541: Climate Sensitivity Has Never Been Demonstrated by Experiment in the Laboratory or in the Field

Peter L. Ward
U.S. Geological Survey retired
Science Is Never Settled
Jackson, Wyoming
peward@Wyoming.com

American Meteorological Society, Austin, Texas
Tuesday January 9, 2018, 3:45 – 5:30 pm, Poster Hall D-F

Surprisingly, increases in greenhouse gas concentrations have never been shown by experiment to cause observed global warming. Experimental proof of theory is a cornerstone of the scientific method. As Steven Chu put it, "the final arbitrator of any point of view are experiments that seek the unbiased truth." Don't you think it would be wise to do such a basic experiment before spending trillions of dollars to reduce CO_2 emissions?

There are many good reasons to wonder. Knut Ångström (1900), an expert in radiation physics, concluded from experiments that "under no circumstances should carbon dioxide absorb more than 16% of terrestrial radiation, and the amount of this absorption varies quantitatively very little, as long as there is not less than 20% of the existing value."

Climate sensitivity is not measured directly. It is estimated assuming that observed increases in greenhouse gases are the primary cause of observed increases in temperature. The IPCC (2013) estimated "with high confidence" that the increase "in annual global mean surface temperature following a doubling of the atmospheric equivalent carbon dioxide concentration" is in the range of 1.5 to 4.5 °C. While annual average concentrations of CO_2 rose from 280 ppm in the 1850s to 403 ppm in 2016 (a factor of 1.4), annual average global temperatures rose 1.1 ^{o}C (HadCRUT4). From 1998 through 2013, however, CO_2 rose at ever increasing rates while temperature increased very little. More than 100 peer-reviewed papers have searched unsuccessfully for a clear explanation of this "global warming hiatus." What if greenhouse gases are not the primary cause of global warming?

Scientists have proposed five different mechanisms for how increasing concentrations of greenhouse-gases could cause global warming: 1) direct heating of air by absorbing terrestrial infrared radiation, 2) direct heating of air that slows the rate of heat loss from Earth, 3) re-radiation of absorbed energy that slows the rate of heat loss from Earth, 4) re-radiation of absorbed energy back to Earth where it is absorbed and causes warming of Earth, and 5) climate feedbacks.

1) Direct heating of air by absorbing infrared radiation does not appear significant. I placed air in two Styrofoam boxes (45 liters each) with identical boundary conditions. The only difference was that one box contained normal air with 425 ppm CO_2, the other with more than 9999 ppm CO_2 (>23 times normal). When heated at the same time through a thin plastic membrane by the same infrared radiation from a black pot of water at 325K,

membrane by the same infrared radiation from a black pot of water at 325K, the CO_2-rich air warmed only 0.1K more than regular air. CO_2 is observed to absorb infrared terrestrial radiation, but only along spectral lines making up less than 16% of the frequencies radiated by Earth. This radiant energy is absorbed into the bonds holding the molecule together, while temperature of a gas is proportional to the average translational velocity of the 2500 other molecules making up air. Greenhouse gases simply do not absorb enough thermal energy to warm Earth significantly.

2) Earth loses heat through the troposphere primarily by weather systems driven by convection due to temperature decreasing with height and temperature decreasing from the tropics to the poles. Loss of heat by radiation affected by greenhouse gases is at least an order of magnitude less.

3) It is widely assumed that gas molecules radiate significant energy in all directions. A CO_2 molecule can only re-radiate the energy it absorbs, which is <16% of the frequencies radiated by Earth while temperature of matter is a function of a very broad continuum of frequencies described by Planck's law. A layer of air is not a black body, has minimal thermal mass, and thus can only radiate thermal energy that is continuously convected from below as observed in the solar photosphere.

4) Planck's law shows that radiation from a warmer body of matter contains higher frequencies of oscillation and higher amplitudes of oscillation at every frequency. Radiation from a colder body of matter, therefore, cannot physically warm a warmer body of matter as enshrined in the second law of thermodynamics—it does not contain high enough frequencies and amplitudes of oscillation. Temperature of tropospheric air decreases with increasing altitude. Even if a layer of gas could radiate, radiation from a colder layer cannot make Earth warmer.

5) Feedbacks, including snow and ice albedo, water vapor and lapse rate, clouds, aerosols, carbon sinks, and wetland methane emissions, must be reevaluated recognizing that thermal energy is a function of frequency of oscillation of the bonds holding matter together, not amount.

According to the Planck-Einstein relation, thermal energy (E) in matter is equal to the frequency of oscillation (ν) of each degree of freedom, of each bond holding matter together times the Planck constant (h) where $E=h\nu$ — the energy of a frictionless atomic oscillator. Radiant thermal energy (E) in air and space is induced by a broad continuum of such frequencies of oscillation on the surface of the radiating body. Atmospheric chemists use $E=h\nu$ in their chemical equations to specify the energy needed, for example, to dissociate molecular oxygen.

