Correcting a fundamental mistake in radiation physics shows how the middle atmosphere plays the primary role in determining how effectively earth is heated by sun

Peter L. Ward, U. S. Geological Survey retired, Science Is Never Settled, Inc.

The thermal and chemical structure of the middle atmosphere is determined by molecules of air absorbing high-energy, solar, ultraviolet radiation. The dominant photochemical reaction for forming the stratosphere is dissociation of a molecule of oxygen into two atoms of oxygen. When a molecule is dissociated, the two pieces fly apart at high velocity. Temperature of air is directly proportional to the average velocity of all its molecules and atoms squared. Thus, photochemical dissociation converts bond energy efficiently and completely into air temperature.

A molecule of oxygen is dissociated by absorbing ultraviolet-C radiation with frequencies around 1237 terahertz, energies around 5.1 electronvolts. Since oxygen makes up 20.95% of Earth's atmosphere, there is ample oxygen to absorb all solar ultraviolet-C of appropriate frequencies that reaches the stratosphere, keeping the stratopause 30 to 40 ^{o}C warmer than the tropopause. Thus, the stratosphere forms an "electric" blanket warming Earth—electric in the sense that the thermal energy comes from a distant source, Sun, not from the body under the blanket, Earth.

The second most important photochemical reaction in the stratosphere is dissociation of ozone by ultraviolet-B radiation with frequencies around 967 terahertz, energies around 4.0 electronvolts. While ozone concentrations, even in the ozone layer, are less than 10 parts per million, ozone is continually being formed and dissociated in the endless ozone-oxygen cycle, absorbing most solar ultraviolet-B radiation. When atoms of chlorine reach the lower stratosphere especially in winter, ozone concentrations that normally increase in winter can be depleted. One atom of chlorine, under the right conditions, can destroy 100,000 molecules of ozone. Depletion of the ozone layer allows more ultraviolet-B radiation than normal to reach Earth. Ultraviolet-B radiation is observed to cause sunburn, cataracts, skin cancer and mutations. It also dissociates ground-level ozone pollution, warming air in populated regions and penetrates oceans more than one hundred meters, very efficiently increasing ocean heat content as observed.

Because of the ozone-oxygen cycle, where there are increased concentrations of ozone in the atmosphere, there is increased temperature. Sudden stratospheric warmings of 30-40 ^{o}C within days are typically associated with high concentrations of ozone and occur most frequently at altitudes of 30-50 km where dissociation of oxygen and ozone are most efficient.

In 1798, Sir Benjamin Thompson proposed the mechanical theory of heat generated by friction when boring canon. This mechanical theory evolved into two fundamental assumptions: 1) heat is a flux of thermal energy measured in watts per square meter and 2) the greater the amount of flux absorbed, the hotter the body will become. Note that this approach never addresses the issue of what heat or thermal energy are, physically. These two assumptions still dominate physics, thermodynamics, and atmospheric physics. They form the basis for greenhouse-warming theory. They were developed long before we understood the

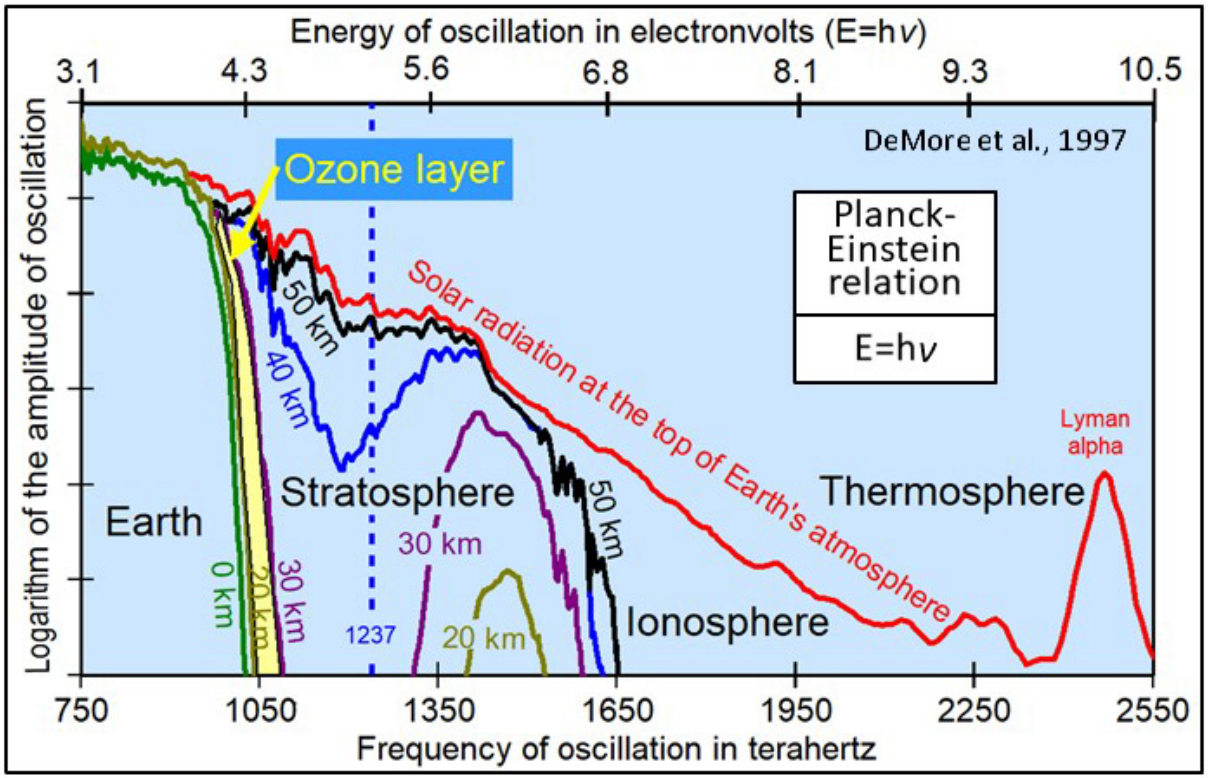
atomic and molecular structure of matter—long before we discovered that the bonds holding matter together are not rigid. We now understand in considerable detail that these bonds oscillate at trillions of cycles per second—the hotter the body, the higher the amplitudes of oscillation and the higher the dominant frequencies of oscillation. We also now understand that heat flux is proportional to temperature difference.

