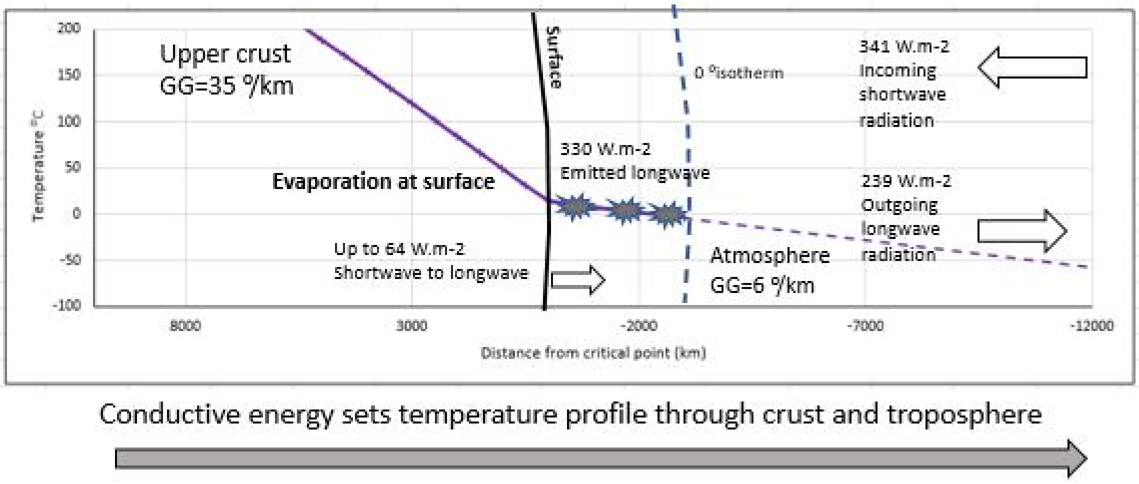
Geoscience and Climate Change

Current climate models discount energy input from crustal heat flow as insignificant because the thermal conductivity of rock is low (the average heat flow of the earth is only 87 $mW.m^{-2}$). The Greenhouse model therefore attempts to amplify solar radiation via absorption and re-emission by Greenhouse gases to account for the warmth of earth's atmosphere. Based on the IPCC Energy flow, the Greenhouse model requires 64 $W\ m^{-2}$ of incoming shortwave solar radiation (the amount that is available at surface after reflection off clouds, snow, absorption in atmosphere etc) to be transformed into 396 Wm^{-2} of outgoing longwave radiation. This is impossible and the infrared radiation is largely, in fact, energy from the earth's crust, not solar radiation. An alternative model that incorporates the geological component of climate is summarised below.



As shown in the above figure, the temperature profile through the upper crust and troposphere is a continuum, with temperature gradients changing from a rock/water medium to an air/water vapour medium. We tend to think of geothermal gradients as reflecting increasing heat with depth, when, from a climate/atmosphere perspective, it is more useful to think of them as reflecting heat loss with distance from the heat source (the crust).

The mean surface temperature is very close to the value of the subsurface geothermal gradient extrapolated to the surface. This temperature equilibrium at the interface is evident at all latitudes. Because the rate of cooling is very low, there is very little **heat flow** recorded between subsurface and atmosphere. The **heat flux** however is apparent when non-adjoining points are connected eg deep mines in which rocks are exposed to atmospheric conditions. An analogue would be a heated concrete slab floor (the earth) and an open fire (the sun). The slab is emitting heat 24/7 at a low rate; the open fire is used a few hours each day and burns directly into the room. Comparing instantaneous heat flow does not reflect the heating contribution of each source over longer periods of time.

The transfer of heat from the subsurface to atmosphere is complex. Rock generates heat (through radiogenic decay), water stores it (in oceans, groundwater and in pore spaces), and air dissipates it. Evaporation is an important part of the climate, cooling the surface by transferring warm water into the atmosphere. Evaporation is caused by incoming short wavelength radiation (UV) being absorbed by oxygen molecules, which then warm, reducing the density of the air column and in turn reducing the pressure on the air/water interface, enabling the formation of vapour.

As water vapour rises, it cools by emitting long wavelength (infrared) radiation in all directions – this energy is what climate science claims as evidence of the Greenhouse Effect but is more likely to be energy from the earth's interior.

