Climate Change Studies:
A Few Highlights

Eunice Newton Foote

As the evidence for ice ages began to accumulate, back in the 1800's, more people began to study how the temperature of the Earth's atmosphere could change.

Eunice Newton Foote, an American Woman, was the first to publish the results of an experiment showing that CO_2 could have a heating affect on the atmosphere. She also was the first to predict that changing the amount of CO_2 in the atmosphere could change its temperature. Her work was published in 1856, over 160 years ago. For more information go to her Wikipedia page.

Joseph Fourier, John Tyndall

Link to a comprehensive hypertext history of climate change studies, created by Spencer Weart, on the American Institute of Physics (AIP) website is here. https://history.aip.org/climate/index.htm

In the 1820s, French scientist Joseph Fourier was the first to realize that something in the Earth's Atmosphere retains heat radiation. He speculated that the Earth's temperature was much higher than expected for its distance from the sun. However, nobody knew the mechanism by which gases in the atmosphere were trapping heat.

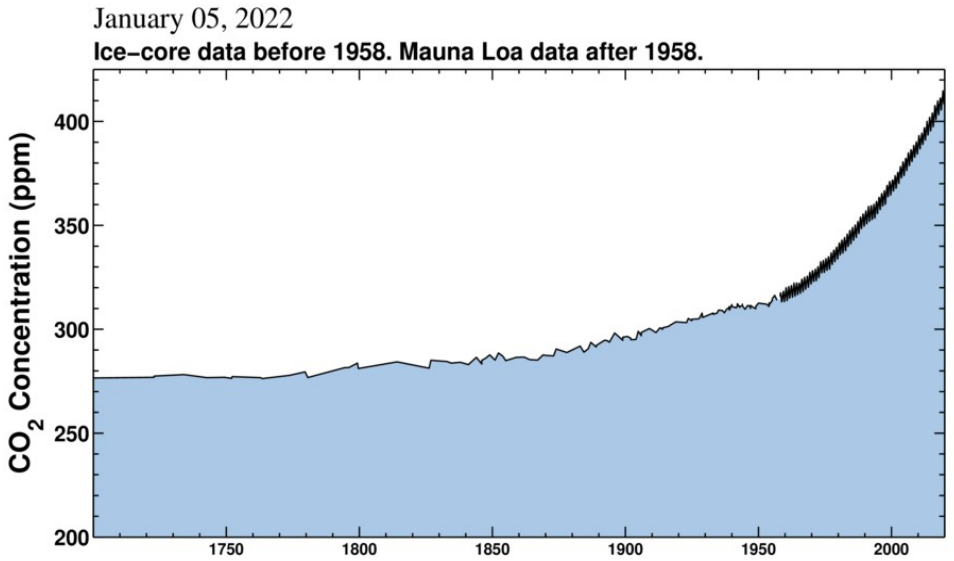
In 1859, Irish scientist John Tyndall showed that gases, including water vapor (H_2O), carbon dioxide (CO_2) and methane (CH_4), can absorb heat. His radiation source was a copper cube containing boiling water. The infrared radiation coming from this source is similar to that coming from the Earth's surface. Tyndall had discovered, and could now qualitatively explain, what we currently call the "greenhouse effect". He wrote: "Thus the atmosphere admits of the entrance of the solar heat; but checks its exit, and the result is a tendency to accumulate heat at the surface of the planet."