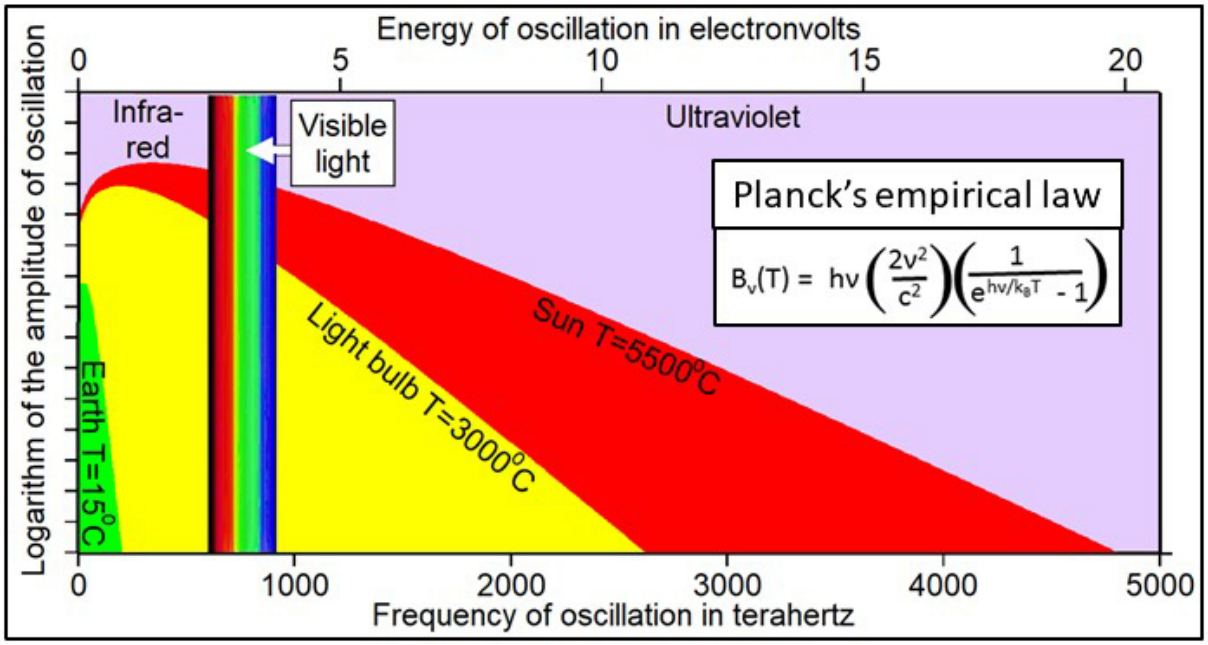
In 1900, Max Planck discovered, by trial and error, an equation that calculates, for thermal radiation from a black body, the observed amplitude of oscillation at each frequency of oscillation as a function of the temperature of the body. Planck's empirical law not only shows the physical properties of radiation as a function of temperature but also shows the physical properties of oscillations on the surface of matter emitting the radiation and the physical properties of oscillations within the body. Thus, for a body to "possess" the temperature of Sun, the oscillations on its radiating surface must include all the amplitudes of oscillation at all the frequencies of oscillation shown in green, yellow, and red in the lower figure. Planck's empirical law shows unequivocally that both temperature and heat are the result of a broad continuum of frequencies of oscillation.

Heat is what a body of matter must absorb to increase its temperature and lose to decrease its temperature. The physical properties of heat Earth must absorb to increase its temperature to 3000 °C are described by the yellow-shaded area in the lower figure. Heat is the result of a broad continuum of frequencies of oscillation of all the bonds holding matter together and is proportional to the difference in temperature between the emitter and the absorber. Heat is a broad continuum of values that cannot be described by some single number of watts per square meter as is currently done. In his original formulation, Planck was confused about intensity or amplitude of oscillation, putting energy on the y-axis even though he postulated that energy equals frequency times a constant on the x-axis as shown. Radiation only consists physically of frequencies and amplitudes of oscillation.

Note that a hotter body has a higher amplitude of oscillation at each frequency of oscillation and has a higher frequency of oscillation at the dominant amplitude of oscillation. This is why a body of matter can only be warmed by a hotter body of matter. A body cannot be warmed in any way by its own radiation, as assumed in greenhouse-warming theory, because its own radiation does not contain the higher amplitudes of oscillation at every frequency of oscillation required to increase temperature. The greater the difference in temperature, the greater the difference in amplitudes of oscillation especially at higher frequencies. This is why Earth is heated far more efficiently by ultraviolet-B radiation than by visible light or infrared radiation.

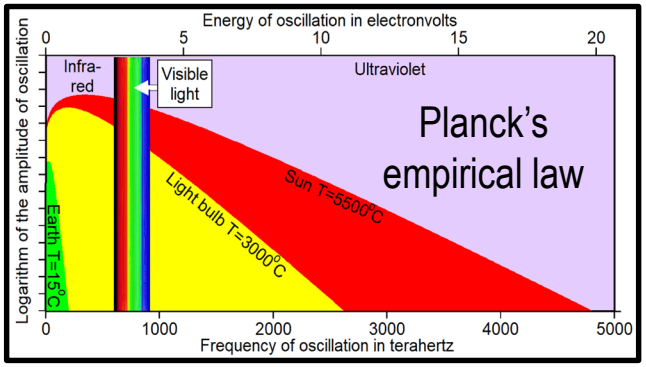
Today, most climate scientists are so convinced that global warming is caused by increases in greenhouse gas concentrations that they refuse to even consider the reality that greenhouse-warming theory is physically impossible as explained cogently at Physically-Impossible.com. This creates a crisis in climate science because they are urging world leaders to spend tens of trillions of dollars right now to reduce greenhouse-gas emissions. The details are explained at WhyClimateChanges.com.


Energy of oscillation in electronvolts (E=hν)
3.1
4.3
5.6
6.8
8.1
9.3
10.5
DeMore et al., 1997
Ozone layer
Planck-Einstein relation
E=hν
Solar radiation at the top of Earth's atmosphere
Lyman alpha
Thermosphere
Stratosphere
Earth
Ionosphere
50 km
40 km
30 km
20 km
0 km
1237
Logarithm of the amplitude of oscillation
750
1050
1350
1650
1950
2250
2550
Frequency of oscillation in terahertz


Energy of oscillation in electronvolts
0
5
10
15
20
Infra-red
Visible light
Ultraviolet
Planck's empirical law
$B_\nu(T) = h\nu\left(\frac{2\nu^2}{c^2}\right)\left(\frac{1}{e^{h\nu/k_BT} - 1}\right)$
Sun T=5500°C
Light bulb T=3000°C
Earth T=15°C
Logarithm of the amplitude of oscillation
0
1000
2000
3000
4000
5000
Frequency of oscillation in terahertz

Poster 913

Correcting Fundamental Mistakes in Radiation Physics Shows How the Middle Atmosphere Plays the Primary Role in Determining How Effectively Earth is Heated by Sun