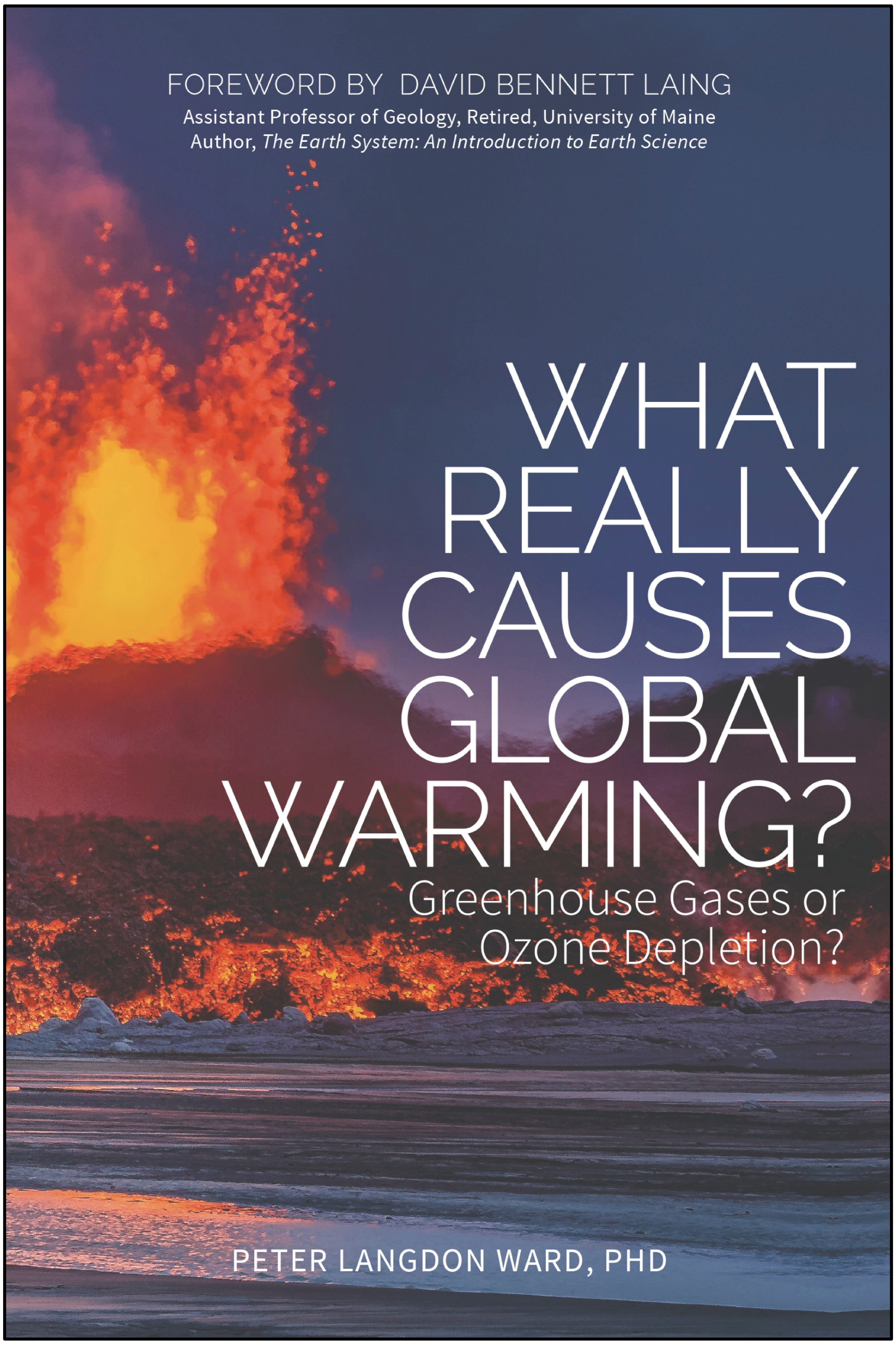
Climate scientists currently assume that radiation has the same physical properties no matter the temperature of the radiating body, that hotter bodies emit more of this generic radiation, and that a body absorbing more of this generic radiation, more watts per square meter, gets hotter. Planck's law, however, shows that radiant thermal energy is a function of frequency of oscillation ($E=h\nu$), which is a function of how hot the radiating body is, not a function of amount of some generic radiation. Ultraviolet-B solar radiation reaching Earth when the ozone layer is depleted, has a peak frequency content that is 48 times higher, 48 times "hotter" than the frequencies of terrestrial infrared radiation absorbed most strongly by CO_2.

Ozone depletion, caused by man since 1970 and caused by major extrusive, basaltic volcanic eruptions throughout Earth history, allows more than normal of this very "hot" solar ultraviolet-B radiation to reach Earth, explaining observed details of global warming far more clearly and much more precisely than greenhouse-warming theory.

Ward, P. L., 2017, **Ozone depletion explains global warming**: Current Physical Chemistry, v. 6, no. 4, p. 275-296, doi: 10.2174/1877946806999160629080145

