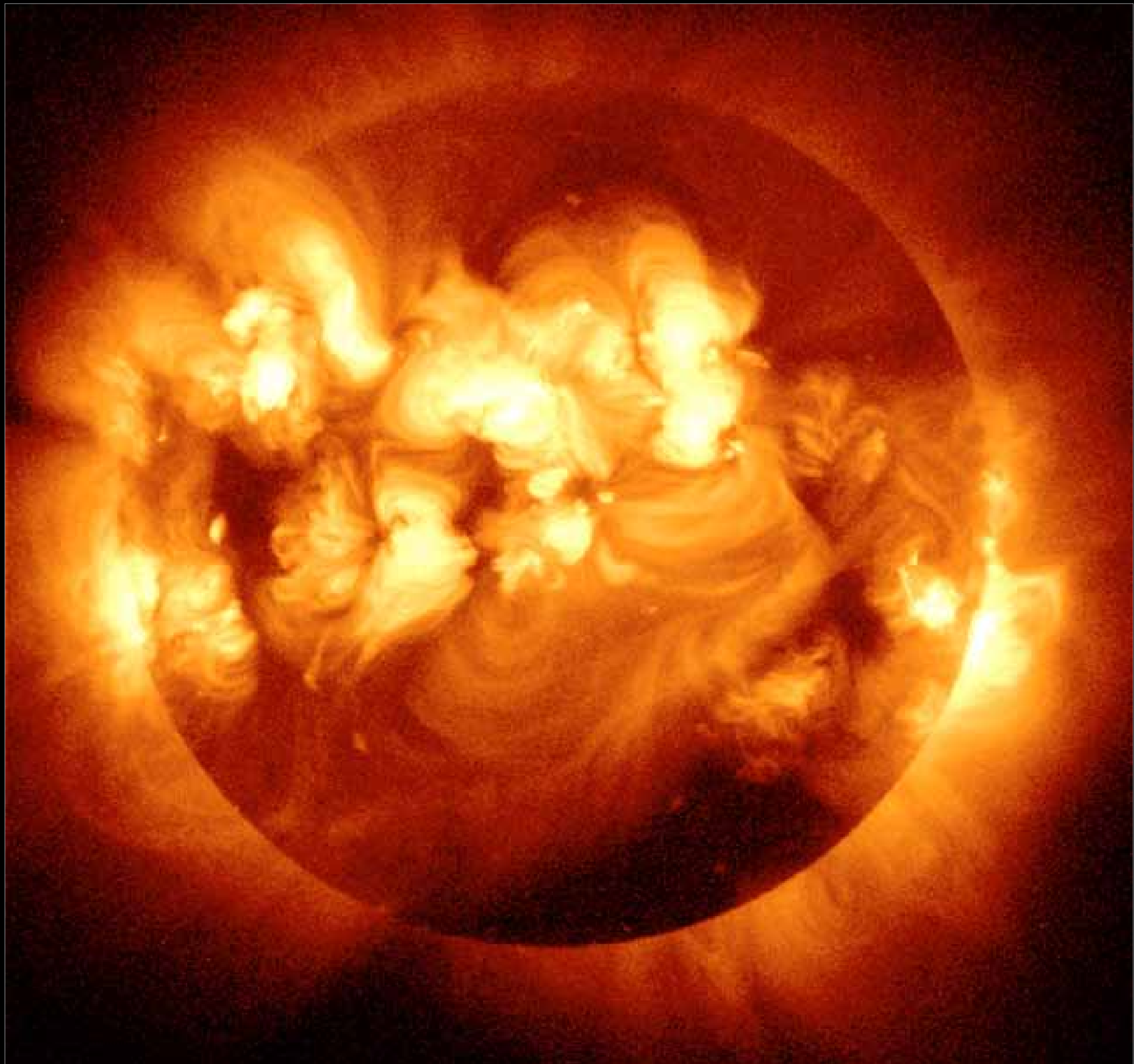
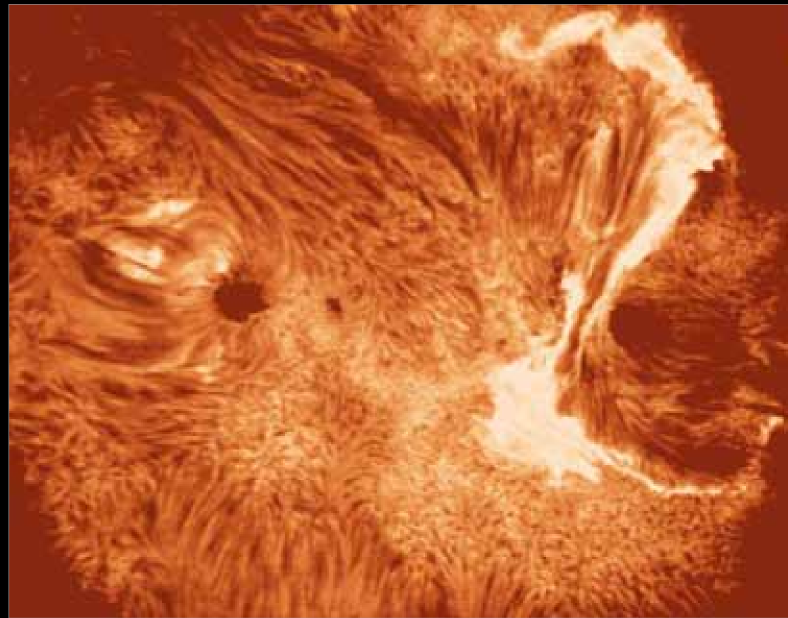
HYDROGEN: LIFE'S PRIMARY DRIVER

The primary drive for the Earth's biosphere comes from the fusion of hydrogen atoms in the Sun's interior. The energy radiated to earth fluctuates in direct proportion to the number of storms that perturb the Sun's surface. The more solar storms there are, the warmer our planet becomes.



Storms on the Sun, Dec. 2006 (magnetic imaging, Hinode International spacecraft, JAXA/NASA)