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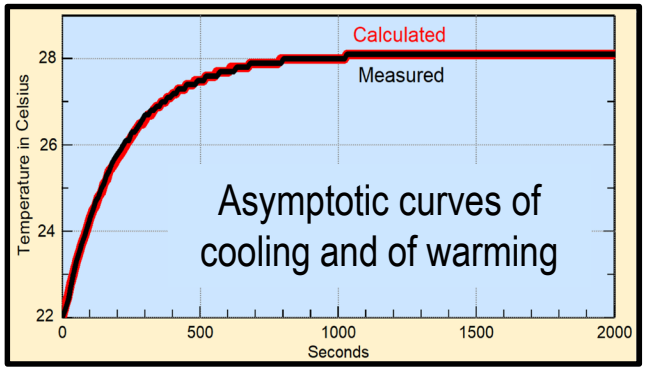
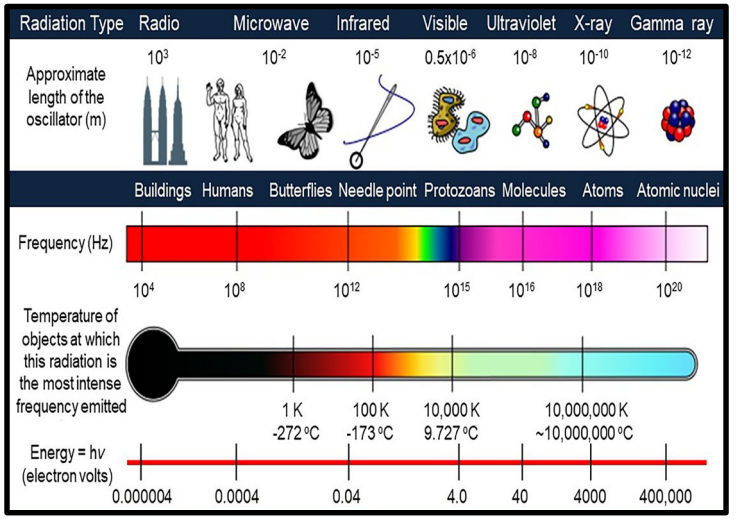


Current mistakes thinking about the physics of radiation

1) That electromagnetic radiation, including visible light, physically is waves, photons, or wave-particle duality.

No. Electromagnetic radiation, light, is well-known physically to be a very broad continuum of frequencies of oscillation ranging from very low frequency radio signals to very high frequency gamma rays.

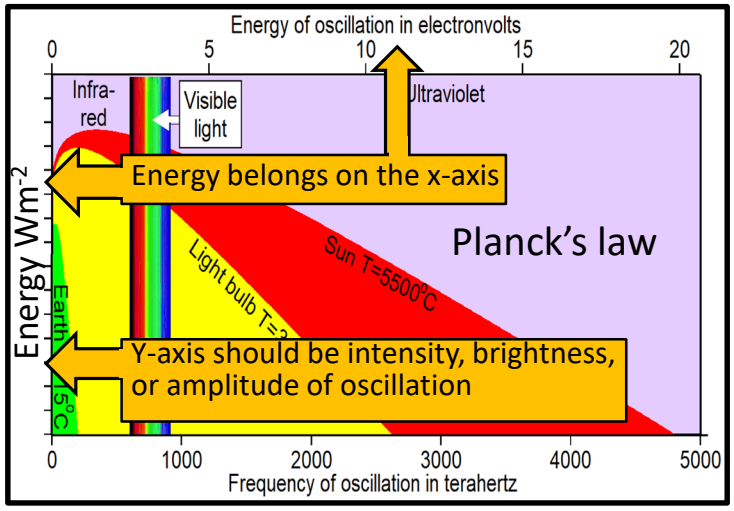


2) That frequency of electromagnetic radiation is wave frequency, i.e. the velocity of light divided by wavelength.

No. Electromagnetic radiation is a broad spectrum of frequencies of oscillation of all the bonds holding matter together.

3) That electromagnetic radiation travels through air and space as waves or photons.

No. Electromagnetic radiation travels through air and space as frequency by resonance, where amplitudes of oscillation at each frequency of oscillation are averaged or shared.



4) That energy of electromagnetic radiation is the same thing as intensity or brightness.

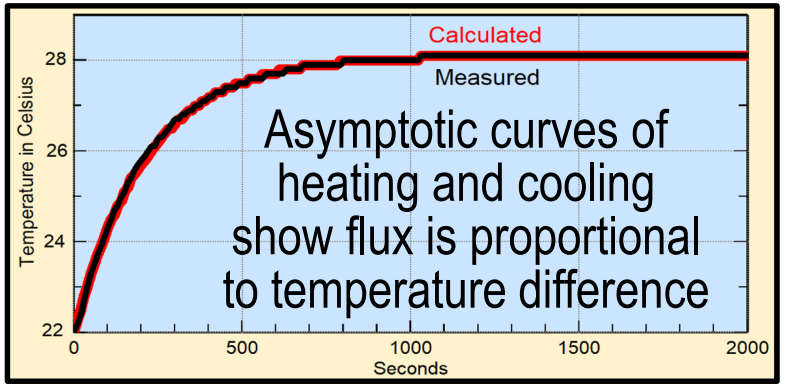
No. Energy of electromagnetic radiation (E) is well-known to equal the Planck constant (h) times frequency (ν), $E=h\nu$. Since frequency is a broad continuum, energy must be a broad continuum.

5) That flux of electromagnetic radiation can be quantified as a single number or amount of watts per square meter.

No. Energy of electromagnetic radiation (E) equals the Planck constant (h) times frequency (ν), $E=h\nu$. Since frequency is a broad continuum, energy must a broad continuum with a different value of watts per square meter at each frequency.

6) Flux of electromagnetic radiation is proportional to temperature of the emitting body.

No. Flux is proportional to the difference in temperature. This is why all curves of warming or cooling approach the final temperature asymptotically.



7) That energy is additive. That flux is additive. That radiative forcings can be added together.

No. Temperatures are averative. They are averaged together.

8) That thermal energy is some unspecified generic thing that is additive (can be added together).

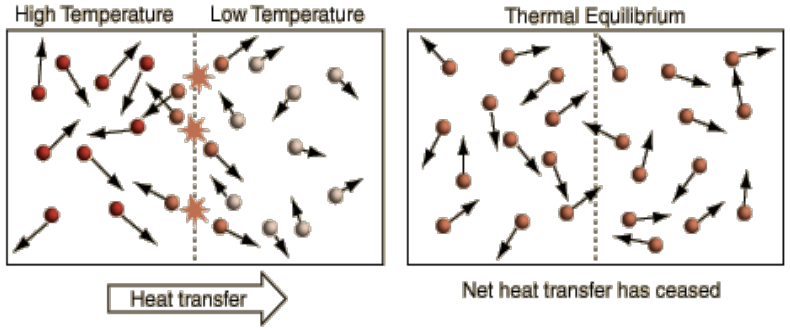
No. Thermal energy is the simultaneous oscillation of all bonds that hold matter together. The hotter the body of matter, the greater the amplitude of oscillation at each and every frequency and the higher the frequencies with the greatest amplitudes of oscillation.