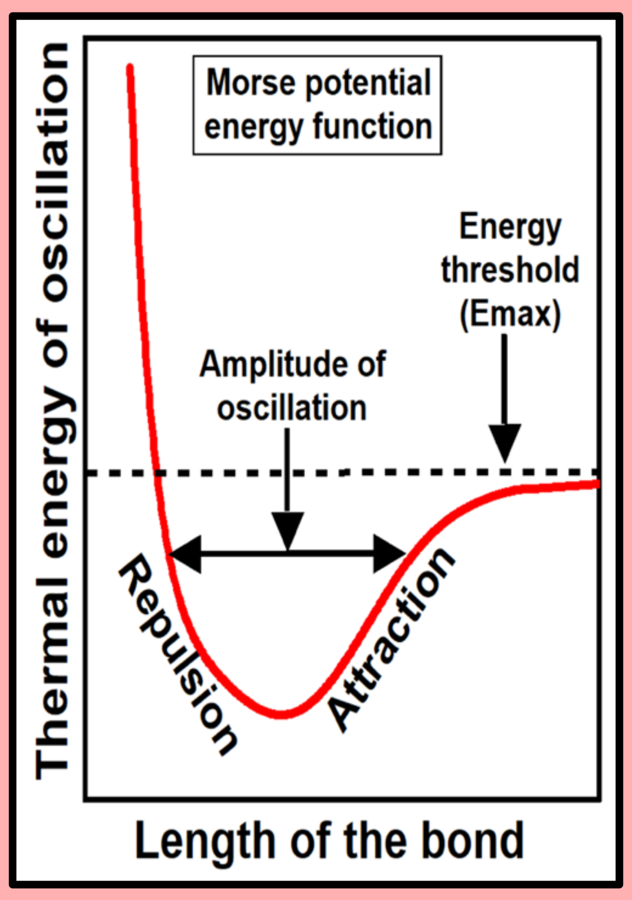
WhyClimateChanges.com

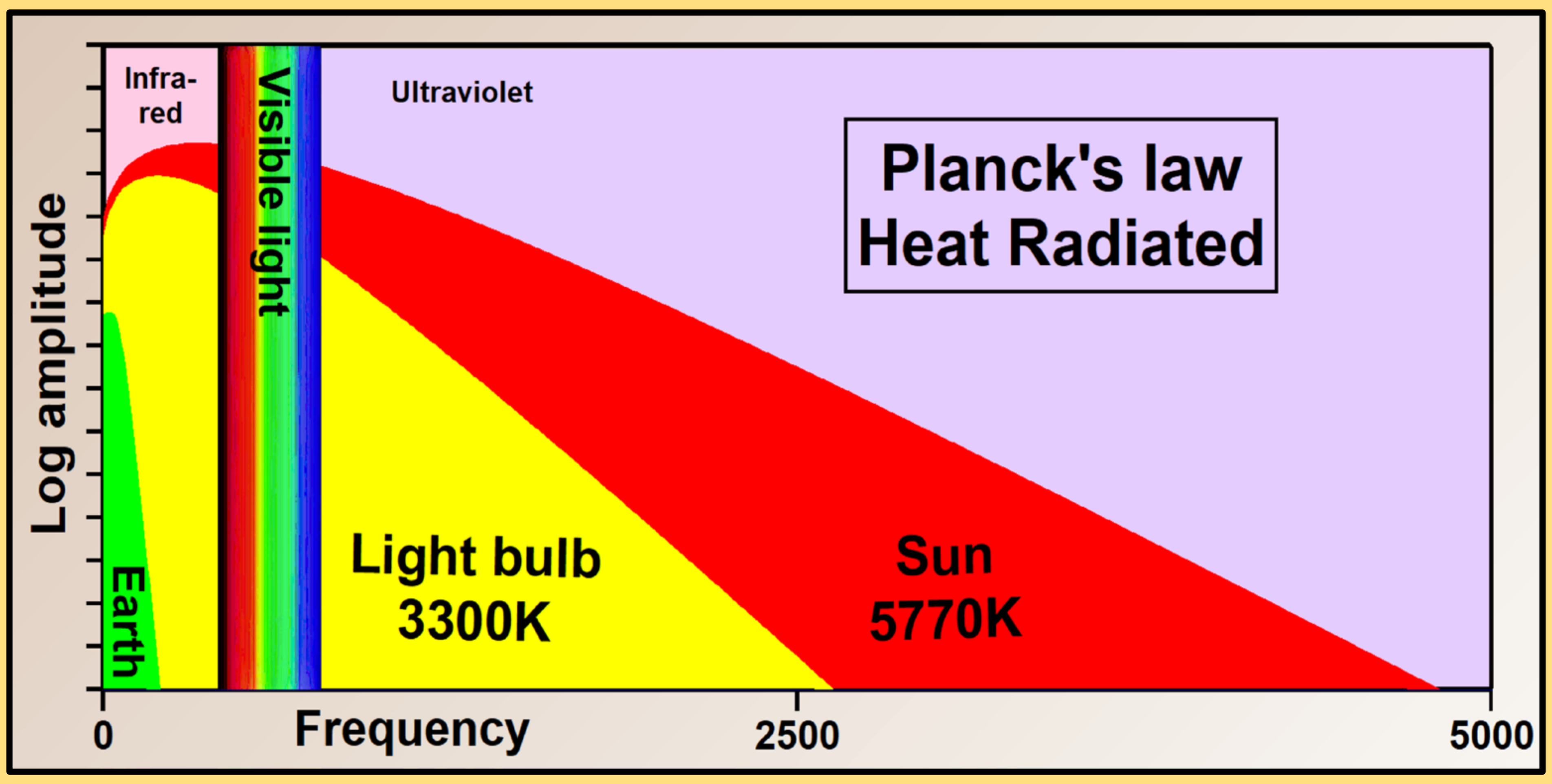
@YClimateChanges



Heat is a broad continuum of frequencies and amplitudes of oscillation of all the bonds holding matter together

The bonds holding matter together are not rigid. Each normal mode of each degree of freedom of each bond oscillates between the electrodynamic forces of attraction and repulsion, best visualized as a Morse potential energy function. **The thermal energy (E) of each oscillator equals the Planck constant (h) times the frequency of oscillation (*v*) where E=h*v***, the Planck-Einstein relation. With increaseing thermal energy, which we observe as increasing temperature, the frequency of oscillation in terahertz and amplitude of oscillation in picometers increase until the bond is dissociated, comes apart.

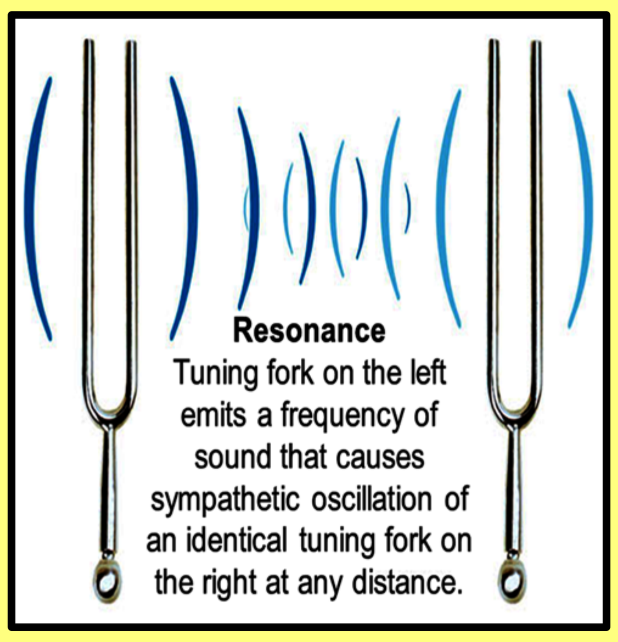




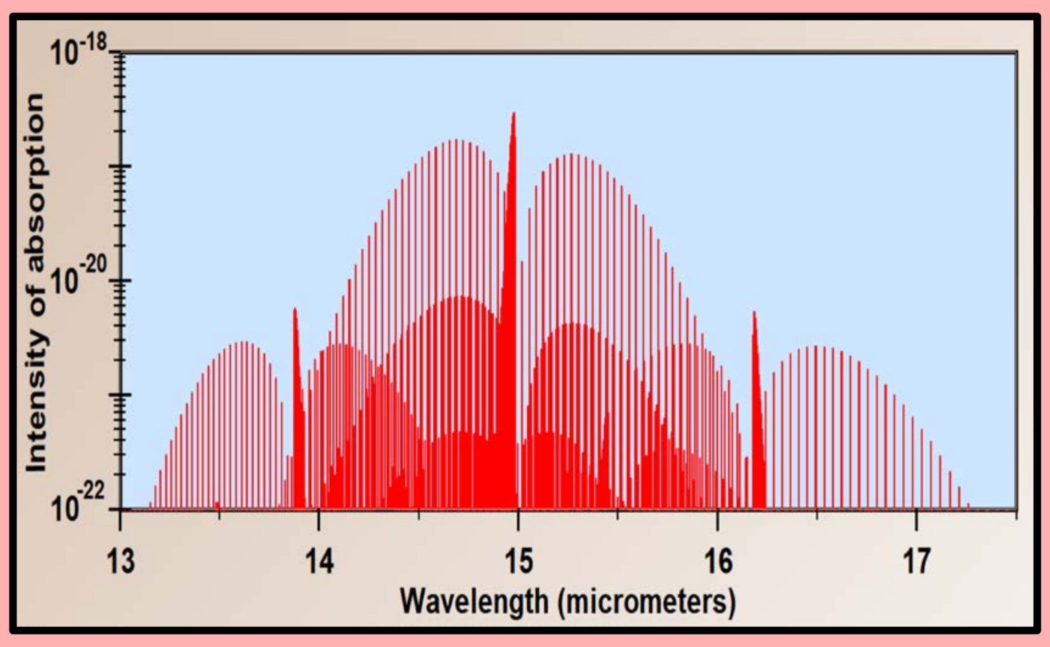
Planck (1900) developed an equation empirically that describes radiation observed to be emitted from a body of matter as a function of its temperature. The hotter the body, the broader the continuum of frequencies, the higher the peak frequencies of oscillation, and the higher the amplitude of oscillation at each frequency of oscillation.

