Principles Of Global Warming

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Weather, global warming and climate change are topics that Michiganders hear about these days and may find the information confusing. They experience local weather and are accustomed to some really hot or cold days, heavy rainfalls with local flooding, infrequent heavy snow storms and long periods of drought. However, there are reports that the seasonal weather is changing and these changes may be precursors to a future with high food and transportation costs, unemployment, rampant disease and poverty. Moreover, it is pointed out if this happens our generation will be held responsible by future generations. There are groups that are taking these reports seriously, notably the Green New Deal, which is pressing policymakers to take action and pass legislation to head off these dire predictions. Some people believe the weather patterns are cyclic and natural; others vehemently deny there will be future weather changes that impact their standard of living. However, for the most part, local, state or federal governmental programs are not in place to deal with the possible changes.

The goal of this article is to assist readers in understanding the main cause of global warming. With this understanding a person may advocate for policies to reduce global warming.

The air we breathe is made up of gases which are in a layer that surrounds the earth. The gas layer is called an atmosphere; it extends up about seven miles from the earth's surface. The primary gases in the atmosphere are nitrogen (N_2) 78% and oxygen (O_2) 21%; the remaining 1% of the gases is made up of a number of trace gases. The trace gases include, among other gases, water (H_2O), carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (NO).[1] The gases originate from both natural and man-made (anthropogenic) sources. Some of the trace gases are classified as greenhouse gases because they contribute to the warming of the earth and its atmosphere. CO_2 is the main greenhouse gas.

Figure 1: Saint Petersburg Botanical Garden Greenhouse

The reason some trace gases are called greenhouse gases is they have a property similar to the glass used in greenhouses.[2] A greenhouse is a building with a roof and walls made out of clear glass. The building is used to maintain a warm environment inside the greenhouse for growing plants at the time of a year when it is cold outside

Glass is used because it has interesting optical properties, namely, it is transparent to visible sunlight and absorbs infrared radiation. Warm surfaces inside a greenhouse produce infrared radiation much like a fireplace with burning logs. A person standing in front of the fireplace is warmed by the infrared radiation from the hot burning logs. Sunlight passes through the glass roof and walls of the greenhouse and is absorbed by plants and surfaces inside the greenhouse. The light stimulates plant growth and heats or warms the interior surfaces of the greenhouse. The warm surfaces produce infrared radiation which cannot pass through the glass roof and walls of a greenhouse. The radiation is trapped inside the greenhouse, warming it and maintaining a temperature higher than the outside temperature.

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In summary, the greenhouse glass has a property that results in warming the interior of the greenhouse when the sun shines on it. These ideas will be used to understand global warming.

The role that greenhouse gases play in global warming of the earth is illustrated in Figure 2.[3] The earth, with the shape of a globe, is enclosed in the atmosphere much like glass encloses a greenhouse. The atmosphere has optical properties like glass; it is transparent to sunlight but traps infrared radiation. The infraredradiation trapping mechanism is due to the scattering, or colliding, of the radiation with the CO_2 molecules in the atmosphere. The collisions result in heating the atmosphere.

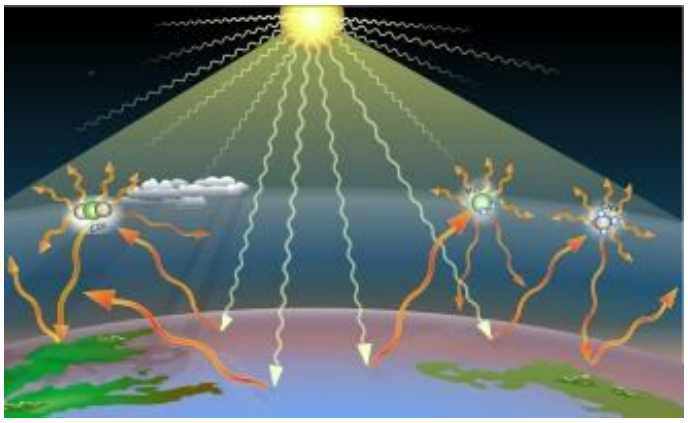

Figure 2. Illustration of Sun, Sunlight, Atmosphere, Clouds, Earth, Infrared Radiation and CO_2.

The top of the atmosphere is symbolized in the figure by the clouds. The sunlight is represented by the white rays in the figure that emanate from the sun. The sunlight passes through the atmosphere and is absorbed at the surface of the earth, heating or warming it, and producing infrared radiation. Infrared radiation is symbolized in Figure 2 by the red rays. The CO_2 in the atmosphere is represented by the small white spheres. The atmosphere, like glass in a greenhouse, traps the infrared radiation preventing some of it from escaping into outer space. The scattering mechanism is represented in the figure by the red rays colliding with the CO_2 molecules. The larger the density of the CO_2 molecules in the atmosphere, the more difficult it is for the infrared radiation to escape from the atmosphere, resulting in greater warming of the earth.

In summary, sunlight passes through the atmosphere, is absorbed at earth's surface, and heats it producing infrared radiation. Infrared radiation is trapped in atmosphere preventing a significant portion of it from escaping to outer space. The greater the density of CO_2 in the atmosphere, the greater the heating or warming of the atmosphere.