The measured black curve is the warming caused by a picture light shining on a small black piece of metal. The calculated red curve is the temperature calculated by multiplying 4.6% times the average of the existing temperature and the ending temperature of 28 °C at each 10-second interval. The 4.6% has to do with the conductivity per second of heat into the black object and other boundary conditions.

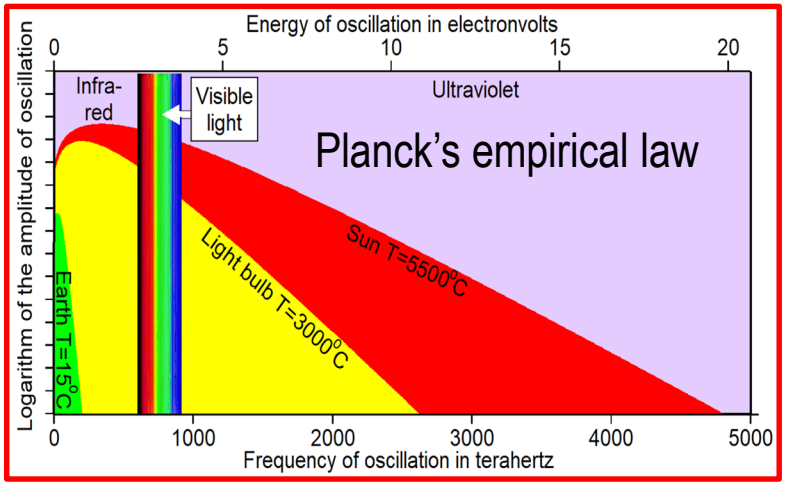
Electromagnetic radiation is a broad continuum of frequencies of oscillation of all the bonds on the surface of matter that hold matter together.

Temperature is a measure of how fast atoms are moving. The higher the average velocity of the atoms, the higher the temperature.

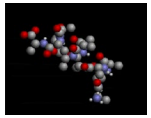
Temperature in a gas is a measure of translational kinetic energy $E=1/2mv^2$



CO_2 absorbs terrestrial infrared energy into the bonds holding the molecules together. This does not change the temperature of air!

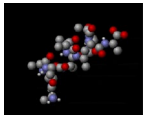


Temperature in solid matter is a measure of a broad continuum of internal oscillatory kinetic energy



Oscillation of what?

Oscillation of all bonds holding matter together.



Planck's empirical law describes the physical properties of temperature in solid matter as:

1. A broad spectrum or continuum of frequencies of oscillation on the lower x-axis.
2. A broad continuum of energies of oscillation on the upper x-axis since energy equals frequency times a constant (E=hv).
3. Planck's empirical law then calculates a broad continuum of amplitudes or intensities of oscillation on the y-axis.

The higher the temperature, the higher the amplitudes of oscillation at each and every frequency of oscillation and the higher the frequencies with the greatest amplitudes of oscillation.

O_2 absorbs ultraviolet-C into the bonds holding the molecules together, causing dissociation. The two oxygen atoms fly apart at high velocity, converting all bond energy efficiently and completely into air temperature, heating the stratosphere.

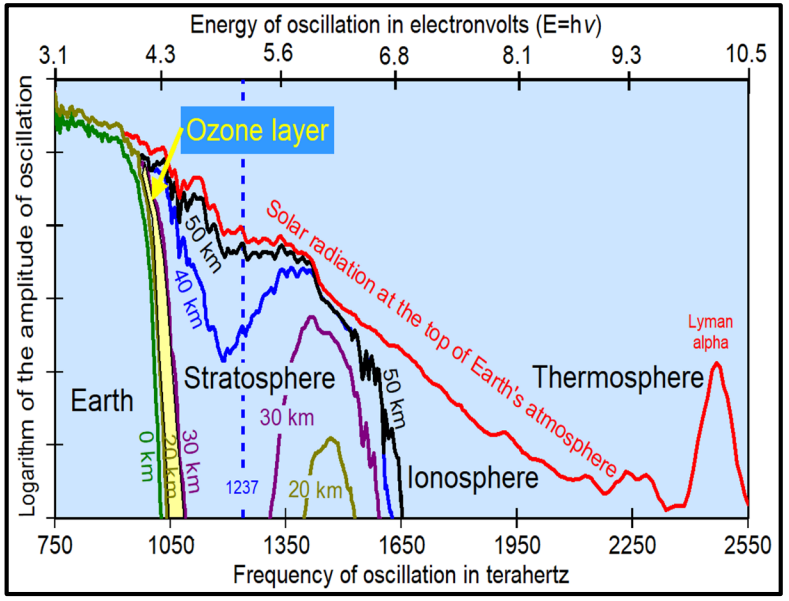
Planck's law says for Earth to increase its temperature, it must absorb increased amplitudes of oscillation primarily at ultraviolet-B frequencies

Most frequencies of oscillation of solar radiation greater than around 1650 terahertz are absorbed in the ionosphere to create ions.

Most frequencies of oscillation of solar radiation between 1650 and 1000 terahertz are absorbed in the stratosphere to dissociate oxygen and other molecules warming the stratosphere.

The highest frequencies of oscillation of solar radiation penetrating the ozone layer are some ultraviolet-B (952 to 1070 Thz), all ultraviolet-A (790 to 952 Thz), and all visible light (405 to 790 Thz).

Thus changes in the intensities (amplitudes of oscillation) of ultraviolet-B solar radiation reaching Earth's surface have THE primary effect on average surface temperatures.



