



The Whole Earth System and the Human Impact

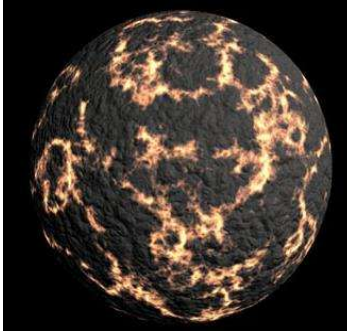
[Biosphere Restoration Plan](#)

Following the first rule of problem solving, the Envisionation team went back to basics and started, by asking:

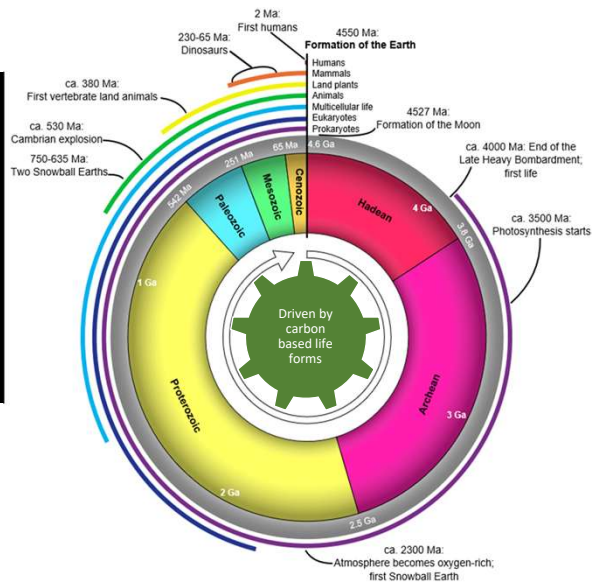
- What was full functionality of the Whole Earth System, before human intervention?
- How badly is it damaged?
- Can we fix it?

The answers are terrifying and exciting!

You are here because life has spent 4 billion years terraforming Earth



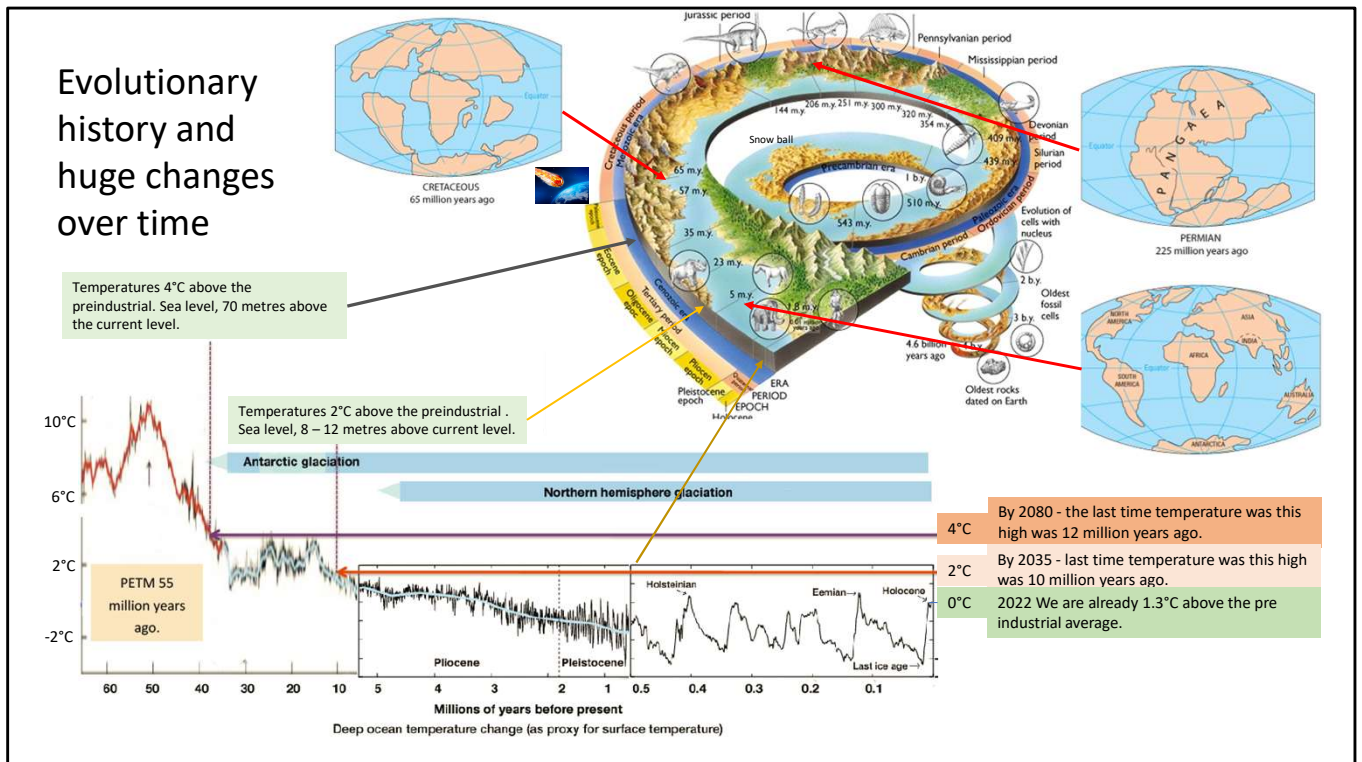
Coagulated space junk left over from exploding stars



Perfectly stabilised environment

Congratulations!

The fact that you are alive, means that you are part of an unbroken chain of events that is 4 billion years old. You are part of a terraforming life force that has converted the finite supply of elements of a coagulated lump of space junk, leftover from exploding stars, into ever more complex molecular structures, to create our beautiful world.



Let's dispel some misunderstandings about climate change

It is important to understand that in the past, conditions have been very different; much hotter and very much colder, due to the degassing of Earth's interior, changing configuration of Earth's landmasses and resultant changes in ocean circulation.

It is the past 5 million years that are particularly relevant to us with the continents positioned as they are now and the Earth orbits around the Sun, in its current configuration. During this time, average global surface temperatures have had a range of around 6°C between the cold glacial maximums and the warm interglacial peaks, causing ice sheets to advance and retreat on average every 110,000 years, as sea levels rise and fall, by up to 120m.

The last time Earth had an average surface temperature 2°C warmer than now, was 10 million years ago and the last time it was 4°C warmer, was at least 12 million years ago. It was a very different world then, with average sea levels 70m higher than they are now!