Heat propagates through matter and space via resonance

Because atomic oscillators are frictionless, they can only gain or lose energy via resonance. Resonance occurs when two oscillators with nearly the same frequency "share" amplitude of oscillation. Sharing is accomplished by physical touching within matter or by line of sight through an electromagnetic field across air and space, what Einstein called "spooky action at a distance." After sharing, the amplitudes of oscillation in each oscillator are identical. Thus the oscillator with the highest amplitude of oscillation "gives up" half the difference in amplitude to the other oscillator. In this way, amplitude can only "flow" from higher to lower values, from higher temperature to lower temperature. The rate or flux of heat flowing increases with increasing difference in temperature.



Resonance is all around us. We see and hear via resonance.



Resonance explains the spectral lines of energy that a molecule of CO_2 is observed to absorb from an electromagnetic field, shown here. These spectral lines are the resonant frequencies of all the normal modes of all the degrees of freedom of all the bonds that hold the molecule together. Plotted traditionally as wavelength, but no waves are involved.

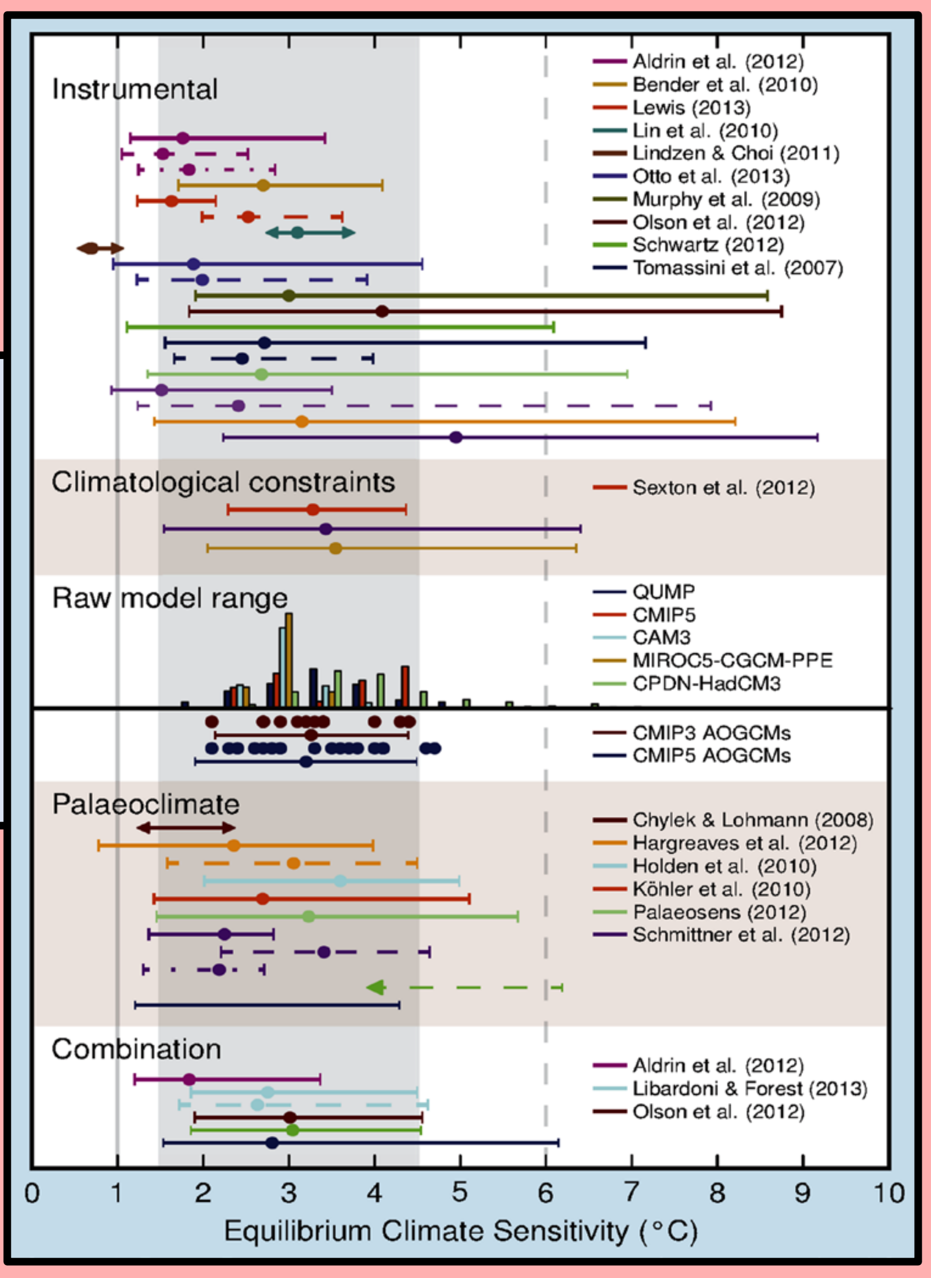
Resonance is enabled across air and space via an electromagnetic field. The oscillation of charge on the surface of matter is thought to induce an electric field, that induces a magnetic field, that induces an electric field, ad infinitum, enabling frequency to propagate across air or space as observed with any radio signal. When propagating through space, frequencies are observed not to interact in any way or to change with distance, but amplitudes are observed to decrease with the square of the distance travelled. Since E=h*v*, energy is constant with distance, but amplitude, which is intensity, decreases with distance squared.