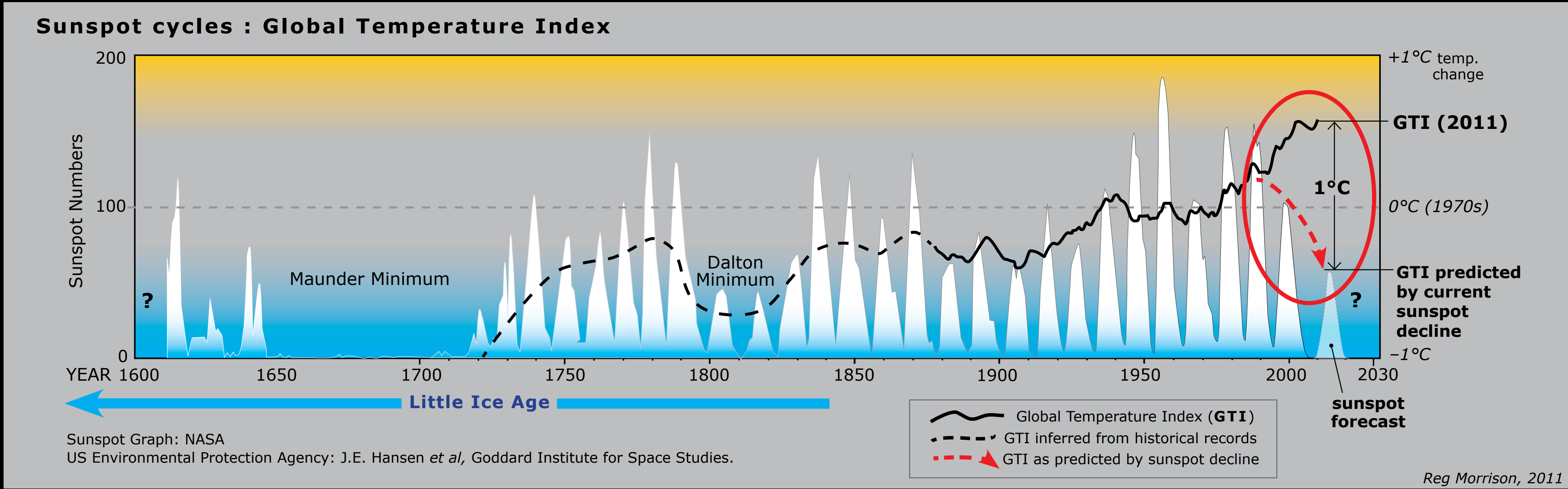


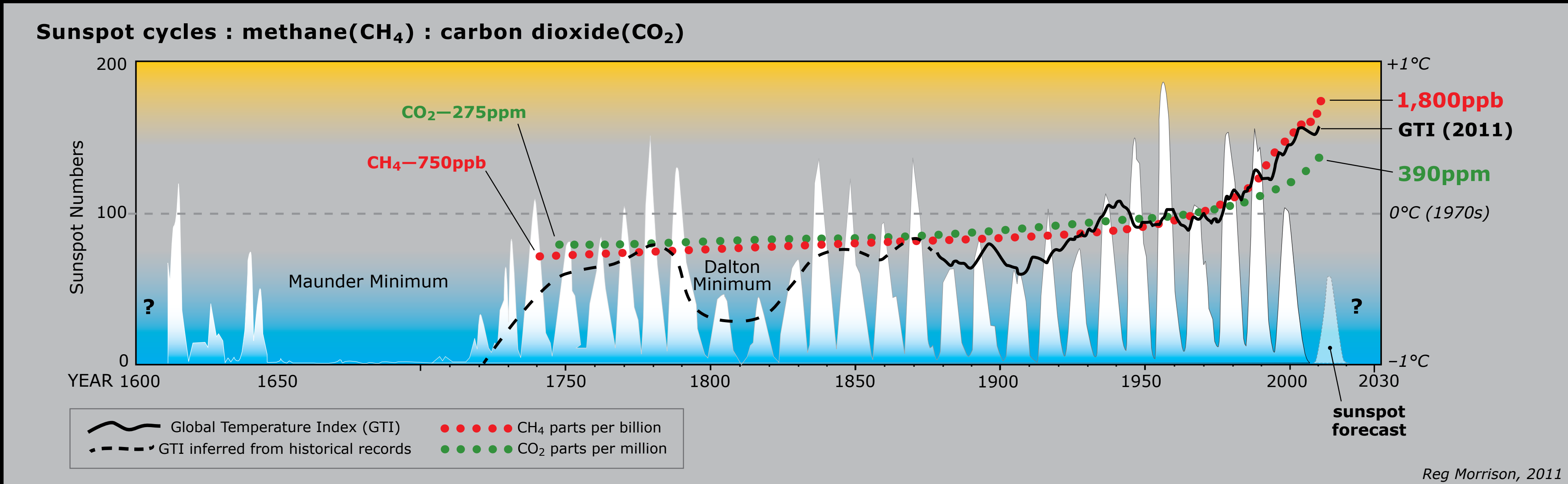
LEFT & ABOVE: The dark spots that appear on the surface of the Sun are all that we see of the violent storms that usually rage across its face. These composite images show the vast eruptions of energy that accompany those storms. Such eruptions, known as faculae, are a primary cause of the 11-year cycle that modulates Earth's temperature fluctuations.

The Sun's face is currently blemish free—a relatively rare phenomenon. So Earth's global temperature should be plunging.

But it isn't ...

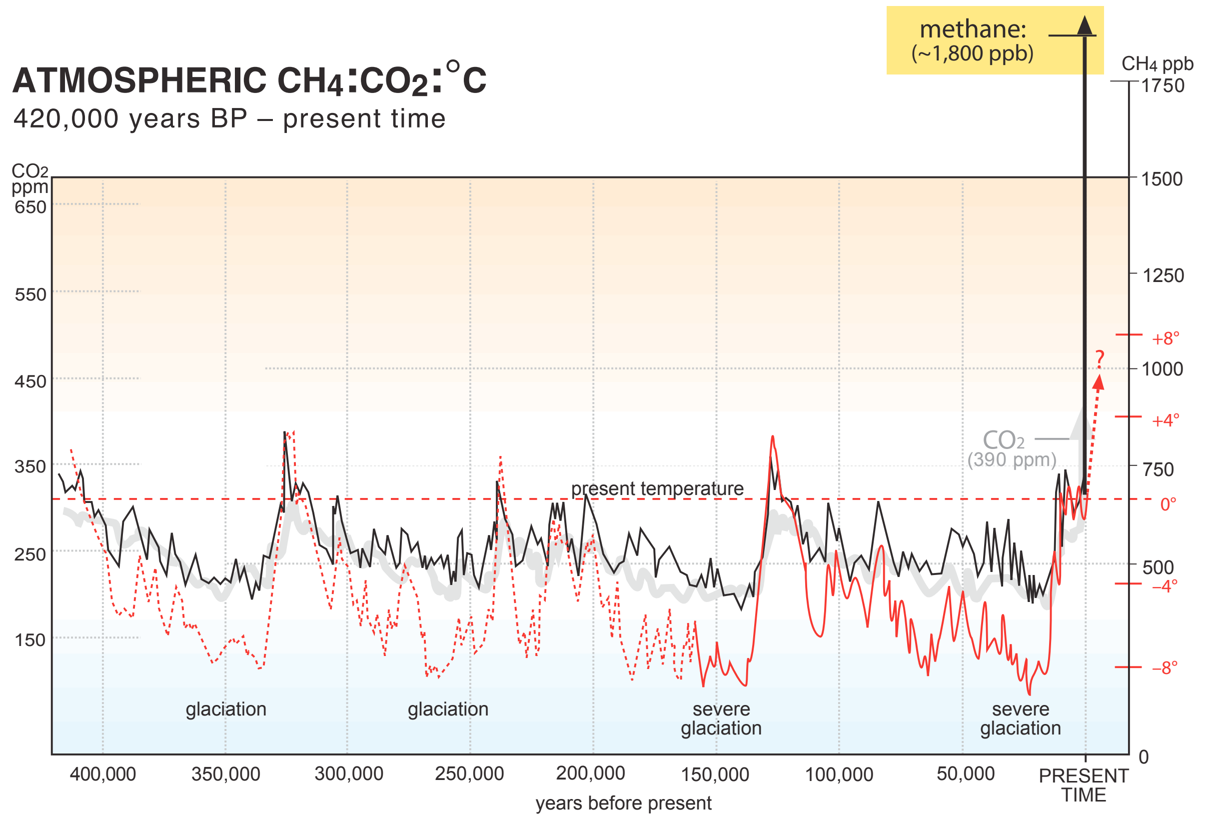
The Global Temperature Index has diverged from the sunspot trend for the first time in 400 years.





The coincidental leap in atmospheric methane and carbon dioxide offers an explanation for the discord.

Energy (food and fuel) harvested from the environment invariably extracts a fee that is directly proportional.



Based on Antarctic and Greenland ice-core data, and atmospheric data from Cape Grim, Tasmania.

Vostok ice core data: Petit et al, Nature *(No.399, 1999)*
Law Dome ice core data: Etheridge et al., Journal of Geophysical Research *(1996)*
Cape Grim Station data: CSIRO Atmospheric Research and Bureau of Meteorology
°C between 160,000 and 420,000 years BP from IPCC.

