

# Climate change: more than global warming

Earth's climate is changing – it's getting warmer, faster. And that change – particularly over the past 50 years – is a direct result of human activity.

Our climate has undergone many changes over millions of years – from ice ages to tropical heat and back again. Natural changes have generally been gradual, allowing people and other species to adapt or migrate, although some prehistoric climate changes may have led to mass extinction of species.

## Speeding up

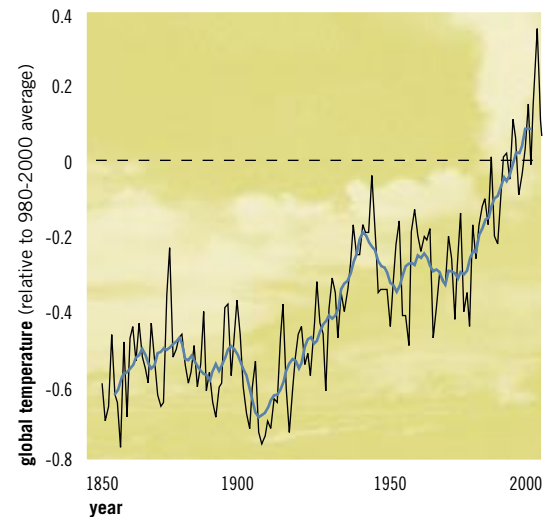
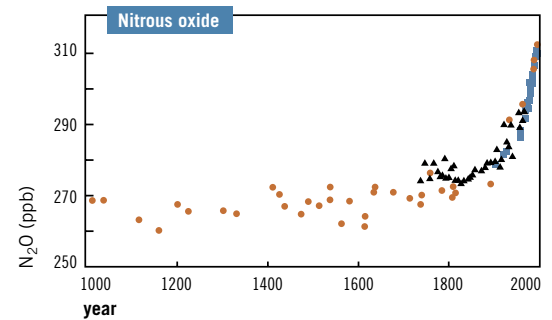
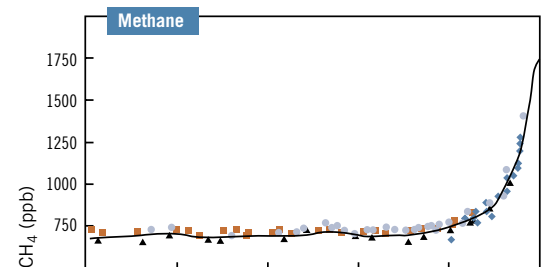
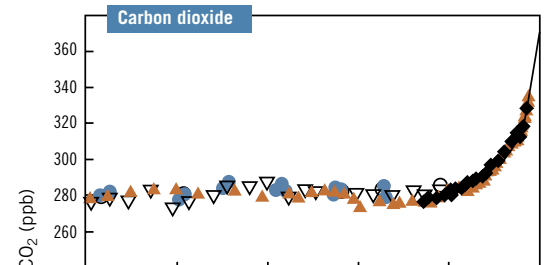
Over the last 50 to 100 years, the process of change has sped up because of the growing build-up in the atmosphere of trace 'greenhouse' gases – carbon dioxide (CO<sub>2</sub>), methane and nitrous oxide.

These gases act like a blanket keeping the sun's warmth from escaping – making life on Earth possible.

Because of human-caused emissions of these gases, their concentrations in the atmosphere have increased at unprecedented rates and the blanket is getting thicker. This produces an 'enhanced greenhouse effect' that is warming up the globe. The changes ahead of us will be much larger and will happen more quickly than any recent natural climate variations.

The effects are already measurable:

- the world's 10 warmest years have all been since 1983, seven of them since 1990
- the global mean temperature went up about 0.6°C between 1861 and 2000
- sea levels went up about 10 to 20cm between 1900 and 2000
- glaciers are retreating
- arctic sea ice is thinning and reducing
- 1998 was the world's – and New Zealand's – hottest year since records began.