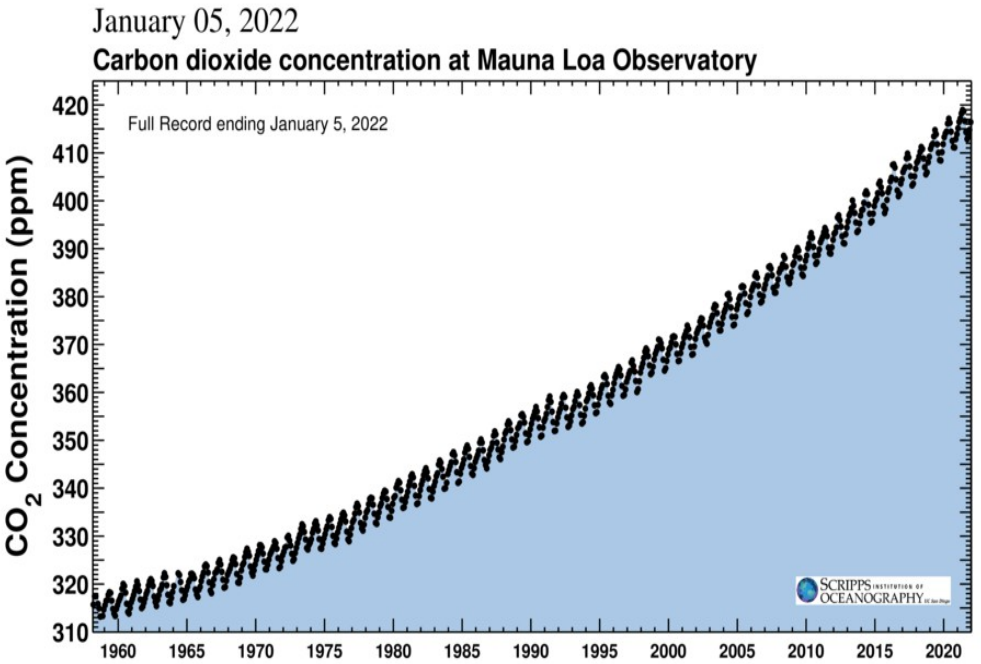
Svante Arrhenius

In 1896 the Swedish physical chemist, Svante Arrhenius published his pioneering study of how changes in the amount of CO_2 could affect climate. In his model, he showed how temperature changes in the atmosphere, produced by changes in atmospheric CO_2 concentration, could be amplified by the resultant changes in atmospheric H_2O.

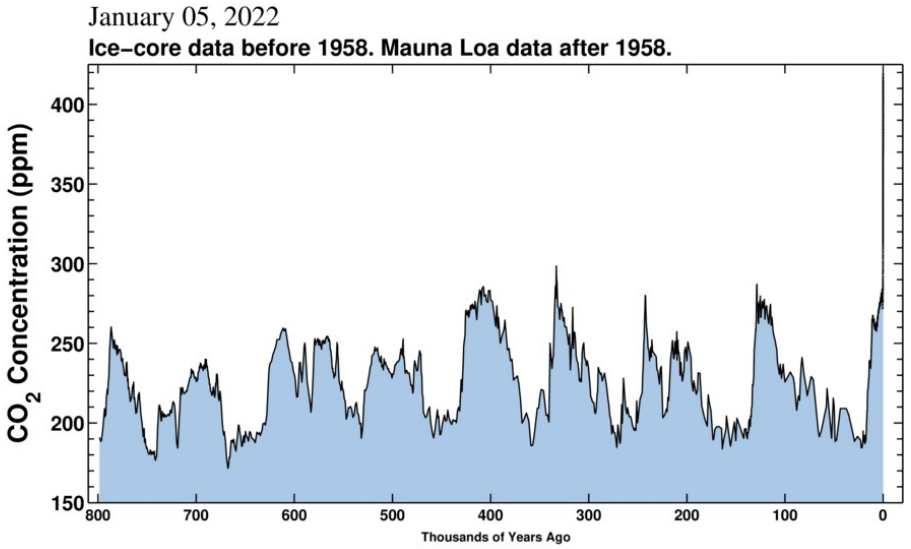
H_2O is also a greenhouse gas, but it cycles in and out of the atmosphere in days, while CO_2 stays in the atmosphere for centuries. He showed an increase in temperature as a result of increased CO_2 increases the amount of H_2O in the atmosphere, which further increased the temperature. Increased H_2O in the atmosphere also leads to increased precipitation.