Our Living Biosphere



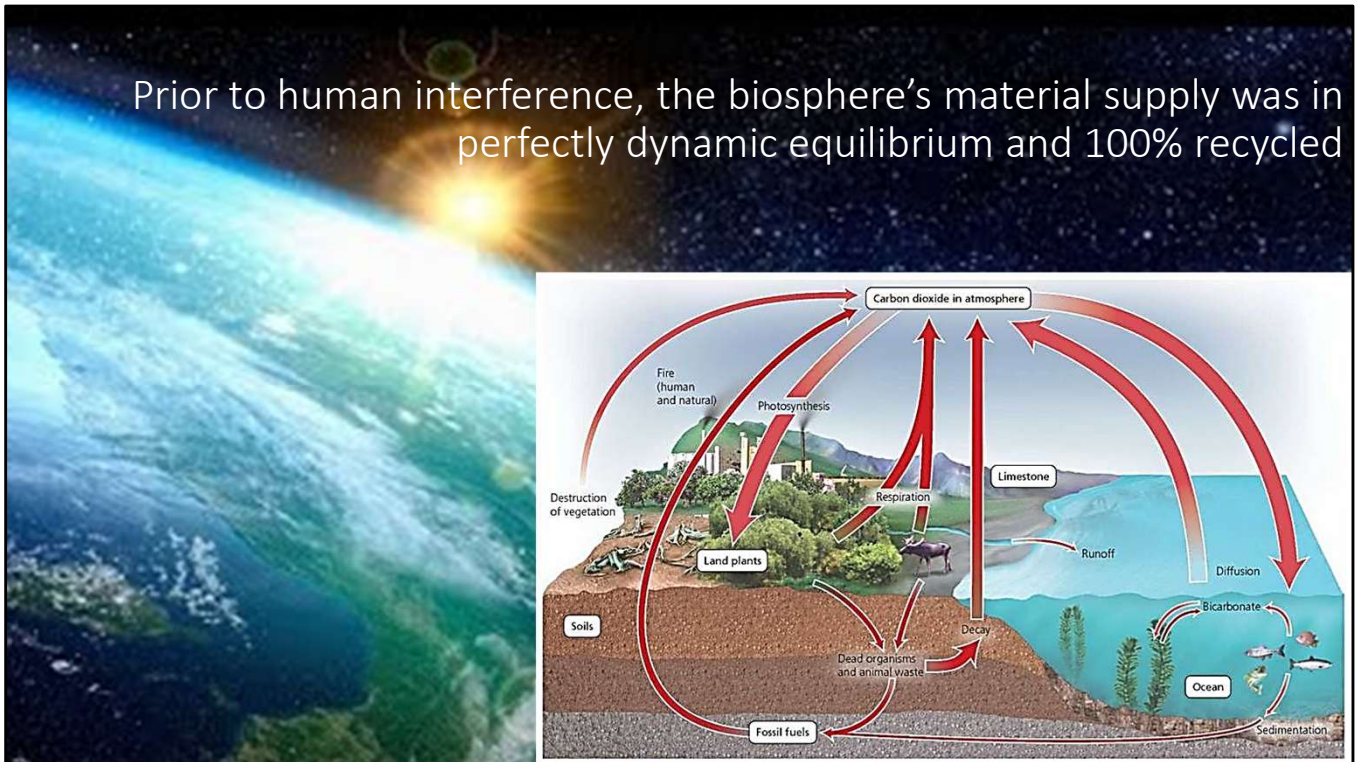
Our living Biosphere is a fragile membrane of land, ocean and atmosphere, known as the Critical Zone. It's an incredibly complex interconnected system, within which life maintains conditions suitable for its existence.

It is self-healing and able to provide stability under changing physical conditions. Given time, it is even able to recover from massive astrological and geological shocks.

It is our climate management and life support system.

Nothing is more precious or valuable. All of life and civilisation depends upon it.

Prior to human interference, the biosphere's material supply was in perfectly dynamic equilibrium and 100% recycled



Life does this, by circulating the finite supply of available elements

Of these, the carbon cycle and water cycles are the most important to climatic temperature control, as they balance the runaway greenhouse effect, by locking away surplus atmospheric carbon, as rocks, oil, gas and coal, to maintain average surface temperatures, within an acceptable range.

Self regulating temperature management by the entangled web of the integrated biosphere



Plants open and close stomata to control the rate of evaporation which cools, fungi release spores for water droplet formation in clouds. Microorganisms in the ocean load sea spray and evaporating water vapour with organic matter and dimethyl sulphide to control cloud formation. Clouds which then cool by reflecting away sunlight.

The entire biosphere appears to be entangled like a neural network in a quantum way. So that potentially a microscopic zooplankton in the South Pacific is linked and interacts with an oak tree in Europe which in turn is impacted by a fungal spore released from the Amazon. These are systems that we do not fully understand yet, but the evidence for their existence becomes ever stronger. Now consider what we have done to these systems.

The Human Impact

Almost everything we do is hostile to other life, as our actions disrupt the natural nutrient cycles

So much so, that over the past 10,000 years, we have reduced the overall amount of living things on Earth, to less than half of what had existed, for at least the preceding 2 million years!

We have reduced the planet's climate management engine to half of its original size!



The problem is that almost all human activity is hostile to other life forms

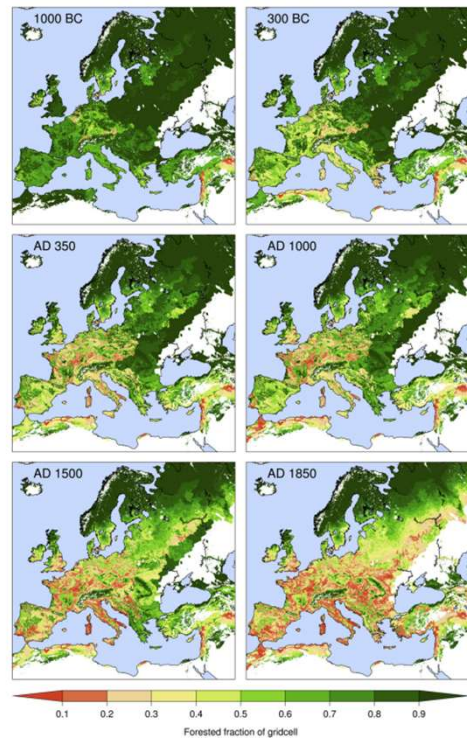
For over 10,000 years, we have been disrupting and degrading previously dynamically balanced ecosystems, by hunting, clearing forests for agriculture, grazing livestock, fishing, burning hydrocarbons and polluting with a vast array of non-natural chemicals.

So much so, that we have reduced the overall amount of living things, to less than half of what had existed for at least the preceding 2 million years.

That's greater than a 50% reduction in the size of our climate management engine. A system that we are completely dependent upon!

