

## Climate Change in Less than 5 Minutes



Here is a climate change experiment you can do in less than 5 minutes. Get 2 bags of popcorn and microwave the first bag in the usual way. I used 1.5 minutes on the bag on the left. It came out just about perfect and if you want you can munch on the first part of the experiment while you do the second part. In the second part, added 1 minute to the cooking time (I used 2.5 minutes) and microwaved the second bag. Don't add any more time because I think it might catch on fire. Cooking it will stink up the kitchen for a couple of hours and smoke will be coming out of the bag. I took it outside and cracked an opening in the bag and let air out for several minutes.

Microwaves add very low amounts of energy, which excite the water molecules to spin and rotate over and over throughout the sample. Their kinetic energy is transferred to the food molecules, and then they are re-excited over and over, while increasing the temperature until the desired result is obtained. Add too much energy and, well, things get burned.

In global warming about 70% of visible light from the sun is converted to infrared radiation at the surface of the earth and randomly radiated back out to space through the earth's atmosphere (up and down, front and back, right and left). Along the way the infrared radiation excites the bonds in water molecules and carbon dioxide molecules to vibrate and bend more energetically. They in turn collide with the IR inactive nitrogen and oxygen molecules and argon atoms pushing them into more energetic states (higher kinetic energy and temperature). The H<sub>2</sub>O and CO<sub>2</sub> become relaxed back to their ground state, ready to be re-excited again, and again, and again by additional IR radiation. The more water and carbon dioxide in the atmosphere the more IR radiation is absorbed and bounced around and the warmer the earth gets. IR is about 100 times greater in energy than microwaves, but, of course, the "dish" we are cooking (earth) is much, much larger. So, it takes more than 2.5 minutes to burn it. Also, the popcorn doesn't have an ocean of water to absorb much of the excess energy (heat). However, warmer water in the ocean has a higher water vapor pressure, which puts more water in the atmosphere and heats it up even more, which absorbs more IR radiation and, well, you get the idea.

For about 12,000 years earth has been in a sweet climate spot, 280 ppm CO<sub>2</sub> and average temperature of 15C (59F). Over the past 1,000,000 years earth has cycled back and forth between 180 ppm (ice age) and where we are now (very comfortable for humans). The actual difference in 'average' temperatures between these 2 very different climates is only about 5C (9F). Water is the main greenhouse gas, but the water molecules turn over about every 9 days in a state of equilibrium with the oceans and there's nothing we can do about that. The amount of CO<sub>2</sub> is like the thermostat. When there is more CO<sub>2</sub> the thermostat is set higher. There are various reasons why CO<sub>2</sub> levels fall and rise and all have occurred over earth's history. CO<sub>2</sub> can fall when there is very exceptional growth of plants (the opposite occurs when we deforest the earth or burn the forest as is going on in the Amazon rainforest right now). CO<sub>2</sub> levels can also drop by weathering of new rocks, as is occurring where India is colliding with south Asia (the Himalayas) (silicate rocks transform into carbonate rocks). Increases in CO<sub>2</sub> levels can occur with very active volcanic eruptions. Perhaps the most incredible example was the Siberian Traps, which cover central Russia and occurred over a 2,000,000 period 500,000,000 years ago. Usually this occurs over 1000s to 10,000s of years (or longer), but we are adding CO<sub>2</sub> about 100 times faster than nature has in the past. The vast fossil fuel reservoirs (coal, oil and natural gas) were built up over 100,000,000s of years. We have basically poked in over 1,000,000 straws (oil wells) into the fossil fuel milk shake and are sucking out the black goo as fast as we can, about 100 times faster than volcanoes exploded it out with their best effort. We've only been digging and pumping for about 200 years and are going faster than ever. Of all the CO<sub>2</sub> released since James Watts' steam engine in 1770, 50% has been released in the last 30 years!.

So you can see, climate change is just slow motion cooking using IR radiation instead of microwaves. And instead of popcorn, we are cooking the earth. Throughout its history, the earth has gone through many cycles of hot house earth and glacial earth for a variety of reasons, but almost always CO<sub>2</sub> is part of the reason. The earth was actually getting ready to cycle back into an ice age over about 40,000 years, but we have reversed that and appear to be heading into what is called a "hot house" earth. At its hottest, all the ice at the poles was melted and sea levels were over 300 feet higher than today. That's not likely to occur in our time (no one living now will ever see that). Scientists only predict out to about 2100, even though warming will continue for centuries. They predict 4 possible scenarios. The original goal from the Paris conference was no more than 1.5C. There is almost zero chance of seeing that one. The consequences of that increase are what we are seeing today. The next goal is 2C, also very unlikely, but still within the realm of possibility, if we frantically stop putting CO<sub>2</sub> into the atmosphere and perhaps start sequestering CO<sub>2</sub> out of the atmosphere. Serious consequences are certain but adaptations are possible. The 3<sup>rd</sup> possibility is about 4C with more dire consequences (no comment here) and the worst, if we do nothing at all, is 8C and that would be a total disaster, considering that things don't stop in 2100.

The older you are the less you will see and the younger you are the more your life will be very different. This is why younger people are more concerned about climate change. They will have to actually live it. Whoever you vote for in future elections, make sure addressing climate change is at the top of their agenda.

Anyway, here are a few things to think about while you eat your popcorn.