The Greenhouse Gas (GHG) Model

Increasing atmospheric temperatures over the last 150 years have been attributed to increasing concentrations of greenhouse gases, notably carbon dioxide and methane. This is based on the capacity of these gases to absorb and emit infrared radiation. Logically, more gas means more infrared emissions, leading to higher temperatures. This, however, does not stand up to scrutiny based on first principles (refer to www.kaurioilandgas.co.nz).

Carbon dioxide is heavier than air, and isotopic data confirm atmospheric carbon dioxide is largely derived from thermal sources (volcanism, geothermal and burning of fossil fuels). Carbon dioxide ascends rapidly as a plume until it reaches desublimation temperatures, undergoes a phase change to dry ice, then falls back through the atmosphere, **absorbing** energy. A minor component is derived from the breakdown of methane in the troposphere. Methane is ubiquitous on the surface and in the subsurface, and is lighter than air, so the atmosphere should be rich in methane, yet it is present in ridiculously low concentrations (1500 ppb).

The Chlorofluorocarbon (CFC) Model

The CFC model is straightforward and fits the data as well as, and in most areas better than, the GHG model. The correlation between CFCs and temperature has been noted numerous times, but only in the context of their capacity to act as Greenhouse gases.

1. Chlorofluorocarbons (CFCs) deplete ozone, allowing more UV radiation to reach the surface;

2. Ozone reacts with methane rising from the surface to generate water and CO2

$$\mathbf{CH_4 + O_3 \rightarrow CO_2 + H_2O + H_2}$$

   As ozone concentrations decline, more methane survives in the troposphere; hence increasing methane levels have little to do with increased emissions.

3. Increased UV results in more evaporation;

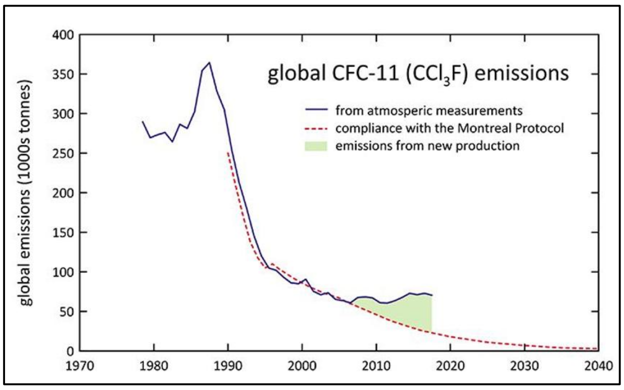
4. Evaporation moves water down the temperature gradient, cooling as it releases heat in the form of infra-red radiation;

5. Chlorine released from CFCs reacts under UV frequencies to form HCL, which accumulates in the oceans.

$$CH_4 + O_3 + Cl \rightarrow CO_2 + H_2O + 2HCl$$

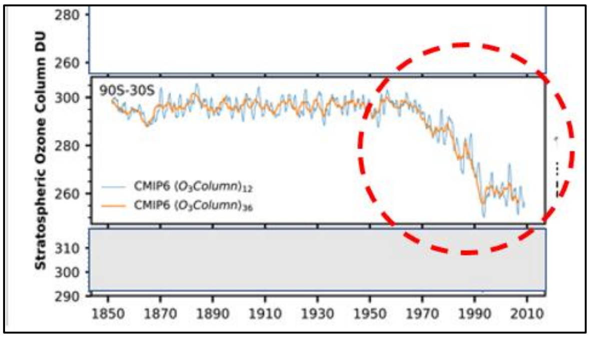
Methane + ozone + chlorine → carbon dioxide + water + Hydrochloric Acid

Ozone depletion started in the southern hemisphere in the 1950s and increased until the 1990s. CFCs were banned under the Montreal Protocol of 1987.