Historical forest clearance: 1000 BC to 1850 AD

The evidence is all around us

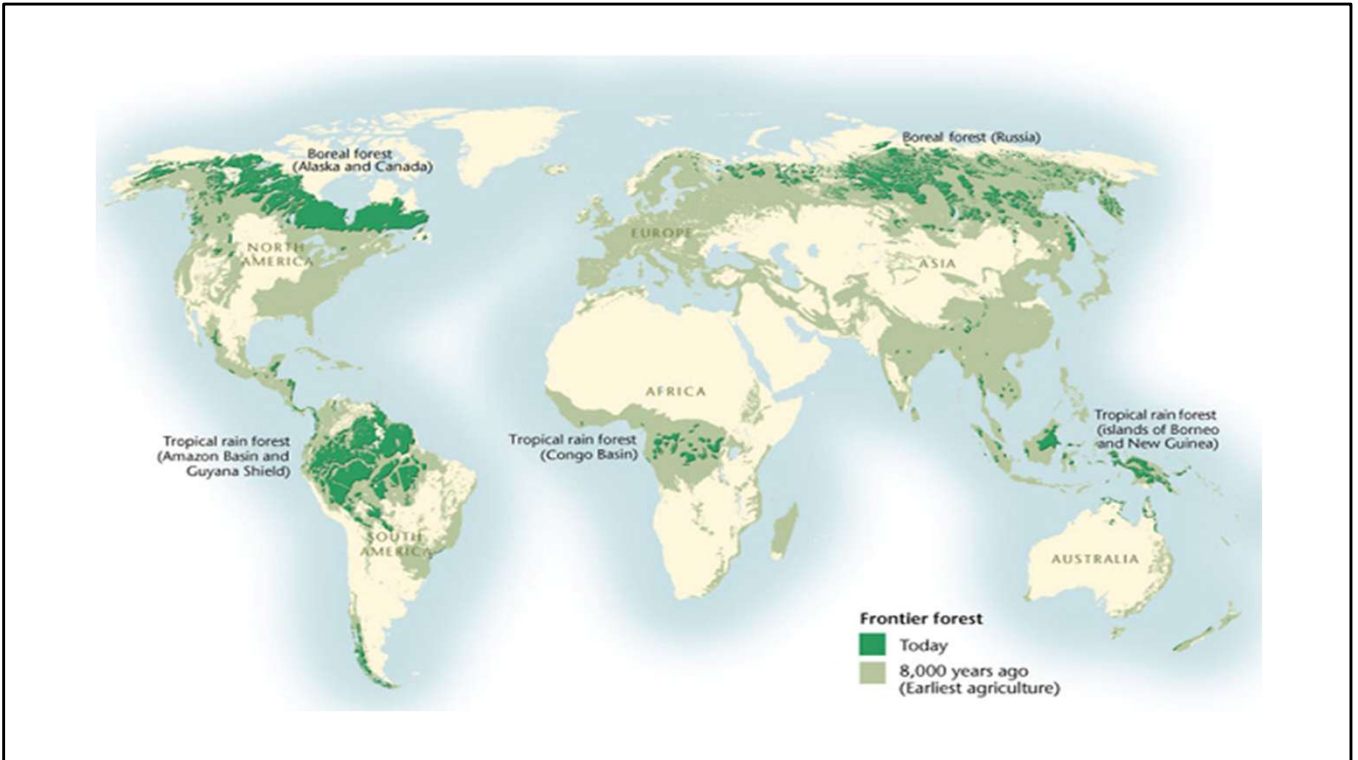


The evidence of biomass loss is everywhere, but we don't see it. We think our environments are normal!

Clearing forests and grazing animals have changed entire regions. The resulting loss of soil humus and subsurface life forms may be even more serious.

In this image, compare the green fields of England to natural forest, and consider the overall reduction in living biomass that the conversion from woodland to fields entails. On the right, the images show deforestation of Europe and North Africa from 1000 BC to 1850 AD.

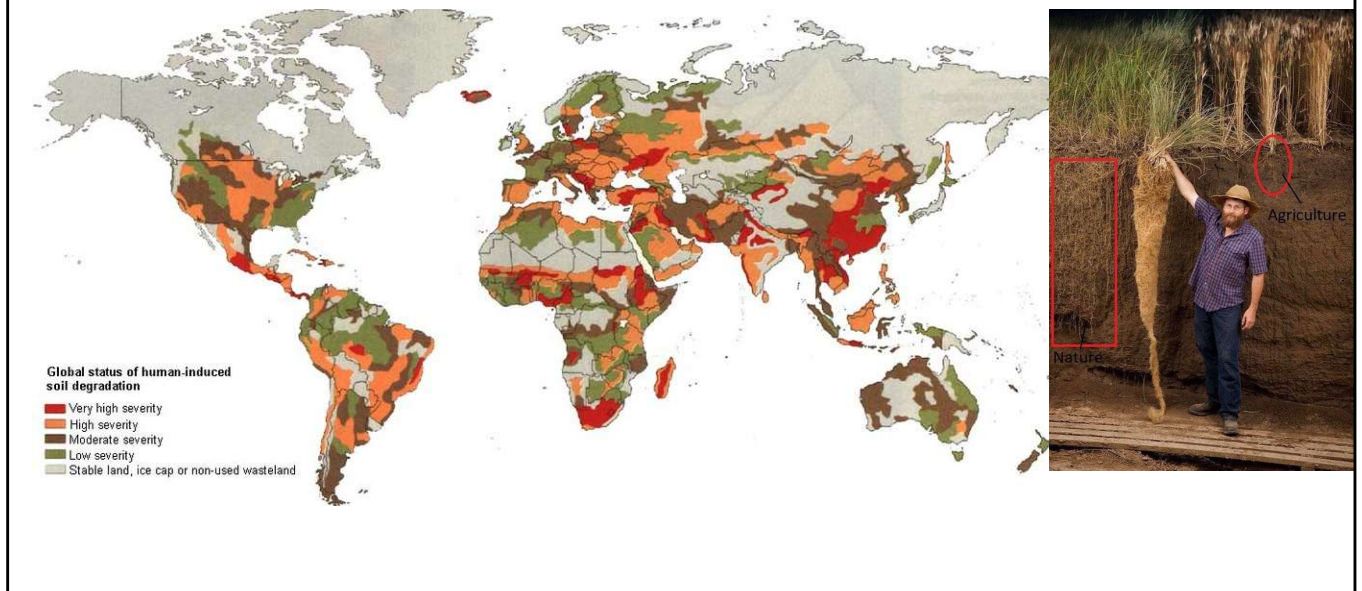
It's a colossal change!



The destruction has been repeated on every continent and continues today, at an accelerating pace.

This map shows what's left of the mature ancient primary forests, compared to 8000 years ago – and what's left are in the main, severely degraded ecosystems that are much less resilient and hold far less life.

Soil degradation



As the trees go, so do the soils.

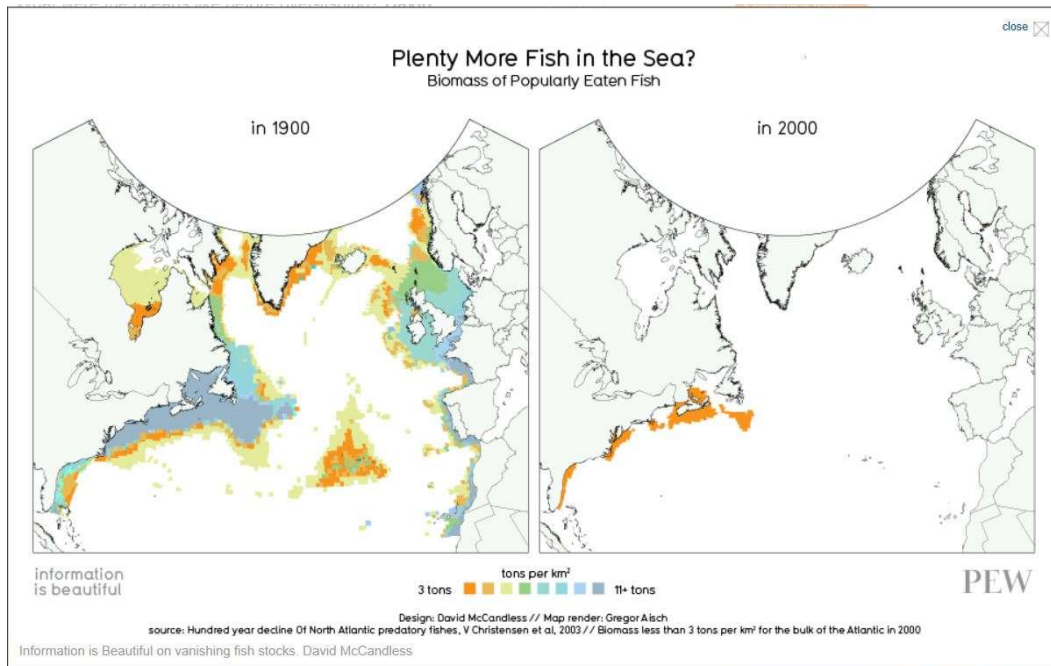
Mature soils hold massive amounts of life and provide stability against extreme weather.

Modern farming methods rip the biodiversity out of soils, reducing their ability to hold carbon and recirculate nutrients, so that we are forced to artificially fertilise our crops to grow.

The image on the right shows the root system of natural prairie grass, compared to that of wheat. They clearly contain very much more carbon.

So much of the damage we have done to the natural carbon storage system is hidden!

It's the same in the seas.



This slide shows the collapse of fish stocks between 1900 and the year 2000.