REG MORRISON
regm@optusnet.com.au

GREENHOUSE GASES

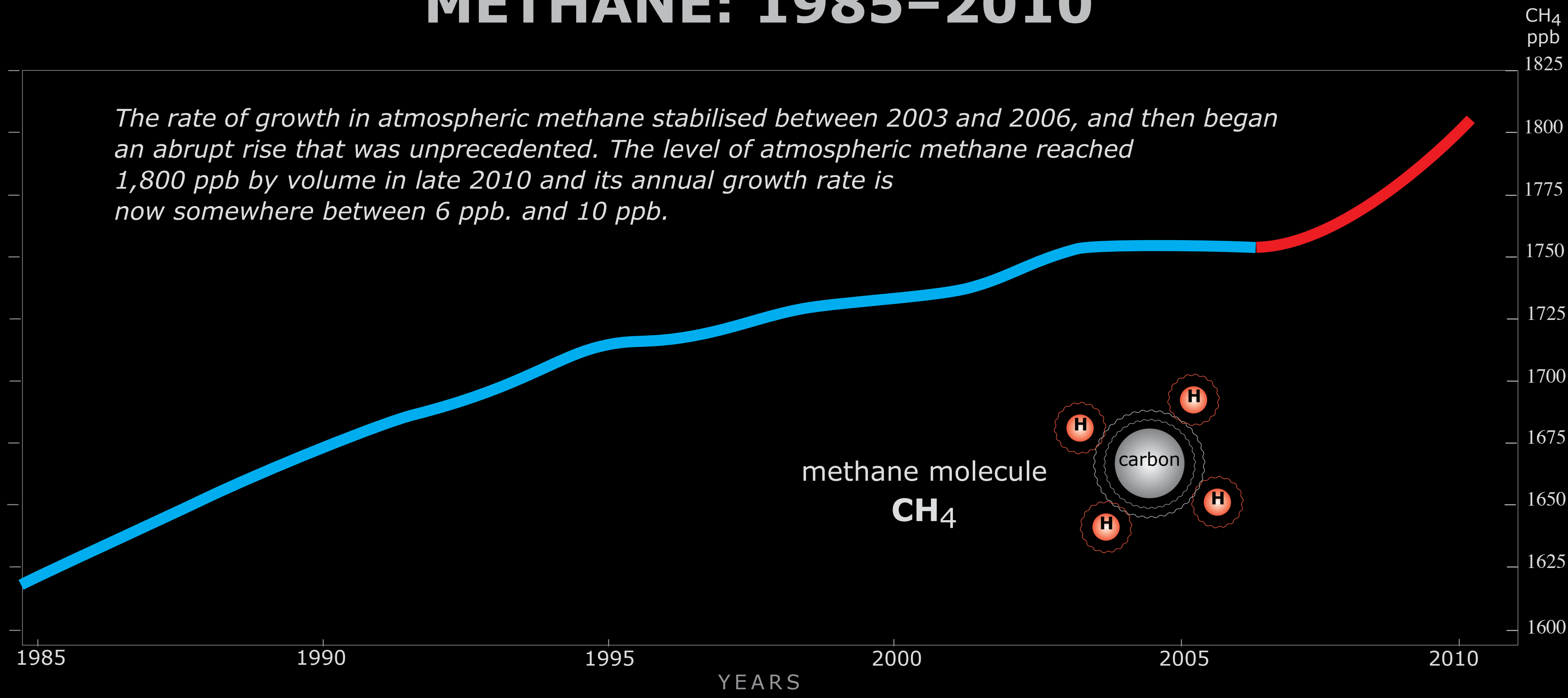
Atmospheric levels of two key greenhouse gases, methane and carbon dioxide, have varied continuously throughout the life of the planet and their fluctuations have generally coincided with changes in global temperature.

Although carbon dioxide is more abundant, it is now known that methane is at least 60 times more effective as a greenhouse gas when measured over a short period such as 20 years, and about 100 times more effective over 5–7 years.

This savage short-term effect is partly due to hydrogen's tendency to react with other atmospheric components in ways that multiply methane's effectiveness as a greenhouse gas.

Atmospheric carbon dioxide has risen 36% during the past 150 years, but during that time the level of atmospheric methane has more than doubled. It is now at its highest level in 400,000 years. The above graph shows the tight correlation between temperature spikes and the methane spikes. This suggests that the most immediate threat to our survival on this overloaded planet is not carbon dioxide … it is methane.

METHANE: 1985–2010



A reassessment of methane's Greenhouse impact

The volume of methane in the atmosphere has grown fairly steadily since the beginning of the modern industrial era (~1750) when it was only about 680 ppb. When the daily rate of methane decay finally caught up with the increased rate of injection in 2003, the level stabilised for almost four years. Towards the end of 2006 however, the methane level began to surge again, due no doubt to the accelerating disintegration of submarine and tundra hydrates as the polar ice began to melt.

It has been recently calculated that methane's interaction with other constituents of the atmosphere, especially hydroxyl (OH) and sulfate particles, has enhanced methane's warming effect by 20–40% over previous estimates. Climatologists at NASA's Goddard Institute for Space Studies now believe that methane may account for up to a third of the global warming from greenhouse gases between 1750 and today.

Methane hydrates

Methane discharged by the vast mass of bacteria that inhabit the Earth's crust tends to accumulate in the upper layers of the seabed wherever porous marine sediments happen to freeze. The ice in these layers forms a dense, interlocked lattice of crystals that traps the bubbles of methane and prevents their escape into the atmosphere.

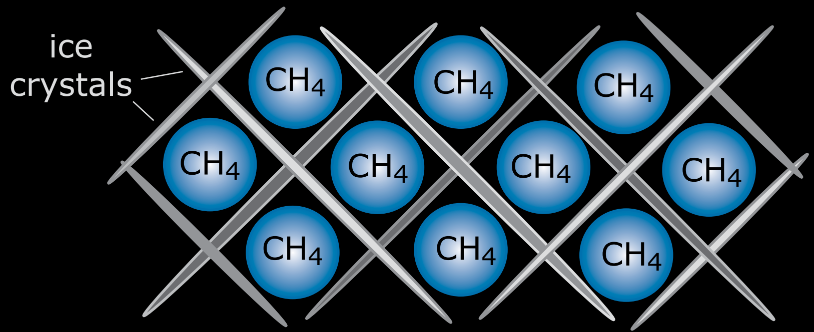
These huge methane reservoirs are continuously recharged by the decay of biological material washed from the continent, and by waste gas that migrates upward from the methanogenic bacteria that inhabit all crustal material, especially the sedimentary apron that fringes the continental land masses. These vast submarine gas reserves are believed to contain at least 3,000 times the volume of methane that is presently in the atmosphere.

Seismic activity or significant temperature changes can rupture these methane hydrates, and on occasions, unpin the overlying sediments, allowing them to slip down the slopes that fringe most continents. Some submarine landslides have been very large indeed, and methane that is released in this abrupt fashion represents a major threat to the global climate. One relatively recent land-slippage appears to have involved an area of seabed that was almost the size of Scotland, according to British marine scientists.

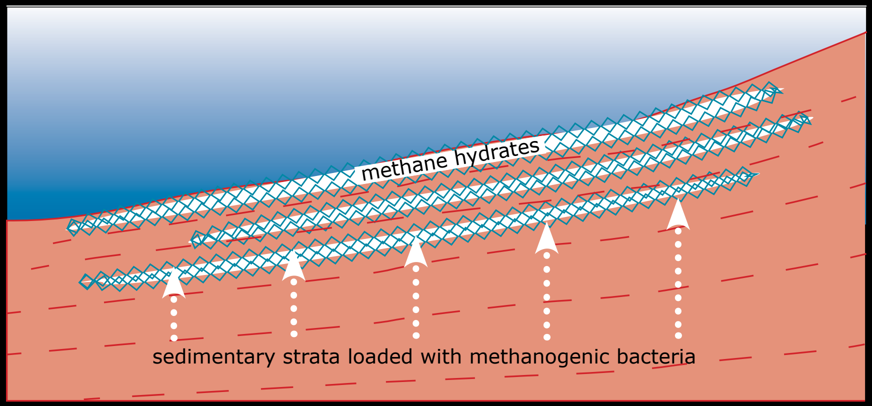
Such explosive releases of methane are now believed to have been responsible for several of the more abrupt temperature rises that ended glacial episodes in the past, and appears to have contributed to the end of the world's longest and most savage ice age some 630 million years ago. Methane also helped to wipe out more than 90% of marine species and 70% of land life during the world's worst mass extinction 251 million years ago.*

From our perspective, the widespread disintegration of polar permafrost and marine hydrates thereby represents an ominous evolutionary development ...