The top 3 panels show the concentrations of 3 important greenhouse gases (carbon dioxide, methane and nitrous oxide) emitted by human activities. Human emissions have caused a strong rise in greenhouse gas concentrations over the past 100 years. This rise coincides with an increase in the global average temperature (shown in bottom panel), and model studies find that most of the warming over the past 50 years is likely due to the increased greenhouse gases concentrations. Source: Intergovernmental Panel on Climate Change, 2001.

There has been debate in the past on whether humans were responsible for the observed climate change, or whether it was just a case of natural variability. Recent worldwide observations and complex climate models have produced new and stronger evidence that most of the warming observed over the past 50 years is in fact due to human emissions of greenhouse gases. This finding by the Intergovernmental Panel on Climate Change was also supported by the American Academy of Sciences.

**“There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities.”** Intergovernmental Panel on Climate Change.

## What will happen in the future?

**As Earth’s temperature continues to rise, the weather will become more extreme.**

Projections of future global temperature rises range from 1.4 to 5.8°C over the next 100 years, depending on future greenhouse gas emissions. This will mean higher maximum and minimum temperatures, more hot days and heat waves, and fewer cold spells nearly everywhere.

Rainfall patterns are likely to change, and the variability of rainfall is expected to increase. This will lead to more frequent rain in some mid and high latitude areas, but possible reductions in others. Large continental land areas will suffer from an increased risk of drought.

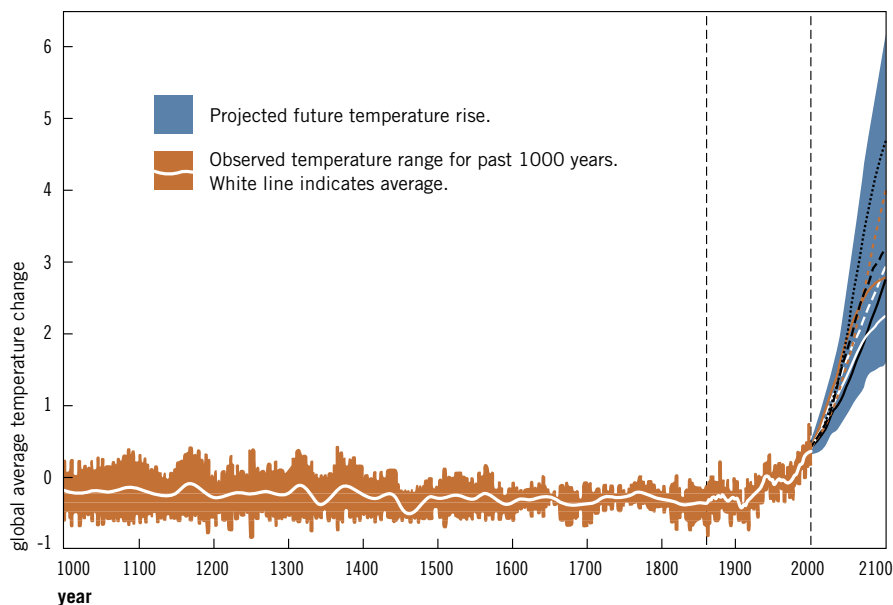
Apart from gradual changes, extremely heavy rainfall could increase in severity and frequency. Tropical cyclone winds are likely to become more intense with heavier rainfall causing floods and property damage.

Sea levels will continue to rise by between 9 and 88cm by 2100, eroding coastlines and flooding low-lying areas. Sea levels will continue to rise for many more centuries, even after atmospheric temperatures have reached a new stable level.

### Changes are already happening

In some parts of the world, we can already see changes in response to the increasing temperatures, with shifts in the habitat range for some plants and animals, earlier flowering of trees and emergence of insects. Glaciers are receding worldwide, and seasonal snow and ice cover has reduced in northern high latitudes. The growing season in mid to high latitudes has extended by up to 11 days over the past 30 years.