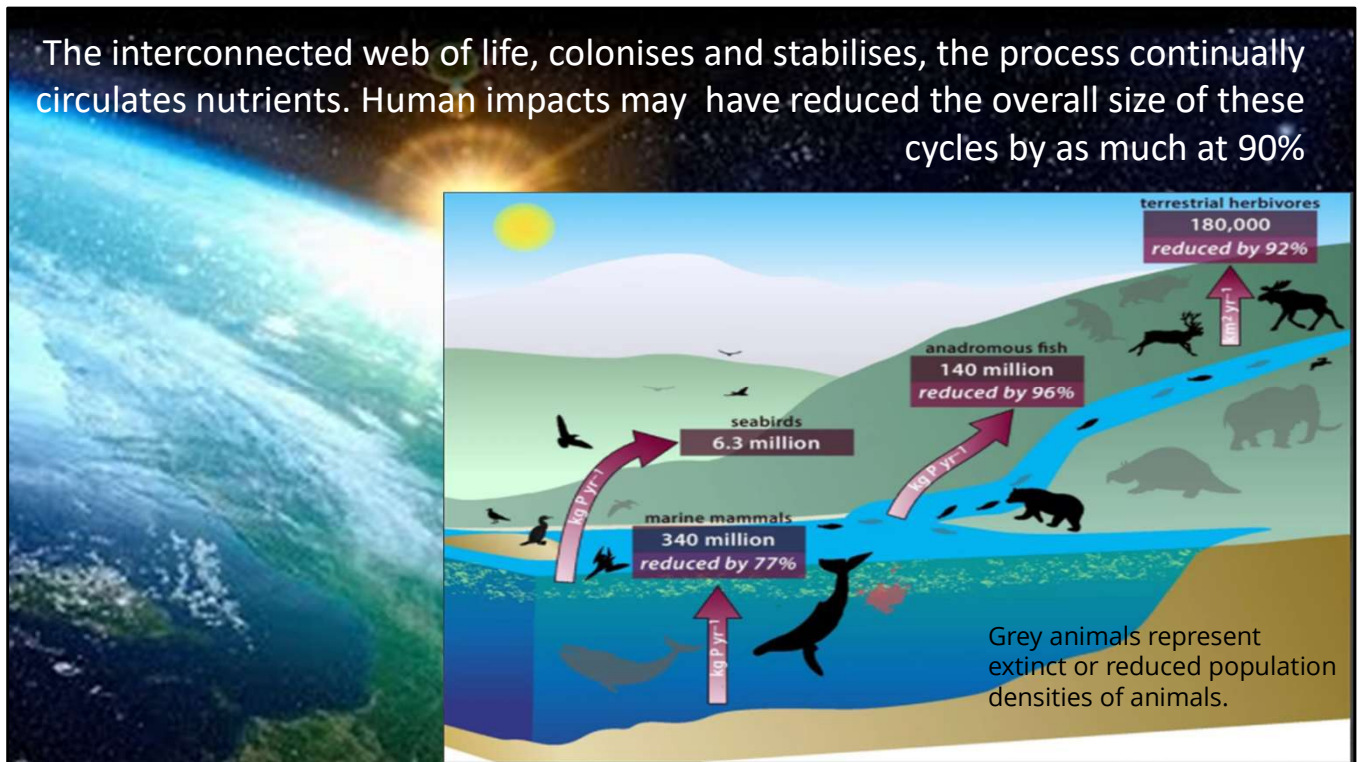
Back in 1500, almost the entire ocean in this image would have been coloured dark blue. Evidence of this can be found in the logbooks of the early fishing vessels, that record shoals of fish, so thick that vessels could hardly sail through them. After his voyage in 1497, John Cabot's crew reported cod off Newfoundland so plentiful that they could be swept out of the sea with a basket.



The loss of the whales destroyed nutrient cycles

It wasn't fishing boats that caused the collapse of the cod stocks, it was the reduction in phytoplankton, resulting from a shortage of whale poo, that powered the food chain, that fed the cod, that broke the nutrient cycle.

The interconnected web of life, colonises and stabilises, the process continually circulates nutrients. Human impacts may have reduced the overall size of these cycles by as much as 90%



The living things are the engines of the nutrient cycles

Whales dive deep in the oceans, to feed, then defecate at the surface, delivering essential nutrients for phytoplankton, which power the marine food chain. Seabirds and fish migrating up rivers, transport nutrients from the ocean to the land where, insects, birds, reptiles and mammals circulate them before such nutrients seep into the soil to fertilize the web of fungi that continuously exchange nutrients with various networks of vegetation roots, rivers return the nutrients to the seas.

Take out key links in the chain, and the system starts to degrade. The diagram shows 70-90% reductions in natural world nutrient cycling!

In nature, the more complex an ecosystem is, the more stable and robust it is.

<https://www.pnas.org/content/113/4/868> (Note the figures in rectangles are x billions of Kg per year)



The aforementioned damage, is before we consider man's hydrocarbon pollution of the biosphere

Almost every single action we take has a pollution cost, with many knock-on impacts. All of which are hostile to living things, including ourselves.



Add to this, the disposal of plastics and runoff of industrial and agricultural chemicals, and not only have we disrupted the nutrient cycles, we are actively adding vast amounts of non-recyclable pollutants, further poisoning ecosystems.



Part 2: The Impact on the Climate of Human Actions

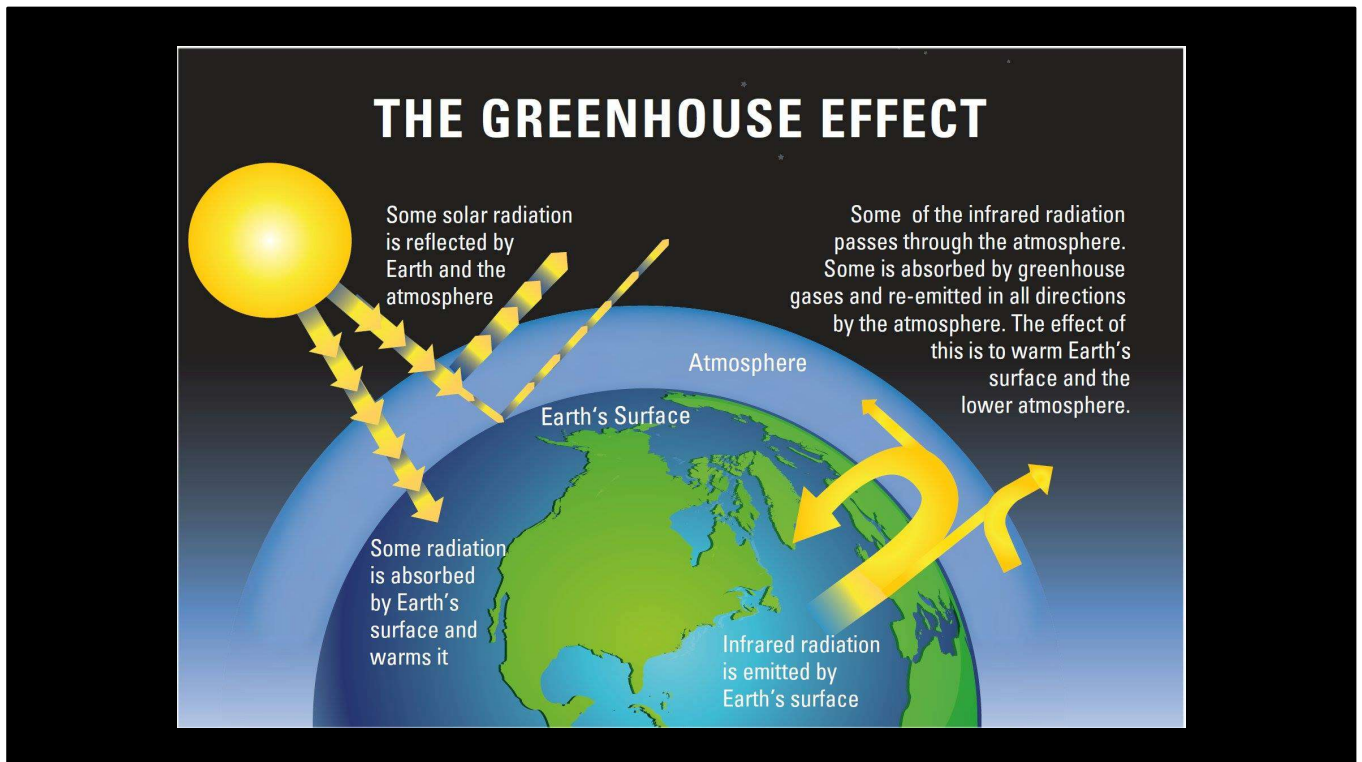
Biosphere Restoration Plan

Part 1 set out the working of the Whole Earth System and extent of the human impact on the essential natural nutrient cycles.