Climate sensitivity has never been measured directly

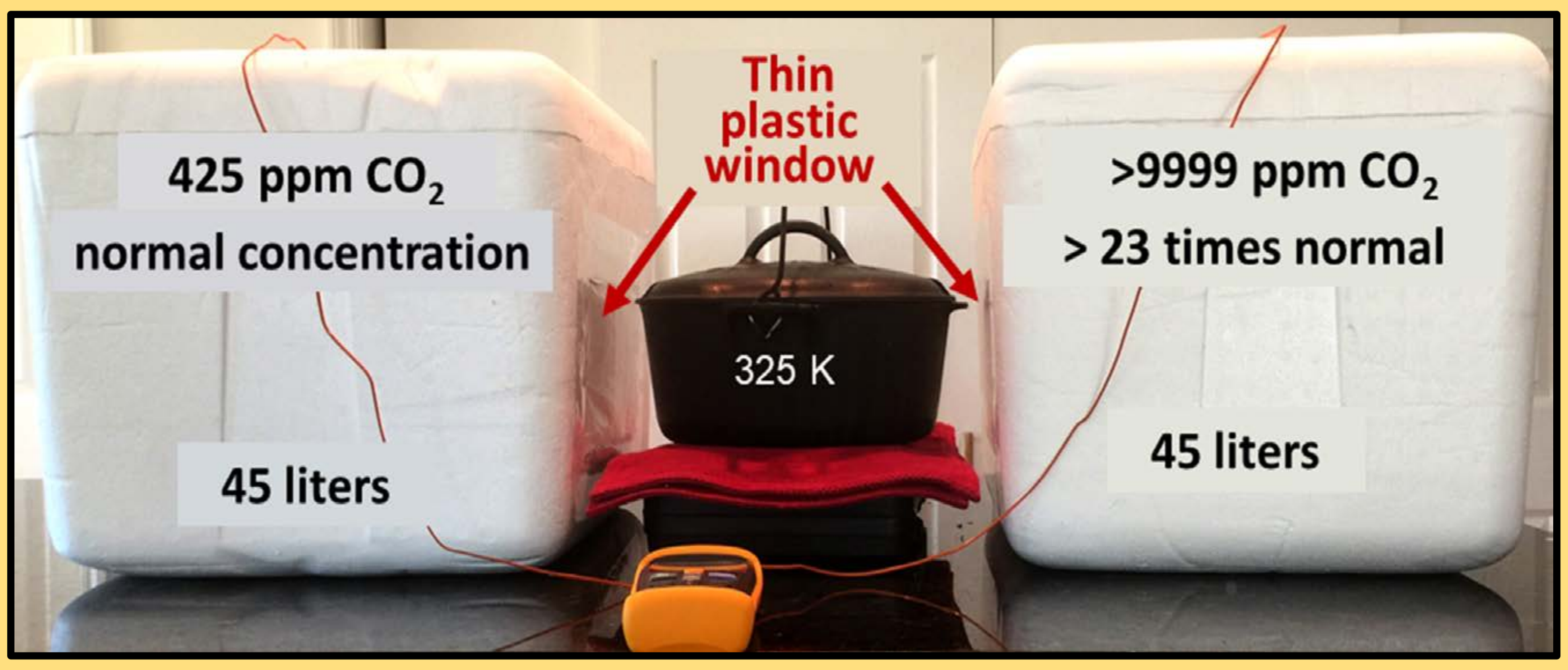
The IPCC (2013) concludes "with high confidence" that a doubling of atmospheric CO_2 concentrations will increase global temperatures by 1.5 to 4.5 °C.

This climate sensitivity has never been observed directly. It is approximated in many different ways by assuming that essentially all warming observed results from observed increases in greenhouse-gas concentrations.

But all warming observed since 1945 and throughout geologic history is explained much more clearly and in much more detail by ozone depletion caused primarily by manufactured CFC gases and by volcanic emissions of chlorine and bromine.



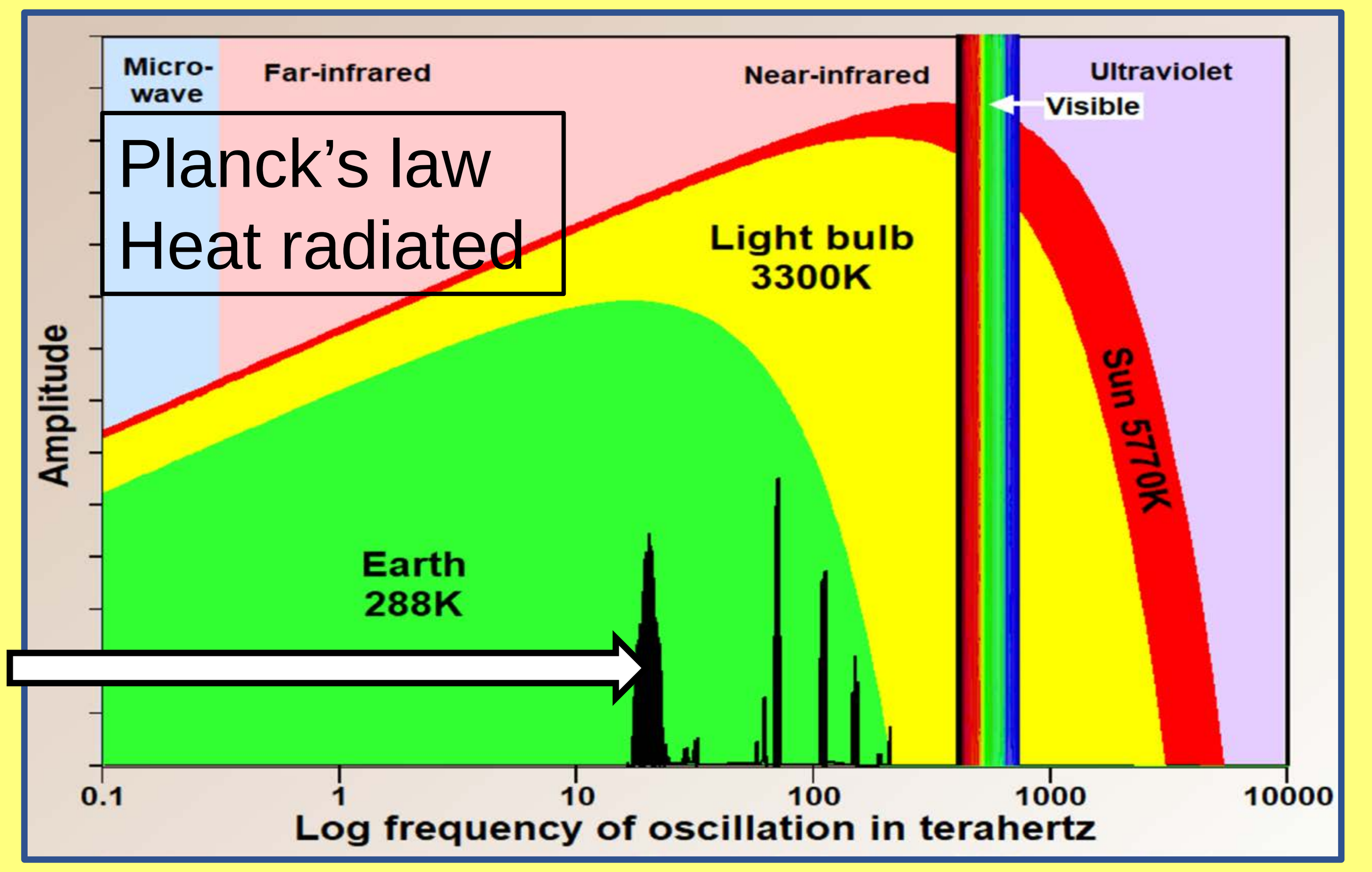
Increasing concentrations of greenhouse gases have never been shown experimentally to cause air to warm