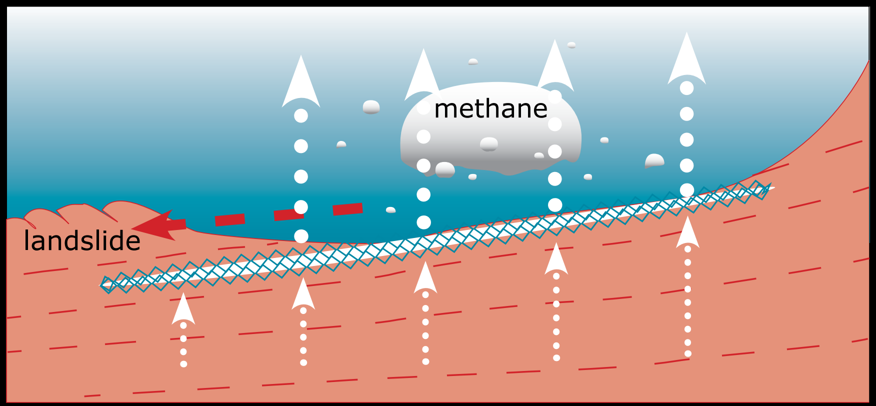
Methane Hydrate
(schematic)



Cold seas



Warm seas



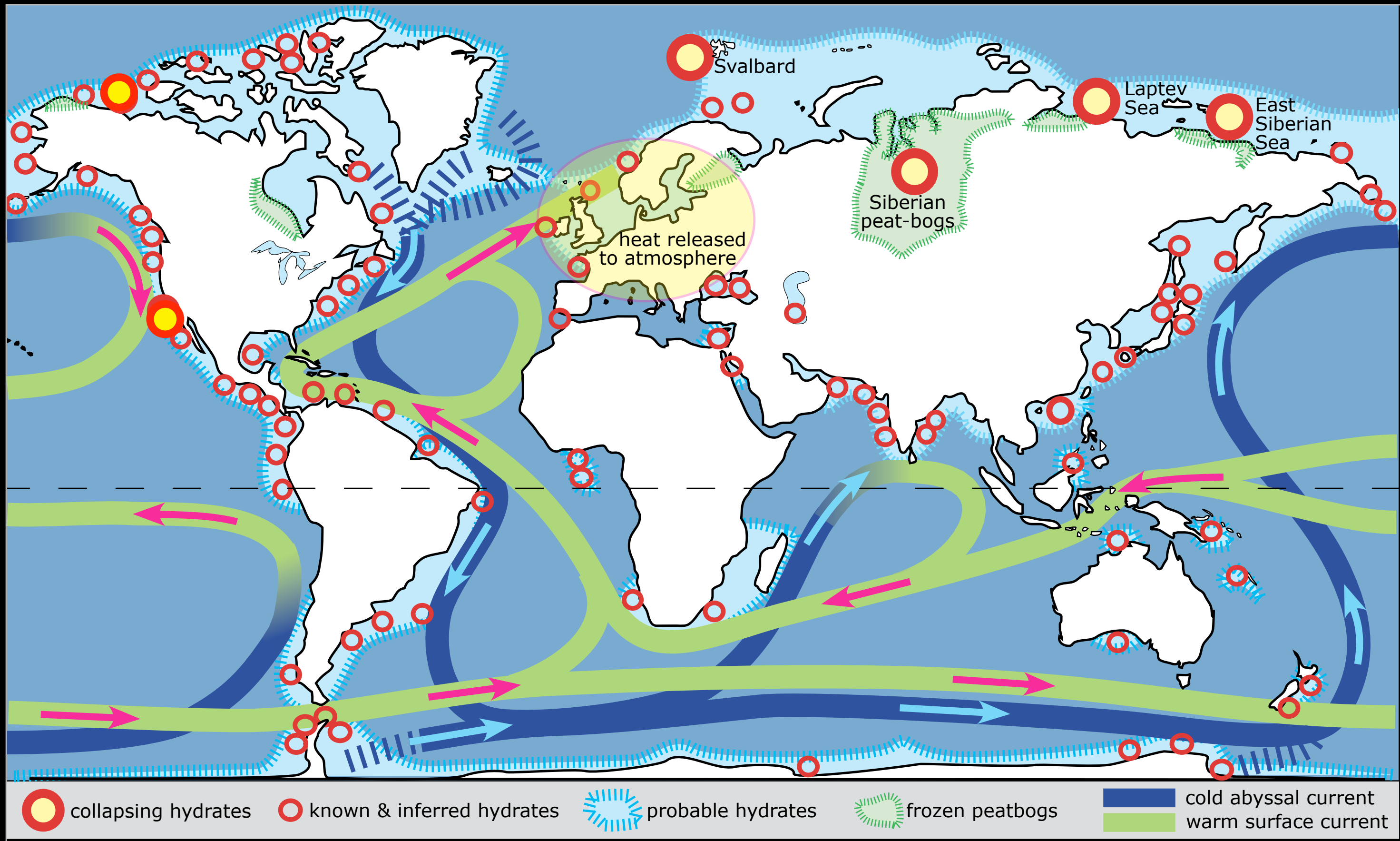
* Douglas H. Erwin 2006, "Extinction" (Princeton University Press) pp.174–179

Global Hydrates

Russian scientists have measured aerial concentrations of methane that are up to a hundred times the background level, spread over many thousands of square kilometres of the Siberian continental shelf. They also saw patches of sea that were foaming with the gas as it bubbled up from the sea floor in the form of "methane chimneys".

They believe that vast blankets of submarine permafrost, which used to act like a lid to prevent the gas from escaping, have recently melted, releasing methane from underground deposits that predated the last glacial period.

Scientists on a British research ship said that they too had recorded methane plumes bubbling from a relatively shallow seabed (~400m deep) in an area covering about 50 square kilometres off the west coast of Svalbard. They counted about 250 plumes at that site alone and then discovered a second set of plumes rising from about 1,200 metres.



The flow pattern of ocean currents, schematically traced out above in blue and green, represents the thermo-haline circulatory system that girdles the planet and helps to redistribute heat throughout its oceans. The system is largely driven by the sinking of cold dense salt water in polar regions while the westward flow of the equatorial current is generally helped on its way by trade winds.

It takes somewhere between 1000 and 2000 years for water to complete the cycle and this continual redistribution of heat energy plays a major role in maintaining the world's weather patterns and global temperature.

Whenever the polar drive slows, the seas' well-defined temperature layers mix, and the ocean warms. This dissolves some hydrate ices, releasing their methane. Similarly, when the oceans warm the atmosphere, the tundra permafrost degrades, releasing some of its methane.

A vast expanse of frozen swampland in western Siberia has now begun to release methane that has been locked in its permafrost for some 27,000 years. So much gas is now escaping that some lakes are refusing to freeze, even in midwinter.

Hydrate collapse

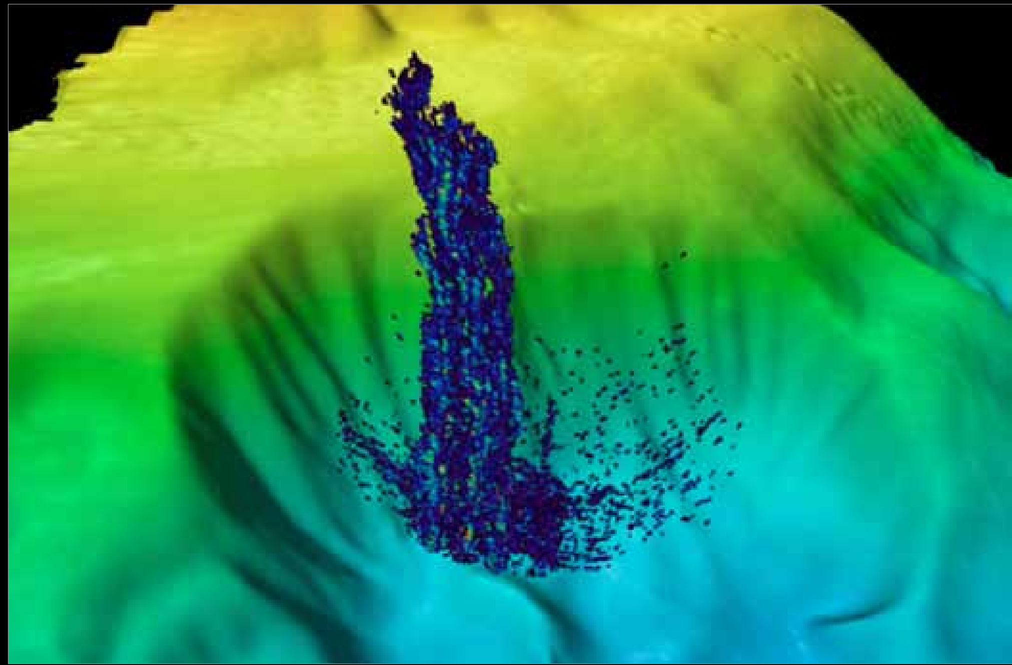
This is a sonar image of a plume of methane bubbles rising from disintegrating hydrates on the seabed off the coast of California. It was discovered by accident during a test of newly developed multi-beam sonar equipment by the National Oceanic and Atmospheric Administration (NOAA). The slumping pattern around the plume suggests a recent landslide.

