THE EARTH IS GETTING WARMER

By Hani Mohammadi

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Preface

Man-made climate change is one of the biggest threats to the world, and climate change poses an increasing threat to the stability of Earth’s systems. The effects are already being seen through receding glaciers, ocean acidification and an increase in extreme weather such as hurricanes, floods, and droughts. We must work to find solutions to climate change. If we want to protect our planet from dangerous and unprecedented change, first, we must understand the science behind climate change and teach it to people.

Hani Mohammadi

Chapter 1: Climate Change

Getting Warmer

Scientists have been observing Earth for over a hundred years. They use satellites and other instruments to collect information about Earth's land, atmosphere, ocean, and ice. This information tells us that our Earth is getting hotter. The impacts of climate change are being experienced all over the world. Extreme weather events are becoming more common, such as hurricanes, floods, and droughts. Polar ice caps are receding, and sea levels are rising.

But Earth had always had times when it became hotter and colder? Is this warming that we are experiencing now connected to Earth's natural cycle?

Figure (1-1) shows global temperature changes since 1800. Line 0 is the average temperature for the time of the year. Anything below 0 is cooler and everything above 0 is warmer for that time of year. As you can see, since the 1970s, temperatures around the world have continued to go higher.

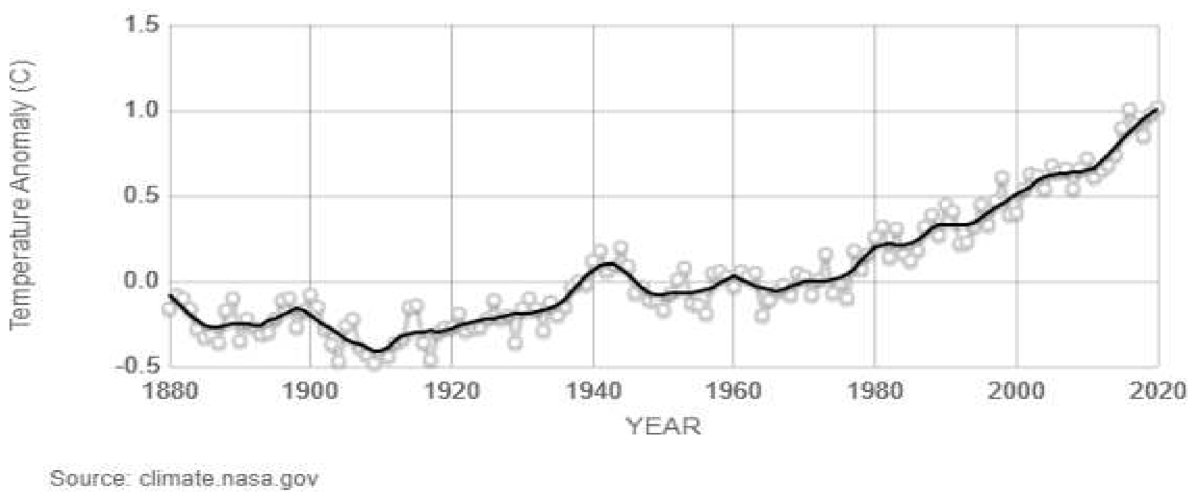

Figure (1-1) Global temperature index since late 1880s.
Source: climate.nasa.gov

Recent studies suggest that the Earth is warming at a dramatically fast rate, almost ten times faster than it has in the past.

The Earth’s average surface temperature has risen about 1.18 degrees Celsius since the late 19th century, a change driven primarily by increased carbon dioxide emissions into the atmosphere and other human activities. The ocean has absorbed much of this increased heat, with the top 100 meters of ocean showing warming of more than 0.33 degrees Celsius since 1969. The global sea level rose about 20 centimeters in the last century. However, the rate in the last two decades is nearly double that of the last century and accelerating slightly every year.

Antarctic ice and Arctic Sea ice sheets have decreased in mass. Glaciers are retreating almost everywhere around the world.[1]

It is undeniable that human activities have warmed the atmosphere, ocean, and land and that widespread and rapid changes in the atmosphere, ocean, cryosphere, and biosphere have occurred. Our actions affect our planet not only at a local level but also at a global level.