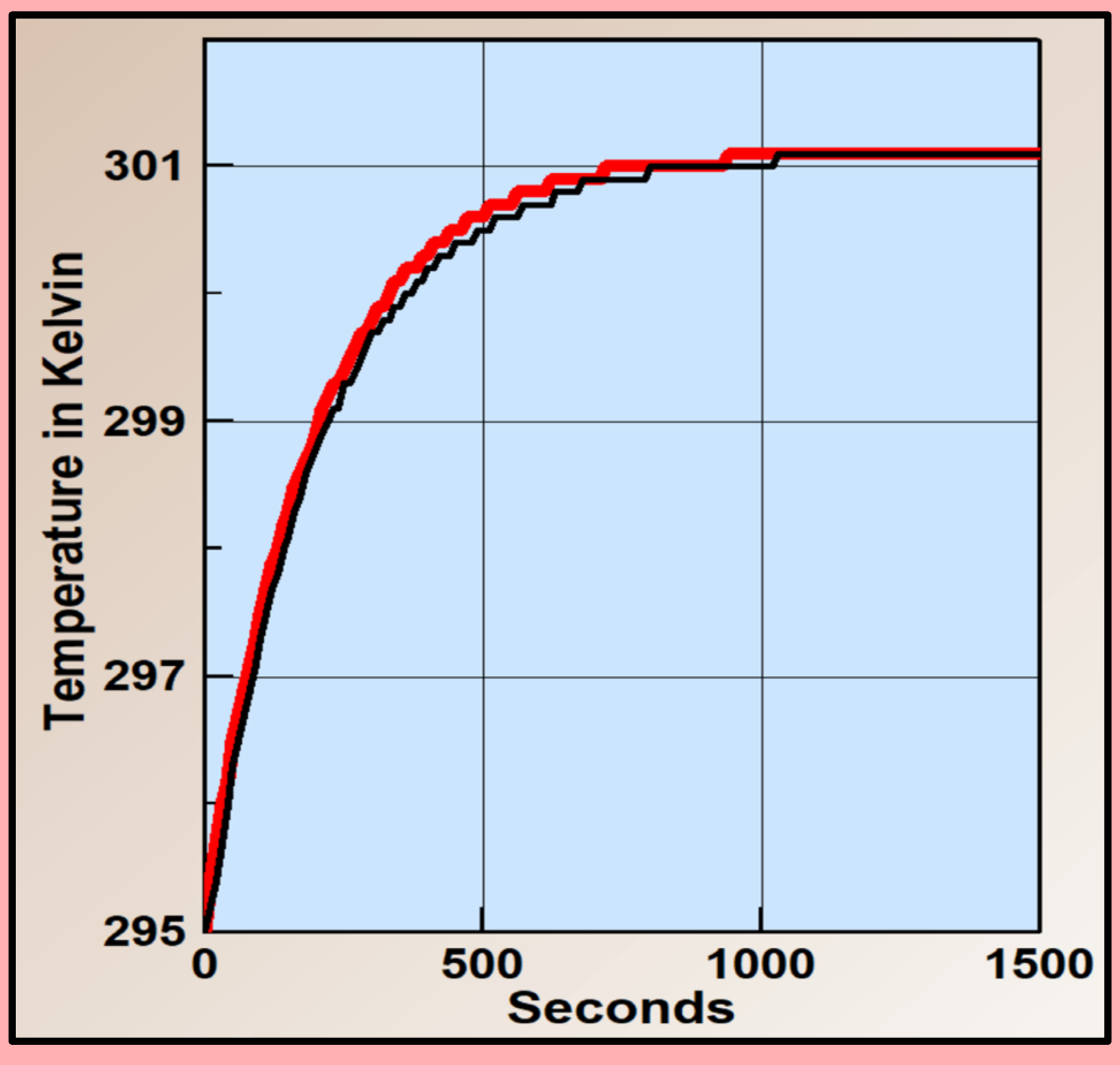


When measuring the increase in temperature of air caused by infrared radiation from a black body at 325K (125°F), there was no difference, within the resolution of the digital thermometer (0.1K), between the temperature of normal air and of air containing >23 times normal concentrations of CO_2.

In this experiment, the temperature of the air may equilibrate very rapidly with the temperature of the walls, making any direct measurement of gas in a container difficult.

However, as Angstrom (1900) pointed out, carbon dioxide absorbs less than 16% of the frequencies making up terrestrial radiation shown by the black vertical lines in this figure. Greenhouse gases simply do not absorb enough heat to heat the atmosphere or Earth.

