

# Climate change on a live Earth\*

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**Resum.** Els líders mundials consideren que les conclusions del Grup Intergovernamental d'Experts sobre el Canvi Climàtic (GIECC) són fiables; tant és així que les prediccions obtingudes s'utilitzen per a formular lleis i polítiques. No obstant això, el GIECC no ha sobreestimat el canvi climàtic, sinó que ha subestimat la gravetat de l'escalfament global, principalment perquè ha prestat massa atenció a les emissions de diòxid de carboni i no la suficient a la resposta de la Terra. Al llarg dels últims quaranta-quatre anys he treballat observant la Terra d'una manera diferent, com un sistema dinàmic que regula activament el clima i la composició atmosfèrica per mantenir el planeta habitable. La Terra no accepta passivament l'acció humana. Respon al canvi climàtic d'una manera molt més mortífera que el petit canvi que estem provocant. La teoria de Gaia sosté que el sistema Terra pot actuar com un amplificador i les petites modificacions, ja siguin cap a la calor o al fred, s'intensifiquen, fet que podria ser la causa dels canvis erràtics de temperatura. En aquest article intentaré demostrar que aturar el canvi climàtic pot ser més difícil del que creuen els governs. La nostra tasca, en cas que l'escalfament global continuï, és adaptar-nos a la nova situació i preparar-nos per a sobreviure.

**Paraules clau:** teoria de Gaia · canvi climàtic · escalfament global · Grup Intergovernamental d'Experts sobre el Canvi Climàtic (GIECC) · ciència del sistema terrestre

**Summary.** The findings of the Intergovernmental Panel on Climate Change (IPCC) are taken by world leaders as authoritative, so much so that their predictions are used to frame legislation and policy. However, the IPCC has not overestimated climate change, they have, instead, underestimated the severity of global heating mainly because they paid too much attention to our emissions of carbon dioxide and not enough to the Earth's response. For the past 44 years I have worked on a different way of looking at the Earth, seeing it as a dynamic system that actively regulates the climate and the atmospheric composition to keep the planet habitable. The Earth does not passively accept what we do to it. It responds to climate change and that response is far more deadly than the small change that we are making. Gaia theory teaches that the Earth system can act as an amplifier and small changes either to heat or cold are intensified and this could be the cause of the erratic shifts of temperature. In this article I will try to show that stopping climate change may be more difficult than our governments believe. Our task, should global heating continue, is to adapt and prepare to survive.

**Keywords:** Gaia theory · climate change · global warming · Intergovernmental Panel on Climate Change (IPCC) · Earth System Science

## What happened to global warming?

You must be wondering what has happened to global warming. The average temperature has barely changed during the last ten years. Does this mean that global warming is no more than a green nightmare and we need no longer feel guilty about our carbon emissions? Sadly, the facts do not justify such a conclusion. If we want a more authoritative account of the cli-

mate we still must turn to the Intergovernmental Panel on Climate Change, the IPCC.

It is made up from over 1000 of the world best climate scientists and importantly they regard climate change as real, and potentially deadly. Their findings are taken by world leaders as authoritative, so much so that their predictions are used to frame legislation and policy looking 40 or more years into the future. European governments argue for massive and expensive action now if we are to avoid damaging climate change. Governments worldwide seem to assume that merely reducing carbon emissions will stabilize or even reverse climate change. In this article, which is about the Earth and its climate, I will try to show that stopping climate change may be more difficult than our governments believe.

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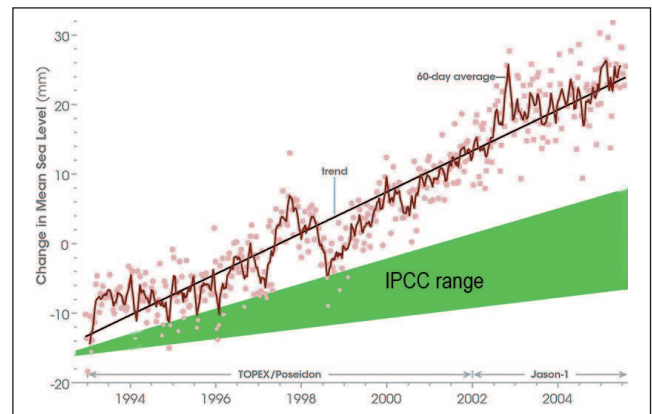
because they paid too much attention to our emissions of carbon dioxide and not enough to the Earth's response. The Earth does not passively accept what we do to it. It responds to climate change and that response is far more deadly than the small change that we are making. Because the Earth's responses are happening in the deserts, the forests, in the ocean, and at the poles—all far away from the cities—we do not notice them. But to me they bring an apocalyptic view of the future because I see 7 to 8 billion of humans faced with ever diminishing supplies of food and water in an increasingly intolerable climate.