This methane plume originates at a depth of 1,800 metres and after rising about 1,400 metres from the seabed the column of bubbles gradually disappears as the methane dissolves into the seawater, converts to CO_2, and helps to acidify the seas.

This absorption shows up most clearly in the sonar image of the Californian plume which peters out entirely after rising 1.4km through the water column.

Methane injected into the world's oceans in this fashion not only increases their acidity, it extracts free oxygen from the water and reduces the ocean's future capacity to absorb CO_2 from the atmosphere, thereby maximising the greenhouse impact of our own carbon emissions. When the water's free oxygen is exhausted, the sea's biota gradually dies. Such oxygen starved regions are multiplying and expanding around the world.

Data collected between 1981 and 2004 by researchers from the University of East Anglia, UK,[1] suggest that the vast Southern Ocean, one of the world's largest carbon sinks, has been saturated with CO_2 for at least two decades, and its high level of acidity is already showing up in the biota.



National Oceanic and Atmospheric Administration (NOAA)

The carbonate casings that protect one species of plankton (*Globigerina bulloides*) have proven to be 30%–35% thinner than shelly casings deposited by the same plankton about 250 years ago, just before the modern industrial era began. According to recent drill-core evidence gathered from the Great Barrier Reef, these casings are now far thinner than they have been for at least 200,000 years.[2]

Planktonic organisms underpin the entire marine food chain, so any threat to its food base is an ominous sign indeed. Even more ominous is the fact that marine acidification occurs as the water accumulates hydrogen ions. Once again, hydrogen is life's final regulator.

1. Lough, J., Australian Institute of Marine Science. ABC News in Science: http://www.abc.net.au/science/articles/2005/09/30/1470355.htm

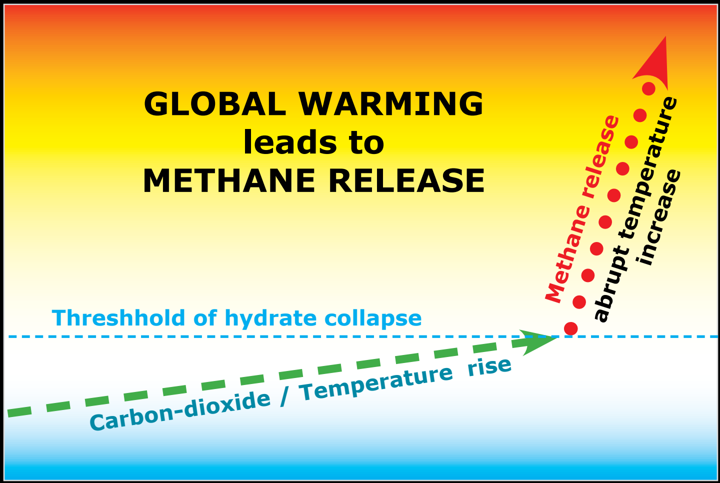
2. Kleypas, S.R. Palumbi, O. Hoegh-Guldberg, R. Van Woesik, J.C. Ogden, R.B. Aronson, B.D. Causey and F. Staub."A call to action on coral reefs." *Science*, 10 October 2008: 189b-190b (DOI: 10.1126/science.322.5899.189b)

METHANE RELEASE

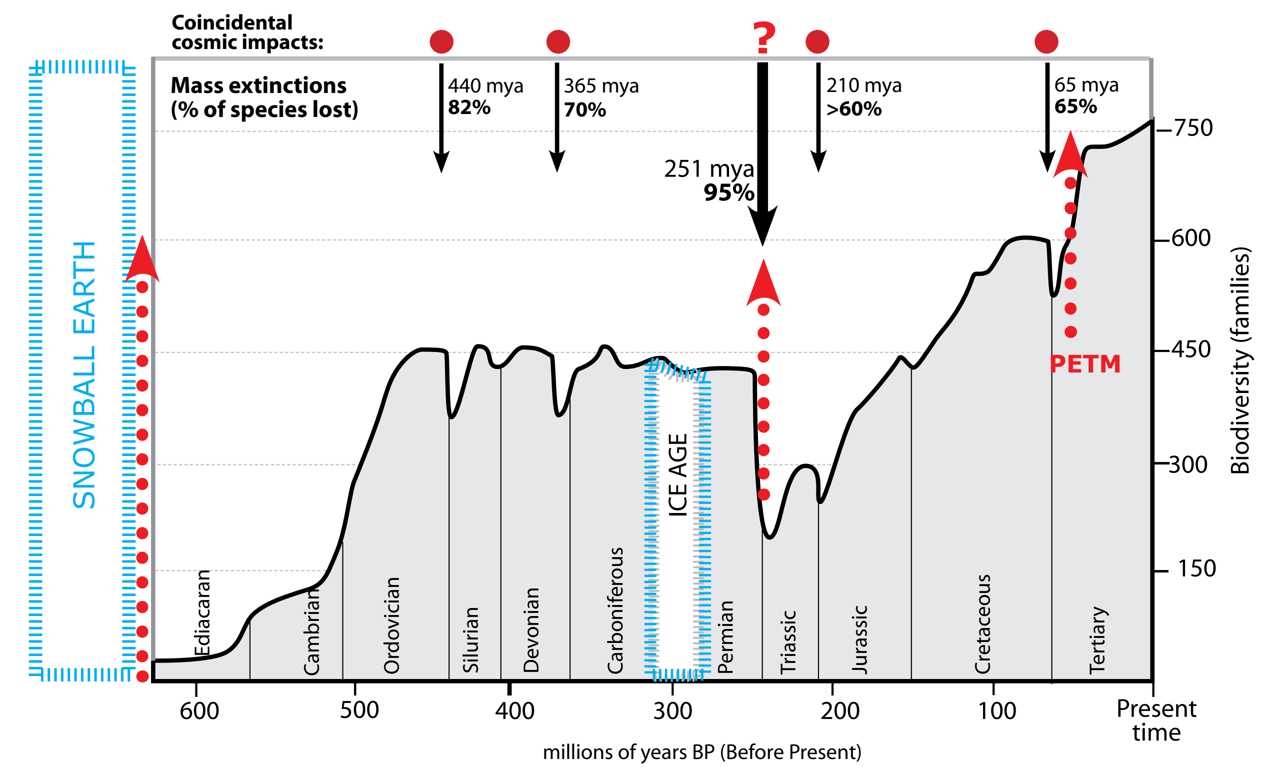
The massive reserves of bacterial methane that become trapped in marine and tundra ices for long periods of geological time may well represent the ultimate climate-control mechanism for the whole planet.

There is good geological and biological evidence to suggest that there have been three or four occasions in the past when eruptions of methane into the atmosphere have sent global temperatures soaring upwards. On each of these occasions the geological and fossil record indicates an increase in atmospheric CO_2 and a slow temperature rise, followed by an abrupt warming that can only be accounted for by a massive release of methane.

Ominously, each of these methane eruptions also coincides with a mass extinction of life.



MASS EXTINCTIONS : COSMIC IMPACTS : METHANE



Based on J. Sepkowski, 1988.