Now let's look at the impact on the Earth's climate systems.



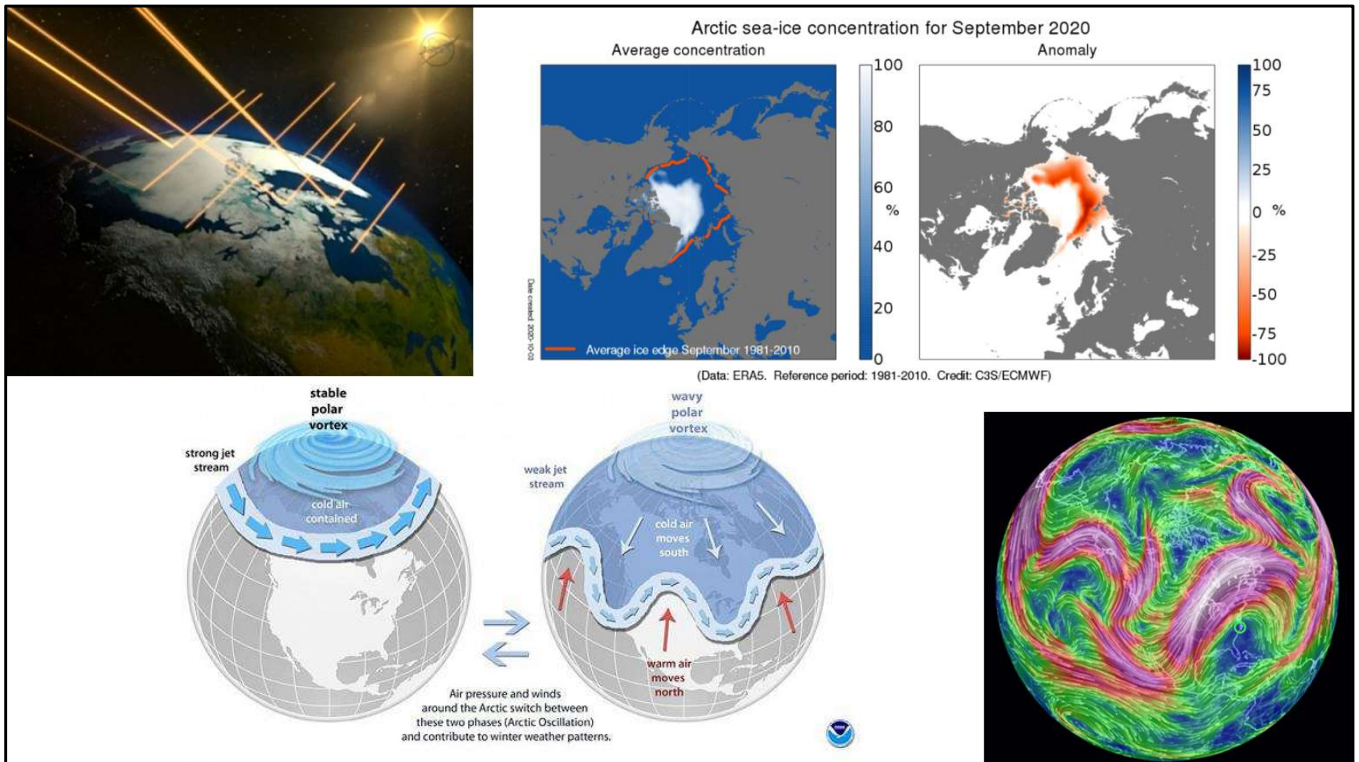
What does it mean? Just how bad is this and what's the time scale?



Burning hydrocarbons, destroying forests, as well as hunting and killing living things, thickens the CO₂ blanket trapping extra heat and causing the planet to warm and destabilise the climate.

It's like the difference between clear cold nights and warm cloudy nights that we are all familiar with. On clear nights, energy is radiated back out into space and the land cools, sometimes causing a frost. Cloudy nights are warmer, because heat is retained and reflected back to Earth's surface by the clouds.

CO₂ does the same thing, it's just that the blanket is invisible!

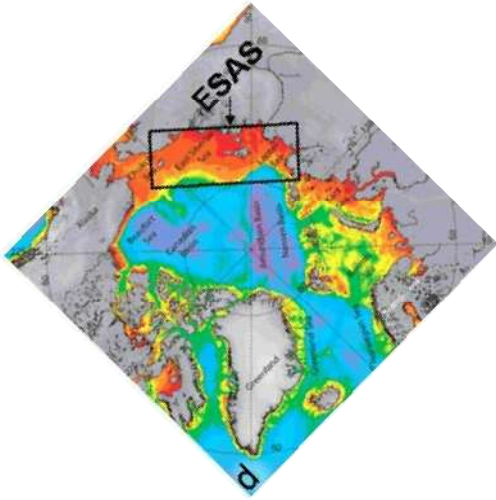


As we warm the Arctic, sea ice melts, the planet's polar regions reflectivity (Earth's albedo) reduces – dark oceans absorb heat, where once white ice and snow reflected it away

The CO₂ blanket is warming the polar regions 2-3 times faster than the equatorial regions, reducing the temperature gradient between the Equator and the Poles. It was the temperature gradient that maintained a tight stable jet stream in the past climate.

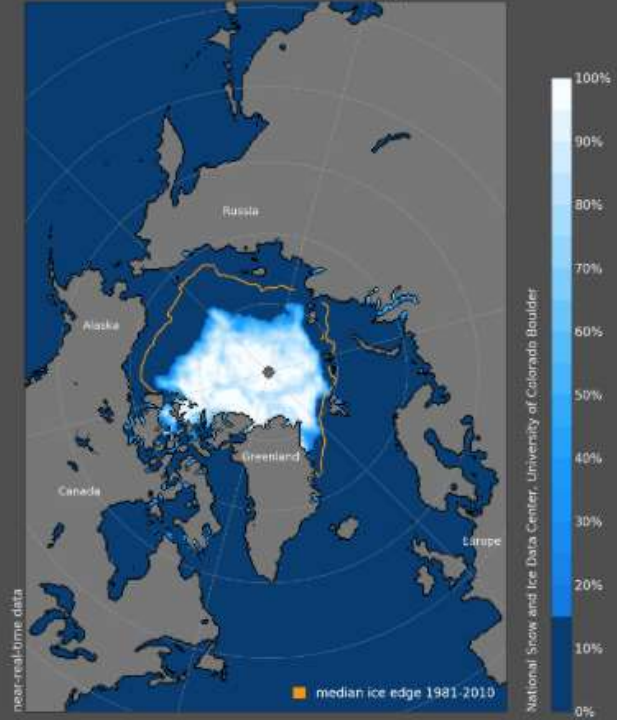
Now the jet stream looks like this, allowing rapid mixing of warm tropical air with cold polar air, which destabilises the jet stream causing more extreme weather events.