## How will climate change affect us?



**The speed of the change, the size of Earth’s population and the reduction in natural habitats mean humans and other species could find it difficult to adapt.**

Over the next 100 years, the expected rate of change in global average temperatures is likely to be larger than any natural variations in at least the past 10,000 years.

The projected future global average temperature rise can be compared with the temperatures over the past 1000 years or more, deduced from tree rings, corals, ice cores and bore holes. It shows that the changes over the next 100 years will be more rapid than any natural climate variations experienced in the past. The individual lines in the blue shaded area correspond to different future greenhouse gas emission scenarios. Source: Intergovernmental Panel on Climate Change, 2001.



But the effect of global warming is more than just a rise in the world's temperature. Any changes in the global system have a flow-on effect. A warmer surface means more water vapour enters the atmosphere. This affects the complex systems controlling Earth's climate and can significantly change weather patterns.

Under continued climate change, water will become a more precious resource in many areas, especially in drier areas of the sub-tropics. Agricultural productivity will fall in tropical areas. Temperate regions may see a temporary increase, but even their production will decline if warming continues unchecked. More frequent incidences of climatic extremes, such as floods and droughts, will cause damage for agriculture and urban infrastructure in some places even where the average climate change has only a moderate effect.

Some natural habitats are highly vulnerable to a changing climate – particularly coral reefs and forests. Many areas will be lost.

Floods due to rising sea levels and heavy storms could force millions of people from their homes. The threat from diseases such as dengue fever, malaria and cholera will increase. Water quality and supply will be affected.

### Good news & bad

The news isn't all bad. In some areas agricultural productivity will temporarily increase, and some regions will benefit from increased average rainfall.

Timber production could rise from appropriately managed forests. Warmer winters will mean fewer cold-related deaths in some areas and will reduce heating costs, but hotter summers will mean increased cooling costs. Heat waves will increase heat stress particularly for poor people without air conditioning in urban areas.

## What is causing the climate to change?

**Human activity is causing the build-up of greenhouse gases in the atmosphere. They act like a blanket, trapping heat in the atmosphere.**

Increasing industrialisation over the past century is a major factor – carbon dioxide is released by burning fossil fuels like coal, petrol and gas. They supply around 90% of the world's commercial energy needs. The carbon in these fuels, stored in Earth's crust over tens of thousands of years, is being released at a rapid pace (see front page).

Other greenhouse gases like methane and nitrous oxide come from:

- agricultural practices (rice cultivation or livestock farming)
- waste disposal
- industrial processes and industrial applications.

The effects are made worse by the destruction of much of the world's forests, which absorb CO<sub>2</sub> from the atmosphere.

### Energy use rising

Global energy use has increased nearly 70% since 1971 and is likely to rise at more than 2% annually for the next 15 years. This will raise greenhouse gas emissions about 50% above current levels, unless we increase energy efficiency and move away from fossil fuels.

Developing nations account for more than three quarters of the world's population but consume only about one third of the world's energy and emit less than half of all human-created greenhouse gases. Despite continuing growth, in 30 years, per capita energy consumption and CO<sub>2</sub> emissions in the developing world are still likely to be much less than that of the industrialised world.

## Who will be most affected?

Developing countries will be worst affected by changing climate patterns. Many have land areas that are particularly sensitive to change and prone to floods or drought, and few resources to cope with negative impacts.

Coastlines in poorer countries are more vulnerable to flooding – 49 of the 50 countries whose shore protection costs are likely to rise substantially are less developed countries.

Agriculture plays a larger part in the economies of developing countries which makes them more vulnerable to climate extremes, and poorer nutrition and health care will mean higher loss of life.

Many developing countries are also less able to adapt quickly to changes in climate because of a lack of technology, education, infrastructure and money.



## What can we do?

We can reduce the output of greenhouse gases. We can protect particularly vulnerable areas. We already have the technology to stabilise atmospheric levels of carbon dioxide over the next 100 years.