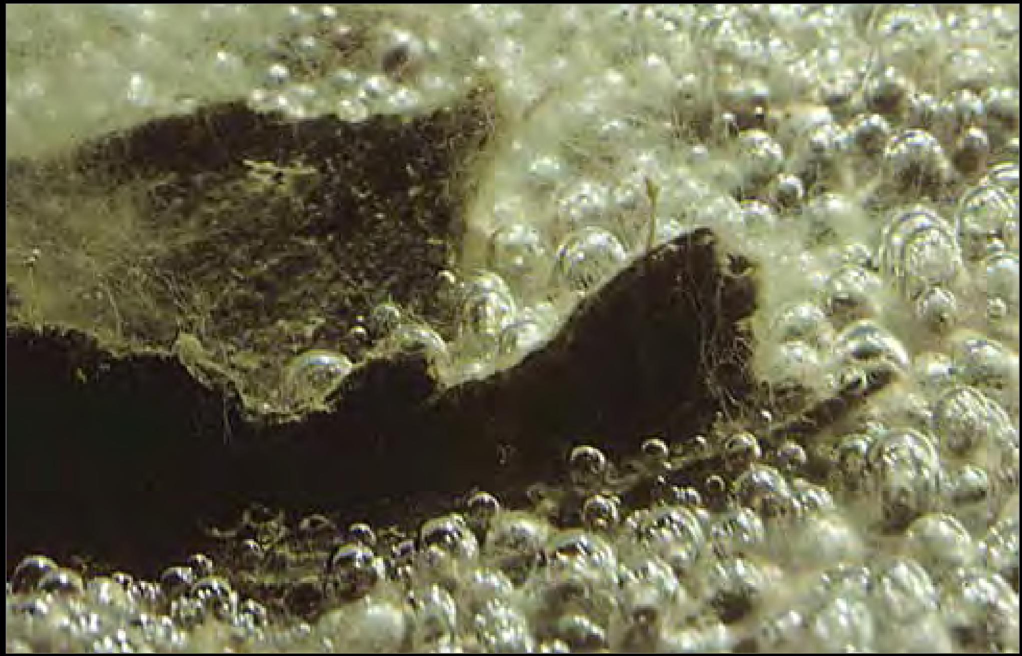
The two-stage sequence consisting of a long, slow temperature rise followed by abrupt global warming has been clearly identified on at least three occasions in the past. By far the most spectacular of these was the two-stage warming event that ended the world's greatest Ice Age around 630 million years ago. It ended more than 100 million years of global deep freeze, a time known as 'Snowball Earth'.

The second major methane release came around 251 million years ago when the massive forests that characterised the Permian period lay rotting in the deepening swamps of the world. It coincided with the greatest mass extinction of life in the fossil record. A smaller methane release occurred about 55 million years ago during a lethal warming event known as the Palaeocene-Eocene Thermal Maximum (PETM).

METHANE: extinction agent

Methane appears to have been a major factor in three or four of the world's great extinction events—around 630 million years ago, then at 260 and 252 million years ago, and most recently, 55 million years ago. On each of these occasions the atmosphere's CO_2 rose slowly, and then the world warmed abruptly. Only a massive injection of methane (CH_4) can account for such an abrupt temperature change. In the second-last event (252mya) methane appears to have been implicated in the disappearance of most of the world's surface life.

More than 20% of the world's methane emissions are natural and come from hydrogen-hungry archaebacteria that inhabit the Earth's crust to a depth of almost 4 kilometres. They are known as methanogens. The other 60% are attributable to human activity ...



Bubbles of methane carpet a stagnant pool beside the Finke River, NT.

Kow Swamp, VIC.

*LEFT & BELOW: Methane-generating archaebacteria discharge large volumes of the gas as they digest cellulose in anoxic environments such as swamps, flood-irrigated fields, stagnant waterholes, dams and reservoirs. The ancient forests of Redgums (*Eucalyptus camaldulensis*) shown here were drowned by waters impounded for irrigation purposes in the Murray valley, VIC. Decaying forests like these will yield hundreds of tonnes of methane for many decades to come as the trees fall into the water and become food for methanogenic bacteria.*

Lake Mulwala, VIC.

Human-generated Methane sources

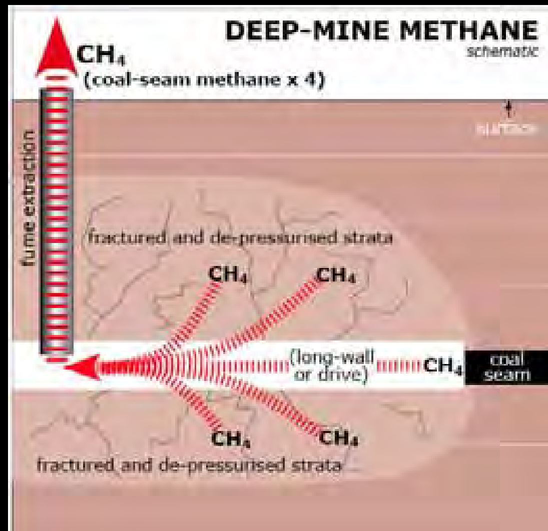
More than 60% of the daily methane emissions around the globe are directly attributable to human activity. The main sources are our vast herds of cattle and sheep (22%), the bacterial decay of manure and other liquid waste (14%), and swamp gas generated by flood irrigation, notably rice and cotton (more than 18%). In similar fashion, some hydroelectricity reservoirs release so much methane from rotting vegetation in their sediments that their greenhouse impact is greater than that of a coal-fired power station of comparable electricity output.

The mining of fossil hydrocarbons (coal, oil, gas) also releases a huge volume of bacterial methane into the atmosphere. ...

Beef cattle at an artesian bore, NT

Flooding of the Hebe coalmine, Collie, WA (1965).

Most coal-mine methane is discharged by the coal-eating bacteria that infest the seam wherever water is present. Some Australian coals are up to 67% water by volume. Drilling and blasting during the coal-mining process initiates an extensive pattern of fractures in the surrounding strata, thereby releasing most of the methane trapped in the country rock. The evacuated air often contains four times the methane in the coal seam itself.