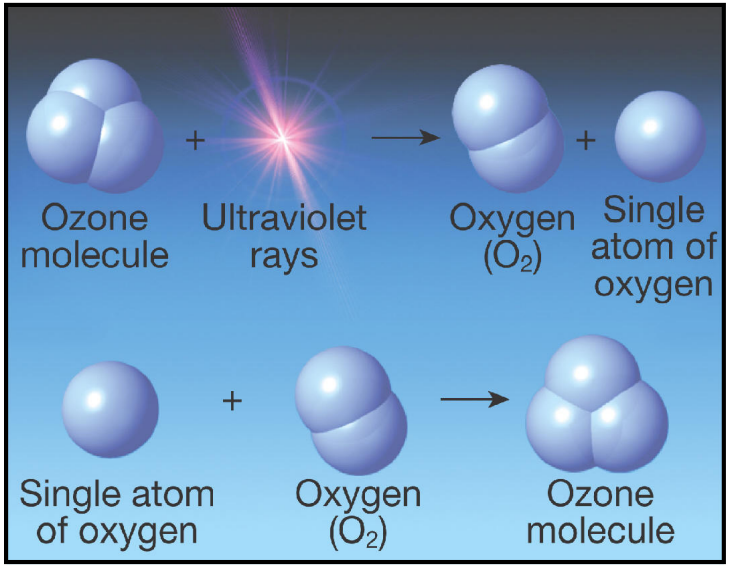
UV-C at 1237 THz dissociates oxygen

UV-B at 967 THz dissociates ozone

The annual average surface temperature of Earth is determined primarily by how much ultraviolet-B solar radiation penetrates the ozone layer and reaches Earth's surface, where it dissociates ground-level ozone depletion warming air and penetrates oceans hundreds of meters, efficiently raising ocean heat content.

How much solar ultraviolet-B reaches Earth is determined primarily by how much ozone depletion occurs in mid to late winter when ozone concentrations are unusually large

When solar radiation is present, the oxygen-ozone cycle continuously dissociates oxygen, heating air and then dissociates ozone, heating air. The average lifetime of an ozone molecule is only around 8.3 days.

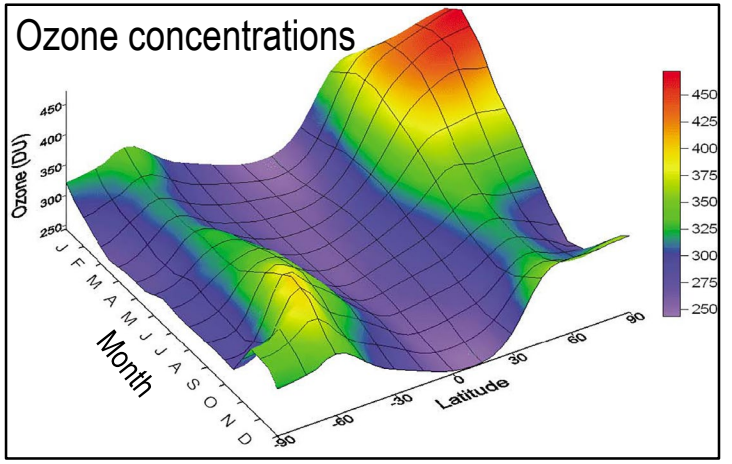


Thus, air is warmer wherever there is more ozone.

During winter, less ultraviolet-B reaches the ozone layer in polar regions so that ozone concentrations accumulate.

Ozone depletion is most effective when atoms of chlorine interact on the aqueous surfaces of polar stratospheric clouds formed during the coldest periods of polar winter.

Under these conditions, one atom of chlorine can lead to the destruction of more than 100,000 molecules of ozone.

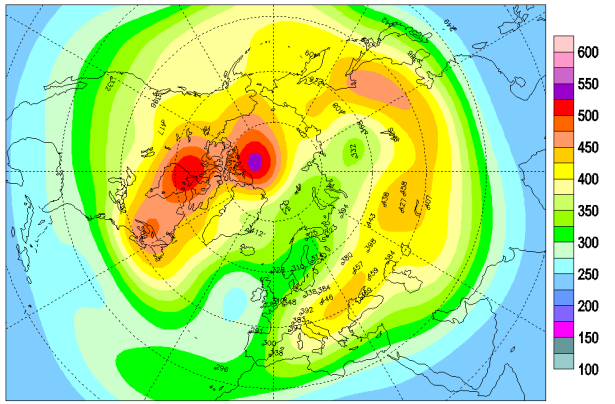


This is why the greatest effect of ozone depletion is observed to be an increase in winter minimum temperatures.

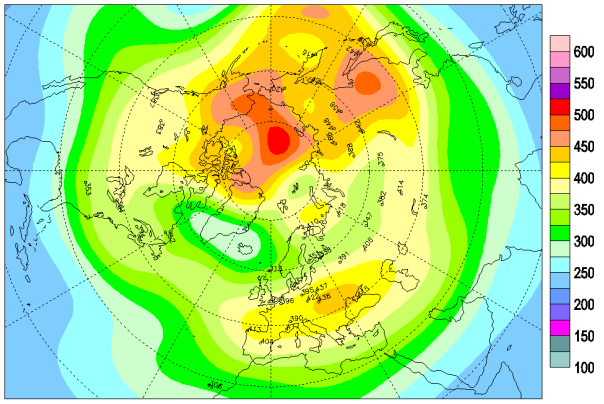
Maps of ozone concentrations vary daily.
Air containing ozone is warmer than surrounding air.

Dobson (1929) showed that maximum positive daily deviations of ozone values from monthly means are generally found to the rear of surface low-pressure areas, while maximum negative deviations are found to the rear of surface highs.

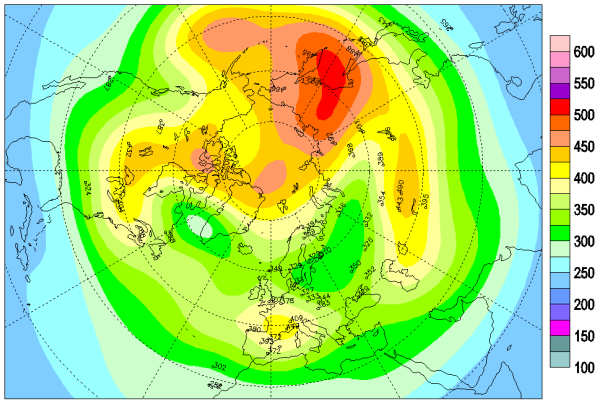
Total ozone (DU) / Ozone total (UD), 2010/02/01



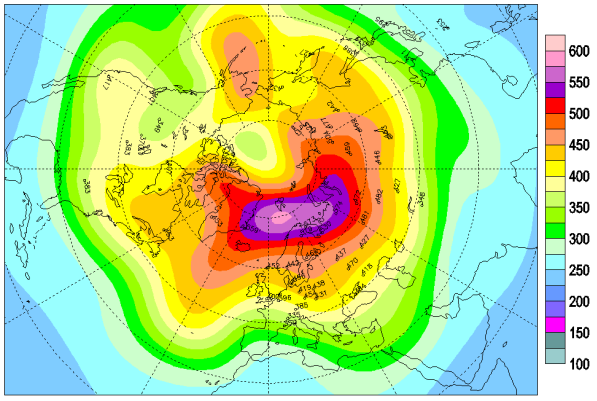
Total ozone (DU) / Ozone total (UD), 2010/02/08