You may well ask how we scientists have let this potentially disastrous future steal up on us unaware. There are three main reasons. First was our success in solving the problem of stratospheric ozone depletion. This gave atmospheric scientists false confidence in their ability to deal with the far greater and more complex danger of global heating. Second is the division of Science into almost unconnected specialities. Climate science is almost wholly about atmospheric physics and chemistry and ecological science is almost entirely about the biology of living organisms. Neither of these groups of scientists is yet ready to embrace Gaia theory which offers a unified Earth science. Unfortunately for us the Earth is not so divided and so long as we treat it as two separate entities, the geosphere for the material Earth and the biosphere for life, we will fail to understand our planet.

The third reason for science to have been wrong footed is the old division between theory and practice. The ever growing power of computers has made it easier to build apparently realistic theoretical simulations of our planet, and its climate. It becomes too tempting to believe that the computer model is the real world and that the hard down to earth effort of gathering data on the polar glaciers or in the tropical forests is less needed.

We should have been warned. The first inexcusable error occurred when it was realised that ozone in the stratosphere was in danger of destruction by the chlorofluorocarbons (CFCs) we used in our spray cans and refrigerators. In the 1980s theorists and modellers of stratospheric ozone depletion were so sure that their models were true that they ignored data about CFC abundance in the atmosphere. I know this because I was one of the few scientists who were making the measurements. They also ignored data about ozone in the stratosphere. Earth orbiting satellites first saw that ozone was being destroyed over the South Pole but this was not predicted by theory or models. The theorists were so sure that they were right that they instructed the satellites to ignore low values of ozone and several years passed before we realised that ozone was being destroyed. It was not until two scientists at an Antarctic base looked up into the sky with a simple spectrometer that the hole in the ozone layer was seen and only then did we realise how serious ozone depletion was. Now another deadly hole has appeared, this time in the floating ice of the Arctic Ocean, and much sooner than the models forecast. Yet again the theorists are failing to forecast what is actually happening in the real world. The lesson has not been learnt.

If the climate models are unreliable how can we be sure about the climate of ten years from now still less the end of the

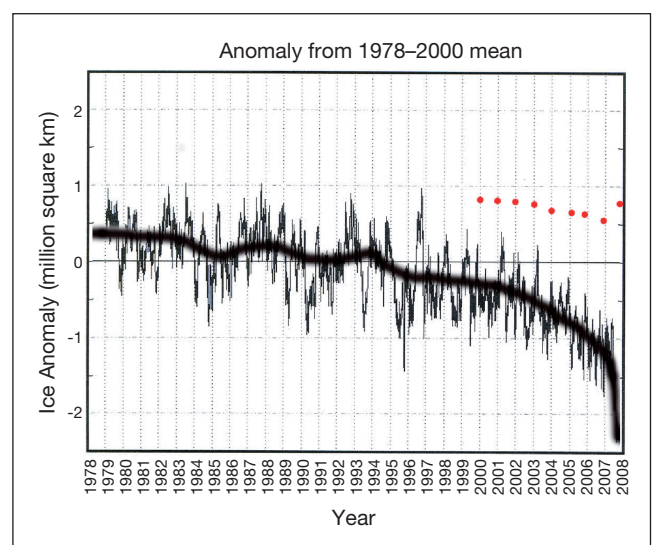


**Fig. 1.** Comparison between measured median sea level change and IPCC forecast (1993–2005).

century? The simple answer is that we can't. Figure 1, for example, shows a comparison between the measured sea level of the past two decades and what the IPCC forecast.