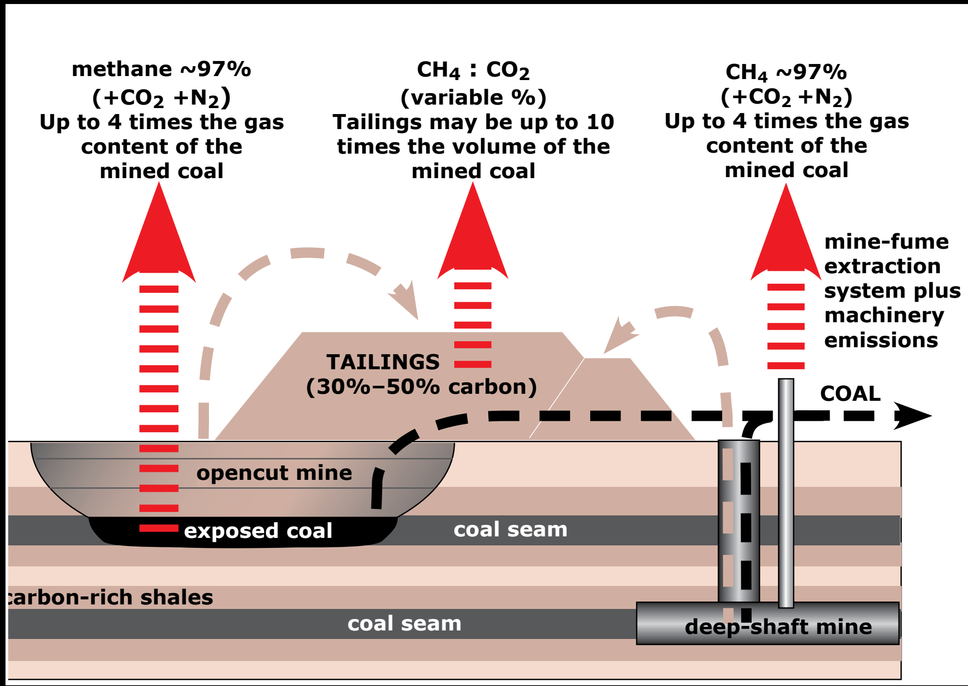


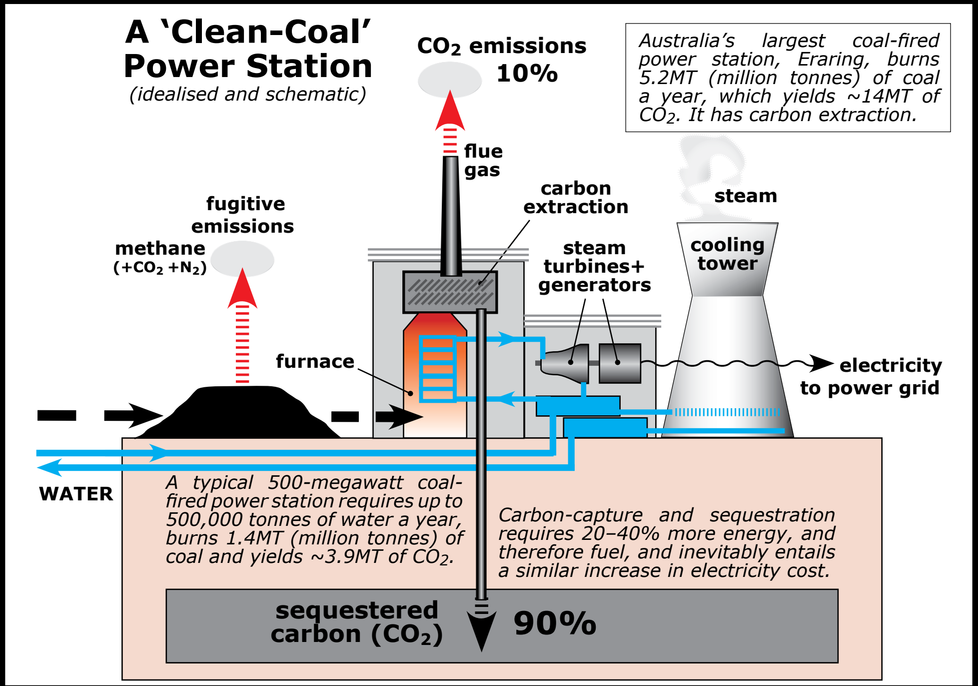
FUGITIVE METHANE EMISSIONS

All coal mining, whether deep-shaft or open-cut, is responsible for releasing significant quantities of carbon into the atmosphere. The common belief is that all these carbon loaded emission come from power-station chimney stacks. In fact, most are released before the coal is burnt.

Significant volumes of methane (CH4), and small quantities of carbon monoxide (CO), carbon dioxide (CO2), sulfur dioxide (SO2) and nitrogen oxides (NOX) are released into the atmosphere whenever an underground coal seam is breached or the overburden is removed. The act of exposing a coal seam to the air inevitably releases the embedded gases and then allows the exposed coal to generate additional CO2 as it oxidises and decays. Meanwhile, the overburden that is removed during opencut mining may constitute up to 10 times the volume of the mined coal, and these tailings inevitably contain a considerable percentage of coal which oxidises on contact with the interstitial air in the tailings, releasing still more CO2.

Deep-shaft mine tailings that are unfit for use in power generation have a similar gas problem, and although the volume of gas that is released varies considerably from mine to mine, the gas content of Queensland coal seams occasionally ranges up to 15 cubic metres per tonne and contains up to 97% methane. Some coal seams are so rich in these greenhouse gases that mining is impossible without first purging them of their methane. *





*"Fugitive Emissions from Coal Mining." Reported in a 1999 paper by The Australian Academy of Technological Sciences and Engineering.

‘Fracking’ for gas

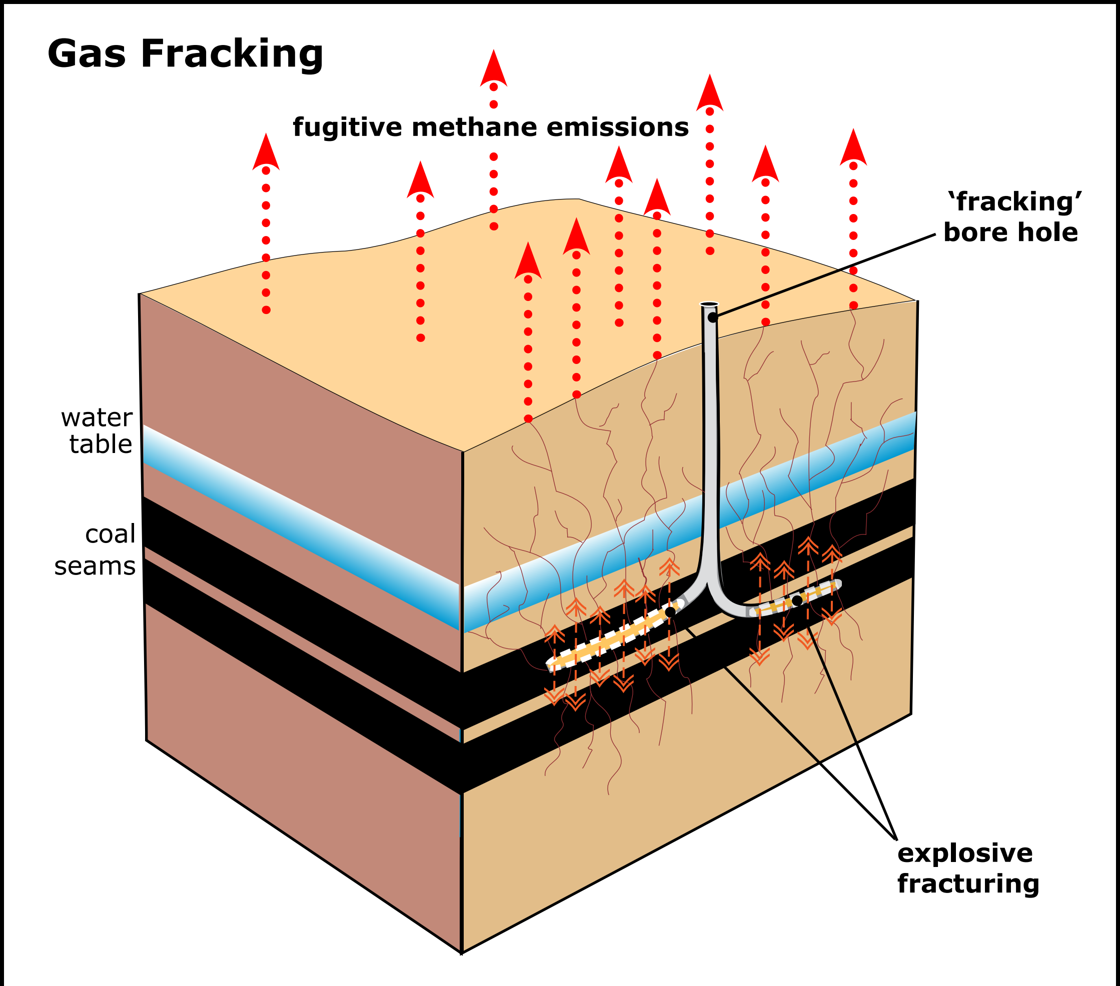
The primary intent of ‘fracking’ (hydraulic fracturing) is to open a multitude of cracks in the surrounding strata in order to release bacterial methane that has been accumulating in the country rock over hundreds of thousands, and perhaps millions of years. (Methane lasts indefinitely in anoxic interstitial environments.)

Since gravitational pressure increases with depth, the shallower the rock strata, the more easily it fractures. So fractures that begin at a coal-seam drill site invariably extend upwards much more easily than do those fractures that extend downwards.

This virtually guarantees that any blast designed to fracture the strata surrounding a coal seam will open a filigree of fine cracks throughout the region, some of which will extend all the way to the surface.

This extensive fracturing guarantees that methane and a variety of fracking chemicals will leak into any water table that overlies the coal seam, and also guarantees that methane will continue to leak into the atmosphere from small surface fractures on a semi-permanent basis.

When commercial interest in the gas field ceases, for whatever reason, maintenance of the the metal and concrete installations will cease and they will gradually disintegrate. This will enable an increasing leakage of methane from the boreholes.



“Fracking” is the technique of pumping a mixture of water, sand and a cocktail of toxic chemicals under pressure into horizontally drilled wells in order to liberate the gas from coal seams and shale. But fracking extracts only 20 per cent of the gas, a figure confirmed by Canada’s National Energy Board. The rock formations shattered by fracking will allow the remaining 80 per cent of shale gas to continue bubbling into the groundwater and into the atmosphere through the fracture system and the disused and disintegrating wellhead fittings. *

*Marc Durand, former Professor of Hydrogeology, L’Université du Québec à Montréal (UQAM).