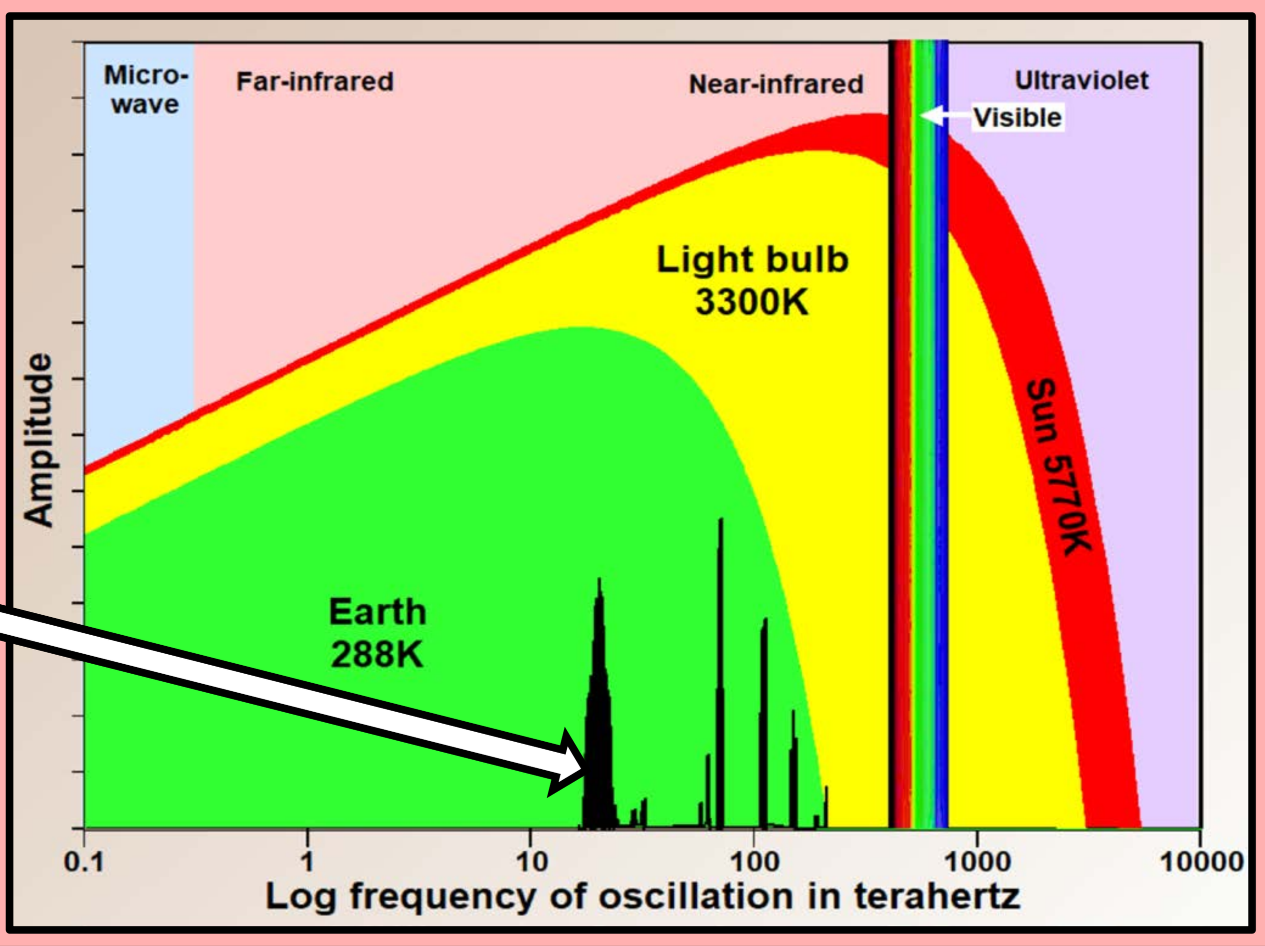


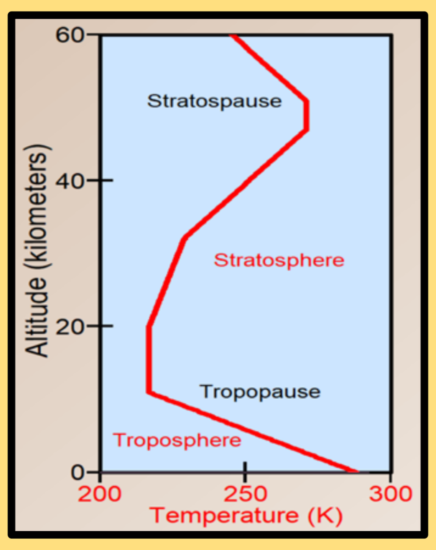


When heating a small metal plate with radiation from a light bulb, temperature rises quickly at first and then much more slowly as the metal approaches its warmest temperature. The black line shows temperature measured every 10 seconds. The red line shows temperature every ten seconds calculated as an increase of five percent of the difference between the previous temperature and the ultimate temperature. Thermal flux decreases exponentially as the difference in temperature decreases. **Flux is a function of temperature difference, not amount of radiation as currently assumed.**

5 ways that greenhouse-gases are thought to heat Earth

1) Heat air directly: Terrestrial infrared radiation is absorbed into the bonds holding a CO_2 molecule together, while temperature of a gas is proportional to the translational kinetic energy of the molecule, something very different. Therefore, bond energy must be converted into translational velocity. These spectral lines absorbed make up less than 16% of the frequencies radiated by Earth, and this energy must be shared with 2500 other molecules in air. CO_2 simply does not absorb enough energy or heat to warm air or to warm Earth.