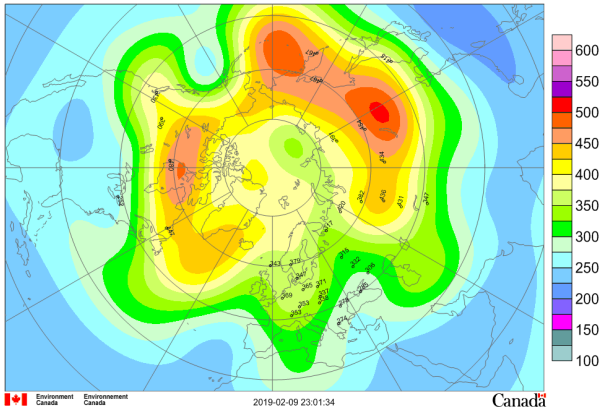
Total ozone (DU) / Ozone total (UD), 2010/02/11



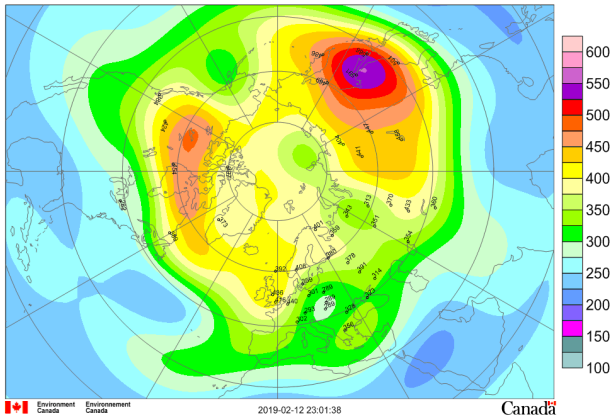
Total ozone (DU) / Ozone total (UD), 2010/02/27



Total ozone (DU) / Ozone total (UD), 2019/02/04

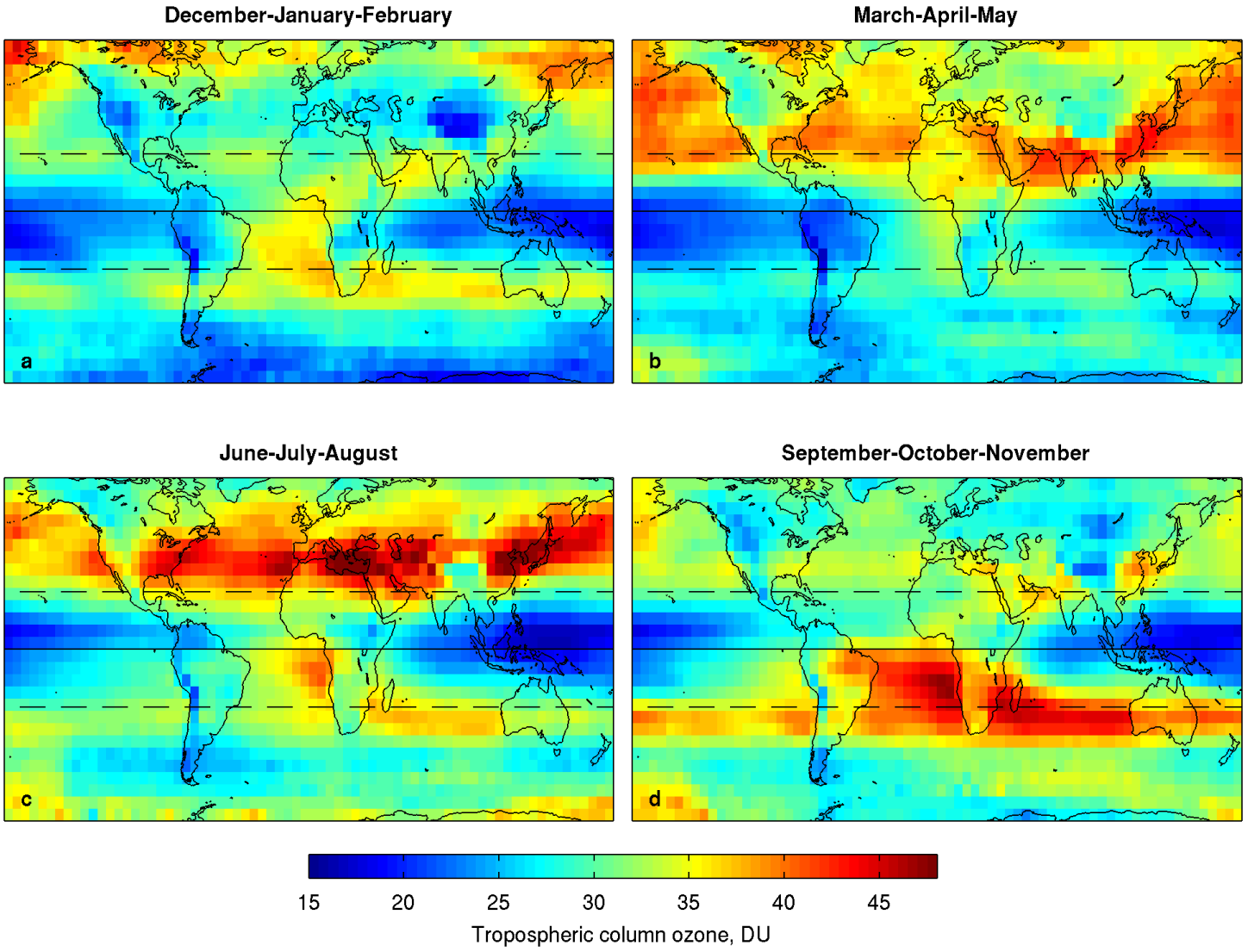


Total ozone (DU) / Ozone total (UD), 2019/02/07



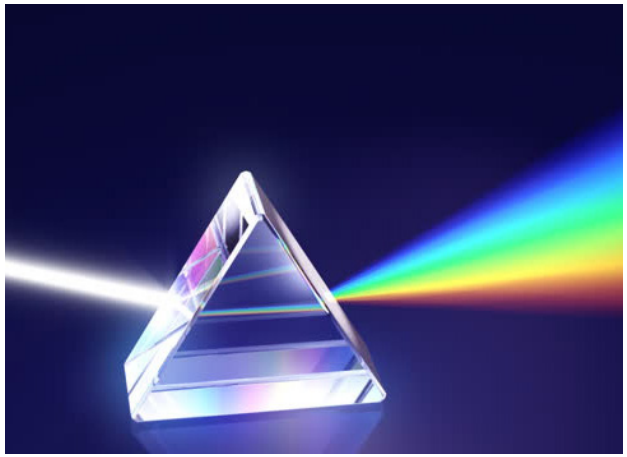
The primary way ozone depletion heats air is when increased ultraviolet-B radiation causes dissociation of ground-level ozone pollution

This is why warming has been twice as great in the northern hemisphere as in the southern hemisphere.