The risk of catastrophic methane release



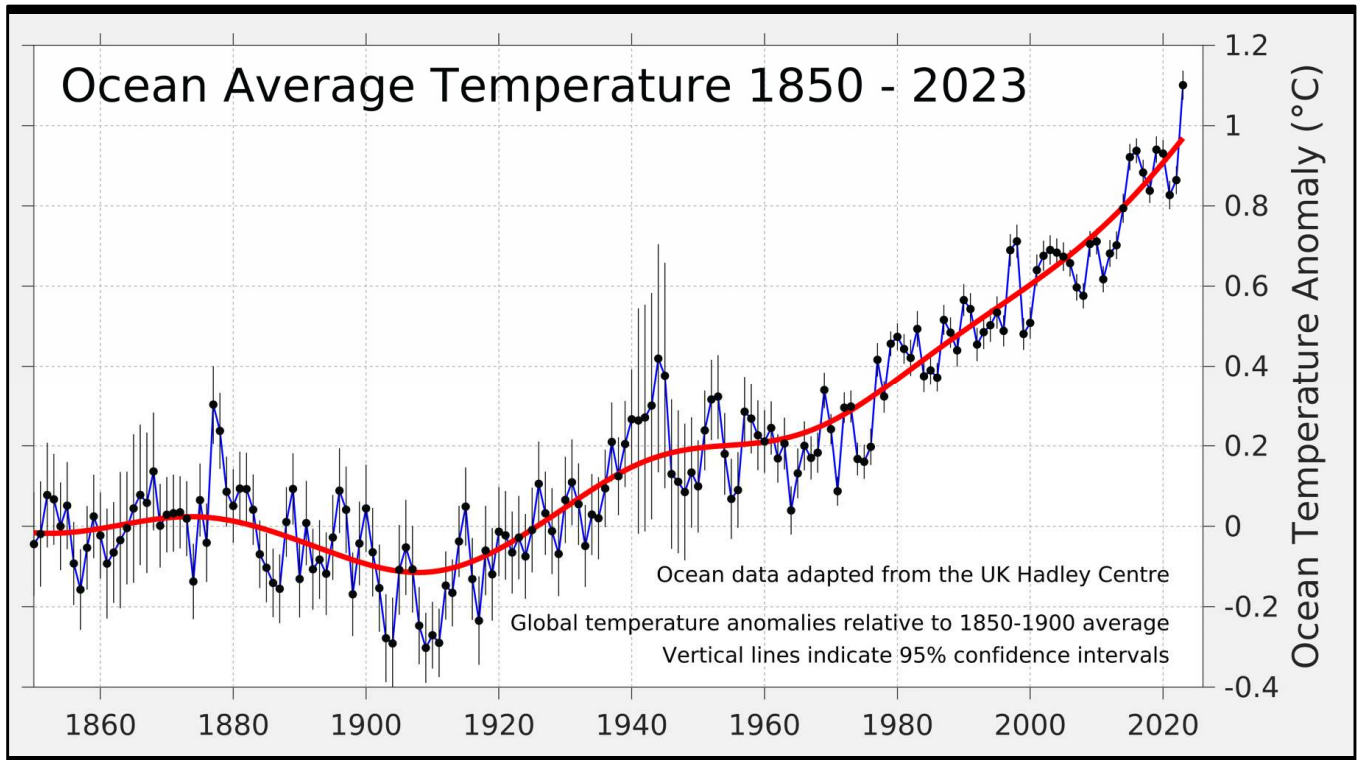
Red areas are a depth of less than 50m where sub sea permafrost is vulnerable to defrosting resulting in methane release.

Sea Ice Concentration, 19 Sep 2019



Under the seabed of ESAS (East Siberian Arctic Sea) (you are going to hear a lot about that in the coming years), are vast amounts of crystalline methane hydrates, which when warmed, release methane, a greenhouse gas that over a 10-20 year time scale is 80 -100 times more potent than CO₂.

If these escape into the atmosphere, and the indications are that this may have started to occur, it is likely to cause runaway warming. Once the increase of average global surface temperature passes 4°C from the pre-industrial era it will probably be unstoppable and our opportunity to control the situation may be lost.



Without the oceans, Earth would already be very much hotter

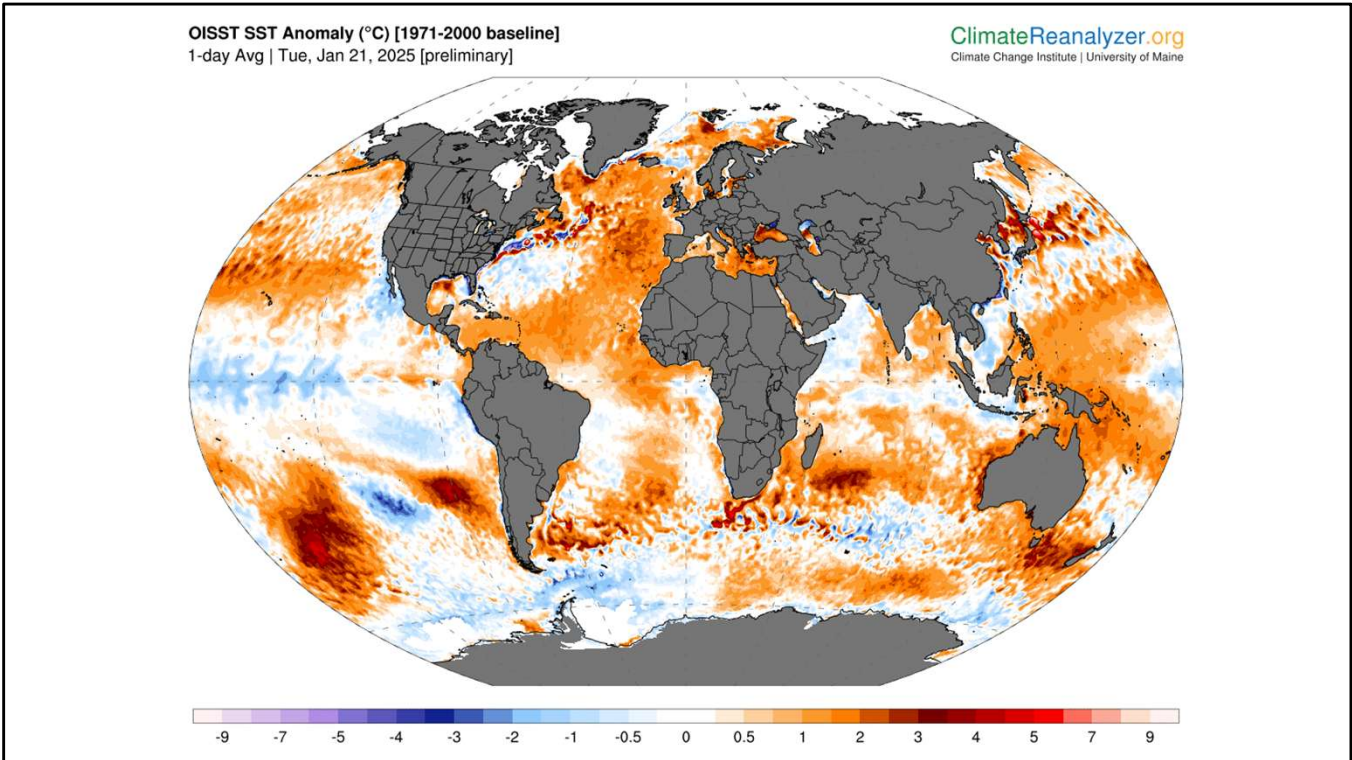
Fortunately, due to its high heat capacity, 90% of the extra heat trapped by the greenhouse effect, is absorbed by the oceans – think of them as giant night storage heaters, acting as a buffer to slow atmospheric warming.

It’s a colossal problem, even after we stop adding to the greenhouse effect by burning hydrocarbons, the heat in the oceans will keep melting the sea-ice and warming of both the oceans and the atmosphere will continue to well into the future.