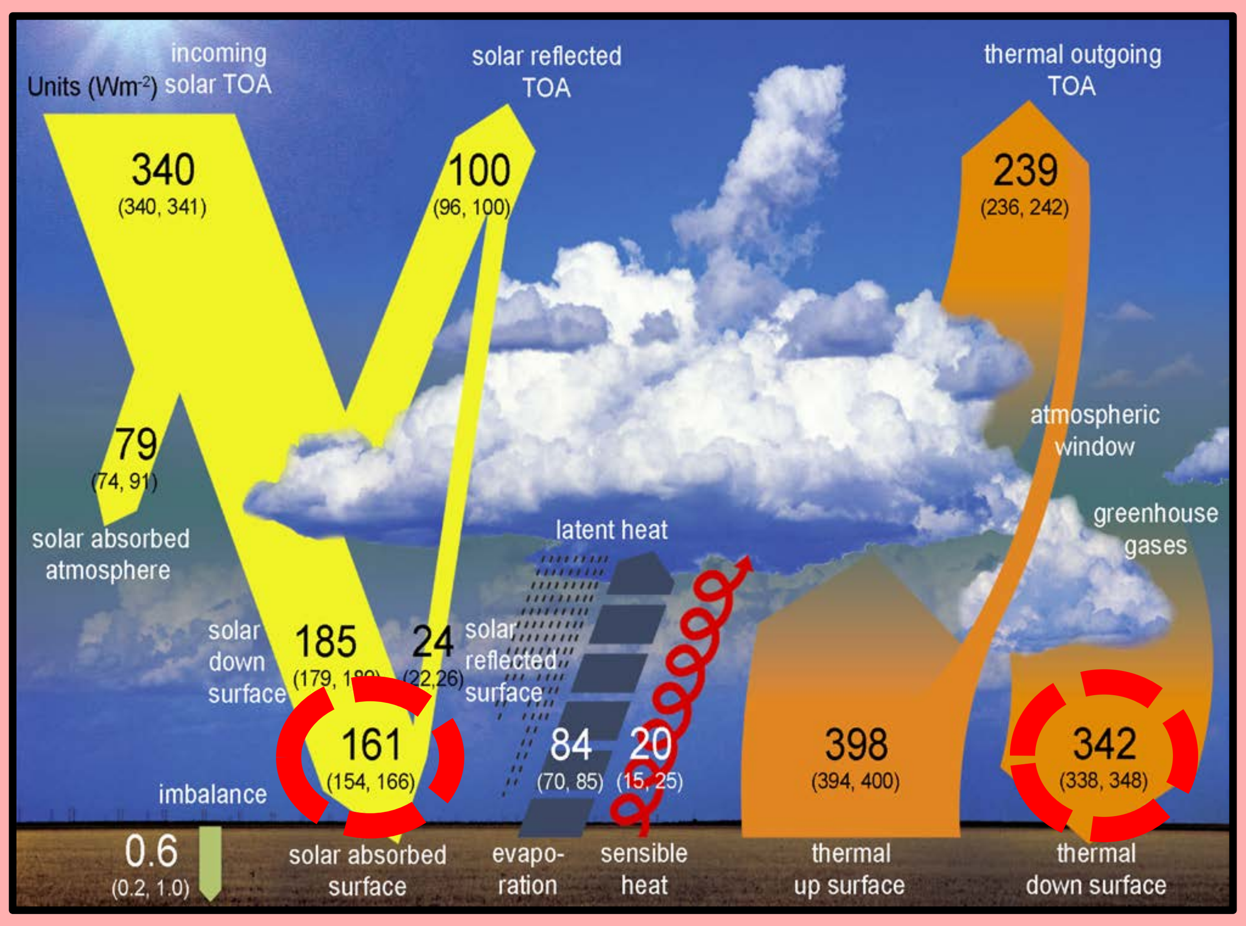




2) Slowing the cooling of Earth: The flow of heat from the surface to the tropopause is controlled primarily by convection due to differences in air density. Convection is driven by warm air rising and by warm air moving from the tropics to the poles. The lapse rate is determined primarily by the amount of water in the constantly mixing troposphere. Radiation plays a very small role.

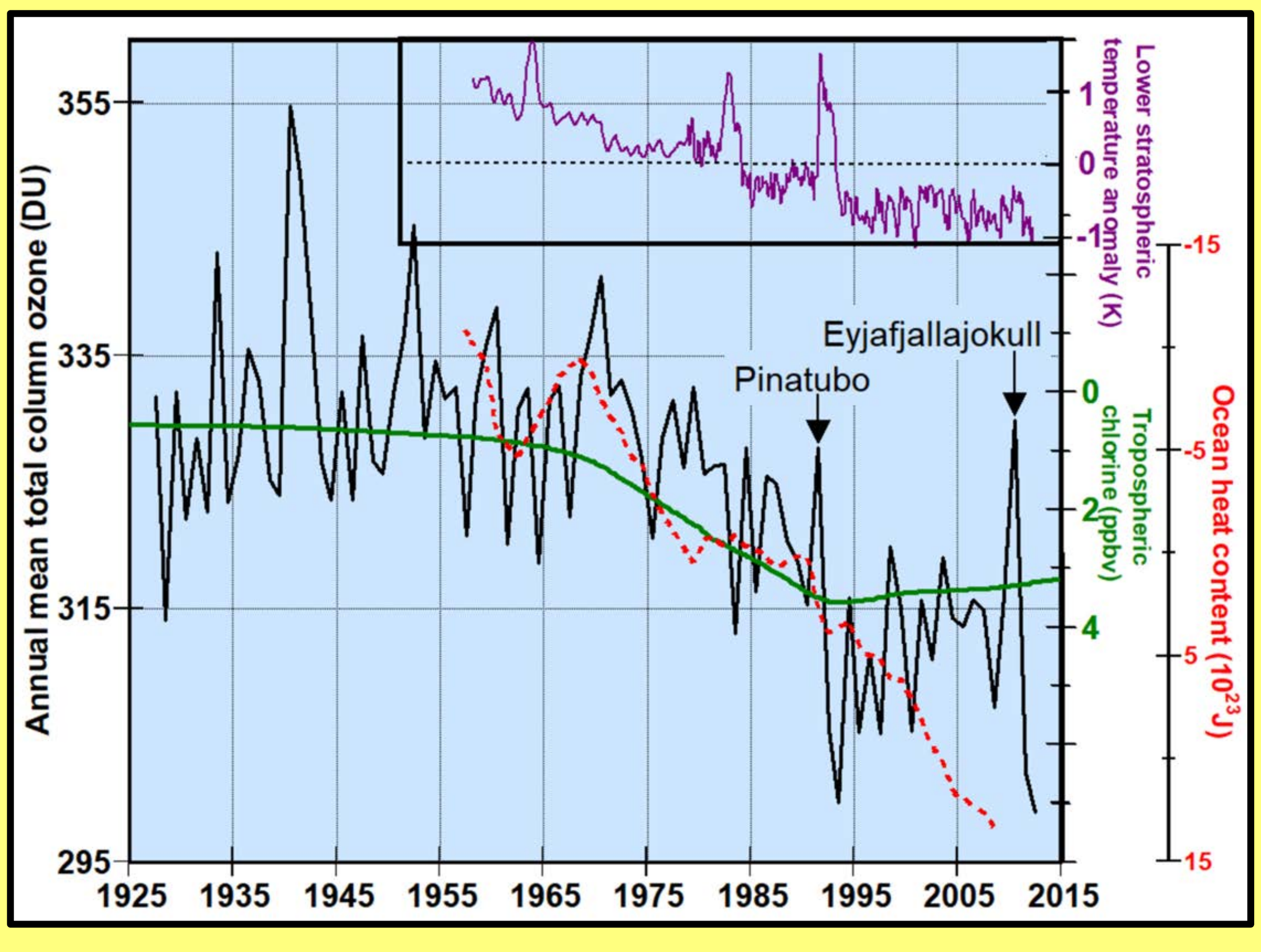
3) Re-radiating absorbed energy to warm air: Central to the greenhouse effect is the widespread assumption that greenhouse-gases emit infrared radiation in all directions. The only frequencies that can be re-emitted, however, are those absorbed into the bonds, which make up <16% of terrestrial radiation.

4) Re-radiating absorbed energy back to Earth: Average flux of downwelling radiation from greenhouse gases in the atmosphere, 342 Wm^{-2} in this diagram, is more than twice the incoming flux of solar radiation absorbed by Earth's surface of 161 Wm^{-2}. This does not make physical sense since Earth is heated primarily by sun. The problem is that the concept of radiative forcing currently does not account for the fact that radiant energy is a strong function of frequency.



5) Feedbacks: Numerous feedbacks thought to amplify greenhouse warming have been proposed including snow and ice albedo, water vapor and lapse rate, clouds, aerosols, carbon sinks, and wetland methane emissions. The importance of these feedbacks must be reevaluated recognizing that thermal energy is a function of a continuum of frequencies of oscillation of the bonds holding matter together.

Warming of Earth is explained clearly by ozone depletion



Annual average ozone (green) at Arosa Switzerland decreases from 1970 to 1990 related to increasing tropospheric chlorine from CFCs (green). Ozone is depleted much more following the eruptions of Pinatubo and Eyjafjallajökull. As ozone was depleted, temperatures in the lower stratosphere decreased especially following eruptions of Agung (1963), El Chichón (1982), and Pinatubo (1991) because less stratospheric ozone absorbed less UV-B, cooling the stratosphere, and more UV-B warmed Earth.