Planck's confusion about radiant energy

In the late 1800s, many radiation physicists used a prism to separate the colors of visible light. They then moved a sensor through each color and measured a very small electric current that they thought of as the amount of energy. They assumed light travelled as waves and thought of frequency as wave frequency.



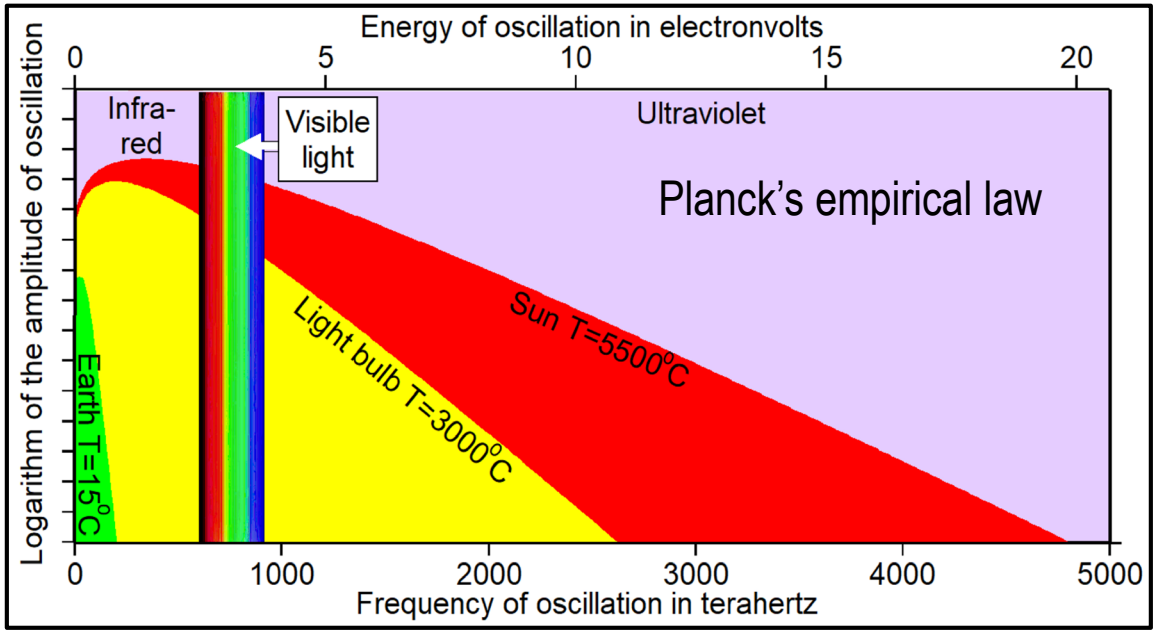
Planck, then, wrote his equation assuming that energy in watts per square meter was on the y-axis and that total energy could be calculated by integrating as a function of frequency.

But to justify his equation, Planck postulated that radiant energy (E) equals the Planck constant (h) times frequency (v). But he never stopped to think if E=hv, energy must be plotted on an alternative x-axis, parallel to frequency and the y-axis must be intensity or brightness.

Planck also never stopped to think that it makes no sense to integrate as a function of frequency because, for light, all frequencies coexist in air and space. It makes no physical sense to add them together.

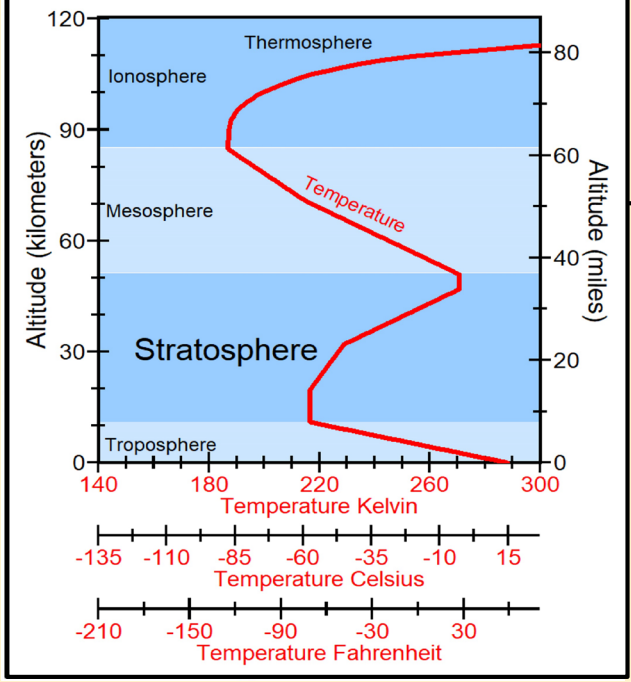
Planck's empirical law

$$B_\nu(T) = h\nu\left(\frac{2\nu^2}{c^2}\right)\left(\frac{1}{e^{h\nu/k_BT} - 1}\right)$$