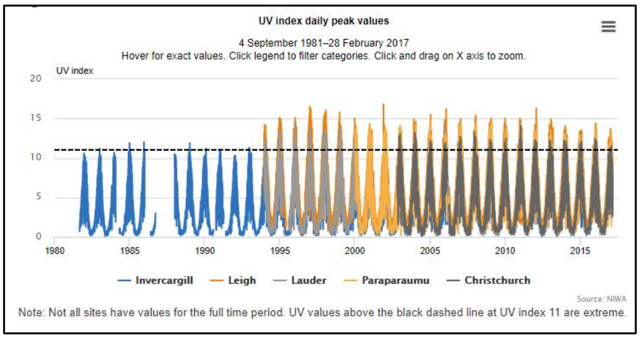
Global CFC Emissions (Paul Crumell, CSIRO)

Global CFC emissions reached a peak in the 1980s, when the damage to the ozone layer was recognised and the Montreal Protocal was enacted, banning the use of CFCs. Emissions fell sharply until the mid 1990s, but the fall was arrested and is now being reversed by the increasing use of CFcs by China (shaded green). This fall in emissions can be traced through all stages of the CFC Process – these data represent different scales – local, regional, hemisphere and global, and lag times are evident between events that may be different if a consistent dataset was complied.



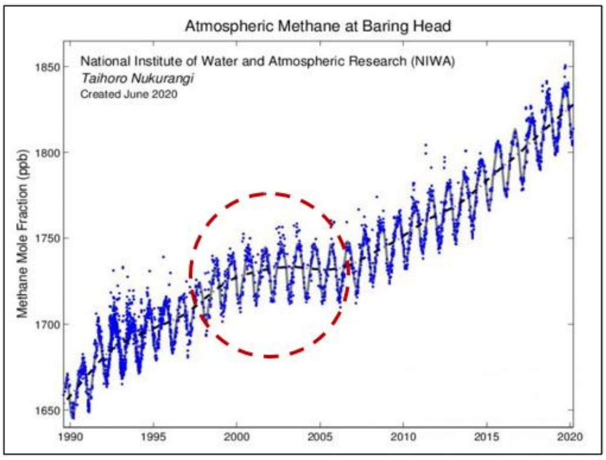
Ozone column in southern hemisphere (Checa-Garcia et.al, 2018)

The rapidly increasing use of CFCs is reflected in the ozone density (shown for the southern hemisphere stratosphere), which dropped dramatically between the 1960s and 1990s, but then stabilised from 1990.



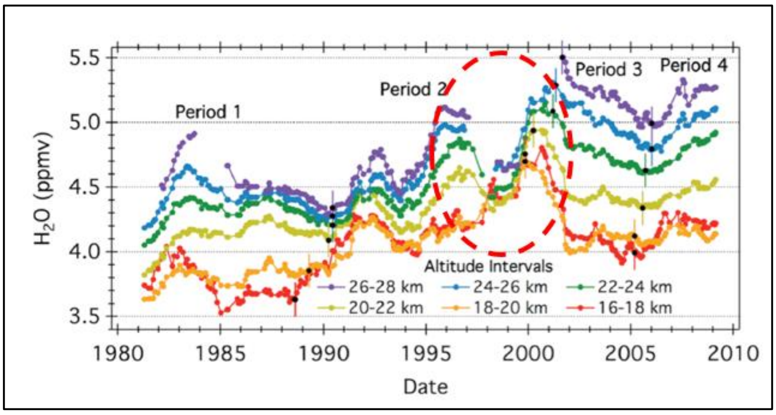
UV Index New Zealand 1981 – 2017 (Ministry for the Environment)

The UV Index in New zealand has been Extreme (above the black dotted line) since 1994.



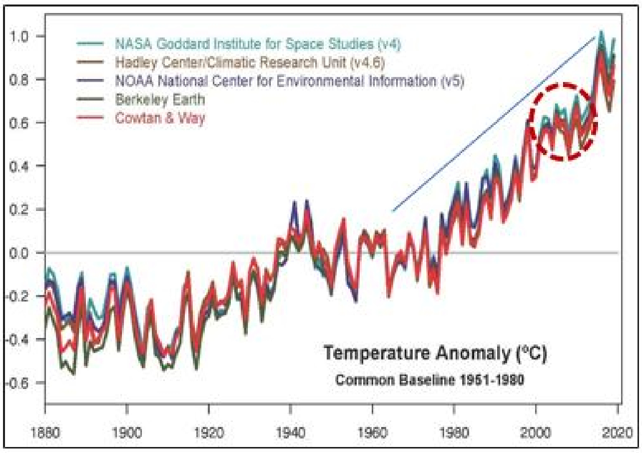
Methane Concentrations, Baring Head, N.Z (NIWA)

Methane concentrations have been steadily rising, but plateaued during the period 1998-2006