That heat must be radiated back out into space if we are to prevent glacial melt from Greenland and Antarctica causing catastrophic sea level rise.

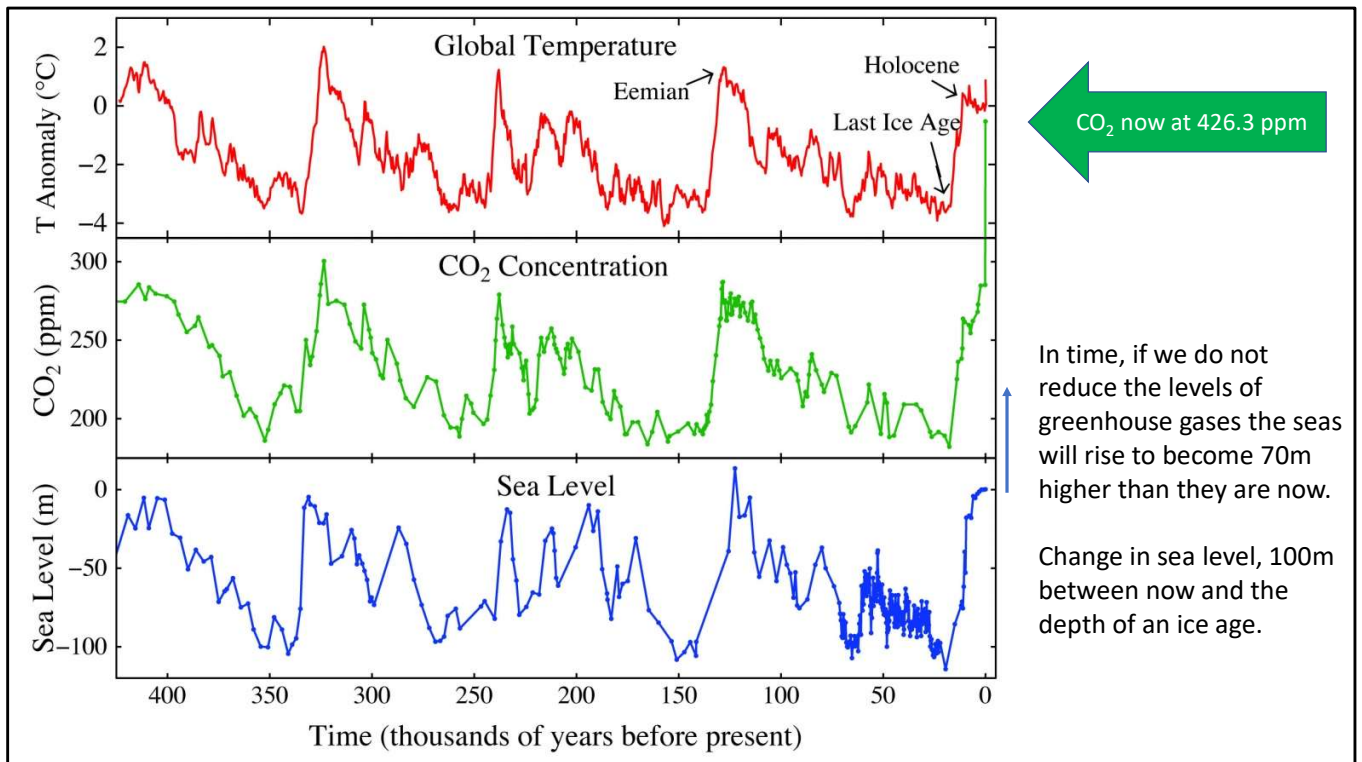
Unfortunately, it’s not just heating, the oceans have taken up a vast amount of our CO2 emissions, making them more acidic, which is damaging to many marine life forms.

<https://essd.copernicus.org/articles/12/2013/2020/essd-12-2013-2020-f06-high-res.png>



Climate Reanalyzer is a platform that integrates climate and weather datasets and models, making data easily accessible for visualization. It draws on climate reanalyses, models, and historical station data to create different plot maps, correlations, and time series. Climate reanalysis refers to physically-based numerical frameworks that simulate the state of Earth's climate through time, guided by frequent input of real-world observations.

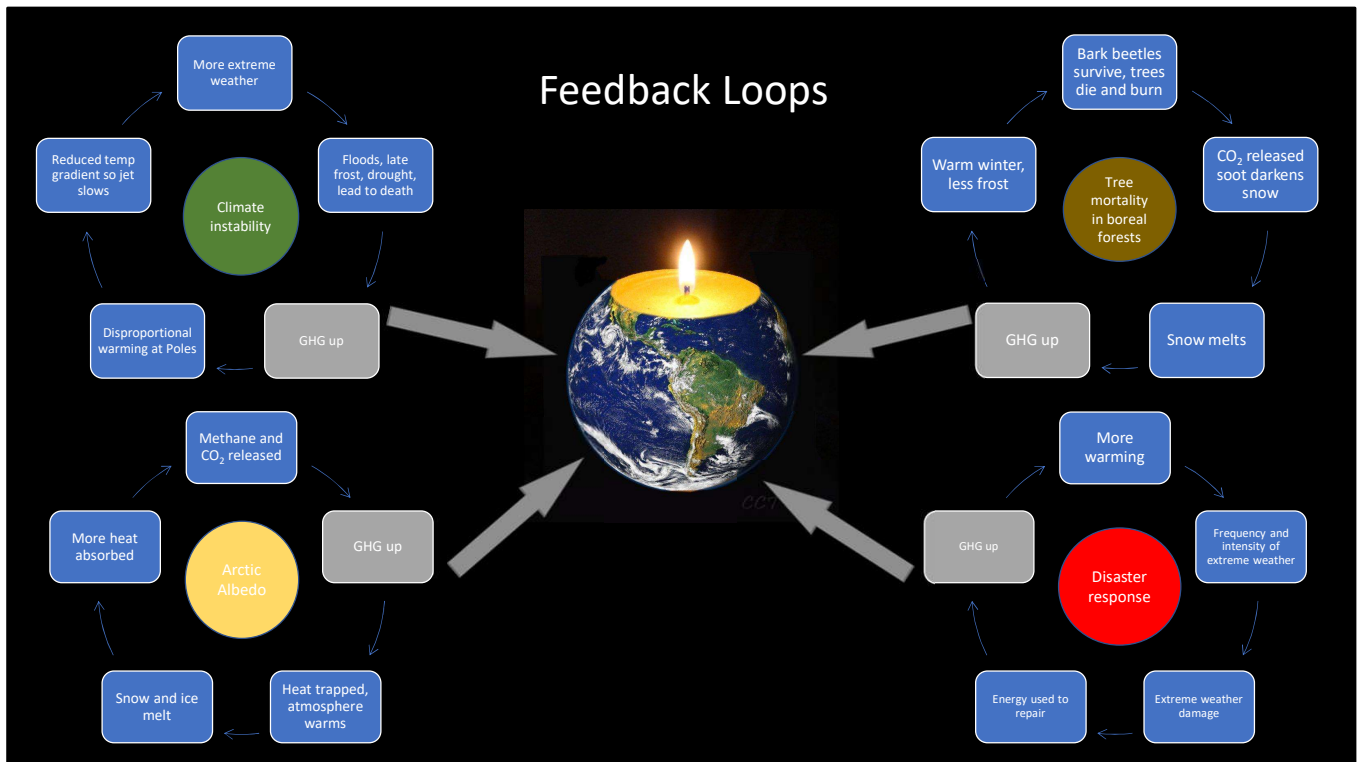
Visit [Climate Reanalyzer](https://climate-reanalyzer.org) to explore what's happening to our climate.



The results of hydrocarbon burning and biomass destruction

In these 3 graphs, you can see how temperature, sea level and CO₂ concentrations are linked.