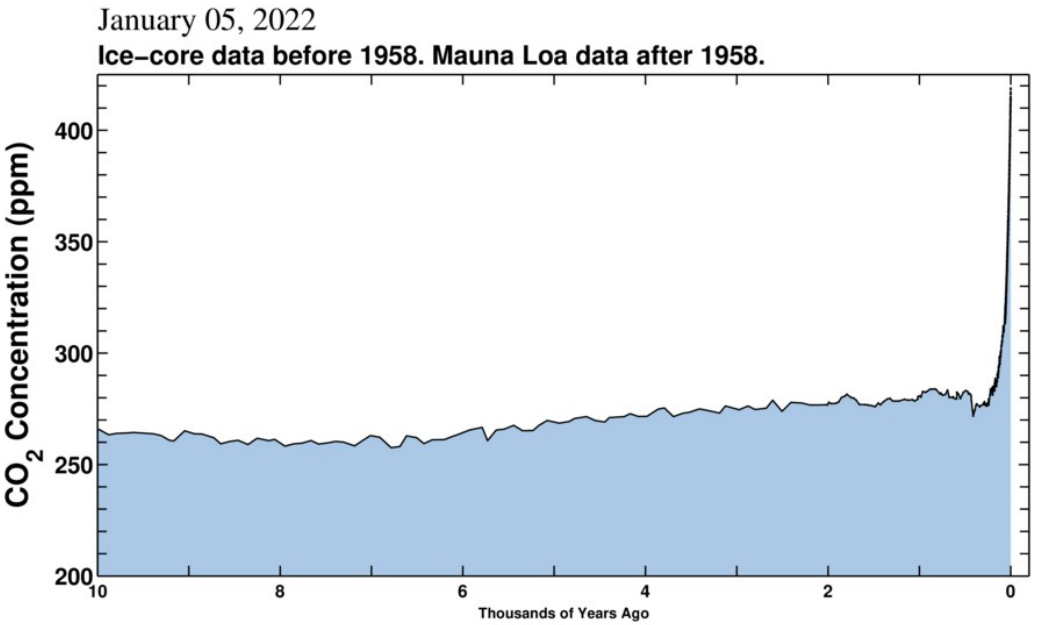
CO_2, from 1700 & 1958



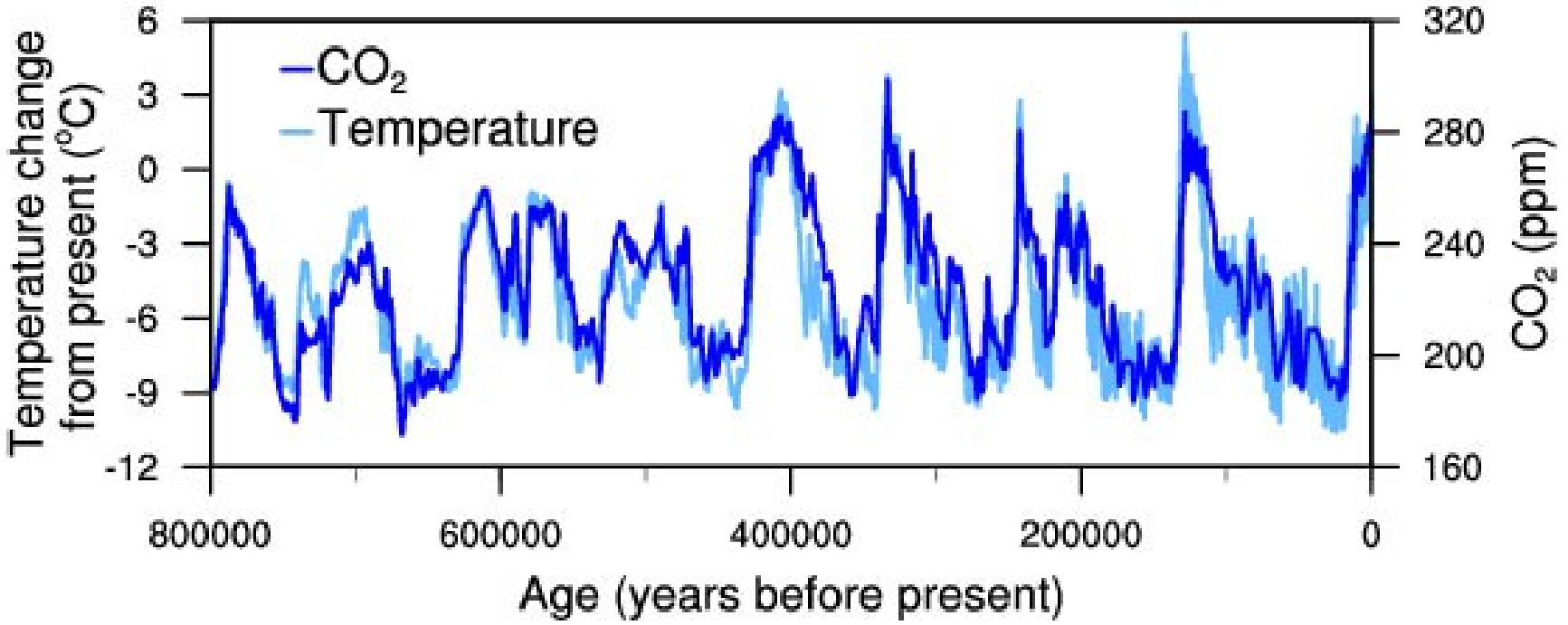


CO_2, Last 800k & 10k Years



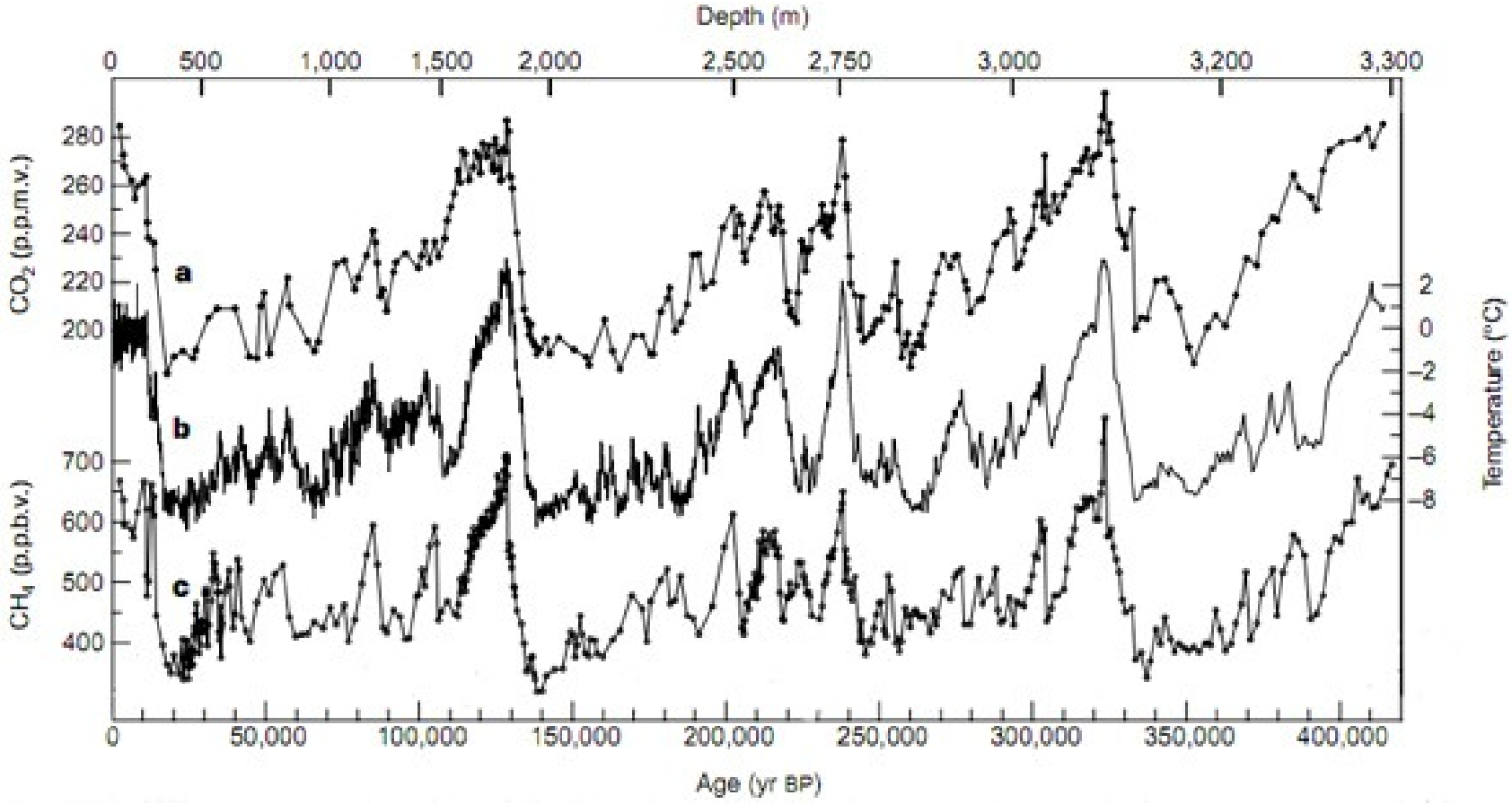


Antarctic Ice Core Temperature and CO_2 Graph

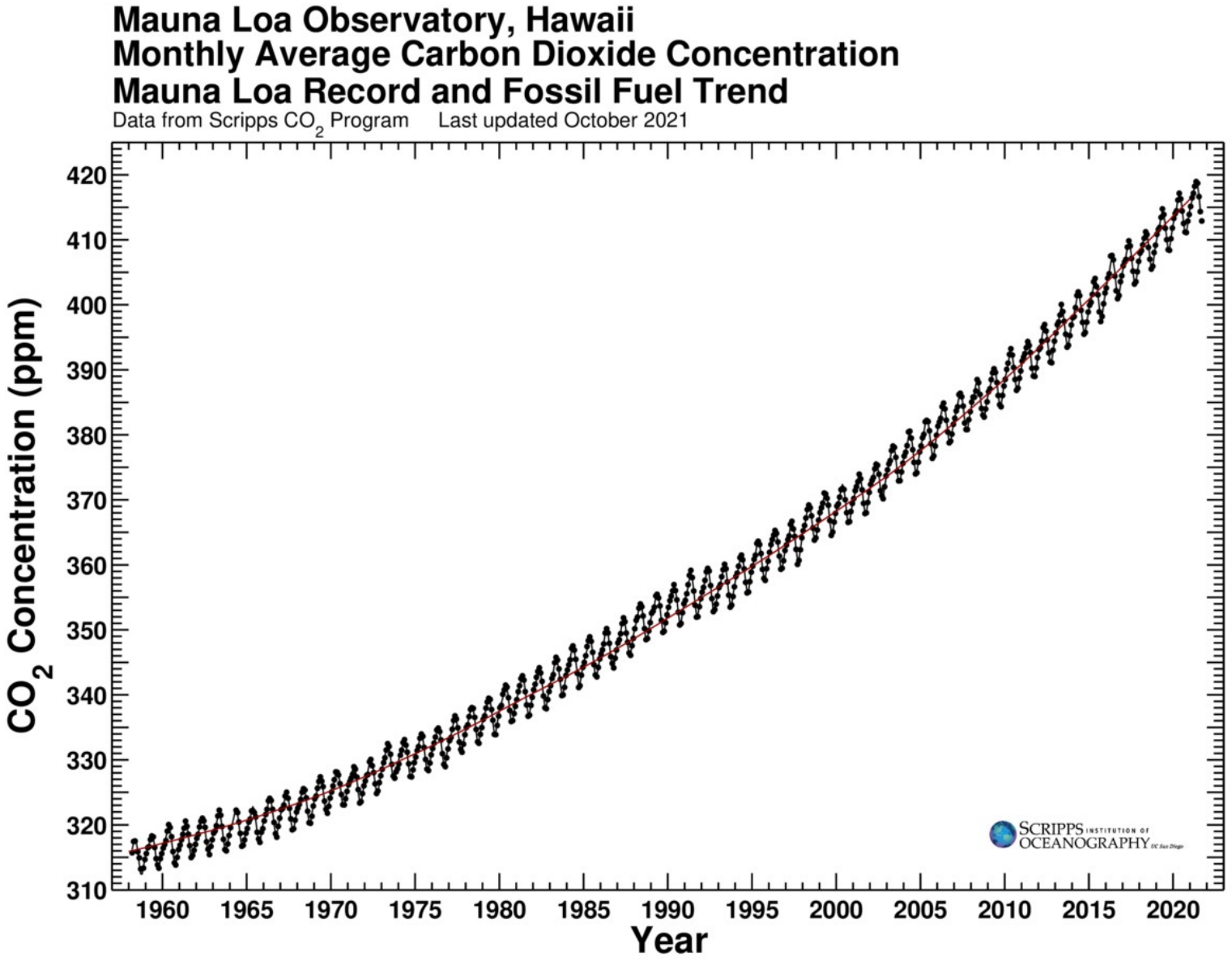


File:Temperature-change-and-carbon-dioxide-change-measured-from-the-EPICA-Dome-C-ice-core-in-Antarctica-v2.jpg

Vostok Ice Core, 1999



Red Curve: Fossil fuel trend of a fixed fraction (57%) of the cumulative industrial emissions of CO2 from fossil fuel combustion and cement production. This fraction was calculated from a least squares fit of the fossil fuel trend to the observation record.



Atmospheric Energy Content