### Sea level: Earth's own thermometer

If you really want to take the temperature of the Earth and see if its complaint of global heat is real, ignore air and land surface temperatures, these fluctuate from year to year and place to place. Look instead at the Earth's own thermometer, the level of the sea. There are only two important causes of sea level rise. The expansion of the ocean as its temperature rises and the addition of water as ice on the land melts. Because the oceans are confluent over the surface, the sea level is representative for the whole ocean and is a realistic Earth thermometer. More than 70% of the Earth's surface is ocean and it is on average about 4 kilometres deep. The capacity to hold warmth of this large mass of water is about 800 times greater than that of the atmosphere. So long as the sea level keeps rising global heating is happening (Fig. 2).



**Fig. 2.** Northern hemisphere sea ice anomaly. Anomaly from 1978–2000 mean.

The extra heat absorbed by dark ocean water as the floating ice melts is causing an acceleration of system driven heating whose total will soon or already be greater than that from all of the pollution CO<sub>2</sub> that we have so far added. If it continues there will soon be an outburst of methane and other greenhouse gases from the melting arctic permafrost. The Earth is not merely responding, it is now driving global heating.

### Gaia theory and climate history

For the past 44 years I have worked on a different way of looking at the Earth, seeing it as a dynamic system that actively regulates the climate and the atmospheric composition to keep the planet habitable. This is Gaia theory. It is now accepted as mainstream science and often called Earth System science; but although accepted in principle there has not yet been time to include the theory in the separated Life and Earth sciences which still continue to view the Earth from within either Life or Earth science.

Gaia theory fits better with the climate history of the Earth than does conventional science. The historical record suggests that the Earth has at least two stable climate states, one about 6 degrees hotter than now and one about 5 degrees colder than now. Geologists call these two states, the greenhouse and the icehouse. If we look back to climate history about 14,000 years ago we see from Greenland ice core records how the real climate moves from one state to another (Fig. 3).

This irregular course of the world's temperature is very different from the smooth curves of the IPCC's models. Gaia theory teaches that the Earth system can act as an amplifier and small changes either to heat or cold are intensified and this could be the cause of the erratic shifts of temperature.

I find it extraordinary that climate scientists could have put their names to predictions as far away as the end of the century and in the face of such great uncertainties. I know scientists of the IPCC and some are personal friends. I know that they are

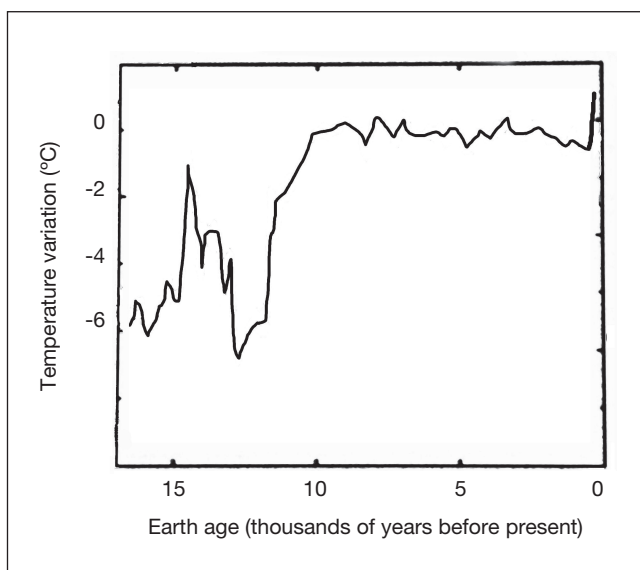


Fig. 3. Global mean temperature.

wise, competent and principled. So what made them persist with what may be the wrong kind of climate model and let their forecasts be used to frame policy? One answer may be that they had no option. Having persuaded governments that large expensive modelling centres, the battleships of the climate war, were needed. They just had to sail in them and hope for the best.

### So what is the prognosis?

If we assume that the IPCC is more or less right about the next thirty years then they forecast a torrid world by 2040 with an average summer in north temperate regions as hot as the summer of 2003 in Europe when over 30,000 died from heat. By then we may cool ourselves with air conditioning and learn to live in a climate no worse than that of Bagdad now. But without extensive irrigation the plants will die and both farming and natural ecosystems will be replaced by scrub and desert. What will there be to eat? The same dire changes could affect the rest of the world and I can envisage Americans migrating into Canada and the Chinese to Africa or Siberia. But will there be enough food for them all? Much of Europe will be arid desert land that will depend on Northern Europe and islands like the UK and Ireland for food. Heat alone will not be the main problem. What will be is too much or too little water from catastrophic floods or prolonged drought.