Every day we make decisions that will influence future emissions – designing buildings, buying vehicles, using fuels to power industry and provide electricity, using public transport.

Technological progress in the past five years has been far more rapid than predicted:

- reducing industrial by-products
- using technologies such as wind turbines, hybrid engine cars, and fuel cells
- storing carbon dioxide underground.

Switching fuels (such as from coal to oil to gas), improving energy efficiency and using renewable forms of energy are all possible. Many of these options have other direct benefits – saving energy saves money, and using renewable energy reduces our reliance on imported fossil fuels.

We know that forests and agricultural land can 'lock-up' carbon dioxide. By encouraging reforestation and slowing deforestation, and improving management of forests and cropland we can enhance this.

## No more business-as-usual

To stabilise greenhouse gases in the atmosphere, all regions of the world must eventually change from business-as-usual. Most greenhouse gases so far have come from industrialised countries. Total emissions from developing countries will soon exceed those levels, but – per person – their levels will still be lower.

Ways must be found to ensure that commitments to greenhouse gas reductions are fair and equitable across all countries. Such reductions are often possible as win-win solutions, for example:

- relying less on carbon fuels for energy production will improve air quality and reduce acid rain, for example
- using alternative forms of transport will cut down air pollution and reduce traffic congestion
- changing agriculture and forestry management practices will improve soil fertility and encourage biodiversity.

## It needn't cost a fortune

It doesn't have to cost a fortune to start doing something about it. Many of the world's largest companies have already decided – voluntarily – to do their part. Most European countries believe they can address climate change in a cost-effective way.

The IPCC has concluded that about 50% of the projected increases in greenhouse gas emissions over the next 10 to 20 years can be avoided at negative cost (that is, with direct financial benefits).

Further improving technology and working in partnership with developing countries will help us minimise future climate changes and adapt to the changes already taking place.

## Climate change and the ozone layer

Confused about climate change and the ozone layer? Often, they are seen as one and the same thing. While both issues have to do with human emissions of gases causing damage to the natural balance of the atmosphere, they are quite different phenomena.

Ozone is found in a layer some 15 to 30km high in the atmosphere. This layer protects life on Earth by shielding it from harmful ultraviolet radiation from the sun. Some chemicals, in particular chlorofluorocarbons (used as refrigerants and in some industries), can damage the ozone layer. The most striking example of this is the ozone hole over Antarctica, where more than 50% of all ozone disappears each spring. Damage to the ozone layer leads to greater levels of ultraviolet radiation at the ground, leading to skin cancer in humans and potential crop damage

International agreements have been put in place to stop the manufacture and release of ozone-damaging chemicals. The production of ozone-damaging chemicals is now greatly reduced, and, all going well, the ozone layer should recover to its natural state over the next 50 years.

Climate change, on the other hand, refers to the fact that some gases trap heat in Earth's atmosphere – these gases are called greenhouse gases. Their increased emission from human activities will cause global average surface temperatures to rise, and will lead to changes in climate patterns, rainfall distribution, more extreme weather events like droughts and floods, and more intense tropical cyclones.

The two most important greenhouse gases are carbon dioxide, produced from the burning of fossil fuels such as coal and petrol, and methane, produced by rice cultivation, landfills, and some animals such as sheep and cattle.

But, while climate change and the ozone layer are different things, there are some important links. For example, damage to the ozone layer and climate change both put our well-being at risk and threaten natural ecosystems, although by different means.

Even more concerning is the fact that many ozone-destroying gases are also greenhouse gases, causing trouble to both the ozone layer and the global climate. Fortunately, this also has the advantage that if we reduce their use, we protect the ozone layer and reduce global warming in one hit.

Another link lies in the fact that global warming is likely to slow down the recovery of the ozone layer by 15 to 20 years, despite the fact that the chemicals which destroy ozone directly (the chlorofluorocarbons) are now being reduced. This reinforces the need to tackle both greenhouse gases and ozone-destroying chemicals at the same time.