Energy required to produce a 1°C, (1.8°F) increase in the average temperature of the Earth's atmosphere is more than the energy of 80,000,000 Hiroshima size atomic bombs. The Earth's surface is about 200,000,000 square miles. Thus, the added energy in the column of air above every 2.5 square miles of the Earth's surface increases by about the energy of one Hiroshima atomic bomb.

Note: 50% of Earth's atmosphere is below 18,000 feet above sea level, and 90% is below about 53,000 feet. So, the vast majority of this added energy is in that portion of the atmosphere that contains the Earth's weather.

As the Earth has heated up, not all parts of the Earth's surface have heated at the same rate. In particular, there has been more heating at the poles so the Greenland and Antarctic ice fields have been affected more than other areas.

Quote from “Past Climate Cycles: Ice Age Speculations” section of “The Discovery of Global Warming” by Spencer Weart

“By the start of the 21st century, it was clear that the connection between global temperature and greenhouse gas levels was a major geological force. All through the Pleistocene, the greenhouse gas feedback had turned the planet's orbital cycles from minor climate variations to grand transformations that affected all life on the planet. The geological record gave a striking verification, with wholly independent methods and data, of the processes that computer models were predicting would bring a rapid and severe global warming – a disruption of climate exceeding anything seen since the emergence of the human species”.

As we get further into the 21st century we are seeing more Glacier melting, melting of the permafrost (which releases more CO2), and more extreme weather events. I strongly believe that waiting for more evidence of global warming before taking action is like a person diagnosed with cancer waiting until they feel worse before taking action. We must immediately start developing ALL energy sources, that do not produce greenhouse gasses, in order to supply our future “clean” energy needs as soon as possible.

Finally, I strongly recommend a 2015 DVD of a 2014 documentary, directed by Robert Kenner, that was inspired by Naomi Oreske's 2010 book, ***Merchants of Doubt.*** A copy of this DVD, call number DVD 174.95 MERCHAN, is in both the Jefferson Co. Library and the PT Public Library.