Earth has not experienced CO₂ levels this high, for at least 12 million, maybe even 40 million years. In time, if we do not reduce the levels of greenhouse gases, the seas will rise to become 70m higher than they are now.

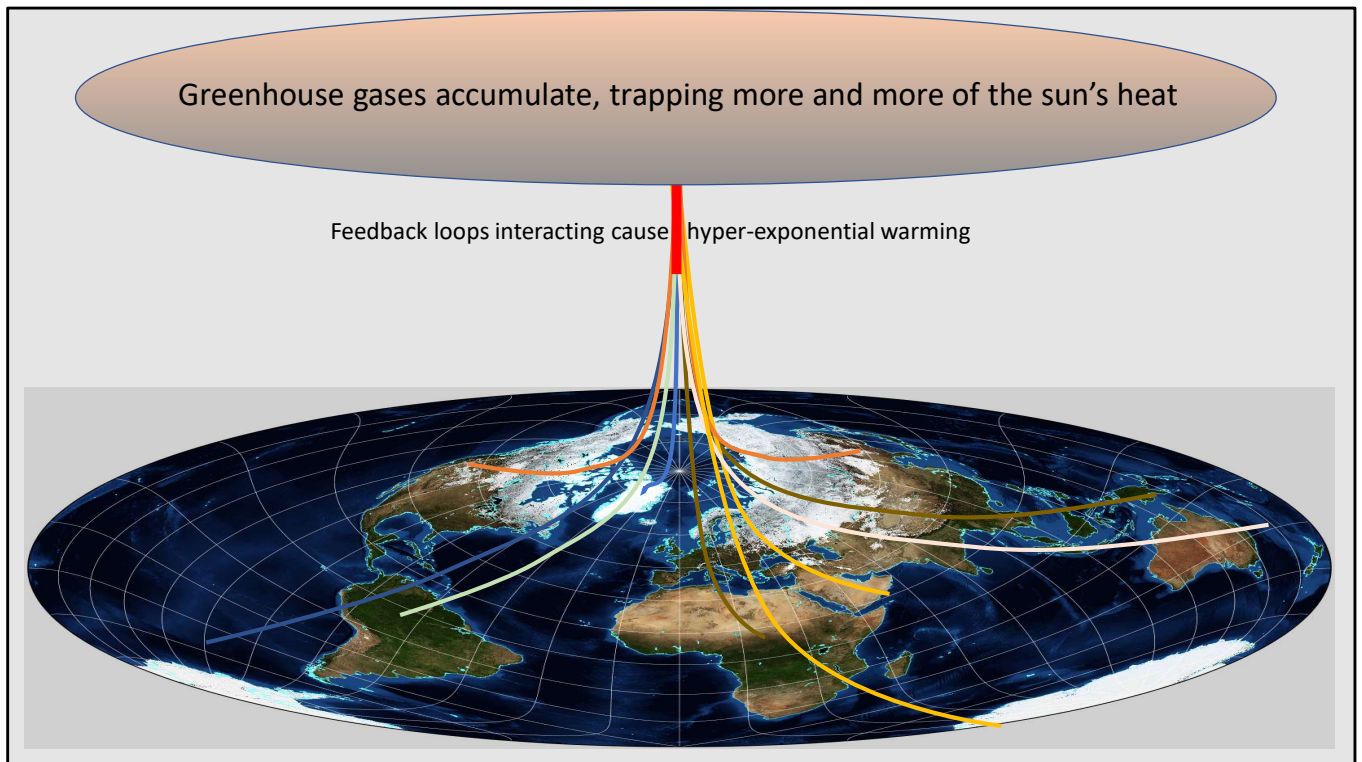


The destabilisation of the climate system has kicked off lots of self-reinforcing feedback loops – these are just a few of them

Arctic Albedo - the loss of reflectivity - as sea ice melts, more heat is absorbed by the darker ocean, which warms the ocean floor to release previously stable methane hydrates, which are particularly potent greenhouse gases - so more warming, greater destabilisation of the atmosphere, causing more extreme weather events. Resulting in things dying, leading to higher greenhouse gas concentrations.

Warmer winters with less frost, allow bark beetles to thrive and survive the winter, as a result, trees die, then burn, releasing CO₂ that leads to warming the climate. Soot then lands on the snow and ice, which, because it is darker, then absorbs more heat, melting the ice faster, so less ice over land and sea and more heat absorbed into the ocean. So, warmer winters again.

All causing – **Human Disaster Responses**. After every flood or fire, we repair, rebuild, dry out and replace – all of which require vast amounts of energy, leading to more CO₂ emissions – so, more warming. Furthermore, every flash flood event, washes thousands of tons of plastic and other pollutants into the sea, where they are ingested by living things that subsequently die, and our life support system is further eroded.

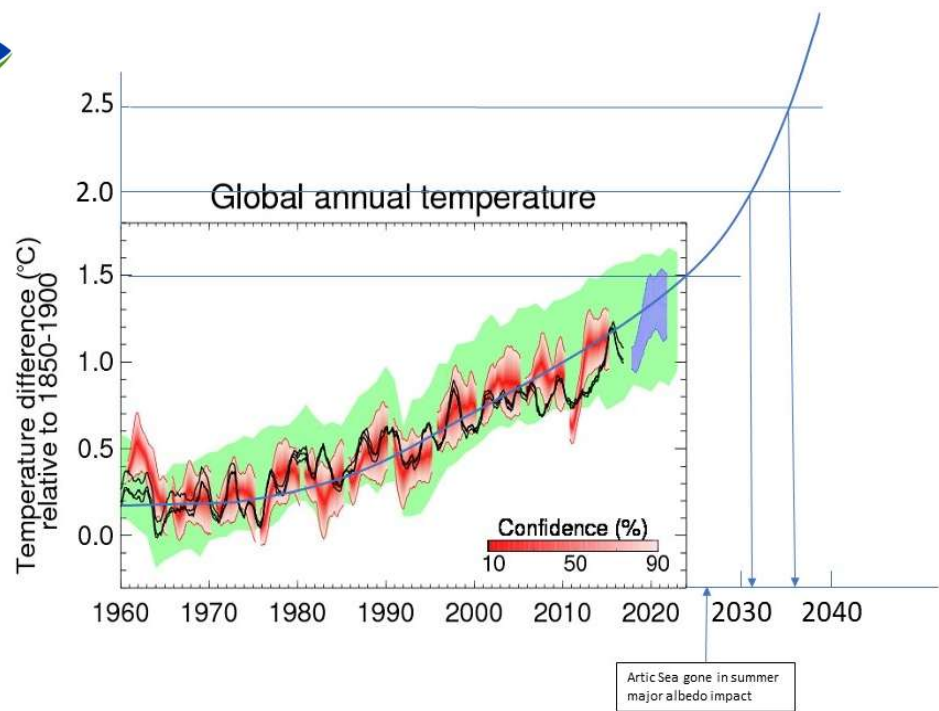


This is why you need to be deeply worried!

Multiple positive feedback loops combine to interact, reinforcing and accelerating each other, to warm the planet and destabilising the biosphere, faster and faster, overwhelming the natural balance of the system.

And, with less than half the amount of original life remaining, the resilience of the biospheres is greatly reduced. Thus, we become ever more vulnerable.

The interaction between most feedback loops is only partially accounted for in the IPCC analysis and their Advice to Policymakers.



The impacts are upon us

We extrapolating the line **for business as usual** in 2022 and as predicted in Jan of 2025 we are now above 1.5°C and on track for 2°C of warming, soon after 2032. By then, the Arctic sea ice will be gone for most of the summer and trajectory becomes much steeper, with 2.5°C of warming around 2037, and a potentially un-survivable 3.5°C to 4°C, by 2050.