OUR FREE RIDE IS OVER

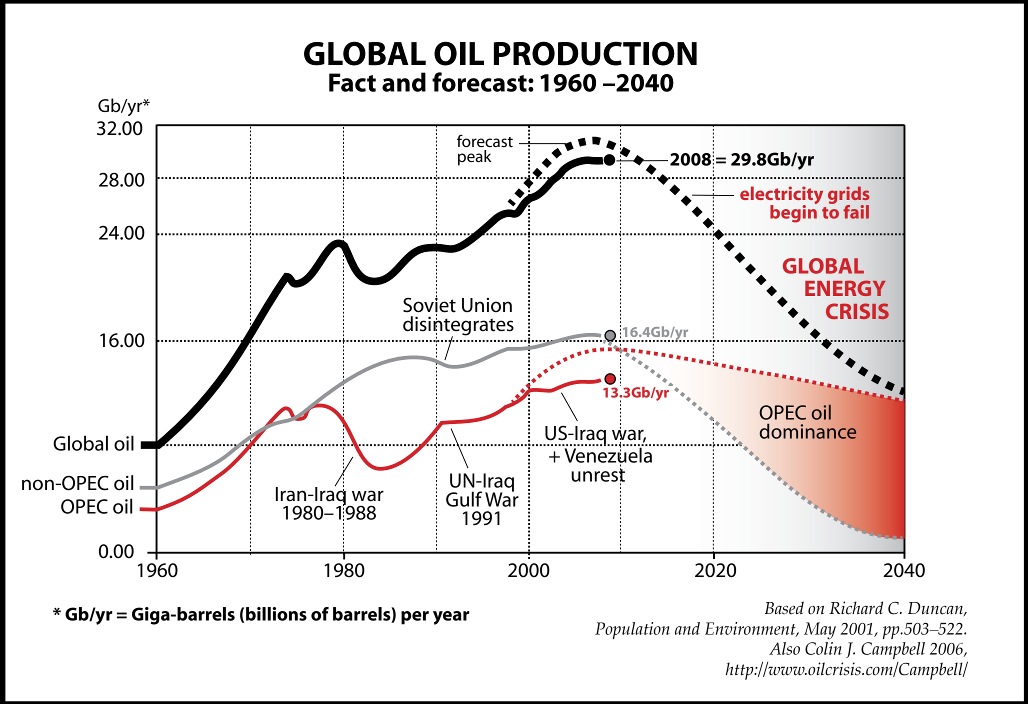
In view of hydrogen's role as the primary energy carrier throughout the cosmos and its consequent role as the maker and breaker of life, it now seems likely that our civilisation's extreme dependence on the three fossil hydrocarbons, coal, oil and gas has placed our species on evolution's endangered list. The most crucial of those three fossil fuels is oil. Not only is it the easiest to extract, transport and burn, it is by far the most energy-rich because of its hydrogen content. The more hydrogen an oil contains, the more calories each litre yields when it is burnt.

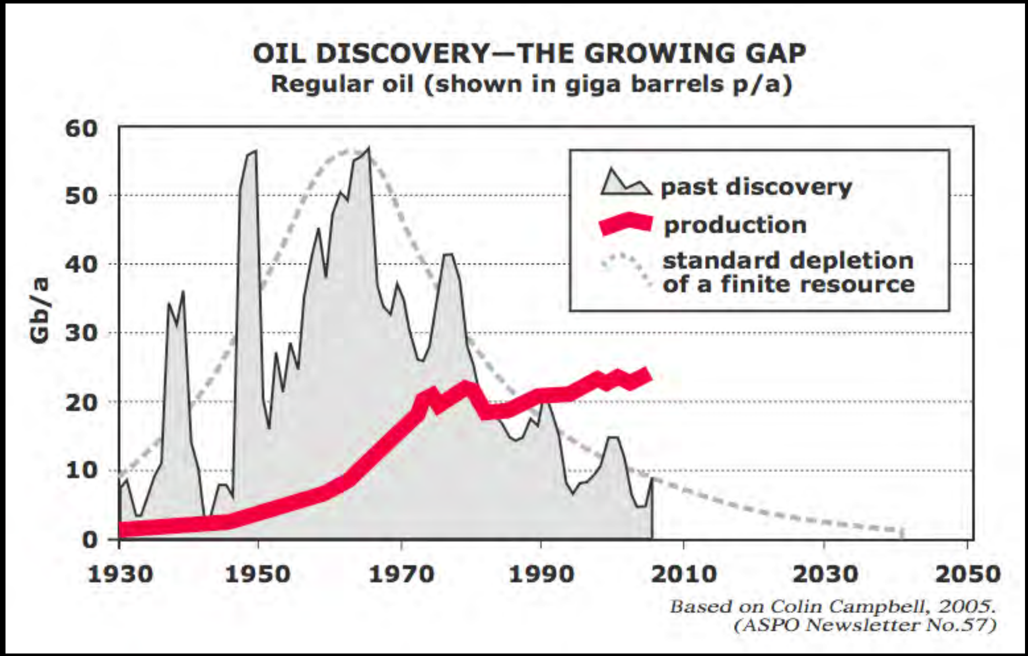
Luckily for us, the world had large natural reserves of oil, and it has been relatively cheap to extract. But the pump price gives no hint of the real cost of the multitude of petroleum products that civilisation consumes each day.

For example, each litre of petrol that we burn in our cars is the distilled residue of some 23 tonnes of ancient organisms (generally phytoplankton). Meanwhile, the volume of oil products consumed by modern civilisation in a single day originally cost the planet some 13 months of continuous photosynthesis to produce.

It is an economically viable fuel because the planet has already done most of the preliminary distillation work. No other energy sources, finite or renewable, can possibly compete with it for this reason.

Thanks to the Earth's generous reserves of oil, humanity has had a relatively free ride into the twenty-first century, but oil production peaked in 2005 and is now about to decline. Meanwhile, our technology-based culture is so dependent on oil that it takes some 10 calories of petroleum to deliver each calorie of food that we eat.





EVOLUTION'S PENALTY CLAUSE

• *Energy only dissipates*

(second law of thermodynamics)

All energy gains are short-term and conceal disproportionate energy debt in the long-term

• As the world's oil reserves begin to shrink and concern over CO_2 emissions from coal-burning grows, our increasing hunger for energy is switching commercial attention to the extraction of methane (CH_4).

The rush to drill explosively into coal seams and gas-bearing shales will inevitably open billions of new methane leaks from the hundreds of thousands of new gas fields that are being tapped on all continents.

Recent research from several US gas fields shows that fugitive methane emissions from each well site commonly averages around 4% of the total volume of the extracted gas. This peer-reviewed study, published in *Nature* warns that this figure does NOT include additional losses from the pipeline and distribution system. This new assessment is more than double the official inventory figure. *

• With atmospheric methane already at an all-time high and accelerating upwards due to the melting of marine hydrates and tundra permafrost, it seems that evolution's Faust clause is being invoked yet again, as evolution collects its energy debt via runaway global warming and catastrophic sea level rise.

* http://www.nature.com/news/air-sampling-reveals-high-emissions-from-gas-field-1.9982

ENERGY SUMMARY

- As a component of the thermodynamic cosmos Earth's energy gradient is similarly Chaotic, fractal and sensitive to any altered input.
- As an interchangeable expression of the Earth's crust its biota is also a component of the planet's energy-dissipation machinery.
- Each species' survival is therefore strictly determined by its energy budget. Species that extract too little or too much energy are swiftly eliminated. (Inadequate energy extraction leads directly to energy starvation and population collapse. Conversely, excess energy extraction produces exponential reproduction, and this too, leads to energy starvation and population collapse.)
- Our *Homo* genus evolved as an Ice-Age primate omnivore some 2.5 million years ago, and survived well for most of that time.
- Threatened by global warming 10,000 years ago our *Homo sapiens* ancestors switched to agriculture to augment their nutrient intake.
- Boosted by the development of combustion engines, fossil-fuels, monoculture, intensive irrigation, petroleum-based fertilisers, pesticides, and mechanised fishing techniques, food became abundant during the 19th and 20th centuries, triggering a global plague of *H.sapiens*.
- That abundance of food and fuel has now come to its inevitable end, and as mysticism reveals its Faustian face on a global scale in waves of civil unrest and fear-charged aggression, population growth will grind to a halt and our species will enter its terminal decline phase.
- In accordance with the laws of thermodynamics this collapse is now unavoidable and will prune *H. sapiens* back to its genetic roots.

Last of Australia's desert nomads, Little Sandy Desert, WA (1963).

regm@optusnet.com.au

Website: http://regmorrison.edublogs.org