That is what the IPCC forecasts. Earth history and Gaia theory both suggest that climate change can be faster and more severe and can fluctuate between hot and cool before making its final move to the stable state, about 5 degrees hotter than now. As the hot state is approached stopping emissions will make little difference to the dire course of events and could even make matters worse. Because we are uncertain about the climate future we can only guess at geographic and demographic change. What can be said is that the north temperate and arctic regions that include Canada and Siberia will be favoured. So will oceanic strips along the continents like here in Galicia and places such as the British Isles, and New Zealand. Many tropical islands may also be habitable and on the continents there will be oasis areas and habitable land along rivers.

The most vulnerable nations are those of the Indian subcontinent and China. The Indian group of nations will suffer both inundation and drought. A great loss of life seems almost inevitable. China is not in a much more favourable position than India and Pakistan. In these nations and mainland Europe, population excess is at least as large a factor as climate change. Some of the nations less vulnerable to climate change are unfortunately densely populated but will increasingly become the destination for refugees. The large and agonizing problem will be restricting population to the number that can be fed otherwise starvation will achieve the same result.

Governments should not assume that their remedies for global heating—carbon capture and storage, renewable energy and biofuel—will halt or even slow global heating, they are all profitable but that is not enough. The fact that the Earth now has five or more sub-systems each adding its own heat sug-

gests that we are committed to move to a hotter state. Our task, should global heating continue, is to adapt and prepare to survive and this alone may be an exhausting task. Gaia has survived far worse insults than industrialised humans and will almost certainly save itself, we are the ones in danger, not the Earth.

We are a tough species and have survived seven major climate crises in the past million years—by this I mean the violent move from ice age to interglacial. These we now know happened about every 140,000 years, but the number of survivors may have been as low as 2000 after one of these catastrophes. We won't be made extinct by global heating but we may be cut back to a billion or less. We have to survive global heating and hope that the stresses it imposes will encourage the natural selection of a more capable form of human. We truly have to concentrate on saving ourselves; it is hubris to think that we can 'save the planet.'

Perhaps the saddest thing is that if we fail and humans go extinct, The Earth will lose as much or more than we do. Not only will wildlife and whole ecosystems vanish, but in human civilization the planet has a precious resource. We are not merely a disease; we are through our intelligence and communication the planetary equivalent of a nervous system. We should not feel guilty; in the Earth's history there have been other organisms that in their early development wreaked havoc yet in time became vital components of Gaia. Photosynthesisers that released oxygen must have been far worse polluters than we are. Yet over the years life adapted and then made use of this reactive gas to empower animal life and us.

Gaia has had to wait 3.5 billion years for natural selection to choose an intelligent partly social animal species. The photosynthesisers had to wait a long time before they became trees and so we humans have to be patient while evolution selects us to become an integrated part of an intelligent planet, but what a future for humans that would be.

Professor James E. Lovelock, author of Gaia theory and recipient of the Fonseca Prize of Scientific Popularization 2009, pronounced the lecture entitled "Climate change on a live Earth" for the award ceremony, on 6 October 2009 in Santiago de Compostela.



The Consortium of Santiago and the University of Santiago de Compostela, aware of the importance of the transfer of knowledge and society's science education needs, agreed in 2006 to create the ConCiencia Programme to invite the greatest intellects of the international scientific community to transmit their ideas in a city which is a symbol of culture and knowledge. Under the auspices of the ConCiencia Programme, the Fonseca Prize for Scientific Popularization was created with the aim of promoting the transfer of knowledge to the society. The award recognizes those individuals who have had a distinguished career in the field of scientific communication or are a public reference in stimulating and promoting the general interest in scientific and technical knowledge. Other recipients of this award have been Professor Stephen W. Hawking (2008), Sir David Attenborough (2010) and Sir Roger Penrose (2011). More information: [www.usc.es/conciencia](http://www.usc.es/conciencia).