentration over tie the major anthropogenic sources of atmospheric CH_4 are rice cultivation, livestock farming, the burning of coal and natural gas, the combustion of biomass, and the decomposition of organic matter in landfills. Future trends are particularly difficult to anticipate. This is in part due to an incomplete understanding of climate feedbacks associated with CH_4 emissions. In addition it is difficult to predict how, as human populations grow, possible changes in livestock raising, rice cultivation, and energy utilization will influence CH_4 emission. It is believed that a sudden increase in the concentration of methane in the atmosphere was responsible for the warning event that raised average global temperature by 4-8c over a few thousand years during the so called Paleocence- Eocen thermal maximum or PETM. This episode had been taking place roughly 55 million years ago, and the rise in CH_4 appears to have been related to a massive volcanic eruption that interacted with methane- containing flood deposits, as a results, large amounts of gaseous CH_4 were injected into the atmosphere it is difficult to know precisely how high these concentrations were or how long they persisted. At very high concentrations, residence times of CH_4 in the atmosphere can become much greater than the normal 10 years residence time that applies today. Methane concentration have also varied over a smaller range in association with paleocence ice age cycles. Preindustrial at levels of CH_4 in the atmosphere were approximately 700ppb as evels exceeded 1876ppb in late 2018 the net reactive forcing by anthropogenic CH_4 emissions is approximately 0,5 watts per square meter or roughly one third of the radioactive forcing of CO_2.

4. Surface level ozone and other components.The next most significant greenhouse gas is surface or low-level, ozone (O_3). Surface O_3 is a result of air pollution. It must be distinguished from naturally occurring stratospheric O_3, which has a very different role in planetary radiation balance. The primary natural source of surface O_3 is the subsidence of stratospheric O_3 from the upper atmosphere In contrast, the primary anthropogenic source of surface O_3 is photochemical reactions involving the atmospheric pollutant carbon monoxide (CO). The best estimated of the natural concentration of surface O_3 are 10ppb, and the net radioactive forcing due the anthropogenic emissions of surface O_3 is approximately 0,35watt per square meter. Ozone concentration can rise above unhealthy levels in cities prone to photochemical smog, additional trace gases produced by industrial activity that have greenhouse properties include nitrous oxide (N_2O) and the fluorinated gases (halocarbons), the later including sulfur hexafluoride, hydrofluorocarbons (HFCs) and perfluorocarbons (PFCS). Nitrous oxide is responsible for 0,16 watt per square meter radioactive forcing, while fluorinated gases are collectively responsible for 0,34 watt per square meter nitrous oxide have small background concentration due to natural biological reaction in solid and water where the fluorinated gases are their existence almost entirely to industrial sources.

5.Aerosols

The production of aerosols represents an important anthropogenic radioactive forcing of climate. Collectively, aerosols block- that is reflect and absorb a portion of incoming solar radiation, and this creates a negative radioactive forcing. Aerosols are second only to greenhouse gases in relative importance in their impact on near surface air temperatures. Unlike the “well-mixed greenhouse gasses” such as CO_2 and CH_4 aerosols are readily flushed out of the atmosphere within days, either by rain or snow (dry deposition). They must therefore be continually generated in order to produce a steady effect on radioactive forcing, aerosols have the ability to influence climate directly by absorbing or reflecting incoming solar radiation but they also produce indirect effects on climate by modifying cloud formation or cloud properties. Most aerosols serve as condensation nuclei. Aerosols can be transported thousands of kilometers from their sources of origin by winds and upper-level circulation in the atmosphere. Perhaps the most important type of anthropogenic aerosol in radioactive forcing is sulfate aerosol. It is produced from sulfur dioxide (SO_2) emissions associated with the burning of coal and oil. Since the late 1980s, global emissions of SO_2 have decreed from about 151.5 million tons to less than 100 million tons.