Unfortunately, it took us a long time to realize that taking no action affects us negatively. We are beginning to see the effects of climate change. The challenge we face today is finding ways to reduce these footprints. We can take actions individually at local and national levels to slow and mitigate these changes. The first step towards taking these changes is to understand and educate about the mechanisms of climate change

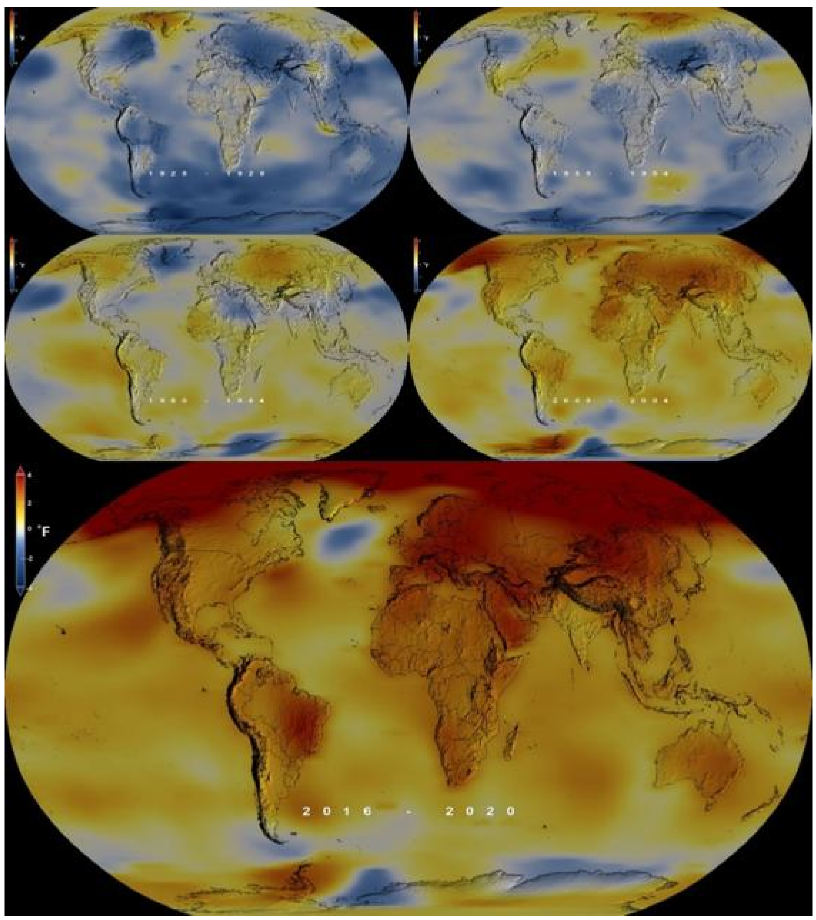

Figure (1-2) color map displays a progression of changing global surface temperature anomalies.

Source: climate.nasa.gov

Greenhouse Effect

what is the greenhouse effect?

The process gets its name from the greenhouse, a plastic or glass structure that stays warm for growing plants (figure 1-3). Greenhouse receives incoming light from the Sun, which passes easily through the glass. Some of that incoming sunlight is absorbed by the surfaces inside the greenhouse. Plants and the soil in the greenhouse re-emit heat radiation. Some of these heat radiations try to escape to space, and the rest gets trapped inside by the glass building. That is why it's hotter inside a greenhouse than outside. This is basically the same process that keeps Earth warm for sustaining life. On the Earth, certain gases in the atmosphere trap or hold the Sun's heat, just like in a greenhouse. This is called the greenhouse effect.