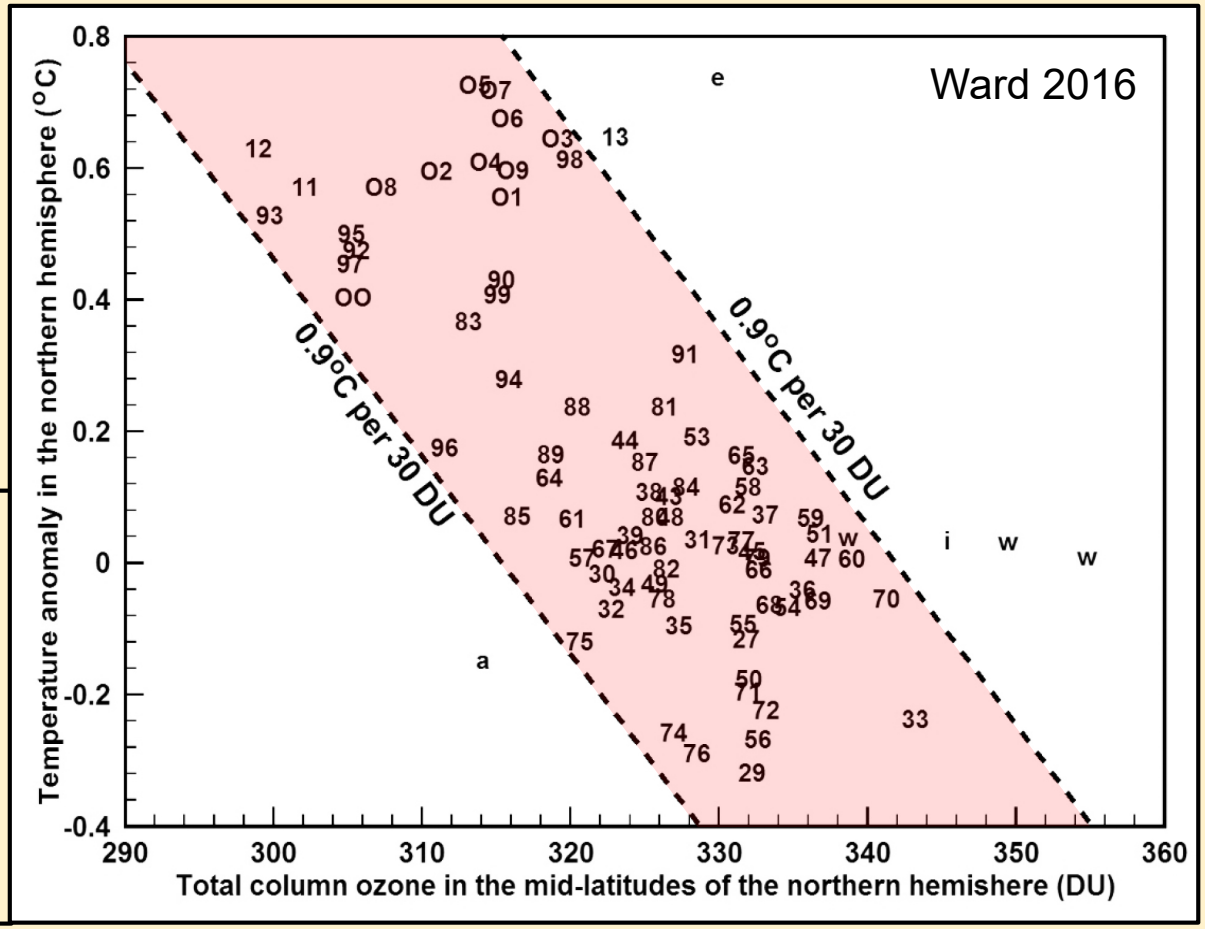


Primary role of the middle atmosphere in determining global temperatures

Atmospheric temperature



The stratosphere, absorbing solar ultraviolet C and B, forms an "electric blanket" around Earth, raising the temperature of the stratopause 30 to 35 degrees Celsius above the temperature of the tropopause. "Electric blanket in the sense that the thermal energy comes from a distant source, Sun, not from the body under the blanket, Earth.



A decrease in yearly total column ozone at mid-latitudes of the northern hemisphere by 30 Dobson Units (DU) corresponds to a 0.9 °C increase in temperature anomaly in the northern hemisphere based on HadCRUT4. Numbers are the years observations were made at Arosa Switzerland.

Resonance is a fundamental physical property of oscillating systems

When one discrete molecular-bond-sized oscillator on the surface of the emitting body is in resonance with one discrete oscillator on the surface of the absorbing body oscillating at the same frequency and within line-of-sight, amplitude of oscillation is observed to decrease on the emitting body and increase on the absorbing body.

Resonance, in an ideal case, averages amplitudes of oscillation, just as temperatures are averaged when two identical bodies of matter with different temperatures are placed in thermal contact.

A simple example of resonance via mechanical contact is when you push a child on a swing. If you push at exactly the same frequency of oscillation as the swing is swinging, the amplitude of the swing will increase.

Radios work by resonance. A radio transmitter causes a frequency of oscillation on its antenna. You tune your radio receiver to resonate at the same frequency of oscillation as the transmitter.

Electromagnetic radiation travels through air and space via resonance

Electromagnetic radiation, heat, travels through air and space by simultaneous resonance of all modes of oscillation of all molecular bonds on the surfaces of the bodies that are visible to each other.

Resonance operates very quickly over any distance between bodies that are within line-of-sight

Conduction of heat in matter is by resonance made possible by physical touching.

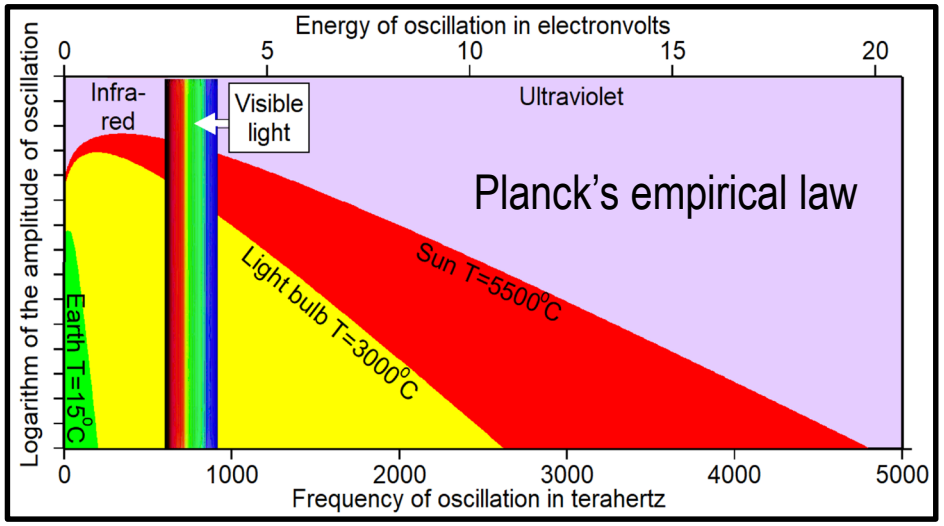
Resonance is all around us. You see by resonance. You hear by resonance. Radios, televisions, and cell phones all receive signals via resonance.

Resonance is the physical process that the concept of **quantum entanglement** tries to explain, what Einstein called **spooky action at a distance**.

Conclusions

Heat is what a body of matter must absorb to increase its temperature and lose to decrease its temperature.

Planck's empirical law shows unequivocally that both temperature and heat are the result of a broad continuum of frequencies of oscillation and a broad continuum of amplitudes of oscillation of all the bonds holding matter together.



This continuum of energies cannot be described by some single number of watts per square meter as is currently done.

Since thermal energy is well known to be equal to the Planck constant times frequency of oscillation, there is a different value in watts per square meter for every frequency.

Heat flux is proportional to the difference in temperature between the emitter and the absorber causing asymptotic curves of warming and cooling.

Earth's temperature is determined primarily by how much ultraviolet-B radiation reaches Earth, which is determined by the optical thickness of the ozone layer.