Nitrate aerosols are not as important as sulfate aerosol, but is the potential to become significant source of negative forcing. One major source of nitrate aerosol is smog released from the incomplete burning of fuel in internal combustion engines. Another source of ammo (NH_3), which is often used in fertilizers or released by the burning of plants and other organic materials, both sulfate and nitrate aerosols act primarily by reflecting incoming solar radiation, thereby reducing the amount of sunlight reaching the surface. Most aerosols, unlike greenhouse gases, impart a cooling rather warming influence on earth's surface. One prominent exception is carbonaceous aerosols such as carbon black or soot, which are produced by the burning of fossil fuels and biomass Carbon black tends to absorb rather than reflect incident solar radiation, and so it has a warming impact on the lower atmosphere where it resides. Because of its absorptive properties, carbon black is also capable of having an additional indirect effect on climate through its deposition in snowfall it can decrease the albedo of snow cover and this reduction in the amount of solar radiation reflected back to space by snow surfaces creates a minor positive radioactive forcing like other natural sources of aerosols including volcanic eruptions, which is produce sulfate aerosol, and biogenic aerosols, such as terpenes, are produced naturally by certain kind of trees or other plants. For example, the dense forests of blue ridge mountains of Virginia in the USA emit terpenes during the summer months, which in turn interacts with the high humidity and warm temperatures to produce a natural photochemical smog. Anthropogenic pollutants such as nitrate and ozone both of which serve as the precursor molecules fir the generation of biogenic aerosols, appear to have increased the rate of production of these aerosols. This process appears to be responsible for some increased aerosol pollution in region undergoing rapid Urbanization.

6. Land use changes. There are number of ways in which changes in land use can influence climate. The most direct influence is through the alteration of earths albedo, surface reflectance. For example, the replacement of forest by ocropland and pasture in the middle latitudes in the past several centuries has led to an increase in albedo, which in turn has led to greater reflection of incoming solar radiation in those regions. This replacement of forest by agriculture has been associated with a change in global average radioactive forcing of approximately 0,2 watts per square meter since 1750. In Europe and major agricultural regions, such land use conversion began more than 1000 years ago and had proceeded nearly to completion for Europe, the negative radioactive forcing due to land-use change has probably been substantial, perhaps approaching 5 watts per square meter. The influence of early land-use on radioactive forcing may help to explain a long period of cooling in Europe that followed a period of relatively mild conditions roughly 1000 years ago. It is generally believed that the mid temperature of this "medieval warm period" which was followed by long period of cooling. Rivaled those of 20^{th} Century Europe. Land use changes can also influence climate through their influence on exchange of heat between earth's surface and the atmosphere. For example, vegetation helps to facilitate the evaporation of water into the atmosphere through evapotranspiration. In this process plants take up liquid water from the soil through their root systems. Eventually this water is released through transpiration into the atmosphere, as water vapor through the stomata in leaves. Deforestation generally leads to surface cooling due to the albedo factor discussed above, the land surface may also warm as the result of release of latent heat by the evapotranspiration process. The relative importance of these two factors, one exerting a cooling effect, and the other warming effect, varies, by both seasons and region while the albedo effect is likely to dominate in the middle of latitudes, especially during the period from autumn through spring, the evapotranspiration effect may dominate during the summer in the midlatitudes and year round in the tropics. The latter case is particularly important in accessing the potential impacts of continued tropical deforestation. The rate at which tropical regions are deforested is also relevant to the process of carbon sequestration, the long-term storage of carbon in under-ground cavities and biomass rather than the atmosphere. By removing carbon from the atmosphere, carbon sequestration acts to mitigate global warming.
7. stratospheric ozone depletion Since the 1970s the loss of ozone (O3) from the stratosphere has led to a small amount of radioactive forcing of the surface. This negative forcing represents a competition

between two distinct effects caused by the fact that ozone absorbs solar radiation. In the first case as ozone levels in the stratosphere are depleted, more solar radiation reaches earth's surface. In this absence of any other influence, this rise in insolation would represent a positive radioactive forcing of the surface. However ,that is related to its greenhouse properties. The amount of ozone in the stratosphere is decreased, there is also less ozone to absorb longwave radiation reference there is a corresponding decrease in the downward reemissions of radiation. This second effect overwhelms the first and results in a modest negative radioactive forcing of the earth's surface and modest cooling of the lower stratosphere by approximately 0.5C per decade since the 1970s.

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ადამიანის საქმიანობის გავლენა კლიმატზე

რეზიუმე

ნაშრომში განხილულია ადამიანის საქმიანობის გავლენა გლობალური დათბობის მეტად აქტუალურ პრობლემებზე. დადგენილია, რომ დედამიწის საშუალო ტემპერატურის მუდმივი ზრდა გამოწვეულია „სათბურის“ აირების ინტენსიური გამოყოფით. მათ შორის განსაკუთრებული მნიშვნელობა აქვს ნახშიროჟანგს, მეთანს, ოზონს, აეროზოლების და სხვადასხვა ნიტრატებს. ასევე დიდია სასოფლო-სამეურნეო საქმიანობისა და მის შედეგად გამოწვეული უარყოფითი შედეგები.