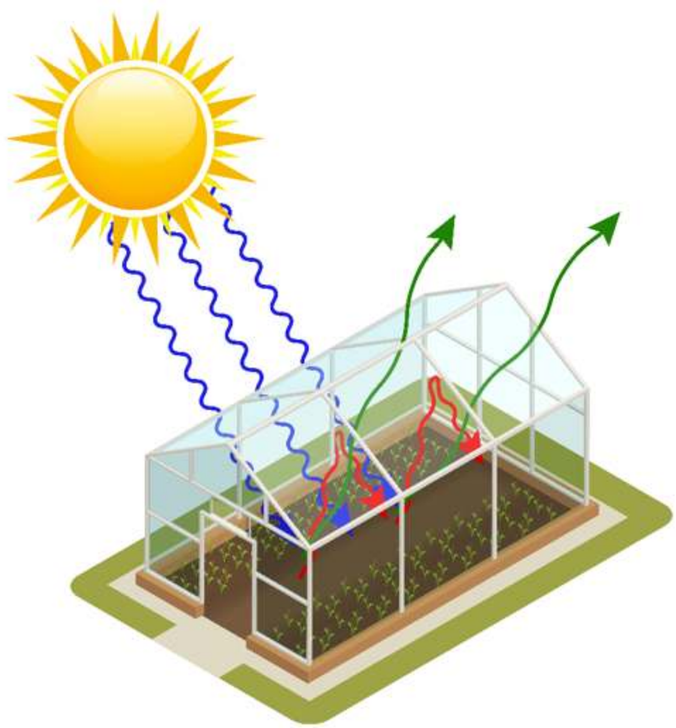

Figure (1-3) a greenhouse

One example of the greenhouse effect that most of us experience is the warming of a car's interior when left out in the Sun. You have probably noticed that your car is always much hotter inside than the outside temperature if it has been sitting there for a while. When the shortwave energy of the Sun's rays passes through the car windows, they heat up the surfaces inside the car. Some of the Sun's rays get absorbed in the seats, dashboard, steering wheel, etc. The heat from the surfaces produces longwave infrared radiation that radiates off the hot surfaces. But now, the car's windows preventing most of the radiated heat from leaving. The result is a gradual increase in the temperature inside the car.

The Sun is 150 million kilometers away from us. Based on the distance between the Sun and the Earth, it should be an average of -18 degrees Celsius on Earth, which seems way too cold. We know that can't be right. If that were true, the water on Earth would be frozen, and life on Earth would not have been possible. It is in fact much warmer. But why do we get this extra boost of heat so that Earth's average temperature is a balmy 15 degrees Celsius where you can have liquid water and Earth becomes habitable? Well, that's the greenhouse effect.

You probably know something about the electromagnetic spectrum of energy. Figure (1-4) shows the full spectrum. Starting with the very short wavelength low-energy least harmful radio waves and finally the more harmful rays ultraviolet, x-rays, and gamma rays. Most of the energy we get from the Sun comes as visible light.

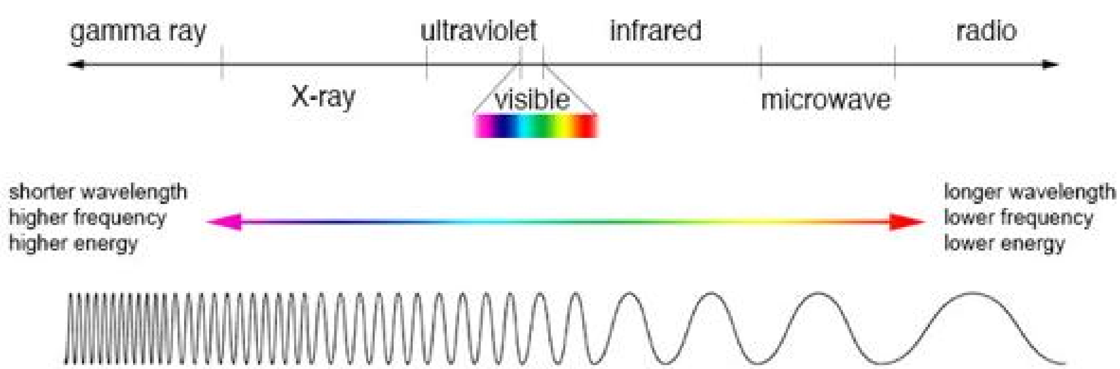

Figure (1-4) electromagnetic spectrum.
source: NASA's Imagine the Universe