Stratospheric water vapour trends over Colorado (Hurst et al. 2011)

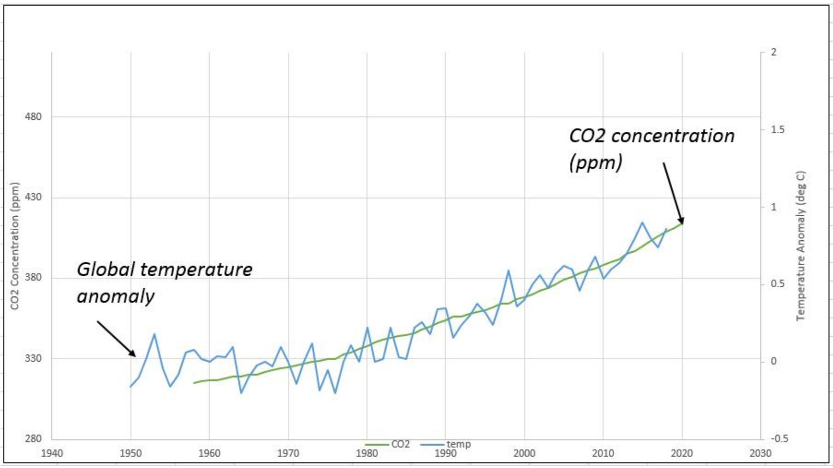
The increased UV led to increased evaporation, reflected in water vapour concentrations. The above plot shows data above Colorado, with a significant decrease in the period 1997-2002.



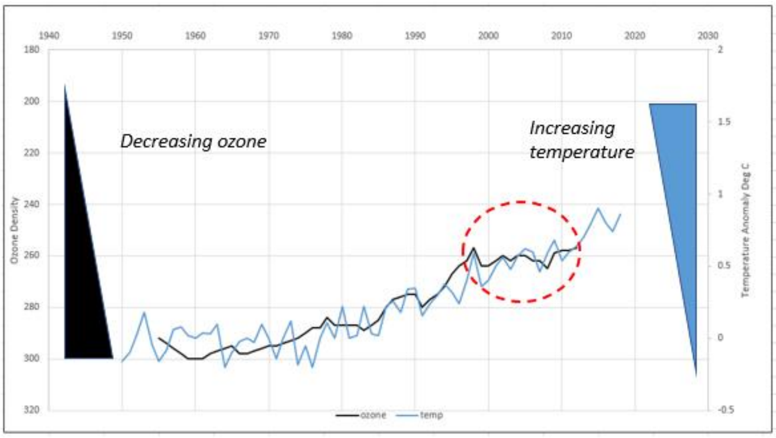
Global Temperature Anomaly (NASA)

The current trend of increasing temperatures started in the 1950s and continues to the present day at a rate of around 0.12 ^{0}C per decade, except for the period 1998 – 2012 (widely referred to as the **Temperature Hiatus**) when it slowed to 0.05^{0} C per decade.

Climate scientists in NZ, Australia, UK, USA and elsewhere have been "correcting" pre-1950s temperature measurements to fit the steadily rising CO2 curve.



Plot of atmospheric CO_2 concentration against Global Temperature Anomaly. This is the basis for the current climate science. CO_2 concentrations have risen steadily at 4% .



Plot of Global Temperature Anomaly against Ozone concentration (with a lag of 5 years).

CFC production decreased by 57% between 1990 and 1999. Ozone depletion stabilised from 1993 (a lag of 3 years). The rate of temperature increase decreased by 58% between 1998 (a further lag of 5 years) and 2012. CO_2 concentrations increased steadily by 4% during both of these periods.

It is not Greenhouse gases that are to blame for rising temperatures and falling ocean alkalinity. **Ozone depletion** is the cause of accelerated temperature increase since the 1950s. The Greenhouse Effect is slight, and carbon dioxide produced from combustion of fossil fuels is not responsible for current trends in climate. We know ozone depletion can be repaired and this is urgent – the southern hemisphere Ozone hole is now getting as large as it was in the 1980s and 1990s (23 million sq km in 2020, 19.3 million sq km in 1987).

The world has embarked on a costly, unnecessary, and ultimately futile mission to decarbonise the environment and thereby accelerate the ultimate extinction event. Crustal heat flow contributes to atmospheric climate and climate science must integrate earth science.

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