Figure 3 shows the amount, in parts per million (ppm), of CO_2 in the atmosphere for the past 800,000 years.[4] The term volumetric density is used to indicate the fraction of the molecules in air that are CO_2 molecules; the graph shows there are between 200 and 300 CO_2 molecules for every million air molecules during the ice ages. The CO_2 volumetric density underwent major changes about every 50,000 to 100,000 years. Up until about 1880, the minimum CO_2 volumetric density was about 173 ppm, the maximum about 300 ppm and the average about 237 ppm. The maximum is 63 ppm above the average and the minimum is 63 ppm below the average. The value of the volumetric density before 1880, and over the preceding 800,000 years, was 237 ppm plus or minus 63 ppm or plus or minus 27%; it increased during the warm periods and decreased during the ice ages. The changes in CO2 in the atmosphere before 1880 **occurred over thousands of years** and have been correlated with natural processes, namely, ice ages and warm periods of the earth. The volumetric density of CO2 from about 1880 to 2018, 138 years, increased to 407 ppm, 169 ppm, or 71% above the 237 ppm average. The increase is 107 ppm above the highest previous value of 300 ppm occurred **in just 138 years**. This large change in such a short period of time suggests, that after 1880, the change in the CO2 volumetric density is due to sources other than the natural carbon dioxide sources.

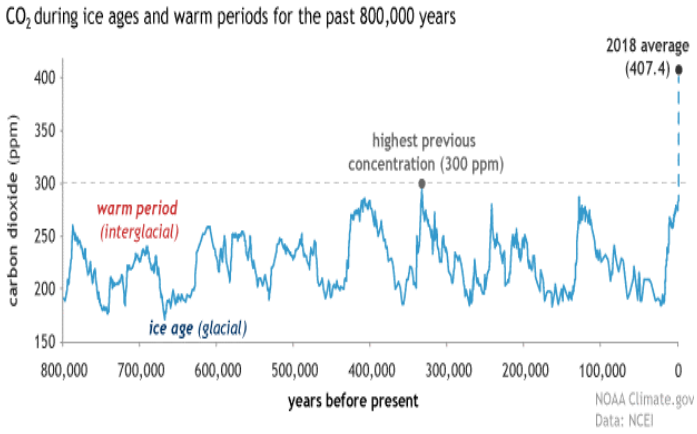

Figure 3. CO_2 during the ice ages and warm periods for the past 800,000 years.

The red curve in Figure 45 shows the global average temperature change for the period 1880 to 2020. Note the curve has a steep slope for the 1900 to 2020 period suggesting that the mechanism producing the temperature change is different than for the past 800,000 years. The temperature change for the 1930 to 2020 period is about 1.0 degree Celsius or 1.8 degrees Fahrenheit. Scientific research shows the increase in CO2 volumetric density shown in Figure 4 is the mechanism responsible for the increase in global temperature.

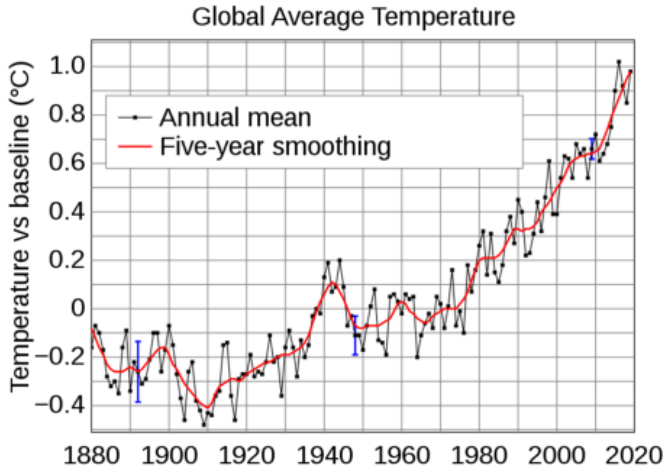

Figure 4. Global Average Temperature Change for 1880-2020 Relative to the 1951-1980 Average.

The logical question is what causes the increase in atmospheric carbon dioxide density and average global temperature change in the 1880 to 2018 period? The period before 1880 is called the pre-industrial period and the period after 1880 the industrial period. There was a great demand in the industrial period for energy in manufacturing, transportation, agriculture and electric power generation. By and large the energy demand was met by burning fossil fuels, namely, coal, oil and natural gas. The main gas produced by burning fossil fuels is CO2. Studies show the large increases in the atmospheric volumetric CO2 density and global temperature change, over such a short period of time, are due to burning fossil fuels.

In summary, there are two sources of atmospheric CO2, natural and man-made (anthropogenic) processes. The main source before 1800, called the pre-industrial period, was natural sources. After the start of the industrial period in 1800, usage of fossil fuels for various processes is the main source of atmospheric CO2. Research shows man-made processes resulting in atmospheric CO2 is the major cause of global warming.

References

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[2] https://en.wikipedia.org/wiki/Greenhouse

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